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The variation of agronomic characteristics of European malting barley varieties

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Abstract. The field experiments were carried out in 1999–2002 at the Jõgeva Plant Breeding Institute (PBI) in Estonia to investigate the genetic and environmental variation of agronomic characteristics of malting barley. 57 malting barley varieties were included in the trials. Grain yield, number of tillers per 1m², plant height, lodging resistance and growing time were measured in the trial with malting barley.

Despite very different weather conditions, the grain yield stability of malting barley varieties was very high. Tillering showed somewhat lower genetic variability compared to the variation of grain yield. The plant height indicates moderate genetic variability. Lodging resistance and growing time showed low genetic variability.

Key words: agronomic charactristics, genetic variability, malting barley, grain yield, tillering, plant height, lodging resistance, growing time

INTRODUCTION

Breeders' general objectives include enhancing grain yields, obtaining plants with shorter, stiffer straw to minimise stem breakage and lodging and simplify combine-harvesting, and ensuring that ears do not shatter, break off the stem or shed grain, while still allowing grains to separate cleanly during threshing. Breeders need varieties that are resistant, or at least tolerant, to locally important diseases, droughts, etc., and well adapted to the local climate and ripen at a convenient time (Briggs, 1998).

Barley breeders work with narrow germplasm pool to develop new cultivars. This is made by choice because narrow crosses have led to continued improvements in agronomic and quality traits, indicating that genetic variability is present. Many cultivars are very closely related, as can be seen by their pedigrees and high coefficients of parentage (Wych & Rasmusson, 1983; Peel, 2000).

MATERIALS AND METHODS

The trials of malting barley varieties were carried out at the Jõgeva PBI in 1999–2002 to estimate the variation of agronomic characteristics of malting barley. 57 malting barley varieties from different countries (Germany, Sweden, Denmark, Great Britain, France, the Netherlands, Finland, and Estonia) were tested. Grain yield, number of tillers per 1m², plant height, lodging resistance, and growing time were estimated.

The trial was carried out in 4 replications on 10-m² plots. The seeding rate was 500 seeds/m². The precrop was potato. Fertiliser background was N60 P13 K25.

The trials were organised by using NNA method. Data processing was carried out in Agrobase. To estimate the variation of agronomic characteristics, the minimum and maximum values, averages and coefficients of the variation were calculated. These values were calculated for the results of each year and for the average results of 1999–2002.

The climatic conditions were quite different in the period of 1999–2002. The growth of barley was inhibited by heavy drought in 1999 and 2002. The vegetation period was very rainy with moderate temperature in 2000. The summer was hot and rainy with heavy thunderstorms in 2001. Heavy rains and winds caused lodging in 2000 and 2001.

RESULTS AND DISCUSSION

Grain yield. The development of high-yielding varieties is the primary objective of most barley breeding programmes. But barley for malting must also meet a number of specific criteria such as high extract and enzyme level (Kunze, 1996).

The genetic variability of grain yield in the trial was highest compared to the other barley agronomic characteristics (Table 1). The coefficient of variation of the average results was 11% and varied between 12–16% in a year. The minimum and maximum values showed great differences (1,983–5,189 kg/ha) between individual varieties in the testing years. The average grain yield of the varieties differed only from 3,530 to 3,834 kg/ha in the testing years. The highest grain yields, as the averages of 4 years, were shown by the varieties 'Anni' (4,748 kg/ha), 'Pasadena' (4,456 kg/ha), 'Krona' (4,381 kg/ha), 'Scarlett' (4,379 kg/ha), 'Polygena' (4,338 kg/ha, 'Elo' (4,335 kg/ha), etc. Despite very different weather conditions, the yield stability was very high.

Tillering. The number of tillers per 1 m² is influenced by the density of stand and the genetics of the cultivar, as well as by environmental factors. At common seeding rates, a single plant usually develops from one to six stems, but under thin stands and favourable conditions it may have several times that number (Reid & Wiebe, 1979; Briggs, 1998).

There were great differences between the minimum and maximum values of this character in the trial. The coefficient of variation of tillering (number of tillers per 1m²) varied from 9–13% in the testing years, and was 7% in the average results. It indicates somewhat lower genetic variability of this character compared to the variation of grain yield. The average number of tillers per 1m² of the varieties varied between 636–778 tillers/m². This shows the quite low influence of weather conditions on barley tillering in the trial.

Plant height. Plants with short straw generally lodge less than tall plants and are able to respond better to increased N fertilisation without lodging (Wych et al., 1985; Briggs, 1998). The great differences between the minimum and maximum values of plant height showed significant variation in the level of this character between individual varieties (Table 2). The coefficients of the variation of plant height were between 6 and 8 % in each testing year and reached 5% in the average results of the tested varieties. It indicates moderate genetic variability of this agronomic trait.

Table 1. Variation of grain yield and the number of tillers of malting barley varieties (n = 57) in Estonia in 1999–2002.

Year		Grain yield kg/ha	Number of tillers per 1m²
	Min–max		
1999		2,733–4,611	515–776
	Mean ± SE	3,566 ± 57	636 ± 7
	Coef. of variation	12	9
	Min–max		
2000		2,037–5,189	544–844
	Mean ± SE	3,834 ± 82	716 ± 10
	Coef. of variation	16	11
	Min–max		
2001		1,983–5,084	542–841
	Mean ± SE	3,530 ± 76	708 ± 8
	Coef. of variation	16	9
	Min–max		
2002		2,571–4,747	472–957
	Mean ± SE	3,644 ± 69	778 ± 13
	Coef. of variation	14	13
Average of 1999–2002			
	Min–max		
		2,615–4,748	571–814
	Mean ± SE	3,644 ± 55	710 ± 6
	Coef. of variation	11	7

Table 2. Variation of plant height, lodging resistance and the growing time of malting barley varieties (n = 57) in Estonia 1999–2002.

Year		Plant height cm	Lodging resistance 1–9 points*	Growing time days
	Min–max			
1999		56–75	9.0–9.0	77–89
	Mean ± SE	64 ± 1	9.0 ± 0.0	82 ± 0
	Coef. of variation	6	0,0	3
	Min–max			
2000		67–91	7.4–9.0	90–105
	Mean ± SE	77 ± 1	8.8 ± 0.0	98 ± 0
	Coef. of variation	6	2,9	4
	Min–max			
2001		65–82	7.0–9.0	84–91
	Mean ± SE	74 ± 1	8.7 ± 0.0	86 ± 0
	Coef. of variation	6	3,8	1
	Min–max			
2002		44–63	9.0–9.0	78–89
	Mean ± SE	51 ± 1	9.0 ± 0.0	86 ± 0
	Coef. of variation	8	0,0	2
Average of 1999-2002				
	Min–max			
		59–75	8.4–9.0	83–93
	Mean ± SE	67 ± 0	8.9 ± 0.0	88 ± 0
	Coef. of variation	5	1.3	2

* 9 = no lodging

The average plant height was shortest (51 cm) in 2002 when the development of plants was inhibited by heavy drought and tallest (77 cm) in wet weather conditions in 2000. The variation of average results of plant height (51–77 cm) in the testing years indicates the great influence of weather conditions on the level of this characteristic.

Lodging resistance. Good lodging resistance requires short culms, sturdy straw, and a root system capable of anchoring the plant in the soil (Anderson & Reinbergs, 1985; Briggs, 1998). Malting barley varieties showed very little lodging in 2000 and 2001. There was no lodging in the trials of 1999 and 2002.

Growing time. The low values of variation coefficients of growing time showed low genetic variability of this characteristic. There were considerable differences between the minimum and maximum values of growing time. It indicates the presence of individual varieties with quite different growing time in the trial compared to the average level. The average growing time of the varieties varied from 82 to 98 days in the testing years. This indicates the significant influence of weather conditions on this characteristic.

CONCLUSIONS

The genetic and environmental factors can cause a different level of variation of the tested agronomic characteristics of malting barley. The genetic variability of grain yield was highest compared to the other barley agronomic characteristics. The highest grain yields, as the averages of 4 years, were shown by the varieties 'Anni' (4,748 kg/ha), 'Pasadena' (4,456 kg/ha), 'Krona' (4,381 kg/ha), 'Scarlett' (4,379 kg/ha), 'Polygena' (4,338 kg/ha, 'Elo' (4,335 kg/ha) etc. The influence of weather conditions on the grain yield was very low.

The genetic variability of tillering was to some extent lower compared to the variation of grain yield. The effect of weather conditions on barley tillering was rather low in the trial. There was moderate genetic variability of plant height. The variation of the average results of plant height in the testing years indicated the great influence of weather conditions on this trait. The low values of variation coefficients of growing time showed the low genetic variability of this characteristic. There was significant influence of weather conditions on the growing time of varieties. The genetic variation of barley growing time remained low.

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