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Chemical and Biological Management of Coriander Stem Gall Disease

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A B S T R A C T

Coriander is one of the first spices to be used by mankind dates back to 5000 BC. It is called as 'Miraculous herb' as all parts of the plant including seeds and leaves are used both as spice as well as herbal medicine. Among various diseases attacking coriander, stem gall disease caused by *Protomyces macrospores* Unger is the most devastating disease resulting 16-50 per cent yield loss. Considering the seriousness of this disease, present investigation was carried out on various aspects *viz*., survey, germplasm screening and integrated disease management at T.C.A., Dholi campus of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar during 2015-2016 to 2017-18. Under disease management, after three years of experimentation (2015-16 to 2017-18), pooled analyzed mean data reveals lowest disease severity (PDI=12.22), highest disease reduction over control (79.40%), yield (2.26 t/ha) and yield increase over control (121.57%) in treatment where seed treatment was done with fungicide Propiconazole 25EC @0.20% followed by spraying at 45,60 & 75 days after sowing (DAS) @0.10%. 2nd lowest disease incidence (PDI=18.67) and 2nd highest disease reduction over control (68.53%) yield (2.02 t/ha) and yield increase over control (98.04%) were recorded in treatment T_5 where Hexaconazole 5EC @0.20% was used for seed treatment & the crop was sprayed at 45, 60 & 75 DAS with same fungicide @0.10%. But the highest ICBR (1:10.69) was found in treatment T_2, where seed treatment as well as spraying of crop at 45, 60 & 75 DAS was done with IISR *Pseudomonas* talc formulation @0.40% followed by ICBR of 1:10.32 was recorded in treatment T_5, where seed treatment was done with Hexaconazole 5EC @0.20% and spraying of crop done at 45, 60 & 75 DAS was done with fungicide Hexaconazole 5EC @0.10%. The best treatment with respect to have its effect on highest disease reduction and giving highest yield registered 3rd best ICBR of (1:9.02). In control, highest PDI (59.33) and lowest yield (1.02 t/ha) was obtained.

Introduction

Coriander (*Coriandrum sativum* L.) is an annual herbaceous plant (2n=22) in the family Apiaceae. India stands in first place in production, consumption and export among all the countries of the world (Saxena and Gandhi, 2015).

This seed spices crop is grown in India on around 544.239 thousand hectares, with an output of 721.394 thousand tonnes per year. Similarly the annual production of Bihar was 1.886 thousand tonnes grown on an area of 2.078 thousand hectares. (DASD, Calicut, Kerala, 2017).

The yield of the crop is constrained by many fungal diseases *viz*., Powdery Mildew, Wilt and Stem gall. Among them, stem gall caused by *Protomyces macrospores* Unger is one of the most serious diseases which leads to greater reduction in quality and yield of the crop. Gupta (1954) reported approximately 20 per cent mean losses per plant in the field with an average disease intensity of 23 per cent. According to different reports by Gupta (1964) and Prasad (1983) diseased seeds lose their distinctive odour and condiment value.

The gall manifests as tumor-like swellings of stems, leaves, peduncles, and deformed seeds. The swellings on the veins give the leaves a swollen hanging appearance. The swellings are primarily glossy in appearance but later rupture and become rough with varying size of the infected part. A systemic infection provides distortion to a greater extent in various parts of the plant.

The inflorescence may show surface outgrowth. The fruit grows abnormally in large size due to uniform invasion, but partial invasion may result in distortion (Gupta, 1962; Rao, 1972). The symptoms begin as galls on the lower part of the stem and progress upward to the flower and seeds. Depending on the stage of infection, diseased seeds become hypertrophied, lowering yield and deteriorating the quality of the crop (Kumar *et al.*, 2014). Coriander stem gall appears continuously every year when grown in a field with high soil pH and favourable environmental conditions (Verma *et al.*, 2017). Different methods *viz*., use of disease free seeds, proper field sanitation, proper treatment of diseased plant debris, crop rotation and use of chemical fungicides are in practice to manage the coriander stem gall disease caused by *P. macrospores* (Mehrotra and Aggarwal, 2003). Shukla *et al.*, (2006) reported that seed treatment with carbendazim (1g/kg) + foliar spray with Bayleton (0.04%) was the most effective combination which reduces the disease severity by 56.66 per cent followed by seed treatment with carbendazim + foliar spray with karathane (0.04%) and foliar spray with Bayleton (0.04%).

According to Kumar *et al.*, (2014), hexaconazole as seed treatment (0.2 per cent) and foliar spray after 40, 60, and 75 days of sowing (0.2 per cent) is a more effective treatment for management of coriander stem gall disease than bio fungicide seed treatment (0.4 per cent) and foliar spray of *Trichoderma* species (0.4 per cent) after 40, 60, and 75 days of sowing. Hence, keeping in view of its importance and devastating nature of the pathogen and scarcity of available information, the present investigation **"**Chemical and Biological Management of Coriander Stem Gall Disease**"** was carried out.

Materials and Methods

The field experiment was conducted during *Rabi*, 2015-16 to 2017-18 at the Experimental Farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar. The Experimental farm is situated at an altitude of 52.0 meter above mean sea level, at a latitude of 25.98^{o} N and

longitude of 85.67^{o} E. The climate is sub-humid type and monsoon receiving an average annual rainfall of 1250 mm mainly during the months June to October. The trail was laid in RBD with seven (7) treatments and three (3) replication. Liquid formulation of *Trichoderma* and talc formulation of *Puseudomonas* was supplied from Indian Institute of Spices Research (IISR), Calicut, Kerala used in the present study. The treatments and other specification of the trial are as follows:

Treatment details

T_1 = Seed treatment with IISR *Trichoderm*a liquid formulation @0.40% + spray at 45, 60 and 75 DAP @0.40%.

T_2 = Seed treatment with IISR *Puseudomonas* talc formulation @0.40% + spray at 45, 60 and 75 DAP @0.40%.

T_3 = Seed treatment with Carbendazim 50WP @0.20%+ spray at 45, 60 and 75 DAP @0.10%.

T_4 = Seed treatment with Copper Oxychloride 50WP @0.20%+ spray at 45, 60 and 75 DAP @0.20%.

T_5 = Seed treatment with Hexaconazole 5EC @0.20% + spray at 45, 60 and 75 DAP @0.20%.

T_6 = Seed treatment with Propiconazole 25EC @0.20% + spray at 45, 60 and 75 DAP @0.10%.

T_7 = Control.

Variety : Rajendra Swati (Susceptible to stem gall disease)

Plot Size : 3 x 1m

Spacing : 30 x 10cm

For calculating PDI, following (0-4) disease rating scale was followed, where a healthy plant scores 0, while a fully diseased plant scores 4 point (Anon., 2004).

Disease rating scale for Stem gall disease of coriander:

Disease Score	Symptom on plant	Disease Reaction
0	No Gall	HR
1	Galls on stem alone	R
2	Galls on stem & leaf	MR
3	Galls on inflorescence	S
4	Galls on stem, leaf & inflorescence	HS

The score of each subunit depends on the extent of the disease (on the length for stems and pedicels, area covered for leaves and for seeds number of diseased seeds).
PDI was calculated according to the formula given by Mc Kinney (1923) as follows:

$$\text{Per cent Disease Index} = \frac{\text{Sum of all disease score}}{\text{Total no. of observation} \times \text{maximum disease score}} \times 100$$

Finally, the yield / plot were recorded at the time of harvest of turmeric rhizome and subsequently it was converted in tonne/ hectare. The incremental cost benefit ratio (ICBR) was also calculated as below:

ICBR

$$= \frac{\text{Income from the yield over control per hectare}}{\text{Expenditure incurred for spraying per hectare (cost of fungicide / chemicals + cost of labour charge)}}$$

Statistical analysis

The statistical analysis was done with the aid of off-campus OP-STAT analyses package

and the method as suggested by Gomez and Gomez (1984). Critical difference (CD) was calculated at 5 per cent level of significance for comparison of treatment.

Results and Discussion

A field trial was conducted on stem gall disease of coriander to see the effect of different fungicides and bio-control agents on control of stem gall disease of coriander. Table.1 shows all the treatments to have statistically significant effect on reduction of stem gall incidence and increasing yield over control except disease severity which was not significantly influenced by treatments (T_1 & T_2) *i.e.*, seed treatment as well as spray by IISR *Trichoderma* and *Pseudomonas* formulation @0.40% at 45, 60 and 75 DAP. Highest yield (2.28t/ha) with lowest PDI (15.00) was recorded in treatment (T_6) where seeds were treated with Propiconazole 25EC @0.20% prior to sowing and also the crop was sprayed at 45, 60 and 75 DAP @0.10%.

In the second year of experimentation, all the treatments were found to have statistically significant effect on disease severity, reduction of stem gall incidence and increasing yield over control (Table 2). Highest yield (2.22t/ha) with lowest PDI (5.00) was recorded in treatment (T_6) where seeds were treated with Propiconazole 25EC @0.20% prior to sowing and also the crop was sprayed at 45, 60 and 75 DAP @0.10%. Next highest yield (1.99t/ha) and 2nd lowest disease incidence (PDI=9.00) was recorded in treatment T_1 *i.e.*, seed treatment as well as spray by IISR *Trichoderma* liquid formulation @0.40% at 45, 60 & 75 DAP. In the third year of experimentation also, all the treatments were found to have statistically significant effect on reduction of stem gall incidence and increasing yield over control (Table 3). Highest yield (2.29t/ha) with lowest PDI (16.67) was recorded in treatment (T_6) where seeds were treated with Propiconazole 25EC @0.20% prior to sowing and also the crop was also sprayed with same at 45, 60 and 75 DAP @0.10%. Next highest yield (2.15t/ha) and 2nd lowest disease incidence (PDI=18.33) was recorded in treatment T_5 *i.e.*, seed treatment was done by Hexaconazole 5EC @0.20% followed by spraying with same at 45, 60 and 75 DAP @0.10%.

After three years of experimentation (2015-16 to 2017-18), pooled analyzed mean data reveals all the treatments to have statistically significant effect on reduction of stem gall incidence and increasing yield over control (Table.4). Lowest disease severity (PDI=12.22), highest disease reduction over control (79.40%), yield (2.26 t/ha) and yield increase over control (121.57%) was recorded in treatment where seed treatment was done with fungicide Propiconazole 25EC @0.20% followed by spraying at 45,60 & 75 days after sowing (DAS) @0.10%. 2nd lowest disease incidence (PDI=18.67) and 2nd highest disease reduction over control (68.53%) yield (2.02 t/ha) and yield increase over control (98.04%) were recorded in treatment T_5 where Hexaconazole 5EC @0.20% was used for seed treatment and the crop was sprayed at 45,60 & 75 DAS with same fungicide @0.10%. But the highest ICBR (1:10.69) was found in treatment T_2 where seed treatment as well as spraying of crop at 45, 60 and 75 DAS was done with IISR *Pseudomonas* talc formulation @0.40% followed by ICBR of 1:10.32 was recorded in treatment T_5, where seed treatment was done with Hexaconazole 5EC @0.20% and spraying of crop done at 45, 60 & 75 DAS was done with fungicide Hexaconazole 5EC @0.10%.

The best treatment with respect to have its effect on highest disease reduction and giving highest yield registered 3rd best ICBR of (1:9.02). In control, highest PDI (59.33) and lowest yield (1.02 t/ha) was obtained.

Table.1 Effect of fungicides and bio-control agents on stem gall disease of coriander (2015-16).

Treatments	PDI	Disease reduction over control (%)	Yield (t/ha)	Yield increase over control (%)
T_1	46.67 (43.11)	19.99	1.75	63.55
T_2	40.00 (39.23)	31.42	1.91	78.50
T_3	28.33 (32.14)	51.43	2.13	99.07
T_4	33.33 (35.24)	42.86	1.98	85.05
T_5	21.67 (27.76)	62.85	2.18	103.74
T_6	15.00 (22.79)	74.28	2.28	113.08
T_7	58.33 (49.78)	-	1.07	-
CD (p=0.05)	7.68	-	0.27	-
CV (%)	12.42	-	8.13	-

Note: Figure within parentheses represents the angular transformed value of corresponding data.

Table.2 Effect of fungicides and bio-control agents on stem gall disease of coriander (2016-17).

Treatments	PDI	Disease reduction over control (%)	Yield (t/ha)	Yield increase over control (%)
T_1	9.00 (17.46)	84.48	1.99	109.47
T_2	15.00 (22.79)	74.14	1.88	97.89
T_3	25.50 (30.33)	56.03	1.50	57.89
T_4	25.50 (30.33)	56.03	1.83	92.63
T_5	16.00 (23.58)	72.41	1.72	81.05
T_6	5.00 (12.92)	91.38	2.22	133.68
T_7	58.00 (49.60)	-	0.95	-
CD (p=0.05)	13.47	-	0.48	-
CV (%)	34.41	-	15.66	-

Note: Figure within parentheses represents the angular transformed value of corresponding data.

Table.3 Effect of fungicides and bio-control agents on stem gall disease of coriander (2017-18).

Treatments	PDI	Disease reduction over control (%)	Yield (t/ha)	Yield increase over control (%)
T_1	46.67 (43.11)	24.32	1.67	60.58
T_2	43.33 (41.15)	29.74	1.39	33.65
T_3	38.33 (38.23)	37.84	1.84	76.92
T_4	31.67 (34.27)	48.65	1.94	86.54
T_5	18.33 (25.33)	70.28	2.15	106.73
T_6	16.67 (24.12)	72.97	2.29	120.19
T_7	61.67 (51.77)	-	1.04	-
CD (p=0.05)	6.72	-	0.25	-
CV (%)	10.30	-	8.18	-

Note: Figure within parentheses represents the angular transformed value of corresponding data.

Table.4 Effect of fungicides and bio-control agents on stem gall disease of coriander (Pooled data).

Treatments	PDI	Disease reduction over control (%)	Yield (t/ha)	Yield increase over control (%)	ICBR
T_1	34.11 (35.73)	42.50	1.47	44.12	1:1.55
T_2	32.78 (34.94)	44.75	1.73	69.61	1:10.69
T_3	30.72 (33.65)	48.22	1.82	78.43	1:6.12
T_4	30.19 (33.34)	49.16	1.92	88.24	1:8.54
T_5	18.67 (25.62)	68.53	2.02	98.04	1:10.32
T_6	12.22 (20.44)	79.40	2.26	121.57	1:9.02
T_7	59.33 (50.36)	-	1.02	-	-
CD (*p*=0.05)	14.19	-	0.57	-	-
CV (%)	25.62	-	18.39	-	-

Note: Figure within parentheses represents the angular transformed value of corresponding data.

Management of the disease is important in view of its severity to reduce the disease incidence, increase in the crop yield and seed quality. The management can be done through the use of different methods like cultural practices, biological control, chemical control through different fungicides and use of host resistance. In the present investigation, different approaches were made through various treatments as presented. Evaluation of various fungicides and bio-agents as treatment was done under field conditions. Among seven treatments under disease management, minimum PDI of 12.22 (79.40% disease reduction) and maximum yield of 2.26 t/ha (121.57% yield increase) was recorded in treatment, T_6 *i.e.*, Seed treatment with Propiconazole 25EC @0.02% followed by foliar spray with same @0.01% at 45, 60 and 75 DAS. Realization of comparatively low ICBR (1:9.02) in the most effective treatment against the disease as well increasing the yield is because of involvement of high cost in the treatment compared to the treatment *viz.*, Seed treatment with IISR *Puseudomonas* talc formulation @0.40% + spray at 45, 60 and 75 DAP @0.40% giving highest ICBR (1:10.69).

The finding of the present study gets strengthen by the findings of similar investigation carried in other coriander growing areas of the country. The findings collaborate with the earlier reports of several workers (Vinale *et al.*, 2012; Kumar *et al.*, 2014; Khan and Parveen, 2018).

Khan and Parveen (2018) found that *T. viride* was superior over other biocontrol agents both singly as well as in combination with botanicals in promoting the yield characters as well as reduction in stem gall intensity of coriander. Mishra Kumar *et al.*, (2017) discovered that Propiconazole (51.70, 49.57%) reduced stem gall disease the most, followed by Carbendazim (44.60, 39.48%) at the blossoming and maturity stages, respectively. Sharma *et al.*, 2018 conducted field evaluation and found that fungicides Tebuconazole and Difenoconazole + Azoxystrobin gave 100 per cent growth inhibition at 500 ppm concentration, while fungicides Propiconazole and Hexaconazole (250 ppm) demonstrated per cent growth inhibition. The best disease control was provided by Hexaconazole (52.44%), followed by Propiconazole and Tebuconazole.

Kumar *et al.*, (2014) reported that seed treatment and foliar spray of *Pseudomonas* spp. controlled disease by 32.65 per cent and seed treatment with *Trichoderma* reduced disease incidence by 24.5 per cent.

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