Influence of Organic, Inorganic and Biofertilizers on Growth, Yield, Quality, and Economics of Okra [Abelmoschus esculentus (L). Moench] under Assam Condition

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A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during March to July 2016 to study the “Influence of organic, inorganic and biofertilizers on growth, yield, quality and economics of okra”. The results indicated that application of RDF (T1) recorded the highest branches plant⁻¹ (1.80), Leaves plant⁻¹ (14.66), Leaf area index (1.36), Chlorophyll content of leaf (0.210 mg/g), Fruit length (14.62 cm), Fruit girth (4.64 cm), fruit weight (12.56 g), Fruit yield plant⁻¹ (190.96 g) with the B:C ratio of 3.89 followed by followed by T2 [75% RD of NPK + Vermicompost @ 1 t ha⁻¹ (mixed with microbial consortium)]. However, among the quality parameters the highest carbohydrate (6.98 g/100g) and the lowest fiber (14.30 %) content of fruit recorded in T3. It was found that with lesser fiber content the quality of okra fruit increased. The present investigation revealed that most of the growth, yield and yield attributes were found highest in treatment receiving RDF. Whereas superior value regarding the quality of fruit observed in the treatment receiving the combination of organic, inorganic and biofertilizers. Considering the adverse effect on soil health and environment it is not advisable to use chemical fertilizers at a higher quantity. A study led to the conclusion that good growth, yield with better quality of okra can be achieved by judicious application of organic, inorganic and biofertilizers.

Keywords
RDF, Microbial consortium, Vermicompost, Okra, Quality parameters.

Introduction

Okra [Abelmoschus esculentus (L). Moench] is one of the most important vegetable crop in India and grown over a wide range of soil and climatic condition. It is a warm season crop and prefers a temperature between 22°C and 35°C. Okra is susceptible to frost at temperatures below 12°C. The climatic condition of Assam is subtropical humid with a hot summer experienced during May to August suitable for okra cultivation. Use of High Yielding Variety (HYV) and intensive agriculture depleted the nutrient status of the soil. Excessive use of chemical fertilizers to obtained high yield resulted in several hazards to the soil, deficiency of micronutrients (Kanwar and Randhawa, 1978) and nutrient imbalance (Singh et al., 1989), ultimately resulting in the reduction of crop yield.

Organic manures are very cheap and easily available, apart from partially fulfilling the nutrient demand, improve soil structure,
enhance fertility and promote biological activity. The organic manure gives better quality produce as compared to those grown with the inorganic source of fertilizer (Abusaleha and Shanmugavelu, 1988). But the release of nutrients from organic sources is much slower than chemical fertilizers, for which rapid demand of crop needs cannot be met through organic manures alone.

Biofertilizers such as Azospirillum, PSB, VAM, have potential practical applications, which contribute to increasing crop productivity through increased biological nitrogen fixation, increased availability or uptake of nutrients through phosphate solubilization or increased absorption, stimulation of plant growth or by rapid decomposition of organic residues.

Several researchers reported that there is no single source of nutrient which can meet the nutrient demand of crops. Therefore all the nutrient sources i.e., organic, inorganic and biofertilizer should be applied in appropriate combination. Good nutrient management often involves a combination of organic and inorganic sources of nutrients. The organic material maintains and improves soil productivity, whereas chemical fertilizers are often needed if production is to increase. Combination of organic, inorganic and biofertilizer contributes to better farm management, minimizing environmental pollution, reducing the cost of chemical fertilizers, improving soil productivity, and the production of safe food and feed.

Materials and Methods

A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during March to July 2016. The experiment was laid out with Randomized Block Design and replicated three times.

Results and Discussion

Growth parameters

In this present investigation growth parameters differs significantly due to the
application of inorganic, organic and biofertilizers (Table 1). The highest number of branches per plant (1.80), number of leaves per plant (14.66), leaf area index (1.36), and chlorophyll content (0.210 mg g\(^{-1}\)) was recorded in treatment T\(_1\) (RDF) followed by T\(_2\) and T\(_4\). This might be due to higher level of nutrients added to soil and uptake by the plant, leading to early vegetative growth and increased plant height resulting in more number of branches, leaves per plant which in turn increased the leaf area index because nitrogen has favourable influence to produce large cell with thinner cell wall and its contribution in cell division and cell elongation. Moreover, nitrogen is a structural element of chlorophyll and protein molecules and thereby affects the formation of chloroplasts and accumulation of chlorophyll. Similar finding was reported by Kadlag \textit{et al.}, (2010). Among the treatments T\(_2\) and T\(_4\) increased in growth parameters which might be due to the fact that combine application of organic, inorganic and biofertilizer increased total microbial population that improved the phosphorous and nitrogen availability and uptake by the plant. Thus, increase in nutrient level enhanced vegetative growth and simultaneously increased the number of functional leaves, leaf area index and chlorophyll content of the leaf. These results are in accordance with Ghuge \textit{et al.}, (2015) in okra.

**Yield attributing parameters and yield**

The combined application of organic, inorganic and biofertilizers could bring significant differences on yield attributing characters viz., fruit length, fruit girth, fruit weight and yield per plant (Table 1). The highest fruit length (14.62 cm), fruit girth (4.64 cm), fruit weight (12.56 g) and fruit yield per plant (190.96 g plant\(^{-1}\)) was recorded in treatment T\(_1\) (RDF) followed by T\(_2\) and T\(_4\). This might be due to the application of balanced fertilization, which build-up the adequate food reserves for formation and elongation of cells, and enhanced the photosynthetic activity by increasing the leaf area and rate of photosynthesis. The synthesized photosynthates might have translocated to the growing fruits having more demand of assimilates which consequently lead to greater length, thickness, weight of fruit and also yield. Increased yield attributes in T\(_2\) and T\(_4\) might be due to the additive effect of biofertilizers which might have provided better soil conditions inclusive of improved soil fertility, nitrogen fixation, phosphate solubilization, enhanced the efficacy of applied N and P; enhanced the activities of other microbes and also released of growth stimulants and much more. Efficacy of the inorganic fertilizer was pronounced when they are combined with biofertilizers (Dhawale \textit{et al.}, 2011). Similar results were demonstrated by Sharma \textit{et al.}, (2011) and Gayathri and Reddy (2014) in okra.

**Quality parameters**

Carbohydrate content in okra seemed to be affected by different treatments significantly (Table 1). The highest carbohydrate content (6.98 g 100 g\(^{-1}\)) was recorded in T\(_3\) [50% RD of N,P,K + Vermicompost @ 2 t ha\(^{-1}\) (mixed with microbial consortium)] and lowest carbohydrate content (6.05 g 100g\(^{-1}\)) was recorded in T\(_1\) (RDF). It might be due to the fact that when a plant is exposed to with more nitrogen, it increases protein production and reduces carbohydrate concentration (Worthington, 2001).

In the present study, it has been observed that crude fiber was lowest under treatment T\(_3\) (Table 1). This might be due to the easy availability of nitrogen leading to balance C: N ratio, enhancing the vegetative growth resulting in high photosynthetic activity.
Table 1 Influence of organic, inorganic and biofertilizers on growth, yield, quality and economics of okra under Assam condition

| Treatment | Branches Plant | Leaves Plant | Leaf Area Index | Chlorophyll content of leaf | Fruit length | Fruit girth | Fruit weight | Fruit yield plant | Carbohydrate (g 100 g⁻¹) | Crude fiber (%) | B:C Ratio |
|-----------|----------------|--------------|-----------------|-----------------------------|--------------|-------------|--------------|------------------|----------------------|---------------|-----------|
| T₁        | 1.80           | 14.66        | 1.36            | 0.210                       | 14.62        | 4.64        | 12.56        | 190.96           | 6.05                 | 17.37         | 3.89      |
| T₂        | 1.65           | 12.33        | 1.20            | 0.180                       | 13.10        | 4.44        | 11.50        | 176.35           | 6.60                 | 16.43         | 3.63      |
| T₃        | 1.30           | 9.88         | 0.94            | 0.154                       | 11.43        | 4.15        | 10.12        | 140.58           | 6.98                 | 14.30         | 2.31      |
| T₄        | 1.55           | 12.05        | 1.12            | 0.175                       | 13.04        | 4.36        | 11.42        | 168.73           | 6.51                 | 16.50         | 3.45      |
| T₅        | 1.25           | 9.72         | 0.90            | 0.149                       | 11.31        | 4.00        | 10.01        | 132.13           | 6.90                 | 14.55         | 2.24      |
| T₆        | 1.10           | 8.60         | 0.73            | 0.124                       | 9.11         | 3.79        | 9.20         | 108.20           | 6.26                 | 15.57         | 2.24      |
| T₇        | 1.00           | 8.54         | 0.70            | 0.123                       | 9.06         | 3.69        | 9.13         | 96.97            | 6.20                 | 15.83         | 2.21      |
| S.Ed(±)   | 0.06           | 0.45         | 0.05            | 0.008                       | 0.66         | 0.08        | 0.31         | 5.12             | 0.05                 | 0.13          | —         |
| CD at 5%  | 0.12           | 0.97         | 0.10            | 0.018                       | 1.44         | 0.17        | 0.67         | 11.15            | 0.12                 | 0.29          | —         |

Addition of organic manure and consortium tended to produce tender fruits with least fiber content due to the action of organic acids secreted by microbes (Evers, 1989). Premsekhar and Rajashree (2009) also reported that better quality fruits were produced with less fiber content in organic manure treatment.

**Economics of production**

In the present investigation the highest benefit: cost ratio (3.89) was observed in treatment T₁ (RDF) followed by treatment T₂ [75% RD of NPK + Vermicompost @ 1 t ha⁻¹ (mixed with microbial consortium)] i.e., 3.63. This might be due to more yield obtained under this treatment.

From the present study, it can be concluded that good vegetative growth, yield, and quality of okra can be produced by combine use of organic, inorganic and biofertilizer. Although more yield was obtained in treatment receiving recommended dose of fertilizer (RDF) but continuous use of chemical fertilizers at higher amount posses negative impact on the soil as well as on the environment. So, it is not advisable to use chemical fertilizers at the higher rate. Combine use of organic, inorganic and biofertilizer not only helps in improving the yield and quality of produce but it also help in reducing soil and environment pollution. Therefore, treatment T₂ [75% RD of NPK + Vermicompost @ 1 t ha⁻¹ (mixed with microbial consortium)] was found best considering the above points and recommended for okra cultivation under field condition.

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