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Comparative efficacy of chemical agents against *Rhizoctonia bataticola* causing dry root rot in chickpea (*Cicer arietinum* L.)

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Abstract
Chickpea (*Cicer arietinum* L.) is an important pulse crop globally, valued for its high protein content and contribution to sustainable agriculture through nitrogen fixation. Despite its adaptability to semi-arid conditions, chickpea production is severely affected by dry root rot (DRR), caused by *Rhizoctonia bataticola*. The pathogen survives in soil through micro-sclerotia and proliferates under hot and dry environmental conditions, making management challenging. In this study, infected chickpea plant samples were collected from various growing regions, and *R. bataticola* was isolated and identified based on cultural and morphological characteristics. Pathogenicity was confirmed on a susceptible chickpea variety under controlled conditions. The comparative efficacy of ten chemical fungicides was evaluated using the poison food technique at different concentrations. Among the tested fungicides, Carbendazim 50% WP exhibited the highest inhibition of mycelial growth (92.45%), followed by Tebuconazole 25.9% EC (89.30%) and Hexaconazole 5% SC (86.70%) at their recommended doses. In contrast, Mancozeb 75% WP showed the least inhibition (55.25%). The study highlights the potential of specific fungicides in managing DRR effectively and provides a foundation for integrated disease management strategies in chickpea. Future research will aim at combining chemical, biological, and resistant cultivar-based approaches to develop more sustainable and eco-friendly management practices against dry root rot.

Keywords: *Rhizoctonia bataticola,* bio-agents, chickpea, disease management

1. Introduction
Chickpea (*Cicer arietinum* L.), commonly known as Chana or Bengal Gram, is a vital pulse crop belonging to the Fabaceae family. It holds significant importance in sustainable agriculture and human nutrition, particularly in vegetarian diets, due to its rich protein and nutrient content. Additionally, chickpeas improve soil health by forming a symbiotic relationship with Rhizobium bacteria, which fix atmospheric nitrogen. This natural nitrogen fixation enhances soil fertility and reduces reliance on synthetic fertilizers, supporting eco-friendly farming practices (Ferguson *et al.*, 2010) [7].

Chickpeas are cultivated in diverse climatic conditions. In tropical and subtropical regions, they are typically grown post-monsoon (rabi season), utilizing residual soil moisture. In temperate and Mediterranean climates, planting occurs in spring. While chickpeas thrive in semi-arid environments, they are highly susceptible to drought stress, especially during critical growth stages like flowering and pod formation.

Nutritionally, chickpeas are a powerhouse of essential nutrients, containing approximately 21.1% protein, 61.5% carbohydrates, 4.5% fat, 6% crude fiber, and 6% soluble sugars (Ahlawat *et al.*, 1996) [1]. They are also rich in minerals such as calcium (202 mg), phosphorus (312 mg), and iron (10.2 mg), along with vitamin C (3.0 mg) and B-complex vitamins. A 100-gram serving provides around 360 kcal, making chickpeas a highly nutritious plant-based food source.

Globally, chickpea is the second most widely cultivated legume after common beans. Asia dominates production, accounting for 89.20% of the cultivation area and 84.47% of total output. India leads as the largest producer, contributing 64.61% of the global supply, followed by Australia (7.22%), Myanmar (4.62%), Pakistan (4.27%), Turkey (3.76%), Ethiopia (3.67%), Russia (2.64%), Iran (1.46%), Mexico (1.00%), and the United States

(0.89%) (FAOSTAT, 2024) [5].

Despite its agricultural significance, chickpea production faces severe challenges from diseases, with Dry Root Rot (DRR) being one of the most devastating. Caused primarily by the fungus *Rhizoctonia bataticola* (syn. *Macrophomina phaseolina*), DRR thrives in hot (30-35 °C), dry conditions and often targets chickpea plants during flowering and podding stages (Hwang *et al.*, 2003) [10]. This pathogen has a broad host range, infecting over 500 plant species, including cereals, pulses, and vegetables (Farr *et al.*, 1995) [6]. It persists in soil for years through micro-sclerotia, making chemical control methods largely ineffective.

Recent research has emphasized eco-friendly disease management strategies. Plant-derived extracts from medicinal herbs have demonstrated strong antifungal properties against DRR, offering safe, cost-effective, and sustainable solutions (Doubledee *et al.*, 2010; Hammerschmidt, 1982) [4, 8]. In countries like India, where low-input farming is prevalent, botanical treatments and integrated approaches are gaining traction, though further field studies are necessary (Ravi & Sharma, 2011) [20].

Chemical control of dry root rot is not effective as *R. bataticola* has a broad host range and survives in soil for longer periods in the form of sclerotia. The sclerotia can survive up to ten months even in the absence of the host plants and under prevailing dry soil conditions. Use of host plant resistance is the most economical approach for management of dry root in chickpea. A few chickpea lines with field tolerance to dry root rot have been identified, but high levels of resistance are scarce in cultivated genotypes**.**

2. Materials and Methods

The research experiments for the study "comparative efficacy of chemical agents Against *Rhizoctonia bataticola* causing dry root rot in chickpea (*Cicer arietinum* L.)" were carried out at the Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (208002). The work was conducted in collaboration with the Division of Crop Protection at the Indian Institute of Pulses Research (IIPR), located in Kalyanpur, Kanpur (208002).

2.2 Disease Symptoms

Rhizoctonia bataticola exhibits highest pathogenicity during chickpea's reproductive stages, specifically flowering and pod formation. Initial field symptoms present as irregular patches of wilted plants with progressive foliar desiccation. Leaves develop chlorosis followed by necrosis, adopting a characteristic straw-yellow appearance.

Subterranean symptoms involve extensive taproot degeneration, beginning as brown discoloration advancing to cortical decay. Secondary root systems frequently exhibit extensive necrosis, severely compromising structural integrity. Affected plants demonstrate significantly reduced root anchorage, facilitating easy extraction from soil (Mehrotra and Aneja, 1990) [15].

Pathological examination reveals fungal colonization of vascular tissues, with both mycelial networks and sclerotial bodies obstructing xylem vessels. This vascular occlusion induces rapid systemic wilt, often culminating in complete plant collapse within 48-72 hours of symptom onset. Multiple studies (Kannaiyan and Nene, 1981; Pande *et al.*, 2006; Sharma *et al.*, 2012) [11, 18, 23] confirm this disease progression pattern, with severity directly correlated to ambient temperatures of 25-30 °C and pathogen load in soil.

Table 1: Survey and collection of diseased samples of dry root rot of chickpea

S. No.	Isolate Code	Place	Latitude	Longitude	Crop Stage
01	RB-01	Manda	26°31'30"N	80°03'30"E	Podding
02	RB-02	Bardhari	26°16'25"N	80°25'48"E	Flowering
03	RB-03	Devai	26°07'57"N	80°27'46"E	Podding
04	RB-04	Oilseed Dept.	26°29'11"N	80°18'30"E	Podding
05	RB-05	Simarua	26°16'58"N	80°23'10"E	Podding
06	RB-06	Dobha	26°11'29"N	80°01'10"E	Flowering
07	RB-07	Padhara	26°07'05"N	80°31'11"E	Flowering
08	RB-08	Choti Pali	26°17'15"N	80°22'44"E	Podding
09	RB-09	Sarwan Khera	26°07'57"N	80°27'46"E	Podding
10	RB-10	Akhari	26°12'48"N	80°25'20"E	Flowering
11	RB-11	Dev Mai	26°08'00"N	80°28'28"E	Podding
12	RB-12	Madlawa	26°14'40"N	80°25'56"E	Podding
13	RB-13	Bairi Sawai	26°33'06"N	80°04'45"E	Flowering
14	RB-14	Karouli	26°22'41"N	80°24'56"E	Podding
15	RB-15	Bhaisauli	26°10'43"N	80°28'38"E	Podding
16	RB-16	Gadhi	26°18'10"N	80°22'36"E	Flowering
17	RB-17	Hridaykheda	26°17'45"N	80°27'47"E	Flowering
18	RB-18	Jawajpur	26°05'01"N	80°36'42"E	Flowering
19	RB-19	Parsedepur	26°15'14"N	80°29'52"E	Flowering
20	RB-20	Arera	26°43'47''N	80°26'07'E	Flowering
21	RB-21	Patari	26°07'48"N	80°28'15"E	Flowering
22	RB-22	Bharari Farm	25°32'28"N	78°34'10"E	Flowering
23	RB-23	Mauhar	26°05'50"N	80°36'22"E	Flowering
24	RB-24	Nandpur	26°22'02"N	79°47'47"E	Flowering
25	RB-25	Kharauli	26°10'54"N	80°30'21"E	Flowering
26	RB-26	Rooma	26°20'46"N	80°25'42"E	Flowering
27	RB-27	Agronomy	26°29'40"N	80°17'43"E	Flowering
28	RB-28	Khadra	26°10'09"N	80°32'27"E	Flowering
29	RB-29	Arerkala	26°44'41''N	80°26'54"E	Flowering
30	RB-30	KVK, Belatal	25°16'26"N	79°34'11"E	Flowering
31	RB-31	Bhojla	25°31'12"N	78°34'44"E	Flowering
32	RB-32	Rawatpur	26°29'36"N	80°17'39"E	Flowering
33	RB-33	Rusi	26°09'27"N	80°28'49"E	Podding
34	RB-34	Karchalpur	26°09'41"N	80°30'56"E	Podding
35	RB-35	Keshwapur	26°55'14"N	80°00'45"E	Podding
36	RB-36	Bilsarayan	26°22'57"N	80°03'21"E	Podding
37	RB-37	Jagannath Pur	26°33'28"N	81°46'41"E	Podding
38	RB-38	Gauri Hasanpur	26°23'24"N	79°35'58"E	Podding
39	RB-39	Trial Farm	25°32'04"N	78°34'27"E	Podding
40	RB-40	Nunariya	26°33'29"N	79°48'12"E	Podding
41	RB-41	Anntpur	26°24'39"N	79°43'50"E	Flowering
42	RB-42	Araul	26°55'21"N	80°01'15"E	Podding
43	RB-43	Mishrikheda	26°11'34"N	80°28'35"E	Flowering
44	RB-44	Gaur	26°11'40"N	79°50'47"E	Flowering
45	RB-45	Kasari	26°35'44"N	81°41'09"E	Podding
46	RB-46	Mishrikheda	26°11'33"N	80°28'35"E	Podding
47	RB-47	Kapasi	26°29'18"N	79°45'17"E	Podding
48	RB-48	Karbigwasandh	26°12'52"N	80°30'53"E	Podding
49	RB-49	Rampur Shivli	26°34'01"N	80°02'29"E	Podding
50	RB-50	Ayodhya	26°32'31"N	80°49'40"E	Podding

2.3 Isolation, purification and identification of *Rhizoctonia bataticola*

The isolation and identification of *Rhizoctonia bataticola* are essential for studying its disease-causing mechanisms and developing effective control measures against Dry Root Rot in chickpea. The process begins by collecting infected root samples or soil from affected fields. Diseased tissues showing symptoms like wilting and root decay are surface-sterilized with 0.5% sodium hypochlorite, rinsed in sterile water, and placed on potato dextrose agar (PDA) to promote fungal growth while suppressing bacteria. After incubating at 28 °C for 5-7 days, brown, velvety fungal colonies resembling *Rhizoctonia* species are transferred to fresh PDA plates for purification (Huang *et al.*, 2009) [9].

To obtain pure cultures, hyphal tips or single spores are isolated and sub-cultured. Identification relies on observing key morphological features, including dark micro-sclerotia, irregular branching hyphae, and clamp connections under a microscope. However, molecular techniques, such as sequencing the ITS region of rDNA, provide more accurate identification and help distinguish *R. bataticola* from similar fungi like *Macrophomina phaseolina* (Soni *et al.*, 2012) [25]. ITS sequences from confirmed isolates are stored in genetic databases, aiding future research and diagnostics (Latha *et al.*, 2013) [13]. PCR-based methods are now preferred over traditional microscopy due to their speed and precision in pathogen detection.

Isolating and characterizing *R. bataticola* is fundamental for investigating its virulence, genetic diversity, and spread. This knowledge supports the development of targeted management strategies, such as resistant chickpea varieties or bio-control agents, tailored to specific pathogen strains (Mishra *et al.*, 2016) [16].

2.4 Identification of the pathogen based on presence of sclerotia

The fungus was identified by looking at it under a microscope. Some *R. bataticola* mycelium was taken from its pure culture and smeared it on a glass slide. I crushed it with a sterile needle, stained it with Rose Bengal dye, and covered it with a coverslip. Using Leica DM 2000 Compound Microscope at 10X. Presence of small black sclerotia and right-angled hyphal branching confirmed that the fungus is *Rhizoctonia bataticola.*

2.5 Pathogenicity confirmation and inoculum preparation of *R. bataticola*

The pathogenicity of *Rhizoctonia bataticola*, the causal organism of dry root rot (DRR) in chickpea (*Cicer arietinum* L.), was established using the highly susceptible cultivar BG-212 under controlled greenhouse conditions. Pathogenicity testing was conducted following the standardized sick-pot method described by Devi and Singh (1998) [3], which effectively mimics natural root rot infection in a confined environment, ensuring consistent disease development.

For inoculum preparation, a 10-day-old culture of *R. bataticola* was initially grown on a sand-maize meal medium, comprising sterilized sand and maize flour mixed in a 2:1 ratio. Corn kernels were fragmented into 3-4 mm pieces, soaked in distilled water for 12 hours, and blended with the sterile sand. Portions of 100 g of this mixture were then transferred into 250 mL Erlenmeyer flasks and sterilized by autoclaving at 121 °C (15 psi) for 20 minutes. Once cooled, each flask was inoculated with a 5 mm mycelial disc cut from a 7-day-old actively growing *R. bataticola* culture and incubated at 28±2 °C for 15 days, facilitating complete fungal colonization (Sharma *et al.*, 2015) [21].

The fully colonized inoculum was thoroughly mixed into sterilized soil at a concentration of 50 g/kg soil. The final potting mixture consisted of the inoculated soil combined with 2 kg of sterile soil and 500 g of sterilized farmyard manure (FYM), enhancing both soil structure and disease establishment. After pot preparation, the soil was moistened and allowed to stabilize for four days before sowing. Fifteen seeds of the susceptible chickpea variety BG-212 were sown per pot, with two replicates per treatment alongside two un-inoculated control pots maintained for comparison.

Throughout the experiment, plants were maintained under greenhouse conditions with regulated watering to ensure optimal soil moisture. Disease progression was assessed regularly by observing seed germination rates, seedling mortality, and characteristic DRR symptoms beginning 15 days after sowing and continuing until flowering. Typical symptoms included root brittleness, dark discoloration, and shredding of root tissues, consistent with field observations of dry root rot (Mayek-Pérez *et al.*, 2001) [14].

To fulfill Koch's postulates, *R. bataticola* was successfully re-isolated from symptomatic root tissues. The pathogen was cultured again on potato dextrose agar (PDA), and the re-isolates exhibited identical morphological traits to the original isolate, including colony characteristics, pigmentation, and formation of micro-sclerotia, thereby confirming the pathogenicity of the fungus. This experimental protocol not only validated the aggressive nature of *R. bataticola* but also provided a reliable framework for comparative evaluation of different isolates under standardized conditions.

2.6 Evaluation of chemical fungicides against *Rhizoctonia bataticola*

The efficacy of ten fungicides mainly Hexaconazole 5% + Captan 70% WP, Chlorothalonil 75% EC, Hexaconazole 5% EC, Metalaxyl 8% + Mancozeb 64% WP, Thiram 75% WP, Difenconazole 25% EC, Copper oxychloride 50%, Carbendazim 12% + Mancozeb 63%, Carbendazim 50% WP and Mancozeb 75% WP (Table 02) were evaluated *in vitro* against *Rhizoctonia bataticola* at seven different concentrations i.e. 10, 20, 50, 100, 200, 500 and 1000 PPM by using poison food technique (Nene and Thapliyal, 1979) [17]. Active ingredient of fungicides was calculated with respect to 100 ml potato dextrose agar medium. Three replications were kept for each concentration. Required quantity of the fungicide was added in PDA and thoroughly mixed at the time of pouring in laminar air flow chamber. Twenty ml of medium was poured in each pre-sterilized 90 mm diameter petri plate. A five mm disc of eight days old culture of R. bataticola was placed on the medium in upside down position to maintain a continuous contact of fungus with poisoned medium. The medium without fungicide served as control. The radial growth of the fungus on the poisoned medium was recorded at 3rd, 5th and 7th days after inoculation.

Table 2: List of chemical fungicides used against *Rhizoctonia bataticola*:

S. No.	Chemical Name	Trade Name
01	Hexaconazole 5% + Captan 70% WP	Taquat
02	Chlorothalonil 75% EC	Kavach
03	Hexaconazole 5% EC	Contaf Plus
04	Metalaxyl 8% + Mancozeb 64% WP	Matco
05	Thiram 75% WP	Thiram
06	Difenconazole 25% EC	Score
07	Copper oxychloride 50%	Blitox
08	Carbendazim 12% + Mancozeb 63%	Companion
09	Carbendazim 50% WP	Benfil
10	Mancozeb 75% WP	Indofil

2.6.1 Collection of Chemical fungicides

Ten fungicides mainly Hexaconazole 5% + Captan 70% WP, Chlorothalonil 75% EC, Hexaconazole 5% EC, Metalaxyl 8% + Mancozeb 64% WP, Thiram 75% WP, Difenconazole 25% EC, Copper oxychloride 50%, Carbendazim 12% + Mancozeb 63%, Carbendazim 50% WP and Mancozeb 75% WP were collected from Khandelwal Chemicals situated at Kuli Bazaar, Kanpur, Division of Crop Protection at Indian Institute of Pulses Research, Kalyanpur, Kanpur and Dept. of Soil Science and Agricultural Chemistry at Chandra Shekhar Azad University of Agriculture and Technology, Nawabganj, Kanpur.

2.6.2 Poison Food Technique

The poison food technique (Nene and Thapliyal, 1979) [17] was followed to evaluate the efficacy of non-systemic and systemic fungicides in inhibiting the mycelial growth of *Rhizoctonia bataticola.* The fungus was grown on PDA medium for seven days prior to setting up the experiment. The PDA media was prepared and melted. The fungicide on commercial formulation basis was added to the melted media to obtain the required concentrations of the poisoned media. Each sterilized petri plates was filled by 15 ml of poisoned medium. Suitable check was maintained without addition of any fungicide. Mycelial disc of 5 mm was taken from the periphery of nine days old colony was placed in the center of petri plates and incubated at 28±2 0C for two days and three replications were maintained for each treatment. The radial growth of the pathogen on the poisoned medium was recorded at 3rd, 5th and 7th days after inoculation and growth was calculated in mm with the help of a measuring scale. The diameter of the colony was measured in two directions and average was recorded.

Percent inhibition of mycelial growth of the *Rhizoctonia bataticola* was calculated by using the formula by Vincent (1927) [26].

$$\text{Percent Inhibition} = \frac{(\mathrm{C} - \mathrm{T})}{\mathrm{C}} \mathrm{X}\,100$$

Where,
C = Radial growth of pathogen in control.
T = Radial growth of pathogen in treatment.

2.6.3 *In vitro* evaluation of fungicides against the *Rhizoctonia bataticola*

Efficacy of ten commonly used fungicides viz., Hexaconazole 5% + Captan 70% WP (Taquat), Mancozeb 75% WP (Indofil), Chlorothalonil 75% EC (Kavach), Difenconazole 25% EC (Score), Hexaconazole 5% EC (Contaf Plus), Carbendazim 50% WP (Benfil), Metalaxyl 8% + Mancozeb 64% WP (Matco), Copper oxychloride 50% WP (Blitox), Thiram 75% WP (Thiram) and Carbendazim 12% + Mancozeb 63% (Companion) were evaluated against *R. bataticola* at different concentrations viz., 10, 20, 50, 100, 200, 500 and 1000 ppm by using food poison technique.

The data revealed that all the fungicides at all concentrations reduced mycelial growth of *R. bataticola* with respect to control. It is evident from the data (Table 03, and Fig. 01), among all the fungicides that were tested Carbendazim 12% + Mancozeb 63%, Carbendazim 50% WP and Mancozeb 75% WP showed 100 percent inhibition of mycelial growth at all concentrations of 10, 20, 50, 100, 200, 500 and 1000 ppm (Fig. 02). However, the Copper oxychloride 50% showed 100 percent inhibition at 50, 100, 200, 500 and 1000 ppm and Difenconazole 25% EC showed 100 percent inhibition at 500 and 1000 ppm. Other fungicides like Hexaconazole 5% + Captan 70% WP, Chlorothalonil 75% EC, Hexaconazole 5% EC, Metalaxyl 8% + Mancozeb 64% WP and Thiram 75% WP do not give 100 percent inhibition at any ppm. Average mycelial growth and average inhibition percent were also shown in Fig. 03. Average inhibition percent of *R. bataticola* by different fungicides was shown in Fig. 04.

3. Results and Discussion

3.1 Mycelium growth and Inhibition by *Rhizoctonia bataticola*

On the basis of the fungicidal inhibitory effect on the growth of *R. bataticola*, ten fungicides of various concentrations was tested *in-vitro* against *R. bataticola.* All the fungicides at all concentrations reduced mycelial growth of *R. bataticola* with respect to control. Companion, Benfil and Indofil showed 100 percent inhibition of mycelial growth at all concentrations and superior over other fungicides. Other fungicides like Taquat, Kavach, Contaf Plus, Matco and Thiram do not give 100 percent inhibition even at any ppm. Similar findings were also reported by (Paul *et al.*, 2008) [19] and (Konde *et al.*, 2008) [12] who revealed that carbendazim was most effective fungicide against all the *S. sclerotiorum* and *Rhizoctonia solani*.

3.2 Efficacy of chemical fungicides

Efficacy of four different bio-agents, *Trichoderma aureoviride*, *Trichoderma harzianum*, *Trichoderma asperellum* and *Trichoderma longibrachiatum* were evaluated by using dual culture technique. Among these *Trichoderma asperellum* showed maximum inhibition percent of 67.44 followed by *Trichoderma harzianum* and *Trichoderma aureoviride* which gives 66.67 and 63.88 inhibition percent respectively. Least percent inhibition was given by *Trichoderma longibrachiatum.*

Table 22: ***in vitro*** evaluation of fungicides against *Rhizoctonia bataticola*

S. No.	Fungicides	Colony Diameter (MM) AT PPM							Avg. Growth	Inhibition percent							Avg. Inhibition
		10	20	50	100	200	500	1000		10	20	50	100	200	500	1000	
01	Hexaconazole 5% + Captan 70% WP	40.00	36.30	32.00	24.30	18.30	11.60	5.00	23.92	55.55	59.66	64.44	73.00	79.66	87.11	94.44	73.42
02	Chlorothalonil 75% EC	47.70	41.60	33.30	28.30	23.30	20.00	16.70	30.13	47.00	53.77	63.00	68.55	74.11	77.77	81.44	66.52
03	Hexaconazole 5% EC	61.87	51.50	40.73	29.43	15.33	5.33	3.33	29.64	31.25	42.77	54.74	67.30	82.96	94.07	96.30	67.07
04	Metalaxyl 8% + Mancozeb 64% WP	64.40	58.27	51.60	33.30	27.80	21.13	14.47	38.70	28.44	35.25	42.66	63.00	69.11	76.52	83.92	57.00
05	Thiram 75% WP	48.40	38.27	29.73	19.43	10.57	7.23	3.86	22.49	46.22	57.47	66.97	78.41	88.25	91.97	95.71	75.01
06	Difenconazole 25% EC	38.33	35.00	31.67	28.33	25.00	00	00	22.62	57.41	61.11	64.81	68.52	72.22	100.00	100.00	74.86
07	Copper oxychloride 50%	44.30	33.90	00	00	00	00	00	11.17	50.77	62.33	100.00	100.00	100.00	100.00	100.00	87.58
08	Carbendazim 12% + Mancozeb 63%	00	00	00	00	00	00	00	00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
09	Carbendazim 50% WP	00	00	00	00	00	00	00	00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
10	Mancozeb 75% WP	00	00	00	00	00	00	00	00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Control		90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	00	00	00	00	00	00	00	00
S.Ed		0.435	0.565	0.633	0.435	0.764	0.875	0.865	--	0.654	0.7	0.644	0.756	0.743	0.354	0.434	--
S.Em		0.235	0.435	0.546	0.643	0.876	0.765	0.657	--	0.767	0.34	0.234	0.875	0.456	0.334	0.456	--
C.D.		0.875	0.454	0.755	0.768	0.134	0.986	0.564	--	0.345	0.75	0.234	0.675	0.234	0.643	0.256	--

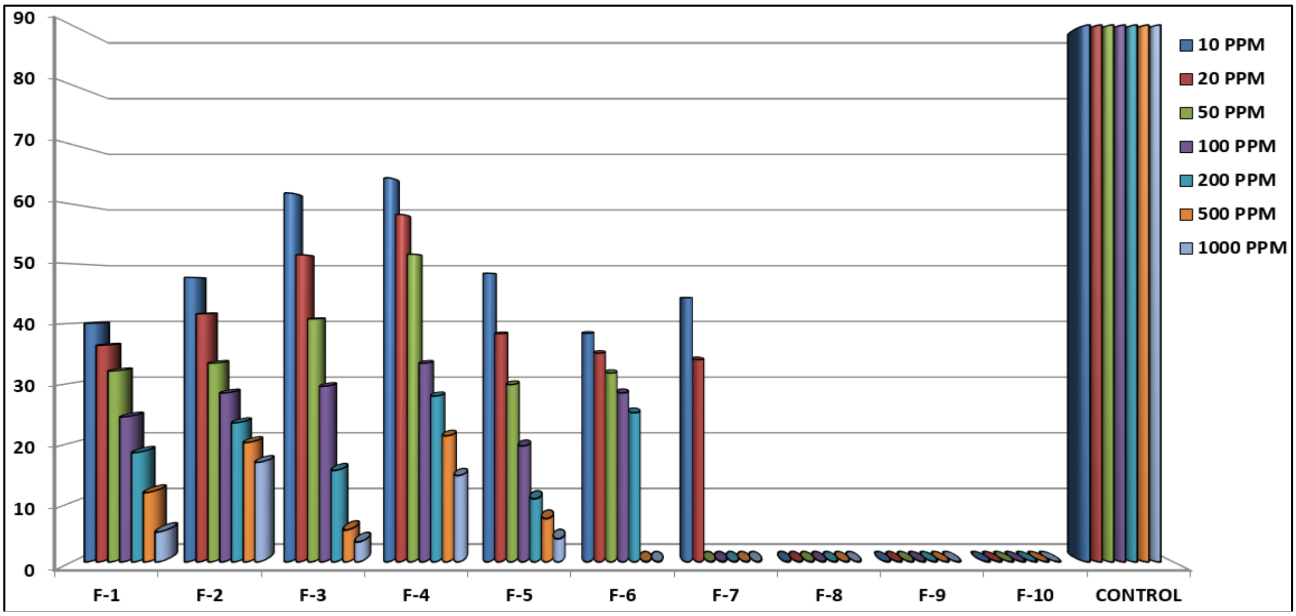

Fig 1: Effect of fungicides on mycelial growth of *Rhizoctonia bataticola* at different PPM

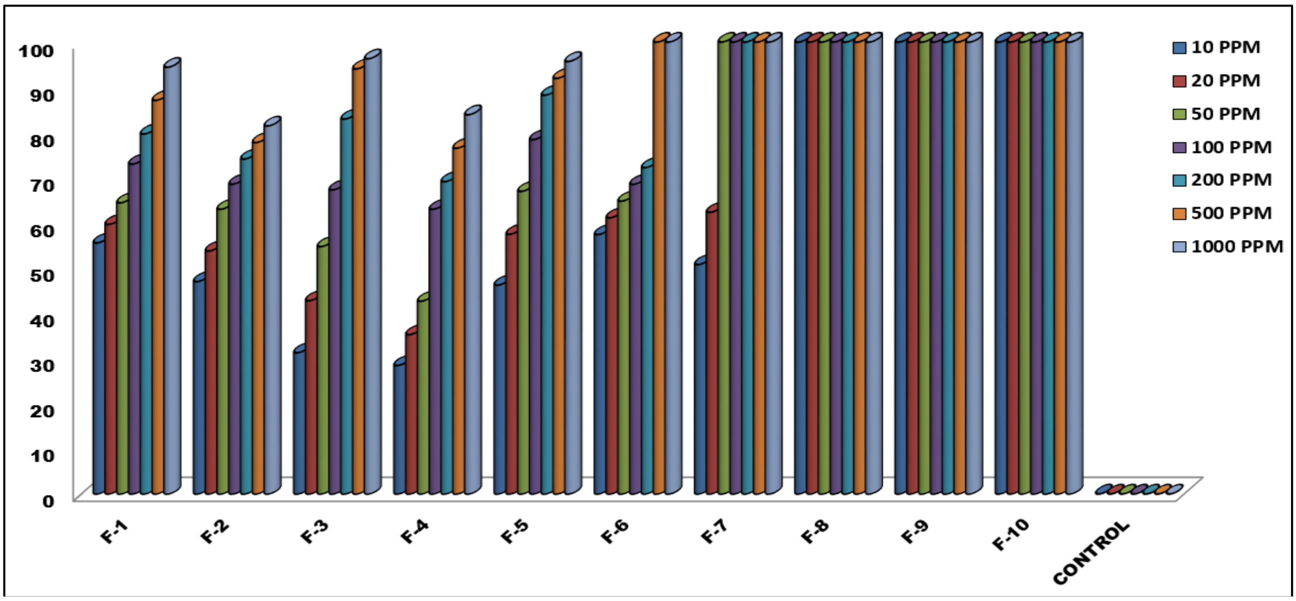

Fig 2: Effect of fungicides on percent inhibition of *Rhizoctonia bataticola* at different PPM

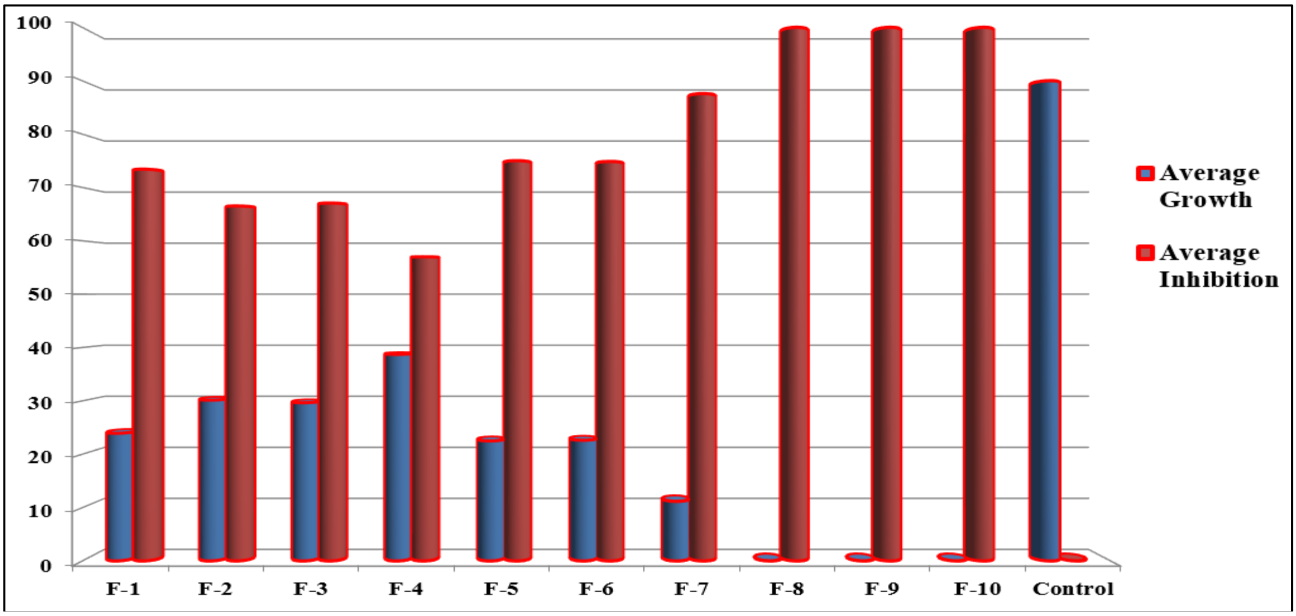

Fig 3: Average growth and average inhibition of fungicides against *Rhizoctonia bataticola*

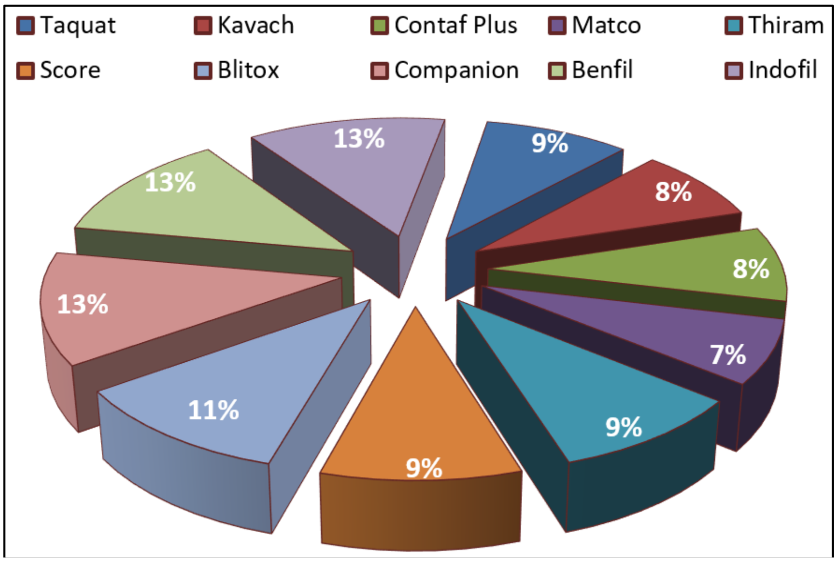

Fig 4: Effect of fungicides on average inhibition of *Rhizoctonia bataticola.*

3. Results and Discussion

3.1 Mycelium growth and Inhibition by *Rhizoctonia bataticola*

On the basis of the fungicidal inhibitory effect on the growth of *R. bataticola*, ten fungicides of various concentrations was tested *in-vitro* against *R. bataticola*. All the fungicides at all concentrations reduced mycelial growth of *R. bataticola* with respect to control. Companion, Benfil and Indofil showed 100 percent inhibition of mycelial growth at all concentrations and superior over other fungicides. Other fungicides like Taquat, Kavach, Contaf Plus, Matco and Thiram do not give 100 percent inhibition even at any ppm. Similar findings were also reported by (Paul *et al.*, 2008) [19] and (Konde *et al.*, 2008) [12] who revealed that carbendazim was most effective fungicide against all the *S. sclerotiorum* and *Rhizoctonia solani*.

3.2 Efficacy of chemical fungicides

In *in-vitro* evaluation of fungicides efficacy of ten fungicides was evaluated. Among these Carbendazim 12% + Mancozeb 63%, Carbendazim 50% WP and Mancozeb 75% WP showed 100 percent inhibition of mycelial growth at all concentrations of 10, 20, 50, 100, 200, 500 and 1000 ppm. So, by these results it is concluded that above mentioned fungicides are highly effective against *Rhizoctonia bataticola* causing dry root rot of chickpea.

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