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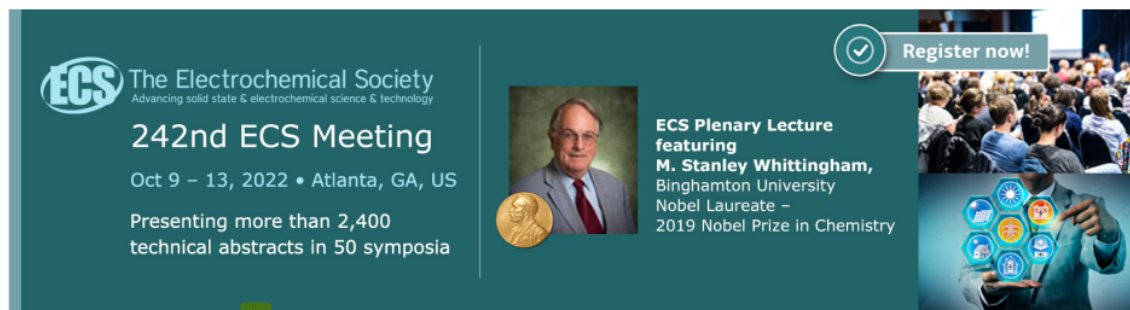
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Growth and production of three chili varieties with liquid organic fertilizer application

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Abstract. This study aimed to determine the best concentration of liquid organic fertilizer on the growth and production of three chili varieties. An experiment was conducted with a Split Plot Design. The first factor was the seed variety, namely the variety of Dewata, Bara, and Maruti. The second factor was the concentration of SNN liquid organic fertilizer with a concentration of 0 cc L⁻¹, 3 cc L⁻¹, 4 cc L⁻¹, 5 cc L⁻¹. The results showed that the Liquid Organic Fertilizer treatment affected several observed parameters. The Maruti variety had the highest plant height of 59.39 cm and was significantly different from the other treatments, the flowering age parameter also showed that the Maruti variety showed an average the average age of the fastest flowering was at age 52.08 day after planting and significantly different in other treatments. The fruit length parameter showed that Bara variety has the longest fruit length (1.48 cm) and was significantly different from other treatments. There was an interaction between liquid organic fertilizer with seed varieties on the parameters of production with the highest production per hectare was achieved by the dose of 5 cc L⁻¹ liquid fertilizer and Maruti varieties. The value was 1 ton per hectare.

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1. Introduction

The production of chili in Indonesia tends to increase since 1980-2014 along with the increase in harvested area, but the supply tends to fluctuate due to irregular peak harvest time each year [1]. The area of chili in Indonesia in 2017 was 167,600 ha with a production of 1,153,159 tons and productivity of 6.88 tons ha⁻¹. Based on the statistics [2], the harvested area of chili in South Sulawesi in 2017 was 6,009 ha with a total production of 45,770 tons and productivity of 7.62 tons ha⁻¹. [3] The productivity of chili is still far from its potential which can reach 10 tons ha⁻¹. The problem that is currently common for farmers is crop failure. Harvest failure could be the result of several constraints, especially low levels of soil fertility, use of local varieties, pest and disease occurrence and high water evaporation caused by air temperatures so that the production of chili is still relatively low [4].

Efforts to improve yield of chili can be carried out by intensification. It intends to increase the production through best practice of fertilizer application. The application of fertilizer aims to increase the availability of nutrients in the soil. One type of fertilizer that is highly recommended in farming is organic fertilizer. The use of organic fertilizers has a great influence on the physical, biological and chemical properties of the soil. Therefore the provision of organic fertilizer is considered very supportive in efforts to increase the productivity of agricultural crops [5].

According to Surtinah [6], the recommended concentration of liquid fertilizer for chili is 30 cc/10 liters of water, 40 cc/10 liters of water and 50 cc/10 liters of water. These are equal to 3 cc L⁻¹ of



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water, 4 cc L⁻¹ of water and 5 cc L⁻¹ of water. The content of macro and micro essential nutrients contained in liquid organic fertilizer include N (25%), P (25%), K (5%), Mg, S, Ca, Fe, Na, Zn, Cu, Mn, B, Cl, and other elements with complete composition that meet the needs of plants in their growth.

In addition to the use of liquid organic fertilizer, the use of a superior variety is also essential to increase the production of chili. Varieties according to Harpenas & Dermawan [7] that worth to try in order to increase production include Dewarta, Bara, and Maruti. Apart from high productivity potential, they are also resistant to bacterial wilting. Bara variety is a type of chili that has broad adaptation, can be planted in the lowlands to highlands, has upright plant stems with many branches. The color of the green fruit is easily shiny, when ripe, the shiny red and maruti varieties have high productivity and are resistant to the yellow virus.

1.1. Dewata variety

The Dewata variety is a hybrid chili that is recommended to be planted in low to high lands with an altitude of 10-1,300 masl. Paddy growth type, yield potential between 0.6-0.8 kg per plant. One kilogram has 400-450 chilies with an average size of 5-6 cm long with a diameter of 0.6-0.7 cm. Harvest age varies according to the altitude, the average between 65-75 days after planting [8].

Dewata can be harvested in three levels of maturity with three different colors marked. light color (yellow) half done (orange) and ripe (bright red). Leaves are oval with the not jagged edge. The tip of the leaf is pointed. The number of crowns are 5-6 strands, with purple-blue stamen and yellow pistil. Fruit is elliptic with smooth shiny surface [8].

1.2. Bara variety

The Bara variety is a high quality variety that has the advantage of being a fast and very productive nature. This chili is ideal for low-altitude area. The characteristics of this chili are quite easily known by its upright growth and many branches. The fruit is erect and dense with bright green color, glossy and is very spicy [9].

Yield potential between 0.4-0.6 kg per plant. One kilogram has 500-600 chilies with an average size of 3-4 cm long with a diameter of 0.5-0.6 cm. Harvest age varies according to the altitude, the average between 90-105 days after planting. Bara has medium resistance to bacterial wilt caused by *Pseudomonas solanacearum* [9].

1.3. Maruti variety

Maruti is a hybrid chili which can adapt well in medium land with an altitude of 200-775 masl. The number of fruits per plant is 300-400 and they are easy to pick. The young chili is yellowish green and turn solid red when ripe. This chili can be harvested at the age of 85-90 days after planting with a fruit length of 5.6 - 6.5 cm and a diameter of about 1 cm. It has potential yields of 2.5 - 3 tons per hectare. [10].

2. Methodology

The experiment was arranged with a split plot experimental design with a factorial pattern. The experimental design consisted of two factors: the liquid fertilizer (P) as the main plot consisting of: no liquid fertilizer application (P0), concentration of 3 cc L⁻¹ of liquid fertilizer (P1), concentration of 4 cc L⁻¹ of liquid fertilizer (P2), and Concentration of 5 cc L⁻¹ of liquid fertilizer (P3). The second factor was the variety (V) as the sub plots consisting of three levels: Dewata variety (v1), Bara variety (v2), and Maruti variety (v3).

2.1. Plot preparation

The land is cleared of the weeds, then as many as 36 plots were prepared. The size of each plot was 300 cm x 200 cm, the height of the plot was 25 cm and the distance between the plots was 50 cm. The plots were prepared for plant spacing of 50 x 60 cm, hence 15 plants could be planted per plot, making

a total of 540 plants population. Basic fertilizer i.e. 130 kg compost per plot was applied. The plots were left for about 2 weeks before planted.

2.2. Seeds selection and preparaton

The chili seeds were soaked in water for 5-10 minutes. The sinking seeds were taken and then transferred to a polybag that has been previously filled with soil media added with chicken manure, all polybags that have been filled with chili seeds are stored in a place that is not exposed to direct sunlight regularly. Selected seeds were those that grow uniformly and healthy. After 30 days seedlings were then transferred to the plots of the planting site and planted in a 10 cm-deep hole.

3. Liquid fertilizer application

The application of liquid organic fertilizer was performed by spraying it into the plant in accordance with the treatments. First application was one week after transplantation (WAT) with an interval of application once a week until just before harvest time.

3. Result

3.1. Plant height at 28, 72 and 86 DAT

Based on observation of plant height at age 28, 72 and 86 DAT, it was found that the treatment of variety (v) had very significant effect, whereas the treatment of liquid fertilizer concentration (P) and the interaction did not significantly affect the height of the chili plant.

Table 1. Average plant height of 58 DAT of various chili varieties at several concentrations of liquid organic fertilizer application.

Liquid fertilizer	Variety			Average
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	32.67	43.33	46.67	40.89
P1	33.78	44.34	46.55	41.56
P2	38.89	36.00	54.00	42.96
P3	36.22	37.22	58.78	44.07
Average	35.39 ^b	40.22 ^b	51.50 ^a	
SD 0.05%	8.36			

Notes: The numbers followed by the same letters in lines (a, b) are not significantly different in the LSD test with a confidence level of 0.05.

Table 1 shows the highest average plant height was achieved by the Maruti Variety (v3) i.e. 51.50 cm and significantly different from the other treatments.

Table 2. Average plant height of 72 DAT of various chili varieties at several concentrations of liquid organic fertilizer application.

Liquid fertilizer	Variety			Average
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	33.89	51.11	52.00	45.67
P1	37.22	48.66	51.89	45.93
P2	41.44	43.78	59.45	48.22
P3	38.00	44.44	64.89	49.11
Average	37.64 ^c	47.00 ^b	57.06 ^a	
LSD 0.05%	8.36			

Notes: The numbers followed by the same letters in lines (a, b, c) are not significantly different in the LSD test with a confidence level of 0.05.

Table 2 shows the highest average plant height was achieved by Maruti Variety (v3) i.e. 57.06 cm and significantly different from the other treatments

Table 3. Average plant height of 86 DAT of various chili varieties at several concentrations of liquid organic fertilizer application.

Liquid fertilizer	Variety			Average
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	38.67	52.22	54.55	48.48
P1	37.89	50.44	55.33	47.89
P2	42.00	45.89	61.00	49.63
P3	38.44	45.78	66.67	50.30
Average	39.25 ^c	48.58 ^b	59.39 ^a	
LSD 0.05%	8.59			

Notes: The numbers followed by the same letters in lines (a, b, c) are not significantly different in the LSD test with a confidence level of 0.05.

Table 3 shows the highest average plant height was achieved by Maruti Variety (v3) i.e. 59.39 cm and significantly different from the other treatments

Based on the observation of plant height at the age of 58, 72 and 86 DAT, it can be seen that there are significant differences among several varieties of chili on plant height at each time of observation.

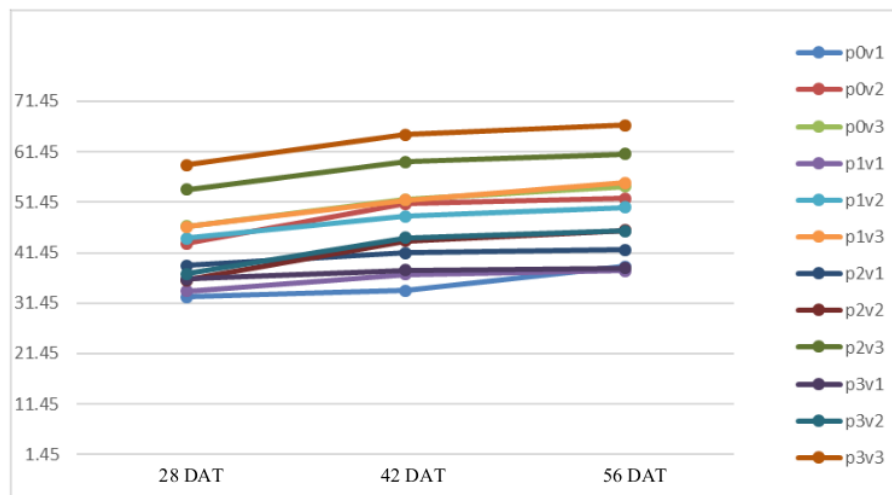


Figure 1. Graph of plant growth per week in the concentration of liquid organic fertilizer (p) and several plant varieties (v).

Figure 1 shows that the p3v3 treatment gave the best plant height growth compared to the other treatments at each time of observation. Whereas the p3v1 treatment gave the smaller increase in plant height at each time of observation compared to other treatments.

3.2. Flowering Age

The results of variance indicate that the variety (V) has a very significant effect, while the liquid fertilizer (P) and interactions did not significantly affect the flowering age the chili.

Table 4. Average Flowering Age of various chili varieties at several concentrations of liquid organic fertilizer

Liquid fertilizer	Variety			Average
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	57.67	62.67	54.00	58.11
P1	55.00	63.67	47.67	55.55
P2	55.67	65.67	53.67	58.33
P3	55.00	60.67	53.00	56.22
Average	55.83 ^b	63.17 ^a	52.08 ^c	
LSD 05%	2.65			

Notes: The numbers followed by the same letters in lines (a, b, c) are significantly different in the LSD test with a confidence level of 0.05.

Table 4 shows the fastest flowering achieved by Maruti variety (v3) i.e. at the age of 52 DAT and significantly different from other treatments.

3.3. Harvest time

The results of statistical analysis showed that the treatment of varieties (V), treatment of POC (P), and interactions did not significantly affect the time of the harvest.

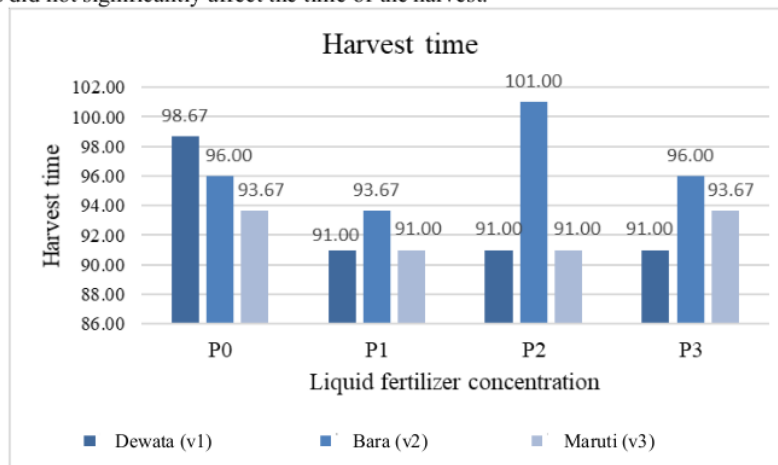


Figure 2. Graph of harvest time by application of several liquid fertilizer concentration (p) and three plant varieties (v)

Figure 2 shows that the concentration 40 cc of liquid organic fertilizer (p3) on Dewata (v1) and Maruti (v3) varieties tended to achieve the fastest harvest time i.e. 91.00 DAT. Whereas at the concentration of 40 cc liquid organic fertilizer (p2) on the varieties of Bara (v2), it tended to obtain a longer harvest time of 101.00 DAT.

3.4. Fruit length

Statistical analysis showed the variety (V) had a very significant effect, while the concentration of liquid fertilizer (P) and the interaction did not significantly affect fruit length.

Table 5. Average length of chili fruit in various varieties of chili at several concentrations of liquid organic fertilizer

Liquid fertilizer	Variety			Average
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	20.81(1.29)	62.53(1.79)	12.64(1.12)	32.00(1.40)
P1	10.76(1.07)	37.06(1.47)	10.18(1.03)	19.33(1.19)
P2	20.47(1.21)	23.96(1.29)	16.10(1.21)	20.17(1.24)
P3	14.84(1.17)	31.68(1.37)	15.09(1.20)	20.54(1.25)
Average	16.72(1.19) ^a	38.81(1.48) ^b	13.50(1.14) ^a	
LSD (5%)	12.54 (0.18)			

Notes: The numbers followed by the same letters in column (a, b) are significantly different in the LSD test with a confidence level of 0.05. (In brackets are transformed values)

Table 5 shows the longest average fruit length was achieved by the Bara Variety (v2) i.e. 1.48 cm and significantly different from the other varieties.

3.5. Yields per plant

Analysis of Variance showed that the concentration of liquid organic fertilizer (P) and the three chili varieties (v) as well as its interaction had no significant effect on the production of chili per plant.

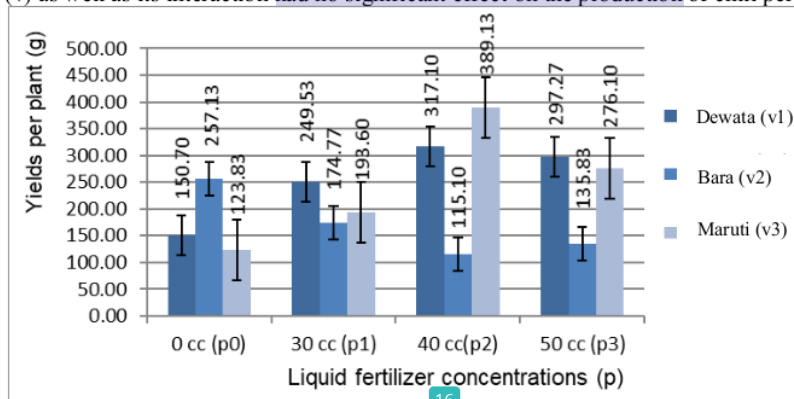


Figure 3. Production of chilies per plant (g) with the treatment of liquid organic fertilizer (P) and three chili varieties (v)

Figure 3 shows that the concentration 40 cc liquid organic fertilizer and Maruti variety (p2v3) tended to show the highest production of chilli fruit per plant which was 389.13 g, while the concentration of 40 cc liquid organic fertilizer and Bara (p2v2) tended to have the least fruit production per the plant i.e. 115.10 g.

3.6. Productivity (Yields per hectare)

Analysis of variety shows that the treatment of liquid organic fertilizer (P) and the three varieties (v) as well as its interactions had a significant effect on the chili production of per hectare.

Table 6. The average production of chili per hectare at several concentrations of liquid organic fertilizer and three varieties of chili.

Liquid fertilizer	Variety			LSD 0.05%
	Dewata (v1)	Bara (v2)	Maruti (v3)	
P0	0.4(1.17) _b ^y	0.6(1.28) _a ^x	0.4(1.20) _b ^y	0.16
P1	0.9(1.39) _a ^x	0.4(1.20) _a ^y	0.5(1.23) _b ^y	
P2	0.7(1.28) _{ab} ^x	0.7(1.30) _a ^x	0.8(1.32) _{ab} ^x	
P3	0.5(1.22) _b ^y	0.5(1.23) _a ^y	1.0(1.43) _a ^x	
LSD 0.05%	0.15			

Notes: The numbers followed by the same letters in column (a, b) are significantly different in the LSD test with a confidence level of 0.05. (In brackets are transformed values)

The average production of chili per hectare in Table 6 shows the highest average value of 1.43 (1.43) tons/ha in the treatment of 50 cc of liquid organic fertilizer and Maruti Variety (p3v3) which is significantly different from the other treatments.

4. Discussion

The results of variance indicate that the interaction between the liquid fertilizer and the variety significantly influences the production of chili per hectare, but it did not significantly affect other parameters. This situation could be an indication that the liquid fertilizer and the variety factor can be mutually together as individual factor in influencing the growth and yield of chili plants. As explained by Gomez & Gomez [11] that the two treatment factors are said to interact when the influence a treatment factor changes when the level of another treatment factor changes. Furthermore it was stated by Steel & Torrie [12] that if the effect of different interactions was not real, it was concluded that among the treatment factors acting independently of one another. This incident was caused because during the growth and development of chili plants there were different growth phases of intensity, so that nutrient requirements during the process were also different or not in the same amount.

The results of variance showed that liquid organic fertilizer treatment did not significantly affect several parameters of observation. The effect of liquid organic fertilizer as a whole was not significant on the growth and production of chili. This was due to environmental conditions that are less than optimal so that the influence of microorganisms becomes ineffective (very long drought during experiment period). Tjandra [13] stated chili plants are sensitive to insufficiency of water because the root system is shallow. Water insufficiency will inhibit the process of nutrient absorption needed by plants.

The results of variance showed that chili varieties significantly affected the parameters of observation of plant height and fruit length, but did not significantly affect other parameters. Further test results on plant height parameters showed that Maruti varieties produced the highest average chilli plant height (59.39 cm) and significantly different from the Dewata (39.25 cm) and Bara (48.58 cm). This is in line with the description of each variety based on the Ministry of Agriculture data. However, the results of this study have not been able to reach the potential characteristics of plant height of each variety, this is due to environmental factors which occur during planting to harvest i.e. persistent drought which presumably inhibiting the plant growth. Syukur [14] described high temperatures during the day to be the reason plants to wither and flowers to fall.

Flowering time parameters found the maruti to give the fastest flowering time (33.92 DAT) and significantly different from the Dewata (35.83 DAT) and Bara (39.92 DAT). It is in accordance with the description of each variety based by the Ministry of Agriculture data base.

Bara variety had the longest chili length (1.48 cm) and differed significantly from the Dewata (1.19 cm) and Maruti variety (1.14 cm). This study has not been able to achieve the potential characteristics of the fruit length of each variety. This is due to the flowering and fruit formation phases where water

availability was limited as Riadi [15] emphasized that low rainfall can cause stunted chili plant growth and can affect fruit size. The intensity of good rainfall for plant growth is 600-1250 mm per year.

5. Conclusion

There was one variety with several observational parameters that provide better growth and chili production. Plant height showed the variety of Maruti (v3) to have the best plant height (59.39 cm) and was significantly different from other varieties, Flowering time parameters showed Maruti (v3) to give the fastest flowering time (52 DAT) and significantly different from other varieties. The fruit length parameter showed that the Bara variety (v2) had the longest fruit (14.48 m) and was significantly different from others. There was an interaction between the treatment of liquid organic fertilizer with varieties on the growth and production of chili per hectare.

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