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Evaluation of multiple sources of resistance and integrated management of linseed wilt

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Abstract
For screening under natural epiphytotics, a set of 90 initial varieties and advanced varieties from breeding trial were screened against wilt, alternaria blight, powdery mildew and rust under natural condition. Among them 11 entries viz., RL-29210, RLC-153 and BAU-15-06, test entries RC-1007, RLC-153, RLC-157, SLS-101, SLS-106, NDL-2014-11 and BAU-06-03 recorded multiple disease resistant reaction. An integrated disease management trial resulted that minimum disease incidence of wilt (20.92 %) and maximum grain yield (726.39kg/h)was recorded on ST with *T.viride*@ 4g/kg+ soil appln of *T.viride* @4g/kg with 40 kg/ha well rotten FYM which was at par with ST with *T.harzianum* @ 4g/kg + soil appln of *T.harzianum* @4g/kg with 40 kg/ha well rotten FYM recorded (26.67 %) disease incidence and (681.94kg/h) grain yield as compare to (56.67 %) wilt incidence and (501.39 kg/h) grain yield in untreated control.

Keywords: Resistance, Integrated management, Linseed wilt

Introduction
Linseed is one of the oldest cultivated crops, commonly known as “Ulsee” or “Tisee”. (*Linum usitatissimum* L.) (2n = 30) belongs to the family *Linaceae* is second commercially most important *Rabi* oil seed crops after rape seed mustard in area as well as in production. It is a multipurpose crop grown either for fiber or oil. Every part of the plant is utilized commercially either directly or after processing. Linseed grain contains about 40 per cent oil and 24 per cent crude protein. Recently, incorporation of linseed in food and food products has been gaining importance due to its high content of essential omega-3 fatty acid (alpha –linolenic acid), dietary fiber and natural phenolic antioxidants (Kasote, 2013) [4]. About 80 per cent of linseed oil produced utilized in industries and used as drying oil for manufacturing of paints, varnish, oil cloth, linoleum, printing ink etc. The oil cakes are used as a manure to maintain the fertility level as well as best organic amendments against soil born pathogen. The productivity of this important oil seed crop is very low in India. 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 the crop are Alternaria blight, powdery mildew, rust and wilt. Wilt of Linseed is caused by *Fusarium oxysporum* f. sp. *lini* (Fol) caused up to 87 % losses to the crop (Sharma and Mathur., 1971) [10]. Rust caused by *Melampsora lini* inflicts severe epidemic year after year with 60-100 per cent yield losses (Sagwan *et al*., 2005) [8]. Whereas the extent of losses occur 60 % due to Alternaria blight and Powdery mildew (Reddy *et al*., 2009) [6]. Besides loss in seed yield, it also reduces the quality of the seeds. Development of cultivar with durable resistance to disease is the most economic and eco-friendly method of plant disease management. Keeping in view the importance of this method, 'the study was conducted under field condition for identification of sources of multiple disease resistance and integrated disease management of wilt.

Materials and Methods
Evaluation of linseed genotypes for multiple disease resistant reaction
The study was conducted in the wilt sick plot at AICRP Linseed Farm of Birsa Agricultural University, Kanke, Ranchi, Jharkhand during *Rabi*, 2016-2017. Ranchi is situated at 23° 17’ North latitude and 85° 19’ East longitude with an altitude of 625 meter above mean sea level in the plateau region of Jharkhand state. For screening under natural epiphytotics, a set of 64 initial varieties and 26 advanced varieties from breeding trial were screened against wilt, alternaria blight, powdery mildew and rust. Each genotypes under test was sown in 3 meters long, single row, 25 cm apart, in rod row design. A highly susceptible variety Chambal was planted after every 10 rows against wilt and after 20 rows for foliar diseases. Sowing was done during the month of November and Fertilizer application, weeding, irrigation and other

intercultural operation were done as per the normal recommended practice. Each test entries were carefully observed for disease symptom after appearance of disease in susceptible check and final disease severity was recorded at the time of crop maturity. Disease scoring was done on 0-5 rating scale (Saharan, 1988) as described below and the entries were categorized as highly resistant to highly susceptible on the basis of highest disease score recorded on that entry during the crop season.

Alternaria blight, powdery mildew and rust should be scored following 0-5 scale:

0 = No disease or free (HR)
1= 0 to 10% area of leaves/plant infection (R)
2= 10.1 to 25% area of leaves/plant infection (MR)
3 = 25.1 to 50% area of leaves/plant infection (MS)
4 = 50.1 to 75% area of leaves/plant infection (S)
5 = Above 75% area of leaves/plant infection (HS)

Integrated management

Field experiments were conducted in Randomized Block Design with three replications during *Rabi*, 2016. Before sowing seeds of Linseed cultivar Chambal were treated *Trichoderma viride* @ 4g or ml/kg or Thiram + Bavistin (2g+1g/kg) and soil treatment by *Trichoderma viride* or *Trichoderma harzianum* @ 4g/kg with 40 kg/ha well rotten FYM and sown in 4 m x 3 m plot. Recommended agronomic package of practices were adopted during experimentation.Control plots were maintained without seed treatment and without soil application of bio-control agents.

Observations of the number of total plants and wilted plants were recorded at 20, 40 and 60 days after sowing (DAS) and the per cent of mortality were calculated by using the formula:

$$\text{Mortality \%} = \frac{\text{Wilted plants}}{\text{Total plants}} \times 100$$

Result and Discussion

For screening under natural epiphytotics, a set of 90 test entries 64 from initial varieties and advanced varieties and 26 entries advanced breeding line were screened against wilt, alternaria blight, powdery mildew and rust under natural condition. Out of which, disease free (F) and highly susceptible (HS) germplasm were not found. Only 11 test entries RL-29210, RLC-153, BAU-15-06, RC-1007,RLC-151,RLC-153,RLC-157, SLS-101,SLS-106, NDL-2014-11 and BAU-06-03 recorded multiple resistant reaction, 20 test entries shows moderately resistant reaction, 16 moderately susceptible reaction and 29 shows susceptible reaction against Alternaria blight, powdery mildew, wilt and rust (Table 1). Fourteen test entries were poorly germinated during the experimentation. These lines also showed better response to seed yield and can be used as good donor to improvement for resistant varieties in linseed breeding programme. Kumar *et al.*, (2012) [5] also evaluated that out of fourteen parents one line, NP-72 and Tester T- 397 were found resistant evaluated against *Alternaria* blight under field conditions. Whereas seven lines namely RLC-33, RLC-24522, RL.2450, C-429, NPRR-137 Acc.no.2901 and RL-24109 and three testers viz, Padmini Jawahar- 23 and Jeevan were found moderately resistant.

Table 1: Reaction of linseed genotypes for multiple disease resistant reaction

Scale	Disease Intensity	Disease Reaction	No. of germplasm	Name of germplasma
0	0% infection	Disease Free (F)	NIL	
1	1-10% infection	Resistant (R)	11	RL-29210, RLC-153, BAU-15-06,RC-1007, RLC-151, RLC-153, RLC-157, SLS-101, SLS-106, NDL-2014-11 and BAU-06-03,
2	10.1-25% infection	Moderately Resistant (MR)	20	RL-29005, PCL-55, LCK-1404, SLS-101, NDL-2014-01, NDL-2011-33, RLC-154, RLC-155 RLC-148, RLC-147, KL-263, BAU-14-9, BAU-14-2, BAU-14-9, BAU-14-3, BAU-2012-1, BAU-13-1, SLS-104, OL-98-15-2,RLC-156,
3	25.1-50% infection	Moderately Susceptible (MS)	16	BAU-13-1, RLC-148, KL-263, NDL-2011-33, Kota Barani-4, LCK-1516, SLS-99, SLS-95, OL-8-2-7, Binwa, R-552,OL-08-2-7, SLS-98, RLC-147, LCK-1502, LCK-151. SJKO-36,
4	50.1-75% infection	Susceptible (S)	29	LCK- 1529, LCK-1508, NDL-2011-03, SLS-103, LSL-93, PKVNL-260, Polf-6, SJKO-49. Jabalpur -367, KL-169, NP-8, BAUP 101, BAUP 102, BRSL 102, LMS-2014-103, PCL-55, NL-287, SJKO-71, RKD-3, OLC-48, OLC-52, RKY-14, SJKO-71, RLC-49, LS-1, H-11, BAU-111-1, NP-121, NP-48,
5	Highly Susceptible (HS)	NIL		

An integrated disease management trial were formulated with the treatment includes seed treatment with fungicide (Thiram+ Bavistin) or biocontrol agents (*T. viride /T.harzianum*) alone and in combination with soil application of FYM enriched with and biocontrol agents (*T. viride /T.harzianum*) against untreated control. The result revealed that the minimum disease incidence of wilt (20.92 %) and maximum grain yield (726.39kg/h)was recorded on ST with *T.viride*@ 4g/kg+ soil appln of *T.viride* @4g/kg with 40 kg/ha well rotten FYM which was at par with ST with *T.harzianum* @ 4g/kg + + soil appln of *T.harzianum* @4g/kg with 40 kg/ha well rotten FYM recorded (26.67 %)disease incidence and (681.94kg/h) grain yield as compare to (56.67 %) wilt incidence and (501.39 kg/h) grain yield in untreated control (Table 2).

Table 2: Integrated management of wilt through fungicide and biocontrol agent

Treatments details	Disease Severity (%)	Grain Yield (Kg/ha)	Benefit Cost ratio
T1-Seed treatment with *T.harzianum* @4g/kg	34.58	618.06	
T2-Seed treatment with *T.viride*@ 4g/kg	32.75	651.39	1:11.26
T3-ST with *T. harzianum* @4g/kg + soil appln of T.*harzianum* @4g/kg with 40 kg/ha well rotten FYM	26.67	681.94	1:14.68
T4- ST with *T. viride* @4g/kg + soil appln of T.*viride* @4g/kg with 40 kg/ha well rotten FYM	20.92	726.39	1:7.68
T5-ST with Thiram + Bavistin (2g+1g/kg)	39.17	562.50	1:9.81
T6- ST with Thiram + Bavistin (2g+1g/kg) + soil appln of T.*harzianum* @4g/kg with 40 kg/ha well rotten FYM	30.58	659.72	1:5.70
T7- ST with Thiram + Bavistin (2g+1g/kg) + soil appln of T.*viride* @4g/kg with 40 kg/ha well rotten FYM	27.58	675.00	1:6.73
T8-Control (untreated and unsprayed check)	56.67	501.39	1:7.51
SEm	2.49	33.63	
CD at 5%	7.62	103.63	
CV	12.23	9.18	

Successful and potential use of bio control agents against several diseases including *Fusarium wilt* as component of integrated disease control system was reported by Lynch and Ebben, (1986) [3]. Akhtar *et al.*, (1982) [1] reported that addition of the antagonist *Trichoderma harzianum* before sowing effectively reduced the incidence of *Fusarium oxysporum* f.sp. *lini*. Jayarajan and Ramakrishnan (1995) [2] used a talc based formulation of *Trichoderma viride* for dry seed treatment of oilseeds and pulses. As a result of seed treatment, the plants recorded improved growth and higher population of *Trichoderma viride* throughout the growing period indicating its high rhizosphere competence. Singh *et al.* (2008) [9] conducted a field experiment in Kanpur, during the *Rabi*, 1999-2000 and 2000-01 and evaluate The efficacy of the *Trichoderma viride* at 4 g/kg, *T. harzianum* at 4 g/kg, *T. viride* + *T. harzianum* + thiram at 4 g/kg, *T. viride* + Thiram, *T. harzianum* + Thiram, Thiram at 4 g/kg, *T. harzianum* + *T. viride* at 4 g/kg each, and FYM [farmyard manure] at 5 t/ha. All treatments significantly increased plant density and seed yield, and reduced disease incidence over the control. 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%).

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