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THE EFFECT OF DIFFERENT TYPES OF ORGANIC FERTILIZERS ON GROWTH AND YIELD OF *ABELMOSCHUS ESCULENTUS* L. MOENCH (OKRA)

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Abstract

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The experiment was carried out at the University Sultan Zainal Abidin (UniSZA) farm to study the effect of different types of organic fertilizers on yield performances of *Albemoschus esculentus L. Moench* (okra). Six different treatments (no fertilizer, NPK fertilizer, poultry manure, rat manure, goat manure and rabbit manure) were replicated three times in three beds. The experiment, arranged in Randomize Complete Block Design (RCBD), was carried out from January 2015 till May 2015. The data were collected on the growth and yield parameters including plant height (cm), leaf area (cm^2), number of branch/plant, number of flower/crop, chlorophyll content, number of pods/plant, number of seeds/pod, photosynthesis rate, internal CO_2, transpiration rate, weight of pods and lastly total soluble solids. From this study, the application of poultry manure increased significantly the growth and yields performances on okra compared to other types of organic fertilizers. The results indicated a significant increase in growth parameters of okra including (plant height, number of branch, leaf area, chlorophyll content, photosynthesis rate, number of flower, weight of pod, number of pod and lastly number of seeds). Poultry manure significantly increased the plant height with 52.64 cm, while the lowest of 35.98 cm was from control plot. Okra yield of poultry manure plot had the highest number of pods with 9.67, while control plot had the lowest number of pods with 2.00. Based on the findings of the experiments, it can be concluded that application of poultry manure significantly increased the growth and yields performances on *Albemoschus esculentus L. Moench* (okra) compared to other types of organic fertilizers.

Key words: organic fertilizer; okra; growth; yield; quality

Introduction

Okra (*Albemoschus L. Moench*) known in English speaking countries as ladies's fingers, bhindi, bamia, ochro or gumbo is the flowering plant in the mallow family. Okra is one of the most popular vegetable crops grown throughout the tropics of the world during spring and summer seasons. It is valued for its edible green seed pods. The plant is cultivated in tropical, subtropical and warm temperate regions around the world. The present study was carried out by choosing *Albemoschus* as the main crop to study on the effect of different types of organic fertilizers on the yield and growth performances of okra.

Organic fertilizers are defining as those derived exclusively from decomposed or decomposing plant or animal remains (Buob, 2008). Some examples of common organic fertilizers are raw or composted animal manures, compost without synthetic additives, green manure and organic mulches such as legume hay or leaves. Organic fertilizers used in this study are using different types of animal manure such as cow dung, poultry manure, rabbit and goat manure directly from available livestock operation. There are many advantages of animal manures in which they make an excellent garden soil amendment by building organic matter and can contribute significant amounts of plant nutrients al-

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though the nutrient content of animal manures varies widely with type and age of the animals, feeds and manure management methods. Organic fertilizer which is farm yard manure gave resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity, and exchangeable calcium, magnesium and potassium which invariably enhance crop yield and productivity (Bhata and Sukla, 1982). There are high availability of NPK content for suitability and usefulness of organic fertilizers (Waddington, 1998), that capable to enhance soil fertility (Thomas, 1997). Some of the organic manure may give the high yield and growth performance on okra, thus the study is to investigate which animal manure or organic fertilizer is the best to be applied on plants.

Generally, excessive amounts of inorganic fertilizers are applied to vegetables in order to achieve a higher yield (Stewart et al., 2005) and maximum value of growth. However, the use of inorganic fertilizers alone may cause problems for human health and the environment (Arisha and Bradisi, 1999). Used of chemical fertilizer also may cause negative impact on soil health. The other problem regarding this study is that the potentialities of organic source is very limited to afford higher crop production due to slow release of plant nutrient from organic matter. Only one fifth to half of the nutrient supplied from manure was recovered and reminder was released after 24 hours per annum (Miah, 1994). In tune with the contemporary problems the present study was carried out to test the effect of difference types of organic fertilizers on growth performances of Okra.

Organic fertilizers are very essential for proper development of plants as they offer rapid growth with superior quality by containing some nutrient that necessary for better development. It has been reported that application of vermicompost and poultry manure subsequently increase yield attributing characters and yield of okra (Sameera et al., 2005). It was also reported that poultry manure seems to promote higher growth and yield of okra (Tiamiyu et al., 2012). In addition, organic matters help in improving the soil fertility and also the physical properties of soil. Organic fertilizer also have potential to replace chemical fertilizer in order to reduce negative impact of intensive use of chemical fertilizer in agricultural. Thus, the objectives of this study were to evaluate the growth and yield performances of okra in different types of organic fertilizers and identify the best organic fertilizer which enhances both growth and yield of okra.

Materials and Methods

Experiment material

Experiment was carried out at the University Sultan Zainal Abidin (UniSZA), Tembila Campus farm from January 2015 to June 2015. Materials used in this field experiment include seeds of okra (*Albemoschus esculentus L.* Moench), hoe, shovel, compost, NPK fertilizer, rat manure, poultry manure, rabbit and goat manure.

Experimental Design

Seeds were planted at a spacing of 50 cm × 50 cm and two seeds were put per hole and later were thinned to one seedling per stand after their germination. Each plot consisted of 5 plants with total of 6 plots for each bed. Overall of the plants including all three beds are 90 plants with each bed consisted of 30 plants. The area of each plot is 2.25 m × 2.3 m. The experiment was arranged in Randomize Complete Block Design (RCBD) of 6 treatments replicate 3 times.

Trial Management

Before data were collected, compost was applied by broadcasting and thoroughly into experimental plot. The plot then were watered and left for one week before planting the seed. After two weeks the data were collected.

Treatments

There were six treatments including the positive control (NPK fertilizer), negative control (no fertilizer), T1 (poultry manure), T2 (rat manure), T3 (goat manure), T4 (rabbit manure). For positive control, NPK blue was applied 10 g per plant. The rates of different organic manures amounted to 5 kg per plant during vegetative growth of plant.

Data Collection

In this experiment, ruler was used for measuring plants height (cm). Other growth parameters such as number of branches/plant, number of flowers/crop, number of pods/plant, and number of seeds/pod were measured manually. Meanwhile, weights of pod were determined by weighing scale. In addition, leaf area (cm^2) was measured by leaf area meter. The average for each result was calculated and the data was recorded.

Measurement of chlorophyll content

Chlorophyll content was measured by using a SPAD-502 meter (Minolta, Japan). This SPAD meter was hand-held device that widely used for rapid, accurate and non-destructive measurement of leaf chlorophyll content by means of absorbance or transmittance measurements. Before use the meter, it was calibrated about 15 minutes so that readings can take accurately. The measurement was taken by meter was simply clamp over leafy tissue. After that, meter showed an indexed chlorophyll content reading in less than 2 seconds. The reading has scale from -9.9 to 199.9 then readings were recorded.

Measurement of photosynthesis rate (Pn), transpiration rate, and internal CO_2

The photosynthesis rate (*Pn*), transpiration rate, and internal CO_2 were determined by using portable photosynthesis system CI-340 Handled Photosynthesis System. The measurement was taken at 9.00 a.m to 1.00 p.m. The clip of this system was clamped over the leaf for 15 minutes. The readings were observed and recorded.

Determination of total soluble solids (TSS)

The TSS content of pod was evaluated by using Atago 8469 hand-held refractometer (Atgo Co. LTD., Tokyo, Japan) and was expressed as percentage Brix (% Brix). The samples were collected from each different fertilizer used. The samples then were cleaned and air dried. Then, it was weighed about 1g for each treatment by using electronic balance. The weighed samples were crushed in mortar and pestle and 1 ml of distilled water was added to produce juice. Two drops of juice were placed to the refractometer sensor. The readings showed in percentage and the data were recorded.

Insect and pest management

The plants were observed regularly for heliothis, eggfruit caterpillar, fruit fly, aphids, mites and silverleaf whitefly. The plants will also be monitor for the present of bacterial spot, bacterial wilt, mosaic, sclerotium base rot, sudden wilt, tomato spotted wilt virus, grey mould (Botrytis), powdery mildew and sclerotinia rot. Appropriate chemicals were used to apply to the plants.

Statistical Analysis

Data obtained were subjected to statistical analysis using Analysis of Variance (ANOVA) to determine if the treatments have any significant effect on parameters measured. All data were analyzed according to One-Way ANOVA using SPSS software version 20.0.

Results

Figure 1 showed effects of different types of organic manure on plant height of OKRA at 10 week after planting. The result showed that plant height was significantly ($P \leq 0.05$) affected by different types of organic manure used. The NPK fertilizer plot had the highest height mean value which was 64.77 cm followed by poultry manure plot with 52.64 cm and the lowest height was no fertilizer plot with 35.98 cm.

The effect of different types of organic fertiliser on yield of OKRA

In this experiment, Table 1 showed that number of branch was significantly ($P \leq 0.05$) affected by different types of organic manure and NPK fertilizer used. The NPK fertilizer plot had the highest number of branches with mean of 7.00 followed by 5.67 from poultry manure while no fertilizer had the lowest number of branches with mean 3.00.

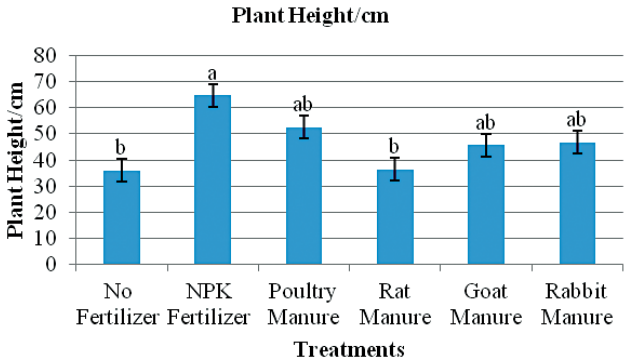

Fig. 1. Plant height (cm) of OKRA versus different types of organic fertilizer used at 10 WAP. Bars indicate (±S.E)

Table 1
Effect of different types of organic fertilizer on number of branches, number of flowers, number of pods and number of seeds

Treatments	Branches/ plant	Flowers/ plant	Pods/ plant	Seeds/ pod
No Fertilizer	3.00^{c}	2.00^{c}	2.00^{c}	60.00^{b}
NPK Fertilizer	7.00^{a}	9.00^{a}	10.33^{a}	91.67^{a}
Poultry Manure	5.67^{ab}	8.33^{ab}	9.67^{a}	77.67^{ab}
Rat Manure	4.33^{bc}	2.33^{c}	2.33^{c}	63.00^{b}
Goat Manure	5.33^{ab}	6.67^{ab}	7.00^{b}	73.33^{ab}
Rabbit Manure	4.33^{bc}	3.67^{c}	3.67^{bc}	72.67^{ab}

Means within the same column followed by the same letter, do not differ significantly according to LSD test at α=0.01

Besides that, the numbers of flower per plant were significantly ($P \leq 0.05$) increased by the application of different types of organic fertilizer. More number of flowers was recorded in NPK fertilizer plot which is 9.00 followed with poultry manure which was 8.33. The lowest was no fertilizer plot, with only 2.00 for mean value and control with 2 flowers only.

Figure 2 showed that the highest is NPK fertilizer with mean value of 28.33 following with poultry manure with 22.67 and the lowest is negative control plot with 16.67. The result showed that, the effect of different type of organic fertilizer on weight of pod was not significant.

In addition, result showed that number of pod also was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The results also showed the same with the previous result which NPK fertilizer plot had the highest

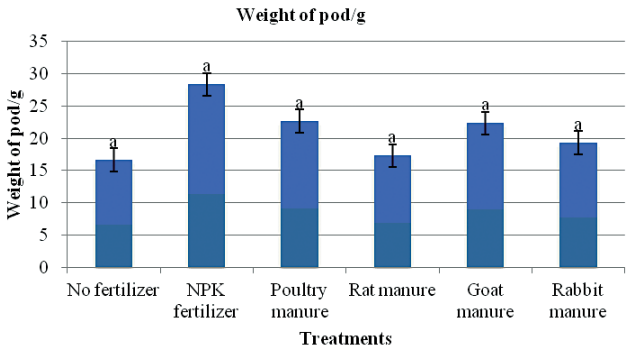

Fig. 2. Weight of pod versus different types of treatments. Bars indicate (±S.E)

number of pods with mean of 10.33 followed by 9.67 from poultry manure while no fertilizer had the lowest number of pods with mean 2.00. For the seed yield also, similar result showed that NPK fertilizer was the highest with mean value 91.67. Meanwhile, poultry manure is the second with mean value 77.67 and the lowest is no fertilizer with 60.00. Figure 3 showed the effects of different types of organic fertilizer on leaf area of Okra plant. It was shown that the effect of different types of organic fertilizer on leaf area was significant ($P < 0.05$). The plants at poultry manure plot had the highest value of 628.0 cm^2, followed by NPK fertilizer, rabbit manure, goat manure, rat manure and the last was the control plot with 164.86 cm^2.

The effect of different types of organic fertiliser on chlorophyll content of OKRA

Figure 4 showed chlorophyll content of OKRA plant versus different types of organic fertilizer. The result showed that, the effect of different types of organic fertilizer on chlorophyll content was not significant. The highest reading is poultry manure and the lowest one is NPK fertilizer.

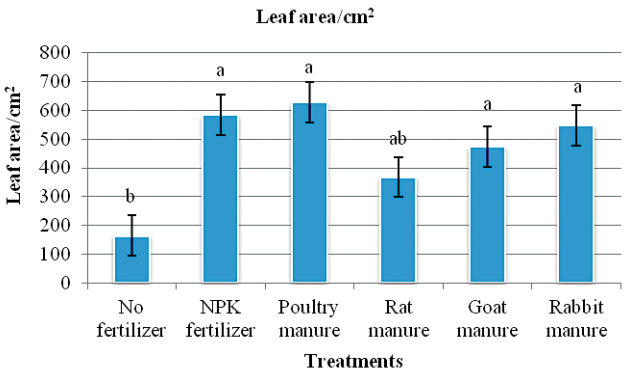

Fig. 3. Leaf area of OKRA plant against different types of organic fertilizer at 10 WAP. Bars indicate (±S.E)

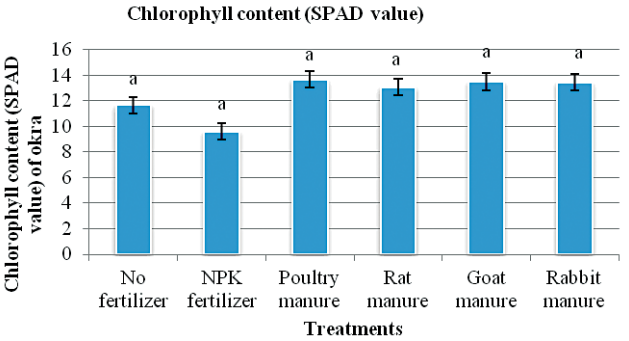

Fig. 4. Chlorophyll content (SPAD value) of okra plant versus different types of organic fertilizer at 10 WAP. Bars indicate (±S.E)

The effect of different types of organic fertilizer on photosynthesis rate, transpiration rate and internal CO_2 of okra

Photosynthesis rate of OKRA plants using different types of organic fertilizer at 10 WAP was shown in Table 2. The result showed that the effect of different types of organic fertilizer on photosynthesis rate was not significant. The plants at the poultry manure plot showed the highest mean value of 13.67, followed by the goat manure plot with mean value 13.50 while the lowest was the NPK fertilizer plot with 9.60. Furthermore, it was shown that transpiration rate was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The highest was goat manure with mean value of 2.37 and the lowest was NPK fertilizer with 1.07. It was also shown that internal CO_2 was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The highest was for no fertilizer plot (T0) with mean value of 38.67 and the lowest was goat manure plot (T4) with only 31.90.

Table 2
Effect of different types of organic fertilizer on photosynthesis rate, transpiration rate and internal CO^2 of OKRA

Treatments	Photosynthesis rate (µmol/m^2/s)	Transpiration rate (mmol/m^2/s)	Internal CO^2 (ppm)
No Fertilizer	11.67^a	1.40^{ab}	38.67^a
NPK Fertilizer	9.60^a	1.07^b	34.50^b
Poultry Manure	13.67^a	1.13^{ab}	32.67^c
Rat Manure	13.07^a	1.60^{ab}	34.67^b
Goat Manure	13.50^a	2.37^a	31.90^c
Rabbit Manure	13.47^a	1.27^{ab}	32.53^c

Means within the same column followed by the same letter, do not differ significantly according to LSD test at α=0.01

The effect of different types of organic fertilizer on Total soluble solids (TSS)

Figure 5 showed that TSS was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The highest is

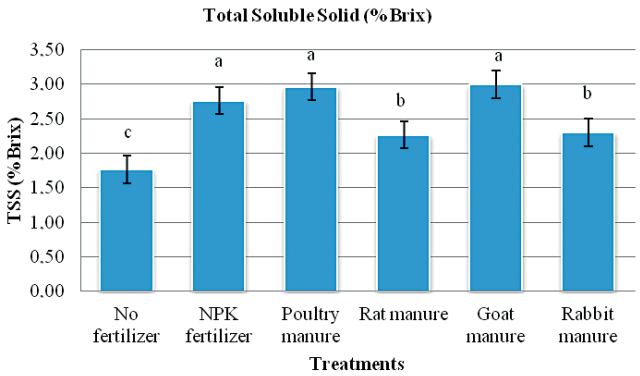

Fig. 5. Total soluble solid versus different types of organic fertilizer. Bars indicate (±S.E)

goat manure with 3.00 and the lowest is no fertilizer plot with 1.77.

Discussions

Organic manure have gained a lot of attention from public as they are available abundantly, free from any chemicals, as well as can increase the soil fertility. The soil fertility can be improved by organic and inorganic fertilizers application depends on several factors such as soil type, nature of crop and socio-economic conditions of the area. Organic manures improve soil fertility by activating soil microbial biomass (Ayuso et al., 1996). Application of manures sustains cropping system through better nutrient recycling (El-Shakweer et al.,1998). Manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil (Abou El-Magd et al., 2006). Toriman et al. (2009) reported that BRIS soil is sandy and nutrient deficient and the presence of sodium (N), zinc (Zn), iron (Fe), lead (Pb), copper (Cu) and manganese (Mg), albeit in small quantities.

Our result showed that plant height was significantly ($P \leq 0.05$) increased by different types of organic fertilizer. Highest height mean was obtained from OKRA plants in NPK fertilizer plot which is 64.77 cm. Then followed by poultry manure plot with 52.64 cm and the lowest height was no fertilizer plot with 35.98 cm. The result was supported by Ajari et al. (2003) that organic manure especially poultry manure could increase plant height of crops when compared with other sources of manures.

For the effect of different types of organic fertiliser on yield of OKRA which includes number of branches, number of flowers, number of pods and number of seeds, the highest result achieved was using NPK fertilizer, followed by poultry manure and the lowest was no fertilizer plot. Onwu et al. (2014) also reported that the application of poultry manure recorded the highest number of branches and was significantly different from all other treatments. Similar to number of flowers, Nweke et al. (2013) reported that more number of flowers were recorded in poultry manure compared to the other treatment.

Besides that, number of pod also was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The NPK fertilizer plot had the highest number of pods with mean of 10.33 followed by 9.67 from poultry manure while no fertilizer had the lowest number of pods with mean 2.00. The result was supported by Onwu et al. (2014) who reported that the application of poultry manure gave the most in pod yields while the least was from control plot.

Based on the Table 1, the number of seed was highest in NPK fertilizer with mean value of 91.67 followed with poultry manure plot with 77.67 and the lowest was no fertilizer with 60.00. Alaisiri and Ogunkeyede (1999) reported that application of poultry manure gave the optimum seed yield of okra. The result showed that number of seeds per pod was significantly ($P \leq 0.05$) affected by different types of organic fertilizer.

Figure 2 showed weight of pods versus different types of treatments. The highest was NPK fertilizer with mean value of 28.33 following with poultry manure with 22.67 and the lowest was negative control plot with 16.67. The result showed that, the effect of different type of organic fertilizer on weight of pod was not significant. The increase in fresh pod weight of okra was due to poultry manure application could be attributed to easy solubilization effect of released plant nutrient leading to improved nutrient status and water holding capacity of the soil. The results obtain were in agreement with the findings of (Premsekhar and Rajashree, 2009) in which they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants.

The importance of leaf area in relation to basic plant metabolic processes, such as photosynthesis and respiration, is generally recognized. Furthermore, the quantification of several growth analysis parameters requires the measurement of leaf area at several stages during the life cycle of the plant (Bueno, 1979). It was observed that organic fertilizer treatment significantly increased the leaf area of okra plant under field conditions. The plants at poultry manure plot had the highest value of 628.0cm^2, followed by the control plot with 164.86cm^2.This finding was supported by the results of Ufera et al. (2013) who stated that the largest leaf area was produced by the application of poultry manure.

In addition, chlorophyll is an extremely important biomolecule, critical in photosynthesis, which allows plants to absorb energy from light. This makes chlorophyll content is an important experimental parameter in agronomy and plant biology research (Lamb et al., 2012). The result showed that, the effect of different type of organic fertilizer on chlorophyll content was not significant. The highest reading was poultry manure and the lowest one was NPK fertilizer. According to Sevik et al. (2012), amount of chlorophyll shows alteration depending on many edaphic and climatic factors such as salt stress, water stress, light, air pollution, fertilizer and also it shows alteration depending on time in vegetation period. Premsekhar et al. (2009) reported that the chlorophyll content in the leaves might have been significantly improved with the application of organic sources of nutrients.

All living organisms in nature depend on photosynthesis in terms of energy. Photosynthesis is the production of organic compounds by using luminous energy in living creatures having chlorophyll (Sevik et al., 2012). Through photosynthesis process, living creatures get sources of nutrients and oxygen. Chlorophyll absorbs sun light and converts it to chemical energy (Yakar and Bilge, 1987). Therefore, the main factor is chlorophyll in photosynthesis having vital importance for living creatures. Table 2 showed the photosynthesis rate of OKRA plants using different types of organic fertilizer at 10 WAP. The plants at the poultry manure plot showed the highest mean value of 13.67, followed by the goat manure plot with mean value 13.50 while the lowest was the NPK fertilizer plot with 9.60. The increased application of farm yard manure or organic fertilizer, which contains appreciable quantities of magnesium, might have helped in chlorophyll synthesis which in turn increased the rate of photosynthesis. The results are in agreement with the findings of Nehra et al. (2001) and Sanwal et al. (2007).

Furthermore, the process of transporting water through an actual, vegetated plant into the atmosphere is known as transpiration process. According to Wallace et al. (1962), factors that affect transpiration rates are species, light, temperature, humidity, availability of water, stage of development of plants, root aeration, wind velocity, cutinization, and size, number, and distribution of stomata. It our experiment, it was shown that transpiration rate was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The highest was goat manure with mean value of 2.367 and the lowest was NPK fertilizer with 1.07. Besides that, it was also shown that internal CO_2 was significantly ($P \leq 0.05$) affected by different types of organic fertilizer. The highest was for no fertilizer plot (T0) with mean value of 38.67 and the lowest was goat manure plot (T4) with only 31.90. For the TSS's result, goat manure with 3.00 became the highest organic fertilizer which produce pod that had higher soluble solids content and the lowest was no fertilizer plot with only 1.77. Shin et al. (1998) reported that increased photosynthetic activity enhanced the yield and sugar content of fruits.

From all the results, we concluded that aside from positive control (NPK fertilizer) and negative control (no fertilizer), the best organic manure that can be used as a media was poultry manure due to its excellent effect to growth and development of OKRA's plants. This was proven by Ali (2005) that poultry manure has been reported to contain more plant nutrients than all other organic manures.

Conclusion

Regardless of positive control: NPK fertilizer and negative control: no fertilizer, poultry manure showed the best effect in most of the growth parameters including (plant height, number of branch, leaf area, chlorophyll content, photosynthesis rate, number of flower, weight of pod, number of pod and lastly number of seeds). It can be concluded that application of poultry manure significantly increase the growth and yields performances on *Albemoschus esculentus L. Moench* (okra) compared to other types of organic fertilizers. By comparing together with the positive control and negative control, NPK fertilizer was the best and no fertilizer was the least. The differences between NPK fertilizer and organic manure are due to the differences in rates of decomposition and nutrient release pattern. Therefore NPK fertilizer is good for those who want to harvest their yield early but by using organic manure especially poultry manure they can save the production cost, and improving the soil physical properties because organic manure is friendly to environment.

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