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RESPONSE OF EGGPLANT (*Solanum melongena L.*) TO COMBINATION OF INORGANIC-ORGANIC N AND EM4

Moch. Dawam Maghfoer*), Roedy Soelistyono and Ninuk Herlina

Faculty of Agriculture, Brawijaya University Jl. Veteran Malang 65145 East Java Indonesia
*Corresponding author Phone: +62-813-34057203 E-mail: dmaghfoer@yahoo.com

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ABSTRACT

A research to reduce application of N inorganic fertilizer through combination of inorganic-organic N and EM4 on eggplant has done on paddy field in Poncokusumo, Malang Regency, East Java, from June to September 2013. The experiment used a randomized complete block design with two factors and three replications. The first factor was the combination of inorganic-organic N fertilizer, ie. 100% urea, 75% urea + 25% goat manure, 50% urea + 50% goat manure, and 25% urea + 75% goat manure . The second factor was dose of EM4, ie. 10, 20, and 30 liters EM4 ha^{-1}. The results showed a reduction in the proportion of urea up to 50% and replace it with goat manure resulted growth and fruit yield of eggplant better than the others. The application of 100% urea gave the lowest fruit yield. Application of EM4 on eggplant enhanced growth and increased fruit yield. EM4 application with doses of 30 liters ha^{-1} resulted the highest fruit yield, accelerate the decomposition and mineralization of N.

Keywords: eggplant, urea, goat manure, EM4, decomposition

INTRODUCTION

Eggplant (*Solanum melongena L.*) is the most important vegetable in the world after potato, tomato and cucumber. The annual production of eggplant experienced a decrease from 7.75% (CBS, 2009) to 5.71% in 2008- 2009. Seeing the food shortage in the last few years, Adiyoga (2009) doubted if food production, including vegetables, could go in line with the increasing number of populations. Moreover, the variability in upcoming annual production tends to be uncertain due to extreme climate condition.

Climate change may contribute to the increase of CO_2 concentration, rising temperature, fluctuation in rainfall and plant diseases, which may trigger the decrease in agricultural production. Kowalska (2008) agreed that high temperature could cause the flowers to fall and decrease the number of eggplants. Nevertheless, eggplant is prone to diseases and rot in areas with high rainfall. Therefore, enviro-friendly fertilising technique is required in order to increase the production of eggplant.

Eggplant require a great amount of nitrogen. Eggplant has quite long harvest period and is exposed to soil for too long, so that nitrogen fertiliser is to be given sufficiently during their growth (Nafiu *et al*., 2011). Ul Hasan *et al.* (2010) agreed that the availability of N was essential in maintaining leaf viability. Theoretically, the presence of young leaves is important to help with the process of photo-synthesis during generative phase, which is then expected to be able to increase the yields despite the ageing in the plants. The application of N increases the number of fruits per plant, the length, and the percentage of fruit set (Moraditochaee *et al*., 2011).

Inorganic and organic fertiliser can serve as a source of N fertiliser. Urea is the most commonly used as the source of nitrogen by farmers due to its high nitrogen content (46%) (Lingga and Marsono, 2008). Agbo *et al.* (2012) suggests that nutrient in inorganic fertiliser is capable of increasing soil productivity for a short time. However, the nutrient tends to be swept away through washing, evaporation, and nitrification. The application of manure could possibly trigger the availability of needed nutrients and could maintain soil structure.

The combination of sources of nitrogen is able to meet the need for plant nutrients through enviro-friendly technique. Sutanto (2002) stated that the single application of organic fertiliser was seen to be able to decrease the production, while

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the single application of chemical fertiliser with no organic matters could disturb the environment. Thus, the combination of organic and inorganic matters is required. In addition to providing nutrients, the application of organic fertiliser could help with the chemical and biological characteristics of soil (Adil *et al*., 2006). What comes as a problem is that the fact that the rate of decomposition process is not in line with the plant growth, so that accelerating the release of nutrients needs to be done.

EM4 is capable of accelerating nutrient release and control diseases in eggplants. Conventionally, organic matters take 4-6 months to decompose, while the application of EM4 may accelerate the decomposition process (Hardianto, 2000). Ruhukail (2011) suggests that EM4 is also capable of maintaining soil condition, suppressing the growth of microbes which may cause diseases, and maintaining the efficiency in the use of organic matters through plants. Crop failure is mostly caused by high disease intensity from fungi and bacteria. Biological control is expected not only to reduce the intensity but also to increase yield. However, impacts on environment caused by pesticides must always be taken into account (Lwin and Ranamukhaarachchi, 2006).

The improvement in fertilising technique by applying the combination of N and EM4 is expected to be able to increase plant production without negatively affecting Mother Nature.

MATERIALS AND METHODS

The research was conducted from June to September 2013 on paddy fields located in Poncokusumo, Malang regency, East Java on the altitude of 600 m asl., with the soil of andosol and 5.4 pH level. In this research, eggplant seeds of green variety, goat manure, Urea, SP-36 and KCl were employed.

Randomized Complete Block Design (RCBD) consisting of two factors and three replications was applied in this research. Factor 1 involved combination of inorganic-organic N fertilizer (equivalent to 138 kg N ha^{-1}) comprising 4 stages: K_0 = 100 % Urea, K_1 = 75% Urea + 25% goat manure, K_2 = 50% Urea + 50% goat manure, K_3 = 25% Urea + 75% goat manure. Furthermore, factor 2 involved the dosage of EM4 which consisted of the following 3 stages: 10 litres EM4 ha^{-1} (100 ml EM4 solution $plant^{-1}$), E_2 = 20 litres EM4 ha^{-1} (200 ml EM4 solution $plant^{-1}$), E_3 = 30 litres EM4 ha^{-1} (300 ml EM4 solution $plant^{-1}$).

Eggplants were planted and spaced in 70x40 cm between plant on 2.8 m x 5.2 m observation plots, given SP-36 and KCl as the basic fertiliser with the dosage of 278 kg ha^{-1} (100 kg ha^{-1} P_2O_5) and 168 kg ha^{-1} (100 kg K_2O) each, which was given when the plant was 7 days old after planting. Urea was applied three times at 7, 28 and 49 days after planting (DAP) with 1/3 dose each. The goat manure was applied during soil cultivation with a certain dosage by sowing evenly over the soil surface. EM4 was given twice in two weeks before planting and two weeks after planting with a half of a dosage of treatment.

Plant maintenance involved replacing dead plants, pruning, installing stakes, tying down the plants to the stakes, and controlling pests and diseases. Controlling the growth of weeds was done manually. Watering was done once a week, but in generative phase, it took once in two weeks. Control on pests was based on the intensity of the attack.

The observation was conducted destructively on the leaf area index, crops growth rate, and net assimilation rate. The observation took weight of fruit, fruit number, length and diameter of fruit, which was done 8 times starting from 56 days after planting (DAP) with seven-day interval. Besides, observation on the decomposition process of organic matter and the percentage of dead plant due to attack by diseases was also carried out.

The data obtained were analysed by using analysis of variance, followed by Least Significant Difference (LSD) test of 5%.

RESULTS AND DISCUSSION

Eggplants applied with 75% of urea and 25% of manure had higher leaf area index compared to those with other types of fertiliser (Table 1). It indicated that there was a synchronisation between nutrient release of both sources of N and the time when the plant was in need of the nutrient, so that the plant obtained the N as long as it grew. Masinde *et al.* (2009) explained that the increase of N availability would also increase the leaf area, exposure to sunlight, and dry weight. In the beginning of the plant growth, the plant was sufficiently supplied with N coming from Urea, for it could produce N particle in a short time. Indranada (1986 *in* Sudartiningsih *et al*., 2002) confirmed that Urea was hydrolysed by enzyme of urease into

ammonium carbonate which released ammonium ion ($NH4^+$). Urea, as it is known, is easily hydrolysed into ammonium carbonate in 2-3 days. The N obtained from manure was sufficiently available for eggplants. The release of N gradually guaranteed the availability of N for the plants.

The application of N, along with manure, was essential for the efficiency of nutrient uptake through the betterment of physical, chemical and biological characteristics of soil such as cation exchange capability in term of enabling plant to effectively absorb the nutrient. Akanbi *et al*. (2010) mentioned that sufficient availability of nutrient would increase leaf area and leaf area index with high content of chlorophyll for the plant to get more sunlight.

Efficiency of N uptake had a significant influence on the growth rate of plants. The higher the N uptake, the faster the growth rate of the plant will be. As presented in Table 2, during 14 days to 42 days after planting (DAP), the growth rate of eggplant fertilised with urea reached 75%, and 25% of goat manure gave higher growth rate which was not different from the application of 100% urea. In day 56 after planting, the combination of 75% urea + 25% manure gave better growth compared to the application of 100% urea. It indicates that the efficiency of N uptake in the plant given 100% Urea was lower than that given the combined fertiliser of organic and inorganic. The plant fertilised with 100% Urea only used the Nitrogen until day 42 after planting, while in the following days, the plant no longer sufficiently obtained the Nitrogen, which lowered the growth rate. This is probably related to the high rainfall when the plant was only 35 days old, where the available Nitrogen was washed away by the rain. Suwandi (2009) emphasised that the fertilising efficiency using N only ranged from 30-40%.

Table 1. Leaf area index of eggplant caused by combination of inorganic-organic N and EM4

Treatments	Leaf area index			
	14 DAP	28 DAP	42 DAP	56 DAP
Source of N (138 kg N ha^{-1})				
K0 (100 % urea)	0.0605	0.49 a	1.56 b	2.75 a
K1 (75% Urea + 25 % goat manure)	0.0611	0.53 b	1.61 b	3.13 c
K2(50 % Urea + 50 % goat manure)	0.0598	0.46 a	1.48 a	2.99 bc
K3 (25% Urea + 75% goat manure)	0.0591	0.44 a	1.47 a	2.83 ab
LSD 5%	ns	0.05	0.07	0.17
Dose of EM4				
E1 (10 $l.ha^{-1}$)	0.0596	0.45 a	1.50 a	2.78 a
E2 (20 $l.ha^{-1}$)	0.0602	0.48 ab	1.52 a	2.90 a
E3 (30 $l.ha^{-1}$)	0.0605	0.51 b	1.58 b	3.09 b
LSD 5%	ns	0.05	0.06	0.15

Remarks: Numbers followed by different letter at each column are significantly different at P=0.05. ns=not significant

Table 2. Crops growth rate of eggplant caused by combination of inorganic-organic N and EM4

Treatments	Crops growth rate (g m^{-2} d^{-1})		
	14-28 DAP	28-42 DAP	42-56 DAP
Source of N (138 kg N ha^{-1})			
K0 (100 % urea)	3.35 b	13.61 bc	34.53 a
K1 (75% Urea + 25 % goat manure)	3.57 b	14.38 c	42.59 c
K2(50 % Urea + 50 % goat manure)	2.99 a	12.32 b	40.02 bc
K3 (25% Urea + 75% goat manure)	2.87 a	10.88 a	35.62 ab
LSD 5%	0.33	1.32	4.47
Dose of EM4			
E1 (10 $l.ha^{-1}$)	3.06 a	12.11 a	35.49 a
E2 (20 $l.ha^{-1}$)	3.12 a	12.63 ab	38.55 ab
E3 (30 $l.ha^{-1}$)	3.40 b	13.36 b	40.52 b
LSD 5%	0.28	1.14	3.87

Remarks: Numbers followed by different letter at each column are significantly different at P=0.05. ns=not significant

The application of 75% of urea and 25% of goat manure in eggplant could result in higher growth rate than the combination of N from other sources, which was due to the double benefits given through nitrogen released by Urea and nutrient produced by manure when the plant was 42 days old. In addition, the application of manure to the plant could contribute to the betterment of physical, chemical and characteristics of soil in which the uptake capability for N will also be improved. Moreover, higher efficiency of N uptake maintains organs needed for plant growth.

Low dosage of EM4 gives the lower growth rate in plant. It takes time for N fertiliser to release nutrient needed by plants. The release of nutrient in manure, however, could be accelerated through EM4 unless the dosage given is low. The lower the dosage of EM4 is given to goat manure, the more time it is required to release the nutrient. Table 5 reveals that C/N ratio in manure mixed with EM4 (10 litres ha^{-1} was higher than that applied with 20 and 30 litres ha^{-1}. Hardjowigeno (1989) stated that the process of change from N-organic into N-inorganic required the process of amination, ammonification, and nitrification where those processes were influenced by the presence of bacteria. The low nitrogen available caused the process of photosynthesis to run slower than normal, so that the accumulation of photosynthate required is also low. This causes the plant to grow slower as well.

The increase of N uptake is able to increase the net rate of plant assimilation. The application of 75% of urea + 25% of manure could increase the efficiency of N uptake, so that the photosynthesis process is effective recalling that Nitrogen is totally required in the process of photosynthesis. More nitrogen taken by the plant would maximise the growth of plant organs such as leaves. Table 1 shows at 56 days old of plant, the combination of 75% of urea + 25% of manure increased the leaf area index by 3.13. According to Murrinie (2011), the maximum production of plant dry matter is usually at leaf area index of 3-5. Higher leaf area index will allow plant to get more sunlight for more effective photosynthesis process and net rate of plant assimilation. Thus, the result of photosynthesis was useful for plant organs, which also maximised the formation of plant dry matter.

The net assimilation rate in eggplant given 100% of Urea degraded along with the age of the plant. In the early growth of plant (at 14 to 42 days old), the net rate of assimilation in eggplant with 100% of Urea was higher than the plant given another treatment, where it was not significantly different from the plant given 75% of Urea + 25% of goat manure (Table 3). This was caused by the fact that the plant obtained the nitrogen in sufficient amount for the process of photosynthesis which maximised the leaf growth. Wider leaf area enabled plant to receive more sunlight for more effective photosynthesis process. Effective process of photosynthesis surely increased the net rate of assimilation in plant. At 42 days old, the plant obtained less nitrogen compared to that given another treatment because the loss of nitrogen from urea often happened, for the rainfall had occurred and washed away the nitrogen since the plant was 35 days old. In such a loss, the growth of leaf area was hampered, and it caused photosynthesis process and net rate of plant assimilation to be lower.

Table 3. Net assimilation rate of eggplant caused by combination of inorganic-organic N and EM4

Treatments	Net assimilation rate (g m^{-2} d^{-1})		
	14-28 DAP	28-42 DAP	42-56 DAP
Source of N (138 kg N ha^{-1})			
K0 (100 % urea)	16.30 ab	14.78 b	16.41 a
K1 (75% Urea + 25 % goat manure)	16.69 b	14.89 b	18.76 b
K2(50 % Urea + 50 % goat manure)	15.19 a	14.07 b	18.23 b
K3 (25% Urea + 75% goat manure)	15.13 a	12.75 a	16.29 a
LSD 5%	1.19	1.42	1.81
Dose of EM4			
E1 (10 l.ha^{-1})	15.71	13.85	16.15 a
E2 (20 l.ha^{-1})	15.59	14.06	18.10 b
E3 (30 l.ha^{-1})	16.18	14.46	18.02 b
LSD 5%	ns	ns	1.57

Remarks: Numbers followed by different letter at each column are significantly different at P=0.05. ns=not significant

Eggplant fertilised with 25% of Urea and 75% of manure grew more slowly than the plants given the combination of other sources of Nitrogen. This might be caused by the absence of synchronisation of N nutrient. The bigger proportion of N produced from manure compared to urea might cause the plant to lack nitrogen in its early growth. Nitrogen obtained from goat manure was not yet proven to be effectively used by plant due to its slow release of N, while N of urea was perceived to fail to meet plant need. The absence of synchronisation of nutrient in the combination of nitrogen sources led to the slower growth process although the amount of nitrogen produced was equal to that from the combination of other nitrogen sources.

The eggplant fertilised with the combination of urea and manure yielded more fruit. As represented in Table 4, it is explained that the equal dosage of N did not guarantee the same results, depending on the synchronisation of nutrient occurring. In the combination of 75% of urea + 25% of manure and 50% of urea + 50% of manure gave better synchronisation than 100% of urea or 25% of urea + 75%, in which the former gave more higher yield per hectare. This result is linear with the research conducted by Kamili *et al*. (2002) implying that the application of 75% of N fertiliser according to recommended dosage which was combined with microbes inoculated into the soil, was proven to give higher yield of eggplants per hectare than the plants fertilised with 100% of inorganic fertiliser.

The 25% reduction of dosage in Urea, and the replacement of this percentage with goat manure with equal dosage (K_1) gave higher yield of eggplants. This shows that there was a synchronisation between the release of nutrient and the plant need for nutrient. This synchronisation existed because the proportion of the two N sources could meet the nutrient availability for the eggplant. The application of 75% of urea could meet the need for Nitrogen, while the 25% of manure not only provided the N but it also maintained the physical, chemical and biological characteristics of soil. This result is parallel to research once conducted by Nursyamsi *et al*. (1996) which informs that the combination of inorganic fertiliser (urea) and compost is able to increase nitrate ($NO3^-$), C-organic, cation-exchange capacity (CEC) of soil, and maintain corn production. Nutrient release from urea was rapidly available and instantly usable by the plant. However, this nutrient was easily lost due to evaporation, volatilisation and washing. In manure, nutrient was released gradually so that they were not instantly available, but the loss of nutrient due to washing and volatilisation could actually be hampered. Bhoye *et al*. (2010) suggested that the N release in manure would depend on mineralisation of N and C/N ratio in manure. Nitrogen would be available in a great amount along with time. Therefore, the above combination was able to meet the plant need.

Table 4. Fruit number and fruit weight caused by combination of inorganic-organic N and EM4

Treatments	Fruit number plant^{-1}	Fruit weight		
		(g fruit^{-1})	(kg.plant^{-1})	(t.ha^{-1})
Source of N (138 kg N ha^{-1})				
K0 (100 % urea)	6.36 a	275.05 a	1.76 a	22.13 a
K1 (75% Urea + 25 % goat manure)	8.63 c	345.07 c	2.98 c	48.70 c
K2(50 % Urea + 50 % goat manure)	7.74 bc	318.99 b	2.48 b	43.21 bc
K3 (25% Urea + 75% goat manure)	7.17 ab	304.67 b	2.19 ab	38.96 b
LSD 5%	1.01	23.61	0.40	6.74
Dose of EM4				
E1 (10 l.ha^{-1})	6.81 a	293.92 a	2.02 a	30.18 a
E2 (20 l.ha^{-1})	7.39 ab	310.56 ab	2.31 a	37.62 b
E3 (30 l.ha^{-1})	8.22 b	328.36 b	2.73 b	46.96 c
LSD 5%	0.88	20.44	0.34	5.84

Remarks: Numbers followed by different letter at each column are significantly different at P=0.05

The lack of N in eggplant would give lower yield. However, the eggplant with 25% of urea + 75% of manure and 100% of urea would result in weightier fruit per hectare than the combination of other N sources. It was not because of the equal initial dosage given, but rather due to the different portion of N available, stemming from the different level of nutrient synchronisation.

Nutrient synchronisation in the application of 100% of urea and 25% of urea + 75% of manure was lower. Fertilisation with 100% of urea gave insignificant efficiency because too little nutrient was not absorbed by the plant. Nitrogen in urea was easily available and, thus, it was likely to be washed, to evaporate or volatilise. This caused the nutrient to be available in very limited amount. Hayati *et al*. (2011) emphasised that the plant would not grow and yield optimally when the nutrient needed by the plant was not available in sufficient amount. In the combination of 25% of urea + 75% of manure, the low efficiency of N was caused by the insufficient availability of N from manure during the early growth of eggplant, while N produced by urea could not also meet the plant need. According to Nyakpa *et al*. (1998), nitrogen must be available for the plant before the new cells in the plant were formed, recalling that the growth would be impossible to occur without N. The plant grows proportionally with sufficient availability of N, while inadequate Nitrogen will hamper the plant growth.

EM4 applied to the eggplant could increase the plant yield. Thirty litres of EM4 ha^{-1} gave higher fruit yield per hectare compared to EM4 given in a lower dosage (Table 4). Higher dosage of EM4 applied to soil would help with the re-arrangement of organic matters in the soil, so that the process of nutrient release could run faster. EM4 contains bacteria such as *Azotobacter sp.* which could accelerate the decomposition process of organic matters. Rahmawati (2005) stated that the bacterium of *Azosprillium sp.* and *Azotobacter sp.* were capable of improving the efficiency in nitrogen uptake, and reducing the likelihood of nitrogen loss caused by washing, denitrification, and volatilisation. Table 5 shows that the application of EM4 (30 litres ha^{-1}) rapidly reduced C/N of organic matters compared with EM4 given in 10 doses and 20 litres ha^{-1}. The availability of nitrogen in soil could enhance the process of photosynthesis; therefore, the accumulation of photosynthate in the fruit increased.

EM4 is also able to enhance the resistance of plant to diseases and reduce the death rate of plant. Table 6 shows that death rate of eggplant could be reduced along with the increase of EM4 dosage. The death rate of eggplant could be reduced up to 31.9% when given 30 litres ha^{-1} of EM4. Moreover, 10 litres ha^{-1} of EM4 could reduce the plant death rate up to 40.91%. The more dosage of EM4 was applied to the soil, the more varied the microorganism would be in the soil. Therefore, the disease carrying bacteria could be resisted. Eggplant is prone to wilt disease. With the application of EM4, it is expected that the eggplant is able to withstand diseases and improve the yield quantity per hectare. Sayed *et al.* (1998) believed that the application of EM4 served as an alternative in controlling diseases in the plants of *Solanaceae*. EM4 contains several microorganisms, by which, through fermentation process, organic acids, plant hormones, vitamins and antibiotics are produced for the protection of the plant from attack by pathogen.

Table 5. C/N ratio in goat manure

Treatments	C/N ratio (%)				
	0 DAP	7 DAP	14 DAP	28 DAP	56 DAP
K1E1	13	12.36	12.31	9.97	9.33
K1E2	13	11.67	11.24	8.90	8.55
K1E3	13	11.42	10.26	8.17	6.65
K2E1	13	11.52	10.09	9.48	8.13
K2E2	13	11.38	9.94	8.78	6.83
K2E3	13	10.91	9.71	7.43	6.00
K3E1	13	12.11	9.47	7.69	7.33
K3E2	13	11.11	8.88	6.77	6.38
K3E3	13	10.89	6.47	6.10	5.80

Table 6. Percentage of death plant caused by combination of inorganic-organic N and EM4

Treatments	E_1	E_2	E_3	Average
K_0	58.00	51.00	42.00	50.33
K_1	39.60	34.50	31.10	35.07
K_2	34.60	30.00	27.50	30.70
K_3	31.45	29.10	27.00	29.18
Average	40.91	36.15	31.90	

CONCLUSION AND SUGGESTION

Conclusion

The 50% reduction in the proportion of urea and the replacement of this percentage with goat manure could increase the eggplant fruit yield, respectively 48.70 t ha^{-1} and 43.21 t ha^{-1} for the combination of 75% urea + 25% goat manure and 50% urea + 50% goat manure. The application of 100% of urea gave less fruit yield than the combination of urea + goat manure, which was 22.13 t ha^{-1}. Increasing the dosage of EM4 in soil could improve the yield of eggplant. EM given in 30 litres ha^{-1} could significantly increase fruit yield (46.96 t ha^{-1}). The application of 30 litres ha^{-1} EM4 could also accelerate decomposition and mineralisation of nitrogen. Moreover, EM4 could also increase the plant resistance to diseases and suppress the death rate of plant to the lowest point. Thirty litres ha^{-1} of EM4 could reduce the death rate of plant up to 31.9%.

Suggestion

The 25% reduction of urea is able to enhance the growth and yield of eggplants better than the combination of other nitrogen sources. In order to increase the production of eggplants in an enviro-friendly way, the use of 75% of urea combined with 25% of goat manure is recommended. As it proved in the research that giving EM4 in the right dosage could enhance the plant growth, increase yield, and help with the plant resistance to diseases, the application of 30 litres ha^{-1} of EM4 is encouraged.

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REFERENCES

Adil, W.H., N. Sunarlim and I. Roostika. 2006. The effect of three kinds of nitrogen fertilizer on vegetables. (in Indonesia). Biodiversitas 7(1): 77-80.

Adiyoga, W. 2009. Trend analysis of results per unit area of vegetables in Indonesia year 1969-2006 (in Indonesia). J. Hort. 19(4): 484-499.

Agbo, C.U., P.U. Chukwudi and A.N. Ogbu. 2012. Effects of rates and frequency of application of organic manure on gowth, yield and biochemical composition of *Solanum melongena* L. (cv. 'Ngwa Local') Fruits. Journal of Animal and Plant Sciences. 14(2): 1952-1960.

Akanbi, W.B., O.A. Olaniran., F.M. Tairu., J.A. Akinfasoye., M.A. Ojo., A.S. Adeyeye and E.A.O. Ilupeju. 2010. Response of *Solanum melongena* to NPK fertilizer and age transplant in the Guinea Savana Zone of Ecological Area of South Western Nigeria. Libyan Agriculture Research Center Journal International. 1(4): 202-210.

Bhoye, K.P., P.G. Shete and V.S. Baviskar. 2010. Effect of partially and fully decomposed FYM on nitrogen mineralization, carbon loss and available nutrient status of shorghum. An Asian Journal of Soil Science. 5(2): 249-252.

BPS. 2009. Vegetable production in Indonesia. (in Indonesia). Central Statistics Beureau Republic of Indonesia.

Hardianto, R. 2000. Utilization of effective micro-organisms and bokashi for soil fertility restoration and enhancement productivity in dryland farming. (in Indonesia). Buletin Teknologi dan Informasi Pertanian. 2(1): 61-72.

Hardjowigeno, S. 1989. Soil science. (in Indonesia). PT. Mediyatama Sarana Perkasa, Jakarta.

Hayati, M., E. Hayati and D. Nurfandi. 2011. The effect of organic and inorganic fertilizer on growth of several sweet corn varieties in Tsunami area. (in Indonesia). J. Floratek. 6: 74-83.

Kamili, I.A., M,Y, Zargar and M.A. Chatto. 2002. Effect of microbial inoculants, chemical nitrogen and their combination on brinjal (*Solanum melongena* L.) Veg.Sci. 29(1): 87-89.

Kowalska, G. 2008. Flowering biology of eggplant and procedur intensifying fruit set – review. Acta Sci. Pol. Hortorum Cultus 7(4): 63-76.

Lingga, P and Marsono. 2008. Fertilizer use instructions. (in Indonesia). Penebar Swadaya. Jakarta. pp.150.

Lwin, M and S.L. Ranamukhaarachchi. 2006. Development of biological control of *Rals-tonia solanacearum* through antagonistic microbial populations. Int. J. Agi. Biol. 8(5): 657-660.

Masinde, P.W., J.M. Wesonga., C.O. Ojiewo., S.G. Agong and M. Masuda. 2009. Plant growth and leaf N content of *Solanum villosum* genotypes in response to nitrogen supply. Dynamic Soil, Dynamic Plant. 3(1): 36-47.

Moraditochaee, M., H.R. Bozorgi and N. Halajisani. 2011. Effects of vermicompost application and nitrogen fertilizer rates on fruid yield and several attributes of eggplant (*Solanum melongena* L.) in Iran. World Applied Sciences Journal. 15 (2) : 174-178.

Murrinie, E.D. 2011. Peanut plant growth analysis and shifting composition of weed at different weeding frequency and planting distance. Faculty of Agriculture, Muria University, Kudus. p. 1-15. (in Indonesia).

Nafiu, A.K., A.O. Togun, M.O. Abiodun and V.O. Chude. 2011. Effects of NPK fertilizer on gowth, drymatter production and yield of eggplant in Southwestern Nigeria. Agic. Biol. J. N. Am. 2 (7) : 1117-1125.

Nursyamsi, D., J.S. Adiningsih, Sholeh, and A. Adimihardja. 1996. Utilization of organic matter for Improving efficiency of N fertilizer and Ultisols soil productivity in Sitiung, West Sumatra. (in Indonesia). Jurnal Tanah Tropika 2: 26-33.

Nyakpa, M.Y., A.M. Lubis, M.A. Pulung., A.C. Amrah., A. Munawar, G.B. Hong and N. Hakim. 1988. Soil fertility. Universitas Lampung. p. 174-176. (In Indonesia)

Rahmawati, N. 2005. Utilization of biofertilizer on organic farming. (in Indonesia). A Paper of Faculty of Agriculture, University of North Sumatra, Medan. (in Indonesia).

Ruhukail, N.L. 2011. Influence of EM4 cultured on bokashi and inorganic fertilizers on production of peanut (*Arachis hypogaea* L.) in Kampung Wanggar, Nabire Regency. (in Indonesia). Jurnal Agoforestri. 6(2): 114-120.

Sayed, B.C., B. Roy and H.Abdullah. 1998. Effects of effective microorganisms (EM) and calcium nitrate ($Ca(NO_3)_2$) on bacterial eilwt establishment in eggplant (*Solanum melongena* L.). Capsicum and Eggplant Newsletter. 17: 88-91.

Sudartiningsih, D., S.R. Utami and B. Prasetya. 2002. Effect of urea and enriched organic fertilizer on the availability, uptake and production of long Chilli (*Capsicum annuum* L.) on Inceptisol in Karangploso, Malang. (in Indonesia). Agrivita. 24(1): 63-69.

Sutanto, R. 2002. Organic farming towards alternative and sustainable agriculture. (in Indonesia). Kanisius. Yogyakarta

Suwandi. 2009. Measuring plant nutrient requirements in innovation development of sustain-able vegetable cultivation. (in Indonesia). Pengembangan Inovasi Pertanian 2(2): 133-147.

Ul Hassan, S.W., F.C. Oad, S. Tunio, A.W. Gandahi, M.H. Siddiqui., S.M. Oad and A.W. Jagirani. 2010. Effect of N application and N spliting strategy on maize N uptake, biomass pro-duction and physio-agronomic charactertics. Sarhad J. Agric. 26(4): 551-558.