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INTEGRATION MANAGEMENT OF ALTERNARIA BLIGHT OF PIGEONPEA WITH SOME FUNGICIDES AND ANTAGONISTS IN POT CONDITION

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ABSTRACT
The pot culture studies were found out to be the effect of seed treatment, foliar spray and seed treatment + foliar with six fungicides, two antagonist and their combinations on alternaria blight of pigeonpea. Artificial inoculation of mass culture of *Alternaria tenuissima* was done in the inoculated seed treatment and after foliar spray on the plants sixty DAS to create the desirable level of disease pressure of the pathogen. Among them twenty five seed treatments, combination of Mancozeb with *Trichoderma viride* was found to be most effective in reducing the disease intensity and disease control (6.15 and 71.08%) followed by Mancozeb with *T. harzianum* (6.28 and 70.45%) and Mancozeb (6.35 and 70.14%) alone, respectively. In case of foliar spray of Mancozeb with *T. viride* was found most effective in reducing the disease intensity and disease control (11.92 and 71.29%) followed by combination of Mancozeb with *T. harzianum* (12.11 and 70.82%) and Mancozeb alone (12.25 and 70.48%) treatment, respectively. In case of both seed treatment and foliar spray of Mancozeb with *T. viride* was found most effective in reducing the disease intensity and disease control (11.37 and 72.69%) followed by combination of Mancozeb with *T. harzianum* (11.43 and 72.53%) and Mancozeb (11.49 and 72.40%) alone, respectively. Whereas least effective and maximum disease intensity and disease control were observed *T. harzianum* (33.85 and 18.67%) alone as compared to control.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the important food legume crops and rank second after chickpea in area, production and productivity of the tropics and sub-tropics. India has largest acreage under pigeonpea (3.90 mh) with a total production and productivity of 2.89 mt and 741 kg/ha, respectively (DAC, 2011). The shift of pigeonpea cultivation from the traditional *kharif* season to pre *rabi* September sowing in north Bihar has not only shown an increased production potential of this important pulse crop but have also opened altogether a new possibilities in land use pattern of the rainfed areas of Bihar and adjoining states. Among the several factors responsible for reduction yield and quality deterioration of pigeonpea in India, diseases occupy a vital place. Among the diseases, alternaria blight (*A. tenuissima* (Kunze ex pers.) Wiltshire) was reported for the first time from Varanasi, India by Pavgi and Singh (1971). Later, Kannaiyan and Nene (1977) reported its occurrences from Hyderabad as a disease of minor importance but recently alternaria blight has become one of the serious fungal diseases of pigeonpea, especially in September sown crop. This disease has been reported to cause yield losses up to the tune of 40-50 percent (Kushwaha *et al*., 2010) similarly 20-80 percent (Sharma *et al*., 2012) reduction in yield, in pigeonpea. Fungicide application can minimize disease and thus increase the genetic potential and ultimately yield. However, there are reports of resistances development against fungicides. Therefore, it is necessities to judicial use of fungicides at proper time. Biological control of plant pathogens has been considered as a potential control strategy in recent years and search for potential biological agents has increased. *Trichoderma* is the most commonly used fungal bio control agent and have long been known as effective antagonists against plant pathogenic fungi (Chet *et al*., 1981; Kumar and Mukerji, 1996). Thus the present study was aimed to evaluate combination of fungicides and antagonistic activity of *Trichoderma spp*. under pot conditions and to determine optimal timing of their application for the control of alternaria blight on pigeonpea.

MATERIALS AND METHODS

Three different experiments were carried out for the management of the disease by seed treatment, foliar spray and seed treatment + foliar spray of the fungicides, bio- agents and their treatment combinations which to assess most effective in the bioassay test, using highly susceptible pigeonpea variety (Bahar) in pot experiments under glass house condition, in the Department of Mycology and Plant Pathology, during the years of September 2010-11 and 2011-12 at B.H.U., Varanasi. The seed of cultivar was inoculated by rolling with 10 days old culture of *A. tenuissima* in Petri plates. After inoculation with the pathogen, the inoculated seeds were soaked for 30 minutes in concentration of 2.5 percent of six fungicides (Carbendazim, Chlorothanlonil, Copper oxychloride, Iprodione, Mancozeb and Proximain), two bio-agents (*Trichoderma harzianum,* and *T. viride*) and their combinations. The required amount of fungicides and bio-agents were added to seed in 100 ml erlenmeyer flask and shaken thoroughly to give an uniform coating of respective fungicides before sowing (Agarwal and Sinclair, 1987). The treated seeds were sown in twenty four pots having 30 cm diameter filled with sterilized soil and five seeds per pot were maintained having along with one untreated (control) in a C.R.D. with three replications. The pots were watered as and when required.

In second experiment sowing of pigeonpea cultivar seeds in twenty five pots were done. After attaining the age of sixty days the old plants were inoculated with spore cum mycelial suspension of test pathogen. The suspension was prepared in sterilized distilled water. A desired spore concentration (1.5×10^4 spores/ml) was obtained as viewed under light microscope/ haemocytometer. Plants were inoculated by spraying the spore cum mycelial suspension with the help of an automizer. Similarly control plants were sprayed with only sterilized distilled water for comparison. Before inoculation of the plants relative humidity of about 90 percent maintained by spraying sterilized distilled water on plants and covering with polythene bags for 24 hr. The plants were covered with polyethylene bags and were incubated for 48 hr to ensure successful penetration of the pathogen into the tissue. Spraying six fungicides (conc. 0.25/lit) and two bio-agents (conc.1×10^4 spores/ml) were done forty eight hours after inoculation and repeated at 10 days of interval with two subsequent sprays. Similarly, control plants were sprayed with the sterilized distilled water for comparison. Observations were made regularly for the appearance and development of symptoms.

In third experiment seed treatment + foliar spray was conducted with above follow procedure in seed treatments experiment, cultivar seed inoculated with test pathogen after fungicides, bio-agents and their combination treated. The treated seeds were sown in twenty four pots and one pots have only pathogen inoculated seed as a controls. After attending sixty days olds cultivar plants same procedure adopted in foliar spray were inoculated with test pathogen after fungicides and bio-agents and their combination. Observation of disease intensity was recorded after 10 days of last spray of fungicides and bio-agents based on per cent leaf area covered by disease symptoms (leaf spot) by using table - 1 disease rating key 0-5 scale (Mayee and Datar 1986).

The data on the per cent infection of the disease were also converted into angular values and analyzed statistically**.** Data on percent disease intensity and percent disease control were recorded. Total twenty five treatment combination used in fungicides and bio-agents were denoted as follows *i.e.,* T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, $T_{1X}T_7$, $T_{2X}T_7$, $T_{3X}T_7$, $T_{4X}T_7$, $T_{5X}T_7$, $T_{6X}T_7$, $T_{7X}T_7$, $T_{8X}T_7$, $T_{1X}T_8$, $T_{2X}T_8$, $T_{3X}T_8$, $T_{4X}T_8$, $T_{5X}T_8$, $T_{6X}T_8$, $T_{7X}T_8$, $T_{8X}T_8$ and T_9.

Table -1: Disease intensity recorded using 0-5 scale

Scale	Description	Degree of Resistant
0	No Disease	High resistant
1	0.1-5.0%	Resistant
2	5.1-10%	Moderent resistant
3	10.1-25.0%	Moderent susceptible
4	25.1-50.0%	Susceptible
5	50.1 % and above	High susceptible

Whereas,

Bavistin (Carbendazim) = T_1, Blitox-50 (Copper oxychloride) = T_2, Kavach (Chlorothanlonil) = T_3, Indofil M-45 (Mancozeb) = T_4, Rovral (Iprodione) = T_5, Propineb (Proximain) = T_6, *Trichoderma viride* = T_7, *T. harzianum* = T_8 and Control = T_9

RESULTS AND DISCURSION

1. Effect of seed treatment with fungicides and bio-agents on alternaria blight of pigeonpea

The effect of six fungicides systemic and non-systemic (Mancozeb, Copper oxychloride, Proximain, Iprodione, Chlorothanlonil and Carbendazim), two bio- agents (*Trichoderma harzianum, and T. viride*) and their combinations at their respective doses were tested in pot conditions as seed treatment against the pathogen during the years of 2010-11 and 2011-12.

All the six fungicides, two bio-agents and their combination tested in seed treatment found significantly or partially effective and reduced the disease intensity as compared to control (Table-2 and -3). Amongst them twenty five treatments, combination of Mancozeb with *T. viride* was found most effective in reducing the disease intensity and disease control in two consecutive years (6.15 and 71.08%) followed by Mancozeb with *T. harzianum* (6.28 and 70.45%) and Mancozeb (6.35 and 70.14%) alone, respectively. While, *T. harzianum* alone was least effective and maximum disease intensity disease control (14.30 and 32.76%) recorded as a compared to control followed by *T. harzianum* (13.98 and 34.25%) double dose and *T. harzianum* and *T. viride* (13.92 and 34.56%) combination treatment, respectively. The combination of Mancozeb with *T. viride*, Mancozeb with *T. harzianum* and Mancozeb single were significantly at par in reducing the disease intensity of *A. tenuissima* over control. Our results with chemical is (Carbendazim) in agreement with the similar findings reported by (Pal, 1984; Kumar; Patnaik, 1985) seed infection of *A. tenuissima* to reduced greatly by seed treatment. Ansari *et al*., (1990) reported seed treatment with six fungicides checked and the pre-and post-emergence loss of seedling, to a varying extent against *A. brassicae* infected rapeseed mustard and found Mancozeb was most effective followed by copper oxychloride. Khare and Kumar (2006) reported that Mancozeb and Carbendazim significantly improved seed germination and vigor of pigeonpea seed (cv. Bahar) against the alternaria blight pathogen. Girish *et al*., (2007) found that seed colonization by *A. alternata* and *A. brassicae* infected pigeonpea were significantly inhibited in all the fungicides used namely iprodione and carbendazim treatments as compared to control.

Bora (1977) demonstrated the antagonistic effectiveness of *T. viride* against *A. alternata* on eggplant seedling under *in vitro* and screen house. Kumar *et al*., (2000) reported that seed treatment with *T. viride* controlled seed borne fungal pathogens (*A. alternata*) of pigeonpea. Use of antagonists, particularly *Trichoderma* species has been reported quite effective against different pathogens (Chattopadhyay *et al.,* 2002) particularly as seed treatment followed by fungicidal spray used in managing many fungal diseases (Rohila, *et al.,* 2001).

Table: 2 Effect of seed treatment, foliar spray and seed treatment and foliar spray with systemic and non systemic fungicides and biocontrol agents on the disease intensity of alternaria blight of pigeonpea in pot experiment

Treatment	Dose (%)	Disease intensity								
		Seed treatment			Seed treatment and foliar spray			Foliar spray		
		2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean
T_1	0.2	12.47	12.53	12.50	25.67	25.78	25.73	26.07	26.40	26.23
		(20.67)*	(20.72)	(20.70)	(30.43)*	(30.50)	(30.47)	(30.69)*	(30.91)	(30.80)
T_2	0.2	10.37	10.50	10.43	21.70	21.83	21.77	22.22	22.35	22.29
		(18.77)	(18.90)	(18.84)	(27.75)	(27.85)	(27.80)	(28.11)	(28.20)	(28.16)
T_3	0.2	7.57	7.73	7.65	14.87	15.00	14.93	15.90	16.10	16.00
		(15.96)	(16.14)	(16.05)	(22.67)	(22.77)	(22.72)	(23.49)	(23.63)	(23.57)
T_4	0.2	6.33	6.37	6.35	11.44	11.53	11.49	12.03	12.47	12.25
		(14.58)	(14.61)	(14.59)	(19.76)	(19.84)	(19.80)	(20.29)	(20.65)	(20.47)
T_5	0.2	6.63	6.70	6.67	14.37	14.53	14.45	15.43	15.57	15.50
		(14.92)	(14.99)	(14.96)	(22.26)	(22.40)	(22.33)	(23.12)	(23.22)	(23.17)
T_6	0.2	12.57	12.63	12.60	28.57	28.83	28.70	29.50	29.67	29.58
		(20.75)	(20.81)	(20.78)	(32.30)	(32.46)	(32.38)	(32.88)	(32.99)	(32.94)
T_7	1x10^4	13.47	14.33	13.90	31.85	32.03	31.94	32.93	33.07	33.00
		(21.52)	(22.24)	(21.88)	(34.34)	(34.46)	(34.40)	(35.01)	(35.09)	(35.05)
T_8	1x10^4	13.73	14.87	14.30	33.70	34.00	33.85	34.80	34.97	34.88
		(21.74)	(22.66)	(22.20)	(35.47)	(35.65)	(35.56)	(36.14)	(36.24)	(36.19)
$T_{1x}T_7$	0.2x1x10^4	11.83	11.90	11.87	25.60	25.70	25.65	25.60	25.90	25.75
		(20.11)	(20.17)	(20.14)	(30.38)	(30.45)	(30.42)	(30.38)	(30.58)	(30.48)
$T_{2x}T_7$	0.2x1x10^4	9.40	9.47	9.43	21.33	21.57	21.45	21.20	21.43	21.32
		(17.84)	(17.91)	(17.88)	(27.50)	(27.66)	(27.58)	(27.40)	(27.57)	(27.49)
$T_{3x}T_7$	0.2x1x10^4	7.13	7.17	7.15	14.57	14.73	14.65	14.97	15.27	15.12
		(15.48)	(15.52)	(15.50)	(22.43)	(22.56)	(22.49)	(22.75)	(22.99)	(22.87)
$T_{4x}T_7$	0.2 x 1x10^4	6.13	6.17	6.15	11.32	11.42	11.37	11.87	11.97	11.92
		(14.33)	(14.37)	(14.35)	(19.65)	(19.74)	(19.69)	(20.14)	(20.23)	(20.19)
$T_{5x}T_7$	0.2 x 1x10^4	6.47	6.50	6.48	13.90	14.07	13.98	14.23	14.60	14.42
		(14.73)	(14.76)	(14.74)	(21.88)	(22.01)	(21.95)	(22.16)	(22.45)	(22.30)
$T_{6x}T_7$	0.2 x 1x10^4	12.13	12.17	12.15	27.17	27.40	27.28	27.63	28.10	27.87
		(20.38)	(20.41)	(20.39)	(31.40)	(31.55)	(31.48)	(31.70)	(32.00)	(31.85)
$T_{7x}T_7$	1x10^{4x}1x10^4	13.13	14.07	13.60	31.20	31.37	31.28	31.53	31.67	31.60
		(21.23)	(22.01)	(21.62)	(33.94)	(34.05)	(33.99)	(34.15)	(34.23)	(34.19)
$T_{8x}T_7$	1x10^{4x}1x10^4	13.40	14.43	13.92	32.53	32.68	32.61	32.87	33.07	32.97
		(21.46)	(22.32)	(21.89)	(34.76)	(34.85)	(34.81)	(34.97)	(35.09)	(35.03)
$T_{1x}T_8$	0.2x1x10^4	12.27	12.33	12.30	25.61	25.73	25.67	25.90	26.23	26.07
		(20.49)	(20.55)	(20.52)	(30.39)	(30.47)	(30.43)	(30.58)	(30.80)	(30.69)
$T_{2x}T_8$	0.2x1x10^4	10.17	10.30	10.23	21.47	21.63	21.55	21.93	22.11	22.02
		(18.59)	(18.71)	(18.65)	(27.59)	(27.71)	(27.65)	(27.91)	(28.04)	(27.97)
$T_{3x}T_8$	0.2x1x10^4	7.47	7.50	7.48	14.73	14.83	14.78	15.37	15.73	15.55
		(15.85)	(15.89)	(15.87)	(22.56)	(22.64)	(22.60)	(23.07)	(23.36)	(23.21)
$T_{4x}T_8$	0.2x1x10^4	6.23	6.33	6.28	11.40	11.47	11.43	11.97	12.25	12.11
		(14.45)	(14.57)	(14.51)	(19.73)	(19.79)	(19.76)	(20.23)	(20.48)	(20.35)
$T_{5x}T_8$	0.2x1x10^4	6.53	6.60	6.57	14.17	14.36	14.27	14.70	15.33	15.02
		(14.80)	(14.88)	(14.84)	(22.10)	(22.25)	(22.17)	(22.54)	(23.04)	(22.79)
$T_{6x}T_8$	0.2 x 1x10^4	12.43	12.47	12.45	27.50	27.78	27.64	27.90	28.50	28.20
		(20.64)	(20.67)	(20.65)	(31.62)	(31.80)	(31.71)	(31.87)	(32.25)	(32.06)
$T_{7x}T_8$	1x10^4 x 1x10^4	13.37	14.23	13.80	31.50	31.71	31.62	31.50	31.87	31.68
		(21.42)	(22.15)	(21.79)	(34.13)	(34.26)	(34.19)	(34.13)	(34.35)	(34.24)
$T_{8x}T_8$	1x10^4 x 1x10^4	13.43	14.53	13.98	32.60	33.47	33.03	33.40	34.17	33.78
		(21.49)	(22.40)	(21.94)	(34.80)	(35.73)	(35.07)	(35.29)	(35.75)	(35.52)
T_9		21.20	21.27	21.23	41.47	41.77	41.62	41.47	41.53	41.50
		(27.40)	(27.45)	(27.43)	(40.07)	(40.25)	(40.16)	(40.07)	(40.11)	(40.09)
Mean		10.64	10.93		23.21	23.41		23.72	24.01	
		(18.78)	(19.03)		(28.40)	(28.53)		(28.76)	(28.97)	
Factors		C.D.	SEm ±		C.D.	SEm ±		C.D.	SEm ±	
Fungicides and bio-agents		0.44	0.16		0.38	0.14		0.49	0.18	
Year		0.12	0.04		0.11	0.04		0.14	0.05	
Fungicides and bio-agents × Year		0.64	0.22		0.45	0.19		0.77	0.25	

* Average of three replications. Figures in parenthesis are arc sin transformation and others are original values.
Where as:
T_1 = Bavistin (carbendazim), T_2 = Blitox-50 (copper oxychloride), T_3 = Kavach (chlorothanlonil), T_4 = Indofil M-45 (mancozeb), T_5 = Rovral -50 (iprodione), T_6 = Propineb (proximain), T_7 = *Trichoderma viride,* T_8 = *Trichoderma harzianum,* T_9 = Control

Table: 3 Effect of seed treatment, foliar spray and seed treatment and foliar spray with systemic and non systemic fungicides and biocontrol agents on the disease control of alternaria blight of pigeonpea in pot experiment

Treatment	Dose (%)	Percent Disease control								
		Seed treatment			Seed treatment and foliar spray			Foliar spray		
		2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean
T_1	0.2	41.19	41.24	41.22	38.11	38.27	38.19	37.14	36.43	36.79
T_2	0.2	51.10	50.77	50.94	47.67	47.73	47.70	46.41	46.18	46.30
T_3	0.2	64.31	63.74	64.03	64.15	64.09	64.12	61.66	61.23	61.45
T_4	0.2	70.13	70.15	70.14	72.41	72.39	72.40	70.98	69.98	70.48
T_5	0.2	68.71	68.59	68.65	65.36	65.21	65.28	62.78	62.52	62.65
T_6	0.2	40.72	40.77	40.75	31.10	30.97	31.03	28.86	28.57	28.71
T_7	$1x10^4$	36.48	32.80	34.64	23.20	23.31	23.25	20.59	20.38	20.48
T_8	$1x10^4$	35.32	30.30	32.76	18.74	18.60	18.67	16.08	15.80	15.94
T_{1x} T_7	$0.2x1x10^4$	44.18	44.21	44.20	38.27	38.47	38.37	38.27	37.64	37.95
T_{2x} T_7	$0.2x1x10^4$	55.66	55.62	55.64	48.56	48.37	48.46	48.88	48.39	48.63
T_{3x} T_7	$0.2x1x10^4$	66.35	66.40	66.38	64.87	64.73	64.80	63.91	63.24	63.57
T_{4x} T_7	$0.2x1x10^4$	71.07	71.09	71.08	72.71	72.67	72.69	71.38	71.19	71.29
$T_{5\ x}$ T_7	$0.2x1x10^4$	69.50	69.53	69.51	66.48	66.32	66.40	65.68	64.84	65.26
$T_{6\ x}$ T_7	$0.2x1x10^4$	42.77	42.96	42.86	34.49	34.40	34.45	33.37	32.34	32.85
T_{7x} T_7	$1x10^4x1x10^4$	38.05	34.05	36.05	24.76	24.91	24.84	23.96	23.75	23.86
T_{8x} T_7	$1x10^4x1x10^4$	36.79	33.33	34.56	21.55	21.76	21.66	20.75	20.38	20.56
T_{1x} T_8	$0.2x1x10^4$	42.14	42.18	42.16	38.24	38.39	38.31	37.55	36.83	37.19
T_{2x} T_8	$0.2x1x10^4$	52.04	51.71	51.88	48.24	48.21	48.22	47.13	46.76	46.94
T_{3x} T_8	$0.2x1x10^4$	64.78	64.84	64.81	64.47	64.49	64.48	62.95	62.12	62.53
T_{4x} T_8	$0.2x1x10^4$	70.60	70.31	70.45	72.51	72.55	72.53	71.14	70.50	70.82
T_{5x} T_8	$0.2x1x10^4$	69.18	69.06	69.12	65.84	65.61	65.73	64.55	63.08	63.82
T_{6x} T_8	$0.2x1x10^4$	41.35	41.55	41.45	33.69	33.48	33.59	32.72	31.37	32.05
T_{7x} T_8	$1x10^4x1x10^4$	36.95	33.27	35.11	24.04	24.08	24.06	24.04	23.27	23.65
T_{8x} T_8	$1x10^4x1x10^4$	36.64	31.86	34.25	21.39	19.88	20.63	19.46	17.73	18.60
T_9	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* Average of three replications. Figures in parenthesis are arc sin transformation and others are original values.
Where as:
T_1 = Bavistin (carbendazim), T_2 = Blitox-50 (copper oxychloride), T_3 = Kavach (chlorothanlonil), T_4 = Indofil M-45 (mancozeb),
T_5 = Rovral -50 (iprodione), T_6 = Propineb (proximain), T_7 = *Trichoderma viride,* T_8 = *Trichoderma harzianum,* T_9 = Control

2. Effect of foliar spray with fungicides and bio-agents on alternaria blight of pigeonpea

Effect of six fungicides systemic and non-systemic, two bio-agents and their combinations at their respective doses were tested as foliar spray against pathogen during aforesaid two years.

In the present investigation of all the fungicides, bio-agents and their treatment combination tested as foliar sprays were significantly or partially reduced the disease intensity as compared to control (Table-2 and -3). Out of twenty five treatments, combination of Mancozeb with *T. viride* was found most effective in reducing the disease intensity and disease control for two consecutive years (11.92 and 71.29%) followed by Mancozeb with *T. harzianum* (12.11 and 70.82%) and Mancozeb (12.25 and 70.48%) alone treatments, respectively. Whereas, least effective and maximum disease intensity and disease control were observed in *T. harzianum* (34.88 and 15.94%) at a single dose followed by *T. harzianum* (33.78 and 18.60%) at a double doses and combination of *T. harzianum* with *T. viride* (32.97 and 20.56%) treatments, respectively as a compared to control. A combination of Mancozeb with *T. viride*, Mancozeb with *T. harzianum* and Mancozeb alone were significantly at par with each other in reducing the disease intensity over control. Our results with fungicides (iprodione, mancozeb, copper oxychloride, chlorothanlonil and carbendazim) is in conformity with similar findings of Lal *et al*., (2000), Kushwaha and Narain (2001) and Kushwaha *et al*., (2010) tested in pigeonpea infected by *A. tenuissima* in order to minimize the losses by spraying aforesaid fungicides. Khan *et al*., (2007) reported that systemic fungicides carbendazim alone and in combination with non-systemic fungicide Mancozeb were evaluated *in vivo* for their effectiveness to manage alternaria blight of rapeseed mustard (*A. brassicae*) and found that Ridomil reduced disease severity and was followed in effectiveness by the combination of carbendazim +Captaf. Alternaria blight disease severity was controlled when Mancozeb was applied and highest reduction in the disease was achieved (Gondal *et al*., (2012); Bhuiyanet *et al*., (2007)), it was also observed that the performance of non systemic fungicides was better in controlling the disease in comparison to systemic fungicides.

Our similar findings in bio control agents with Kumar *et al*., (2000) who found that leaf spot infection of pigeonpea effectively controlled by antagonist *T. viride*. Lal and Upadhyay (2002) evaluated of *T. viride* and *T. harzianum* were against *A. tenuissima* (in pre-rabi pigeonpea) under field, sprays of *T. viride* gave effective control. Kumar et *al*., (2005) tested efficacy of antagonists against alternaria leaf spot of *Vicia faba* under field conditions, the bio agents provided protection to the crop, being maximum in *T. viride* and minimum in *T. harzianum* treatment, respectively. Mishra (2011) evaluated effect of *T. viride* for the control of alternaria leaf spot in pigeonpea and found that foliar application of *T. viride* resulted in minimum disease intensity and highest plant growth. Reshu and Khan (2012) tested bio control agents against *A. brassicae* in mustard in field and found that *T. viride* proved to be most effective in the reduction of disease intensity on leaves and pods, respectively.

3. Effect of seed treatment and foliar spray with fungicides and bio-agents on alternaria blight of pigeonpea

Effect of six fungicides systemic and non-systemic, two bio-agents and their treatment combination seed treatment and foliar spray at their respective doses were tested against the pathogen during aforesaid for two consecutive years.

All the six fungicides and two bio-agents and their treatment combinations were tested seed treatment + foliar spray significantly or partially effective in reducing the disease intensity and disease control as compared to control (Table-2 and-3). Out of twenty five treatments, combination of Mancozeb with *T. viride* treatment was found most effective in reducing the disease intensity and disease control in two consecutive years (11.37 and 72.69%) followed by Mancozeb with *T. harzianum* (11.43 and 72.53%) and Mancozeb (11.49 and 72.40%) single treatment, respectively. While, least effective and maximum disease intensity and disease control were observed of *T. harzianum* (33.85 and 18.67%) single doses followed by *T. harzianum* (33.03 and 20.63%) double doses and *T. harzianum* and *T. viride* in combination (32.61 and 21.66%) treatments, respectively as compared to control. A combination of Mancozeb with *T. viride*, Mancozeb with *T. harzianum* and Mancozeb alone were significantly at par with each other in reducing the disease intensity of test pathogen over control. In our results with chemical fungicides Mancozeb and Copper oxychloride completely inhibited the growth of the pathogen. Mancozeb as foliar spray was most effective for controlling the blight conformity the findings of Ansari *et al.,* (1990) who tested fungicides for their effects on growth of *A. brassicae* and for ascertaining their fungicidal and fungistatic natures in artificial cultures. They further demonstrated that efficacy as seed treatment and foliar application fungicides in the management of blight of rapeseed. Also similar results were found when Amaresh and Nargund (2002) tested efficacy of Mancozeb, Chlorothanlonil, Copper oxychloride, Iprodione and Carbendazim on sunflower and maximum percent disease intensity of leaf blight was observed in untreated control while, Chlorothanlonil treatment found to have lowest percent disease intensity. Rathi and Singh (2010) tested efficacy of different bio-agents and fungicides with different combinations as seed treatment with *T. harzianum* seed followed by foliar spray of Ridomil and Carbendazim and deduced that significant reduction was achieve in the alternaria leaf blight affected mustard. Karthikeyan *et al.,* (2008) tested fungicide alone and in combination of different antagonistic microorganisms against onion blight disease (*A. palandui*) in bulb (seed) treatment and bulb treatment + foliar spray and found Mancozeb was most effective followed by *T. viride* for control of disease.

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