EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF *VIGNA UNGUICULATA* SUBSP. *SESQUIPEDALIS* L. (VERDC.)

Siti Naimah S., Nashriyah M. and Mohd Noor A. G.
School of Agricultural Sciences and Biotechnology, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin (UniSZA), Tembila Campus, 22000 Besut, Terengganu, MALAYSIA
Tel: 6(09)-6688548; Fax: 6(09)-6687850; Email: mnoor@unisza.edu.my

ABSTRACT

A field study was conducted to examine the effects of organic and inorganic fertilizers on growth and yield of yard long bean, *Vigna unguiculata* Subsp. *sesquipedalis* L.. Three rates (14.5 g, 11.2 g, 17.8 g/plant) of organic fertilizer (poultry manure) and three rates (5 g, 3 g, 7 g/plant) of inorganic fertilizer which is NPK blue special (12:12:17:2) were evaluated to study the growth and yield of yard long bean. The experimental design used was Completely Randomized Design (CRD) with three replications. The application of fertilizer had significant effect on number of leaves and plant height but no significant effect on the chlorophyll content. The yield was also increased from two pods at a rate of 7 g of NPK blue special/plant to 16 pods at a rate of 14.5 g of poultry manure/plant. This study showed that the rate of fertilizer application for different types of fertilizers was not significant on the growth and yield parameters of yard long bean. The use of poultry manure at the rate of 17.8 g/plant was probably more suitable to elevate the growth and yield of yard long bean instead of using inorganic fertilizer.

Keywords: Yard long bean, organic fertilizer, inorganic fertilizer, growth, yield

INTRODUCTION

Yard long bean or *Vigna unguiculata* subsp. *sesquipedalis* L. (Verdc.) is a member of the Fabaceae family. It is an important leguminous vegetable and mostly cultivated in China, Southeast Asia, the Carribean, Central and West Africa (FAO 1993; Piluek 1994). The yard long bean is considered to be one of the most important vegetable crops in Indonesia, Thailand, Philippines, Taiwan and China (Rachie 1985). Yard long bean has been reported as one of nine selected vegetables that has contributed to sufficient domestic supply (Jabatan Pertanian Malaysia 2010).

Due to its economic potential, the farmers depend on inorganic fertilizers to gain more productivity. Inorganic fertilizers are produced artificially and do not need time for decomposition since it contains nutrients that can be readily absorbed by the plant. Mass production of synthetic fertilizers has greatly increased crop yields. Inorganic fertilizers are designed to give plants all the nutrients that they need in appropriate proportions and amounts especially nitrogen, phosphorus and potassium.

During the last 10 to 20 years, negative effects from inorganic fertilizer runoff into waterways have been identified and due to this, there is a renewed interest in organic fertilizer usage as an environmentally friendly alternative. Organic fertilizer refers to the natural by-product or end product that is used as fertilizer. These fertilizers have been used in agriculture for thousands of years. The application of organic fertilizer is one of the ways to improve soil fertility and enhance soil microbial activities. Organic fertilizers are safer to use and more friendly to the environment. This type of fertilizer also contains micronutrients that are needed by plants. Since organic fertilizer contains lower nutrient content than inorganic fertilizers, more organic fertilizer has to be applied in order to get equivalent nutrients.

The objectives of this research were to identify the best application rate of inorganic and organic fertilizers for yard long bean, and to evaluate the effects of organic and inorganic fertilizers on growth and yield of yard long bean. The result of this study was expected to reveal the optimum amount of

ISSN No 1985-0484

fertilizers that should be applied in the cultivation of yard long bean that can help farmers to obtain increase in yield and income.

MATERIALS AND METHODS

Seed Germination

The experiment was conducted under the rain shelter at Universiti Sultan Zainal Abidin farm at Gong Badak Campus, Kuala Terengganu, Malaysia. The yard long bean cultivar used in this study was purchased from the Department of Agriculture (DOA). First, the seeds were germinated in 152 cells of germination trays with 2.5 cm depth for six days to get the best germination rate, with the addition of peat moss which was moistened by watering. One seed was placed in each hole. The seeds germinated after two days. The germinated seeds were then selected to be transplanted to the polybag when it has 2 to 3 leaves.

Planting Activity

The six-day old yard long beans were transplanted into a 37 x 45 cm polybag. The silver shine was used to cover the weed under the rain shelter, before arranging the polybags in a Completely Randomized Design (CRD) in three replicates. Raffia rope was used to build the trellis and provide sturdy support. The vines grew to the top of the trellis. The trellis was built low to make harvesting easier. Sufficient irrigation was provided when flowering starts.

Fertilizer Application

Poultry manure and NPK blue 12:12:17:2 fertilizers were applied one week after transplanting. These two fertilizers were applied once a week following different rates of application for each treatment (Table 1).

Table 1. Rates of fertilizer application

Treatment	Types of fertilizer	Rate of application per polybag (g)
1(control)	NPK Blue Special (12:12:17:2)	5
2	NPK Blue Special (12:12:17:2)	3
3	NPK Blue Special (12:12:17:2)	7
4	Poultry manure	14.5
5	Poultry manure	11.2
6	Poultry manure	17.8

Pest and Disease Control

The activity of pest and disease control was carried out one week after transplanting. The fungicide used was Mancozeb. Approximately 20 g of Mancozeb was added to the sprayer and dissolved in 10 litres of water before spraying.

Harvesting

The pod can be harvested two weeks after first flowering. The harvesting was done at least twice a week and in the morning to avoid the pod from losing too much of water and not be crispy anymore if harvesting activity is done in the afternoon. The pruning shear was used to cut the matured pod. The pods are normally picked when the outline of the seeds is just visible on the outside of the pods.

Data Collection

Data collection activity began from one week after transplanting until the sixth week. Both data for growth and yield parameters were taken at weekly intervals.

The growth parameters measured were number of leaves, chlorophyll content and plant height. The number of leaves for each plant was counted and recorded. The relative chlorophyll content of intact leaves was measured by using CCM-200. This handheld device was used by placing the leaf under the measuring head and press. Then, the head was held down until a beep sound is produced. The measurement was done under normal growing conditions. The height of yard long bean was measured by using a measuring tape. The plant height was taken from the ground surface to the apical tip of the stem.

The yield parameters measured were number of pod, length of pod, pod weight and biomass and moisture content. The number of pod produced by plant was counted and recorded. The length of pod was measured by using a measuring tape and recorded. The pod was weighed using the analytical weight balance and recorded. The data for root biomass, stem biomass, leaves biomass and percentage of moisture content were taken at the end of the experiment. The aerial plant parts (stem and leaves) and the root were separated from the plant. The fresh weight was determined immediately before wrapping with newspaper. The stem, root and leaves were then dried in oven at 105 ^{o}C for 48 hours and weighed. The root, stem, and leaves of yard long beans were dried in oven to get the dry weight and the water content. The percentage of moisture content was calculated by using the following formula:

Fresh Weight - Dry Weight = Moisture Content

$$\frac{\text{Moisture Content}}{\text{Fresh Weight}} \times 100 = \%\ \text{Moisture Content}$$

Statistical Analysis

The data obtained were subjected to statistical analysis using ANOVA procedure with the SPSS statistics version 17.0 software. The Dunnet test was used in order to compare each treatment with the control. The Tukey's Honest Significance Difference (HSD) test, at $\alpha = 0.05$ level of significance was done to find the means that are significantly different from T1. The result was presented in term of mean ± SE.

RESULTS AND DISCUSSION

The results showed that not all the growth parameters were affected by the fertilizer application. Only two out of three growth parameters showed significant effect from the treatment used and these were the number of leaves and plant height. All the yield parameters showed non-significant results.

Number of leaves

The number of leaves increased gradually every week. Based on Tukey's HSD test, the significant result for number of leaves was derived from T5 and T6, with mean difference of -12.81. However, Figure 1 clearly showed that all the treatments were not significantly different with control (57.1 ± 2.6). Highest mean for number of leaves (64.4 ± 4.6) came from T6 (17.8 g of poultry manure/plant). Meanwhile, T5 (11.2 g of poultry manure/plant) gave the lowest number of leaves (51.6 ± 2.9).

A study by Singh and Agarwal (2001) stressed that the increase in leaf number due to enough nutrition can be explained in terms of possible increase in nutrient absorption capacity of plant, as a result of better root development and increased translocation of carbohydrates from sources to growing points. As reported by Meyer et al. (1973), higher concentration of nitrogen has a tendency to increase leaf cell number and cell size with an overall increase in leaf production.

The relative impact of N on cell division and cell expansion depends on the developmental stage of the leaf (del Amor 2006). Besides that, organic manures especially poultry manure contain high percentages of nitrogen and phosphorus and are able to mineralize gradually to make the nutrients available for plant uptake. Some of the organic substances released during the mineralization may act as chelates that help in the absorption of iron and other micronutrients (Schlecht et al. 2006). This ability is low when compared with inorganic fertilizer.

Chlorophyll content

T6 also gave the highest mean (64.1 ± 3.7) of chlorophyll content while the lowest mean (54.4 ± 9.1) was T3 (7 g of NPK blue special/plant). Overall result in Figure 2 had pointed that the fertilizers did not have a significant effect on chlorophyll content of leaves. Chlorophyll content of leaves is one of the good indicators for photosynthesis activity since it is the most important pigments for photosynthesis (Evans 1989; Niinemets and Tenhunen 1997). This parameter also allows assessment on the nutritional status of plant. The results of study by Batchelor et al. (1984) showed that N concentration is greater in leaves than in roots. It is greater in roots in contrast to stems, during most part of the plant cycle.

Follet et al. (1981) reported that chlorophyll coloration is related to the amount of nutrients absorbed by the plant from the soil. Nitrogen is a vital macronutrient that is absorbed by plants in the form of nitrate and ammonium ions. This essential macronutrient is needed for the formation of all amino acids, enzymes and protein. The strong relationship between nitrogen and chlorophyll content is associated with the role of nitrogen. Nitrogen is a structural element of chlorophyll and protein molecules, and thereby affects formation of chloroplasts and accumulation of chlorophyll in them (Tucker 2004). Chapman and Barreto (1995) strongly convinced that nitrogen is part of the enzymes associated with chlorophyll synthesis due to its role in the formation of protein. Therefore, the measurement of leaf chlorophyll content is a very good criterion for estimating crop nitrogen status (Gitelson and Merzlyak 1997), since the total amount of nitrogen in plants is able to influence the photosynthesis process. Another factor that causes insignificant result in this parameter was the amount of light received by the plants. Light is a basic climatic factor that is essential in the production of chlorophyll and in photosynthesis. Therefore, inability of plant to receive sufficient light will simultaneously affect these two major processes. The weather during the time of study is an abiotic factor that cannot be controlled by human.

Plant height

In this experiment, plant height was significantly increased by nutrient availability (Fig. 3). The mean of plant height for all treatments is constantly increased from one week to another week. The highest mean (297.5 ± 10.4) for plant height was from T4 (14.7 g of poultry manure/plant). The lowest mean (240.6 ± 13.3) was from control. This was due to the increased nutrient use efficiencies. This agrees well with the findings by Muhammad (2008) who studied rice. The variation in plant height due to nutrient sources was related with the variation in the availability of major nutrients. Poor performance in terms of plant height can be related to the content of NPK in soil which is below the critical level.

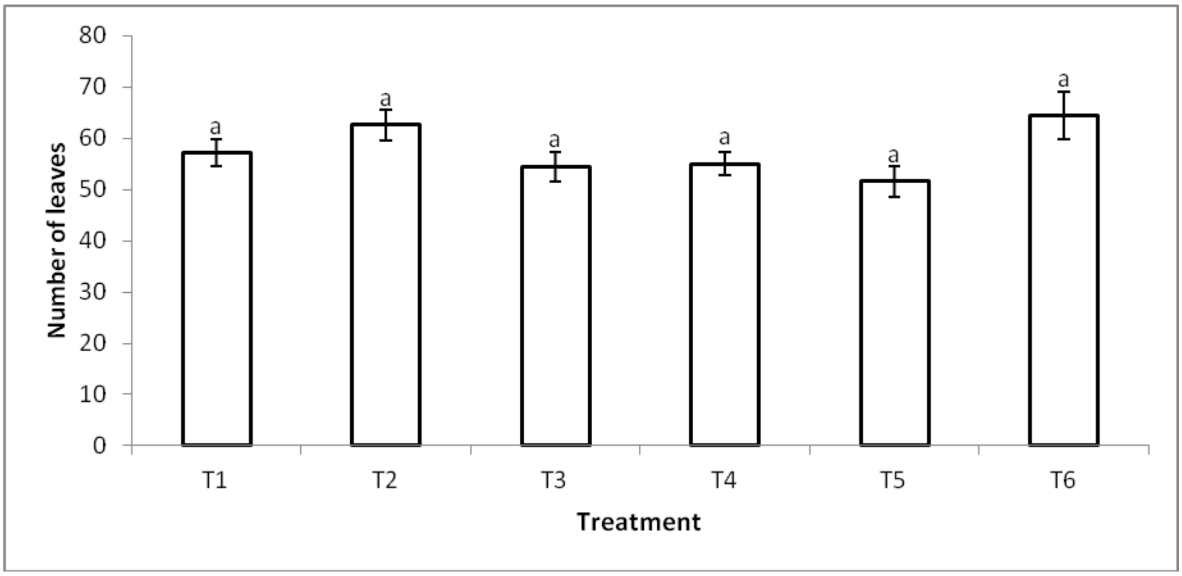

Figure 1. Mean ± SE number of leaves for each treatment compared with control treatment (T1). Means followed by the same letter (s) indicate that they are not significantly different (Dunnet test, $p < 0.05$).

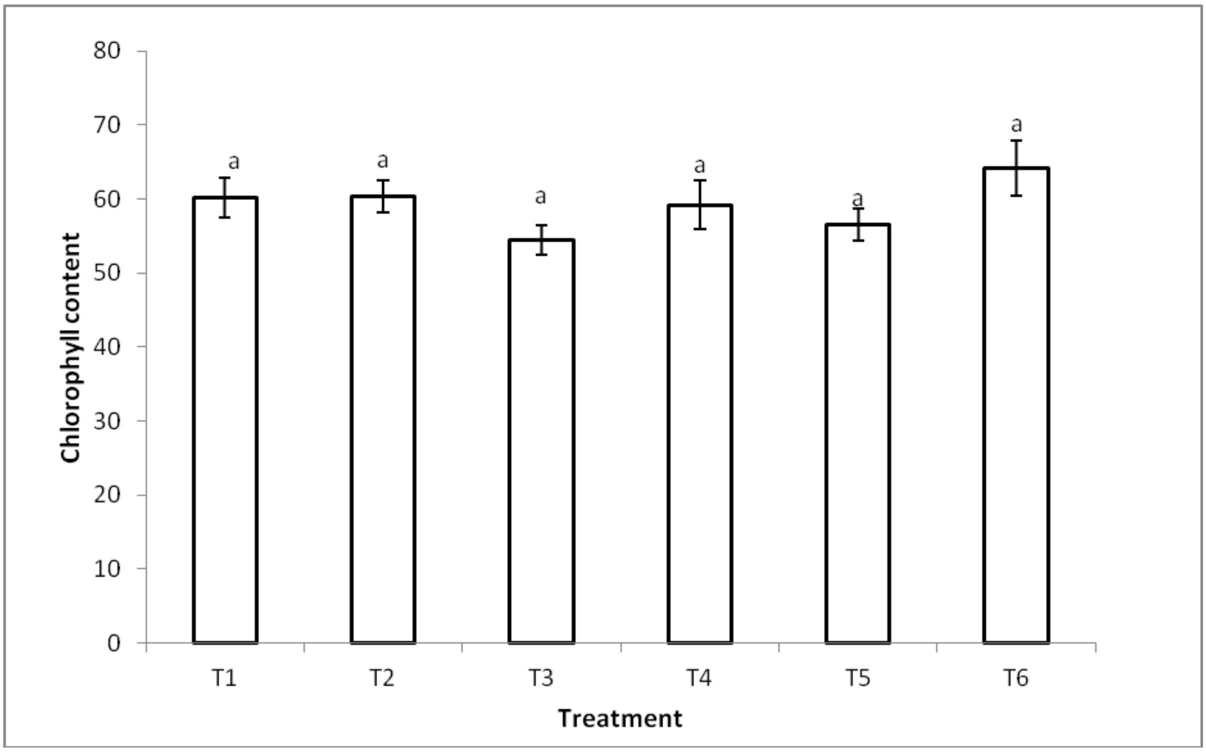

Figure 2. Mean ± SE of chlorophyll content for each treatment comparing with control treatment (T1). Means followed by the same letter (s) indicated that they are not significantly different (Dunnet test, $p < 0.05$).

Number of pod

The effect of fertilizer on the pod number of yard long bean is not significant. According to Fig. 4, T5 (11.2 g of poultry manure/plant) gave the highest number of pod (1.57 ± 0.423). The lowest yield was from T3 (7g of NPK blue special/plant) with mean of 1.07 ± 0.396. T3 gave low yield as a result of fewer production of leaf. Production of more leaves means higher light interception and more assimilates production that increases yield. Most of the observation plants died when applied with T3 during this study. This is due to the excessive application rate of NPK. It was reported by Tilak et al. (2005) and Nahed et al. (2007) that the excessive application of NPK or in their higher dose causes salt toxicity to occur, which then subsequently resulted in low nutrient uptake and reduced growth. Excess of nutrients in the rooting zone would cause adverse effects on yield due to ammonia or salt injury.

The yield pattern may vary depending on factors like soil types, management practices and weather. Another reason for insignificant result on parameter of pod number is probably because of the environment during the time from flowering to pod formation, which experienced continuous rain with high amount of water, a lot of clouds and hence little light, resulting in less flowering. Yard long bean is self-pollinated plant and sometimes can be crossed-pollinated by wind or insect. However, a strong wind during the rainy season at the time of flower initiation and pod setting may reduce the number of flower, thus affect the number of pod formed. The yield of yard long bean was highest under organic fertilizer because of high and continuous mineralization of nutrient. Many studies have demonstrated that application of manure will produce crop yields equivalent or superior to those obtained with chemical fertilizers (Motavalli et al, 1989).

Length and weight of pod

The means of pod length of yard long bean was high for T6 (59.75 ± 1.998). T2 had the lowest 54.07 ± 1.894 (Fig. 5). The result of pod length is not positively associated with pod weight. The mean of pod weight of yard long bean (Fig. 6) was found to be high in T1 with mean of 28.9783 ± 2.83946. The lowest result (24.3450 ± 1.24019) was recorded when 14.5 g of poultry manure (T4) was applied. Pod weight was considerably increased from 18.23 g to 35.86 g when poultry manure was applied with 5 g of NPK blue special/ plant (T1).

Biomass

The total biomass was calculated by adding the dry weight for all three parts of yard long bean. Table 2 showed that the dry weight of leaves (29.75 g), stem (49.93 g) and root (1.53g) were high when plant was treated with 3 g NPK blue special (T2). The most pronounced effect of nutrient availability on dry leaves, stem and roots weights occurred in T2, which indicated a greater ability of T2 to compete for below-ground resources. This result was supported by findings from Sharoar et al. (2006) who stated that NPK is effective in increasing the final plant weight. Total biomass (Table 3) was low for plant treated with 14.5 g of poultry manure (T4).

A dry weight of each part is a measure of assimilate partitioning. Species of plant, ontogeny and the environments experienced by the plant are three factors that can influence the distribution of biomass to different part of plant. At low nutrient and water availability, roots use relatively more of the limiting amounts of photosynthates, leaving less for the leaves (Poorter and Nagel 2000). Low nutrient availability usually results in an increase of plant root capacity for nutrient uptake, an increase of dry matter allocation to roots and a decrease in tissue nutrient content (del Amor 2006).

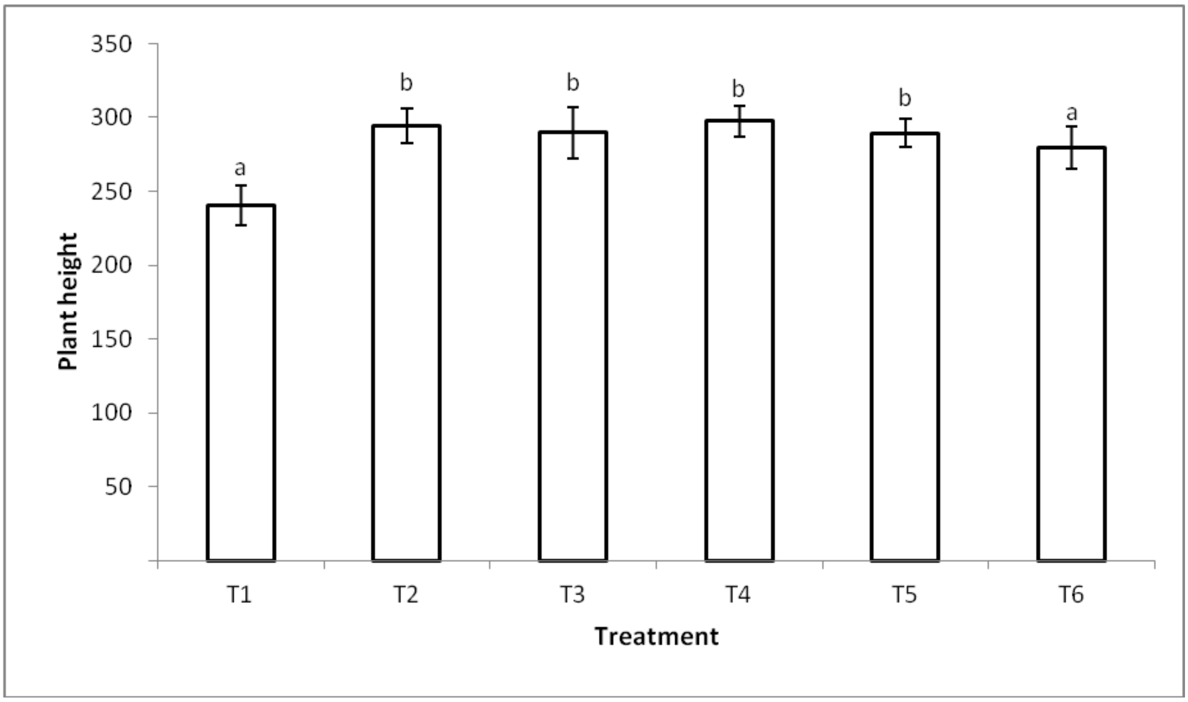

Figure 3. Mean ± SE of plant height for each treatment comparing with control treatment (T1). Means followed by the same letter (s) indicated that they are not significantly different (Dunnet test, $p < 0.05$).

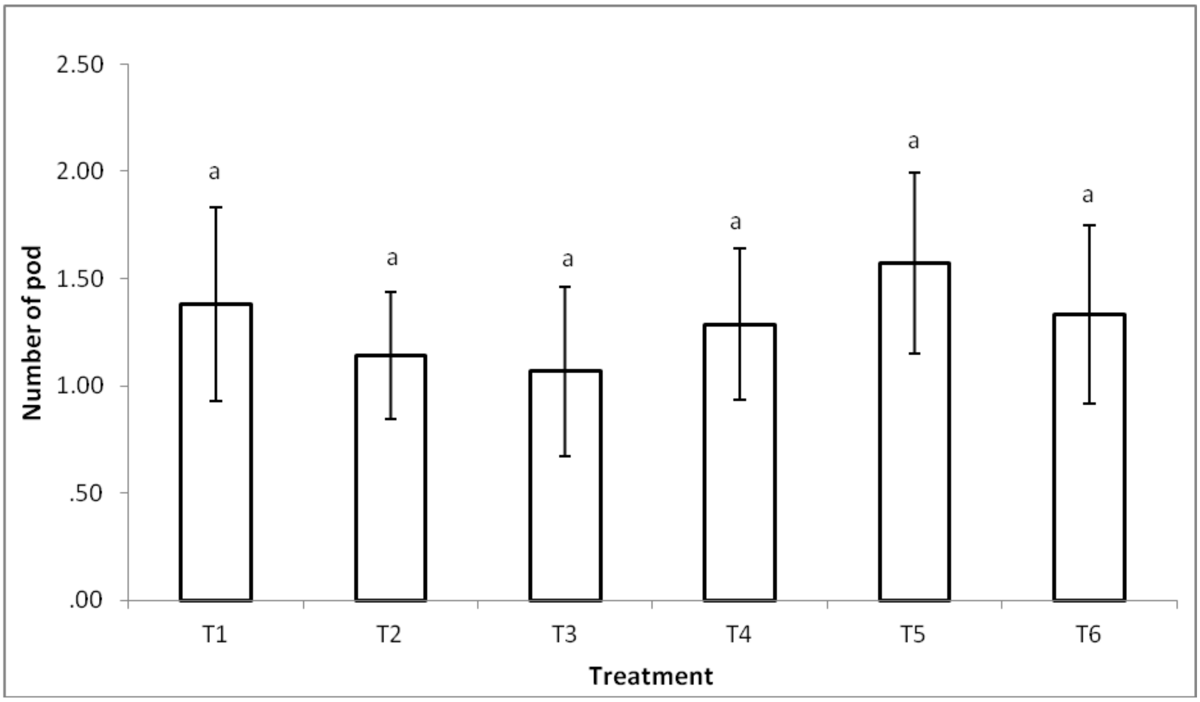

Figure 4. Mean ± SE for number of pod for each treatment comparing with control treatment (T1). Means followed by the same letter (s) indicated that they are not significantly different (Dunnet test, $p < 0.05$).

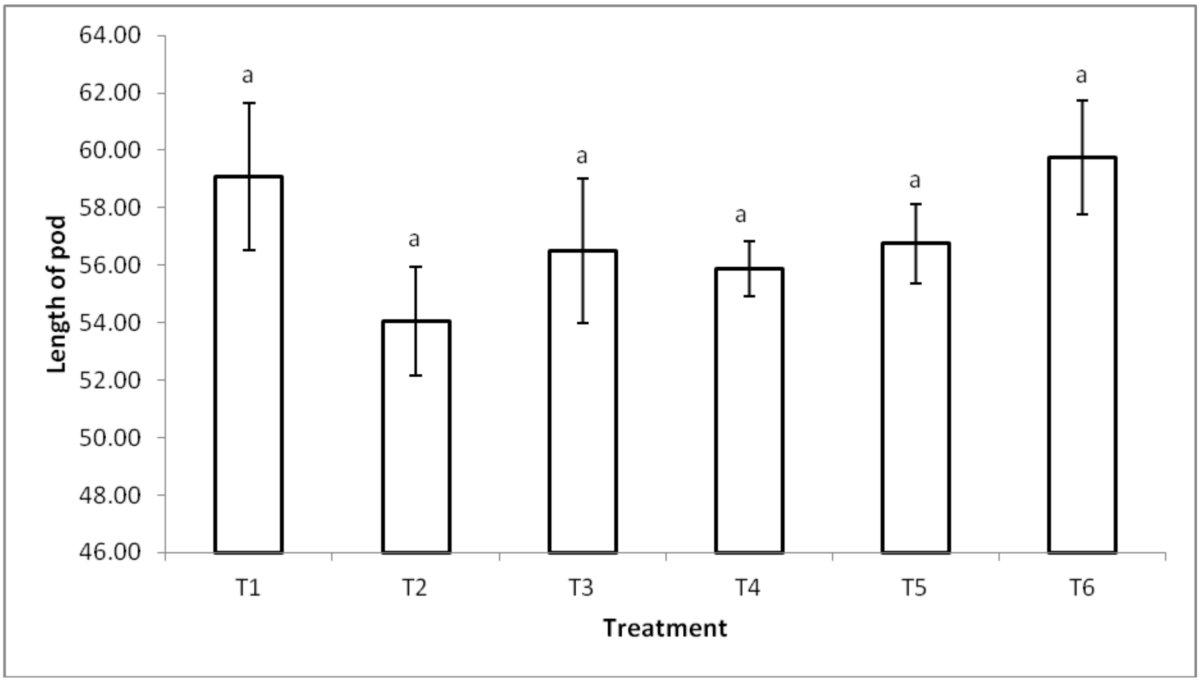

Figure 5. Mean ± SE for length of pod for each treatment comparing with control treatment (T1). Means followed by the same letter (s) indicated that they are not significantly different (Dunnet test, $p < 0.05$).

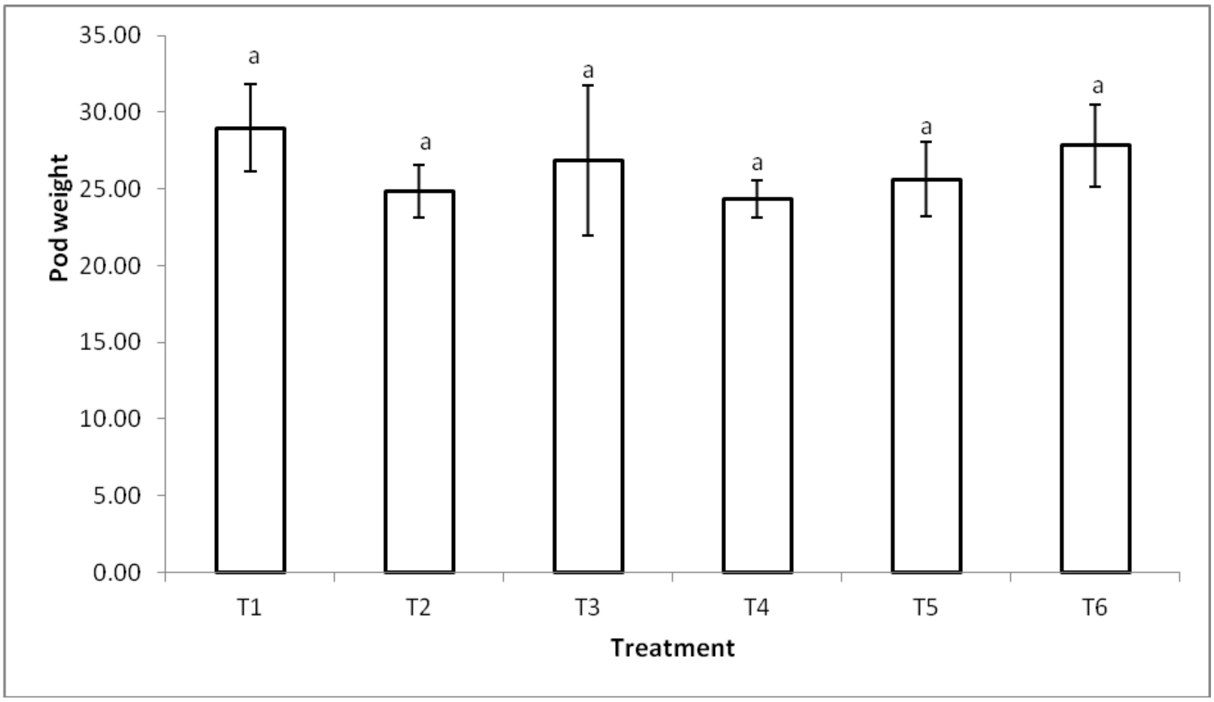

Figure 6. Mean ± SE of pod weight for each treatment comparing with control treatment (T1). Means followed by the same letter (s) indicated that they are not significantly different (Dunnet test, $p < 0.05$).

Table 2. The biomass and moisture contents of leaves, stem and roots

Treatment	Biomass (g)						Moisture Content			% Moisture Content		
	Fresh Weight			Dry Weight								
	Leaves	Stem	Roots	Leaves	Stem	Roots	Leaves	Stem	Roots	Leaves	Stem	Roots
1	59.60	78.76	3.75	24.60	22.47	1.05	35.00	56.29	2.70	58.72	71.47	72.00
2	56.28	105.28	6.99	29.75	49.93	2.38	26.53	55.36	4.61	47.14	52.58	65.95
3	39.12	58.14	5.22	14.46	18.73	1.54	24.66	39.41	3.68	63.04	67.78	70.50
4	15.88	73.14	5.60	6.41	14.72	1.58	9.47	58.42	4.02	59.63	79.87	71.79
5	44.52	80.21	5.18	24.57	23.06	1.69	19.95	57.15	3.50	44.81	71.25	67.57
6	29.29	91.16	5.29	12.60	47.30	2.06	16.69	43.86	3.23	56.98	48.11	61.06

Table 3. Total biomass and total percentage of moisture content for each treatment

Treatment	Total Biomass (g)	Total % Moisture Content
1	48.12	202.19
2	82.06	165.67
3	34.73	201.32
4	22.71	211.29
5	49.32	183.63
6	61.96	166.15

Percentage of leaf moisture content

Total percentage of leaf moisture content (Table 3) was found high in plants treated with T4 (211.29), while low percentage was recorded from T2 (165.67). This was due to the ability of poultry manure to increase the water holding capacity. According to Hosner and Juo (1999), the beneficial effect of organic nutrient is to improve soil structure and increase water holding capacity. Physiologically, the uptake of nutrients depends on water availability (Marschner 1986). Mineral nutrients are delivered from the root to the shoot along the transpiration stream and therefore, soil water deficits can limit nutrient transport simply by reducing the volume of water that moves into the plant (Kramer and Boyer 1995).The plant growth and yield performance depend on the interaction between water and nutrient availability. The data analysis showed that increasing rate of fertilizer would subsequently increased the water content of aerial plant parts. This shows that the yard long bean was able to conserve water internally during this study.

Higher organic matter addition could increase organic carbon content of the soil which resulted in an increased water holding capacity of the soil. The humus can absorb water two to six times of its own weight. Soil organic matter (SOM) is responsible directly or indirectly in turning the soil into suitable condition and proper environment for the growth of crops. It exerted this benefit largely through its effect on improving soil aggregation and porosity, which directly influenced the soil structure, water infiltration, moisture storage, drainage, aeration, temperature and microbial activities. Most crop take up the majority of the nutrients during the periods of vegetative growth and translocate stored nutrients to developing grain during reproductive growth. Plant roots require certain conditions to obtain these nutrients from the soil. The soil must be sufficiently moist to allow the roots to take up and transport the nutrients. Sometimes the plants are unable to take up the nutrient in the soil due to improper pH, temperature and moisture of the soil.

Increased application rate of NPK blue special in T2 and T3 did not give any strong effect or difference when comparing with T1 (control). This can be seen in the results of the number of leaves, chlorophyll content, number of pod, pod weight, and length of pod. These two application rates only showed significant effect in comparison with T1 in term of plant height. A study by Xuewen (1990) on soybean, has shown that the difference in nitrogen levels had slight influence on the mean number of leaves per plant. T6 gave the highest mean for the growth parameter compared with T4 and T5. It also performed better than T1 in growth and yield parameters. Whereas, the number of pod was high when the plant is treated with T5 but the result was not considered significant after running the SPSS analysis. The application rate of NPK blue special at 7 g/plant (T3) caused the plant to die, despite of adequate watering, mulching and soil preparation. The overall result indicated that T6 gave the best performance in terms of growth and yield parameters as compared to T2, T3, T4 and T5.

Most of the growth and yield parameters in this experiment showed positive result when treated with poultry manure. The number of leaves, chlorophyll content, plant height, the number of pod, length of pod and pod weight were found higher from the treatments using poultry manure. This has shown similarity with the results obtained by Perkins (1964), Boateng et al. (2006) and Lv et al. (2011) when studying the bambara groundnut landraces. Waldrip et al. (2011) stated that, the incorporation of poultry manure into soil promoted transformation and mineralization of less-liable inorganic and organic P into labile P in the rhizosphere, which resulted in higher root P concentration and higher total uptake by plant. Phosphorus is the most important nutrient element (after nitrogen) that can limit agricultural production in most regions of the world (Holford 1997; Kogbe and Adediran 2003). Consequently, inadequate P supply will result in a decreased synthesis of RNA, the protein maker, leading to depressed growth (Hue 1995).

Other macronutrients needed by legumes and supplied in large amount by poultry manure is potassium. Potassium enhances the synthesis and translocation of carbohydrate (Henry 1982). Hue (1995) indicated that potassium is needed in large quantities by many crops. It plays an important role in regulating water retention in the plant tissue, water and photosynthates, as well as water uptake from the soil. All these roles are related to its function in regulating the osmotic potential of cells as well as the closure and opening of stomata. This important macronutrient is also responsible for cell extension. Bergmann (1992) reported that with adequate K, cell walls are thicker, thereby improving plant resistance to lodging, pests and diseases.

Potassium is an essential nutrient for legumes and other crops. It is an activator for many enzymes, especially for those that involved in protein synthesis. In legumes, this macronutrient is needed for the proper development and functioning of root nodules. Atmospheric nitrogen fixation process is carried out by *Rhizobium* bacteria in the nodules of legume plant. There is high tendency for the plant to suffer a nitrogen deficiency with reduced yield as the nitrogen fixation is affected by potassium deficiency. The legume plant can also become stunted.

The better performance of yard long bean in growth and yield parameters when treated with poultry manure, could be due to the fact that this type of fertilizer contained essential nutrient elements associated with high photosynthetic activities and thus promotes roots and vegetative growth (John *et* al. 2004). The increased in number of fruits and average weight could be attributed to the ability of poultry manure to promote vigorous growth, increase meristematic and physiological activities in the plants. All these abilities are necessary to supply the plant nutrient and improve the soil properties, which subsequently provide the synthesis of more photo-assimilates, which is used in producing fruits. Gupta and Shukla (1977) reported an increase in number of fruits and size due to increase in N application.

The failure of the plants to show good performance at the end of this experiment is correlated to the climatic factors. The rainy season during December 2012 until January 2013 affect the ability of the observation plant to thrive well. Generally, it is believed that light favours absorption of mineral nutrients by the leaves. Leece (1978) stated that high air temperatures during rapid leaf expansion may enhance the absorption of mineral nutrients by the leaves due to a lower amount of waxes on unit surface area of leaf. Reed and Tukey (1982) also claimed that under conditions of high air temperatures the surface wax components have vertical configuration and the leaf surface coverage decreases which consequently may increase nutrient absorption.

Bukovac and Wittwer (1959) showed that the uptake of P by bean leaves is doubled when the treated surface was kept moist, compared with similar treatments in which leaf surfaces were allowed to dry. According to Tukey and Marcyzński (1984), positive influence of air humidity on nutrient absorption by leaves is related to the reduction in drying of droplets. Competition for resources such as light due to crowding could be the main reasons that contributed to reduction in growth and yield of plants.

As mentioned previously, climatic condition is an abiotic factor that cannot be manipulated in this study. The weather and climatic condition during December 2012 until January 2013 had totally affected the maintenance and harvesting activity. Plants also became more susceptible to pests and diseases. The growth of vegetative parts also do not performed well starting from week 4 until the end of the observation. The amount and regularity of rainfall varies with location and climate types, and affect the dominance of certain types of vegetation as well as crop growth and yield. Temperature is one of the climatic factors that influences all plant growth processes such as photosynthesis, respiration, transpiration, protein synthesis and translocation. At high temperature, the translocation of photosynthate is faster so that plants tend to mature earlier.

Enzyme activity and the rate of most chemical reactions generally increase with rise in temperature. But excessive temperature may cause denaturation of enzymes and other proteins. Excessively, low temperatures can also cause limiting effects on plant growth and development. The expansion of water as it solidifies in living cells causes the rupture of the cell walls (Devlin 1975). Air movement or wind is due to existence of pressure gradient on a global or local scale, as caused by differences in heating. This climatic factor serves as a vector of pollen from one flower to another, thus aiding in the process of pollination. Moderate winds favour gas exchanges. Reversely, strong wind is not favourable since it can cause severe water loss *via* transpiration stream as well as lodging or toppling of plants. Once the transpiration rate is above the rate of water absorption, the stomata tend to close partially or completely, thus restrict the diffusion of carbon dioxide into the leaves. This will result in a decrease in the rate of photosynthesis, growth and yield (Edmond et al. 1978).

The method of application and the quantity of organic fertilizers have a tendency to give effects on crop yield and nutrient uptake. This study showed that inorganic fertilizers resulted in lower yields compared to organic manures in the production of pod. Owen (2003) reported that the chemical fertilizer does not possess good characteristics of aggregating the soil particles. As a result, the plants produced by inorganic fertilizers showed relatively lower yield compared to organic materials.

CONCLUSION

From the above discussion, it can be concluded that the rate of fertilizer application manipulated in this study was not significant with the growth and yield parameters of yard long bean. It is clear that the best application rate was from T6 (17.8 g poultry manure/ plant). Plant treated with organic fertilizer showed the best performance compared to control treatment using inorganic fertilizer. Increasing the organic fertilizer from 14.5 g to 17.8 g was able to increase the performance of growth and yield parameters. It cannot be denied that sole usage of poultry manure can also supply the essential nutrient required by yard long bean. Poultry manure perhaps can be a better supplement of NPK blue special in fertilization program of yard long bean in order to achieve better growth and yield performance. From the economic point of view, farmers can use the poultry manure alone to get the similar or higher yield than by using NPK blue special with good planting environment and management practices.

REFERENCES

Batchelor JT, Scott HD and Sojka RE, 1984. Influence of irrigation and growth stage on element concentrations of soybean plant parts. *Commun Soil Sci Plan* **15**, 1083-1109.

Bergmann W, 1992. *Nutritional disorders of plants*. 2nd Edition. Gustav Fischer Verlag, Jena, Germany.

Boateng SA, Zickermann J and Kornahrens M, 2006. Poultry manure effect on growth and yield of maize. *West Afr J Ecol* **9**, 1-11.

Bukovac MJ and Wittwer SH, 1959. Absorption and distribution of foliar applied mineral nutrients as determined with radioisotopes. In: *Proc. 3rd Colloq. Plant Analysis and Fertilizer Problems*. Montrel, Canada, 215-230.

Chapman SC and Barreto HJ, 1995. Using a chlorophyll meter to estimate specific leaf nitrogen of tropical maize during vegetative growth. *Agron J* **89**, 557-562.

Del Amor F M, 2006. Growth, photosynthesis and chlorophyll fluorescence of sweet pepper plants as affected by the cultivation method. *Ann Appl Biol* **148:** 133-139.

Devlin R, 1975. *Plant Physiology*. D. Van Nostrand Company, New York, 600.

Edmond JB, Senn TL, Andrews FS and Halfacre RG, 1978. *Fundamentals of Horticulture.* 4th Edition. McGraw-Hill. Inc, London, 87-130.

Evans JR 1989. Photosynthesis and nitrogen relationships in leaves of C3 plants. *Oecologia* **78**, 9-19.

FAO 1993. Underexploited and Potential feed Legumes in Asia. FAO PARA Publication. FAO, Bangkok, Thailand.

Follet RH, Murphy LS and Donalue RL, 1981. Soil-fertilizer-plant relationship. *Fert Soil Amend* **6**(16), 478-481.

Gitelson A and Merzlyak MN, 1997. Remote estimation of chlorophyll content in higher plant leaves. *Int J Remote Sens* **18**, 2691-2697.

Gupta A and Shukla V, 1977. Response of response of tomato (*Lycopersicorn esculentum* Mill.) to plant spacing, Nitrogen, phosphorus and potassium fertilization. *Indian J Hort* **34**, 270-276.

Henry D, 1982. Effect of potassium on plant growth. *J Orn Hort Sci* **6**, 320-321.

Holford ICR, 1997. Soil Phosphorus: Its measurement and its uptake by plants. *Aust J Soil Res* **35**, 227-239.

Hossner LR and Juo ASR,1999. Soil Nutrient Management for Sustained Food Crop Production in Upland Farming Systems in the Tropic. Food and Fertilizer Technology Centre, Taiwan.

Hue N V, 1995. Sewage Sludge. In: *Soil amendment and environmental quality.* J. E. Rechcigl. Ed. Lewis Publ., Boca Raton, 193 – 239.

Jabatan Pertanian Malaysia, 2010. http://www.doa.gov.my/ [12 November 2012].

John LW, Jamer DB, Samuel LT and Warner LW, 2004. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management.* Pearson Education, India.

Kogbe JOS and Adediran JA 2003. Influence of nitrogen, phosphorus and potassium application on the yield of maize in the savanna zone of Nigeria. *Afr J Biotechnol* **2** (10), 345 – 349.

Leece DR, 1978. Foliar absorption in *Prunus domestica.* Nature and development of the surface wax barrier. *Aust J Plant Physiol* **5**, 749-766.

Lv M, Li Z, Che Y and Liu M, 2011. Soil organic, nutrients, microbial biomass and grain yield of rice (*Orysasativa* L.) after 18 years of fertilizer application to an infertile paddy soil. *Biol Fertil Soil.* **47**, 777-783.

Marschner H, (1986): Mineral nutrition in higher plants. Wd Ltd. The Greystone Press, Antrim, Northern Ireland.

Meyer BS, Banderson D, Bohning RH and Fratianne DG, 1973. *Introduction to Plant Physiology.* D. Van Nostrand Company, New York, 193-322.

Motavalli PP, Kelling KA and Converse JC, 1989. First – year nutrient availability from injected dairy manure. *J Environ Qual* **18**, 180- 85.

Muhammad I, 2008. Response of wheat growth and yield to various levels of compost and organic manure. *Pak J Bot* **40**(5), 2135-2141.

Nahed GA, 2007. Stimulatory effect of NPK fertilizer AND Benzyladenine on growth and chemical constituents of *Codiaeum variegatum* L. plants. *Am-Euras J Agric Environ Sci* **2**(6), 711-719.

Niinemets U and Tenhunen JD, 1997. A model separating leaf structural and physiological effects on carbon gain along light gradients for the shade-tolerant species *Acer saccharum*. *Plant Cell Environ* **20**, 845-866.

Owen P, (2003).Origin and distribution of lettuce. http://www.calettuceresearchboard.org/Origin.html (16/08/2008)

Perkins HF, 1964. Chicken Manure: Its Production, Composition and Use as a Fertilizer. Georgea Agricultural Experiment Stations. University of Georgea College of Agriculture, Dahlonega, USA, 123.

Piluek K, 1994. The Importance of Yardlong Bean. In: *Proc. 2nd Symp.Vegetable Legumes.* Kasetsart University Research and development Institute and ARC–AVRDC, Bangkok, Thailand.

Poorter H and Nagel OW, (2000) The role of biomass allocation in the growth response of plants to different levels of light, CO2, nutrients and water: a quantitative review. *Aust J Plant Physiol* **27**, 595–607.

Rachie KO, 1985. Introduction. In: *Cowpea research, production and utilization*. S.R. Singh and K.O. Rachie. Eds. Wiley Publication, Chichester, England, xxi–xxviii.

Reed DW and Tukey JR,1982. Temperature and light intensity effects on epicuticular waxes and in ternal cuticle ultrastructure of Brussels sprouts and carnation leaf cuticles. *J Amer Soc Hort Sci* **107**, 417-420.

Schlecht E, Buerkert A, Tielkes E and Bationo A, 2006. A Critical Analysis of Challenges and Opportunities for Soil Fertility Restoration in Sudano-Sahelian West Africa. *Nutr Cycl Agroecosyst* **76:**109-136.

Sharoar MG, Deb AC and Khaleque MA, 2006. Effect of different ages on some root characters, Nodules and yield components in Blackgram (*Vigna mungo* (L.) Hepper). *Asian J Plant Sci.* **5**(4), 717-720.

Singh R and Agarwal SK, 2001. Analysis of growth and productivity of wheat in relation to levels of FYM and nitrogen. *Indian J Plant Physiol* **6**, 279-83.

Tilak KVBR, Ranganayaki N, Pal KK, De R, Saxena AK, Nautiyal CS, Mittal S, Tripathi AK, Johri BN, (2005) Diversity of plant growth and soil health supporting bacteria. *Curr Sci* **89**(1),136–150

Tucker M, (2004): Primary Nutrients and Plant Growth. - In: Essential Plant Nutrients (SCRIBD, Ed.). North Carolina Department of Agriculturae.

Uphoof N, 2002. Changes and evolution of SRI methods. In: Uphoff et.al. Eds. *Assessment of the System for Rice Intensification (SRI).Proc of an International Conference,* Sanya, China, 8-14.