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Comparative Efficacy of Biological Components (Plant Extract and Bioagents) and Chemical in Wilt Management of Linseed Caused by *Fusarium oxysporum* Schlecht. Ex. fr. f. sp *lini*. (Bolley) Synder and Hansen

Virendra Kumar[1*], Dharmendra Kumar Gautam[2], Prem Naresh[1] and Kishan lal[1]

[1]Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur 208002 (UP), India
[2]Department of horticulture, S.V.P.U.A.T., Meerut, India
**Corresponding author*

A B S T R A C T

Linseed is commonly known as "*Ulsee*" or "*Tisee*" (*Linum usitatissimum.* L.) Linseed wilt caused by *Fusarium oxysporum* f. sp *lini*. pathogens, and screened out against this fungus. Out of 11 treatments, though maximum initial plant population (350 and393) was noted with treatment T_8 [Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)] followed by T_4 [Seed and soil treatment with mycorrhiza (12.5 kg/ha) and T_2 STTH + soil treatment with TH (2.5 kg/ha)]. Wilting of the plant started in control plots just 15 to 20 days after sowing. While in treated plots wilting started after 35 to 40 days of sowing. Maximum seed yield of 499.99 kg/ha and 527 kg/ha were also recorded with same treatment T_8 followed by T_4 396.66 kg/ha and 438.33 kg/ha and T_2 393.33 kg/ha and 416.66 kg/ha, respectively, during both the years.

Keywords

Linseed (*Linum usitatissimum*) wilt *Fusarium oxysporum* and Resistant sources.

Article Info

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Introduction

Linseed (*Linum usitatissimum* L.) commonly known as "*Ulsee*" or "*Tisee*" (2n = 30) belongs to the family Linaceae. In India among *rabi* oil seed crops linseed have second place after rape seed mustard in area as well as in production grown. Linseed is one of the oldest crop cultivated for its seeds and fiber. The two products of seed are linseed oil and linseed meal. The oil and protein percent in seed of linseed varies from 37.8 to 43.2% and 20.00 to 24.8% respectively. Linseed cake serve as a proteinous supplement for livestock. It provides moisture 11%, carbohydrate 32% protein, oil 10% fibre 9%, minerals 6% (Singh *et al.*, 1997). Globally linseed is an important crop and its production is 21.23 lac tonnes from 21.12 lac/ hac with an average yield of 1006 kg/ha. While our national production is 1.54 lac tonnes from an area of 3.42 lac ha with poor productivity of 449 kg/ha. India ranks second in area after Canada in the world, but is at fourth place in term of production after Canada, China and U.S.A. In term of productivity India (449kg/hac) is far below to Canada (1492kg/ha), U.S.A (1484kg/ha), Egypt

(1465kg/hac), Russia (1292kg/hac) and China (944kg/hac). In our country, Madhya Pradesh leads in both (Yield 0.328 lakh tonnes and acreage 1.044 lakh ha) followed by Uttar Pradesh (yield 0.271 lakh tonnes and acreage 1.080 lak ha respectively. In Uttar Pradesh the total area under this crop is about 1.080 lakh hectares and annual production of 0.271 lakh tonnes with productivity of 251 kg/ha (Anonymous, 2012).

In India the production of this important oil and fibre yielding crop is very low. Amongst the various factors responsible for lowering down its yield, the diseases especially those caused by fungi are considered to be the major one. The important diseases affecting crops are Alternaria blight, powdery mildew, rust and wilt. Consequent upon continuous cropping of linseed in same marginalized field, year after year, soil becomes sick with root rot (*Rhizoctonia* spp., *Pythium* spp., *Fusarium* spp.) and wilt [*Fusarium oxysporum* Schlecht. Ex. fr. f. sp lini. (Bolley) Synder and Hansen] pathogens, resulting in partial or total yield loss due to these diseases (Kolte and Fitt, 1997; Sharma *et al.*, 2002). Therefore, keeping in view the importance of the crop and seriousness of the disease the present investigation was under taken with Evaluation of botanicals against pathogen in *in vitro* condition and evaluation of botanicals/bioagents against disease under sick field conditions.

Materials and Methods

Isolation and purification of pathogen

The diseased plants of linseed were collected from the experimental plots of Genetics and Plant Breeding Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). The causal organisms were isolated from affected roots of linseed plants. The affected roots were first washed in tap water to remove dust particles and then thoroughly washed with sterilized water in order to remove the surface contaminants.

Instruments to be used were sterilized by using 95 per cent methylated alcohol. Small pieces of diseased portion along with healthy parts were cut into pieces with a sterilized blade.

The cut pieces were surface sterilized with 0.1 per cent mercuric chloride solution under aseptic conditions inside the laminar flow and washed thoroughly 3-4 times with sterilized water to remove the traces of mercuric chloride. Excess moisture was removed by placing them in the fold of sterilized blotting papers. These pieces were transferred to 2 per cent Potato Dextrose Agar (PDA) medium in 90 mm Petri dishes, previously autoclaved at 15 p.s.i. for 20 minutes with the help of sterilized needles. The petridishes were then transferred at 28±2ºC temperature for 7 days in B.O.D. incubator. These incubated plates were observed for mycelial growth of the causal fungus after 24 hours of inoculation daily once till the growth of the fungus was noted. As soon as the mycelial growth was visible around these pieces the hyphal tips from the advancing mycelium were cut and transferred into the culture tubes containing Potato-Dextrose Agar medium for further purification, identification and maintenance of culture. The pure culture of fungus was obtained by adopting single spore techniques.

The purification of fungal isolates was taken following single spore isolation technique. A dilute spore suspension was poured on plain agar Petri dishes to form a very thin layer on it and spores allowed settling down on the agar surface. Settled spores were separated out from each other, selected under the microscope and encircled with the help of dummy cutter in Petri dishes. They were lifted along with agar blocks and transferred to Petri dishes containing sterilized 2 per cent

PDA medium. After proper growth of fungus obtained by single spore culture regular sub-culturing was done to check contamination, till pure cultures were obtained. These cultures were sub cultured at monthly intervals and maintained on Potato-Dextrose-Agar slants under refrigeration at 6 to 8 ^{0}C for further studies.

Modified Czapek-Dox-Agar medium was used for isolation of Fusarium wilt pathogen using method of Singh and Chaube (1970). Potato-Dextrose-Agar medium was composition prepared by using method described by Johnston and Booth (1983), was used for present study used for maintaining of pure culture of the wilt pathogen.

All botanicals were collected from university campus and bioagents were obtained from department and incubated BOD. The fungicides were also collected from local market.

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Effect of botanicals/ bioagents against disease under sick field condition

This experiment was conducted in the wilt sick plot of Genetic and Plant Breeding Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj ($26^0 47^{'}$ N,82^0 $12^{'}$ E, 113m above sea level), Faizabad following recommended cultural practices during 2010-11 and 2011-12 crop seasons to evaluate the performance of active botanicals (*Xanthium strumanium* and *Tribulus terrestris*), bioagents (*Trichoderma harzianum* and Mycorrhiza) to manage the Fusarium wilt of linseed, as seed dressers and soil application and compare these with fungicide carbendazim.

The seeds of susceptible cultivars Chambal was treated with above botanicals, bioagents and fungicide before sowing *Trichoderma harzianum* @ 4g/kg seed was mixed with seed and soaked with few ml of water, so that bioagents get adheres to the surface of seed. The Trichoderma coated seed was incubated for 24 hours for the germination of spore. The incubated seeds were used for sowing after drying under shade for 2 to 3 hours. Mycorrhiza @ 12.5g/kg seeds was also mixed with seed and soaked with few ml of water 24 hours before sowing.

Leaf extracts of botanicals (*Tribulus terrestris and Xanthium strumanium*) were prepared by mixing 100g of leaf with 100ml sterilize water and crushing them in warring blender. Extracted was filtered by double layered muslin cloth. Seeds were soaked with extract for 24 hours and were dried under shade for 2 to 3 hours before sowing. The treated seeds were sown as per lay-out given below:

Variety: Chambal
Design: R.B.D.
Plot size: 4 m × 3m
Spacing: 25cm × 10cm
Fertilizer: 80:40 N.P. kg/ha

Treatment: 11

T_1= Seed treatment with *Trichoderma harzianum* (ST TH) (4 g/kg seed)

T_2= STTH + Soil treatment with TH (2.5 kg/ha)

T_3 = Seed treatment with Mycorrhiza (50 g/kg seed)

T_4 = Seed treatment with Mycorrhiza + soil treatment with Mycorrhiza (12.5 kg/ha)

T_5 = Seed treatment with leaf extract of *Xanthium strumanium* (10% W/V)

T_6 = Seed and soil treatment with extract of *Xanthium strumanium* (10% W/V)

T_7 = Seed treatment with leaf extract of gokhru (*Tribulus terrestris* L.) (10% W/V)

T_8 = Seed and soil treatment with leaf extract of gokhru (*Tribulus terrestris* L.) (10% W/V)

T_9= Seed treatment with carbendazim (0.2%)

T_{10} = Seed and soil treatment with carbendazim (0.2%)

T_{11} = Control

Results and Discussion

Evaluation of botanicals/bioagents against disease under sick field condition

In this study the efforts has been made to evaluate active botanical, bioagents as seed dressers and as a soil application in comparison to fungicide against the Fusarium wilt of linseed under sick plot condition.

The experiment was conducted at Genetics and Plant Breeding Farm of this University during 2010-11 and 2011-12 by using susceptible cultivar Chambal.

It is evident from the table 1 that no significant effect of the treatments in initial plant population was observed over control.

Though maximum initial plant population (350 and393) was noted with treatment T_8 [Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)] followed by T_4 [Seed and soil treatment with mycorrhiza (12.5 kg/ha) and T_2 [STTH + Soil treatment with TH (2.5 kg/ha)].

Wilting of the plant started in control plots just 15 to 20 days after sowing. While in treated plots wilting started after 35 to 40 days of sowing. All the treatments were found significantly superior over check (untreated control) in controlling the disease severity by checking the wilting of plants. Minimum per cent wilting of 40.13% and 26.02% were recorded with treatment T_8 followed by T_2 and T_4 (40.54% and 30.60%) (41.33% and 30.79%) respectively during both the years. All these treatments were at par among themselves during 2010-11while treatment T_8 was found significantly superior over T_2 and T_4 during 2011-12 in controlling disease severity but the latter were at par.

Maximum disease was also controlled the same treatments T_8 (50.24% and 60.44%) followed by T_2 49.73% and 53.39%) and T_4 (48.75% and 53.19) respectively during both the years of testing over check.

Maximum per cent wilting of 80.65% and 65.78% were recorded in untreated control plots during 2010-11 and 2011-12 respectively. The treatments T_3 [Seed treatment with mycorrhiza (50 g/kg seed)] and T_{10} [Seed and soil treatment with 2g/kg sed.] were found less effective in controlling the disease in comparison to others.

Regarding seed yield, all the treatments significantly increased the seed yield over check. Maximum seed yield of 499.99 kg/ha and 527 kg/ha were also recorded with same treatment T_8 followed by T_4 396.66 kg/ha and 438.33 kg/ha and T_2 393.33 kg/ha and 416.66 kg/ha, respectively, during both the years.

The former was found significantly higher than latters while latters were at par among themselves. Minimum seed yield of 124.99 kg/ha and 160.83 kg/ha were recorded during 2010-11 and 2011-12 respectively in control plots.

Amongst the treatments minimum yield was recorded with the treatment T_{10} (304.99 kg/ha and 333.33 kg/ha) during both the year, which was found at par with treatment T_1, T_3, T_5 and T_9 during first years and treatment T_3 T_5 T_6 T_7 and T_9 during second year, respectively (Table 2).

Table.1 Effect of different treatments against severity of *Fusarium* wilt in linseed during 2010-11 and 2011-12

Treatment	2010-11				2011-12.			
	Initial Plant Population	Final Plant Population	% Plant wilted	% Disease control over check	Initial Plant Population	Final Plant Population	% Plant wilted	% Disease control over check
T_1= Seed treatment with *Trichoderma harzianum* (ST TH) (4 g/kg seed)	500	287	42.52	47.27	515	354	31.02	52.84
T_2= STTH + Soil treatment with TH (2.5 kg/ha)	510	299	40.54	49.73	510	353	30.66	53.39
T_3 = Seed treatment with mycorrhiza (50 g/kg seed)	495	254	50.59	37.27	515	320	41.54	38.85
T_4 = Seed and soil treatment with mycorrhiza (12.5 kg/ha)	520	305	41.33	48.75	525	363	30.79	53.19
T_5 = Seed treatment with leaf extract of *Xanthium strumanium* (10% W/V)	505	278	44.90	44.32	520	316	39.02	40.68
T_6 = Seed and soil treatment with leaf extract of *Xanthium strumanium* (10% W/V)	515	290	43.55	46.00	518	335	35.15	46.56
T_7 = Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)	515	290	43.49	46.07	510	333	34.88	46.97
T_8 = Seed and soil treatment with leaf extract of *Tribulus terrestris* (10% W/V)	530	317	40.13	50.24	535	393	26.02	60.44
T_9= Seed treatment with carbendazim 2g/kg sed.	520	288	44.42	44.92	515	319	38.97	40.75
T_{10} = Seed and soil treatment with 2g/kg sed.	518	275	46.77	42.02	505	310	38.62	41.28
T_{11} = Control (Untreated)	475	91	80.65	-	495	169	65.78	-
Genral Mean	512	270	-	-	517	324		-
SEm±	23.38	8.01	-	-	16.03	9.83		-
CD at 5%	68.96	23.63	-	-	47.29	29.00		-

Table.2 Effect on treatment on seed yield of linseed during 2010-11 and 2011-12

Treatments	**2010-11**			**2011-12**		
	Kg/Plot	**Kg/ha**	**Avoidable yield loss**	**Kg/Plot**	**Kg/ha**	**Avoidable yield loss**
T_1= Seed treatment with *Trichoderma harzianum* (ST TH) (4 g/kg seed)	0.412	343.33	63.59	0.480	399.99	59.79
T_2= STTH + Soil treatment with TH (2.5 kg/ha)	0.472	393.33	68.22	0.500	416.66	61.40
T_3 = Seed treatment with mycorrhiza (50 g/kg seed)	0.366	304.99	59.01	0.426	354.99	54.69
T_4 = Seed and soil treatment with mycorrhiza (12.5 kg/ha)	0.476	396.66	68.48	0.526	438.33	63.33
T_5 = Seed treatment with leaf extract of *Xanthium strumanium* (10% W/V)	0.382	318.33	60.73	0.420	349.99	54.04
T_6 = Seed and soil treatment with leaf extract of *Xanthium strumanium* (10% W/V)	0.466	388.33	67.81	0.466	388.33	58.58
T_7 = Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)	0.466	388.33	67.81	0.446	371.66	56.72
T_8 = Seed and soil treatment with leaf extract of *Tribulus terrestris* (10% W/V)	0.600	499.99	75.00	0.633	527.47	69.50
T_9= Seed treatment with carbendazim (2g/kg seed)	0.440	366.66	65.91	0.426	354.99	54.69
T_{10} = Seed and soil treatment with carbendazim (2g/kg seed)	0.366	304.99	59.01	0.400	333.33	51.75
T_{11} = Control	0.150	124.99	-	0.193	160.83	-
SEm±	0.019	15.83		0.023	19.16	
CD at 5%	0.057	47.49		0.070	58.33	

All the treatment avoided yield loss from 59.01% to 75% during 2010-11 and 51.75% to 69.50% during 2011-12, respectively in comparison to control. Maximum yield loss of 75% and 69.50%was avoided with treatment T_8 followed by T_4 (68.48% and 63.33%) and T_2 (68.22% and 61.40%) during 2010-11 and 2011-12 respectively. Minimum loss was avoided with treatment T_{10} (50.01% and 51.75%), respectively during both the years. Singh *et al.*, (2008) also evaluated the efficacy of *Trichoderma viride* (4g/kg seed), *T.*

harzianum (4g/kg), Thiram (4g/kg) and Farm yard manure (5t/ha) alone and in combination against wilt of linseed and found that Seed treatment with *T. harzianum* resulted in the highest mean plant density and grain yield (675.33 kg/ha), and the lowest mean disease incidence (27.7%). Rai and Singh (1996) evaluated oilcakes of *neem*, mustard, *mahua*, coconut, linseed and sesame at different concentrations (0.25, 0.5, 1.0 and 2.0%) against radial growth of *F. udum* and found neem, mustard and mahua oilcakes most effective in reducing fungal growth and were used in pot culture to test their efficacy on *F. udum* and found best growth of *pigeon pea* plants was recorded with *mahua* oilcake but the *neem* oilcake was most effective in controlling wilt incidence,

Kishor and Singh (2008) evaluated the effects of Bavistin [carbendazim], Benlate [benomyl], thiram + Bavistin, Roko (thiophanate-methyl), thiram, Agrosan G.N. [phenylmercury acetate], captan, Vitavax [carboxin], Companion, mancozeb and Ridomil [metalaxyl] on the growth and development of *F. oxysporum* f.sp. *lini* in linseed (cv. Chambal) and found systemic fungicides Bavistin, Benlate and Roko were the most effective (reduced wilt incidence by 82.4, 69.0 and 53.5%, respectively), followed by thiram, Agrosan G.N., captan and Vitavax. The fungicides increased the yield by 59-97%.

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