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Growth and Yield of Okra Applied with a Bio-Stimulant from Golden Apple Snails Extracts and Fertilizer on Ultisol

Pertumbuhan dan Hasil Okra dengan Pemberian Bio-Stimulan Ekstrak Keong Mas dan Pupuk di Ultisol

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ABSTRAK

Budidaya tanaman okra pada tanah ultisol yang memiliki sifat fisik, kimia, dan biologi tanah yang buruk dapat diperbaiki dengan pemberian bio-stimulan ekstrak keong mas dan dikombinasikan dengan pupuk NPK. Penelitian ini bertujuan untuk mendapatkan kombinasi perlakuan bio-stimulan ekstrak keong mas dan dosis pupuk NPK dalam meningkatkan pertumbuhan dan hasil tanaman okra di tanah ultisol. Menggunakan Rancangan Acak Lengkap faktorial dengan 2 faktor perlakuan, yaitu faktor pertama bio-stimulan ekstrak keong mas terdiri dari 4 perlakuan dan faktor kedua pupuk NPK terdiri dari 3 perlakuan. Kombinasi pupuk organik dan pupuk anorganik ditemukan signifikan dalam meningkatkan pertumbuhan tanaman secara keseluruhan. Bio-stimulan ekstrak keong mas mengandung bahan organik dapat memperbaiki sifat fisik (meningkatakan agregasi, retensi kelembaban, konduktivitas hidrolik tanah), kimia (meningkatkan kandungan karbon organik tanah), dan biologi (meningkatkan biomassa mikroba tanah). Kandungan hara dalam pupuk NPK dapat menambah hara, ketersediaan unsur hara dalam tanah menjadi seimbang dan dapat diserap oleh tanaman, sehingga proses fotosintesis pada tanaman dapat berjalan dengan baik yang dapat meningkatkan pertumbuhan dan hasil tanaman okra. Berdasarkan hasil penelitian kombinasi bio-stimulan ekstrak keong mas 20 mL/L air dan pupuk NPK 150 kg/ha (1 g/polibag) merupakan perlakuan yang menghasilkan nilai rerata tertinggi pada pertumbuhan dan hasil tanaman okra di tanah ultisol.

Kata kunci: *Abelmoschus esculentus*, ekstraks, hara, *Pomacea canaliculata*, suboptimal soil

ABSTRACT

Cultivation of okra on ultisol soils having poor physical, chemical, and biological soil properties can be improved by administering a bio-stimulant extract of golden snails and combined with NPK fertilizer. This research objective was to study a combination of bio-stimulant treatment of golden apple snail extract and NPK fertilizer dosage in increasing the growth and yield of okra on ultisol soil. This study used a factorial completely randomized design with two factors. The first factor was Bio-stimulant golden apple snails extract consisting of 4 treatment, and the second factor was levels of NPK fertilizer

consisting of 3 treatment. Fertilizers had a significant effect on increasing overall plant growth. The bio-stimulant extracts of golden apple snails contain organic materials that can improve physical properties (increasing aggregation, moisture retention, soil hydraulic conductivity), chemical (increasing soil organic carbon content) and biology (increasing soil microbial biomass). The nutrient content in NPK fertilizers can increase nutrients; the availability of nutrients in the soil is balanced and can be absorbed by plants so that the photosynthesis process in plants can run well and increase on growth and yield of okra. The combination of bio-stimulant extract of golden apple snails of 20 mL/L water and NPK fertilizer of 150 kg/ha (1 g/polybag) had the highest resulted in the average value of growth and yield of okra on the ultisol soils.

Keywords: *Abelmochus esculentus,* extract nutrients, *Pomacea canaliculata,* tanah suboptimal

INTRODUCTION

South Sumatra Province, particularly the Ogan Komering Ulu District is dominated by sub-optimal soils, namely ultisol soil types (podzolic red yellow) (Central Bureau of Statistics of OKU, 2014). Ultisol soils have very acidic soil chemical properties (pH < 4.5). The acidic soils can reduce plant growth due to the increased soil concentrations of Al, Fe and Mn to toxic levels that reduce the availability of nutrients Ca, Mg and P, capacity cation exchange (CEC) and soil physical properties with low structural stability with high nutrient leaching (Lin et al., 2018).

Organic fertilization is the most efficient approach to increase soil organic matter content and soil fertility (Liang et al., 2014; Maillard & Angers, 2014; Wang et al., 2017; Lin et al., 2019). The application of organic matter has a positive effect on the physical properties of the soil, that is increasing the aggregation and aggregate stability (Karami et al., 2012; Yu et al., 2012; Zhou et al., 2013; Lin et al., 2019). Organic carbon content, microbial biomass, moisture retention, water infiltration rate, and soil hydraulic conductivity are some of the components that can be increased by the addition of organic matter in the soil, as a result the yield increases.

The use of bio-stimulant extracts of golden apple snails (*Pomacea canaliculata*) can be combined with inorganic fertilizers such as NPK fertilizers alone as a (Amoah et al., 2012; Bravo et al., 2012). The use of organic substitute for chemical fertilizers is not sufficient to maintain soil productivity. The efficiency of substitution related to the inorganic and organic fertilizers in meeting the availability and sustainability of plant nutrients is shown in the combination of organic fertilizers plus mineral fertilizer (Asbur & Purwaningrum, 2015).

The application of liquid biofertilizer of 1.5 mL/18 mL increased optimal yield and quality of okra fruit (Dunsin & Caleb, 2016). The contribution of NPK fertilizer of 250–280 kg ha - 1 NPK 15:15:15 for the growth and yield of tomatoes of UC82B variety was higher than those of Roma VF varieties (Isah et al., 2014). This study aimed to obtain a combination of bio-stimulant treatment of golden apple snails extract and NPK fertilizer dosage in increasing the growth and yield of okra on ultisol soil

MATERIALS AND METHODS

This study was conducted in Tanjung Baru village, sub-district of East Baturaja, district of Ogan Komering Ulu from September to November 2019. The materials used in this study were green okra seeds, Bio-stimulant extract of golden apple snails used the method of Andriani (2018), compound NPK (15:15:15) commercially sold in the market and ultisol soil (podzolic red yellow).

Preparation of Planting Media

The soil used ultisol soil (podzolic red yellow) which was already cleaned of dirt, then weighed as much as 10 kg and put into a polybag.

Seed Preparation and Planting

Designed using a factorial Completely Randomized Design (CRD) with 2 treatment factors, repeated 3 times and each treatment consisting of 3 sample plants. Before being planted, the seeds were first soaked in water for 20 minutes for the imbibition process. The number of planted okra seeds was 2 seeds/polybag. When the plants were 1 week old, they were reduced into 1 plant/polybag.

Application of Bio-Stimulant of Golden Apple Snails Extract and Compound NPK Fertilizer

The first factor, dosage treatment of Bio-stimulant golden apple snails extract, namely: E0: Control (without Bio-stimulant golden apple snails extract); E1: Bio-stimulant of 10 mL/L water golden apple snails extract; E2: Bio-stimulant of 20 mL/L water golden apple snails extract; E3: Bio-stimulant of 30 mL/L water golden apple snails extract; the concentration was based on research Andriani (2018). Provision of bio-stimulant extract of golden apple snails as carried out every day for 7 days after planting (dap) until 63 dap, by pouring it into the ground using a measuring cup as much as 250 mL/polybag (field water capacity of 10 kg of soil).

The second factor, dosage treatment of NPK fertilizer, namely: P1: NPK of 100 kg/ha (0.5 g/polybag); P2: NPK of 150 kg/ha (0.75 g/polybag); P3: NPK of 200 kg /ha (1 g/polybag). Compound NPK (15:15:15) fertilizer was given in two applications, namely ½ the dose was given 1 week after planting and supplementary fertilization was given 30 days after planting using circular array method. Okra harvest was done once every 2 days after 50 to 90 days after planting, with a length of about 7 cm and the tips of the fruit were easily broken using a sharp knife.

Growth Observation

Plant Height (cm)

The plant height was measured from the base of the stem to the point of plant growth using a tape measure, carried out at the end of the study on the sample plants.

Flowering Age (DAP)

Flowering age was calculated at the time the flowers emerged; the flowering plants were observed every day starting from the first flower coming out to 60% of the sample plants flowering.

Plant Wet Weight (g)

Observation of the plant wet weight was carried out after harvest by weighing the entire top of the plant, using the Ohaus brand digital scale.

Root Wet Weight (g)

Observation of root wet weight was carried out after harvest by weighing all parts of the roots of the plant, using the Ohaus brand digital scale.

Canopy Dry Weight (g)

The canopy dry weight was observed at the end of the study. The weighed canopy was the one that was already separated from the roots and oven-dried at 80 ^{o}C for 24 hours; then it was weighed using the Ohaus brand digital scale of a 2-kg capacity.

Root Dry Weight (g)

Observation of root dry weight was conducted at the end of the study. The weighed roots were those already separated from the canopy and oven-dried at 80^{o} C for 24 hours; then it was weighed using the Ohaus brand digital scale of a 2-kg capacity.

Observation of the Results

The Number of Fruit Planted (Fruits)

Observation of the number of fruits was carried out by counting the number of fruits

produced per sample plant, starting from the first harvest to the end of the harvest.

Fruit Length (cm)

Observation of fruit length was carried out at the end of the study by measuring the length of the fruit produced by the sample plants; the measurement started from the base of the fruit to the tip of the fruit using a tape measure.

Fruit Weight (g)

Observation of fruit weight by weighing the fruit already harvested each time using the Ohaus brand digital scale. The fruit weights presented were the total number of fruit yielded on the sample plants during the harvest and then its average number was taken.

Data Analysis

Data on plant height, flowering age, plant wet weight, root wet weight, plant dry weight, root dry weight, number of fruits per plant, fruit length, fruit weight per plant were all variables compared between the treatments using analysis of variance (F test). If the treatment had a significant effect, then the test was continued with the LSD 5% test. All calculations were conducted using the SAS program.

RESULTS

Okra Growth

The results of the analysis of diversity (F-Test) of bio-stimulant extract of golden apple snails combined with NPK fertilizer on growth variables had a significant effect on plant height and had no significant effect on flowering age, canopy wet weight, canopy dry weight, root wet weight, and dry weight root. The single treatment of bio-stimulant extract of golden apple snails ad a significant effect only on the flowering age. The single treatment of NPK fertilizer significantly affected the flowering age (Table 1).

Okra Results

The results of the analysis of the diversity (F-value) of bio-stimulant extract of golden apple snails combined with NPK fertilizer on the variable of yield not significant effect on variable of fruit length, fruit weight and number of fruits. The single treatment of golden apple snails extract bio-stimulant had significant effect on number of fruits. The single treatment of NPK fertilizer had no significant effect on variables of fruit length, fruit weight and number of fruits. LSD test results of 5% (Table 2) show that E3P3 treatment was not different from E0P2, E0P3, E1P2, and E2P1 treatments, but different from others. The results of the average treatments with the fastest flowering were E1P3, E2P2, E2P3, E3P2, and E3P3. On the growth variable of dry weight of the header, E1P3 treatment produced the highest mean. On the production variable, E2P2 treatment produced the highest mean on fruit length, fruit weight and number of fruits.

LSD test results of 5% (Table 3) show growth and production response of okra plants to provision of LOF of golden apple snails for flowering age variable, E2 treatment was not different from E1 and E3 treatments but different from E0 treatment. In the variable of number of fruits, E2 treatment was different from E0, E1, E3 treatments.

In tabulation, E3 treatment resulted in the highest mean on the variable of plant height, E2 treatment resulted in the highest mean on the variable of wet weight of the header, root dry weight, root wet weight, fruit length, fruit weight and number of fruit, and E1 treatment resulted in the highest mean on the variable of dry weight of the header. LSD test results of 5 % (Table 4) show P2 treatment on flowering age variable, P3 treatment was different from P1 but not with P2 treatment. In tabulation, P2 treatment produced the highest mean in almost all observed variables except for dry and wet weight of the header, the highest average was found in P3 treatment. P2 treatment produced the

highest mean value on the growth variable of dry weight of the header and all production variables.

DISCUSSION

The combination of bio-stimulant extract of golden snail and NPK fertilizer had a significant effect on the plant height variable but had no significant effect on other variables. The significant effect of giving the bio-stimulant extract of golden snail was shown on plant length, number of leaves, leaf width, and number of melon branches. One of the ingredients of golden snail meat is the amino acid tryptophan. The amino acid tryptophan is a precursor for the formation of Indol Acetic Acid (IAA), playing a role in promoting growth by elongating cells (Andriani, 2019). The IAA produced by the golden apple snails extract has a role in increasing the length and surface area of the roots, thereby increasing the ability of the roots to absorb nutrients (Glick, 2012). In contrast to the results of the study, the application of liquid organic fertilizer of golden apple snails had no significant effect on the height of rice plants. This is because the application carried out was different, namely by spraying the plant parts (Sulfianti et al., 2018).

The tabulation results on the growth and yield of okra plants showed that each phase gave a different response to the treatment (Table 2). The E3P3 treatment resulted in better growth and the E2P2 treatment resulted in better production than other treatments. Integration of the combination of organic and inorganic fertilizers was significant in improving overall plant growth, yield and soil macro nutrient status compared to the single application of any of these nutrients (Wulandari et al., 2018).

The single factor of giving the Bio-stimulant extract of golden apple snails on E2 treatment had a significant effect on the variables of flowering age and number of fruits, had no significant effect on the variables of fruit length, fruit weight, canopy wet weight, canopy dry weight, root wet weight, root dry weight, number of leaves and plant height. The E1 treatment resulted in better growth in the vegetative phase than the E0, E2 and E3 treatments. In the generative phase, the E2 treatment resulted in better production than the E0, E1 and E3 treatments (Table 3). The liquid organic fertilizer of golden apple snails was the fertilizer with high NPK content and good for plant growth. The NPK has a function that supports the growth and yield of a plant. Nitrogen in liquid organic fertilizers is beneficial for growth and development in the vegetative phase of plants such as stems, leaves and roots. It plays an important role in the formation of chlorophyll useful in photosynthesis.

The increase in soil organic matter content occurred due to the application of liquid organic fertilizers; plants fertilized with liquid animal fertilizers had the highest total biomass with the development of new organs that developed more profitably (leaves and root fibers). The liquid organic fertilization resulted in increased macro and micronutrient uptake compared to plants treated with mineral fertilizers. In addition, the organic fertilization has a positive effect on carbohydrate content (fructose, glucose and sucrose), particularly in leaves during summer (Martínez et al., 2016).

The results of the F test showed that the application of NPK fertilizer had a significant effect on the variable of flowering age, but had no significant effect variables of plant height, fruit weight, canopy wet weight, canopy dry weight, root wet weight, root dry weight and number of leaves (Table 4). The NPK fertilizer at a dose of 200 kg/ha (1 g/polybag) could accelerate the flowering age of okra plants. The potassium (K) plays a role in accelerating the growth of flowers and fruit, increasing fruit weight, improving the quality of taste and aroma of melons, and increasing plant resistance to disease. The element of nitrogen (N), namely accelerating plant growth, extending the vegetative period to stimulate the growth of

stems, branches, leaves, cell division, cell enlargement and slowing seed maturation. It has a very significant effect on melons on plant height, number of branches, number of leaves, maximum leaf area, leaf fresh weight, stem fresh weight, leaf dry weight, stem dry weight, fruit dry weight and root dry weight (Sunadra et al., 2019). The provision of micro fertilizer + NPK produced the best fruit weight for each sample and fruit weight for each plant. The combination of organic fertilizers (20 tons/ha) and inorganic NPK + micro fertilizers produces the best fruit weight for each cucumber plant (Marliah et al., 2020).

Table 1. Analysis of variety of increase of growth and yield of *abelmoschus esculentus* by giving bio-stimulant extract of lammarck *Pomacea canaliculata* and NPK on ultisol soil in all observed variables

Variables	Interaction (I)			LOF			NPK			CD %
	F-Tab	F-value		F-Tab	F-value		F-Tab	F-value		
A. Plant Growth										
1. Plant height (cm)	2.51	4.37	*	3.01	0.28	ns	3.40	2.46	ns	11.86%
2. Flowering Age (dap)	2.51	0.60	ns	3.01	6.60	*	3.40	3.80	*	2.43%
3. Wet Weight of the Header (g)	2.51	1.50	ns	3.01	0.33	ns	3.40	0.38	ns	4.27%
4. Dry Weight of the Header (g)	2.51	0.43	ns	3.01	0.52	ns	3.40	1.51	ns	4.08%
5. Root Wet Weight (g)	2.51	1.26	ns	3.01	1.31	ns	3.40	1.01	ns	3.07%
6 Root Dry Weight (g)	2.51	0.61	ns	3.01	0.75	ns	3.40	0.79	ns	2.95%
B. Production of Plants										
1. Fruit Length (cm)	2.51	1.61	ns	3.01	1.45	ns	3.40	2.79	ns	8.56%
2. Fruit Weight (gr)	2.51	1.55	ns	3.01	2.17	ns	3.40	1.40	ns	14.66%
3. Number of Fruits (peace)	2.51	1.22	ns	3.01	3.94	*	3.40	1.29	ns	19.61%

Notes: * = significant, ns = non significant, CD = coefficient of diversity

Table 2. LSD test results of 5% and the mean response of increase of growth and yield of *Abelmoschus esculentus* by giving bio-stimulant extract of lammarck *Pomacea canaliculata* and NPK on ultisol soil in all observed variables

Treatment	Variables								
	Plant Height (cm)	Flowering Age (day)	Wet Weight of the Header (g)	Dry Weight of the Header (g)	Root Wet Weight (g)	Root Dry Weight (g)	Fruit Length (cm)	Fruit Weight (g)	Number of Fruits (piece)
EOPI	60.94[a]	32.00	104.44	14.57	35.42	7.22	11.76	89.50	16.67
P EOP2	72.83[bcde]	32.00	168.89	15.95	43.33	8.44	10.97	92.15	18.67
EOP3	73.94[bcde]	30.67	186.66	17.37	52.22	7.78	11.94	100.12	22.33
E1PI	62.94[ab]	30.67	140.00	13.75	38.89	7.28	11.08	99.14	16.67
E1P2	79.54[de]	30.67	186.66	18.22	56.66	9.55	12.17	93.70	16.33
E1P3	62.72[ab]	30.00	107.77	26.06	34.44	6.74	11.44	103.69	16.00
E2PI	75.05[cde]	30.67	215.55	17.15	52.22	8.87	11.20	109.69	19.33
E2P2	69.50[abcd]	30.00	147.77	16.81	61.11	9.06	13.83	127.66	26.33
E2P3	65.50[abc]	30.00	160.00	17.47	51.11	9.59	12.16	91.60	20.67
E3PI	65.83[abc]	30.67	124.44	13.39	41.11	6.37	11.44	93.90	17.33
E3P2	66.50[abc]	30.00	145.11	15.98	37.77	7.36	12.41	104.80	17.67
E3P3	81.50[e]	30.00	224.57	17.63	55.55	9.36	12.25	97.15	18.67
LSD of 5%	11.61								

Notes: Numbers followed by the same notation or letter mean not significantly different. Numbers followed by the same notation or letter mean significantly different. E0: Control (without Bio-stimulant golden snail extract); E1: Bio-stimulant of 10 mL/L water golden apple snails extract; E2: Bio-stimulant of 20 mL/L water golden apple snails extract; E3: Bio-stimulant of 30 mL/L water golden apple snails extract, P1: NPK of 100 kg/ha (0.5 g/polybag), P2: NPK of 150 kg/ha (0.75 g/polybag), P3: NPK of 200 kg/ha (1 g/polybag)

Table 3. LSD test results of 5 % and the average Increase of growth and yield of *Abelmoschus esculentus* by giving bio-stimulant extract of lammarck *Pomacea canaliculata* on ultisol soil in all observed variables

Variables	E0	E1	E2	E3	LSD (5%)
A. Plant Growth					
1. Plant Height (cm)	43.22	42.59	43.80	44.75	
2. Flowering Age (dap)	24.40[b]	23.56[a]	23.4[0a]	23.40[a]	0.73
3. dry weight of the header (g)	115	108.61	130.83	123.53	
4. dry weight of the header (g)	11.97	14.51	12.86	11.75	
5. root wet weight (g)	32.74	32.50	41.11	33.61	
6 root dry weight (g)	5.86	5.89	6.88	5.77	
B. Production of Plants					
1. fruit length (per piece)	8.67	8.67	9.30	9.03	
2. fruit weight (per plant)	8.66	106.39	120.47	104.47	
3. number of fruits (piece)	18.02[c]	15.85[a]	20.18[d]	17.02[b]	3.6

Note: Numbers followed by the same notation or letter mean not significantly different, Numbers followed by adifferent notation or letter mean significantly different. E0: Control (without Bio-stimulant golden apple snails extract); E1: Bio-stimulant of 10 mL/L water golden snail extract; E2: Bio-stimulant of 20 mL/L water golden apple snails extract; E3: Bio-stimulant of 30 mL/L water golden apple snails extract

Table 4. LSD test results of 5% and the average increase of growth and yield of *Abelmoschus esculentus* by giving bio-stimulant extract of lammarck *Pomacea canaliculata* and NPK on ultisol soil in all observed variables

.Variables	Treatment Average			
	P1	P2	P3	LOF of 5%
A. Plant Growth				
1. Plant Height (cm)	54.58	60.48	59.30	
2. Flowering Age (dap)	31.73[b]	31.40[ab]	30.90[a]	0.73
3. dry weight of the header (g)	146.11	162.11	169.75	
4. dry weight of the header (g)	14.72	16.74	19.63	
5. root wet weight (g)	41.91	49.72	48.33	
6 root dry weight (g)	7.44	8.60	8.37	
B. Production of Plants				
1. fruit length (per piece)	11.37	12.34	11.59	
2. fruit weight (per plant)	98.06	104.58	98.14	
3. number of fruits (piece)	17.50	19.75	19.42	

Note: Numbers followed by the same notation or letter mean not significantly different, Numbers followed by a different notation or letter mean significantly different, P1: NPK of 100kg/ha (0.5 g/polybag), P2: NPK of 150 kg/ha (0.75 g/polybag), P3: NPK of 200 kg/ha (1 g/polybag)

CONCLUSION

The combination of bio-stimulant extract of golden apple snails of 20 mL/L water and NPK fertilizer of 150 kg/ha (1 g/polybag) resulted in the highest average value of growth and yield of okra on the ultisol soils.

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