

## Screening of Linseed Germplasm for Resistance/Tolerance against *Fusarium oxysporum* F Sp. Lini (Bolley) Disease

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### Abstract

Absence of resistance/tolerance against diseases and insect pests in linseed (*Linum usitatissimum* L.) varieties is one of the main reasons for their low yield in India. During the summer season, *Fusarium oxysporum* f sp. *lini* epidemic damage the crop in most of the linseed seed growing area. For the purpose of identifying resistance/tolerance in linseed germplasm, a disease screening in trial, comprising of 200 test entries was developed. Screening was done under natural conditions in 2012 at C.S.A. University of agriculture and technology Kanpur. Out of 200 germplasm, 116 resistances, 51 moderately resistant, 30 moderately susceptible, 3 susceptible and 1 germplasm highly susceptible were found.

**Keywords:** Resistance; Germplasm; Screening; *Fusarium oxysporum* f sp. *lini*.

### Introduction

Cultivated Flax (*Linum usitatissimum* L.), commonly known as 'linseed' or 'alsi' is a extensively cultivated oilseed crop. It is one of the oldest cultivated crops, grown either for fiber or oil. Fiber is obtained from flax straw and used to make paper and linen, while the oil is attained from the seeds and has been used in the production of oil which is used in the industries as well as domestically [1]. In industries oil is used for the manufacturing of paints, varnish, oil cloth, linoleum, printing ink etc. The oil cake is used as manure to maintain the fertility level as well as agent against soil born pathogen. The productivity of this important oil seed crop is very low in India. Among various factors responsible for lowering down its yield, diseases are important one. The most important disease which stand out is, wilt caused by *Fusarium oxysporum* f sp. *lini*. Causes significant yield loss [2]. Besides loss in seed yield, it reduces the quality of the seed also [3]. However the resistance among varieties can differ due to the variability of pathogen races in different geographical regions with varying temperature and environmental conditions [3,4].

### Material and Methods

In case of soil-borne disease such as wilt, use of resistant germplasm varieties is the most economic and ecofriendly method of management. Keeping in view the importance of this method, 'the study was conducted under field condition in the wilt sick plot of Nawabganj Research farm. A set of 200 germplasm varieties of linseed received from project coordinating unit (Linseed) (P.C. unit) situated at C.S. Azad University of Agriculture and Technology, Kanpur were screened for resistance against the pathogen. Each germplasm variety under test was sown in 2.5 meters long, single row, 25 cm apart, in rod row design A highly susceptible variety (Chambal) was planted after every 6<sup>th</sup> row of test entries. Fertilizer application, irrigation, weeding and other intercultural operation were done as per the normal recommended practice. The total numbers of plants in each row were counted for initial plant stand wilting of plants was carefully monitored right after emergence of seeding to crop maturity. The final wilt incidence was calculated by deducting the number of plants survived from the initial crop stand. The percentage of wilting was calculated using the following formula:

$$\text{Percentage wilt incidence} = \frac{\text{Number of wilted plants}}{\text{Total plant population}} \times 100$$

The following rating scale was used for grouping of resistance and susceptibility to categories the germplasm/varieties (Table 1).

### Result and Discussion

The linseed germplasm/varieties against *F. oxysporum* f. sp. *lini* interaction presented in Table 2. revealed that out of the two hundred germplasm tested in which 116 germplasm/ varieties i.e. T-397, No-7, No-11, Pol F-16, RLC-23, Polf-25, RLC-52, LC-2021, LCK-9303, LCK-9320, S-801, JLT-26, KL-134, LCK-9324, LCK-9436, EC-1398, EC-1402, EC-1497, EC-1352, EC-9204, EC-9828, EC-23595, EC-322659, EC-322681, EC-199749, SJKO-6, SJKO-7, SJKO-18, SJKO-60, SJKO-62, SJKO-63, RSJ-29, RJK-20, NP (RR)-44, ES-1476, Barmer, ES-16381, GS-51, H-5, JLS293, JRF-3, POLF-23, 1406 LCK-87312, LCK-8722, No.294, 1420 LMH-21, NP-40, POLF-30, POLF-39, LC-

| S.No. | Wilting percentage | Scale                  | Abbreviation |
|-------|--------------------|------------------------|--------------|
| 1.    | No wilting         | Immune                 | I            |
| 2.    | 0.1-10%            | Resistant              | R            |
| 3.    | 10.1-25%           | Moderately resistant   | MR           |
| 4.    | 25.1-50 %          | Moderately susceptible | MS           |
| 5.    | 50.1-75%           | Susceptible            | S            |
| 6.    | 75 % and above     | Highly susceptible     | HS           |

**Table 1:** Rating scale was used for grouping of resistance and susceptibility to categories the germplasm/varieties.

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| S. No. | Name of germplasm   | Disease incidence | Scale | S. No. | Name of germplasm | Disease incidence | Scale |
|--------|---------------------|-------------------|-------|--------|-------------------|-------------------|-------|
| 1.     | EC-9826             | 17                | MR    | 101.   | EC-322646         | 9.25              | R     |
| 2.     | EC-41656            | 9.28              | R     | 102.   | EC-822659         | 1.76              | R     |
| 3.     | FR-3                | 17.50             | MR    | 103.   | EC-822681         | 2.49              | R     |
| 4.     | Kanpur 41/2         | 9.58              | R     | 104.   | EC-199749         | 1.98              | R     |
| 5.     | GS-204              | 25.49             | MS    | 105.   | SJKO-2            | 34.69             | MS    |
| 6.     | GS-232              | 38.00             | MS    | 106.   | SJKO-6            | 2.76              | R     |
| 7.     | GS-344              | 8.95              | R     | 107.   | SJKO-7            | 3.55              | R     |
| 8.     | GS-362              | 14.37             | R     | 108.   | SJKO-10           | 26.66             | MS    |
| 9.     | H-22                | 8.14              | R     | 109.   | SJKO-18           | 2.69              | R     |
| 10.    | H-42                | 10.06             | MR    | 110.   | SJKO-22           | 7.00              | R     |
| 11.    | HY-38               | 26.87             | MS    | 111.   | SJKO-25           | 14.77             | MR    |
| 12.    | LCFR-7              | 29.46             | MS    | 112.   | SJKO-60           | 3.96              | R     |
| 13.    | ILS-169             | 8.13              | R     | 113.   | SJKO-62           | 2.78              | R     |
| 14.    | KL-31               | 41.00             | MS    | 114.   | SJKO-63           | 3.84              | R     |
| 15.    | Jabalpur local      | 13.6              | MR    | 115.   | RSJ-29            | 3.98              | R     |
| 16.    | KL-176              | 8.0               | R     | 116.   | KL-225            | 13.00             | MR    |
| 17.    | Kangra local        | 5.47              | R     | 117.   | RKY-9             | 5.56              | R     |
| 18.    | Kala-2              | 54.00             | S     | 118.   | RKY-15            | 9.15              | R     |
| 19.    | KP-4                | 66.66             | S     | 119.   | RJK-20            | 3.46              | R     |
| 20.    | KP-13-13            | 17.20             | MR    | 120.   | NP (RR)-44        | 3.00              | R     |
| 21.    | L-35                | 18.23             | MR    | 121.   | ES-1462           | 5.17              | R     |
| 22.    | L-36                | 12.00             | MR    | 122.   | ES-1476           | 1.96              | R     |
| 23.    | Mayur Bhanjan Local | 9.79              | R     | 123.   | Barner            | 4.00              | R     |
| 24.    | LCK-11              | 10.15             | MR    | 124.   | ES-16381          | 3.25              | R     |
| 25.    | LCK-41              | 45.00             | MS    | 125.   | FRU-12            | 5.75              | R     |
| 26.    | LCK-8504            | 11.30             | MR    | 126.   | C.F. Lalhi FC     | 6.10              | R     |
| 27.    | LCK-88311           | 9.25              | R     | 127.   | GS-51             | 4.20              | R     |
| 28.    | LS-3                | 7.25              | R     | 128.   | Nagar Kot         | 7.49              | R     |
| 29.    | NP (RR)-18          | 7.64              | R     | 129.   | Kiran             | 10.00             | R     |
| 30.    | MS-3                | 48.11             | MS    | 130.   | EC-384154         | 8.44              | R     |
| 31.    | MS-4                | 32.00             | MS    | 131.   | H-8               | 14.33             | MR    |
| 32.    | NCL-3512            | 10.50             | MR    | 132.   | H-10              | 15.67             | MR    |
| 33.    | T-397               | 3.00              | R     | 133.   | R-204 x4129       | 14.00             | MR    |
| 34.    | No-7                | 2.96              | R     | 134.   | ECL-27            | 5.36              | R     |
| 35.    | No-11               | 2.00              | R     | 135.   | H-43              | 10.27             | MR    |
| 36.    | No-16               | 6.59              | R     | 136.   | JRF-1 (8)         | 5.39              | R     |
| 37.    | No-18               | 13.10             | MR    | 137.   | GS-401            | 11.33             | MR    |
| 38.    | No-22               | 9.50              | R     | 138.   | GS-407            | 12.52             | MR    |
| 39.    | No-348              | 7.50              | R     | 139.   | H-5               | 3.47              | R     |
| 40.    | NP-19               | 8.53              | R     | 140.   | H-II              | 14.55             | MR    |
| 41.    | NP-47               | 46.70             | MS    | 141.   | H-12              | 13.10             | MR    |
| 42.    | NP-26               | 6.57              | R     | 142.   | H-17              | 15.12             | MR    |
| 43.    | NP-115              | 37.80             | MS    | 143.   | H-15              | 12.52             | MR    |
| 44.    | NPHY-38             | 15.50             | MR    | 144.   | H-24              | 35.20             | MS    |
| 45.    | POLF-5              | 31.90             | MS    | 145.   | H-25              | 8.40              | R     |
| 46.    | POLF                | 27.92             | MS    | 146.   | Meera             | 14.35             | MR    |
| 47.    | OP-2-2              | 28.15             | MS    | 147.   | ICAR-2            | 5.72              | R     |
| 48.    | POLF-2              | 14.96             | MR    | 148.   | JLS-293           | 4.96              | R     |
| 49.    | POLF-16             | 5.00              | R     | 149.   | JRF-3             | 2.55              | R     |
| 50.    | POLF-17             | 8.75              | R     | 150.   | POLF-23           | 4.16              | R     |
| 51.    | POLF-36             | 7.10              | R     | 151.   | KL-168            | 38.00             | MS    |
| 52.    | RL-8-1              | 5.25              | R     | 152.   | KS-169            | 43.19             | MS    |
| 53.    | RL-39-4             | 8.00              | R     | 153.   | KP-8              | 19.20             | MR    |
| 54.    | RLC-23              | 3.96              | R     | 154.   | L-18              | 5.42              | R     |
| 55.    | P-650               | 5.85              | R     | 155.   | No.6<br>LCK-87312 | 5.00              | R     |
| 56.    | POLF-33             | 13.10             | MR    | 156.   | LCK-8722          | 4.54              | R     |
| 57.    | RLC-3               | 7.00              | R     | 157.   | No.-294           | 4.36              | R     |
| 58.    | RLC-7               | 6.49              | R     | 158.   | ES-44             | 39.10             | MS    |
| 59.    | RLC-34              | 8.00              | R     | 159.   | L-43              | 36.79             | MS    |

|      |             |       |    |      |              |       |    |
|------|-------------|-------|----|------|--------------|-------|----|
| 60.  | OR-I-4      | 6.20  | R  | 160. | LCK-152      | 37.15 | MS |
| 61.  | F-42        | 24.72 | MR | 161. | LCK-9436     | 21.00 | MR |
| 62.  | POLF-11     | 14.28 | MR | 162. | LCK-852      | 6.75  | R  |
| 63.  | POLF-34     | 6.30  | R  | 163. | 1420 MH- 21  | 1.50  | R  |
| 64.  | POLF-25     | 3.00  | R  | 164. | 40-41-561    | 34.12 | MS |
| 65.  | POLF-30     | 20.10 | MR | 165. | 40-41-562    | 38.47 | MS |
| 66.  | R-552       | 5.75  | R  | 166. | NP-40        | 5.00  | R  |
| 67.  | RLC-52      | 3.43  | R  | 167. | NP-65        | 31.20 | MS |
| 68.  | 5-93-3      | 18.00 | MR | 168. | NP-66        | 26.19 | MS |
| 69.  | 5-91.35     | 60.00 | S  | 169. | NP-71        | 6.54  | R  |
| 70.  | Sagar Local | 7.15  | R  | 170. | Rashmi       | 22.73 | MR |
| 71.  | 4-6         | 7.58  | R  | 171. | NP-112       | 26.55 | MS |
| 72.  | KL-1        | 11.20 | MR | 172. | NPHY-37      | 39.09 | MS |
| 73.  | LC-2014     | 6.00  | R  | 173. | POLF-15      | 7.56  | R  |
| 74.  | LC-2021     | 2.96  | R  | 174. | POLF-129     | 10.25 | MR |
| 75.  | LC-2032     | 5.45  | R  | 175. | PKY-2        | 11.00 | MR |
| 76.  | LC-2127     | 20.33 | MR | 176. | POLF-30      | 3.47  | R  |
| 77.  | LC-2045     | 7.14  | R  | 177. | POLF-39      | 4.10  | R  |
| 78.  | LCK-9303    | 3.49  | R  | 178. | NP (RR)-193  | 16.00 | MR |
| 79.  | LCK-9320    | 3.63  | R  | 179. | 67-RLC-45    | 10.72 | MR |
| 80.  | RLC-55      | 6.92  | R  | 180. | LC-2002      | 1.43  | R  |
| 81.  | S-91-11     | 42.00 | MS | 181. | LC-2023      | 25.59 | MS |
| 82.  | S-91-25     | 7.33  | R  | 182. | LC-2057      | 9.52  | R  |
| 83.  | S-801       | 3.10  | R  | 183. | S-91-26      | 18.61 | MR |
| 84.  | Sirmor-2    | 6.30  | R  | 184. | KL-178       | 16.70 | MR |
| 85.  | Jabalpur-9  | 5.00  | R  | 185. | LCK-9414     | 1.75  | R  |
| 86.  | JLT-26      | 3.22  | R  | 186. | RL-56-6-2    | 4.84  | R  |
| 87.  | KL-134      | 3.10  | R  | 187. | RL-903       | 23.15 | MR |
| 88.  | KL-168      | 44.00 | MS | 188. | KFS-11       | 14.92 | MR |
| 89.  | LC-2057     | 12.72 | MR | 189. | LCK-8504     | 9.15  | R  |
| 90.  | LCK-9119    | 6.74  | R  | 190. | SJKO-17      | 20.52 | MR |
| 91.  | LCK-9312    | 8.18  | R  |      | Chambal (SC) | 78.3  | HS |
| 92.  | LCK-9324    | 4.44  | R  | 191. | SJKO-20      | 10.49 | MR |
| 93.  | LCK-9436    | 2.43  | R  | 192. | SJKO-42      | 6.22  | R  |
| 94.  | EC-1398     | 3.15  | R  | 193. | EC-41590     | 4.24  | R  |
| 95.  | EC-1402     | 1.43  | R  | 194. | BRM-13       | 2.89  | R  |
| 96.  | EC-1497     | 2.20  | R  | 195. | S-91-25      | 5.00  | R  |
| 97.  | EC-1352     | 2.49  | R  | 196. | KL-217       | 10.29 | MR |
| 98.  | EC-9204     | 1.96  | R  | 197. | KL-220       | 12.55 | MR |
| 99.  | EC-9828     | 2.15  | R  | 198. | KL-221       | 4.45  | R  |
| 100. | EC-23595    | 1.66  | R  | 199. | KL-223       | 3.72  | R  |
|      |             |       |    | 200. | KL-227       | 7.84  | R  |

Abbreviation: R: Resistant, MR: Moderately Resistant, MS: Moderately Susceptible, S: Susceptible, HS: Highly Susceptible

**Table 2:** Reaction of linseed germplasm/varieties against *Fusarium oxysporum* f. sp. *lini* (2010-11).

2002, LCK-9414, RL-56-6-2, EC-41590, S-91-25, KL-221, KL-223, EC-41656, Kanpur 41/2, GS-344, H-22, ILS-169, KL-176, Kangra local, Mayerbhanj local, LCK88311, LS-3, NP (RR)-18, No.16, No-22, No-348, No-19, NP-26, Polf-17, Polf-36, RL-8-1, RL-39-4, P-650, RLC-3, RLC-7, RLC-34, OR-I-4, Polf-34, R-552, Sagar local, 4-6, LC-2014, LC-2032, LC-2045, RLC-55, S91-25, SIRMOR-2, LCK-9119, LCK9312, EC-322646, SJKO-22, Pky-9, Pky-15, ES-1462, FRW-12, C.F. Lalhi FC, Nagar Kot, EC-384154, ECL-27, JRF-1, H-25, ICAR-2, L-18, LCK-852, NP-71, POLF-15, LC-2057, LCK-8504, SJKO-42 and KL-227 were found to be resistant to disease as the disease incidence in these cultivars were below 10 percent disease intensity. 51 cultures including some of the promising varieties like Kiran R-552 (EC-9826, FR-3, GS-362, H-42, Jabalpur local, KP-1313, L-35, L-36, LCK-11, LCK-8504, Rashmi, NCL-3512, No.-18, NPHY-38, POLF-2, POLF-33, P-42, POLF-11, POLF-30, 5-93-3, KL-1, LC-2127, SJKO-25, KL-225, H8, H-10, R-204 x 4129, H-43, GS-401, GS-407, H-II, H12, H-17,

H-15, Meera, KP-8, LCK-9436, POLF-129, RKY-2, NP (RR)-193, 67-RLC-45, S-91-26, KL-178, RL903, KFS-11, SJKO-17, SJKO-20, KL-217, JKL-220, KL229), fell in moderately resistant category. 30 genotypes i.e. GS-204, GS-232, HY-38, LCFR-7, KL-31, LCK-41, MS-3, MS-4, NP-47, NP-115, POLF-5, POLF-19, OP-2-2, S-9111, KL-168, SJKO-2, H-24, KL-168, KU-169, L-43, LCK152, 40-41-561, NP-65, NP-66, NP-112, NPHY-37 and LC2023 were found moderately susceptible which were shown 10.1-25% Disease intensity, 3 germplasm/ varieties were found susceptible i.e. Kala-2, KP-4, 5-91-35 these germplasm were shown 25.1-50% Disease intensity and the genotype 'Chambal' highly susceptible which shown 50-75% disease intensity.

The results revealed that out of the two hundred germplasm tested, 116 germplasm/varieties were found to be resistant to disease incidence in these cultivars was below 10 percent.

Use of resistant varieties is most economical, feasible and safe

method to manage the disease. Keeping in view two hundred varieties/germplasm of linseed were screened in wilt sick plot. Tested genotypes were categorized into resistant, moderately resistant, moderately susceptible, susceptible and susceptible as per incidence of wilt. However, some of the high yielding improved varieties reported [5] (Kerkhi et al.) to be resistant to wilt were found moderately resistant and moderately susceptible in the present study.

The disease was characterized by rolling and withering of cotyledons when disease appeared at seedling stage, and young seedlings collapsed on ground. In grown up plants, dark green to brown patches appeared on leaves. The leaves shriveled later on dropping off symptoms from tip of the plant and drying of leaves and stem, discoloration of the vascular tissues were the similar symptoms to wilt caused by *Fusarium oxysporum* f. sp. *Lini* as reported by similar workers [6,7].

### Conclusion

A survey was conducted to know the occurrence and distribution of linseed wilt in Kanpur. The highest incidence (9%) was recorded at Gopalpur (Bithoor) followed by Aliapur (Ghatampur) Kanpur. Overall wilt percentage was recorded about (0-9%) in fields where linseed was not grown earlier and (10-37%) in wilt sick field.

The screening of two hundred germplasm /varieties of linseed was carried out under artificial epiphytotic condition in the wilt sick nursery. Out of which viz., 116 were found to be resistant, 51 were moderately resistant, 30 moderately susceptible and 3 were susceptible and 1 was highly susceptible as found in the study.

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