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The occurrence of powdery mildew on crested hairgrass in different growing conditions

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Abstract. Crested hairgrass (*Koeleria gracilis* Pers., *syn. K. macrantha* (Ledeb.) is classed as a good turfgrass. A first cultivar 'Ilo', released by the Jõgeva Plant Breeding Institute was entered into the Estonian Variety List in 1997. Seed production agrotechnics of crested hairgrass cultivar 'Ilo' was studied in field experiments at the Jõgeva PBI in 2001–2005. It has been recognized that the incidence and severity of disease level and seed yield losses are influenced by pathogens and weather. For four seasons the severity of the occurrence of powdery mildew (*Blumeria graminis* DC.) was investigated in these field trials. Disease infection was scored by visual assessment of full plants at shooting, flowering and seed ripening stages and at post–harvest re-growth on a 5–point scale. Infection was more intensive in the flowering stage: 2.6 points (2002), 3.0 (2003) and 3.7 (2004). Infection at post–harvest re-growth was assessed at 3.1 points in 2002.

Key words: *Koeleria gracilis*, *Blumeria graminis*, infection, growing stage, seed yield

INTRODUCTION

The northern border of the natural habitat of crested hairgrass (*Koeleria gracilis* Pers., *syn*. *K. macrantha* (Ledeb.)) reaches as far as south–east Estonia. Its first variety 'Ilo' was released at the Jõgeva Plant Breeding Institute in 1994 (Bender, 1995). Vegetative growth of the species is very slow and the plant does not produce very large tussocks. Its leaves die gradually during the autumn and winter when growth is minimal, but the plant remains green until early spring growth commences. The number of inflorescences is quite low in the first summer when it is seeded in autumn, compared with the tussocks by the end of later years. In every growing season attention must be paid to factors that influence the seed yield. It is generally accepted that foliar diseases are important causes of seed losses. The leaves of *K. gracilis* may be infected by the powdery mildew (*Blumeria graminis* (DC.) Golovin ex Speer) (Dixon, 2000).

The objective of this study was to assess the severity of powdery mildew infection and the dependency of seed yield on various agrotechnical treatments in field experiments.

MATERIALS AND METHODS

The disease estimates of crested hairgrass variety 'Ilo' have been carried out for four seasons (2002–2005) in the field trials which were seeded in 2001. The following aspects that affect the seed yield were studied: 1) sowing date, 2) the rate and time of nitrogenous fertilizer applications, 3) sowing rate and 4) drill space. The trials were established in four replications, plot size 11.25 m²; sowing rate of seeds was 5 kg ha^{-1} and a yield was measured from 6 m². The trials lay on calcaric cambisol (K_0), pH_{KCl} 6.1, P 230, K 229, Ca 1550 and Mg 77 mg kg^{-1} soil, concentration of total nitrogen 0.13% and humus 2.1%. Fertilizer rates applied prior to sowing were equal to P_2O_5 44, K_2O 80 and N 70 kg ha^{-1}. Phosphorus and potassium were applied in the form of complex fertilizer Skalsa, (producer Kemira), and nitrogen, as ammonium nitrate. During the harvest years N 70 kg ha^{-1} was applied in spring after the onset of plant growth. Direct harvesting with a combine Hege 125C was accomplished at full maturity of the seeds. Disease infection with powdery mildew was scored as a grade on 0…5 scale by visual assessment of five tussocks per plot at randomly selected places (EPPO Bulletin, 1990). The observations were carried through at shooting, flowering and seed ripening stages and at post–harvest re-growth. Phenological growth stages were determined according to BBCH–identification keys of mono- and dicotyledonous plants (Meier, 2001).

The data were subjected to ANOVA, and the means were separated by the least significant difference (LSD) test by mean of Agrobase 20 software package (1999 Agronomix Software, Inc. Manitoba, Canada).

RESULTS AND DISCUSSION

Each species of pathogens has an optimum temperature and moisture regime for growth and survival. Powdery mildew can be found during the whole growing season, but is most common beginning in early summer. Under optimal conditions, it requires a relatively short time to germinate. Conidia can germinate over a wide temperature range above 3°C. Studies (Lundin, 1978) indicate that mildew spores can germinate in rather dry conditions but the best germination is often found at relative humidity levels close to 100%. Conidiospores and chains of conidia are formed 5–10 days after inoculation. A conducive abiotic environment is also necessary for successful infection by a pathogen, especially in terms of meteorological conditions such as the presence of moisture on a leaf surface (Al–Naimi et al., 2005).

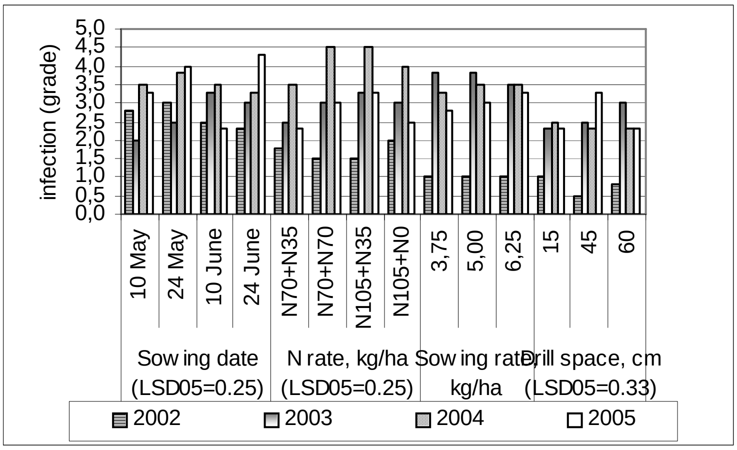

Fig. 1. Development of powdery mildew on ‘Ilo’ in 2002–2005.

The severity of infection with powdery mildew pathogens is higher in years with high disease pressure. A hot and dry spring restricted the development of powdery mildew in 2002. The springs of 2003 and 2004 had high precipitation and were suitable for the infection and spreading of foliar diseases (Fig.1). The susceptibility of crested hairgrass may vary with the age of plant tissues. Crested hairgrass is a winter-type species. The infection with the fungus *Blumeria graminis* (DC.) – the cause of powdery mildew - was more severe in the spring than in the previous autumn. Survival of the pathogen may be extended by its ability to sporulate on other hosts.

The sowing date can have an impact on the tussocks' structure and stand density in the following year. Stand density has an impact on disease risk because higher plant densities and larger canopies favour the spread of powdery mildew. Drill spacing and sowing rate affect disease risk by changing the proximity of tussocks, which influences the movement of pathogens from plant to plant. A high level of nitrogenous fertilizer also encourages the development of dense plant stands and increases the risk of disease on crested hairgrass.Plant disease can limit crop production. Loss of seed yield depends on the strategy employed (Tab.2).

Table 2. Seed yield (kg ha^{-1}) dependency of 'Ilo' on agrotechnics in 2002–2005.

	2002	2003	2004	2005
Sowing date				
10 May	300.5	157.2	246.7	215.7
24 May	270.4	254.7	205.4	228.3
10 June	253.3	324.5	203.0	178.3
24 June	27.0	390.1	272.4	189.4
LSD_{05}	21.1	30.40	45.2	11.4
Nitrogenous rate, kg ha^{-1}				
N70+N35	5.7	619.5	291.6	189.5
N70+N70	8.6	575.6	293.2	170.3
N105+N35	7.3	555.5	286.5	153.3
N105+N0	6.7	528.1	263.8	180.4
LSD_{05}	3.0	21.1	15.6	11.4
Sowing rate, kg ha^{-1}				
3,75	11.3	545.8	391.4	163.3
5,00	10.4	530.4	376.4	226.6
6,25	12.2	545.0	341.9	260.1
LSD_{05}	6.5	78.4	29.3	14.1
Drill space, cm				
15	11.8	574.6	326.1	190.1
45	10.5	435.8	381.7	163.8
60	9.7	322.5	289.2	160.6
LSD_{05}	4.2	64.7	44.2	18.9

The seed of crested hairgrass ripens in mid-July. At the time of harvest the plants are comprised of approximately equal quantities of living and dead shoots. Seed yield rises in the second crop year. The highest yield was obtained two years after sowing from the plot seeded at the first opportunity in spring. Optimum nitrogen application rates were 70 kg ha^{-1} applied in spring and 35 kg ha^{-1} added in summer. Grain in the total yield mainly arose from the higher seed yield in the second crop year and narrow (15cm) drill space. Narrow space produced a greater number of reproductive shoots per surface unit.

CONCLUSIONS

Management practices that reduce the risk of powdery mildew (*Blumeria graminis* DC.) infection on crested hairgrass (*Koeleria gracilis* Pers., *syn*. *K. macrantha* (Ledeb.)) include the choice of optimal date and rate of sowing, and balanced fertilization. The key risk factor that favours the build-up of pathogen populations on crested hairgrass includes favourable weather conditions for powdery mildew development. The disease has the potential to reach damaging levels in a relatively short period of time.

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