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The 3rd International Conference Tropical Agrifood, Feed and Fuel

FACULTY OF AGRICULTURE MULAWARMAN UNIVERSITY

2023

Recover Together, Recover Stronger, Building A Sustainable and Resilient Agriculture Food System

Balikpapan, September 19th, 2023

PROCEEDING BOOK

INTERNATIONAL CONFERENCE
ON TROPICAL AGRIFOOD, FEED, &FUEL(ICTAFF) 2023

"Recover Together, Recover Stronger,
Building A Sustainable and Resilient Agriculture Food System "

September, 19-20th 2023

Organizer:
Faculty of Agriculture, Mulawarman University
Samarinda, East Kalimantan

Publisher:
Department of Agroecotechnology, Faculty of Agriculture,
Mulawarman University

Published: October 2023

PROCEEDING BOOK OF
INTERNATIONAL CONFERENCE
ON TROPICAL AGRIFOOD, FEED, &FUEL(ICTAFF) 2023
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FOREWORD

This proceeding book is a collection of scientific thoughts presented by researchers at the 2023 International Conference on Tropical Agrifood, Feed, & Fuel (ICTAFF) Seminar. The theme of the seminar was: **"Recover Together, Recover Stronger, Building A Sustainable and Resilient Agriculture Food System".**

Agriculture in the broadest sense has become one of the cornerstone sectors for economic growth. The development of globalization still leaves unresolved problems in all aspects of agriculture, especially added to the problems in the period after the current pandemic, the rapid development of technology and the flow of globalization are increasingly putting pressure on various agricultural actors both in Indonesia and internationally, especially third world countries. The local potential in the agricultural sector in Indonesia has a huge opportunity both from social, cultural and technological aspects to provide a distinctive characterization. Local wisdom in the agricultural sector can have a positive impact.

Agricultural sustainability is also supported by aspects of local wisdom that have advantages in the quality of these products. These potentials can still be improved through the empowerment of local potentials so that they can be competitive and have high economic value. Increasing this potential can be done in terms of increasing the agricultural value of form utility, time utility, place utility, and possesion utility. Activities that can be carried out in the form of agricultural production that is capable of high productivity and quality, processing of agricultural products to increase added value, agricultural marketing so that agricultural products are of high selling value and can be available and affordable by the community, as well as supporting systems and agricultural institutions that support the smooth running of productive activities.

This International Seminar intends to produce various innovative and solutive thoughts related to the problems that become the theme. It takes an active role from various parties in order to contribute to the Indonesian economy. The publication of these proceedings is expected to be a picture and reference for improving agriculture to become high value-added and competitive in order to realize the welfare of farmers. We would like to thank all parties involved in the completion of these proceedings. Hopefully this book will be useful and open our insights into agriculture as a life support. Long live Indonesian Agriculture.

Samarinda, September 19th 2023

Editor

FOREWORD BY THE CHAIRMAN

Assalammu'alaikum Warahmatullahi Wabarakatuh.
Good morning.
Whom I respect,
Rector of Mulawarman University Samarinda;
Dean of the Faculty of Agriculture, Mulawarman University, Samarinda;
Vice Dean of the Faculty of Agriculture, Mulawarman University, Samarinda;
Main Speaker, Speaker and moderator; Guests as well as:
We are proud of the seminar participants and attendees.

Thank God to Allah SWT who has given His grace, so that today we can attend the 3rd ICTAFF International Seminar, Faculty of Agriculture, Mulawarman University in good health. The ICTAFF activity is a biennial research results dissemination agenda that has been carried out by the Faculty of Agriculture, Mulawarman University since 2018. This 3rd ICTAFF activity carries the theme **Recover Together, Recover Stronger: Building a Sustainable and Resilient Agriculture Food System**.

It is believed that the agricultural sector can be a beacon of hope in maintaining national economic stability. The agricultural sector not only guarantees food availability, but also absorbs large numbers of workers, reduces poverty and improves people's welfare. Universities as centers for the development of science and innovation must be able to provide the best solutions to increase production and maintain the quality of food products. The use of science, innovation and technology is critical to meeting the global challenges of producing food more efficiently, improving nutrition and helping families who depend on agriculture for a living become more resilient.

In connection with this international seminar, we presented five resource persons as main speakers, namely Prof. Ivan Galis (Institute of Plant Science and Resources, Okayama University, Japan), Prof. Normaz Wana Ismail (Vice Dean of Research, Funding, Corporate and Community Linkages School of Business and Economics University Putra Malaysia), Prof. Worawan Panpipat (Dean of the Faculty of Agricultural Technology, Walailak University, Thailand), Prof. Md. Sazedul Hoque, Ph.D (Chair, Faculty of Fisheries, Putuakhali Science and Technology University, Bangladesh), Prof. Sahat M. Pasaribu, Ph.D. (BRIN Industrial, Services and Trade Economic Research Center, Indonesia), and Dr. Odit Ferry Kurniadinata, S.P., M.Sc. (Department of Agroecotechnology, Faculty of Agriculture, Mulawarman University, Indonesia). As well as people as accompanying resource persons from various domestic and foreign institutions and universities.

On this occasion, allow us to thank the Rector of Mulawarman University, the Dean of the Faculty of Agriculture, Mulawarman University, the sponsors who have participated in this seminar activity. As well as the highest appreciation to the entire committee who have worked wholeheartedly for the success of this seminar activity.

We realize that the implementation of this international seminar still has many shortcomings, for that we apologize profusely. Finally, I hope that all seminar participants who attended can get the maximum benefit from this seminar activity. Billahi taufiq wal hidayah Wassalammu'alaikum warahmatullahi wabarakatuh.

Balikpapan, September 19th 2023

Chief Executive,
Dr Syamad Ramayana

FOREWORD BY THE DEAN

Ladies and gentlemen,

Distinguished guests, speakers, researchers, and fellow participants,

It is with immense pleasure and great enthusiasm that I extend a warm welcome to all of you at the opening of the third International Conference of Tropical Agrifood, Feed, and Fuel hosted by the Faculty of Agriculture. Today, we gather here to explore the horizon of agriculture, share knowledge, and envision a more sustainable and resilient agrifood system for the future. Our theme for this conference is, "Recover together, recover stronger: Building a Sustainable and Resilient Agriculture Food System."

Agriculture is the cornerstone of life, the backbone of our existence. It is an industry that touches every aspect of our lives, from the food we eat to the fuel that powers our world. In the tropical regions, agriculture plays an even more critical role, providing sustenance, employment, and economic development to countless communities. It is only fitting that we convene here today to discuss the challenges and opportunities that lie ahead in tropical agrifood production.

The past few years have brought unforeseen challenges to the global agricultural landscape. Climate change, the COVID-19 pandemic, and economic fluctuations have shown us the vulnerabilities in our current systems. However, we are resilient beings, and with every challenge come an opportunity to adapt and evolve. It is during times like these that our collective knowledge, expertise, and innovative spirit shine the brightest.

This conference aims to be a platform where experts from various fields, researchers, and policymakers come together to engage in fruitful discussions, share their research findings, and inspire one another with innovative solutions. We hope to explore sustainable agricultural practices, cutting-edge research in agrifood technology, and policies that promote resilience and inclusivity in the agricultural sector.

Together, we will examine the impact of emerging trends, such as precision agriculture, biotechnology, and sustainable resource management, on tropical agrifood production. Our goal is to foster a global understanding of the unique challenges and opportunities that tropical agriculture presents and to work collectively towards building a more sustainable and resilient agriculture food system.

As we embark on this intellectual journey over the next few days, I encourage all of you to actively participate, engage in thought-provoking discussions, and establish connections that may lead to collaborations and breakthroughs in the field of agriculture. We believe that through shared knowledge and collective efforts, we can indeed recover together and recover stronger.

Ladies and gentlemen,

As we gather here today for the opening of this prestigious international conference, I would like to extend our heartfelt gratitude to our distinguished international speakers who have traveled from afar to share their invaluable insights and expertise with us.

We are honored to have with us Prof. Worawan Panpipat from Walailak University, Thailand, Prof. Dr. Ivan Galis from Okayama University, Japan, Prof. Normaz Wana Ismail from Universiti Putra Malaysia, Prof. Sahat M. Pasaribu from BRIN, and Dr. Odit Ferry Kurniadinata from Mulawarman University, Indonesia. Your dedication to advancing knowledge and your commitment to this conference are truly appreciated. Your contributions will undoubtedly enrich the discussions and inspire us all as we work towards building a more sustainable and resilient agricultural food system. Thank you for your presence and your dedication to the betterment of agriculture on a global scale.

I also want to express my heartfelt gratitude to all the participants, our distinguished the organizing committee, and our generous sponsors for their support and dedication in making this conference a reality.

With that, I officially declare the third International Conference of Tropical Agrifood, Feed, and Fuel open. Let us work together towards a more sustainable and resilient future in agriculture. Thank you, and I wish you all a successful and inspiring conference.

Balikpapan, September 19th 2023

Dean,

Prof. Dr.Ir. H. Rusdiansyah, M.Si

Table of Content

The Family Scarcity of Tree Species in Different Aged Tropical Secondary Forests in Sarawak

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ABSTRACT

Several species and families of plants are rarely found in tropical secondary forests. The number of trees belonging to this species and genus is very small. The objective of this study was to investigate the family scarcity of plant species in different aged tropical secondary forests in Sarawak, Malaysia. The vegetation surveys were carried out in one-hectare plots each in 5, 10, and 20 years old secondary forests. The enumeration and identification were conducted for all the woody trees within the plot with the diameter at breast height (DBH) of > 5 cm. The scarce family is distinguished based on the number of individuals, species, and/or genus. The result showed that 21 out of 28 families in 5 years old secondary forest, 25 out of 46 families in 10 years old secondary forest, and 25 out of 43 families in 20 years old secondary forest were included in the scarce family category. In 5 years old secondary forests, 5, 13, and 3 recorded families were categorized into scarce, very scarce, and extremely scarce family, respectively. There were 4 families (scarce family), 10 families (very scarce family), and 11 families (extremely scarce family) observed in the 10 years old secondary forest. The number of scarce, very scarce, and extremely scarce families in the 20 years old secondary forest were 3, 15, and 7 families. The information on rare species can be used as a basis for categorizing the plant species that need to be protected in the secondary forest.

Keywords: family, scarcity, secondary forest, species, tree.

INTRODUCTION

Degradation processes in large areas of tropical forest can occur due to selective logging, forest fires, and abandonment dynamics (Pinheiro et al. 2016). Biodiversity affected by global changes around the world can lead to different consequences among individual species and environments. Scarcity is a condition associated with vulnerability and risk of extinction, so it can be a detrimental factor that increases the acceleration of global change (Cebrian et al. 2022). Biotic interactions can be used to compare the characteristics of common and rare or invasive and non-invasive species (Kempel et al. 2020).

Species diversity is an aspect of plant community structure. Structurally, many rare species are minor components of a community (Sanjit & Bhatt, 2005). The rare tropical tree species are endangered due to reduced forest and the loss of old forests. The existence and regeneration of these rare tree species can often not be predicted with certainty though some old, undisturbed, and logged-over forests are protected (Ngo & Hölscher, 2014).

The sustainability and development of forest ecosystems in the future are threatened by the loss of trees biodiversity (Pamoengkas et al. 2018). The existence of plantation forests that are managed less intensively and secondary forests which are both 40 years old in the tropical forest can develop into forests with complex structural and floristic diversity similar to primary forests through natural ecologicalprocesses towards established ecosystems after the abandonment period (Brown et al. 2022).

Three families (Euphorbiaceae, Dilleniaceae, and Verbenaceae) are families that the most dominant based on the number of trees in secondary forests aged 5 and 10 years. *Theaceae, Moraceae*, and *Rhizoporaceae* are the three most dominant families based on individual density in the 20 years old secondary forest (Karyati et al. 2021). The most dominant tree species in terms of basal area and volume per hectare in 5 and 10 years old fallow lands after abandonment was *Macaranga gigantea* (*Euphorbiaceae*). Meanwhile, *Adinandra dumosa (Theaceae)* was the most common species based on

density, basal area, volume, and Importance Value Index (IVi) in the 20 years old secondary forest (Karyati et al. 2018).

The existence of a rare species becomes an uncertainty related to its existence as a key future provider of ecosystem services or species contributions which will eventually decrease or never increase. This uncertainty increases efforts to protect biodiversity as a service provider in the future and could provide incentives for the protection of more critical species (Dee et al. 2019). The role of rare tree species in natural tropical forests can make a significant contribution to species richness and biodiversity, but they are often threatened with extinction (Peque and Holscher, 2014). Several studies on rare tree species in tropical forests have been reported (Hikmat, 2005; Islam, 2002). However, research on rare tree species and familiesin different types of land cover and forest types is still limited. The objective of this study was to investigatethe family scarcity of plant species in the different ages of tropical secondary forests in Sarawak, Malaysia. Information about tree species belonging to rare families can be used to determine the composition of forest stands which is useful as a basis for forest management activities.

MATERIAL AND METHODS

Study Sites

This study was conducted in three stages of fallows, or period of abandonment, such as 5, 10, and 20 years old secondary forest in Sabal, Sri Aman, Sarawak, East Malaysia as reported by Karyati et al. (2018) and Karyati et al. (2021). The study plots at Sabal were located approximately 110 km southeast of Kuching along the Kuching-Sri Aman Road, and 5 to 15 km from the Sabal Agroforestry Centre.

Data Collection and Analysis

Twenty-five subplots of 20 m × 20 m were established from every study site, enabling sampling and data collection of the main study to be carried out systematically. All the woody trees within the plot with a diameter at breast height (DBH) of > 5 cm were enumerated and identified. Their DBH were measured using diameter tape at 1.3 m above the ground.

According to Hikmat (2005) and Islam (2002), the scarcity of the vegetation family in the study site was classified into (1) ‘scarce family’ is if a family was represented by a single genus, (2) ‘very scarce family’ is if a family was represented by single genus and species, and (3) ‘extremely scarce family’ is if a family was represented by single genus, species, and individual (stem).

RESULT AND DISCUSSION

The scarcity of trees (DBH $\geq$ 5 cm) in 5, 10, and 20 years old secondary forests are presented in Tables 1, 2, and 3. The 21 out of 28 families in 5 years old secondary forest, 25 out of 46 families in 10 years old secondary forest, and 25 out of 43 families in 20 years old secondary forest were included in the scarcity category of families. In 5 years old secondary forest, the 21 recorded families were categorized into scarce (five families), very scarce (13 families), and extremely scarce family (three families). Among the families categorized as scarce were Sapindaceae, Lauraceae, Apocynaceae, Clusiaceae, and Dilleniaceae. Meanwhile, Ampelidaceae, Annonaceae, and Rhizoporaceae were classified as extremely scarce families (Table 1).

Table 1. Scarcity of trees family (DBH $\geq$5 cm) in terms of genus, species, and number of individuals in 1 hectare of 5 year old secondary forest.

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
1	Sapindaceae	1	1	2.33	2	3.23	4	0.40	*
2	Lauraceae	1	1	2.33	2	3.23	5	0.50	*
3	Apocynaceae	1	1	2.33	3	4.84	27	2.71	*
4	Clusiaceae	1	1	2.33	3	4.84	95	9.53	*

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
5	Dilleniaceae	1	1	2.33	3	4.84	137	13.74	*
6	Aquifoliaceae	1	1	2.33	1	1.61	2	0.20	**
7	Melastomataceae	1	1	2.33	1	1.61	2	0.20	**
8	Actinidiaceae	1	1	2.33	1	1.61	3	0.30	**
9	Lecythidaceae	1	1	2.33	1	1.61	3	0.30	**
10	Myristicaceae	1	1	2.33	1	1.61	3	0.30	**
11	Symplocaceae	1	1	2.33	1	1.61	3	0.30	**
12	Elaeocarpaceae	1	1	2.33	1	1.61	4	0.40	**
13	Thymelaeaceae	1	1	2.33	1	1.61	4	0.40	**
14	Ixonanthaceae	1	1	2.33	1	1.61	5	0.50	**
15	Loganiaceae	1	1	2.33	1	1.61	11	1.10	**
16	Asteraceae	1	1	2.33	1	1.61	19	1.91	**
17	Rhamnaceae	1	1	2.33	1	1.61	53	5.32	**
18	Rutaceae	1	1	2.33	1	1.61	85	8.53	**
19	Ampelidaceae	1	1	2.33	1	1.61	1	0.10	***
20	Annonaceae	1	1	2.33	1	1.61	1	0.10	***
21	Rhizophoraceae	1	1	2.33	1	1.61	1	0.10	***
	Total	21	21	48.84	29	46.77	468	46.94	
	Total per hectare	28	43	100.00	62	100.00	997	100.00	
						Total	*		5
							**		13
							***		3

Note: * = Scarce family, ** = Very scarce family, and *** = Extremely scarce family.

Polygalaceae belongs to the order Fabales, which consists of Fabaceae and two other small families, namely Quillajaceae and Surianaceae (APG IV, 2016). The plants can be categorized as rare because the total population of the species has only a few individuals or is only found in a narrow geographical area, or both which are usually rarely found in large areas (USDA, 2023). Many tree species are currently endangered due to their limited geographic distribution, unique habitat, reduced local abundance, or because of the synergism between these variables (Caiafa & Martins, 2010).

Table 2. Scarcity of trees family (DBH $\geq$5 cm) in terms of genus, species, and number of individuals in 1 hectare of 10 year old secondary forest.

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
1	Apocynaceae	1	1	0.93	2	1.16	26	1.41	*
2	Ebenaceae	1	1	0.93	3	1.73	9	0.49	*
3	Elaeocarpaceae	1	1	0.93	3	1.73	58	3.15	*
4	Dilleniaceae	1	1	0.93	4	2.31	267	14.50	*
5	Combretaceae	1	1	0.93	1	0.58	2	0.11	**
6	Ulmaceae	1	1	0.93	1	0.58	2	0.11	**
7	Aquifoliaceae	1	1	0.93	1	0.58	3	0.16	**
8	Ampelidaceae	1	1	0.93	1	0.58	4	0.22	**
9	Rosaceae	1	1	0.93	1	0.58	4	0.22	**
10	Ochnaceae	1	1	0.93	1	0.58	5	0.27	**
11	Myrsinaceae	1	1	0.93	1	0.58	6	0.33	**
12	Asteraceae	1	1	0.93	1	0.58	7	0.38	**
13	Chrysobalanaceae	1	1	0.93	1	0.58	8	0.43	**
14	Rutaceae	1	1	0.93	1	0.58	21	1.14	**
15	Actinidiaceae	1	1	0.93	1	0.58	1	0.05	***

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
16	Ixonanthaceae	1	1	0.93	1	0.58	1	0.05	***
17	Lecythidaceae	1	1	0.93	1	0.58	1	0.05	***
18	Loganiaceae	1	1	0.93	1	0.58	1	0.05	***
19	Magnoliaceae	1	1	0.93	1	0.58	1	0.05	***
20	Meliaceae	1	1	0.93	1	0.58	1	0.05	***
21	Polygalaceae	1	1	0.93	1	0.58	1	0.05	***
22	Rhizophoraceae	1	1	0.93	1	0.58	1	0.05	***
23	Sabiaceae	1	1	0.93	1	0.58	1	0.05	***
24	Sterculiaceae	1	1	0.93	1	0.58	1	0.05	***
25	Symplocaceae	1	1	0.93	1	0.58	1	0.05	***
	Total	25	25	23.36	33	19.08	433	23.51	
	Total per hectare	46	107	100.00	173	100.00	1842	100.00	
						Total	*		4
							**		10
							***		11

Note: * = Scarce family, ** = Very scarce family, and *** = Extremely scarce family.

Five families were classified into very scarce families in 5 years old secondary forest and extremely scarce families in 10 years old secondary forest, such as Actinidiaceae, Lecythidaceae, Symplocaceae, Ixonanthaceae, and Loganiaceae. Elaeocarpaceae was categorized as very scarce family in 5 years old secondary forest and scarce family in 10 years old secondary forest. Ampelidaceae was included in extremely scarce family of 5 years old secondary forest and very scarce family of 10 years old secondary forest. In 10 and 20 years old secondary forest, there were four families categorized as very scarce, namely Chrysobalanaceae, Asteraceae, Ulmaceae, and Rutaceae. Two families of Ebenaceae and Elaeocarpaceae were classified into scarce families and extremely scarce families in 10 and 20 years old secondary forest. Lecythidaceae and Ixonanthaceae were included in extremely scarce families in 10 years old secondary forest and very scarce families in 20 years old secondary forest. In 10 and 20 years old secondary forest, Rosaceae was classified as very scarce and scarce family, respectively. Meanwhile, Myrsinaceae was recorded as very scarce and extremely scarce family in these 10 and 20 years old secondary forest.

Factors that can lead to scarcity of plant species are (1) forest and environmental degradation, (2) reproductive problems in rare plants, (3) human intervention, and (4) disturbance by animals (Wijana et al. 2021). Conservation of rare tree species such as two species of *Taxus cuspidata* and *Torreya grandis* from the Taxaceae family for reforestation activities in China needs to pay attention to the ecological requirements for nurseries by creating a fairly shady environment where this can improve the ecological quality of the forest restoration (Jensen et al. 2021).

Table 3. Scarcity of trees family (DBH ≥5 cm) in terms of genus, species, and number of individuals in 1 hectare of 20 year old secondary forest.

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
1	Rosaceae	1	1	1.33	2	2.02	5	0.60	*
2	Myrtaceae	1	1	1.33	2	2.02	11	1.32	*
3	Dilleniaceae	1	1	1.33	4	4.04	35	4.20	*
4	Aquifoliaceae	1	1	1.33	1	1.01	2	0.24	**
5	Flacourtiaceae	1	1	1.33	1	1.01	3	0.36	**
6	Chrysobalanaceae	1	1	1.33	1	1.01	4	0.48	**
7	Olacaceae	1	1	1.33	1	1.01	4	0.48	**
8	Lecythidaceae	1	1	1.33	1	1.01	5	0.60	**
9	Asteraceae	1	1	1.33	1	1.01	6	0.72	**
10	Proteaceae	1	1	1.33	1	1.01	6	0.72	**

No.	Family	No. of family (ha^{-1})	No. of genera (ha^{-1})		No. of species (ha^{-1})		No. of individuals (ha^{-1})		Category
			Total	%	Total	%	Total	%	
11	Ixonanthaceae	1	1	1.33	1	1.01	8	0.96	**
12	Ulmaceae	1	1	1.33	1	1.01	8	0.96	**
13	Anacardiaceae	1	1	1.33	1	1.01	12	1.44	**
14	Rutaceae	1	1	1.33	1	1.01	14	1.68	**
15	Sapotaceae	1	1	1.33	1	1.01	14	1.68	**
16	Verbenaceae	1	1	1.33	1	1.01	19	2.28	**
17	Actinidiaceae	1	1	1.33	1	1.01	22	2.64	**
18	Theaceae	1	1	1.33	1	1.01	169	20.26	**
19	Celastraceae	1	1	1.33	1	1.01	1	0.12	***
20	Connaraceae	1	1	1.33	1	1.01	1	0.12	***
21	Ebenaceae	1	1	1.33	1	1.01	1	0.12	***
22	Elaeocarpaceae	1	1	1.33	1	1.01	1	0.12	***
23	Myrsinaceae	1	1	1.33	1	1.01	1	0.12	***
24	Polygalaceae	1	1	1.33	1	1.01	1	0.12	***
25	Sterculiaceae	1	1	1.33	1	1.01	1	0.12	***
	Total	25	25	33.33	30	30.30	354	42.45	
	Total per hectare	43	75	100.00	99	100.00	834	100.00	
						Total	*		3
							**		15
							***		7

Note: * = Scarce family, ** = Very scarce family, and *** = Extremely scarce family.

Based on the same scheme of family scarcity, Dahalan (2011) observed that Ebenaceae, Symplocaceae, and Rosaceae were categorized as scarce families at Gunung Raya Forest Reserve (GRFR) and Gunung Machinchang Forest Reserve (GMFR) in Langkawi Island. Four families were classified as very scarce families in these two sites, namely Tiliaceae, Lecythidaceae, Aquifolaceae, and Ixonanthaceae. Apocynaceae was recorded as very scarce in GRFR. Other families such as Ulmaceae, Rutaceae, and Rhizoporaceae were included in very scarce families in GMFR.

There are 42 species included in the IUCN red list plants, eight of which are classified as endangered plants, namely *Aglaia angustifolia, Artocarpus tamaran, Dracontomelon costatum, Durio dulcis, Durio kutejensis, Eusideroxylon zwageri, Myristica magnifica,* and *Shorea guiso*. These plants have an average IVI value of less than 10% and the species abundance index is close to zero. In general, the forest condition is classified as moderate with a diversity index value at each growth stage in the range of values 1-3. However, IVI of each species, especially those belonging to the endangered, endemic, and protected plants are on average low (Dodo & Hidayat, 2020). Several factors which lead the scarcity of tree species, including biotic and abiotic drivers, and changes in habitat can act as causes of species rarity (Maciel and Martins, 2019). Analysis of scarcity patterns can be used to guide conservation efforts by identifying priority targets when information is obtained about direct threats to rare or incomplete habitat (Cebrian et al. 2022).

CONCLUSION

Rare family categories are divided into scarce families, very scarce families, and extremely scarce families. There were 21, 25, and 25 families included in rare families in secondary forest aged 5, 10, and 20 years respectively. Information about species belonging to rare families can be used as a basis for consideration in the management and conservation of forest resources and the environment. Even though the number of trees and genera belonging to the rare family is very small, their presence can also affect the stand structure, species composition, and plant diversity in secondary forests in the future.

ACKNOWLEDGEMENTS

We acknowledge to Hidir Marzuki, Sekudan Tedong, Salim Arip, and Muhd Najib Fardos for their field assistance during this survey.

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Relationship between Factors Affecting the Income of Livestock Farmers Kalang Buffalo in Tanjung Terakan Group, Muara Wis District Muara Wis Kutai Kartanegara Regency

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ABSTRACT

Buffaloes are livestock that have a wide range of agrosystem development. Factors that need to be considered in buffalo rearing management are seed selection, feeding, housing system, management, management and marketing. The existence of these factors will affect the amount of revenue and income earned by each farmer. This study was conducted to determine the level of income of farmers and what factors significantly affect the income of buffalo farmers in the Tanjung Terakan livestock group, Muara Wis District, Kutai Kartanegara Regency. This research was conducted in Muara Wis District, Kutai Kartanegara Regency from August to November 2022. The study used a survey method and the results of data obtained from production costs, revenue and income of the Tanjung Terakan livestock group. The data obtained were analyzed using the *Spearman Rank Correlation* method. This study shows the production costs of feed costs can affect the income of farmers with a coefficient value of r_s 0.774** (0,002 < 0.05), and the number of livestock also affects the income of farmers with a coefficient value of r_s 0.774** (0,002 < 0.05). Thus, feed$_{cost}$ (X1) and number of livestock (X2) have a very significant relationship with the income of the Tanjung Terakan livestock group.

Keywords: feed cost, number of livestock, kalang buffalo, farmer's income, muara wis.

INTRODUCTION

Buffaloes can be found in almost every province in Indonesia due to their wide agrosystem diversity (Pari, 2018). Due to the increasing population in Indonesia, animal protein consumption continues to rise. As more buffaloes are developed, this can help increase the productivity of the red meat supply. Crucial to Indonesia's smallholder livestock system, buffalo are traditionally kept as a side business and use family labor on a small scale.

Buffalo have advantages and disadvantages as livestock. Low reproductive rate, poor seed quality, feed quality, inbreeding and long gestation period are some of the problems often faced by buffalo farmers (Haloho and Manurung, 2020). One of the benefits of buffaloes is their long production period and their ability to convert high protein feed into high crude fiber, which produces meat and milk. Better livestock rearing systems can increase buffalo production (Haloho and Manurung, 2020).

Smallholder livestock businesses must concentrate on developing livestock agribusiness as a side business and achieving family economic goals in the long term (Pasaribu *et al*., 2019). Smallholder livestock businesses will be the main source of income (at least) and can help fulfill family needs such as business and economic activities. Selecting breeds, feeding, housing systems, management, management and marketing are all aspects of buffalo rearing management. In addition, economic elements that need to be considered also include finding net income through income analysis so that the business can run effectively and stably.

Revenue analysis is conducted by calculating the business's income from the sale of products received, then deducting the operational costs during the production process. Livestock businesses must also consider production costs, which consist of fixed and variable costs. In the income analysis, there are a number of socioeconomic factors that can affect income and livestock population. These factors include

farmer age, education level, farming experience, number of family dependents, and business scale (Permana *et al*., 2014).

The purpose of this study was to determine the income level of farmers and what factors have a significant influence on the income of buffalo farmers in the Tanjung Terakan livestock group, Muara Wis District, Kutai Kartanegara Regency.

MATERIALS AND METHOD

To determine the sample size, the survey method was used to identify the livestock groups working on the kalang buffalo farm in Muara Wis Village. The Tanjung Terakan group, consisting of 13 people, received the livestock taken. The Tanjung Terakan livestock group in Muara Wis Sub-district, Kutai Kartanegara Regency, was interviewed through a questionnaire, which assisted this study.

Primary and secondary data were collected through observation methods. Primary data was obtained from questionnaires distributed to members of the kalang buffalo breeder group, and secondary data was obtained from various related agencies.

Income Analysis

After data was tabulated from farmer interviews, income analysis was used to calculate production costs, revenues, and business income of kalang buffalo. kalang buffalo cattle business, which can be mathematically formulated as follows (Anindyasari *et al*., 2019):

$$TC = TFC + TVC \ldots. (1)$$
$$TR = P. Q \ldots\ldots\ldots\ldots (2)$$
$$\pi = TR - TC \ldots\ldots\ldots (3)$$

Description:
TC : Produksi Cost (rupiah/tahun)
TFC : Fixed Costs (rupiah/tahun)
TVC : unfixed costs (rupiah/tahun)
TR : revenue (rupiah/tahun)
P : Price (rupiah)
Q : amount (ekor)
Π : income (rupiah/tahun)

Rank Spearman Correlation

Based on the results obtained, to see the relationship between the factors that influence significance or not on the income of breeders can be seen using the Rank Spearman Method. The following formula is used (K. Azmi and C. Arif. 2018):

$$r_s = 1 - \frac{6 \sum (R(xi) - R(yi))^2}{n\,(n^2 - 1)}$$

Description:
rs : Spearman coefficient
R(xi) : ranking data xi
R(yi) : ranking data yi
n : respondent
1 dan 6 : constant number

RESULTS

Farmer Identity

There were 13 respondents who were interviewed and observed directly in the field. Respondents consisted of members of the Tanjung Terakan group who were active in the buffalo business activities in Muara Wis Sub-district, Kutai Kartanegara Regency.

1. Age of Farmer

Most farmers aged 45-54 years are the most dominant in the buffalo business at 46.2%, between 35-44 years old at 38.5% and between 55-64 years old at 15.4%. Therefore, members of the Tanjung Terakan group have a productive age because it affects the physical and mindset in determining management patterns so that it is closely related to work ability in business (Indrayani and Andri, 2018).

2. Level of Education

The educational level of farmers is dominated by high school graduates whose percentage is 69.2%, so that the level of education is one of the factors that affect income because it affects the level of information capture, attitudes, knowledge and behavior (Dewi, 2019).

Production Cost

Production costs are capital or funds that must be spent by farmers to produce products or services to cultivate their livestock business to the best. Fixed and variable costs make up production costs. Fixed costs are costs incurred in the production process with the total amount fixed at a certain volume of activity, while variable costs, according to Dhaniarthi (2015), are costs whose total amount changes in proportion to changes in the volume of activity.

Tabel 1. Average production costs incurred by Tanjung Terakan group members

Cost Type	Amount (Rp/year)
Variable Cost	
Feed	5.932.486,00
Medicine	192.310,00
Vaccines	11.093.750,00
Fixed Costs	
Electricity	576.925,00
Depreciation	7.538.462,00
Membership Dues	2.196,250,00
Transportation	2.884.615,00
Total	30.414.798,00

Source: Primary Data (2022)

The average production costs incurred by buffalo farmers of Tanjung Ternak Group amounted to Rp.30,414,798/year or Rp.2,534,566/month. Table 1 shows that vaccine costs amounted to Rp.11,093,750/year; feed costs amounted to Rp.5,932,486/year; and medicine costs amounted to Rp.192,310/year. Fixed costs consist of membership fees of Rp.2,196,250/year; transportation costs of Rp.2,884,615/year; depreciation costs of Rp.7,538,462/year; and electricity costs of Rp.576,925/year.

Revenue

According to Pasaribu (2018), the revenue received by producers as a result of multiplying the product price by the product selling price is called revenue. It is also referred to as total business revenue because it is not deducted from the total costs incurred in the production process.

Tabel 2. Average Revenue generated by Members of the Tanjung Terakan Group

Description	Revenue (Rp/year)
Breeding livestock	621.923.077,00
Buffalo calf	80.769.230,00
Total	702.692.308,00

Source: Primary Data (2022)

The average revenue generated by the Tanjung Terakan Group is Rp.702,692,308.00/year or Rp.58,557,692.00/month. The revenue of the Tanjung Terakan livestock group comes from the sale of breeding buffaloes and seedlings. Revenue is influenced by buffalo sales due to the number of animals owned by farmers. According to Mayulu *et al*. (2020), the number of livestock owned by farmers can be calculated by multiplying all production results by the selling price.

Income

Total production costs are the sum of fixed costs and variable costs. Revenue is obtained by deducting revenue from total costs incurred during the production process.

Tabel 3. Average Income generated by Members of the Tanjung Terakan Group

Description	Amount (Rp/year)
Revenue	702.692.308,00
Production	30.414.798,00
Income	672.277.510,00

Source: Primary Data (2022)

The average income generated by the Terakan cape group is Rp.672,277,510.00/year or Rp.56,023,126.00/month. According to Asiah *et al*. (2021), the size of livestock ownership, or the number of livestock owned by farmers, affects farmers' income. Therefore, the number of livestock can also affect production costs and revenue from farmers.

Spearman Rank Correlation Analysis

Rank Spearman correlation to determine the level of relationship or significance of the associative hypothesis with each variable. Feed cost (X1) and number of livestock (X2) are components that affect the income of Tanjung Terakan group farmers. Table 4, shows the results of the coefficient value and correlation between variables.

Tabel 4. Spearman Rank Correlation Analysis Test Results on Breeder Income

Correlation	Coefficient Value	Significance	Description
Feed (X_1) with Income (Y)	$0{,}774^{**}$	0,002	Very Strong
Number of Livestock (X_2) with Income (Y)	$0{,}774^{**}$	0,002	Very Strong

Source: Primary Data (2022)

Based on Table 4, it can be seen that the parameters of feed cost (X1) and number of livestock (X2) have a very strong relationship with the income of Tanjung Terakan group farmers. The resulting coefficient value of feed costs (X1) is r_s 0.774** and the number of livestock (X2) is r_s 0.774**. The significance value in the table above shows that Sig. (2-tailed) of 0.002 (0,002 < 0.05 or 0.01). This states

that H0 is rejected and H1 is accepted, so the relationship between feed costs and the number of livestock has a very significant effect on the income of Tanjung Terakan group farmers.

DISCUSSION

Relationship between Feed Costs and Income

Aspects that can affect the income of buffalo farmers include feed. Feed is an important component of the livestock business, and as feed costs can account for up to 80% of total production costs, feed must be available for livestock to stay alive (Rusdiana *et.al*.,2019). The main feed provided to kalang buffaloes by the Tanjung Terakan livestock group is forage, which is collected from the rivers around the location of the kalang buffalo farm. As a means of transportation, green fodder is collected through a diarit process.

The kalang buffaloes are released during one period, from the first month to the fourth month of the dry season. Buffaloes are released in the river to forage on their own during the dry season, but green fodder is not collected independently. During the day, buffaloes can forage for themselves by swimming and wallowing in water or mud. Farmers can establish integrated buffalo farming patterns and can also utilize local feed sources from agricultural, plantation and horticultural waste. Growing fodder crops on farmers' land or plantations can also help with feed availability.

Table 4 shows the highly significant effect of feed costs on income, with a correlation value of r_s 0.774**, indicating that hypothesis H0 is rejected and hypothesis H1 is accepted. The costs incurred for feed will have an impact on farmers' income. Tanjung Terakan livestock group members spend an average of Rp 5,932,486/year on feed each year. This is due to the high cost of obtaining feed for kalang buffaloes. Although kalang buffaloes can forage on their own, procuring additional feed requires higher costs (Mayulu *et.al.,* 2018).

Relationship between Number of Livestock and Income

Farmers use the number of livestock as one of their production outcomes to make a profit from their livestock business. The number of livestock is included in the socio-economic characteristics that can influence the decisions they make that provide benefits for their livestock business. The effect of the number of livestock can make the income earned by farmers more optimal and profitable. Farmers earn more money when they have more livestock. The number of livestock that increases by 1% will have an impact on income, and farmers' income will increase by 0.13% (Hausufa *et.al*., 2015).

The Tanjung Terakan group has 374 livestock, with an average of 29 livestock. The livestock sold by this group are mother livestock and breeding livestock, which generate income. Table 9 shows that H0 is rejected and H1 is accepted because the number of livestock has a correlation value of r_s 0.774**. So, the number of livestock greatly affects the income of the Tanjung Terakan livestock group. A large number of livestock will increase farmers' income, and the more livestock kept, the greater the income of kalang buffalo farmers (Indrayani and Andri, 2018).

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded as follows:

1. The buffalo cattle business by members of the Tanjung Terakan cattle group generates an average income of Rp. 30,414,798.00/year or Rp. 2,534,566.00/month consisting of the sale of mother cattle and seedlings.
2. Factors that influence the income of buffalo business in Tanjung Terakan group members are feed costs and number of animals. The results showed a coefficient value of 0.774** with a significance value or Sig. (2-tailed) of 0.002. Then the relationship between these factors is highly significant (0.002 <0.05 or 0.01) and positive.

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Reproductive Performance of Female Bali Cattle in Kutai Barat Regency

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ABSTRACT

This research sought to evaluate the reproductive performance of female Bali cattle in the West Kutai Regency, with a specific focus on various parameters encompassing maternal age, service per conception, conception rate, pregnancy rate, age at first parturition, calving interval, weaning age, mating system, and body condition score. The study was carried out between January and March 2023 in multiple locations situated within the Kutai Barat Region, including Barong Tongkok, Linggang Bigung, Sekolaq Darat, Melak, and Tering Subdistrict. To collect the necessary data, a multifaceted research approach was employed, incorporating surveys, direct observations, and the systematic collection of parameter data through structured interviews with local farmers using a standardized questionnaire. The selection of research sites was meticulously executed through purposive sampling, with a focus on targeting five districts characterized by the highest Bali cattle populations in the region. The study involved a sample size of 100 female Bali cattle. The research yielded several pivotal findings. Notably, the average maternal age of the cattle was approximately 85.32 months, accompanied by an average of 1.44 services per conception. The conception rate was ascertained to be 7%, while the pregnancy rate exhibited a substantially higher rate of 85%. The age at which the cattle underwent their initial parturition averaged around 39.29 months, and the calving interval was observed to be approximately 12 months. Furthermore, the weaning age of the offspring averaged approximately 5.04 months. In terms of the mating system, natural mating predominated, accounting for 68% of cases, while artificial insemination was utilized in 32% of instances. The average body condition score of the female Bali cattle approximated 2.64. In summary, the reproductive performance of female Bali cattle within the Kutai Barat Region appears to fall short of optimal levels, tyaking into account the age of the female Bali cattle maintained by breeders and the body condition score within the Kutai Barat Region.

Keywords: female bali cattle, kutai barat, reproductive performance

INTRODUCTION

Bali cattle constitute the predominant breed of beef cattle in Indonesia, primarily owing to their commendable reproductive capabilities and their suitability as working animals in rice paddy fields, as noted by Putu et al. in 1998. These cattle have garnered substantial attention for their impressive slaughter rates, production of lean meat, high carcass yield, and the advantageous phenomenon of positive heterosis, as corroborated by the research of Pane in 1990 and the recent findings of Suhardi et al. in 2022. In the Indonesian agricultural landscape, Bali cattle hold a significant role due to their adaptability, both as sources of meat production and their utility in farm labor. Their robust reproductive performance is particularly noteworthy, making them valuable contributors to the country's beef industry. Moreover, their capacity to thrive in the demanding work environment of rice paddy fields further underscores their versatility and importance in Indonesian agriculture. The recognition of Bali cattle as an economically and agriculturally significant livestock breed has been substantiated by a body of research over the years. Pane's work from 1990 and the recent study conducted by Suhardi and colleagues in 2022 both provide compelling evidence of the breed's remarkable attributes, solidifying their status as a crucial.

The reproductive performance of small-scale livestock is generally low, there are several factors that can influence the reproductive performance of livestock (Suhardi *at al*., 2023) , including (1) inappropriate mating systems, (2) low knowledge of breeders to detect lust, (3) low quality or inappropriate use of bulls in natural mating, (4) lack of inseminator skills, (5) inappropriate implementation of AI, (6) low breeder knowledge about reproductive management, (7) reproductive disorders, (8) environment and feed management (Dwatmadji *et al*., 2017). Moreover, biosecurity systems, hygiene sanitation in farm areasand animal welfare are not implemented properly in the small-scale farms. Beef cattle farms in East Kalimantan in 2017-2022 experienced an increase in population of 8% each year, however, in 2018 there was a population decline of around 1% (BPS, 2023). An imperfect replacement stock system of cattle, inaccurate selection system and slaughter of the high-quality cattle will cause the decline of Bali cattle

performance (Samariyanto, 2004). Beef cattle farms in West Kutai in 2022 had a population of 7,616 heads and the majority of the cattle population was concentrated in Barong Tongkok District, namely more than 14% of the total population (Disper, 2020). This population number has decreased from the previous year. This is because beef cattle farming in West Kutai is only carried out on a small scale, causing livestock management to still be traditional, with the reason that livestock is only considered as savings or ordinary pets that have not been developed as a main source of income. The rearing patterns implemented by livestock in West Kutai, which are still traditional, have consequences for the reproductive number of beef cattle in West Kutai. Hence, the present study was conducted to assess the performance of female Bali cattle in the West Kutai Regency with a focus on various parameters, including maternal age, services required per conception, conception rates, pregnancy rates, age at initial calving, calving intervals, weaning age, mating systems, and body condition scores.

MATERIALS AND METHODS

Data Collection

The research was carried out from January - March 2023 in West Kutai Regency in Barong Tongkok, Linggang Bigung, Sekolaq Darat, Melak, Tering subdistrict. This study used 100 female Bali cattle, with 20 female Bali cattle taken from each subdistrict. The sample was taken purposively, meaning using certain considerations, namely: 1) the Bali cattle observed in this study were female; 2) have been pregnant and given birth at least twice; 3) The female Bali cattle used in this study were in the lactation period.

Research Parameter

This research is to conduct surveys/direct observations in the field and conduct intensifely interviews with farmers including the variables observed in this research include:

Maternal Age

The age of the parent was determined by interviewing and observing the teeth (Suhardi, 2020).

Service per Conception

The Service per Conception is the number of matings that have been carried out to produce a pregnancy for each individual. According to Toelihere (1993) Service per Conception can be calculated with the formula:

$$S/C = \frac{\text{Number of mating}}{\text{Number of pregnant cows}}$$

Conception Rate

The Conception Rate is the number of first mated females who are positive for pregnancy divided by the number of mated females multiplied by 100%. Conception Rate can also be calculated using the formula (Jaeinudeen, 2000):

$$CR = \frac{\text{number of cows that mate first}}{\text{number of fcows bred}} \times 100\%$$

Pregnancy Rate

The Pregnancy rate (PR) is the number of pregnant cows divided by the total number of cows and multiplied by 100%. Gestational age is expressed in months calculated with the formula: (Pian *et al*., 2000).

$$PR = \frac{\text{Number of pregnant cows}}{\text{total number of cows bred}} \times 100\%$$

Age of First Birth

The age at first calving was obtained through direct interviews with breeders and based on the age of the mother at the time of observation (Suhardi, 2020).

Calving Intervals

The Calving Interval (CI) is the time interval from calving to the next calving (days) (Kristahun *et al*., 2000). Calculation of the CI value according to Ball and Peters (Ball and Peters, 2004), by using the

following formula:

Calving Interval (month) = time of birth i - time of birth (i-1).

Weaning Age

Weaning age was obtained through interviews with breeders (Suhardi, 2020).

Mating System

The mating system was obtained through interviews with breeders (Suhardi, 2020).

Body Condition Score

The Body Condition Score was obtained by observing livestock visually and by feeling the fat deposits at the base of the tail, hips and spine (Alfan, 2016).

Data Analysis

Data obtained from interviews and observations were then analyzed descriptively.

RESULT AND DISCUSSION

Table 1. Repoduction Performance Female Bali Cattle

No	Subdistrict	Maternal Age (month)	Service per Conception	Age of First Birth (month)	Calving Interval (month)	Weaning Age (month)
1	Barong Tongkok	87.00±18.21	2.05±0.83	38.10±1.92	12.20±0.00	4.75±2.31
2	Sekolaq Darat	78.00±22.20	1.40±0.50	39.95±2.58	12.30±0.00	4.90±2.59
3	Melak	85.20±22.67	1.15±0.37	38.75±2.34	11.90±0.00	5.40±2.70
4	Linggang Bigung	89.40±18.86	1.40±0.50	39.55±2.86	11.80±0.00	5.10±1.49
5	Tering	87.00±15.51	1.20±0.41	40.10±2.29	12.10±0.00	5.05±2.24
	Avarage	**85.32±19.49**	**1,44±0,52**	**39.29±2.40**	**12.06±0.00**	**5.04±2.27**

The findings of this study reveal notable insights into the average maternal age of Bali cattle in West Kutai Regency, which stands at 85.32 ± 19.49 months, as presented in Table 1. When juxtaposed with the research outcomes reported by Suranjaya et al. (2019) in Badung and Tabanan Regencies, where the average maternal ages were recorded at 50.76 and 54 months, respectively, it becomes evident that the maternal age of Bali cattle in West Kutai Regency is significantly higher. This discrepancy raises pertinent questions about the maturity and reproductive status of the cattle population in the region. In line with the regulatory framework established by the Minister of Agriculture Regulation number 35 of 2011, it is stipulated that productive female ruminants are categorized as large ruminants if they have given birth less than five times or are under eight years old, while small ruminants fall into this category if they have given birth less than five times and are under four years and six months of age. By these standards, the higher average maternal age observed in West Kutai Regency suggests that a substantial portion of the Bali cattle population may not have yet reached optimal reproductive maturity.

This disparity in maternal age underscores the need for further investigation into the factors contributing to delayed reproductive maturity in Bali cattle in West Kutai Regency. Additionally, it prompts consideration of potential interventions or management strategies that could be implemented to optimize the reproductive performance of these cattle, aligning with the regulatory standards for productive female ruminants. Further research in this area could provide valuable insights into improving cattle productivity and the overall sustainability of the livestock sector in the region.

Service Per Conception

In general, the service per conception value of Bali cattle in West Kutai Regency in this research is around 1-2 times with an average service per conception value of 1.44±0.52 (Tabel 1), both for natural mating and using artificial insemination (AI). This result is higher than research by Suranjaya *et al*. (2019) which reported the service per conception value in Badung Regency was 1.62±0.39 and Tabanan Regency 1.90±0.38. This shows that the value of service per conception in West Kutai Regency is still relatively good.

The high or low value of service per conception depends on several factors, including the skill of the inseminator, the time in carrying out artificial insemination and the breeder's knowledge in detecting oestrus. If the value of service per conception for the mother is less or less than 2, it indicates that the mother cow can calve or have calves every year (Sulaksono *et al*., 2010). If the service per conception figure is greater than 2, it means that the ideal calving distance is not achieved or it can also be stated that the reproduction of the mother cow is less efficient because the calving distance is longer (Sulaksono *et al*., 2010; Suhardi *et al*., 2020). There are several other factors that cause a high number of services per conception in a mother cow, including abnormalities in the mother cow's reproductive organs, and poor transportation (Ismoyo dan Widiyaningrum, 2008).

Conception Rate

Tabel 2. Conception Rate and Pregnancy Rate

No	Subdistrict	Conception Rate	Pregnancy Rate
		%	
1	Barong Tongkok	17	89
2	Sekolaq Darat	0	82
3	Melak	0	84
4	Linggang Bigung	0	85
5	Tering	19	84
	Average	**7**	**85**

The results of this research show a conception rate of 7% (Table 2), compared to research by Frandy Febrianthoro (Febrianthoro *et al*., 2015) which stated that the conception rate in Pringsewu Regency was 50.38%. The conception rate results obtained showed poor results. Based on a statement from Hardjopranjoto (Hardjopranjoto, 1995) which states that the conception rate value is considered good if it reaches a value of 65-75% in a livestock population. The factor that influences the conception rate value of Bali cattle in West Kutai Regency is that breeders still use old heifers, so very few young Bali cattle are used as prospective sires.

Pregnancy Rate

In this study the average pregnancy rate in West Kutai Regency was 85% (Tabel 2). This result is better when compared with research by Dapasesi *et al*. (2020) which showed the pregnancy rate in East Kupang District, Kupang Regency was 60%. Dapasesi *et al.* (2020) stated that the low pregnancy rate in cattle was caused by lack of precise mating management, inaccurate observation of estrus and mating time, low quality bulls used in natural mating, inseminator skills, and lack of knowledge or understanding of breeders regarding artificial insemination.

Age of First Birth

The present study yields significant insights into the average age at first calving among Bali cattle in West Kutai Regency, which is reported as 39.29 ± 2.40 months, as presented in Table 1. This finding presents a contrast with the research conducted by Siswanto et al. in Pulukan Village, Jembrana sub-district, where the average age at first calving was recorded at 36.8 months. This discrepancy prompts an exploration into the factors contributing to variations in the age at first calving across different regions, and it underscores the importance of understanding the age of puberty and first mating in cattle. The age at whichlivestock attain puberty and engage in their initial mating significantly impacts the age at first calving. Thisobservation aligns with the assertion made by Sari and Said (2020) that earlier breeding can expedite the reproductive process in livestock. Moreover, Sari and Said (2020) advocate that achieving an earlier age atfirst calving can enhance the overall productivity of cows during their reproductive lifespan.

Various factors may contribute to delayed calving, including livestock management practices, fertility issues, and animal health, as highlighted by Zavadilova and Stipkova (2013). These factors suggest a multifaceted interplay between management, health, and reproductive physiology that can influence the timing of first calving in cattle populations. Therefore, it is imperative for cattle farmers and practitioners to consider these factors comprehensively in their management strategies to optimize reproductive performance and enhance the overall productivity of Bali cattle in different regions. Further research in this

domain is warranted to delve deeper into the specific factors influencing age at first calving among Bali cattle in West Kutai Regency and to identify context-specific interventions that can be implemented to facilitate timely and productive reproductive cycles in this important livestock population. Such research endeavors can contribute to the enhancement of cattle production practices and, subsequently, the sustainability of the livestock sector in the region.

Calving Interval

Based on the findings derived from the investigation into calving intervals across five sub-districts within the West Kutai Regency, it is evident that a consistent value of 12.06 ± 0.00 months was observed, as depicted in Table 1. This outcome contrasts with the research conducted by Guntoro and Supeli (2022) in Lembah Kuamang Village, which reported a slightly higher calving interval value of 12.57 months. Notably, Ball and Peters (as cited in Suranjaya et al., 2019) have identified 12 months as an optimal calving interval.

The variance in calving intervals among different regions can be attributed to various factors. Anissa et al. (2018) have emphasized that environmental conditions and feed management practices play pivotal roles in determining the duration of calving intervals in livestock populations. Furthermore, Fauziah et al. (2015) have underscored the significance of understanding calving intervals, as they represent a crucial aspect of the reproductive performance of individual animals. Calving intervals signify the capacity of an animal to consistently produce offspring during its reproductive lifespan. In light of these findings and the broader literature, it is evident that the calving interval is a critical metric in livestock management, with its ideal value set at 12 months. Factors such as environmental conditions and feed management practices contribute to variations in calving intervals across different regions. Thus, an in-depth exploration of these factors and their contextual implications is essential for optimizing the reproductive performance of cattle populations. Future research endeavors should focus on elucidating region-specific influences on calving intervals to facilitate more effective management strategies and enhance overall productivity in the livestock sector.

Weaning Age

Based on the research findings, it is evident that the average weaning age of cattle in the West Kutai Regency stands at 5.04 ± 2.27 months, as indicated in Table 1. This observation aligns with established norms within smallholder farms, where calf weaning practices typically span a range from 3 to 6 months. The timing of calf weaning plays a critical role in reproductive efficiency, as it directly impacts the recovery of the mother's reproductive organs and, consequently, the swift resumption of normal reproductive activity, rendering the mother ready for mating and conception, as elucidated by Trobos in 2016.

While early weaning, as early as one month of age, is feasible, it is associated with an increased risk of calf mortality and can impede optimal calf growth. Conversely, weaning calves at three months of age offers distinct advantages, including the reduction of the postpartum estrus period (referred to as anoestrus postpartum or APP) and a consequent abbreviation of the calving interval (CI), which can be reduced to 384 days, in accordance with findings presented by Pertanian in 2020. In light of these considerations, the observed average weaning age of 5.04 ± 2.27 months in the West Kutai Regency is consistent with prudent husbandry practices. It not only promotes the well-being of the mother but also has the potential to enhance reproductive efficiency and optimize the overall productivity of cattle populations in the region. Further research may be warranted to delve into the specific contextual factors and management strategies influencing calf weaning practices, ultimately contributing to well-informed approaches for cattle management and the improvement of reproductive performance.

Mating System

Tabel 3. Mating System

No	Subdistrict	NM*	AI**
		%	
1	Barong Tongkok	80	20
2	Sekolaq Darat	55	45
3	Melak	65	35
4	Linggang Bigung	65	35
5	Tering	75	25
	Average	**68**	**32**

Note: * NM= Natural Mating, **AI= Artificial Insemination

Based on the research results, it can be seen that 68% of the mating system used by breeders in West Kutai Regency uses the narural mating (NM) system, while for mating using artificial insemination (AI) only 32% Tabel 3, the low number of AI due to the limited number of inseminators in West Kutai Regency, as well as the low success rate, therefore breeders tend to prefer to use NM.

Body Condition Score

Tabel 4. Body Condition Score

No.	Subdistrict	Body Condition Score (x)
1	Barong Tongkok	2.75
2	Sekolaq Darat	2.60
3	Melak	2.50
4	Linggang Bigung	2.60
5	Tering	2.75
Average		**2.64**

In this study, it was found that the body condition score of Bali female cattle in West Kutai Regency ranged from 2-3 with an average of 2.64 (Tabel 4), this result was lower when compared to the results of Alfan's research (2016) which reported the body condition score value in Linggsar District, West Lombok Regency which has an average of 3.05. Yusuf *et al*. (2015) stated that a decrease in the body condition score value of livestock had an effect on reducing the reproductive performance of Bali cattle.

CONCLUSION

The reproductive performance of female Bali cattle in West Kutai Regency is relatively low, looking at the age results of the mothers kept by breeders, as well as the body condition score of female Bali cattle in West Kutai Regency.

ACKNOWLEDGEMENT

Authors would like to thank to Faculty of Agriculture, Mulawarman University that supported this research.

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Resistance of Mauli Bananas to Banana Bunchy Top Disease (BBTV) Due to the Provision of PGPR with Bamboo Roots and Chitin

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ABSTRACT

This research aims to determine the effect of Plant Growth Promoting Rhizobacteria (PGPR) and chitin in increasing the resistance of Mauli banana plants to Banana Bunchy Top Virus (BBTV) disease and the growth of Mauli banana plants. The research was conducted in a greenhouse and involved the application of PGPR from bamboo roots and chitin to healthy Mauli banana plants. Subsequently, the aphid Pentalonia nigronervosa was inoculated. The research design followed a Completely Randomized Design (CRD) consisting of 8 treatments, each with 3 replications. The treatments were as follows: Control (0 ml/liter water) (A0), 5 ml PGPR/liter water (A1), 10 ml PGPR/liter water (A2), 15 ml PGPR/liter water (A3) 0 ml PGPR + 7 ml chitin/liter water (K0), 5 ml chitin + 5 ml PGPR/liter water (KA1), 10 ml chitin + 10 ml PGPR/liter water (KA2), 15 ml chitin + 15 ml PGPR/liter water (KA3). Observation parameters included disease intensity, plant height, leaf width, leaf length, root length, and the number of roots. The results of PGPR from bamboo roots and chitin application on banana plants, where BBTV was transmitted via the P. nigronervosa aphid, showed no significant effect in increasing the resistance of Mauli banana plants. The treatment with bamboo root PGPR at a concentration of 10 ml, along with 10 ml chitin, exhibited lower BBTV disease intensity (20.13%) compared to other treatments. Concentrations of bamboo root PGPR and chitin showed no significant effect on plant height, leaf length, root length, and the number of roots, except for leaf width at 49 days after inoculation.

Keywords: PGPR from bamboo roots, chitin, banana bunchy top virus

INTRODUCTION

Banana (Musa paradisiaca Linn.) is a tropical and subtropical fruit plant with numerous health benefits, containing vitamins, proteins, carbohydrates, calcium, phosphorus, iron, and various secondary metabolites (Atun et al., 2007). Bananas hold significant economic value (Kaleka, 2013) and are cultivated extensively in tropical and subtropical regions worldwide (Satuhu & Supriyadi, 2008).

Although banana production in Indonesia showed growth from 2011 to 2015, a 0.29% decline was recorded in 2016 (Agriculture, 2017). This decline was attributed to pest and disease attacks on banana plants, leading to decreased fruit production. To boost banana production, efforts and strategies must be employed, including intensification and extensification. One prevalent disease affecting banana plants in Indonesia is Dwarf disease, which has affected seven districts, notably in Kutai Kartanegara since 2003, causing significant losses for banana farmers. The extent of the Banana Bunchy Top Virus (BBTV) disease can vary depending on several factors, such as the activity of the Pentalonia nigronervosa aphid, planting density, pesticide usage, wind conditions, and the movement of banana seedlings (Thomas, 2015).

According to Heru Gendroyono, a staff member at the East Kalimantan Province Plant Protection Center, Dwarf disease was first observed in Muara Kaman District, Kutai Kartanegara Regency, in 2002. In 2013, the East Kalimantan Provincial Plant Protection Center documented 22 clumps in Muara Badak District displaying symptoms of Dwarf disease. Despite the similarities between Dwarf disease and Banana Bunchy Top Virus (BBTV) symptoms, no research has addressed the issue of Dwarf disease or the extent of BBTV disease spread in the banana planting areas of Kutai Kartanegara Regency (Sila et al., 2020).

Plant Growth Promoting Rhizobacteria (PGPR) are beneficial soil bacteria found around plant roots known for their role in enhancing plant growth and controlling diseases and pests. PGPR can provide essential nutrients, produce growth hormones (e.g., indole-3-acetic acid, gibberellin, cytokinins, ethylene), and release compounds such as glucanase, chitinase, cyanide, siderophores, and P nutrient solubilization. Various plant species can associate with diverse rhizobacteria, and bamboo roots, in particular, harbor beneficial microorganisms, including Pseudomonas fluorescens (PF) and Bacillus sp., which enhance soil phosphorus (P) solubility, bolster plant resistance to pathogens, and promote plant growth (Maulina et al., 2015).

Shrimp shell waste comprises three primary components: protein (25%-44%), calcium carbonate (45%-50%), and chitin (15%-20%). Chitin, existing as mucopolysaccharides in shrimp shells, binds to inorganic salts, especially calcium carbonate (CaCO3), proteins, lipids, and pigments. Chitin can serve as

a carbon substrate for the growth of chitinolytic bacteria, increasing chitinase production when bacteria are cultured in chitin-altered mediums. Combining selected PGPR with chitin has shown a synergistic effect in providing enhanced protection against various pathogens (Kavino et al., 2007). Considering the information above, it is essential to investigate the effects of PGPR from bamboo roots and chitin on increasing the resistance of Mauli banana plants to Banana Bunchy Top Virus (BBTV) disease.

MATERIAL AND METHODS

Bahan dan Metode berisi uraian tentang bahan, alat dan metode utama yang digunakan dalam penelitian. Bagian metode harus cukup rinci untuk menggambarkan apakah jenis penelitian eksperimental atau eksplorasi. Metode yang dijelaskan harus cukup detail dan memadai sehingga kajian dapat direplikasi. Jika penelitian anda menggunakan metode peneliti sebelumnya, maka jelaskan secara singkat metode tersebut. Jika Anda membuat modifikasi, gambarkan bagian yang dimodifikasi. Uraian bahan dan metode menggunakan Times New Roman, 10 pt).

Time and Place

This research was conducted from April to August 2022 at the Plant Pests and Diseases Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda. Healthy banana plant seeds were obtained from Tenggarong Seberang District, Kutai Kartanegara Regency.

Material Used

The materials used in this study included healthy banana plant seeds, soil, husk, manure, 3 kg bran, 3 tablespoons of sugar, 7 liters of clean water, 2 tablespoons of MSG (micin), 2.5 pieces of shrimp paste, 2 tablespoons of lime, 1/2 kg of brown sugar, 1 kg of bamboo roots, 70% alcohol, aquades, 100 g shrimp shell powder, 3.5% NaOH (Sodium Hydroxide) 500 ml, and 1 N HCl (Hydrochloric Acid) 640 ml.

Research Design

The research design followed a Completely Randomized Design (CRD) consisting of 8 treatments with 3 replicates each. The treatments were as follows:
Control (A0) - 0 ml/liter water
A1 - 5 ml PGPR/liter water
A2 - 10 ml PGPR/liter water
A3 - 15 ml PGPR/liter water
K0 - 0 ml PGPR + 7 ml chitin/liter water
KA1 - 5 ml chitin + 5 ml PGPR/liter water
KA2 - 10 ml chitin + 10 ml PGPR/liter water
KA3 - 15 ml chitin + 15 ml PGPR/liter water
Each experimental unit consisted of 4 Mauli banana plant seeds.

Research Procedure

Preparation of Test Plants

Test plants in the form of banana seeds were isolated for one month by covering them with clear plastic to ensure the seeds were completely healthy from BBTV disease. Then, soaking for 15 minutes with PGPR bamboo roots and chitin according to the treatment. Next, it is planted in polybags containing soil, husks, and manure.

Propagation of *Pentalonia nigronervosa Aphids*

Source Inoculum and Transmission by Vector. Aphids are kept on BBTV sick banana plants that will be used as viral infectious insects (vectors). Insects are allowed to multiply until there are enough numbers for virus inoculation.

Preparation of PGPR Bamboo Roots

Prepare a pot that already contains 7 liters of well water, 3 kg of bran, 3 tablespoons of sugar, 2.5 pieces of shrimp paste, 2 tablespoons of chalk, 2 tablespoons of micin put in the pot. The ingredients are stirred until well mixed and boiled to boil. Bamboo roots are cut into small pieces with a size of ± 1-5 cm. PGPR media as much as 3 liters is poured into a plastic bucket that has a lid that has contained the ingredients from the stew then, bamboo roots are inserted in the plastic bucket. Fermented for 2 weeks by closing a plastic bucket. PGPR that has been fermented will smell like a tape smell which indicates that the propagated rhizobacteria have developed properly. PGPR solution is ready for use according to treatment. The duration of PGPR administration every 7 days.

Chitin Manufacture

A total of 100 g of shrimp shell powder is put into Erlenmeyer and 500 ml of 3.5% NaOH is added. The mixture is stirred on a magnetic stirer for 2 hours at 60oC. The formed precipitate is separated from the filtrate. The precipitate is washed with aqueous to neutral pH and then dried in the oven for 4 hours at 60oC.Demineralization Stage: A total of 64 g of deproteinated dried shrimp shells are dissolved in 640 ml of HCl 1 N. The mixture is allowed to stand for two days at room temperature. The precipitate obtained is washed with aqueous to neutral pH and dried again in the oven for 4 hours at 60oC, so that chitin is obtained.

Application of PGPR and Chitin to Banana Plants

The application of PGPR and chitin in each polybag of banana plants is carried out once a week after planting in the polybag in accordance with the treatment of PGPR and chitin that has been determinedby watering.

BBTV Vector Inoculation

If new leaves appear on healthy banana plant seeds during the growth phase, BBTV is inoculated with 5 Pentalonia nigronervosa aphids /plant. Investment of aphids is carried out for 3 days, after which the aphid is sprayed with insecticide in the amount of 2 ml / liter of water.

Observation Parameters

Data will be obtained by observing and measuring banana plants once a week 7 times. Symptoms of BBTV disease are observed in changes in the color and shape of the leaves, begin to be observed at 7 to 49 days after inoculation. Plant height measurement is carried out using a meter from the base of the stem to the tip of the highest plant (header). Measurement of leaf width is done by measuring from the largest leaves using a ruler. Leaf length measurement is done by measuring from the base of the petiole to the tip of the last leaf and what is measured is the longest leaf, Root length measurement is done at the end of the observation by measuring the longest root using a ruler.

Data Analysis

The data obtained in the analysis with analysis of varian, and if there is a significant difference at the level of 5%, then further tests will be carried out using LSD 5%.

RESULTS AND DISCUSSION

Symptoms of Banana Bunchy Top Virus (BBTV) Disease

BBTV causes systemic diseases in banana plants. Symptoms do not appear until two new leaves have grown after the inoculation of the *P. nigronervosa aphid*. These symptoms typically manifest between 28 to 49 days after observation. They include leaves that become shrunken, stiff, and grow upright. Additionally, the leaf edges show chlorosis, which eventually progresses to necrosis, turning brown to black (see Figure 1). When examined from the underside of the leaf facing sunlight, a dark green "J" line near the leaf vein becomes visible. The stunted growth and altered morphology of the leaves are believed to disrupt the plant's future fruit-bearing potential. BBTV cannot be transmitted from adults to their offspring (Thomas, 2015). Healthy mauli banana seeds and diseased mauli bananas from the field exhibit striking differences. One noticeable distinction is the color of the midrib on the banana stem, which appears paler in diseased plants and has relatively fewer roots. This occurs because the growth of stunted banana plants is inhibited, resulting in reduced new root formation (Sila et al., 2020). Figure 3

illustrates the relatively healthier roots of banana plants compared to the relatively few roots of dwarf banana plants.

Figure 1. BBTV Symptoms

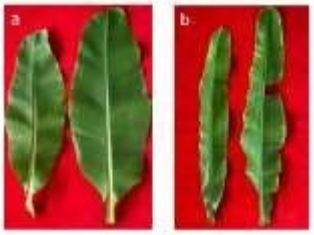

Figure 2. Healthy Banana Leaves (a) and BBTV (b)

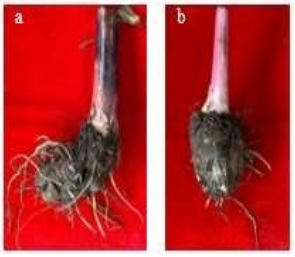

Figure 3. Healthy Banana Root (a) and BBTV (b)

Incubation Period and Intensity of BBTV Disease in Mauli Banana Plants

The intensity of BBTV disease in mauli banana plants shows symptoms of BBTV attacks that begin to appear on the 28th to 49th day after inoculation. Changes in BBTV attack intensity from day 28 to day 35 were quite high in some treatments but, on day 42 to day 49 there was no change in the number of symptoms of BBTV attacks on mauli banana plants. In the combination treatment between PGPR bamboo root 10 ml and chitin 10 ml (KA2) on day 28 to day 49 showed symptoms of BBTV attack on mauli banana plants with low intensity (20.13%). Therefore, this treatment can be said to be able to increase resistance to BBTV attacks. The high and low intensity of BBTV disease can be seen in Figure 4.

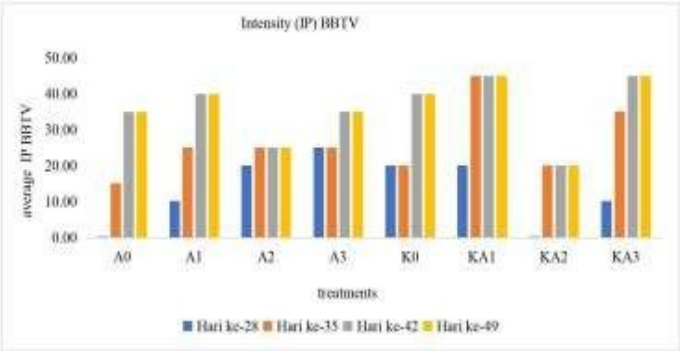

Figure 4. Diagram of Average BBTV Disease Intensity in Mauli Banana Plants. A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 mlChitin).

Plants treated with PGPR have a better state of methodobolism, so that the presence of pathogen inoculation does not cause plants to be in a state of stress or gripping. Conversely, plants that were not treated with PGPR became severely suffocated at the time of inoculation of the pathogen, so that plants respond rapidly by mobilizing secondary metabolites to fight pathogenic infections (Taufik et al., 2010). Factors that can affect the spread of the virus, namely cultivation factors such as planting patterns, sanitation or weed control (Irwansyah &; Sofian, 2019).

Hight on Mauli Banana Plant

Table 1 shows that the treatment of A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin) does not affect the height of mauli banana seedlings at the age of observation 7 days after inoculation until 49 days after inoculation because there are many symptoms of BBTV attack on mauli banana seedlings. According to (Semangun, 1989), banana dwarf virus can inhibit plant height growth. The average plant height (cm) of mauli bananas in each treatment can be seen in Figure5

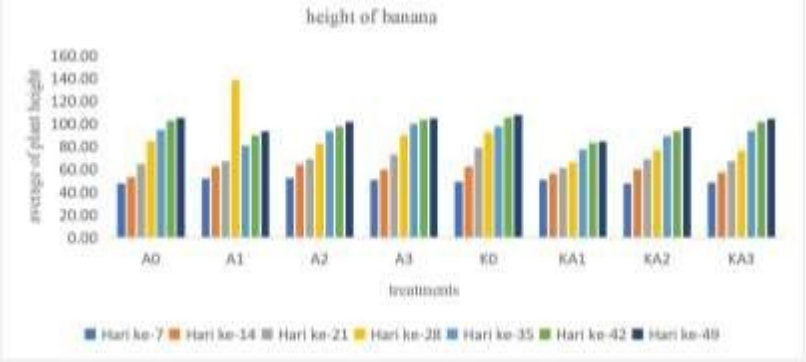

Figure 5. Diagram of average height in mauli banana plants. A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 mlPGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin).

Leaf Width on Mauli Banana Plant

Table 2 shows that the treatment of A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin) for leaves at the observation age of 7 days after application has not experienced growth, so that observations cannot be made. Then, at the observation age of 14 days to 42 days did not affect the width of the leaves of mauli banana seedlings but, at the observation age of 49 days had a real effect, where the number of symptoms of BBTV attack on mauli banana plants was quite small so that the treatment that showed the best results, which was found in KA2 treatment (10 ml PGPR + 10 ml Chitin) compared to other treatments. Leaf width is one of the factors that support plant growth because it is related to the area of light absorption absorption in the process of photosynthesis (Haryanto et al., 2018). The average leaf width (cm) of mauli banana in each treatment can be seen in Figure 6.

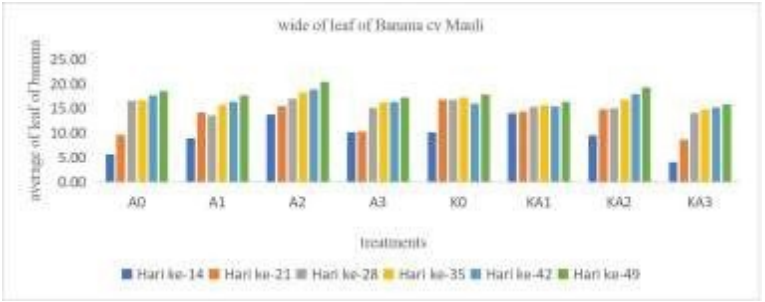

Figure 6. Diagram of the average width of leaves in mauli banana plants. A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin).

Leaf Length on Mauli Banana Plant

Table 3 shows that the treatment of A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin) for leaves at observation age 7 days after application has not experienced growth, so observations cannot be made. Then, at the age of observation 14 days to 49 days after inoculation did not affect the length of the leaves of mauli banana seedlings because there were many symptoms of BBTV disease in mauli banana seedlings. High leaf length (amount of chlorophyll) will cause the photosynthesis process to run well. The average leaf length (cm) of mauli bananas in each treatment can be seen in Figure 7.

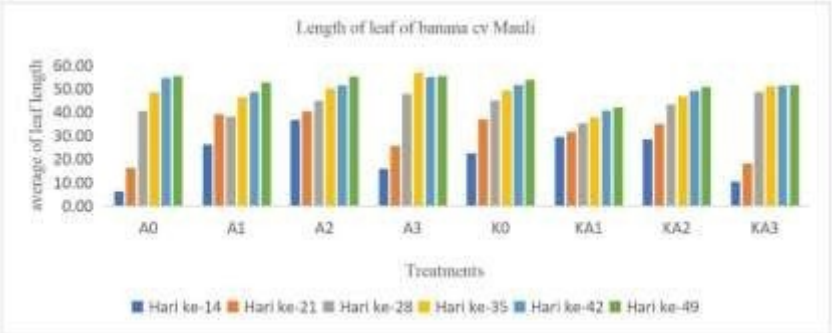

Figure 7. Diagram Rata-rata Panjang Daun Pada Tanaman Pisang Mauli. A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Kitin), KA1 (5 ml PGPR + 5 ml Kitin), KA2 (10 ml PGPR + 10 ml Kitin), dan KA3 (15 ml PGPR + 15 ml Kitin).

Root Length in Mauli Banana Plant

Table 4 shows that the treatment of A0 (PGPR 0 ml), A1 (PGPR 5 ml), A2 (PGPR 10 ml), A3 (PGPR 15 ml), K0 (PGPR 0 ml + Chitin 7 ml), KA1 (PGPR 5 ml + Chitin 5 ml), KA2 (PGPR 10 ml + Chitin 10 ml), and KA3 (PGPR 15 ml + Chitin 15 ml) It did not affect the root length of mauli banana seedlings at the age of observation 49 days after inoculation or carried out at the end of observation. (Rineksane, 2005) said that growth on roots can be affected by the hormone auxin contained in roots and translocated to roots to promote plant root growth. The average root length (cm) of mauli bananas in each treatment can be seen in Figure 8.

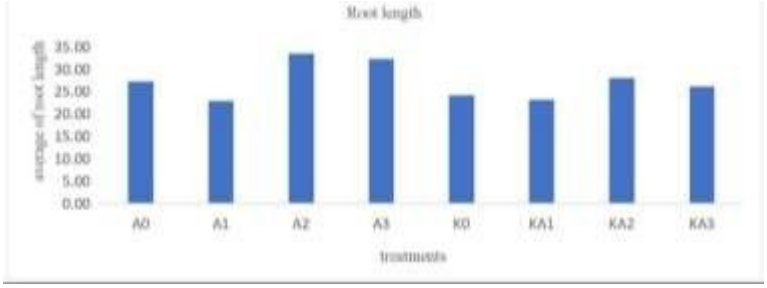

Figure 8. Diagram of the average length of roots in mauli banana plants. A0 (0 ml PGPR), A1 (5 ml PGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin).

Number of Roots on Mauli Banana Plants

Table 5 shows that the treatment of A0 (PGPR 0 ml), A1 (PGPR 5 ml), A2 (PGPR 10 ml), A3 (PGPR 15 ml), K0 (PGPR 0 ml + Chitin 7 ml), KA1 (PGPR 5 ml + Chitin 5 ml), KA2 (PGPR 10 ml + Chitin 10 ml), and KA3 (PGPR 15 ml + Chitin 15 ml) did not affect the number of roots of mauli banana seedlings at the observation age of 49 days after inoculation or carried out at the end of the observation. (Ross &; Salisbury, 1995) said that each plant has its own hormones in the plant body and plants also have a controlmechanism for giving auxin from outside, so that if the synthesized hormone has sufficiently supported themetabolic process, then the provision of growth regulators from outside will not have an effect on growth.The average number of roots (fruits) of mauli bananas in each treatment can be seen in Figure 9.

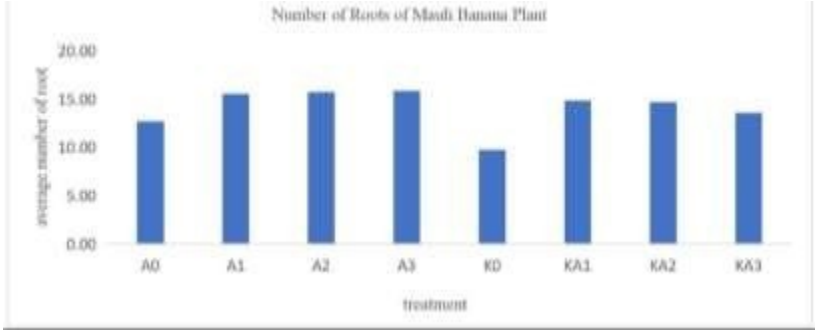

Figure 9. Diagram of the average number of roots in mauli banana plants. A0 (0 ml PGPR), A1 (5 mlPGPR), A2 (10 ml PGPR), A3 (15 ml PGPR), K0 (0 ml PGPR + 7 ml Chitin), KA1 (5 ml PGPR + 5 ml Chitin), KA2 (10 ml PGPR + 10 ml Chitin), and KA3 (15 ml PGPR + 15 ml Chitin).

Morfology aphid *Pentalonia nigronervosa*

Based on the results of observations on banana aphids that have been inoculated on banana plants, mauli has an influence by transmitting dwarf virus or BBTV and shows several symptoms of attack such as upright leaves, chlorosis, brown leaf edges, and the letter "J" appears on the leaves. These aphids are identified using a digital microscope to see their overall morphology. The characteristics possessed by aphids include: body length of about 2 mm, has 2 antennae with a length of 3 mm, there are 2 chornickels on the back or end of the body of aphids in the form of a cylinder with black color, and stilets that have a length up to the abdomen segment 1 which can be seen in Figure 8.

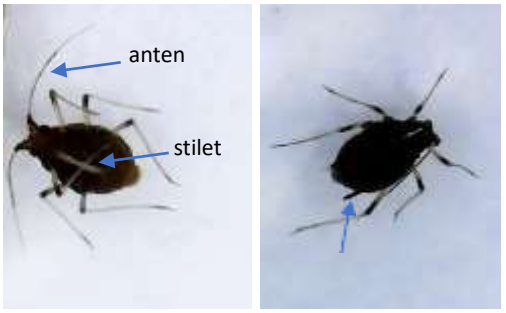

Figure 10. *Aphid Pentalonia nigronervosa*

BTV is a persistent virus. The virus is persistent once obtained from the vector, then the virus will survive in the body of the vector throughout the life of the tick but, the virus will not thrive in the body of the tick. Instead, the virus will reproduce to higher titer concentrations in its host plant (Dubois & Coyne, 2011).

CONCLUSION

Based on the results of the research conducted, the following conclusions can be drawn: the application of PGPR treatment involving bamboo roots and chitin did not significantly increase the resistance of mauli banana plants to BBTV attacks. However, it is worth noting that in the PGPR treatment group with bamboo roots (10 ml) and chitin (10 ml), the intensity of BBTV disease was relatively low at 20.13%. The varying concentrations of bamboo roots and chitin had no significant effect on the observed parameters, including plant height, leaf length, leaf width, root length, and the number of roots.

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Identification of Rhizosphere Bacteria In Pisang Kepok, Pisang Rutai, and Pisang Hutan

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ABSTRACT

The banana plant (Musa sp.) is a horticultural commodity that has several advantages, including productivity, nutritional value, high genetic diversity, adaptability to a wide ecosystem, low production costs, and has been widely accepted by the community. The rhizosphere is the layer of soil that covers the surface of plant roots which is still influenced by root activity. The thickness and thinness of the rhizosphere layer is different for each plant. The rhizosphere is an excellent habitat for bacterial growth; therefore, plant roots provide various organic materials which generally become a place for microbial growth. The research was carried out at the Pest and Plant Disease Laboratory, Faculty of Agriculture, Universitas Mulawarman. This research aims to identify bacteria in the rhizosphere area of Kepok Banana, Rutai Banana and Wild Banana and to identify bacterial genera that have the potential to become PGPR. This research method is in the form of qualitative exploratory research, namely studying based on identification to then produce information that can be utilized. The research results obtained 32 isolates of rhizosphere bacteria from kepok bananas, 4 isolates of rhizosphere bacteria from rutai bananas and 4 isolates from forest bananas. Macroscopic morphological identification obtained varied colony shapes, elevations and colony edges in the three banana rhizosphere samples. After microscopic identification using gram staining of Kepok bananas, 12-gram positive isolates and 20 gram negative isolates were obtained, with 5 isolates in the form of bacilli and 27 isolates in the form of cocci. Forest banana rhizosphere bacteria 4 isolates were gram negative; 3 isolates were cocci and 1 isolate was bacillus. Forest banana rhizosphere bacteria 4-gram negative isolates, all in the form of cocci.

Keywords: rhizosfer bacteria, kepok banana, rutai banana, wild banana

INTRODUCTION

Banana plants (Musa sp.) are one of the horticultural commodities that have several advantages, including high productivity, nutritional value, high genetic diversity, adaptability to a wide range of ecosystems, low production costs, and widespread acceptance by the community. Banana plants can grow and thrive in various agroecological conditions, from lowland areas with wet climates like Sumatra and Kalimantan, to higher altitudes with drier climates in eastern parts of Indonesia [Rustam, 2007]. Bananas are one of the plants with great biodiversity. The banana commodity is generally easy to cultivate and develop in Indonesia, with many varieties, and it is a fruit that is widely consumed by the public due to its relatively affordable price and easy availability. The production of bananas in Indonesia increased at a rate of 4.16% per year during the period from 1980 to 2015 [PDSIP, 2016].

Banana plants are divided into two types: cultivated bananas and wild bananas. Cultivated bananas are intentionally grown in gardens or yards, have few seeds, and are triploid or some diploid. Cultivated bananas are widely utilized, while wild bananas are not extensively utilized economically, even though they have untapped potential. Overall, Indonesia has a substantial number of cultivated and wild banana varieties. To date, there are 325 banana cultivars recorded [Setyadjit, 2003]. Meanwhile, at least 12 types of wild bananas and 15 varieties of M. acuminata Colla have been discovered in Indonesia, distributed widely from Sumatra, Java, Lesser Sunda Islands, Kalimantan, Sulawesi, to Papua [Nasution, 2001].

The overall banana production in East Kalimantan reached 103,888 tons in 2019, which was the highest among fruit production in East Kalimantan. However, banana production decreased to 89,861 tons in 2020. This decrease was attributed to improper cultivation techniques and high pest and disease pressures [Dispan TPH Kaltim, 2021]. Soil fertility is also one of the factors affecting production, as fertile soil contains a wealth of microorganisms that enhance plant productivity. Soil serves as a habitat for organisms ranging from macro-sized organisms like worms and predators like rodents to microorganisms like fungi, bacteria, and protozoa. Microorganisms in the soil play a crucial role as decomposers. Their primary function is to break down and decompose nutrient immobilized residues in their biomass, producing new organic compounds as a source of nutrition and energy for other organisms. The collaborative functions of soil microorganisms result in nutrients that can be used by plants. Several

microorganisms that surround the roots of healthy plants are known to act as protectors against pathogen attacks [Nurbaya, 2011].

Every environment, such as soil, air, and water, always contains microorganisms. Generally, the number of microorganisms in the soil is higher than in water and air. For their survival, each type of microorganism has the ability to transform one compound into another to obtain energy and nutrients. The presence of microorganisms in the soil leads to the cycling of elements like carbon, nitrogen, phosphorus, and other elements in nature [Sumarsih, 2003]. Bacteria exhibit diverse characteristics, and therefore, the study and understanding of bacteria within a specific group require identification. Identification is done by identifying characteristics of organisms that are not yet known and then comparing them with organisms that are already known. The identification of newly isolated microorganisms requires detailed, descriptive, and precise comparisons with descriptions published previously for similar microorganisms [Pelczar, 1989]. Therefore, this research is conducted to determine the diversity of bacteria found in the rhizosphere of banana plants, including "pisang kepok," "pisang rutai," and wild banana varieties.

MATERIALS AND METHODS

Time and Location

This research was conducted for approximately 3 months, from December to February 2023, at the Laboratory of Plant Pest and Disease Science, 3rd floor, Faculty of Agriculture, Universitas Mulawarman**.**

Tools and Materials

The equipment used in this research includes PVC pipes, markers, plastic bags, a camera, an analytical balance, beaker glassware, Erlenmeyer flasks, stirring rods, Petri dishes, test tubes, sewing needles, an autoclave, laminar air flow cabinet, Bunsen burner, aluminum foil, cotton, plastic wrap, glass slides, cover glasses, pipettes, an oven, a hot plate, spoons, an Optilab camera, syringes, and a microscope. Meanwhile, the materials used in the research include soil samples, Nutrient Agar (NA) media, alcohol, crystal violet solution, Lugol's solution, safranin solution, distilled water (aquades), cucumber seeds, malachite green solution, Oxidative-Fermentative (OF) media, SIM media, H2O2 solution, and King's B media.

Data Collection Method

The data observed in the research consists of primary data, which is collected directly through laboratory observations. Laboratory observations involve examining the morphology and physiology of bacteria. Macroscopic morphology observations of bacterial colonies include the shape of the colony, colony color, colony edge, colony elevation, and microscopic observations using a microscope to examine the cell shapes of the bacteria. Physiological observations can be conducted through biochemical tests, and physiological observations can be carried out through testing methods such as the catalase test, motility test, hypersensitivity test, gram staining, KOH test, endospore staining, oxidative-fermentative (OF) test, and fluorescent pigment test. Data collection also involves the use of secondary data, which is data obtained indirectly from its source, such as quoting information or data from previous research.

Research Procedure

Sample Collection

The sample collection was conducted by taking soil from around the "pisang kepok," "pisang rutai," and wild banana plants. Soil samples were obtained using a soil auger at 3 points around each tree, with a total of 10 "pisang kepok" trees, 10 "pisang rutai" trees, and 10 wild banana trees. Subsequently, the collected soil samples were placed in labeled sample bags.

Sterilization of Tools and Materials

Before using laboratory equipment such as needles, stirring rods, pipettes, spoons, and Petri dishes, they were first washed, dried, and wrapped in wrapping paper. Equipment like Erlenmeyer flasks, beaker glasses, and test tubes were washed, dried, then sprayed with 70% alcohol and dried again. All of these tools were then sterilized in an oven at a temperature of 121°C for approximately 15-20 minutes. Other equipment used in the field for sample collection, such as PVC pipes and plastic bags, were sterilized by spraying them with 70% alcohol and allowing them to dry.

The preparation of NA (Nutrient Agar)

The preparation of NA (Nutrient Agar) media is carried out by first weighing 20 grams of NA powder on an analytical balance. Then, 1 liter of distilled water (aquades), NA powder, and agar are placed into a beaker glass. The mixture is heated on a hot plate and stirred with a stirring rod to homogenize the NA with the aquades, resulting in a yellowish-brown color. Heating is done to accelerate the dissolution of NA and aquades. Once the mixture is homogenous, the NA solution is poured into an Erlenmeyer flask. The mouth of the Erlenmeyer flask is sealed with cotton, covered with aluminum foil, and wrapped with plastic wrap. The Erlenmeyer flask is then placed in an autoclave for sterilization to minimize contamination of the media. After sterilization, the NA media is aseptically poured into Petri dishes and test tubes within a laminar airflow cabinet and allowed to solidify and cool.

Bacterial Isolation

The isolation of bacteria from soil was performed by preparing NA (Nutrient Agar) media in Petri dishes. A soil sample weighing 1 gram was taken and placed in a test tube containing 10 ml of sterile aquades. The mixture was shaken to ensure thorough mixing. Then, 1 ml of this solution was taken using a pipette and added to another test tube containing 9 ml of sterile aquades. This dilution process was repeated to achieve dilution levels of 10^-3, 10^-5, and 10^-10. From the diluted soil samples, 1 ml was taken and injected into Petri dishes containing NA media. The Petri dishes were then wrapped with plastic wrap. Subsequently, they were incubated at room temperature, approximately 27°C-28°C, for 72 hours. This procedure allowed for the isolation and cultivation of bacteria from the soil samples on the NA media in the Petri dishes.

Bacterial purification

The method used for purification in this process is the streak plate method, and the medium employed is Nutrient Agar (NA). Each colony that grows is separated and inoculated onto separate Petri dishes to obtain single colonies. The single colonies that have grown are then streaked in a zigzag pattern on Petri dishes containing NA media and incubated for 24 hours. All the isolates that have been purified are collected and maintained in media for subsequent identification and testing purposes.

Purification and Multiplication of the Fungus Rhizoctonia solani Kühn

Then, isolation and propagation are carried out by harvesting the fungi that have grown during the purification process. These fungal cultures are transferred to new PDA (Potato Dextrose Agar) media to obtain a larger quantity of isolates as needed. Each Petri dish is labeled accordingly for identification and further use.

Observation of bacteria

The observation of bacteria is conducted through macroscopic, microscopic, and biochemical methods. Macroscopic observations of bacterial cells include the observation of colony morphology, which involves examining the shape, elevation, margin, and color of bacterial colonies grown on media. Microscopic observations are carried out by examining the shape and color of cells using Gram staining under a microscope. Several methods are used to determine the genus based on Bergey's Manual of Determinative Bacteriology by Holt et al. (1994) and Schaad et al. (2001).

Gram stain

The Gram staining procedure serves to differentiate bacteria into two groups: Gram-positive and Gram-negative bacteria, and it imparts a color to them, either red or blue. The working procedure for Gram staining is as follows: Clean the glass slide with 70% alcohol. Then, create a thin bacterial smear on the glass slide using a sterilized inoculating loop that has been heated with a Bunsen burner. Allow the smear to air-dry. Next, apply 1 or 2 drops of crystal violet stain and leave it for 30 seconds. Rinse the slide with distilled water and allow it to air-dry. Afterward, apply 1 or 2 drops of iodine solution (Lugol's) and leave it for 1 minute. Rinse the slide with 70% alcohol, being careful during this crucial step. Follow this with a rinse using distilled water. Allow the slide to air-dry. Then, apply 1-2 drops of safranin stain and leave it for 30 seconds. Rinse the slide with distilled water. Allow the slide to air-dry and then observe it under a microscope. Gram-positive bacteria will appear purple/blue, while Gram-negative bacteria will appear red.

3% KOH test

This test is conducted to determine whether bacteria are Gram-positive or Gram-negative. A loopful of 24-hour-old bacteria is suspended on a glass slide that has previously been treated with 3% KOH. The

slide is then observed for the formation of mucus-like material, which is achieved by lifting it with a sterilized inoculating loop. If mucus-like material forms, the bacteria are classified as Gram-negative. Conversely, if no mucus-like material forms, the bacteria are classified as Gram-positive. The treatment of 3% KOH disrupts the cell walls of Gram-negative bacteria, causing them to release DNA, which has a viscous or mucus-like quality.

Hypovirulence Test

The Hypovirulence test is conducted using cucumber seeds as an indicator plant because they exhibit a rapid response to pathogen attacks. The test involves cucumber seeds that have been previously soaked in 70% alcohol and a 2% Sodium hypochlorite solution, followed by rinsing with distilled water three times.The seeds are germinated on Whatman filter paper for 3 days. After germination, the cucumber seeds are immersed in a bacterial isolate that has been homogenized with sterile water. Subsequently, the seeds are transferred to Petri dishes containing Water Agar media, with four seedlings per Petri dish. Observations are then made over a period of 2 weeks (Asmara et al., 2021), followed by calculating the Disease Severity Index (DSI). The Disease Severity Index (DSI) is determined using a formula proposed by Worosuryani et al. (2006):

$$\text{DSI} = \frac{\sum N}{Z}$$

Explanation:
N = the category of attack per individual
Z = the total number of individuals used

The Disease Severity Index (DSI) is as follows:
0 = healthy, without spots on the hypocotyl
1 = 1 or 2 light brown spots with a size on the seedling < 0.25 cm
2 = bright brown spots (size 0.25-0.5 cm) covering less than 10% of the seedling
3 = bright to dark brown spots (size >1 cm) covering 10-100% of the seedling (leaves not wilting and hypocotyl still firm and white)
4 = hypocotyl with black spots, wilting leaves, and dead seedlings

If the isolate does not exhibit any disease symptoms or if the symptoms induced on cucumber seedlings by the isolate are minimal (DSI < 2.0), the isolate can be categorized into five virulence levels, as follows: isolates with a DSI value of 0-0.3 are considered non-virulent or hypovirulent. A DSI value of 0.5-0.9 indicates low virulence, DSI 1-1.9 represents a moderate category, DSI 2-2.9 is virulent, and DSI values of 3-4 are highly virulent isolates.

Fluorescent Pigment Test

The fluorescent pigment testing aims to assess the ability of bacteria to produce fluorescent pigments. Bacteria are cultured on selective King's B media using the streak plate method and incubated for 24-48 hours. Subsequently, the bacterial cultures that have grown are observed under ultraviolet (UV) light. A positive reaction for the production of fluorescent pigments occurs when bacteria produce green, glowing pigments. This indicates that the bacteria belong to the Pseudomonas group. Conversely, a negative reaction occurs when there is no green fluorescence observed when bacteria are exa mined under ultraviolet (UV) light.

Phosphate Test

Bacteria are isolated using the spread plate method on solid Pikovskaya media. Incubation is carried out for 2-3 days at room temperature. The growth of phosphate-solubilizing bacteria is indicated by the presence of a clear zone around the colonies. The halo zone (clear zone) surrounding the colony serves as an indicator that the bacterial colony is phosphate-solubilizing bacteria [Larasati, 2018].

Observation Variables

The application of botanical pesticides involves heating the PDA media in a microwave beforehand. Once the media is heated, it is transferred into a laminar airflow chamber that has been previously isolated. Each solution is poured into prepared Petri dishes and labeled according to the treatment and number of replicates. After the PDA media solidifies, inoculate R. solani in the center of the PDA media. Repeat this process for all Petri dishes, then tightly seal the Petri dishes using plastic wrap. Store the isolates in a closed room and observe the development of the fungus daily.

Calculation of Colony Count/Bacterial Density

The number of colonies that grow on the media is counted using a colony counter with a standard plate count constant. Bacterial density is calculated using the plate count method with the following formula [Waluyo, 2008]:

$$\text{Bacterial density} = \text{number of colonies} \times \frac{1}{dilution\ factor}$$

Bacterial Abundance

The observation variable in this test is quantitative data. The total bacterial colonies are counted after the bacterial incubation period on NA media for 48 hours at room temperature. The counted samples are the bacteria cultured on NA media. The total colonies that can be counted on NA media are colonies with a count ranging from 30 to 300. The calculation of the total colonies can be done using the formula:

$$\text{Bacterial abundance } (cfu/g) = \frac{number\ of\ counted\ colonies \times dilution\ factor}{weight\ of\ soil\ (grams)}$$

Data Analysis

The data is analyzed using a descriptive method to characterize the types and characteristics of bacteria obtained from the rhizosphere of banana plants, including Pisang Kepok, Pisang Rutai, and Pisang Hutan.

RESULTS AND DISCUSSION

Result

Table 1. Sample collection locations of Pisang Kepok, Pisang Rutai, and Pisang Hutan

No.	Sample Collection Locations	Village/District	GPS Coordiantes	Decription
1	Teluk Dalam Experimental	Karang Tunggal/ Tenggarong Seberang	0.3966° S, 117.1088° E	Pisang Kepok and Pisang Hutan
2	Odah Etam Sejahtera Farmers Group's	Lok Bahu	0°29'21.6"S 117°03'38.9"E	Pisang Rutai

Table 2. Macroscopic observation results

Sample Code	Elevation	Shape	Color	Edge	Size
PK 1	Flat	Round	White	Whole	Small
PK 2	Flat	Irregular	White	Wavy	Medium
PK 3	Raised	Round	White	Whole	Small
PK 4	Raised	Coil	White	Whole	Medium
PK 5	Flat	Irregular	White	Wavy	Small
PK 6	Flat	Irregular	White	Whole	Medium
PK 7	Convex	Round	White	Whole	Small
PK 8	Flat	Irregular	White	Curly	Small
PK 9	Flat	Coil	White	Undulate	Medium
PK 10	Flat	Irregular	Yellow	Whole	Big
PK 11	Convex	Point	White	Whole	Small
PK 12	Flat	Irregular	White	Undulate	Big
PK 13	Flat	Irregular	Yellowish White	Whole	Big
PK 14	Raised	Root-like	Yellowish White	Jagged	Big
PK 15	Flat	Filamentous	White	Filamentous	Big
PK 16	Flat	Round	White	Whole	Small
PK 17	Flat	Round	White	Undulate	Medium

Sample Code	Elevation	Shape	Color	Edge	Size
PK 18	Raised	Round	White	Undulate	Medium
PK 19	Flat	Irregular	Yellowish White	Undulate	Medium
PK 20	Raised	Round	White	Whole	Big
PK 21	Flat	Irregular	White	Curly	Medium
PK 22	Flat	Irregular	White	Undulate	Medium
PK 23	Raised-flat	Irregular	White	Fibrous	Medium
PK 24	Level	Irregular	White	Whole	Small
PK 25	Raised-flat	Irregular	White	Jagged	Medium
PK 26	Level	Round	White	Curly	Small
PK 27	Level	Irregular	Yellow	Curly	Small
PK 28	Raised-flat	Round	White	Whole	Small
PK 29	Level	Coil	White	Wavy	Small
PK 30	Level	Irregular	White	Wavy	Medium
PK 31	Raised	Round	White	Wavy	Small
PK 32	Raised	Irregular	Cream		
PR 1	Level	Irregular	White	Wavy	Medium
PR 2	Raised-flat	Round	Yellow	Whole	Medium
PR 3	Level	Fibrous	White	Fibrous	Medium
PR 4	Raised	Irregular	Cream	Jagged	Big
PH 1	Level	Coil	Yellowish White	Wavy	Medium
PH 2	Level	Root-like	White	Fibrous	Medium
PH 3	Level	Fibrous	Yellow	Curly	Medium
PH 4	Level	Irregular	Yellow	Wavy	Big

Table 3. Microscopic observation results & some further tests

Sample Code	Cell Shape	Gram Test	KOH Test	Hypovirulence Test	Fluorescent Pigment Test
PK 1	Bacillus	+	+	Hypovirulence	-
PK 2	Cocci	-	+	Moderate	-
PK 3	Bacillus	+	+	Hypovirulence	-
PK 4	Bacillus	-	+	Hypovirulence	-
PK 5	Bacillus	-	+	Low Virulence	-
PK 6	Bacillus	-	+	Hypovirulence	-
PK 7			-	Low Virulence	-
PK 8	Cocci	-	+	Low Virulence	-
PK 9	Cocci	-	+	Hypovirulence	-
PK 10	Cocci	-	-	Moderate	-
PK 11	Cocci	-	+	Hypovirulence	-
PK 12	Cocci	+	+	Low Virulence	-
PK 13	Cocci	-	-	Moderate	-
PK 14	Cocci	+	+	Low Virulence	-
PK 15	Cocci	+	+	Low Virulence	-

Sample Code	Cell Shape	Gram Test	KOH Test	Hypovirulence Test	Fluorescent Pigment Test
PK 16	Cocci	+	-	Hypovirulence	-
PK 17	Cocci	+	+	Low Virulence	-
PK 18	Cocci	-	+	Low Virulence	-
PK 19	Cocci	-	+	Low Virulence	-
PK 20	Cocci	-	+	Hypovirulence	-
PK 21	Cocci	-	+	Hypovirulence	-
PK 22	Cocci	-	+	Hypovirulence	-
PK 23	Cocci	-	-	Hypovirulence	-
PK 24	Cocci	-	-	Hypovirulence	-
PK 25	Cocci	-	-	Low Virulence	-
PK 26	Cocci	-	-	Hypovirulence	-
PK 27	Cocci	-	-	Low Virulence	+
PK 28	Cocci	+	-	Moderate	-
PK 29	Cocci	+	-	Low Virulence	-
PK 30	Cocci	+	-	Hypovirulence	-

Table 4. Colony count, bacterial density and bacterial abundance

Sample Code	Dilution Level	Colonies Count	Bacterial Density	Bacterial Abundance
PK 1	10^{-3}	70	7×10^{-2}	70×10^{3}
PK 2	10^{-3}	112	112×10^{-1}	112×10^{3}
PK 3	10^{-3}	33	33×10^{-2}	33×10^{3}
PK 4	10^{-3}	49	49×10^{-2}	49×10^{3}
PK 5	10^{-3}	60	6×10^{-2}	60×10^{3}
PK 6	10^{-3}	143	143×10^{-1}	143×10^{3}
PK 7	10^{-3}	98	98×10^{-2}	98×10^{3}
PK 8	10^{-3}	68	68×10^{-2}	68×10^{3}
PK 9	10^{-3}	79	79×10^{-2}	79×10^{3}
PK 10	10^{-3}	185	185×10^{-1}	185×10^{3}
PK 11	10^{-3}	219	219×10^{-1}	219×10^{3}
PK 12	10^{-3}	128	128×10^{-1}	128×10^{3}
PK 13	10^{-3}	47	47×10^{-2}	47×10^{3}
PK 14	10^{-3}	63	63×10^{-2}	63×10^{3}
PK 15	10^{-3}	77	77×10^{-2}	77×10^{3}
PK 16	10^{-3}	43	43×10^{-2}	43×10^{3}
PK 17	10^{-3}	84	84×10^{-2}	84×10^{3}
PK 18	10^{-3}	174	174×10^{-1}	174×10^{3}
PK 19	10^{-3}	124	124×10^{-1}	124×10^{3}
PK 20	10^{-3}	81	81×10^{-2}	81×10^{3}
PK 21	10^{-3}	169	169×10^{-2}	169×10^{3}
PK 22	10^{-3}	58	58×10^{-2}	58×10^{3}
PK 23	10^{-5}	62	62×10^{-4}	62×10^{5}
PK 24	10^{-5}	98	98×10^{-4}	98×10^{5}
PK 25	10^{-5}	33	33×10^{-4}	33×10^{5}
PK 26	10^{-5}	72	72×10^{-4}	72×10^{5}
PK 27	10^{-5}	113	113×10^{-3}	113×10^{5}
PK 28	10^{-5}	51	51×10^{-4}	51×10^{5}
PK 29	10^{-5}	117	117×10^{-3}	117×10^{5}

Sample	Dilution Level	Colonies Count	Bacterial Density	Bacterial Abundance
PK 30	10^{-5}	67	67×10^{-4}	67×10^{5}
PK 31	10^{-5}	44	44×10^{-4}	44×10^{5}
PK 32	10^{-5}	51	51×10^{-4}	51×10^{5}
PR 1	10^{-10}	223	223×10^{-8}	223×10^{10}
PR 2	10^{-10}	90	9×10^{-9}	90×10^{10}
PR 3	10^{-10}	87	87×10^{-9}	87×10^{10}
PR 4	10^{-10}	63	63×10^{-9}	63×10^{10}
PH 1	10^{-10}	118	118×10^{-8}	118×10^{10}
PH 2	10^{-10}	74	74×10^{-9}	74×10^{10}
PH 3	10^{-10}	53	53×10^{-9}	53×10^{10}
PH 4	10^{-10}	86	86×10^{-9}	86×10^{10}

Discussion

Characterization of Bacterial Isolate Physiology and Biochemistry

Here are the results of bacterial identification based on physiological characteristics and biochemical tests following the identification steps in Bergey's Manual of Determinative Bacteriology by Holt et al. (1994) and Schaad et al. (2001) [45,46].

Gram Staining

Based on the Gram staining test, there were 12 bacterial isolates that exhibited a blue or purple color, indicating that these bacteria are Gram-positive. Additionally, there were 27 bacterial isolates that appeared red in the Gram staining test, indicating that they are Gram-negative when observed under the microscope. The bacterial isolates identified as Gram-negative include isolates with the following codes: PK2, PK4, PK5, PK6, PK8, PK9, PK10, PK11, PK13, PK18, PK19, PK20, PK21, PK22, PK23, PK24, PK25, PK26, PK27, PR1, PR2, PR3, PR4, PH1, PH2, PH3, and PH4. On the other hand, the bacterial isolates identified as Gram-positive include isolates with the following codes: PK1, PK3, PK12, PK14, PK15, PK16, PK17, PK28, PK29, PK30, PK31, and PK32.

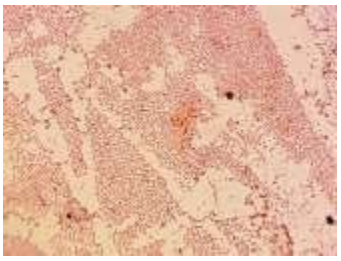

Figure 1. Result of the gram-negative test on isolate pk 11

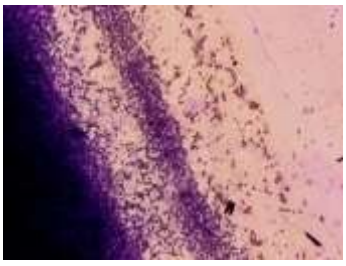

Figure 2. Result of the gram-positive test on isolate pk 15

KOH 3% Test

The results of the KOH 3% test revealed that 19 bacterial isolates did not show any mucus, indicating that these bacteria are Gram-negative. On the other hand, 21 bacterial isolates exhibited the presence of mucus, signifying that they are Gram-positive.

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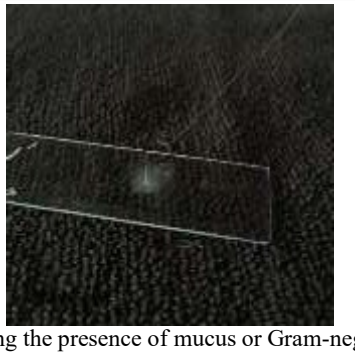

Figure 3. The KOH test result showing the presence of mucus or Gram-negative characteristics in isolate PK7.

Hypovirulence Test

The results of the hypovirulence test indicate that there are 14 bacterial isolates that are hypovirulence or non-virulent, 12 bacterial isolates with low virulence, and 3 isolates with moderate or sufficient virulence.

CONCLUSION

Based on cell shape, gram staining, and colony color, it is estimated that there are 5 genera of bacteria; There were 12 samples which were gram positive bacteria and 28-gram negative bacteria; There are 2 forms of bacterial cells, they are bacill and cocci; and Based on the hyposensitive test, bacteria were found to be hypo-virulent (10), moderate and low virulent (8).

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Yield Test of Maize (*Zea mays* L.) Merah Sigi with the Application of Several ZPTs

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ABSTRACT

Maize is the second most important staple crop after rice. Sigi Red Maize (MESI) is a type of maize from Sigi,known for its attractive appearance, sweet taste, and distinctive aroma. One of the efforts to obtain optimal yields from Sigi maize cultivation is by using plant growth regulators (PGRs). The research aimed to determine the crop yield potential of MESI maize with the application of various PGRs. The study was conducted at the Bangun Rejo Agricultural Technology Park, Tenggarong Seberang District, Kutai Kartanegara Regency, East Kalimantan, from April to July 2023. The research employed a non-factorial Randomized Complete Block Design (RCBD) with fourtreatments replicated eight times, consisting of the application of Bioactivator at 7 ml L^{-1}, Boosterat 7 ml L^{-1} , and acombination of Bioactivator at 3.5 ml L^{-1} and Booster at 3.5 ml L^{-1} . Data were analyzed using analysis of variance(ANOVA) and further subjected to the Least Significant Difference (LSD) test at a 5% significance level. The resultsshowed that the application of the Bioactivator, Booster, and their combination had not significantly on all observed parameters. The treatment with Booster at 7 ml L^{-1} resulted in an average weight of 100 grains at 23.70 g, representing a 4.64% increase compared to the control. This weight of 100 grains is still inline with the potential weight of 100 grains of MESI maize, which is 23.01 g.

Keywords: maize, *zea mays* l., lokal merah sigi, zpts

INTRODUCTION

Indonesians traditionally rely on rice as their staple food, although various other food crops, such asmaize, have the potential to serve as staple foods. Maize, a cereal crop, plays a significant role in the national economy and holds promise as a source of foreign exchange through export market development. It serves a multifunctional and strategic purpose in achieving food self-sufficiency. Maize is widely consumed as a staple food in many countries worldwide and is the second most important food crop after rice in Indonesia. Indonesia's archipelago boasts a rich variety of local maize cultivars. Among them, Sigi Red local maize (MESI), also known as Dale Lei, stands out. MESI maize is renowned for its appealing appearance, sweet taste, and distinctive aroma, setting it apart from other maize varieties. It is the predominant maize cultivated by the local community, prized not only for its economic value but also for its role as a rice substitute in the form of maize rice and as a high-quality raw material for animal feed.

Maize is native to tropical climates and exhibits high adaptability. While it thrives in subtropical to wet tropical climates between 0-500 N and 0-400 S latitude, Central Sulawesi and East Kalimantan sharemicroclimates that are sufficiently similar for MESI maize to thrive in the East Kalimantan region. However, MESI maize faces growth challenges, including small stem size, tall plant height (up to 2.5 meters), which makes it prone to lodging, and relatively low production levels. Traditional cultivation methods contribute to these limitations. To enhance productivity and optimize maize growth, it is essential to provide the necessary nutrients in accordance with the plant's requirements.

Maize requires both macro and micronutrients, with essential macronutrients including nitrogen (N),phosphorus (P), and potassium (K). Often, inorganic fertilizers like NPK fertilizers are applied due to their ability to supply all three macronutrients simultaneously. Organic fertilizers, on the other hand, have lower levels of macronutrients N, P, and K but contain sufficient quantities of micronutrients vital for plant growth. This study introduces Growth Regulators (ZPT) comprising Bioactivator and Booster, produced through the fermentation of organic materials. Bioactivator, derived from a mixture of organic fruits, contains essential ZPTs, including Indole Acetic Acid (IAA) at 5.029 mg/L, Gibberellin (Ga-3) at 9.819 mg/L, Zeatin at 1.603 mg/L, and Kinetin at 0.933 mg/L. These ZPTs play pivotal roles in promoting root and stem growth, facilitating cell division, stimulating cambium for xylem and phloem tissue formation, and expediting fruit ripening. Gibberellins accelerate seed germination, shoot growth, stem elongation, flowering, fruit development, and root differentiation. Zeatin contributes to root and stem growth, branch formation by inhibiting apical dominance, regulating leaf and shoot growth, and overseeing flower and fruit formation. The Booster, derived from Photosynthetic Bacteria (PSB), amino

acids, and Lactobacillus, contains lactic acid compounds, amino acids, and microorganisms that produce growth regulators (ZPT). It serves as a fruit enhancer while bolstering plant immunity. Lactic acid bacteria play active roles in decomposing organic matter in soil and facilitating nutrient absorption in plants. Amino acids promote soil microbial activity and support nutrient assimilation for plant roots.

MATERIALS AND METHODS

Time and Location

This research was conducted at Agricultural Technology Park Bangun Rejo Village, Tenggarong Seberang District, Kutai Kartanegara Regency, East Kalimantan; Agronomy Laboratory, Faculty of Agriculture, MulawarmanUniversity from April 2023 - July 2023.

Materials and Tools

The materials used in this study were Merah Sigi maize seeds, Dolomite, Manure, Bioactivator C-01, Booster C-05, Herbicides, Insecticides, Fungicides, Urea, SP-36, and KCl. The tools used were hoe, machete, ruler, meter, vernier, name plate, scales, raffia rope, wood stakes tugal, sprayer, hand tractor, moisture meter, bucket, stationery, and calculator.

Trial Design

This study used a Randomized Complete Block Design (RCBD) consisting of 4 treatments repeated 8 groups. The treatment in this study was the application of growth regulators with 4 treatments, consisting of: P_0 = Without ZPT (control); P_1 = Bioactivator 7 ml L^{-1}; P_2 = Booster 7 ml L^{-1}; and P_3 = Combination of Bioactivator 3.5 ml L^{-1} + Booster 3.5 ml L^{-1}.

Research Procedure

Land Preparation

The land was cleared of weeds and other crop residues by using a machete and spraying herbicides. Next, tillage was carried out using a hoe with a depth of 25 cm and the soil was turned over then the chunks of soil were crushed until a loose structure was obtained. Then 8 groups were made as replicates with a distance between groups of 60 cm and a distance between plots of 50 cm. Each plot measured 265 cm x 120 cm.

Calcification

The soil pH measurement result was 5.28, which showed that the soil condition was acidic. Then the soilpH was raised to 7 by applying dolomite as much as 500 g per plot.

Planting

Planting is done with a tugal system, which is making planting holes using a wooden stake. Each planting hole will be filled with 3-4 seeds with a planting hole depth of about 3-5 cm and covered with manure. The plandistance used is 75 x 20 cm, which is made using the help of raffia rope so that the plants grow parallel according tothe planting distance.

Treatment

Bioactivator and Booster were applied in the afternoon. During the vegetative phase, Bioactivator (P1) and Booster (P2) are given by shoveling on the roots of maize plants, repeated every 10 days, namely at 10 day after planting with a concentration of 50 ml per plant and 20 days after planting with a concentration of 100 ml per plant. Then, when entering the generative phase or before the emergence of panicles, namely 40 day after planting with a concentration of 100 ml per plant, the application of Bioactivator (P1) and Booster (P2) is done by spraying all parts of the plant. The combination of Bioactivator and Booster treatment is in accordance with P1 and P2.

Maintenance

Watering is done every day in the morning and evening according to the needs of the plants using awatering can. When rainy weather occurred, watering is not needed.

Embroidering

Replanting was carried out on the maximum seeds that did not grow or had abnormal growth when the plants were 7 days after planting (DAP) then replaced with embroidery plants that had been prepared. Replanting aims to maintain the plant population.

Weeding and Tilling

Weeding is done by cleaning weeds that grow around plants using a machete and herbicides if the weed population grows in large enough quantities. Weeding is done with the aim of avoiding competition between plants and weeds in the absorption of nutrients. The first weeding is done at the age of 18 DAP and the second weeding at the age of 28 days along with the second fertilization. The purpose of hilling is to strengthen the position of the stem so that the plants do not easily lodge and improve aeration in the soil. Hilling is done by hilling the soil on the right and left of the plant row using a hoe, then stockpiled in the plant row so that an elongated mound is formed.

Plant Pest and Disease Control

Pest and disease control is carried out if symptoms or attacks are found on the maize plants. The method and timing of control depends on the type of pests and diseases that attack. Traditional prevention is done if the attack is still at a reasonable level. MESI maize plants were attacked by leafminer caterpillars and stem rot at 15 DAP and sprayed with insecticides Lamda Sihalotrin and Tiametokam, as well as Abamectin and Chlorantraniliprole. Fungicides made from Azoxystrobin and Difenaconazole at 28 DAP. Early symptoms are characterized by watery and rotting lower stems which then break or lodge.

Harvesting

Harvesting was done after the corn plants showed the criteria of being ready for harvesting, such as light brown cobs colour, shiny seeds and dry cobs. Harvesting is done in the morning by picking the cobs using hands and the help of a cutter until they are detached from the stems, then put into sacks.

Observation Parameters

Plant Height (cm)

Plant height observations were made when the plants were 2, 4 and 6 weeks after planting (WAP). Measurements were taken using a meter, starting from the base of the plant at ground level which had been marked using stakes, namely in the first book on the second segment of the stem to the tip of the longest leaf after straightening it upwards.

Number of Leaves (blade)

Observation of the number of leaves is done by counting total number of leaves per plant. Measurements were taken at the age of 2, 4 and 6 weeks after planting (WAP).

Stem Diameter (cm)

Measurement of stem diameter of corn plants was carried out using a caliper by pinching the flat part of the stem and located at 1/3 of the plant. Stem diameter observations began after the plants were 2, 4 and 6 weeks after planting (WAP).

Length of cob without weft (cm)

The length of the cob is measured from the bottom of the maize cob to its upper end after harvest using an iron ruler. Previously, maize cobs were peeled off the cob and cleaned of the hairs that grow on its surface, followedby measurement starting from the tip of the cob to the base of the cob.

Cob Diameter (cm)

The cob diameter was measured at the center of the cob using a vernier caliper. Previously, the corn cobs were peeled off the cob and cleaned from the hairs that grow on the surface, then continued with the measurement atthe center of the cob.

Number of Seed Rows (rows)

The number of seed rows is obtained by counting the number of seed rows on the cob, done vertically from the top end to the bottom.

Number of Seeds in a Row (grains)

The number of seeds is determined by counting the number of seeds contained in each row.

Weight of Cobs without Tuber per Plot (g)

Weight of unhusked cobs per plot was obtained by weighing all unhusked cobs in the yield plot using an analytical balance. 9. Weight of Cobs without Tuber (g).

Weight of Cobs without Tuber (g)

The weight of the unhusked cob is done by weighing all parts of the cob without hulls using an analytical balance.

Dry Kernel per Plot (kg)

The weight of dry snacks per plot was obtained by weighing all dry snacks in the yield plot using an analytical balance with a moisture content of 14%.

Dry Kernel per Sample (g)

The weight of dry snacks per cob was obtained by weighing all dry snacks per cob using an analyticalbalance with a moisture content of 14%.

Weight of 100 Grains (g)

The weight of 100 plant seeds was measured by weighing 100 maize seeds and was done at the end of the study with 14% moisture content.

Data Analysis Method

All data obtained were analyzed using Analysis of Varians. If the results of variance showed that the effect oftreatment was significantly different, then continued with the BNT test at the 5% level.

RESULT AND DISCUSSION

The results of Analysis of Varians of the observation parameters showed that the effect was not significantly different in all treatments given to MESI maize.

Table 1. Average growth parameters of MESI maize

Treatment	Plant Height (cm)			Number of Leaves (blade)			Stem Diameter (mm)		
	2 WAP	4 WAP	6 WAP	2 WAP	4 WAP	6 WAP	2 WAP	4 WAP	6 WAP
P_0	66.84	192.30	242.21	7.30	8.94	11.55	6.33	16.44	17.55
P_1	65.76	183.87	240.88	7.05	8.63	11.42	6.65	16.08	17.56
P_2	66.64	202.32	258.80	7.28	9.41	11.66	6.79	17.30	18.50
P_3	66.23	191.55	246.87	7.06	8.77	11.54	6.57	16.25	17.74

Plant height continues to increase with increasing plant age. This is because the addition of basic fertilizerssuch as SP-36, KCl and Urea can supply the needs of nutrients in the soil needed by plants. The average growth of plant height increases with increasing plant age. The highest average plant height at the age of 2 weeks after plantingwas found in the treatment P_0 (Control) which was 66.84 cm, while the lowest average plant height was found in the treatment P_1 (Bioactivator) which was 65.76 cm. This phenomenon is thought to be due to the day period between the treatment given to the plants (10 days after planting) with the observations made (14 days after planting) only 4 days difference, so it has not shown significant effect. Changes began to be seen in plants 4 and 6 WAP with the highest average shown by the P_2 (Booster) treatment, namely 202.32 cm and 258.50 cm, respectively. The lowest average plant height was shown by the P_1 (Bioactivator) treatment which was 183.87 cm and 240.88 cm respectively.The number of leaves parameter showed an effect that was not significantly different in all treatments given. This occurs due to genetic factors from the use of the type of maize variety itself which varies from 8-48 leaves [6]. The results of Analysis of Varians showed that the treatment of Bioactivator and Booster as well as the interaction between the two treatments did not give a significantly different effect on stem diameterparameters at allobservation ages.

Table 2. Average yield parameters of MESI maize

Treatment	Lengt of Cob (cm)	Cob Diameter (mm)	Number of Seed Rows (line)	Number of Seeds in a Row (grains)	Cob Weigt per Plot (kg)	Cob weight (g)
P_0	14.47	38.56	13.01	25.56	1.37	88.58
P_1	15.31	37.29	12.49	26.23	1.39	88.25
P_2	15.39	38.98	13.03	26.99	1.52	98.81
P_3	15.52	37.73	12.88	26.63	1.53	94.84

Cob length and diameter affect plant productivity more than 100-grain weight. This is because longer and larger cobs have more seeds. The average cob length was found by treatment P3 which is a combination of Bioactivator and Booster at 15.52 cm, while the lowest average was found by treatment P0 (control) at 14.47 cm. Thus, the average cob length in all treatments given has not met the cob length standard according to the variety description (19.87 cm). This study obtained the highest cob diameter of 38.98 mm found in treatment P2 (Booster), while the lowest average was found in treatment P1 (Bioactivator) which was 37.29 mm. The effect that was not significantly different in all treatments given was thought to be due to the high number of plant populations in one plot affecting plant growth and yield [7]. The number of seed rows with the highest average was found in the treatment of P2 (Booster) which was 13.03 rows (Table 2), the results in this study have reached the average number of seed rows in accordance with the description of plant varieties. The effect that is not significantly different in all treatments given is due to the number of rows of seeds is a plant parameter that is more influenced by plant genetic factors [8]. The treatment of P2 (Booster) gives the highest average on the number of seeds in the row which is 26.99 grains, while the lowest average is found in the treatment of P0 (Control) which is 25.56 grains and still does not meet the standards of the variety in accordance with the description. The results of variance analysis showed that the highest average cob weight per plot was found in treatment P3 which was 1.53 kg which was a combination of both Bioactivator and Booster treatments, while the lowest average was found in treatment P0 (Control) which was 1.37 kg. The highest average cob weight per sample was found in treatment P2 (Booster) which was 98.81 (Bioactivator) which was 88.25g g, while the lowest average was found in treatment P1

Tabel 3. Average dry shelled yield of MESI Maize

Treatment	Dry Kernel per Plot (kg)	Dry Kernel per Sample (g)	Weight of 100 Grains (g)
P_0	1.08	69.84	22.65
P_1	1.04	70.01	22.74
P_2	1.10	73.16	23.70
P_3	1.18	72.15	22.89

Based on the data of cob length and number of seed rows (Table 2), there was no significantly different effect on all treatments given, so that the increase in dry kernel per plot or per sample was not significant. The results of Analysis of Varians variance showed that the highest average weight of dry kernel per plot was found in treatment P3 which was 1.18 kg which was a combination of both Bioactivator and Booster treatments, while the lowest average was found in treatment P1 (Bioactivator) which was 1.04 kg. The highest average dry kernel weight per sample was found in the P2 (Booster) treatment at 73.16 g, while the lowest average was found in the P0 (Control) treatment at 69.84g. The increase in seed dry weight is related to the amount of photosynthate translocation into seeds and the better root system of plants to absorb nutrients from the soil [9].

The results Analysis of Varians presented in Table 3 show that the highest average 100-grain weight was found in the P2 (Booster) treatment at 23.70 g, which is slightly higher than the description of the MESI maize variety at 23.01 g, while the lowest average was found in the P0 (Control) treatment at 22.65 g. The 100-grain weight indicates the size of the maize kernels produced. The higher the 100-grain weight of a maize variety, the larger the size of the maize kernels in that variety [8].

The treatments that have not significantly affected all observation parameters is suspected to be high rainfall causing nutrient leaching of all treatments given to plants, so that it cannot be absorbed optimally by plant roots and cannot support optimal plant growth and yield. The second factor that is thought to influence is the planting distance of 75 x 20 cm which is intended for a population of 1 plant per planting hole in accordance with the recommendations of the Agricultural Research and Development Agency [10]

for maize populations ranging from 66,000-71,000 plants/ha. However, in this study, 2 plants were grown per planting hole, which may have affected vegetative growth. Irregular plant spacing can cause competition for sunlight, nutrients, and water with other individual plants [11]. Thus, the spacing of plantsand the number of seeds per plant hole is one of the factors that can affect the growth and production of maize [12]. The closer the distance between plants, the lower the rate of photosynthesis that occurs due to competition in obtaining nutrients, water and light, thus affecting the formation of the number of leaves.

Based on the results of the recapitulation of research data, it shows that the Booster treatment tends to produce the highest average in most observation parameters followed by the combination treatment between Booster and Bioactivator, and the Bioactivator treatment. This is probably because in addition to containing ZPT-producing microbes, Booster is also made of Photosyintetic Bacteria (PSB), amino acids, and Lactobacillus and contains lactic acid compounds. The lowest averages were mostly found in the P1 treatment or the provision of Bioactivator, namely in the parameters of plant height 4 and 6 weeks after planting, number of leaves at all observation ages, stem diameter 4 and 6 weeks after planting which was not much different from the control, cob diameter, number of rows of seeds per cob, cob weight per plot, weight of dry kernel per plot. Bioactivator concentrations given at 10, 20, 40 days after planting were respectively 50 ml, 100 ml, 100 ml on each plant with a dose of 7 ml L-1.

Based on the results Analysis of Varians most of the lowest average were found by the P1 treatment or the treatment of Bioactivator. It is also possible that the lowest average of the Bioactivator treatment compared to the control treatment was probably the concentration of the solution given was too high. Bioactivator contains ZPT, namely Indole Acetic Acid (IAA), Giberelin (Ga-3), Zeatin, and Kinetin. ZPT can spur plant growth at certain concentrations, otherwise at higher concentrations it can inhibit growth, poison, and even kill plants [13]. Bioactivator application in sorghum plant research at a dose of 10 ml L-1 applied to the leaves three times spraying which was repeated every 10 days at the age of 24, 34, and 44 days gave the best performance in plant height, stem length, stem diameter, fruit weight per plant, dry grain productivity per hectare productivity per hectare, sap volume, sugar yield and brix value [14].

CONCLUSIONS

The treatment of Bioactivator and Booster ZPT and their combinations did not show a significant effect. However, the application of Booster tends to give the highest average effect compared to other treatments on all observation parameters and followed by the treatment of giving a combination of both Bioactivator and Booster treatments.

ACKNOWLEDGMENTS

Thank to Mrs. Penny Pujowati S.P., M.Si. as the supervisor who has guided the author since the preparation of the research proposal until the end of this research. Thanks to Bangun Rejo Agricultural Technology Park for giving the author the opportunity to conduct research at Bangun Rejo Agricultural Technology Park.

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Productivity And Cost Analysis of Land Clearing in Industrial Plantations Forest

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ABSTRACT

Activities in industrial plantation forests consist of two main stages: forest development and forest management. Utilization of forest products, such as wood, in industrial plantation forests involves a series of activities, including land preparation, nursery operations, planting, maintenance, harvesting, processing, and marketing. Among these activities, land clearing holds particular significance. This study aims to determine the work time, productivity, and associated costs involved in land clearing activities within Industrial Plantation Forests. The research focuses on a seriesof land clearing activities conducted using a Pc 210 Excavator in the PT Mahakam Persada Sakti area. Productivity inland clearing is calculated by measuring work time and the cleared area. Working time is measured using a stopwatchwith a non-stop method. Additionally, both fixed and variable cost components are collected to calculate the total costs incurred. The results indicate an average working time of 8.61 hours per day, with an average effective time of 7.47 hours per day and an average ineffective time of 1.14 hours per day. Land clearing productivity is determined to be 0.12 hectares per hour. The total costs for land clearing activities amount to IDR 451,463.25 per hour, with a business cost of IDR 3,762,193.75 per hectare.

Keywords: cost analysis, excavator, land clearing, plantation forest, working time

INTRODUCTION

Industrial plantation forests in Indonesia are designated as production forest areas that employ intensive silviculture practices. The primary aim of these practices is to enhance the productivity of production forests to meet the raw material demands of the timber industry. This approach also generates business opportunities for economic growth, fosters community empowerment, improves environmental quality, and promotes the competitiveness of timber industry products, including sawmills, pulp and paper, furniture, and more. These endeavors cater to both domestic and foreign needs (Wahdaniah et al., 2022). This definition, in accordance with the Law of the Government of the Republic of Indonesia No. 7 of 1990, underscores that Industrial Plantation Forests are forests established with the purpose of improving the productivity and quality of production forests through intensive silviculture practices. This is done to satisfy the raw material requirements of the forest products industry. The law also delineates that industrial plantation forest concession rights encompass activities such as planting, maintenance, collection, processing, and marketing. It's noteworthy that land clearing stands out as an essential initial step in the planting process.

Plantation forestry activities follow a continuous annual cycle of work rotations, with the duration corresponding to the number of planting blocks. This cycle commences with the clearance of land (Saptarini et al., 2007). Land clearing is an initial process that involves the removal of overgrown trees, weeds, and other forms of biodiversity from the selected area, which may have been previously forested land. It serves various purposes, including preparing the land for plantations (Setiadi et al., 2018). One of the land clearing techniques commonly employed in Indonesia involves the use of heavy machinery, such as excavators, which can have a significant financial impact (Nugraha et al., 2019). The utilization of machines for forest management tasks, including land clearing, can increase productivity and save time and labor but typically comes with higher costs compared to conventional methods. Mahakam Persada Sakti (MPS), located in East Kutai Regency, East Kalimantan Province, is a company specializing in the management of Industrial Plantation Forests. Land clearance is one of the critical processes carried out by MPS Company. The objective of this study is to calculate productivity and analyze the costs associated with land clearing at this location. While research has been conducted on various aspects of land clearing (Denich et al., 2004; Lezberg et al., 2006; Jaboury et al., 2013; Marpaung et al., 2021; Pratiwi et al., 2021; Pringle et al., 2021; Laitila et al., 2023; Muniarti & Suharti, 2023; Suwarno et al., 2023; Umeghalu et al., 2023), there is a dearth of publications on the productivity and cost analysis of land clearing activities in industrial plantation forests, especially in East Kalimantan. Therefore, it is crucial to undertake this study, and the results are expected to provide valuable insights for the improvement of industrial plantation forest management.

MATERIALS AND METHODS

This review paper was created by conducting a comprehensive review of several relevant articles to assess the current status and development of tiwai onions. To achieve this objective, the author reviewed various sources, including journal articles, conference proceedings, books, book sections, dissertations, theses, and online resources related to the development of tiwai onions. After collecting andanalyzing the data, the author summarized all the information. In the concluding discussion, essential findings and insights were synthesized, which can serve as additional knowledge, references, and recommendations for the further development of this local plant.

RESULTS AND DISCUSSION

Location and Time of Research

This research was conducted at Mahakam Persada Sakti Company, situated in Batu Ampar District, Telen District, and Rantau Pulung District, East Kutai Regency, East Kalimantan Province. The research duration spanned approximately six months, encompassing literature review, field orientation, data collection, and data processing and analysis. The administrative boundaries of MPS Company include Batu Timbau Village, Beno Harapan Village, and Mugi Rahayu Village in Batu Ampar District, Rantau Pulung District, and Telen District, East Kutai Regency, East Kalimantan Province. Geographically, MPS Company is located at coordinates 0° 36' 05" - 0° 50' 27" latitude (LU) and 116° 50' 10" - 117° 03' 28" east longitude (E).

Research Materials and Tools

In this research, various materials and tools were employed, including digital stopwatches to measure work duration during land clearing, meters for assessing the cleared land's dimensions, clocks to precisely mark the start and end times of work, tally sheets and stationery for recording research data, cameras to document research activities, and computers equipped with Microsoft Word and Excel software for data processing and report compilation.

Research Procedure

Determination of Work Elements

The work elements were determined by field orientation, observing the land clearing process and working methods at the study site. From the observations, the work elements were categorized into effective and ineffective time (Table 1).

Table 1. Work elements of land clearing activities at the research site

No	Elements of Working Time Ineffective Time	Elements of Working Time Effective Time
1	Break	Operator starts and/or warms up the machine
2	Operator eats and drinks	Machine runs forward
3	Personal activities	Machine runs backwards
4	Refueling	Machine pushing the vegetation
5	Moving the hut	Machine knocking down trees
6		Machine pulling the trees
7		Machine Bucking the tree
8		Machine digging the land
9		Operator switches off the machine

Working Time Measurement

The measurement of working time for land clearing involves recording the time for each work element within a land clearing work cycle. A land clearing cycle begins when the operator activates or heats up the machine and ends when the operator deactivates the machine. Time measurement is performed using the continuous, non-stop method with a stopwatch, which remains running throughout the observation. The

time for each work element is determined as the time difference between two consecutive work elements. Data collection was conducted over a period of 4 days.

Calculation of Land Clearing Productivity

To calculate the productivity of land clearing, you need data on the total area cleared (in m2) and the total working time spent on land clearing (in hours). The assessment of the land clearing area involves measuring both its length and width. An estimate of the cleared area is then obtained by multiplying the length by the width. In general, productivity is calculated as output divided by input. In this study, the output is represented by the area of land that has been cleared, while the input is the total time spent on landclearing. The productivity of land clearing can be determined using the following formula:

$$P = \frac{V}{\mathrm{T}}$$

Whereas:

P = Land clearing productivity (m^2 $hour^{-1}$)
A = Area of cleared land (m^2)

T = Total time of land clearing (hour), is the sum of the effective time and the ineffective time.

Calculation of Land Clearing Efficiency

To calculate land clearing efficiency, the following formula is used:

$$E = \frac{ET}{\mathrm{T}} \text{ x } 100\%$$

Whereas:

E = Land clearing efficiency (%)
ET = Effective time (hour)
T = Total time of land clearing (hour)

Calculation of Land Clearing Costs

To calculate the costs of land clearing, a calculation method adapted from FAO (1992), which sums up fixed and variable costs. Fixed costs consist of Excavator rental cost and tax. Meanwhile, variable costs include fuel, oil, rotary grease, hydraulic motor oil, final drive oil, and operator wages. In addition, business costs were also calculated using the following formula:

$$Bussiness\ Cost = \frac{Total\ Cost}{\text{Productivity}}$$

RESULTS AND DISCUSSION

At the time of this study, the land clearing activities at the MPS company were being carried out mechanised,using a 5-year-old Komatsu PC 210 excavator (Figure 1).

Figure 1. Excavator Komatsu Pc 210

Pc 210 Excavator specifications can be seen in Table 2:

Table 2. Specifications of Excavator Pc 210

No	Specification	Size and Units
1	Weight	22.12 ton
2	Length	9.775 m
3	Width	2.8 m
4	Height	3.281 m
5	Bucket capacity	1.44m^3
6	Engine type	SAA6D107E3
7	Engine power	158 HP/118 kW
8	Emission level	IV
9	Track width	600 mm
10	Number of cylinders	6

Source: www.lectura-specs.com

Working Time of Land Clearing

In this study, the primary purpose of land clearing is to prepare the site for tree planting in plantation forests. Land clearing in plantation forests involves the removal of trees, stumps, shrubs, and includes leveling areas that are too steep. As the initial stage of land conversion, clearing the land has become a crucial step for removing the vegetation, which typically harbors numerous weeds and insects (Marpaung, 2021). The total land clearing activity was 34.45 hours, with an average of 8.61 hours per day during the 4 days of data collection. The average effective working time is 7.47 hours, and the percentage of the duration of each work element can be seen in Figure 2 below:

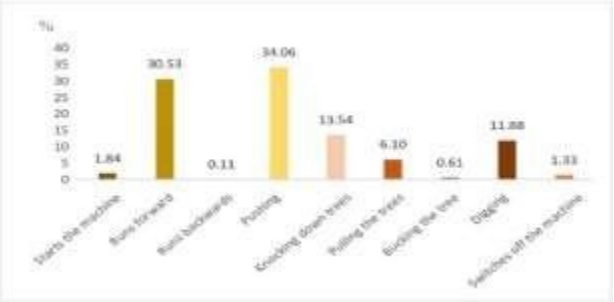

Figure 2. Percentages of effective working time elements

The graph illustrates that the most time-consuming task was pushing the vegetation (34.06%), followed by walking forward (30.53%). On the other hand, the least time-consuming operation was walking backward (0.11%), followed by cutting logs (0.61%). It's important to note that the activities of walking backward and cutting logs are not always carried out during land clearing. These work elements are only performed when the operator is digging terraces/roads to facilitate planting or when encountering untransported logs. Thus, the two activities with the least time are executed only occasionally. Regarding ineffective time, the average duration was 1.14 hours, and the percentage breakdown of each ineffective time work element can be observed in Figure 3 below:

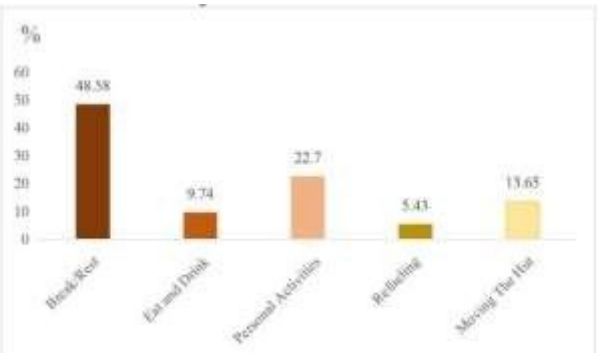

Figure 3. Percentages of ineffective working time elements

The figure above illustrates that the most time-consuming work element is the break/rest period (48.58%). During these breaks, workers engage in activities such as sleeping, using the toilet, and using their mobile phones. The second-largest work element is personal activity (22.70%), which typically includes activities like smoking and conversations among workers. Following that is the work element of moving the hut (13.65%), which is aimed at facilitating work by reducing the distance to the hut after clearing the land. The two smallest work elements are eating and drinking (9.74%) and refueling (5.34%). Meanwhile, the comparison between effective and ineffective working time can be observed in Figure 4 below:

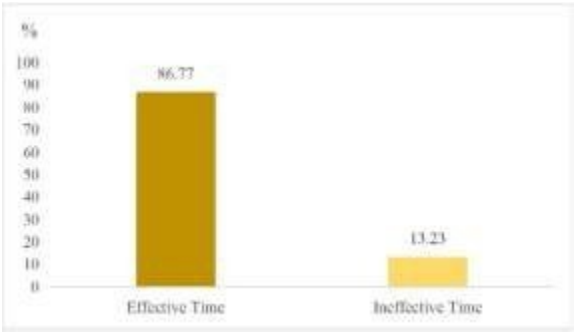

Figure 4. Comparison of Percentages between effective and ineffective working time

The figure above indicates that the effective working time accounts for 86.77% of the total working time, while the ineffective time comprises 13.23%. This suggests that land clearing activities have been conducted efficiently, with operators utilizing their working time effectively.

Productivity and Efficiency of Land Clearing

Based on the measurement and calculation of working time for land clearing activities, a total of 34.45 hours was recorded for clearing an area of 3.82 hectares. Consequently, the calculated productivity of land clearing using a Komatsu PC 210 excavator is 0.12 hectares per hour. The efficiency of the land clearing work can be determined by comparing the effective time of 29.89 hours to the total time of 34.45 hours, resulting in an efficiency rate of 86.64%. This indicates that the land clearing work is efficient. Numerous factors influence machinery work productivity, including the operator's performance. Kymalainen et al. (2023) emphasized the significance of factors like work ability and adequate rest in enhancing productivity when using heavy equipment in forestry. Furthermore, the condition of the heavy equipment itself plays a crucial role in work productivity. As stated by Prokopop et al. (2023), timely and high-quality maintenance has the most significant impact on machine reliability and performance metrics.

Cost of Land Clearing

Table 3. Breakdown of fixed and variable cost

No.	Cost Component			Amount of Cost (Rp per Hour)
I	Fixed Cost			
	a. Machine Rental	(MR)	=	250,000.00
	b. Taxes	(T)	=	17,751.25
	Total Fixed Cost	(TFC)	=	267,751.25
II	Variable Cost			
	a. Solar	(S)	=	146,832.00
	b. Oil	(O)	=	4,300.00
	c. Rotary Grease	(GR)	=	2,700.00
	d. Hydraulic Engine Oil	(HEO)	=	4,600.00
	e. Final Drive Oil	(FDO)	=	280.00
	f. Operator Wage	(OW)	=	25,000.00
	Total Variable Cost	(TVC)	=	183,712.00
III	Total Cost (TFC+TVC)	(TC)	=	451,463.25

Based on the calculations outlined above, the total cost of land clearing using a Komatsu PC 210 excavator is IDR 451,463.25 per hour. This cost can be broken down into two components: fixed costs and variable costs. The total fixed cost is IDR 267,751.25 per hour, comprising a machine rental cost of IDR 250,000 per hour and a tax cost of IDR 17,751.25 per hour. On the other hand, the total variable cost is IDR 183,712 per hour, which includes: fuel cost: IDR 146,832 per hour, oil cost: IDR 4,300 per hour, rotary grease cost: IDR 2,700 per hour, hydraulic motor oil cost: IDR 4,600 per hour, final drive oil cost: IDR 280 per hour, operator wages: IDR 25,000 per hour. The business cost, calculated by dividing the sum of the total costs by productivity, stands at Rp 3,762,193.75 per hectare. It's worth noting that machine maintenance costs are part of the variable costs and play a critical role. Inadequate technical maintenance can lead to increased failure rates, reduced productivity, decreased machine running hours, and higher operating expenses (Prokopop et al., 2023).

CONCLUSION

The average working time for land clearing using a Komatsu PC 210 excavator in the Mahakam Persada Sakti working area is 8.61 hours per day, with an average effective time of 7.47 hours per day and an average ineffective time of 1.14 hours per day. The productivity of land clearing is calculated at 0.12 hectares per hour. The cost of land clearing is IDR 451,463.25 per hour, with operating costs totaling Rp 3,762,193.75 per hectare. The land clearing efficiency is notably high, reaching 86.67%, indicating that the work was carried out efficiently.

ACKNOWLEDGMENTS

The authors extend their sincere gratitude and appreciation to Mahakam Persada Sakti Company for their cooperation and support during this research**.**

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Phytochemical Analysis and Efficacy Test of Mangrove Leaf Extract *(Rhizophora apiculata*) from Marang Kayu District, Kutai Kartanegara Regency, East Kalimantan Province Against *Propionibacterium acnes* Bacteria

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ABSTRACT

Mangroves have several compounds that can be used as antibacterials, one of which is *Rhizophora apiculata.* Samples of the *R. apiculata* type of mangrove were taken from Marang Kayu District, Kutai Kartanegara Regency, East Kalimantan Province. The aim of this study was to determine whether the *R. apiculata* mangrove leaf extract takenfrom Marang Kayu District, Kutai Kartanegara Regency, East Kalimantan Province had an antimicrobial effect on Propionibacterium acnes Bacteria. Research methods included taking leaf samples, drying and grinding, maceration and extraction, phytochemical tests, sterilization of tools and materials, bacterial culture, preparation of test media and antibacterial activity tests. Observations were made after 1x24 hours of incubation period. The clear zone formed around the wells was measured horizontally and vertically. The diameter of the inhibition zone is measured in millimeters (mm). The results of research conducted on oil mangrove leaves (*Rhizophora apiculata*) obtained the content of phytochemical compounds in the form of tannins, flavonoids, saponins, alkaloids, carotenoids and steroids.Antibacterial tests on P. acne showed that the inhibition zone became larger as the concentration of the extract increased. The inhibition zone at 20% concentration was 17 mm. The smallest inhibition value (MIC) at a concentration of 2.5%is 9.50

Keywords: Mangroves, leaf extract, phytochemical compounds, concentration of the extract, diameter of the inhibition zoner

INTRODUCTION

Indonesia is a maritime country consisting of more than 17,000 islands with the second longest coastline in the world, which is 99,083 km / 61,567 miles long. (Countries by Coastline 2023). It has large climate variations that support a variety of vegetation that grows from coastal areas to mountainous areas. Mangrove forests have high economic and ecological value. The economic functions of mangrove forests include providing wood, leaves as raw materials for medicines and so on. Ecological function as a provider of nutrients for aquatic biota, spawning and nurturing place for various kinds of biota, preventing abrasion, raging hurricanes and tsunamis, absorbing waste, preventing sea water intrusion and so on (Halidah, 2014).

On most of Indonesia's coastlines, various types of mangroves grow. These mangroves form a forest ecosystem whose width ranges from several meters to several kilometers. Ordinary people call mangroves mangroves. In fact, mangroves and mangroves are different things. Mangrove is the local name for Rhizophora sp., one of the mangroves that exist in nature. So, mangroves are not necessarily mangroves, but mangroves are definitely mangroves. Rhizophora is a type of mangrove.

Mangroves are typical plants found in river estuaries and coastal areas which are influenced by sea tides. Most of the mangrove plants are useful as food and medicine (Purnobasuki, 2004 in Henny, et al., 2017). Mangroves have compounds such as alkaloids, flavonoids, phenols, terpenoids, steroids andsaponins which are called secondary metabolite compounds, these compounds are used as fish poisons and antimicrobials (Kordi, 2012 in Senoaji and Muhamad Fajrin Hidayat 2016).

Acne is a disease that often occurs on the surface of the skin on the face, neck, chest and back. Acne appears when the skin's oil glands are too active, so that the skin pores become blocked by excessive fat deposits (Sawarkar, 2010 in Virsa Handayani 2016). If the deposits are mixed with sweat, dust and other dirt it will cause fat deposits with black spots on them which are called blackheads.

Bacteria that cause acne include Propionibacterium acnes and Staphylococcus epidermis. Propionibacterium acnes is a normal flora of the Pilosebaceous glands of human skin, this bacterium causes acne by producing lipase which breaks down free fatty acids from skin lipids. The genome of this bacterium has been sequenced and research shows that several genes can produce enzymes to shed skin and proteins, which may be immunogenic (activate the immune system) (Pramasanti, 2008).

Acne treatment is usually done with antibiotics and chemicals such as sulfur, resorcinol, salicylic acid, tetracycline, erythromycin and clindamycin. However, these drugs also have side effects such as

antibiotic resistance and skin irritation. Based on this, it is necessary to carry out research to look at the formulation and antibacterial potential of natural plants in Indonesia, not only because the side effects are relatively low but also because of the adequate bioavailability of natural ingredients.

The results of research conducted by Mutik et al., in the 2022 Tropical Marine Journal, show that Rizophora apiculata leaf extract from the waters of Jepara's Awur Bay contains several bioactive compounds such as: alkaloid, flavonoid, phenolic and saponin bioactive compounds in methanol solvent; alkaloid, phenolic and steroid compound groups in ethyl acetate solvent; while the alkaloid and steroid compound groups are in n-hexane solvent. *R. apiculata* leaf extract in the three solvents did not show any antibacterial activity against MDR bacteria (*Pseudomonas aeruginosa, Escherichia coli, Bacillus cereu*s dan *Bacillus subtilis*). Based on this, the author wants to conduct research on the activity test of mangrove leaf extract of the *Rhizophora apiculata* species taken from pond areas in Marang Kayu District, Kutai Kartanegara Regency, East Kalimantan Province.

MATERIAL AND METHODS

This research was carried out at the Wood Properties and Product Analysis Laboratory, Samarinda State Agricultural Polytechnic campus, majoring in Forest Products Technology (THH), starting from February 21 2023 to March 24 2023, including activities in the field and experiments in the laboratory.

Material

The research tools and materials used in this study are essential for conducting experiments and gathering data effectively. These tools include scissors, a blender, a dropper pipette, aluminum foil, a rotary evaporator, a spectrophotometer, a laminar airflow hood, an analytical balance, an autoclave, a measuring cup, a hole punch/well-making tool, tweezers, a spoon, an ose needle, test tubes, Erlenmeyer flasks, beaker glasses, micro pipettes, Petri dishes, a fume hood, stationery, a mobile camera, and a computer for data input and processing. Additionally, the materials used in this research consist of oil from Mangrove leaves (Rhizophora apiculata), Propionibacterium acne bacteria, cotton swabs, filter paper, 95% alcohol for maceration, 10% ethanol as a solvent and negative control, nutrient agar (Nutrient Broth, agar, glucose) as a bacterial growth medium, Pb acetate, acetone, hydrochloric acid (HCl 2N), NaOH, CH3COOH, Mayer's reagent, Dragendorff's reagent, Bouchardat's reagent, $CHCl_3$ (chloroform), NaCI (sodium chloride), and chloramphenicol as a positive control. Aquades was used as a liquid for making agar media and other purposes.These tools and materials were crucial for conducting experiments, analyzing samples, and ensuring the accuracy of the research results. They allowed for precise measurements, controlled conditions, and proper documentation of research activities.

Research Implementation

The research conducted in this study is a laboratory experimental research focused on evaluating the antibacterial activity of Mangrove Oil (Rhizophora apiculata) leaf extract against Propionibacterium acne bacteria. The evaluation was performed in vitro using the well diffusion method, and the diameter of the inhibition zone was measured to determine the antibacterial efficacy.

Research Procedure

Sample Preparation

Samples of Oil Mangrove (Rhizophora apiculata) leaves were collected manually from the vicinity of a pond near Bunga Putih Village, Marang Kayu District, Kutai Kartanegara Regency, East Kalimantan Province.

Preparation of Simplisa and Extraction of Secondary Metabolite Compounds

The collected leaves were dried indoors for four days and then finely ground using a blender. This resulted in finely powdered Mangrove Oil (Rhizophora apiculata) leaves suitable for extraction.

Extraction Process

A 50-gram sample of the finely powdered Mangrove Oil (Rhizophora apiculata) leaves was weighed. This sample was then subjected to maceration using 95% alcohol as the solvent for two rounds of 24-hour extraction with occasional stirring. After the extraction process, the mixture was filtered through filter paper, and the solvent was evaporated using a rotary evaporator at 40°C, yielding a crude ethanol extract.

Phytochemical Testing

The crude ethanol extract underwent phytochemical testing to identify the types of secondary metabolite compounds it contained. The tests conducted included Tannin, Flavonoid, Saponin, Alkaloid, Carotenoid, Steroid, and Triterpenoid tests.

Antimicrobial Activity Test

- Sterilization of Tools and Materials
- Propionibacterium acne bacteria were cultured to create a pure bacterial culture.
- Test media were prepared.
- Positive control (+) was created using 0.0030 mg of chloramphenicol dissolved in 5 ml of 10% ethanol.
- Negative control (-) was prepared using 10% ethanol.
- Test solutions were prepared, and Minimum Inhibitory Concentration (MIC) was determined.

Observation and Data Collection

After a 24-hour incubation period, observations were made by examining the clear zone formed around the well and measuring its diameter horizontally and vertically. The diameter of the inhibition zone was measured in millimeters (mm) using a ruler, calculated as the overall diameter minus the hole diameter of 7 mm. The diameter of the clear zone was then categorized based on its antibacterial inhibitory strength using Davis and Stout's classification.

Data Analysis

The analysis of antimicrobial activity involved measuring the diameter of the clear zone around the wellhole. According to Davis and Stout (1971), antibacterial strength categories were defined as follows: a clear zone diameter of over 20 mm indicated very strong antibacterial activity, 10-20 mm indicated strong activity, 5 mm indicated moderate activity, and less than 5 mm indicated weak activity.

Table 1. Classification of Bacterial Inhibitions (Davis and Stout, 1971)

No	Resistance Area Diameter	Response To the Inhibition of *Propionibacterium acnes* Growth
1	> 20 mm	Very strong
2	10-20 mm	Strong
3	5-10 mm	Moderate
4	< 5 mm	Weak

RESULT AND DISCUSSION

Mangrove Leaf Extract Oil (*Rhizophora apiculata*)

In this study, Mangrove Leaf Extract Oil (*Rhizophora apiculata*) was obtained through the maceration method, involving the use of 50 grams of dry sample and 95% alcohol solvent, resulting in the extraction of 13.14 grams of extract in a paste-like form. The extract displayed a dark green color and a thick paste-like texture. The maceration method was chosen for its ability to efficiently extract active compounds through soaking without the application of heat, thus minimizing the risk of damaging unstable or heat-sensitive components (Dean, 2009). Phytochemical tests were conducted to identify secondary metabolite compounds within the plant, providing initial insights into its potential biological activity. The analysis revealed that the leaves of Oil Mangrove (*Rhizophora apiculata)* contained various phytochemical compounds, including tannins, flavonoids, saponins, alkaloids, carotenoids, and steroids.

Antibacterial Activity

The assessment of antibacterial activity against Propionibacterium acne involved measuring the diameter of the inhibition zone around each well on agar plates after 24 hours of incubation.

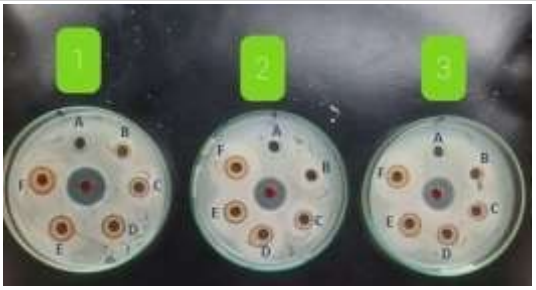

Figure 1. Inhibitory zone of mangrove leaf extract Mangrove Oil

Information:

+	: Positive Control
A	: Negative Control
B	: Concentration 2,5 %
C	: Concentration 5 %
D	: Concentration 10 %
E	: Concentration 15 %
F	: Concentration 20 %

The results, presented in Figure 1, displayed varying inhibition zone diameters corresponding to different extract concentrations. Notably, a concentration of 20% demonstrated the highest inhibition against the bacteria compared to other concentrations. This variation in inhibition zone diameter can be attributed to differences in the concentration of active compounds within each extract, with higher concentrations yielding more significant antibacterial effects (Lingga et al., 2016).

Phytochemical Testing

The crude ethanol extract underwent phytochemical testing to identify the types of secondary metabolite compounds it contained. The tests conducted included Tannin, Flavonoid, Saponin, Alkaloid, Carotenoid, Steroid, and Triterpenoid tests.

Tannin

The results of tannin analysis of oil mangrove (*R. apiculata*) leaf extract were declared positive. This is characterized by the formation of a yellow precipitate when the sample extract is reacted with a 1% Pb Acetate solution. In the world of medicine, tannins are used to treat diarrhea, stop bleeding, and treat hemorrhoids (Noviyanty, et al. 2019). Tannin is a bioactive compound which is included in the polyphenol group (Wrasiati et al., 2011) and plays a role in defense against microorganisms (Anggraito et al, 2018 in Akasia, 2021). Tannins can dissolve in alcohol solvents based on phytochemical tests. The results of tannin testing on Oil Mangrove (R. apiculata) leaves showed positive results as demonstrated by the formation of brownish yellow precipitates. This condition occurs because tannin compounds are polar so they can dissolve in alcohol which also has polar properties. This is in accordance with Prabowo's (2014) statement which states that tannin compounds have many OH groups so that tannins which are polar can dissolve in polar solvents so they can be extracted well.

Flavonoids

Flavonoids were detected in the leaves of Oil Mangrove (*R. apiculata*) characterized by the formation of a yellow color when dilute NaOH solution was added and the yellow color disappeared again when dilute HCl was added. The existence of flavonoids in plants was also stated by Waluyo, 2013 in Noviyanty, et al. 2019 that flavonoids are a group of polyphenol compounds that are naturally found in fruits, vegetables, nuts, seeds, flowers, leaves, skin, trees, etc. Flavonoids are a group of aromatic compounds which include polyphenols and contain antioxidants.

Flavonoids function as growth regulators, photosynthetic process regulators, antimicrobial and antiviral substances (Endarini, 2016). This compound is usually produced by plant tissue as a response to infection (Endarini, 2016). These results show that alcohol can dissolve flavonoid compounds. This is reinforced by Markham's (1988) statement that flavonoids have bonds with sugar groups which cause flavonoids to dissolve more easily in polar solvents.

Saponins

Saponin testing on Oil Mangrove (*R. apiculata* leaves was declared positive. Saponin is a type of chemical compound that is abundant in various plant species. This compound is an amphipathic glycoside which can produce foam if shaken vigorously in the solution and the foam is stable and does not disappear easily. Saponin has glycosyl which functions as a polar group and is active so that when shaken with water, saponin can form micelles. In the micelle structure, the polar groups face outward while the non-polar groups face inward. This condition looks like foam, therefore in this analysis the ability of the sample to form foam is looked.

Alkaloids

The results of the research showed that the oil mangrove (*R. apiculata*) leaf extract contained alkaloids as indicated by the presence of a white precipitate after adding Dragendorf's reagent. The alkaloid content in plants can be used in many ways, including in medicine. Plants are considered the oldest source of alkaloids, and some of the most widely known alkaloids, such as morphine, quinine, strychnine, and cocaine, come from plants (O'Connor, 2010). In general, alkaloids are often used in medicine (Harborne, 1996). Alkaloids can function as antioxidants, this is supported by antioxidant test research (Hanani et al., 2005). According to Priyanto (2012), the levels of alkaloids produced by green plants are not the same in all tissues and at each stage of growth.

Carotenoids

Carotenoids are very important natural substances, this is because some carotenoids can be converted into vitamin A, where these pigments are often found in plants together with chlorophyll (Apriyantono, 1989). The results of the phytochemical test for rubberonioid on oil mangrove (*R. apiculata*) leaf extract showed positive results. Carotenoids are pigments that are yellow, orange to red in color (Gross, 1991). This pigment is found in many vegetables and fruits, and is also found in fungi, bacteria, animals and humans (Gross, 1991).

Steroids

In the analysis of steroids and triterpenoids in plants, they can be tested using the Liebermann-Buchard method which will give a red or purple color for terpenoids and a green or blue color for steroids. This test is based on the ability of triterpenoid and steroid compounds to form color in the presence of concentrated H2SO4 in glacial acetate solvent to form an orange color (Marlinda, 2012). The results of the steroid analysis of Mangrove Oil (*R. apiculata*) leaf extract were positive for containing steroids because the solution turned green.

Antibacterial Activity

The antibacterial activity assessment against P. acne bacteria revealed inhibition zones ranging from 9.50 mm to 17 mm. This inhibition of bacterial growth was attributed to damage to the structural components of the bacterial cell membrane caused by the bioactive compounds present in the mangrove extract, including steroids, saponins, flavonoids, and tannins. It's worth noting that the concentration of the extract significantly influenced the antibacterial activity, with higher concentrations yielding larger inhibition zones (Zuhud, 2001).

Proposed Improvements

To fully harness the potential of Oil Mangrove (*Rhizophora apiculata*) leaves, it is recommended to explore various solvents for extraction and extend antibacterial testing to a broader spectrum of bacteria. Additionally, conducting antioxidant testing could further elucidate the extract's potential health benefits. When conducting antibacterial assays, it is advisable to use freshly cultured bacteria to ensure the accuracy of results. It is essential to maintain the sterility of research tools to prevent contamination and uphold result integrity.

CONCLUSION

In the extract of Mangrove Oil (*Rhizophora apiculata*) leaves collected from the pond area around Bunga Putih Village, Marang Kayu District, Kutai Kartanegara Regency, we identified various secondary metabolite compounds, including flavonoids, saponins, carotenoids, tannins, alkaloids, and steroids. Notably, terpenoids were absent in the extract. This Mangrove Oil (*Rhizophora apiculata*) leaf extract

exhibits potential as an antibacterial agent, with a minimum inhibitory concentration (MIC) of 2.5% against P. acne. Among the concentrations tested, the highest inhibitory effect on the growth of P. acne bacteria was achieved at a concentration of 20%, resulting in an inhibition zone measuring 17 mm. The observed differences in inhibition zone diameters can be attributed to varying levels of bioactive compounds within the *R. apiculata* mangrove leaf extract. As Dewi (2010) explained, higher extract concentrations contain more active compounds, directly influencing the diameter of the inhibition zone formed in bacterial tests. This suggests the extract's potential as a valuable antibacterial agent against P. acne, which warrants further investigation and development.

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Literature Review of The Potential of *Eleutherine americana* Merr and Its Application in Food Products

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ABSTRACT

Tiwai onions, also known as Dayak onions, are a variety of plants found in Indonesia, particularly in the Kalimantan region, where they are traditionally cultivated by the Dayak people. These onions are commonly used in ways similar to shallots, including pickles, sweets, culinary spices, and herbal drinks. Tiwai onions are rich in bioactive compounds, such as alkaloids, steroids, flavonoids, glycosides, tannins, and phenolics, which offer various health benefits. The extraction of these bioactive components from tiwai onions typically employs the maceration method, using various solvents such as ethanol, distilled water, n-hexane, ethyl acetate, and others. Different solvents yield varying amounts of bioactive components. Several studies have highlighted the numerous benefits of tiwai onions, which include the potential to reduce high blood pressure, high cholesterol, diabetes, constipation, kidney stones, cancer, and the risk of stroke. Currently, tiwai onions are being explored as a supplement or fortification ingredient in food products, including candies. Future research in this area is anticipated and should focus on innovative food fortification technologies that can effectively incorporate tiwai onion extracts. This approach can potentially enhance both the yield and economic viability of tiwai onion cultivation.

Keywords: tiwai onions, functional food, bioactive, bioactivity, extraction

INTRODUCTION

Sabrang onions or Dayak onions are a species of onion originating from the United States, which belongs to the Iridaceae family. Some people call the Latin name *Eleutherine americana*, *Eleutherine bulbosa, and Eleutherine palmifolia*. This plant is widely cultivated in South America, Africa and Southeast Asia, such as Indonesia (Kusuma et.al, 2010; Insanu et.al, 2014). Dayak onions are a plant that grows a lot on the island of Kalimantan, that's why people across Kalimantan call them "diamond onions or sabrang onions" because they have to 'nyabrang' or cross to Kalimantan Island if they want to pick them. Meanwhile, Dayak onions are obtained by the Dayak tribe in the forest, so they call them "forest onions or kambe onions" and tiwai onions. Because of its health benefits, Malays often call it the Mecca onion (Indrawati and Razimin, 2013). The Dayak tribe traditionally uses tiwai onions as a medicinal plant, food flavoring, pickle, or as a stamina enhancer and is now also being developed as a functional drink. Tiwai onion plants can be seen in Figure 1.

Figure 1. Tiwai onion plant (Personal documentation, 2023).

The extraction process is the initial stage that needs to be carried out to extract bioactive compounds from the sample matrix, such as bulbs, to facilitate the process of further analyzing phytochemical compounds. Extraction of materials is typically considered a separation process, where bioactive

compounds are isolated from the food. Different parts of plants produce varying phytochemical contents due to the structure of the plant matrix. The choice of solvents for the extraction process depends on the bioactive compounds being analyzed (Sarajlija et al., 2012; Rehman et al., 2020). Solvents can be categorized based on their polarity, such as polar, semi-polar, and non-polar. Examples of polar solvents include water, acetonitrile, methanol, and ethanol, while non-polar solvents include acetone, chloroform, and ethyl ether. According to Abarca-Vargas et al. (2016), phytochemical compounds in plants or food have different polarities; therefore, bioactive compounds can be extracted using appropriate solvents. The choice of solvent for the extraction process is crucial in maximizing the extract yield and bioactivity of plant extracts, depending on the specific properties of the desired phytochemical content. Solvent polarity is an important factor in determining the desired bioactive compound (Waszkowiak et al., 2015; Altemimiet al., 2017). Each solvent has different qualities for separating phytochemical compounds.

The superiority and evaporation process of the solvent when extracting tiwai onions are determining factors in obtaining high bioactive compounds. The extraction process for Tiwai onions can be carried out using methods such as maceration, percolation, soxhletation, reflux, and steam distillation. Various types of solvents are used in the maceration of tiwai onions. For instance, Sulastri and Oktaviani (2015), Syamsul et al. (2015), Yuliandra et al. (2018), Asih and Suprapto (2018), Jannah et al. (2018), Kartikasari and Anggraini (2018), Christopher et al. (2017), Kuntorini et al. (2016), Kuntorini and Astuti (2010), Saleh (2010), Kuntorini (2013), Nurliani and Santoso (2012), and Sulastri and Oktaviani (2015) reported that the extraction process using maceration with 96% ethanol produces a thick tiwai onion extract. On the other hand, Chen et al. (2019) and Han et al. (2008) used only methanol in their research. HS and Sampepana (2007) and Rauf et al. (2018) employed methanol extract and Tiwai onion water, while Sa'adah and Nurhasnawati (2015) used ethanol extract and water. Furthermore, in the food sector, this extract has found widespread application in various food products as a food additive, functional drink ingredient, processed snacks, candy, natural coloring, and nutritional additive for animal feed.

MATERIALS AND METHODS

This review paper was created by conducting a comprehensive review of several relevant articles to assess the current status and development of tiwai onions. To achieve this objective, the author reviewed various sources, including journal articles, conference proceedings, books, book sections, dissertations, theses, and online resources related to the development of tiwai onions. After collecting and analyzing the data, the author summarized all the information. In the concluding discussion, essential findings and insights were synthesized, which can serve as additional knowledge, references, and recommendations forthe further development of this local plant.

RESULTS AND DISCUSSION

Phytochemistry and Quantification of Bioactive Compounds Tiwai Onion

Tiwai onion bulbs consist of three main groups of compounds: naphthalene, anthraquinone, and naphthoquinone (Wang et al., 2015). Meanwhile, compounds isolated from this herbaceous plant include eleutherin, isoeleutherin, eleutherol, isoeleutherol, hongconin, eleutherinol, elecanacin, eleutherinoside A and B, and eleuthraquinone A and B (Insanu et al., 2014). Kamarudin et al. (2019) conducted an HPLC analysis revealing eight bioactive compounds: eleutherine, gallic acid, chlorogenic acid, quercetin, kaempferol, rutin, epicatechin gallate, and myricetin. Nascimento et al. (2012) identified anthraquinones, triterpenoids, saponins, while research by Pratiwi et al. (2013) reports that tiwai leaves contain flavonoids, saponins, phenols, and tannins. According to Kuntorini and Nugroho (2010), the secondary metabolite content varies during the development process of tiwai onion plants in the bulbs, increasing significantly with bulb development, but the secondary metabolite content in the leaves is not significant.

Bioactivity of Tiwai Onion

Tiwai onion bulb extract is traditionally used by the Dayak Community for various health purposes, including treating diabetes, stroke, breast cancer, hypertension, increasing breast milk production, addressing fertility problems, alleviating menstrual pain, and promoting anti-inflammatory and wound healing effects (Ieyama et al., 2011; Saragih et al., 2014; Saragih et al., 2017; Han et al., 2008). This plant is often consumed in the form of tea and is well-known in phytotherapy in the Amazon for treating amoeba-induced diarrhea (Nascimento et al., 2012).

Tiwai onion bulb extract is obtained through the extraction process of fresh or dried tiwai onion bulbs using various solvents. Tiwai onion bulb extract has demonstrated bioactive properties such as antibacterial, antioxidant, antihypertensive, antifungal, anti-inflammatory, antidiabetic, and anticancer effects. These bioactive properties of the extract will be discussed further in the following subsection.

Anti-bacterial

Tiwai onion bulb extract, especially ethanol extract, is rich in secondary metabolite compounds, some of which exhibit antibacterial properties by inhibiting the growth of bacteria, both gram-positive and gram-negative types. Secondary metabolite compounds with antibacterial functions include tannins, saponins, and flavonoids. Research by Munaeni et al. (2017) reported that the ethanol extract of tiwai onion bulbs significantly inhibited the growth of Vibrio harveyi in a dose-dependent manner compared to chloramphenicol. The inhibitory diameter increased with higher concentrations, and phytochemical analysis revealed the presence of flavonoids, alkaloids, quinones, and triterpenoids. Harlita and Oedjijono (2018) found that n-hexane, ethyl acetate, and 96% ethanol extracts of tiwai onion bulbs demonstrated effective microbial inhibition against pathogenic bacteria such as Bacillus cereus, MRSA, Shigella sp, and Pseudomonas aeruginosa using the disc diffusion agar method. Furthermore, Jiang et al. (2020) investigated the antimicrobial activity of active fractions extracted from tiwai onion bulbs against pathogenic bacteria like Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa. The results showed that the compounds eleubose A and B exhibited moderate inhibitory activity against E. coli with a minimum inhibitory concentration (MIC) value of 12.5 g/mL and mild inhibition against S. aureus and P. aeruginosa with an MIC value of 25 g/mL compared to the positive control (clarithromycin). Meanwhile, research conducted by Mahmudah et al. (2019) using a water extract of tiwai onion bulbs significantly inhibited the growth of E. coli, with an inhibitory diameter ranging from 6 mm at the lowest concentration of 10% to 30 mm at the highest concentration of 100% compared to the positive control, ceftriaxone (35 mm).

Antioxidant

Antioxidant activity is aimed at preventing the formation of free radicals, which are compounds or molecules containing one or more unpaired electrons in their outer orbital, making them highly reactive and prone to causing diseases (Sunarni et al., 2007). The parameter used to assess antioxidant activity is the efficient concentration (EC50) or Inhibition Concentration (IC50), representing the concentration required to inhibit 50% of radicals (Naspiah et al., 2013). Substances with high antioxidant activity have low IC50 values. A compound is considered a very strong antioxidant if its IC50 value is less than 50 ppm, strong if between 50-100 ppm, moderate if between 100-150 ppm, and weak if between 151-200 ppm (Mardawati et al., 2008). Munaeni et al. (2020) conducted research on the antioxidant activity of tiwai onion bulbs, demonstrating strong antioxidant activity with an IC50 value of 1.48 g/mL in DPPH testing, compared to the positive control ascorbic acid. Strong antioxidant activity can promote the growth of prebiotic bacteria, indicating the potential of tiwai onion bulb extract to act as both an antioxidant and a prebiotic. Kamaruddin et al. (2020) obtained similar results, with DPPH testing showing 75.2% and ABTS of 74.9% antioxidant activity under optimized extraction conditions compared to Trolox, indicating strong antioxidant activity in tiwai onion bulb extracts. Other research has shown that ethanol extracts of tiwai onion bulbs exhibit strong antioxidant activity against DPPH (1,1-diphenyl-2-picrylhydrazyl) with an IC50 value of 25.33 ppm (Kuntorini and Astuti, 2010). Additionally, Pratiwi et al. (2013) reported that ethanol extracts of tiwai leeks obtained through maceration had an IC50 value of 31.97 ppm.

Agustin et al. (2016) found that the most effective solvent for extracting polyphenols from tiwai onion bulbs is 70% methanol, resulting in a phenol content of 20 mg GAE/g DW and flavonoids of 15.03 mg QE/g DW compared to gallic acid and quercetin. It also showed an IC50 value of 39.06 g/mL in DPPH testing. Shi et al. (2019) discovered that tiwai onion bulb extracts are rich in phenols and flavonoids, indicating strong antioxidants as evidenced by their high peroxyl radical scavenging capacity in HepG2 cells. Moreover, Morabandza et al. (2016) reported that ethanol solvent extracts of tiwai onion bulbs contained a total phenolic content of 27.12 mg GAW/g DW and flavonoids of 17.97 mg RE/g DW compared to water extracts. The ethanol extracts of tiwai onion bulbs also exhibited high polyphenol content, resulting in high antioxidant activity with an IC50 value of 0.595 mg/mL compared to water extracts of tiwai onion bulbs with an IC50 value of 1.251 mg/ML. In vivo research has demonstrated that tiwai onion bulb extract's antioxidant activity can improve sperm quality in mice. It was found that the extract significantly increased sperm concentration in rats induced by lead acetate (Jayanti et al., 2019). Meanwhile, Ernawati and Nurliani (2012) stated that the ethanol extract of tiwai onion bulbs, when administered to male rats exposed to cigarette smoke, increased free radical inhibition activity, leading to an increase in spermatid cell count from 3.00 to 3.36. This effect counteracted the decrease in cell count initially caused by free radicals from cigarette smoke. The variation in results from these studies can be attributed to different factors, such as

the different regions from which onion bulbs were sourced, resultingin varying concentrations of active compounds. Additionally, differences in the solvents used and potentialerrors in the preparation of simplicia and tiwai onion bulb extracts could also contribute to variations in outcomes.

Antidiabetic

Diabetes mellitus is a genetic disease characterized by chronic metabolic disorders that result in various vascular complications and cardiac dysfunction due to elevated blood glucose levels (Sharma et al., 2020). Research on tiwai onion bulb extract as a functional bioactive agent has been conducted both in vitro and in vivo. In vitro research conducted by Ieyama et al. (2011) demonstrated that a compound isolated from the methanol extract of tiwai onion bulbs, namely eleutherinoside A, exhibited inhibitory activity against the ά-glucosidase enzyme with an IC50 value of 0.5 mM. Inhibition of this enzyme prevents the breakdown of carbohydrates into monosaccharides and their absorption in the intestine, thereby reducing blood glucose levels. This property attributes antidiabetic potential to tiwai onions by inhibiting the ά-glucosidase enzyme. Chen et al. (2018) found potential therapeutic effects of compounds isolated from tiwai onion bulbs (eleutherol A, B, and C; eleuthinone B and C) against hyperglycemia, providing a protective effect on human umbilical vein endothelial cells (HUVECs) exposed to high glucose levels. Furthermore, Lahrita et al. (2015) investigated traditional medicinal plants in Indonesia used to alleviate diabetes symptoms and found that tiwai onion bulbs exhibited activity in increasing glucose absorption induced by insulin at a concentration of 50 g/mL, similar to 12 other medicinal plants when compared to rosiglitazone. In vivo research conducted by Saleh (2010) examined the hypoglycemic effect of ethanol extract of tiwai onion tubers by orally administering the extract to male rats previously given glucose. The results indicated that the extract had a hypoglycemic effect on rats at a dose of 50 mg/kgBW. Additionally, Febrinda et al. (2014) reported that the consumption of water and ethanol extracts of tiwai onion bulbs inhibited the alpha-glucosidase enzyme, thereby reducing postprandial blood glucose levels.

Another study by Ahmad et al. (2018) found that methanol extract of tiwai onion bulbs, obtained using three different extraction methods, reduced glucose tolerance levels in Swiss albino mice. The results showed significant reductions with glucose levels reaching 62.2% and 74.6% 90 minutes after treatment for the reflux and maceration methods, respectively, compared to the positive control, glibenclamide, which showed a 55.2% reduction. According to Nurcahyawati et al. (2017), research on tiwai onion tuber extract at a dose of 400 mg/kg demonstrated kidney protection in Wistar rats induced by alloxan when compared to the positive control, metformin.

Anticancer

Cancer is a disease resulting from the failure to regulate cellular proliferation and other homeostatic functions in multicellular organisms. It is characterized by uncontrolled cell growth, invasiveness into surrounding tissues, and metastasis to other parts of the body (Sumardika et al., 2010). In vitro studies have shown that tiwai onion bulbs possess strong cytotoxic properties against various cancer cells. For instance, research by Lestari et al. (2019) demonstrated a potent cytotoxic effect on mouse lymphocytic leukemia cell lines, with a half IC50 inhibitory concentration of 9.56 ppm. Mutiah et al. (2019) reported a robust cytotoxic effect on cervical cancer cells (HeLa), particularly when tiwai onion extract was used in combination with doxorubicin, showing synergy compared to doxorubicin alone. This finding aligns with previous research by Mutiah et al. (2018) that investigated the synergistic effects of tiwai onion bulbs and Macrosolen cochinchinensis on HeLa cancer cells, revealing increased synergistic activity against cancer cells. Li et al. (2009) identified compounds eleutherinoside C and isoeleutherine from isolated tiwai onion tubers that exhibited selective cytotoxic properties against cancer cells and inhibited TCF/β-catenin transcription in SW480 cancer cells, surpassing the positive control, quercetin, in effectiveness. Furthermore, ethanol extracts of tiwai onion tubers were tested on LNCaP prostate cancer cells and were found to inhibit cell proliferation significantly with an IC50 value of 162.5 ppm (Abdulah et al., 2011).

Application of Tiwai Onion in the Food Sector

Tiwai onion bulbs have found wide-ranging applications in various fields, particularly in the food industry, healthy snacks, and feed additives. Extracts from tiwai onion bulbs have been utilized in the production of various food products, including effervescent tablets (Saragih, 2013), natural food coloring agents (Saragih et al., 2011), candies (Saragih, 2010), functional drinks, herbal dips (Saragih, 2011), and tiwai coffee (Saragih et al., 2022). Tiwai onion bulb extracts have also been employed as food additives

(Suroto HS, 2007), functioning as natural preservatives and antioxidants. Suroto and Yustini (2015) reported on the microencapsulation of tiwai onion extract, making it easier to incorporate into food recipes, particularly pasta. This research emphasized that the composition of the coating material and temperature, as well as their interactions, significantly affect parameters such as phenol content, water content, solubility in water, diameter size, and ethanol content at a 5% confidence level.

Phoem and Voravuthikunchai (2013) demonstrated that encapsulating tiwai onion bulb extract and oligosaccharide extract have the potential to act as a prebiotic, supporting the growth of infant intestinal microbiota and promoting the production of short fatty acids. Subsequent research by Phoem et al. (2015) showed that the microencapsulation technique of Bifidobacterium longum and tiwai onion bulb extract in fresh milk tofu and pineapple juice exhibited good resistance under refrigerated storage and heat treatment when compared to free cells. Encapsulated pineapple juice, in particular, maintained low acidity levels compared to free cells. Other researchers have reported that the addition of tiwai onion bulb extract at a concentration of 15% improved the organoleptic quality of taste, smell, tenderness, and texture while marginally affecting the color and overall acceptability of Arabic chicken nuggets compared to the control (Ismanto et al., 2014). The incorporation of tiwai onion tuber extract has also been shown to enhance the antioxidant activity of tempeh nuggets (fermented soybeans) when mixed at a 15% ratio (Damayanti et al., 2018). Moreover, the inclusion of tiwai onion tuber extract in homemade salad dressing demonstrated excellent anti-staphylococcal activity and remained stable under varying heat and pH conditions, ultimately enhancing the overall food quality (Ifesan et al., 2009).

Beyond its role as a food additive, tiwai onion bulb extract has potential as a snack ingredient, as observed by Lesmana and Parman (2019). They produced onion sticks from a combination of tiwai onion tubers and rice flour (50g of tubers in 100g of rice flour), which were favored by respondents due to their crunchy texture and delicious taste. Furthermore, tiwai onion bulb extract has been used as an additive in laying hen feed, as studied by Ooi et al. (2018). Their research demonstrated that diet supplementation with 1% bulb extract led to a significant reduction in the number of Enterobacteriaceae, lowered fecal pH, and increased fecal lactic acid bacteria compared to the control treatment. Similarly, Hardi and Handayani (2018) conducted research on striped catfish feed (Pangasianodon hypophthalmus) and found that supplementation with 30g/kg of tiwai onion bulb extract increased amylase activity, leukocyte count, growth rate, and phagocytosis rate in fish.

CONCLUSION

Tiwai onion bulb extract represents a valuable component of Indonesia's biodiversity, particularly on Kalimantan Island, characterized by its rich content of bioactive compounds and antioxidants. Various solvents, including ethanol, methanol, and water extracts, have been employed to extract and isolate phytochemicals from Tiwai onion bulbs, with the goal of achieving higher yields and improved quality. Tiwai onion bulb extract offers a wide range of health benefits, including antibacterial, antioxidant, antidiabetic, and anticancer properties, among others. In the food sector, this extract has found extensive applications as a food additive, a key ingredient in functional drinks, processed snacks, candies, natural food coloring agents, and nutritional additives for animal feed. Further exploration of its potential in various food sectors, particularly food fortification technology utilizing Tiwai onion bulb extract, holds promise for future research.

ACKNOWLEDGEMENT

The author extends gratitude to the Faculty of Agriculture at Mulawarman University for their invaluable support and resources, which have greatly contributed to the completion of this article.

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Status of Land Degradation for Biomass Production and Management Efforts inTabang Sub-districts, Kutai Kartanegara Regency

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ABSTRACT

The objectives of the study of land degradation status for biomass production are: (1) to collect data and information on initial soil conditions on land use for biomass production; (2) determine land degradation status for biomass production on land use for biomass production; and (3) mapping the status of land damage in Tabang sub-District, Kutai Kartanegara Regency. The research was carried out for 4 months, the research location was in Sidomulyo, Umaq Dian, Buluq Sen and Tukung Ritan Villages, Tabang sub-District, Kutai Kartanegara Regency. Research activities carried out include: preparation, field observations, soil sampling, soil sample preparation, soil analysis in the laboratory, data processing and interpretation, and reporting. The results showed that: (1) Land with not degradated status was found at four location i.e TB 2, TB 4, TB 10 and TB 11; (2) lightly degradated status occurred in 7 location i.e TB 1, TB 3, TB 5, TB 7, TB 8 dan TB 9; (3) land with moderate degradated statusoccurred at TB 6. Land degradation for biomass production mostly occurs in dryland caused by damage to the basic properties of the soil which includes soil pH, soil erosion, and bulk density.

Keywords: land degradation, biomass production, land management.

INTRODUCTION

The excessive use of natural resources in order to meet development needs has led to a decrease in the quality of the environment which has resulted in various ecological disasters, ranging from global warming, land degradation, scarcity of natural resources to loss of germplasm, all of which are losses that are not only experienced by people living today but also by future generations. A good and healthy environment is the basic right of every Indonesia citizen as mandated in Article 28 of the 1945 Constitution of the Republic of Indonesia; therefore, it is the obligation of all parties to maintain the quality of the environment so as to encourage all parties to implement it.

Soil is classified as a renewable natural resource, meaning that damage to land can still be repaired, but with different efforts depending on the level of damage. However, for land that has suffered severe damage (severe degradation) it requires a great deal of effort to restore it both in terms of cost, time and other resources. Land degradation caused by land management that does not pay attention to soil conservation principles (exceeding its carrying capacity). Examples of land degradation that is difficult to repair are salinization, severe erosion, peat subsidence, increased soil acidity due to oxidation of pyrite compounds and the entry of pollutants that are difficult to degrade into the soil system. Land degradation has direct implications for reducing the ability of the soil to produce biomass. For land use to produce biomass, land use must be controlled and must not exceed the damage threshold. Soil degradation can occur in the physical, chemical and biological properties of the soil (Saragih, Nasrul, and Idwar, 2013; Hartanto et al, 2022).

Land degradation can be caused by the natural nature of the soil, it can also be caused by human activities which cause the land to be disturbed/degradated so that it is no longer able to function to support its productivity. According to Winarso (2005) that the main problems of land in relation to land management are poor soil and nutrient deficiency, soil erosion and degradation, inefficient use of water, low pH loss of organic matter, soil compaction, drought, flooding and poor drainage.

Human activities that make uncontrolled use of land and other natural resources and do not pay attention to conservation principles can result in soil damage, thereby reducing its quality and function, which in turn can threaten the survival of humans and other living things. The government has issued Government Regulation (PP) Number 150 of 2000 concerning Land Damage Control for biomass. With the issuance of the PP so that land use can be carried out wisely, taking into account the interests of presentand future generations, so that land can be used sustainably with good and optimal quality levels (Suzana, 2019). An inventory of potential land damage needs to be carried out because it is an important step in overcoming land damage. The results of the inventory are the initiation of regional development and

development planning that takes into account aspects of the sustainability of land or soil resources. According to Sukisno et al., (2011) that mapping the potential and status of land damage can determine appropriate soil and land management actions so that land damage can be prevented and/or repaired. The aim of the study was to determine the status of the level of land degradation for biomass production in Tabang District, Kutai Kartanegera Regency and efforts to improve it.

MATERIAL AND METHODS

Time and Location

The research was carried out for 4 months, the research locations were in Sidomulyo Village, Umaq Dian Village, Buluq Sen Village and Tukung Ritan Village, Tabang sub-District, Kutai Kartanegara Regency.

Materials and Tools

Materials used: soil samples, chemicals for soil analysis in the laboratory; The equipment used in this study includes field equipment and laboratory equipment. Field observations and taking soil samples as well as compiling maps include; sample rings, soil drill, field knife, GPS (geographic positioning system), meter, documentation, abney level, stationery, label stickers and plastic bags as well as geographic information system (GIS) tools for making work maps and yield maps. While laboratory equipment is used to measure and determine soil characteristics.

Research Implementation

Research activities carried out include: preparation, field surveys, soil sampling, soil sample preparation, soil analysis in the laboratory, data processing and interpretation, reporting.

Data Collection

There were 3 locations for soil sampling/land observation in Sidomulyo Village, 3 locations in Umaq Dian Village, 1 location in Buluq Village and 4 locations in Tukung Ritan Village. The data collected are: (1) soil properties obtained through field surveys, namely: soil solum, surface rock and soil erosion; and (2) soil properties obtained through analysis in the laboratory, namely: soil pH, fraction composition, bulk density, total porosity, degree of water permeability, electrical conductivity (DHL), redox value and number of microbial.

Assessment of Land Degradation for Biomass Production

After identifying the initial soil conditions, analyzing the basic properties of the soil, then evaluating it. The evaluation was carried out by comparing the average values of the same parameters for biomass production which are similar to the results of analysis of the basic properties of the soil with the standard criteria for soil degradation to land based on Minister of Environment Regulation No. 7 (2006). The basic properties of the soil used to determine the status of land degradation for biomass production are 11 parameters. If one of the basic soil property thresholds is exceeded, the soil status is considered degradated. Furthermore, the level of soil degradated is divided into four categories based on the number of basic soil properties that have exceeded the critical limit, namely: (1) not degradated, (2) slightly degradated, (3) moderately degradated and (4) heavily degradated. The following categorizes the level of soil damage status for biomass production presented in Table 1 and Table 2.

Table 1. Soil degradated evaluation for biomass production

No.	Basic Soil Properties	Critical Limid
1.	Solum	< 20 cm
2.	Surface rocks	> 40 %
3.	Fraction Composition	< 18 % clay; > 80 % sand
4.	Bulk density	>1,4 g/cm^3
5.	Porosity	< 30 % ; > 70 %
6.	Permeability	< 0,7 cm/hour; > 8,0 cm/hour
7.	Erosion	0,9 mm/years
8.	pH	< 4,5; > 8,5
9.	Electric Conductivity	> 4,0 mS/cm
10.	Redoks	< 200 mV
11.	Number of Microba	< 10^2 cfu/g

Source: government regulation number 150 (2000)

Table 2. Category of land degradated status

Soil Damage Status	Number of Basic Soil Properties Exceeding Critical Limits
Not degradated	0
Lightly Degradated	1-2
Moderate Degradated	3-5
Heavily Degradated	>5

Source: Compilation Team (2022)

RESULTS AND DISCUSSION

General Information on Sampling Locations

Administrative research locations include Sidomulyo Village, Umaq Dian Village, Buluq Sen Village and Tukung Ritan Village. Land use consists of paddy fields, mixed gardens, shrubs, agroforestry plantations and dry land agriculture. The physiography of the land consists of plains, undulating plains and hills. Dry land in Tabang District is the dominant land use because it fits the land typology in the form of undulating plains to hills. Dry land use types consist of mixed plantations, oil palm plantations and rubber plantations. Mixed gardens are not managed properly, without the provision of agricultural inputs and the condition of the land is not maintained. Wetlands are only found in Sidomulyo Village with an area of around 40 ha. The type of paddy field is in the form of technically irrigated rice fields so that the land can be planted twice a year. An overview of the research locations is presented in Table 3.

Table 3. General information of soil sampling locations/land observation

No	Field code	Village	Coordinate		Physiography	Slope (%)	Land Use Type
			°BT	°LU			
1	TB1	Sidomulyo	116,0215	0,5803	Plains	3-5	Pasture
2	TB2	Sidomulyo	116,0050	0,5842	Hills	20-25	Agroforestry
3	TB3	Sidomulyo	116,0012	0,5896	Hills	35-35	Dryland farming ex preparation for oil palm land
4	TB4	Umaq Dian	116,0200	0,5605	Undolating	3-5	Forest plantations and shrubs
5	TB5	Umaq Dian	116,0130	0,5528	Hills	5-20	mixed farm
6	TB6	Umaq Dian	115,9948	0,5198	Hills	25-35	Small scale oil palm plantations
7	TB7	Buluq Sen	116,0458	0,4398	Hills	15-20	Small scale oil palm plantations
8	TB8	Tukung Ritan	116,0588	0,3900	Hills	20-25	Mixed farm and shrubs
9	TB9	Tukung Ritan	116,0595	0,3964	Hills	15-20	Rubber and palm plantations
10	TB10	Tukung Ritan	116,0649	0,3991	Hills	15-20	Small scale oil palm plantations
11	TB11	Tukung Ritan	116,0693	0,4017	Hills	15-20	Small scale oil palm plantations

Basic Properties of Soil

The soil at the study location has a solum thickness of 66 cm to more than 120 cm. The solum is likened to a body of soil, where there are minerals, water and air in it. Good land is land that has deep soil solum. Deep soil solum (more than 100 cm) can support the uprightness of plants, and is also able to provide water in the soil body. The thickness of the soil solum is greatly influenced by soil-forming factors, such as topography and parent material (Khanifar and Khademalrasoul, 2020). Apart from that, surface rocks are found in a low percentage, namely less than 5% or still below the critical limit for soil damage for surface rock parameters. The low percentage of surface rock makes it easier to cultivate the land. Other basic soil properties, namely unit weight, DHL, redox value and number of microbial also show values that do not exceed the critical limit.

Basic properties of soil that exceed the critical limit are fraction composition, soil erosion, soil pH, and permeability. Clay as a soil colloid has an active surface so it is able to exchange cations adsorbed on the clay surface with cations in the soil solution. This condition allows nutrients (most of which havea positive charge) to be exchanged to prevent soil nutrient loss (Bi et al, 2023). The results of observations on the basic properties of the sat the study site are presented in Table 4.

Table 4. Soil basic properties in tabang sub-district

Location Code	Solum (cm)	Surface rock (%)	Erosion(mm/ years)	Sand (%)	Clay (%)	Bulk Density (g/cm^3)	Porosity (%)	Permeability (cm/h)	PH	DHL (mS/cm)	Redox Value (mV)	Number of Microbial (cfu/g)
TB 1	>120	< 5	0,2	26,06	56,06	1-,20	54, 83	0, 55*	4, 70	0, 65	310, 15	2, 6x10
TB 2	104	< 5	0,4	22,65	44,94	1,11	58,26	1,02	4,62	0,65	305,7	$4,2 \times 10^5$
TB 3	85	< 5	1,1*	14,88	47,07	1,22	54,13	1,02	4,40 *	0,76	213,1	$2,0 \times 10^4$
TB 4	>120	< 5	0,4	55,07	29,08	1,06	59,99	7,90	4,75	0,80	347,1	$3,1 \times 10^5$
TB 5	>120	< 5	0,5	65,72	20,42	1,14	57,07	3,58	4,24 *	0,61	331,7	$4,8 \times 10^5$
TB 6	80	5-10	1,1*	19,74	3,07*	0, 93	64,72	7,63	4,29 *	0,62	319,5	$2,2 \times 10^5$
TB 7	66	5-10	1,2*	68,87	29,97	1,1	57,134	0,79*	4,70	0,79	359,7	$2,5 \times 10^5$
TB 8	110	<5	0,4	47,41	35,37	1, 12	57,74	5,10	4,43*	0,51	344,0	$3,4 \times 10^5$
TB 9	112	<5	0,4	53,64	32,50	1, 15	56,60	4,55	4,42*	0,53	256,1	$3,1 \times 10^5$
TB 10	98	<5	0,5	54,40	31,10	1, 04	60,75	3,24	4,54	0,51	310,4	$2,7 \times 10^5$
TB 11	89	<5	0,4	26,06	56,06	1, 13	57,36	3,81	4,56	0,59	334,2	$2,1 \times 10^5$

Information: * = exceeding critical limit
Source: Results of Laboratory Analysis and Field Observations (2020)

Land degradation Status

The results of the assessment regarding the status of land degradation for biomass production in Tabang District arepresented in Table 5 below.

Table 5. Status of land degradation for biomass production

No	Location Code	Number of Limited Factors	Status
1.	TB 1	1	Lightly Degradated
2.	TB 2	0	Not degradated
3.	TB 3	2	Lightly Degradated
4.	TB 4	0	Not degradated
5.	TB 5	1	Lightly Degradated
6.	TB 6	3	Moderate Degradated
7.	TB 7	2	Lightly Degradated
8.	TB 8	1	Lightly Degradated
9.	TB 9	1	Lightly Degradated
10.	TB 10	0	Not degradated
11.	TB 11	0	Not degradated

Based on the data in Table 4 to Table 5, the results of evaluating the status of land degradation for biomass production in Tabang District obtained the status of land damage as follows:

Not Degradated

There are four locations of dry land with not degradated status, i.e TB 2, TB 4, TB 10 and TB 11. Types of land use in these locations include agroforestry, forest plantations and shrubs and smallholder oil palm plantations. None of the basic soil properties exceeds the critical limit. Land management carried out on these lands can maintain land sustainability. Therefore, land/land management needs to be maintained to protect the land from degradation.

Slightly Degradated

Land with lightly degradated status was found in 6 locations, namely TB 1, TB 3, TB 5, TB 7, TB 8, and TB 9. At least there are one to two basic soil properties that exceed the critical limits at these locations, namely fraction composision, soil pH, soil erosion and degree of water permeability. These lands experienced light damage, where the damage did not significantly affect the land's ability to produce biomass, except for the TB 3 location, so that overall the land could still be restored with low input. In addition, land use in the form of plantations and mixed gardens can naturally improve the basic properties of the soil. At the TB4 location, low soil pH and erosion are the basic soil properties that exceed the critical limit. The slope of the land at the TB 3 location is large, so that land management on smallholder plantation land use types has not been able to reduce the rate of erosion to below the critical limit. Therefore, it is necessary to improve land management, according to Munawar (2010) to increase soil pH by liming, adding organic matter or planting tolerant plants. Furthermore, stated by Aeni (2021) thatto reduce the rate of soil erosion can be done through several efforts, namely soil conservation, terracing, counter farming, reforestation/greening.

Moderately Degradated

Land with moderately damaged status is located at TB 6 location, there are three basic soil properties that have exceeded the critical limit, namely soil pH, soil erosion and fraction composition. The type of land use in that location is smallholder oil palm plantations. The land has a steep slope, with a moderate land cover density, that is, without using a cover crop. Land conditions like this cause high erosion rates, where erosion reaches 1,1 mm/year.

The high erosion rate is thought to cause a lot of clay colloids to erode and if left unchecked can cause damage to other soil properties, such as the degree of water permeability and the number of soil microbes. Therefore, efforts to restore basic soil properties that have exceeded critical limits need to be prioritized at the TB 7 location for soil damage restoration activities for biomass production in Tabang District, especially prevention of soil erosion.

Efforts to restore land damage at TB7 locations are suggested through vegetative methods, namely by planting cover crops. Cover crop leaves that are very dense can prevent soil aggregates from being dispersed by rainwater and the root system of these plants can increase rainwater infiltration so as to reduce surface runoff. The combination of these benefits can reduce the rate of soil erosion below a critical limit, and can also restore damage to the physical properties of the soil that has been caused by erosion. As stated by Kartasapoetra et al. (2000) cover crops can function as a protector of the soil surface from the blows of raindrops, slow down surface runoff, and can increase soil organic matter levels. Furthermore, Arsyad (2010) stated that legume plants are more suitable as ground cover plants because they can add soil nitrogen and their roots do not provide heavy competition to staple crops; and Sharma et al. (2018) explained that leguminous cover crops are plants that can increase soil fertility, reduce soil erosion, add and protect soil, both in terms of soil nutrition and water availability and soil quality.

In general, Land degradasion in Tabang District, Kutai Kartanegara Regency is caused by low soil pH, soil erosion, and fraction composition. The results of this study are similar to the results of research reported by Zulkarnain (2022) that the status of damage to dry land in Marang Kayu Village District, Kutai Kartanegara Regency is classified as moderate due to low soil pH and high sand fraction. A map of the location of land damage status in Tabang District, Kutai Kartanegara Regency is presented in Figure 1 below.

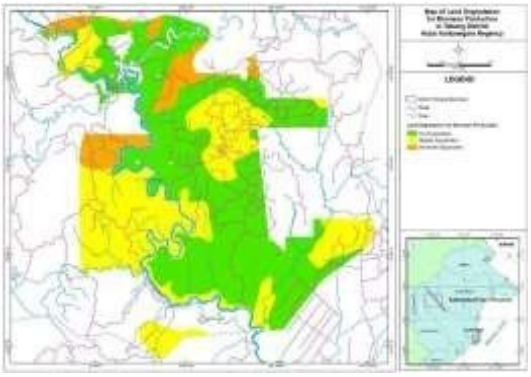

Figure 1. Map of land degradation for biomass production in tabang district

CONCLUSIONS

Based on the results of research and discussion, conclusions are drawn, namely land with not degradated is found inTB 2, TB 4, TB 10 and TB 11. Land with lightly deradated status occurs at locations TB 1, TB 3, TB 5, TB 7, TB 8, and TB 9. Land with moderate dedradated occurred at location TB 6 andno experienced severe degradated. Land degradation for biomass production is caused by damage to thebasic properties of the soil which include low soil pH, soil erosion, and fraction composition.

ACKNOWLEDGMENT

This research is the result of collaboration with the Kutai Kartanegara Regency Environmental Service so that the sampling process can be carried out, in addition to the support from farmers in the Tabang sub-district who helped in the research process, especially determining sample points.

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Selection of Lines BC1F5 Pandan Ungu/Kambang//Pandan Ungu (PU/K//PU) Based on Agronomic Characteristics

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ABSTRACT

This research was conducted from May to September 2022 to assess the growth and yield of BC1F5 Pandan Ungu/Kambang//Pandan Ungu rice plants, determine the influence of environmental factors on the agronomic characteristics of BC1F5 Pandan Ungu/Kambang//Pandan Ungu rice lines through heritability analysis, and establish correlations between agronomic characteristics and the yield of the BC1F5 Pandan Ungu/Kambang//Pandan Ungu line. The research followed a randomized block design with three replications, using different strains as treatments. Data obtained were subjected to variance analysis (Fisher's test) at a 5% significance level. If a significant effect was observed, Duncan's Multiple Range Test (DMRT) was conducted at the 5% level. To assess the impact of environmental factors, heritability analysis (h2) was performed. Additionally, a correlation analysis was carried out using the Pearson product-moment correlation formula to understand the relationships between characters. The results of the research revealed variations in growth and yield among the 24 backcross lines of Purple Pandan/Kambang//Purple Pandan. Three characters exhibited high heritability values: plant height, panicle length, and the number of grains per panicle. Four characters showed moderate heritability values: harvest age, number of grains per hill, weight of 1000 grains, and weight of grain per hill. One character had a low heritability value: the number of offspring. Based on the four selection criteria, 12 lines were identified for further selection, specifically lines 17, 41, 55, 57, 117, 141, 149, 197, 296, 303, 375, and 389. Notably, the character of grain weight per hill had a significant and positive correlation with the number of tillers and the number of grains per hill, while the other characters did not significantly affect grain weight per hill.

Keywords: Agronomic characteristics, correlation, F5 strains, heritability, Pandan Ungu/Kambang//Pandan Ungu..

INTRODUCTION

Rice (Oryza sativa L.) is a crucial food commodity for a significant portion of the global population, particularly in Indonesia. As the population continues to grow each year, there is a demand for increased rice production to meet the food needs of the population. However, the capacity and availability of food production are becoming increasingly limited. In 2021, rice production amounted to 244,677.96 Mg, which represented a decrease of approximately 17,756.56 Mg or a decline of 6.77% compared to 2020 when it was 262,434.47 Mg (BPS, 2021). Several factors contribute to the decline in rice productivity, including unpredictable climate conditions, pest and disease attacks, limited functional rice field areas for production, the conversion of rice fields to other uses, declining soil fertility, and inadequate primary and secondary irrigation network conditions (BPS, 2019).

One of the efforts to address this issue is by utilizing local rice varieties and developing them into superior rice varieties. The use of superior rice varieties is expected to enhance rice productivity even in limited quality and land areas. Based on explorations conducted in several regions of East Kalimantan, 12 rice germplasms cultivated by farmers were identified. Following identification and selection, five of theserice cultivars displayed good agronomic characteristics and high yield potential. These cultivars are knownas Kambang, Roti, Sikin Merah, Amas, and Pandan Ungu (Rusdiansyah, 2012). Subsequently, crossbreeding was carried out between Pandan Ungu and Kambang to produce F1 plants. Selection was conducted among the F1 plants, and then a backcross was performed with the female parent, Pandan Ungu,resulting in BC1F1 lines. Selection continued until BC1F5 lines were obtained. Based on this background, research was conducted to select BC1F5 Pandan Ungu/Kambang//Pandan Ungu (PU/K//PU) lines based on their agronomic characteristics. The objectives were to assess the growth and yield of BC1F5 Pandan Ungu/Kambang//Pandan Ungu rice plants, determine the influence of environmental factors on the agronomic characters of BC1F5 Pandan Ungu/Kambang//Pandan Ungu rice lines through heritability

analysis, and establish correlations between agronomic characteristics and the yield of the BC1F5 Pandan Ungu/Kambang//Pandan Ungu lines.

MATERIALS AND METHODS

The research was conducted from May to November 2022, taking place in the paddy fields of Karang Tunggal Village, Tenggarong Seberang District, Kutai Kartanegara, East Kalimantan. The materials used in the research included 24 BC1F5 strains, which were part of the collection by Prof. Dr. Ir. H. Rusdiansyah, M. Si, and were the result of seed selection from BC1F4 research in the previous study. Additionally, urea and NPK fertilizers, pesticides (insecticides and herbicides), and dolomite lime (CaMg(CO3)2) were also used. The equipment used in the research included a hand tractor, sprayer, plastic clips, analytical scale, moisture meter, plastic labels, label strings, scissors, measuring tape, hoe, machete, brown envelopes, ruler, sacks, camera, and writing tools. The data obtained were subjected to analysis of variance (Fisher's test) at a significance level of 5%. If a significant effect was observed, the Duncan's Multiple Range Test (DMRT) was performed at a 5% significance level. To determine the influence of environmental factors, heritability analysis (h2) was conducted in a broad sense. Correlation analysis was also conducted to study the relationships among the observed parameters and the yield. All data analyses were carried out using SAS Ver. 12 software. The parameters observed in this research included plant height (cm), harvesting age (days), number of tillers (stems), panicle length (cm), number of grains per panicle (grains), number of grains per hill (grains), weight of 1000 grains at 14% moisture content (g), and grain weight per hill (g).

RESULT AND DISCUSSION

Plant height, number of tillers, and harvesting age

The analysis of variance conducted on the 24 BC1F5 strains that were selected showed significant effects on plant height, number of tillers, panicle length, and harvesting age. This indicates a considerable variation among the 24 selected BC1F5 strains in terms of plant height, number of tillers, panicle length, and harvesting age. The Duncan's Multiple Range Test (DMRT) at a 5% significance level for plant height revealed that there were 11 strains with no significant difference in plant height compared to the Pandan Ungu and Kambang parent strains. The shortest plant height was recorded in strain 41 at 103.01 cm, while the tallest plant height was found in strain 209 at 130.49 cm (Table 1; Figure 1). Overall, it can be observed that there are 6 strains with a plant height of <110 cm, namely strains 41, 141, 303, 375, 117, and 296, indicating their potential as short-stemmed strains. Furthermore, the DMRT at a 5% significance level for the number of tillers showed that there were 19 strains with no significant difference compared to the Pandan Ungu and Kambang parent strains. The highest number of tillers was obtained in strain 141 at 14.74 stems, while the lowest number of tillers was recorded in strains 43 and 57, at 10.71 stems each (Table 1; Figure 2). According to the Department of Agriculture (2003), the ability to form tillers in the 24 selected BC1F5 strains falls into the moderate category (10-19 stems).

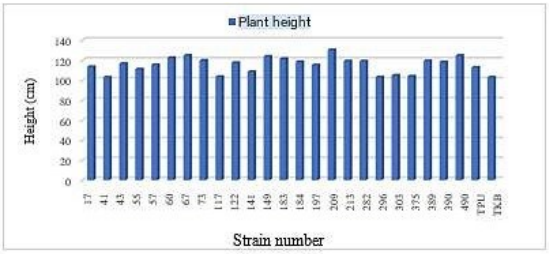

Figure 1. Average Plant Height Graph of 24 BC1F5 Backcrossing Strains PU/K//PU

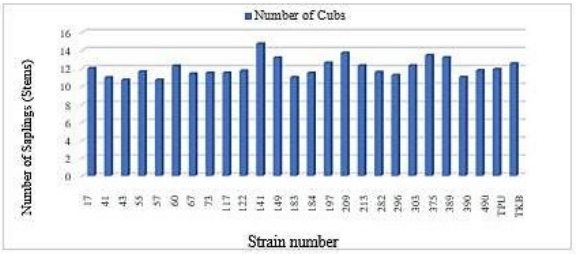

Figure 2. Average Number of Tillers Graph of 24 BC1F5 Backcrossed Strains PU/K//PU.

Regarding the panicle length parameter, the DMRT test at 5% significance level showed that there were 11 strains significantly different from the Pandan Ungu and Kambang parents. The longest panicle length was obtained in strain 73 with a length of 27.45 cm, while the shortest panicle length was obtained in strain 141 with a length of 22.38 cm (Table 1; Figure 3). According to Janne et al. (2018), overall, the panicle length of the 24 BC1F5 strains selected falls into the moderate category (20-30 cm). Meanwhile, the DMRT test at the 5% significance level for the harvest age parameter showed that there were 15 strains with no

significant difference in harvest age compared to the Pandan Ungu and Kambang parents. The shortest harvest age was obtained in strain 183 at 86.67 days after planting (DAP), while the longest harvestage was obtained in strain 55 at 94 DAP (Table 1; Figure 4). Overall, it can be observed that all 24 selectedBC1F5 strains have moderate tiller numbers, moderate panicle length, and early harvest age, meeting the expected selection criteria. Based on the parameters of plant height, tiller number, panicle length, and harvest age analyzed, it can be concluded that the backcross method is highly effective in eliminating undesirable traits and obtaining the desired traits.

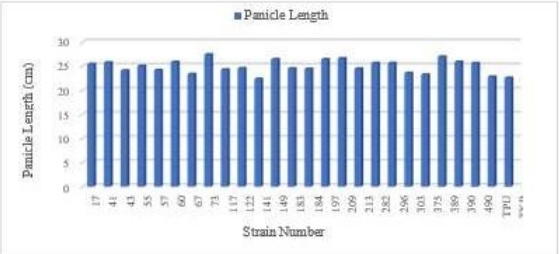

Figure 3. Average panicle length chart of 24 BC1F5 backcross strains PU/K//PU.

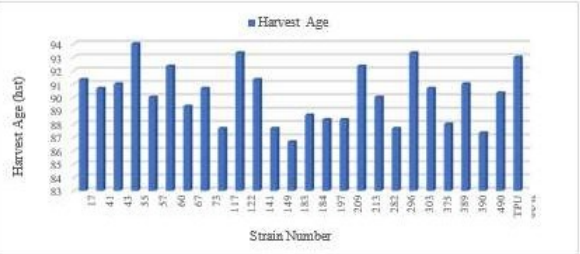

Figure 4. Average Harvest Age chart of 24 BC1F5 backcross strains PU/K//PU.

Table 1. Average plant height, number of tillers, panicle length and harvest age of 24 PU/K//PU backcross F5 lines

No	Variety	Plant Height		Number ofTiller		Panicle Length		Harvest Age	
1	17	113,63	a-e	12,00	Ab	25,47	bcde	91,33	a-e
2	41	103,01	A	10,96	B	25,79	abcd	90,67	a-e
3	43	116,70	a-f	10,71	B	24,12	d-i	91,00	a-e
4	55	111,22	a-e	11,63	Ab	25,08	b-f	94,00	A
5	57	115,69	a-e	10,71	B	24,21	d-i	90,00	a-e
6	60	122,65	Def	12,27	Ab	25,91	abcd	92,33	abcd
7	67	124,92	Ef	11,38	Ab	23,39	fghi	89,33	a-e
8	73	120,01	Def	11,48	Ab	27,45	a	90,67	a-e
9	117	103,75	Ab	11,50	Ab	24,31	d-h	87,67	De
10	122	117,69	b-f	11,71	Ab	24,59	c-g	93,33	Ab
11	141	108,69	Abcd	14,74	A	22,38	i	91,33	a-e
12	149	124,09	Ef	13,17	Ab	26,48	abc	87,67	De
13	183	121,72	Def	10,98	B	24,56	c-g	86,67	E
14	184	118,68	Cdef	11,48	Ab	24,47	d-h	88,67	bcde
15	197	115,39	a-e	12,60	Ab	26,45	abc	88,33	bcde
16	209	130,49	F	13,71	Ab	26,65	ab	88,33	bcde
17	213	119,47	Def	12,29	Ab	24,50	d-h	92,33	abcd
18	282	119,28	Def	11,56	Ab	25,66	abcd	90,00	a-e
19	296	103,32	A	11,23	Ab	25,67	abcd	87,67	De
20	303	105,01	Abc	12,29	Ab	23,60	e-i	93,33	Ab
21	375	104,11	Ab	13,46	Ab	23,27	fghi	90,67	a-e
22	389	119,63	Def	13,19	Ab	27,01	ab	88,00	Cde
23	390	118,50	Cdef	11,00	B	25,92	abcd	91,00	a-e
24	490	124,84	Ef	11,75	Ab	25,66	abcd	87,33	De
25	TPU	113,01	a-e	11,90	Ab	22,84	ghi	90,33	a-e
26	TKB	103,09	A	12,52	Ab	22,60	hi	93,00	Abc
		KK = 5.65%		KK = 15.24%		KK = 3.98%		KK = 2,96%	

Note: Average numbers followed by the same letter in the same column are not significantly different based on the DMRT 5%test.

Number of grains per panicle and number of grains per hill

The analysis of variance on 24 BC1F5 strains that were selected showed a significant effect on the parameters of the number of grains per panicle and the number of grains per hill. This indicates a significant variation among the 24 BC1F5 strains selected for the number of grains per panicle and the number of grains per hill. The DMRT test at the 5% level for the number of grains per panicle showed that there were 19 strains that did not significantly differ from the Pandan Ungu and Kambang parents. The highest number of grains per panicle was obtained in strain 55, with 194.17 grains, while the lowest number of grains per panicle was obtained in strain 213, with 112.13 grains (Table 2; Figure 5). The number of grains per panicle is categorized into three groups: few <150 grains, moderate 150-300 grains, and many >300 grains (Budi Irawan and Kartika, 2008). Based on these categories, it can be seen that out of the 24 selected BC1F5 strains, nine strains had a moderate number of grains per panicle (>150), namely strains 183, 197, 122, 296, 389, 184, 73, 149, and 55. Meanwhile, the DMRT test at the 5% level for the number of grains per hill showed that there were two strains that did not significantly differ from the Pandan Ungu and Kambang parents. The highest number of grains per hill was obtained in strain 55, with 1991.80 grains, while the lowest number of grains per hill was obtained in strain 117, with 1235.85 grains (Table 2; Figure 6). Overall, it can be seen that out of the 24 strains planted, 12 strains had a number of grains per hill >1500, namely strains 122, 375, 390, 303, 396, 197, 282, 184, 209, 55, 389, and 73, making them potential candidates for further selection.

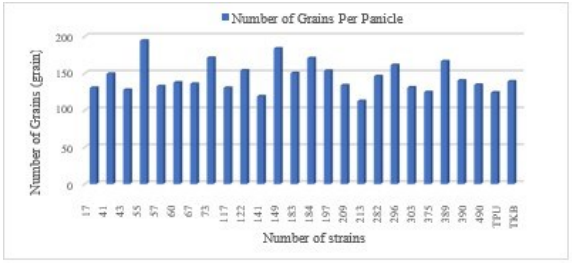

Figure 5. Average graph of the number of grains per panicle for 24 BC1F5 crossbred PU/K//PU lines.

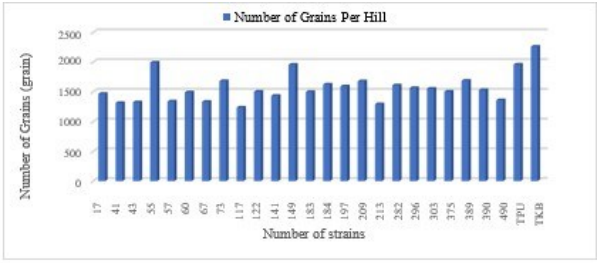

Figure 6. Average graph of the number of grains per hill for 24 BC1F5 crossbred PU/K//PU lines.

Table 2. Average number of grains per panicle and per hill from 24 F5 backcrossed lines PU/K//PU

Number	Strain	Number of Grains			
			Per Panicle		Per Hill
1	17	130,18	f-k	1465,70	De
2	41	149,21	c-h	1312,00	De
3	43	127,55	g-k	1324,30	De
4	55	194,17	A	1991,80	Ab
5	57	132,33	f-k	1338,50	De
6	60	137,32	e-j	1492,10	De
7	67	135,61	f-k	1334,10	De
8	73	170,88	Bc	1681,50	Bcd
9	117	130,27	f-k	1235,90	E
10	122	153,81	Cdef	1502,60	De
11	141	118,74	Jk	1433,30	De
12	149	183,58	Ab	1957,10	Abc
13	183	150,15	c-g	1499,00	De
14	184	170,45	Bc	1624,60	Bcde
15	197	153,43	Cdef	1592,40	Bcde
16	209	133,63	f-k	1678,20	Bcd
17	213	112,13	K	1293,30	De
18	282	145,96	d-i	1609,90	Bcde
19	296	161,14	Bcde	1563,50	Cde
20	303	130,71	f-k	1552,90	Cde
21	375	124,38	Hijk	1503,80	De

Number	Strain	Number of Grains			
			Per Panicle		Per Hill
22	389	166,23	Bcd	1687,30	Bcd
23	390	140,04	e-j	1529,20	De
24	490	134,37	f-k	1359,40	De
25	TPU	123,74	Ijk	1959,20	Abc
26	TKB	138,92	e-j	2259,10	A
			KK = 8.89%		KK = 13.52%

Note: Average numbers followed by the same letter in the same column are not significantly different based on the DMRT (Duncan's Multiple Range Test) at 5% level.

Weight of 1000 grains and weight of grains per hill

The analysis of variance on the 24 BC1F5 strains that were selected showed a significant effect on the parameter of weight of 1000 grains and weight of grains per hill. This indicates that there is a considerable variation among the 24 BC1F5 strains that were selected for the parameters of weight of 1000 grains and weight of grains per hill. The DMRT (Duncan's Multiple Range Test) at a 5% level for the weight of 1000 grains showed that there were 18 strains that did not differ significantly from the Pandan Ungu parent but differed significantly from the Kambang parent. The heaviest weight of 1000 grains were obtained from strain 41, weighing 26.49 g, while the lightest weightof 1000 grains were obtained from strain number 213, weighing 21.78 g (Table 3; Figure 7). The weight of 1000 grains are grouped into three categories: light <20 g, medium 20-25 g, and heavy >25 g (Ninik, 2013). Overall, it canbe seen that out of the 24 strains planted, 7 strains have a weight of >25 g or fall into the heavy category, namely strains 17, 41, 67, 183, 197, 209, and 375, and thus have the potential for selection as the next strains, while the other strains fall into the medium category. On the other hand, the DMRT at a 5% level for the weight of grains per hill showed that there were 6 strains that did not differ significantly from the Pandan Ungu and Kambang parents. The heaviest weight of grains per hill was obtained from strain 209, weighing 41.83 g, while the lightest weight of grainsper hill was obtained from strain number 43, weighing 24.90 g (Table 3; Figure 7). The weight of grains per hill is grouped into three categories: light <25 g, medium 25-50 g, and heavy >50 g (IRRI, 2002). Overall, it can be seen thatalmost all of the strains planted have a weight of >25 g, falling into the medium category, and thus have the potentialfor selection as the next strains, except for strain number 43, which has a weight of 24.90 and falls into the light category.

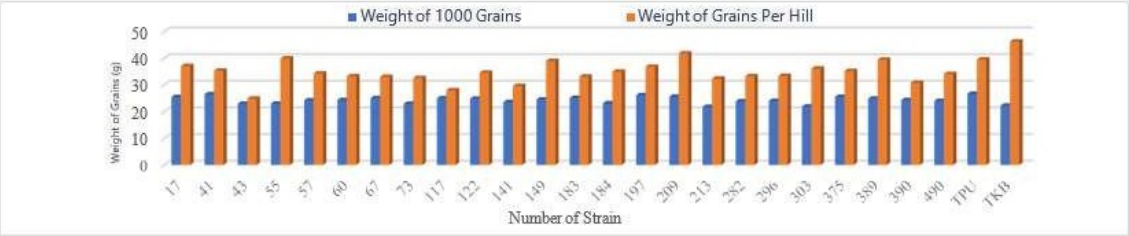

Figure 7. Average weight of 1000 grains and weight of grains per hill of 24 bc1f5 crossbreed strains pu/k//pu

Table 3. Average Weight of 1000 Grains and Weight of Grains per Hill of 24 BC1F5 Crossbreed Strains PU/K//PU.

Number	Strain	Weight of Grains (g)			
		1000 Grain		Per Hill	
1	17	25,45	Abcd	37,11	Abcd
2	41	26,49	Ab	35,35	Bcd
3	43	22,98	Cde	24,90	E
4	55	22,98	Cde	39,93	Abc
5	57	24,23	a-e	34,29	Bcde
6	60	24,35	a-e	33,23	Bcde
7	67	25,04	a-e	33,02	Bcde
8	73	22,97	Cde	32,61	Bcde
9	117	25,00	a-e	28,02	De
10	122	24,85	a-e	34,60	Bcde
11	141	23,57	a-e	29,61	Cde
12	149	24,54	a-e	39,00	Abc
13	183	25,14	a-e	33,12	Bcde
14	184	23,13	Bcde	35,00	Bcde

Number	Strain		Weight of Grains (g)		
			1000 Grain		Per Hill
15	197	26,15	Abc	36,80	Abcd
16	209	25,62	Abcd	41,83	Ab
17	213	21,78	E	32,40	Bcde
18	282	23,87	a-e	33,23	Bcde
19	296	24,02	a-e	33,39	Bcde
20	303	21,91	E	36,12	Bcd
21	375	25,55	Abcd	35,24	Bcd
22	389	24,87	a-e	39,49	Abc
23	390	24,36	a-e	30,78	Cde
24	490	24,03	a-e	34,09	Bcde
25	TPU	26,70	A	39,54	Abc
26	TKB	22,26	De	46,30	A
			KK = 7.10%		KK = 14.79%

Note: The average numbers followed by the same letter in the same column do not differ significantly based on the DMRT 5% test.

Heritability (h2)

To ensure that the selection process runs effectively, the genetic variability needs to be analyzed. Heritabilityvalues are classified into three categories: low heritability when h2 < 0.2, moderate heritability when 0.2 ≤ h2 ≤ 0.5,and high heritability when h2 > 0.5 (Riswanto, 2020). The analysis of heritability showed that all observed characteristics have heritability values ranging from (0.04-0.69). There are three characteristics with high heritabilityvalues, namely plant height (0.53), panicle length (0.62), and the number of grains per panicle (0.69). Four characteristics have moderate heritability values, which include harvest age (0.22), the number of grains per hill (0.50), weight of 1000 grains (0.21), and weight of grains per hill (0.29). There is one characteristic with low heritability, which is the number of tillers (0.04) (Table 4).

Table 4. Heritability (h2) Analysis Results

Parameter	$\sigma^2 g$	$\sigma^2 e$	$\sigma^2 p$	h^2	Category
Plant height	48,53	42,46	90,99	0,53	High
Harvest age	2,04	7,14	9,18	0,22	Medium
Number of tillers	0,12	3,35	3,23	0,04	Low
Panicle length	1,61	0,99	2,59	0,62	High
Weight of 1000 grains (JGM)	357,89	164,34	522,23	0,69	High
Weight of grains per hill (JGR)	45692,00	45008,25	90700,26	0,50	Medium
Weight of 1000 grains(Berat 1000 butir)	0,79	2,98	3,77	0,21	Medium
Weight of grains per hill (Berat gabah per rumpun)	10,79	26,74	37,52	0,29	Medium

The obtained high heritability values for the traits of plant height, panicle length, and number of grains per panicle indicate that these traits are more influenced by genetic factors than environmental factors. Therefore, plant height, panicle length, and number of grains per panicle can be used as selection criteria. Additionally, even though the number of grains per hill has moderate heritability, its value of 0.50 suggests it can still be used in selection activities. High heritability values indicate that selection can be efficiently applied to these traits, making it easier to modify them. Traits with higher heritability are easier to improve. Based on the heritability values obtained, it is suggested that there is a good chance to improve the observed traits. The 12 selected strains (lines 17, 41, 55, 57, 117,141, 149, 197, 296, 303, 375, and 389) can be further evaluated and used in breeding programs.

Correlation Analysis (r)

The relationship between agronomic traits can be assessed through correlation analysis, which provides correlation coefficients. Based on the correlation analysis results, it is evident that the weight of grains per hill has a highly significant and positive correlation with the number of tillers (r = 0.39112) and

the number of grains per hill (r= 0.81616). However, the other traits do not significantly affect the weight of grains per hill (Table 5).

Table 5. Correlation Analysis Results

	TT	UP	JA	PM	JGM	JGR	B1000	BGR
TT	1,00000							
	0,0							
UP	-0,31560	1,00000						
	0,0049	0,0						
JA	0,18600	-0,18149	1,00000					
	0,1030	0,1118	0,0					
PM	0,43022	-0,28926	-0,03731	1,00000				
	0,0001	0,0102	0,7457	0,0				
JGM	0,10478	-0,15627	0,00271	0,46095	1,00000			
	0,3613	0,1719	0,9812	0,0001	0,0			
JGR	-0,05086	0,07090	0,34620	0,00771	0,41588	1,00000		
	0,6583	0,5373	0,0019	0,9466	0,0002	0,0		
B1000	0,18475	-0,29954	0,05416	0,05688	-0,00154	-0,11650	1,00000	
	0,1054	0,0077	0,6377	0,6208	0,9894	0,3098	0,0	
BGR	0,04868	0,02899	0,39112	0,06537	0,29427	0,81616	0,07415	1,00000
	0,6721	0,8011	0,0004	0,5696	0,0089	0,0001	0,5188	0,0

Note: TT = plant height, UP = harvest age, JA = number of tillers, PM = panicle length, JGM = number of grains per panicle, JGR = number ofgrains per hill, B1000 = weight of 1000 grains, and BGR = weight of grains per hill

The positive correlation values between the weight of grains per hill and the number of tillers and the number of grains per hill indicate that an increase in the number of tillers will lead to an increase in the weight of grains per hill. The number of tillers produced by rice plants significantly influences the weight of grains producedbecause a plant with a higher number of productive tillers will result in an increased number of grains. Similarly,an increase in the number of grains per hill will lead to an increase in the weight of grains per hill. Conversely, adecrease in both of these characteristics will result in a decrease in the weight of grains per hill. Therefore, to increase rice grain production per hill Yyield), efforts can be made to improve the number of tillers and the number of grains on rice plants. This can be achieved through optimal fertilizer application, proper irrigation practices, and careful spacing during planting (Pusat Penyuluh Pertanian, 2019).

CONCLUSION

The research results indicate that there are differences in growth and yield among the 24 backcross strainsof Pandan Ungu/Kambang//Pandan Ungu (PU/K//PU). Three characters, namely plant height, panicle length, andthe number of grains per panicle, have high heritability values, indicating that these agronomic traits are more influenced by genetic factors than environmental factors. Four characters, including days to maturity, number ofgrains per hill, 1000-grain weight, and grain weight per hill, have moderate heritability values. Additionally, onecharacter, the number of tillers, has low heritability, meaning it is more influenced by environmental factors than genetic factors. Based on these four selection characters, 12 strains are recommended for further selection: strains17, 41, 55, 57, 117, 141, 149, 197, 296, 303, 375, and 389. The character of grain weight per hill has a highly significant and positive correlation with the number of tillers and the number of grains per hill, while the other characters do not significantly influence grain weight per hill.

ACKNOWLEDGEMENT

The author would like to express gratitude to Prof. Dr. Ir. H. Rusdiansyah, M.Si., who provided financial support and allowed the author to participate in the research, as well as to all the relevant parties who assisted and provided facilities to ensure the smooth conduct of the research.

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Performance and Role of Leading Sectors in Labor Absorption and Work Opportunity Creation in West Kutai, East Kalimantan

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ABSTRACT

West Kutai District in East Kalimantan Province, Indonesia, has a Gross Regional Domestic Product (GRDP) and a smallerlabor force compared to most other districts/cities in the province. Another fact indicates that welfare is not evenly distributed in West Kutai. Appropriate policies can improve people's welfare while simultaneously stimulating regional economic growth. Prioritizing development is necessary to expedite progress and achieve development objectives. The purpose of this research is to analyze the performance of various business sectors, categorize them, assess labor absorption capacity, and estimate the potential for job creation in West Kutai. Time-series data were collected for this research, and data analysis employed both qualitative and quantitative descriptive methods. Business sectors were categorized based on the Location Quotient (LQ) index, and job creation potential was determined by labor multiplier analysis. From 2013 to 2021, West Kutai's average contribution to East Kalimantan's GRDP was 4.297% per year. The district had six leading sectors and eleven non-leading sectors. The average labor absorption in business fields was 73,788 people per year from 2017 to 2021 in West Kutai, with an average labor multiplier of 1.085 during thesame period. The choice of prioritized business fields should align with the development approach. Capital-intensive development should focus on sectors with a high average LQ, while labor-intensive development should prioritize sectors with a high average labor multiplier.

Key words: labor, leading sector, West Kutai, job opportunities.

INTRODUCTION

Economic growth is significantly influenced by the performance of business sectors, which serves as the driving force and is reflected in the Gross Regional Domestic Product (GRDP) value [1]. In 2021, the GRDP of WestKutai District (WK) at constant prices amounted to IDR 21,509.22 billion, contributing 7.63% to the GRDP of East Kalimantan Province (EK) [2]. Although WK's GRDP was higher than that of Penajam Paser Utara and Mahakam Ulu Districts, it still lagged behind the GRDP of seven other districts/cities in East Kalimantan. This indicates that theperformance of business sectors in WK has not yet reached its full potential. The GRDP value of WK is the cumulativeresult of the domestic product generated by all business sectors within the region [3]. The low GRDP reflects that thedevelopment goal of increasing regional productivity has not been fully realized. Furthermore, the impact of development in one business sector can affect the progress of other sectors. Therefore, development activities within a business sector should be carried out in an integrated manner, in alignment with the development of other sectors [4], and should be integrated into a comprehensive work program designed for a specific area [5]. Accelerating the achievement of regional development goals is more effective when the development strategy is focused on key or leading economic sectors [6]. Previous research ([1] [7]) has indicated the need for setting development priorities, yetthe scope of these studies covered only 11 of the 17 main business sectors in WK, leaving six sectors with an unknownclassification as leading or non-leading.

The development of business sectors is supported by the role of human resources, among other resources. Labor plays a crucial role in achieving development objectives [8]. The level of output [9] is determined by factors such as the availability and utilization of human resources, technological level, market conditions, the economic system framework, and the attitude toward output. The greater the economic potential of a region, the more resources (including labor) are utilized, and the more the regional economy advances [10]. In 2021, business sectors in WK employed 72,394 people, accounting for only 4.189% of the total working population in EK [2]. Labor absorption in WK was higher than in Mahulu District but lower than in eight other regencies/cities in EK. The limited labor absorption capacity in business sectors is related to their ability to create employment opportunities.

The capacity to create employment opportunities also indicates the role of business sectors in economic development within the community. The greater a sector's ability to create employment opportunities, the more workopportunities are available for the workforce [7], leading to increased social

welfare. However, in 2021, 7.998% of WK's population was still categorized as poor (13,780 people out of a total population of 172,290). WK ranked sixthin terms of the highest number of poor people among the ten regencies/cities in EK, where the total number of poor people in EK in 2021 was 230,270 people [2]. This suggests that the overarching goal of development policy to promote overall economic growth and social welfare [9] has not been fully realized. Therefore, it is essential to formulate development policies that can enhance people's welfare while concurrently stimulating regional economic growth.

The objectives of this research were to analyze the performance of business sectors, determine their categorization, measure labor absorption capacity, estimate the ability to create employment opportunities, and formulate strategies to enhance the role of business sectors in driving the economy of WK and EK. The benefits of this research lie in its potential to serve as a foundation for shaping regional development policies and as reference material for academic and other research endeavors.

METHODS

This research focused on the economic conditions in West Kutai District, East Kalimantan Province, Indonesia.The research was conducted from August to December 2022, and it utilized secondary data as its primary source. Datawere collected from publications by the West Kutai (WK) and East Kalimantan (EK) Statistics offices. The collecteddata included time series data on the Gross Regional Domestic Product (GRDP) from 2013 to 2021 and the number of the working population from 2017 to 2021. Data analysis involved qualitative and quantitative descriptive methods, including calculations of totals, averages, maximum and minimum values, and percentages, along with the use of graphs.

The economy can be categorized into two sectors ([11] [9]): the leading sector (base) and the non-leading sector(non-base). The relationship between these two sectors, in the form of leading sector development, can drive the growth of the non-leading sector. Leading sectors are identified through Location Quotient (LQ) analysis. Several assumptions related to the LQ technique are (a) that the pattern of residents' demand in a region is similar to national(regional) demand, (b) that labor productivity in each industrial sector in the region is similar to that in the national industry, (c) that the goods produced by each industry are homogeneous within each sector, and (d) that the country'seconomy operates as a closed economy. The LQ method compares the relative share of income from sector i at the regional level to the total regional income with that at the national level to the total national income ([12] [13]). The LQ formula is expressed as (vi/vt)/(Vi/Vt) [12]. In this study, the LQ mathematical equation was applied as follows:

$$LQ = \frac{vi/vt}{Vi/Vt}$$

Where:
LQ = LQ index;
vi = WK GRDP at constant prices of 2010 for business fields of Processing Industry; Procurement of Electricityand Gas; Water Procurement, Waste Management, Waste, and Recycling; Wholesale and Retail Trade, Repair and Maintenance of Cars and Motorcycles; Transportation and Warehousing; and Information and Communication;
vt = WK's total GRDP at constant prices of 2010;
Vi = GRDP of EK at constant prices of 2010 for business fields of Processing Industry; Procurement of Electricity and Gas; Water Procurement, Waste Management, Waste, and Recycling; Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle; Transportation and Warehousing; and Information and Communication;
Vt = EK's total GRDP at constant 2010 prices.

Decision rules:
- LQ = 1, meaning the production value of certain business fields in WK is the same as the same business field in EK,that sector is a non-leading sector.
- LQ > 1, meaning the production value of certain business field in WK is greater than the same business field in EK,that sector is a leading sector in WK which has the potential to be developed and can become a mover of WK'seconomy and its production has potential to be exported.
- LQ < 1, meaning the production value of certain business fields in WK is smaller than the same sector in EK, that sector is not a leading sector in WK because it lacks potential to be developed as a mover of WK's economy and its production has the potential to be imported.

The capacity of labor absorption in each business field in WK and EK is known by analyzing the level and rateof labor absorption in 2017-2021. The ability of each business field to create work opportunities is known from the analysis of labor multiplier. The assumption is the proportion of regional income

which is spent in the region proportional to the proportion of regional labor [12]. The multiplier analysis consists of three types, namely the multiplier of production, the multiplier of household income, and the multiplier of total labor [14]. The formula usedto determine the labor multiplier in this study was as follows [12]:

$$MS = \frac{1}{1 - (\frac{YN}{Y})}$$

Where:
MS = labor multiplier of the studied sector;
Y = total labor in WK;
YN = labor of other sectors;
YB = labor of studied sector.

RESLUT AND DISCUSSION

Business Fields Performance in West Kutai District, East Kalimantan Province

In 2021, the Gross Regional Domestic Product (GRDP) of West Kalimantan (WK) and East Kalimantan at constant prices of 2010 stood at IDR 21,509,220.00 million (4.441%) and IDR 484,297,350.00 million, respectively.The highest GRDP for WK during the period of 2013-2021 was achieved in 2021. Conversely, the lowest GRDP forEast Kalimantan was recorded in 2013, totaling IDR 438,532,907.00 million. The total GRDP of WK and East Kalimantan at constant prices of 2010 for the years 2013-2021 is illustrated in Figure 1. On average, WK's contribution to the formation of East Kalimantan's GRDP between 2013 and 2021 amounted to 4.297% per year.

Figure 1. Gross regional domestic product of West Kutai District and East Kalimantan Province in 2013-2021 at constant prices of 2010 ([2] [15] [16] [17]).

The Wholesale and Retail Trade, Repair, and Maintenance of Car and Motorcycle sectors in WK exhibited thebest performance compared to the other five business fields (Figure 2). This is evident from its capacity to generate alarger GRDP compared to the capabilities of the other five business fields. Meanwhile, two business fields, namely Water Procurement, Waste Management, Waste, and Recycling, as well as Procurement of Electricity and Gas, madea smaller contribution to the formation of WK's GRDP compared to the other four business fields.

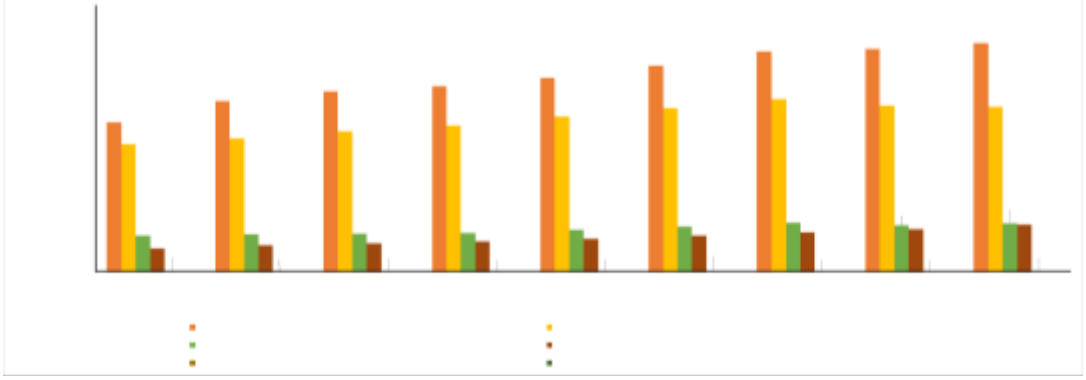

Figure 2. Gross regional domestic product several business fields in West Kutai District and East Kalimantan Province in 2013-2021 at constant prices of 2010 ([15] [16]).

In contrast to the performance of the six business fields in WK, at the provincial level, the Processing Industry sector exhibited the best performance compared to the five other sectors. The performance of the other five business fields tended to be relatively similar in terms of their ability to generate GRDP. During the period of 2013-2021, the Processing Industry sector generated an average GRDP of IDR 92,844,184.56 million per year. Meanwhile, the GRDP generated by the other five business fields remains below IDR 25,000,000.00 million per year (Figure 3).

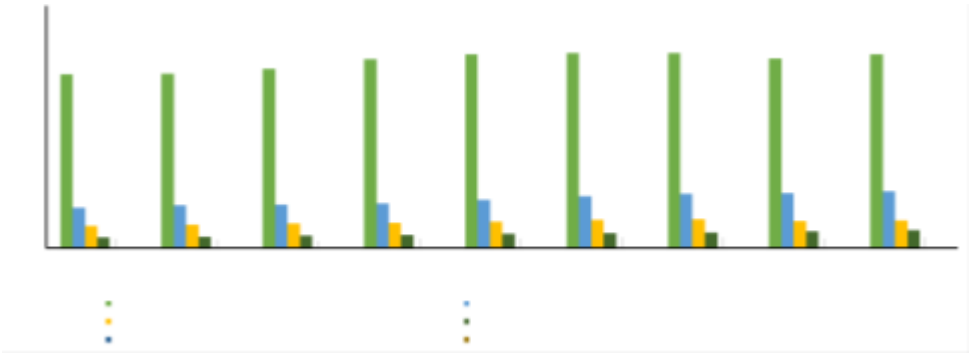

Figure 3. Gross regional domestic product of several business fields in east Kalimantan Province in 2013-2021 at constant prices of 2010 ([2] [17]).

Leading Sector in West Kutai District

The results of data analysis (Figure 4) indicate that the Local Quotient (LQ) of the Wholesale and Retail Trade,Repair, and Maintenance of Car and Motorcycle sector was consistently above 1 during the 2013-2021 period. Therefore, this business field has been the leading sector in WK for the past 9 years. This sector operates independently, meeting the local area's needs, and its surplus production can be exported outside the WK region. In contrast, the other five business fields studied were not leading sectors, as they had LQ values below 1 during the 2013-2021 period.

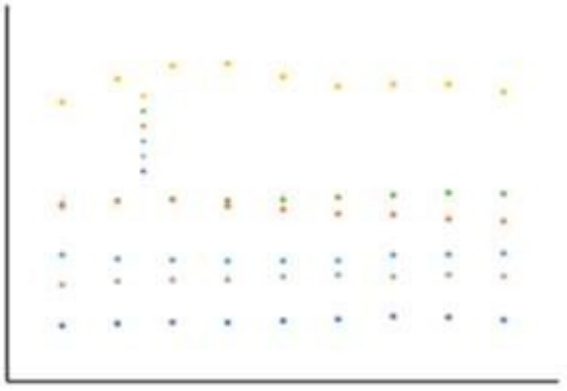

Figure 4. Location quotient of several business fields in West Kutai District in 2013-2021

The results of the study (Table 1) show that there were 6 leading sectors of 17 developing business fields in WK. The status as a leading sector shows that this business field is able to perform well in supporting the WK region'seconomy. Meanwhile, the other 11 business fields are non-leading sectors. Most of the business fields developed by the government, such as Procurement of Electricity and Gas, Water Procurement, Waste Management, Waste, and Recycling, and Educational Services, are non-leading sectors. Limited production and a narrow market can hinder thedevelopment of non-leading sectors into the leading sectors.

Labor Absorption in West Kutai District, East Kalimantan Province

During the period of 2017-2021, both the total number and the rate of labor absorption in WK experienced fluctuations. In 2017, the recorded working population in WK across all business fields was 66,562 people. By 2021,this number had increased to 78,633 people. The rate of labor absorption in WK witnessed an 11.435% increase in 2018 but decreased by 3.815% in 2019. It then increased by 4.989% in 2020 but decreased once again by 3.100% in 2021 (Table 2). Fluctuations in labor absorption can be attributed to the interdependencies among sectors [12]. For example, the connection between the agricultural sector and the trade sector in distributing agricultural products, as well as the link between the agricultural sector and the industrial sector, where the latter produces derivative productsfrom agricultural goods.

The majority of the workforce (41.50%), averaging 30,652 people per year, is employed in the Agriculture, Forestry, and Fisheries sector in WK. Conversely, a smaller proportion of the labor force (0.114%), averaging 84 people per year, is engaged in the Procurement of Electricity and Gas sector. The agricultural sector absorbs a substantial amount of labor because it does not require specialized skills or a particular level of formal education andis influenced by the man-land ratio [18]. In East Kalimantan, the rate of labor absorption has fluctuated but remainedbelow 6% over the last 5 years. The average labor force in East Kalimantan was 1,671,105 people per year during the2017-2021 period. The Wholesale and Retail Trade; Repair and Maintenance of Car and Motorcycle sector absorbs the most workers, with an average of 356,547 people per year. Conversely, the Real Estate sector employed the fewestworkers compared to other business fields, averaging only 5,763 people per year (Table 3). Labor absorption increasesdue to sector mobility within an area and its surrounding regions [12].

Table 1. Total and mean Location Quotient and business field category in West Kutai Regency in 2013-2021.

No.	Business field	Total	Mean	Category
1	Administration Government, Defense, and Compulsory Social Security	20.633	2.293	Leading sector
2	Agriculture, Forestry, and Fisheries	16.838	1.871	Leading sector
3	Construction	12.249	1.361	Leading sector
4	Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle	11.502	1.278	Leading sector
5	Health Services and Social Activities	10.808	1.201	Leading sector
6	Mining and Quarrying	10.330	1.148	Leading sector
7	Educational Services	8.926	0.992	Non leading sector
8	Information and Communication	7.021	0.780	Non leading sector
9	Water Procurement, Waste Management, Waste, and Recycling	6.573	0.730	Non leading sector
10	Real Estate	5.938	0.660	Non leading sector
11	Transportation and Warehousing	4.745	0.527	Non leading sector
12	Other Services	4.581	0.509	Non leading sector
13	Procurement of Electricity and Gas	3.951	0.439	Non leading sector
14	Provision of Accommodation and Food and Drink	3.101	0.345	Non leading sector
15	Company Services	2.587	0.287	Non leading sector
16	Processing Industry	2.322	0.258	Non leading sector
17	Financial Services and Insurance	0.722	0.080	Non leading sector
Total		132.827	14.759	
Mean		7.813	0.868	

Source: [1], [7], secondary data processed (2022).

Table 2. Number of working populations by main business fie lds in west Kutai district in 2017-2021

No.	Business field	Year					Total (person)	Mean (person)
		2017	2018	2019	2020	2021		
1	Agriculture, Forestry, and Fisheries	32,316	31,144	24,951	29,907	34,943	153,261	30,652
2	Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle	8,427	10,171	11,124	11,898	9,536	51,156	10,231
3	Administration Government, Defense, and Compulsory Social Security	6,952	10,047	8,735	8,463	7,809	42,006	8,401
4	Educational Services	3,201	4,065	4,782	4,557	5,298	21,903	4,381
5	Processing Industry	3,544	3,667	3,904	4,725	5,908	21,748	4,350
6	Mining and Quarrying	2,522	3,996	3,745	4,491	3,159	18,809	3,762
7	Construction	2,629	1,563	3,402	1,959	1,509	18,020	3,604
8	Other Services	2,051	1,477	2,036	2,466	2,818	10,484	2,097
9	Provision of Accommodation and Food and Drink	1,265	1,984	1,219	2,110	1,720	10,062	2,012
10	Transportation and Warehousing	1,395	820	1,415	1,564	1,393	8,428	1,686
11	Health Services and Social Activities	1,082	930	723	342	686	6,274	1,255
12	Company Services	813	588	114	291	294	3,494	699
13	Financial Services and Insurance	180					1,467	293
14	Water Procurement, Waste Management, Waste, and Recycling		438	240	297	138 297	816	163
15	Information and Communication				233		594	119
16	Procurement of Electricity and Gas	185					418	84
17	Real Estate							
	Total labor absorption (person)	66,562	75,156	72,394	76,195	78,633	368,940	73,788
	Rate labor absorption (%)		11.435	-3.815	4.989	3.100		

Source: National Labor Force Survey 2021

Table 3. Number of working populations by main business fields in East Kalimantan Province in 2017-2021

No.	Business field	Year					Total (person)	Mean (person)
		2017	2018	2019	2020	2021		
1	Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle	333,623	333,863	363,350	373,658	378,242	1,782,736	356,547
2	Agriculture, Forestry, and Fisheries	331,114	361,838	331,185	346,768	358,508	1,729,413	345,883
3	Mining and Quarrying	125,663	140,111	140,747	123,059	122,077	651,657	130,331
4	Provision of Accommodation and Food and Drink	90,034	114,693	127,489	121,228	131,768	585,212	117,042
5	Administration Government, Defense, and Compulsory Social Security	119,232	114,633	113,204	113,818	123,864	584,751	116,950
6	Processing Industry	10,653	119,992	130,652	105,416	113,368	574,081	114,816
7	Educational Services	98,744	104,731	95,787	97,502	99,805	496,569	99,314
8	Construction	84,251	85,386	100,492	108,493	99,693	478,315	95,663

No.	Business field	Year					Total (person)	Mean (person)
		2017	2018	2019	2020	2021		
9	Transportation and Warehousing	76,357	73,177	92,140	85,867	79,296	406,837	81,367
10	Other Services	76,248	75,001	85,276	82,625	69,331	388,481	77,696
11	Company Services	32,969	37,932	50,849	35,932	43,220	200,902	40,180
12	Health Services and Social Activities	28,496	28,582	29,626	36,164	41,630	164,498	32,900
13	Financial Services and Insurance	26,303	27,751	23,196	21,302	18,402	116,954	23,391
14	Information and communication	14,315	14,957	12,709	15,185	14,895	72,061	14,412
15	Water Procurement, Waste Management, Waste, and Recycling	8,331	8,442	13,215	9,376	11,050	50,414	10,083
16	Procurement of Electricity and Gas	5,284	6,497	10,706	10,455	10,888	43,830	8,766
17	Real Estate	7,548	3,450	7,546	5,948	4,324	28,816	5,763
Total labor absorption (person)		1,563,16	1,651,036	1,728,16	1,692,79	1,720,36	8,355,52	1,671,105
Rate labor absorption (%)		-1.156	5.322	4.463	-2.090	1.602		

Source: National Labor Force Survey 2021

Work Opportunity Creation in West Kutai District, East Kalimantan Province

From a quantitative perspective, work opportunities indicate the number of people who are currently employedor can potentially find employment in a specific business field. Work opportunities are realized through the availability of job openings that enable individuals to engage in productive work. Thus, work opportunities can be understood asthe demand for labor [18]. The data in Table 4 illustrates the labor multiplier for each business field in WK during theperiod of 2017-2021. The average labor multiplier in the Agriculture, Forestry, and Fisheries sector was 1.725. This means that an increase in labor absorption in the Agriculture, Forestry, and Fisheries sector by one person is predictedto create new job opportunities that can increase labor absorption in other business fields, aside from Agriculture, Forestry, and Fisheries, by as many as two people.

The development of agriculture, forestry, and fisheries not only expands work opportunities within the sector itself but also induces the creation of work opportunities in other sectors related to Agriculture, Forestry, and Fisheriesby a factor of two. The average labor multiplier for all business fields in East Kalimantan from 2017-2021 was 1.068,which is lower than that in WK (1.085). The labor multiplier for each business field in East Kalimantan during the same period is presented in Table 5. A declining labor multiplier in a business field over time indicates a diminishingrole in expanding work opportunities or generating quality jobs in that field and other related business fields. Conversely, an increase in the labor multiplier for a business field signifies an amplified role in expanding work opportunities.

Table 4. The labor multipliers of business fields in West Kutai District in 2017-2021

No.	Business field	Year					Total	Mean
		2017	2018	2019	2020	2021		
1	Agriculture, Forestry, and Fisheries	1.944	1.708	1.526	1.646	1.800	8.623	1.725
2	Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle	1.145	1.157	1.182	1.185	1.138	5.806	1.161
3	Administration Government, Defense, and Compulsory Social Security	1.117	1.154	1.137	1.125	1.110	5.643	1.129
4	Educational Services	1.051	1.057	1.071	1.064	1.072	5.314	1.063
5	Processing Industry	1.056	1.051	1.057	1.066	1.081	5.312	1.062
6	Mining and Quarrying	1.039	1.060	1.090	1.039	1.041	5.271	1.054
7	Construction	1.041	1.056	1.055	1.063	1.042	5.256	1.051

No	Business field	Year					Total	Mean
		2017	2018	2019	2020	2021		
8	Other Services	1.032	1.021	1.049	1.026	1.020	5.148	1.030
9	Health Services and Social Activities	1.017	1.011	1.020	1.021	1.018	5.086	1.017
10	Company Services	1.012	1.013	1.010	1.005	1.009	5.048	1.010
11	Provision of Accommodation and Food and Drink	1.019	1.020	1.029	1.033	1.037	5.139	1.028
12	Transportation and Warehousing	1.021	1.027	1.017	1.028	1.022	5.116	1.023
13	Water Procurement, Waste Management, Waste, and Recycling		1.006	1.003		1.002	3.011	1.004
14	Information and Communication				1.004	1.004	2.008	1.004
15	Financial Services and Insurance	1.003	1.008	1.002	1.004	1.004	5.020	1.004
16	Procurement of Electricity and Gas	1.003			1.003		2.006	1.003
17	Real Estate							
Total		15.499	15.349	15.248	16.313	16.400	78.809	17.367
Mean		1.107	1.096	1.089	1.088	1.093	4.926	1.085

The average labor multiplier for all business fields in East Kalimantan during the period of 2017-2021 was 1.068, which is lower than that in WK (1.085). Table 5 presents the labor multiplier for each business field in East Kalimantan for the same period. A declining labor multiplier in a business field over time indicates that the role of that business field in expanding work opportunities or creating quality jobs in itself and other related business fields is diminishing. Conversely, an increase in the labor multiplier for a business field signifies an enhanced role in expanding work opportunities.

Increasing the Role of bussines fields in West Kutai District, East Kalimantan Province

Leading sectors in the business field are not always the ones that generate the highest GRDP or have the greatest capacity for labor absorption. The results of data analysis (Table 6) provide recommendations for the development priorities of business fields based on the average LQ (Location Quotient) and the average labor multiplier. The choiceof development policy will determine the selected development priorities. If capital-intensive development is chosen,it is advisable to prioritize business fields based on the average LQ, such as (1) Government Administration, Defense, and Compulsory Social Security, (2) Agriculture, Forestry, and Fisheries, (3) Construction, (4) Wholesale and RetailTrade, Repair and Maintenance of Car and Motorcycle, and so on. However, if development will focus on labor- intensive methods, the selection of business field development priorities can be based on the ranking of the average labor multiplier, including (1) Agriculture, Forestry, and Fisheries, (2) Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle, (3) Government Administration, Defense, and Compulsory Social Security, (4)Educational Services, and so on.

Table 5. The labor multipliers of business fields in East Kalimantan Province in 2017-2021

No	Business Field	2017	2018	2019	2020	2021	Total Person	Mean Person
1	Wholesale and Retail Trade, Repairand Maintenance of Car and Motorcycle	1.271	1.253	1.266	1.266	1.283	6.356	1.271
2	Agriculture, Forestry, and Fisheries	1.269	1.281	1.237	1.258	1.263	6.307	1.261
3	Mining and Quarrying	1.087	1.093	1.089	1.078	1.076	5.424	1.085

No	Business field	Year					Total	Mean
		2017	2018	2019	2020	2021		
4	Provision of Accommodation and Food and Drink	1.061	1.075	1.080	1.077	1.083	5.376	1.075
5	Administration Government, Defense, andCompulsory Social Security	1.083	1.075	1.070	1.072	1.078	5.377	1.075
6	Processing	1.072	1.078	1.082	1.066	1.071	5.369	1.074
7	Industry	1.067	1.068	1.059	1.061	1.062	5.317	1.063
8	Educational Services	1.057	1.055	1.062	1.068	1.062	5.303	1.061
9	Construction	1.051	1.046	1.056	1.053	1.048	5.256	1.051
10	Transportation and Warehousing Other Services	1.051	1.048	1.052	1.051	1.042	5.244	1.049
11	Company Services	1.022	1.024	1.030	1.022	1.026	5.123	1.025
12	Health Services and SocialActivities	1.019	1.018	1.017	1.022	1.025	5.100	1.020
13	Financial Services andInsurance	1.017	1.017	1.014	1.013	1.011	5.071	1.014
14	Information and Communication	1.009	1.009	1.007	1.009	1.009	5.044	1.009
15	Water Procurement, WasteManagement, Waste, and Recycling	1.005	1.005	1.008	1.006	1.006	5.030	1.006
16	Procurement of Electricityand Gas	1.003	1.004	1.006	1.006	1.006	5.026	1.005
17	Real Estate	1.005	1.002	1.004	1.004	1.003	5.017	1.003
Total		18.150	18.149	18.139	18.150	18.151	90.740	18.148
Mean		1.068	1.068	1.067	1.068	1.068	5.338	1.068

Efforts to increase GRDP, labor absorption, and work opportunities should be tailored to the conditions and development needs of each business field. For example, in the agricultural sector, it is essential to modernize agricultural technology and provide agricultural counseling to encourage community involvement in farming.Additionally, the development and maintenance of core and ancillary infrastructure in all business fields are necessaryto boost production capacity and facilitate marketing

Table 6. The averages of gross regional domestic product, location quotient, labor, and labor multiplier in west Kutai district

Prio -rity	Business field	GRDP mean of 2013-2021 (IDR billion)	*LQ* mean of 2013-2021	Category	Prio -rity	Business field	Labor mean of 2017-2021 (person)	Labor multiplier mean of 2017-2021
1	Administration Government, Defense, and Compulsory Social Security	775.712	2.293	Leading sector	1	Agriculture, Forestry, and Fisheries	30,652	1.725
2	Agriculture, Forestry, and Fisheries	2,424.986	1.871	Leading sector	2	Wholesale and Retail Trade, Car and Motorcycle Repair	10,231	1.161
3	Construction	1,899.834	1.361	Leading sector	3	Administration Government, Defense, and Compulsory Social Security	8,401	1.129
4	Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle	1,322.137	1.278	Leading sector	4	Educational Services	4,381	1.063
5	Health Services and Social Activities	134.444	1.201	Leading sector	5	Processing Industry	4,350	1.062
6	Mining and Quarrying	11,052.833	1.148	Leading sector	6	Mining and Quarrying	3,762	1.054
7	Educational Services	265.436	0.992	Non	7	Construction	3,604	1.051

Prio -rity	Business field	GRDP mean of 2013-2021 (IDR billion)	*LQ* mean of 2013-2021	Category	Prio -rity	Business field	Labor mean of 2017-2021 (person)	Labor multiplier mean of 2017-2021
				leading sector				
8	Information and Communication	234.781	0.780	Non leading sector	8	Other Services	2,097	1.030
9	Water Procurement, Waste Management, Waste, and Recycling	6.724	0.730	Non leading sector	9	Health Services and Social Activities	1,255	1.017
10	Real Estate	114.207	0.660	Non leading sector	10	Company Services	699	1.010
11	Transportation and Warehousing	290.820	0.527	Non leading sector	11	Provision of Accommodation and Food and Drink	2,012	1.028
12	Other Services	50.546	0.509	Non leading sector	12	Transportation and Warehousing	1,686	1.023
13	Procurement of Electricity and Gas	4.547	0.439	Non leading sector	13	Water Procurement, Waste Management, Waste, and Recycling	163	1.004
14	Provision of Accommodation and Food and Drink	53.751	0.345	Non leading sector	14	Information and Communication	119	1.004
15	Company Services	10.800	0.287	Non leading sector	15	Financial Services and Insurance	293	1.004
16	Processing Industry	1,031.690	0.258	Non leading sector	16	Procurement of Electricity and Gas	84	1.003
17	Financial Services and Insurance	23.132	0.080	Non leading sector	17	Real Estate		
Total		177,269.434	14.759				73,788	17.367
Mean		19,696.604	0.868				4,612	1.085

CONCLUSION

In the period of 2013-2021, WK's GRDP played a significant role in contributing to East Kalimantan's GRDP,with an average annual contribution of 4.297%. The leading sectors in WK, which have the potential for further development and economic growth, include:

1. Government Administration, Defense, and Compulsory Social Security
2. Agriculture, Forestry, and Fisheries
3. Construction
4. Wholesale and Retail Trade, Repair and Maintenance of Car and Motorcycle
5. Health Services and Social Activities
6. Mining and Quarrying

On the other hand, 11 other sectors in WK are classified as non-leading sectors. The business fields in WK were successful in absorbing labor, providing an average of 73,788 job opportunities per year during the period of 2017-2021. The average labor multiplier for all business fields in WK from 2017-2021 was 1,085 per year. This implies that the addition of one laborer is predicted to create new job opportunities, increasing labor absorption in another business field by one person. When determining the priority for capital-intensive development, it is recommended to consider the average LQ. However, if a policy favors labor-intensive development, the priority should be based on the average labor multiplier.

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Design of Palm Fruit Digester and Pressing Equipmentand Its Application in Red Palm Oil (RPO) Production

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ABSTRACT

This research aims to design a digester and press machine for palm fruits (*Elaeis guineensis*) to produce red palm oil, whichcan be utilized by palm fruit farmers, particularly in East Kalimantan. The digester equipment is crafted using stainless steel, forming a cylinder with a diameter of 49 cm and a plate thickness of 2 cm. Five chopping knives are constructed from 6 mm thickiron plates, each measuring 19 cm in length. They are connected to an iron shaft and powered by a ¾ HP 1-phase 1450 rpm Wiproelectric motor via a V-belt. The palm oil press is designed with two cylinders made of stainless steel, featuring an inner cylinder diameter of 29.5 cm and an outer diameter of 38 cm, assisted by a 6-ton Tekiro hydraulic jack. From the testing results, using 5 kgof palm fruit as feedstock, 920 ml of Crude Palm Oil (CPO) was obtained, which underwent filtration to yield 500 ml. The chemicalanalysis of the resulting CPO showed a water content of 0.2% and a Free Fatty Acid (FFA) content of 3.4%. The IC50 value for CPO was measured at 41.29 µg. mL-1, α-Tocopherol at 198.73 µg. mL-1 ± 2.30, and β-Carotene at 30.12 µg.mL-1 ± 0.36. These results indicate its potential use as raw material for Red Palm Oil (RPO) production. Based on the digester and palm oil press testing results, further optimization is still necessary, particularly concerning the steaming time of palm fruits before the digestionprocess.

Keywords: CPO, digester, FFA, pressing equipment, RPO.

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INTRODUCTION

In early October 2021, Indonesia faced a cooking oil shortage, primarily driven by the COVID-19 pandemic, reduced production, surging global demand, and distribution disruptions. This shortage led to a significant increase inthe market price of cooking oil, exceeding the normal price by more than double. The scarcity and price hike deeply affected the Indonesian population, especially those in the lower to middle-income groups (Andriessa et al., 2022). One potential solution to address the cooking oil shortage is the utilization of red palm oil. Indonesia is one of the world's leading producers of palm fruit (*E. guinensis*), ensuring a relatively more accessible and abundant supply of raw materials for red palm oil production (BPS, 2021).

Red palm oil, characterized by its pale red color, offers numerous health benefits. Some of these benefits include: Richness in vitamins A, E, and K, with vitamin E protecting cells and promoting skin health. High content ofunsaturated fatty acids, beneficial for heart health and improving blood lipid profiles. Abundance of antioxidants, suchas carotenoids, which prevent cell damage and enhance skin health. Potential for reducing blood pressure and improving the quality of life for individuals with hypertension, making it a healthier cooking oil option compared to others.

Beta-carotene, a common carotenoid present in red palm oil, serves as an antioxidant and food colorant in various food products. It also acts as a precursor to vitamin A and offers additional benefits as an antioxidant, anticancer, anti-inflammatory agent, and supporter of eye health and cardiovascular health. To enhance their income,farmers have the option of processing Fresh Fruit Bunches (FFB) into red palm oil. Typically, FFB sales are uncertainand less profitable due to market fluctuations. However, by transforming raw materials into finished or semi-finishedgoods, farmers can add value and increase their profits. The integration of a 6-ton hydraulic jack into palm fruit pressequipment has made the oil extraction process more efficient and user-friendly for field working farmers.

The production of Red Palm Oil (RPO) involves several essential steps, including boiling, digestion,

pressing,and refining. Among these stages, digestion and pressing are critical and require specialized equipment. To facilitateoil extraction, a digester or masher is essential to chop and reduce the size of oil palm fruits. Therefore, it is crucial toconduct research on the engineering of oil palm fruit digesters and presses, particularly in the East Kalimantan region, to develop user-friendly and efficient equipment for farmers. The overarching goal of this research is to produce RPOthat meets the Indonesian National Standard and is suitable for use at the farmer level.

MATERIALS AND METHODS

Materials, Equipment, and Test Laboratories

For the fabrication of the digester and pressing equipment, the following materials were utilized: a ¾ hp 1450RPM electric motor, a 6-ton hydraulic bottle jack, a V-belt, pulleys, bearings, bolts, nuts, electrodes, 5 cm UNP iron,an iron shaft, 2 mm stainless steel plates, threaded iron, 8 mm iron plates, 10 mm iron plates, a 5 mm drill bit, and ironpipes. The tools employed in the construction of the digester and pressing equipment encompassed an electric welding machine, an electric drill, a grinder, pliers, a hammer, a measuring tape, a marker, wrenches, and screwdrivers. For the testing phase, palm fruits were sourced from Muara Badak, East Kalimantan. Pro Analysis grade ethanol, DPPH,α-Tocopherol, and β-carotene standards were obtained from Sigma-Aldrich in the USA. The equipment used for chemical testing included an oven, analytical scales (Toledo, US), an LC-04S centrifuge machine (Oregon, China), and a UV-Vis Bio-spectrophotometer (Eppendorf, Germany). The fabrication and testing processes were conducted at several locations, including the Hikmah Mandiri Makroman Welding and Lathe Workshop, the Post-Harvest and Packaging Laboratory, and the Chemistry and Biochemistry Laboratory of the Agricultural Products Technology Program, Faculty of Agriculture, Mulawarman University, Samarinda.

Crude Palm Oil (CPO) Preparation

A total of 5 kg of palm fruit bunches is used. The palm fruit bunches are steamed for 15 minutes. After the steaming process, the palm fruit is introduced into the digester until it reaches a paste-like consistency. Following this,pressing is conducted on the palm fruit paste for 5 minutes to extract the oil.

Chemical Analysis

The chemical content analysis, including water content and Free Fatty Acids (FFA), was measured using the standardized method outlined in AOAC (2012).

Antioxidant Activity Using DPPH

The total antioxidant activity was assessed using the spectrophotometric method with 2,2-diphenyl-1- picrylhydrazyl (DPPH) according to Farhan et al. (2012). One milliliter of the extract, previously diluted in ethanol (Kimia Farma, Indonesia), was combined with 1 mL of DPPH solution (0.15 mM in ethanol, Sigma Aldrich, USA). Simultaneously, a control mixture was prepared by mixing 1 mL of DPPH with 1 mL of ethanol. The reaction mixturewas thoroughly hand-mixed and incubated in the dark at room temperature for 30 minutes. The absorbance was measured at 519±2 nm. Vitamin C (Sigma Aldrich, USA) served as a positive control, and ethanol was used as a blank. The percentage of antioxidant activity was calculated as the difference between the blank and sampleabsorbances divided by the blank absorbance. Antioxidant activity, expressed as the 50% reduction of free radical DPPH (IC50), was determined using linear regression.

Determinan of α-Tocopherol

The α-tocopherol content in the product was assessed following the method described by Larasati (2007). A 100 mg sample was dissolved in 10 mL of pro-analysis ethanol. The solution was then subjected to UV spectrophotometry at a wavelength of 286 nm to measure its absorbance. A blank sample, treated in the same manner but without α-tocopherol, was also prepared. The quantitative determination of α-tocopherol content in the sample was derived from a calibration curve. This calibration curve was established using standard α-tocopherol in ethanol, covering a concentration range of 2 to 10 µg. mL-1 in 10 mL of P.A. grade ethanol

Determinan of β-Carotene

The solvent extraction was carried out using pro-analysis (P.A.) grade ethanol, and the measurement

of β- carotene concentration was conducted through UV-Vis's spectrometry detection, with a modification of the method outlined by Biswas et al. (2011). A 10-gram sample was dissolved in 20 mL of ethanol and homogenized using a magnetic stirrer for 10 minutes. This was followed by centrifugation at 1370× g for 10 minutes, and the supernatant was collected and filtered using Whatman No. 42 filter paper. β-carotene standards (Sigma-Aldrich, USA) were prepared, covering a concentration range from 5 to 25 µg. mL-1 in P.A. grade ethanol. The absorbance of the extract,blank, and standards was measured at 445 nm using a spectrophotometer. The concentration of β-carotene in the samples was extrapolated using the standard absorbance versus known β-carotene concentration curve.

RESULTS AND DISCUSSION

Design of Palm Fruit Digester

The construction of the palm fruit digester machine (Figure 1) began with the fabrication of a mounting frame,which serves as the foundation and support for all the components of the apparatus. The frame's dimensions (L x W xH) are 50 cm x 50 cm x 40 cm and are constructed using 5 cm UNP iron. The support legs are positioned 15 cm abovethe ground level. The cylindrical tube, measuring 50 cm in diameter and 40 cm in height, is constructed from a 2 mmthick stainless-steel plate. At the bottom of the tube, there is an access door with an open-close mechanism, measuring18 x 20 cm. An iron shaft is centrally installed within the cylindrical tube to accommodate the kneading and pulverizing blades. The shaft has a height of 50 cm and a diameter of 3.5 cm. Five knife blades are affixed to the shaft,with a blade-to-blade distance of 4 cm from the lowest bearing, followed by intervals of 2 cm, 7 cm, 7 cm, and 7 cm for the subsequent blades, and 14 cm for the top blades, up to the bearing housing. Bearings are positioned at the lowerand upper ends of the shaft to facilitate its movement. At the upper end of the shaft, it is connected to a 3/4 HP electric motor to provide the driving force. The top of the cylindrical tube serves as the entry point for raw materials and is equipped with a lid.

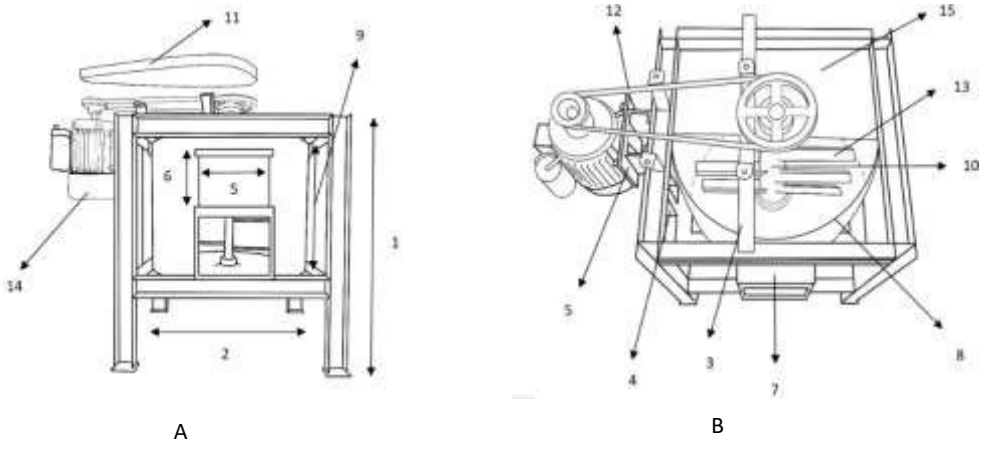

Figure 1. The design of palm fruit digester

Figure 1 description: 1) the heigth of frame (65 cm), 2) the wide of frame (50.5 cm), 3) bearing support length (57 cm), 4)elevation of the electric motor bracket (48.5 cm), 5) the wide of output (18 cm), 6) the height of output (20 cm), 7) the length of protrude output (7 cm), 8) cylinder (D = 50 cm), 9) the height of cylinder (40 cm), 10) the length of the steel shaft (50 cm), 11) thelength of safety V-belt (62 cm), 12) the length of V-belt type A (50 cm), 13) the length of steel knife blades (19 cm), 14) electricalmotor, and 15) the cover of digester.

The primary choice in various industries, including manufacturing, construction, medical equipment, and food, has been touse stainless steel as a material for the cylinder. Several key advantages are offered by this material, with its corrosion resistance being a primary consideration (Ashraf et al., 2008), making it suitable for humid environments or areas prone to moisture exposure(Dewangan et al., 2015). Additionally, stainless steel is known for its high mechanical strength (Gardner, 2005), resistance to extreme temperatures (Dewangan et al., 2015), ease of cleaning, and a professional aesthetic appearance. The working capacity ofthis machine is a maximum of 20 kg. The selection of an electrical motor with a power of ¾ HP, 1 phase, and 1450 rpm is also aimed at reducing electricity consumption. This allows the machine to operate with lower electrical voltage. With the presence of this machine, it is expected to be easily replicated and to assist palm fruit farmers, especially in East Kalimantan, in producing RPO.

Design of Pressing Equipment

The press equipment (Figure 2) for palm fruit is designed with a sturdy support structure made of 5 cm-sized UNP iron, measuring 75 cm x 46 cm x 93 cm in length, width, and height. Within this frame, a perforated cylindrical tube, like a basket, is assembled using a 2 mm thick stainless-steel plate, measuring 29.5 cm in diameter and 40 cm in height. To ensure stability, a plateis attached to the base of the cylindrical tube, providing ample space for a 6-ton hydraulic jack to exert upward pressure during theoil extraction process. A threaded pressing plate with a diameter of 28.4 cm and a thickness of 10 mm is located above the cylindrical plate, with a threaded rod measuring 2.6 cm in diameter and 34 cm in length securing it in place. Lastly, an iron pipe isincorporated into the lower section of the cylindrical tube to facilitate oil drainage.

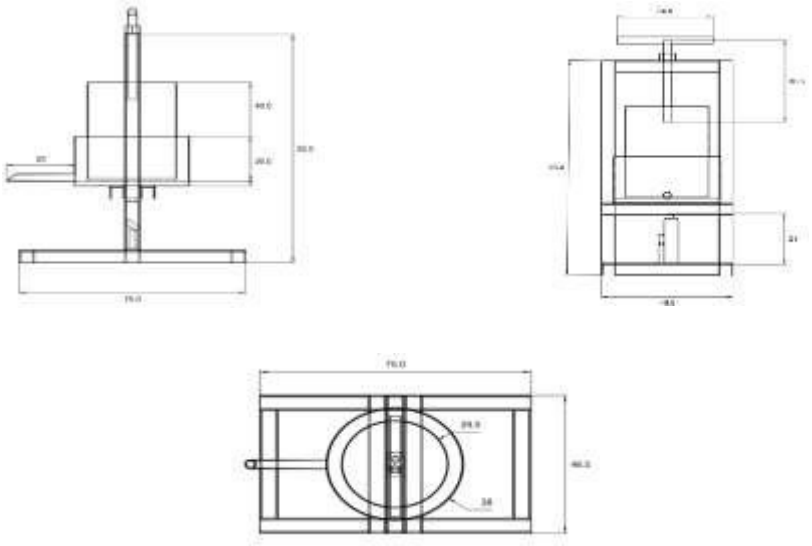

Figure 2. The design of palm fruit pressing equipment. A) side view, B) front view and C) overhead view

The use of UNP iron as a material for frames in equipment or machinery offers several highly valued advantages across various industries. The primary benefits of UNP iron include its high structural strength, the abilityto withstand heavy loads, and resistance to pressure and tension (Shishegaran et al., 2018). Additionally, UNP iron isrelatively easy to process and weld, making it a reliable choice for constructing robust frames. This pressing equipment is designed with a cylinder size that can accommodate a maximum input material (FFB) of 5 kg. With the integrationof a 6-ton hydraulic jack, the palm fruit press equipment becomes notably more user-friendly and efficient for farmers,especially those who work in the field. This advancement is poised to greatly simplify and enhance the process of extracting oil from palm fruit.

The Results of Initial Testing

The experimentation conducted on the digester machine (Figure 3) and pressing equipment (Figure 4), using 5kg of FFB, has yielded highly satisfactory results. The extraction of 920 ml of CPO is a significant accomplishment, and the subsequent rigorous filtration process has produced 500 ml of refined and pristine palm oil (Figure 5). Thesefindings suggest that the efforts invested in optimizing the palm oil production process have been fruitful. These findings indicate that both the digester machine and pressing equipment operate efficiently. Insufficient steaming timecan cause problems when extracting palm oil. The duration of steaming plays a vital role in the palm oil extraction process. Increasing the steaming time has the potential to increase the yield of oil extraction significantly. Extendingthe steaming time can bring about additional benefits, such as increasing the tenderness of palm fruit. This can enhance the efficiency of the digestion process, and ultimately maximize the yield of palm oil extraction. Indeed, the durationof the pressing time also plays a significant role in influencing the quantity of CPO obtained.

Figure 3. The test of FFB digester machine

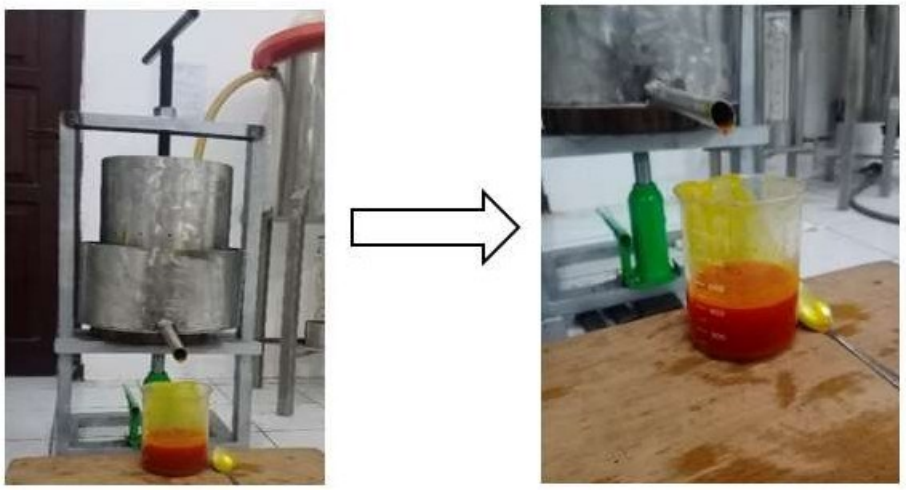

Figure 4. The test of FFB pressing equipment

Based on the results of chemical analysis on the obtained oil, the data is presented in Table 1. It can be observed that the water content is recorded at 0.2%, while the FFA content is at 3.4%. The moisture content of 0.2% and Free Fatty Acid (FFA) content of 3.4% in the tested oil still falls within the range of good quality as per the SNI 2901-2021standard for Crude Palm Oil (CPO). According to SNI 2901-2021, the maximum moisture content is 0.25% for premium quality and 0.50% for regular quality. Meanwhile, the maximum FFA content is 3% for premium quality and 5% for regular quality. These results indicate that the produced oil meets the quality requirements set by the standard and can be considered a high-quality CPO product. This is highly positive, as good oil quality is key in the production of RPO.

Numerous studies have provided extensive information on the benefits of antioxidants, alpha-tocopherol, and beta-carotene. These compounds have shown utility in various health aspects (Fiedor & Burda, 2014), such as cancerprevention (Tucker & Townsend, 2005), liver diseases (Elvira-Torales et al., 2019), cardiovascular disorders (Fiedor & Burda, 2014), photosensitivity (Fiedor & Burda, 2014), heart diseases (Tucker & Townsend, 2005), and Alzheimer'sdisease (Tucker & Townsend, 2005). Carotenoids represent a unique type of antioxidant. The findings of the study, which indicated that the palm fruit possessed a considerable amount of antioxidant activity, with a value of 41.29 µg/mL, suggested that it could serve as a viable raw material in the production of RPO. The alpha-tocopherol and beta-carotene tests conducted also yielded high values, with alpha-tocopherol at 198.73 µg/mL and beta-carotene at 30.12 µg/mL, further emphasizing the potential health benefits of RPO.

Table 1. The results of chemical properties, antioxidant activity, α-Tocopherol, and β-Carotene

Content	Amount
Water content	0.2 %
FFA	3.4%
IC_{50}	41.29 µg. mL-1
α-Tocopherol	198.73 µg. mL-1
β-Carotene	30.12 µg. mL-1

Figure 5. The crude palm oil (CPO) obtained

CONCLUSION

These results indicate its potential use as raw material for Red Palm Oil (RPO) production. Based on the digester and palm oil press testing results, further optimization is still necessary, especially regarding the steaming time of palm fruits before the digesting process. From the testing results, using 5 kg of palm fruit as feedstock, 920 ml of Crude Palm Oil (CPO) was obtained, which underwent filtration to yield 500 ml. The chemical analysis of the resulting CPO showed a water content of 0.2%, Free Fatty Acid (FFA) content of 3.4%, and IC50 value of 41.29 µg/mL for the crude palm oil, α-tocopherol at 198.73 µg/mL ± 2.30, and β-carotene at 30.12 µg/mL ± 0.36.

ACKNOWLEDGMENT

Heartfelt appreciation is extended to the Faculty of Agriculture at Mulawarman University, Samarinda, for generously providing the necessary facilities and funding. This support was instrumental in ensuring the seamless andsuccessful execution of this research.

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Soil Respiration and Some Soil Properties UsingPremium Compost Application in Ultisols

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ABSTRACT

Soil respiration is an indicator of soil biological fertility by the presence of biological activity such as soil microorganisms,roots or other life in the soil which is also influenced by the use of fertilizers in the soil. The premium compost fertilizer producedby a Pineapple Plantation Company in Lampung Province with a mixture of several organic materials such as compost, lignite, andother ingredients in it which Plants are expected to provide the necessary nutrients and enhance soil respiration. The purpose of this study was to study the effect of various applications of compost on soil respiration rate in Ultisols in Central Lampung, and tostudy the effect of various applications of compost on soil C-organic, soil temperature, soil pH, and soil water content, as well as the correlation between C- soil organic matter, soil temperature, soil pH, and soil water content with soil respiration rate. This research was conducted at PT. Great Giant Pineapple and analysis soil respiration were carried out at the Soil Science Laboratory,University of Lampung use Randomized Block Design (RBD) consisting of 4 treatments and 4 replications. Data were analyzed by analysis of variance and Tukey's test followed by Duncan's Multiple Range Test (DMRT) at 5% level. The results showed thatthe application of premium compost A (P1) increased soil respiration at a depth of 0-10 cm at 16 months after planting (MAP) compared to other treatments. The results of the application of premium compost to the soil showed that Premium B compost (P2)increased soil organic C at 14 MAP and premium A compost (P1) increased soil pH at 13 MAP compared to other treatments. Correlation tests showed that there was a negative correlation between soil water content with soil respiration at 14 MAP.

Keywords: Compost, lignite, pineapple, soil respiration

INTRODUCTION

Marginal soil known as Ultisols has the potential to be used for agriculture. However, it possesses certain characteristics such as high soil acidity, low soil fertility, high Al saturation, low organic matter content, base saturation less than 35%, and highly soluble Fe and Mn oxides, which can harm plants. Despite these challenges, Ultisol soil can be cultivated as agricultural land by large plantations in Lampung Province with proper soil and plantmanagement, according to Siregar and Nugroho (2021). To improve soil properties and increase nutrient content, adding organic matter to Ultisol soil is a viable solution. Improving soil properties such as physical, chemical and biological aspects can be achieved through the use of organic matter, a type of soil conditioner. Organic matter playsa crucial role in enhancing soil structure and texture, and in the formation of soil aggregates (Rajiman et al., 2008). Compost, which is produced by the decomposition of organic material through microbes, is an excellent soil conditioner that provides various benefits. Compost can improve soil structure, enhance water resistance andabsorption, increase drainage and pores, and add nutrients that activate the soil microbes (Susetya, 2016). Accordingto Noverita (2005), compost has a significant impact on the physical and biological properties of soil. Cow dung compost and premium compost produced by a pineapple plantation company are two types of compost that have been used. Premium compost, in particular, is an organic fertilizer that contains multiple organic matter types, enriching the suDAPrate available to microorganisms in the soil.

Soil respiration is a key indicator of the biological activity present in soil, including microbes, plant roots, andother forms of life. This activity is crucial for maintaining a healthy ecosystem within the soil. The process of determining soil respiration involves measuring the amount of CO2 produced by soil microorganisms and the amountof O2 consumed by them, as described by Anas in 1989. Adding organic soil material is anticipated to boost the amount of organic matter in the soil. A high concentration of organic carbon in the soil will enhance its physical, chemical, and biological characteristics, with soil respiration rate being an indicator of its biological properties. A study conducted by Jauhiainen et al (2012) found a direct correlation between soil microorganism activity and soil organic material. Compost, as an organic

matter, serves as a source of nutrients for the soil, thus improving its physical, chemical, and biological properties. Compost is a suitable alternative for maintaining soil quality, increasing the life of soil microorganisms, and boosting the rate of soil respiration. Soil respiration is a method used to determine the level of soil microbial activity (Hanafiah, 2005), and according to Sakdiah (2009), it can also be used to determine soil microbial activity around roots. This research aimed to investigate whether the application of premium compost can increase the rate of soil respiration in Ultisols in Central Lampung.

MATERIAL AND METHODS

This research was conducted from December 2021 to March 2022. The location for this research was on the pineapple plantation area owned by PT. Great Giant Pineapple. This study used a non-factorial Randomized Block Design (RBD) method consisting of 4 treatments, as follows:
P0: Without compost (cultivation standard)
P1: Compost A premium (79% cow dung compost + 10% young coal)
P2: Compost B premium (74% cow dung compost + 15% young coal)
P3: 100% cow dung compost

At PT. Great Giant Pineapple, the soil processing for pineapple plants is done in several stages. The premiumcompost composition used includes cow dung compost, light coal, vermicompost, zeolite, and Liquid organic biofertilizer (LOB). The stages involved in soil processing are chopping, plowing, harrowing, subsoiling, finishing harrow or finishing rotary, and rigging. The application of fertilizer in the pineapple plantations was based on the research treatment, which includes fertilization one day prior to planting (DAT) and standard cultivation of pineappleplants from 5 to 11 months after planting (MAP). In this study, three types of fertilizers were used: premium compostA, premium compost B, and cow dung compost. The primary variable observed and sampled was soil respiration. While to determine the correlation with soil respiration, the study used several supporting variables including C- organic (measured with the Walkley and Black Method), soil temperature, soil pH, and water content. The collected data underwent analysis to test for homogeneity of variance using the Bartlett test, while the Tukey test was used to test the additivity of the data. In order to analyze the relationship between organic matter, soil pH, soil water content, and soil temperature with soil respiration, a correlation test was conducted. If the assumptions are met, the data is thenanalyzed using the analysis of variance method, followed by the Duncan Multiple Range Test (DMRT) at a 5% level.

RESULTS AND DISCUSSION

Application of Premium Compost on Soil Respiration in Ultisols Central Lampung

At 16 DAP, applying premium compost had a noteworthy impact on soil respiration in the 0-10 cm depth. However, there was no significant effect on soil respiration at 13 DAP, 14 DAP, and 15 DAP (Table 1). This differencecan be attributed to the presence of various organic materials resulting from different treatments, which are more accessible in the 0-10 cm soil layer. The depth of the soil affects the number of soil microorganisms, the deeper the soil, the less in number soil microorganisms. According to Fitrah et al. (2016) said the number of bacteria decreases with soil depth. Research shows that the highest concentration of bacteria (0-10cm) is obtained through incubation.

Table 1. Summary results analysis of variance of premium compost applications on soil respiration at depths of 0-10 cm and10-20 cm at 13 DAP, 14 DAP, 15 DAP and 16 DAP

Treatment	Soil Respiration (mg CO_2-C g^{-1} day^{-1})							
13 MAP			14 MAP		15 MAP		16 MAP	
	0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm	0-10 cm	10-20 cm
P_0	8.87	8.47	7.41	7.20	7.63	7.84	1.71 (0,23)	2.70
P1	8.96	10.42	6.75	8.14	7.85	8.44	4.96 (0,65)	1.71
P2	8.14	7.07	6.51	7.76	7.46	7.16	1.97 (0,29)	1.84
P3	5.19	6.99	8.36	6.81	8.96	8.87	2.61 (0,41)	3.00
SK				F-calculation dan Significance				
Treatment	2.11^{tn}	2.94^{tn}	1.09^{tn}	0.39^{tn}	0.88^{tn}	1.28^{tn}	$5.15\ (5.88)^{tn}$	0.83^{tn}

Note: P_0 = No compost (cultivation standard); P_1 = Premium compost A; P_2 = Premium compost B; P_3 = Cow dung compost; tn = no significant effect at the 5% level; * = significant effect at the 5% level; numbers in brackets indicate data transformation values.

Additional testing was conducted to investigate how applying premium compost affects soil respiration. Theresults indicated that the premium compost treatment A (P1) demonstrated a significantly higher level of soil respiration than the treatment without compost (cultivation standard or P0), as well as the premium compost treatment B (P2). However, there was no significant difference in soil respiration between the premium compost treatment A (P1) and the cow dung compost treatment (P3), as shown in Table 2.

Table 2. Effect of premium compost application on soil respiration rate at a depth of 0-10 cm at 16 MAP

Treatment	Soil Respiration (mg CO_2-C g^{-1} day^{-1})
No compost (cultivation standard) (P0)	0.23 [a]
Premiun Compost A (P1)	0.65 [b]
Premiun Compost B (P2)	0.29 [a]
Cow dung Compost (P3)	0.41ab

Note: Values with the same letter are not significantly different at the 5% DMRT test level.

According to the findings of the research, premium compost A (P1) which contains a mixture of different organic materials including 79% cow manure compost and 10% lignite has a considerably greater effect than premium compost B (P2) composed of 74% cow manure compost and 15% lignite coal. The reason for this is thata combination of different organic materials has been added to premium compost A (P1). This mixture includes 79% cow dung compost and 10% young coal. This mixture is more effective at improving soil respiration comparedto premium compost B (P2), which contains 74% cow dung compost and 15% lignite. Additionally, compost-free cultivation (P0) was also tested as a standard. When the percentage of organic matter (such as cow dung compost)in the soil is higher, it can greatly improve the intake of organic matter. This is especially true if the organic mattercontent in the topsoil (0-10 cm) is increased, as it can lead to higher soil respiration. Adding compost to the soil can also increase the availability of important nutrients for plant growth and development. Studies by Prihandini and Teguh (2007) have shown that organic fertilizers like cow dung compost have high levels of N, P, and K content, making them a great source of nutrients for the soil. Similarly, Mayadewi (2007) found that applying manure can improve soil structure, increase nutrient availability, and enhance the growth of microorganisms.

Effect of Premium Compost Application on Soil Organic C, Soil Water Content, Soil pH and Soil Temperature

Increasing the amount of organic matter in soil has a positive impact on its fertility. This is because organic matter serves as an energy source for microorganisms that break down and recycle nutrients, as well as decompose organic and inorganic compounds. As a result, organic matter plays a key role in improving soil fertility, according toresearch by Budhisurya et al. (2013). The effects of premium compost application on soil properties were studied at four locations: 13 DAP, 14 DAP, 15 DAP, and 16 DAP. The results, shown in Tables 3 and 4, detail changes in soil C-organic levels, water content, pH, and temperature.

Table 3. Summary of analysis of various applications of premium compost on soil C- organic and water content at 13 MAP, 14MAP, 15 MAP and 16 MAP.

Treatment	Soil Respiration (mg CO_2-C g^{-1} day^{-1})							
	13 MAP		14 MAP		15 MAP		16 MAP	
	C-organic	Water content	C-organic	Water content	C-organic	Water Content	C-Organic	Water content
P0	1.16	17.26	1.06	13.05	1.00	14.78	0.95.	15.59
P1	1.30	16.95	1.34	12.97	1.31	16.42	1.26	16.78
P2	1.21	17.50	1.48	13.88	1.23	15.41	1.20	16.39
P3	1.35	19.03	1.26	13.20	1.23	15.73	1.18	16.63
SK				F-calculation dan Significant				
Treatment	$2,04^{tn}$	1.41^{tn}	4.19^{tn}	1.08^{tn}	1.08^{tn}	3.10^{tn}	1.12^{tn}	1.31^{tn}

Note: P_0 = No compost (cultivation standard); P_1 = Premium compost A; P_2 = Premium compost B; P_3 = Cow dung compost; tn = no significant effect at the 5% level; * = significant effect at the 5% level; numbers in brackets indicate data transformation values.

Table 4. Summary of analysis of various applications of premium compost on soil temperature and pH at 13 MAP, 14 MAP, 15MAP and 16 MAP.

Treatment	Soil Respiration (mg CO_2-C g^{-1} day^{-1})							
	13 MAP		14 MAP		15 MAP		16 MAP	
	Soil Temp.	PH	Soil Temp.	PH	Soil Temp.	PH	Soil Temp.	PH
P0	27.13	4.38	27.25	4.40	27.13	4.29	27.75	4.24
P1	26.88	4.45	27.00	4.51	27.00	4.42	27.63	4.55
P2	27.35	4.28	27.38	4.52	27.75	4.70	27.38	4.80
P3	27.13	4.42	27.38	4.33	27.38	4.85	27.75	4.76
SK				F-calculation dan Significant				
Treatment	1.161^{tn}	7.2^{**}	1.139^{tn}	0.68^{tn}	1.62^{tn}	2.99^{tn}	0.47^{tn}	1.67^{tn}

Note : P_0 = No compost (cultivation standard); P_1 = Premium compost A; P_2 = Premium compost B; P_3 = Cow dung compost; tn = no significant effect at the 5% level; * = significant effect at the 5% level; numbers in brackets indicate data transformation values.

Based on the results of the study, premium B compost (P2) containing a blend of different organic materials including 74% cow manure compost and 15% young coal demonstrated a greater impact than the cultivation standard (P0) without compost or premium compost A (P1) with 79% cow dung compost and 10% lightcoal. By adding a combination of different organic materials to premium compost B (P2), which comprises of 74%cow manure compost and 15% young coal, the soil's organic C content can be improved compared to not using anycompost (cultivation standard or P0) or using premium compost A (P1) which contains 79% cow dung compost and 15% light coal and is used without compost (cultivation standard) (P0). According to Zulkarnain et al. (2013),the application of compost and manure can increase soil organic carbon content. The more organic fertilizer addedto the soil, the greater the increase in organic carbon content.

After analyzing the results in Table 3, it appears that the treatment did not have a significant effect on thewater content and soil temperature at 13 WST, 14 WST, 15 WST, and 16 WST. However, it did have a very significant effect on the soil pH at 13 WST. This is likely due to the addition of a mixture of organic materials to premium compost A (P1), which consisted of 79% cow manure compost and 10% lignite. This mixture was foundto be more effective at increasing soil pH compared to premium compost B (P2), which consisted of 74% cow manure compost and 10% light coal, as well as the provision without compost (cultivation standard) (P0). If the organic matter content in the soil is high, it can have an effect on the intake of organic matter in the soil and also affect the pH level. For this study, Ultisol soil type with high acidity and an average pH level of less than 4.50 wasused (Prasetyo et al., 2006). The pH level of soil plays a crucial role in the growth and development of microorganisms. According to Lay's research (1994), microorganisms thrive within the pH range of 5-8 and exhibitmaximum growth at a neutral pH of 7. The higher the pH value, the more active and productive the microorganismsbecome. Additionally, based on the findings of Sinaga et al. (2015), microorganisms such as bacteria, fungi, and actinomycetes can survive in acidic soil conditions. Soil pH levels are categorized as acidic or alkaline based on research results. Correlation between soil organic carbon, soil moisture content, soil pH, and soil temperature withsoil respiration. Table 4 summarizes the results of the correlation test conducted on C-organic, soil water content, soil pH, and soil temperature at locations 13 DAP, 14 DAP, 15 DAP, and 16 DAP. The data indicates that there isa significant correlation between soil water content and soil respiration. However, there is no observed correlationbetween soil C-organic, soil pH, and soil temperature.

Table 5. Test the correlation between organic C, soil water content, soil pH, and soil temperature with soil respiration

Variable	Soil Respiration (mg CO2-C g^{-1} day^{-1})			
	13 MAP	14 MAP	15 MAP	16 MAP
Correlation coefficient (r)				
Soil C-organic	$0,02^{tn}$	$-0,21^{tn}$	$0,22^{tn}$	$0,29^{tn}$
Soil water content	$-0,37^{tn}$	$-0,55^{*}$	$-0,01^{tn}$	$0,06^{tn}$
Soil pH	$0,21^{tn}$	$0,13^{tn}$	$0,09^{tn}$	$0,30^{tn}$
Soil temperature	$-0,36^{tn}$	$0,34^{tn}$	$-0,09^{tn}$	$-0,05^{tn}$

Note: tn = not significantly different at the 5% level; * = significantly different at the 5% level.

Based on the results of the correlation test conducted between soil water content and soil respiration, there was a significant negative correlation with R = 0.303 and r = -0.55 (as shown in Figure 1). This indicates that an increase in soil water content will lead to a reduction in the rate of soil respiration. It is

important to note that soil water content plays a crucial role in sustaining soil processes, particularly those that involve microorganisms.

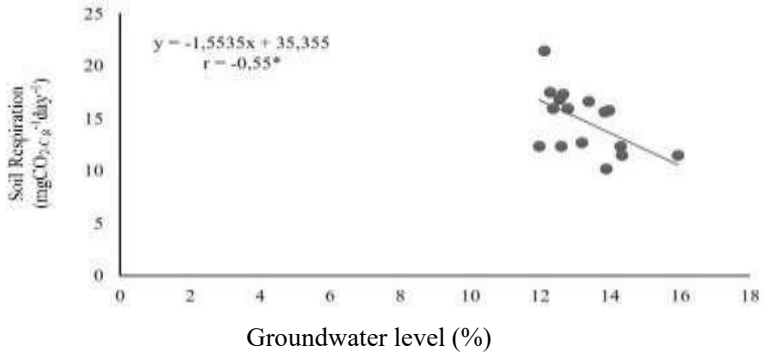

Figure 1. Correlation graph between soil water content and soil respiration at 14 DAP

Based on the correlation test showed that there is no correlation between soil C, soil pH, and soil temperature with soil respiration due to the limited research time. Soil water content plays a crucial role in air recirculation for the presence of oxygen in the soil. According to Boyd (1993), water content has an impact on thedecomposition process which relates to dissolved oxygen levels. A higher water content reduces oxygen availability, inhibiting the aerobic decomposition process, which can indirectly affect soil microbe activity and population. The research results showed that soil water content ranges from 11.98% - 15.95%, which can affect soilmicrobial activity as the low water content restricts the microbe activity.

CONCLUSION

The use of premium compost A (P1) led to an increase in soil respiration at a depth of 0-10 cm in 16 DAP when compared to other treatments. Similarly, the application of premium compost B (P2) resulted in a boost in soil organic C in 14 DAP, while premium compost A (P1) contributed to a rise in soil pH in 13 DAP in comparison to other treatments. At 14 DAP, there is a negative correlation between soil water content and soil respiration.

ACKNOWLEDGEMENT

We would like to thank the Great Giant Pineapple Company in Terbanggi, Central Lampung for their supportof the research facilities.

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Weeds Management in Jasmine (*Jasminum Sambac* L.W.Ait)

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ABSTRACT

A study evaluating weed management over the garden of jasmine (*J. sambac*) has been carried out with the aim of (1) knowing the weed species found in jasmine garden, (2) obtaining information on weed control techniques carried out in jasmine garden, (3) knowing the profit level of jasmine farmers related to weed control techniques, has been held in January-March 2019. The results showed that the weeds *Ageratum conyzoides* L., *Paspalum conjugatum* Berg., *Cyperus rotundus* L., and *Bryopsida* sp.was most commonly found in garden, and was controlled by both mechanical and chemical techniques. The average profit of Jasmine farmers is Rp Rp 3.524.806, -/month/ha.

Keywords: Weeds, weed control techniques, Jasmine farmers income

INTRODUCTION

Weed management is an effort to manage the presence of weeds around cultivated plants (Kohli, *et al*., 2005). In general, weeds will compete when associated with crops to sunlight, water, and nutrients (Rijn, 2000). The decisionto control weeds depends on the size of the population against the economic threshold level of weed control. This applies generally to all cultivated plants, especially food crops, vegetables, fruits and ornamental plants. In relation to the jasmine plant (*J. sambac* Ait.) then weeding by hand should be done twice a year. Light digging of the soil around the basin helps to clean it from weeds. Mulching with plastic cover or leaf litter controls weed growth and retains soil moisture (Chaitanya, *et al*., 2018).

Jasmine plants for some people in Bukit Pinang sub-district, Samarinda Ulu District, Samarinda City are something that cannot be separated in life and it has long been known that Jasmine cultivation is carried out by the community there. This shows there were an economic dependence on jasmine products, which is confirmed by the establishment of this area as a jasmine cultivation center in Samarinda City (Agriculture Office Samarinda City, 2017).In general, farmers always maintain the cleanliness of the garden, including controlling weeds, in relation to the easeof caring for plants and harvesting jasmine flowers. Given the involvement of variable cost in the form of labor, equipment, fertilizers, and pesticides, it is felt important to conduct this research, which aims (1) knowing the weed species found in jasmine garden, (2) obtaining information on weed control techniques carried out in jasmine garden, (3) knowing the profit level of jasmine farmers related to weed control techniques.

MATERIAL AND METHODS

This research was conducted in Bukit Pinang Village, Samarinda Ulu District, Samarinda City, from Januaryto March 2019. The equipment used in this study includes questionnaires, stationery, cameras, and various secondarydata that support the research. The respondents consisted of all Jasmine farmers in Bukit Pinang Village, consisting of 18 people, with a census purposive sampling technique. Secondary data is in the form of reports from related institutions, while primary data is in the form of interviews with respondents using the115tolonifnnaire, and also weeds data from observation on Jasmine garden.

Cost and revenue data are analyzed using economic analysis formulas as mentioned by Soekartawi (2003), Nicholson and Snyder. (2017). , namely Total Cost = TC = TFC + TVC (TC=Total Cost, TFC=Total Fixed Cost, TVC= Total Variable Cost), Total Revenue = TR = P x Q (TR=Total Revenue, P=Price, Q=Quantity), Revenue π=TR-TC (π=Profit or Revenue, TR=Total Revenue, TC=Total Cost). To determine whether or not there is an effect of weed control costs on revenue for jasmine crop production, a simple linear regression is used according to Toutenburgh and Shalabh, (2009), namely $Y = b_0 + b_1X$, (Y = value of jasmine crop production, b_0 = constant, if weedcontrol costs = 0, b_1 = regression coefficient, X = weed control costs).

RESULT AND DISCUSSION

Overview of research sites and description of weeds in jasmine gardens

The location of this study is hilly topography and lowlands with an altitude of 0-100m asl., where the soil isgenerally acidic to close to neutral (Ph = 4.8-6.5), has a humid-tropical climate with average rainfall ranging from 1258-1560mm per year. The wet month consists of seven months, and the rest are dry months, but there is no clear boundary given the position of the dry moon spread between the wet months in a year. The average temperature in Bukit Pinang is 21^0-37^0 C.

Some common weeds found in jasmine gardens are *Ageratum conyzoides* L.*, Paspalum conjugatum* Berg.*, Cyperus rotundus* L.*,* and the lichen *Bryopsida* sp. After Xu and Chang (2017), *Ageratum* habitat are valleys, forests,forest margins on slopes, riversides, grasslands, field margins. Ecology *Ageratum* often occurs in many types of habitats and grows well from wet to drought situations. It usually grows aggressively and forms dense mats in many habitats and sometimes forms monocultures. It prefers sunny condition and tolerates harsh environments. Its weedy and invasive properties always crowd out the native species and gradually invade into paddy fields and seem to fit for slightly submerged surroundings. Harmfulness *A. conyzoides* is a vicious weed in drought or wet land situations andusually infests corn, potato, and sugarcane fields and has a large amount of occurrence. Native to tropical America, especially in Brazil, and considered an invasive weed in many other regions in the world. Utilization: *A. conyzoides* is used medicinally in China to treat common colds, headaches, boils, eczema, bleeding wounds, and burns. It is alsowidely used by many traditional cultures, especially as an antidysenteric. It is also an insecticide and nematicide. It isalready employed as one of the important plants in comprehensive pest managements.

Paspalum is a large genus with nearly 400 species, mainly distributed throughout the Americas with species inhabiting ecologically diverse habitats such as savannas, coastal dunes, grasslands, as well as tropical and subtropicalforests The highest centers of diversity have been found in Brazil's Cerrados and in grasslands throughout Argentina,Uruguay, and southern Brazil. Several species of Paspalum are found in Africa, Asia, and Oceania, but the genus is thought to have originated in tropical South America. Many Paspalum species have been used as grasslands in tropical and subtropical regions and some of these are economically important grasses and ornamental grasses. *P. conjugatum* is easily recognized by its combination of stoloniferous growth habits and its distinctive compound flowers, consisting of a pair of widely spreading racemes with small, pale, fringed grains(Giussani *et al*., 2009).

Cyperus rotundus habitat were Grasslands, mountain slopes, stream margins, along trails, sandbanks, ditch margins, water margins in valleys, and paddy field margins. Ecology: the rhizomatous sedge, mostly propagated by tubers, is one of the most noxious weeds in wet to drought situations, having spread out to a worldwide distribution in tropical and temperate regions. It usually forms dense clumps or predominant or monodominant populations in grasslands, gardens, or wet places, due to its tough competitive and allelopathic characteristics, along with resistanceto most herbicides. Moreover, the tubers of the weed can survive at harsh conditions, leading difficulty to eradicate it.Harmfulness A notorious weed. It significantly reduces the crop yield in infested fields. Diffusion Characteristics Seedreproduction and tuber clonal propagation. Widely distributed in Southeastern Asia, Africa, Australia, Central, North,and South America, Europe, the Indian Ocean Islands, and Pacific Islands (Xu and Chang, 2017).

From observations in the field, on the trunks, and branches of jasmine there are mosses that grow and mutualistic symbiosis with plants. It is suspected that this is a member of the *Bryopsida sp.* family. And live without harming the Jasmine plant. It is known that this moss performs photosynthesis which absorbs carbon dioxide and water, then supplies oxygen to the atmosphere so that its role is very important in maintaining the balance of air components and helping to maintain global temperatures due to changes in greenhouse gases. So despite its small size, mosses' cumulative carbon sequestration worldwide is enormous and contributes to the mitigation of greenhousegas emissions, therefore, protecting moss-rich ecosystems, such as peatlands and swamps, is critical to maximizing carbon storage potential and conserving these regions helps combat climate change by preventing the release of carbon stores into the atmosphere.

Respondent Profile

From the results of the interview, it is known that the average garden area per respondent is 0.05 ha, and thetotal cultivated area is 1.02 ha. There were 14 male respondents, and 4 female respondents with an average age of 50years. There are 11 farmers who carry out weed management both mechanically and chemically, while there are 7 farmers who rely on weed management using chemistry alone.

Cost of Production Means and Labor

The calculation of costs related to production facilities, and related to the management of weeds and insect pests in the form of herbicides, insecticides, labor for mechanical weeding, spraying labor issued monthly is as shownin Table 1 below. Meanwhile, the total cost and total revenue and monthly income from Melati farming are listed inTable 2 below

Table 1. Cost of production and labor per month

Respondent number	Cost (Rp per month)				Total (Rp)
	Herbicide	insecticide	Mechanical weeding	Spraying	
1	14.133	189.200	120.000	225.000	323.333
2	18.000	126.250	250.000	225.000	394.250
3	9.600	77.866	133.333	280.000	220.800
4	4.800	68.400	.0	80.000	73.200
5	7.200	189.200	50.000	210.000	246.400
6	14.400	198.400	133.333	300.000	346.133
7	4.700	24.400	33.333	80.000	62.433
8	9.600	84.600	0	120.000	94.200
9	2.400	9.733	0	70.000	12.133
10	10.800	73.200	0	225.000	84.000
11	2.400	12.400	20.000	40.000	34.800
12	18.000	89.000	83.333	375.000	190.333
13	21.600	268.200	300.000	360.000	589.800
14	10.800	58.400	0	225.000	69.200
15	2.400	12.200	16.666	40.000	31.266
16	4.800	25.866	0	70.000	30.666
17	2.400	23.600	0	55.000	26.000
18	14.400	126.133	140.000	300.000	280.533
Total (Rp)	172.433	1.657.050	1.280.000	3.280.000	3.109.483

Table 2. Total Cost (TC), Total revenue (TR) and Profit (π) per month

Respondent number	Total Cost (TC)	Total Revenue (TR)	Π
1	1.989.593	4.800.000	2.810.407
2	4.554.683	14.400.000	9.845.317
3	1.628.587	3.840.000	2.211.413
4	563.760	1.800.000	1.236.240
5	1.207.240	3.000.000	1.792.760
6	4.514.480	12.000.000	7.485.520
7	509.760	1.500.000	990.240
8	685.320	1.680.000	994.680
9	602.413	1.920.000	1.317.587
10	1.630.260	4.800.000	3.169.740
11	415.080	1.500.000	1.084.920
12	3.371.600	10.800.000	7.428.400
13	4.952.320	14.400.000	9.447.680
14	1.862.127	6.000.000	4.137.873
15	464.880	1.800.000	1.335.120
16	1.227.060	2.700.000	1.472.940
17	402.113	1.200.000	797.887
18	3.112.213	9.000.000	5.887.787
Total (Rp)	33693490	97.140.000	3.524.806

The profit and loss calculation from Table 2 shows that this jasmine farming business earns an average profitper month per ha of Rp 3,524,806,-

Relationship of Chemical Weed Control Cost to Revenue

Regression analysis conducted on the cost of chemical weed control with Revenue showed the equation Y=0.77+0.25X, R=0.66. This equation provides information that if weed control is not carried out using chemical techniques, a result of 0,77 x Rp 1.000.000 is obtained, - but if control is carried out using chemical techniques, therewill be a result of 0,77 x Rp 1.000.000, - plus 0,25 x Rp 10.000, - for each additional unit cost, as shown in Figure 1 below.

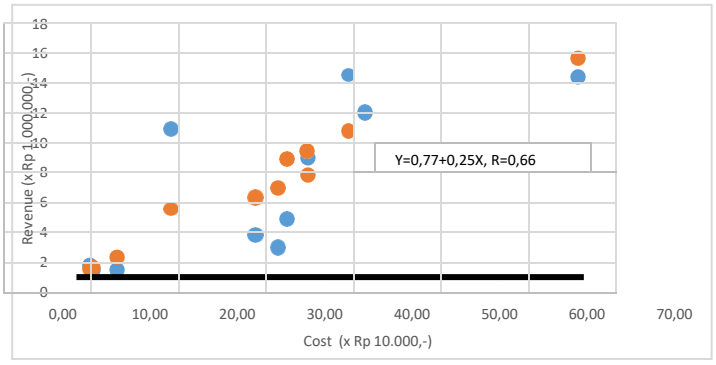

Figure 1. Relationship between Cost and Revenue of Chemical weeds control inJasmine garden

Relationship of Chemical Weed Control Cost to Revenue

Regression analysis conducted on the cost of chemical weed control with Revenue showed the equation Y=1,4+2,94X, R=0,70. This equation provides information that if weed control is not carried out using chemical andmechanical techniques, a result of 1.4 x Rp 1.000.000 is obtained, - but if control is carried out using chemical and mechanical techniques, there will be a result of 1,4 x Rp 1,000,000, - plus 2,9 x Rp 10,000, - for each additional unit cost, as shown in Figure 2 below.

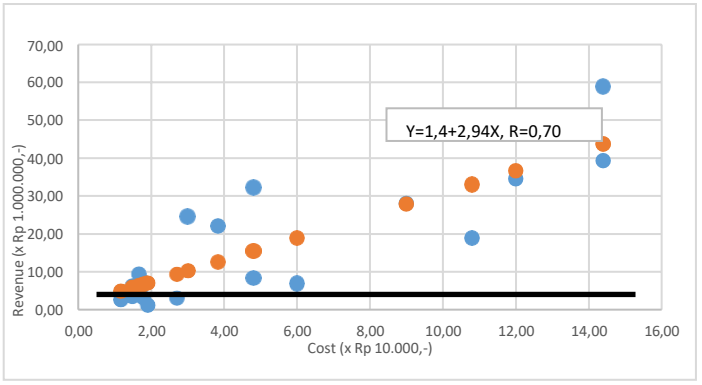

Figure 2. Relationship between Cost and Revenue of chemical and mechanical weeds control in Jasmine garden

CONCLUSION

From the description that has been described earlier, the results of this study can be concluded as follows:

1. The weed species found in jasmine garden were: *A. conyzoides, P. conjugatum, C. rotundus*, and *Bryopsida* sp.
2. Weed control techniques carried out in jasmine garden were chemical alone, and Mechanical combine withchemical.
3. The profit level of jasmine farmers related to weed control techniques were average profit per month per ha of Rp3,524,806, -
4. There was revenue as 0,77 x Rp 1,000,000, - plus 0,25 x Rp 10,000, - for each additional unit cost if weeds controlusing chemical techniques.
5. There was revenue as 1,4 x Rp 1,000,000, - plus 2,9 x Rp 10,000, - for each additional unit cost if weeds controlusing chemical and mechanical techniques.

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THE EFFECT OF ADMINISTRATION OF GIBERELLIN ZPTON THE GROWTH AND YIELD OF PURPLE EGGPLANT(*Solanum melongena* L.) VARIETY YUVITA F1

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ABSTRACT

This study aimed to assess the impact of Gibberellin Plant Growth Regulator (PGR) on the growth and yield of purple eggplants (variety: Yuvita F1). Conducted from January to March 2022 in Loa Duri Ulu Village, Loa Janan District, Kutai Kartanegara Regency, the experiment followed a Randomized Complete Block Design (RCBD) with four different Gibberellin concentration treatments: p0 (0.00 mL gibberellin L-1, control), p1 (0.15 mL gibberellin L-1), p2 (0.30 mL gibberellin L-1), and p3 (0.45 mL gibberellin L-1), each with 10 replications. Statistical analysis included variance followed by the Least Significant Difference (LSD) test at a 5% significance level.The results highlighted that the p2 treatment (0.30 mL gibberellin L-1) exhibited a significant positive impact, promoting the optimal growth and yield of purple eggplants. Specifically, this treatment led to a 14.51cm increase in plant height (15.92% improvement compared to the control), 3.60 additional branches (38.88% increase comparedto the control), a 40.10 HSPT reduction in flowering age (-3.10% compared to the control), a 19.13 cm increase in fruit length (17.61% compared to the control), 6.90 more fruits per plant (24.63% compared to the control), and a 0.44 kg increase in fresh fruitweight per plant (22.72% compared to the control).

Keywords: Gibberellin, Purple eggplant, Growth, Yield, Yuvita F1

INTRODUCTION

Eggplant fruit generally has high nutritional value and is suitable for consumption to improve nutrition. Every100 g of fresh eggplant contains around 24 calories, 1.5% protein, 0.2 g fat, 5.5 g hydrate, 15 g calcium, 37 mg phosphorus, 0.4 mg iron, vitamin A 30 SI, vitamin B1 0.04 mg, and vitamin C 5 mg (Wijayanti, 2016). Along with the increase in population, demand for eggplant also continues to increase. However, this increase in demand was notaccompanied by an increase in production quantities. One of them is caused by the low productivity of eggplant. According to (BPS Indonesia 2020) and (the Directorate General of Horticulture 2022), national eggplant productionwas 509,724 Mg from a harvested area of 44,829 ha. Increasing eggplant production can be done through extensification and intensification, one of which is by increasing productivity and land use efficiency, so that intensification is the right choice to implement. One effort that can be done is through the use of fertilizer and ZPT (Astuti *et al*, 2014).

Gibberellin is used as a hormone that accelerates seed germination, helps shoot/embryo formation, stem elongation, leaf growth, stimulates flowering, fruit development, stem elongation, leaf growth, stimulates flowering, fruit development, influences root growth and differentiation. Gibberellins are able to influence the genetic characteristics and physiological processes found in plants, such as flowering, parthenocarpy, and carbohydrate mobilization during the germination period (Mandasari, 2021). The aim of the research was to determine the effect ofgiving Gibberellin ZPT with different concentrations on the growth and yield of purple eggplant (Solanum melongenaL.) Yufita F1 variety. and gibberellin ZPT concentration which provides the best growth and yield in purple eggplant(Solanum melongena L.) Yufita F1 variety.

MATERIALS AND METHODS

Time and Place

The research was carried out for 3 months, from January to March 2022, at Loa Duri Ulu Village, District.

Materials and

The materials used were purple eggplant seeds of the Yuvita F1 variety, gibberellin ZPT, plastic seedlings, gamal leaves, papaya leaves, tobacco leaves, detergent, soil and cow manure.The tools used were a hoe, polybag measuring 40 cm x 40 cm, measuring tape, writing utensils, basket, ruler, basin, digital scales, documentation tools, calculator, gembor, and hand sprayer.

Experimental design

The research was a single factor experiment, concentration of ZPT gibberellin (P), prepared using a Randomized Block Design (RAK), consisting of four treatments and ten replications. The treatments tested consistedof: p0 = 0.00 (Control/no gibberellin); p1 = 0.15 mL gibberellin L-1; p2 = 0.30 mL gibberellin L-1; p3 = 0.45 mL gibberellin L-1.

Observation

Increase in plant height

Measuring the increase in plant height starts from the base of the stem which is above the ground surface to the growing point where the plant height increases. The increase in plant height is the difference between the results of measuring the increase in plant height at the time of observation and the results of measuring the increase in plant height at the start of planting. Measurements were carried out at 14, 28 and 42 days after transplanting (HSPT) usinga rolling meter and expressed in centimeters (cm).

Number of Branches

The number of branches is determined by counting the number of branches that have grown perfectly startingafter transplanting until entering the generative (flowering) phase. Counting the number of branches was carried out when the plants were 14 days old after transplanting at 14-day intervals, and expressed in branch units.

Flowering Age

Observations of flowering age for each plant were calculated from transplanting until the plant flowered, marked when the flowers opened, expressed in days after transplanting (HSPT).

Age of Harvest

Observation of harvest age was carried out by observing eggplant fruit. The characteristics of fruit that is readyto be harvested are that the fruit is fully filled, the flesh is not yet hard, the color of the fruit is shiny purple, the fruit looks fresh, and the size of the fruit is neither too big nor too small, expressed in days after transplanting (HSPT).

Fruit Length

The length of the fruit is measured using a meter. Fruit length is measured from the tip to the base of the fruit and is expressed in centimeters (cm).

Number of Fruits per Plant

The number of fruits per plant is determined by calculating the number of fruits harvested on each plant from the first harvest to the fifth harvest with a harvest interval of 3 days, and expressed in fruit units.

Fresh Fruit Weight per Plant

The fresh weight of fruit is determined by weighing the fruit at harvest from the first harvest to the fifth harvestof each plant, then adding them up, expressed in kg units.

Data Analysis Method

The research data were analyzed using variance tests, if the variance results showed significantly different treatment effects, then it was continued with the Least Significant Difference Test (BNT) at a significance level of 5%.

Experimental Design

The research was a single factor experiment, concentration of ZPT Gibberellin (P), prepared using a Randomized Block Design (RAK), consisting of four treatments and ten replications. The treatments tested consistedof: p0 = 0.00 (Control/no gibberellin); p1 = 0.15 mL gibberellin L-1; p2 = 0.30 mL gibberellin L-1; p3 = 0.45 mL gibberellin L-1.

RESULTS AND DISCUSSION

Results

The results of the chemical analysis of the planting media, the results of the chemical analysis of the soil beforethe research, showed a pH content of 6.70, organic C 2.21%, total N 0.26%, C/N ratio 8.4, P 4.85 ppm, K 9.68 ppm, Cat. AI3+ acid 0.5, H+ 0.29, while after research it shows pH content 6.98, organic C 2.63%, total N 0.34%, C/N ratio7.8 P 42.32 ppm, K 114 .68 ppm, Cat. Acid AI3+ 0.6 H+ 0.35

Table 1. changes in the nutritional status of the plant media before and after planting the test plants

No	Nutrition	Before planting	Status	After Planting	Status	Changes of status
1.	pH	6,70	Neutral	6,98	Neutral	Increase
2.	Organic-C (%)	2,21%	Moderate	2,63%	Moderate	Increase
3.	Total of N (%)	0,26%	Moderate	0,34%	Moderate	Increase
4.	C/N ratios	8,40	Low	7,90	Low	Decrease
5.	P available (ppm)	4,85	Low	42,32	Very High	Increase
6.	K available (ppm)	9,68	Low	114,68	Very High	Increase
7.	Aluminum Saturation	0,50	Very low	0,60	Very low	Increase
8.	Base Saturation	0,29	Very low	0,35	Very low	Increase

Source: Primerly Data

The guidelines for the criteria for assessing soil chemical properties used are the guidelines used by BalittanahBogor, as in the table below.

Table 2. The criteria for assessing soil chemical properties for agriculture – the best conditions for soil fertility

No.	Chemical Properties of Soil	Very Low	Low	Moderate	High	Very High
1,	C (%)	< 1,0	1,0 – 1,9	2,0 – 2,9	3,0 – 5,0	> 5,0
2.	Organic Matter	< 1,72	1,71 – 3,27	3,28 – 4,99	5,0 – 8,6	> 8,6
3.	N (%)	< 0,10	0,10 – 0,20	0,21 - 0,50	0,51 – 0,75	> 7,5
4.	C/N rasio	< 5	5 – 10	11 - 15	16 – 25	> 25
5.	P Bray (ppm)	< 4	4 – 6	7 - 11	12 – 15	> 15
6.	K	< 5	5 – 16	17 - 24	25 – 40	> 40
7	pH H_2O Very Acidic	Acidic	Slighly acidic	Neutral	Slighly Alkaline	Alkaline
	< 4,5	4,5 – 5,5	5,6 -6,5	6,6 – 7,5	7,6 – 8,5	> 8,5

Source: Soil Research Institute of Bogor

The method for testing the nutritional parameters of the planting media used is as shown in the table below.

Table 3. The Test of parameters and the methods used

No	Test Parameter	Method Used
1	pH H_2O	pH H_2O determined using a pH meter with a soil to solvent ratio of 1: 12
2	Organic-C	Organic-C was determined using wet digestion and using potassium bichromate according to the Walkley and Black method
3	N (Total)	Total of N was determined by the Kjehldahl method
4	C/N Ratios	The C/N ratio is determined by directly dividing the Organic C number by the Total N number
5	P_2O_5 (Available)	Total phosphate content (mg/100g) was determined using 25% HCl extraction, while available phosphate (ppm) was determined using Bray extraction.
6	K_2O (Available)	Total potassium was determined using 25% HCl extraction

Source: Soil Science Laboratory of Agriculture Faculty of Mulawarman University

The results of research data analysis on the effect of giving gibberellin ZPT on the growth and yield of purpleeggplant (Solanum melongena L.) of the Yufita F1 variety, are presented in the table below

Table 4. Recapitulation of Data and Results of Data Analysis Research on the Effect of Giving Gibberellin ZPT on the Growthand Yield of Purple Eggplant (Solanum melongena L.) Yufita F1 Variety.

Concentration of Gibgerelin (P) (mL L^{-1})	Increase in Plant Height (cm)			Number of Branches (Branch)	Flowering Age (DAT)	Harvest Age (DAT)	Fruit Length (cm)	Number of Fruits per Plant (Fruit)	Fresh Fruit Weight per Plant (kg)
	14 DAT	28 DAT	42 DAT						
p0 : 0.00	5,82[a]	12,20[a]	36,80	2,20[a]	41,70[b]	59,10	15,76[a]	5,20[a]	0,34[a]
p1 : 0.15	6,60[ab]	12,07[a]	36,40	2,40[a]	41,80[b]	58,90	16,25[a]	5,20[a]	0,35[a]
p2 : 0.30	7,17[b]	14,51[b]	41,20	3,60[b]	40,10[a]	58,70	19,13[b]	6,90[b]	0,44[b]
p3 : 0.45	6,29[ab]	12,36[a]	37,40	2,60[a]	41,60[b]	59,40	16,51[a]	5,00[a]	0,38[a]
Anova	*	*	NS	**	*	NS	**	**	**
LSD 5%	0,89	1,93	-	0,61	1,19	-	0,85	0,56	0,05

Remark: DAT = Day After Transplating, NS: Not significant, *: Significant, **: Very Significant

DISCUSSION

Increase in plant height

The results of variance analysis for the plant height increase variable showed that the effect of gibberellin concentration was significantly different at 14 and 28 days after transplanting (DAT). The highest increases in plant height were obtained, namely 7.17 and 14.51 cm. This figure is smaller than the results of research (Wulansari, 2014),namely 51.01 cm. This is due to the provision of Plants Growth Regulator (PGR) gibberellin so that plants can absorbPGR well through the stomata on the leaves, and gibberellin is a PGR that can control enzyme synthesis and can stimulate cells so that the cells elongate because in these cells an osmotic process occurs which causes water to be forced upwards which process It is formed by the amylase enzyme which hydrolyzes starch and the sugar levels in cells increase (Wulansari, 2014).

Number of Branches

The results of variance analysis on the variable number of branches showed that the effect of different gibberellin concentrations was very significant, treatment p2 (0.30 mL gibberellin L-1). The best result was obtained,namely 3.60 branches. This figure is smaller than the results of research (Zainal, 2015), namely 11.67 branches. Thisis because gibberellin is a PGR that stimulates cell division and elongation, and has an effect on plant vegetative growth which stimulates plant growth such as enlargement of stem segments, increasing the number of branches, leaves, flowers and even fruit. The higher the gibberellin concentration applied to plants, the better it will support thegibberellin PGR that the plants need (Zainal, 2015).

Flowering Age

The results of variance analysis on the flowering age variable showed that the effect of gibberellin

concentration was significantly different, treatment p2 (0.30 mL Gibberellin L-1). The fastest flowering age was obtained, namely 40.10 HSPT. This figure is greater than the results of research (Triani, 2020), namely 36.56 HSPT with the administration of gibberellin PGR with a concentration of 0.30 mL L- water causing plants to flower more quickly. This happens because gibberellin affects cell differentiation. Gibberellins play a role in accelerating plant flowering by producing proteins that will induce the expression of genes for the formation of floral organs, sub-apicalmeristem and producing bolting that initiates the emergence of flowers (Triani, 2020).

Age of Harvest

The results of variance analysis for the harvest age variable showed that the effect of different gibberellin concentrations was not significant. P3 treatment (0.30 mL gibberellin L-1), The fastest harvest age was obtained, namely 58.70 DAP. This happens because gibberellins can accelerate seed germination, help shoot/embryo formation,stem elongation, leaf growth, stimulate flowering, fruit development, stem elongation, leaf growth, stimulate flowering, fruit development, harvest time is influenced by environmental factors (Sodiqin *et al*, 2017).

Fruit Length

The results of variance analysis on fruit length variables show that the effect of different gibberellin concentrations is very significant. The p2 treatment (0.30 mL gibberellin L-1The longest fruit was obtained, namely
19.13 cm. This figure is greater than the results of research (Sodiqin *et al*, 2017), namely 4.20 cm. This occurs due tothe provision of gibberellin which is carried out from the beginning of the fruit formation period which is able to meetthe gibberellin content requirements required by solanecea plants, the provision of gibberellin PGR which is given isable to increase the process of absorbing nutrients from the soil, increase the amount of chlorophyll, increase the formation of branches, increase the number of buds and flowers as well as preventing flower drop and increasing fruitsize (Sodiqin *et al*, 2017).

Number of Fruits per Plant

The results of variance analysis on the variable number of fruit per plant show that the effect of different gibberellin concentrations is very significant. The p2 treatment (0.30 mL gibberellin L-1obtained the most fruit, namely, 6.90 fruit. This figure is smaller than the results of research (Triani, 2020), namely 18 fruit, giving gibberellinPGR can increase the number of flowers which can result in a greater number of fruit being formed but also increasesthe risk of the flowers and fruit dropping more. Flower drop occurs due to organic nutria deficiency caused by competition between flowers and fruit on a head, or panicle. The main hormones that play a role in fruit growth are auxin and gibberellin. These two hormones work synergistically in the fruit formation process. The increase in gibberellin concentration given was positively correlated with an increase in the number of fruit formed. The numberof fruits per plant will affect the total fruit per plant. The concentration of gibberellin PGR can increase the number of fruit and the fresh weight of the fruit (Triani, 2020).

Fresh Fruit Weight per Plant

The results of variance analysis on fresh fruit weight per plant showed that the effect of different gibberellin concentrations was very significant. Treatment p2 (0.30 mL gibberellin L-1). The heaviest fruit was obtained, namely
0.44 kg. This figure is smaller than the research results (Triani, 2020), namely 0.67 kg. Fruit weight increases due to two processes, namely cell division followed by cell enlargement. The concentration of gibberellin is able to increaseauxin levels which have a role in cell division, while gibberellin itself has a role in cell expansion so that the synergyof the two can increase cell size. This process is able to increase the gibberellin PGR and increase the weight of the fruit produced by the plant (Triani, 2020).

The results of the analysis of variance of orthogonal polynomial regression analysis of gibberellin PGR application on fresh fruit weight per plant showed a quadratic relationship with the equation $\hat{y}$=0.3603 + 0.0601x witha coefficient of determination R2=0.0371. This shows that the effect of giving gibberellin PGR on the fresh weight offruit per plant is 0.37%, meaning that there is a close relationship between giving gibberellin PGR and fresh fruit weight per plant. The effect of giving the best gibberellin PGR concentration of 0.30 mL gibberellin L-1 with a yieldof 0.44 kg.

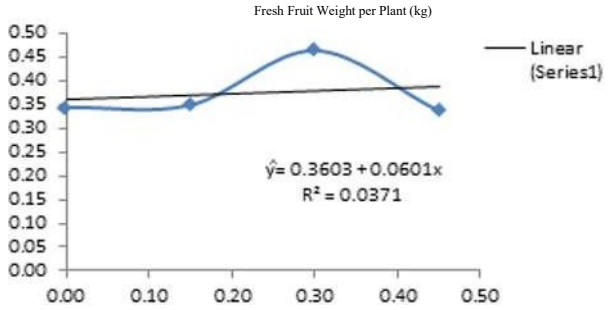

Figure 1. Graph of the effect of gibberellin plant growth regulator (PGR) application on fresh fruit weight per plant

CONCLUSION

Based on the results of the research concerning the impact of Gibberellin Plant Growth Regulator (PGR) on thegrowth and yield of the Yuvita F1 variety of purple eggplants (Solanum melongena L.), several key conclusions can be drawn:

1. Gibberellin PGR significantly influences various growth and yield parameters of Yuvita F1 purple eggplantplants. These variables include an increase in plant height, the number of branches, flowering age, fruit length, the number of fruits per plant, and the weight of fresh fruits per plant.

2. Among the different concentrations tested, a dosage of 0.30 mL gibberellin L-1 emerged as the most effectivefor promoting the growth and yield of Yuvita F1 purple eggplant plants. Specifically, this concentration resulted in a substantial increase in plant height (14.51 cm), a higher number of branches (3.60 branches), a delayed flowering age (40.10 HSPT), longer fruit length (19.13 cm), a greater number of fruits per plant (6.90), and a higher fresh fruit weight per plant (0.44 kg)

Furthermore, the relationship between the concentration (mL L-1) of gibberellin PGR and fresh fruit weight per plant indicates a correlation coefficient of 0.4338. This signifies a direct association between gibberellin PGR concentration and fresh fruit weight per plant, with an optimal concentration of 0.30 mL L-1, resulting in the maximum yield of fresh fruit weight per plant, namely 0.44 kg.

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Factors That Influence Samarinda's Desireable Dietary Pattern

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ABSTRACT

In the world there are more than 50 thousand types of edible plants, but only 15 types of food plants provide 90% of energy intake. Among the 15 food commodities, rice, corn and wheat account for 2/3 of world food consumption. Food diversity is one of the main prerequisites for consuming food of sufficient quality and nutrition. One of the indicators used to see the achievement of diversity in food consumption is through the consumption Desireable Dietary Pattern (DDP) score. Data obtained from the Samarinda City Food Security and Agriculture Service. These data are analyzed using tables, as well as simple statistical analysis (average calculation, growth rate, and achievement percentage). Samarinda city DDP in 2019-2022: 83.1; 88.2; 76; and 84.8. Dropped drastically in 2021, this year's DDP value is lower than the previous year, this is due to a decrease in the macro level of availability, this is due to several times when farmers experienced crop failures and also the covid-19 outbreak which attacked the city of Samarinda. DDP data also shows that there is no tendency that people have changed the source of carbohydrates from rice to tubers, indicated by the absence of an increase in the DDP score from the tuber food group, instead there has been a decrease from 1.1 in 2020 to 0.8 in 2021 In 2022, Samarinda people consume an average of 278.2 kcal less energy than the recommended 2100 kcal. DDP is strongly influenced by consumption behavior, availability, price, expenditure on food, family size, maternal nutritional knowledge and income.
Keywords: consumption, desirable dietary pattern

INTRODUCTION

In the world there are more than 50 thousand types of edible plants, but only 15 types of food plants provide 90% of energy intake. Among the 15 food commodities, rice, corn and wheat account for 2/3 of world food consumption. Until now, diversity in food consumption is still a big problem for the government. For this reason, the government continues to make various efforts to increase awareness and instill culture so that people are not focused on only certain types of food for daily consumption. One of the indicators used to see the achievement of diversity in food consumption is through the Desirable Dietary Pattern score.

Desirable Dietary Pattern (DDP) or Pola Pangan Harapan (PPH) is an arrangement of various foods that is based on the contribution or contribution of energy and main food groups and a pattern of food availability or consumption patterns. FAORAPA (1989) defines a hopeful food pattern as the composition of the main food groups which, when consumed, can meet energy and other nutritional needs. Food diversity is one of the main prerequisites for consuming food of sufficient quality and nutrition. In this case, food diversity is one of the main pillars of food security, so that if food security increases, the Desirable Dietary Pattern (DDP) score will also increase. The problem faced so far is that diversifying food towards consuming foods other than rice is not easy, considering the low consumption of non-rice foods such as tubers and other cereals as well as consumption of vegetables and fruit. Coupled with the paradigm circulating among the public that you are not full if you haven't eaten rice, it makes it increasingly difficult to change people's diet towards tubers as an alternative source of carbohydrates (Saragih, 2018).

The Desirable Dietary Pattern (DDP) Score based on consumption data is an indicator to see the diversity of food consumption and can also be used as a tool to plan food consumption needs. The ideal Food Pattern Score of Expectations is 100, where the higher the Score of Food Pattern Expectations in an area, the more diverse the food consumption of the population in that area. The status of achieving the DDP can be classified into the categories medium =80≤DDP score≤90, Good= DDP Score>90 is good; low =DDP score <80 (National Food Agency, 2022).

The higher the DPP score indicates that food consumption is more varied, nutritionally balanced and safe. Expected Food Pattern is an arrangement of food diversity that is based on the energy contribution of the main food groups at the level of food availability and consumption. The use of the Consumption Expectation Food Pattern is to assess the consumption situation and plan food consumption. In 2022 the National DDP Score will reach 92.9 above the target of 92.8. Meanwhile, the National DDP Score target for 2024 according to the National Medium Term Development Plan (RPJMN) is 95.2 (National Food Agency, 2022). The expected food pattern score for the city of Samarinda in the last 7 years is still below the DDP score for East Kalimantan Province, as well as other districts and cities in East Kalimantan and is far from the national strategic target which has reached 94 in 2023. Therefore, it is necessary to carry out a descriptive study of DDP and factors related to the problem of low DDP in Samarinda City.

METHODS

Data Sources and Data Types

Data obtained from the Samarinda City Food Security and Agriculture Service. The type of data is data on food consumption and desirable dietary pattern from 2016-2022.

Data analysis

Data on consumption and Desirable Dietary Pattern were analyzed using tables, as well as simple statistical analysis (average calculation, growth rate and percentage of achievement), then discussions were carried out and the addition of related references and descriptive analysis to find out what dominant factors were related to DDP in Samarinda City.

RESULT AND DISCUSSION

Food Consumption

The increase in population growth each year is closely related to food needs. The population of Samarinda City, based on the 2022 population census, is 834,824 people, consisting of 424,837 male residents and 409,987 female residents. Meanwhile, the sex ratio in 2022 for the male population to the female population is 103.62. Population density in Samarinda City in 2022 will reach 1,153 people/km2 (BPS, 2023). Population density in the 10 sub-districts is quite diverse with the highest population density being in Samarinda Ulu sub-district with a density of 5,869 people/km2 and the lowest in Palaran sub-district at 286 people/km2. Food consumption is influenced by food availability, which at the macro level is indicated by the level of national production and sufficient food reserves, while at the regional and local level it is indicated by the level of food production and distribution.

Energy consumption (calories) of Samarinda city residents in 2017 decreased compared to 2016 and increased again until 2020, then decreased again in 2021 (Figure 1), this fluctuation is largely influenced by people's consumption behavior.

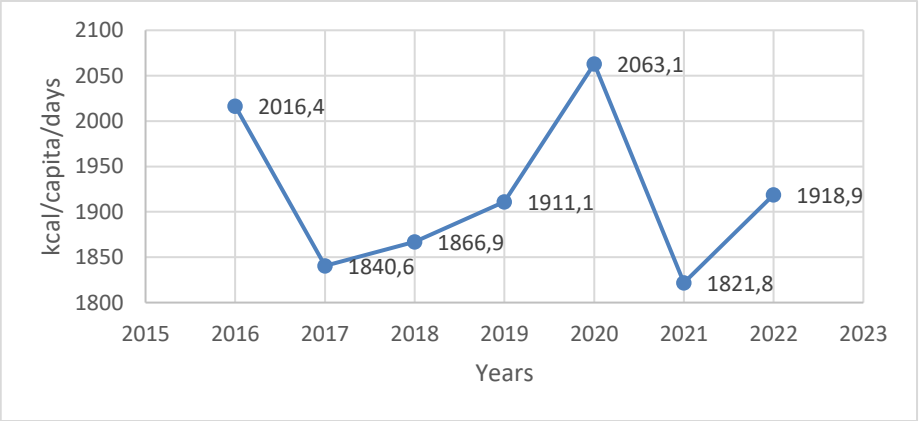

Figure 1. Average energy consumption of Samarinda people in the last 7 years

Protein consumption also decreased in 2021, increasing again in 2022 to 65.6 (Figure 2). Protein, as a building block, protein is needed for growth and replacement of damaged cells, this shows that protein availability has met the minimum standard of 63 grams/capita/day so its supply needs to be maintained.

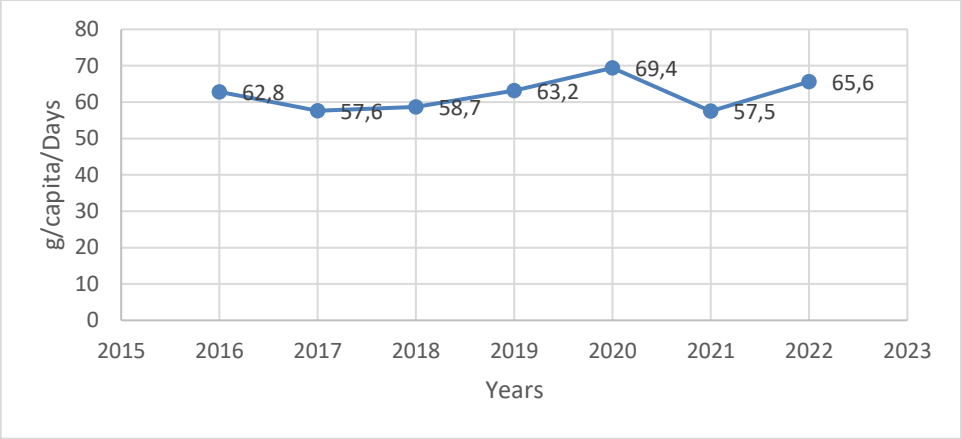

Figure 2. Average protein consumption of Samarinda people in the last 7 years

Based on Figure 2, it can be seen that per capita energy consumption of 1821.8 kcal/capita/day is still below the standards set by the government, based on Minister of Health Regulation (PMK) Number 28 of 2019, the recommended RDA for Indonesian people is 2,100 kcal. /capita/day. This condition shows that there is a shortage of energy consumption in the average population of 278.2 kcal, and this can cause health problems. Meanwhile, the DDP value is still below standard, indicating a lack of balance in consumption of food groups. To balance the food consumed according to energy levels, changes in consumption behavior in society are needed. Consuming foods high in carbohydrates such as rice and wheat should be changed to other ingredients with lower carbohydrate/energy content such as sweet potatoes or other substitute foods. Consumption of animal foods, vegetables and fruit needs to be increased as a source of protein and vitamins. Vegetables and fruit are especially important as sources of vitamins so that vitamin and mineral deficiency diseases can be suppressed.

Desirable Dietary Pattern (DDP)

The DDP of Samarinda city residents also experienced fluctuations and decreased most in 2021, namely 76 (Figure 3). There is no visible trend that people have changed the source of carbohydrates from rice to tubers, as indicated by the absence of an increase in the DDP score from the tuber food group, instead there has been a decrease (from 1.1 in 2020 to 0.8 in 2021).

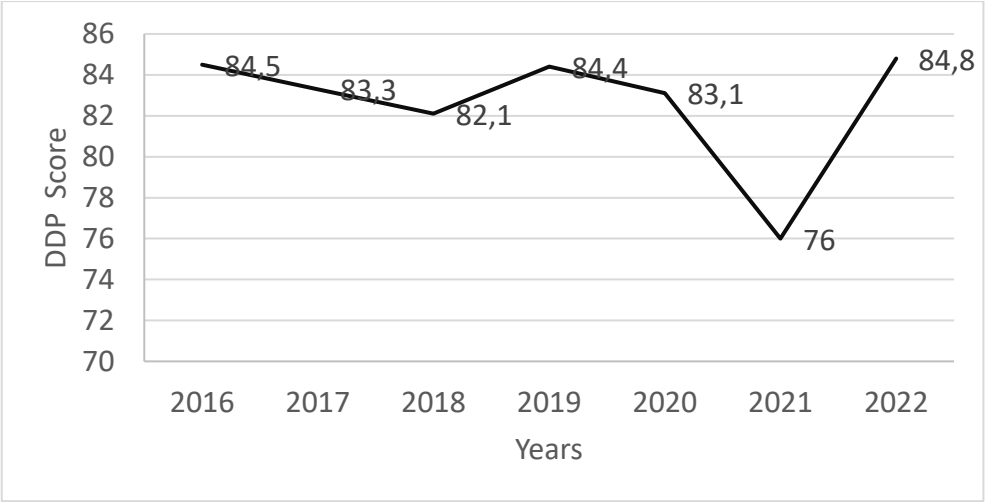

Figure 3. Graph of the development of the DDP score for the city of Samarinda in 2016–2022

To assess the diversity of food availability using the DDP instrument or DDP score, food availability data presented in the Food Balance Sheet (FBS) is used and the Energy Adequacy Rate (EAR) is used at the supply level, namely 2,400 cal/capita/day. Meanwhile, to assess the diversity of food consumption quality using the DDP instrument and the DDP score, food consumption data is used and the Energy Sufficiency Rate is used at the consumption level, namely 2,150 cal/capita/day. The composition of DDP

availability presented in table 1 consists of eight food ingredient groups excluding other food ingredient groups. From the 8 (eight) groups of food items, it can be seen that the DDP score in Samarinda City in 2022 is 84.8 with total energy consumption of 1821.8 cal/capita/day. A more detailed description of the Desirable Dietary Pattern scores for each food group can be seen in Table 1 below.

Table 1. Samarinda City Desirable Dietary Pattern Score Data Per Food Group 2016–2022

No	Food Group	Years						
		2016	2017	2018	2019	2020	2021	2022
1	Grains/cereals	25	25	24.8	24.4	24.9	22.1	23.9
2	Tubers	1.1	1.5	1.1	0.8	1.1	0.8	1.0
3	Animal food	24	24	24	24	24	24	24
4	Oil and fats	5	5	5	5	5	5	5
5	Oily fruit/seeds	0.4	0.4	0.3	0.3	0.3	0.2	0.2
6	Legumes	4.8	4.9	4.7	5.5	5.4	4.3	5.7
7	Sugar	2	2.3	1.9	1.8	1.9	1.9	1.8
8	Vegetable and fruit	22.2	20.2	20.5	22.7	25.5	17.6	23.3
9	Etc	0	0	0	0	0	0	0
Total DDP score		84.5	83.3	82.1	84.4	83.1	76.0	84.8

Source: Susenas 2016-2022

Description:

- *The grain group includes: rice; corn; and flour.*
- *The tuber group includes: cassava; sweet potato; potato; sago; and other tubers.*
- *The animal food group includes: ruminant meat; poultry; egg; and fish.*
- *The group of oils and fats includes: coconut oil; other oils; margarine.*
- *The oily fruit/seed group includes: coconut; candlenut.*
- *The legume group includes: soybeans; peanuts; mung beans; other nuts.*
- *The sugar group includes: granulated sugar; Brown sugar*
- *The vegetable and fruit group includes: vegetables; fruit*

In 2022 there will be an increase in DDP, especially in the vegetable and fruit sector, this phenomenon shows that people with increased income will spend their income to buy vegetables and fruit. However, there was also an increase in rice and tubers. Shifts in a person's consumption patterns can be influenced by their income, the greater a person's income, the more diverse their food consumption patterns are and vice versa. The dimensions of poverty and food insecurity are two interrelated social phenomena, even seen as having a causal relationship and the two can exacerbate each other because food insecurity will reduce quality of life and productivity (Saragih, 2010; Saragih, 2022). The condition of vulnerable food security becomes a source of poverty, conversely because poor people become food insecure or do not have food security, the threat of poverty, hunger and malnutrition in infants and toddlers requires serious attention by all elements of the nation (Saragih, 2008; Saragih, 2014). Poverty is a situation where there is a shortage of things that are usually owned, such as food, clothing, shelter and drinking water, these things are closely related to quality of life.

Poor households obtained food security in the last month 98 (82%), and food insecure 22 households (18%). The proportion of food secure households in poor households is greater than in food insecure households. Social support can increase food security resilience in poor households, as evidenced by the higher social support scores in families that are food secure compared to food insecure families. 72.7 percent of households who are food insecure say that the advice given by their neighbors helps them solve their problems and 87.8 percent of households who are food insecure (Saragih et al, 2023).

The DDP score for Samarinda City in 2021 is 76 and the score must be increased to meet the National standard of 100. Especially for several food ingredients whose DDP scores are lower than the standard. Meanwhile, for foodstuffs whose score is higher or the same as the standard, their availability must be maintained, so that food supplies remain available and are affordable for the community. This year's PPH value is lower than the previous year, this is due to a decrease in macro availability levels, this is due to several times when farmers experienced crop failures and also the covid-19 (Coronavirus Disease 2019) outbreak which attacked Samarinda City since March 2020. Several factors are related such as changes in eating habits with age, diversity of food with type of work, breakfast habits with type of work, consumption consumption with changes in eating habits. Some factors that are not related such as the diversity of consumption with worries about lack of food, breakfast habits with worries about lack of food, the habit of drinking spices with frequency of eating and types of spices with weight gain (Saragih, 2020).

Factors associated with Desirable Dietary Pattern

Based on the results and data above, it shows that shifts in a person's consumption patterns can be influenced by their income, the greater a person's income, the more diverse their food consumption patterns are and vice versa. Achieving the Desirable Dietary Pattern score is greatly influenced by several complex problems, such as: limited people's purchasing power, limited knowledge about food and nutrition, the influence of ready-to-eat food and cultural eating habits. The growth rate of the DDP score during 2016-2022 is still very low, namely -1.9, and is below the target growth rate of 0.02 for East Kalimantan Province. This condition really requires various efforts to accelerate the food diversity movement.

The Desired Diet Pattern score in 2021 is lower than the previous year, this is due to a decrease in macro availability levels, this is due to several times when farmers experienced crop failures and also the Covid-2019 outbreak which attacked Samarinda City since March 2020. Research results Saragih, 2020, showed that as many as 76% of respondents tended to make empon-empon (spices) as a drink during the Covid-19 pandemic. The type of spice most widely used is ginger at 44%, followed by orange/lemon and turmeric. Respondents experienced an increase in eating frequency by 54.5% and the amount of food consumption increased by 51%. Respondents experienced an increase in body weight of 54.5% and respondents who were not worried about food shortages were 54.5% higher than those who were worried about food shortages at 44.5%.

Food consumption is influenced by food availability, which at the macro level is indicated by the level of national production and sufficient food reserves, while at the regional and local level it is indicated by the level of food production and distribution. DDP is strongly influenced by consumption behavior, availability, expenditure on food, family size, maternal nutritional knowledge and income. Several factors are related, such as changes in eating habits with age, food diversity with type of work, breakfast habits with type of work, diversity of consumption with changes in eating habits. Several factors are not related, such as consumption diversity with concerns about food shortages, breakfast habits with concerns about food shortages, empon-empon drinking habits with meal frequency and types of empon-empon (spices) with weight gain (Saragih, 2020). Another factor that could influence the decline in consumption of the tuber group is the issue of price, because if you take into account the economic value, the price of tubers is much more expensive than rice, besides that rice is easier to obtain anywhere and at any time (it doesn't know the season), this This is one thing that makes people continue to choose rice as a staple food.

CONCLUSION

The growth rate of the DDP score during 2016-2022 is still very low, namely -1.9, and is below the target growth rate of 0.02 for East Kalimantan Province. The Desired Diet Pattern score in 2021 is lower than the previous year, this is due to a decrease in macro availability levels, this is due to several times when farmers experienced crop failures and also the Covid-19 outbreak which attacked Samarinda City since March 2020. Food consumption is influenced by food availability, which at the macro level is indicated by the level of national production and sufficient food reserves, while at the regional and local level it is indicated by the level of food production and distribution. DDP is strongly influenced by consumption behavior, availability, price, expenditure on food, family size, maternal nutritional knowledge and income.

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Effect The Concentration of Chrysanthemum Flower Extract (*Chrysanthemum morifolium* Ramat) Against Anthracnose Disease in Tomato Plants (*Solanum lycopersicum* L.)

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) is a vegetable horticultural commodity that has great potential in fulfilling the needs of household consumption, the food processing industry, US well US a mixture of processed ingredients. The last five years the production of tomato plants has declined mainly due to disease attacks, one of which is anthracnose disease caused by a fungus. *Colletotrichum* sp. which can cause damage to tomatoes in the rainy season seasons. Therefore, it is necessary to control fungal pathogens to reduce disease attacks on tomato plants by using vegetable pesticides, one of which is the application of chrysanthemum flower extract. This research was conducted to identify disease-causing fungi, determine the effect of chrysanthemum flower extract on the fungus, and analyze the best concentration of chrysanthemum flowers extract to controls the fungus that causes anthracnose disease in tomato plants. This research was conducted at the Laboratory of Plant Pests and Diseases (IHPT), Faculty of Agriculture, Mulawarman University from November 2022 to March 2023. A factorial experiment in a completely randomized design with 4 treatments and 10 repetitions was used in this study. The single factors in this study was the inhibition of chrysanthemum flowers extract on fungal growth *Colletotrichum* sp. the data obtained were analyzed using variance (ANOVA) and further tested using the Least Significant Difference (LSD) test at the 5% level. This study showed that 0.1%, 0.2% and 0.3% concentrations of chrysanthemum flower extract had inhibition of the growth of the tested fungal colonies. Increasing the concentration of chrysanthemum flowers extract showed a bigger areas (zone) of inhibition of fungal growth. The best concentration in inhibiting the growth of the tested mushroom colonies was shown at a concentration of 0.3% on number 34.31%. This shows that the antifungal activity of chrysanthemum flower extract is able to inhibit the growth of the fungal mycelium *Colletotrichum gloeosporioides* .

Keywords : Tomato (*Solanum lycopersicum* L.), chrysanthemum (*Chrysanthemum morifolium* Ramat), manthracnose, *Colletotrichum* sp.

INTRODUCTION

Tomato plants (*Solanum lycopersicum* L.) are one of the vegetable horticultural commodities that have great potential in meeting the needs of household consumption, the food processing industry, and a mixture of processed ingredients. [1]. However thereby, plant tomato Still need enforcement Serious in matter enhancement Power competitive production results in meeting high market demand [2]. Efforts to develop and produce tomatoes do not always run smoothly due to many obstacles, both economic, social and biological. Biological factors that often become obstacles are attacks that cause disease, and one of the diseases caused is anthracnose caused by *Colletotrichum* sp. [3]. Fluctuations in the cumulative development of the area plus anthracnose attacks on tomato production in the last five years in Samarinda City show the real influence of attacks by the pathogen *Colletotrichum* sp. is the cause of anthracnose disease and data covering an area of East Kalimantan Province shows that the number of attacks by the fungus *Colletotrichum* sp. causing a significant decrease in tomato yields, affecting high demand, so that fungal control efforts are still needed that can offset the number of anthracnose attacks on tomato plants [4]. Attack of the pathogen *Colletotrichum* sp. which causes anthracnose in tomato plants can cause production yields to decrease because the control measures taken are inadequate [5]. Therefore, an effective control effort is needed to control the attack of the pathogen *Collettorichum* sp.

One environmentally friendly control effort is to use vegetable pesticides, namely extraction with raw materials derived from plants so that it is safe because it is *biodegradable* (easily broken down) and

not leaving residue. The extract obtained has active compounds that are capable of causing pests and diseases to become resistant [3]. One plant that has the potential to be used as a pesticide is the chrysanthemum flower (*Chrysanthemum morifolium* Ramat). Chrysanthemum flower extract contains compounds found in chrysanthemum flowers, namely flavonoids, alkaloids, tannins, saponins and terpenoids which play the most important role as antifungals. Not only that, several studies also shows that *chrysanthemum* contains a number of compounds that have properties antibacterial, antifungal, and anti-inflammatory. Study previous has proven there are compounds in it chrysanthemums showing antifungal activity viz terpenoids in the active compounds *zingiberene* , ®- *sesquiphellandrene* , ∝ - *curcumene* , (E)-®- *farnasene* , and 1,8- *cineole* [6]. However, identification has never been carried out administration of chrysanthemum flower extract which showed antifungal activity on the pathogen *Colletotrichum* sp. causes anthracnose disease in tomato plants.

MATERIAL AND METHOD

Time And Place

The research will take place from November 2022 to March 2023, starting from preparation of tools and materials to data analysis. This research was carried out at the IHPT (Pest and Disease Science) Laboratory Plants), Faculty of Agriculture, Mulawarman University, Samarinda.

Procedure Study

1. Preparation Tool And Material
   Equipment preparation is carried out by sterilizing it to assist identification and accurate research results. Preparing the raw materials used were tomatoes infected with anthracnose, judging from the characteristics shown, as well as a number of *White Fiji chrysanthemum cultivar flowers* for making test extracts.
2. Isolation Pathogen
   Isolation of pathogenic fungi done by preparing sample first formerly fruit infected tomatoes anthracnose disease is square in shape with a size of 1 cm of infected fruit x 1 cm of uninfected fruit and is sterilized from other pathogens using distilled water. Then sample isolated on media PDAs Which Already thicken And close meeting by using *wrap.*
3. Identification Pathogen
   Colony the mushroom grow on the media PDAs, then observe morphological characteristics fungi macroscopically and microscopically which shows the characteristics of the fungus *Colletotrichum* sp.
4. Purification And Propagation Mold
   The identification results show the characteristics of the fungus *Colletotrichum* sp. then purified isolation is carried out on PDA media and multiplication is carried out by harvesting the required amount of mushrooms that grow during purification .
5. Making Extract Test
   chrysanthemum flowers (*Chrysanthemum morifolium*) *White Fiji cultivar* are washed clean then dried and separated from other parts of the flower. 250 grams of crushed flowers were dissolved in 850 ml of 96% ethanol in *a baker's glass* and covered tightly with *aluminum foil* and plastic *wrap* . Then the solution was macerated for 1 x 24 hours with *an Orbital Shaker* and then filtered using filter paper to obtain chrysanthemum flower extract phytrate. The filtration results are then evaporated for approximately 6 hours. The evaporation results are then placed in the oven to evaporate the remaining solvent odor to obtain the final chrysanthemum flower extract in a paste texture. The results of extraction with these raw materials obtained a yield based on calculations of 0.9607%, amounting to 2.402 grams of extract.
6. Making Concentration Extract Test
   The concentrations used were 0.1%, 0.2%, and 0.3% which were obtained by switching between the volumes of the solution Which desired in milliliters And concentration Which will made Then shared with concentration Which available to obtain concentration results of 0.25 ml, 0.50 ml, and 0.75 respectively
7. Making *Potato Dextrose So that* (PDA) + Extract Test
   Making PDA using raw materials such as potatoes, agar, refined sugar, plus *Chloramphenicol* in the laboratory. Treatment formulation by adding chrysanthemum flower extract according to the treatment, the first *Erlenmeyer* contains 250 ml of PDA media, the second *Erlenmeyer* contains 249.75 ml of PDA media plus 0.25 ml of chrysanthemum flower extract, the third *Erlenmeyer* contains 249.50

ml of PDA media plus 0.50 ml of chrysanthemum flower extract, and the fourth *Erlenmeyer flask* contained 249.25 ml of PDA media plus 0.75 ml of chrysanthemum flower extract.

8. Isolation Mold *Colletotrichum* sp. On Media PDAs + Extract Test
   To be able to observe inhibition tests on fungal growth, isolates of *Colletotrichum* sp. then isolated on PDA media which had been added with chrysanthemum flower extract at several treatment concentrations and carried out as many repetitions on *the entkas* .
9. Collection Data Observation
   Data collection in the form of descriptive data came from observing the morphological characteristics of the fungus *Colletotrichum* sp. of each treatment using a microscope at 400x magnification. Quantitative data was obtained from measuring the diameter of the fungal colony growth on each treatment ranging from three days to thirteen days after inoculation (3 days – 13 days) then calculate the percentage of inhibition.

Method Analysis Data

Data results study analyzed with fingerprint variety use Design Random Complete (RAL). Comparison average treatment use test Different Real Smallest (BNT) level 5 %.

RESULTS AND DISCUSSION

1. Identification Characteristics Morphology Mold *Colletotrichum* sp.

Based on the results of the identification of the test mushroom, namely the *Colletotrichum* sp. The cause of anthracnose disease in tomato plants, was observed macroscopically and microscopically at the Laboratory of Pest and Plant Disease Science, Faculty of Agriculture, Mulawarman University, data obtained which can be seen in the table and figure as follows.

Table 1. Character Morphology Mold Test

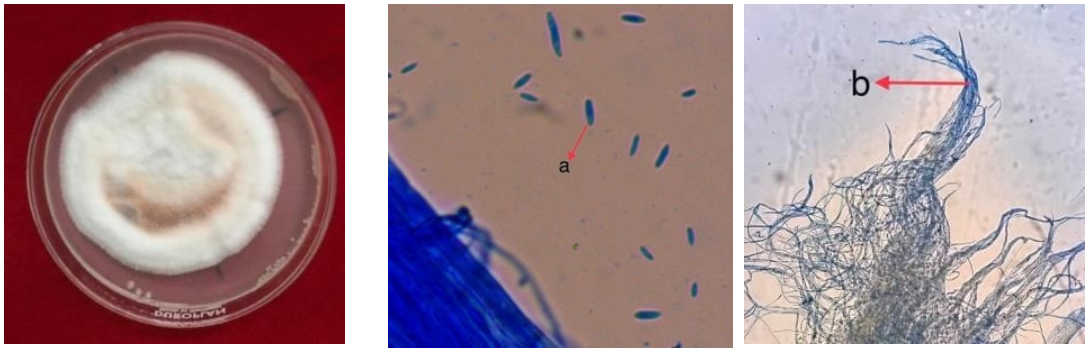
Characteristics Morphology	Results Observation	
	Macroscopic	Microscopic
Color surface colony	White clean with freckles orange on surface colony	
Direction growth	To side until fulfil Cup (9 cm) And to on	
Texture colony	Fine like cotton	
Spores		Hyalin, unicellular, Cylindrical /extend with end blunt/Ovoid, Amount very Lots
Hyphae		Hyalin, branching And partitioned, conidiophores simple

Information : Identification use microscope with 400x magnification .

The results of the identification of the test mushrooms in the table above show the morphological characteristics of the fungus *Colletotrichum* sp. Macroscopically, the fungal colony can be seen as round in shape, the edges of the colony are flat with the direction of growth to the side until on the thirteenth day after inoculation (13 days later) the average diameter of the fungal colony fills the cup (9 cm), the colony is pure white with orange spots on the surface of the colony and the hyphae thicken like fine cotton. Morphological characteristics of the fungus *Colletotrichum* sp. microscopically shows the results of observations Unicellular spores are colorless (transparent), have a cylindrical/elongated shape with two blunt ends (ovoid) and are very numerous. The hyphae observed were insulated, elongated with a growth speed of approximately 12.5 mm per day and branched, the conidiophores were simple and had hyaline (transparent) properties. This is in accordance with the macrobiological morphological characteristics and microbiology of fungus colonies isolated from tomatoes infected with anthracnose, namely *Colletotrichum gloeosporioides* [8]. Macroscopically, the morphological characteristics of the fungus *C. gloeosporioides* are white colonies with flat edges, a slightly smooth surface and a round shape. Microscopically, it has

cylindrical conidia with blunt ends, non-separated, unbranched conidiophores and insulated hyphae. Microscopically, *C.gloeosporioides* shows characteristic hyaline conidia, oval-shaped, single-celled [7] formed at the tip of a simple conidiophore [9].

Morphology of the Fungus Colletotrichum sp. in the fungal colony with the addition of chrysanthemum flower extract (in the treatment) macroscopic and microscopic can be seen in the following picture.



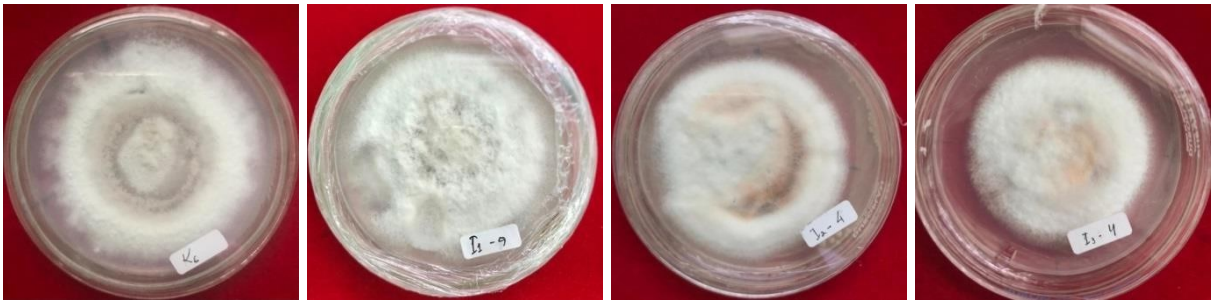
Macroscopic Microscopic

Figure 1. Mold *Colletotrichum* sp. on treatment observed in a way macroscopic And microscopic : a Spores; b. End Hyphae

Figure 1 is a picture of the morphology of the fungus after being treated macroscopically and microscopically. The microscopic appearance of the fungus was observed using *methylene blue* dye on a microscope with 400x magnification with the help of Optilab. Microscopic characteristics of fungi include transparent, insulated and branched hyphae, clumped hyphae tips and shorter hyphae length than usual, as well as very few spores, cylindrical in shape with both blunt ends. The characteristics of macroscopic and microscopic observations show characteristics the fungus *Colletotrichum gloeosporioides* [7].

The results of the identification of treated mushrooms in table 3 show the morphological characteristics of the fungus *Colletotrichum* sp. Macroscopically, it can be seen that the fungal colonies are round in shape with thick flat edges with a sideways growth direction with a slow growth rate (different for each concentration) so that on the thirteenth day after inoculation the average diameter of the fungal colonies has not yet filled the cup, the colonies are white, slightly orange with spots. orange on the surface of the colony and hyphae thick like fine cotton. Morphological characteristics of the fungus *Colletotrichum* sp. Microscopically, the observation results show that the unicellular spores are colorless (transparent), have a cylindrical/elongated shape with both blunt ends (ovoid) and the number of spores is very small compared to the test fungus. The hyphae observed were insulated with the size of each septum being shorter than the test fungus, elongating with decrease increase and branched, the tips of the hyphae are thickened (clumped), the conidiophores are simple and have hyaline (transparent) properties. This shows that there is an effect of giving chrysanthemum flower extract with different effects from each concentration treatment on the macrobiological and microbiological characteristics of the fungus colony that causes anthracnose disease in tomatoes, namely *Colletotrichum gloeosporioides* [10].

Colony growth *C.gloeosporioides* fungus on media PDAs and what has been added a number of The concentration of chrysanthemum flower extract after thirteen days after inoculation (13 days later) can be seen in the following picture.



Test Mushroom (Control) I1 (Treatment 1) 0.25 ml I2 (Treatment 2) 0.50 ml I3 (Treatment 3) 0.75 ml

Figure 2. *C.gloeosporioides* Fungus Colony Observation 13 days later

Figure 2 shows the difference between the colony of the fungus *Colletotrichum gloeosporioides* observed 13 days later with normal growth in the macrobiological morphological characteristics of the test (control) fungus colony *C.gloeosporioides* without the administration of chrysanthemum flower extract, namely growing well until it filled the petri dish, while the fungal colony *C.gloeosporioides* in treatment 1 by adding 0.25 ml of chrysanthemum flower extract, treatment 2 by adding 0.50 ml of chrysanthemum flower extract, and treatment 3 by adding 0.75 ml of chrysanthemum flower extract respectively. show colony with edge thickened And decline speed growth so that No can fill the petri dish. This happens because of the toxic compounds in chrysanthemum flower extract which can be deadly conidia and inhibit the growth of fungal mycelium. There is a tendency that the higher the concentration, the larger the area (zone) of inhibition produced [10].

2. Influence Concentration Extract Flower Chrysanthemum To Growth Colony Mold *Colletotrichum* sp.

Diameter of colony growth of the pathogenic fungus *Colletotrichum* sp. by observing the increase in size diameter of test fungal colonies and fungal colonies with the addition of chrysanthemum flower extract at concentrations of 0.1%, 0.2% and 0.3%. Based on the results of the analysis of variance, it shows that each treatment has a very significantly different effect (F count > F table) on the growth of colonies of the pathogenic fungus *Colletotrichum* sp. starting from the third day to the thirteenth day after inoculation (3 hsi-13 hsi).

Table 2. Average diameter growth mold *Colletotrichum* sp. treatment giving extract flower chrysanthemum with giving extract flower chrysanthemum on a number of concentration

Treatment	Day after inoculation (hsi)										
	3	4	5	6	7	8	9	10	11	12	13
Control	3.19d	4.14d	4.85d	5.68d	6.21d	6.79d	7.36d	7.96d	8.34d	8.64d	8.93d
I1	2.89c	3.66c	4.23c	4.81c	5.31c	5.87c	6.38c	6.86c	7.32c	7.69c	8.03c
I2	2.49b	3.18b	3.75b	4.35b	4.81b	5.15b	5.48b	5.83b	6.13b	6.39b	6.67b
I3	2.16a	2.69a	3.13a	3.66a	4.30a	4.75a	5.12a	5.40a	5.73a	5.94a	6.34a

Information :

1. The numbers that followed letter Which different on column the same shows the value different very real on test BNT 5% (3 hsi = 0.15), (4 hsi = 0.26), (5 hsi = 0.25), (6 hsi = 0.27), (7 hsi = 0.24), (8 hsi = 0.26), (9 hsi =0.29), (10 hsi = 0.27), (11 hsi = 0.31), (12 hsi = 0.291), (13 hsi = 0.290).
2. Unit size Which used in centimeter (cm)

Based on the table above, it shows that changes in the growth diameter of the pathogenic fungus *Colletotrichum* sp. from three days after inoculation to thirteen days after inoculation (3 days after - 13 days after) had a significantly different effect on each treatment, namely the treatment without giving chrysanthemum flower extract compared to the treatment with giving extract flower chrysanthemum on a number of concentration I1 (concentration 0.1% = 0.25 ml), I2 (concentration 0.2% = 0.50 ml) and I3 (0.3% concentration = 0.75ml). treatment I1 showed a very significant different effect on treatment I2, and treatment I2 showed a very significantly different effect from treatment I3.

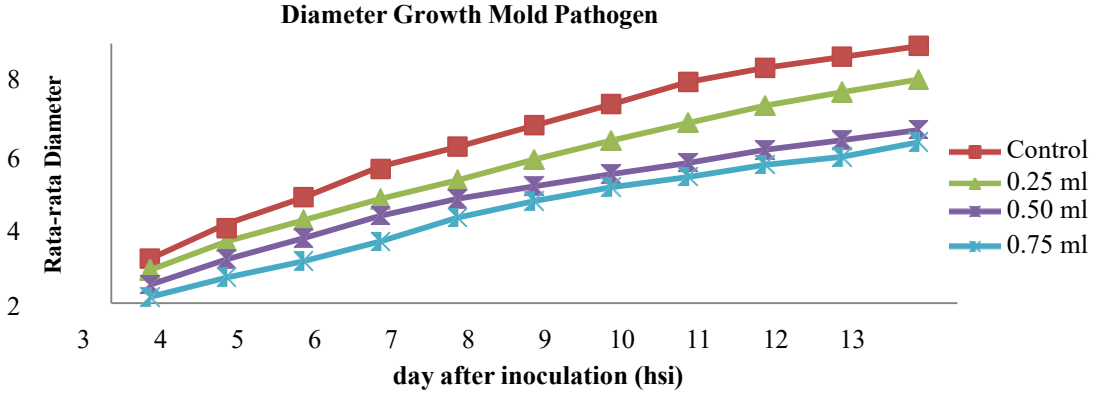


Figure 3. Chart Diameter Growth Colony *C. gloeosporioides* fungus On every Treatment

C.gloeosporioides fungus colony , in order from the lowest, was in treatment 3, namely the administration of chrysanthemum flower extract with a concentration of 0.75 ml, which was the highest concentration so that It contains more antifungal compounds which function to inhibit the growth of *C.gloeosporioides fungal colonies* . Followed by treatment 2, namely giving chrysanthemum flower extract with a concentration of 0.50 ml, and followed by treatment 3, namely giving chrysanthemum flower extract with a concentration of 0.25 ml, and the highest in the test mushrooms (control), namely without giving chrysanthemum flower extract. This can be caused by the real antifungal effect in chrysanthemum flower extract at a lower concentration (0.1%) which is less than the maximum percentage of inhibition of fungal growth compared to giving higher concentrations (0.2% and 0.3%). This is in accordance with the opinion that an increase in extract concentration indicates a greater diameter of the inhibitory zone for the growth of pathogenic mycelia [11].

The diameter of the inhibition zone decreased further on the sixth day. This indicates that fungal growth is occurring during period incubation six day, although in in media contain extract flower chrysanthemum. With thereby chrysanthemum flower extract with concentrations of 0.1%, 0.2%, and 0.3% as treatment is not able to kill the fungus, but only inhibits [12] because the fungus is resistant to the active substance of chrysanthemum flower extract.

3. Analysis Concentration Best Extract Flower Chrysanthemum For Control Mold *Colletotrichum* pathogen sp.

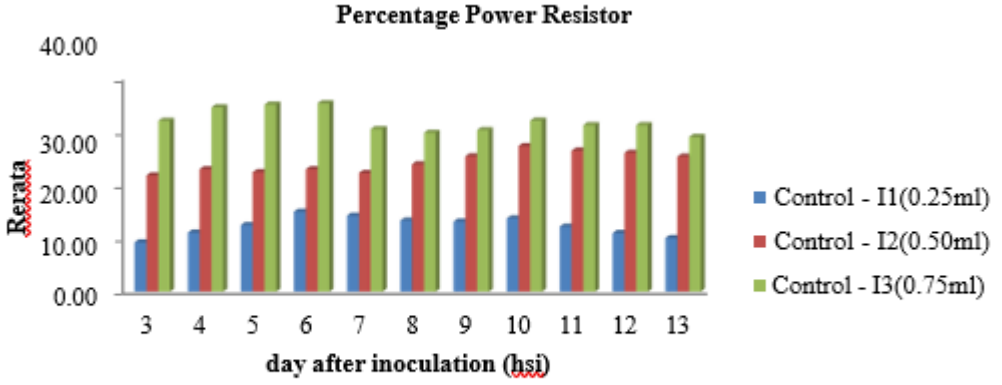
The growth of the fungus colony *Colletotrichum* sp showed differences due to the inhibition of the chrysanthemum flower extract content. Based on the results of variance analysis, it shows a very significant different effect (F count > F table) on the growth of the pathogenic fungus colony *Colletotrichum* sp.

Table 3. Average Power Resistor (%) Mold *Colletotrichum* sp. Consequence Treatment Giving Extract Flower Chrysanthemum Compared to With Every Treatment Giving Extract Flower Chrysanthemum Which Has In Transform Arcsin

TREATMENT	Day after inoculation (hsi)										
	3	4	5	6	7	8	9	10	11	12	13
I1	17.23 a	18.07 a	19.85 a	22.45 a	21.94 a	21.06 a	20.86 a	21.45 a	20.23 a	19.25 a	18.45 a
I2	27.57 b	28.08 b	27.77 b	28.03 b	27.87 b	29.06 b	30.05 b	31.40 b	30.80 b	30.60 b	30.10 b
I3	34.38 c	35.90 c	36.22 c	36.42 c	33.43 c	32.96 c	33,31 c	34.44 c	33.90 c	33.90 c	32.50 c

Information :

1. The numbers that followed letter Which different on column Which same shows mark different very real on BNT test 5% (3 hsi = 4.12), (4 hsi = 6.14), (5 hsi = 5.38), (6 hsi = 4.8), (7 hsi = 3.88), (8 hsi = 3.95), (9 hsi = 3.89), (10 hsi = 3.30), (11 hsi = 3.37), (12 hsi = 2.70), (13 hsi =2.63).
2. Mark Which obtained originate from comparison treatment without giving extract flower chrysanthemum (control) For each treatment, chrysanthemum flower extract was given in several concentrations
3. Unit size Which used in centimeter (cm)



Picture 4. Diagram Percentage Inhibition Extract Flower Chrysanthemum To Mold *C. gloeosporioides*

The diagram above shows the differences in the inhibitory power of chrysanthemum flower extract against the fungus *Colletotrichum* sp. at each concentration. The percentage of inhibitory power of chrysanthemum flower extract was carried out by comparing the growth of test fungal colonies without treatment to each treatment with respective concentrations of 0.1%, 0.2% and 0.3%. The overall chrysanthemum flower extract treatment provided significantly different inhibitory power and the best inhibitory power was 34.31% in the 0.3% concentration treatment (0.75 ml), followed by an inhibitory power of 29.24% in the 0.2% concentration treatment (0. 50 ml), and inhibitory power of 20.11% at a concentration of 0.1% (0.25 ml) on growth colony Colletotrichum sp . This matter caused by activity compound antifungal especially Terpenoids contained in chrysanthemum flower extract play an inhibitory role in the growth of fungal colonies on the microbiological morphology of the fungus *Colletotrichum* sp. This is in accordance with the statement that the antifungal properties of secondary metabolite compounds in *Chrysanthemum morifolium* linked with a number of content terpenoids like *zingiberene* , ®-*sesquiphellandrene*, ∝ - *curcumene* , (E)-®- *farnasene* , And 1,8- *cineole* can hinder growth mushrooms by lowering permeability of microorganism cell membranes [13].

The highest inhibitory power to inhibit fungal growth *Colletotrichum* sp. at a concentration of 0.3% with the addition of 0.75 ml of chrysanthemum flower extract it was 34.31%. The results of the inhibition test showed that the higher the concentration of chrysanthemum flower extract, the larger the inhibition zone.

CONCLUSION

Based on results study Which done so can taken conclusion as following :

1. Results identification pathogen reason disease anthracnose on plant tomato show characteristics macrobiological and microbiological morphology of the fungus colony *Colletotrichum* sp. shown as follows:

a. Characteristic features morphology show results identification characteristics special mold with species *Colletotrichum gloeosporioides*
b. There were changes at the tips of the hyphae after being treated with chrysanthemum flower extract, namely the size of the hyphae shortened and thickened (clumped up).

2. There is an effect of giving chrysanthemum flower extract on the pathogen that causes anthracnose disease in tomato plants, namely the fungus *Colletotrichum* sp. in inhibiting the growth of fungal colonies in-vitro, namely by inhibiting growth and reducing the number of spores.
3. The best concentration of chrysanthemum flower extract to inhibit the growth of pathogenic fungal colonies *Colletotrichum* sp. reason Anthracnose disease on tomato plants in vitro is treatment 3 with a concentration of 0.3% when given 0.75 ml of 34.31% extract.

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Strengthening the Taro Plant Potential in Peatlands Ecosystem in Central Mahakam, East Kalimantan, Indonesia

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ABSTRACT

Peatlands play a very important role in the global ecological balance. In Central Mahakam, there are many taro plants (Araceae) that grow well. However, no information has been found regarding the type and potential of this plant in terms of ecology, economy, and benefits for the community. This activity aims to inventory and characterize taro plant species and their potential in Central Mahakam and the expected outputs include but are not limited to (1) taro species in Central Mahakam and their habitat typology; and (2) taro utilization by the community in Central Mahakam from economic, social and cultural perspectives. Based on the results of research conducted in three target villages, namely Lebak Rinding Village, Kampung Minta, and Tuana Tuha Village in the central Mahakam region, the following conclusions can be drawn: (1) 9 types of taro have the potential to be developed and studied as superior and mainstay local commodities in the three target villages, i.e. Xanthosoma sagittifolium, Alocasia plumbea, Colocasia esculenta, Alocasia macrorrhizos, and several genera of Colocasia sp. which has its specificities and characteristics; (2) The habitat characteristics of the Araceae family found are divided into two types, namely terrestrial and non-terrestrial habitats towards aquatic in tidal swamps and peatlands.

Keywords: cultivar; rural farming; peatland; tidal; local potential.

INTRODUCTION

Peatlands play a very important role in the global ecological balance, including climate and water management, biodiversity conservation, forest products, carbon storage, carbon sequestration, and community livelihoods. Peatlands are unique ecosystems and require special handling and care in their utilization due to their fragile nature. Of the total peatland area in East Kalimantan, about 94 percent is located in the Kutai Kartanegara and West Kutai districts, making it the main locus of project implementation. This peat swamp ecosystem area with cascade lakes in Kutai Kartanegara, West Kutai, and East Kutai is hereafter referred to as Central Mahakam. The region has abundant potential for natural resources, environmental services, and culture. Agriculture is one of the choices that the community has made in addition to fisheries as the main backbone of their economy in this region. In Central Mahakam, there are many taro plants (*Araceae*) that grow well. However, no information has been found regarding the type and potential of this plant in terms of ecology, economy, and benefits for the community(Matthews et al. 2012). Inventory and characterization activities can reveal the potential of superior plants and the information obtained is used as a reference to introduce taro species in this area in a wider scope (Asih and Lestari 2022). This activity aims to inventory and characterize taro plant species and their potential in Central Mahakam and the expected outputs include but are not limited to (1) taro species in Central Mahakam and their habitat typology; and (2) taro utilization by the community in Central Mahakam from economic, social and cultural perspectives.

METHODS

This activity uses a descriptive method: identifying, inventorying, and characterizing taro plant species in the Central Mahakam region. The morphological identification of taro will follow the International Union for the Protection of New Varieties of Plants (UPOV) Guidelines according to Etna Adriana et al 2019 the data collected consists of primary data obtained through direct observation in the field, namely the types of taro found, then morphologically observed vegetative characteristics that characterize one type with another which include: (1) Leaves, which include young leaf color, old leaf

color, leaf shape, leaf blade shape, leaf tip shape, leaf width (cm), leaf length (cm), petiole length (cm), petiole color, leaf margin color, leaf margin line, and leaf margin color; (2) Stems, including plant height (cm) and stem color; and (3) Tubers, including the number of stolons, tuber shapes such as conical, rounded, cylindrical, elliptical, dumbbell, elongated, flat and multi-faced, bunches, tuber flesh color, tuber skin color, and tuber yield per plant.

To obtain data on taro species, a survey was conducted to village locations in Central Mahakam around the Mahakam River, i.e. Minta Village and the area around Penyinggahan Sub-district in West Kutai Regency and Muara Muntai Village in Muara Muntai Sub-district and Tuana Tuha Village in Kenohan Sub-district in Kutai Kartanegara will be the data collection locations.

Sampling is done through accidental sampling, which is by taking samples that are coincidentally encountered or available at the location in accordance with the research context.

In addition, information collection methods related to socio-economic aspects will also be carried out using FGDs and interviews with selected respondents by applying the in-depth interview model and open questionnaires with key questions. Data triangulation will be conducted through key informants throughout the activity and additional informants to test the initial information obtained, including comparing it with other secondary data such as village information data.

RESULTS AND DISCUSSION

Based on the results of the study conducted in the three villages, several taro species were found growing wild or cultivated by local communities. Some taro found in one village is also found in other villages, however, several types of taro are known by local people as food but not found in other villages.

1. Lebak Rinding Village

Types of taro plants found in Rebak Rinding Village, District. Muara Muntai, Kab. Kutai Kertanegara, are as follows:

NO	GENUS	SPESIES	LOCAL NAME	HABITAT	WILD-GROWN/CULTIVATED
1.	Alocasia	macrorrhiza	Lejong	Terestrial	wild-grown
2.	Alocasia	indica	Birah	Terestrial	wild-grown
3.	Colocasia	esculenta	Keladi	Terestrial / Semi Terestrial	wild-grown and cultivated
4.	Colocasia	esculenta var.antiquorum*	Keladi	Terestrial / Semi Terestrial	cultivated

2. Minta Village

Types of taro plants found in Minta Village, District. Stopover, Kab. West Kutai, are as follows:

No	Genus	Spesies	Local Name	Habitat	Koodinat	wild-grown/cultivated
1.	Alocasia	macrorrhiza	Lejong	Terestrial	S 00.036917° E 116.26129°	wild-grown
2.	Alocasia	indica	Birah	Terestrial	S 00.036854° E 116.26074°	wild-grown
3.	Colocasia	esculenta var.esculenta	Keladi	Terestrial / Semi Terestrial	S 00.036839° E 116.26514°	cultivated
4.	Colocasia	esculenta var.antiquorum*	Keladi	Terestrial / Semi Terestrial	S 00.036839° E 116.26514°	cultivated
5.	Xanthosoma	sagittifolium	Keladi	Terestrial	S 00.036839° E 116.26514°	once cultivated/ wild-grown
6.	Colocasia	esculenta	Keladi liar	Terestrial	S 00.036834° E 116.26512°	wild-grown
7.	Colocasia	esculenta	Keladi liar	Terestrial / Semi Terestrial	S 00.036839° E116.26514°	wild-grown

3. Tuana Tuha Village

Types of taro plants found in Tuana Tuha Village, District. Bangung City, Kab. Kutai Kertanegara, are as follows:

NO	GENUS	SPESIES	Local Name	Habitat	Koodinat	wild-grown/cultivated
1.	Alocasia	macrorrhiza	Lajong	Terestrial		wild-grown
2.	Alocasia	indica	Birah	Terestrial		wild-grown
3.	Colocasia	esculenta var.esculenta	Keladi	Terestrial / Semi Terestrial	S 00.037410°;E 116.25937° Dan S 00.01898°; E 116.42331°	cultivated
4.	Colocasia	esculenta var.antiquorum	Keladi	Terestrial / Semi Terestrial	S 00.01938°; E 116.42327° Dan S 00.01898°; E 116.42331°	wild-grown / cultivated
5.	Xanthosoma	sagittifolium	KAJING	Terestrial	S 00.01898° ; E 116.42331°	Budidaya
6.	Colocasia	gigantea	Keladi liar	Terestrial / Semi Terestrial	S 00.03231°; E 116.42316°	wild-grown
7.	colocasia	esculenta	Keladi Pulut	Terestrial / Semi Terestrial	S 00.01898°; E 116.42331°, S 00.030327°; E 116.42223° & S 00.03231°; E 116.42316°	wild-grown / cultivated
8.	colocasia	esculenta	Keladi Kuning	Terestrial / Semi Terestrial	S 00.01898°; E 116.42331°	cultivated
9	Colocasia	esculenta	Keladi liar			cultivated

9 types of taro have the potential to be developed and studied as superior and mainstay local commodities from the three villages (Gupta et al. 2019; Matthews et al. 2012). The types of Araceae family found are *Xanthosoma sagittifolium, Alocasia plumbea, Colocasia esculenta, Alocasia macrorrhizos*, and several genus *Colocasia sp*. which has their specificity and characteristics (Dorly and Sulistyaningsih 2018; Rio Eka Desi Purwandari Hartanti, Sulmin Gumiri, and Siti Sunariyati 2020).

All of the 9 taro species found, there is potential for taro development towards the taro commodity product industry which includes upstream and downstream sectors, from seed procurement, cultivation, care, harvest and post-harvest, processing of derivative products and market development, as well as strengthening the economy and local community organizations in supporting the development of taro as a

potentially superior and reliable commodity. The habitat characteristics of the Araceae family (Dorly and Sulistyaningsih 2018; Rio Eka Desi Purwandari Hartanti, Sulmin Gumiri, and Siti Sunariyati 2020)are divided into two types, namely terrestrial and non-terrestrial habitats towards aquatic on tidal marsh and peatlands. Taro plants are carbohydrate-producing plants that have a strategic role not only as a source of food, and industrial raw materials but also for animal feed. Taro plants have high economic value because most parts of the plant can be utilized for human consumption. Taro plants which are carbohydrate producers have the potential to substitute rice.

CONCLUSION

Based on the results of research conducted in three target villages, namely Lebak Rinding Village, Kampung Minta, and Tuana Tuha Village in the central Mahakam region, the following conclusions can be drawn:

1. 9 types of taro have the potential to be developed and studied as superior and mainstay local commodities in the three target villages. The types of the Araceae family found are Xanthosoma sagittifolium, *Alocasia plumbea*, *Colocasia esculenta*, *Alocasia macrorrhizos*, and several genera of *Colocasia sp*. which have their own specificities and characteristics.
2. The habitat characteristics of the Araceae family are divided into two types, namely terrestrial and non-terrestrial habitats towards aquatic in tidal swamps and peatlands.

ACKNOWLEDGEMENT

Special thanks go to Deutsche Gesselschaft fur Internationale Zusammenarbeit (GIZ) Indonesia, especially GIZ PROPEAT East Kalimantan for supporting this research.

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Suitability of Rubber Plantation on Old Volcanic Parent Material at Barong Tongkok, East Kalimantan

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ABSTRACT

This study is aimed to obtain information about the suitability of rubbert plantation on old vuocanic parent materials in Barongtongkok of East Kalimantan. The soil profile have been done by team of JICA, and selected at two different fisiographic i.e. on almost flate and undulating/hilly topography. The climate used from available data as close as posibble by location study, where both climate data (rainfall, terperature, and relative humidity) and soil profile, chemical analyzed data used to evaluate according to FAO soil evaluation system modified by Sys and Van Ranst (1993) and classified the soil using Key to soil taxonomy (USDA, 2022). In general, the climate characteristics of Barong Tongkok clmate are suitable for rubber plantation but, base on the pedon analyzed, the soil of plat topography classified as very suitable for the development of rubber plants and moderately suitable for the undulating/hilly topographic classes. The suitability classification of Soil with a flat soil topography according to land characteristics (climate, soils and landscape) of the study area with the requirements for growing rubber plants plantation gives the result that flat land is classified as suitable (S1) and moderately suitable (S2ts) with topographic limiting factor and soil physic (clay. 60%). Soil of the study area has highly developed and show low activity clay (CEC clay less than 16 C mol (+), clasified as Humic Kandiperox (flate area/slope 0%) and Andic Kandiperox on slope 11 % (undulating/hilly) which mean that the soil has Isohyperthermic temperature regime and perudic soil moisture regime, Ochric epipedon, Oxcic and Kandic subsurface Horizon which have ECEC of less than 1.50 cmol (+) per kg clay, pH (1N KCl) of 5 or more on undulating topography and pH (1N KCl) of less than 5 on plate area.

INTRODUCTION

Rubber plantations still promise to be a livelihood for the people of Kubar. In this area there are 42 thousand hectares of rubber with a production of around 32 thousand tons a year, or one month can produce around 3,100 tons (Kaltim Post, 2022).

Petrus (2019) added, Kubar has extraordinary potential for rubber cultivation. Kubar is also very well known as a potential region with the first order in East Kalimantan and is capable of producing 34,964 tons of rubber latex in a year with an area of 44,525 hectares. Thus, 41 percent of the area of rubber plantations in East Kalimantan is in Kubar.

Because the color of the soil is like this (dark brown), the characteristics of fertile soil contain nutrients that are good for plants. Even though there are no Developed volcanoes here. "From the Japanese and Dutch era, this has been a plantation (Isran Noor, 2021), and his said also encouraged the regency government and residents to take advantage of this fertile land, because it is an opportunity for the community to develop plantations, especially rubber.

The soil formed in West Kutai, especially the Tunjung plateau, originates from the weathering of Old Volcanic Parent material, but the soil has developed further due to soil-forming factors such as climate, topography, living being, parent material and the one that plays the most role in soil formation in Barongtongkok is time (Mulyadi, 2022).

According to atlas, East Kalimantan, Indonesia by *Frithjof Vos,* the geology of the area is dominated by Neogene Volcanic Rock, belongs to the physiographic region of West Kutai Volcanic Region, and the area divided into three major geomorphological unit; the 1st unit is lava fiield area, the 2nd is volcanic shield and 3rd is extinct Volcano. The elevation of lava field range from some 80 to 230 m asl, vulcano shield range from 180 to 350 m asl and extinct volcano range from 320 to 550 m asl (Tanaka, N. 1994)

Based on visual observations of the area and growth of smallholder rubber plantations which can also improve the welfare of the Barong Tongkok community, it is necessary to carry out a more in-depth study of rubber lands in this area using a pedogenesis and land suitability approach. Based on this study, it is hoped that it can provide an understanding of the potential of the Barong Tongkok land for the development of even more massive rubber plantations.

METHODOLOGICAL APPROACH

Soil saple were taken during soil survey acyivities in Barong Tongkok, East Kalimantan. Eghten pedons were identified for characteristics of soil developed on Volcanic Parent Materials In Barong Tongkok Area, East Kalimantan Indonesia and classified according FAO Systems.

In the laboratory, all the soil samples (more than 100) were extracted from the 18 pedon i.e. Particle size distribution, bulk density, water permebility, soil chemical property such as pH H_2O and KCl, CEC, Base Saturation, ECEC, Exchangable hydrogen, Total organic carbon (%), total nitrogen (%), Available nitrogen NH_4N and NO_3 N (mg/100 gr soil), total P_2O_5 (mg/100g soil) and available P_2O_5 (mg/100gr soil).

Table 1. Pedon depth soil colors, texture, chmecal properties

Pedon	Horizon symbol	Depth (cm)	Soil color	Texture	Chemical properties					
					pH H_20	KCl	CEC	BS	C	N
	Ah	0 - 9	7.5 YR 2/2	Clay loam	4.9	4.00	24.65	18.9	6.42	34.3
	Ah2	9 - 20	7.5 YR 2/2	Clay	4.96	4.02	23.18	19.8	6.07	25.9
1	Bw1	20 - 42	10 YR 3/3	Clay	4.99	4.36	14.19	16.7	2.92	13.8
Slope	Bw2	42- 100	1o YR 4/4	Clay loam	5.14	4.80	5.25	67.2	0.97	11.5
0%	Bw3	100 - 150	10 YR 4/4	Clay	5.20	4.96	4.53	93.6	0.65	7.7
2	Ah	0 - 10	10 YR 3/3	Clay	4.99	3.99	18.69	23.8	6.05	6.9
Slope	B1	10 - 45	10 YR 3/3	Clay	5.12	4.29	7.42	43.6	2.21	0.9
11%	B2	45 - 81	10 YR 3/4	Clay	5.05	4.30	5.24	23.0	0.79	1.1
	B3	81 - 123	10 YR 3/3	Clay	5.32	4.41	2.47	18.7	0.59	1.6
	B4	123 - 164	10 YR 3/5	Clay	5.38	4.46	3.71	24.6	0.50	0.4
	BC	164 - 200	10 YR 3/5	clay	5.34	4.41	5.90	60.2	0.52	0.2

Based on the two selected pedon data above, it is then classified for both soil classification using the key to soil taxonomy (USDA, 2022) and land suitability classification for rubber plantations using the FAO system modified by Sys and Van Rants (1991).

RESULT AND DISCUSSION

Genesis and Classification

From pedon data by Jica Expert (Tanaka, N, 1994), the soil description shows that on the plate area by slope (0%) has an Umbric epipedon by using, namely brownish black to dark brown in color with color value and chroma 2-3 (moist) to a depth of 42 cm from the soil surface, with base saturation ranging from 16.7 - 19.8% (NH_4OAc pH 7). Texture clay loam to clay, fine granular to strong very fine blocky to moderate very fine and fine subangular blocky, fribale to moist consistency and abruptly smooth of soil boundary.

Soil analysis of the subsurface horizon which also uses the same key to soil taxonomy in layers Bw2 (42-100 cm) and Bw3 (100-150 cm) shows that the soil in this flat area, its has an Umbric Epipedon covering the kandic subsurface horizon to a depth of 150 cm. Meanwhile, based on originally field observations in, the soil profile description described Bw1, Bw2 and Bw3 indicated to have a Kambic horizon, but based from soil chemistry data, especially CECclay on that layers, the CECclay is less than 16 cmol (+) per 100 grams (6.67 in the Bw2 layer and 10.4 in the Bw2 layer Bw4) clay is classified as low activity clay so it is classified as a kandic horizon because there is also an increase in clay from the eluvial to the illuvial horizon as required of the kandic horizon in key to soil taxonomy.

In soils with an undulating to hilly topography with a concave shape of the lava fields, its shows that the soil still has an Umbric epipedon with a color value of 3 and chroma 3 up to 45 cm depth with Base Saturatin (NH_4OAc pH 7) ranging from 23.8 to 43.6 %. This epipedon also has soil texture clay, moderate very fine and fine granular and blocky to weak fine and medium subangular blocky, friable consistency and clear smooth boundary.

Observing and analyzing the results of soil profile and soil analysis on undulating to hilly areas, shows that the soil has indicated further development from the top layer of the subsurface horizon (B1) to the deeper layers (B4) with the characteristic of an increase in clay of more than 8%. CECclay calculated in this layer gives varying values i.e between 3.74 cmol (+) in the B3 horizon to 12.26 cmol (+) in the B1

horizon, but all subsurface horizon is classified as low activity clay (CECclay < 16 cmol (+).

From the results of observations of the diagnostic horizon, it can be seen that in the B1 layer there has been a change in the diagnostic horizon from a kandic horizon to an oxic horizon due to topographic factors and increasing time in the same climate, although the destruction/change is still at the beginning with indications that the clay content has not increased until it reaches 8%. The next horizon is still classified as a kandic horizon (B2-BC).

The characteristics of the study of these two soil profiles (flat and undulating/hilly) in the Barong Tongkok area show that there is a change/destruction of the diagnostic horizon from Cambic horizon to Candic horizon (flat area) on lava field parent material to Oxic horizon over time, even in only upper subsurface horizon B2. The climatic factor is a factor that greatly influences pedogenesis in this area, caused by the influence of high rainfall and temperature of the topography of the region.

Based on climate data in Barong Tongkok, it has an isohyperthermic soil temperature regime and perudic soil misture regime, with an annual average rainfall of 3134 mm, mean monthly air temperature of 26 ^{0}C and an annual PET of 1545 mm so that it has a surplus of around 1589 mm. This means that a large amount of rainfall reaches the ground surface and some of it evaporates through transpiration. The amount of rainfall that reaches the soil surface will enter the soil through the infiltration, some of that moves on the surface (runoff) or move laterally (seepage) in the soil when the soil have been saturated with water (upermeable layers). The amount of water that enters the soil (infiltration) depends on how much water is lost in the soil (seepage) and this process continues until the rain stops.

Table 2. Climatic Records of Barong Tongkok

Station : Barong Tongkok	Latitude : -0.2332□
Station ID : BRT	Longitude : 115.6861□
Period of Record : 1980 – 2012	Elevation : 90 m
Period Type : normal	Waterholding Capacity : 200 mm
Mean Annual Precipitation : 3134 mm	Soil Moisture Regime : Perudic
Soil Temperatur Regime : Isohyperthemic	Subgroup Modifier :

Soil Climate Regime—Newhall Simulation Model
(MAST – MAAT + 2.5 °C ; Amplitudo 0.66)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Mean Monthly Air Temperature (°C)												
25.70	25.80	26.10	26.10	26.30	26.10	25.80	26.10	26.10	26.30	26.10	26.00	26.00
Mean Monthly Precipitation (mm)												
263.00	274.00	320.00	324.00	277.00	201.00	172.00	177.00	230.00	259.00	306.00	332.00	3134.00
Modeled Estimate of Monthly Total Potential Evapotranpiration (mm)												
125.11	114.61	132.07	128.21	135.60	128.15	126.63	132.02	128.21	135.78	128.38	130.40	1545.17
Modeled Estimate of Monthly Total Water Balance (mm)												
137.09	159.39	107.93	195.79	141.40	72.85	45.37	44.98	101.79	122.22	177.52	201.60	1588.83

Source Makhrawie, 2019.

On the land with relatively flat topography, water infiltration will be greater than in areas with undulating/hilly topography. This is because in areas with undulating/hilly topography the runoff process and lateral water movement are greater due to the slope. As a result, the large amount of water infiltration in flat areas will be able to increase the kinetic energy of leached out weathering results such as texture and dissolved bases or others weathering product, into deeper layers and even dissolve the silica content of the soil into deeper layers compared to areas with undulating/hilly topography.

The effect of water infiltration on both soil profiles (flat and undulating/hilly) has changed the diagnostic horizon from cambic to kandic without the formation of an argillic horizon, likewise on soil with undulating/hilly topography there has been a change in the kandic horizon in the upper layer of the subsurface horizon to become an oxic horizon. This means that over time, the pedogenetic destruction process will continue until finally the soil will develop into older soil, namely soil with a positive charge (pH H_20 - pH KCl) is positive.

A. Soil Classification (USDA, 2022)

Based on the pedogenetic analysis above, the soil is classified into soil order Oxisol because its contain surface clay (eluvial) with a thickness of 18 cm from the surface greater than 45% (percent), and suborder Perox because it has a perudic soil moisture regime (PET > R throughout the year). Great group Kandiperox (other perox that a kandic horizon within 150 cm of the mineral soil surface) and subgroup Humic Kandiperox because the soil have 17.39 % organic carbon (kg/m^2) between the mineral soil surface and a depth of 100 cm..

B. Land Suitability for Rubber Plantation

The land suitability is process to determine the degree of suitability of one area for a cartain use. The land suitability of one area maybe different depends on the specific land utilization type required. Area can be considered suitable actually or potentially, when the area are consider potentially, the suitability can develop to actually after improving limiting factors.

The land suitability classification is the evaluation of an area systematically and grouping inti some categories based on land characteristics (Physical environment) as a limiting factors.

In evaluating the fertility of an area, there are some components that must be taken into account such as the quality and characteristics of the land. Based on the quality and characteristic of the land, the land suitability of an area is determined in the Orders, Classes, or oven subclass levels.

1. Land suitability orders and classes

In general, land suitability can be divided into two orders and five classes were devined, namely :

42- Order suitable (S) : use only 3 classes; they are S1 (Suitable), S2 (Moderately Suitable), and S3 (Marginally Suitable).

43- Order Unsuitable (N); use only 2 subclasses they are N1 (Actually unsuitable but potentially suitable); and N2 (Actually and potentially unsuitable).

2. The Land Suitability Subclasses

The subclasses are reflecting kinds of limitations, or main kinds of improvement measures required, whitin classes. They are indicated in the symbol using lower case letters which mnemonic significance. The following subclasses have been defined: c (climatic limitations), t (topographic limitation), w (wetness limitations), s (physical soil limitation/influencing soil or water relationship and management), f (soil fertility limitations not readily to be corrected), n (salinity and/or alkalinity limitations). (Sys and Van Ranst, 1991).

3. Evaluation of Land Suitability Classification of Survey area

Based on land characteristics (climate, soil and landscape) of the surveyed area, the degree of land suitability classification for oil plam plantation of each soil mapping units as a specific land utilization types have been determined.

3.1. Climate

The rubber tree is original from the tropical rain forest, therefore the temperature range for growth is situated between 22 - 35 ^oC, optimally growth conditions are met between temperature of 27 - 28 ^oC (Sys and Van Ranst, 1993).

Rubber performs well in region with a total annual precipitation of over 1700 mm/year, well distributed throughout the growing period, that have 2 or less consecutive dry months. In order to get high yields the annual number of sunshine hours should exceed 1300 hours/year (Sys and Van Ranst, 1991).

The methodology suggest in the evaluation of the climate with us ultimate aim, the determination of climatic rating to be introduced in the overall evaluation. For this reason the climatic kcharacteristic are grouped into 3 groups, they are: Characteristics related to rainfall, temperature and radiation.

For calculation of the climatic index (Sys and Van Ranst, 1993) said that the lowest characteristics rating of each group is used. This is because there is alwas a strong interaction between characteristics of the same group of climatic group and because they do not act together.

The climatic evaluations of the surveyed are show that the climatic characteristics such as annual precipitation, month of the excessive rain, length of dry season, mean annual maximum, average daily

minimum of the coldest month, mean annual temperature han an maximum value for rubber plantation. The mean annual sunshine hours (n/N) has moderate value, but the whole the climatic characteristics has optimum value by rating value 95 due to sunshine hours (4.99 hours). This climatic index is tranferred into a climatic rating that will be used in the total land evaluation by formula:

$$\text{Climatic rating} = 16.67 + 0.9\ (\ 95) = 100$$

3.2. Soil

Rubber tree has an sensitive root system with a tap-root that can go 3.0 - 4.0 m deep and shallow lateral roots (in the 0 - 0.3 m layer) that can extend to over 20 m. Accordingly the ideal soils are deep (> 1 m), well aerated, well structured and provided with an adequate water holding capacity (the fine earth should contain uo to 50 % of clay).

Rubber trees need well drained soils (a ground water table permanently at 4.0 -6.0 m below the surface) with a good supply of water throught the year. Under poor drainage condition the root atrophy. Clayey and to some extend medium texture are most suitable. Soils that are subject erosion need the application of conservation techniques. Land with slope of < 8 % is most suitable.

3.3. Suitability Classification For Rubber Plantation

The suitability classification for rubber plantation using storie method by formula :

A = B/100 x C/100 x D/100 ……. where : B, C, D : rating

Table 2. Landsuitability subclasses (actual) for rubber plantation

Profile/Land form	Soil Taxonomy	Land suitability	Limiting Factors	Conclussion
Flat area	Humic Kandiperox	S1	-	Very suitable
Undulating/Hilly area	Andic Kandiperox	S2ts	- Topography - Soil Phisic (texture)	Moderately suitable

CONCLUSION AND RECOMMENDATION

Soil profile observations were carried out by JICA Experts in the Barong Tongkok area were selected to study which are believed to represent flat and undulating to hilly topography conditions on volcanic parent materials, as well as collected climatic data as close as soil profile data. From soil morphology, chemical, and other data are Classified using soil taxonomy (USDA, 2022) up to subgroup level and it was found that land with a flat topography produced an Humic Kandiperox, while areas with undulating to hilly topography produced an Andic Kandiperox.

The results of observations on the climate rating using table of rubber growing requirements such as rainfall, temperature and solar radiation, obtained a rating of ninety five (95) because solar radiation in Barong Tongkok only lasted about 4.99 hours, after processing with the formula obtained an Index rating of 100. It means climate very suitable for rubber plantations.

Based on the climate index obtained, then combined with soil and landscape requirements such as topography, wetness (floding, drainage), physical soil characteristics, soil fertility characteristics, salinity and alkalinity, it is obtained that land with flat topography is classified as very suitable (S1), while Land with undulating/ hilly topography is quite suitable (S2ts) with topographical constraints (11%) and relatively high clay content (> 60%). These two limiting factors do not need improvement because they only interfere with workability if they are managed on a high commercial scale, but if they are managed on a smallholder rubber plantation scale, they will not have much effect.

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SEMI-QUANTITATIVE EVALUATION OF SOIL FERTILITY OF UPLAND AND LOWLAND RICE AREAS BY USING MULTIVARIATE ANALYSIS

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ABSTRACT

The qualitative way is a process of evaluation in which soil may be grouped into fertility classes only by inference, whereas the quantitative one classifies soil fertility in a more objective form. The objectives of the study were to evaluate the status of soil fertility semi-quantitatively using multivariate analysis and to select a minimum set of soil characteristics as limiting factors to soil fertility. The study area is located in East Kalimantan, Indonesia, and comprises thirty-seven soil observation sites. The soil sample was compositely collected using a soil auger with a 0-30 cm depth. The soil characteristics used in this study were; pH H_2O, TC, TN, exchangeable Ca^{2+}, Mg^{2+} and K^{+}, CEC, BS, available phosphate (AP), and clay content. The fertility status for individual soil was established by the fertility index (FI) value, which was calculated from the numeral rating value (0– 100) of the mean score of the principal components. Results of the study showed that the first factor was designated as *Base Status* (BS) that determined primarily by base cation contents. The second factor might be called *Inherent Potentiality* (IP) indicated by TC, TN, CEC, and clay content. The third factor could be interpreted as *Available Phosphate Status* (AP), comprised of AP with high loading. The high to very high soil fertility status has a FI range from 51.40 to 91.70. Very low fertility status of upland rice soils with FI range from 7.38 to 10.38, mainly caused by the highest negative value of each factor score.
Keywords: Soil fertility evaluation, multivariate analysis

INTRODUCTION

When land needs to be selected to meet the increase in agricultural production, two procedures are commonly used; to select the high-potential soil and to choose a land that is physically possible and economically and socially relevant to specified kinds of use. Evaluation of soil fertility is to be a prerequisite for determining the status and potentiality of a certain soil. This evaluation aims to diagnose nutritional problems such as levels of nutrient availability and their balance in the soil. Several technical approaches to assess the status of soil fertility have been developed from qualitative to quantitative ways. The advantages and disadvantages of these two ways are a subject of much discussion. The qualitative way is a process of evaluation in which soil may be grouped into fertility classes only by inference (subjective), whereas the quantitative one classifies soil fertility in a more objective form. Adeyolanu and Ogunkunle (2016) state that the biggest hurdle is to establish soil quality standards that can be used by farmers to assess practical and useful changes. Consequently, the results obtained, whether through qualitative or quantitative methods, should provide a similar evaluation of the soil's quality. Otherwise, the methods cannot be considered equivalent.

Soil fertility studies and mapping are an effective way to diagnose soil status and recommend the nutrients for a particular crop in the area as per the need. Evaluation of soil fertility that is based on transient properties of the topsoil mainly, can vary vastly by soil management such as tillage, compaction, irrigation, and drainage. The variation of those soil properties will affect the final status of soil fertility.

Maurya *et al* (2020) state that evaluating just one parameter from physical, chemical, or biological cannot assess soil quality accurately. Therefore, it's necessary to establish a minimum dataset (MDS) that should include all these parameters to assess the quality of soil appropriately.

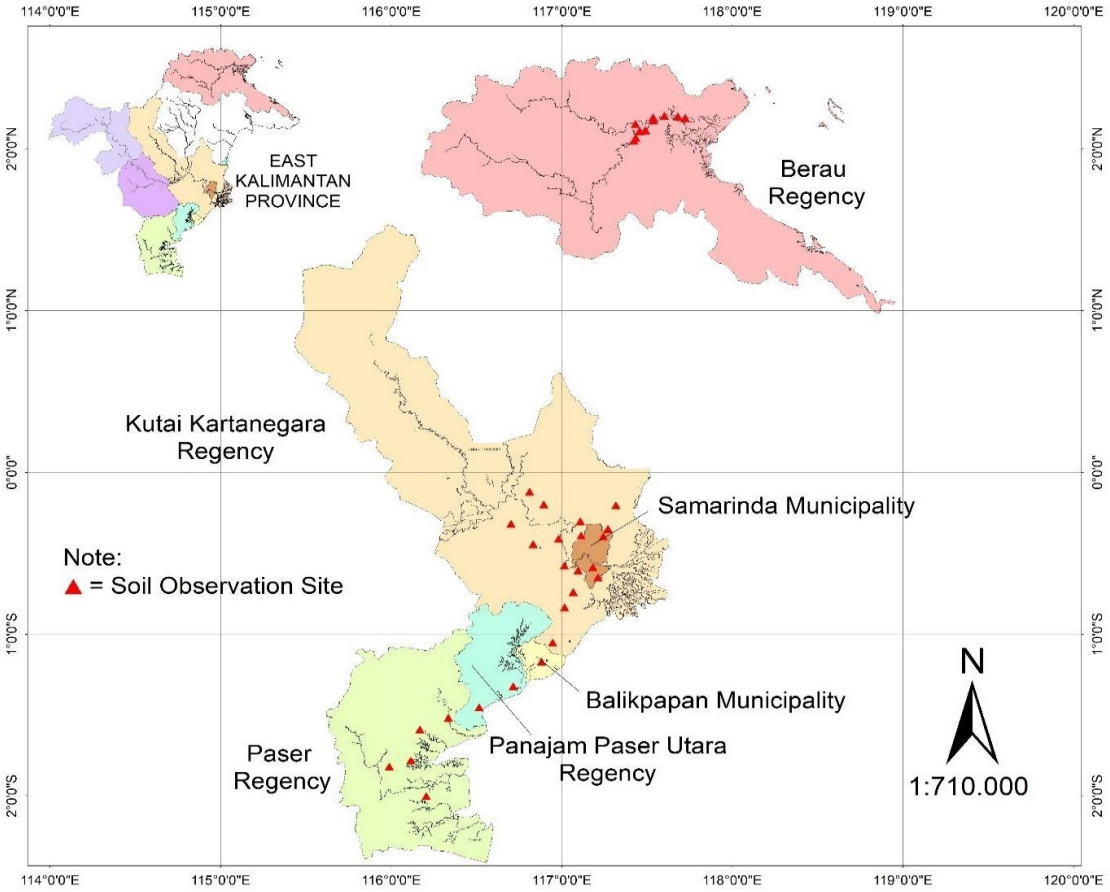
Multivariate analytical capabilities can be used as a tool to evaluate and classify soil fertility (Fernandez-Moya *et al,* 2014). Multivariate analysis (MVA) techniques allow more than two variables to be analysed at once (Kumar *et al.,* 2013). This MVA is one of the most useful methods to determine relationships and analyze patterns among large sets of data. It takes a whole host of variables into consideration (Devulapalli, 2021). Bartholomew (2010) says that multivariate analysis is concerned with the interrelationships among several variables. In this study, selecting soil properties taken into account and then classifying the soil groups are important phases. There are, of course, obvious advantages to focusing on a sub-set of soil properties that carry a high content of information.

The objectives of the study were to evaluate the status of soil fertility semi-quantitatively usingmultivariate analysis and to select a minimum set of soil characteristics as limiting factors to soil fertility.

MATERIAL AND METHODS

Study Area

According to the Statistical Office of East Kalimantan (2021), the study area (as shown in Figure 1) is classified as an Af climate type, based on the Schmidt and Ferguson classification, with an annual rainfall range of 2,367.2 to 4,071.6 mm. The minimum and maximum temperature range from 21.70 to 22.20 and from 34.0 to 34.5 oC, respectively. The average relative humidity ranges from 85.67 to 87.00%. The lithology consists of sedimentary rocks including claystone, sandstone, and mudstone that have not undergone significant alteration. The hill landforms in the study area were created by the folding and fracturing of sedimentary rocks containing ophiolite, basaltic, and andesite. In the northern part of the area, there are Alluvial plains mixed with Marine-Alluvium in the basin concave area. The soils are mainly acidic and are called Ultisols with a low content of organic carbon, phosphorus, nitrogen, and CEC at the topsoil layer, and high soil acidity and Al saturation. These soils are used for growing rice, food crops, and cash crops. Rice production yield in the study area during 2019-2020 was low, ranging from 3,638 to 3,641 tons/ha.



Soil Sampling and Analysis

During the course of the field survey, a soil sample (1 kg) was compositely collected from 4-5 sub-samples of a representative area, using a soil auger with a depth of 0-30 cm. The soil augering was done at lowland and upland rice-growing areas and/or at the potential areas for growing rice/food crops.

Air-dried, 2 mm sieved fine earth was prepared for the general analysis of the soil materials. Analytical items and methods are as follows: (1) pH by a glass electrode pH meter, (2) Electrical Conductivity (EC) by EC meter, (3) Exchangeable Sodium Percentage (ESP) was calculated by dividing the percentage of exchangeable cation Na^+ by CEC, (4) Available Phosphate by Bray No. 2, (5)

Exchangeable Ca^{2+} and Mg^{2+} were measured by Atomic Absorption Spectrometry (AAS) and Exchangeable K^+ and Na^+ by Flame Emission Spectrometry, (6) CEC by titration method, (7) Base Saturation (BS) was calculated by dividing the sum of exchangeable cations base Ca, Mg, K, and Na by CEC, (8) Texture by pipette method, and (9) TC and TN were determined by dry combustion method using an NC full-automatic analyzer.

Data Process and Analysis

Thirty-seven top layer soil samples derived from 37 different observation sites were used in evaluating soil fertility status. The soil characteristics used in this study were ten variables, i.e.; pH H_2O (pH H_2O), total carbon (TC, %), total nitrogen (TN, %), exchangeable Ca^{2+} (ex-Ca^{2+}, cmol(+) kg^{-1}), exchangeable Mg^{2+} (ex-Mg^{2+}, cmol(+) kg^{-1}), exchangeable K^+ (ex-K^+, cmol(+) kg^1), cation exchange capacity (CEC, cmol (+) kg^{-1}), base saturation (BS, %), available phosphate (AP, Bray-P, ppm), and clay content (Clay, %).

Selection of the above soil characteristics in evaluating the fertility of rice soils was based on two following considerations: (1) soil characteristics data are directly from soil analysis, and (2) the considered soil characteristics that are required for growing and production of lowland and upland rice have to not indicated high negative correlation one each other.

In this study, two multivariate statistical methods; Principal Component Analysis (PCA) and Factor Analysis (FA) as outlined by Kyuma and Kawaguchi (1975) with a little modification, were used in evaluating semi-quantitatively soil fertility status. The procedures were described below:

(1) To attain a multivariate normal distribution, original data were standardized by expressing all observations as to standard deviations about the respective means:
$$Z = \frac{(X-\mu)}{\sqrt{\delta}}$$
Where X is the original variable, μ is the mean variable and δ is the standard deviation.

(2) Determination of several factors to be considered using PCA. A characteristic equation, in which R is the correlation matrix of the variables used:
$$|R - \kappa I| = 0$$
is solved. Principal components having eigenvalues (κ) larger than 1 are retained.

(3) Preliminary communalities are computed as the squared multiple correlations (R^2) between a variable and the rest of the variables in the set. The communality's h_i^2 is defined as follows:
$h_i^2 = a_{i1}^2 + a_{i2}^2 + \ldots.. + a_{im}^2$
where the a_{im} is the factor loading for the i^{th} variable and m^{th} common factor.

(4) Principal factor analysis; starting from the reduced correlation matrix. The pre-determined number of factors (step 2) is extracted, and from eigenvalues and eigenvectors, new communalities estimates are obtained. The same process is continued until differences in the two successive communality estimates become negligible.

(5) The factor loading is computed from the final solution of eigenvalues and eigenvectors, as follows:
$a_{ik} = \lambda\ k^{\frac{1}{2}} * I_{ik}$

(6) The obtained factor axes are orthogonally rotated by Kaiser's varimax (normalized) method, which aims at Thurston's simple structure to facilitate interpretation of the factors. Kaiser's varimax method maximizes the variance of the square of the elements of a factor-loading vector to attain this goal.

(7) If the results of the rotation are reasonably interpretable, the factor scores for individual soil are computed by the following general formula:
$f_k = b_{1k}x_1 + b_{2k}f_2 + \ldots.. + b_{ik}f_i + \ldots.. b_{pk}X_p$
where b_{ik} is the factor score coefficient for the i^{th} variable and k^{th} factor. In the least square estimation, the (m x p) matrix B (matrix of the factor score coefficient) can be computed by the formula:
$B = A'R^{-1}$
Where A' is the transposed factor-loading matrix, and R^{-1} is the inverse of the correlation matrix.

(8) The fertility status for individual soil is established according to the fertility index (FI) value, which is calculated from the numeral rating value of the mean score of n principal factors. The rating value (0 to 100 scale) is stated corresponding to the categorized distribution data of the mean score of the n considered principal factors.

The software STATISTICA Version 10 for Windows (Statsoft Inc., 2011) is used for PC and FA computations.

RESULTS AND DISCUSSION

Description and observation analysis of the soil characteristics data

Analysis of soil characteristics data shows that AP was the greatest coefficient of variance (CV),

followed by ex-Ca^{2+} and ex-Mg^{2+}. The lowest CV was given to pH H_2O. The variation of soil nutrient contents was greatly different between lowland soils and upland soils. AP, ex-Ca^{2+} and ex-Mg^{2+}, organic carbon and clay contents of the lowland soils were higher than those of the upland soils. In Alluvial lowland soils mainly, as noted by Kyuma and Kawaguchi (1975) that the variability of the soil properties is the greatest, of all soil groups. This soil is conditioned by the geology and the degree of weathering in the catchment area and/or the milieu of sedimentations.

The distribution pattern of AP, pH and ex-Ca^{2+} data was highly positively skewed. The AP ranges of 800 to 900 ppm and pH ranges of 7.5 to 8.0 seem to be expected normal distribution. For AP and ex-Ca^{2+}, there were 21 soil samples (56.76 %) of the total samples (37 observation sites) showing values of 0–100 ppm P_2O_5 and 0–5 cmol(+) kg^{-1} soil, respectively.

The maximum AP (832.57 ppm) and the minimum AP (28.26 ppm) were found in Rantau Panjang lowland rice soil (B9) and Samboja upland soil (K28), respectively. The difference of AP content for these two soils was mostly related to the differences in soil acidity (pH) and ex-Ca^{+2} content. Available phosphate was very significantly correlated with pH H_2O (r=0.62**), ex-Ca^{2+} (r= 0.56**) and base saturation (r= 0.49**), as shown in Table 1.

Table 1. Correlation cofficients between all pairs of ten standardized soil characteristics

Soil Characteristics	Bray-P	BS	Clay	CEC	Ex-Ca^{2+}	Ex-K^{+}	Ex-Mg^{2+}	pH H_2O	TC	TN
Bray-P	1.00	0.49	-0.11	0.29	0.56	0.33	0.16	**0.62**	0.09	0.12
BS		1.00	-0.33	0.10	**0.78**	**0.60**	**0.68**	**0.87**	-0.21	-0.08
Clay			1.00	**0.71**	0.01	0.16	0.27	-0.49	0.55	0.58
CEC				1.00	0.58	0.45	0.55	-0.10	**0.79**	**0.88**
Ex-Ca^{2+}					1.00	**0.60**	**0.71**	0.58	0.20	0.36
Ex-K^{+}						1.00	**0.70**	0.54	0.17	0.22
Ex-Mg^{2+}							1.00	0.38	0.16	0.32
pH H_2O								1.00	-0.23	-0.18
TC									1.00	**0.96**
TN										1.00

Note: Correlation cofficient (r)≥ 0.33 was significant at $\alpha < 5\%$ (*) and correlation cofficient (r) ≥ 0.45 wassignificant at $\alpha < 1\%$ (**)

The minimum pH (4.41) and the maximum content of TC (9.07 %) were found in Batu-Batu lowland rice soil. The lowest pH in this soil was possibly due to the effect of brackish sediment and saline water containing sulfide compounds as potential sources of acidity. The Batu-Batu area is located near the mouth of the Berau river. The soil material of the Batu-Batu area is derived from Marine-Alluvium sediments, which it can be classified as Fluvaquents.

The highest BS (99.77 %) was found in Rantau Panjang lowland rice soil B9). The high BS of those areas was strongly influenced by highly pH and exchangeable cations. The correlation cofficient among the soil characteristics (variables) as presented in Table 1 shows that BS was very significantly correlated with pH H_2O (r= 0.87**), ex-Ca^{2+} (r= 0.78**), ex-Mg^{2+} (r= 0.68**), and ex-K^{+} (r= 0.60**).

Handil Bakti lowland rice soil showed the highest CEC (38.40 cmol(+) kg^{-1} soil), the highest clay content (84.60 %), and the high content of TC (8.92 %). The lowest CEC (5.71 cmol(+) kg^{-1} soil) and the lowest content of TC 1.53% were found in sandy loam textured upland rice soil of Panajam km 40. Differences in CEC for the two soils were clearly caused by differences in organic matter and soil texture. CEC was very significantly correlated with clay content (Table 1). Soils with a high organic matter and clay have a higher CEC compared topsoils with low organic matter or sandy soils (Purnamasari *et al*, 2021). Besides those quoted above, other soil characteristics (variables) with a correlation coefficient higher than 0.70 were given to pairs of CEC~TC, CEC~TN, ex-Ca^{2+}~ex-Mg^{2+}, and TC~TN, as listed in Table 1.

Principal Component and Their Interpretation

By means of a correlation matrix of 10 standardized soil characteristics, as given in Table 1, the Principal Component Analysis (PCA) was run to estimate the number of factors to be considered. The data in Table 2 shows eigenvalues, percentage of the total variance and cummulative percentage, explained by each of the 10 principal components derived from PCA.

Among the ten principal components (PCs), the most informative PC was the first which accounted for around 43 % of the total variance, followed by the second PC and the third PC accounted for around 34 % and 10 % of the total variance, respectively. The last PCs were the least informative. The remaining factors according to Kosaki and Juo (1989) are less meaningful and can be considered as errors which

included the random factor of soil variation and various types of errors produced in every stage of soil sampling and analysis.

Table 2. Eigenvalues, percentage of the total variance and cummulative percentage for 10 principal component

Principal component	Eigenvalues	Percent of total variance	Cumulative percent of total variance
1	**4.329**	43.289	43.289
2	**3.367**	33.675	76.964
3	**1.004**	10.035	86.999
4	0.523	5.233	92.232
5	0.427	4.267	96.499
6	0.192	1.919	98.418
7	0.104	1.045	99.463
8	0.033	0.329	99.792
9	0.013	0.133	99.925
10	0.008	0.075	100.000

Since the first three factors together account for more than 87 % of the total variance, so that for the next steps of analysis, only the first three factors having eigenvalues greater than 1 (one) were considered.

The selected eigenvectors for the PCI had an absolute value larger than the selection criterion (SC), except for clay and TC contents. The soil characteristics of PC1 with eigenvectors larger than SC were important constituents for the PC1, including exchangeable cations, BS, CEC, TN, pH and AP. For PC2 and PC3, the numbers of soil characteristics selected by SC were fewer (Table 3).

Table 3. Soil characteristics, eigenvalues, cummulative percentage and eigenvectors for the first three principal components

Principal Component	PC1	PC2	PC3
Eigenvalues	4.329	3.367	1.004
Cummulative percentage	43.289	76.964	86.999
Eigenvector for soil characteristics			
Bray-P	0.267*	0.180	0.636*
Base saturation	0.328*	0.370*	-0.104
Clay	0.136	-0.428*	-0.265
Cation exchange capacity	0.371*	-0.332*	0.039
Exchangeable Ca^{2+}	0.425*	0.131	0.050
Exchangeable K^{+}	0.372*	0.104	-0.299
Exchangeable Mg^{2+}	0.388*	0.048	-0.508*
pH H2O	0.253*	0.418*	0.188
Total Carbon	0.225	-0.417*	0.289
Total Nitrogen	0.283*	-0.398*	0.214
Selection Criterion	0.240	0.272	0.499

Note: SC= $0.5/(\text{PC eigenvalue})^{1/2}$, *= eigenvector of soil chracteristic was larger than the selection criterion

By using squared multiple correlation coefficients (R^2) between a specific variable and the others in the set as the preliminary communality estimate, factor loading with iteration was performed, as shown in Table 4.

Loading can be expressed by the value of the correlation coefficient between the variable and the derived principal components (PCs). The data in Table 5 shows that all soil characteristics (variables) had moderately to highly positive loading on the first factor, except the clay variable had low loading. BS and pH indicated highly positive loading, while clay, CEC, TC and TN indicated negatively high loading on the second factor. On the third factor, soil AP indicated highly positive loading, whereas ex-Mg^{2+} had moderately negative loading. Other variables showed low positive and negative loading on the third factor.

The communalities figures in Table 4 explained that the amounts of variance of the employed variables were largely represented by the first three factors. Their rests were representedby a specific factor called uniqueness or specific variance. Because the data of loading presentedin Table 4 was difficult to interpret, the varimax (normalized) rotation was required. According to Acal *et al* (2020), that the first approach consists of a rotation of the eigenvectors that preserves the orthogonality between the eigenfunctions but

the rotated principal component scores are not uncorrelated. The second approach is based on rotation of the loadings of the standardized principal component scores that provides uncorrelated rotated scores but non-orthogonal eigenfunctions.

Table 4. Factor loading matrix and final communality for the first three principal components,before rotated

Soil Characteristics	Principal Component 1	Principal Component 2	Principal Component 3	Communality
Bray-P	0.556	0.330	0.637	0.824
Base Saturation	0.683	0.678	-0.104	0.937
Clay	0.283	-0.786	-0.265	0.768
Cation Exchange Capacity	0.772	-0.610	0.039	0.970
Exchangeable Ca^{2+}	0.885	0.241	0.050	0.844
Exchangeable K^{+}	0.773	0.190	-0.299	0.723
Exchangeable Mg^{2+}	0.808	0.088	-0.509	0.920
pH H_2O	0.526	0.768	0.187	0.902
Total Carbon	0.468	-0.765	0.289	0.888
Total Nitrogen	0.589	-0.730	0.214	0.926

The result of the varimax normalized rotation was given in Table 5. The first factor washighly correlated with exchangeable cations and BS, and moderatey correlated with pH H_2O. The first factor designated as ***Base Status*** **(BSs)** that determined primarily by base cations contents. The BS increased together with pH and exchangeable cations. The second factor is difficult to interpret. However, it might be called ***Inherent PotentialityStatus*** **(IPs)** that indicated by variables of TC, TN, CEC, and clay content with high loading. Organic matter and clay content mutually affect to CEC. Organic matter has cation adsorptability greater than clay coloid. The third factor could be interpreted as ***Available Phosphate Status*** **(APs)**, comprised AP with high loading. The loading of AP was affected by high loading of pH and moderate loading of ex-Ca^{2+} and BS.

Table 5. Factor loading matrix for the first three principal factors, after rotated by varimax normalized

Soil Characteristics	Principal Component 1	Principal Component 2	Principal Component 3
Exchangeable Mg^{2+}	**0.930**	0.231	-0.031
Exchangeable K^{+}	**0.815**	0.174	0.167
Base Saturation	**0.790**	-0.234	0.509
Exchangeable Ca^{2+}	**0.715**	0.266	0.512
pH H_2O	0.531	-0.326	**0.715**
Total Nitrogen	0.091	**0.955**	0.073
Total Carbon	-0.054	**0.939**	0.067
Cation Exchange Capacity	0.368	**0.911**	0.065
Clay	0.117	**0.739**	-0.456
Bray-P	0.157	0.152	**0.881**

Soil acidification is primarily caused by a reduction in base cations such as Ca^{2+} and Mg^{2+} and an increase in exchangeable Fe^{3+} and Al^{3+} ions. This leads to a depletion of soil nutrients. Soil pH levels also impact the availability of soil P and base cations in temperate regions, as noted by Zarif *et al* (2020).

The factor loading of Base Status (BSs), inherent potentiality (IPs) and available phosphate status (APs) were uncorrelated one each other. Plots of rorated factor loadings for factors pairs BSs, IPs, APs were displayed in Figure 2. The components of principal factor loadings could be grouped along the factor axes. Plots of rotated principal component loadings were different.

The first three rotated principal factors were mutually statistically independent. However, the component loading of each the rotated pincipal factor was in accordance with the correlation matrix. This brought an undestanding that soil characteristic with high loading mainly, was the impotant soil characteistic to be considered in determining soil fertility status (class).

Factor Score and Soil Fertility Status

The factor scores of the first three principal components were computed for individual soil/observation site. They were sum of the product of factor score coefficient for the i^{th} variable and the k^{th} factor (see equation 5). The factor score cofficient was given in Table 6. Result of factor score computation was displayed in Table 7. The factor score for each soil was standardized, thus having a mean of zero and a variance of one.

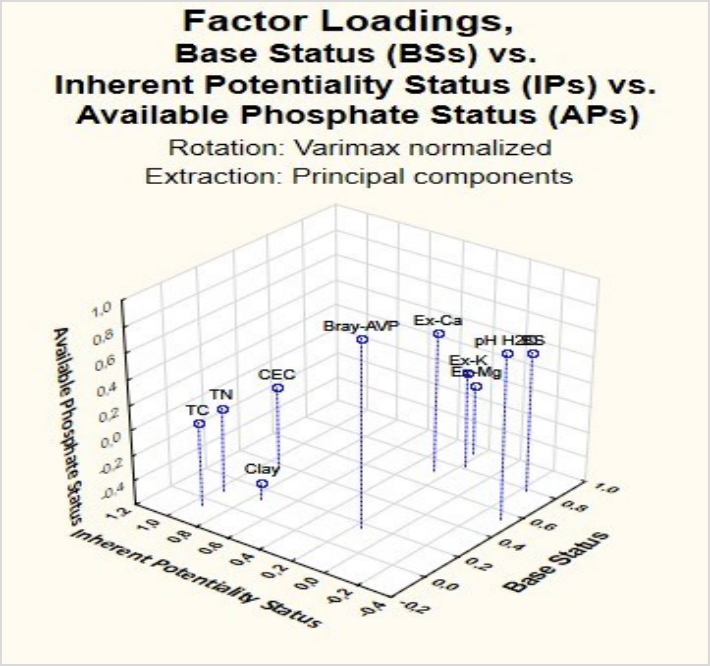


Figure 2. Plots of rotated loadings for factor pairs of BSs-IPs-APs

Table 6. Factor score cofficient matrix for the first three principal components

Soil characteristics	BSs	IPs	APs
Exchangeable Mg^{2+}	0.441	-0.037	-0.311
Exchangeable K^{+}	0.324	-0.020	-0.136
Base Saturation	0.243	-0.109	0.075
Exchangeable Ca^{2+}	0.148	0.057	0.156
pH H_2O	0.057	-0.086	0.301
Total Nitrogen	-0.088	0.297	0.124
Total Carbon	-0.156	0.307	0.167
Cation Exchange Capacity	0.055	0.250	0.020
Clay	0.127	0.169	-0.289
Bray-P	-0.237	0.124	0.598

The fertility status for individual soil was established by fertility index (FI) value, which was calculated from numeral rating value of mean score of three principal components. The rating value (0 to 100) was stated corresponding to the categorized distribution data of the mean score, as displayed in Table 8. The distribution of mean score was slightly positive skewed. The positive score values indicated above-average status with reference to the overall mean for all soils, and negative scores values indicated below-average status (Figure 3).

Table 7. Factor score of individual soil (observation site) for the first three principalcomponents by different selected growing area

Observation Site	*Principal Component 1 (BSs)*	*Principal Component 2 (IPs)*	*Principal Component 3 (APs)*	*Selected Growing Area*
Berau Regency				
1. Teluk Bayur (B1)	-0.866	-0.165	-0.119	Lowland
2. Meluang (B2)	0.228	-0.784	-0.471	Upland
3. Meluang (B3)	1.158	-0.893	1.694	Lowland
4. Sembakungan (B4)	-0.007	1.315	1.318	Lowland
5. Batu-batu (B5)	-1.167	2.223	0.203	Lowland
6. Merancang Hilir (B6)	0.679	0.561	-0.388	Lowland
7. Singkoang (B7)	0.095	-0.707	-0.555	Upland
8. Singkoang (B8)	-0.032	0.517	-0.587	Lowland
9. Rantau Panjang (B9)	0.366	-0.656	4.291	Lowland
10. Rantau Panjang (B10)	1.871	-0.361	-0.140	Lowland
11. Pegat Bukur (B11)	1.604	-0.488	-0.206	Lowland
12. Inaran (B12)	1.417	-0.024	1.853	Lowland
Kutai Regency				
13. Perangat (K15)	-0.492	-1.021	-0.476	Upland
14. Bukit Soeharto (K20)	-1.288	-0.574	-0.096	Upland
15. Loa Janan (K21)	0.272	0.200	-0.733	Lowland
16. Teluk Dalam (K22)	0.433	0.492	0.161	Lowland
17. Separi I (K23)	0.878	-0.152	-0.680	Lowland
18. Sebulu (K24)	-0.749	-0.255	-0.294	Upland
19. Muara Kaman (K25)	-0.645	-0.761	0.023	Upland
20. Kota Bangun (K26)	-0.288	-0.004	-0.172	Upland
21. Tunas Harapan (K27)	2.820	-0.271	-0.965	Upland
22. Samboja (K28)	-1.008	-0.132	-0.615	Upland
23. Marga Sari Loa Kulu (K29)	0.768	0.315	-1.050	Lowland
24. Tenggarong, Dam (K30)	1.818	0.897	-1.548	Lowland
Panajam Paser Utara dan PaserRegency				
25. Panajam, Km 12 (P31)	-0.315	2.017	-0.450	Lowland
26. Panajam, Km 40 (P32)	-0.889	-1.101	-0.138	Upland
27. Long Kali (P33)	-0.014	2.154	0.962	Lowland
28. Suatan Baru (P34)	-0.347	-1.066	0.256	Upland
29. Batu Kajang (P35)	-0.788	-0.326	-0.338	Upland
30. Kuaro (P36)	0.343	-0.006	-0.030	Upland
31. Long Ikis (P37)	-0.662	-0.708	0.277	Upland
Samarinda Municipality				
32. Pampang (S13)	-0.733	-0.699	-0.495	Upland
33. Karang Mumus (S14)	-0.706	-0.175	-0.363	Lowland
34. Handil Bakti Palaran (S18)	-0.860	2.879	0.298	Lowland
35. Sanga-sanga (S19)	-1.282	-0.938	0.049	Upland
Balikpapan Municipality				
36. Balikpapan, Km 95 (N16)	-0.655	-0.795	-0.571	Upland
37. Balikpapan, Km 91.5 (N17)	-0.958	-0.840	0.094	Lowland

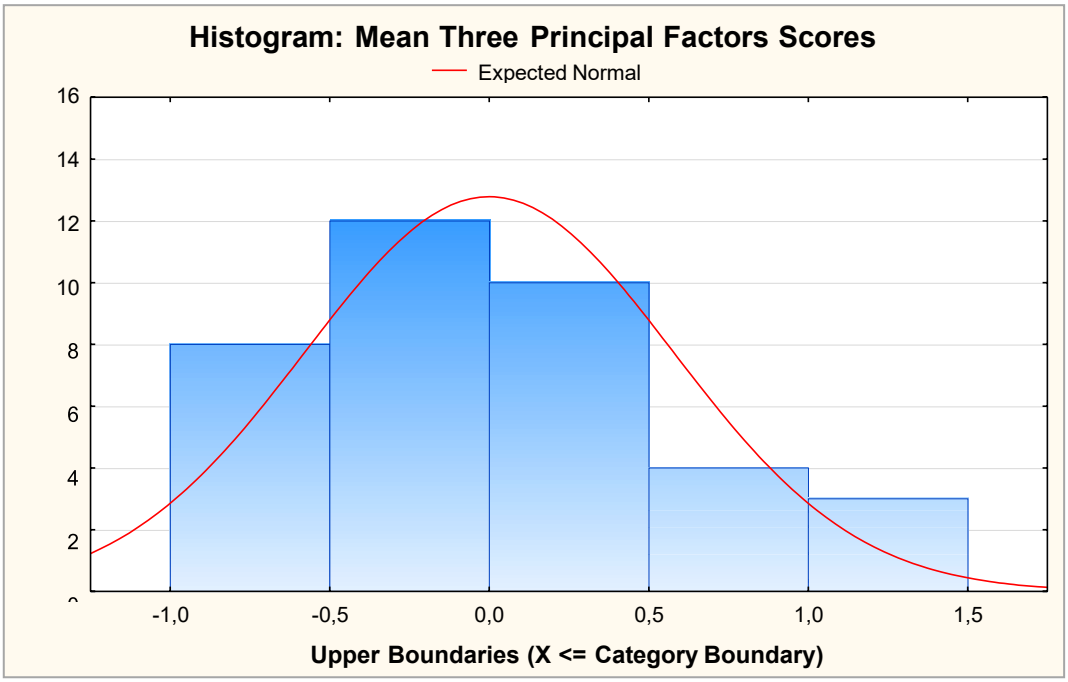


Figure 3. Histogram showing distribution of mean factor score

Table 8. The category, number of samples for mean score of the three principal factors, ratingvalue and soil fertility index (class)

Category	No. of Samples for mean three principal factors scores	Rating Value	Soil Fertility Index (Class)
1.5 – 1	3	100 – 85	100 -75 (very high)
1 – 0.5	4	85 – 60	75 – 50 (high)
0.5 – 0	10	60 – 40	50 – 25 (moderate)
0 – -0.5	12	40 – 25	25 – 12.5 (low)
-0.5 – -1	8	25 – 0	12.5 – 0 (very low)

Based on rating value stated in Table 8, fertility index and class for individual soil were obtained, as given in Table 9 and Fig. 4. Generally, the lowland soils had soil fertility status higher than those of upland soils. According to Tran *et al* (2021) that the soil fertility of upland soil is probably changed by different agricultural management practices regardless of soil type.

The difference of both soils could be seen from the mean nutrient content of all considered soil properties, especially on the mean AP, calcium dan magnesium contents. The mean AP, ex-Ca^{2+} and ex-Mg^{2+} in lowland soils were respectively for 2.77, 3.12 and 1.82 times higher than those of upland soils. The mean TC and TN contents also showed clearly difference between the two soils.

Table 9. Mean score of the first three principal components, rating value, fertility index and class (status) by different selected growing area

Observation Site	Mean score of the first three principal components	Rating value	Fertility index	Fertility class (Status)	Selected growing area
Berau Regency					
1. Teluk Bayur (B1)	-0.273	31.81	18.18	Low	Lowland
2. Meluang (B2)	-0.342	29.74	16.45	Low	Upland
3. Meluang (B3)	0.653	67.65	57.65	High	Lowland
4. Sembakungan (B4)	0.876	78.80	68.80	High	Lowland
5. Batu-batu (B5)	0.420	56.80	46.00	Moderate	Lowland
6. Merancang Hilir (B6)	0.284	51.36	39.20	Moderate	Lowland
7. Singkoang (B7)	-0.389	28.33	15.28	Low	Upland
8. Singkoang (B8)	-0.034	38.98	24.15	Low	Lowland
9. Rantau Panjang (B9)	1.334	95.02	91.70	Very High	Lowland
10. Rantau Panjang (B10)	0.457	58.28	47.85	Moderate	Lowland
11. Pegat Bukur (B11)	0.303	52.12	40.15	Moderate	Lowland
12. Inaran (B12)	1.082	87.46	79.10	Very High	Lowland
Kutai Regency					
13. Perangat (K15)	-0.662	16.90	8.45	Very Low	Upland
14. Bukit Soeharto (K20)	-0.653	17.35	8.68	Very Low	Upland
15. Loa Janan (K21)	-0.087	37.39	22.82	Low	Lowland
16. Teluk Dalam (K22)	0.362	54.48	43.10	Moderate	Lowland
17. Separi I (K23)	0.015	40.60	25.75	Moderate	Lowland
18. Sebulu (K24)	-0.433	27.01	14.18	Low	Upland
19. Muara Kaman (K25)	-0.461	26.17	13.48	Low	Upland
20. Kota Bangun (K26)	-0.155	35.35	21.12	Low	Upland
21. Tunas Harapan (K27)	0.528	61.40	51.40	High	Upland
22. Samboja (K28)	-0.585	20.75	10.38	Very Low	Upland
23. Marga Sari Loa Kulu (K29)	0.011	40.44	25.55	Moderate	Lowland
24. Tenggarong, Dam (K30)	0.389	55.56	44.45	Moderate	Lowland
Panajam Paser Utara dan Paser Regency					
25. Panajam, Km 12 (P31)	0.417	56.68	45.85	Moderate	Lowland
26. Panajam, Km 40 (P32)	-0.709	14.55	7.28	Very Low	Upland
27. Long Kali (P33)	1.034	86.02	76.70	Very High	Lowland
28. Suatan Baru (P34)	-0.386	28.42	15.35	Low	Upland
29. Batu Kajang (P35)	-0.484	25.48	12.90	Low	Upland
30. Kuaro (P36)	0.102	44.08	30.10	Moderate	Upland
31. Long Ikis (P37)	-0.364	29.08	15.90	Low	Upland
Samarinda Municipality					
32. Pampang (S13)	-0.642	17.90	9.95	Very Low	Upland
33. Karang Mumus (S14)	-0.415	27.55	14.62	Low	Lowland
34. Handil Bakti Palaran (S18)	0.772	73.60	63.60	High	Lowland
35. Sanga-sanga (S19)	-0.723	13.85	7.38	Very Low	Upland
Balikpapan Municipality					
36. Balikpapan, Km 95 (N16)	-0.674	16.30	8.15	Very Low	Upland
37. Balikpapan, Km 91.5 (N17)	-0.568	21.60	10.80	Very Low	Lowland

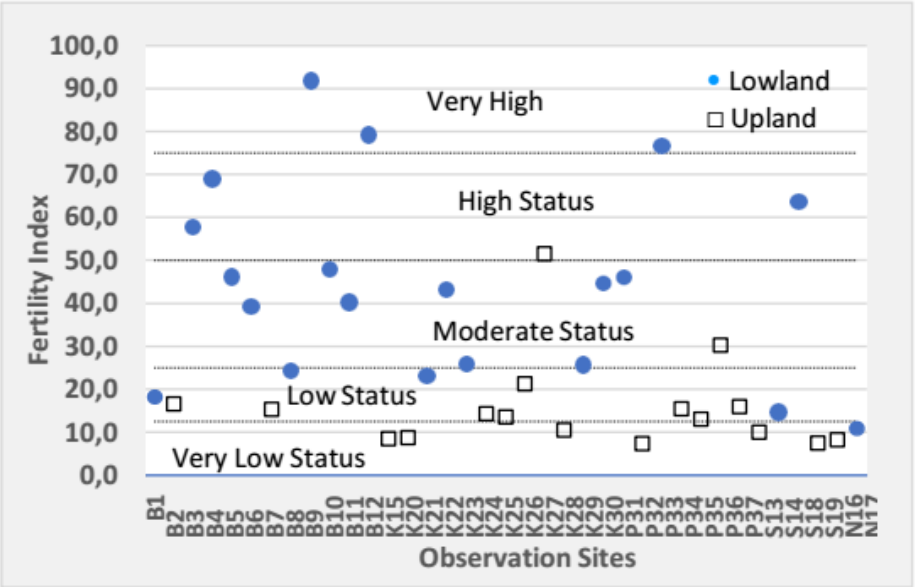


Fig. 4. Soil fertility index and status for 37 observation sites

The lower contents of ex-Ca^{2+} and ex-Mg^{2+} in upland soils were possibly caused by the process of leaching that taken place much more than those of lowland soils. The process of leaching could be estimated from low average BS and CEC of upland soils. Beside that, the higher content of sand in upland soils was other cause-factor on possibility of nutrient leaching. The highly rainfall in the study area (2,367.2 to 4,071.6 mm/year), affected greatly on leaching process in the upland soils. Sandy soils are infertile due to their high sand content (>85%), which contributes to their low water holding capacity, soil pH (4.5–5.5), CEC, soil organic matter, and plant nutrients, ultimately leading to low crop productivity (Fujii *et al*., 2017).

The lower content of AP in upland soils was more closely related to the lower contents of exchangeable cations and pH. The effect of exchangeable cations and pH were possibly indirect.

According to studies conducted by some soil scientists, the major soil factors affecting P sorption are time, soil pH, soil organic matter, and iron and aluminium oxides of soils. Studies conducted indicated that adsorption of the P increases as the P ages in the soil. Soil pH affects phosphate adsorption but the effect is limited for adsorption by soils in the pH range of 4–8. Organic matter may affect P adsorptionin two ways: indirectly by inhibiting iron oxide crystallisation and directly by competing for adsorption sites (Asomaning, 2020).

The low content of TC, TN as well as AP in the upland soils were also possibly due to soil erosion (run-off) effect, such as indicated qualitatively by a wide range of slope classes of upland rice growing area from sloping to steep.

The low content of TC, TN as well as AP in the upland soils were also possibly due to soil erosion (run-off) effect, such as indicated qualitatively by a wide range of slope classes of upland rice growing area from sloping to steep.

The high to very high soil fertility status was found in the B3, B4, B9 and B12 lowland rice soils of Berau Regency with fertility index (FI) range of 57.65 to 91.70, in the P33 lowland rice soil of Paser Regency with FI of 76.70, in the S18 lowland rice soil of Samarinda Municipality with FI of 63.60, and in the K27 upland rice soil of Kutai Kartanegara Regency with FI of 51.40. Very low fertility status of soils were notably found in upland rice soils of K15, K20, K28, N16, P32, S13 and S19 with FI range from 7.38 to 10.38. While very low soil fertility status for lowland rice soil was found in N17.

Very high fertility status of lowland rice soils of B9, B12 and P33 was determined by similar factor, i.e.; AP status (APs) factor. This factor was to be a very dominant affected-factor for B9, within which it given the highest factor score (4.29). The APs factor score for B12 and P33 was 1.85 and 0.96, respectively. Beside APs factor, the soil fertility status of B12 was also determined by base status (BSs) factor, while for P33 by inherent potentiality (IPs) factor.

The soil limiting factor on fertility status in the study area were widely varied. As presented in Table 9, the lowest soil fertility status of K15, K20, K28, P32, S13, S19, N16 and N17 were determined by the negative factor score of two to three principal components. The main cause-factor on decreasing of soil fertility status of observation site could be investigated from the highest negative value of each factor score or from the nutrient contents directly. The dominant limiting factors for K15 upland rice soil for instance,

were determined by inherent potentiality (IPs) with factor score of -1.021 (PC2). While, N17 lowland rice soil was considerably restricted by exchangeable cations and BS with factor score of -0.958 (PC1), texture and organic carbon with factor score of -0.840 (PC2). There was slightly difficult to determine the potential cause-factor on the lowest soil fertility status of N16. The three principal component (BSs, IPs and APs) relatively contributed the negative factor scores with a tie. For this case, it was reasonable to give an attention on negative factor score of PC1, where PC1 indicated as a the most informative factor.

The numbers and values of negative factor score influenced greatly on decreasing of the rating value and the index value of soil fertility. The higher value of negative factor score the rating value and soil fertility index was lower, and contrarily.

By means of the cause-factor relating to soil fertility status for each observation site as a proper direction (indicator), soil fertility amelioration efforts could be done more easier and more effective.

CONCLUSION

The variation of soil characteristics in the study area was great, especially indicated byhighly coefficient of variance of available phosphate, and exchangeable calcium and magnesium.

The fertility status (classes) of lowland soils were hihger than those of upland soils. The very highly fertility status of Rantau Panjang lowland soil with fertility index (FI) of 91.70 and Inaran lowland soil with FI of 79.10 was determined by factor score of available phosphate status (APs) and base status (BSs), respectively.

The main cause-factor on decreasing of soil fertility status of observation site could be investigated from the highest negative value of each factor score or from the nutrient contents directly. The higher value of negative score the rating value and soil fertility index (class) was lower and contrarily.

Determination of factor score using multivariate statistical technique can be considered as a most useful approach for evaluating soil fertility semi-quantitaively.

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PGPR Suppresses Herbivore Attacks and Promotes The Growth Of Common Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

Plant defense against herbivores can be constitutive or inducible. One of these defense inducers is a group of rhizobacteria known as PGPR. In general, apart from stimulating plant growth, PGPR can induce systemic resistance to pathogens and herbivores in many crops. Therefore, in this study, we tested the ability of PGPR from elephant grass *Pennisetum purpureum* to increase the defense of the common bean *Phaseolus vulgaris* L. against herbivores. The research was carried out using a randomized complete block design (RCBD), consisting of five of treatments each repeated five times. The data has been analyzed using analysis of variance, and further tests with the LSD test at the 5% level. The results showed that the application of PGPR at a concentration of 20 mL-1 could significantly reduce the intensity of insect herbivore attacks on leaves and pods. Apart from that, PGPR has also increased plant growth, both plant height and number of leaves, accelerated the flowering phase, and increased pod weight per plant. It can be concluded that giving PGPR to common bean plants can improve growth performance and increase defense responses against herbivores.
Keywords: Plant defense, PGPR, Herbivores, Common beans

INTRODUCTION

Chickpeas (Phaseolus vulgaris L.) are a source of vegetable protein that is cheap and easy to grow. Its potential socio-economic value is very high, it can improve the household and national economy, provide nutritious food for the population, efficiently maintain soil fertility, and be used as an export commodity. However, chickpea production has fluctuated due to the reduction in the area of land planted and the high intensity of pest attacks.

Efforts to maintain the stability of crop production can be done by intensification, including fertilization. To achieve this goal, farmers usually use inorganic fertilizers, which have a faster effect. However, continuous application of mineral fertilizers, especially in excessive amounts, can reduce soil fertility, stimulate the development of pathogens, cause nutrient poisoning, and reduce crop resistance to pests, diseases, and the elements.

The application of inorganic fertilizers can be replaced by the use of biological fertilizers, one of the biological fertilizers that can be used is PGPR. It is a fertilizer that contains a group of beneficial bacteria that reside in the rhizosphere zone (a thin layer of soil 1-2 mm around the root zone). A thin layer of soil that covers the root surface and positively affects plant growth.

Plant Growth Promoting Rhizobacteria as an alternative environmentally friendly technology in the field. PGPR is a type of bacteria that lives around plant roots. The bacteria live in colonies covering the roots of plants. For plants, the presence of these microorganisms will be very good. These bacteria provide benefits in the process of plant physiology and growth. PGPR plays a role in increasing plant growth, yield and soil fertility. PGPR directly increases plant growth because it produces hormones, nutrients, organic acids and mobilizes nutrients to be easily absorbed by plants.

Plant Growth Promoting Rhizobacteria from elephant grass roots have two forms of bacteria, namely bacteria with a rod shape with another name Bacillus and bacteria with a round shape with another name Coccus. It is known that PGPR bacteria from the roots of elephant grass have gram-positive blue color and gram-negative red color.

Previous research conducted by A'yun et al. (2013) showed that the application of PGPR with a concentration of 10 ml/L on cayenne pepper plants can reduce the intensity of TMV (Tobacco Mosaic Virus) attacks by 89.92%, increase the production of chili plants, and can increase the height of cayenne pepper plants. Iswati's research (2012) showed that PGPR application with a concentration of 12.5 ml/L had a significant effect on plant height and root length of tomato plants, and a concentration of 7.5 ml/L could maximize the number of leaves and the number of roots in tomato plants.

The application of Plant Growth Promoting Rhizobacteria (PGPR) to bean plants gives a very different effect with bean plants that are not treated with PGPR (control). Chickpea plants treated with PGPR had the lowest pest attack intensity, pod attack intensity, number of branches, plant age at flowering,

plant age at harvest, number of plant pods and pod weight per plant.

The purpose of this study was to examine the effect of PGPR application of elephant grass roots (Pennisetum purpureum) on the resistance of upright chickpea plants to pest attacks and to see the concentration of PGPR that provides resistance to upright chickpea plants to pest attacks.

MATERIALS AND METHODS

Place and Time

The research was conducted for four months (December 2022 to March 2023), from the preparation of the research until the last data collection. The research was conducted in the Green House/Field and Laboratory of Plant Pests and Diseases, Faculty of Agriculture, Mulawarman University, Samarinda.

Materials and Tools

The materials used consisted of upright chickpea seeds, kepok banana roots, whiting, sugar, shrimp paste, water and bran. The tools used in the research consisted of hoes, polybags, machetes, buckets, filters, pans, scales, meters, and documentation tools.

Research Methods

This research was arranged in a group randomized design with 6 treatments and repeated 4 times. The treatments given in this study used PGPR kepok banana root with the concentration in each treatment as follows.

P_0 = Kontrol
P_1 = 10 mL PGPR L^{-1}
P_2 = 20 mL PGPR L^{-1}
P_3 = 30 mL PGPR L^{-1}
P_4 = 40 mL PGPR L^{-1}
P_5 = 50 mL PGPR L^{-1}

Observation Parameters

Pest Attack Intensity

Observations were made by calculating the intensity of pest attacks every 1 week. The observation variable is the category of damage scale on the leaves/plants based on qualitative observations which are then made into a scale value (score). This scale number will be used to calculate the intensity of pest attack on upright chickpea plants. The formula used to calculate the intensity of attack is as follows:

$$IS = \frac{\sum(n \times v)}{Z \times N} x\ 100\%$$

Pod Attack Intensity

Observations were made by calculating the intensity of attack on plant pods from the first harvest to the fourth harvest of each plant. The formula used to calculate the intensity of attack on plant pods is as follows:

$$IS = \frac{\sum(n)}{N} x\ 100\%$$

Type of Pests and Symptoms of Attack

These observations were only made on biting and chewing pests with damage criteria such as perforated leaves, tears, etc. Symptoms of piercing and sucking pests are also observed although it is rather difficult to distinguish the symptoms of pests and plant diseases. Identify stabbing and sucking pests found in the field.

Plant Height (cm)

Plant height was measured when the plants were 2, 4, 6 and 8 mst old. Measurement of plant height was carried out from the lower base of the stem at the same point to the growing point of the plant using a ruler.

Number of plantlets per plant (stems)

The number of branches is determined by counting the number of branches that grow on the main stem, carried out at the end of the study, namely after harvest is complete.

Plant Age at Flowering (HST)

Plant age at flowering is determined when there is at least one flower that blooms and is calculated from the first flower blooming.

Plant Age at Harvest (HST)

Plant age at harvest is determined in days from planting to the first harvest.

Number of Pods per Plant (fruit)

The number of pods per plant was determined by counting the number of all pods produced by plants from the first harvest to the fourth harvest of each plant, then calculated the average per plant.

Fresh Pod Weight per Plant (g)

The weight of fresh pods per plant was determined by calculating the average weight of chickpea pods from the first harvest to the fourth harvest of each plant.

Results and Discussion

Pest Attack Intensity

The results of variance analysis on the intensity of pest attack of upright chickpea plants showed that the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 1.

Table 1. Effect of Plant Growth Promoting Rhizobacteria on the Intensity of Pest Attacks of Upright Chickpea Plants 4,5,6,7,8 MST That Have Been Transformed Arschin

PGPR concentrations (mL L^{-1})	Pest Attack Intensity				
	4 MST	5 MST	6 MST	7 MST	8 MST
p0 (0)	23,12[a]	22,19[a]	21,00[a]	28,05[a]	33,61[a]
p1 (10)	17,44[b]	17,35[b]	16,70[bc]	20,06[b]	22,18[b]
p2 (20)	15,14[c]	14,83[c]	14,03[c]	14,17[b]	16,20[c]
p3 (30)	18,19[b]	19,00[b]	17,09[b]	20,51[b]	22,57[b]
p4 (40)	18,23[b]	19,43[b]	17,21[b]	20,90[b]	24,31[b]
p5 (50)	18,71[b]	19,66[b]	17,45[b]	20,97[b]	24,61[b]

Observations of the intensity of pest attacks on bean plants showed a very significant effect at the age of 4, 5, 6, 7 and 8 weeks after planting. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 decreased the curve. This shows that giving PGPR concentrations of 0, 10, 20 mL L-1 causes a decrease in the intensity of pest attacks on chickpeas in accordance with the addition of PGPR concentrations. The increase in PGPR concentrations of 30, 40 and 50 mL L-1 caused an increase in the curve. The lowest average intensity of pest attack starting from 4, 5, 6, 7 and 8 mst was shown by p2 (20 mL L-1), namely: 15.14%, 14.83%, 14.03%, 14.17% and 16.20%, while the highest intensity of pest attack was shown by the control (0 mL L-1), namely: 23.12%, 22.19%, 21.00%, 28.05% and 33.61%.

This is because PGPR is able to spur the growth of root physiology and can reduce disease or damage by pests. In addition, PGPR also increases the availability of other nutrients such as phosphate, sulfur, iron and copper. PGPR can also produce plant hormones, increase beneficial bacteria and fungi and control pests and diseases in bean plants.

The dose treatment of Plant Growth Promoting Rhizobacteria (PGPR) had a very significant effect on the intensity of pest attacks on upright chickpea plants. This indicates that the PGPR can reduce the intensity of pest attacks on upright chickpea plants.

PGPR are beneficial bacteria that aggressively occupy (colonize) the rhizosphere (root zone). The activity of rhizobacteria is beneficial to plants both directly and indirectly. The direct effect of PGPR is based on its ability to provide and facilitate the uptake of various nutrients in the soil as well as to synthesize and alter the concentration of plant-promoting phytohormones. The indirect effect of PGPR is related to its ability to suppress pathogen activity by producing compounds or metabolites such as antibiotics.

Pod Attack Intensity

The results of variance analysis on the intensity of pod attack of upright chickpea plants showed the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 2.

Table 2. The Effect of Plant Growth Promoting Rhizobacteria on the Intensity of Attack of Upright Chickpea Plant Pods Harvest 1, 2, 3 and 4

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	0,43	0,28	0,44	0,50	0,37	1,65	0,44[a]
p1 (10)	0,16	0,18	0,21	0,19	0,38	1,11	0,22[b]
p2 (20)	0,11	0,11	0,06	0,10	0,15	0,53	0,08[c]
p3 (30)	0,21	0,29	0,43	0,29	0,24	1,46	0,23[b]
p4 (40)	0,19	0,32	0,26	0,38	0,39	1,54	0,25[b]
p5 (50)	0,34	0,41	0,25	0,31	0,33	1,65	0,26[b]

Observations of the intensity of attack on chickpea pods showed a significantly different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 decreased the curve. This shows that giving PGPR concentrations of 0, 10, 20 mL L-1 causes a decrease in the intensity of attacks on chickpea pods in accordance with the addition of PGPR concentrations. Increasing PGPR concentrations of 30, 40 and 50 mL L-1 caused an increase in the curve. The average intensity of attack on the pods was the lowest in treatment p2 (20 mL L-1), which was 0.8%, while the highest number of branches was shown by the control (0 mL L-1), which was 0.44%.

The intensity of the attack on the pods of the plants that have been observed shows that the PGPR treatment makes the intensity of the attack lower than the plants without using PGPR (control). This is caused by the ability of PGPR to act as a biofertilizer, which helps provide nutrients needed by plants. One of them is by dissolving the P element bound in the soil. Element P has an effect on cell division, flowering, fertilization and plant immunity to certain diseases, therefore the use of PGPR will further accelerate the dissolution of element P, so that plant resistance to pest attacks is better maintained and can also increase pod and seed production in upright chickpea plants.

Table 3. Types of Pests and Symptoms of Infestation

Types of Insects	Status	Treatment					
		T0	T1	T2	T3	T4	T5
Larva *Orgyia leucostigma*	Pest		✓				
Black Looper (*Hyposidra talaca*)	Pest		✓	✓	✓	✓	✓
Leaf Roller (*Lamprosema indicare*)	Pest	✓	✓	✓	✓	✓	✓
Mealybug (*Paracoccus marginatus*)	Pest	✓				✓	
Pod Borer (*Maruca vitrata*)	Pest	✓	✓	✓	✓	✓	✓
Polyphagous Predator (*Rhinocoris fuscipes)*	Pest			✓	✓		
Mantis (*Mantodae*)	Predator	✓				✓	
Riptortus linearis (*Riptortus linearis*)	Predator	✓					
Bullet Ant (*Paraponera clavata)*	Predator		✓	✓			
Wasp Moth (*Hamata huebneri*)	Pollinator				✓		

The most common pests found in the field are caterpillars (*Hyposidra talaca*) and caterpillars (*Lamprosema indicare*), as well as other pests that attack bean plants such as Orgyia leucostigma larvae, mealybugs (*Paracoccus marginatus*), pod borers (*Maruca vitrata*).

a. Black Looper (*Hyposidra talac*a)

Black looper (*Hyposidra talaca*) or caterpillar kilan, morphologically this caterpillar is very distinctive, because the way the caterpillar walks on tiptoe, the caterpillar is like the motion of the human hand when measuring by inch by inch, namely by means of the tip of the back body pulled to the front so that the body is curved, then the front body moves forward. Caterpillars move like that because caterpillars do not have legs in the middle of their body. If there is a disturbance, the caterpillar will straighten its body (supine position). The following is the classification of the caterpillar that attacks the leaves on bean plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Geometridae, Genus: Hyposidra, Species: *Hyposidra talaca*. Caterpillars in their reproduction belong to the Holometabola insect group, which is a group of insects that experience four stages of development, namely eggs, larvae, pupae (cocoons), and imago.

Caterpillars (larvae) attack young leaves at the edges of the leaves by eating them, so that the edges of the leaves are torn, in severe attacks causing perforated leaves and bare plant shoots, so that only leaf bones remain. When the young leaves are exhausted, this pest will increase the attack to the old leaves below. Attacks generally occur at night until early morning. Caterpillars begin to actively damage bean plants from the time they hatch from eggs until they become pupae.

The high percentage of caterpillar attacks on bean plants is thought to occur due to the high rainfall factor, soil moisture becomes quite high and is favored by caterpillar larvae to breed. Based on observations in the field, it is known that the availability of young leaves as a source of food is quite abundant, making the caterpillar population increase, fluctuations in the caterpillar population are in line with changes in the intensity of the formation of young leaf shoots. If there are many shoots formed, the caterpillar population will increase. However, if there are few shoots formed, the caterpillar population will also be small.

Caterpillars have several natural enemies, including pathogens that attack caterpillars in the larval phase. There are also parasitoid flies from the Sarcophagidae family that attack the caterpillars in the pupa phase. Too much rainfall can cause high mortality in the larval vase. Larvae trapped by rainwater are unable to escape and die. In the pupal phase, soil moisture conditions that are too wet or too dry can also increase caterpillar mortality.

b. **Leaf Roller (*Lamprosema indicare*)**

Caterpillar (Lamprosema indicare) is a greenish larva, the head is light yellow and shiny, on the prothorax there is a pair of black spots, the type of mouth biting chewing. The following is the classification of the caterpillar found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Pyralidae, Genus: Lamprosema, Species: *Lamprosema indicata.*

Leaf roller caterpillar pests attacked chickpea plants at the age of 35 HST. The attack began to spread evenly throughout the bean plants at the age of 50 HST. Observations showed that these caterpillars attacked the plants by rolling the leaves by gluing one leaf to another from the inner side with the adhesive substance it produces. Inside the leaf roll, the caterpillar eats the leaves of the plant until finally only the leaf bones are left. When the scroll is unrolled, blackish caterpillars or droppings are found. The larvae attack the second or third leaf from the shoot, in severe infestations the larvae also attack the shoot, then the leaf is pulled until it joins another leaf roll.

c. Orgyia leucostigma larvae

Orgyia leucostigma larvae are potential pests and not major pests, but they can become major pests if the ecosystem is disturbed and changed. Climate change characterized by a prolonged rainy season is the main factor causing caterpillar explosions.

The caterpillars found are brightly colored, the hair growing on the head is black and longer than the hair growing on other parts, the head is bright red and there is a white or yellow stripe on each side of the dorsal midline with a black stripe along the middle of the back. Bright red defense glands are visible from the rear end of the back. There are four white toothbrush-like tufts protruding from the back, and a gray-brown hair pencil at the back end, the larva is 1-1.5 inches long. The hairs all over the caterpillar's body cause an itchy reaction when in contact with the skin [39]. This caterpillar is the larva of one of the species of the Lymantridae (moth) family. The following is the classification of caterpillars found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Erebidae, Genus: Orgyia, Species: *Orgyia leucostigma.*

This caterpillar attacks T1R4 plants at the age of 3 weeks until harvest. Observations showed that this pest attacked the plants by eating the leaves of T1R4 bean plants and leaving only the leaf bones. The attack of this caterpillar on T1R4 plants was quite severe, making the plants slow to flower and have few fruits.

d. Mealybug (*Paracoccus marginatus*)

White fleas (*Paracoccus marginatus*) are a type of flea whose entire body is covered with a white waxy coating. The body is oval in shape with white hair-like appendages of short size. This pest consists of males and females and has several developmental phases, namely: egg, preadult (nymph), and imago phases. Paracoccus marginatus eggs are round, greenish-yellow in color and covered by a cotton-like mass and will hatch within 10 days. Here are the mealybugs found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Homoptera, Family: Pseudococcidae, Genus: Paracoccus, Species: *Paracoccus marginatus.*

Mealybug pests are usually clustered up to tens of thousands. They damage by sucking the liquid. All parts of the plant can be attacked from fruit to shoots. Observations show that this pest attacks plants on the shoots, causing the leaves to become stunted and wrinkled as if burned.

e. Pod borer (*Maruca vitrata*)

Pod borer (*Maruca vitrata*) is an important pest in bean plants that attacks flowers and pods. Eggs are laid on flowers, leaves and pods in clusters. One group of eggs consists of 2-4 eggs with a slightly flattened oval shape and yellowish white color with a length of up to 18 mm. The head is brown to black in color and each segment consists of dark spots along the body located on the back. The larval stage lasts for 10-15 days. The pupa forms in the soil or inside the pods. The brown body of the pupa is approximately 13.5 mm long and the pupa stage lasts 7-10 days. The following pod borers are found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Pyralidae, Genus: Maruca, Species: *Maruca vitrata* Fab.

This pest attacks the plant at the time of flowering and the symptoms and characteristics caused by the attack of this pest appear in the flowers and pods of plants that are damaged and then fall. One larva can damage 4-6 flowers per plant during its lifetime. Germination on the pods causes the seed pods on the bean plants to be damaged, the skin on the bean pods becomes perforated and from the holes come out wet gerek powder mixed with brown larvae feces.

Plant Height (cm)

The results of variance analysis of upright chickpea plant height showed the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 4.

Table 4. Effect of Plant Growth Promoting Rhizobacteria on Upright Chickpea Plant Height 2, 4, 6, and 8 mst (cm)

PGPR concentrations (mL L^{-1})	Plant Height			
	2 MST	4 MST	6 MST	8 MST
p0 (0)	12,3^{d}	25,9^{c}	35^{c}	45,2^{c}
p1 (10)	15,3^{b}	31,6^{b}	44^{b}	52,9^{b}
p2 (20)	16,8^{a}	37,5^{a}	53^{a}	61,1^{a}
p3 (30)	14,8^{bc}	30,^{b}	42,6^{b}	51,3^{b}
p4 (40)	14,5^{bc}	30,4^{b}	42,2^{b}	50,6^{b}
p5 (50)	14,2^{c}	30,2^{b}	41,2^{b}	50,1^{b}

The observation of the height of chickpea plants gives a very significantly different effect. This shows that the application of PGPR concentrations of 0, 10, 20 mL L-1 causes an increase in the height of chickpea plants in accordance with the addition of PGPR concentrations. The increase in PGPR concentrations of 30, 40 and 50 mL L-1 causes a decrease. The highest average plant height starting from 2, 4, 6 and 6 weeks after planting was found in treatment p2 (20 mL L-1), namely, 16.8; 37.5; 53; and 61.1 cm, and the lowest plant height was found in the control (without PGPR), namely, 12.8; 25.9; 35; and 45.2 cm.

The treatment of Plant Growth Promoting Rhizobacteria (PGPR) dose had a very significant effect on the height of upright chickpea plants at the age of 2, 4, 6, and 8 weeks after planting. This shows that the provision of PGPR can increase the height of upright chickpea plants, with the provision of PGPR nutrients in the soil can increase and can be absorbed by plants optimally. PGPR can improve the quality of plant growth through the production of growth hormones, the ability to fix nitrogen to increase the supply of soil nitrogen, the producer of osmolytes as an osmoprotectant in drought stress conditions and the producer of certain compounds that can kill pathogens in plants.

PGPR can produce IAA, Cytokinin and Gibberellin, because IAA is an active form of auxin hormones found in plants that play a role in improving crop quality and yield, can increase cell development, stimulate growth, and increase enzyme activity. Auxin and Gibberellin are both found in embryos and apical epical meristems and function for cell elongation so that it is thought that these two hormones have an influence on plant height. However, because the response to hormones is usually not so dependent on the absolute amount of the hormone, but depends on its relative concentration compared to other hormones, it is suspected that this phenomenon is the influence so that even though the dose of PGPR is increased to a certain extent there is an increase in influence but not significantly different.

During the experiment, environmental conditions such as rainfall and high humidity will affect plant growth. The effect of PGPR on control with treatments (10; 30; 40; and 50 mL L-1) was not significantly different on plant height, presumably because plants could not absorb nutrients optimally. This is caused by high rainfall so that the soil in the planting media becomes dense which results in plant roots not being able to absorb nutrients optimally. Rainfall during the vergetative phase, namely April to June 2023 averaged 133; 271; and 159 mm per month, including quite high rainfall (100-300 mm per month) [27].

Number of Branches per Plant (branches)

The results of variance analysis of the number of branches on upright chickpea plants showed the effect of PGPR application was significantly different. The average number of branches of chickpea plants can be seen in Table 5.

Table 5. Effect of Plant Growth Promoting Rhizobacteria on the Number of Plant Branches

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p_0 (0)	6	4	4	5	4	23	$4,2^c$
p_1 (10)	5	5	8	4	6	28	6^b
p_2 (20)	5	6	7	4	5	27	$6,4^b$
p_3 (30)	7	7	8	8	8	38	8^a
p_4 (40)	5	4	6	5	6	26	$5,8^b$
p_5 (50)	4	7	4	5	4	24	$5,6^b$

Observations of the number of branches of chickpea plants gave a significantly different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 30 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, 20 and 30 mL L-1 causes the highest number of branches in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

The results of variance analysis of the effect of PGPR application with different concentrations showed significantly different on the number of branches on upright chickpea plants. Comparison test using BNT at 5% level showed that the treatment of 5% BNT test results showed that among the five PGPR treatments (10; 20; 40; and 50 mL L-1) were not significantly different, but all four were significantly different from p0 (0 mL L-1) and p3 (30 mL L-1). Between p0 (0 mL L-1) and p3 (30 mL L-1) were significantly different. The average number of branches is most shown by p3 (30 mL L-1), which is 8 branches, while the least number of branches is shown by the control (0 mL L-1), which is 4.2 branches.

The number of branches of bean plants with PGPR treatment is more than the number of branches on plants that are not treated with PGPR (control). This is because nitrogen (N) nutrients in plants treated with PGPR are thought to be more available in sufficient quantities compared to bean plants that are not treated with PGPR (control). Nitrogen contained in PGPR is very beneficial for growth, namely (1) making plants fresher green and containing many green leaf grains that play a role in the photosynthesis process, (2) accelerating plant growth (height, branches, etc.), (3) increasing protein content in plants.

In addition, rooting bacteria can help plant roots absorb nitrogen better than plants that are not treated with PGPR. Plant Growth Promoting Rhizobacteria contains a group of beneficial bacteria that are around plant roots, able to increase free nitrogen which helps in plant growth.

Plant Age at Flowering (HST)

The results of variance showed that the effect of PGPR concentration was significantly different on plant age at flowering. The average age of bean plants can be seen in Table 6.

Table 6. Effect of *Plant Growth Promoting Rhizobacteria* on Plant Age at Flowering (HST)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p_0 (0)	41	41	42	40	41	205	42,2[a]
p_1 (10)	38	37	38	41	40	194	37,8[c]
p_2 (20)	36	36	37	36	38	183	36,2[d]
p_3 (30)	38	41	38	40	39	196	38[bc]
p_4 (40)	40	40	39	39	41	199	39,6[bc]
p_5 (50)	40	41	40	41	40	202	39,2[b]

The observation of the age of flowering plants gives a very different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the age of flowering plants to be faster in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

Based on Table 6. shows that PGPR treatment p2 (20 mL L-1) is the treatment that appears the fastest flowers compared to other treatments, namely, 36.2 hst and the slowest is found in the control (without PGPR), namely, 42.2 hst. Vegetative growth that affects the age of flowering in plants is not only influenced by a treatment alone but also influenced by the environment in which it lives. In addition to environmental and genetic factors, soil factors, availability of light, water and nutrients also play a role in triggering the flowering process. The availability of nutrients for bean plants will affect the growth of the vegetative phase, where plants will accelerate their generative phase.

Plant Growth Promoting Rhizobacteria (PGPR) is useful as a growth regulator (biostimulant) that can produce the hormone gibberellin. Gibberellins are able to stimulate flower growth and strengthen stem conditions in bean plants. In addition, in the flowering phase, gibberellin plays a role in preventing flower shedding.

PGPR can prevent the flowering process in plants because of the presence of rooting bacteria that help plants absorb and meet nutrient needs [31] Rooting bacteria contained in PGPR function to dissolve and increase the availability of phosphorus (P) in the soil which can later be absorbed by plants through the roots. The element P functions as a component of cell membranes, seed formation, reduces fruit loss, stimulates root growth, especially the roots of young plants, accelerates and strengthens the growth of young plants into mature plants while accelerating flowering.

The flowering age is the slowest in the dick treatment (without PGPR) because there is no PGPR given compared to other plant treatments that are absorbed by plant roots, causing the flowering age to be late. P-deficient soils while ultisol soils are very poor in P. The consequences of P deficiency in utilization include physical, chemical and biological properties that are less supportive of soil growth. The pH value, which is usually acidic, and the nutrient content, especially P, which is low due to P diksation are obstacles to plant growth.

Plant Age at Harvest (HST)

The results of variance analysis showed that the application of PGPR was significantly different on the age of upright chickpea plants at harvest. The average harvest age of bean plants can be seen in Table 7.

Table 7. Effect of *Plant Growth Promoting Rhizobacteria* on Plant Age at Harvest (HST)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	68	67	68	67	68	338	68[a]
p1 (10)	64	64	65	64	65	322	65[c]
p2 (20)	64	65	64	64	65	322	63,4[d]
p3 (30)	65	65	66	68	65	329	66[bc]
p4 (40)	67	65	67	67	65	331	66,4[b]
p5 (50)	68	67	65	68	65	333	66,8[b]

The observation of the age of harvest plants gives a very different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the age of flowering plants to be faster in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

Based on (Figure 6) shows that PGPR treatment p2 (20 mL L-1) is the treatment with the fastest age compared to other treatments, namely, 63.4 hst, while the age of plants at harvest is the slowest shown by p0 (0 mL L-1), which is 68 hst. This is because the provision of PGPR with a concentration of p2 (20 mL L-1) in increasing the age of harvest because the bacteria in PGPR stimulate the formation of hormones so that plants are more fertile.

The benefit of PGPR is as a biostimulant (growth regulator) that is useful for the process of growth and fertilization in plants. Gibberellin produced by PGPR is not only useful for flowering in plants, but also helps accelerate the formation of fruit ovules.

In addition to containing gibberellins, PGPR contains phosphorus (P) nutrients that play a role in the pod maturation process. Phosphorus (P) is useful for improving flowering, fruit formation and maturation, seed formation, and accelerating harvest age. In addition to phosphorus (P) from PGPR, phosphorus from the soil is dissolved by Rhizobium contained in PGPR because Plant Growth Promoting Rhizobacteria also produce Rhizobium bacteria that breed in plant roots. Rhizobium bacteria can help dissolve P so that P absorption becomes better.

Number of Pods per Plant (fruit)

The results of variance analysis showed that the application of PGPR was significantly different on the number of pods of upright chickpea plants per plant. The average harvest age of bean plants can be seen in Table 8.

Table 8. Effect of Plant Growth Promoting Rhizobacteria Number of Pods per Plant (fruit)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	28	29	24	24	30	135	25,5[c]
p1 (10)	32	34	29	27	26	148	31,2[b]
p2 (20)	38	37	33	39	33	180	36[a]
p3 (30)	28	28	25	28	29	138	30[b]
p4 (40)	32	28	31	26	31	148	29,6[b]
p5 (50)	29	32	36	32	33	162	29,4[b]

The observation of the number of pods per plant gave a significantly different effect. The application of PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 experienced an increase in the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the number of pods per plant to increase faster in accordance with the addition of PGPR concentrations. Increasing PGPR concentrations of 40 and 50 mL L-1 caused a decrease in the curve.

Based on Table 8, it shows that PGPR treatment p2 (20 mL L-1) is the treatment with the highest number of pods compared to other treatments, namely 36 pods, while the least number of pods is shown by

p0 (0 mL L-1), namely 25.6 pods.

This is due to the presence of gibberellins in the PGPR solution that can help ripen the fruit [38]. Therefore, upright chickpea plants given PGPR averaged more number of pods such as p2 (20 mL L-1), which is (36 pieces), followed by p1 (10 mL L-1), which is (31.2 pieces), p3 (30 mL L-1), which is (30 pieces), p4 (40 mL L-1), which is (29.6 pieces), and p5 (50 mL L-1), which is (29.4 pieces), while the least plant pods in the treatment p0 (0 mL L-1), which is 25.5 pieces.

Besides gibberellins, PGPR also contains phosphorus. Phosphorus is an essential nutrient that plays a role in pod formation. In addition to containing nutrients that can be absorbed by plants, PGPR also contains P-solubilizing bacteria. Pseodomonas sp. and Bacillus sp. bacteria contained in PGPR are useful for absorbing P elements available in the soil to meet the nutrient needs of plants.

High rainfall can cause disease, reduce crop quality and yield components. This is in accordance with the weather conditions at the time of the study. The high rainfall caused some bean pods to rot, so they could not be harvested,

Pod Weight per Plant (g)

The results of variance analysis showed that the application of PGPR was significantly different on the weight of upright chickpea pods per plant. The average harvest age of chickpea plants can be seen in Table 9.

Table 9. Effect of Plant Growth Promoting Rhizobacteria on the Number of Pod Weights per Plant (g)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	14	13	16	18	17	78	17^{c}
p1 (10)	29	18	27	20	14	108	27,2^{b}
p2 (20)	37	29	35	43	24	168	33,6^{a}
p3 (30)	20	29	28	24	17	118	26,4^{b}
p4 (40)	29	23	20	26	27	125	26^{b}
p5 (50)	23	27	29	27	30	136	25,2^{b}

Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that the application of PGPR concentrations of 0, 10, 20 mL L-1 causes an increase in the weight of fresh pods of chickpeas in accordance with the increase in PGPR concentration. Increasing PGPR concentrations of 30, 40 and 50 mL L-1 causes a decrease in the curve. The highest average weight of chickpea pods in treatment p2 (20 mL L-1), which is 33.6 g, while the lowest weight of chickpea pods in treatment p0 (0 mL L-1), which is: 17 g.

Plant Growth Promoting Rhizobacteria contains phosphorus needed by plants during the process of pod and seed formation. In addition to getting phosphorus from PGPR, plants can absorb phosphorus in the soil, because PGPR contains bacteria Pseudomons sp. and Bacillus sp. which play a role in helping plants meet their phosphorus needs. Nutrients from soil and cow dung fertilizer can be dissolved by these bacteria so that plants given PGPR provide better fresh pod weight compared to the control.

Pseudomons sp. and Bacillus sp. bacteria present in PGPR help plants absorb phosphorus by converting these nutrients into soluble and available nutrients for plants. During the pod filling process, the role of nutrients, especially phosphorus, is needed to stimulate fruit and seed formation in plants, the largest period of phosphorus use by plants occurs since pod formation until about 10 days before seeds begin to develop.

Phosphorus is a necessary nutrient in plants, functioning to accelerate the harvest period, stimulate flower growth, and increase flowers into seeds and fruits [44]. Pods that are not perfectly filled are caused by phosphorus deficiency. Lack of phosphorus nutrient causes the pods to form incompletely [45].

CONCLUSION

Based on the results of research on the effect of Plant Growth Promoting Rhizobacteria for bean plant resistance to pests, it can be concluded as follows:

1. The results showed that the application of Plant Growth Promoting Rhizobacteria (PGPR) was able to control pests in upright chickpea plants.

2. The results showed that the best results were at a concentration of 20 mL PGPR L-1 with the lowest pest attack intensity (16.20%), pod attack intensity (0.08%), number of branches (6.4 branches), plant age at flowering (36.2 HST), plant age at harvest (63.4 HST), number of plant pods (36 pieces) and pod weight per plant (33.6 g).

ACKNOWLEDGMENTS

Thank you to Mr. Rosfiansyah, S.P., M.Si., Ph.D. as the first examiner and Dr. Ir. Muhammad Akhyar Roeslan, M.P. as the second examiner who has given direction and input.

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