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## Evaluations on resistance genotypes against wilt of linseed caused by *Fusarium oxysporum* f. sp. *lini* (Bolley) Synd. and Hans

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### Abstract

Linseed (*Linum usitatissimum* L.), also known as flax, is a member of the family Linaceae. The essential oils are Angiosperm plants species including herbs, shrubs, and tree; extracted by Clevenger Hydro distillation method. So, the present study was undertaken to evaluate the effects of some eco-friendly essential oils against *Fusarium oxysporum* f. sp. *lini*, by which we can improve the agricultural production of linseed. Screening of germplasm/varieties was made to find out the sources of resistance against *F. oxysporum* f. sp. *lini*. Screening was conducted on 46 available germplasm/varieties during 2019–2020 and 2020–2021 in rabi season of linseed under natural conditions. Out of total 46 entries, 1 cultivars were found to be resistant to disease as the disease incidence in these cultivars were between 0 and 10%. 12 cultivars fell in moderately resistant category with 10.1–25% wilt incidence. 8 genotypes were found moderately susceptible showing 25.1–50% disease incidence, 8 genotypes were found susceptible showing 50.1–75% and 17 genotypes were found highly susceptible to disease (above 75%).

**Keywords:** Linseed, Wilt, *Fusarium oxysporum* f. sp. *lini*, screening, resistance, susceptible

### Introduction

Linseed (*Linum usitatissimum* L.) is one of the most important extensively cultivated oilseed crop. Linseed oil is used for various industrial preparations and flax is used for preparing linen cloth in temperate countries. The crop encounters a number of diseases of fungal, bacterial, viral and nematode origin, which are responsible to take away a heavy toll of the crop loss every year. Among the fungal diseases of linseed, wilt caused by *Fusarium oxysporum* f.sp. *lini* (Bolly) Snyder and Hansen is a major constraint responsible for low production and productivity (Sharma *et al.* 2002)<sup>[6]</sup>. It damages the quality of seed (Damodaran and Hegde, 2005)<sup>[1]</sup>. On a global level, India occupies the first place in areas under cultivation; however, the productivity of this crop is very low, i.e. 407 kg/ha.

### Materials and methods

In the case of soil-borne diseases such as wilt, use of resistant varieties is the most economic and eco-friendly method of management. Keeping this in view, a set of 46 germplasm/varieties collected from All India Co-ordinating Research Project Unit (Linseed) were screened in a highly wilt sick field of at College of Agriculture, (IGKV) Raipur, during rabi seasons of 2019-20, 2020-21. Each germplasm/variety was sown in 3 m long single row, 45 cm apart in rod-row design. A highly susceptible (R-7) variety was planted after every ten rows of test entries. The crop was sown on November 2019 & November 2020 in the both year. Fertilizer application, irrigation, weeding and other intercultural operations were done as per the normal recommended practice. The experiment was conducted in three replications during both the years. Total numbers of plants per row were counted immediately after emergence. Wilting of plants was carefully monitored right after emergence of seedlings to crop maturity. The final wilt incidence was calculated by deducting the number of plants survived from initial crop stand. The percentage of wilting was calculated using the following formula:

$$PDI = \frac{\text{No. of plants wilted}}{\text{No. of total plant observed}} \times 100$$

The Percent mortality was calculated on the basis of these observations of wilted plants. The percent mortality was categorized in 0 to 5 scales as under:

| Disease Score | Grading                         | Mortality |
|---------------|---------------------------------|-----------|
| 0             | High Resistance                 | < 1       |
| 1             | Resistance                      | 1-10%     |
| 2             | Moderate resistance (Tolerance) | 10.1-25%  |
| 3             | Moderate susceptible            | 25.1-50%  |
| 4             | Susceptible                     | 50.1-75%  |
| 5             | High Susceptible                | 75.1-100  |

The location severity index (LSI) was calculated by using the following formula

$$LSI = \frac{\text{Sum of multiplication values of the score and the entries under different score}}{\text{Total number of entries observed}}$$

### Result and Discussion

Fourty six germplasm lines of linseed made available from the Department of Genetics and Plant Breeding were evaluated against *Fusarium* wilt under field conditions to find out the resistant sources. The experiment was performed at IGKV, Raipur during *rabi* seasons of 2019-20 and 2020-21 using susceptible check of variety R-7. Observations on Percent wilt incidence were recorded at pre flowering stage for categorization of the genotypes. Categorization of varieties was done in to different groups on the basis of wilt incidence as immune (no disease), resistant (1-10%), moderately resistant (10.1-25%), moderately susceptible (25.1-50%), susceptible (50.1-75%) and highly susceptible (above 75.1%).

Table 1 Shows that the wilt incidence in different linseed genotypes ranged from 0 to 100%. In susceptible check variety R-7 average wilt incidence during experimental year was 100%. Based on the standard rating scale for *Fusarium* wilt as described by Sharma *et al.* (1972) [6], the linseed

genotype were screened in the field. (Table 1) and (Plate 1). Amongst 46 genotypes screened, 1 genotypes *viz.*, 20204 were categorized as resistant (R). While 12 entries *viz.*, 20205, 20208, 20210, 20213, 20220, 20224, 20232, 20234, 20235, 20238, 20242 and 20247 were categorized as moderately resistant (MR). Beside these, 8 lines 20209, 20211, 20215, 20216, 20222, 20227, 20244 and 20246 showed average wilt incidence and categorized as moderately susceptible (MS), whereas 8 lines *viz.*, 20206, 20218, 20219, 20223, 20231, 20236, 20237 and 20245 were categorized as susceptible (S) and 17 lines *viz.*, 20201, 20202, 20203, 20207, 20212, 20214, 20221, 20225, 20226, 20228, 20229, 20230, 20233, 20239, 20240, 20243, 20248 were showed high wilt incidence was categorized as highly susceptible (HS). Location severity index calculated in 3.61 (Table- 2).

Many researchers on identifying the resistance sources against *Fusarium oxysporum* f. sp. *lini* in field conditions. Similarly Kumar *et al.* 2014 [4] 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.

Kisore *et al.* 2011 Out of total 78 entries, 27 cultures were found to be resistant to disease as the disease incidence in these cultivars were between 0 and 10%. Twenty-three cultivars fell in moderately resistant category with 10.1–25% wilt incidence. Nine genotypes were found moderately susceptible showing 25.1– 50% disease incidence, 14 genotypes were found susceptible showing 50.1–75% and 6 genotypes were found highly susceptible to disease (above 75%). Rest of the resistant/moderately resistant genotypes are the new record which can be utilized in future resistance breeding programme and these along with moderately susceptible genotypes may further evaluated for their agronomic characters with a view to release some of them as cultivars and may be used in wilt prone areas.

**Table 1:** Disease incidence (%) of wilt in differential germplasm against different isolates of *Fusarium oxysporum* f. sp. *lini*

| S. No. | Entries | Percent Disease Incidence |         | Mean  | Disease reaction |
|--------|---------|---------------------------|---------|-------|------------------|
|        |         | 2019-20                   | 2020-21 |       |                  |
| 1      | 20201   | 88.37                     | 88.54   | 88.45 | HS               |
| 2      | 20202   | 98.83                     | 96.41   | 97.62 | HS               |
| 3      | 20203   | 91.80                     | 94.20   | 93.00 | HS               |
| 4      | 20204   | 9.26                      | 8.08    | 8.67  | R                |
| 5      | 20205   | 12.60                     | 14.96   | 13.78 | MR               |
| 6      | 20206   | 75.21                     | 73.78   | 74.49 | S                |
| 7      | 20207   | 81.10                     | 83.48   | 82.29 | HS               |
| 8      | 20208   | 9.67                      | 11.13   | 10.40 | MR               |
| 9      | 20209   | 51.46                     | 47.85   | 49.66 | MS               |
| 10     | 20210   | 18.82                     | 21.44   | 20.13 | MR               |
| 11     | 20211   | 44.08                     | 54.65   | 49.37 | MS               |
| 12     | 20212   | 96.72                     | 94.44   | 95.58 | HS               |
| 13     | 20213   | 18.65                     | 22.09   | 20.37 | MR               |
| 14     | 20214   | 82.24                     | 80.12   | 81.18 | HS               |
| 15     | 20215   | 26.60                     | 31.23   | 28.91 | MS               |
| 16     | 20216   | 29.46                     | 32.29   | 30.87 | MS               |
| 17     | 20218   | 65.96                     | 65.08   | 65.52 | S                |
| 18     | 20219   | 63.89                     | 59.78   | 61.84 | S                |
| 19     | 20220   | 19.14                     | 20.24   | 19.69 | MR               |
| 20     | 20221   | 85.19                     | 86.67   | 85.93 | HS               |
| 21     | 20222   | 28.99                     | 27.12   | 28.05 | MS               |
| 22     | 20223   | 67.92                     | 65.89   | 66.91 | S                |
| 23     | 20224   | 12.26                     | 8.15    | 10.21 | MR               |

|     |       |        |        |        |    |
|-----|-------|--------|--------|--------|----|
| 24  | 20225 | 85.37  | 81.48  | 83.42  | HS |
| 25  | 20226 | 90.74  | 86.96  | 88.85  | HS |
| 26  | 20227 | 30.25  | 31.12  | 30.68  | MS |
| 27  | 20228 | 85.42  | 82.26  | 83.84  | HS |
| 28  | 20229 | 80.95  | 82.18  | 81.57  | HS |
| 29  | 20230 | 81.36  | 85.33  | 83.34  | HS |
| 30  | 20231 | 63.64  | 64.86  | 64.25  | S  |
| 31  | 20232 | 13.89  | 16.23  | 15.06  | MR |
| 32  | 20233 | 86.44  | 82.78  | 84.61  | HS |
| 33  | 20234 | 14.18  | 16.17  | 15.18  | MR |
| 34  | 20235 | 13.31  | 16.52  | 14.92  | MR |
| 35  | 20236 | 73.63  | 68.29  | 70.96  | S  |
| 36  | 20237 | 49.71  | 53.50  | 51.61  | S  |
| 37  | 20238 | 14.63  | 11.38  | 13.01  | MR |
| 38  | 20239 | 100.00 | 100.00 | 100.00 | HS |
| 39  | 20240 | 93.94  | 92.22  | 93.08  | HS |
| 40  | 20242 | 17.47  | 18.58  | 18.02  | MR |
| 41  | 20243 | 100.00 | 95.00  | 97.50  | HS |
| 42  | 20244 | 31.10  | 34.18  | 32.64  | MS |
| 43  | 20245 | 56.36  | 56.60  | 56.48  | S  |
| 44  | 20246 | 31.09  | 27.35  | 29.22  | MS |
| 45  | 20247 | 16.97  | 22.26  | 19.61  | MR |
| 46  | 20248 | 100.00 | 100.00 | 100.00 | HS |
| C-1 | R-7   | 100.00 | 100.00 | 100.00 | HS |

C-1= Check variety- R-7

**Table 2:** Screening of available linseed germplasm against *Fusarium oxysporum* f. sp. *lini* 2019-2020 and 2020-21

| Disease Score | Grading                         | Mortality | Total no. of germplasm line | Name of germplasm line  |
|---------------|---------------------------------|-----------|-----------------------------|---|
| 0             | High Resistance                 | < 1       | 0                           | -   |
| 1             | Resistance                      | 1-10%     | 1                           | 20204   |
| 2             | Moderate resistance (Tolerance) | 10.1-25%  | 12                          | 20205, 20208, 20210, 20213, 20220, 20224, 20232, 20234, 20235, 20238, 20242, 20247                                    |
| 3             | Moderate susceptible            | 25.1-50%  | 8                           | 20209, 20211, 20215, 20216, 20222, 20227, 20244, 20246,   |
| 4             | Susceptible                     | 50.1-75%  | 8                           | 20206, 20218, 20219, 20223, 20231, 20236, 20237, 20245  |
| 5             | High Susceptible                | 75.1-100  | 17                          | 20201, 20202, 20203, 20207, 20212, 20214, 20221, 20225, 20226, 20228, 20229, 20230, 20233, 20239, 20240, 20243, 20248 |
| Total         |                                 |           | 46                          |   |

Location Severity Index (LSI) = 3.61



**Plate 1:** Crop reaction to wilt disease (a) Experiment site (b) Highly susceptible (c) Susceptible (d) Moderately Susceptible (e) Moderately resistant (f) Resistant (g) Check line

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