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Management of Stem Gall Disease in Coriander using *Pseudomonas* and *Trichoderma* (Bioagents) and Fungicides

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Seed spices have emerged as one of the important group of spice crop in India. The global demand estimated for seed spices crop is about 150000 tonnes, and India contributes 70,125 tonnes annually accounting to 47 % of the total world trade. The cultivation of seed spice crop suffers from major disease like stem gall (*Protomyces macrosporus* Unger). In this investigation the effect of seed treatment and foliar spray of bioagents *Trichoderma viride*, *Pseudomonas fluorescens* and fungicides like Carbendazim, Ridomil, Blitox-50, Hexaconazole and Propiconazole on the incidence of stem gall disease of coriander tested. The trial was conducted in a Randomized Block Design with three replications and eight treatments including check. Hexaconazole as seed treatment (0.2%) and foliar spray after 40,60 and 75 DAS (0.2%) is more effective treatment for management of stem gall disease of coriander than the seed treatment of biofungicides like *Trichoderma viride* (0.4%) and foliar spray of *Trichoderma* species (0.4%) after 40,60 and 75 days of sowing. Maximum seed yield in Hexaconazole and Propaconazole treatment was at par to each other. Maximum cost benefit ratio of 1:4.36 was observed in the seed treatment of IISR *Trichoderma* liquid formulation @ 0.4% + foliar spray at 40, 60 and 75 DAS @ 0.4%.

Key words: Stem gall disease, *Pseudomonas fluorescens*, *Trichoderma viride*, Hexaconazole, Propaconazole.

Seed spices have emerged as one of the important group of spice crop in India. The global demand estimated for seed spices crop is about 150000 tonnes, of which India contributes 70,125 tonnes annually accounting to 47 % of the total world trade[10]. The cultivation of this most important seed spice crop suffers from major disease like stem gall (*Protomyces macrosporus* Unger.) and other diseases like wilt, powdery mildew etc. Among them stem gall diseases bear importance due to severe loss in the yield of seed. The symptom first appears as gall like appearances on the lower part of stem which gradually extends upwards to flower and seeds. The diseased seed are hypertrophied depending upon the stage of infection, ultimately lowering the crop yield and quality. Seeds looses their value in respect to seed and consumption as well[2-3]. Studies undertaken in the past on stem gall disease shows clearly that disease appears continuously in every year in the field of coriander grown on high pH soil, moisture, and adverse ecological & adaptic factors[8]. Soil and infected seed material serve as a source of inoculum causing heavy loss in Eastern U.P. and other states[1, 4, 5, 8]. Studies on complete management of disease in the field are still lacking.

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Application of variety of fungicides like organo-mercurials, copper fungicides, antibiotics, Bavistin, Thiram, Calixin, Captan, Vitavax, and organic amendments although have better result in lowering disease incidence but did not controlled the diseases *in toto*[6,7] . This is an attempt to investigate the effect of seed treatment and foliar spray of bioagents *Trichoderma viridae*, *Pseudomonas fluorescens* and fungicides like Carbendazim, Ridomil, Blitox-50, Hexaconazole and Propiconazole on the incidence of stem gall disease of coriander.

MATERIALS AND METHODS

Experiments were conducted during *Rabi* season at Main Experiment Station of Department of Vegetable Science (Main Campus), Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad in the North Indo-Gangetic plains of Eastern Uttar Pradesh. The experimental field was ploughed once with disc harrow and three times with cultivator followed by planking. The trial was conducted in a Randomized Block Design with three replications and eight treatments including control. Coriander variety UD-743 was sown in lines with row to row distance of 30 cm and plant to plant distance of 20 cm. All agronomical practices were adopted for a good stand of the crop.

Treatment consisted of:

a) T_1 = Seed treatment with IISR *Trichoderma* liquid formation* @ 0.40% + foliar spray at 45, 60 and 75 DAS @ 0.40%,

b) T2 = Seed treatment with IISR *Pseudomonas* talc formulation* @ 0.40% + foliar spray at 45, 60 and 75 DAS @ 0.40%,

c) T3 = Seed treatment with Carbendazim @ 0.20% + foliar spray at 45, 60 and 75 DAS @ 0.20%,

d) T4 =Seed treatment with *Ridomil* @ 0.20% + foliar spray at 45, 60 and 75 DAS @ 0.20%,

e) T5 =Seed treatment with Blitox-50 @ 0.20% + foliar spray at 45, 60 and 75 DAS @ 0.20%,

f) T6 =Seed treatment with Hexaconazole @ 0.20% + foliar spray at 45, 60 and 75 DAS @ 0.20%,

g) T7 = Seed treatment with Propiconazole @ 0.20% + foliar spray at 45, 60 and 75 DAS @ 0.20%,

h) T8 = Control (water spray).

* *Trichoderma* liquid formulation and *Pseudomonas* talc formulation contained 10^{10} spores /ml & 10^9 cells/ml, respectively. Recommended dose of 50:30:30 kg NPK/ha fertilizers were applied to the crop. Disease severity of stem gall was recorded using 10 plants selected randomly in each treatment. Observations were recorded on 10 tagged plants in each treatment every five days of interval after first appearance of disease symptoms. The disease severity and intensity of disease was represented in 0-4 scales (Anonymous, 2004).

S.No.	Score	Code	Description
1.	0	F	Disease free
2.	1	R	1-5.0
3.	2	MR	5.1-20
4.	3	MS	20.1-50
5.	4	S	>50

F = Disease free , R = Resistant, MR = Moderately resistant, MS = Moderately susceptible, S = Susceptible

Cost benefit ratio was calculated on the basis of standard procedure. Data was statistically analyzed following the procedure of Randomly Block Design and test for significance for the treatment means. The percentage data of stem gall disease severity were transformed into angular transformed values for presentation.

RESULTS AND DISCUSSION

Incidence of stem gall disease in coriander is a regular feature in this area. The disease appears almost every year on the crop. However, disease intensity may vary year to year. Management of disease is important in view of its severity to reduce the disease incidence, increase the crop yield and seed quality.

Experimental findings suggest that all treatment bear significant effect in decreasing the stem gall disease incidence and yield of seed (Table-1). Minimum percentage of disease incidence of 44.16 was recorded by treatment of seeds with Hexaconazole (0.2%) and foliar spray of Hexaconazole (0.2%) after 40, 60 and 75 days of sowing (T_6). This treatment controlled stem gall

Table 1. Effect of bio-agents and fungicide on the stem gall disease and yield of coriander

S. No.	Treatments	Disease incidence (PDI)	Per cent decrease in incidence of disease	Yield (q/ha)	Percent increase in yield
1.	T_1=Seed treatment with IISR *Trichoderma* liquid formulation @ 0.4% + spray at 40, 60 & 75 DAS @ 0.4%.	61.66 (51.76)	24.50	17.85	54.59
2.	T_2=Seed treatment with IISR *Pseudomonas* talc formulation @ 0.4% + spray at 40, 60 & 75 DAS @ 0.4%.	55.0 (47.89)	32.65	15.42	34.67
3.	T_3=Seed treatment with Carbendazim @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%.	61.67 (51.76)	24.50	16.01	39.82
4.	T_4=Seed treatment Ridomil @ 0.2% + spray at 40, 60 & 75 DAS (@ 0.2%.	66.66 (54.74)	18.37	13.90	21.39
5.	T_5 =Seed treatment Blitox-50 @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%.	66.67 (54.74)	18.37	13.34	16.50
6.	T_6=Seed treatment Hexaconazole @ 0.2% + spray at 40, 60 & 75 DAS (@ 0.2%	44.16 (41.65)	45.92	18.54	61.92
7.	T_7= Seed treatment Propiconazole @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%	44.33 (44.04)	40.82	19.09	66.72
8.	T_8=Control (water spray)	81.67 (64.71)	-	11.45	-
	SEM±	1.42	1	0.051	1
	CD	4.31	-	0.157	-

*Values in parenthesis are angular transform value

Table 2. Economics of coriander crop as affected by the use of bioagent and fungicide

S. No.	Treatments	Yield (q/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs)	Net income (Rs)	Cost: benefit ratio
1.	T_1=Seed treatment with IISR *Trichoderma* liquid formulation @ 0.4% + spray at 40, 60 & 75 DAS @ 0.4%.	17.70	106200	19790	86410	1:4.36
2.	T_2=Seed treatment with IISR *Pseudomonas* talc formulation @ 0.4% + spray at 40, 60 & 75 DAS @ 0.4%.	15.27	91620	19790	71830	1:3.62
3.	T_3=Seed treatment with Carbendazim @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%.	15.88	95280	20720	74560	1:3.59
4.	T_4=Seed treatment Ridomil @ 0.2% + spray at 40, 60 & 75 DAS (@ 0.2%.	13.75	82500	22190	60310	1:2.71
5.	T_5 =Seed treatment Blitox-50 @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%.	13.18	79080	19985	59095	1:2.95
6.	T_6=Seed treatment Hexaconazole @ 0.2% + spray at 40, 60 & 75 DAS (@ 0.2%	18.39	110340	20820	89520	1:4.29
7.	T_7= Seed treatment Propiconazole @ 0.2% + spray at 40, 60 & 75 DAS @ 0.2%	18.95	113700	25620	88080	1:3.43
8.	T_8=Control (water spray)	11.45	68700	16750	51950	1:3.10
	SEM±	0.051				
	CD	0.157				
	CV%	11.80				

disease by 45.92 % over control. This was followed by stem gall disease of 48.33 PDI by seed treatment of Propiconazole (0.2%) and foliar spray of Propiconazole (0.2%) after 40, 60 and 75 days after sowing (T_7) controlling the disease by 40.82 % over control. Seed treatment of *Pseudomonas* (an IISR strain) in talc formulation @ 0.4% and foliar spray @ 0.4% at 45, 60, 75 days after sowing controlled disease by 32.65 % and showed PDI of 55.0 % against control (81.67%). Disease control by seed treatment with Carbendazim @ 0.2 % and foliar spray at 40, 60 and 75 days of sowing (0.2%) (T_3) was at par with seed treatment with IISR *Trichoderma* liquid formulation @ 0.4% and foliar spray at 40, 60 and 75 days of sowing @ 0.4% (T_1) treatment controlling the disease by 24.50 %. Maximum disease intensity of 66.67% of stem gall was recorded with seed treatment with Blitox-50 @ 0.2% and foliar spray @ 0.2% after 40, 60. Treatment of Hexaconazole superceded the treatment of bioagent *Trichoderma* in disease control. Yield in Hexaconazole and Propaconazole treatment was at par to each other.

Maximum cost benefit ratio of 1:4.36 was calculated in the treatment combination T_1 (seed treatment of IISR *Trichoderma* liquid formulation @ 0.4% + foliar spray at 40, 60 and 75 DAS @ 0.4 % followed by T_6 treatment of seeds with Hexaconazole (0.2%) and foliar spray at 40, 60 and 75 DAS @ 0.2%(Table -2). The benefit cost ratio in T_6 was in close to range of T1 treatment and there appeared not much difference in cost benefit ratio or are at par to each other.

CONCLUSIONS

In the present studies use of chemical fungicides like Hexaconazole as seed treatment (0.2%) and foliar spray after 40,60 and 75 DAS (0.2 %) is more effective treatment for management of stem gall disease of coriander than the seed treatment of biofungicides like *Trichoderma viride* (0.4%) and foliar spray of *Trichoderma* species (0.4%) after 40,60 and 75 days of sowing. Maximum seed Yield in Hexaconazole and Propaconazole treatment was at par to each other. Maximum cost benefit ratio of 1:4.36 was observed in the seed treatment of IISR *Trichoderma* liquid formulation @ 0.4% + foliar spray at 40, 60 and 75 DAS @ 0.4 % followed by treatment of seeds with Hexaconazole (0.2%) and foliar spray at 40, 60 and 75 DAS @ 0.2% . The benefit cost ratio in both the treatments was in close to each other and there appeared not much difference.

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