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Evaluation of suitable varieties against wilt of linseed caused by *Fusarium oxysporum* f.sp. *lini* (Bolley) Snyder & Hansen

Akash Singh, Narendra Singh, Abhishek Singh, Rahul Singh Raghuvanshi, Ankur Tripathi and Shivam Singh

Abstract
Among the oilseed crops grown during *Rabi*, linseed (*Linum usitatissimum* L.) is next in importance to rapeseed and mustard in area as well as in production. In industrial oil production, it ranks first in the country. The cultivation of the crop as such goes back to more than 5000 years. Linseed is one of the predominant industrial oilseed crops grown in temperate climate. Oil of linseed crop is rich in α-linolenic acid (ALA) because of this linseed oil readily polymerizes on exposure to oxygen, making it useful for a variety of industrial products. In India it is cultivated mainly at central India, although it's cultivated in patches are spread from Himalaya in north to Karnataka in south. In India it grown mainly for commercial oil but in European & American countries it is cultivated for fiber. Linseed is plant grown as winter crop. The experiment was conducted under wilt sick field condition at Nawabganj, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) In Randomized Block Design (RBD) during 2019-20, Eleven cultivars namely, Jeevan, Sweta, Parvati, Surbhi, NDL-2004-05, Kiran, RLC-92, Indira Alsi, Dipika, Shekhar including susceptible cultivar Chambal were sown in the month of October, 2019 in three replication having plot size of 3 m x 1.5 meter with plant to plant spacing of 25 cm x 10 cm. Field experiments conducted during 2016-2017 for the management of wilt of linseed (*Linum usitatissimum* L.), eleven varieties namely, Jeevan, Sweta, Parvati, Surbhi, NDL-2004-05, Kiran, RLC-92, Indira Alsi, Dipika, Shekhar including susceptible cultivar Chambal were sown in the month of October, 2016. Out of 11 varieties, the maximum initial plant population (537.67 and 516.33/ plot) was noted with Shekhar followed by NDL-2004-05 respectively. Susceptible check Chambal has average initial plant population of 490.67/plot after germination. The minimum percentage of wilting was recorded in cultivar RLC-92 (6.66 percent) followed by Jeevan (8.97 percent) and Indira Alsi (9.57 Percent), respectively but all were at par statistically.

Keywords: *Linum usitatissimum* L, *fusarium*, genotypes, resistant, wilt of linseed

Introduction
Among the oilseed crops grown during *Rabi*, linseed (*Linum usitatissimum* L.) is next in importance to rapeseed and mustard in area as well as in production. It is the nation's top producer of industrial oil. The crop has been grown as a crop for more than 5000 years. One of the most common industrial oilseed crops grown in temperate climates is linseed. Because linseed oil easily polymerizes when exposed to oxygen due to its high content of -linolenic acid (ALA), it is beneficial for a range of industrial goods. Although it is grown in spots from the Himalaya in the north to Karnataka in the south, the most of it is grown in central India. It is primarily farmed for commercial oil in India, but for fibre in European and American nations. Plants are planted for linseed as a winter crop. The optimal temperature for vegetative and reproductive phase is between 21 and 27 °C. High temperature (above 32°C) accompanies with moisture stress during flowering stage reduces the seed yield. Linseed is cultivated in four agro-climatic zones of India *viz*. Zone I: Himachal Pradesh, Punjab, Haryana, J&K, Zone II: Uttar Pradesh excluding Bundelkhand, Bihar, Jharkhand, West Bengal, Assam & Nagaland, Zone III: Bundelkhand area of Uttar Pradesh, Madhya Pradesh & Rajasthan and Zone IV: Chhattisgarh, Odisha, Maharashtra & Karnataka. The annual area under the cultivation of linseed in the world is 2,764,340 hectares with total production of 2,925,282 tonnes, giving the average yield of 1058.2 kg/ha. Cultivation of linseed in India accounts for about 293,000 hectares with seed production of 125,000 tonnes and national average yield of 426.6 kg/ha (FAOSTAT, 2016).

The important biotic stresses affecting this crop are wilt, powdery mildew, rust and Alternaria blight (Kolte and Fitt, 1997). Among biotic stresses linseed wilt incited by *Fusarium oxysporum* f. sp. lini is the most destructive disease. Linseed wilt was first reported in Madhya Pradesh at 1923. Since then, it has been found in other linseed growing areas of the country (Rae, 1926) [8]. Sattar and Hafiz (1952) reported losses by wilt disease in linseed crop up to 80% under favourable conditions and appeared epidemic in 1952 at the Govt. research form Kanpur.

Wilt of linseed is a soil borne disease. Housten & Knowles (1949) demonstrated that this pathogen survived in the field even where no flax cultivation was done for the past fifty years. Anwar (1949) [1] revealed that it was tolerant to soil antagonists such as *Trichoderma lingolum*. As the disease is soil borne, development of wilt resistant varieties appear to be the only solution of this problem. The study of inheritance of *Fusarium oxysporum* f. sp. *lini* in linseed is important for development of resistant varieties. Some studies on inheritance of resistance reported earlier had shown various gene action involved, indicating the complicated inheritance behavior for resistance. Goray *et al*. (1987) [3].

Material and method

The experiment was carried out in a wilt-sick field at the C. S. Azad University of Agriculture and Technology in Kanpur, Uttar Pradesh. In 2019–20, using Randomised Block Design (RBD), Eleven cultivars, including the susceptible cultivar Chambal, were sown in three replications with a plot size of 3 metres by 1.5 metres and a plant to plant spacing of 25 centimetres by 10 centimetres in the month of October 2019. These cultivars included Jeevan, Sweta, Parvati, Surbhi, NDL-2004-05, Kiran, RLC-92, Indira Alsi, Dipika, and Shekhar. To ensure a successful crop, recommended agronomic practises (fertilisers of 80 kg N and 40 kg P/ha irrigation) were used. Crops were kept an eye out for any signs of disease. Each variety's maximum disease severity as well as the amount of seeds produced per plot (kg) were recorded separately.

Table 1: Evaluation of different varieties against wilt of linseed

Varieties	Initial Plant Population	Final plant population	No. of Wilted Plant	% plant wilted	Seed yield per plot (kg)	Seed yield (kg/ha.)
Jeevan	495.250	458.050	41.100	8.970	396.000	878.710
Chambal	493.670	456.600	350.450	76.750	116.000	257.640
Sweta	520.300	481.250	290.250	60.310	129.000	287.860
Parvati	515.330	476.630	221.450	46.460	151.000	334.700
Surbhi	501.690	464.100	75.800	16.330	350.000	777.450
Shekhar	440.330	407.270	311.450	76.470	91.000	199.950
NDL-2004-05	519.350	480.350	61.330	12.770	417.000	928.810
Kiran	512.500	474.020	165.400	34.890	213.000	472.460
RLC-92	515.450	476.750	31.150	6.660	460.000	1017.220
Indira Alsi	512.363	473.580	45.300	9.570	403.000	895.310
Dipika	516.350	477.580	50.150	10.500	421.000	935.350
G.M.	503.840	5.2153	149.4400	32.7000	286.0900	
SE (m)	6.9532	7.3744	3.4803	0.5222	1.7402	
SE (d)	9.8317	10.4274	4.9214	0.7384	2.4607	
C.D.	20.5165	15.3885	10.2697	1.5409	1.0544	
C.V.	2.3903	1.9380	4.0339	2.7658		

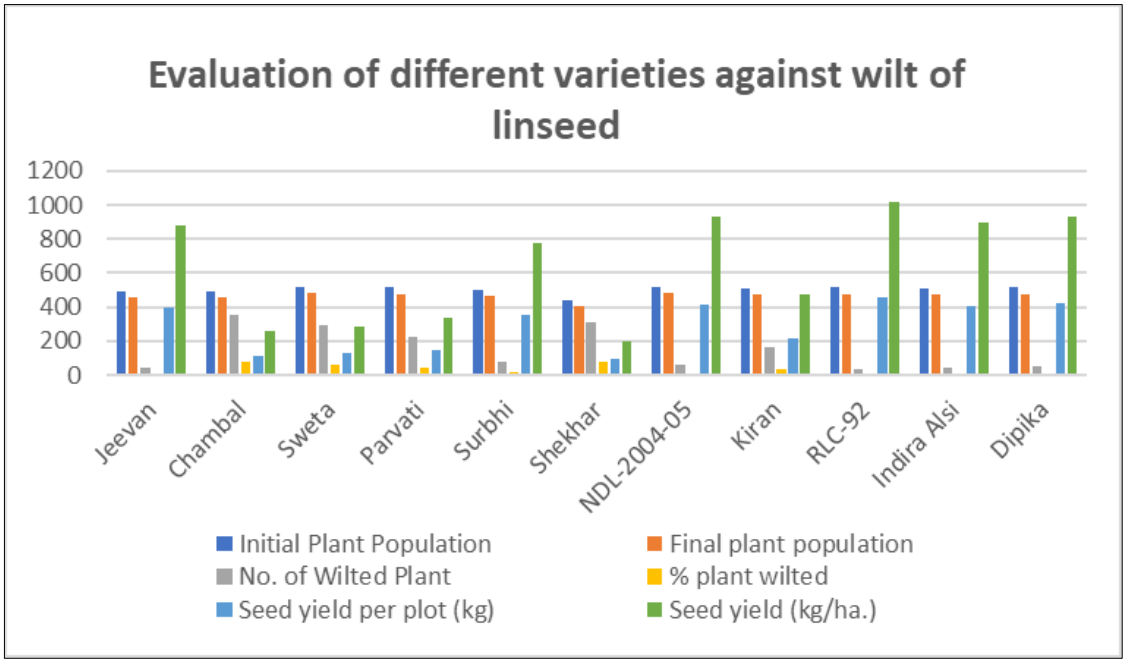

Fig 1: Shows the evaluation of different varieties against wilt of linseed

Result and Discussion

The studies were carried out to find the suitable variety against Fusarium wilt of linseed. Eleven cultivars namely, Jeevan, Sweta, Parvati, Surbhi, NDL-2004-05, Kiran, RLC-92, Indira Alsi, Dipika, Shekhar including susceptible cultivar Chambal were sown in the month of October, 2016, under well-developed sick field conditions. The data presented in the Table 1 and Figure 1 showed that the initial plant population was noted after germination in each cultivar. Average initial plant population per plot in different cultivars was noted in between 490.50 to 537.67 plants/plots, maximum being in Shekhar and minimum in Jeevan. Susceptible check Chambal has average initial plant population of 493.67/plot after germination. Wilting of the plants started in different cultivars after 15 to 20 days of sowing, which gradually increased up to maturity of crops. The minimum percentage of wilting was recorded in cultivar RLC-92 (6.66 percent) followed by Jeevan (8.97 percent) and Indira Alsi (9.57 Percent), respectively but all were at par statistically. Maximum percent wilting was recorded in susceptible cultivar Chambal (76.75 Percent) followed by Shekhar (76.47 Percent), Sweta (60.31 Percent), and Parvati (46.46 Percent). The latter were also at par among them. Maximum seed yield of 935.35 kg/ha was recorded in cultivar Dipika followed by NDL-2004-05 (928.81 kg/ha) and Indira Alsi (895.31 kg/ha), respectively, which was significantly higher over others. Yields of Indira Alsi and Jeevan were also significantly higher over other test cultivars. Minimum yield was recorded in Shekhar (199.95 kg/ha) followed by Chambal (257.64kg/ha), Sweta (287.86kg/ha) and Parvati (334.7kg/ha) respectively (Table 1 & Fig 1). Statistically all these were at par among them. Singh and Singh (2011) [9] also evaluated commercially grown cultivars namely Jawahar-23, Jeevan, Kiran, Padmini, R-552, Surbhi, Type-397 and Chambal against wilt disease under sick field condition for evaluation of their resistance and yield concurrent with present findings. They have also reported Jeevan and Surbhi as resistant and moderately resistant respectively with higher yield. However, in present finding NDL-2004-05 gave maximum yield (955.55 kg/ha) and showed resistant reaction. The cultivar Jeevan and Surbhi were reported resistant by Kishor *et al*., (2011) from Faizabad also. These cultivars may be sown in wilt prone areas of different genotypes/cultivars by different workers time to time (Goel and Swarup, 1964; Kulkarni *et al*., 1966; Pant *et al*., 2001) [2, 5, 7].

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