e- ISSN: 2394-5532
p- ISSN: 2394-823X
Scientific Journal Impact Factor: 3.762
International Journal of Applied And Pure Science and Agriculture
www.ijapsa.com

EFFECT OF BIOFERTILIZERS ON YIELD ATTRIBUTING CHARACTERS AND YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH)

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Abstract

Field experiments were conducted to assess the effect of biofertilizers on okra in Kerala during Kharif in a Randomised Block Design with 13 treatments and 3 replications. The variety Arka Anamika was treated with FYM and three different biofertilizers (Azospirillum, Arbuscular Mycorrhizal Fungi and Frateuria) in different combinations. Performance with respect to yield and yield attributing characters were best in the treatment where combined application of all the three biofertilizers along with double dose of FYM was given (T_8). This was closely followed by the treatment where full dose of FYM, ¾ of inorganic fertilizers and biofertilizers (T_{10}) were applied.

Keywords: Okra, Yield, Azospirillum, Arbuscular Mycorrhizal Fungi, Frateuria

I. INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable crops grown for its tender green fruits. In India okra occupies an area of 4.5 lakh ha with a production of 48.03 lakh tonnes [1]. It has high nutritive value, therapeutic benefits and export potential. Nutritional requirement of vegetables is very high due to its short duration and hence usually chemical fertilizers are used for vegetable production. This has disturbed the natural balance of the soil, by destroying the beneficial microorganisms which maintain the health and fertility of the soil by their metabolic activities. The beneficial plant microbe interactions in the rhizosphere are the primary determinants of plant health and soil fertility. The lost biological activity in the soil, due to excess use of chemical fertilizers, can be restored slowly by incorporating artificially multiplied cultures of beneficial microorganisms in the form of biofertilizers.

Biofertilizers are carrier based preparations containing live or latent cells of efficient strains of beneficial microorganisms in a viable state intended for seed, soil or root application with the objective of increasing the number of such microorganisms and accelerating certain microbial process to augment the extent of availability of nutrients in a form which can be easily assimilated by the plants [2]. They influence the total soil microflaura, soil enzyme activity and in turn soil health [3]. They produce growth promoting substances and vitamins and help to maintain soil fertility and suppress the incidence of pathogen and control diseases [4]. As a cost effective supplement to chemical fertilizers, biofertilizers can help to economize the high investment needed for fertilizer use [5]. These non-conventional sources of nutrients are gaining immense importance as they improve long term sustainability of soil which ultimately results in improved yield and yield components.

In this context the present study was conducted to assess the effect of biofertilizers on yield and yield and yield attributing characters of okra and also to investigate the effectiveness of biofertilizers, when applied along with chemical fertilizers

II. MATERIALS AND METHODS

The experiment was conducted on okra cv. Arka Anamika during June-September in the Department of Olericulture, College of Horticulture, Kerala Agricultural University, Thrissur. The experiment was laid out in a Randomised Block Design with 13 treatments and 3 replications. The

plot size adopted was 3.6 x 3.6 m with a spacing of 60 x 45 cm. The manures and fertilizers were given as per Package of Practices recommendation of Kerala Agricultural University (FYM - 12 t ha^{-1}; N: P_2O_5: K_2O - 50:8:25 kg ha^{-1}). All the biofertilizers (*Azospirillum*, Arbuscular Mycorrhizal Fungi and *Frateuria*) were given as soil application @ 2 kg ha^{-1} along with FYM.

The treatment combinations were T_1 = FYM + *Azospirillum,* T_2 = FYM + AMF, T_3 = FYM + *Frateuria,* T_4 = FYM + *Azospirillum* + AMF, T_5 = FYM + *Azospirillum* + *Frateuria,* T_6 = FYM + AMF + *Frateuria,* T_7 = FYM + *Azospirillum* + AMF + *Frateuria,* T_8 = FYM (double dose) + *Azospirillum* + AMF + *Frateuria,* T_9 = FYM (as per POP) + ½ (NPK) + *Azospirillum* + AMF + *Frateuria*, T_{10} = FYM (as per POP) + ¾ (NPK) + *Azospirillum* + AMF + *Frateuria,* T_{11} = POP + *Azospirillu*m + AMF + *Frateuria,* T_{12} = *Azospirillum* + AMF + *Frateuria* and T_{13} = Manures and fertilizers as per POP recommendation (control).

The source of nitrogen, phosphorus and potassium were urea, factomphos and muriate of potash. The bioinoculants *Azospirillum* and Arbuscular Mycorrhizal Fungi were procured from College of Agriculture, Vellayani, Trivandrum, Kerala and *Frateuria* was obtained from T-Stanes and Company, Coimbatore, Tamil Nadu. Observations were recorded on fruit weight, fruit girth, number of fruits per plant, yield per plant and total fruit yield. Data relating to each character was analysed by applying the Analysis of Variance (ANOVA) and the means were compared using Duncan's Multiple Range Test (DMRT). MSTATC was used for computation and analysis of data.

III. RESULTS AND DISCUSSION

Inoculation of all the three biofertilizers along with double dose of FYM (T_8) recorded the highest fruit weight (19.80 g) and fruit girth (6.17 cm) compared to control (Table 1). It was followed by T_{10} where FYM, inorganic (¾ NPK) fertilizers and all the three biofertilizers were applied.

Application of FYM might have helped the soil to improve the nutrient status, water holding capacity, physical, chemical and biological properties which in turn helped better absorption of nutrients and expression of better biometrical parameters. FYM also provided room for better establishment of inoculated microorganisms along with accumulation of excess humus content [6]. Conjoint application of FYM, inorganic fertilizers and biofertilizers might have acted complementary and supplementary to each other and resulted in adequate and slow, but steady supply of nutrients resulting in better parameters in T_8 and T_{10}

Number of fruits per plant showed significant differences among the treatments and it ranged from 20.00 to 31.67. The highest number of fruits per plant (31.67) was recorded in the treatment where double dose of FYM was applied along with *Azospirillum*, AMF and *Frateuria* (T_8), which was 43.95 per cent more than control. T_{10} (FYM as per POP + ¾ NPK + *Azospirillum*, AMF, *Frateuria* each @ 2 kg ha^{-1}) also recorded a comparatively higher fruit number.

Better availability of nutrients at vital growth period, greater synthesis of carbohydrates, their proper translocation and improved water status of plants might have enabled the plant to put up better vegetative growth and profuse flowering combined with high fruit set resulting in higher number of fruits per plants [7]. Moreover, addition of biofertilizers might have increased various endogenous hormonal levels which in turn enhanced the pollen germination and tube growth [8]. Supply of nutrients might have increased the production, translocation and accumulation of photosynthates to growing points. This might have stimulated the plants to produce productive flowers ultimately resulting in increased yield and more number of fruits per plant.

Table 1: Comparison of yield and yield attributing characters in okra

Treatments	Fruit weight (g)	Fruit girth (cm)	No. of fruits per plant	Fruit yield per plant (g)	Total fruit yield (t/ha)
T_1	16.80	5.87	20.27	318.20	11.06
T_2	17.00	5.93	22.27	353.67	11.14
T_3	17.13	6.00	22.47	367.93	11.22
T_4	17.47	6.07	22.13	358.53	12.88
T_5	17.47	6.07	25.93	407.27	13.68
T_6	17.27	5.87	20.53	320.13	11.69
T_7	17.88	6.13	27.80	425.80	14.54
T_8	19.80	6.17	31.67	544.40	16.33
T_9	17.27	6.07	26.40	431.47	14.34
T_{10}	19.40	6.13	29.60	488.73	15.52
T_{11}	17.87	6.07	24.93	408.47	12.67
T_{12}	15.00	5.73	20.00	302.13	9.64
T_{13}	17.13	6.07	22.00	360.53	11.75

Significant differences were noticed with respect to fruit yield (Table 1). Combined application of all the three biofertilizers along with double dose of FYM (T_8) recorded the highest fruit yield per plant (544.40 g) and total fruit yield(16.33 t ha^{-1}). It was 50.99 per cent and 38.97 per cent higher than the control. Application of FYM, inorganic (¾ NPK) fertilizers and biofertilizers (T_{10}) also recorded 35.56 per cent more fruit yield per plant (488.73 g) and 32.08 per cent more total yield (15.52 t ha^{-1}) than the control. It could be observed that the activity of microorganisms in promoting fruit yield was more pronounced when it was enriched with double dose of FYM, and the more so, when it was further supplemented with lower dose of chemical fertilizers. This suggests that recommended dose of NPK could be replaced with double dose of FYM along with all the three biofertilizers. It also suggests that application of all the three biofertilizers along with judicious application of inorganic fertilizers and FYM could save 25 per cent of inorganic fertilizers.

Application of double dose of FYM might have created better soil condition due to higher rate of multiplication of inoculated microbes leading to enrichment and mobilisation of bound nutrients and improvement in soil aggregation. FYM provides macro and micro nutrients, increase the water holding capacity and aeration for better root formation [9,10]. Decomposition of FYM increased solubility of nutrients by forming humic complex which are easily assimilated by plants [11]. All these might have made quick mobilisation and availability of nutrients which could have resulted in increased yield attributes like fruit weight, fruit length and number of fruits ultimately resulting in higher yield.

The higher yield observed in T_{10} might be due to the supply of additional nutrients as well as improvement in physical and biological properties of soil by organics and inorganics. Active and rapid multiplication of microorganisms in rhizosphere creating a favourable condition for nutrient availability and uptake, secretion of hormones like IAA, cytokinin, vitamin B_{12}, GA [12,13] and supply of antibacterial and antifungal compounds [14] and micronutrients might have favoured growth and yield.

Response of biofertilizers were better at lower dose of chemical fertilizers. *Azospirillum* might have increased the number of cells as well as elongation of individual cells and better translocation of soluble ions whereas AMF might have mobilised the nutrients from beyond the depletion zone around root [15] thus improved the availability and uptake of nutrients and also produced growth promoting

substances [16]. Better crop due to all these factors might have helped in increasing photosynthetic rate and more physiological and biochemical activities which in turn resulted in increased yield and yield components.

The findings of the present study indicated that combined application of all the three biofertilizers along with double dose of FYM was the best, with respect to yield. The second best performance was obtained when FYM, inorganic fertilizers (¾) and biofertilizers were applied signifying that a reduction of 25 per cent chemical fertilizers is possible by using biofertilizers.

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