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Management of alternaria blight of sunflower caused by *Alternaria helianthi*

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Abstract
The present investigation was field experiment conducted during *kharif* 2016 on the field of Oilseeds research unit Dr. Panjabrao Deshmukh Krishi Vidyapith, Akola in Randomized Block Design with Morden, a highly susceptible variety to *Alternaria* leaf blight. The results obtained under *in vitro* efficacy of four fungicides against *Alternaria helianthi* revealed that the maximum inhibition of the test pathogen recorded in propiconazole @ 0.1% (91.66%) this was followed by carbendazim @ 0.2% (88.26%). The results of *in vitro* evaluation of three fungal and one bacterial bio-agents against *Alternaria helianthi*, among them *Trichoderma viride* mutant M_1 was found most effective which recorded maximum growth inhibition (81.64%) of the test pathogen over control (00.00%). This was followed by *Trichoderma viride* mutant M_2 (76.18%), *T. viride* mother culture (67.2%) and *P. fluorescens* (59.44%). Highest seed yield (1227 kg/h) was also recorded in treatment T_3 (seed treatment with carbendazim 75 WP @ 2 g/kg seeds + spray of propiconazole 25 EC @) 0.1% as soon as disease appears and 15 days later) with 48.61% increase the seed yield over control. This was followed by treatment T_1 (seed treatment with *Trichoderma viride* @ 4 g/kg seed + spray of propiconazole 25 EC @ 0.1% as soon as disease appears and 15 days later) i.e. 1154 kg/h seed yield with 45.37% increase seed yield over control.

Keywords: alternaria blight, sunflower caused, *Alternaria helianthi*

Introduction
Sunflower is major oil seed crop in India next to soyabean and groundnut at the global level. (Shilpa, 2015) [17]. This crop was introduced into India's vegetable scenario around 1969 and made a significant dent on the country's vegetable oil front. The crop became popular in India due to its adoptability and high yield potential (Indumathi, 2011) [12]. India is the largest grower of sunflower with an area of 0.90 million hectares, production of 0.62 million tones and the average productivity of 696 kg/ha. Important sunflower growing states in the country are Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Bihar, Punjab, Haryana and Uttar Pradesh. Almost 50 % of area and production is accounted for by Karnataka followed by Andhra Pradesh and Maharashtra. In Maharashtra sunflower is cultivated on an area of 0.20 million hectares, and production of 0.11 million tonnes with an average productivity of 677 kg/h (Anonymous, 2011) [3]. In vidarbha region sunflower is cultivated on an area of 0.084 lakh hectares, production of 0.027 lakh tones and the average productivity of 322 kg/h. (Annual progress report 2014-15, AICRP on sunflower). Sunflower seeds are highly nutritious containing about 20 % protein and 40 to 50% vegetable oil associated with high calorific value. The oil is considered to be of high quality due to its non-cholesterol properties and has been recommended for the patient having heart problem. It contains 60-73% linoleic acid with sufficient amount of calcium, iron and vitamins like A, B, E and K (Gosal *et al*., 1988) [9]. Sunflower seed is source of high quality oil (45-52%) have higher content of polyunsaturated fatty acid. It also contains good quality protein (19 to 25%) in seeds. Despite its several merits, the crop is still subjected to the uncertainties because of rainfall fluctuations and plant protection problems.

Sunflower suffers from many diseases caused by fungi, bacteria, and viruses. Sunflower is the known host of more than 30 pathogens mostly fungi which under certain climatic condition may impair the normal physiology of the plant, so that yield and oil quality are reduced significantly (Gulya *et al*., 1994) [10].

Among them Alternaria leaf blight caused by *Alternaria helianthi* (Hansf.) Tubaki and Nishahara has been considered as a potential and destructive disease in India and other countries like Yugoslovia, Australia, Tanzania, Uganda and North Africa

(Balasubrahmanyam and Kolte, 1980; Zimmer and Hose, 1978) [4, 21] and is devastating under humid tropical conditions (Hiremath *et al*., 1990) [11]. The pathogen was first described as *Helminthosporium helianthi* (Hans f.) by Hansford (1943) as the cause of blackish brown zonate spot on leaves of sunflower in Uganda. Later Wallace and Wallace (1950) reported its severe outbreak on sunflower in Tanaganyika. Tubaki and Nishihara (1969) detected the pathogen in Japan and renamed it *Alternaria helianthi* because of presence of longitudinal septa in the conidia and progenous conidial development, this name is currently accepted. Sunflower is most susceptible to *A. helianthi* during anthesis and seed filling stage of growth. However, *A. helianthi* can cause seedling blight, which reduces crop stand and can infect both leaves and stems of 10–32 days old plants. The disease symptoms appear more frequently on older leaves than on young and expanding ones (Ahila devi 2014) [2].

Alternaria leaf blights are considered as a major disease and can cause yield losses from 15 to 90 % (Berglund, 2007) [5]. The disease can cause severe leaf spots, stem spots and blight resulting in premature defoliation and stem breakage. It can also infect other parts such as capitulum, disc and ray florets. It is more serious in India and yield losses go up to 80% (Agrawal *et al.,* 1979) [1]. The Alternaria blight is both internally and externally seed borne disease. The economic value of sunflower seeds is greatly influenced by the associated seed borne fungi which may reduce oil quality due to increase of free fatty acids amount in seeds during storage (McGee and Christensen 1970, Singh and Prasad, 1977). Sunflower is a crop of high commercial value but its yield is affected by several factor including diseases. Alternaria leaf blight is major disease of sunflower. For controlling this disease, current study undertaken and tested the fungicides and bio-agents for effective management of Alternaria leaf blight of sunflower and improving the quality and quantity of the seed yield.

Material and Methods

The present field experiment was conducted in RBD with twelve treatments during *kharif* 2016 to evaluate the efficacy of fungicides and bio-agents against Alternaria blight of sunflower. The mother culture of *Trichoderma viride* and carrier based formulation of *Pseudomonas fluorescens* were obtained from department of plant pathology Dr. P.D.K.V., Akola. The mutants of *Trichoderma viride* (*Tv* M1 and *Tv* M2) were obtained through mutation induced by Gamma Radiation. Induction of mutation by gamma radiation was carried according to the procedure of Gadgil *et al*. (1995), Migheli *et al*. (1998) and Rey *et al*. (2000) at Bhabha Atomic Research Centre, Mumbai. The 10 days old sporulated culture of *Trichoderma viride* was irradiated with Cobalt – 60 gamma radiation @41.6 gray/min. The applied doses level were 25 k-rad, 50 k-rad and 75 k-rad with time interval of 15,30,45 min. After irradiated culture were transfers on fresh PDA medium and grown up to six generations to check the stability of *Trichoderma* mutants. The treatments detail are as below.

Treatments detail

T_1 Seed treatment with *T. viride* @4g/kg seed + spray of Propiconazole 25EC @ 0.1% as soon as disease appears and 15 days later.

T_2 Seed treatment with *P. fluorescens* @4g/kg seed + spray of Propiconazole 25EC @ 0.1% as soon as disease appears and 15 days later.

T_3 Seed treatment with Carbendanzim 75WP @2g/kg seed + spray of Propiconazole 25EC @ 0.1% as soon as disease appears and 15 days later.

T_4 Seed treatment with *T. viride* @4g/kg seed + spray of Azoxystrobin 25SC @0.05% as soon as disease appears and 15 days later.

T_5 Seed treatment with *P. fluorescens* @4g/kg seed + spray of Azoxystrobin 25SC @0.05% as soon as disease appears and 15 days later.

T_6 Seed treatment with Carbendanzim 75WP @2g/kg seed + spray of Azoxystrobin 25SC @0.05% as soon as disease appears and 15 days later.

T_7 Seed treatment with Metalaxyl 35 SD @6g/kg seed + spray of Azoxystrobin 25SC @0.05% as soon as disease appears and 15 days later.

T_8 Seed treatment with *T. viride* @4g/kg seed + spray of *T. viride* @0.5% as soon as disease appears and 15 days later.

T_9 Seed treatment with *P. fluorescens* @4g/kg seed + spray of *P. fluorescens* @4gm/l as soon as disease appears and 15 days later.

T_{10} Seed treatment with *T. viride* Mutant (M_1) @4g/kg + spray of *T. viride* Mutant (M_1) @0.5% as soon as disease appears and 15 days later.

T_{11} Seed treatment with *T. viride* Mutant (M_2) @4g/kg + spray of *T. viride* Mutant (M_2) @0.5% as soon as disease appears and 15 days later.

T_{12} Control (Without treatment)

The seeds of sunflower variety Morden susceptible to Alternaria blight were sown (29.07.2016) in the field of oilseeds research unit Dr. P.D.K.V., Akola. The observations on seed germination, days to initiate disease, per cent disease incidence and intensity were recorded at 15 days interval after germination.

Percent disease incidence was calculated from the number of infected plant against the total number of plants observed at the time of observation by using following formula.

$$\text{Per cent disease incidence (PDI)} = \frac{\text{No. of diseased plants}}{\text{Total number of plant examined}} \times 100$$

Per cent disease intensity

To record disease intensity 0-9 rating scale developed by Mayee and Datar (1986) [13] was used. Two leaves located at the bottom, two middle and two top of the plant were chosen for the observations and scored as per scale.

Grade	Reaction	Description
0	Immune	No infection
1	Highly resistant	1 or less than 1% leaf area damage
3	Resistant	1 to 10% leaf area damage
5	Moderately resistant	11 to 25% leaf area damage
7	Susceptible	26 to 50% leaf area damage
9	Highly susceptible	50 or more than 50% leaf area damage

The average intensity of each plot was worked out by using formula

$$\text{Percent Disease Intensity (PDI)} = \frac{\sum \text{of all numerical ratings}}{\text{Total number of leaves examined x ratings maximum}} \times 100$$

Percent reduction in disease over control

Percent reduction in disease over control was calculated by using formula.

$$\text{Per cent reduction in disease over control} = \frac{C - T}{C} \times 100$$

Where,

C = Disease intensity in control.

T = Disease intensity in treatment

Results and Discussion

Data presented in table 1 revealed that seed treatment of fungicides and bio-agents helps to increase seed germination and also delayed the initiation of Alternaria blight of sunflower. All the treatments significantly increase the seed germination. The highest germination (93.68%) was recorded in treatment T_3 (Seed treatment with carbendazim @ 2 g/kg seed). The next best treatment was T_4 (Seed treatment with apron @ 6 g/kg seed) 92.09% followed by treatment T_5 (Seed treatment with *T. viride* M_1 @ 4 g/kg seed) and T_6 (Seed treatment with *T. viride* M_2 @ 4 g/kg seed) i.e. (91.14%) and (90.17%) respectively. The lowest seed germination (79.71 %) was recorded in treatment T_7 (Control).

Table 1: Effect of seed treatment on seed germination and days to initiate disease

T. No.	Treatments	Germination (%)	Days to initiate disease
T_1	*T. viride* @ 4 g/kg seed	88.62 (9.46)*	25
T_2	*P. fluorescens* @ 4 g/kg seed	87.33 (9.39)	23
T_3	Carbendazim @ 2 g/kg seed	93.68 (9.73)	28
T_4	Metalaxyl @ 6 g/kg seed	92.09 (9.64)	27
T_5	*T. viride* M_1 @ 4 g/kg seed	91.14 (9.59)	26
T_6	*T. viride* M_2 @ 4 g/kg seed	90.17 (9.59)	24
T_7	Control	79.71 (8.98)	22
	'F' test	Sig.	
	S.E. (m) ±	0.07	
	CD at 5%	0.24	

No disease incidence was recorded on sunflower up to 21st DAG (days after germination). Initiation of Alternaria blight was recorded on 22nd DAG in T_7 (control) whereas initiation of disease was delayed i.e. up to 28 DAG in T_3 (seed treatment with carbendazim @ 2 g/kg seed) followed by treatment T_4 (seed treatment with apron @ 6 g/kg seed), T_5 (seed treatment with *T. viride* M_1 @ 4 g/kg seed) T_6 (seed treatment with *T. viride* M_2 @ 4 g/kg seed), T_1 (seed treatment with *T. viride* @ 4 g/kg seed) and T_2 (seed treatment with *P. fluorescens* @ 4 g/kg seed).

Present finding were correlate with Mogle and Maske (2012) reported seed treatment with carbendazim, diethane M-45, benomyl, *Trichoderma* alone and combination with leaf extract to cowpea was evaluated. The seed treatments improved seed germination, vigour index and reducing seed borne mycoflora of cowpea seeds. And Ahila devi *et al*. (2014) [2] reported sunflower seeds treated with *T. viride* recorded maximum germination (90.20%) than without treated seeds (60.50%).

Table 2: Effect of seed treatment and spraying of fungicides and bio-agents on per cent disease incidence and intensity at 30, 45 and 60 DAG

Tr. No.	Treatments	Per cent disease incidence at DAG			Per cent disease intensity at DAG			Reduction over control (%)	Yield kg/h	Increase yield over control (%)
		30	45	60	30	45	60			
T_1	*T. viride* @ 4 g/kg seed + Propiconazole @ 0.1 %	7.17 (2.64)*****	20.00 (26.53)*****	27.83 (31.83)*****	1.73 (1.65)	12.84 (3.58)******	22.84 (28.54)	41.96	1154	45.37
T_2	*P. fluorescens* @ 4 g/kg seed + Propiconazole 0.1 %	12.50 (3.56)	23.33 (28.83)	30.83 (33.70)	2.34 (1.82)	13.58 (3.68)	23.58 (29.03)	38.71	1137	44.55
T_3	Carbendazim @ 2 g/kg seed + Propiconazole @ 0.1 %	1.67 (1.27)	12.50 (20.64)	20.00 (26.53)	0.74 (1.31)	9.01 (2.99)	17.47 (24.66)	57.77	1227	48.61
T_4	*T. viride* @ 4 g/kg seed + Azoxystrobin @ 0.05 %	7.50 (2.73)	30.83 (33.72)	38.33 (38.25)	1.73 (1.65)	17.65 (4.19)	27.65 (31.71)	27.03	920	31.48
T_5	*P. fluorescens* @ 4 g/kg seed + Azoxystrobin @ 0.05%	14.17 (3.76)	31.67 (34.24)	39.17 (38.74)	2.47 (1.86)	17.90 (4.21)	27.90 (31.88)	25.10	895	29.56

T_6	Carbendazim @ 2 g/kg seed + Azoxystrobin @ 0.05 %	3.33 (1.82)	25.00 (29.98)	32.50 (34.74)	1.23 (1.49)	14.56 (3.81)	24.56 (29.61)	37.39	1112	43.31
T_7	Metalaxyl @ 6 gm/kg seed + Azoxystrobin @ 0.05 %	10.83 (3.29)	29.17 (32.68)	36.67 (37.26)	2.22 (1.79)	17.03 (4.11)	27.03 (31.32)	28.19	947	33.43
T_8	*T. viride* @ 4 g/kg seed + *T. viride* @ 0.5 %	7.50 (2.73)	28.33 (32.15)	35.83 (36.76)	1.85 (1.68)	16.42 (4.04)	26.41 (30.90)	30.67	978	35.54
T_9	*P. fluorescens* @ 4 g/kg seed + *P. fluorescens* @ 4 gm/l	13.33 (3.65)	33.33 (35.26)	40.83 (39.71)	2.84 (1.95)	18.39 (4.28)	28.39 (32.19)	23.01	807	21.88
T_{10}	*T. viride* M_1 @ 4 g/kg seed + *T. viride* M_1 @ 0.5 %	5.33 (2.30)	25.83 (30.54)	33.33 (35.26)	1.36 (1.53)	15.80 (3.97)	24.80 (29.85)	34.90	1095	42.43
T_{11}	*T. viride* M_2 @ 4 g/kg seed + *T. viride* M_2 @ 0.5 %	6.67 (2.58)	27.50 (31.61)	35.00 (36.26)	1.60 (1.61)	16.41 (4.05)	26.00 (30.65)	31.71	1083	41.79
T_{12}	Control	15.83 (3.97)	40.00 (39.22)	47.50 (43.56)	5.55 (2.55)	22.45 (4.73)	36.45 (37.13)	0.00	631	00.00
	'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.		Sig.	
	S.E.(m) ±	0.06	0.89	0.79	0.016	0.11	0.86		34.64	
	CD at 5%	0.19	2.62	2.33	0.048	0.34	2.53		102.26	

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