Effect Of Cutting Materials And Fertilizers on Yield Of Terubuk (*Saccharum Edule* Hasskarl)

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ABSTRACT

The objectives of the research were to determine the effect of cutting material and planting position and effect of fertilization on terubuk production. Two experiments were conducted from December 2007 to December 2008 at SANREM Experimental Station in Nanggung, Leuwiliang and Cikabayan, Darmaga-Bogor. First experiment was arranged in Completely Randomized Block Design with two factors (number of nodes: one, two, and three nodes; cutting position: horizontal and vertical). In the second experiment, the design was based on Completely Randomized Block Design with one factor (fertilization: control, manure, inorganic fertilizer, manure + inorganic fertilizer). First experiment showed that number of nodes in cutting and the interaction with planting position increased number of bud formation and the weight of flowers. Second experiment showed that the fertilization with manure and NPK increased plant height, weight and diameter of flower significantly compared to that of the control.

INTRODUCTION

Terubuk (*Saccharum edule* Hasskarl) is one of indigenous vegetables (Anonymous, 2007). Based on harvested part, terubuk is classified as flower vegetable. Terubuk or telur terubuk has not been known widely or limitedly known in West Java area. It is not planted extensively (not in a large area) and intensively, so that the supply in the market is not continuous. It is considered quite expensive (Rp 1000-1500/ flower). The flower is favorite vegetable if available in the market. Since it is a high value vegetable, an intensive cultural practice is needed to give continuous supply.

Terubuk is propagated vegetatively by stem cutting. According to Wudianto (2002) from stem cutting, complete plant possessing root, stem, and leaves can be obtained rapidly. Factors affecting the success of cutting are stem position at mother plant, cutting age, and media. Setiyawan (2000) stated that 3-node cutting gave significant on number of shoot of bamboo 'Ampel Hijau'.

In crop production, fertilizers are among the most important factors affecting yield. Leiwakabessy dan Sutandi (2004) stated that the objective of fertilization was to improve soil fertility through addition of macro and micro

nutrients for growth and development of plants. Addition of nutrients are possible through organic and inorganic fertilizers. Khaliq *et al.* (2006) reported that addition of organic matter and NPK fertilizer increased 14 % of cotton production. Addition of manures improved soil structure and nutrients. Application of organic matter increased yield of sugarcane significantly (Yadav, 1995). Report by Sanjaya (2002) also showed that manure application increased vegetative growth, number and weight of sweet corn ear.

Nitrogen plays an important role on vegetative growth. It also increase number of roots in cutting. Suryanto (1999) reported that addition of N fertilizer increases yield of broccoli florets. According to Kano *et al.* (2007), nitrogen application increased glucose and fructose content in cabbage cells.

Potassium has role in physiological process and resistance to diseases. Results of Sanjaya (2002) showed that application of K fertilizer in sweet corn increased number and weight of ear and increased sweetness. Komariah (2007) reported that application of urea (N), SP-36 (P) dan KCl (K) increased height (214.43 cm), weight of ears with sheath (3.86 ton/ha) and ear without sheath (1.89 ton/ha) of baby corn.

The objectives of the research were to determine (1) effect of node number and planting position (2) effect of manure, urea, SP36, KCl on growth and yield of terubuk.

MATERIALS AND METHOD

Experiment 1. Number of Nodes and Planting Position

The experiment was conducted in SANREM Station, Nanggung, Leuwiliang from Desember 2007-August 2008. Altitude is 308 m above sea level. Soil on the site is red-yellow podzolic and soil pH is 4.2. Materials used in the experimets were stem cuttings of terubuk (*Saccharum edule* Hasskarl) 1-node, 2-nodes and 3-nodes. Cuttings were planted in a plot size of 4 m x 1 m with spacing 50 cm x 30 cm. Soil was prepared and fertilized with chicken manure 3 kg/plot (or 7.5 ton/ha). Cuttings were planted horizontally or vertically depending on treatments.

A randomized block design was the experimental design in experiment on number of nodes and planting position. The first factor consisted of three levels: 1-none, 2-node, 3-node cutting and the second factor was planting position: cutting was planted horizontally or vertically. The experiment was replicated three times.

Experiment 2. Fertilizer Experiment

The experiment was conducted in University Farm, Cikabayan, Darmaga, Bogor from April to December 2008. Altitude of the site is 200 m above sea level. Soil type is latosol with pH 4.8. Two-node stem cuttings were planted horizontally in plot size of 4 m x 1 m. Soil has previously been prepared in beds. Plant spacing was 50 cm x 30 cm.

Four fertilizer treatments (Table 1) were (1) control/without fertilizer (P0), (2) chicken manure (P1), (3) N,P,K (in the form of urea, SP-36, and KCl) (P2) and (4) chicken manure + N, P, K (P3). The manure was applied at 2 kg/ plot or 5 ton/ha a week before planting. SP-36 (150 g/plot P_2O_5 or 135 kg/ha) was applied at planting time. Urea and KCl were applied at 87 g/plot (N 100 kg/ha) and 90 g/plot (K_2O 135 kg/ ha) where 50% was given 2 weeks after planting (WAP) and 50% was given 6 WAP. The experimental design was randomized block design with three replicates.

Table 1. Dosage of fertilizer treatments

Treatment	Manure (g/plot)	Urea (g/plot)	SP36 (g/plot)	KCl (g/plot)
P0	-	-	-	-
P1	2000	-	-	-
P2	-	87	90	150
P3	2 000	87	90	150

Maintenance consisted of irrigation, plant replacement, weeding, pest aand disease control. Furadan 3G was applied to prevent termite. Harvest was started in the fifth or sixth month. The plant part harvested was flower enclosed by sheath. Observation was conducted on the following variables: plant height, number of shoots, number of flowers, flower weight, diameter and length, and harvest time. Plant height and number of shoots were observwd on 5 samples per plot. Flowers were graded according to the following:
Grade A: flower length > 10 cm
Grade B: flower length 8.0 cm - 10.0 cm
Grade C: flower length < 8.0 cm.

RESULTS AND DISCUSSION

During the experiment, climate data taken from Climatology Station in Darmaga, Bogor showed that monthly average temperature was 25.5 ^{0}C and average relative humidity was 84.4 %. Average monthly rainfall in Leuwiliang was 208.57 mm, while in Darmaga was 303.13mm. Terubuk grows well at temperature 20-30^{o}C, and annual rainfall 1800-2500 mm (http://ecocrop.fao.org). Pests found during terubuk planting were termites and grasshoppers. Use of young stem cuttings and application of Furadan 3G was to control pests. Disease found was 'karat' with symptom yellow brownish spot on leaves. The symptom was also found on flowers. However, the level of infestation was small.

Experiment 1. Number of Nodes and Planting position

Planting position did not affect shoot number. Number of nodes affected number of shoots in 3, 4, 6 and 10 weeks after planting (WAP) but the effect was not significant in other weeks. At 10 WAP, 3-node cutting gave 4.2 shoots, higher than 1-node cutting (2.8 shoots) (Table 1).

Table 1. Number of shoots as influence by node number and planting position

Treatment	**WAP**							
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1 Node	1.40 b	1.5b	1.6	1.8b	1.9	2	2.3	2.8b
2 Nodes	1.69 ab	1.7ab	1.7	1.9ab	2.3	2.8	3.3	4.0ab
3 Nodes	2.01a	2.0a	2.2	2.3a	2.5	2.8	3.4	4.2a
F Test	**	*	Ns	*	ns	ns	ns	*
Vertical	1.89 a	1.7	1.8	1.9	2.2	2.4	3	3.5
Horizontal	1.71a	1.8	1.9	2.0	2.2	2.6	3	3.9
F Test	ns	Ns	Ns	ns	ns	ns	ns	ns

Interaction	ns	Ns	Ns	ns	ns	ns	ns	ns

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*) ; ns: not significant

Three-node cutting gave higher number of shoots than other cutting materials. In 3-node cuttings, food resource is higher than that in other cutting materials. In addition, the more the nodes, the more the possibility of shoots emerge from the nodes. Belehu dan Hammes (2004) reported that 3-node cuttings of sweet potato gave more shoots than 1-node cuttings. Number of nodes, planting position, and node-planting position interaction did not affect plant height (Table 2). Similar result was reported by Setiyawan (2000) on bamboo 'Ampel Hijau'.

Tabel 2. Plant height of terubuk

Treatment	WAP							
	3	4	5	6	7	8	9	10
1 Node	15.8	21.5	28.9	34.5	38.9	42.8	47.1	54.9
2 Nodes	16.5	23.7	28.5	33.1	36.7	39.9	47.1	54.9
3 Nodes	18.5	23.1	28.6	33.8	37.2	44.3	49.8	58.3
F Test	ns	ns	ns	Ns	ns	ns	ns	ns
Horizontal	17.4	22.9	28.2	34.3	39.1	43.9	50.6	58.7
Vertical	16.5	22.7	29.2	33.2	36.1	40.7	45.4	53.4
F Test	ns	ns	ns	Ns	ns	ns	ns	ns
Interaction	ns	ns	ns	Ns	ns	ns	ns	ns

Note: ns: not significant

Based on Table 3, number of nodes significantly affected number of flower. Cutting with 3 nodes yielded the highest number of flower, i.e 85.2 flowers, while 2-node cutting yielded 76.0 flowers. Three-node cutting showed highly significant effect on both weight of flower with and without sheath (Table 3 and Table 4). The 3-node cutting yielded 4992.6 g flowers with sheath /4 m^2 (4.16 ton/ha) and 899.5 g flower without sheath /4 m^2 (0.75 ton/ha). Three-node cutting treatment yielded 4093.2 g flower's sheath/m^2 (Tabel 5).

Table 3. Number of flower and weight of flower with sheath of terubuk

Treatment	Flower number	Weight of flower with sheath	
		g/4 m^2	ton/ha
1 Node	56.2b	2912.5b	2.43b
2 Nodes	76.0a	4446.7a	3.71a
3 Nodes	85.2a	4992.6a	4.16a
F Test	**	**	**
Horizontal	73.7	4314.7	3.60
Vertical	71.2	3919.8	3.27
F Test	ns	ns	ns

Interaction	ns	ns	ns

Note: Different letters following values in the same column means significant different according to HSD at 1 % level (**)

Table 4. Weight of flower without sheath of terubuk

Treatment	Weight of flower without sheath	
	g/4 m^2	ton/ha
1 Node	405.2b	0.34b
2 Nodes	677.9a	0.56a
3 Nodes	899.5a	0.75a
F Test	**	**
Horizontal	697.9	0.58
Vertical	623.8	0.52
F Test	Ns	ns
Interaction	Ns	ns

Note: Different letters following values in the same column means significant different according to HSD at 1 % level (**)

Table 5. Weight of flower's sheath of terubuk

Treatment	Weight of flower's sheath	
	g/4 m^2	ton/ha
1 node	2507.3b	2.09b
2 nodes	3768.8a	3.14a
3 nodes	4093.2a	3.41a
F test	**	**
Horizontal	3616.8	3.01
Vertical	3296.0	2.75
F test	Ns	ns
Interaction	Ns	ns

Note: Different letters following values in the same column means significant different according to HSD at 1 % level (**)

Flower development related to nutrition uptake by plants. The higher the number of nodes, the higher food resources can be found which induced the higher number of root and number of shoots. More roots improved nutrition uptake. The condition increased vegetative and reproductive growth and development. In terubuk, one shoot will become one mature plant and yielded one flower. Therefore, the higher the number of shoots produced by the cutting, the more flower emerged. This means the higher yield of terubuk per hill and leads to earlier harvest time.

Percentage of weight of terubuk flower without sheath to weight of flower with sheath in 3-node cutting (17.8%) was higher than those yielded by 1-node and

2-node vuttings (13.9% and 15.8%, respectively). The results indicated that photosyntate partition to edible part was higher in 3-node cutting than in 1-node or 2-node cuttings (Tabel 6 and Table 7).

Table 6. Percentage of weight of flower's sheath to flower with sheath.

Treatment	Horizontal	Vertical
	----- % -----	
1 Node	86.1a	86.1a
2 Nodes	84.2ab	85.4ab
3 Nodes	82.2b	81.7b
Interaction *		

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*)

Tabel 7. Percentage of weight of flower without sheath to flower with sheath

Treatment	Horizontal	Vertical
	----- % -----	
1 Node	13.9b	13.9b
2 Nodes	15.8ab	14.6ab
3 Nodes	17.8a	18.3a
Interaction *		

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*)

Harvest time period in terubuk started at 25 WAP up to 40 WAP (Figure 1). The first harvest was done at 25 WAP in plants originally from 3-node cutting treatment. Harvest time of plants from 2-node cutting started at 26-27 WAP, while for plants from 1-node cutting started at 28-29 WAP. It is apparent from Figure 1, that in 3-node cutting treatment the harvest's peak and the highest flower weight were obtained from 31 WAP to 33 WAP (Figure 1).

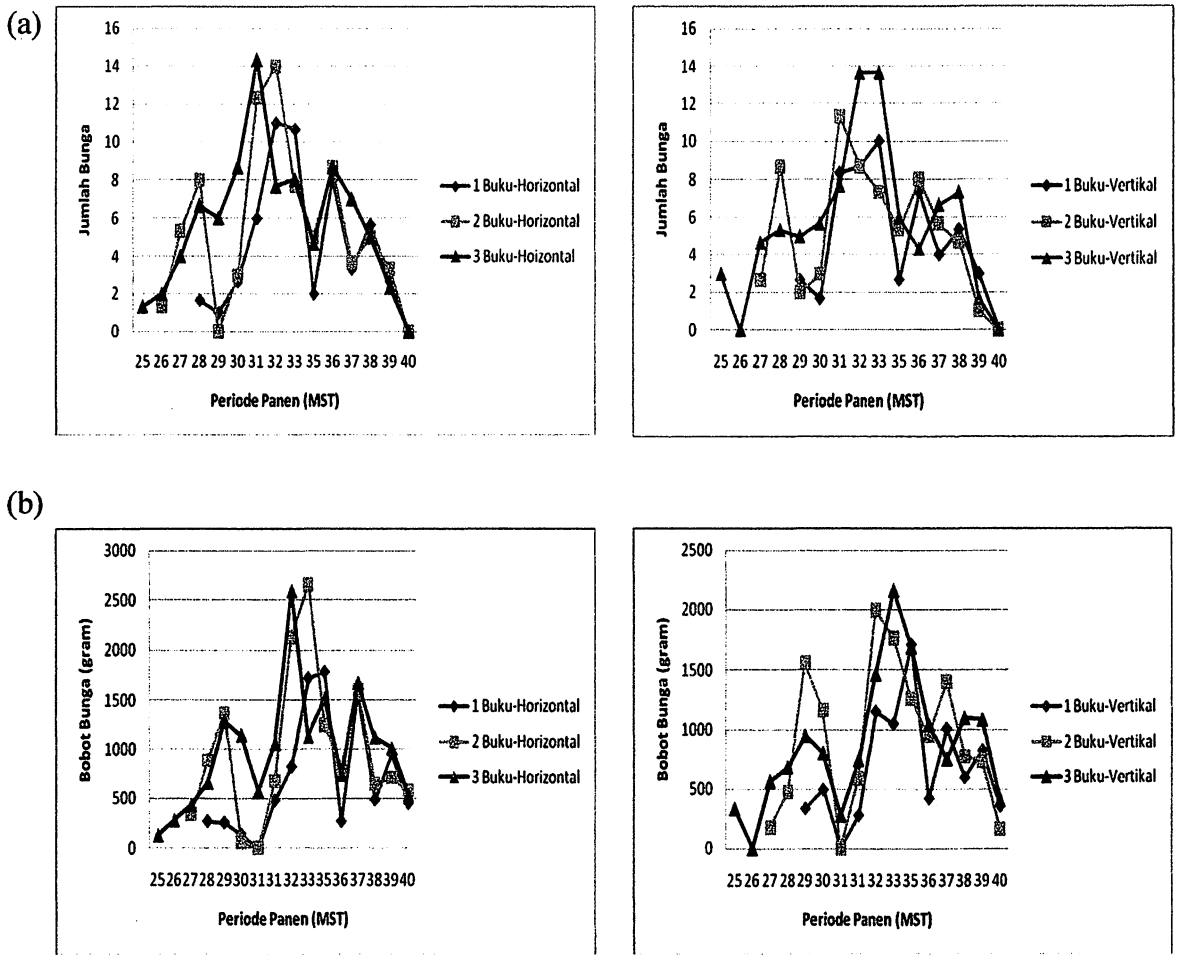


Figure 1. Number of flower (a) and flower weight (b) of terubuk during harvest period

Experiment 2. Fetilization Experiment

Fertilizer treatment (Table 8) showed different results that were not significantly different for number of emerging shoots. Fertilizers did not significantly affect number of shoot because of the low nutrient content in the soil due to low pH, i.e 4.8 (N-total: 0.16%, P: 8.4 ppm, K: 0.21 me/100g).

According to Buckman and Brady (1972), nitrogen (N) content in the soil is low, because N is easy leach or volatilize into the air. Potassium (K) in soil is also easy to leach. In acidic soil (low pH), phosphorus (P) will be bound by iron (Fe) and aluminum (Al) causing P not available for plants (Hanafiah, 2005).

Table 8. Number of terubuk shoots as influenced by fertilizer treatments

Treatment	WAP									
	4	6	8	10	12	14	16	18	20	22
Control	1.67	1.73	2.47	4.78	6.95	9.40	9.53	9.27	10.8	10.33
Manure	1.80	1.93	3.00	6.53	7.07	10.07	11.20	11.20	12.07	11.40
N+P+K	1.60	1.80	2.87	4.17	6.45	8.47	10.47	10.93	12.73	11.33

Manure + N+P+K	1.73	1.60	3.00	6.18	7.55	9.93	10.67	11.67	12.73	13.27
F Test	ns	ns	ns	ns	Ns	ns	ns	ns	ns	ns

Note: ns: not significant; N+P+K: Urea + SP36 + KCl

Table 9 indicated that fertilizerscaused significantly different of plant height between control and mix fertilizer treatment (manure and Urea + SP36 + KCl) at 16-20 WAP. Plants treated with mix fertilizer treatment gave the highest plant height (189.97 cm) although it was not significantly different from that of manure + Urea + SP36 + KCl treatments.

Table 9. Plant height of terubuk as affected by fertilizer treatments

Treatment	WAP									
	4	6	8	10	12	14	16	18	20	22
	----------cm----------									
Control	28.50	36.83	48.33	71.48	85.53	105.07	121.73b	142.00b	158.13b	173.53
Manure	27.17	34.77	53.20	70.53	87.23	107.93	136.97ab	152.13ab	175.13ab	187.43
N+P+K	26.51	33.17	45.13	69.23	89.08	104.53	140.73ab	162.93ab	175.87ab	184.30
Manure + N+P+K	24.05	34.57	59.07	76.24	97.68	118.80	149.17a	177.40a	189.97a	202.07
F Test	ns	ns	ns	ns	ns	ns	*	*	*	ns

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*); ns: not significant; N+P+K: Urea + SP36 + KCl

According to Sanjaya (1995), N, P dan K fertilizers significantly increased plant height. Nitrogen gave the quickest and highest significant effects in inducing vegetative growth (Soepardi, 1983). Moreover, according to Hanafiah (2005), physiologically potassium (K) functions in carbohydrate metabolism such as starch formation and fractionation, sucrose translocation for further growth acceleration and development of meristematic tissues (apex, shoots). Potassium fertilization will accelerate carbohydrate metabolism and cell division process causing acceleration in plant growth process. Fertilizer treatment did not significantly affect number of flowers (Tabel 10). Number of flower depends on number of shoot produced per hill. One shoot only produced one mature plant and yielded only one flower.

Table 10. Effect of fertilization on number of flower in terubuk

Treatments	Number of flower
Control	37.7
Manure	36.0
N+P+K	36.3
Manure+N+P+K	46.7
F Test	ns

Note: ns: not significant; N+P+K: Urea + SP36 + KCl

It is apparent that mix fertilizer treatment (Urea + SP36 + KCl + manure) gave significantly higher yield of flower with and without sheath compared to control (Table 11). Mix fertilizer treatment gave 3,352.7 g flower with sheath/4 m2 (2.79 ton/ ha) and 1,429.7 g flower without sheath/4 m2 (1.19 ton/ha).

Table 11. Weight of flower of terubuk under different fertilizer treatments

Treatments	Harvest fresh weight			
	Flower with sheath	Flower without sheath	Flower with sheath	Flower without sheath
	g/4m^2	g/4m^2	ton/ha	ton/ha
Control	1781.0 b	690.1b	1.48b	0.58b
Manure	2299.6ab (129%)	927.2ab (134%)	1.92ab	0.77ab
N+P+K	2317.1ab (130%)	971.8ab (140%)	1.93ab	0.81ab
Manure + N+P+K	3352.7 a (188%)	1429.7a (207%)	2.79a	1.19a
F Test	*	+	*	+

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*) and 10% (+); Number in between parentheses is a percentage based on control treatment; N+P+K: Urea + SP36 + KCl

The increase in weight of flower with and without sheath might be related to the amount of photosyntate translocated to flower part. The higher the amount of photosyntate translocated to flower part, the higher also the weight of that flower. Salisbury and Ross (1992) stated that the availability of nutrient during plant growth affected the amount of photosyntate produced by plant.

Mix fertilizer treatment (manure + Urea + SP36 + KCl) significantly affected weight of flower's sheath (Table 12). Mix fertilizer treatment yielded 1929.0 g flower's sheath/4m^2, and this was higher than that produced in control which yielded 1090.9 g flower's sheath/4m^2. In manure + Urea + SP36 + KCl treatment, more photosyntate translocated to the edible part. While in plants with manure, Urea + SP36 + KCl and especially in control (without fertilizer) treatments, photosyntate translocated more to flower's sheath rather than to the flower itself as an edible part.

Table 12. Effect of fertilizer treatment on sheath and flower of terubuk

Treatments	**Sheath Weight**	**Ratio sheath weight to total weight**	**Ratio of flower to total weight**
	g/4 m^2	%	%
Control	1090.9 b	61.3	38.7
Manure	1372.4ab	59.7	40.3
N+P+K	1345.8ab	58.1	41.9

Manure + N+P+K	1929.0 a	57.4	42.6
F Test	*	ns	ns

Note: Different letters following values in the same column means significant different according to HSD at 5% level (*); ns: not significant; N+P+K: Urea + SP36 + KCl; Total weight= weight of flower with sheath; flower= flower without sheath

Treatment of manure + Urea + SP36 + KCl increased nutrient content in soil, especially for N, P and K. They function in plant production process. According to Khan et al. (2007), manure will increase the content of N (~27%), K (3-11%) and P (~23%) in the mixture. According to Hanafiah (2005) N was important in formation of protein and chlorophyll which played important role in photosynthesis.. This eventually will increase photosynthesis and carbohydrate formation.. Research of Alemu and Bayu (2005) in sorghum showed that the addition of manure to inorganic fertilizer increased 51% more yield compared to that of control (without fertilizer).

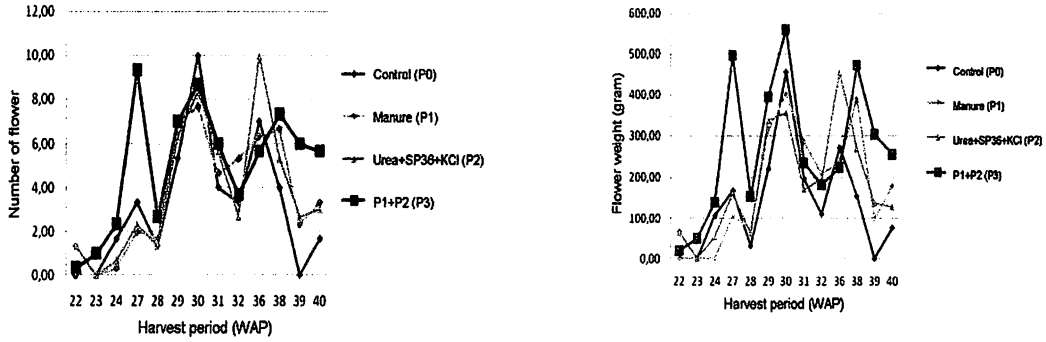
Table 13. Length and diameter of terubuk flower with and without sheath

Treatments	With sheath		Without sheath	
	Length (cm)	Diameter (cm)	Length (cm)	Diameter (cm)
			-----cm-----	
Control	35.66	2.23	10.33	1.84b
Manure	36.68	2.58	10.19	2.01ab
NPK	37.52	2.50	10.81	2.00ab
Manure+NPK	37.13	2.43	9.70	2.16a
F Test	ns	Ns	ns	+

Note: Different letters following values in the same column means significant different according to HSD at 10 % level (+), ns: not significant; N+P+K: Urea + SP36 + KCl

Based on length and diameter of flower, almost all terubuk flowers harvested in this experiment fulfill the good criteria. The diameter of flower without sheath ranged between 1.84 - 2.16 cm with the length between 9.70 - 10.81 cm (Table 13). Fertilizer treatments did not significantly affect length and diameter of flower with sheath and length of flower without sheath. However, treatment of manure+ N+P+K increased flower diameter of flower without sheath from 1.84 cm to 2.16 cm.

Harvest period of terubuk was 22 WAP to 40 WAP. Fertilizer treatments caused the earliest harvest period at 22 WAP, while in control the harvest started at 24 WAP. Harvest peak and the highest yield were obtained at 24 to 38 WAP (Figure 2).



Gambar 2. Number of flower (left) and flower weight (right) during harvest

Mix fertilizer increased the availability of nutrient for plant. At 27, 29, and 38-40 WAP. Mix fertilizer treatment gave number of flower more than the other treatments. Mix fertilizer treatment also showed the highest flower weight at 28, 30 and 38-40 WAP. Figure 3 showed that there were an increase and decrease in number of harvested flower during harvest period. This might due to harvest criteria, i.e. the maturity of flower. The differences in level of maturity made the differences in number of harvested flower. Harvest criteria of terubuk flower are based on length of flower and flower quality (flower color and flower condition as affected by pest and disease). The flower is graded into A, B or C depended on their length and quality (Table 14)

Table 14. Number of terubuk flower without sheath based on its grade

Treatments	Grade				Total
	A	B	C	Culled	
Control	17.3 (39.9)	14.7 (31.7)	7.7 (17.7)	3.7 (8.5)	43.4
Manure	19.0 (41.3)	20.7 (45.0)	4.3 (9.3)	2.0 (4.3)	46.0
N+P+K	20.3 (45.2)	14.0 (31.2)	8.3 (18.5)	2.3 (5.1)	44.9
Manure+N+P+K	36.0 (57.4)	19.7 (31.4)	4.7 (7.5)	2.3 (3.7)	62.7
F Test	ns	Ns	ns	ns	ns

Note: Statistical analyses on number of graded flower was based on transformation of $\sqrt{y+0.5}$ and log y+1. Data presented was the original observation. Number between parenthesis is precentage to total number of flower per plot ; ns: not significant; N+P+K: Urea+SP36+KCl

Table 15. Weight of terubuk flower without sheath (g) based on its grade

Treatment	Grade				Total
	A	B	C	Culled	
Control	331.3 (48.0)	256.4 (37.1)	26.6 (3.9)	75.9 (11.0)	690.1
Manure	523.1 (55.4)	362.9 (38.5)	15.5 (1.6)	42.2 (4.5)	943.7
N+P+K	605.5 (62.3)	261.0 (26.9)	57.9 (5.9)	47.5 (4.9)	971.8
Manure+N+P+K	971.8 (56.5)	640.1 (37.2)	63.7 (3.7)	43.5 (2.5)	1719.0
F Test	ns	ns	ns	ns	ns

Note: Statistical analyses on number of graded flower was based on transformation of $\sqrt{y+0.5}$ and log y+1. Data presented was the original observation. Number

between parenthesis is precentage to total number of flower per plot ; ns: not significant; N+P+K: Urea+SP36+KCl

Fertilizer treatments did not significantly affected number of flower based on its grade. Although there was not significantly different, however average number and weight of flower in grade A were better in manure + Urea + SP36 + KCl treatment, i.e. 36 flower (57.4% from total harvested flower) and 971.8 gram, respectively (Table 14 and 15). Culled flower in control (without fertilizer treatment) was the highest with the average number of 3.7 flowers and weight of 75.85 gram.

CONCLUSION

Terubuk planting using 3-node cutting (horizontally planted) yielded more shoots than the other treatments. Three-node cutting yielded 4992.6 g flower with sheath/4 m^2 (4.16 ton/ha) and 899.5 g flower without sheath/4 m^2 (0.75 ton/ha). Fertilization using mixture of manure and inorganic (N, P, and K) fertilizers gave the highest plant height (189.97 cm), yield of 3352.7 g flower with sheath/4 m^2 (2.79 ton/ha) and 1429.7 g flower without sheath/4 m^2 (1.19 ton/ha) and also the diameter of 2.16 cm.

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