Data Article

An account of Fusarium wilt resistance in flax *Linum usitatissimum*: The disease severity data

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**ABSTRACT**

A collection of flax accessions maintained by the Russian Federal Research Center for Bast Fiber Crops was characterized to evaluate its resistance to Fusarium wilt. 297 samples representing different morphotypes and selection status were infected with highly virulent M139 strain of *Fusarium oxysporum* f. sp. *lini*. Evaluation of disease symptoms was performed at the full emergence stage in a greenhouse. The experiment lasted for 3 successive years. The disease severity index (DSI) record was obtained for every genotype in each year of the experiment. The data set was produced in a framework of a project focused on both a) deciphering the mechanisms of plant immunity, and b) development of flax cultivars resistant to Fusarium wilt. The data is available via Figshare repository.

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Specifications Table

| Subject                                      | Agricultural and Biological Sciences (General) |
|---------------------------------------------|-----------------------------------------------|
| Specific subject area                      | Flax resistance to Fusarium wilt.             |
| Type of data                                | Table                                         |
| How the data were acquired                  | The accessions were evaluated under greenhouse conditions in three successive years, namely, 2019 – 2021. The seeds were planted into a container, in which the infection background was created by introducing a pure culture of MI39 Fusarium oxysporum f. sp. lini strain. The severity of disease symptoms was estimated at the full emergence stage by calculating the disease severity index (DSI) for every combination genotype/year. |

**Instruments:**
- Greenhouse
- Soil containers, where seeds were arranged in rows. Container dimension was 50x85x20 cm, distance between the seed hole centers: 5 cm.
- Laminar air flow cabinet FlowFAST H 12
- Analytical balance ViBRA HT-84RCE
- Tuttnauer 2540MK 220v Sterilizer
- **Shaker-incubator** ES-20 (BioSan, Latvia)

**Data format**
- Raw

**Description of data collection**
- Seeds of flax accessions were planted into containers on a 12 day after the inoculation with the pure culture of the highly virulent MI39 Fusarium oxysporum f. sp. lini strain. 16 seeds for each genotype were sowed. The nutritional area of a plant was 2.5 × 2.5 cm. Two genotypes, AP5 and I-7 were used as a Foli-susceptible and Foli-resistance controls. Plants were evaluated for disease symptoms at the full emergence stage.

**Data source location**
- Institution: Federal Research Center for Bast Fiber Crops
- City/Region: Torzhok/Tver Region
- Country/Russia
- Latitude and longitude for collected samples/data: 57°02’N, 34°58’E; Altitude: 165m

**Data accessibility**
- Repository name: Figshare
- Data identification number: 
- Direct URL to data: https://figshare.com/s/522224909a&c69695650

Value of the Data

- The data can be re-used to develop markers for marker-assisted selection.
- The data can be used in GWAS to identify candidate genes in control of plant immunity.
- Breeders can use the data to develop new cultivars resistant to Fusarium wilt.
- The data can be used to estimate the success of the modern breeding programs.
- Comprehensive characterization of a large collection of samples, which captures nearly all variation in flax.

1. Data Description

The data presented here incorporates records on resistance to Fusarium wilt observed in 297 flax (Linum usitatissimum L.) genotypes maintained by the Federal Research Center for Bast Fiber Crops (Torzhok, Russia) [1,2]. The dataset contains: 179 fiber flax accessions, 117 linseed (oil) flax accessions and 1 accession of unknown morphotype. Oil samples are further subdivided into four unique groups, namely: intermediate accessions – 98 samples, large-seeded accessions – 4 genotypes, and crown accessions – 15 specimens. Furthermore, the dataset contains accessions attributed to different selection status: landraces, elite cultivars and breeding lines. All genotypes, regardless of their selection status or group were infected with highly virulent MI39 strain of Fusarium oxysporum f. sp. lini (Foli) isolated from the straw of the Svetoch variety. Three independent trait evaluations were performed in 3 successive years (2019 – 2021). The disease severity index (DSI) was estimated for every genotype in each year of observations. To obtain
Table 1
Scale used to evaluate Fusarium wilt symptoms in individual plants.

| Scale value | Symptoms                                      |
|-------------|-----------------------------------------------|
| 0           | healthy plant                                 |
| 1           | partial plant browning or stem browning from one side |
| 2           | fully browned plant with bolls                |
| 3           | fully browned plant collapsed before the formation of bolls |

The DS1, first, the disease severity score (DSS) was determined for each plant. Second, the number of plants with the identical DSS was calculated for each genotype. The DSS was graded in accordance with the scheme where grades were set up in the following way (Table 1). The grade ranges from 0 to 3, where 0 value indicates a healthy plant, 1 stands for partial plant browning or stem browning from one side, 2 corresponds to a fully browned plant with bolls, and 3 to a fully browned plant, that collapsed prior to the formation of bolls.

2. Experimental Design, Materials and Methods

The accessions were evaluated for Foli resistance under greenhouse conditions in randomized complete block design.

The pure culture inoculum was prepared by first growing MI39 on beer-wort agar-agar medium with a subsequent incubation on the oat grain substrate (the grain to water ratio of 1 to 1.75) for 3–4 weeks; such a time period was sufficient for macro and microconidia development. After three to four weeks, when oats were completely infected by the fungus, the pathogen was introduced into the soil. The required amount of the introduced infection for a container (400g for a container of 50x85x20cm) was established experimentally. The indicator of the reliability of the infectious background was the standard varieties (resistant and susceptible genotypes), which were sown along the edges and in the middle of each container (16 seeds per row).

The pure culture was uniformly distributed over said container filled with soil up to 2/3 of its volume. Next, the container was further packed with soil to the brim. All containers were watered abundantly, covered with a plastic wrap and set aside for the development of Fusarium infection. Two genotypes, namely, AP5 and I–7 were used as a Foli-susceptible and Foli-resistance controls. The accessions were planted on a 12 day after the inoculation with the pure fungal culture.

Prior to sowing the soil was smoothened. A check mark indicating 1cm depth was placed into the container. The nutritional area of a plant was 2.5 × 2.5cm, the sowing depth was 1 cm. 16 seeds of each genotype were planted in a cross-container row; one seed per hole. Two rows all the way around the container perimeter were seeded with susceptible genotype AP5 thus forming a safety strip. Two rows of controls (i.e. one row of the resistant and one row of the susceptible cultivar), were planted in the middle, as well as along the edges of each container. The seeded part of the container was covered with dry sand spread through a sieve. The container was watered and covered with plastic wrap until germination to promote pathogen grow and plant infection. Plant care during the growing season consisted of systematic watering (by volume), weeding and selective phytoanalyses of dead plants.

Fusarium wilt in flax is manifested as follows: the plants turn brown (wilting), wither and die [2]. Infected young plants rot primarily at the stem extension stage; their leaves turn brown, shrink and fall off the plant. The roots deteriorate and, finally, the plant dies. In the case when disease manifests late in the life cycle of the plant (i.e. from the bud visible to late flowering stages) the browning of the stems is observed. Sometimes the browning is observed on the side of the stem, where it forms a solid dark brown stripe. These symptoms are accompanied by a delay in plant growth and premature ripening. As a result of severe disease plants turn brown,
dry out and die. In the case when flax plants do develop bolls, the seeds in them are puny or do not set at all.

Plants were evaluated for disease symptoms at the full emergence stage. The final assessment of the disease severity was carried out during the harvesting period in the phase of early yellow ripeness.

The phytopathological analyses were carried out as follows. First, the disease severity score (DSS) was estimated for each individual plant. Second, the number of plants with the identical DSS was determined for each genotype, which was replicated 16 times. The disease severity index (DSI) was calculated for each genotype using the standard formula accepted in phytopathology [3]:

\[ DSI = \frac{\sum ab}{AK} \times 100\% , \]

where

a - is the number of plants with an estimated DSS,
b – the estimated DSS for an individual plant,
A is the total number of plants, and
K is the largest DSS grade (i.e. 3).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

CRediT Author Statement

Tatyana Rozhmina: Conceptualization, Funding acquisition, Data curation, Methodology, Writing – original draft; Anastasia Samsonova: Writing – review & editing; Alexander Kanapin: Writing – review & editing; Maria Samsonova: Conceptualization, Writing – original draft, Supervision.

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