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Evaluation of a hulled wheat (emmer and spelt) collections

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Abstract. A collection of 422 accessions of hulled wheat (219 emmer and 203 spelt) was studied to individuate the variability for some morphological and qualitative traits (heading date, plant height, thousand kernel weight, grain protein content, SDS sedimentation test). Results of this work highlighted a huge variability for the examined traits both for emmer and spelt accessions. Several accessions, possessing useful agronomical traits like earliness, short straw, large kernel, high protein content and SDS values, were identified for further evaluation in replicated trials.

Keywords. Hulled wheat – Emmer – Spelt – Variability – Germplasm collection – Marginal environments – Qualitative traits.

Évaluation de collections de blé mondé (amidonnier et épeautre)

Résumé. *Une collection de 422 accessions de blé mondé (219 d'amidonnier et 203 d'épeautre) a été étudiée pour identifier la variabilité de certains caractères morphologiques et qualitatifs (date d'épiaison, hauteur de la plante, poids de mille grains, teneur en protéines du grain, test de la vitesse de sédimentation SDS). Les résultats de ces travaux ont mis en évidence une grande variabilité des caractères examinés pour les accessions d'amidonnier et d'épeautre. Plusieurs accessions, possédant des caractères agronomiques utiles comme la précocité, la paille courte, un gros grain, une teneur en protéines et des valeurs du SDS élevées, ont été identifiées pour une future évaluation dans des répétitions.*

Mots-clés. *Blé mondé – Amidonnier – Épeautre – Variabilité – Collection de matériel génétique – Milieux marginaux – Caractères qualitatifs.*

I – Introduction

Triticum turgidum L. subsp. *dicoccon* Schrank (emmer) and *Triticum aestivum* subsp. *spelta* (spelt) are among the most ancient cereal crops (Nesbitt and Samuel, 1996). Over the centuries the cultivation of these hulled wheats was replaced by free-threshing and higher-yielding wheats. At present emmer and spelt are considered minor crops, cultivated in marginal areas of several European countries, including Italy (Perrino *et al.*, 1996). Their main value lies in their ability to give good yield in poor soils and tolerance to abiotic and biotic stresses. Hulled wheats should know a new development due to the nutritional value of the grain, the special taste of the products and their characters of resistance to pests and disease (Zaharieva *et al*., 2010). The increasing interest for ecologically grown products and for special diets based on health foods has led to a renewed interest in their cultivation, mainly for organic farming.

The growing attention for hulled wheats led scientists to start improvement programs to increase their adaptability, yield and qualitative characteristics as well as identify useful traits that could be transferred to durum and bread wheat (Pagnotta *et al*., 2009).

The aim of this work is to describe the variability for some morpho-physiological and qualitative traits of an emmer and spelt collection.

II – Material and methods

The collection, mainly from Institute of Plant Genetics of the Italian National Research Council (CNR-IGV), consists of 422 accessions (219 emmer and 203 spelt). Accessions were grown in single-row plots in 2011 at CRA-QCE experimental farm in central Italy (Rome-41°58'N 12°28'E alt 20 m asl) on deep soil having an outright clayey texture. Sowing date was February 9 and harvest date was July 15.

Some morpho-phisiological and qualitative traits were determined: heading date, plant height, thousand kernel weight (TKW), grain protein content, sodium dodecyl sulphate sedimentation (SDS).

The heading date, reported as number of days after April 1st, is the date in which 70% of the plants of the plot shows the spike emerged. Plant height (cm) is the average size of the plants of the plot from the ground level at the peak of the spike, excluding awns.TKW was determined by counting the number of kernels in a sample of at least 5 g. The sample was obtained by manual removing the hulls from spikelets.

Protein content (% d.m.) was performed by Dumas combustion method and Leco FP 428 instrument; SDS test (ml) was carried out following the ICC method 151, using a solution of SDS in lactic acid at 3% for tetraploid wheats and at 2% for hexaploid wheats.

III – Results and discussion

A summary of geographical origin of the accessions is reported in Table 1.

Table 1. Geographical origin of the accessions.

Geographical areas	Number of Accessions	
	Emmer	Spelt
Central East Africa	22	
Western Asia	20	
Eastern Europe	12	
Spain	11	72
Balkans	10	
Germany	1	6
Switzerland		11
Other areas	8	3
Unknown origin	14	7
Total	219	203

Most of the emmer accessions are from Central-East Africa (48 accessions) and Western Asia (44 accessions) while most of spelt accessions are from Spain (147 accessions).

A high level of variability was detected for most of the traits of emmer and spelt (Table 2 and Figure 1). Heading date of 219 emmer accessions ranged from May 8 to June 3 (38 days and 64 days after April 1st, respectively), with an average value of 52.7 da; 57% of the accessions showed a cycle length not lower than 53 da. Heading dates of 203 spelt accessions ranged from May 16 to June 10 (46 days and 71 da after April 1st, respectively) with an average value of 62.1 da, about ten days later than emmer. Almost 80% of the spelt accessions showed late cycle with heading dates ranging from 60 to 65 da.

Hulled wheats are generally tall plants. In the examined collection, values of emmer plant height were between 60 and 143 cm, with an average of 96.8 cm and half the accessions shorter than

100 cm. Average plant height of spelt accessions was 119.4 cm, taller than emmer one, ranging from 73 to 146 cm; more than 90% of the materials were taller than 100 cm.

Table 2. Means and range of variations for some traits measured for 219 emmer and 203 spelt accessions.

	Emmer				Spelt			
	Average	**Min**	**Max**	**SD**	**Average**	**Min**	**Max**	**SD**
Heading time	52.7	38	84	6.2	62.1	46	71	3.2
Plant height	96.8	60	143	15.7	119.4	73	146	12.6
TKW	36.1	21.1	51.3	6.6	39.8	23.2	56.6	5.7
Grain protein	17.3	13.2	22.8	1.7	18.5	13.6	23.5	1.4
SDS	32.1	14	80	13.5	56.3	15	90	11.5

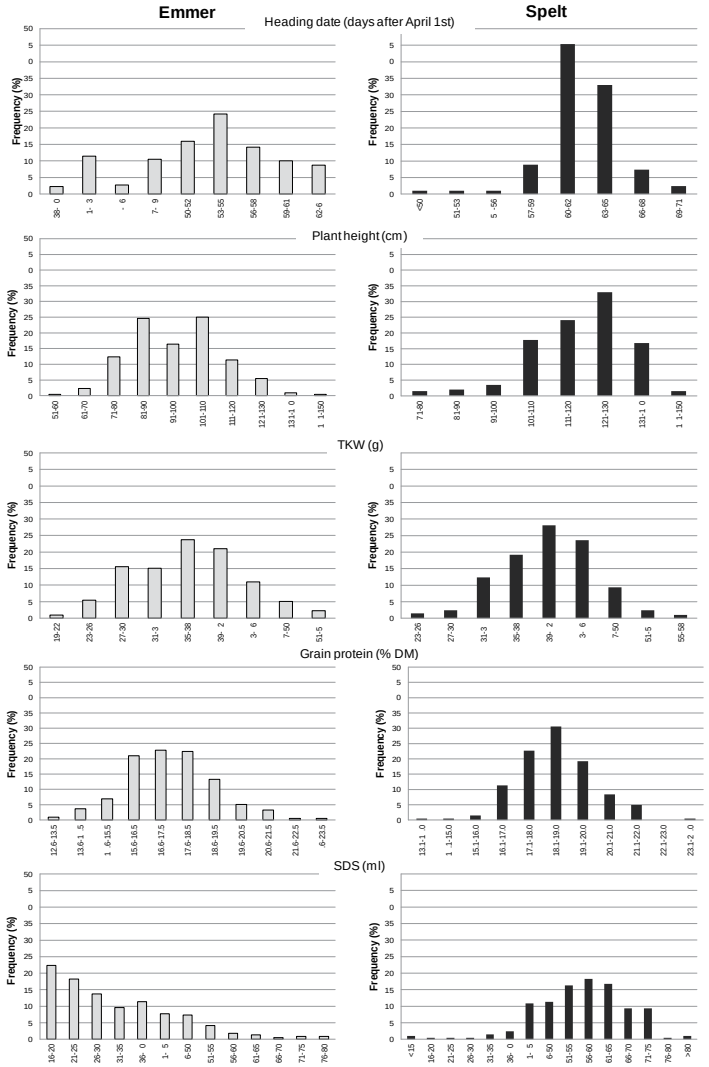

Figure 1. Distribution of frequency for heading date, plant height, TWK, grain protein and SDS measured on the Emmer (219 accessions) and Spelt (203 accessions) collection.

TKW is the character indicating seed dimension. TKW of 219 emmer accessions ranged from 21.1 to 51.3 g, with an average of 36.1 g; TKW of 203 spelt accessions was slightly higher than emmer, ranging from 23.2 g to 56.6 g with an average of 39.8 g. About one-half of spelt materials (99 accessions) achieved TKW value higher than 40 g, while such threshold was exceeded only by 58 emmer accessions (about a quarter).

Hulled wheats are characterized by high protein content that can reach 18-23% (Blanco et al., 1990; Perrino *et al*., Cubadda and Marconi, 1994). Analysis of grain protein content highlighted that all the accessions of the collection were characterised by a protein level higher than 13% (emmer accessions: range 13.2 - 22.8%; spelt accessions:13.6-23.5%), with 9 out to 10 materials having a protein content exceeding 15.5% for both species. Grain protein content was higher than 17% for 171 spelt accessions (84%) and 118 emmer accessions (54%).

SDS sedimentation volume is correlated with rheological parameters (Borghi *et al.,*1996) and gives a reliable evaluation of quantitative and qualitative aspects of protein, particularly of gluten.

A high variation was found for SDS in hulled wheats (Blanco *et al*., 1990; Perrino *et al*., 1993). In the examined collection, the range of SDS test values was similar for the two species (emmer: 14-80 ml; spelt: 15-90 ml) but more than 90% of the spelt accessions were characterised by high values, exceeding 40 ml (average value 56.3 ml); on the contrary emmer SDS values were lower: 75% of accessions was lower than 40 ml and 50% lower than 30 ml, with an average value of 32.1 ml.

IV – Conclusions

Results of this work highlighted a huge variability for the examined traits both for emmer and spelt accessions. Several accessions of emmer and spelt, possessing useful agronomical traits like earliness, short straw, large kernel, high protein content and SDS values, were identified for further evaluation in replicated trials. It is worth to highlight the large number of spelt accessions showing both high grain protein content and SDS sedimentation test values.

Further field trials are needed in order to identify the accessions suitable for different Italian environments or useful as source of genetic diversity for future wheat breeding programs.

The cultivation of these crops may highlight the links of products with territory and its history offering, at the same time, final products with high qualitative, organoleptic and nutritional traits.

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