EFFECTS OF CHICKEN MANURE AND NPK GREEN ON THE GROWTH, DEVELOPMENT AND YIELD OF OKRA (*Abelmoschus esculentus* L.)

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ABSTRACT

This study using polybags was conducted for 10 weeks to evalute the effects of different rate of chicken manure and NPK Green on okra growth, development and yield, and soil chemical parameters. Chicken manure was addded to the planting medium a week before transplanting and at 5th week after sowing at the rates of 30 t ha^{-1}, 50 t ha^{-1}, and 70 t ha^{-1}. NPK Green was added to the planting medium in 4 split application at the rates of 300 kg ha^{-1}, 500 kg ha^{-1}, and 700 kg ha^{-1} respectively. The study was carried out in an open area using complete ramdomized design (CRD) with four replications. All datas were analyzed using One-way ANOVA and Tukey's test was used for means separation. The results showed significant differences in growth, development, yield, leaf nutrient content, and soil chemical properties between the treatments. The highest growth was obtained from plants growth on soil fertilized with 70 t ha^{-1} of chicken manure (T3); plant height, leaf dry weight, stem dry weight and root dry weight increased by 125.5%, 400.0%, 618.6%, and 836.6% respectively compared to control (T7) treatment. Treatment T3 also resulted in the shortest number of days to first flowering (42.8 days). The study indicated that okra plant (10 WAS) did not flower or fruit when no fertilizer was applied (control). Treatment T3 showed the highest mean pod fresh weight (37.6 g), length (18.2 cm) and diameter (7 cm). In comparison to soil properties before planting, soil chemical properties fertilized with 70 t ha^{-1} of chicken manure was the heighest in values of pH, total organic C, N, P, and K increased by 32.1%, 86.7%, 300.0%, 283.3% and 713.0% respectively. The results of analysis showed that treatment T3 mean total N (5.5%), P (1.4%) and K (4.8%) leaf nutrient content was the highest compared to the control (T7) treatment. The study concludes that 70 t ha^{-1} of chicken manure appplication was the best treatment for okra growth, development, yield, leaf nutrient content and soil chemical properties.

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KESAN BAJA TAHI AYAM DAN NPK HIJAU TERHADAP PERTUMBUHAN, PEMBESARAN DAN HASIL OKRA (Abelmoschus esculentus L.)

ABSTRAK

Penyelidikan dengan penggunaan polibeg ini dijalankan selama 10 minggu untuk mengkaji kesan baja tahi ayam dan NPK Hijau pada pertumbuhan okra, pembesaran dan hasil, serta sifat kimia tanah perlakuan. Baja tahi ayam adalah ditambah pada media tanaman seminggu sebelum ditanam dan pada minggu ke-5 selepas ditanam dengan kadar 30 t ha^{-1}, 50 t ha^{-1}, dan 70 t ha^{-1}. NPK Hijau ditambah ke media tanaman dalam 4 ulangan pada tahap 300 kg ha^{-1}, 500 kg ha^{-1}, dan 700 kg ha^{-1}. Penelitian ini dilakukan di kawasan terbuka dengan menggunakan reka bentuk rawak penuh (CRD) dengan empat ulangan pada setiap rawatan. Semua data telah dianalisa dengan ANAVA satu hala dan ujian Tukey's digunakan untuk perbahagian mean. Keputusan kajian menunjukkan perbezaan yang signifikan dalam pertumbuhan, pembangunan, pengeluaran, kandungan nutrien daun, dan sifat kimia tanah antara perlakuan. Pertumbuhan tertinggi diperolehi daripada tanaman yang diberi baja dengan 70 ha^{-1} baja tahi ayam (T3), tinggi tanaman, berat kering daun, berat kering batang dan berat kering akar mencatatkan peningkatan sebanyak 125.5%, 400.0%, 618.6%, 836.6% dibandingkan dengan perlakuan kawalan (T7). Perlakuan T3 juga menunjukkan bahawa jumlah tempoh terpendek bagi tanaman okra untuk berbunga (42.8 hari). Keputusan kajian menunjukkan bahawa tanaman okra (10 WAS) tidak berbunga ataupun berbuah tanpa pembajaan (kawalan). Rawatan T3 menunjukkan angka tertinggi bagi berat segar buah (37.6 g), panjang (18.2 cm) dan diameter (7 cm) buah. Pembandingan kesuburan tanah sebelum diberi baja, sifat kimia tanah yang diberi baja dengan baja tahi ayam adalah tertinggi bagi nilai pH, jumlah organik C, N, P, dan K masing-masing mencatatkan peningkatan sebanyak 32.1%, 86.7%, 300.0%, 283.3% dan 713.0%. Keputusan analisis menunjukkan perlakuan T3 memperolehi mean jumlah N (5.5%), P (1.4%) dan K (4.8%) yang tertinggi terhadap kandungan nutrien daun dibanding dengan perlakuan kawalan (T7). Hasil kajian menunjukkan bahawa kadar pembajaan 70 t ha^{-1} baja tahi ayam adalah yang terbaik untuk pertumbuhan okra, pembesaran dan hasil, kandungan nutrien daun dan sifat kimia tanah.

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LIST OF ARREVIATIONS

ANOVA	Analysis of Variance
CRD	Completely Randomized Design
DAS	Days after sowing
WAS	Weeks after sowing
UMS	Universiti Malaysia Sabah

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CHAPTER 1

INTRODUCTION

1.1 Background

Soil is the foundation of agricultural production. The uptake of nutrients from soil is essential for plant growth. However, the continuous drain of nutrients for crop production will deplete soil fertility which is important for profitable agriculture. Thus, soils must be continuously replenished to maintain the inherent fertility of the soil, and requirements of the crops to be grown. Organic and inorganic fertilizers are the principal means of maintaining soil fertility (Mahmood, 2008).

According to Brady and Weil (1999), improved soil fertility through the application of fertilizers is an essential factor enabling the world to feed the billions of people that are being added to its population. Thus, organic fertilizers are an important source of nutrients for crop growth, especially for organic farming. These are organic byproducts with lowest heavy metal content and free of organic pollutants as compared to inorganic fertilizers which are produced through industrial processes (Madejon *et al.*, 2001).

The alternative practice to chemical fertilizer is organic fertilizer added directly to the soil either before or after planting. Organic fertilizers such as animal manure, green manure, compost and sewage sludge may be added to cultivated soil (Splittstosser, 1990). Studies done by Abu-Agwa and El-Koumey (1993) showed that organic fertilizers may improve the physical and biological properties of the soil and serve as a source of mineral nutrients.

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Farmers add chemical fertilizers to improve soil fertility and to increase the yield of their crop. However extensive application of inorganic fertilizers have some disadvantages on. the plant environment. Application of inorganic fertilizers alone decreases the stability of macro-aggregates and moisture retention capacity but increases the bulk density (Sarkar *et al.*, 2003). Inorganic fertilizers may also undergo decomposition and leach down to ground water and lakes (Al- Samarraie, 1978).

Okra is a herbaceous, annual vegetable crop which belongs to the family Malvacea. Okra is thought to have originated in northern Africa around the upper Nile and Ethopia before spreading to the Mediterranean, Asia and South East Asia (Biggs *et al.,* 2005). In Malaysia, okra is known as lady's finger, 'kacang bendi', kacang tanduk', or 'kacang lendir'. This vegetable grows well in the lowland tropics on any soil, although it does best on well-manured loams. The plants are grown for their immature fruits which are used as a vegetable (Sahadevan, 1987).

1.2 Justification

The use of organic fertilizers is one of the ways to reduce excessive use of chemical fertilizers and over-dependency on them. Abdelaziz *et al.*, (2007) mentioned that the intensive use of chemical fertilizers has side effects such as polluting underground water, destroying microorganisms and insects, making plants more susceptible to the attack of diseases and reducing soil fertility. Chicken manure acts as an organic fertilizer for plant growth. Thus, the application of chicken manure in the farm can reduce chemical pollution of the environment. According to Mohamed Ali (2009), the use of these organic products will also reduce the dependence on mineral fertilizers which are now more expensive. With the rise in prices of chemical fertilizers, beyond the capability of rural area farmers, organic fertilizers seem more appealing as an alternative way for farmers to replenish soil fertility. Vegetables grown with organic fertilizers are safer to consume.

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1.3 Objectives

Therefore, this study was undertaken based on the following objectives:

1) To evaluate the effects of chicken manure and NPK Green on okra (*Abelmoschus esculentus* L.) growth, development and yield.

2) To evaluate the effects of chicken manure and NPK Green on total nitrogen, total phopshorus and total potassium in okra (*Abelmoschus esculentus* L.) leaves.

3) To evaluate the effects of chicken manure and NPK Green on soil carbon, nitrogen, phosphorus, potassium and pH.

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CHAPTER 2

LITERATURE REVIEW

2.1 Okra

Okra is a herbaceous crop, locally also known as lady's finger, originating from tropical Africa and widely spread throughout the tropics. Okra is grown in low-land tropics on any soil although it does best on well-manured loams. Okra is adaptable to a wide range of soil types provided there is no water logging. In Malaysia, okra is best on heavier soils and mature peat. Although it is tolerant to acidic conditions, the plant grows best at pH 5.5 to 6.5 (Sahadevan, 1987). The suitable temperature for the plant's growth is 22-32°C with a rainfall of 168 mm per month or 300 mm per season and ideal altitude would be 500 m above sea level (Rachman and Sudarto, 1991).

The plants are grown for their immature fruits which are used as vegetable. It is a robust, erect annual herb, 1-2 m tall. The fruit is a pyramidal-oblong, beaded capsule, 10-30 cm x 2-3 cm dimensions and longitudinally furrowed. The fruit dehisces longitudinally when ripe. Seeds are dark green to dark brown, rounded, tuberculate and 5 mm in diameter (Sahadevan, 1987). The stem is green in colour, hairy and turns woody when matured. Okra leaves are green in colour, arranged alternately and palmate shaped. The flowers have five yellow petals with a dark red or purple base and are around 5 cm in diameter. Its stigma is red or dark purple colour and about 5-7 cm in length (Chin, 1999).

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There are more than 20 cultivars of okra distributed around the world. Okra cultivars such as Clemson's Spineless, Annie Oakley, Pentagreen, Burgundy, North-South and Green Best are among the popular cultivars (FAMA, 2005). According to Sahadevan (1987), okra vary in height and leaf shape and their fruits vary in length, shape and colour. In Malaysia, the four commonly grown ones are five-angle, eight-angle, nine-angle and crimson spineless. However, five-angle cultivar is preferred. This is because the plant is the shortest of all the cultivars. Further, it fruitings early and yields more compared to the others. Five-angle cultivar fruits also fetch higher prices than the others.

The MKBe 1 (5 angle) and MKBe 2 (7 angle) are the two okra varieties that have been developed by MARDI. Other varieties such as E1 (5 angle), E2 (5 angle), No.71 (10 angle) and No.77 (7 or 8 angle) can be found in Tenom and Tuaran, Sabah. These varieties were introduced by the Sabah State Department of Agriculture (FAMA, 2005).

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Okra is of great economic importance because of its nutritional value. The fruits contain some essential vitamin (vitamin C) and mineral salts such as calcium, phosphorus, magnesium and iron, including water, in varying proportions (Ibeawuchi et al, 2005). According to Oyelade *et al.* (2003), okra seed is known to be rich in high quality protein especially with regards to its content of essential amino acids, relative to other plant protein sources. Table 2.1 (FAMA, 2005) shows the nutritional content per 100 g of edible portions of okra.

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Table 2.1 Nutritional value of edible portion of okra

Components	Nutritional value (per 100 g)
Water content	89.9 %
Protein	1.7 g
Carbohydrate	5.9 g
Fat	0.1 g
Fiber	1.0 g
Calcium	77.0 mg
Iron	1.3 g
Beta-carotene	200 μg
Thiamin	0.1 mg
Nicothiamin	0.7 mg
Riboflavin	0.2 mg
Ascorbic acid	19.3 mg
Phosphorus	32.0 mg

Source: FAMA, 2005

The immature pods can be fried, steamed or added to soups and other sauces that go with cereals or tubers. The pod can be fried, steamed or added into stews or soups. In addition, roasted okra seeds are a good coffee substitute (Chooi, 2006). The plant leaves, flower buds and flowers can be eaten, cooked as greens. The plant leaves can be dried, crushed into a powder and used as a flavoring (Facciola, 1990). Usher (1974) stated that a fiber obtained from the stems of okra is used as a substitute for jute. It is also used in making paper and textiles (Hills, 1952).

According to Romanchick-Cerpovicz *et al.* (2006), okra gum is an acceptable milk-fat ingredient substitute in chocolate frozen dairy dessert. More importantly, okra is valuable with regards to anti-carcinogenicity, human immunity promotion, and aging prevention. The immature pods are used in the treatment of catarrhal infections, ardor urinae, dysuria and gonorrhea (Chopra *et al.*, 1986). In view of health care and traditional use, the fresh fruits and leaves are boiled and eaten to cure cough and throat infections. (Ibeawuchi et al, 2005).

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Based on the uses of the okra plants, Malaysia's okra production has big potential to be developed. Currently the total area planted with okra is just 500 hectares, which comprises 34.5% of the total area planted with selected vegetable in this country, which totals 14,500 hectares (Tables 2.2 and 2.3).

Table 2.2 Total area for vegetable-growing according to countries in 2005

Countries	Total area ('000 hectares)
Pakistan	307.0
India	5,667.4
Bangladesh	429.6
Myanmar	187.4
Japan	411.0
Republic of Korea	394.3
Thailand	187.4
Malaysia	14.5
Indonesia	822.5
Philippines	134.0
Vietnam	279.0
China	3935.9

Source: FAMA, 2005

2.2 Animal Manure Effects on Plant and Soil

According to Relf (1997), animal manure is a complete fertilizer, but low in the amount of nutrients it supplies. Manures vary in nutrient content according to the animal source and what the animal has been eating. A fertilizer ration of 1:1:1, N:P:K is typical. Commonly available manures include chicken, horse, cow, pig and sheep. The highest nutritional concentration is found in manure when it is fresh. As animal manure ages, is exposed to weather, or composted, nutrient content is reduced. However, most gardeners prefer to use composted forms of manure to ensure lesser amounts of salts, thereby reducing the chance of burning plant roots. Due to its low concentration of plant nutrients, manure is best used as a soil conditioner instead of a fertilizer.

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Table 2.3 Total production and total area used for planting of okra in Malaysia (2005).

Subject	Total value
Total land area used ('000 hectares)	0.5
Production (tons/ha)	26.8
Production ('000 tons)	14.3

Source: FAMA, 2005

The concentration of nutrients in animal manures is very low compared with that in chemical fertilizers. However, animal manures supply useful amounts of calcium, magnesium, sulphur and other trace elements which are largely neglected in modern or inorganic fertilizers. If well conserved and incorporated into the soil, they can give considerable savings in the amount of fertilizer required (Simpson, 1986). Zhang (2000) stated that the actual nutrient value of animal manure will differ considerably with the method of collection, storage facilities, and species of animal. Rachman (2002) has shown that different types of organic fertilizers have different content of nutrients (Table 2.4).

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Table 2.4 Nutrient composition in commonly used organic fertilizers

Types of organic manures	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Chicken manure	1.0-2.1	8.9-10.0	0.4
Cow dung	0.5-1.6	2.4-2.9	0.5
Buffalo dung	0.6-0.7	0.2-2.5	0.4
Horse dung	1.5-1.7	3.6-3.9	4.0

Source: Rachman, 2002

Manure application to agriculture land involves the addition of all the components of the manure to the soil. An appropriate balance should be maintained between agronomic requirements and negative environmental impacts. Negative impacts, which could be defined as soil pollution, have to do with the addition of heavy metals, organo-chlorines and many salts. Also, weed's seed be spread through manuring the land. On the other hand, manuring almost always has a positive influence on the buildup of soil organic matter and thus improves the "intrinsic" fertility of the soil, as well as the soil structure (FAO, 2005).

According to FAO (2005), after application of manure, decomposition of the organic material by microorganisms into carbon dioxide, water, and minerals of plant nutrients such as N, P, S, and metals will begin. The transformation of organically bound elements into plant available nutrients during microbiological decomposition is called mineralization. Organic matter that remains one year after application is assumed to be part of the soil organic matter and will decompose gradually over the years, releasing plant nutrients in a way that resembles a slow release fertilizer.

Plants which had been fertilized with chicken manure had the highest growth parameters (Michael *et al.* 2010). Saeed *et al.* (2001) also found that the height of okra is an important growth character directly linked with the productive potential of plant, stem, and root. According to Boateng *et al.* (2006); and Muhammad and Khattak (2009), application of organic manure improved plant height and leaf area in plants. Michael *et al.*, (2010) reported that dry matter content was higher in plants treated

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with organic fertilizers compared to inorganic fertilizers. In addition, a study by Magkos *et al.* (2003) evaluated the dry matter content of several vegetables and found that organically cultivated crops had higher dry matter content than those grown conventionally. According to Obi *et al.* (2005), there is no significant increase in both dry and fresh weight of okra plant with increasing NPK fertilizer treatment rates. Baiyeri *et al.* (2011), reported that the application of poultry manure at planting reduced the number of days to flowering and harvest.

In another study, chicken manure treatment gave a relatively higher marketable yield of red lettuce, followed by cattle manure and bounce back manure, while, inorganically fertilized plants had the least (Michael *et al.*, 2010). Adekayode and Ogunkoya (2010) reported that chicken manure treatment gave a relatively higher marketable yield of red lettuce, followed by cattle manure and bounce back manure while, inorganic fertilized plants had the least. These findings are in accordance with previous reports of Obi *et al.* (2005) who reported no significant increase in both fresh and dry weight of okra plant with increasing NPK fertilizer treatment rates.

Chicken manure applications can affect soil properties. In support of this, Ano and Agwu (2006) found that animal manure increased soil pH and macronutrients of soil in southern Nigeria. Studies by Agbede *et al.,* (2010) showed that application of poultry manure improves soil pH, organic C, N, P, K, Ca and Mg compared to the NPK fertilizer. Recent studies had also shown that poultry manure increased soil pH, organic matter, nitrogen, phosphorus and CEC (Adeniyan and Ojeniyi, 2003; Mbah and Mbagwu, 2006; Ayeni *et al.*, 2008). Apart from the direct releases of mineral nutrients, poultry manure has been shown to increase soil pH and microbial activity (Ano and Agwu, 2005).

According to Kalbasi *et al.* (2009), application of organic fertilizers had a significant effect on soil pH depending on the rate, the number of applications, and the treatment type. The increase in soil pH observed in this study could be attributed to increase in organic matter and calcium ions released into the soil solution during microbial decarboxylation of manure which is known to buffer change in soil pH (Agbede *et al.,* 2010). Application of both organic and inorganic fertilizers significantly increased the organic carbon content of soil as compared to the control (Kalbasi et al.,

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2009). However, the increase was much larger for organic fertilizers depending on the rate and number of applications.

Previous studies show that animal manure improved soil nitrogen content (Ayed, 2002). The increase in soil available levels of N and P with application rates of animal manure could be attributed to increased microbial activities as a result of increased concentration of nutrients. This could have resulted in enhanced decomposition of the organic forms of N and P, and hence increased availability of N and P. This is supported by studies conducted by Bomke and Lavkulich (1975) and Schegel (1992) who observed that poultry manure had the highest effect on soil available levels of P and N compared to other animal manures.

In addition, application of animal manure improved soil potassium content, supported by the findings of Ayed (2002). This is supported by the studies conducted by Ouba and Mahadeen (2008) which indicate that a higher value of leaf N could be attributed to the ability of organic manure to supply nutrients throughout mineralization and improvements in the physical and chemical properties of the soil and the ability of organic fertilizer to release nutrients gradually throughout the growing season. Application of organic manure increasing leaf nitrogen content is also supported by Hegazi *et al.* (2007) and Ayed (2002).

According to Agbede *et al.,* (2010), leaf N, P, K, Ca and Mg in plants fertilized by poultry manure was significantly higher than in plants fertilized by NPK fertilizer. Total nitrogen, pH, organic matter, available phosphorus, exchangeable cations and percent base saturation were improved by application of poultry manure (Adeleye *et al.,* 2010). Previous studies show that plant tissue content related positively to the amount of mineralized N in the growing media.

Total N mineralized from chicken manure and N uptake by barley plants were higher compared to inorganic fertilizer, chicken manure pellet, horse manure, sheep manure and control treatment (Ofosu-Anim and Leitch, 2009). Application of organic manure increased leaf phosphorus content, supported by Hegazi *et al.* (2007) and Ayed (2002). However, decline of P and K concentrations in the leaves were due to their remobilization to the yields of plant (Ouba and Mahadeen, 2008).

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2.3 Inorganic Fertilizer Effects on Plant and Soil

Inorganic fertilizers exist in many forms. Each has advantages either in uptake by plant or method of application. Some inorganic fertilizers are in the form of granules, liquids, pellets and powders, while capsules are the latest form. Inorganic fertilizer in pellet form is the most common method currently used by farmers (Mustafa, 2002).

A complete fertilizer is a fertilizer that has three elements, namely complete nitrogen, phosphorus and potassium content. Besides these three main elements, a complete fertilizer also contains micro-elements that are essential for crop growth. For example, NKP green and blue NPK are complete fertilizers (Mustafa, 2002). The nutrient content of different types of NPK fertilizers are stated in Table 2.3.

Table 2.5 Different types of NPK fertilizers and their nutrient content

Type of NPK fertilizer	Nutrients content (N % : P_2O_3 % : K_2O %)
NPK Green	15 : 15 : 15
NPK Blue	12 : 12: 17 : 2MgO : Trace elements
NPK Yellow	15 : 16 : 6 : 4MgO
NPK Red	13 : 13 : 20
NPK Purple	15 : 12 : 9 : 2.5 MgO
NPK Brown	9 : 3 : 30 : 2MgO

Source: FAO, 2005

In most chemical fertilizers, the concentrations are measured by the percentage of nitrogen (N), phosphorus (P) and potassium (K). Amount of nitrogen will encourage leaf and stem growth by assisting in the formation of protein and chlorophyll. However, phosphorus is needed to produce healthy flowers, fruits and roots for plant growth. Phosphorus can also increase the resistance of plants to certain diseases. Potassium nutrient, serves to reinforce the leaves and stems. All three major nutrients clearly have an impact on crop plants whereby there are differences in the NPK concentrations needed for the cultivation of vegetables, flowering plants and fruit crops (Mustafa, 2002).

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