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# Effect of Organic fertilizers on the Growth and Biochemical Characteristics of Okra (*Abelmoschus esculentus* (L.) Moench)

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**Abstract:** ***The application of organic fertilizers has significant effect on the growth and biochemical performance of Abelmoschus esculentus (L.) Moench. The growth response such as seed germination, seedling vigour index, shoot length, root length and plant fresh and dry weight were significantly increased with plants amended with organic fertilizers. The response was varied with respect to fertilizers. The organic fertilizers amendment greatly affected the all growth characters of Okra compared to control plants. There was a significant difference was observed in the rate of seed germination and the rate germination index in the plants treatment with vermicompost followed by farmyard manure. The soil amended with vermicompost had a significant effect on the shoot as well as root length. Likewise, the biochemical characters such as total chlorophyll, protein, glucose, ascorbic acid content and NR activity were significantly increased in the plants amended with organic fertilizers over the control plants.***

**Keywords:** Organic fertilizers, okra, growth, development, biochemical

## 1. Introduction

Organic farming is a new agricultural production system involves locally and naturally available organic materials or agro inputs to meet out the production system without endangering our precious natural resources. The organic farming is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, or enhance ecological harmony. The primary goal of organic farming is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Yuda *et al*., 2016).

Organic manures generally improve the soil physical, chemical, biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop production. Although the organic manures contain plant nutrients in small quantities as compared to the inorganic fertilizers, the presence of growth promoting principles like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity. Farmyard manure (FYM), compost, green manure, Neem cake, Vermicompost and Wood ash are the most important and widely used bulky organic manures. Farmyard manure has been used as a soil conditioner since ancient times and its benefit have not been fully harnessed due to large quantities required in order to satisfy the nutritional needs to crops (Makinde *et al*., 2007; Pennington *et al*., 2015).

The compost prepared from organic materials using earthworms is a low cost and eco-friendly technology called vermicomposting that contain higher levels of nitrogen, phosphorous and potassium (NPK) in available form, micronutrients, microflora, enzymes and growth regulators (Ansari, 2011). Neem cake is a potential source of organic manure. That improves the organic matter content of the soil, helping improvement in soil texture, water holding capacity, soil aeration for better root development (Khan *et al*., 2012). Wood ash is a residual material produced during the conversion of biomass to electrical energy by wood-burning power plants. It is obtained from the combustion of wood. It can be related to fly ash since fly ash is obtained from coal, which is a fossilized wood (Campbell, 1990).

## 2. Material and Methods

The seeds of okra (*Abelmoshcus esculentus* (L.) Moench and organic fertilizers were procured from Tamilnadu Agricultural University. The soil mixture was prepared by mixing of black soil, red soil and sand in the ratio of 1:1:1 for the nursery experiment. Organic fertilizers such as vermicompost, FYM, organic manure, neem cake, wood ash were applied 10g each at the top soil of the pots. The treatment details were: 1.Control, 2. Farm yard manure, 3. Organic manure, 4. Neem cake, 5.Vermicompost and 6.Wood ash.

The growth parameters such as seed germination (ISTA, 1995), germination index AOSA (1983), Seedling Vigour Index I (SVI I) and II (SVI II) Kharb *et al*. (1994), shoot length, root length, number of leaves, fresh weight and dry weight were studied in the treated and untreated control plants. The number of seeds germinated in each treatment was counted on 7 day after sowing. The final count of germination was recorded on the 7$^{th}$ day and number of normal seedlings was expressed as percentage germination. Germination Index was calculated with the number of germinated seeds and days of first count to the days of last count. Seedling Vigour Index was calculated with the help of data recorded on germination percentage and seedling

growth. Seedling Vigour Index II was calculated with the help of data recorded on germination percentage and seedling dry weight.

For the analysis of plant biomass, the plants were uprooted without causing any damage to the seedlings and it was thoroughly washed with tap water in order to remove soil and debris particle. Then the shoot length was measured with the help of meter scale. In uprooted plants, the root length was measured with the help of meter scale and expressed in centimeter. The fresh weight of whole plant parts (shoot, leaves and root) was weighed using electronic balance. The fresh undamaged whole plant system of seedlings were kept in the oven at 80°C 4-6 hours and the dried seedlings were weighed using electronic balance. Biochemical characters such as Chlorophyll and carotenoids (Wellburn and Lichtenthaler, 1984), Protein (Lowry *et al*., 1951), total glucose (Jayaraman 1981), free amino acid (Jayaraman, 1981), NR activity (Jaworski, 1971) and ascorbic acid (Roe, 1954) were estimated.

**Statistical Analysis**

The data obtained were subjected to analysis of variance (ANOVA) and the significant means were segregated by critical difference (CD) at 0.05% (CD P= 0.05%) level of significance.

## 3. Result

Effect of organic fertilizers on the growth characters were studied from the control and treated seedlings of *Abelmoschus esculentus.* Accordingly, the growth characters such as seed germination, germination index, seedling vigour index (I and II), shoot length, root length, fresh weight, dry weight and number of leaves were studied. The significant difference was observed in the rate of seed germination of okra and the rate was higher in the plants treatment with vermicompost followed by farmyard manure and organic manure. The speed of germination index also varied according to nature of organic fertilizers. The plants amended with vermicompost had a significant effect on the shoot length. The plants amended with vermicompost had a significant effect on the shoot length. Among them the vermicompost produced maximum shoot length followed by organic manure, while the lowest shoot length was obtained from the control plants. The results indicated that the root length was higher in all treated plants over the control. The effect was varied with different organic fertilizers. It was observed that the plants grown with vermicompost produced taller roots. The number of leaves per plant was significantly influenced by organic manure than the control. The highest number of leaves was found in plants applied with organic manure closely followed by neem cake (Table 1).

Among the different organic amendments, vermicompost significantly increased the plant fresh weight followed by organic manure and least in neemcake. Like fresh weight, same trend was observed in plant dry weight also. Plants treated with vermicompost significantly increased the plant dry weight. The result also revealed that the more number of leaves were observed in the organic fertilizers treated okra plants than in those of control plants. The highest value of seedling vigour index-I and seedling vigour index-II was for the application of soil to vermicompost compared to other organic fertilizers (Table 1).

Organic amendments significantly increased total chlorophyll content of seedlings. The maximum chlorophyll content was observed in plants treated with organic manure followed by neem cake. The lowest chlorophyll content was recorded in seedling without any organic amendments. The result also indicated that the carotenoid content was higher in plants treated with organic manure and wood ash. The protein content was significantly higher in plants treated with organic manure and least in farm yard manure. Application of organic amendments increased the free amino acid in the leaves of okra in all treated plants. The effect was higher in plants amendment with organic manure over other organic amendments and control (Table 2).

The result revealed that there was a marked difference in the glucose content among treatments. The highest glucose content was noticed in plants treated with organic manure followed by farmyard manure and wood ash. NR activity was estimated in the leaves of treated and control plants. The results indicated that NR activity was higher in plants treated with organic manure over all other treated plants. The ascorbic acid content was significantly higher in plants treated with organic manure and least in farmyard manure treated plants (Table 2).

## 4. Discussion

The nursery soil amended with organic manures such as vermicompost, farm yard manure, organic manure, neem cake and wood ash had a positive impact in crop response such as growth as well as biochemical attributes. The results revealed that the organic fertilizers significantly increased crop response with reference to growth and biochemical attributes.

There was a significant difference was observed in plant growth of *Abelmoschus esculentus* amendment with different types of organic fertilizers. There was a significant impact of organic fertilizers on the growth character such as seed germination, germination index, seedling vigour index (I & II), shoot length, root length, fresh weight and dry weight. The growth response was higher in plants amendment with vermicompost. Vermicompost application coupled with poultry manure recorded higher plant height and number of leaves per plant at different stages of growth. The plant height and number of leaves, which were significantly higher when compared to glyricidia, FYM, poultry manure and vermicompost application alone (Channabasangowda *et al*., 2008; Mojeremane *et al.,* 2015). This response may be due to better nutrient availability and its uptake by the plants (Roy and Singh, 2006; Achsah and Lakshmi Prabha, 2013)

Prabha *et al*. (2007) found that the growth parameters such as root length, shoot length, number leaves of vegetables like *Hibiscus esculenta* and *Solanum melongena* and medicinal plants like *Adhatoda vasica* and *Solanum trilobatum* showed higher values in vermicompost applied after 90 days. The vermicompost application increased the plant height, number of tillers and of leaves, early ear heading, ear head length and dry matter of *Triticum estivum* than control. The seedling vigour index and dry weight of seedling which really

indicate the overall seed quality has varied significantly with the treatments of organic manure (Deka *et al*., 2002).

Farmyard manure is an important source of plant nutrients that impact on the fresh and dry weight of tomato. The combined use of vermicompost and biofertilizers significantly increased the vine length in cucumber. The better efficiency in combination with organic manures and biofertilizers might be due to the fact that organic manures would have provided the micronutrients such as zinc, iron, copper, manganese, etc., in an optimum level (Yadav *et al*., 2003).

The pot culture studies have shown that the root and shoot parameters all higher in pots supplied with biofertilizer enriched vermicompost this might due to uptake of readily available micro and macro nutrients in the vermicompost and its associated microbes. From a pot culture study it was found that the combined application of vermicompost, *Azospirillum* and chemical fertilizer is superior in enhancing the growth and development of the green leafy vegetable, *Amaranthus tristis* (Sangeeth *et al*., 2012; Achsah and Lakshmi Prabha, 2013).

The soil amendment with different types of organic manure significantly respond to the biochemical characters such as total chlorophyll, protein, glucose, amino acid, NR activity and ascorbic acid of okra. This may due to the nutrient content of organic manure. Subler *et al*. (1998) observed that the increases in chlorophyll contents in response to vermicompost were observed at early stages of marigold growth later increases in leaf areas and significant increases in the total plant weight.

Nanjundappa *et al*. (2001) reported that increasing in grain protein content with nitrogen for organic and inorganic sources. Application of organic manures not only influenced the growth and yield of wheat, but it also helped in enhancing the seed quality parameters. The increase in quality parameters might be due to the higher protein content and better sized seeds with these treatments. Significantly higher protein content in seed was observed in treatment receiving vermicompost with poultry manure in groundnut (Kachot *et al*., 2001). The application of recommended doses of organic manures like vermicompost and cow dung has much significantly increased the protein contents of mulberry leaves (Latrach *et al*., 2014).

Zaller (2006) findings were supported that the application of vermicompost highly enhanced the carbohydrate content in tomato plants. The study by Densilin *et al.* (2010) revealed that the combined application of biofertilizer, inorganic fertilizers and vermicompost increased the biochemical constituents in chilli fruits. Yadav *et al*. (2006) reported that highest protein content in okra fruit was recorded with application of N through FYM, vermicompost, poultry manure and urea over control. The percentage occurrence of maximum chlorophyll a, chlorophyll b and total chlorophyll, carbohydrate and protein content found in plants treated with biofertilizers enriched vermicompost in *Vigna unguiculata* (L.). Biochemical parameters of chlorophyll, total carbohydrate, total protein and total fat contents found higher in biofertilizer enriched vermicompost treatments. Increased amount of chlorophyll contents seems to correlate the increased photosynthetic properties (Khomami and Moharam, 2013).

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**Table 1:** Effect of Organic fertilizers on the growth characters of okra

| S. No. | Treatment | Seed Germination (%) | Germination Index | Shoot length (cm) | Root length (cm) | Number of leaves/ plant | Fresh weight (g) | Dry weight (g) | Seedling Vigour Index I | Seedling Vigour Index II |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Control | 81 | 0.6 | $28.5^{e}$± 0.76 (100) | $9.2^{c}$±0.17 (100) | $15^{f}$±0.88 (100) | $1.60^{e}$ ±0.21 (100) | $0.31^{f}$ ±0.05 (100) | $23.08^{f}$ ±0.14 (100) | $0.25^{f}$±0.01 (100) |
| 2 | Farmyard manure | 95 | 1.33 | $32.5^{d}$± 0.43 (116) | $10.5^{b}$±0.21 (106) | $20^{e}$±0.88 (109) | $2.30^{c}$ ±0.05 (187) | $0.67^{c}$ ±0.05 (216) | $30.87^{c}$±0.20 (133) | $0.63^{c}$±0.04 (252) |
| 3 | Organic manure | 91 | 1.4 | $36.5^{b}$± 0.72 (128) | $10.2^{c}$±0.12 (105) | $37^{a}$±0.33 (177) | $2.65^{b}$ ±0.11 (212) | $0.470^{e}$±0.10 (151) | $33.21^{b}$±0.14 (143) | $0.42^{e}$±0.03 (168) |
| 4 | Neem cake | 88 | 0.93 | $30.0^{e}$± 0.88 (103) | $10.0^{bc}$±0.21 (102) | $35^{b}$±0.88 (169) | $2.03^{d}$ ±0.02 (169) | $0.58^{d}$±0.02 (187) | 26.4 $^{e}$±0.20 (114) | $0.51^{d}$±0.02 (204) |
| 5 | Vermicompost | 97 | 1.46 | $37.5^{a}$± 0.72 (132) | $13.5^{a}$±0.28 (138) | $32^{c}$±0.57 (163) | $4.01^{a}$±0.03 (333) | $1.37^{a}$±0.11 (441) | $36.37^{a}$±0.15 (157) | $1.32^{a}$±0.03 (528) |
| 6 | Wood ash | 90 | 1.24 | $33.5^{c}$± 0.72 (117) | $10.5^{bc}$±0.21 (103) | $26^{d}$±0.57 (115) | $2.35^{c}$±0.10 (181) | $1.18^{b}$±0.07 (380) | $30.15^{d}$±0.15 (130) | $1.06^{b}$±0.01 (424) |
| CD P = 0.05 % | | | | 1.253 | 0.711 | 1.809 | 0.073 | 0.056 | 1.002 | 0.1543 |

**Table 2:** Effect of organic fertilizers on the biochemical characters of okra

| S. No | Treatment | Total chlorophyll (mg/g LFW) | Carotenoid (mg/g LFW) | Protein (mg/g LFW) | Aminoacids (mg/g LFW) | Glucose (mg/g LFW) | NRA (µ mole/g LFW) | Ascorbic acid (mg/ ml) |
|---|---|---|---|---|---|---|---|---|
| 1 | Control | $2.21^{f}$±0.09 (100) | $1.74^{f}$±0.05 (100) | $5.98^{f}$±0.22 (100) | $4.65^{f}$ ±0.04 (100) | $22.6^{f}$±0.23 (100) | $5.9^{c}$±0.35 (100) | $0.28^{f}$±0.02 (100) |
| 2 | Farmyard manure | $2.90^{e}$±0.08 (127) | $2.18^{e}$±0.02 (130) | $6.78^{e}$±0.23 (112) | $8.12^{b}$±0.06 (170) | $33.5^{b}$±0.20 (149) | $6.91^{d}$±0.03 (132) | $0.35^{e}$±0.03 (128) |
| 3 | Organic manure | $4.16^{a}$±0.03 (185) | $2.70^{a}$±0.09 (161) | $9.23^{a}$±0.09 (132) | $8.50^{a}$±0.05 (176) | $37.3^{a}$±0.12 (167) | $7.08^{a}$±0.04 (135) | $0.49^{a}$±0.04 (177) |
| 4 | Neem cake | $4.11^{b}$±0.44 (181) | $2.69^{c}$±0.13 (152) | $8.47^{b}$±0.07 (146) | $7.30^{d}$±0.12 (155) | $27.6^{e}$±0.32 (121) | $6.58^{ab}$±0.03 (125) | $0.48^{b}$±0.03 (174) |
| 5 | Vermi compost | $3.31^{d}$±0.35 (143) | $2.52^{d}$±0.06 (148) | $7.57^{c}$±0.06 (154) | $7.45^{b}$±0.14 (165) | $28.0^{d}$±0.28 (123) | $7.0^{a}$±0.08 (132) | $0.42^{c}$±0.04 (153) |
| 6 | Wood ash | $4.03^{c}$ ±0.05 (172) | $2.70^{b}$±0.08 (158) | $7.45^{d}$±0.09 (132) | $5.79^{e}$±0.06 (124) | $33.2^{c}$±0.08 (148) | $6.83^{ab}$±0.02 (130) | $0.38^{d}$±0.03 (142) |
| CD P = 0.05 % | | 0.0046 | 0.0019 | 0.0017 | 0.152 | 0.507 | 0.302 | 0.0027 |