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The Effect of Planting Distance and Bokashi from Several Types of Organic Fertilizers on the Growth and Yield of Elephant Ginger Variety (*Zingiber Officinale* var. Roscoe)

Desak Ketut Tri Martini[1] ✉
Desak Putu Raka Paramita[2]

(✉ Corresponding Author)

[1]*Faculty of Agriculture, Universitas Udayana, Indonesia.*
Email: dsktrimartini@gmail.com Tel: +62831-1894-069
[2]*Department of Tropical Biology, Universitas Gadjah Mada, Indonesia.*
Email: paramita.raka@gmail.com Tel: +62 857-1337-3013

Abstract

Given the large market opportunity for ginger to meet consumption, it is necessary to seek various methods of increasing production, both in terms of quality and quantity. To achieve these result, ginger production in Indonesia must be expanded, intensified, and diversified in an appropriate and economically sustainable manner. The goal of this study was to see how spacing and bokashi from various organic fertilizers affected the growth and yield of elephant ginger. This experiment used a factorial design with a randomized block design (RBD) of two factors. The first factor is the spacing (J), which has three levels: 40 cm x 20 cm spacing (J1), 40 cm x 30 cm spacing (J2), and 40 cm x 40 cm spacing (J3). The second factor is organic fertilizer bokashi (B), which is made up of four experiments: no bokashi (Bt), pig manure bokashi (Bb), cow dung bokashi (Bs), and green manure bokashi (Bh). The experimental results were statistically analyzed using analysis of variance. Results showed that the interaction effect of distances and the type of bokashi with organic fertilizer has no significant difference (P 0.05) in the growth and yield of elephant ginger. The average net assimilation rate 90-105 dap, as well as the average plant growth rate 75-90 dap were compared. The highest yield of fresh rhizomes per hectare was obtained in the at a 40 cm x 20 cm spacing.

Keywords: Planting distance, Organic fertilizers, Growth, Variance analysis, *Zingiber officinale* var. Roscoe, *Bokashi*

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Ethical: This study follows all ethical practices during writing.

Contents

Contribution of this paper to the literature
This study provided a piece of information about the effect and significance of planting distance and the usage of bokashi on the growth and yield of Elephant ginger variety (Zingiber officinale var. Roscoe).

1. Introduction

The ginger plant (Zingiber officinale var. Roscoe) is a pseudo-stemmed plant that grows upright and belongs to the Zingiberaceae family. The economic value of this plant is found in its rhizome. Whether fresh or processed, Ginger rhizome can be used for various purposes at a low cost [1]. Given the immense market opportunity for ginger to meet consumer demand, it is necessary to seek various production methods, both in quality and quantity. Ginger production in Indonesia must be expanded, intensified, and diversified in an appropriate and economically sustainable manner [2]. Setting the spacing needs to be considered because it is one way to increase the yield of broad unity rhizomes. The spacing is closely related to the plant's need for nutrients and solar radiation. In selecting the spacing, it must be considered that plant competition may occur, especially in nutrients, water, and radiation, which in turn can affect plant growth.

In addition to spacing, fertilization is required to increase ginger yield, which aims to increase soil fertility, specifically in organic fertilizer bokashi, where the addition of organic matter into the soil is required for the life of microorganisms in the soil. Bokashi results from EM4 technology fermenting organic matter (green manure, manure fertilizer, compost, or plant residues), which can then be used as organic fertilizer to fertilize the soil and increase plant growth and production [3].

Plant growth is helped by proper spacing and the application of organic fertilizer bokashi. Although nutrient availability is limited, the spacing between individual plants determines the level of competition. Meanwhile, the use of organic fertilizer bokashi and directly adding nutrients to the soil increases nutrient availability. Plants can thus use the nutrients in the soil to grow.

This study aimed to see how spacing and bokashi from various organic fertilizers affected the growth and yield of elephant ginger. The following hypotheses can be drawn from the objective: setting the spacing at 40 cm x 20 cm will increase the growth and yield of elephant ginger, giving bokashi cow dung can increase the growth and yield of elephant ginger, and the interaction of 40 cm x 20 cm spacing, bokashi, and cow dung can increase the growth and yield of elephant ginger.

2. Material and Methods

2.1. Study Area and Material

This is a paddy field experiment conducted in Pitera Village, Penebel District, Tabanan Regency at an altitude of approximately 500 meters above sea level. 9-month-old elephant ginger rhizome, green manure bokashi, pig manure bokashi, cow dung bokashi, and soil as a planting medium were used. Thiodan 36 BC and Dithane M-45 are used to control pests and diseases. This is a factorial experiment with two factors and a basic randomized block design (RBD).

2.2. Experimental Set Up

The study area is a paddy field experiment conducted in Pitera Village, Penebel District, Tabanan Regency, at approximately 500 meters above sea level. 9-month-old elephant ginger rhizome, green manure bokashi, pig manure bokashi, cow dung bokashi, and soil as a planting medium were used. Thiodan 36 BC and Dithane M-45 are used to control pests and diseases. Data analysis is a factorial experiment with two factors and a basic randomized block design (RBD).

The variables to be observed were as follows:

The number of tillers per clump, the fresh weight of rhizomes per clump, the weight of oven-dry stems per clump, the weight of oven-dry leaves per clump, the weight of oven-dry roots per clump, the weight of oven-dry roots per clump, the weight of oven-dry roots per clump, the weight of oven-dry roots per clump, the weight of oven-dry roots per clump, the weight of oven Clumps, harvest index, wet rhizome yield per hectare, oven-dry rhizome yield per hectare, leaf area index, average swallowed assimilation rate. Average plant growth rates are all variables to consider. At the ages of 75, 90, 105, and 120 days, observations were made regularly.

2.3. Data Analysis

The experimental results were statistically analyzed using analysis of variance. If there is a significant difference (F count> F Table 5% or 1%), the LSD test is used to determine a different treatment [4]. Regression analysis was used to determine the relationship between the various spacing treatments [4]. Correlation analysis was performed to determine the closeness of the relationship between the treatment given and the observed variables or the close relationship between the variables.

3. Result

According to the findings of the statistical analysis, the interaction between plant spacing and organic fertilizer bokashi type (JxB), spacing (J), and bokashi type (B) had a significant effect on the observation variable of the elephant ginger plant.

Table-1. The significance of the interaction effect between planting distance with organic fertilizer bokashi type (JxB) on the observation of elephant ginger's variable

No	Observation Variable	Treatment		
		JxB	J	B
1	Number of tillers per clump (fruit)	ns	**	**
2	Leaf Area Index (ILD)			
	a. Age 75 dap	ns	**	**
	b. Age 90 dap	ns	**	**
	c. Age 105 dap	ns	**	**
	d. Age 120 dap	ns	**	**
3	Average Net Assimilation Rate (LAB)			
	a. Age 75-90 dap	ns	**	**
	b. Age 90-105 dap	*	**	**
	c. Age 105-120 dap	ns	**	**
4	Average Plant Growth Rate (LPT)			
	a. Age 75-90 dap	**	**	**
	b. Age 90-105 dap	ns	**	**
	c. Age 105-120 dap	ns	**	**
5	Fresh Rhizome Weight Per Clump (gram)	**	**	**
6	Fresh Rhizome Yield Per Hectare (ton)	ns	**	**
7	Weight of Oven Dry Rhizome Per Clump (gram)	ns	**	**
8	Yield of Oven Dry Rhizome Per Hectare (ton)	ns	**	**
9	Oven Dry Rod Weight Per Clump (gram)	ns	**	**
10	Weight of Oven Dry Leaves Per Clump (gram)	ns	**	**
11	Weight of Oven Dry Roots Per Clump (gram)	ns	**	**
12	Oven Dry Stable Weight Per Clump (gram)	ns	**	**
13	Harvest Index (%)	ns	**	**

Information:
Note: ns = no significant effect (P> 0.05).
* = significant (P≤0.05).
** = very significant effect (P≤0.01).
dap= days after planting.

According to Table 1, the interaction between plant spacing and organic fertilizer bokashi (JxB has no significant effect (P> 0.05) on most of the observed growth and yield variables of ginger, with the exception of the weight of fresh rhizomes per clump. The average net assimilation rate between 90 and 105 dap, as well as the average growth rate between 75 and 90 dap. The spacing treatment (J) and the organic fertilizer bokashi treatment (B) had a significant (P0.05) to very significant (P0.01) effect on all observed variables.

4. Discussion

Except for fresh rhizome weight per clump, the average net assimilation rate (LAB) of age 90-105 dap, and the average plant growth rate (LPT) of age 75-90 dap, the interaction effect of spacing and organic fertilizer bokashi type (JxB) showed no significant difference (P> 0.05) on most of the observed variables.

By giving bokashi cow dung (Bs) with a spacing of 40 cm x 40 cm (BsJ3), the average weight of fresh rhizomes per clump, the average net assimilation rate (LAB) at 90-105 dap, and the average plant growth rate (LPT) aged 75-90 dap were obtained in the spacing (J) and organic fertilizer bokashi treatment (B), namely 247.56, 0.69, and 0.21 grams. The interaction occurs because the level of competition against light, nutrients, water, and space is lower at the 40 cm x 40 cm spacing and is also supported by cow dung bokashi, which has a higher nutrient content compared to bokashi pig manure and green manure bokashi. As a result, the combined influence appears to affect the growth of the elephant ginger plant positively.

The spacing effect on oven-dry rhizome yield per hectare was highly significant (P0.01). The highest average yield of fresh rhizomes per hectare was at a spacing of 40 cm x 20 cm (J1), namely 20.49 tons or a 36.60 percent and 57.40 percent increase, respectively, over the treatment spacings of 40 cm x 30 cm (J2) and 40 cm x 40 cm (J3). The greater the spacing, the lower the weight of fresh young harvest rhizomes per hectare.

The spacing effect on oven-dry rhizome yield per hectare was highly significant (P0.01). The highest average yield of fresh rhizomes per hectare was at a spacing of 40 cm x 20 cm (J1), namely 20.49 tons or a 36.60 percent and 57.40 percent increase, respectively, over the treatment spacings of 40 cm x 30 cm (J2) and 40 cm x 40 cm (J3). The greater the spacing, the lower the weight of fresh young harvest rhizomes per hectare. Meanwhile, the spacing treatment with rhizome yield per hectare showed a quadratic relationship with the equation Y = 0.0175 X2 - 1.4267 X + 42.009 and a coefficient of determination (R2) of 0.911.

With a high population, there will be maximum utilization of solar radiation at the start of growth to affect the increase in the rate of photosynthesis, and the formation of more dry matter. Furthermore, high yields at denser spacing or higher plant populations per hectare influence the high leaf area index. The increase in population is followed by an increase in shade between plant leaves, as evidenced by the increasing average leaf area index (ILD) with narrower spacing. The average leaf area index (ILD) values at 75, 90, and 105 days after planting were higher at a spacing of 40 cm x 20 cm (J1), i.e., 0.45, 0.50, and 0.61, compared to a spacing of 40 cm x 30 cm (J2), that is 0.40, 0.48, and 0.60, and a spacing of 40 cm x 40 cm (J3), i.e., 0.39, 0.50, and 0.59. The results showed that the plant population at a spacing of 40 cm x 20 cm (J1) is higher than other spacings, because in a dense population, it allows for the best use of light at the beginning of growth. With a high population at the start of growth, there will be maximum utilization of solar radiation to affect the increase in the rate of photosynthesis, and the formation of more dry matter. The high leaf area index is influenced by the high yield at closer spacing. The relationship between fresh rhizome yields per hectare and average leaf area indexes aged 75, 90, 105, and 120 dap (r = 0.645 **, 0.443 **, 0.433 **, and 0.533 **) demonstrates this.

The level of relative competition was the lowest at 40 cm x 40 cm (J3) due to a high number of fresh weight and oven-dry weight of rhizomes per clump at a wider space J3. This resulted in better development of plant organs. The higher average oven-dry weight of roots, leaves, and stems per clump in plants planted with a spacing of 40 cm x 40 cm (J3) demonstrates this. Plant growth, particularly leaf growth, will result in a large leaf area per plant. The presence of numerous leaves, supported by healthy roots and the availability of adequate growth factors, will result in increased photosynthetic activity and photosynthesis. It can be seen from the net assimilation rate and growth rate of plants aged 75-90, 90-105, and 105-120 dap at a spacing of 40 cm x 40 cm (J3), which is relatively higher than the spacings of 40 cm x 30 cm (J2) and 40 cm x 20 cm (J1). Furthermore, good growth will support high yield per plant, as evidenced by the very significant positive correlation between the average net assimilation rate and the average growth rate of plants aged 90-105 and 105-120 dap oven-dry weight of rhizomes per plant. clumps, namely r = 0.330 *, 0.339 * *, and 0.491 * *, 0.483 * *.

Increased average leaf area index (ILD) can improve net assimilation rate (LAB) and plant growth rate (LPT) in plants aged 75-90, 90-105, and 105-120 dap, with the highest average obtained at a spacing of 40 cm x 40 cm (J3). The high LPT was supported by the high average oven-dry leaf weight per clump, oven-dry stem weight per clump, and oven-dry root weight per clump at a spacing of 40 cm x 40 cm (J3), which were 4.56, 3.16, and 3.77 grams, respectively. A significant correlation between oven-dry leaf weight per clump and average plant growth rate (LPT) aged 90-105, 105-120 dap (r = 0.654 * * and 0.585 * *) was found, the weight of oven-dry stems per clump with a plant growth rate (LPT) of 90-105, 105-120 dap (r = 0.670 * * and 0.646 * *) and oven-dry root weight per clump with a plant growth rate (LPT) of 90-105, 105-120 dap (r = 0.592 * * and 0.602 * *). According to Monteith [5] plant growth is equivalent to photosynthesis rate. Meanwhile, the rate of photosynthesis is determined by the amount of light that plants are able to intercept [6]. Plants will produce more dry matter as a result of the relationship between plant growth rate and leaf area index.

The effect of organic fertilizer type bokashi on fresh rhizome yield per hectare was significant (P0.01), as was the effect on oven-dried rhizome yield per hectare (P0.05). Cow dung bokashi (Bs) produced the highest average yield of fresh rhizomes per hectare, namely 19.40 tons, representing an increase of 22.48 percent, 24.74 percent, and 39.70 percent, respectively, when compared to pig manure bokashi (Bb), bokashi green manure (Bh), and no bokashi (Bt). The high weight of fresh rhizomes per clump, which was also obtained in the treatment of cow dung bokashi (Bs), supported the increase in yield of fresh rhizomes per hectare, i.e., 218.79 grams. When compared to pork dung bokashi (Bb), green manure bokashi (Bh), and no bokashi (Bt), the number increased by 19.56 percent, 24.10 percent, and 34.63 percent, respectively. It was demonstrated by a highly significant positive correlation (r = 0.657 * *) between fresh rhizome yield per hectare and fresh rhizome weight per clump. The increased number of tillers per clump aided the increase in fresh rhizome weight per clump. When cow dung bokashi (Bs) was used, the number of tillers per clump increased by 5.25 percent, 27.71 percent, and 40.00 percent, respectively, when compared to pork manure bokashi (Bb), green manure bokashi (Bh), and no bokashi (Bt).) whose respective scores were 4.44, 4.11, and 3.75. It was demonstrated by a highly significant positive correlation (r = 0.838 * *) between the number of tillers per clump and the weight of fresh rhizomes per clump.

Cow dung bokashi (Bs) produced the highest yield of oven-dried rhizome per hectare, namely 0.60 tons, representing an increase of 16.30 percent, 21.67 percent, and 32.54 percent, respectively. In comparison, 0.52 tons of pork manure bokashi (Bb), 0.50 tons of green manure bokashi (Bh), and 0.46 tons of no bokashi (Bt) were produced. The increased oven-dry rhizome yield and fresh rhizome yield per hectare were supported by a 5.29-gram increase in oven-dry rhizome weight per clump in cow dung bokashi (Bs). The number has increased by 7.24 percent, 21.35 percent, and 32.91 percent, respectively, when compared to pork manure bokashi (Bb), bokashi green manure (Bh), and without bokashi (Bt). In the bokashi treatment of cow dung (Bs), the increase in oven-dry rhizome weight per clump was supported by an increase in fresh rhizome weight per clump of 218.79 (r = 0.465 * *).

Increases in the average leaf area index (ILD) of 75, 90, 105, and 120 dap in the treatment of organic fertilizer bokashi (B) influenced the weight of leaves, roots, and oven-dry stems per clump in the treatment of cow dung bokashi (Bs), as well as the height of fresh rhizome weight and oven-dry rhizome weight per clump in the treatment of cow dung bokashi (Bs). As evidenced by a highly significant positive correlation between oven-dry leaf weight per clump and average leaf area index (ILD) at 75, 90, 105, and 120 dap (r = 0.517 **, 0.635 **, 0.724 **, 0.713 * *), there was a significant correlation between oven-dry stem weight per clump and the mean leaf area index (ILD) at 75, 90, 105 and 120 days after planting (r = 0.582 **, 0.668 **, 0.744 **, 0.735 * *), there was a significant correlation between fresh weight of rhizomes per clump and the mean leaf area index (ILD) aged 75, 90, 105 and 120 dap (r = 0.470 **, 0.553 **, 0.504 **, 0.476 **), a significant correlation between oven dry rhizome weight per clump with mean leaf area index (ILD) at 75, 90, 105 and 120 dap (r = 0.681 **, 0.433 **, 0.335 **, 0.470 **).

Increased light interception from a higher leaf area index (ILD) would boost net assimilation. Cow dung bokashi (Bs) had the highest average net assimilation rate (LAB) aged 75-90, 90-105, 105-120 dap of 0.31, 0.69, 0.46 mg/cm2/hr1 or increased respectively to 29.07 percent, 40.82 percent, and 12.20 percent compared to bokashi pig manure (Bb) 34.78 percent, 43.75 percent, 15 percent compared to green manure bokashi (Bh) and 40 (Bt). In addition to the increase in the average leaf area index, the increase in oven-dry leaf weight per clump in the treatment of cow dung (Bs), namely 5.82 grams or in percentage i.e., 48.85 percent, 50.0 percent, and 80.0 percent compared to the provision of green manure bokashi (Bh), was also due to the increase in oven-dry leaf weight per clump in the treatment of cow dung (Bs), namely 5.82 grams or an increase of 48.85 percent (Bt).

The use of bokashi, an organic fertilizer, can help plants grow faster. The increase in plant growth (LPT) rate reflects this. When cow dung bokashi (Bs) was provided, the average plant growth rate (LPT) at the age of 75-90 dap increased by 40 percent, 75 percent, and 110 percent, and the plant growth rate (LPT) at the age of 90-105 dap increased by 40 percent, 75 percent, and 110 percent, respectively. - Compared to the treatment of bokashi pig manure (Bb), bokashi green manure (Bh), and no bokashi, plant growth rate (LPT) aged 105-120 dap increased by 41.38 percent, 51.85 percent, and 95.24 percent, respectively (Bt). Plant growth rates increased by cow dung bokashi (Bs) can increase net assimilation rate and leaf area index.

The amount of dry matter produced by plants increases as the plant growth rate (LPT) increases. Increased leaf weight, roots, stems, and oven-dry stems per clump in the organic fertilizer bokashi treatment also contributed to the increase in average plant growth rate (LPT). Evidenced by a significant correlation between oven-dry leaf weight per clump with the average plant growth rate (LPT) aged 90-105 dap and 105-120 dap (r = 0.654 **, and 0.585 **), a very positive correlation. The oven-dry root weight per clump and the average plant growth rate (LPT) of 90-105 dap and 105-120 dap (r = 0.592 ** and 0.602 **), the positive correlation was very significant between oven-dry weight per clump. clumps with an average plant growth rate (LPT) of 90-105 dap and 105-120 dap (r = 0.670 **, and 0.646 **), and a significant correlation between oven-dry weight per hill plant growth (LPT) 90-105 dap and 105-120 dap (r = 0.652 **, and 0.620 **).

The availability of nutrients required by plants to carry out physiological and biochemical processes in the plant body encourages good vegetative growth. The use of manure can provide macro and micronutrients to plants while also developing the lives of microorganisms in the soil [7]. Furthermore, the presence of these microorganisms is said to accelerate the weathering process in the soil, increasing soil fertility. It is aided by the high organic matter content of manure. Furthermore, bokashi cow manure improves soil physical properties by increasing groundwater buffering capacity, soil water content, soil permeability, and aeration while decreasing the influence of surface runoff and erosion.

Cow dung bokashi can increase yield due to cow dung's high organic matter content in the soil. Cow dung fertilizer contains more nutrients than pig and green manure, particularly nitrogen content, where the nitrogen content in the experimental soil is shallow, requiring plants to rely heavily on cow dung bokashi. Nitrogen is required to produce amino acids, the formation of proteins, the formation of new cells, cell division, cell enlargement, tissue growth, stem elongation, leaf growth, and vegetative growth in general—nitrogen aids in forming leaf chlorophyll molecules, which serve as a platform for the photosynthesis process. The activity level of microorganisms in each treatment varies due to differences in chemical composition or nutrient content in the organic matter [8]. Moreover, variations in the activity of these microorganisms will affect the rate of carbon dioxide release and the organic compounds produced.

Giving bokashi can boost the population of beneficial microorganisms in the soil to the point where it outnumbers harmful microorganisms. With this dominant population, these microorganisms will play a more significant role in organic matter decomposition and increase the availability of nutrients that plants can use to grow.

5. Conclusion and Suggestion

Based on the results and discussion, it is possible to conclude that the interaction between plant distance and organic fertilizer type has no significant effect on all observation variables of elephant ginger, with the exception of fresh rhizome weight per clump. The average net assimilation rate (LAB) is 90-105 dap, with a 75-90 dap plant growth rate. Cow dung bokashi yields the highest fresh rhizome yield per hectare. Elephant ginger has a high growth rate of about 20.5 percent. The yield of oven-dry rhizomes increased by 36.60 percent, 57.40 percent, and 33.20 percent, 60.33 percent when compared to spacings of 40 cm x 30 cm and 40 x 40 cm.

The discussion and conclusions that have been described can be given and or with a spacing of 40 cm x 20 cm to obtain high yields of elephant ginger and cow dung bokashi. As a consideration, more research should be conducted, paying special attention to the dose of bokashi cow dung used and the treatment of narrower spacing on the same land conditions.

References

[1] F. B. Paimin and Murhananto, *Cultivation, processing, ginger trade*. Jakarta: Penerbit Penebar Swadaya, 1991.

[2] H. B. Santoso, *Elephant ginger*. Yogyakarta: Kanisius, 1994.

[3] G. J. Umpel, *Experience of effective microogranism technology application*. Jakarta: National Seminar on Agriculture, 1997.

[4] I. M. N. Tenaya, "Determining the optimal population using the fan design method on cabbage in lowlands," Scientific Report, Faculty of Agriculture, Udayana University, Unpublished, 1986.

[5] J. L. Monteith, "Climate and the efficiency of crop production in Britain," *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, vol. 281, pp. 277-294, 1977.Available at: https://doi.org/10.1098/rstb.1977.0140.

[6] B. L. Siregar, "Effect of population level and nitrogen dosage on growth and production of ginger (Zingiber officinale Rosc.)," Rhino Harvested Young, Scientific Report, Faculty of Agriculture, Bogor Agricultural University (IPB)1991.

[7] M. M. Sutedjo and A. G. Kartosapoetra, *Fertilizer and fertilization methods*. Jakarta: PT Bina Aksara, 1988.

[8] W. Agata, "The characteristics of dry matter and yield production in sweet potato under field conditions," in *Sweet Potato-Proceedings of the First International Symposium, R.E. Villareal and T.D. Griggs, Eds. Taiwan: AVRDC*, 1981, pp. 119–127.