Research Article

Management of Chickpea (Cicer arietinum L.) Dry root Rot Caused by Rhizoctonia bataticola (Taub.) Butler.

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ABSTRACT

Dry root rot caused by Rhizoctonia bataticola (Taub.) Butler is emerging as a serious biotic constraint for chickpea production. It is the most important and widespread soilborne disease of chickpea grown between latitudes 20^{o} N. and 20^{o} S, where the climate is relatively dry and warm. To find out the prevalence of the disease in Jammu and Kashmir and management of disease through bio-control agents and fungicides, investigation was carried during 2010-2011 in the study area.

Key Words: Dry root rot, Chickpea, Prevalence, Bio-control agents and Fungicides.

INTRODUCTION

Chickpea, Cicer arietinum L. is one of the most important pulse crop of India. It is cultivated in about 8.56 million hectares with a production of 7.35 million tonnes and productivity 858 kg per hectare (Anonymous 2010).

The average production of chickpea is 15-20 quintal per hectare which is low in spite of high yielding varieties and new agronomic practices. The reasons of low yield are so many apart from other reasons the main cause of low yield of this crop is the incidence of diseases. India is the world leader in chickpea production fallowed by pakistan .The chickpea crop is attacked by 172 pathogens (67 fungi, 22 viruses, 3 bacteria, 80 nematodes and mycoplasma) from all over the world (Nene *et al.* 1996). Among all, only a few of them have the potential to devastate the crops. Some of the serious disease in order of their importance are wilt *Fusarium oxysborum f. sp. ciceri)* wet root rot (*Rhizoctonia solani),* dry root rot (*Rhizoctonia, bataticola)* Ascochyta blight (*Ascocthya rabiei)* and coller rot *(Sclerotium rolfsie)*.

Dry root rot disease caused by *Rhizoctonia bataticola* was observed on variety Radhey in Jammu and Kashmir during April-May 2011. Considering the importance of the disease and crop, the present investigation were undertaken to know the prevalence of the disease in Jammu and Kashmir, Physiological studies of the pathogen and Intergraded management of disease through bio-control agent and fungicides.

Review of literature

Chickpea (*Cicer arietinum* L.) is an important pulse and vegetable crop. A critical review of literature has revealed that a number of disease caused by fungi, bacteria, viruses and nematodes are known which lower the quality and quantity of the product of this crop (Nene and Reddy 1987).

Chauhan (1962) found that in sand culture the percentage intensity of dry root rot decrease with the increase in soil pH being very low at pH 9.2 dry weight and seed production were also favoured by increasing pH.

Uppal et al. (1936) reported that two isolates did not grow 9^{0}C and 11^{0}C respectively after 2 days, but slight growth of both isolates was observed after 5 days. Similarly at 40^{0}C, 3.9 cm and 1.9 gm was observed after 7 days, respectively. They also recorded the optimum temperature between 30 and 35^{0}C for the isolates of *R. bataticola* .

Knock Devies (1965) observed that *R. bataticola* could not induce sporulation unless the culture were irradicated with ultra-violet light for 12 to 24 hours at 30^{0}C.

Goyal and Mehrotra (1981) tested 9 fungicides against *R. bataticola* in vitro and on (chickpea) Benlate, Bavistin. Thiophanate methyl and Dyrene were promising. In vitra, Venomyl and Bavistin inhibited fungal growth most.

Sarwar and Raju (1985) tested 8 fungicides in vitro an antibiotic Topsin M-70 was highly effective at 1000, p. pm. Against *R. bataticola* .

Toya *et al.* (1990) in green house tests, in different ways and found that the best control of *R. bataticola* was given by carbendazim alone or in combination with thiram as seed treatment, pre-sowing, soil- drench and seed treatment + drenching after sowing treated seed of chickpea.

Singh *et al.* (1992) reported that integrated pesticide spray schedule provided better control of dry root rot (*R. bataticola)* in chickpea than any of the simple treatments. Higher yields were observed seed treatment with carbendazim +Thiram was followed by 2 sprays of monocrotophas or Endosulfan.

Peshrey *et al*. (1992) reported that thiram, Campton, PCNB moncozeb Iprodine, carboxine,

carbendazim Thiobedazole (all 0.2%) and tridemorph (0.07%) effectively controlled growth on Sclerotial germination of *R. bataticola* in vitro. Carbendazine and thiobendozale were most effective and inhibited growth at the concentration of 0.006%. In successive cultures, the fungus should increase tolerance to Mancozeb and PCNB and to a lesser extent to thiram, Campton, carboxin and iprodione. There was no reduction in sensitivity towards carbendazim or thiobendazale.

Vijay-Mohan *et al.* (2006) reported in fungicidal trails on management of dry root rot of chickpea caused by *R. bataticola* carbendozin (0.2%) and Etaconazole (0.1%) used as seed treatment, soil drenching and seed treatment plus soil drenching recorded lowest disease incidence of 15.6 and 18.2 per cent highest grain yield of 192 and 18.9 q/ha respectively, during rabi 2001-2002 and 2002-2003 crop seasons. The above treatment recorded 57.2 and52.4% higher yield over control with per rupee return of 12.78 and 11.80 respectively.

Singh *et al.* (2007) this chapter focuses on the economically important disease of chickpea, i.e. – Ascochyta blight (caused by *Ascochyta rabiei*) botrytis Grey mould (caused by Botrytis cinerea), Fusarium wilt (caused by *fusarium oxysporum f. sp. ciceris*), dry root rot caused by *Rhizoctonia bataticola*), *Sclerofinia* stem rot (caused by *Sclerotiorum*) foot rot (caused by *Operculella podwickii)*, rust (caused by *Vromyces ciceris-arietini)*, parasite weed (*Orabanche and Cuscuta spp*.) and other diseases information is provided on their distribution, economic importance's symptoms, epidemiology, pathogen variability, host plant resistance and management (using fungicidal control).

Singh and Mehrotra (1980) investigated biological control of *R. bataticola* on chickpea and reported 4 bacteria and 6 actinomycetes proved antagonistic in culture with the exception of streptomyces isolates, all these reduced disease symptoms and increased plant growth and dry matter when tested further by coating chickpea seed sown in field soil inoculated with the pathogen.

Parakhia and Vaishnow (1986) reported that when chickpea seed were treated with *T. harziamum* before sowing in pot inoculated with *R. bataticola* infection reached 18% when the antagonist was applied as a soil drench disease levels were 28% and incorporation of wheat husk bran cultures gave levels of 14% compared with 70% in the untreated controls.

Kumar and Khare (1990) investigated the antagonistic relationship of soybean with *R. bataticola* and *Sclerotium rolfsi.* It was inferred that the population increased and decreased due to the antagonistic activity of *T. harziamum* and *Bacillus subtilis.*

Haram *et al.* (1996) evaluated that *trichoderma harzianum* is an efficient biological agent that is commercially produced to prevent development of several soil seed pathogenic fungi like *Rhizoctonia bataticola, Fusarium Solani, F. oxysporum.* Different mechanisms have been suggested as being responsible for their biocontrol activity, which include competition for space and nutrients, secretion of chitinolytic enzymes mycroparasitism and production of inhibitory compounds.

Chandra Shekhar *et al.* (1997) reported that A procedure that consumes less screening time was developed for screening Rhizophore-competenet bacteria for suppression of the chickpea of the pathogenic fungi *Fusarium oxysparum f. sp. ciceri, Rhizoctonia bactalicola and phytium sp.* of the 478 bacteria by random selection of the predominant.

Xue and Allen, (2002) observed a biological agent and method of use therefore controlling diseases caused by fungal pathogens in plants.

Singh *et al.* (2003) the efficacy of *Trichoderma harzianum. T. Viride, T. hematum, glicladimvire, Psedomona fleurescens* and *Bacillus subtilis* in controlling *Rhizoctonia bataticola* casing dry root rot in chickpea was determined in vitro and in field experiment conducted in Kanpur, Uttar Pradesh, India 2001-02. *T. harzianum* recorded the highest control of the pathogen both in vitro and vivo.

Gurha, -S.N.; *et al.* (2007) reported that this chapter the ecofriendly management of dry root rot (*Rhizoctonia bataticola)* and wilt (*Fusarium oxysporum)* infecting chickpea. The tropic discussed include disease resistance in plant; cultural control; intercropping and rotation; biological control; chemical control. Screening of chickpea germplasm lines against dry root rot disease in pot.

Krishnamohan *et al.* (1981) tested 20 chickpea forms screened under field conditions and artificially in the green house, using a 1-6 score (1-highly resistant), BG205 and BG206, although moderately susceptible in the green house, were, highly resistant under field conditions against. *R. bataticola* .

Singh *et al.* (1982) reported that 3 chickpea cultivars did not to be related to their resistance to *R. bataticola* carbohydrate content was higher in the susceptible cultivar than in the 2 resistant ones.

Singh and Mehrotra (1982) reported resistant to *R. bataticola* was shown by the cultivars BG-203, G-543 and Hare Chhole when grown in infested soil.

Reddy *et al.* (1990) tested resistant to wilt and different root rots of chickpea and found that the mortality of variety J.G.-62 (100%), Avrodhi and ICCC-48 was (20%).

Baker and Ahmed (1991) tested the resistance of 90 genotypes of chickpea in field infested with wilt, dry root rot pathogens and found that ICC 12263 was most resistant.

Jayant –Bhatt and Bhatt (1993) pre-germinated seed of 21 chickpea varieties were sown in

contaminated soil. *R. bataticola* caused seed rot within 24h in NEC874 and EG234, Bold 2375, BG209, JG62, JG315, ICC 3357 and JG1133 developed necrotic lesion 3 to 5 cells deep on the hypocotyls region within 7 days, RSG-44, AGC677, NEC41, GL269, JG74, ICC8983 and ICC 5003, developed only superficial necrosis along the hypocotyle region. BGM416, BG416, ICC1376 and ICC113314 were resistant. Resistant cultivars had a greater number of lateral roots during early growth phases.

Mishra *et al.* (2005) have tested 470 germplasm lines are found KG-86 KWR-4, KWR-108 and KWR-277 as a resistant genotype.

Chaturvedi and Dua (2009) have reported 25 resistant cultivars including KPG-59, Radhey and K-50 against dry root rot.

Aghakhani *et al.* (2009) twenty – three isolates of *R. bataticola* causing dry root rot of chickpea (Cicer arietinum collected from 10 different major chickpea growing states of India were highly variable in their morphological and cultural characters as well as pathogenicity /virulence. The virulence analysis of the isolates on a set of chickpea cultivars namely ICC12441, ICC1224, ICC12450, Pusa 362, BGD112, Pusa1103, Pusa212, Pusa1088 and under blotter paper as well as sick soil grouped them into 6 pathotypes . The pathotype groups were related to agro ecological region of he country. The most virulent isolate (RBI from Bangalore, Karnataka) was fast growing and produced largest Sclerotia. A set of cultivars was proposed for the first time for differentiating the pathotypes of *R. bataticola* causing dry root rot of chickpea.

Ved Ratan *et al.* (2010) reported that the variation in date of sowing was tested as an effective and economic strategy against dry root rot caused by (*R. bataticola)* and wilt (*Fusarium oxysoporum f.sp. ciceris*) disease of chickpea.

MATERIAL AND METHODS

SURVEY TO KNOW THE PREVALENCE OF THE DISEASE IN JAMMU AND KASHMIR

The survey for the occurrence and severity of chickpea dry root rot was made during crop season 2010-11. Observation were recorded mostly from farmers field under natural conditions. Data were recorded on different varieties at different places and dates. Five to six place of each village were selected at random. Five hundred plants were taken randomly from the field and the number of disease and healthy plants were then sorted out. The percentage of plant showing disease was worked out.

The percentage infection of each field in a village was used for calculating the village average and percentage average of each village was used in calculating district average. Sample of naturally infested chickpea plants showing characteristics disease symptoms were collected from each place surveyed, and brought to the laboratory. The sample were critically examined for the presence of causal organism.

COLLECTION OF DISEASE MATERIAL

Naturally infected chickpea plants, showing characteristic symptoms of dry root rot were collected from different villages which were surveyed. Such affected plants were brought to the laboratory. These plant were washed and critically examined for the presence of causal organism. Diseased material was used for isolating the pathogen. Suitable wet and dry specimens were also prepared for future use.

PHYSIOLOGICAL STUDIES OF THE PATHOGEN

Effect of temperature on the growth and sporulation of the pathogen: To study the effect of temperatures on the growth and sporulation of the pathogen, it was grown at eight different temperature viz., 10, 15, 20, 25, 30, 35, 40 and 45^0C. In this study potato dextrose agar was used as basal medium and the method of sterilization, incubation, filtration and determination of the dry mycelial weight, were followed as described earlier. The dry mycelial weight were determined after 15 days of incubation. Three replications were kept for each treatment.

Effect of H-ion concentration on the growth and sporulation of the pathogen: In order to study the effect of H-ion concentration on the growth and sporulation of the pathogen twelve different level, viz. 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0 and 9.0 before autoclaving by Backman pH meter using N/10 sodium hydroxide and N/10 hydrochloric acid. The method of sterilization of the medium, filtration and determination of dry mycelial weight of the fungus were the same as described earlier. The average dry weight of the mycelium and extent of sporulation were recorded after 15 days in incubation at 30 ± 1^0C.

Laboratory bioassay of fungicides: The following eight fungicides were evaluated against the pathogen under laboratory conditions to screen out the best fungicides depending upon their inhibitory effect on the growth of the fungus *(Rhizoctonia bataticola).*

S.No.	Fungicides	Dose %
1.	Indofil M-45	0.2
2.	Bavistin	0.2
3.	Companion	0.2
4.	Copper oxycloride	0.2
5.	Benlate	0.2
6.	Indofil Z-78	0.2
7.	Ridomil	0.2
8.	Sulphur	0.2
9.	Control	0.2

The different fungicides were screened for their efficacy against the pathogen by "Food Poison Techniques" described by *Schmitz* (1930) in which required quantity of each fungicides was thoroughly mixed with 100 ml well sterilized potato dextrose agar medium contained in 150 ml flasks.

Now this medium mixed with fungicides was poured in Petri-plates and allowed to solidify. Each treatment was replicated three times. One set of control was also kept in which the medium was not mixed with fungicides. Equal pieces of the fungal growth, cut by the cark borer were inoculated in each Petri-plate at the center. These inoculated Petri-dishes were incubated at 30 ± 1^0C for 15 days and after 15 days of the incubation, the fungal growth was recorded in each Petri-dishes.

Evaluation of Bio-Agents against the pathogen in vitro: For this study, the pathogen was isolated from dry root rot sick plot of chickpea from Indian Institute of Integrative Medicine (IIIM) , Bonera Pulwama. One week old culture of *Rhizoctonia bataticola* maintained on potato dextose agar Petri-plates of 30 ± 1^0C was used for the study.

The cultures of all the bio-agents were isolated from the rhizosphere of chickpea plants of dry root rot plot of this Institute, Antagonistic activity of these bio-agent against test pathogen was determined by "dual culture technique" (Dennis and Webster, 1971). Five mm dice of pathogen was taken from the actively growing colonies of the test pathogen and antagonist with help of sterilized cork borer. The dices of the pathogen were placed on one side in agar plates aseptically, and the dices of antagonists were placed apposite side, the pathogen in same Petri-plate. Each treatment was replicated three times and incubated at 30 ± 1^0C . Growth of antagonists and pathogen were recorded after 15 days of incubation.

The bio-control agents used for testing were:

1. *Trichoderma Viride*
2. *Trichoderma horzianum*
3. *Psuedomonas fleuroscense*

EXPERIMENTAL FINDINGS

SURVEY TO KNOW THE PREVALENCE OF THE DISEASE IN THE STUDY AREA

Dry root rot disease of chickpea crop was found in all villages which were surveyed since 2010-2011 regularly. No information is available on incidence and distribution of this disease in the study area. Therefore a survey study was under taken to determine the incidence of disease. The results of survey carried out in some villages of both the divisions are summarized in table 4.

Table 4: Sowing results of dry root rot disease in 50 villages

S.No.	Name of the village visited	No. of field visited	Variation of dry root rot	Average dry root rot
1	TRICHAL	5	4-15	14.0
2	MITRIGAM	6	2-12	5.42`
3	WAHIBUGH	5	3-7	6
4	VOATH	5	0-8	6.4
5	MIDOORA	4	1-20	18.0
6	KANGAN	5	1-8	6.4
7	LAAR	5	1-8	6.3
8	DOORU	6	0-16	12.1
9	WAZIRPORA	3	1-5	3.0
10	YARIPORA	4	5-20	14.5
11	KALAMPORA	5	2-10	3.5
12	MAGAM	4	1-6	6.4
13	SHANGUS	6	0-6	40.0
14	NEHAMA	7	0-16	8.7
15	SHADIMARG	4	2-10	14.0
16	NARWA	5	1-18	16.0
17	PAKARPORA	5	2-15	12.15
18	NEWA	6	3-19	17.0
19	NAINA	6	1-5	4.11
20	LOLAB	5	2-16	15.0
21	MANSBAL	6	3-15	18.25
22	PADGAMPORA	5	2-15	12.15
23	MALPORA	6	3-19	17.0
24	NAWHAR	6	1-5	4.11
25	LAJURA	5	2-16	15.0
26	MARHANG	6	3-15	18.25
27	CHANDGAM	5	0-15	11.50
30	JASROTA	6	1-8	7.00
31	LAKHANPORA	5	0-18	16.25
32	RAMKUNT	5	2-18	15.00
33	RAMNAGAR	5	1-10	9.50

34	GOOL	5	1-12	8.23
35	TREHGUM	5	0-40	35.25
36	PAYER	5	3-35	30.75
37	BHARDARWAH	5	2-30	28.0
38	BILLAWAR	5	0-18	16.50
39	MANDI	5	1-16	15.25
40	BUDHAL	6	2-18	17.0
41	CHATROO	6	0-15	13.27
42	BANIHAL	6	1-19	17.75
43	TANGMARG	5	0-16	15.0
44	URI	5	1-16	14.75
45	CHADOORA	5	0-30	28.25
46	BEERWAH	5	1-18	16.25
47	LARPURA	5	3-30	25.25
48	TREHGUM	5	0-40	35.25
49	BADROO	5	3-35	30.75
50	PARIGAM	5	6	0-42

It is evident from table-4 that dry root rot disease was observed in all the village surveyed, though there was no incidence of disease in some field of several villages of both the divisions. The maximum disease was observed in village Shangus (40.0 per cent) of Kashmir division. Minimum disease was observed in Naina (4.11 percent), Kashmir division of district Pulwama. It is remarkable to note that all the six field visited in village Shangus have high dry root rot problem (15 to 80 per cent).

Physiological studies of the pathogen

The physiological studies were carried out on media, temperature and pH on the growth and sporulation of the pathogen, which are described here separately.1. (A)

Effect of different solid media on the growth and sporulation of the pathogen.

The pathogen was grown on eight different natural, synthetic and semi-synthetic media for comparative study to select out the best medium for its growth. The data on radial growth and sporulation were recorded and results are presented in Table -6

Table 6: Effect of various solid media on growth and sporulation of the pathogen

S.No.	Medium	Average diameter of the colony (mm)	Sporulation
1.	Potato dextrose agar	63.35	Nil
2.	Standard nutrient agar	51.86	Nil
3.	Chickpea root extract agar	47.71	Nil
4.	Carrot root extract agar	38.23	Nil
5.	Oat meal agar	29.55	Nil
6.	Czapek's Dox agar	25.43	Nil
7.	Richard's agar	17.13	Nil
8.	Asthana and Hawker's agar	15.26	Nil
	C.D. at 5%	1.26	

Table 7: Effect of various liquid media on the growth and sporulation of *R. bataticola*

S.No.	Medium	Average mycelia l dry weight (mg)	Sporulation
1.	Potato dextrose	22.35	Nil
2.	Standard nutrient	16.57	Nil
3.	Chickpea root extract	15.90	Nil
4.	Carrot root extract	14.22	Nil
5.	Oat meal	13.03	Nil
6.	Czapek's Dox	12.70	Nil
7.	Richard's	11.55	Nil
8.	Asthana and Hawker's	10.12	Nil
	C.D. at 5%	1.00	

A perusal of (Table-6) reveals that potato dextrose agar medium supported the best growth of the pathogen, which was significantly superior to other media tested, followed by standard nutrient agar and chickpea root extract agar media. Fair growth of the pathogen was obtained on Asthana and Hawaker's media, whereas remaining media viz. carrot root extract agar, oat meal agar, Czapek's Dox agar, and Richard agar media supported poor growth. No sporulation was observed on any of the solid media.

(b) Effect of various liquid media on the growth and sporulation of the pathogen.

The experiment was conducted on eight different liquid media in order to find out the best medium for its growth and sporulation, as described in material and method. Observations on mycelial dry weight were recorded 15 day after incubation and the result are summarized in Table-7.

It is evident from the result (table-7). That Potato dextrose medium was best for growth of the pathogen and significantly superior to the rest of other media tested. Good growth was recorded on standard nutrient medium and chickpea root extract, which were statistically at par with each other. Fair growth was obtained on carrot root extract medium, where as the remaining media Asthana and Howker's Richard's Czapek's Dox medium, supported poor growth of the pathogen. Sporulation was not observed on any of the liquid media tested.

2. Effect of different temperature on the growth and sporulation of the pathogen:

The pathogen was grown at ten different temperature ranging from 10^0C to 45^0C as described under "Material and Method" mycelium weight were recorded, and the result are summarized in table 8.

Table 8: Effect of different temperature on the growth and sporulation of the pathogen

S.No.	Temperature	Average mycelial dry weight (mg)	Sporulation
1.	10	66	Nil
2.	15	77	"
3.	20	109	"
4.	25	112	"
5.	30	140	"
6.	35	138	"
7.	40	100	"
8.	45	35	"

C.D. at 5% level -1.6

The result (Table-8) indicate that, pathogen could grow over a wide temperature range of 10^0C to 45^0C but the optimum temperature for its growth was found to be 30^0C. The next best temperature for its growth was recorded 35^0C. Statistically the growth of the pathogen gradually decreased both below and above the optimum temperature (30^0C). Minimum growth was recorded at 10^0C. Sporulation of the fungus was not observed at any temperature in the experiment.

3. Effect of different pH level on the growth and sporulation of the pathogen.

In order to find out the effect of various pH level on the growth and sporulation of the pathogen ten different pH was adjusted as described in material and method. The fungus was grown on potato dextrose medium at 30.0 ± 1^0C. The medium was adjusted ranging from 3.0 to 9.0 pH and dry mycelial weights as well as sporulation were recorded and data obtained are presented in table - 9.

Table 9: Average dry weight of the mycelium of the pathogen at different pH level after 15 days of incubation

S.No.	pH level	Average mycelial dry weight (mg)	Sporulation
1.	3.0	4.89	Nil
2.	3.5	7.4	" "
3.	4.0	9.63	" "
4.	4.5	14.42	" "
5.	5.0	18.36	" "
6.	5.5	23.53	" "
7.	6.0	19.89	" "
8.	6.5	19.87	" "
9.	7.0	15.15	" "
10.	7.5	12.93	" "
11.	8.0	10.25	" "
12.	9.0	10.20	" "
	C.D. at 5%	1.21	" "

It is evident from the above table that the pathogen could grow over a wide range of pH from 3.0 to 9.0 but the optimum pH for its growth was found to be 5.5 followed by 6.0. However with increase upto to 7.0 and thereafter it declined. The minimum growth of the pathogen was recorded at pH 3.0 No. sporulation of the fungus occurred at any pH level.

Laboratory bio-assay of fungicides: Eight different fungicides were tested against the pathogen in vitro. The screening of the effective fungicides was done on the basis of the inhibitory effect of the fungicides on the growth of the fungus by the agar plates method after 15 days of incubation at 30 ± 1^0C . The average diameter of the fungal colonies was noted in the poured plates containing different fungicides as reported in table -10.

Table 10: Inhibitory effect of different fungicides on the growth of *Rhizoctonia bataticola* after 15 days incubation at 30 ± 1^0C

S.No.	Fungicides	Dose %	Average diameter of fungal growth (cm)	Percent inhibition over control
1.	Indofil M-45	0.2	00.00	100.00
2.	Bavistin	0.2	00.00	100.00
3.	Companion	0.2	00.00	100.00
4.	Copporoxycloride	0.2	00.00	100.00
5.	Benlate	0.2	00.00	100.00
6.	Indofil Z-78	0.2	5.23	38.47
7.	Ridomil	0.2	6.48	24.50
8.	Sulphur	0.2	6.70	21.17
9.	Control		8.50	

C.D. at 5% level = 0.01617

It is evident from the result of table-10 and corresponding . that out of eight different fungicides tested in laboratory, Indofil M-45, Bavistin, comparion, copperoxycloride and benlate completely inhibited the growth of the fungus. Other fungicides which were also found effective to check the growth of fungus were Indofil Z-78, Ridomil and Shulphur in descending order of superiority.

Evaluation of bio-agents against the pathogen in vitro

There bio-agent were evaluated for their inhibitory effect against the pathogen by dual culture techniques as described previous chapter the result of average diameter of fungal colony incubated at 30 ± 1^0C after 15 day presented in table-11 .

Table 11: Inhibitory effect of different bio-agents on the growth of *Rhizoctonia bataticola* in vitro incubated at 30 ± 1^0C

S.No.	Bio-agents	Average diameter of fungal colony (cm)	% inhibition over control
1.	*Trichoderma viride + Rhizoctonia Bataticola*	1.41	81.96
2.	*Trichoderma harzium + Rhizoctonia Bataticola*	3.42	56.26
3.	*Psedomonas Fleurescens + Rhizoctonia Bataticola*	5.54	29.15
4.	Control	7.82	

C.D. at 5% level =0.02431

The results presented in table -11 reveal that all the bio-agents suppressed the colony growth of *Rhizoctonia bataticola*.

The suppression of the growth pathogen was maximum with *trichoderma viride* (81.96%) followed by *trichoderma hazarium* and the least effective bio-agent was *Pseudomanas fluoresces*.

DISCUSSION

Chickpea (*Cicer arietinum* L.) is an important pulse crop of India. It is cultivated about 8.56 million hectare with a production 7.35 million tones and productivity 850 kg/hect. Diseases caused enormous damage to this crop and thereby adversely affect the national economy. Merely by controlling the important disease of chickpea crop in the country the problem of malnutrition can be minimized appreciably.

Dry root rot has been found to damage chickpea crop. Therefore, the experiment was under taken to find out its incidence and distribution in Jammu and Kashmir. So far as village of both the divisions is concerned highest (40.0 per cent) disease was observed in village Shangus and lowest (4.11 per cent) in village Naina.

It is because in some of field where no irrigation is possible farmers used to sow chickpea crop year after year in the some field. The high incidence of the disease in such field might be due to the fact that the disease perpetuates through debris in field.

The same type of observation was recorded by Khune and Patil (1992).

The incidences of dry root rot of chickpea caused by *R. bataticola* was observed in late Oct. to mid Nov. the intensity of the disease was highly in the month of Feb. and March during late flowering and podding stage. The symptoms of the disease were yellowing of the leaves within a day or such leaves drop and plant showed completely dried symptoms within a week after the appearance of the first symptom. If the plant were pulled out from the soil and examined the basal stem and main root system of diseased plant showed extensive rooting with most of the lateral roots destroyed. The tissues were weakened and break off easily. In advance cases the Sclerotial bodies may scatted in the pith cavity and on the outer surface of the tap root. The symptoms were resembled with symptoms as described by Chattopadhya and Bathacharya (1967) and Rai and Singh, Ilyas and Sinclair (1974) and Ragaswami (1994).

The effect of eight different solid media was studied on the growth of the pathogen and it was found that potato dextrose agar medium was the best medium for growth the pathogen followed by standard nutrient agar medium chickpea root extract agar medium; and carrot root extract agar medium. Whereas the remaining media viz., oat meal agar, Czapek Dox agar, Richards agar and Asthana and Hawker's agar supported poor to very poor growth. More or less similar results were obtained with these media in liquid form also. No sporulation was observed on any solid and liquid media tested. Earlier, no such systematic effect was made to find out the best suitable medium for the growth and sporulation of *R. bataticola.* However, a few exceptions the reports on media studies made for *R. bataticola* by some workers (Past, 1933: Livington; and ostazisk 1945; Knex –Davies, 1965).

Studies were made to find out optimum temperature for growth and sporulation of the pathogen. It was observed that *R. bataticola* could grow over a wide range of temperature i.e. 10^0C to 45^0C. The optimum growth of the pathogen recorded as 30^0C followed by 35^0C. Sporulation of the fungus was not observed at any temperature. These result agree closely with the finding of Jackson (1965).

Investigation on the pH requirement of the pathogen revealed that although, it could grow over a wide pH range of 3.0 to 9.0 but the optimum pH for its growth was found to be 5.5. The growth of the fungus was reduced both below and above the optimum pH value. However, no sporulation of the fungus occurred at any pH level tested. These results are collaborated by the finding of Dhingra and Sinclair (1973).

Eight fungicides were tested under laboratory condition against *Rhizoctonia bataticola* and found that indofilm-45, Bavistin, companion, copperoxycloride and Benelate were completely inhibited the growth of the fungus on potato dextrose agar medium. Other tested fungicides namely Indofil Z-78, Ridomil and sulphur were also found effective to check the growth of fungus. The result obtained are in agreement with finding of Singh *et al.* (1993).

Three bio-control agents were evaluated in laboratory condition *Trichoderma viride, Trichoderma harzinum* and pseudomonas *Fleuresecense, Trichoderma viride* showed best performance against the pathogen, *Rhizoctonia bataticola,* followed by *pseudomonas fluorescence,* which also checked the fungus growth to some extant similar finding were also reported by Singh *et al.* (2006).

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