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Effect of bio-fertilization and mulch treatments on yield attributes and fruit quality of tomato under hill conditions of Uttarakhand

N.K. Hedau*, J.K. Ranjan, B. Das, Pragya, R.K.Verma, and A.A. Sofi
Central Institute of Temperate Horticulture-Regional Station, Mukteshwar, Distt. Nainital 263 138

ABSTRACT

The effect of bio-fertilization on the nursery of tomato (cv. Manisha) and effect of fertilization in combination with mulching on fruit yield and quality of tomato were studied during 2005 and 2006. Early and maximum seed germination was observed consistently for two years with the treatments, where seeds were inoculated with *Azospirillum* and *Azotobactor* in combination with Microphos. Maximum fruit yield with good quality fruits (Vitamin C and Total soluble solids) were produced with the application of recommended dose of NPK. However, they were on par with the treatments having inoculated tomato seedlings with *Azospirillum* and *Azotobactor.* Significantly increase in fruit yield and number of fruits per plot was observed when mulching was done with black polyethylene. The control (recommended NPK) and all fertilizer treatments with black polythene mulch showed increase in fruit yield and number of fruits per plot. The maximum fruit yield (151.5q/ha in 2005 and 135q/ha in 2006) was recorded with the treatment having recommended NPK and black polyethylene mulch which was on a par with the treatment having *Azospirillum* and black polyethylene mulch.

Key words: Bio-fertilizer, mulch, fruit quality, tomato.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is one of the most important vegetable crops of the hills being cultivated as an off season. It helps hill farmers for fetching high premium price from the market of North Indian plain when the supply of tomato is stopped from the plains. The productivity of tomato in Uttaranchal is 12.89 t/ha which is very lower as compare to other north western hill state (NHB, 11). One of the reasons for the poor productivity is restricted application and supply of chemical fertilizer. Most of the lands of Uttarakhand hills are deprived of nitrogen, which is the major essential element for growth of plants. Nitrogen is required in huge quantity for growth and development of the plants, since it is the basic constituent of proteins, and nucleic acids. It is being provided in the form of synthetic chemical fertilizer (urea). Such chemical fertilizers pose a health hazard and microbial population problem in soil besides beings quite expensive and making the cost of production high. Therefore, the bio-fertilizers play a major role in such situation (Tiwary *et al*., 17). Bio-fertilization of non-legume crops by N_2-fixing bacteria had an immense importance in recent years. The effect of inoculation with bio fertilizer had significant influence on the growth of plant, which reflects in increasing yield. This increase in yield is due to the nitrogen produced by bacteria, in addition of some growth regulators like GA_3, Indole-3-acetic acid (IAA) and ethylene (phyto-hormones) which stimulates growth of the plants. Malak (9) have found significant increase in total yield of tomato fruits with biofertilizer. Barassi *et al.* (3) reported that *Azospirillum*-inoculated seeds had significant effect on seed germination even in adverse soil conditions. Pacovsky (12) reported that inoculation with *Azospirillum brasilense* on sorghum increased total plant and dry weight. Sprenat (16) found that solubilization of mineral nutrients, synthesis of vitamins, amino acids, auxins and gibberellins, which stimulate plant growth, comes as result of inoculation by *Azotobacter spp*.

Therefore, the present investigation was carried out to study the effect of bio-fertilization on nursery raising and effect of mulch and bio-fertilizer / manures on yield and quality of tomato under hill conditions of Uttarakhand.

MATERIALS AND METHODS

The present investigations were carried out during summer to rainy season of 2005 and 2006 at Central Institute of Temperate Horticulture-Regional Station, Mukteshwar with tomato cultivar Manisha (F_1 hybrid) Seedlings were raised in modern green house with temperature, light and humidity control. The following

*Corresponding author' E-mail: hedaunirmal_2003@yahoo.co.in

treatments were applied while raising the nurseries; Control (FYM), T_1: recommended dose of NPK and FYM, T_2: Azotobactor, T_3: Azotobactor and Microphos, T_4: *Azospirillum*, T_5: *Azospirillum* and Microphos. Seed treatment with bio-fertilizer was done with 10 per cent zaggery solution. First of all seeds were soaked in 10 per cent zaggery solution followed by mixing of soaked seeds in bio-fertilizer. The observations on days to 50 percent germination, germination percent, days on which seedlings are ready for transplanting (days to attain 15 cm height), fresh weight of seedling were recorded in each treatment.

Healthy normal seedlings from the best performing treatment in the nursery were transplanted at a spacing of 90 x 30 cm^2 in the field having 3.6 x 1.8 m^2 bed sizes in each treatment and replication. The following treatment and their combination were applied in the field before transplanting. Mulch: No mulch (M_0), Mulching with black polythene sheet Of 200 µ thicknesses (M_1), Mulching with leaf mould (M_2); bio-fertilizer / manures: Control (recommended dose of NPK)., *Azotobactor* (T_1), *Azospirillum* (T_2), FYM (T_3), Forest soil from Oak forest (T_4). In case of bio-fertilizer treatments seedlings were inoculated and then transplanted in the field. The observation on number of fruits per plot, fruit yield per plot, ascorbic acid as per method advocated by AOAC (1) and TSS content of fruits using hand refractometer was recorded. All the experiments were laid out in randomized block design (RBD) with three replications.

RESULTS AND DISCUSION

The result of the studies on effect of bio-fertilizer on nursery raising depicted clear-cut differences on the observations under study. During both the year, days to 50 percent germination showed that all the bio-fertilizer treatments were significantly better than the control and T_1 (recommended dose of NPK and FYM) The treatment having *Azospirillum* with Microphos, and Azotobactor with Microphos showed no significant difference as far as early germination is concerned. However, these two treatments showed significant difference with *Azotobactor* or *Azospirillum* alone with respect to early germination (Table 1). Earliest germination (6.00 days in both years) was recorded in the treatment having combination of *Azospirillum* and Microphos and maximum days (10.50 days in 2005 and 11.25 days in 2006) to 50 percent germination were recorded in the control where only FYM was applied. Further, *Azotobactor* and *Azospirillum* were equally effective in earliness. Similarly germination percent was also maximum (87.75% in 2005 and 87.00% in 2006) in the treatment containing *Azospirillum* and Microphos. However, it was on a par with the treatment containing *Azotobactor* with Microphos. The minimum germination per cent was recorded in the control where only FYM was applied but it was not significantly different than the treatment having both FYM and recommended dose of NPK (Table 1). Lakshmanan *et al.* (8) reported *Azotobacter* and *Azospirillum* significantly increased the germination rate and percentage in *W. somnifera (*Ashwagandha) and *C. angustifolia* (Senna). Another studies conducted by Bacilio *et al.* (2) also observed increased seed germination with the application of A*zospirillum* in case of wheat.

Days on which seedlings attain 15 cm height is considered to be seedlings are ready for transplanting. Minimum days on which seedlings attain 15 cm height were recorded in the treatment having both *Azotobactor* and Microphos. However, it was on par with the treatment containing *Azospirillum* with Microphos. Whereas, seedlings were ready for transplanting in the control after 32.50 in 2005 and 33.25 days in 2006 of sowing (Table 1). Similarly average fresh weight of seedling were found to be maximum during both the years in the treatment containing *Azotobactor* and Microphos, which was significantly higher than the other treatments including control (Table 1). Similar findings were also noticed in the study conducted by Ribaudo *et.al.* (14) and they found significant increase in shoot fresh weight and main root hair length, indicated that inoculated tomato plants with *Azospirillum* sp. resulted in plant growth improvement and also higher levels of indole-3-acetic acid (IAA) and ethylene (phytohormones) related to plant growth, were recorded in same inoculated tomato plants.

The effect of different mulch materials, organic fertilizers and their interactions on fruit yield and number of fruit per plat is presented in Table 2. During both the years, no significant difference was observed between FYM and forest soil treatment with respect to fruit yield and number of fruits per plat. However, all other treatments including control (recommended NPK) had significantly higher fruit yield and number of fruits per plat than treatments with FYM and forest soil. Higher values for above characters were recorded with control (recommended NPK) and followed by *Azospirillum* and *Azotobacter*. The present findings are also in line with workers who observed the significant role of bio-fertilizer in promoting growth and yield by increasing uptake of nitrogen (Das *et.al*.(4), Mehnaz. and Lazarovits, (10) and Sivakumar, (15).

Among mulches, black polyethylene treatment produced significantly higher fruit yield and number of fruits per plat than Leaf mould and no mulch. The higher fruit yield in black polyethylene treatment might be the result of weed free field, less nutrient loss through

Title 1. Effect of different biofertilizer and their combination on nursery raising of tomato (Manisha).

Treatments	Days to 50% germination		Germination %		Days to attained 15 cm height		Fresh weight (mg) after 30 days of sowing	
	2005	2006	2005	2006	2005	2006	2005	2006
Control (FYM)	10.50	11.25	67.50	65.00	32.50	33.25	632.75	641.75
T_1: (NPK + FYM)	10.25	11.00	69.00	70.00	31.00	30.00	660.75	650.00
T_2; Azotobactor	7.50	7.25	83.00	85.00	26.50	27.25	724.50	730.50
T_3: Azot.+ Mic.	6.25	6.00	87.00	88.00	25.00	25.50	757.50	766.50
T_4: Azospirilum	7.25	7.50	82.75	83.50	26.25	26.00	721.50	733.25
T_5: Azos. + Mic.	6.00	6.00	87.75	87.00	25.25	26.00	737.25	739.50
CD (5%)	0.69	0.75	3.58	3.10	0.78	0.88	12.05	10.21

Title 2. Effect of bio-fertilizers and mulches on fruit yield and quality of tomato (cv. Manisha).

Treatments	Fruit Yield (q/ha)		No. of fruits /plot		Ascorbic acid (mg/100g)		T.S.S. (^{0}Brix)	
	2005	2006	2005	2006	2005	2006	2005	2006
Mulches								
M_0	68.66	55.54	71.79	58.04	29.80	29.56	7.26	7.24
M_1	121.40	108.02	126.99	113.11	30.60	30.20	7.64	7.60
M_2	110.18	95.06	115.30	99.47	30.80	30.04	7.60	7.55
CD (5%)	10.25	12.08	9.68	10.32	NS	NS	NS	NS
Organic fertilizers								
NPK	124.17	108.67	127.71	111.77	31.33	30.54	8.55	8.55
T_1	102.93	88.40	106.72	91.65	30.67	30.12	7.77	7.89
T_2	111.30	96.17	116.32	100.51	31.67	31.33	8.44	8.40
T_3	84.90	66.00	89.46	69.54	29.00	28.67	6.44	6.33
T_4	77.10	71.80	83.27	77.54	29.33	29.00	6.29	6.14
CD (5%)	12.32	14.32	18.35	20.22	1.17	1.32	1.92	2.01
Interactions								
M_0 x NPK	88.2	73.2	90.72	75.29	31.00	30.00	8.66	8.33
M_0 x T_1	75.1	61.8	77.86	64.07	29.00	29.80	7.66	7.33
M_0 x T_2	79.3	65.5	82.88	68.46	32.00	31.00	8.00	8.22
M_0 x T_3	47.5	38.2	50.05	40.25	28.00	28.00	6.00	6.11
M_0 x T_4	53.2	39	57.46	42.12	29.00	29.00	6.00	6.22
M_1 x NPK	151.5	135	155.83	138.86	31.00	31.10	8.33	8.66
M_1 x T_1	119.1	103.9	123.48	107.72	31.00	30.90	8.66	8.33
M_1 x T_2	133.6	117.5	139.63	122.81	31.00	31.00	8.66	8.33
M_1 x T_3	113.7	85.4	119.80	89.98	30.00	29.00	6.33	6.66
M_1 x T_4	89.1	98.3	96.23	106.16	30.00	29.00	6.22	6.00
M_2 x NPK	132.8	117.8	136.59	121.17	32.00	30.53	8.66	8.66
M_2 x T_1	114.6	99.5	118.82	103.16	32.00	29.67	7.00	8.00
M_2 x T_2	121	105.5	126.46	110.26	32.00	32.00	8.66	8.66
M_2 x T_3	93.5	74.4	98.52	78.39	29.00	29.00	7.00	6.22
M_2 x T_4	89	78.1	96.12	84.35	29.00	29.00	6.66	6.20
CD (5%)	19.56	20.15	23.35	25.02	NS	NS	NS	NS

leaching favorable soil temperature and moisture, these findings are in agreement with Gonzalez *et al*. (5), Hedau *et al.* (6) and Kashyap *et al*. (7).

The interaction effects between mulch material and biofertlizer were significant for the characters. The control (recommended NPK) and all treatments showed maximum fruit yield and number of fruits per plot with black polythene mulch. The maximum fruit yield (151.5q/ha in 2005 and 135q/ha in 2006) was recorded with the treatment having recommended NPK and black

polyethylene mulch which was on a par with the treatment having *Azospirillum* biofertlizer and black polyethylene mulch. Similar results were also observed with respect to number of fruit per plat hence, the number of fruit directly depicts the fruit yield of the crop.

Control (recommended NPK), *Azospirillum* and *Azotobacter* shown significantly higher values of ascorbic acid content in ripened tomato fruits than the fruits obtained from the FYM and forest soil treatments. The minimum ascorbic acid was recorded in the fruit harvested from the field which had only FYM treatment. No significant difference was recorded between the mulch materials and interaction effects between mulch material and biofertlizer with respect to ascorbic acid content (Table 2). No significant difference was observed between FYM and forest soil treatment as well as among the bio-fertilizer treatments with respect to TSS content of the fruit. However, fruits obtained from plot of control, *Azotobactor* and *Azospirillum* showed significantly higher value of TSS than the fruits obtained from the FYM and forest soil treatments. No significant difference was observed between the mulch materials. Interaction between mulch material and biofertlizer was not significant (Table 2). Similar findings were noticed by Ram *et al*. (13) where fruit quality of guava has increased with the application of bio-fertilizer (*Azotobactor*).

These findings revealed that seed inoculation with *Azospirillum* and *Azotobactor* in combination with Microphos was found most appropriate treatment for raising of healthy and early tomato nursery. The application of bio-fertilizer with black polyethylene mulch in tomato cultivation in hilly areas will prove healthy step in order to reduce chemical load in soil to improve soil health and microbial population and also making cost of cultivation low.

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