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Integrated Management of *Alternaria* Leaf Blight and Necrosis of Sunflower

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A B S T R A C T

Field experiment was conducted at Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* 2013 -14 and 2015-16, to study integrated management of *Alternaria* leaf blight and necrosis of Sunflower. Seed primimg with *Trichoderma viride* @10g/kg seed, Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed, *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed with foliar spray of Propiconazole 25 EC @ 1ml/l + Thiamethoxam 25 WG @ 1.6g/l, 25 EC @ 1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l, *Pseudomonas fluorescence* @ 5 g/l + Azadirachtin 1500 ppm @ 1.5 ml/l were evaluated. Hydro priming has been used to infuse fungicides into seeds. Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed followed by spray of Propiconazole 25 EC @ 1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l at onset of disease and 15 days later (T4) was found economical (1: 7.52 ICBR) and effective for the integrated management of *Alternaria* leaf blight and necrosis of Sunflower.

Introduction

Sunflower (*Helianthus annuus* L.) is an important oil yielding crop, susceptible to a large variety of devastating diseases. Fungal diseases are the main constrain for sunflower industry Worldwide. Among the insect pest and diseases, diseases alone cause 10 per cent yield loss in the field itself. *Alternaria* blight is an important fungal disease of sunflower in India. It reduces the average flower size, number of seeds per plant, seed yield per plant, seed weight and per cent filling seed. Average yield and oil losses in India ranged from 28 to 80 per cent and 31 to 34 per cent, respectively (Balasubrahmanyam and Kolte, 1980). The disease is particularly destructive in regions where a combination of high temperature and extended periods of wet weather causes rapids epidemic development. Sunflower necrosis disease (SND) caused by tobacco streak virus has also emerged as a major disease of sunflower, First it was observed in Karnataka during the year 1997. Subsequently, it spread rapidly to other states with the disease incidence ranging from 2 - 90% (Lavanya *et al.*, 2009). In subsequent years, outbreaks of this disease in major

sunflower-growing states of India, especially Andhra, Karanataka and Maharashtra, have virtually threatened the sunflower cultivation and yield losses ranging from 30 to 100% have been reported (Chander Rao *et al.*, 2000). The disease was found to be transmitted by thrips (Harvir Singh, 2005). Researchers have focused in various aspects to manage the *Alternaria* and Necrosis. In the present study, integration of seed priming with biological and chemical fungicides, foliar spraying of chemical fungicide and botanical has been considered as a management approach.

Materials and Methods

Field experiment on integrated management of *Alternaria* leaf blight and necrosis of Sunflower was conducted at Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif 2013 - 14 and 2015-16, to develop integrated module for foliar disease management in sunflower. The experiment was laid out in Randomized Block Design with seven treatments and three replications. Other recommended practices were followed and applied in all treatments. Sunflower seeds were pre soaked in water for 12 hrs and treated with *Trichoderma viride* @10g/kg seed, Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed, *Trichoderma viride* @10g/kg seed + Thiamethoxam @ 4 g/kg. Foliar spray of Propiconazole 25 EC @ 1ml/l + Thiamethoxam 25 WG @ 1.6g/l, Propiconazole 25 EC @ 1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l, *Pseudomonas fluorescence* @ 5 g/l + Azadirachtin 1500 ppm @ 1.5 ml/l at disease onset, were evaluated. Hydro priming has been used to infuse fungicides into seeds. The treatment details were as given in table 1. Observations viz; per cent intensity of *Alternaria* leaf spots was recorded at one and two months after germination and necrosis was recorded at two months after germination.

Results and Discussion

Seed Germination (%)

Statistically no significant difference was observed amongst the treatments towards germination of seed (Table 2).

Per cent disease intensity of *Alternaria* leaf spot

One month after germination

Two years pooled mean given in table 3 revealed that, minimum 15.87 per cent intensity of *Alternaria* leaf spot was recorded in treatment (T4) i.e seed bio priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed % + Spray of Propiconazole 25 EC @ 1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l followed by T2 viz; seed biopriming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l and T3 i.e Seed bio priming with *T. viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l first at disease initiation and second at 15 days later showing 18.77 and 20.30 per cent intensity of *Alternaria* leaf spot respectively. All these treatments were statistically at par and significantly superior over rest of the treatments.

Two month after germination

Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4 g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l at disease initiation and 15 days later (T2) recorded minimum i.e 17.43 per cent intensity of *Alternaria* leaf spot followed by seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @4g/kg seed +

Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l at disease onset and 15 days later (T4)**,** Seed bio priming with *T. viride* @ 10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l at disease initiation and 15 days later (T3) and Seed biopriming with *T. viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appeared and 15 days later (T1) recording 21.60, 21.83 and 21.87 per cent intensity of *Alternaria* leaf spot respectively, which were statistically at par with each other and were statistically superior over rest of the treatments including untreated control (Table 3).

Necrosis

Minimum incidence of necrosis 4.18 per cent was noticed due to treatment of seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later (T4). Next best treatment with 4.54 % disease incidence was seed bio priming with *T. viride* @10g/kg seed + Thiamethoxam @ 600 FS @ 4g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later (T6) followed by Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam @ 600 FS @ 4g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later (T2), Seed bio priming with *T. viride* @ 10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later (T3), Seed bio priming with *T. viride* @10g/kg seed + Two sprays of *P. fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears (T5) and Seed bio priming with *T. viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later (T1) recording 4.96, 5.08, 5.16 and 5.91 per cent incidence of necrosis, respectively and were at par with each other (Table 4). However significantly superior over control (10.89 % incidence)

Yield and economics

Maximum yield of 1133 kg/ha was obtained from Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l at disease appearance and 15 days later (T2) followed by Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l on disease onset and 15 days later (T4) and Seed bio priming with *T. viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l at disease initiation and 15 days later (T6) recording 1100 and 1030 kg/ha, grain yield respectively. Al these three treatments were at par. However were significantly superior over control (Table 5).

Highest, 7.52 Incremental cost benefit was obtained from the treatment of seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l on disease appearance and 15 days later (T4) followed by seed bio priming with *T. viride* @10g/kg seed + Spray of *P. fluorescence* @ 5 g/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appeared (T5), Seed priming with Carbendazim 50 WP @ 2g/kg seed +

Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease observed and 15 days later (T2), Seed bio priming with *T. viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l at disease initiation and 15 days later (T3), Seed bio priming with *T. viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l on disease appereance and 15 days later (T6) and Seed bio priming with *T. viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appeared and 15 days later (T1) (Table 5).

Results of the present study indicated that, seed bio priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l on disease initiation and 15 days later (T4) was effective and economical against *Alternaria* leaf spot and necrosis disease of sunflower.

Bio priming process had potential advantages over simple seed coating. Seed priming often results in more rapid and uniform seedling emergence and may be useful under adverse soil conditions (Mathre *et al.,* 1994).

The infusion of fungicides into dormant seeds is a useful and efficient means of plant disease control. Hydro priming has been used to infuse systemic fungicides into seeds. The bacterial biocontrol agent may multiply substantially on seed during bio priming (Callan *et al.,* 1990). Efficacy of *Pseudomonas fluorescence* as seed dresser can be enhanced by bio priming the sunflower seeds for the effective and eco-friendly management of *Alternaria* blight of sunflower.

Table.1 Treatment details

S.N.	Treatments
T1	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later
T2	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later
T3	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later
T4	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later
T5	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of *Pseudomonas fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears.
T6	Seed bio priming *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later
T7	Control

Table.2 Effect of treatments on germination

Treatments		Seed germination (%)		
		2013 -14	**2015 - 16**	**Pooled mean**
1	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	97.31 (9.86)*	77.46 (8.80)*	87.39 (9.35)*
2	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	96.66 (9.83)	73.97 (8.60)	85.31 (9.24)
3	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	97.14 (9.86)	73.34 (8.56)	85.24 (9.23)
4	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	97.14 (9.86)	77.78 (8.82)	87.46 (9.35)
5	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of *Pseudomonas fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears.	96.97 (9.85)	73.33 (8.56)	85.15 (9.23)
6	Seed bio priming *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	97.61 (9.88)	78.41 (8.86)	88.01 (9.38)
7	Control	97.93 (9.90)	67.94 (8.24)	82.93 (9.11)
	'F' test	NS	NS	NS
	SE (m)±	-	-	-
	CD at 5 %	-	-	-
	CV %	-	-	-

* Square root transformed values.

Table.3 Effect of treatments on intensity of Alternaria leaf spot

	Treatments	*Alternaria* leaf spot (% intensity)					
		One month after germination			Two month after germination		
		2013 -14	2015 - 16	Pooled	2013 -14	2015 - 16	Pooled mean
1	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	32.33 (34.60)*	23.67 (4.85)**	28.00 (31.89) *	27.00 (31.28)*	16.73 (19.34) *	21.87 (27.87)*
2	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	23.87 (29.18)	13.67 (3.66)	18.77 (25.57)	20.13 (26.64)	14.80 (16.05)	17.43 (24.65)
3	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	24.33 (29.49)	16.27 (4.03)	20.30 (26.74)	26.67 (31.03)	17.00 (19.54)	21.83 (27.81)
4	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	19.13 (25.92)	12.60 (3.55)	15.87 (23.46)	30.20 (33.33)	13.07 (16.51)	21.60 (27.69)
5	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of *Pseudomonas fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears.	48.00 (43.85)	22.20 (4.71)	35.10 (36.31)	49.33 (44.61)	22.73 (24.50)	36.00 (36.84)
6	Seed bio priming *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	57.93 (49.57)	18.27 (5.70)	38.10 (38.11)	59.20 (50.31)	27.67 (25.99)	43.40 (38.15)
7	Control	60.07 (50.86)	27.53 (5.24)	43.80 (41.42)	62.13 (52.09)	30.67 (33.59)	45.37 (42.33)
	'F' test	Sig	Sig	Sig	Sig	Sig	Sig
	SE (m)±	7.73	0.20	1.53	6.77	1.22	1.22
	CD at 5 %	8.57	0.61	4.73	8.02	3.77	3.76
	CV %	12.11	7.67	8.32	11.04	7.98	6.47

* Arc sine transformed values **Square root transformed values

Table.4 Effect of treatments on incidence of necrosis

	Treatments	Necrosis (%) Two month after germination		
		2013 -14	**2015 - 16**	**Pooled mean**
1	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	0.98 (1.16)	10.83 (3.25)	5.91 (2.41)
2	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	0.00 (0.71)	9.92 (3.11)	4.96 (2.20)
3	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	0.64 (1.04)	9.51 (3.08)	5.08 (2.24)
4	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	0.99 (1.22)	7.38 (2.70)	4.18 (2.03)
5	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of *Pseudomonas fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears.	0.32 (0.87)	10.00 (3.16)	5.16 (2.27)
6	Seed bio priming *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	0.97 (1.16)	8.11 (2.76)	4.54 (2.05)
7	Control	6.48 (2.64)	15.29 (3.88)	10.89 (3.28)
	'F' test	Sig	Sig	Sig
	SE (m)±	0.17	0.33	0.25
	CD at 5 %	0.53	1.02	0.76
	CV %	23.81	18.27	18.05

* Figures in parenthesis are square root transformed values

Table.5 Yield and ICBR

Treatments		Seed yield kg/ha			ICBR
		2013 -14	2015 - 16	Pooled mean	
1	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	640	1165	902	2.98
2	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	746	1519	1133	4.62
3	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of Propiconazole 25 EC @1ml/l + Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	664	1053	858	4.32
4	Seed priming with Carbendazim 50 WP @ 2g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears and 15 days later	618	1582	1100	7.52
5	Seed bio priming with *Trichoderma viride* @10g/kg seed + Two sprays of *Pseudomonas fluorescence* @ 5 g/l+ Azadirachtin 1500 ppm @ 1.5 ml/l as soon as disease appears.	585	1171	878	5.00
6	Seed bio priming *Trichoderma viride* @10g/kg seed + Thiamethoxam 600 FS @ 4g/kg + Two sprays of Propiconazole 25 EC @1ml/l + Thiamethoxam 25 WG @ 1.6 g/l as soon as disease appears and 15 days later	557	1502	1030	3.67
7	Control	304	836	570	-
	'F' test	Sig	Sig	Sig	-
	SE (m)±	38.41	84.50	45.75	-
	CD at 5 %	118.34	260.38	140.97	-
	CV %	11.32	11.61	8.57	-

The effectiveness of carbendazim in controlling blight of sunflower caused by *A. helianthi*, with increased yield was reported by Patel *et al.*, (1995).

Sunflower necrosis disease can be managed by treating seeds with thiomethoxam at 4 g/kg along with two sprays of the chemical at 0.05% at 30 & 45 DAS (Shirshikar, 2010).

The incidence of sunflower necrosis disease can be minimized by seed treatment with imidacloprid 70 W.S., @ 5 g/kg (Shirshikar, 2008).

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