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# Fidelity of biofertilizer in okra

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**Abstract**
The experiment was conducted during 2018-19 and 2019-20 at HRS, AAU, Kahikuchi experimental farm where okra (Arka anamika) was grown during summer season. There were 9 treatments. Okra fruit yield was the highest under the treatment with dual culture of *Azospirillum* and PSB along with optimal compost. The highest value of available N, P and K in soil was observed under dual culture of *Azospirillum* and PSB ($T_6$) along with optimal compost. Soil health indicators/attributes such as Microbial biomass carbon and enzyme activities (dehydrogenase and urease) were found to be significantly higher in soil when treated with dual culture of *Azospirillum* and PSB along with optimal compost ($T_6$). Acid phosphatase activity was found to be the highest in $T_4$ (PSB along with optimal compost). Thus, this study has confirmed that the use of dual culture of *Azospirillum* and PSB along with optimal compost is more effective in okra.

**Keywords:** Okra, biofertilizer, soil health

## Introduction

Okra (*Abelmoschus esculentus*, L.) belongs to Malvaceae family, which provides higher nutrition (carbohydrates, fats, protein, minerals and vitamins) in our diet (Tindal, 1983) [13]. It is considered to be the most popular vegetable around the world in respect of area, production and availability and is cultivated for its fibrous fruits or pods containing round, white seeds. Okra dry seeds contain 14-23 percent edible oil and 21-25 percent protein (Thamburaj and Singh, 2005) [9].

The nutritional requirement of okra is found to be very high due to its short duration and hence usually chemical fertilizers are used for vegetable production. It has been found that imbalanced nutrient supply is one of the major constraints in harnessing higher yields. Integrated use of organic and inorganic fertilizers along with biofertilizer can improve crop productivity (Mal *et al*., 2013) [5]. However, the use of costly commercial fertilizers as per the requirement of the crop is not much affordable to the average farmers. The deteriorating productivity of crops has been found to be associated with deterioration of soil physical and biological properties besides imbalance in micronutrients. Inorganic fertilizers are not helpful in intensive agriculture due to reduced crop yield, soil acidity and nutrients imbalance. Substitution of high analysis fertilizers for enhancing crop productivity or insufficient use of biological sources of plant nutrients have rendered most of the Indian soils deficient in macro and micro nutrients (Acharya and Mandal, 2002) [1]. Thus there is an emergent need to utilize such as plant nutrients for sustainable okra production.

Though biofertilizers have been used in vegetable crops under organic farming and / or Integrated nutrient management studies, but no systematic data have been generated to elucidate the role of biofertilizers in vegetable crops grown in Assam. Keeping in view the given facts, the present research is undertaken to study the fidelity of biofertilizers in okra.

## Materials and Method

The experiment was conducted at N 26°06.496′ latitude; E 091°36.621′ longitude and at an elevation of 31 m. The treatments were $T_1$: Control; $T_2$: *Azotobacter* + optimal compost @10 t/ha; $T_3$: *Azospirillum* + optimal compost @10 t/ha; $T_4$: PSB+ optimal compost @10 t/ha; $T_5$: *Azotobacter* + PSB + optimal compost @10 t/ha; $T_6$: *Azospirillum* + PSB + optimal compost @10 t/ha; $T_7$: Consortial biofertilizers containing *Azotobacter*, *Azospirillum* and PSB + optimal compost @ 10 t/ha; $T_8$: Enriched compost @ 5 t/ha and $T_9$: Standard (Recommended dose of fertilizers) + optimal compost @10 t/ha.

At maturity stage, okra was harvested as per treatment. At initial stage, composite soil sample was collected at 0-15 cm depth from the entire experimental plot for both biological and chemical studies followed by sampling soils in the consecutive period of study as per treatment after harvesting of okra. For biological study, rhizosphere soil samples were collected. Standard procedures were followed to determine Soil pH, organic carbon content, available N content, available $P_2O_5$ content and available $K_2O$ content in sample soils. Chloroform fumigation extraction technique following the method of Vance *et al.* (1987) [10] was used to determine MBC of the soil sample. TTC method described by Thalmann (1968) [8] was used to determine DHA enzyme of the soil sample. The acid phosphatase enzyme was determined by the method described by Tabatabai and Bremner (1969) [6]. The Urease activity in soil was determined by Tabatabai and Bremner (1972) [7] method with modification. Economics of production was determined by calculating the net return (Rs./ha) of the crop. Randomized Block Design using standard statistical procedure (Gomez and Gomez, 1984) [4] was used to analyze data obtained from field and laboratory experiments. Critical Difference (CD) test was used to compare between treatment means.

## Result and Discussion

During 2018-19, 2019-20 and pooled analysis the highest plant height of okra was found in the standard i.e. recommended dose of fertilizer + optimal compost @ 10 t/ha ($T_9$) and the lowest was in the control treatment ($T_1$) (Table 1). The increase in plant height might be due to an easy accessibility of the available nutrients in the recommended dose of fertilizer applied treatment. Root length also followed the same trend as that of plant height (Table 1).

**Table 1:** Effect of biofertilizer enriched organics on plant height and root length of okra

| Treatment | Plant height in cm | | | Av. Root length in cm | | |
|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| $T_1$ | 76.83 | 77.17 | 77.00 | 8.40 | 8.57 | 8.48 |
| $T_2$ | 133.70 | 132.17 | 132.93 | 11.30 | 11.17 | 11.23 |
| $T_3$ | 142.23 | 143.33 | 142.78 | 11.40 | 12.00 | 11.70 |
| $T_4$ | 119.50 | 119.67 | 119.58 | 14.13 | 14.00 | 14.07 |
| $T_5$ | 126.50 | 127.83 | 127.17 | 18.57 | 20.33 | 19.45 |
| $T_6$ | 128.50 | 129.10 | 128.80 | 14.03 | 15.00 | 14.52 |
| $T_7$ | 134.00 | 135.13 | 134.57 | 15.80 | 15.33 | 15.57 |
| $T_8$ | 120.03 | 124.00 | 122.02 | 15.53 | 15.83 | 15.68 |
| $T_9$ | 158.50 | 158.83 | 158.67 | 20.17 | 20.50 | 20.33 |
| SE(d) | 2.88 | 1.75 | 1.73 | 0.75 | 1.13 | 0.77 |
| C.D. (5%) | 6.10 | 3.72 | 3.67 | 1.59 | 2.39 | 1.63 |

During 2018-19, 2019-20 and pooled analysis, fruit yield was highest in dual culture treatment of *Azospirillum* and PSB treatment + optimal compost @ 10 t/ha ($T_6$) to the lowest value in the control treatment ($T_1$). The highest yield in dual culture of *Azospirillum* and PSB might be due to easy accessibility of the available form of fertilizer nutrients due to combine effect of N fixation by *Azospirillum* and solubilization of insoluble $P_2O_5$ by PSB in the rhizosphere. Similar reports were found by Anisa *et al.* (2016) [2].

**Table 2:** Effect of biofertilizer enriched organics on fruit yield of okra

| Treatment | Fruit yield (t/ha) | | |
|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled |
| $T_1$ | 3.60 | 3.68 | 3.64 |
| $T_2$ | 7.23 | 7.27 | 7.25 |
| $T_3$ | 6.90 | 7.18 | 7.04 |
| $T_4$ | 5.89 | 5.98 | 5.94 |
| $T_5$ | 6.30 | 6.60 | 6.45 |
| $T_6$ | 7.96 | 7.95 | 7.96 |
| $T_7$ | 7.49 | 7.52 | 7.50 |
| $T_8$ | 6.97 | 7.32 | 7.14 |
| $T_9$ | 5.54 | 5.98 | 5.76 |
| SE(d) | 0.34 | 0.37 | 0.46 |
| C.D. (5%) | 0.72 | 0.79 | 0.97 |

During first year, second year and pooled analysis highest dry matter was found in standard ($T_9$) and lowest dry matter was found in the control (Table 3).This might be due to easy availability of nutrients from fertilizer followed by higher uptake of nutrients and dry matter content in the standard. Maximum biomass production in okra with vermicompost, biofertilizer and 100% RDF was reported by Mal *et al.* (2013) [5].

**Table 3:** Effect of biofertilizer enriched organics on dry matter of okra

| Treatment | Dry matter (t/ha) | | |
|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled |
| $T_1$ | 1.00 | 1.01 | 1.00 |
| $T_2$ | 1.73 | 1.74 | 1.74 |
| $T_3$ | 1.84 | 1.86 | 1.85 |
| $T_4$ | 1.55 | 1.57 | 1.56 |
| $T_5$ | 1.64 | 1.65 | 1.64 |
| $T_6$ | 1.67 | 1.67 | 1.67 |
| $T_7$ | 1.74 | 1.74 | 1.74 |
| $T_8$ | 1.56 | 1.59 | 1.57 |
| $T_9$ | 2.05 | 2.04 | 2.05 |
| SE(d) | 0.09 | 0.10 | 0.09 |
| C.D. (5%) | 0.19 | 0.21 | 0.18 |

During 2018-19, pH ranged from 4.16 in control ($T_1$) to 4.75 in consortial biofertilizers containing *Azotobacter*, *Azospirillum* and PSB + optimal compost ($T_7$). During 2019-20, pH ranged from 4.35 in *Azotobacter* + optimal compost ($T_2$) to 4.75 in standard i.e. recommended dose of fertilizer + optimal compost ($T_9$). Pooled analysis showed that the corresponding range varied from the highest pH of 4.73 in standard i.e. recommended dose of fertilizer + optimal compost ($T_9$) to the lowest of 4.33 in control ($T_1$ ) (Table 4). During first year, second year and pooled analysis highest OC was found in *Azospirillum* + PSB + optimum compost ($T_6$) and lowest value was recorded in control ($T_1$).The higher value of organic carbon in the *Azospirillum* and PSB along with optimal compost ($T_6$) treatment might be due to a higher turnover of native as well as inoculated organic matter by the introduced and native sources of biofertilizers. Incorporation of organic manure and biofertilizers also resulted in an increase in organic carbon content which was reported by various workers (Sarkar and Singh, 1997 [11] and Sharma *et al.*, 2005 [12]).

**Table 4:** Effect of biofertilizer enriched organics on soil pH and organic carbon (OC) content of okra grown soil

| Treatment | pH | | | OC% | | |
|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| $T_1$ | 4.16 | 4.50 | 4.33 | 0.67 | 0.75 | 0.71 |
| $T_2$ | 4.61 | 4.35 | 4.48 | 1.04 | 1.10 | 1.07 |
| $T_3$ | 4.45 | 4.65 | 4.55 | 1.04 | 1.08 | 1.06 |
| $T_4$ | 4.72 | 4.50 | 4.61 | 0.98 | 1.05 | 1.01 |
| $T_5$ | 4.61 | 4.45 | 4.53 | 1.00 | 1.08 | 1.04 |
| $T_6$ | 4.52 | 4.65 | 4.59 | 1.10 | 1.29 | 1.20 |
| $T_7$ | 4.75 | 4.58 | 4.67 | 1.06 | 1.15 | 1.10 |
| $T_8$ | 4.68 | 4.68 | 4.68 | 1.04 | 1.14 | 1.09 |
| $T_9$ | 4.71 | 4.75 | 4.73 | 0.9 | 1.00 | 0.95 |
| SE(d) | 0.23 | 0.21 | 0.17 | 0.16 | 0.21 | 0.12 |
| C.D. (5%) | 0.48 | 0.45 | 0.37 | 0.35 | 0.44 | 0.25 |

During the first two years and the pooled analysis, it was observed that soil available N content in okra soil was found the highest in treatment *Azospirillum* and PSB along with optimal compost ($T_6$) and the lowest in control treatment ($T_1$) for first year and pooled analysis and in second year the lowest value was obtained in standard ($T_9$) (Table 5).

During first year, second year and pooled analysis, the available $P_2O_5$, value was the lowest in the control treatment ($T_1$) and the highest value was obtained in *Azospirillum* and PSB along with optimal compost ($T_6$) (Table 5). Chaudhary *et al.* (2020) [3] recorded significantly maximum available Phosphorous with treatment of FYM @ 20 t/ha + *Azospirillum* @ 2.5 l/ha + PSB @ 2.5 l/ha + KSB @ 2.5 l/ha in their experiment on okra.

Similar with $P_2O_5$, the $K_2O$ content was lowest in the control treatment ($T_1$) and the highest in *Azospirillum* and PSB along with optimal compost ($T_6$). The highest result might be due to more turnover of nutrients by the inoculated biofertilizers *Azospirillum* and PSB along with optimal compost ($T_6$) which ultimately resulted in more available nutrients in soil. Chaudhary *et al.* (2020) [3] recorded significantly maximum available Potassium in okra with treatment of FYM @ 20 t/ha + *Azospirillum* @ 2.5 l/ha + PSB @ 2.5 l/ha + KSB @ 2.5 l/ha under their experiment to study the effect of organic sources of nutrients on N, P & K uptake, available N, P & K and yield of okra.

The microbiological parameter like MBC, DHA and Urease activity was found to be the highest in *Azospirillum* and PSB along with optimal compost ($T_6$) and the lowest value was found in control ($T_1$). Incase of PMEase the enzyme was found to be highest in the single culture treatment of PSB along with optimal compost ($T_4$) and the lowest value was found in control ($T_1$) (Table 6 and 7).

**Table 5:** Effect of biofertilizer enriched organics on soil available N, $P_2O_5$ and $K_2O$ content in okra grown soil after harvest

| Treatment | Av. N in kg/ha | | | Av. $P_2O_5$ in kg/ha | | | Av. $K_2O$ in kg/ha | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| $T_1$: | 244.00 | 263.00 | 253.50 | 34.50 | 38.50 | 36.50 | 107.00 | 115.00 | 111.00 |
| $T_2$: | 263.00 | 263.00 | 263.00 | 40.00 | 46.40 | 43.20 | 179.00 | 198.50 | 188.75 |
| $T_3$: | 260.00 | 263.00 | 261.50 | 39.50 | 46.00 | 42.75 | 175.00 | 190.00 | 182.50 |
| $T_4$: | 250.00 | 265.00 | 257.50 | 38.00 | 41.90 | 39.95 | 148.00 | 155.00 | 151.50 |
| $T_5$: | 248.00 | 269.00 | 258.50 | 39.90 | 43.90 | 41.90 | 170.50 | 173.00 | 171.75 |
| $T_6$: | 263.00 | 278.00 | 270.50 | 57.50 | 63.00 | 60.25 | 200.00 | 214.00 | 207.00 |
| $T_7$: | 260.00 | 276.00 | 268.00 | 52.50 | 53.90 | 53.20 | 191.00 | 198.00 | 194.50 |
| $T_8$: | 258.00 | 275.00 | 263.00 | 42.00 | 45.00 | 43.50 | 184.50 | 196.00 | 190.25 |
| $T_9$: | 250.00 | 257.00 | 253.50 | 39.40 | 40.00 | 39.70 | 115.00 | 155.00 | 135.00 |
| SE(d) | 15.04 | 16.45 | 12.19 | 10.26 | 10.43 | 9.77 | 15.86 | 19.68 | 13.74 |
| C.D. (5%) | 31.88 | 34.88 | 25.83 | 21.76 | 22.10 | 23.72 | 33.62 | 41.71 | 29.13 |

**Table 6:** Effect of Biofertilizers on microbial biomass carbon (MBC) content of okra soil after harvest of crop

| Treatment | MBC (µg/g soil) | | |
|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled |
| $T_1$ | 172.12 | 175.95 | 174.04 |
| $T_2$ | 185.65 | 188.28 | 186.97 |
| $T_3$ | 204.68 | 210.45 | 207.57 |
| $T_4$ | 206.48 | 212.30 | 209.39 |
| $T_5$ | 203.15 | 206.13 | 204.64 |
| $T_6$ | 841.01 | 843.98 | 842.49 |
| $T_7$ | 700.47 | 703.88 | 702.18 |
| $T_8$ | 729.63 | 737.58 | 733.61 |
| $T_9$ | 692.87 | 695.86 | 694.36 |
| SE(d) | 20.34 | 23.11 | 18.45 |
| C.D. (5%) | 43.11 | 48.99 | 39.11 |

**Table 7:** Effect of Biofertilizers on Dehydrogenase (DHA), Acid Phosphatase/Phophomonoesterase (PME) and Urease content of okra soil after harvest of crop

| Treatment | DHA (µg TPF $g^{-1}day^{-1}$) | | | PMEase (µg p-nitrophenol $g^{-1}$ $h^{-1}$) | | | Urease ($NH_4$ - N $g^{-1}$ dw 2 $hr^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1st year | 2nd year | Pooled | 1st year | 2nd year | Pooled | 1st year | 2nd year | Pooled |
| $T_1$ | 53.31 | 56.77 | 55.04 | 228.88 | 233.50 | 231.19 | 371.00 | 374.40 | 372.70 |
| $T_2$ | 68.95 | 69.51 | 69.23 | 579.64 | 563.14 | 576.36 | 433.60 | 451.60 | 442.60 |
| $T_3$ | 75.32 | 81.42 | 78.37 | 464.84 | 475.09 | 469.96 | 467.60 | 471.60 | 469.60 |
| $T_4$ | 80.03 | 83.77 | 81.90 | 672.91 | 678.55 | 675.73 | 439.80 | 441.60 | 440.70 |
| $T_5$ | 70.89 | 75.32 | 73.10 | 584.05 | 573.09 | 578.57 | 457.00 | 457.60 | 457.30 |
| $T_6$ | 128.49 | 146.35 | 137.42 | 305.96 | 316.21 | 311.08 | 517.00 | 518.40 | 517.70 |
| $T_7$ | 95.54 | 105.23 | 100.38 | 362.03 | 367.45 | 364.74 | 440.40 | 445.60 | 443.00 |
| $T_8$ | 107.72 | 114.23 | 110.98 | 596.76 | 600.14 | 598.45 | 458.00 | 459.60 | 458.80 |
| $T_9$ | 95.26 | 95.82 | 95.54 | 361.31 | 366.95 | 364.13 | 398.40 | 399.40 | 398.90 |
| SE(d) | 4.65 | 1.40 | 2.74 | 14.62 | 20.16 | 15.00 | 6.49 | 20.50 | 11.02 |
| C.D. (5%) | 9.864 | 2.976 | 5.806 | 30.995 | 42.732 | 31.803 | 13.754 | 43.463 | 23.350 |

In case of okra highest net income of Rs. 124464.25 / ha was found in treatment $T_6$ and lowest Rs. 45314.25 / ha was found in the control $T_1$ (Table 8).

**Table 8:** Cost of production of okra

| Treatments | Net income (Rs.)/ha |
|---|---|
| $T_1$ | 45314.25 |
| $T_2$ | 103389.25 |
| $T_3$ | 97089.25 |
| $T_4$ | 64089.25 |
| $T_5$ | 79164.25 |
| $T_6$ | 124464.25 |
| $T_7$ | 110439.25 |
| $T_8$ | 50314.25 |
| $T_9$ | 52409.25 |

## Conclusion

Thus the from the present study it can be concluded that application of *Azospirillum* and PSB along with optimal compost is more remunerative in okra and suitable for use as renewable alternative source of energy for soil health management. By considering net return, treatment with *Azospirillum* and PSB along with optimal compost was found the best in okra. Further research is required to study the effect of biofertilizers in other vegetable crops.

## References


1. Acharya CL, Mandal KG. Integrated plant nutrient supply in vegetable crops. In: Compendium recent advances in vegetable production technology proceedings of winter school, 3-23 December 2002, Indian Institute of Vegetable Research, Varanasi (UP); c2002. p. 79-104.
2. Anisa NA, Baby ML, Salykutty J. Effect of biofertilizers on yield attributing characters and yield of Okra (*Abelmoschus esculentus* (L.) Moench). Int. J Appl. Pure Sci. Agric. 2016;2(2):59-62.
3. Chaudhary SB, Patel MV, More SG, Chaudhary SS, Rabari SS. Effect of organic sources of nutrients on N, P & K uptake, available N, P & K and yield of okra [*Abelomoschus esculentus* (L.) Moench] cv. GAO 5. The Pharma Innov. J. 2020;9(3):390-396.
4. Gomez KA, Gomez AA. Statistical procedure for agricultural research. Willy Interscience Publication, John Willy and Sons, New York; c1984.
5. Mal B, Mahapatra P, Mohanty S, Mishra HN. Growth and yield parameters of okra (*Abelmoschus esculentus*) influenced by diazotrophs and chemical fertilizers. J. Crop Weed. 2013;9(2):109-112.
6. Tabatabai MA, Bremner JM. Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. Soil Biol. Biochem. 1969;1:301-307.
7. Tabatabai MA, Bremner JM. Assay of urease activity in soils. Soil Biol. Biochem. 1972;4:479-487.
8. Thalmann A. ZurMethodik der Bestimming der Dehydrogenaseakyiviat in Boden mittels Triphenyl tetrazoliumchloride (TTC). Landw Forsch. 1968;21:249-258.
9. Thamburaj S, Singh N. A text book of vegetables, tuber crops and spices. Directorate of Information and Publications of Agriculture, ICAR, New Delhi; c2005. p. 76-77.
10. Vance ED, Brookes PC, Jenkinson DS. An extraction method for measuring soil microbial biomass C. Soil Biol. Biochem. 1987;19:703-707.
11. Sarkar S, Singh SK. Integrated nutrients management in relation to soil fertility and yield sustainability under dryland farming. Ind. J Agric. Sci. 1997;67:431-433.
12. Sharma KL, Mandal UK, Srinivas K, Vittal KPR, Mandal B, Grace JK, et al. Long-term soil management effects on crop yields and soil quality in a dryland Alfisol. Soil Till. Res. 2005;83(2):246-259.
13. Tindal HD. Vegetables in the Tropics. Mac-Millan Education Limited, Houndmills; c1983. p. 533.