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Effect of Different Methods of Biofertilizer Application in Tomato Seed Production

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ABSTRACT An investigation using four biofertilizers namely *Azotobacter, Azospirillium, Pseudomonas and Vesicular arbuscular mycorrhiza (VAM)* was undertaken during summer season of 2002 and repeated in 2003,to study their role on various aspects of tomato seed production. Application of these biofertilizers was done with three methods i.e nursery soil treatment, seedling treatment and field soil treatment, tried individually and in combinations thereof. Basal application of FYM (25t/ ha) was given to all the plots except control where only recommended dose of NPK (100,75 and 55 kg/ha) was applied.The study revealed that *Azotobacter* when applied to nursery, seedling and field soil, resulted in maximum values with respect to number of fruits per plant(19.23), fruit yield per plant(1109g), per hectare(356.9q) 1000 seed weight (3.63g), seed yield per plant (4.58g), per hectare (152.70kg) along with C:B ratio (l:1.45).However, the results with respect to germination percentage of seeds remained non-significant.

Key words : Biofertilizers, Azotobacter, Azospirillium, Pseudomonas, Vesicular arbuscular mycorrihiza, tomato seed yield.

The use of biofertilizers has currently attained a special significance in crop production to address the sustainability problem and tremendous success has been achieved in several economic crops. Among biofertilizers benefiting crop production-Azotobacter, *Azospirillum*, *Pseudomonas* and *Vesicular arbuscular mycorrhiza* are important. Their method of application and further effectiveness after applying with organic and synthetic fertilizers in crops like tomato are still awaited. Therefore, the present studies were initiated to compare the effect of different methods of biofertigation with themselves and with chemical fertigation in tomato.

MATERIALS AND METHODS

The experiment was conducted on a drained sandy loam soil (pH=7.5) of Vegetable Research Farm, Department of Vegetable Crops, Dr .Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan, in the summer season of 2002 and 2003. Sixteen treatments viz.,T_1 (Azotobacter-nursery soil treatment), T_2 (*Azospirillum*-nursery soil treatment),T_3(Pseudomonas-nursery soil treatment),T_4 (VAM-nursery soil treatment), T_5 (*Azotobacter*-seedling treatment), T_6 (Azosprillum-seedling treatment), T_7 (*Pseodomonas*- seedling treatment), T_8 (*Azotobacter-field* soil treatment), T_9 (*Azospirillum*- field soil treatment), T_{10} (*Pseodomonas*-field soil treatment), T_{11} (VAM-field soil treatment), T_{12} (Azotobaccter nursery+ seedling+field soil treatment), T_{13} (Azospirillum- nursery + seedling + field soil treatment), T_{14} (*Pseodomonas*- nursery+ seedling + field soil treatment),T_{15} (VAM-nursery+ field soil treatment) and T_{16} (Control-recommended dose of NPK i.e., l00kgN, 75kgP2O5and 55kgK2O/ ha).In case of nursery soil treatment, l00g of inoculant of *Azotobacter or Azospirillum or Pseodomonas* was mixed with 900g of well dried powdered FYM and applied in the rows made with the help of a stick to the raised nursery beds. In case of VAM(*Vesicular arbuscular mycorrhiza)*, 1kg of the commercial formulation without any mixture was brought under use. Seeds of tomato cultivar Solan Vajr were sown over these rows and later covered with the same inoculant to get a maximum coverage of biofertilizers to the seeds.

Seedling treatment with *Azotobacter, Azospirillum* and *Pseudomonas* was done at the time of transplanting. 200g of the inoculant was mixed with 1 liter of water(@ 1.5kg/ha inoculant/7.5 liters of water) and the root portion was dipped in that solution for 30 minutes. After that period the

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seedlings were immediately transplanted in the field. No seedling dip treatment was done in case of VAM treatment. In case of field soil treatment all the biofertilizers(*Azotobacater, Azospirillum , Pseudomonas* and VAM) @ 5kg/ha were evenly applied to the plots before transplanting after their volume was increased with 50kg FYM. Various cultural operations and watering in the field was done plot wise and hence the cross contamination of the inoculants was controlled. The biofertilizers were procured from Division of Microbiology, I.A.R.I., New Delhi. A basal dose of farm yard manure @25t/ ha was applied to all the plots except control where only recommended dose of NPK(100,75 and 55kg/ ha) was given. The trial was laid out in RBD having three replications in a plot size of 2.7x 2.0m. The seedlings of tomato cultivar Solan Vajr were transplanted at a spacing of 90 x30cm. Observations on fruit yield, seed yield and quality parameters were recorded during both the years of study and the data were analysed statistically

RESULTS AND DISCUSSION

Growth and yield characters.

The data in Table 1, revealed maximum height of plants (131.7cm) during 2002 and (199.0cm) during 2003, thereby showing mean maximum plant height of 165.3 cm in T_{12} (*Azotobacter* treatment to nursery, seedling and field soil) as compared to control (149.2 cm). Similar results have reported by Sharma and Thakur[l].

The results obtained with respect to number of fruits per plant (Table 1) suggested that the inoculation of *Azotobacter* to nursery soil ,then to the seedlings raised from these nursery beds and later applied to the plots where these treated seedlings were to be planted (T_{12}) resulted in maximum number of fruits (mean 19.23) during both the years of experimentation. In case of control plants, number of fruits recorded were 14.96. However, lowest number of fruits per plant (13.13) were recorded in *Pseodomonas* inoculation to nursery (T_3). Reason might be that nitrogen being a constituent of protein and chlorophyll plays a vital role in photosynthesis. It enhances accumulation of carbohydrates, which in turn increases growth, number of fruits and ultimately yield [2]. Similar findings were obtained by Martinez *et al.* [3] in tomato with the application of *Azotobacter* inoculation.

Fruit yield on plant (1108.50g) and hectare basis (356.9q) was also highest in both the years of experimentation in T_{12} (*Azotobacter* inoculation to nursery, seedling and field soil) as compared to control (925.00g and 308.3q) respectively (Table 1). Increase in fruit yield in *Azotobacter* treated plots over control is obvious due to more number of fruits per plant in the later and also *Azotobacter* inoculation has been reported to contain at least three gibberellin-like substances, indole-3-acetic acid and at least three substances possessing cytokinin activity which led to an increase in fruit yield [4]. Similar findings were reported by Mohandas [5] and Martinez *et* al [3] in tomato.

Fruits picked from control plants showed maximum number of seeds (mean 90.15) during both the years of experimentation. Lowest number of seeds per fruit (44.50) was counted in T_3 (*Pseudomonas* inoculation to nursery soil) (Table 1). It seems that biofertilization treatments has increased pericarp thickness of the fruits resulting in less locular space, for seeds, as is evident from the fruit firmness which was more in all the treated plots than control. The findings of Mahmoud and Amara [6] strongly confirmed these results. According to their study, increasing NPK rates up to 100% dose along with biofertilizers under calcareous soil conditions, increased fruit and seed yield.

As is evident that *Azotobacter* in nursery, seedling and field soil (T_{12}) resulted in maximum seed yield during both the years of experimentation (Table 2) and thus showing mean maximum seed yield per plant (4.58g) and per hectare (152.70 kg) as compared to control (2.82g per plant and 93.91kg per hectare) respectively. Increase in seed yield was certainly due to maximum number of fruits harvested in all the pickings in this treatment. The findings of Verma *et al.* [7] who reported highest seed yield per plant in cabbage due to bio-inoculation treatments are in line with the present investigation. Also the results of Sharma and Thakur [1] who reported increase in seed yield of tomato with *Azotobacter chroococcum* (Natrin) inoculation in combination with l00kg nitrogen support the present work.

In this experiment, the treatment having inoculation of *Azotobacter* in nursery, seedling and field (T_{12}) fetched the highest net profit ratio (1:1.45) to maximum seed yield (152.70kg) per hectare as compared to 1:0.53 in control. However, lowest cost benefit ratio of (1: -0.05) was recorded in T_8 (*Azotobacter*, field soil treatment) (Table 2).

Seed quality parameters

All the methods of biofertilization influenced 1000 seed weight during both the years of study (Table 1). The treatment having *Azotobacter* inoculation to nursery, seedling and field soil (T_{12}) showed maximum values of 1000 seed weight during 2002 and 2003 having mean value of 3.63g which was found superior over no biofertilization (2.48g). Although seed quality may be a genetic character but the A environment under which it is grown also affects its quality. The other reasons might be the solubilization of different inorganic phosphates by *Azotobacter* spp. which led to greater there was no significant effect of various treatments on germination percentage accumulation of food reserves into the seed [8,9]. There was no significant effect of various treatments on germination percentage.

Table 1. Effect of different methods of biofertilizer application on yield and yield contributing characters in tomato cv. Solan Vajr.

S.No.	Treatment	Plant height (cm)			Number of furits/ plant			Fruit yield/plant (g)			Fruit yield/hectare (q)		
		2002	2003	Mean	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
T_1	*Azotobacter* (NST)	116.7	181.7	149.2	16.01	13.30	14.65	960.4	786.7	873.5	302.7	262.2	274.4
T_2	*Azospirillum* (NST)	113.7	175.3	144.5	16.00	12.67	14.33	972.8	757.0	864.9	324.2	252.4	288.3
T_3	*Pseudomonas* (NST)	113.3	170.0	141.7	14.53	11.73	13.13	908.3	700.3	804.3	320.2	233.4	268.1
T_4	VAM (NST)	119.3	182.7	151.2	16.77	13.75	15.17	1095.0	806.3	950.7	364.9	286.7	316.9
T_5	*Azotobacter* (ST)	120.0	184.7	152.3	18.97	14.20	16.58	1150.0	854.3	1002.0	383.3	284.7	334.0
T_6	*Azospirillum* (ST)	119.7	171.0	145.3	18.80	14.20	16.50	1133.0	842.2	987.7	377.7	280.7	329.6
T_7	*Pseudomonas* (ST)	114.3	170.0	142.2	16.67	13.78	15.22	1088.0	823.6	956.0	362.7	274.5	318.6
T_8	*Azotobacter* (FST)	103.3	162.0	132.7	15.13	12.90	14.02	905.0	770.3	837.7	301.6	256.8	279.2
T_9	*Azospirillum* (FST)	103.3	160.0	131.7	15.27	12.03	13.65	948.0	757.0	836.7	315.9	241.7	278.8
T_{10}	*Pseudomonas* (FST)	105.0	160.0	132.5	15.77	12.10	13.93	967.3	721.3	844.3	355.7	256.3	306.0
T_{11}	VAM (FST)	101.0	161.7	132.7	15.24	12.55	13.89	931.5	782.8	857.2	310.5	260.9	285.7
T_{12}	Azotobacter (NST+ST+FST)	131.7	199.0	165.3	20.93	17.53	19.23	1266.0	951.0	1109.0	422.0	320.0	356.9
T_{13}	*Azospirillum* (NST+ST+FST)	127.0	195.0	161.2	18.83	16.67	17.75	1077.0	902.0	989.3	358.9	300.7	329.8
T_{14}	*Pseudomonas* (N.S.T.+ST+FST)	120.0	196.0	158.0	18.57	16.73	17.65	1040.0	907.7	973.8	346.6	302.5	324.6
T_{15}	VAM (N.S.T+FST)	129.3	188.0	158.7	19.53	15.20	17.37	1181.0	802.7	991.7	393.5	267.5	330.5
T_{16}	Control (NPK alone)	118.3	180.0	149.2	16.62	13.30	14.96	1059.0	790.7	925.0	353.1	263.5	308.3
	C.D(0.05)	6.9	7.3		3.86	2.07		204.30	116.18		79.47	41.42	

NST- Nursery Soil Treatment ST-Seedling Treatment; FST-Field Soil Treatment

Table 2. Effect of different methods of biofertilizer application on various growth and yield parameters in tomato cv. Solan Vajr.

S.No.	Treatment	Number of seeds per fruit			Thousand seed weight (g)			Seed yield per plant			Seed yield per hectare (kg)			C:B ratio
		2002	2003	Mean	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean	
T_1	*Azotobacter* (NST)	73.88	61.24	67.56	2.43	3.52	2.97	2.90	2.20	2.55	96.62	95.55	96.08	1: 0.56
T_2	*Azospirillum* (NST)	64.03	51.57	57.80	2.36	3.66	3.01	2.40	1.70	2.05	79.96	56.67	68.33	1: 0.11
T_3	*Pseudomonas* (NST)	38.62	50.38	44.50	2.36	3.95	3.15	1.33	1.63	1.48	44.42	54.33	49.37	1: -0.19
T_4	VAM (NST)	81.67	51.57	66.62	2.49	3.80	3.15	3.46	2.70	3.08	115.50	89.96	102.73	1: 0.67
T_5	*Azotobacter* (ST)	68.74	55.83	62.29	2.69	3.70	3.19	3..46	2.93	3.20	115.50	97.77	106.63	1: 0.74
T_6	*Azospirillum* (ST)	78.12	63.14	70.63	2.52	3.31	2.91	3.53	2.83	3.18	117.70	94.44	106.07	1: 0.73
T_7	*Pseudomonas* (ST)	49.48	41.12	45.30	2.63	4.10	3.36	2.13	2.00	2.06	71.07	77.77	74.42	1: 0.23
T_8	*Azotobacter* (FST)	55.35	50.09	52.72	2.26	3.90	3.08	1.86	1.50	1.68	66.96	50.00	58.48	1:0.05
T_9	*Azospirillum* (FST)	51.18	58.29	54.73	2.30	3.79	3.04	1.80	1.30	1.55	59.97	43.33	51.65	1: -0.16
T_{10}	*Pseudomonas* (FST)	50.13	54.12	52.13	2.25	4.10	3.17	1.63	1.63	1.63	54.42	54.33	54.37	1: -0.11
T_{11}	VAM (FST)	65.00	76.76	70.88	2.14	3.54	2.84	2.06	1.73	1.89	68.72	57.67	63.19	1: 0.02
T_{12}	Azotobacter (NST+ST+FST)	78.40	53.38	65.89	3.11	4.16	3.63	4.93	4.23	4.58	164.40	141.0	152.70	1: 1.45
T_{13}	*Azospirillum* (NST+ST+FST)	85.17	55.44	70.31	2.92	4.08	3.50	4.66	3.97	4.32	155.40	132.3	143.85	1: 1.32
T_{14}	*Pseudomonas* (NST+ST+FST)	65.26	32.19	48.72	2.41	4.06	3.24	2.90	2.18	2.54	96.62	72.54	84.58	1: 0.36
T_{15}	VAM (N.S.T+FST)	86.36	62.64	74.50	2.80	3.92	3.36	4.40	3.70	4.05	146.60	123.3	135.01	1: 1.16
T_{16}	Control (NPK alone)	103.30	77.00	90.15	1.86	3.10	2.48	3.16	2.47	2.82	105.50	82.33	93.91	1: 0.53
	C.D. (0.05)	30.26	18.61		0.26	0.40		0.91	0.84		30.43	25.94		

NST-Nursery Soil Treatment

ST-Seedling Treatment

FST-Field Soil Treatment

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