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Resistance of fibre flax varieties to *Colletotrichum lini* Manns et Bolley

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The anthracnose causal agent *Colletotrichum lini* M. et B. belongs to the group *Fungi imperfecti*, of the class *Coelomycetes* and *Melanconiales* line. The flax varieties currently cultivated in our Republic are not resistant to anthrachnose. The spread of this disease is most often determined by the weather conditions during flax emergence period. One of the most effective means against this disease is developing resistant varieties. In 1985–2000 at the Upyte Experimental Station we assessed the incidence of anthracnose in the flax varieties and breeding lines grown in our station's fibre flax collection.

Key words: flax, variety, fungal disease, resistance, *Colletotrichum lini*

INTRODUCTION

The anthracnose causal agent *Colletotrichum lini* Manns et Bolley. (syn.: *Colletotrichum linicola* Pethybr. et Lafferty, *C. lini* (Westerd.) Tochin.; *Gloeosporium* lini West.), belongs to the group *Fungi imperfecti*, of the class *Coelomycetes* and *Melanconiales* line. [1, 2] These fungi multiply by conidia, which develop in the acervulus covered with small bristles. Conidia of *Colletotrichum lini* M. et B. are single-celled, colourless, with 1–2 fat droplets inside. They are straight or a bit bent in shape, with rounded ends, and have a size of (14.3–21.4) × (2.9–5.7) μm [3]. *Colletotrichum lini* M. et B. in Lithuania is common and affects flax crops at all growth stages. The flax varieties currently cultivated in our country are not resistant to anthracnose, therefore it does great damage to flax crops. The disease is most harmful for emerging flax plants, sometimes a seedling is killed before it emerges on the soil surface. After emergence the first symptoms are spots on the rootlets and cotyledon (orange lesions). Brownish, a bit sunken spots with distinct contours are seen on the cotyledons; the stems are mottled by brown fine spots which sometimes merge. If linseeds are affected at early maturity stage and the disease-causal agent penetrates into the embryo, it kills it and the seed does not germinate. During the flax vegetative period anthracnose is disseminated by the wind, rains and insects. The fungus overwinters on infected seed and inside of them, as well as on flax residues. Some literature sources report that conidia of the flax anthracnose causal agent are well-adapted to survive and overwinter not only on affected flax, but also on some other crops (peas, clover, white goose-foot, creeping knotweed) [3, 4].

Data of many authors suggest that anthracnose is a very harmful and widespread flax disease. In Lithuania, like in many other countries involved in flax production, the spread of anthracnose is controlled by chemical plant protection measures such as seed treatment, fungicide spray applications during the vegetative growth period. However, one of the most effective means against this disease is development of resistant varieties. Plant breeders and immunologists use various methods such as crossing of resistant varieties, physical, chemical mutagenesis and others to attain this purpose [5]. The obtained hybrids and mutants are tested on infection backgrounds. Variety resistance is determined by growing plants in provocative backgrounds, in soil mixtures infected by various strains of anthracnose and by inoculating the seedlings by one or several strains [6–8].

In 1985–2000 at the Upytė Experimental Station we assessed the incidence of anthracnose in the flax varieties registered in Lithuania, which were sown in the variety testing trials as standard varieties. We also assessed anthracnose (*Colletotrichum lini* M. et B.) resistance of some varieties and breeding lines grown in our station's fibre flax collection in the conditions of artificial infection.

Our objective was to assess the incidence of anthracnose in the flax varieties sown in the Upytė Experimental station as well as the resistance to ant-

hracnose of some breeding lines and varieties in order to be able to recommend them for further breeding work.

EXPERIMENTAL

In the competitive variety trials we sowed 25 million germinable seed per hectare with the aid of an SLN-16 sowing machine (with 10 cm spacings between the rows). The record area was 16 m^2 and involved 4 replications. The linseed was not treated before sowing. In our experiments we assessed standard (registered at that time in Lithuania) fibre flax varieties: 'Or□anskij 2' 'Belinka', 'Baltučiai', 'Ariane'. During flax vegetative growth period we recorded the growth and development stages, lodging of individual varieties, disease incidence, etc. The flax was pulled at early yellow maturity stage. Assessment of anthracnose severity on plants involved a 5-score scale. We observed the incidence of anthracnose in 1985–2000 and estimated it in relation to meteorological conditions.

The infection background was created in wooden boxes (85 x 50 x 20 cm) filled with sifted soil from the experimental field. Until sowing, normal soil moisture was maintained in the boxes. Varieties and breeding lines were sown one seed ball per hole in the third ten-day period of May at a depth of 1.5 cm, with 2.5 x 2.5 cm intervals. In total, 20 seeds were sown with 2–3 replications. At the seedling stage, the cotyledons of flax were sprayed with the spores of anthracnose causal agents, which had been washed off the disease-affected stems [8]. During plant vegetative growth period the flax was abundantly watered. The severity of anthracnose was assessed having pulled flax at early yellow maturity stage. We estimated plant damage by anthracnose according to 5 score scale: healthy plants – 0, weakly affected – 1, moderately affected – 2, strongly affected – 3, and very strongly affected or dead plants – 4 scores. We also estimated the disease development intensity % [8, 9].

METEOROLOGICAL CONDITIONS

Meteorological conditions during the experimental period were diverse, therefore the incidence of anthracnose in individual varieties was different. Although in 1992 and 1999 there was little precipitation, the air temperature, which was above normal, contributed to favourable conditions for the spread of anthracnose. In 1998 the summer was very rainy, the flax stands were heavily lodged, and up to 35% of plants were affected by anthracnose. Conditions for the spread of this disease were favourable in 1990 and 1996. The plants were weakly affected by anthracnose (2–6%) in 1986, 1987, 1993, 1995 and 1997, when the weather was cool and dry (there was less precipitation than normal) in July and August, therefore the conditions for the spread of the disease causal agent were unfavourable.

1990 and 2000 were favourable for the growth and development of flax. A high fibre and linseed yield was produced in those years. Unfavourable and droughty were the years 1992, 1994 and 1999, the flax grew short and the stem and linseed yield was low. In July 1998 heavy rainfalls lodged the maturing flax and negatively influenced the yield and fibre quality. The rest of the experimental years were moderately favourable.

RRESULTS AND DISCUSSION

The following standard flax varieties were grown in the competitive variety trials: 'Or□anskij 2' (1986–1997) registered in Lithuania in 1978, 'Belinka' (1986–2000) registered in Lithuania in 1985, 'Baltučiai' (1986–2000) registered in Lithuania in 1991, and 'Ariane' (1995–2000) registered in Lithuania in 1995 (Table 1). The averaged 15-year experimental findings show that the stems of the standard flax variety 'Belinka' were affected 14.2%. A higher number of disease-affected stems and a more severe disease development were recorded in 1990, 1992 and 1998. According to the averaged 14-year findings, the stems of the flax variety 'Baltučiai' were affected 10.4%. A higher disease incidence and severity was recorded in 1992, 1996 and 1999. According to 12-year averaged findings, stems of the variety 'Or□anskij 2' were anthracnose-affected 9.2%. This disease more intensively affected the flax stems in 1992 and 1996. According to the averaged 6-year experimental findings, stems of the variety 'Ariane' were affected 16.7%. The disease was especially severe in 1996, 1998 and 1999.

In the anthracnose-resistance trials on provocative backgrounds involving 100 fibre flax varieties and breeding lines, no completely resistant varieties were found. Table 2 presents the data on several tested varieties. The following varieties and breeding lines were slightly less disease-affected: 'I-16', 'Fibra', 'Madonna', 'Kometa', 'Belorusskij 1', 678-5, 777, 842-14, 782-5, 919-4, 791-8 and others, in them the affected plants accounted for 15.3–23.6% and the disease severity was 4.8–9.3%. The standard (susceptible) variety 'Svetoč' was affected during the experimental years on average 90.4%, and the disease severity was 42.5%.

Table 1. **Disease severity (%) in competitive variety trials 1986–2000, Upytė**

Variety	Year	Damaged plants, %	Variety	Year	Damaged plants, %
Belinka	2000	9	Oršanskij 2	1994	0
Baltučiai	“	7	Belinka	1993	4
Ariane	“	11	Baltučiai	“	3
Belinka	1999	30	Oršanskij 2	“	3
Baltučiai	“	25	Belinka	1992	32
Ariane	“	22	Baltučiai	“	37
Belinka	1998	22	Oršanskij 2	“	24
Baltučiai	“	19	Belinka	1991	5
Ariane	“	35	Baltučiai	“	17
Belinka	1997	11	Oršanskij 2	“	5
Baltučiai	“	2	Belinka	1990	32
Ariane	“	0	Baltučiai	“	5
Oršanskij 2	“	6	Oršanskij 2	“	11
Belinka	1996	20	Belinka	1989	20
Baltučiai	“	20	Oršanskij 2	“	12
Ariane	“	32	Belinka	1988	19
Belinka	1995	32	Oršanskij 2	“	12
Oršanskij 2	“	2	Belinka	1987	2
Baltučiai	“	0	Oršanskij 2	“	2
Ariane	“	0	Baltučiai	“	0
Oršanskij 2	“	1	Belinka	1986	5
Belinka	1994	0	Oršanskij 2	“	2
Baltučiai	“	0	Baltučiai	“	0

Experimental years: Belinka – 15 (1986–2000); Baltučiai – 14 (1986–2000, (except 1989)); Oršanskij 2 – 12 (1986–1997); Ariane – 6 (1995–2000).

Table 2. **Resistance of fibre flax varieties and breeding lines to anthracnose (three years' (1998/2000) averaged data)**

Variety or selection number	Country code	Damaged plants, %	Disease severity, %	Variety or selection number	Country code	Damaged plants, %	Disease severity, %
'Vaižgantas'	LTU	34.0 ± 6.3	12.9 ± 4.7	**'Spartak'**	RUS	76.1 ± 5.9	30.2 ± 6.5
'Solido'	NDL	51.2 ± 6.0	25.3 ± 6.3	**'Madonna'**	NDL	22.3 ± 6.8	9.8 ± 4.0
'Viera'	NDL	58.3 ± 5.9	18.6 ± 5.5	**'1288/12'**	RUS	45.6 ± 5.8	18.4 ± 5.1
'LD-147'	UKR	46.1 ± 6.2	24.1 ± 5.3	**'Koket'**	EST	60.8 ± 5.7	39.1 ± 6.7
'I-16'	RUS	23.6 ± 5.5	9.3 ± 4.0	**221-A-119**	RUS	69.7 ± 6.5	40.7 ± 6.8
'Fibra'	NDL	15.3 ± 4.9	4.8 ± 3.1	**927-1**	LTU	39.8 ± 6.7	12.7 ± 4.7
'Svetoč'	RUS	90.4 ± 3.8	42.5 ± 6.7	**856-12**	LTU	35.4 ± 6.6	14.9 ± 5.0
'Reina'	FRA	60.9 ± 6.1	26.7 ± 6.3	**'Belorusskij 1'**	BLR	29.4 ± 6.9	17.4 ± 6.6
'Svalof 0228'	SWE	39.5 ± 6.8	18.5 ± 3.9	**842-14**	LTU	28.1 ± 5.7	12.4 ± 5.2
'Šokinskij'	RUS	38.2 ± 6.9	20.4 ± 5.6	**678-5**	LTU	20.4 ± 6.2	11.9 ± 6.1
'L-1120'	RUS	43.2 ± 7.8	18.4 ± 3.9	**782-5**	LTU	29.7 ± 6.1	16.3 ± 5.8
'Deep-pink'	GBR	52.5 ± 4.7	19.7 ± 3.6	**919-4**	LTU	27.4 ± 6.9	12.2 ± 4.7
'Severianin'	RUS	72.4 ± 5.8	29.8 ± 6.5	**242-7**	LTU	35.1 ± 5.9	16.0 ± 5.5
'Emmeraude'	FRA	35.0 ± 6.5	17.3 ± 5.7	**'Beriozka'**	RUS	59.4 ± 5.1	31.7 ± 6.8
'I-7'	RUS	79.8 ± 5.6	27.7 ± 6.6	**777**	LTU	22.0 ± 6.0	13.4 ± 6.3
'806/3'	RUS	36.4 ± 6.7	13.0 ± 4.8	**'Pskovič'**	RUS	56.6 ± 4.9	30.0 ± 6.4
'Modran'	CZE	36.2 ± 6.4	15.9 ± 5.4	**921-2**	LTU	35.1 ± 6.5	15.7 ± 5.4
'T-9'	RUS	76.6 ± 6.2	33.2 ± 6.6	**'Banga'**	LTU	32.0 ± 6.0	14.4 ± 5.7
'Diana'	NDL	35.4 ± 6.7	15.9 ± 5.2	**791-8**	LTU	28.7 ± 7.1	13.2 ± 6.2
'T-10'	RUS	61.4 ± 6.2	25.0 ± 6.7	**'Uspech'**	RUS	46.8 ± 5.1	31.1 ± 6.0

CONCLUSIONS

1. Flax seedling blight (or anthracnose – *Colletotrichum lini* M. et B.) occurred in flax stands every year, however, its intensity was different. An especially high disease severity was recorded in 1996, 1998 and 1999.

2. Averaged experimental findings revealed that the stems of the standard varieties were affected as follows: 'Belinka' – 14.2%, 'Baltučiai' – 10.4%, 'Oršanskij 2' – 9.2%, 'Ariane'– 16.7%.

3. No anthracnose-resistant flax varieties and breeding lines were found. The following varieties and breeding lines were slightly less affected: 'I-16', 'Fibra', 'Madonna', 'Kometa', 'Belorusskij 1', 678-5, 777, and others. These genotypes can be used as initial material for the development of new varieties.

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LINŲ VEISLIŲ ATSPARUMAS ANTRAKNOZEI (*COLLETOTRICHUM LINI* MANNS ET BOLLEY)

S a n t r a u k a

Antraknozės sukėlėjas *Colletotrichum lini* Manns et Bolley priklauso grybšių *Fungi imperfecti* grupei *Coelomycetes* klasei ir acervuliečių *(Melanconiales)* eilei. Šiuo metu Respublikoje auginamos linų veislės nėra atsparios antraknozei, kurios paplitimą lemia meteorologinės sąlygos linų vegetacijos metu. Antraknozė – labai žalinga ir kasmet pasitaikanti linų liga, naikinama beicuojant sėklą, purškiant pasėlius fungicidais. Vienas veiksmingiausių kovos su šia liga metodų – atsparių veislių sukūrimas. 1985–2000 metais Upytės bandymų stotyje buvo fiksuojamas antraknozės paplitimas konkursiniuose veislių bandymuose auginamose linų veislėse. Taip pat nustatytas kai kurių veislių bei numerių, esančių stoties pluoštinių linų kolekcijoje, atsparumas antraknozei (*Colletotrichum lini* M. et B.), taikant dirbtinę infekciją.