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

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**Abstract**

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 T8 [Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)] followed by T4 [Seed and soil treatment with mycorrhiza (12.5 kg/ha) and T2 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 T8 followed by T4 396.66 kg/ha and 438.33 kg/ha and T2 393.33 kg/ha and 416.66 kg/ha, respectively, during both the years.

**Keywords**

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

**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

1997
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 lakh 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 °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.

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°47' N, 82°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

T₁ = Seed treatment with Trichoderma
    harzianum (ST TH) (4 g/kg seed)

T₂ = STTH + Soil treatment with TH (2.5
    kg/ha)

T₃ = Seed treatment with Mycorrhiza (50 g/kg
    seed)

T₄ = Seed treatment with Mycorrhiza + soil
    treatment with Mycorrhiza (12.5 kg/ha)

T₅ = Seed treatment with leaf extract of
    Xanthium strumanium (10% W/V)

T₆ = Seed and soil treatment with extract of
    Xanthium strumanium (10% W/V)

T₇ = Seed treatment with leaf extract of
    gokhru (Tribulus terrestris L.) (10% W/V)
T₈ = Seed and soil treatment with leaf extract of gokhru (*Tribulus terrestris* L.) (10% W/V)

T₀ = Seed treatment with carbendazim (0.2%)

T₁₀ = Seed and soil treatment with carbendazim (0.2%)

T₁₁ = Control

**Results and Discussion**

**Evaluation of botanicals/bioagents against disease under sick field condition**

In this study, the efforts have been made to evaluate active botanicals, 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 and 393) was noted with treatment T₈ [Seed treatment with leaf extract of *Tribulus terrestris* (10% W/V)] followed by T₄ [Seed and soil treatment with mycorrhiza (12.5 kg/ha) and T₂ [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 T₈ followed by T₂ and T₄ (40.54% and 30.60%) (41.33% and 30.79%) respectively during both the years. All these treatments were at par among themselves during 2010-11 while treatment T₈ was found significantly superior over T₂ and T₄ during 2011-12 in controlling disease severity but the latter were at par.

Maximum disease was also controlled the same treatments T₈ (50.24% and 60.44%) followed by T₂ 49.73% and 53.39%) and T₄ (48.75% and 53.19) respectively during both the years of testing over check.

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 T₈ followed by T₄ 396.66 kg/ha and 438.33 kg/ha and T₂ 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 T₁₀ (304.99 kg/ha and 333.33 kg/ha) during both the year, which was found at par with treatment T₁, T₃, T₅ and T₉ during first years and treatment T₃ T₅ T₆ T₇ and T₉ 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 strumarium* (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 strumarium* (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 strumarium* (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 strumarium* (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   |       | 58.33               |
| CD at 5%                                                                  | 0.057   | 47.49  | 0.070               |         |       |                    |

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), $T$. 2002
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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