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Impact of different NPK levels and biofertilizers on growth and seed parameters in okra

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Abstract
A field experiment was carried out at the Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P. in 2016 to find out impact of different NPK levels and biofertilizers on growth and seed parameters in okra. The experiment was laid out in randomized block design comprising thirteen treatment combinations and replicated thrice. The treatments comprised of NPK, *Azospirillum*, PSB and VAM including control. Result raveled that growth parameters *viz*. plant height (79.60) and number of nodes/plant (20.17) was recorded maximum under T_{10} whereas, maximum number of leaves/plant (28.17), leaf length (11.92 cm) and leaf breadth (19.27 cm) were noticed with T_{11}, T_8 and T_{10}, respectively at 60 DAS. Seed parameters like maximum number of seeds/fruits (52.30) was reported in T_{12} while, T_{10} resulted highest 100 seeds weight (5.28 g), Seed yield/plant (51.72 g) and Seed yield/hectare (25.54 q).

Keywords: *Azospirillum*, randomized block design, NPK, okra, PSB and VAM

Introduction
Okra is a warm season vegetable crop and it grows best in hot summer with minimum and maximum temperatures of 18^0C and 35^0C respectively (Sajid *et al.*, 2012) [9]. In India it is grown during summer and rainy season. It is extensively grown for its immature green fruits. Okra fruits are used as vegetable in India, Brazil, West Africa and many other countries. After harvesting fruits can be easily transported in bulk and stored for few days without much loss of quality. For the year round consumption sundried (Africa and India), frozen and sterilized (USA) fruits are also important market production. Okra belongs to family Malvaceae. There are two cultivated types of okra *Abelmoschus esculentus*, (L.) Moench and *Abelmoschus caillei*. Okra is originated probably from South East Asia and it is popular in West Africa, Brazil, Philippines, Thailand and India. Biofertilizers are the formulation of living cells of different microorganisms (bacteria, algae, fungi) which have an ability to mobilize nutritionally important elements from non-usable form through biological processes (Tien *et al*., 1979) [12]. These microorganisms require organic matter for their growth and activity in soil and provide valuable nutrients to the plant (Saini *et al*., 2004) [8]. Biofertilizers produce the growth stimulating substances like auxin, gibberellins and cytokinins which contribute towards vigorous growth of the plant.

Materials and Methods
The present investigation was carried out at the Horticultural Research Farm, Department of Horticulture, Banaras Hindu University Varanasi, U.P. during the year 2016 in the month of may-June to find out impact of different NPK levels and biofertilizers on growth and seed parameters in okra cv. Kashi Kranti. The experiment was laid out in randomized block design comprising three replications. The experiment consisted of 13 treatments *viz.* T_0-Control, T_1- 50% NPK, T_2- 50% NPK + *Azospirillum*, T_3- 50% NPK + PSB, T_4- 50% NPK + VAM, T_5- 75% NPK, T_6- 75% NPK + *Azospirillum*, T_7- 75% NPK + PSB, T_8- 75% NPK + VAM, T_9- 100% NPK, T_{10}- 100% NPK + *Azospirillum*, T_{11}- 100% NPK + PSB and T_{12}- 100% NPK + VAM. Obtained findings were analyzed statistically for interpretation of results.

Results and Discussion
The evidence on growth parameters are presented in Table 1. At 60 DAS highest plant height (79.60 cm) was recorded with T_{10} followed by T12 (77.22 cm) whereas, lowest plant height (57.77 cm) was recorded in control. The maximum plant height was recorded with *Azospirillum*. This might be due to the fact that *Azospirillum* is the source of symbiotic nitrogen fixing bacteria and helps in plant growth by increasing the biological activity of

desired microorganism in rhizosphere. Similar finding was also reported by Manivannan and Singh (2004) [6] and Mal *et al.* (2013) [5]. T_{11} resulted maximum number of leaves/plant (28.17) followed by T_{10} (26.57) while, minimum number of leaves/plant (20.17) were recorded in control at 60 DAS. The results resemble with that of Singh *et al.* (2010) [11] who obtained maximum number of leaves/plant with 75% P and full dose of N and K + VAM. The results corroborated with finding of Kachari and Korla (2009) [3] and Sahu *et al.* (2014) [7]. At 60 DAS maximum number of nodes/plant (20.17) were recorded in T_{10} followed by T_{11} 19.03. The minimum number of nodes/plant (14.97) was recorded in control. Similar results were also obtained by Kumar *et al.* (2009) [4]. The longest leaf length (11.92 cm) was recorded in T_8 followed by T_3 (11.85 cm) whereas, smallest leaf length (10.52 cm) was recorded in control at 60 DAS. Bahadur and Manohar (2001) [1] in okra also noticed an increase in leaf length with phosphate solubilizers and plant was supplicated with 50% P and full dose of N and K. At 60 DAS maximum leaf breadth (19.27 cm) was recorded in T_{10} followed by T_8 (18.92 cm) though, minimum leaf breadth (15.87 cm) was recorded in control. Similar findings were also reported by Manivannan and Singh (2004) that the maximum leaf breadth was recorded with *Azospirillum*.

Table 1: Impact of different NPK levels and biofertilizers on growth parameters in okra.

Treatments	Plant height (cm)	Number of leaves/plant	Number of nodes/plant	Leaf length (cm)	Leaf breadth (cm)
T_0	57.77	20.17	14.97	10.52	15.87
T_1	63.02	21.80	17.33	10.85	16.60
T_2	67.17	22.37	17.63	10.78	16.93
T_3	64.57	22.43	18.10	11.85	17.70
T_4	65.58	22.33	17.30	10.65	16.91
T_5	70.07	23.47	17.00	11.47	16.45
T_6	74.32	24.07	18.13	11.32	17.32
T_7	72.91	24.20	18.27	11.33	16.13
T_8	73.62	23.77	17.60	11.92	18.92
T_9	71.60	24.67	18.43	10.93	18.88
T_{10}	79.60	26.57	20.17	11.42	19.27
T_{11}	75.80	28.17	19.03	11.70	17.80
T_{12}	77.22	25.67	18.93	11.44	18.24
CD 5%	2.79	2.29	1.18	1.28	1.28
S.E. (d)	1.35	1.11	0.57	0.62	0.62

The results obtained on seed parameters are presented in Table 2. The maximum number of seeds/fruit (52.30) was recorded under treatment T_{12} followed by T_{10} (52.13) whereas, minimum number of seeds/fruit (40.80) was recorded under control. In treatment 100% RDF + VAM, maximum number of seeds per fruit might be due to increased availability and uptake of macro (particularly nitrogen and phosphorus) and micronutrients (zinc, copper, manganese and iron). Bhusan *et al.* (2013) [2] found that among all the treatments, *Azotobacter* + ½ N + full P and K) recorded maximum number of seeds/pod (57.5) and seed weight/pod (6.1 g) in okra cv. Hisar Unnat. Maximum weight of the 100 seeds (5.28 g) was recorded under T_{10} followed by T_6 (5.06 g) while, control plants resulted with minimum weight of the 100 seeds (4.47 g). Obtained findings were accordance with the findings of Singh *et al.* (2011) [10]. Highest weight of 100 seeds was recorded with *Azospirillum* when it was incorporated with 100% RDF. This might be due better accumulation of source to sink. Maximum seed yield/plant (51.72 g) was recorded under T_{10} followed by T_{12} (45.59 g) whereas, minimum seed yield/plant (28.88 g) was recorded under control. As fruit length and fruit diameter was observed maximum under treatment 100% RDF + *Azospirillum* thus produces more number of seeds. It might be due to fact that higher NPK dose and *Azospirillum* results better translocation of soluble ions. 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 seed yield components thus results in higher seed yield/plant. Maximum seed yield/hectare (25.54 q) was observed in T_{10} followed by T_{12} (22.51 q) whereas, minimum (14.26 q) was recorded under control. Sajid *et al.* (2012) [9] revealed that maximum seed yield (1374.9 Kg/ha) was reported in plots receiving both 150 Kg N/ha and 90 Kg P/ha.

Table 2: Impact of different NPK levels and biofertilizers on seed parameters in okra.

Treatments	Number of seeds/fruit	100 seeds weight (g)	Seed yield/plant (g)	Seed yield/hectare (q)
T_0	40.80	4.47	28.88	14.26
T_1	41.27	4.83	32.88	16.24
T_2	45.73	4.84	37.08	18.31
T_3	42.27	4.71	33.15	16.37
T_4	45.07	4.96	37.15	18.35
T_5	43.60	4.97	36.38	17.97
T_6	41.93	5.06	36.44	17.99
T_7	47.27	4.93	39.73	19.62
T_8	45.43	5.03	38.83	19.17
T_9	47.10	4.58	38.10	18.81
T_{10}	52.13	5.28	51.72	25.54
T_{11}	50.60	4.84	44.48	21.96
T_{12}	52.30	4.91	45.59	22.51
CD 5%	3.96	0.34	4.33	2.14
S.E. (d)	1.92	0.17	2.10	1.04

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