Winter wheat landraces and obsolete cultivars – possible donors of characters for breeding

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SUMMARY

Two sets of winter wheat landraces and obsolete cultivars were studied for three years in field experiments. Increased spike productivity in modern cultivars was mainly due to increased number of grains in the spikelets and HI, whereas TGW was a slight effect. Old cultivars had higher crude protein content. Spike productivity characters, except of TGW, were negatively correlated with grain crude protein content. The number of kernels in spikelets has the highest effect on the spike productivity while the effects of TGW were about half this. Potentially valuable donors of grain quality, earliness and winter hardiness were identified. High crude protein content (up to 18%) was found. In both sets the HMW *Glu* subunits were identified and 67 selected lines were further studied. Among this set 10 lines showed crude protein content of 17.5-18.3% (while gluten index and Zeleny test varied from 28.5 to 54.0 and 36.8 to 61.7 respectively). High values of all quality characters was in cultivars Mindeszentpusztai (HUN), Szekacz 19 (HUN), Bartweizen linie a (AUT), Viglasska cervenoklasa (CZE) and some others.

INTRODUCTION

Many modern cultivars, in wheat and in other crops as well, are often rather similar, with relatively narrow genetic base. Therefore, utilization of new sources of diversity in breeding is often discussed. Landraces, which have arisen through a combination of natural selection and selection performed by farmers (Belay et. al., 1995) have some valuable characters that can contribute to the breeding and broaden the genetic base of modern cultivars (Tesemma et. al., 1998; Keller et. al., 1991). Tolerance to locally appearing stresses (Li et. al., 1997) and, therefore, good yield stability are also often mentioned as characteristics of landraces (Tesemma et. al., 1998). Landraces and obsolete cultivars represent very valuable part of the gene pool (Zou, Yang, 1995, Vojdani et. al., 1993) because they cover most of intra-specific genetic diversity of crops. Also, direct practical utilization of some landraces by local farmers is possible (Brush and Meng, 1998).

Grain quality of some wheat landraces could be of use to breeders because of the much broader diversity founding landraces than in presently grown cultivars. Keller et al., (1991), Wang et al., (1992), Rodriguez-Quijano et al. (1994) and Yang, Liang (1995) refer on very high protein content in some landraces of common wheat. In our experiments selected landraces proved to have not only high protein content, but also good levels of some other quality characters (Michalova, Dotlacil, 1993).

MATERIAL AND METHODS

Two sets of winter wheat landraces and obsolete cultivars (122 in set I and 101 in set II) originating from European countries with 3 modern cultivars as checks were studied in field experiments over three years. Trials were sown in micro-plots (2.5 m²) in Praha - Ruzyne using standard growing practices. We also evaluated the yield of 31 selected landraces and obsolete cultivars in field trials (4 x 10m^2, two sites, 3 years).

Simultaneously, we characterized HMW *glu* patterns (in 100 individual halved grains from single plants) by means of SDS-PAGE. The identification of HMW *Glu* alleles was done using the classification as per Payne and Lawrence (1983).

Further we evaluated 67 selected high- protein lines derived from tested materials in 3 trial years. We analysed agronomic characters, including spike morphology, productivity and harvest index. Protein content was evaluated by Kjeldahl, and the Zeleny test (ml) and Gluten index were determined.

We used the statistical software UNISTAT for data processing.

RESULTS AND DISCUSSION

Increased spike productivity in modern cultivars could be attributed mainly to increased number of grains in spikelets and increased HI, whereas TGW has a marginal effect. Old cultivars had on average 2–3% higher crude protein content in grain than modern ones. Among 10 selected characters, relatively wide diversity (*C.V.* 11–20%) was estimated in spike length and characters of spike productivity (except of grain weight with *C.V.* close to 9%). It was difficult to relate the traits studied to the cultivar origins, however, earliness and lower spike productivity seemed to be characteristic of South-East origin lines whereas cultivars from North-

West Europe showed opposite characters. Correlation analyses showed close relationships between earliness in heading and in maturity and negative relation between late heading and grain filling period, which was positively correlated with TGW and HI (r = 0.26 to 0.38). The number of grains in spikelets was highly correlated with spike productivity and HI (r = 0.62 to 0.69) whereas relations between these two characters and TGW were lower (r = 0.20 to 0.51). Spike productivity characters, except of TGW, are in negative correlation with crude protein content in grain (r = –0.34 to –0.50). Regression analyses confirmed that the main determining character for the spike productivity is number of kernels per spikelet (about 40% of variation) while effects of TGW are about half that level. Crude protein content was positively correlated to by plant height (15–30% of variation), while the impact of grain weight per spike was lower (14–17% of variation) and negative. Potentially valuable donors of earliness and longer grain filling period were identified for further studies and/or utilization in breeding programs. As especially valuable character we considered very high crude protein content (around 18% in cvs Bergland, Ukrajinka, Sippbachzeller, Innichen Nr. 25001 and Barbu du Finistre). High crude protein content combined with relatively good spike productivity and/or long grain filling period or earliness was found in cvs. Visperterminen 640 E, Hatvan, Szekacz 1242, Berchtesgardener Vogel, Ble du Lot and Barbu du Finistere.

Grain yields estimated in 31 selected landraces and old cultivars were always lower than in modern check cultivars. When we analyzed mean yields over 6 environments the modern cultivars provided grain yields of 151% of the mean value of landraces and obsolete cultivars. Relatively good yields were provided by the Czech landraces Bila od Dukovan, Vouska z Tremosnice and Zidlochovicka jubilejni osinatka (over 4.3 $t.ha^{-1}$). To estimate the relative response of cultivars to different environments, linear regression to mean values of these environments were calculated. A higher mean response of modern cultivars to environment (b=1.63) than in old cultivars (b=0.87) was confirmed, however, some landraces and old cvs. proved to be comparable tp modern cvs. (Bila od Dukovan, Brauner Fuchs, Barbu du Maconnais, Baltischer Winterweizen and Gammel Svensk Landhvedte).

HMW *Glu* subunits were identified in 122 landraces and obsolete cultivars (set I). The incidence of particular HMW *Glu* alleles and their combinations is shown in Table 1. Within the 224 lines, allele 1 was the most frequent one at the locus on chromosome 1A (48.7%), nevertheless, the absence of HMW *Glu* subunit (0) at this locus was also very common (45.5 %). Relatively rare was allele 2*, which was found in 6.7% examined cultivars. Similarly, only three different allelic combinations were identified at the locus 1D, among them 2+12 was most common (63% of lines) followed by the 5+10 combination. Allelic combination 3+12 was observed in only 5 cultivars (3.6%). There was broader diversity at the 1B locus where 10 different alleles and /or their combinations could be identified, among them alleles 7+9 (39.7%), 7+8 (22.3 %), 6+8 (16.1%) and allele 20 (present in 12.1% of the lines) can be considered as common and broadly spread. Alleles 8, 6, 9, 7 and the allelic combinations 13+16 and 17+18 were rare.

Subunits 17+18 at 1B were found only in Middle Europe. Gluten patterns themselves were not sufficient for geographic characterization, however, significant differences in European regions were observed. In 1A chromosome, absence of HMW *Glu* subunit was frequent in West and North-West Europe and strongly decreased in Middle and especially East Europe whereas allele 1 has a higher incidence in East Europe. A tendency of decreasing incidence of 2+12 alleles from west (82%) to east (17%) and opposite tendency of 5+10 alleles is typical for the 1D chromosome. At 1B chromosome we noticed increasing incidence from west (16 %) to east (60 %) for alleles 7+9; the inverse trend appears in allele 20.

Lower protein content was found in cultivars with an absence of GS at tha 1A locus (0). The gluten index was considerably higher (59.2) in cultivars bearing the allelic combination 5+10 at 1D. A range of alleles affected values of the sedimentation test.

Table 1. The frequency of HMW *Glu* alleles identified in 122 landraces and old winter wheat cultivars

1A		1B		1D	
allele	%	allele	%	allele	%
0	44.6	7+9	39.7	2+12	63
1	48.7	7+8	22.3	5+10	33
2*	6.7	6+8	16.1	3+12	3.6
		20	12.1		
		17+18	2.2		
		13+16	1.8		
		7	3.1		
		9	1.3		
		8	0.4		
		6	0.9		

High protein content is obviously one of the important characters in wheat landraces (Liu, 1988) which wheat breeders could utilize. Therefore, we evaluated 67 selected high protein lines and 3 check cultivars in trials over three years. Some results for 10 lines of highest protein content (17.5-18.3%) are given in Table 2. As could be expected, high protein content was negatively correlated with number of grains per spike (r= -0.47)

and HI (r= -0.38). Earliness and especially plant height (r=0.52) werepositively correlated with high protein content. However, we were able to find high protein lines with acceptable plant height and spike productivity. Unfortunately, we recorded negative links (r=- 0,43) between protein content and the Zeleny test. However, as Hungarian cvs. Eszterhazi Mindenes and Szekacz 19 proved, we can find acceptable values of the Zeleny test (54.0 ml and 42.0 ml respectively) in cultivars that also have very high protein content (18.3%). This data indicates the possible utilization of some selected landraces and obsolete cultivars in breeding for quality in wheat.

Table 2. Some characteristics of selected high-protein lines

Cultivar	Line	Plant height (cm)	HI	Protein (%)	Zeleny test	GI (%)
Mindeszentpusztai	44/B	131	0,39	18,3	38,0	54,6
Szekacz 19	37/B	128	0,42	18,3	42,0	55,0
Eszterhazi Mindenes	117/C	125	0,38	18,3	54,0	55,8
Bartweizen	16/B	135	0,40	18,0	29,5	50,7
Bergland	18/B	134	0,46	17,8	25,5	36,8
Ostka Czerwona	111/C	136	0,41	17,8	32,0	53,2
Slovenska 2	63/A	134	0,46	17,6	28,5	37,3
Mos 4	105/A	132	0,40	17,5	40,5	41,2
Mos 4	105/B	131	0,35	17,5	33,5	45,4
Bartweizen	16/C	122	0,38	17,5	39,5	61,7
Ilona	check	85	0,52	13,7	40,0	67,8
Sarka	check	87	0,52	13,4	36,5	74,9

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