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Research Article

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Efficacy of Bio-Fertilizers and in Combination with Chemical Fertilizers on Growth of Okra [*Abelmoschus esculents* (L.) Moench]

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ABSTRACT

The present experiment was conducted at Horticultural Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (U.P) during 2016-17. The experiment was conducted in a Randomized Block Design with ten treatments replicated thrice. The experiment comprises of different doses of biofertilizers i.e. Control, RDF (100%) , Azotobacter (100%) , Phosphate Solubilizing Bacteria (PSB) 100%,50% RDF + 50% Azotobacter, 50% RDF + 50% PSB, 50% Azotobacter + 50% PSB, 75% RDF + 25% Azotobacter, 75% RDF + 25% PSB, 25% RDF + 75% Azotobacter, 25% RDF + 75% PSB.The treatments include different basal application of NPK & bio-fertilizer on growth of Okra. The growth attributing characters were recordedmaximum height of plantT_1 (126.20 cm),number of leaves/ plantT_1 (44.61),diameter of stemT_1 (128.36 mm),earliest flowering formationT_1(33.43) days,highest number of flower / plant T_1 (20.31),earliest fruit formation T_1(37.55),number of branches / plant T_1(6.30),produced maximum number of fruits / branch T_1 (12.33),number of fruit / plant T_1(21.42),maximum length of fruit T_1(13.64 cm), maximum girth of fruit T_1(1.85cm) and maximum weight of fruit T_1(12.47 g).

Keywords: *Biofertilizers, Chemical fertilizers, Yield, Quality, Okra.*

INTRODUCTION

Okra [*Abelmoschus esculents* (L.) Moench] is an important vegetable crop in India and is most popular vegetable around the world in respect of area, production and availability. Okra is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. It is most popular vegetable around the world in respect of area, production and availability. Okra is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. The name okra is most often used in the United States, with a variant pronunciation, English Caribbean okra, the word okra is of West African origin and is cognate with Okwuru in the Lgbo language spoken in Nigeria.

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Okra is often known as "lady's fingers" outside of the United States. Okra (Bhindi) is propagated by seeds. It is more remunerative than leafy vegetables. Fresh okra fruits very important and use as vegetables. Nutritional value for 100 g edible unripe okra fruit contain 33Kcal energy, 7.45 g carbohydrates, 3.2 g dietary fiber, 1.48 g Sugars, 0.19 g fat, 2.00 g protein, 90.17 water, 0.08 mg thiamine, 0.06 mg riboflavin, 1 mg niacin, 23 mg ascorbic acid, 82 mg calcium, 0.62 mg iron, 57 mg magnesium, 299 mg potassium, 0.58 mg zinc, 8 mg oxalic acid (USDA Nutrient Database, 2007). The tender green fruit of okra are cooked in curry are also use in soups. Round year consumption, sun dried and frozen sterilized fruit of okra are also important market production. Okra has multiple uses the extract from bhindi and stem use for cleaning cane juice in preparation of jaggery. The dry seeds of okra contain 14-23% edible oil and 21-25% protein (Thamburaj, 2005). The seed cake is also used as an animal feed.In many countries, the ripen seeds of okra are used as substitute of Coffee particularly in Turkey. The dry fruit shell and stem containing crude fiber suitable for use in manufacture of paper and card board. The main aim of the investigationis to effect of bio-fertilizers and in combination with chemical fertilizers on growth, yield and quality of Okra.

MATERIALS AND METHODS

The present investigation entitled, "Efficacy of bio-fertilizers and in combination with chemical fertilizers on growth, yield and quality of okra [*Abelmoschus esculents* (L.) Moench]" was carried out to assess the effect of basal application of NPK & bio-fertilizer on growth, yield and quality of Okra at the Horticultural Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow during the year 2016-2017.Experimental soil was sandy loam and slightly alkaline in nature pH less than 8.2, Electrical conductivity more then 4.0 and Sodium exchangeable % less than 15.0.

The field was thoroughly prepared and the full doses of phosphorous and potassium in the form of Diammonium Phosphate (DAP) and Murate of Potash (MOP) were applied at the time of sowing. Two seeds per hill were sown with a spacing of 45 x 30 cm. Treatment dose of inorganic fertilizers are applied before 25 days of sowing in the field. Thick slurry of each bio-fertilizer *viz.* Azospirillum, Azotobacter, and Phosphate Solubilizing Bacteria was prepared before sowing. Okra seeds were inoculated by dipping them in the slurry of these bio-fertilizers for 24 hours 10% solution of Jaggery (Gur) or Sugar in water was made of quality sufficient to dip the seeds. The solution was prepared in cool but boiled water. The experiment was laid out in a Randomized Block Design replicated thrice with ten treatments i.e. T_0- Control, T_1- RDF (100%), T_2-Azotobacter (100%), T_3-Phosphate Solubilizing Bacteria (PSB) 100%, T_4-50% RDF + 50% Azotobacter, T_5-50% RDF + 50% PSB, T_6- 50% Azotobacter + 50% PSB, T_7- 75% RDF + 25% Azotobacter, T_8- 75% RDF + 25% PSB, T_9- 25% RDF + 75% Azotobacter, T_{10}- 25% RDF + 75% PSB. The observations were recorded on 17 characters under growth, yield and quality attributing traits in broccoli. i.e. Height of the plant, Branches per plant, Number days taking flowering, Stem diameter, Number of leaves of per plant, Number of flowers per plant, Number of days taken to 1st fruit formation, Number of fruits per plant, Number of fruits per branches, Weight of fruits, Length of fruits, Diameter of fruits in okra fruits.

RESULTS AND DISCUSSION

The data obtained at 60 DAS, the maximum height (126.20 cm) of plant was noted under the treatment T_1 (RDF- NPK 100 %) followed by T_7 (122.54 cm), T_8 (120.73 cm), T_4 (117.31 cm) and minimum plant height (112.25 cm). was recorded under T_0 (Control). Singh (1979) studied the effect of application and levels of N (0, 75 and 150 kg/ha) and phosphorous and potash (0, 60 and 120 kg/ha) on PusaSawani variety in summer season at Varanasi, U.P. It was observed that application of only N and P, respectively @ 75 and 60 kg/ha showed maximum value of yield and pant height, numbers of branches, pods and size

of pods per plant. The levels of K did not show any effect. The maximum number of leaves/ plant was noted under the treatment (RDF (N P K) 100 %) T_1 (44.61) followed by (75% RDF + 25% Azotobacter) T_7 (43.66), (75% RDF + 25% PSB) T_8 (42.51) and minimum number of leaves was recorded under control T_0 (31.51). Sharma & Shukla (1993) evaluated the effect of N, P and K application on PusaSawani variety of okra during kharif at IIHR, Bangalore by trying three levels of each N (40, 80 and 120 kg/ha), P (17.44, 34.88 and 52.32 kg/ha) and K (24.9, 49.8 and 74.7 kg/ha). The recommended levels of these nutrients were 118.70 kg/ha N, 38.56 kg P and 52.31 kg K/ha as they were economical. Three levels of nitrogen (22.5, 45.0 and 67.5 kg/ha) and two levels each of phosphorus (22.5 and 45.0 kg/ha) and potash (0 and 22.5 kg/ha) were tried by Chauhan & Gupta (1993) on PusaSawani variety at Gwalior, MP. They observed that height, number of leaves, girth of the plants and yield of green pods were increased with increase in level of nitrogen. There was no beneficial effect of various levels of phosphorus and potash. Maximum yield of 80.4 q/ha was obtained with 67.5 kg N/ha.

The maximum diameter of stem was noted under the treatment (RDF (NPK) 100 %) T_1 (128.36 mm) followed by (75% RDF + 25% Azotobacter) T_7 (126.50 mm), (75% RDF + 25% PSB) T_8 (123.50mm) and minimum diameter of stem was noted under control T_0 (111.41 mm). Sarkar et al. (2010) observed that *Azotobacter* promoted growth and development of cabbage plants by helping in the synthesis of Auxin, vitamins, growth substances, antifungal and antibiotics. While, the minimum stem diameter (1.340cm) was recorded under treatment T_0 control.

Table 1 clearly showed that (RDF (NPK) 100 %) T_1 showed earliest flowering formation of okra i.e. 33.43 days followed by (75% RDF + 25% Azotobacter) T_7 (34.11) days, (75% RDF + 25% PSB) T_8 (35.22) days, (25% RDF + 75% Azotobacter) T_9 (35.44) days, (Azotobacter 100%) T_2 (35.66) days. The late flowering was noted with control (T_0) i.e. (38.00) days. Singh (1981) studied the effect of application and levels of N (0, 75 and 150 kg/ha) and phosphorous and potash (0, 60 and 120 kg/ha) on PusaSawani variety in summer season at Varanasi, U.P. It was observed that application of only N and P, respectively @ 75 and 60 kg/ha showed maximum value of yield and pant height, numbers of branches, Number of days taken to first flowering.

Table 1 clearly showed that (RDF (NPK) 100 %) T_1 produced the highest number of flower / plant (20.31) followed by (75% RDF + 25% Azotobacter) T_7 (19.61), (75% RDF + 25% PSB) T_8 (19.25) and lowest number of flower / plant was noted under the control (T_0) i.e. 10.18. Kamal Nathan et al. (1970) also observed the same result, while minimum (4.90) in control

Table 1 clearly showed that (RDF (NPK) 100 %) T_1 showed earliest fruit formation of okra i.e. 37.55 days followed by (75% RDF + 25% Azotobacter) T_7 (38.11), (75% RDF + 25% PSB) T_8 (39.22), (25% RDF + 75% Azotobacter) T_9 (39.55), (50% RDF + 50% Azotobacter) T_4 (39.60), (Azotobacter 100%) T_2 (39.65), (50% Azotobacter + 50% PSB) T_6 (39.66). The maximum days taken to first fruit formation was noted with control (T_0) i.e. 44.47. Jeevajohti et al. (1993) alsofound *Azotobacter* inoculated have lead to better root development, better transport of water, uptake and deposition of nutrients. Whereas maximum days taken to first fruit formation in control.

Maximum number of branches / plant was recorded (RDF (NPK) 100 %) T_1 produced more number of branches (6.30) followed by (75% RDF + 25% Azotobacter) T_7 (5.66), (75% RDF + 25% PSB) T_8 (4.44) and lowest branches were noted with control i.e. 2.06. . The maximum number of fruit / branch significantly (RDF (NPK) 100 %) T_1 produced maximum number of fruits / branch (12.33) followed by (75% RDF + 25% Azotobacter) T_7 (11.33), (75% RDF + 25% PSB) T_8 (10.00) and lowest no. of fruit / branch was noted with control (T_0) i.e. 4.55.
Number of fruit / plant significantly higher in (RDF (NPK) 100 %) T_1 produced the highest

no. of fruit / plant (21.42) followed by (75% RDF + 25% Azotobacter) T_7 (20.58), (75% RDF + 25% PSB) T_8 (19.58) and lowest number of fruit / plant was noted under the control (T_0) i.e. 9.40. Bashan et al. (1989) reported that inoculation of *Azospirillum* resulted in an increase in plant yield in tomato, while minimum (8.24) in the control.

Length of fruit significantly in (RDF (NPK) 100 %) T_1 produced the maximum length of fruit (13.64cm), followed by (75% RDF + 25% Azotobacter) T_7 (12.50cm), (75% RDF + 25% PSB) T_8 (11.50cm), (50% RDF + 50% Azotobacter) T_4 (10.55cm), (50% RDF + 50% PSB)T_5 (10.30cm), (25% RDF + 75% Azotobacter) T_9 (9.88cm), (50% Azotobacter + 50% PSB) T_6 (9.83cm), (25% RDF + 75% PSB)T_{10} (9.74cm). The lowest length of fruit was noted with control (T_0) i.e. 7.64cm.

Girth of fruit significantly in (RDF (NPK) 100 %) T_1 the maximum girth of fruit (1.85cm), followed by (75% RDF + 25% Azotobacter) T_7 (1.77cm), (75% RDF + 25% PSB) T_8 (1.60cm), (50% RDF + 50% Azotobacter) T_4 (1.59cm), (50% RDF + 50% PSB) T_5 (1.57cm), (Azotobacter 100%) T_2 (1.55 cm), (25% RDF + 75% Azotobacter) T_9 (1.53cm), (25% RDF + 75% PSB) T_{10} (1.50cm). The lowest girth of fruit was noted with control (T_0) i.e. 0.925 cm. Ukey, (1993) who reported that combined inoculation of *Azotobacter* and *Azospirillum* + 20% reduction in N increased the girth of fruit. Whereas, the minimum girth of fruit found with control treatment T_0 (1.40cm)

Weight of fruit significantly in (RDF (NPK) 100 %) T_1 produced the maximum weight of fruit (12.47g), followed by (75% RDF + 25% Azotobacter) T_7 (11.58g), (75% RDF + 25% PSB) T_8 (10.46g) lowest weight of fruit was noted with control (T_0) i.e.7.61g.

Table 1: Effect of different treatment combinations of chemical fertilizers along with biofertilizers growth in okra

S. No.	Treatment	Characters											
		Plant height (cm)	No. of leaves /plant	Diameter of stem (mm)	number of days taken to 1st flowering	No. of flower/ plant	No. of days taken to 1st fruit formation	No. of branches/ plant	No. of fruits/ branch	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Weight of fruit (g)
1.	T_0	112.250	31.51	111.41	38.000	10.183	44.473	2.067	4.550	9.400	7.64	0.925	7.61
2.	T_1	126.200	44.61	128.36	33.430	20.317	37.550	6.303	12.330	21.423	13.64	1.850	12.46
3.	T_2	113.233	36.53	113.36	35.660	14.350	39.650	2.887	7.107	10.417	9.47	1.557	8.80
4.	T_3	115.410	37.46	114.51	36.440	14.333	40.330	3.220	8.330	11.417	9.58	1.480	8.77
5.	T_4	117.310	39.46	120.38	36.330	18.450	39.600	3.883	9.330	16.393	10.55	1.593	10.00
6.	T_5	116.450	38.41	119.46	34.660	17.500	39.723	3.440	8.550	15.523	10.30	1.573	9.55
7.	T_6	113.517	38.31	117.48	35.550	16.400	39.663	2.997	8.303	12.420	9.83	1.383	8.73
8.	T_7	122.543	43.66	126.50	34.110	19.617	38.110	5.663	11.330	20.580	12.50	1.770	11.58
9.	T_8	120.733	42.51	123.50	35.220	19.250	39.220	4.440	10.000	19.580	11.50	1.607	10.46
10.	T_9	115.617	37.63	117.56	35.440	15.550	39.550	2.777	7.330	13.330	9.88	1.537	9.72
11.	T_{10}	115.400	35.50	113.48	36.440	14.500	41.440	2.887	7.440	13.440	9.74	1.509	8.75
	C.D. at 5%	**1.942**	**1.904**	**1.690**	**1.862**	**1.580**	**2.083**	**1.299**	**1.685**	**1.912**	**1.645**	**0.308**	**1.599**

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