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Effects of Bioagents and Fungicides Alone or in Combination on Growth, Yield and Quality of Tomato (*Lycopersicon esculentum* Mill.)

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Abstract

The investigation was conducted to study the effect of bioagents and fungicides on growth, yield and quality of tomato to determine the most suitable bioagent and fungicide alone or in combination for the agro-climatic condition of mid hills of Uttarakhand. The result showed that prowth characters i.e. seed germination (77.67%), seedling length at the time of transplanting (12. 12 cm), days to first harvest (73.67), number of primary branches (4.89), plant height (48.56 cm), shoot fresh weight (701 g) per plant and dry matter of shoot (29.28%) were significantly influenced by the application of *Pseudomonas fluorescens* but the number of healthy fruits was higher with application of fungicides. Highest number of health fruits (154)/plot and ascorbic acid (28.46 mg/100g fresh weight) were found in treatments T_7 and T_1, respectively. Fruit diameter (5.97 cm), average fruit weight (71.7 g), acidity (0.97%) and protein (1.48%) were higher in treatment T_8 in which *Pseudomonas fluorescens* used alone while ascorbic acid was highest in T_1 and T_4 treatment in which *Trichoderma harzianum* was used for foliar application. Specific gravity of fruits was not affected by any treatment and total soluble solids were higher (7.63°B) under control. Highest yield (210.87 q/ha) was obtained when *Pseudomonas fluorescens* was used for seed treatment, whereas seedling root dipping, field drenching and spraying with fungicides (bavistin, copper oxychlorite + streptocyclin and ridomil showed 91.78% higher than the control.
Key words : Tomato, Bioagents, Fungicides, Growth, Yield.

Tomato an important solanaceous fruit vegetable, play vital role in Indian diet by virtue of its nutrients and delicious taste and various mode of consumption and uses. It is being realized that the quality and productivity of crop are adversely affected in different areas due to various diseases. Currently fungicides are the mainstay of disease control and five to six applications are needed for every growing season to produce commercially acceptable tomato. Adoption of this recommendation is hampered by the application of costly chemicals and the inherent dangers associated with their use. It is thus essential to develop an alternative strategy such as biological control, which may be important to ensure successful management of the disease. Some bioagent like *Pseudomonas* sp. improve the soil condition by increasing availability of phosphorus and reduces the attack of pathogen. So bioagnts are helpful to increase the growth, yield and quality. The present study was conducted to study the effect of bioagents and fungicides alone or in combination on growth, yield and quality of tomato under mid hills condition of Uttarakhand.

Methods

The experiment was conducted at Vegetable Research Block of College of Forestry and Hill Agriculture, G. B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal. Ten treatments viz., T_1 (seed treatment with *Trichoderma harzianum* at 4g/kg seed, root dipping of seedling with *Trichoderma harzianum* at 4g/liter, drenching of soil with *Trichoderma harzianum* at 0.4%, spray with *Trichoderma harzianum* at the concentration of 2%), T_2 (Seed treatment with *Pseudomonas fluorescens* at 4g /kg seed, root dipping of seedlings with *Pseudomonas florescens* at 4g/liter water, drenching of soil with *Pseudomonas fluorescens* at 0.4%, spray with *Pseudomonas fluorescens* at the concentration of 2%), T_3 (seed treatment with *Trichoderma harzianum* + *Pseudomonas fluorescens* at 2g/kg seed, root dip-

Table 1. Effect of bioagents and fungicides on growth of tomato.

Treatment	Germination	Seedling length (cm)	Number of primary branch	Days taken to first harvest	Plant height (cm)	Shoot fresh weight (g/plant)	Dry matter of shoot (%)	Number of fruits per plot		
								Healthy	Infected	Total
T_1	70.67	8.57	3.56	72.00	44.78	601	24.60	86	89	175
T_2	74.67	10.51	4.78	72.00	47.67	691	27.20	106	95	201
T_3	75.67	9.60	3.78	72.00	44.00	590	24.00	110	99	211
T_4	70.67	8.85	2.89	72.33	44.67	595	24.56	89	93	182
T_5	70.33	8.77	3.67	73.00	44.78	612	24.90	95	40	135
T_6	74.00	10.62	3.67	72.67	46.71	675	26.15	106	94	200
T_7	74.33	10.60	3.56	73.00	45.80	685	28.17	154	66	220
T_8	77.67	12.12	4.89	73.67	48.56	701	29.28	105	128	233
T_9	71.33	8.21	3.22	71.33	44.99	595	25.07	102	43	145
T_{10}	66.33	8.23	2.67	70.00	43.44	570	23.90	95	61	186
CD at 5%	4.19	0.87	0.80	1.81	3.52	17.72	0.45			17.72

ping of seedlings with *Trichoderma harzianum* + *Pseudomonas fluorescens* at 2g/kg liter, drenching of soil with *Trichoderma harzianum* + *Pseudomonas fluorescens* at 0.2% each, spray with *Trichoderma harzianum* + *Pseudomonas fluorescens* at the concentration of 2%), T_4 (seed treatment with *Trichoderma harzianum* at 4g/kg seed, root dipping of seedlings with bavistin 1g/liter water, drenching of soil with copper oxychloride at 0.2% + streptocyclin at 100 ppm, spray with ridomil at the concentration of 0.2%), T_5 (seed treatment with *Trichoderma harzianum* at 4g/kg seed, root dipping of seedlings with bavistin at 1g/liter water, drenching of soil with copper oxychloride at 0.2% + streptocyclin at 100 ppm, spray with *Trichoderma harzianum* at the concentration of 2%, T_6 (seed treatment with *Pseudomonas fluorescens* at 4g/kg seed, root dipping of seedlings with bavistin at 1g/liter water, drenching of soil with copper oxychloride at 0.2%+ streptocyclin at 100 ppm, spray with *Pseudomonas fluorescens* at the concentration of 2%), T_7 seed treatment with *Pseudomonas fluorescens* at 4g/kg seed, root dipping of seedlings with bavistin at 1g/liter water, drenching of soil with copper oxychloride at 0.2% + streptocylin at100 ppm, spray with ridomil at the concentration of 0.2%), T_8 (soil treatment with *Pseudomonas fluorescens* at 250g/m^2 soil, seed treatment with *Pseudomonas fluorescens* at 4g/kg seed, root dipping of seedlings with *Pseudomonas fluorescens* at 4g/liter water, drenching of soil with *Pseudomonas fluorescens* at 0.4%, spray with *Pseudomonas fluorescens* at the concentration of 2%, T_9 (seed treatment with companion at 3g/kg seed, root dipping of seedlings with bavistin at 1g/liter water, drenching of soil with copper oxychloride at 0.25%, spray with indofil M-45 at the concentration of 0.3%) and T_{10} (Control-without any bioagent and fungicide treatments).

The experiment was laid out in randomized block design with three replications having plot size 5.4 m^2. Seed germination was observed by counting the total sown seeds and finally germinated seeds. Observation were recorded on five randomly tagged plants in each plot for seedling length at the time of transplanting (cm), number of primary branches, days to first harvest, plant height (cm), fresh weight (g/plant), dry matter of shoot (%), number of fruits per plot, fruit diameter (cm), average fruit weight (g), specific gravity of fruits (g/cm^3), acidity (%), total soluble solids (^oB), ascorbic acid (mg/100 g), protein (%), marketable fruit yield per hectare (q), number of healthy fruits and total number of fruits.

Results and Discussion

Table 1 shows that the maximum germination percentage (77.67) was found in treatment T_8 which was 17% higher than control. The seed treatment with *Pseudomonas fluorescens* increased the seed germination (Kumar 1998). The seed treatment with *Trichoderma viride* increased the seedling emergence compared to control (Gagne et al. 1993). The germination percentage directly related to the disease incidence percentage in nursery. It is well known that bioagents and fungicides protect the seed from seed borne dis-

Table 2. Effect of bioagents and fungicides on quality and yield of tomato.

Treatment	Fruit diameter (cm)	Average fruit weight (g)	Specific gravity (g/cm^3)	Acidity (%)	TSS (^{o}B)	Ascorbic acid (mg/100 g)	Protein (%)	Marketable yield (q/ha)
T_1	4.92	66.17	0.98	0.92	6.22	28.72	1.27	109.95
T_2	5.74	70.89	1.00	0.96	6.07	22.41	1.43	138.42
T_3	4.98	67.00	0.96	0.94	6.18	26.15	1.37	135.87
T_4	4.91	65.07	0.99	0.93	6.55	28.46	1.29	107.63
T_5	4.63	63.14	0.99	0.90	6.68	22.82	1.31	110.64
T_6	5.39	69.33	1.00	0.95	6.40	21.58	1.44	136.57
T_7	5.18	70.70	1.01	0.91	6.55	22.91	1.30	210.87
T_8	5.97	71.17	1.04	0.97	6.00	23.12	1.48	138.42
T_9	4.77	63.67	0.97	0.89	7.55	22.41	1.32	121.06
T_{10}	3.97	62.50	0.99	0.88	7.63	24.07	1.26	105.32
CD at 5%	0.81	5.31	0.045	0.08	0.44	8.73	0.17	18.59

eases at the time of germination and also enhance the seed germination percentage. Maximum seedling length (12.12 cm) was recorded in treatment T_8 with the application of *Pseudomonas fluorescens* used as soil and seed treatment. The soil and seed treatment with *Pseudomonas fluorescens* increased the root length, shoot length and biomass production of tomato seedlings (Manoranjitham et al. 2001). Number of primary branches is a potential criteria, directly related to the yield of fruits in tomato. In the present experiment, highest number of primary branches (4.88) was found in treatment T_8 under the seed and nursery soil treatment, seedling root dipping, field drenching and spraying with *Pseudomonas fluorescens* which was 83% higher than control. The tomato plants inoculated with *Pseudomonas fluorescens* gave 72.8% higher number of branches per plant over the control (Amara 1996). Minimum days taken to first harvest (70 days) was found in treatment T_{10} followed by treatment T_9 (71.33 days). However, maximum days taken to first harvest (73.00) were observed in T_8 with *Pseudomonas fluorescens* applied from seed treatment to harvesting, and significantly higher than control. In other experiment result showed that when pea crop sprayed with fungicide (dithane M-45), showed late maturity compared to control (Nene and Thapliyal 1979). The maximum plant height (48.56 cm), fresh and dry weight of shoot, seedling vigor index and number of fruits per plot was recorded higher in treatment T_8 as compared to others. The increase in shoot length, fresh and dry weight of shoot, seedling vigor and number of fruits per plot may be due to the reason that *Pseudomonas fluorescens* increases the availability of phosphorus in soil and release the plant growth substances (Bakker and Marugg 1987). The number of healthy fruits (154) was higher in T_7, as fungicides control the foliage and fruit diseases more effectively than bioagents.

Table 2 shows that maximum fruit diameter (5.97 cm) was found with treatment T_8 in which *Pseudomonas fluorescens* applied for soil and seed treatment in nursery, seedling root dipping, field drenching and spraying was significantly higher than control. Application of *Pseudomonas* spp. increased fruits size and fruit weight (Gagne et al. 1993). The tomato plants inoculated with *Pseudomonas fluorescens* gave increased fruit weight and positive correlation with fruit size (Amara et al. 1996). Average fruit weight (71.17 g), acidity (0.97%) and protein content (1.48%) were maximum in treatment T_8 which was significantly higher than control (T_{10}). These results are in close conformity with the findings of earlier workers (Peixoto et al. 1995). Bioagents and fungicides applications have shown non-significant increase in the specific gravity of fruits. Among bioagents. *Pseudomonas fluorescens* treated plants showed higher (1.04 g/cm^3) but non-significant increase in specific gravity of fruits. When the plants were treated with *Pseudomonas fluorescens* + *Trichoderma herzianum*, fruits have least specific gravity (0.96 g/cm^3). Same result was reported by other scientists (Lewis and Papouizas 1991). Maximum total soluble solids were obtained in control (7.63 ^{o}B) followed by plants treated with fungicides (7.55 ^{o}B). These observations were signifi-

cantly higher than the other treatments. When the muskmelon vive was treated with fungicides gave higher total soluble solids in fruits than *Trichoderma harzianum* and *Gliocladium virens* treated plants (Chattopadhyay and Sen 1996). Maximum marketable fruit yield was observed in treatment T_7 (210.87 q/ha) when seeds were treated with *Pseudomonas fluorescens* but seedling root dipping, field drenching and spraying were done with fungicides followed by treatment T_2 and T_8 (138.42 q/ha) and significantly higher than control treatment T_{10} (105.32 q/ha).

At the initial stage of plant *Pseudomonas* spp. promotes the growth of plants but at a later stage it was least capable to check the foliar diseases and fruit rotting. The seed treatment given by *Pseudomonas fluoresens* followed by seedling root dipping, field drenching and spraying with the fungicides has produced higher marketable yield and better quality fruits.

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