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Comparative efficacy of bio-agents and fungicides in the management of Alternaria blight of chickpea (*Cicer arietinum* L.)

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Abstract
Efficacy of bio-agents and fungicides namely *Trichoderma viride*, *Pseudomonas fluorescens*, Chlorothalonil, Aazoxystrobin, Mancozeb and Thiabendazole was evaluated against Alternaria blight of chickpea under field condition. In field condition bio-agents and fungicides were used as seed treatment. *Trichoderma viride* @ 5g/litre as seed treatment (ST), *Pseudomonas fluorescens* @ 5g/kg as seed treatment (ST), Thiabendazole @ 2g/kg as seed treatment, Mancozeb 3g/kg as seed treatment, Chlorothalonil 2g/kg as seed treatment and Aazoxystrobin 5g/kg as seed treatment. Mancozeb 3g/kg as seed treatment was found effective with less disease severity of 23.09%. The effect of different antagonist' viz. *Trichoderma viride* and *Pseudomonas fluorescens* were evaluated against different Alternaria blight of chickpea by dual culture technique. Among Bio-agents *Trichoderma viride* (49.08%) followed by *Pseudomonas fluorescens* (41.84%) over control were found effective in controlling the Alternaria blight. Among the fungicides, Mancozeb was highly effective in inhibiting the growth of *Alternaria alternata* as it produced 55.27% growth inhibition at 5% concentrations. All bio-agents and fungicides were found effective in reducing the disease severity.

Keywords: Alternaria blight, bio-agents, fungicides, seed treatment, *Alternaria alternata* and chickpea

Introduction
Alternaria alternata is an important seed borne disease of chickpea. Alternaria blight of chickpea was first noticed in 1970-72 from Utter Pradesh by (Vishwakarma and Basuchaudhary (1984). Thereafter, it was also reported by (Haware and Nene (1976) from Andhara Pradesh the disease appears at seedling, flowering and podding time. It first appeares on older leaves. The circular, water soaked small spots appears on leaves which later turned brown to dark brown. The affected leaf-lets turned black and dropped off. On the pods, the lesions are circular, slightly sunken and irregularly scattered and were dark brown to black in colour. The infected pods remain small, get shriveled and turn black. In severe case entire foliage shows blightened appearance. Alternaria sp not only causes diseases on chickpea but also cause on other crops viz., (Tomato, rapeseed, mustard, potato and niger) reportrd by Raut *et al.*, (2014) [11] on tomato, Singh., *et al.* (2014) [12] on 2014 Effective bio-control and fungicides methods for the management of plant diseases. Among various fungal, bacterial bio-control agents are known for their mycoparasitic, antagonistic and antifungal mechanism for the control of fungal disease. The present study was undertaken to evaluate the efficacy of bio-agents and fungicides as seed treatment.

Materials and methods
The field experiment was conducted in randomized block design (RBD) with plot size 2×2m^2 and there were three replication for each treatment. The experiment was conducted on variety K-850 during *rabi* season 2015 and 2016. Treatment was *T. viride @ 5g/kg* seed treatment, *Pseudomonas fluorescens* @ 5g/kg seed treatment, Thiabendazole @ 2g/kg as seed treatment, Mancozeb @ 3g/kg as seed treatment, Chlorothalonil @ 2g/kg as seed treatment and Aazoxystrobin @ 5g/kg as seed treatment. *Trichoderma viride* @ 5g/kg as seed treatment was found effective with less disease severity. The per cent disease intensity was assessed as no. of leaves and pods infected / 5 plants randomly. Per cent disease intensity was recorded on leaves at 15 days interval following 0-9 disease rating scale (Singh, 2004), where, 0= no visible symptoms, 1= 1 %, 3 = 2-10 %, 5 = 11-25 %, 7 = 26-50 % and 9 = > 51 % leaf area infected. Per cent disease intensity was calculated as Mc Kinney's (1923) formula. The formula used was as follows:

Disease intensity (%) was calculated by the following formula:

$$\text{Disease severity \%} = \frac{\text{Sum of all rating}}{\text{Maximum rating} \times \text{number of sample leaves}} \times 100$$

DS was estimated according to the disease index established by 0 to 9 scales.

Results and discussion

Disease severity

The result (Table 1) show that the highest Alternaria blight disease severity (42.26%) was recorded In control treatment T_0 which was statistically superior to all other treatments and Alternaria blight severity (23.63%) was recorded in treatment T_4 where Mancozeb @ 3g/kg (ST), followed by Chlorothalonil @ 2g/kg (27.43%), *T viride* (28.89%) as seed treatment, Aazoxystrobin @ 5g/kg (30.71%), *P fluoresces* (34.16%) as seed treatment, Thiabendazole @ 2g/kg as seed treatment, (36.73)**.**

Effect of seed treatments with Bio agents and fungicides on plant height (cm) of chickpea

The result (Table 1) show that among all the treatments the maximum plant height was recorded in *Trichoderma viride* (48.78cm-T_2), followed by Mancozeb (45.10cm-T_4), and Azoxystrobin (45.03cm-T_6), Thiabendazol (42.98cm-T_3), *Pseudomonas fluoresences* (42.35cm-T_1), Chlorothalonil (41.96cm-T_5), Control (41.37cm-T_0), while it was lowest in Control (41.37cm-T_0), Among the treatment (T_0,T_5,T_1,T_3) (T_5,T_1,T_3),(T_1,T_3) (T_3,T_6,T_4) and (T_4,T_2) are non significant to each.

In the present study, the maximum plant height was recorded in *Trichoderma viride.* The probable reason for such finding may be due to its Antagonistic property, which resulted in the inhibition of disease producing activity of pathogen in the plant and induced resistance in plant. This resulted in better overall growth and good health of chickpea plants. This may be the reason for maximum plant height as compared to other treatments.

Effect of seed treatments with Bio agents and fungicides on no of branches of chickpea at different intervals

The result (Table 1) show that pertaining to mean number of branches was highest in *Trichoderma viride* (4.6-T_6), followed by Azoxystrobin (4.30-T_3), Mancozeb (3.77-T_5), Thiabendazole (3.67-T_1), *Pseudomonas florescence* (3.40-T_2), Chlorothalonil (3.33-T_6), Control (3.10-T_0).

All the treatments were statistically significant over control and among the treatments but there is significant increase in number of branches in treatments over control.

However, treatment with *Trichoderma viride* was superior among all the treatments in increase in number of branches and least significant was with Chlorothalonil.

Effect of different Seed treatments on chickpea yield (t/h)

The result (Table 1) show that the maximum yield (q/h) were recorded in Chlorothalonil (28.163-T_4), followed by Thiabendazole. (27.496-T_3), Mancozeb (27.383-T_5), *Pseudomonas fluoresces* (27.320-T_1), *Trichoderma viride* (26.663-T_2), Azoxystrobin (24.163-T_6), and least was appeared in (Control (21.400 -T_0). 14.3cm) and yield were found statistically significant over other treatments including control.

Evaluation of Fungicides and Bio-agents Against *Alternaria alternata. In vitro* Causing Alternaria Blight of Chickpea (*Cicer arietinum* L.)

Efficacy of fungicides against *Alternaria alternata* by poison food Technique

The result (Table 2) show that among the fungicides tested, Mancozeb was highly effective in inhibiting the growth of *Alternaria alternata* as its produced (55.27%) growth inhibition of *Alternaria alternata* at 5% concentrations. T_5 Chlorothalonil, T_6 – Azoxystrobin and T_3 – Thiabendazole were effective to some extent as they produced growth inhibition (51.54%), (42.23%) and (37.33%) respectively depending upon the concentration of the fungicides. Thiabendazole was least effective. All the treatments differed significantly from check as well as from each other's and were statistically on par to each other's as far as disease intensity was concerned.

Efficacy of Bio Agent against *Alternaria alternata* by Dual Culture Technique.

The maximum growth inhibition of *Alternaria alternata* of chickpea were observed in *Trichoderma viride* (49.80%) followed by *Pseudomonas fluorescens* (41.84) over control. Significant suppression of radial mycelial growth of *Alternaria alternata* by *Trichoderma viride*, in dual culture method reported by Mandhare *et al.* (2008) [5]. *T. viride* maximum inhibition % against Alternaria blight of chickpea (*Alternaria alternata*) found in lab condition.

From the results it can be concluded that for the efficacy of fungal, bacterial and fungicides against *Alternaria alternata* of chickpea showed that the reducing the mycelial growth of pathogen *in vitro* experiment.

Table 1: Effect of seed treatments with Bio agents and fungicides on disease intensity, plant height, no of branches, yield and cost benefit ratio of Alternaria blight of chickpea at different intervals.

Treatments	Disease intensity (%)			Plant Height (cm)			Number of branches			Yield(t/ha)	C:B ratio
	65DAS	75DAS	85DAS	45DAS	60DAS	75DAS	45DAS	60DAS	75DAS		
T0 control	37.29	42.19	47.32	20.05	30.67	41.37	2.13	2.67	3.13	21.40	----------
T1 *P. fluorescens* (ST)	26.99	29.31	34.16	22.29	32.07	42.35	2.07	3.50	3.40	27.32	1:5.12
T2 *T. viride* (ST)	25.68	26.86	28.89	24.08	38.42	48.78	2.53	3.73	4.30	26.66	1:4.98
T3 Thiabendazole. (ST)	27.98	30.12	36.73	23.59	33.92	42.98	2.87	3.40	3.67	27.38	1:4.89
T4 Mancozeb (ST)	22.05	23.61	25.63	22.39	33.64	45.10	2.30	3.33	3.77	27.49	1:4.96
T5 Chlorothalonil ST)	24.78	26.62	27.43	22.44	35.77	41.96	2.13	3.20	3.33	28.16	1:4.57
T6 Azoxystrobin (ST)	25.98	27.22	30.71	25.30	33.76	45.03	3.07	4.23	4.06	24.16	1:4.22
C.D (0.05)	1.90	1.36	1.93	1.96	2.79	2.63	0.52	0.45	0.41	0.75	

Table 2: Efficacy of bio-agents and fungicides against radial growth and percent inhibition of *Alternaria alternata* of chickpea.

Treatments	Percent Inhibition
T0 control	-
T1 *Pseudomonas fluorescens*	41.84
T2 *T. viride*	49.08
T3 Thiabendazole	37.33
T4 Mancozeb	55.27
T5 Chlorothalonil	51.54
T6 Azoxystrobin	42.23
C.D (0.05)	4.51

From the results it can be concluded that integrated effect of bio-agents and fungicides against alternaria blight disease of chickpea showed that the reducing the disease intensity percentage in leaves and maximum yield.

Trichoderma viride is known for its mycoparasitic and antagonistic mechanism for the control of fungal disease. *Pseudomonas fluorescens* is well known for bio-control, plant growth promotion, and recognized as an important plant growth promoting rhizobacteria (PGPR) throughout the world. Even though more research is needed to understand the antagonist mechanism, improvement of strains and development of supplementary products of biocontrol agent for restrain of pathogens. Thus, it is noticeable that a microbial bio-control agent is harmless to the animals and human beings, cheaper than chemicals and comparatively effective.

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