DIFFERENCES IN THE MORPHOLOGICAL CHARACTERISTICS OF THE LAND RACES OF THE SOFT AND EMMER WHEAT IN RELATION TO THE MODERN VARIETIES

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For the organic farmers there is important question which varieties of wheat are right for organic farming in Less Favoured Areas. Modern varieties of wheat are bred in the conditions of conventional (high imput) farming. That is why the organic farmers asked about the suitability of land races of soft wheat (Triticum aestivum L.) or different species like emmer wheat grown in the past (Triticum dicoccum SCHUEBL). The paper results from the study of fourty land races, two intermediate and ten modern varieties of soft wheat in comparison to ten land races of emmer wheat at two locations in the Czech Republic. We evaluated tuft shape, length of plant, length and width of flag leaf, length and density of spike and awnedness. The modern varieties of soft wheat are characterised by a high level of uniformity. Their tuft shape is erect or semi-erect and length of plant is 60-70 cm, it does not rise the weed competitiveness. On the other hand, they have a medium or long flag leaf whose width is narrow or medium. Length of spike is medium or long. On the other hand, emmer wheat land races have the same tuft shape as forgoing modern varieties. Length of plant (89-119 cm) is the positive aspect of the weed competitiveness. Their flag leaf is narrow, but it is compesated by its length. The spike is shorter than the spike of modern varieties of soft wheat, but it is effectivelly compensated by an increased density. Intermediate wheat land races are characterised by looselly spreading tuft shape which puts the weeds down, but on the other hand, it favours the mildew because of the microclimate of soil. Its flag leaf is very short and narrow. Length of spike is medium and it is lax dense. The group of land races of soft wheat is characterised by a high diversity. The tuft shape is most frequently semi-erect. The length of plant varies from 60 to 120 cm, it usually ranges from 90 to 110 cm. Flag leaf is usually long or very long, but its width is very narrow or narrow. The spike is often long, but lax dense. Some of the evaluated varieties of landraces are proved to be suitable for organic farming from the point of view of the morphological characteristics.

***Key words**: morphological characterstics, land races, Triticum aestivum L., Triticum diccocum SCHUEBL*

Genetic diversity of the wild varieties of the cultural crops or related species may contribute to an improvement of the qualitites of the grown crops [HANÁK, PECHAROVÁ *et al.*, 1996]. The genofond of the cultural crops may be used for the breeding [ADARY, 1991, 1995; DENGCAI *et al.*, 2003; DAVOOD *et al.*, 2004; ASHKBOOS *et al.*, 2004; REYNOLDS *et al.*, 2007]; new species may be introduced there and the genetic resources may also be used in future research trials and activities, in cooperation with the other research institutes and organs [BAREŠ, 1998]. The land races have a wide and rich genetic base; they are therefore considered to be a valuable source of the tolerance to diseases and pests [BONMAN *et al.*, 2007; DANXIA *et al.*, 2007; COLLINS and HAWTIN, 1999] and improve the economic characteristics of the varieties [GOLLIN and SMALE, 1999].

Not only little bred species of land races, but also some crops having specific characteristics as good quality, adaptability to particular stress types, etc. are used in practice [DOTLAČIL, 2003]. Obsolete cultivars and land races of soft wheat (*Triticum aestivum* L.) and emmer wheat (*Triticum diccocum* SCHUEBL) are able to compensate the unfavourable environmental conditions and they prove to have higher stability of yield, but lower level of yield than modern varieties of soft wheat [DOTLAČIL, 2000]. Such varieties are characterised by better ability to form root matter, absorb the nutrients from the soil and they need therefore less additional fertilization by the form of soluble nutrients. They are more competitive to weeds thanks to their height and ability to tillering [ZÍDEK *et al.*, 1992]. Their productivity does not usually reach this one of the bred modern varieties and extended species [EHDAIE *et al.*, 1988, 1991]. In spite of this fact, they have been becoming more and more interesting thanks to their qualitative characteristics [DOTLAČIL, 2002].

These crops are suitable for the low-input and organic farming [DOTLAČIL, 2002] thanks to the lower demands and better adaptibility to the environmental conditions [DENGCAI *et al.*, 2003]. Obsolete cultivars and land races are more flexible and plastic, they are therefore used in the developing permaculture farming system [HOLMGREN, 2006]. The importance of the genetic resources of the field crops used in the farming is about to increase as they are more adaptable to the changing environmental conditions, which is caused by the global climatic changes [KOTSCHI, 2006].

They provide lower yield level, but more stable one in the marginal areas [COLLINS a HAWTIN, 1999]. It is necessary not only to grow these crops, but also to process them and to assure the marketing of the products which are usually considered to be regional specialities. Such concept is supported by e.g. the EU countries as an alternative to the intensive farming and production; original and traditional species of the crops are the most important aspect for each region [DOTLAČIL, 2002].

MATERIAL AND METHOD

Seeds of the genetic resources of emmer wheat and modern control varieties of soft wheat come from Gene bank of Research Institute of Crop production (RI) in Prague-Ruzyně (Prague). The file consists of 42 obsolete cultivars, land races, intermediate varieties and 10 modern varieties of the soft wheat and 10 genetic resources of the emmer wheat. As the total amount of seeds is low, they have been seeded in rows on the trial parcels of the RI in Prague-Ruzyně and the University of South Bohemia in České Budějovice (CB). Particular morphological characteristics were studied and evaluated during the growing season (*table 1*). List of the evaluated morphohological characters comes from Methodology of selection and evaluation of spring forms of neglected species of wheat genotypes, suitable for sustainable farming systems [KONVALINA et al., 2008].

Table 1

List of the evaluated morphological characteristics

Level	Code of character	Evaluated characteristics
Plant	M1	tuft shape
	M2	length
Flag leaf	M5	position
	M6	length
	M7	width
Spike	M10	length
	M11	density
	M12	awnedness

RESULTS AND DISCUSSIONS

As the amount of seeds coming from the gene bank is low, the seeds were seeded in the rows and reproduced and screened. The plants were strongly influenced by the „edge effect“ in the rows; that´s why the following morphological characteristics were therefore studied and evaluated: tuft shape in the tillering period, length of the plant, length and width of the flag leaf, density of spike and awnedness of spike.

Emmer wheat. The most of the varieties (70 %) of emmer wheat had erect tuft shape (tab. 2). The plants were 106 cm high on the average. There are not so significant differences between the individual genetic resources, as they are between the other evaluated files of the varieties of soft wheat (D3/06 Tapioszele I. 89 cm , D7/06 Kahler emmer 117 cm). Flag leaf was usually medium long (60 % of the varieties) or long (40 %); it was usually narrow (70 % of the varieties) or very narrow (30 %). Spikes were usually medium long (70 % of the varieties), dense (100 %) and were covered with short or long awns.

Modern varieties of soft wheat. The most of the varieties of soft wheat had erect tuft shape (*tab. 2*). The plants were 66 cm high on the average and there are little differences and variability between the varieties (the difference between the

maximum values and minimum ones rose to 10 cm). Flag leaf was medium long (40 % of the varieties) or long (60 %) and narrow (80 %). Spikes were medium long (80 % of the varieties), lax dense (40 %) or medium dense (60 %). They had not any awns (20 % of the varieties), or short little awns (50 %) and short awns (20%).

Obsolete cultivars and land races of soft wheat coming from the world resources. The most of the varieties of the file had erect tuft shape (83 % of the varieties) or very erect tuft shape (17 %). The plants were 91,5 cm high on the average (tab. 3). A significant differences and variability were noticed between the varieties (S20/06 Jeferson 65 cm, S3/06 Manitoba 120 cm). Flag leaf was usually long (22-27 cm, 57 % of the varieties) or very long (22% of the varieties). Some varieties (S15/06 Kenya farmer and S 23/06 Kundan) had very long (> 27 cm) and medium wide (1,6 - 2,1 cm) flag leaf. On the other hand, the other varieties had very long flag leaf (> 27 cm) (S8/06 Webster and S18/06 Hopea), but also very narrow one (< 1,1 cm). Spikes of the tested varieties were medium long (7-10 cm) (39 % of the varieties) or long (11-14 cm) (61 %). The most of the varieties had lax dense spikes (16,1-21,0 of the spikelets.10cm^{-1}) (52 % of the varieties), 39 % of the varieties had very lax dense spikes (<16 of the spikelets.10cm^{-1}). The most of the varieties had not their spikes covered with awns (48 %), the other ones had long little awns (35%).

Obsolete cultivars and land races of soft wheat coming from the Czech and Slovak resources. This file of the varieties was characterised by erect (47% of the varieties) or very erect (41%) tuft shape. The plants were 97 high on the average. There were significant differences and variability between the varieties (K10/06 Sylva 60 cm, K11/06 Selecty tvrdá bělka 115 cm (*tab. 3*). The most of the varieties (59%) had long flag leaf (22 - 27 cm) or very long one (>27 cm) (29%). The length of the flag leaf was compensated by its width (59% of the varieties had the narrow one, 1,1-1,5 cm, 29% of the varieties had the medium wide one). Spikes were usually medium long (41 % of the varieties) or long (53 %) and relatively lax dense (16,1-21,0 of the spikelets.10 cm^{-1}) (77 %). Spikes had not any awns (24 % of the varieties) or they had short little awns (47 %).

Intermediate varieties of soft wheat. This varieties are characterised by the spreading tuft shape. The plants were 110 cm high (P1/06 Postoloprtská přesívka), or 105 cm high (P2/06 Rosamova přesívka). Flag leaf was very short (<10 cm) and very narrow (<1,1 cm). Spikes of both tested varieties were medium long (7-10 cm), lax dense (16,1-21,0 of the spikelets.10cm^{-1}) and without awns (*tab. 4*).

Modern control varieties of soft wheat, compared with the other varieties, are characterised by the significant uniformity in the evaluated characteristics. The most of the varieties had erect tuft shape in the tillering period. Two intermediate varieties were exceptional and had spreading tuft shape. The spreading tuft shape is optimal from the point of view of the competitiveness to weeds in the agroecosystems similar to the natural ones [KRUEPL *et al.*, 2006; WOLFE *et al.*, 2008]. The competitiveness is also considerably influenced by the plant height, althought the authors do not concur in the unambiguous evaluation of the fact. The

plants of the modern varieties are very small. On the other hand, the average plant height of the other varieties reached 90-100 cm. Such plant height is optimal from the point of view of the competitiveness [CUDNEY *et al.*, 1991; KUNZ, KARUTZ, 1991; EISELE, KOPKE, 1997; MULLER, 1998]. On the other hand, the resistance to lodging has also to be taken into account [KÖPKE, 2005] it was not evaluated becouse of rows plots.

The surface of the assimilating apparatus influences the total degree of the assimilation of the sun shine [PETR *et al.*, 1980], surface of the flag leaf and awnedness of spikes are also very important aspects. Emmer wheat varieties had medium long or long narrow or very narrow flag leaf. A lot of the land races and obsolete cultivars coming from the Czech and Slovak or world resources had long or very long flag leaf, which was on the other hand compensated by its narrowness. The modern control varieties had medium long or long narrow flag leaf. Not only the surface of the flag leaf, but also the position of the flag leaf and the ability of the plant to maintain the powerful assimilating apparatus as long as possible (without any serious damage caused by diseases) [LAMERTS van BUEREN, 2002] are important from the assimilation point of view [PETR *et al.*, 1980; KOSTREJ *et al.*, 1998].

The density of spike has to be taken into account when speaking about the morphological characteristics, especially the resistance to diseases. Lax dense spike becomes to the factors influencing the resistance to fusariosis [MESTERHAZY, 1995; HILTON *et al.*, 1999], as it dries better. All the varieties of emmer wheat has dense spikes (25,1-31,0 of the spikelets.10 cm^{-1}). The modern varieties had lax dense or medium dense spikes, land races and obsolete cultivars coming from the Czech and Slovak or world resources usually had very lax dense or lax dense ones.

CONCLUSIONS

Tuft shape of the plants of emmer wheat, modern varieties, land races and obsolete cultivars of the soft wheat is erect, it does not therefore contribute to the increase of the competitiveness to weeds. On the other hand, the intermediate varieties of the soft wheat had the spreading tuft shape and they were growing slowly in the growing season. The plant height of the genetic resources of the emmer wheat and the most of the land races and obsolete cultivars usually varied from 90 to 140 cm, which contributed to the increase of the competitiveness to weeds, but, on the other hand, it also increased the tendency to the lodging. There were any significant differences in the position of the flag leaf neither between the varieties of the emmer wheat, nor between the modern varieties of the soft wheat. Short and narrow flag leaf is typical for the varieties of emmer wheat; the surface of the assimilating space is assured by the length of the flag leaf.

Table 2

Morphological characteristics (modern varieties of the soft wheat and emmer wheat)

Code of the variety	Name of the variety	Evaluated characteristic (mean of the Praha and CB stations)						
		M1 Tuft shape (°)	M3 Plant height (cm)	M6 Length of the flag leaf (cm)	M7 Width of the flag leaf (cm)	M10 Length of the spike (cm)	M11 Spike density (number of the spikelets.10 cm^{-1})	M 12 Awnedness
Emmer wheat								
D1/06	Horný Tisovník	25-40	97	16-21	<1,1	3-6	25,1-31,0	7
D2/06	Ruzyně	25-40	114	22-27	1,1-1,5	7-10	25,1-31,0	7
D3/06	Tapioszele I.	25-40	89	16-21	<1,1	3-6	25,1-31,0	8
D4/06	Tapioszele II.	25-40	114	22-27	1,1-1,5	7-10	25,1-31,0	7
D5/06	Mestnaja	41-55	94	16-21	<1,1	3-6	25,1-31,0	8
D6/06	Kroměříž	25-40	107	16-21	1,1-1,5	7-10	25,1-31,0	7
D7/06	Kahler emmer	25-40	117	22-27	1,1-1,5	7-10	25,1-31,0	7
D8/06	May emmer	25-40	110	22-27	1,1-1,5	7-10	25,1-31,0	7
D9/06	Sort. Schiemann	<25	94	16-21	1,1-1,5	7-10	25,1-31,0	6
D10/06	No. 8909	<25	119	16-21	1,1-1,5	7-10	25,1-31,0	8
Modern varieties of the soft wheat								
M1/06	Aranka	<25	70	22-27	1,1-1,5	7-10	16,1-21,0	6
M2/06	Munk	25-40	70	22-27	1,1-1,5	7-10	16,1-21,0	3
M3/06	Zuzana	25-40	65	22-27	1,1-1,5	7-10	21,1-25,0	3
M4/06	Swedjet	25-40	70	16-21	1,6-2,1	11-14	21,1-25,0	3
M5/06	Granny	25-40	70	22-27	1,6-2,1	11-14	21,1-25,0	6
M6/06	Vánek	<25	60	16-21	1,1-1,5	7-10	21,1-25,0	3
M7/06	Sirael	25-40	60	16-21	1,1-1,5	7-10	21,1-25,0	5
M8/06	SW Kronjet	25-40	60	16-21	1,1-1,5	7-10	16,1-21,0	2
M9/06	Amaretto	25-40	65	22-27	1,1-1,5	7-10	21,1-25,0	2
M10/06	SW Kadrilj	25-40	65	22-27	1,1-1,5	7-10	16,1-21,0	3

Remark.: M1 – Tuft shape (1=very erect, <25°; 3=erect, 25°-40°; 5=semi-erect, 41°-55°; 7=spreading, 56°-70°; 9=spreading, >70°); Spike - awnedness (1,2 – without awns, 3 – short little awns, 4 – little awns, 5 – long little awns, 6 – short awns, 7 - awns, 8 – long awns, 9 – very long awns)

Table 3

Morphological characteristics (land races and obsolete cultivars of the soft wheat – world resources)

Code of the variety	Name of the variety	Evaluated characteristic (mean of the Praha and CB stations)						
		M1 Tuft shape (°)	M3 Plant height (cm)	M6 Length of the flag leaf (cm)	M7 Width of the flag leaf (cm)	M10 Length of the spike (cm)	M11 Spike density (number of the spikelets.10 cm^{-1})	M 12 Awnedness
S1/06	Svaloefs Diamant II.	25-40	110	>27	1,1-1,5	7-10	16,1-21,0	2
S2/06	Touko	25-40	115	22-27	1,1-1,5	11-14	16,1-21,0	2
S3/06	Manitoba	25-40	120	22-27	1,1-1,5	11-14	16,1-21,0	2
S4/06	Bage	25-40	90	22-27	<1,1	11-14	<16	4
S5/06	Rio Negro	25-40	90	16-21	1,1-1,5	7-10	<16	5
S6/06	Baroota Wonder	25-40	105	22-27	<1,1	11-14	16,1-21,0	2
S7/06	Almadense	25-40	100	22-27	1,6-2,1	11-14	16,1-21,0	2
S8/06	Webster	<25	80	>27	<1,1	11-14	<16	5
S9/06	Turkmenskaja	<25	90	22-27	<1,1	11-14	16,1-21,0	5
S10/06	Kolchoznica	25-40	90	22-27	<1,1	11-14	<16	2
S11/06	Sawtana	25-40	85	16-21	1,1-1,5	7-10	16,1-21,0	2
S12/06	Local	25-40	80	16-21	1,1-1,5	7-10	21,1-25,0	4
S13/06	Barleta Benvenuto	25-40	90	22-27	1,1-1,5	11-14	16,1-21,0	5
S14/06	Hopps	<25	80	22-27	1,1-1,5	7-10	16,1-21,0	5
S15/06	Kenya Farmer	25-40	85	>27	1,6-2,1	11-14	<16	2
S16/06	Hokoku	25-40	90	22-27	<1,1	11-14	16,1-21,0	2
S17/06	Dalnevostocnaja 10	25-40	85	16-21	<1,1	11-14	16,1-21,0	2
S18/06	Hopea	25-40	95	>27	<1,1	11-14	16,1-21,0	2
S19/06	Iona	25-40	70	22-27	1,6-2,1	11-14	<16	6
S20/06	Jefferson	25-40	65	22-27	<1,1	7-10	<16	5
S21/06	Kharkivs'ka 41	25-40	100	22-27	1,6-2,1	7-10	25,1-31,0	9
S22/06	Tritinaldia	<25	105	16-21	1,1-1,5	7-10	<16	5
S23/06	Kundan	25-40	85	>27	1,6-2,1	7-10	<16	5

Remark.: M1 – Tuft shape (1=very erect, <25°; 3=erect, 25°-40°; 5=semi-erect, 41°-55°; 7=spreading, 56°-70°; 9=spreading, >70°); Spike - awnedness (1,2 – without awns, 3 – short little awns, 4 – little awns, 5 – long little awns, 6 – short awns, 7 - awns, 8 – long awns, 9 – very long awns)

Table 4

Morphological characteristics (land races, obsolete cultivars and intermediate varieties of the soft wheat – Czech and Slovak resources)

Code of the variety	Name of the variety	Evaluated characteristic (mean of the Praha and CB stations)						
		M1 Tuft shape (°)	M3 Plant height (cm)	M6 Length of the flag leaf (cm)	M7 Width of the flag leaf (cm)	M10 Length of the spike (cm)	M11 Spike density (number of the spikelets.10 cm^{-1})	M 12 Awnedness
Land races and obsolete cultivars of the soft wheat (CS)								
K1/06	Ratbořská	<25	110	22-27	1,1-1,5	>14	16,1-21,0	2
K2/06	Vega	41-55	105	22-27	1,1-1,5	11-14	16,1-21,0	3
K3/06	Podboranka	25-40	110	22-27	1,1-1,5	7-10	16,1-21,0	3
K4/06	Praga	25-40	90	>27	1,6-2,1	11-14	16,1-21,0	3
K5/06	Dětěnická bílá hladká	<25	95	16-21	1,6-2,1	7-10	<16	3
K6/06	Hodonínská bezosinná	<25	110	22-27	1,1-1,5	11-14	16,1-21,0	1
K7/06	Kostomlatská sametka	56-70	105	16-21	<1,1	7-10	16,1-21,0	1
K8/06	Přerovská PK	25-40	110	22-27	1,1-1,5	11-14	16,1-21,0	2
K9/06	Slovenská skorá	25-40	110	>27	<1,1	7-10	<16	5
K10/06	Sylva	25-40	60	22-27	1,1-1,5	7-10	16,1-21,0	5
K11/06	Selecty tvrdá bělka	25-40	115	>27	1,1-1,5	11-14	<16	3
K12/06	Staroveská bezosinná	25-40	100	22-27	1,1-1,5	11-14	<16	3
K13/06	Ruzyňská II	<25	95	22-27	1,6-2,1	7-10	16,1-21,0	2
K14/06	Dobrovická 3	25-40	95	>27	1,1-1,5	11-14	16,1-21,0	3
K15/06	Zlatka	<25	70	22-27	1,6-2,1	7-10	16,1-21,0	2
K16/06	Oktavia	<25	90	>27	1,1-1,5	11-14	16,1-21,0	6
K17/06	Jara	<25	75	22-27	1,6-2,1	11-14	16,1-21,0	3
Intermediate varieties								
P1/06	Postoloprtská přesívka	56-70	110	<10	<1,1	7-10	16,1-21,0	2
P2/06	Rosamova přesívka	56-70	105	<10	<1,1	7-10	16,1-21,0	2

Remark.: M1 – Tuft shape (1=very erect, <25°; 3=erect, 25°-40°; 5=semi-erect, 41°-55°; 7=spreading, 56°-70°; 9=spreading, >70°); Spike - awnedness (1,2 – without awns, 3 – short little awns, 4 – little awns, 5 – long little awns, 6 – short awns, 7 - awns, 8 – long awns, 9 – very long awns)

The spikes of the emmer wheat varieties and land races of the soft wheat are usually less productive. The spikes of the emmer wheat are usually very dense and short, which is compensated by a higher amount of the spikelets in the spikes. Our results of the studies of the morphological characteristics show that some genetic resources of the emmer wheat and soft wheat are suitable for low-input farming.

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