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EFFECT OF DIFFERENT FUNGICIDES, ORGANIC AMENDMENTS AND BIO-CONTROL AGENTS ON DRY ROOT ROT OF CLUSTER BEAN [*CYAMOPSIS TETRAGONOLOBA* (L.) TAUB] CAUSED BY *RHIZOCTONIA BATATICOLA* (TAUB.) BUTLER

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SUMMARY

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] is an important industrial crop of India. India leads the world in its area and production with 82 and 80 per cent of its global area and production, respectively. Among the various soil borne diseases, dry root rot disease causes heavy losses every year especially in arid and semi-arid regions. The dry root rot fungus *Rhizoctonia bataticola* was isolated from root rot infected clusterbean plant collected from the clusterbean field of Forage Section, Research Farm, CCSHAU, Hisar. A measured amount of fungus suspension was mixed in the upper layer of sterilized soil and covered with a thin layer of sterilized soil for its establishment. Clusterbean seeds were sown at the rate of 10 seeds/pot after two days of inoculation of fungus. Four different fungicides *viz.*, Bavistin, Captan, Thiram and Captan + Hexaconazole (a formulation with a mixture of two fungicide) were used as seed dressing at a dose of 2.0g/kg seed. A minimum disease incidence of 33.3 and 39.9 per cent was recorded when the seeds were coated with bavistin followed by captan+hexaconazole as compared to the highest incidence of 66.7 per cent in clusterbean cv. HG-365 in control pots. Soil incorporation of six organic amendments viz. neem cake, mustard cake, cotton cake and vermicompost at a dose of 2g/kg soil, poultry manure and mushroom spent compost at a dose of 5g/kg soil were tested individually against *R. bataticola* on clusterbean cv. HG 365. A minimum disease incidence of 36.9 and 39.9 per cent was recorded when the soils were incorporated with mustard cake followed by cotton cake. The effect of soil application of *Glomus fasciculatum* (VAM) at a dose of 400, 500, 600 sporocarps/kg soil were evalvated against *R. bataticola*. A maximum of 40 per cent disease control was recorded when the soils were incorporated with VAM 600 sporocarps/kg soil followed by 25 per cent when soils were incorporated with 500 sporocarps/kg soil and a least disease control of 10 per cent was achieved at 400 sporocarps/kg soil. The effect of soil application of *Trichoderma viride* at a dose of 5g and 10g /kg soil was tested for the dry root rot disease management. A maximum of 34.8 per cent plant disease control was recorded when the soils were incorporated with *T. viride* at the rate of 10g/kg soil, whereas, the disease control was 25.1 per cent at 5g/kg soil.

Key words : Clusterbean, bavistin, sporocarps, organic amendments, *Trichoderma viride*, *Glomus fasciculatum*

Clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.), commonly known as 'Guar' is an important kharif legume crop of arid and semi-arid regions of the country. It is commonly grown in North-Western zone *i.e.* Haryana, Rajasthan, Punjab, parts of U.P. and M.P. (Pahuja *et al*., 2010). India occupies first position in cluster bean production in the world with an area of 5.60 million hectare and production of 2.71 million tonnes with a productivity of 485 kg/ha (Anonymous, 2013-14). It suffers severely from the vagary of diseases caused by fungi and bacteria. Among them dry root rot or charcoal rot caused by *Rhizoctonia bataticola* (*Macrophomina phaseolina*) is a serious disease (Prasad,1944; Dhingra and Sinclair,1978 and Lodha, 1993). The first symptom of the disease is yellowing of the leaves which droop in next 2 or 3 days and withers off. The plant may wilt within a week after the appearance of first symptom. When stem is examined closely, dark lesions may be seen on the bark at the ground level. If the plants are pulled from soil, the basal stem and main root may show dry rot symptoms. The tissues are weakened and break off

easily in advanced cases and sclerotial bodies may be seen scattered on the affected tissues. By virtue of its presence in soil or plant debris, it is very difficult to manage *R. bataticola* by a single control approach. No resistant cultivar of clusterbean against *R. bataticola* has been recommended for cultivation so far, but the availability of resistant cultivar(s) of clusterbean against *R. bataticola* may play a key role in dry root rot disease management. Moreover, scanty and incomplete information is available on dry root rot disease management in clusterbean by seed dressing with fungicides, soil incorporation of organic amendments and bio control agents for the maximum disease management. Therefore, keeping in view all these facts, the study was carried out to find out effect of different fungicides, organics amendments and bio-control agents on dry root rot of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] caused by *Rhizoctonia bataticola* (Taub.) Butler.

MATERIALS AND METHODS

Keeping in view the present study was carried out under screen house during 2015- 16 in the Department of Plant Pathology, CCS Haryana Agricultural University, Hisar.

Variety used for the study : The experiment was conducted on most popular cluster bean cv. HG-365.

Effect of seed dressing of fungicides on root rot disease development : In this experiment, sterilized soil (autoclaved at 22 psi for 2 hrs) was filled in 15 centimetre earthen pots. Soil of these pots was inoculated with inoculum of the pathogen. For inoculation, the upper 5 cm layer of soil of each pot was thoroughly mixed with inoculums @ 1000 mg/kg soil in each pot. Healthy surface sterilized seeds were used for sowing. The seeds were dressed with the different fungicides *viz.*, Bavistin, Captan, Thiram and Captan + Hexaconazole (A fungicide formulation containing mixture of two fungicides) separately @ 2 gm/ kg seeds. These dressed seeds were separately sown in pots @ 10 seeds per pot. The experiment was conducted in completely randomized design (CRD) with three replications. Untreated seeds sown in inoculated and uninoculated soils served as checks. The pots were watered as and when required. Observations on pre-emergence (PEM) and post-emergence (POEM) plant mortality were taken up to 30 days after sowing (DAS).

Effect of organic amendments on root rot disease development : The experiment was carried out in 15 centimetre earthen pots. The organic amendments were thoroughly mixed in each pot as per recommended dose (neem cake, mustard cake, cotton cake and vermicompost @ 2g/kg soil ; poultry manure and mushroom spent compost @ 5g/kg soil) before 1 month of sowing . The inoculum was added @ 1000 mg/kg soil and mixed thoroughly up to 5-7 cm depth in the pot. In each pot, 10 surface sterilized seeds were sown. Inoculated and uninoculated soils served as checks. Experiment was conducted in completely randomized design (CRD) in three replicates. Watering was given at regular interval to maintain proper moisture level. Observations on pre-emergence (PEM) and post-emergence (POEM) plant mortality were taken up to 30 days after sowing.

Effect of biocontrol agents on root rot disease development : Two bio control agent *viz. Glomus fasciculatum* (VAM) and *Trichoderma viride* were tested against *R. bataticola.* **Culture of Vesicular arbuscular mycorrhiza (VAM) used for study:** VAM was collected from Tata Energy Research Institute, New Delhi and multiplied under screen house conditions in the Department of Plant Pathology, CCS HAU, Hisar.

Maintenance of mycorrhizal fungi : The mycorrhizal fungi were raised and maintained on wheat (*Triticum aestivum*) and pearlmillet (*Pennisetum glaucum*) in earthern pots, filled with 5 kg sterilized sand. 100g of mycorrhizal inoculum containing about 450-500 extramatrical chlamydospores were put in upper 5 cm soil layer per pot and then ten seeds per pot were sown. The pots were watered regularly. The shoot portions of the growing plants were cut at soil level after 90 days and the soil in pots was left to air dry. The soil was then crumbled and rootlets cut into 1cm segments. This mixture of soil and root segments was used as inoculum.

Extraction of sporocarps from soil : The sporocarps were extracted by wet sieving and decantation technique (Gerdemann and Nicolson, 1963). 250g of soil was suspended in one litre of water. Heavier particles were allowed to settle down for 30 min and the liquid was decanted through 20 mesh sieve, fine enough to remove larger particles or organic material but coarse enough to allow the desired sporocarps to pass through. The sieved suspension was stirred to resuspend all the particles. The heavier particles were allowed to settle down for 10 min and

the suspension was then passed through a 60 mesh sieve. Resultant suspension was sieved serially through 100, 150, 200 and 240 mesh sieves. The maximum sporocarps were retained on 100 mesh sieve. These sporocarps were washed 2-3 times with water in order to free them from soil and organic material. The volume was made to 50 ml and one ml of this spore suspension taken in a watch glass was examined under stereoscopic microscope for sporocarps count.

Soil application of Vesicular arbuscular mycorrhiza (VAM) : Dose of VAM used in the experiment was 400, 500 and 600 sporocarps per kg soil. The VAM was thoroughly mixed in each pot @ 400, 500 and 600 sporocarps/kg soil one week before sowing. Ten seeds of cluster bean were sown in 15 cm earthen pots containing pathogen @ 1000 mg/kg soil. Inoculated and uninoculated soils served as checks. Observations on pre-emergence mortality (PEM) and post-emergence (POEM) plant mortality were taken up to 30 days after sowing.

Culture of *Trichoderma viride* used for study : *T. viride* was collected from the Dept. of Plant Pathology, CCS HAU, Hisar and multiplied on WBSD medium.

WBSD medium : Wheat bran, saw dust and water (WBSD) (3:1:3.5 *w/w/v)* were mixed thoroughly, put in a polypropylene bag, sealed on flame and autoclaved (Mukhopadhyay *et al.*,1986). The contents were thoroughly mixed and put in polypropylene bags (100g/bag) and autoclaved at 15 lbs pressure per square inch for 30 minutes for 2 consecutive days. The sterilized bags were inoculated separately with the three days old culture of *T. viride* under aseptic conditions and incubated at 25±2^{0}C for 10 days. The bags were thoroughly shaken at three days interval to allow uniform growth till 10 days.

Soil application of *Trichoderma viride* : Two different doses *viz.* 5 and 10g per kg soil of *T. viride* were tested against dry root rot disease of clusterbean. The *T. viride* was added in soil one week before sowing. Ten seeds were sown in 15 cm earthen pots containing pathogen inoculums @ 1000 mg/kg soil. Inoculated and uninoculated soils served as checks. Observations on pre-emergence (PEM) mortality and post-emergence (POEM) plant mortality were taken up to 30 days after sowing.

$$\text{Per Cent Plant Mortality} = 100 - \frac{\text{Plants stand in inoculated control}}{\text{Plants stand in uninoculated control}} \times 100$$

The experiment was conducted in a completely randomized design (CRD) with three replications for each treatment under screen house conditions.

Experimental data were analysed by using statistical package of program OPSTAT (2006). Critical differences (C.D.) were calculated at 5 per cent probability.

RESULTS AND DISCUSSION

Effect of seed dressing of fungicides on root rot disease development : The results regarding efficacy of different fungicide against dry root rot of cluster bean presented in Table 1. According to the result, all fungicides were found significantly superior over control in reducing per cent disease incidence 30 days after sowing. Minimum mortality of 33.3 and 39.9 per cent was recorded with bavistin followed by

TABLE 1

Effect of seed dressing of different fungicides on dry root rot of clusterbean cv. HG-365 under screen house conditions

Fungicides (2 g/kg seed)	*PEM[1] (%)	*POEM[2] (%)	Total mortality (%)	Disease control (%)
Captan	16.7 (24.0)	33.3 (35.2)	50.0	25.1
Bavistin	13.3 (21.3)	20.0 (26.5)	33.3	50.0
Thiram	20.0 (26.5)	26.6 (31.0)	46.6	30.0
Captan+Hexaconazole	13.3 (21.3)	26.6 (31.0)	39.9	40.1
Check (Pathogen inoculated)	23.3 (28.8)	43.3 (41.1)	66.6	0.00
Check (No pathogen)	0.5 (4.05)	0.5 (4.05)	-	-
C. D. (P=0.05)	(3.72)	(2.62)	-	-

*(Mean of 3 replications)

Figures in parentheses are angular transformed values

[1]PEM=Pre-emergence mortality [2]POEM=Post-emergence mortality.

captan+hexaconazole as compared to the highest incidence of 66.6 per cent in control pots. Thiram could protect 30 per cent plants from mortality and a minimum protection was provided by Captan *i. e.* 25 per cent as compared to control.

Minimum Pre-emergence plant mortality was 13.3 per cent when bavistin and captan+hexaconazole were used as a seed treatment, however, both the treatments did not differ significantly. Post-emergence plant mortality was 26.6 per cent in captan+hexaconazole as compared to 33.3 per cent when captan was used as a seed treatment and both the treatments differed significantly in reducing post-emergence plant mortality.

Experimental finding of lower disease incidence of dry root rot of cluster bean with carbendazim was in the line of results of Taya *et al.* (1990) and Bhatia *et al.* (1997).

Effect of organic amendments on root rot disease development : Presence of organic manures improves soil structure and increase fertility of soil. They increase water holding capacity, porosity and aeration of the soil which results in rapid root extension and better plant vigour. All these changes indirectly reduce the incidence of root rot disease. Results of effect of soil incorporation of six organic amendments are presented in Table 2. Minimum disease incidence of 36.9 and 39.9 per cent was recorded with mustard cake followed by cotton cake and vermicompost as compared to the highest disease incidence of 66.7 per cent in control pots. Poultry manure and mushroom spent compost could protect only 15 per cent and 19.96 per cent plants respectively, as compared to control.

Four organic amendments *viz,*. mustard cake, neem cake, cotton cake and vermicompost significantly reduced pre-emergence plant mortality as compared to control, whereas, all the six organic amendments significantly reduced the post-emergence plant mortality as compared to control.

The results were in agreement with earlier workers Mathur and Sinha (1970); Sharma *et al*. (2005) who observed that the population density of *R. bataticola* was reduced by organic amendments.

Effect of different concentrations of *Glomus fasciculatum* (VAM) on dry root rot disease development : The disease control was directly proportional to the dose of VAM and results are presented in Table 3. Maximum of 40 per cent disease control was recorded when the soils were incorporated with 600 sporocarps per kg soil followed by 25 per cent when soils were incorporated with 500 sporocarps per kg soil and a least disease control of 10 per cent was achieved at 400 sporocarps per kg soil.

Pre-emergence plant mortality of 13.3 per cent

TABLE 2

Effect of different organic amendments on dry root rot of clusterbean cv. HG-365 under screen house conditions

Organic amendments (g/kg soil)	*PEM[1] (%)	*POEM[2] (%)	Total mortality (%)	Disease control (%)
Poultry manure	23.3	33.3	56.6	15.01
(5 g/kg soil)	(28.8)	(35.2)		
Mustard cake)	10.2	26.7	36.9	44.80
(2 g/kg soil	(18.4)	(31.0)		
Neem cake	13.3	30.0	43.3	34.90
(2 g/kg soil)	(21.3)	(33.2)		
Vermi-compost	16.7	23.3	40.0	40.09
(2 g/kg soil)	(24.0)	(28.8)		
Cotton cake	13.3	26.6	39.9	40.09
(2 g/kg soil)	(21.3)	(31.0)		
Spent compost	20.0	33.3	53.3	19.96
(5 g/kg soil)	(26.5)	(35.2)		
Check	23.4	43.3	66.7	0.00
(Pathogen inoculated)	(28.7)	(41.1)		
Check (No pathogen)	0.5	0.5	-	-
	(4.05)	(4.05)		
C. D. (P=0.05)	(3.70)	(2.74)	-	-

*(Mean of 3 replications); Figures in parentheses are angular transformed values; [1]PEM=Pre-emergence mortality; [2]POEM=Post-emergence mortality.

TABLE 3
Effect of different concentrations of Glomus fasciculatum (VAM) on dry root rot of clusterbean cv. HG-365 under screen house conditions

DOSE (Sporocarps/kg soil)	*PEM[1] (%)	*POEM[2] (%)	Total mortality (%)	Disease control (%)
400	23.3 (28.8)	36.6 (37.2)	59.9	10.0
500	16.6 (24.0)	33.3 (35.2)	49.9	25.1
600	13.3 (21.3)	26.6 (31.0)	39.9	40.1
Check (Pathogen inoculated)	23.3 (28.8)	43.3 (41.1)	66.6	0.00
Check (No pathogen)	0.5 (4.05)	0.5 (4.05)	-	-
C. D. (P=0.05)	(4.49)	(3.81)	-	-

*(Mean of 3 replications); Figures in parentheses are angular transformed values; [1]PEM=Pre-emergence mortality; [2]POEM=Post-emergence mortality.

was significantly reduced by application of 600 sporocarps per kg soil as compared to pre-emergence plant mortality of 23.3 per cent at 400 sporocarps per kg soil. Post-emergence plant mortality was also significantly reduced *i.e.*, 26.6 per cent, 33.3 per cent, 36.6 per cent at 600, 500, 400 sporocarps per kg soil, respectively as compared to control (43.3%).

The results are in agreement with the findings of Jalali *et al*. (1991) and Kumar *et al*. (2007) who reported that inoculation of *G. fasciculatum* suppressed the root rot incidence.

Effect of different concentrations of *Trichoderma viride* on root rot disease development : The results of the study indicated that bio- control agents significantly reduced percent disease incidence (Table 4). Maximum of 34.8 per cent plant disease control was recorded when the soils were incorporated with *T. viride* at the rate of 10g/kg soil, whereas, the disease control was 25.1 per cent at 5g/kg soil.

Pre-emergence plant mortality of 16.7 per cent was obtained by application of *T. viride* at the rate of 5g per kg soil and it was significantly reduced to 13.3 per cent at a dose of 10 g per kg soil, whereas, it was maximum (23.3%) in check. Post-emergence plant mortality was also significantly lower *i.e.*, 30.0 per cent at 10g per kg soil as compared to check (43.3%).

The observations of this experiment are in agreement with findings of Raghuchander *et al.* (1993) and Wuike *et al.* (1995), who observed that application of *T. viride* in soil reduced the incidence of root rot caused by *R. bataticola*.

TABLE 4
Effect of different concentrations of Trichoderma viride on dry root rot of clusterbean cv. HG-365 under screen house conditions

Trichoderma viride (Tv)	*PEM[1] (%)	*POEM[2] (%)	Total mortality (%)	Disease control (%)
Tv @ 5 g/kg soil	16.7 (24.0)	33.3 (35.2)	50.0	25.1
Tv @ 10 g/kg soil	13.3 (21.3)	30.0 (33.2)	43.3	34.8
Check (Pathogen inoculated)	23.3 (28.8)	43.3 (41.1)	66.6	0.00
Check (No pathogen)	0.5 (4.05)	0.5 (4.05)	-	-
C. D. (P=0.05)	(4.8)	(2.3)	-	-

*(Mean of 3 replications); Figures in parentheses are angular transformed values; [1]PEM=Pre-emergence mortality; [2]POEM=Post-emergence mortality.

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