New Polish Cultivars of Flax Resistant to *Fusarium* Wilt

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Abstract

The breeders consider the lack of resistance of fibrous flax cultivars to *Fusarium* wilt the main problem in flax cultivation in Poland. The resistance to diseases, lodging, the quality of fiber and adaptation to local climatic conditions are the main factors that have to be taken into consideration when high yields are involved. Therefore, the selected cultivars must be characterized by these features. In breeding process, conducted at the Institute of Natural Fibres in Poznań, the breeding lines of flax were tested in F4, F5, F8 and F10 in different years. The tests were conducted in provocative conditions. The main aim of breeding of flax is obtaining of new cultivars having the resistance genes to *Fusarium* wilt and genes responsible for high yields. Such genotypes were obtained from crossings between cultivars grown in Poland and cultivars characterized by high quality of fiber, high yield of seeds, resistance to *Fusarium* wilt and lodging. Five among many cultivars obtained at the INF show the best features. These cultivars are: Nike, Artemida, Modran, Selena and Luna.

Keywords: cultivars flax; resistance; *Fusarium* wilt

INTRODUCTION

Fusarium wilt caused by several fungi of *Fusarium* species is a major problem in flax cultivation in many European countries as well as on another continents. The resistance of flax cultivars to *Fusarium* wilt is considered to be a main criterion for flax growth in Poland too.

The only method to breed a variety resistant to this disease is to use a variety carrying resistance factor in the process of breeding (GEIGER, HEUN 1989; JĘDRYCZKA 1995).

In Poland, as well as abroad, it is mainly done with the pedigree method by breeding progenies obtained form crossing of different varieties (PAVELEK 1983; ONDŘEJ 1985; ANDRUSZEWSKA *et al*. 1998).

The genetic resources from the INF Gene Bank, showing resistance to *Fusarium* wilt are tested and used in breeding by this method. The experiments are carried out under natural provocative conditions.

Not only new Polish cultivars, but also some strains, which show stable *Fusarium* wilt resistance in related tests have been presented.

MATERIALS AND METHODS

The research subjects are strains and varieties from the INF Gene Bank collection well adapted to Polish natural conditions.

These strains are tested many, mostly three times, during breeding period, e.g. in F5, F8 and F10 in different years. Researches are conducted on a provocative field by the method of random block in four repetitions. The strain resistance is tested by seeding together a 1000 healthy seeds (4 × 250).

The healthy and infected plants were counted in the following growth stages: after germination, in 6–12 cm height stage, before flowering and in a green seed capsule stage.

Each time a cause of the plant disease was investigated by laboratory mycological tests. Counting healthy plants in green seed capsule stage and comparing the obtained number with the total number of plants after germination provided an evaluation of each strain health.

The average percent of healthy plants from the each combination is compared with the average percent of

healthy plants in the control combination, which is very resistant variety to *Fusarium* wilt: Nike or Natasja.

The final strain resistance estimation is evaluated according to the following scale:

Very resistant > 95% healthy plants in relation to the control.

Resistant 80–95% healthy plants in relation to the control.

Moderately resistant 50–80% healthy plants in relation to the control.

Moderately susceptible 30–50% healthy plants in relation to the control.

Very susceptible < 30% healthy plants in relation to the control.

RESULTS AND CONCLUSIONS

Based on the analysis of research tests results, specific varieties carrying the resistance factor in the after-mentioned crossing were selected. Certainly, very resistant and resistant varieties have to be mentioned, which in crossing with very susceptible and moderately susceptible varieties transmitted their own resistance factor.

The aspect of resistance factor domination occurred for instance in cultivars shown Table 1.

In tested strains a *Fusarium* wilt resistance factor was transmitted mainly by such varieties as: Natasja, Viking, Nike, Orszański 2, Laura, Alexim, Ariane, Marina, Artemida.

According to the analysis of research tests results it is possible to conclude that in a flax varieties collection there are genetic accessions that can give *Fusarium* wilt resistance during breeding process. These cultivars are: Nike, Artemida, Modran, Selena and Luna.

Describing the parameters of cultivars, the quality of fibre is given in Ns. The Ns is a quality of fiber given in the 20–40 scale.

Nike – very resistance to *Fusarium* wilt and also to lodging.

This genotype was obtained from the crosses between very resistant variety Natasja and resistant one Orszański 3.

The length of vegetation period of this cultivar is 101 days (comparing to a collective control – Nike + Laura + Artemida – 100 days).

Flowers are blue.

The length of plants is medium – 74.3 cm.

The cultivar yields a good total fiber yield and shows a good long fiber quality parameters (24.6 Ns).

Nike yields a high yield of seeds (10.5 dt/ha) (Figures 1 and 2).

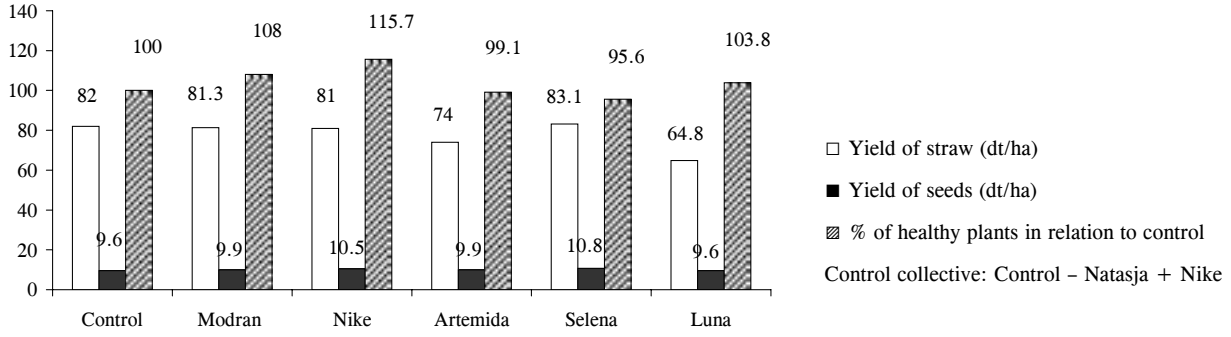

Figure 1. Important parameters of Polish flax cultivars (acc. to Research Centre for Cultivar Testing, Słupia Wielka and INF Poznań 1998–2001)

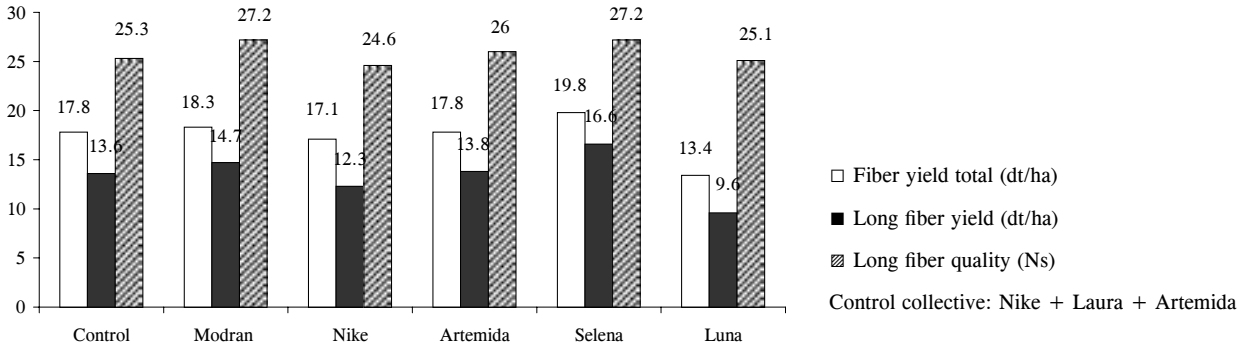

Figure 2. Important parameters of Polish fiber flax cultivars (acc. to Research Centre for Cultivar Testing, Słupia Wielka 1998–2001)

Table 1. Resistance of flax strains to *Fusarium* wilt

No. Strains		Code	Average per cent of healthy plants			
			strains	control cultivar	relation to control	resistance
1. Viking (*V.R.*) × Opaline (*V.S.*)		2590/66	60.6	65.3	91.9	resistant
2. Viking (*V.R.*) × Elise (*M.S.*)		97/6	73.3	62.1	118.0	very resistant
3. Viking (*V.R.*) × Ariadna (*M.S.*)	**Luna**	848/512/588	67.9	65.4	103.8	very resistant
4. Datcha (*M.S.*) × Viking (*V.R.*)		1541/2453	60.7	66.3	91.6	resistant
5. Natasja (*V.R.*) × Datcha (*M.S.*)	**Selena**	R1017	63.1	66.1	95.6	very resistant
6. (Natasja (*V.R.*) × Taiga (*M.S.*)) × Concurent (*V.S.*)		1566/328/993	66.2	68.5	96.6	very resistant
7. Natasja (*V.R.*) × Taiga (*M.S.*)	**Artemida**	R752	78.9	80.4	99.1	very resistant
8. Nike (*V.R.*) × Alba (*M.S.*)		45/17	90.5	80.8	112.0	very resistant
9. Nike (*V.R.*) × Belinka (*M.S.*)		293/12	81.2	80.8	100.5	very resistant
10. Nike (*V.R.*) × Opaline (*V.S.*)		2375/688	72.2	69.9	103.2	very resistant
11. Opaline (*V.S.*) × Orshanskii 2 (*V.R.*)		2261/663	66.8	74.0	90.3	resistant
12. Orshanskii 2 (*V.R.*) × Alba (*M.S.*)		94/21	67.4	93.1	72.4	moderately resistant
13. (Datcha (*M.S.*) × Taiga(*M.S.*)) × Orshanskii 2 (*V.R.*)		1209/970	52.3	49.5	105.7	very resistant
14. (Minerwa (*M.R.*) × Taiga (*M.S.*)) × Orshanskii 2 (*V.R.*)		959/509	60.6	68.5	88.5	resistant
15. Minerwa (*M.R.*) × Fany (*R.*)		507/75	81.3	79.9	101.8	very resistant
16. Ariadna (*M.S.*) × Fany (*R.*)		1260/990	68.6	68.9	99.6	very resistant
17. (Alba (*M.S.*) × Laura (*V.R.*)) × Alba (*M.S.*)		1603/5	73.1	88.3	82.8	resistant
18. (Alba (*M.S.*) × Laura (*V.R.*)) × Laura (*V.R.*)		1604/1	79.5	88.3	90.0	resistant
19. Laura (*V.R.*) × Opaline (*V.S.*)		2589/65	52.0	61.0	85.2	resistant
20. (Ropta (*V.S.*) × Bertelin (*V.S.*)) × Torzhowskij 4 (*M.R.*)		20/230/1530	41.5	66.0	65.9	moderately resistant
21. Regina (*V.S.*) × Torzhowskij 4 (*M.R.*)		565/1342	41.7	63.0	66.2	moderately resistant

(*V.R.*)	– very resistant	> 95% healthy plants in relation to the control
(*R.*)	– resistant	80–95% healthy plants in relation to the control
(*M.R.*)	– moderately resistant	50–80% healthy plants in relation to the control
(*M.S.*)	– moderately susceptible	30–50% healthy plants in relation to the control
(*V.S.*)	– very susceptible	< 30% healthy plants in relation to the control

This variety is registered on the OECD list (Organization for Economic Cooperation and Development).

Artemida – very resistance to *Fusarium* wilt and also to lodging.

This genotype was obtained from the crosses between very resistant and moderately susceptible varieties: Natasja × Tajga.

The length of vegetation period is 99 days.

The flowers are blue.

The plants are tall – 72.1 cm (comparing to a control collective – 72.6 cm).

The long fiber quality of Artemida is high – 26.0 Ns (Figures 1 and 2).

This cultivar is registered on the OECD list.

Modran – new cultivar (like Selena) bred at the Institute. It is very resistance to *Fusarium* wilt and shows the highest resistance to lodging.

This genotype was obtained from the crosses between cultivars very resistant and resistant to *Fusarium* wilt: Ariane × Smoleński.

The length of vegetation period is short – 98 days.

Flowers are blue.

Plants are medium tall – 72.4 cm.

Modran (together with Selena) is a cultivar of the highest long fiber quality (27.2 Ns) (Figures 1 and 2).

Selena – Selena is a new cultivar (like Modran) bred at the Institute. It is very resistance to *Fusarium* wilt and highly resistant to lodging.

This genotype was obtained from the crosses between cultivars: Natasja × Datcha.

This cultivar (together with Modran) is a cultivar of the highest long fiber quality (27.2 Ns).

This cultivar has a short vegetation period – 98 days.

The flowers are blue.

The length of plants is 72 cm. Selena yields the highest yield of seeds (10.8 dt/ha) and straw (83.1 dt/ha) (Figures 1 and 2).

Luna – the newest cultivar bred at the Institute.

It is very resistance to *Fusarium* wilt highly resistant to lodging.

The genotype was obtained from the crosses between very resistant and moderately susceptible cultivars: Viking × Ariadna.

The length of vegetation period length is 101 days (like Nike).

The flowers are blue.

Plants are medium tall – 72.1 cm.

The long fiber quality of Luna is high (25/1 Ns).

This cultivar yields high yield of seed (9.6 dt/ha).

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