Int. Agrophysics, 2000, 14, 187-189

VARIATION OF SOME PHYSICAL AND GEOMETRICAL STEM FEATURES IN DOUBLED HAPLOIDS OF BARLEY

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Accepted December 13, 1999

A b s t r a c t. Some physical and geometrical features related to lodging resistance were observed in barley doubled haploid (DH) lines. DH lines were derived from the cross between two-rowed cultivar Maresi and six-rowed cultivar Pomo by the *Hordeum bulbosum* technique. The initial cultivars, their F_1, F_2 hybrids and DH lines (20 two-rowed and 18 six-rowed) were investigated in the field conditions conducted in the completely randomised block design with three replications. The following characters of the stem were analysed: length, external diameter, wall thickness and elasticity (Young's modulus). Lodging grade was estimated applying a 9-grade scale (where 1 means no lodging and 9-the highest degree of lodging). The stem elasticity was evaluated by the ultrasonic method. Analysis of variance was performed and contrasts between six-rowed and two-rowed genotypes were calculated. Genetic parameters related to with additive gene action [d], dominance [h] and nonallelic interaction of homozygous [i] and heterozygous [l] loci were estimated. The values of the [d] parameter were significant for all the studied traits. The effects of dominance were important only for the stem length and lodging grade. Six-rowed DH lines were characterised by the lower elasticity and shorter stems than the two-rowed ones but were more susceptibile to lodging.

K e y w o r d s: barley, doubled haploids, genetic variation, elasticity index, lodging resistance

INTRODUCTION

Lodging resistance in cereals is determined by both genetic and environmental factors. Many authors observed that lodging resistance of barley plants is affected by the physical and morphological properties of the stem [1,2,4,8, 11,12]. The aim of the present paper was to study variability of some physical and morphological features of the stem in the population of two- and six-rowed barley doubled haploids derived from the cross between the cultivars Maresi and Pomo.

MATERIAL AND METHODS

Plant material for the study consisted of 38 barley doubled haploids (20 two-rowed and 18 six-rowed) derived from F_1 hybrids of a two-rowed cultivar Maresi and a six-rowed cultivar Pomo. DH lines were produced by the "H. bulbosum" technique [9]. The doubled haploids, along with their parental cultivars, and F_1 and F_2 hybrids, were evaluated under field conditions. The experiment was conducted in a completely randomized block design with three replications. The materials were planted in 3 m^2 plots with the seeding rate of 330 seeds per 1 m^2. At full maturity the lodging grade was scored with the use of 9^o-scale, where 1 means no lodging and 9 - the highest lodging. After harvesting, length, diameter and wall thickness of the stem were measured. Moreover, stem elasticity (Young's modulus) was evaluated by the ultrasonic method [3].

The data were analysed by means of the one-factor analysis of variance. Differences between the groups of two- and six-rowed lines

were estimated and tested by F-statistics. The last significant difference was used to distinguish the lines with the maximum and minimum values of each trait. Means of all the DH lines, means the extreme lines and means for F_1 and F_2 hybrids were used to estimate the additive (d), dominance (h) and epistatic (i) (additive x additive), (l) (dominance x dominance) gene effects [10].

RESULTS AND DISCUSSION

The results of statistical analyses showed that DH lines differed in all characters under study (Table 1). The mean values for DH lines, parental cultivars and hybrids are given in Table 2. Estimates of contrasts between two- and six-rowed DH lines and between these groups of lines and parents are presented in Table 3. Cultivar Pomo was observed to be more resistant to lodging than cv. Maresi. The six-rowed cultivar Pomo compared with the two-rowed cultivar Maresi showed a shorter stem, thicker stem walls and greater stem diameter. No significant difference was found between the parental cultivars in stem elasticity. The six-rowed DH lines appeared to be more susceptible to lodging than the two-rowed ones. They had short and thick stems of low elasticity. Significant differences were found between the cv. Pomo and the six-rowed group of lines in the lodging grade, stem length and diameter, wall thickness and stem elasticity (Table 3). Though the two-rowed DH lines did not differ form cv. Maresi in lodging resistance, they were characterised by longer and more elastic stems than cv. Maresi.

T a b l e 1. Analysis of variance for the studied characters of the stem and lodging grade of barley DH lines

Source of variation	D.F.	Mean square				
		stem length	stem diameter	wall thickness	Young's modulus	lodging grade
Genotypes	41	168.07**	0.24**	0.0015**	197.10**	16.60**
Error	86	14.79	0.08	0.0001	1.97	0.47

**P≤ 0.01.

T a b l e 2. Mean values of the studied stem characters and lodging grade of barley DH lines

Character	DH lines			Parents		Hybrids	
	max	min	mean	Maresi	Pomo	F_1	F_2
Stem length (cm)	82.03	60.17	71.13	70.83	63.97	70.48	56.35
Stem diameter (mm)	3.56	2.64	3.23	2.94	3.72	3.03	2.68
Wall thickness (mm)	0.27	0.17	0.21	0.22	0.26	0.22	0.22
Young's modulus (MPa)	59.25	22.28	38.46	37.02	36.33	38.76	37.86
Lodging grade (1-9)	8.86	1.33	3.52	3.00	1.33	2.66	3.00

T a b l e 3. Estimates of contrasts between the two- and six-rowed barley DH lines and parental forms for the studied stem characters and lodging grade

Contrast	Stem length	Stem diameter	Wall thickness	Young's modulus	Lodging grade
6-rowed DHs - 2-rowed DHs	-2.18*	0.16*	0.005	-6.77**	0.56**
6-rowed DHs - Pomo	6.73*	-0.39*	-0.045**	-0.98	2.50**
2-rowed DHs - Maresi	2.04*	0.22	-0.016	5.10**	0.33
Pomo-Maresi	-6.86*	0.78*	0.036*	-0.69	-1.66*

*P=0.05, **P=0.01.

T a b l e 4. Estimates of the genetic parameters for the studied stem characters and lodging grade of barley DH lines

Parameter	Stem length	Stem diameter	Wall thickness	Young's modulus	Lodging grade
m[1]	71.13	3.23	0.21	38.46	3.52
(d)	10.93**	0.46**	0.05**	18.48**	3.77*
(h)	-6.56**	-2.04	0.03	-3.01	0.56*
(i)	-0.63	-0.16*	0.01*	2.20*	1.33*
(l)	5.88*	0.83	-0.02	1.21	3.59*

[1]means of DH lines, *P<0.05, **P<0.01.

Estimates of genetic parameters are presented in Table 4. It can be seen that the effects of the additive gene were significant for all the studied characters, while dominance effects appeared to be important only for the stem lenth and lodging grade. Additive x additive epistatic effects were significant in the case of the lodging grade, stem diameter, wall thickness and stem elasticity, and the dominance x dominance effects were important for the lodging grade and stem length. Similar results related to gene effects were obtained for a population of the two-rowed barley DH lines by Jeżowski *et al.* [6] and Jeżowski [5]. It suggests that the genetic background of lodging resistance in the two- and six rowed genotypes of barley are similar. It should be noted that the six-rowed genotypes despite their similar morphological and physical structure of the stem, are more susceptible to lodging than the two-rowed ones. It may be caused by the fact that the six-rowed spikes have greater weight than the two-rowed ones.

CONCLUSION

Six-rowed barley DH lines are characterized by lower elasticity and shorter stems than two-rowed ones and are more susceptible to lodging. Genetic backgroud of lodging resistance in two- and six-rowed genotypes is similar. Effects of additive gene action are important for all morphological and physical characters of the stem, while dominance effects are siginificat only for stem length and lodging grade.

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