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QUALITATIVE CHARACTERISTICS OF RYE INBRED LINES

ABSTRACT

Qualitative characteristics (kernel and volume weights, the contents of protein, lysine and pentosan, extract viscosity and falling number) of inbred lines created in hybrid breeding program of rye was evaluated in two consecutive years, 1998 (no 135) and 1999 (no 78).

Two groups of rye inbred lines were selected, which present opposite physicochemical properties and thus fulfilling requirements either for bread making or animal feeding. Some lines might be directly utilised as components of experimental hybrids or as donors of qualitative traits for the development of the second cycle inbred lines.

Key words: extract viscosity, falling number, pentosans, hybrid breeding, *Secale cereale* L., winter rye

INTRODUCTION

In Northern and Eastern Europe rye is a traditional cereal that is used either for bread production or as a cereal component in animal feed. Starch and dietary fibre, as in the other cereals, are the principal carbohydrates in this grain. The major constituents of dietary fibre in rye are arabinoxylans and their content has been found to be crucial for both bread–making quality of wholemeal flour and nutritive value. In general, a high content of arabinoxylans has positive effect on bread–making properties of rye as it improves sprouting resistance, increases dough yield, loaf volume and shelf–life (Weipert 1996). On the other hand, a high content of arabinoxylans is detrimental for feed purposes and decreases weigh gain and feed utilisation, especially in young broiler chicken fed diets containing as low as 20% of rye (Friesen *et al.* 1991, Boros, 1998). The soluble fraction of arabinoxylans, which forms very viscous solution in water, is the main causative factor responsible for low nutritive value of rye. (Bedford *et al.* 1991, Bedford and Classen 1993, Boros *et al.* 1997).

The aim of this study was to determine variability of qualitative parameters within inbred lines and their interrelationship.

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MATERIALS AND METHODS

Qualitative characteristics of inbred lines created in hybrid breeding programme of rye was evaluated in two consecutive years, 1998 and 1999 in numbers of 135 and 78, respectively. In both years different male sterile (P) and restorer (R) lines were used. Grain of P lines was produced in the topcross fields and R lines were grown in specially isolated plots.

The following physicochemical grain characteristics were determined: thousand kernel (TKW) and volume weights (VW); the contents of protein, lysine, soluble arabinoxylan (SAX); water extract viscosity (WEV) and falling number (FN).

The content of soluble arabinoxylans was analysed by the colorimetric method of Hashimoto *et al.* (1981) as modified by Delcour *et al.* (1987). Viscosity was measured in water extract obtained by shaking 0.5 g of grain with 5 ml of distilled water for 1 h at 30˚C, using Brookfield Cone Plate Digital Viscometer (Boros *et al.*, 1993).

Falling number was determined by the Hagberg–Perten method using the Falling Number 1800 instrument. The contents of protein and lysine were analysed by Infratec 1255. Coefficients of variability of these qualitative traits as well as their interrelationship were calculated.

RESULTS

Every year quality parameters varied significantly in rye material tested (Table 1 and Table 2). The content of protein in P lines tested in 1998 and 1999 varied from 10.1 to 19.4% and from 7.9 to 16.9%, respec–

Table 1

Variability of the quality parameters among male sterile (P) lines of rye in two years

Parameter	Year	Mean	Minimum	Maximum	CV
Protein	1998	13.7	10.1	19.4	14.3
	1999	12.9	7.9	16.9	16.6
Lysine	1998	0.53	0.41	0.65	11.1
	1999	0.50	0.37	0.64	10.4
SAX	1998	3.45	2.10	4.48	15.4
	1999	2.44	1.37	3.93	25.1
WEV	1998	4.27	2.25	7.49	28.8
	1999	2.90	2.17	3.72	14.9
FN	1998	136	62	303	46.9
	1999	191	75	263	25.0
TKW	1998	27.9	18.4	37.0	12.4
	1999	19.8	14.4	27.2	16.1
VW	1998	67.4	54.3	79.3	7.2
	1999	62.4	51.8	70.0	5.9

n = 105, n = 40 number of samples tested in 1998 and 1999, respectively.
SAX – soluble arabinoxylans, WEV – water extract viscosity, FN – falling number, TKW – thousand kernel weight, VW – volume weight

Table 2

Variability of the quality parameters among restorers of rye in two years

Parameter	Year	Mean	Minimum	Maximum	CV
Protein	1998	13.9	10.7	16.0	9.7
	1999	14.2	9.4	19.3	14.8
Lysine	1998	0.48	0.40	0.56	8.3
	1999	0.49	0.36	0.66	16.5
SAX	1998	2.94	1.85	3.60	13.5
	1999	1.99	0.52	3.30	36.1
WEV	1998	3.01	1.38	4.46	25.5
	1999	3.03	2.16	4.02	17.3
FN	1998	105	61	205	40.0
	1999	133	62	292	53.7
TKW	1998	34.2	20.0	48.9	23.7
	1999	22.2	14.7	28.1	15.1
VW	1998	70.7	58.0	77.0	7.0
	1999	64.3	53.1	72.5	7.0

n = 30, n = 38 number of samples tested in 1998 and 1999, respectively.
SAX – soluble arabinoxylans, WEV – water extract viscosity, FN – falling number, TKW – thousand kernel weight, VW – volume weight

tively (Table 1). In restorers this trait varied from 10.7 to 16.0% and from 9.4 to 19.3% in the same time (Table 2). It is noteworthy that coefficients of variation of protein content was twice as high as described by Madej *et al.* (1990). Variability of lysine content in the group of P lines was lower than that of protein and ranged from 0.37 to 0.64% and from 0.37 to 0.64% in both successive years, respectively. In restorers this character ranged from 0.40 to 0.56 and from 0.36 to 0.66. The highest variability was found for extract viscosity and falling number in the course of testing. In 1998 the extract viscosity varied from 2.25 to 7.49 among P lines and from 1.38 to 4.46 among restorers. In 1999 ranging of this character for P lines and restorers was 2.17 – 3.72 and 2.16 – 4.02, respectively. In both years and both groups of material the falling number ranged form 60 to 300 s. Extract viscosity significantly depended on pentosan content and, moreover, affected the falling number, irrespective of the harvest year. The correlation coefficients between extract viscosity and pentosan content were 0.35 and 0.45 and for water extract viscosity and falling number 0.44 and 0.31, in both experimental years (Table 3). Positive, significant correlation was found between protein and lysine content in both years. The kernel weight and volume weight did not have any influence on other quality traits, except for pentosan content (–0.23 and –0.29 in both years). The lack of correlation between above mentioned characters indicates a possibility of getting good qualitative value concomitantly with good grain filling.

Basing on the results presented, a group of lines showing low extract viscosity, pentosan content and falling number has been selected, which could be used in breeding program directed towards an improved nutritive value. On the other hand another group of lines with high extract viscos–

ity, high pentosan content and falling number could be employed in breeding program for good bread–making quality. Some of these lines might be directly utilised as components of experimental hybrids or as do–nors of qualitative traits for the development of the second cycle inbred lines. These diverse materials with respect to the evaluated qualitative characters may be also used in further genetic investigations.

Table 3

The relationship between quality parameters of inbred lines in two experimental years

Parameter	Year	Protein	Lysine	SAX	WEV	FN	TKW
Lysine	1998	0.67**					
	1999	0.71**					
SAX	1998	–0.20	0.06				
	1999	–0.30**	–0.15				
WEV	1998	–0.05	0.05	0.35**			
	1999	–0.16	–0.15	0.39**			
FN	1998	0.09	–0.11	–0.04	0.44**		
	1999	–0.29**	–0.27*	0.25*	0.31**		
TKW	1998	0.08	–0.08	–0.23*	–0.14	–0.17	
	1999	0.18	0.07	–0.25*	0.00	–0.26*	
VW	1998	0.09	–0.12	–0.25*	0.04	0.19	0.55**
	1999	0.21	–0.01	–0.29**	–0.06	0.05	0.36**

n = 135, n = 78 number of samples tested in 1998 and 1999, respectively.
SAX – soluble arabinoxylans, WEV – water extract viscosity, FN – falling number, TKW – thousand kernel weight, VW – volume weight.
*, ** Correlation coefficient significant at P=0.05 and P=0.01, respectively

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