MORPHOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF THE LAND RACES OF THE SPRING SOFT WHEAT GROWN IN THE ORGANIC FARMING SYSTEM
MORFOLOGICKÁ A BIOLOGICKÁ CHARAKTERISTIKA KRAJOVÝCH ODRŮD JARNÍCH FOREM PŠENICE PRO EKOLOGICKÉ ZEMĚDĚLSTVÍ

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ABSTRACT

Organic farmers have become more interested in the marginally grown (neglected) cultivars, as spring forms of the hulled wheat varieties (eincorn, emmer wheat, spelta wheat) or intermediate forms of the soft wheat. 173 land races from the gene bank at the RI in Praha-Ruzyně were grown on the organic certified parcel and evaluated in 2008. The trial aimed to evaluate the conditions of the competitiveness to weeds, tolerance to diseases, assimilation of the sun shine and establishment of the yield. The results show that all the evaluated material inclines to the competitiveness to weeds. This ability is, nevertheless, reduced because of the inclination to the lodging (all the cultivars have long weak stalks). Eincorn and emmer wheat are resistant to mildew and brown rust, spelta wheat is less resistant cultivar and the intermediate cultivars incline to disease attack very much. Eincorn and emmer wheat have short and dense spikes, spelta wheat has long and sparse spikes. Perspective materials have been found in the study and trials. We are going to focus on a possible increase of the resistance to lodging, choice of the resistant cultivars to funga diseases and increase of the spike productivity.

KEY WORDS: Morphological and biological characteristics, organic farming, eincorn, emmer wheat, spelta wheat, intermediate forms of wheat

ABSTRAKT

Ze strany ekologických farmářů stoupá zájem o pěstování dosud opomíjených plodin, jako jsou jarní formy pluchatých pšenic (jednozrnka, dvouzrnka, špalda) nebo přesívkové formy pšenice seté. V roce 2008 bylo na ekologicky certifikovaném pozemku zhodnoceno 173 krajových odrůd z kolekce Genové banky při Výzkumném ústavu rostlinné výroby v Praze-Ruzyni. Cílem studie bylo vyhodnotit předpoklady ke konkurenceschopnosti vůči plevelům, odolnosti k chorobám, asimilaci slunečního záření a tvorbě hospodářského výnosu. Z našich výsledků je opatrné, že všechny hodnocené materiály mají předpoklad konkurovat plevelům, tato schopnost je snižovaná náchylností k poléhání v důsledku dlouhého a slabého stébla. Pšenice jednozrnka a dvouzrnka je odolná k padlí travnímu a rzi pšeničné, špalda je odolná méně a velmi náchylné k napadení jsou přesívkové formy pšenice seté. Jednozrnka a dvouzrnka mají krátký a hustý klas, špalda dlouhý a řídký. Během hodnocení se podařilo nalézt perspektivní materiály, v další práci se budeme věnovat především zvýšení odolnosti k poléhání, výběru odolných odrůd k houbovým chorobám a zvýšení produktivity klasu.

KLÍČOVÁ SLOVA: morfologické a biologické znaky, ekologické zemědělství, pšenice jednozrnka, dvouzrnka, špalda, přesívka

DETAILNÍ ABSTRAKT

Cílem naší studie bylo zhodnotit mezidruhové rozdíly u vybraných odrůd jarních forem pšenice z kolekce Genové banky při VÚRV, v.v.i. v Praze - Ruzyni a poukázat na druhově vázané rozdíly v morfologických a biologických znacích ve vztahu k ideotypu odrůdy pro ekologické zemědělství. Hodnocení takto rozsáhlého souboru odrůd jarních forem rodu pšenice nebylo přímo v ekologicky certifikovaném systému hospodaření v podmínkách střední Evropy doposud prováděno. Na základě našich výsledků můžeme konstatovat, že většina hodnocených odrůd má předpoklad vysoké konkurenceschopnosti vůči plevelům. Při výběru perspektivních odrůd je nutné zohlednit odolnost k poléhání, protože polehlá odrůda přestává konkurovat plevelům a dochází k velkým výnosovým ztrátám. Nejvíce poléhavé byly přesívkové formy pšenice seté, pšenice dvouzrnka a částečně pšenice špalda. Neméně důležitým kritériem při výběru vhodných odrůd bude zohlednění odolnosti k houbovým chorobám, proti kterým nejsou v ekologickém zemědělství povoleny přímé zásahy. Náchylné k napadení padlím travním a rzí pšeničnou jsou přesívky a špalda. U dvouzrnek je nutné provést důkladnou selekci, protože většina odrůd je rezistentních, ale v hodnoceném souboru bylo několik odrůd, které mají naopak odolnost velmi sníženou. Z pohledu asimilace slunečního záření byly zhodnoceny praporcové listy. Jednozrnky mají praporcový list úzký a krátký stejně jako přesívkové formy pšenice seté. Můžeme předpokládat, že úroveň asimilace jednozrnek bude výrazně vyšší než u přesívek,u kterých je činnost praporcového listu výrazně snížena napadením houbovými chorobami. Z vyhodnocení délky a hustoty klasu je patrné, že pluchaté pšenice tvoří hospodářský výnos spíše počtem produktivních odnoží, kontrolní odrůdy pšenice seté pak produktivitou klasu. Naše studie přinesla řadu cenných poznatků o reakci krajových odrůd doposud opomíjených druhů pšenice na systém pěstování se sníženými vstupy. Perspektivním materiálům se budeme nadále věnovat s cílem vypracovat komplexní metodiky hodnocení vhodnosti odrůd pro ekologické zemědělství, pěstitelské metodiky a výběru odrůd pro ekologické zemědělství.

INTRODUCTION

Modern cultivars of the soft wheat are not able to meet all the requirements of the organic farming, as they were bred for the high-input farming system [46]. Therefore, we should focus on the selection and breeding of the varieties for the organic farming conditions and conditions of low nitrogenous nutrition level [32]. Organic farmers require the cultivars which do not have any negative effects on the health and good functions of the whole agroecosystem. The cultivars should be able to grow in low-input farming system (low input of the nutrients), they should have an efficient root system, they should be able to establish the positive interaction with the soil edaphone, they should be highly competitive to weeds and provide a sufficient yield level and yield quality [33].

Special breeding programmes, focused on the organic farming conditions, or the wide diversity of species of the land races of Triticum L. (as eincorn, Triticum monococum L., emmer wheat, Triticum diccocum SCHUEBL, spelta wheat, Triticum spelta L., or intermediate forms of the soft wheat, Triticum aestivum L., which are included in the world collection of the gene banks) may be used to fulfil the above-mentioned task [46].

Particular genetic resources, having some specific characteristics as good quality, ability to the adaptation to particular stressing factors, etc. [14], may be used in practice. They cannot come up to the modern bred and extended species [15][16]. However, they have been becoming more and more interesting (it is caused by their favourable qualitative characteristics and features) [12]. They are characterised by high nutritive and dietetic value. Hulled wheats (eincorn, emmer wheat, spelta wheat) contain more proteins and microelements (especially zinc and iron), B vitamines (thiamin, riboflavin and niacin) and proteins (16–22 % at average) than the soft wheat [38]. The growing of such varieties would also contribute to the extension of the range of good-quality production proposed to the consumers, market productions of the farmers and enrichment of the agrobiodiversity [13].

The wide range of the genetic resources of the original wheat cultivars may also be used in the breeding process [3][4][11][10][1][42]. The land races of emmer wheat and soft wheat have a wide genetic base, therefore, they solve as valuable resources of the resistance to diseases and pests [6][9][7]. They may improve the economic characteristics of the other varieties [19].

These crops are less demanding and more able to adapt to the current environmental conditions [11]. Therefore, they are suitable for the low-input and organic farming systems [12]. The obsolete cultivars and land races are more flexible, therefore they are more used in the fast developing permacultural farming system [23]. The importance of the genetic resources of the field crops, used for farming too, is about to increase thanks to their ability to adapt to changing environmental conditions caused by the global climatic changes [29]. They provide lower but more stable yields level in the marginal areas [7]. Except the growing of such crops, the processing and marketing of the products have to be assured too (they are usually regional specialities). Such concept is supported

Table 1: Temperature and precipitation characteristics of the location in Ruzyně (growing season from April to August)
Tabulka 1: Teplotní a srážková charakteristika pokusného stanoviště (vegetační sezóna duben-srprpen)

	Month						Mean in the growing season
	3	4	5	6	7	8	
Longtime normal values between 1961 and 1990 (ČHMU, 2009)							
temperature(°C)	3,0	7,7	12,7	15,9	17,5	17,0	14,2
precipitations (mm)	28,1	38,2	77,2	72,7	66,2	69,6	323,9
2008							
temperature (°C)	3,7	8,2	14,1	17,7	18,5	18,2	15,3
precipitations (mm)	20,0	56,8	54,9	66,0	73,7	67,8	319,2

Table 2: Agrochemical soil analysis of the certified organic parcel in Ruzyně
Tabulka 2: Výsledky agrochemického zkoušení půd na ekologicky certifikovaném pokusném pozemku

Soil reaction	Soil reaction	Content of the admissible nutrients in the soil ($mg.kg^{-1}$)				Cox (%)	Humus (%)	Nt (%)
pH/KCl	pH/H2O	P	K	Ca	Mg			
7,63	8,42	87,1	270	4 679	129	2,787	4,805	0,165

Table 3: Basic statistical evaluation of 24 varieties of eincorn
Tabulka 3: Základní statistické zhodnocení 24 odrůd pšenice jednozrnky

Evaluated characteristic		Mean	SD	VK	Median	Quartile	
						Lower	Upper
Tuft shape (code)[1]		4,29	1,3015	30,33	4,50	3,50	5,00
Position of flag leaf (code)[2]		1,83	0,5647	30,80	2,00	1,50	2,00
Flag leaf (code)	length[3]	2,04	0,7506	36,76	2,00	2,00	2,00
	width[4]	1,00	0,0000	0,00	1,00	1,00	1,00
Distance spike-flag leaf (cm)		22,69	2,9813	13,14	22,55	20,68	24,35
Vegetation (days) – emergence to:	flowering	72,42	3,3221	4,59	72,00	70,00	74,00
	soft dought	107,92	2,1042	1,95	108,00	106,00	109,00
Mildew (points)	DC 39	9,00	0,0000	0,00	9,00	9,00	9,00
	DC 59	9,00	0,0000	0,00	9,00	9,00	9,00
Index of lodging (points)	DC 59	9,00	0,0000	0,00	9,00	9,00	9,00
	DC 87	8,13	1,1827	14,54	8,65	7,60	9,00
Brown rust (points)	DC 77	9,00	0,0000	0,00	9,00	9,00	9,00
Position of spike (code)[5]		1,38	0,7697	55,98	1,00	1,00	1,50
Length of plant (cm)		101,04	6,2518	6,19	100,00	95,00	105,00
Awnedness of spike (code)[6]		5,50	0,8341	15,16	6,00	5,00	6,00
Length of spike (cm)		4,75	0,8022	16,90	4,70	4,10	5,00
Density of spike (spikelet.$10cm^{-1}$)		43,98	3,6818	8,37	43,47	42,19	47,12

Remark: [1]1 = <25º, 3 = 25-40º, 5 = 41-55º, 7 = 56-70º, 9 = >70º; [2,5]1 = <55º, 3 = 15-45º, 5 = 46-90º, 7 = 91-135º, 9 = >135º; [3]1 = <10 cm, 3 = 10-15 cm, 5 = 16-21 cm, 7 = 22-27 cm, 9 = >27 cm; [4]1 = <1,1 cm, 3 = 1,1-1,5 cm, 5 = 1,6-2,1 cm, 7 = 2,2-2,7 cm, 9 = >2,7 cm;[6]1 = awnless, 3 = short awns, 5 = semi - awned, 7 = awned, 9 = very long awned

and applied as an alternative to the intensive farming e.g. in the states of the European Union. It is focused on the use of the original and traditional species in each region [12].

MATERIAL AND METHODS

24 samples of the eincorn (Triticum monococum L.), 103 samples of the emmer wheat (Triticum diccocum SCHUEBL), 15 spring varieties of the spelta wheat (Triticum spelta L.) and 28 intermediate forms of the soft wheat (Triticum aestivum L.) were chosen from the collection of the genetic resources of the gene bank at the Research Institute of Crop Production in Praha-Ruzyně (RI) in 2008. The samples were selected according to the area of origin (the growing conditions of the area of origin have to be as similar as possible to the growing conditions in the Central Europe). Two modern varieties - Granny and SW Kadrilj were included in the control varieties of the soft wheat (Triticum aestivum L.).

Certified organic trial parcel of the RI is located in the beet warm and mid-dry area, soil type – degraded black clay-loamy soil, in the altitude of 340 metres, the mean annual temperature of 7,8°C, the mean annual precipitation of 472 mm (Table 1). The results of the soil analysis are shown in Table 2 (Mehlich III.). 173 samples of the above-mentioned wheat varieties were sown on the trial parcel (120 of them were sown on the parcels of 4 m^2 and 53 on the parcel of 2 m^2). The control varieties of the soft wheat were sown on each eleventh trial parcel. The seeding was assured with the seed drill free of rests called Oyjord. The trial parcels were 1,25 metres wide. The rows were 12,5 cm wide. The treatment of the crops during the growing season respected the principles of the organic farming. The particular characteristics were measured and evaluated during the gorwing season and post-harvest period according to the Metodology of selection and evaluation of the genotypes of the spring forms of less used wheat species which are suitable for the sustainable farming systems [26]. We used the nine-degree scale (9 = no disease infestation noticed) for the evaluation of the mildew and brown rust attack. The lodging was measures by the index of lodging which combines the intensity and range of the lodging on a parcel (9 = the variety does not lodge). The other data are represented by a concrete value. The results were also evaluated with the basic instruments of Statistica program.

RESULTS

This study presents the results of the evaluation of the particular morphological and biological characteristics of the land races of wheat related to the ideotype of the variety for the organic farming. The characteristics connected with the competitiveness to weeds, health of the plants and economic yield (assimilation of the sun shine) were chosen and evaluated.

The eincorn is characterised by a short and very narrow flag leaf. Such a features, combined with a semi-erect or erect tuft shape and slow growth of the plants in the growing season may lead to a lower level of the competitiveness to weeds. On the other hand, the enicorn (all the evaluated varieties of the eincorn) is very resistant to the mildew and brown rust attack (Table 3). The plants are 101 cm long at average and the most of the varieties proved to be quite resistant to the lodging (span of the index of lodging: 7,60–9,00). The spike has short awns, it is very short (4,75 cm long at average) and very dense (43,98 spikelets.10 cm^{-1} – the length of spike).

The emmer wheat has the erect tuft shape. The flag leaf is usually mid-long (16-21 cm) and narrow (1,1-1,5 cm). The combination of such factors with the awned spikes and good health of the plants assures a sufficient assimilation surface. Several varieties were attacked by mildew and brown rust (the median and lower and upper quartile indicate the resistance) (Table 4). The total growing period is 104 days at average and it is not very variable (co-efficient of the variation = 2,56 %). The emmer wheat inclines to the lodging, the first varieties of the emmer wheat inclined to the lodging from the stadium of earing (index of lodging = 8,59) and the resistance to lodging even decreased before the harvest stadium (index of lodging = 6,88). The inclination to lodging is connected with the length of plants, which is 107,86 cm at average, and the span of the quartiles, which is 100–110 cm. The varieties of emmer wheat have mid-long (6,13 cm) and very dense spikes (32,81 of the spikelets.10 cm^{-1} the length of spike) which assures a sufficient level of the productivity.

The tuft shape of the land races of spring spelta is semi-erect; therefore, the spelta wheat inclines to the high level of the competitiveness to weeds. The growing season compared to the control varieties (Table 7) is prolonged (Table 5) by one week in the earing stadium and by five days is the soft dought stadium (DC85). In practice, the spelta wheat has a shorter generative stadium of growth. The evaluated varieties were strongly attacked by mildew and brown rust. The selection of the uninfestated varieties by the brown rust was easier (25 % of them were not infestated) than the selection of the uninfestated varieties by mildew (various degree of the infestation) (Table 5). The inclination to lodging was evident in later stages of growth (DC 87). The index to lodging decreased to 6,11 at average. It is connected with the length of plants (120 cm at average). The control varieties of soft wheat are

Table 4: Basic statistical evaluation of 103 varieties of emmer wheat
Tabulka 4: Základní statistické zhodnocení 103 odrůd pšenice dvouzrnky

Evaluated characteristic		Mean	SD	VK	Median	Quartile	
						Lower	Upper
Tuft shape (code)[1]		3,08	0,8006	25,99	3,00	3,00	4,00
Position of flag leaf (code)[2]		2,32	1,0405	44,85	2,00	2,00	3,00
Flag leaf (code)	length[3]	5,35	1,4122	26,40	5,00	4,00	6,00
	width[4]	1,77	0,7822	44,19	2,00	1,00	2,00
Distance spike-flag leaf (cm)		17,79	3,6715	20,64	18,00	15,30	20,40
Vegetation (days) – emergence to:	flowering	71,62	3,1127	4,35	71,00	70,00	73,00
	soft dought	104,38	2,6683	2,56	105,00	103,00	107,00
Mildew (points)	DC 39	8,79	0,6810	7,75	9,00	9,00	9,00
	DC 59	8,70	0,8948	10,29	9,00	9,00	9,00
Index of lodging (points)	DC 59	8,59	0,8642	10,06	9,00	8,60	9,00
	DC 87	6,88	2,1570	31,35	8,00	6,00	8,50
Brown rust (points)	DC 77	8,89	0,7659	8,62	9,00	9,00	9,00
Position of spike (code)[5]		3,35	0,7885	23,54	3,00	3,00	4,00
Length of plant (cm)		107,86	8,3901	7,78	110,00	100,00	110,00
Awnedness of spike (code)[6]		6,58	0,8108	12,32	7,00	6,00	7,00
Length of spike (cm)		6,13	1,1032	18,00	6,00	5,30	7,00
Density of spike (spikelet.10cm^{-1})		32,81	4,2763	13,03	32,96	29,37	35,56

Remark: [1]1 = <25º, 3 = 25-40º, 5 = 41-55º, 7 = 56-70º, 9 = >70º; [2;5]1 = <55º, 3 = 15-45º, 5 = 46-90º, 7 = 91-135º, 9 = >135º; [3]1 = <10 cm, 3 = 10-15 cm, 5 = 16-21 cm, 7 = 22-27 cm, 9 = >27 cm; [4]1 = <1,1 cm, 3 = 1,1-1,5 cm, 5 = 1,6-2,1 cm, 7 = 2,2-2,7 cm, 9 = >2,7 cm;[6]1 = awnless, 3 = short awns, 5 = semi - awned, 7 = awned, 9 = very long awned

Table 5: Basic evaluation of 15 varieties of spelta wheat
Tabulka 5: Základní statistické zhodnocení 15 odrůd špaldy

Evaluated characteristic		Mean	SD	VK	Median	Quartile	
						Lower	Upper
Tuft shape (code)[1]		3,27	1,4865	45,50	4,00	2,00	5,00
Position of flag leaf (code)[2]		4,53	1,1255	24,83	5,00	4,00	5,00
Flag leaf (code)	length[3]	6,67	1,5430	23,15	7,00	5,00	8,00
	width[4]	3,07	0,5936	19,36	3,00	3,00	3,00
Distance spike-flag leaf (cm)		15,58	4,3514	27,92	15,10	12,40	18,00
Vegetation (days) – emergence to:	flowering	70,07	6,1582	8,79	72,00	71,00	73,00
	soft dought	105,00	4,9281	4,69	107,00	105,00	108,00
Mildew (points)	DC 39	7,80	1,2071	15,48	8,00	7,00	9,00
	DC 59	7,20	1,6125	22,40	8,00	6,00	8,00
Index of lodging (points)	DC 59	8,78	0,5185	5,91	9,00	9,00	9,00
	DC 87	7,05	1,9878	28,18	7,00	5,80	9,00
Brown rust (points)	DC 77	8,47	1,4075	16,62	9,00	9,00	9,00
Position of spike (code)[5]		2,20	0,5606	25,48	2,00	2,00	3,00
Length of plant (cm)		112,67	19,074	16,93	120,00	105,00	125,00
Awnedness of spike (code)[6]		3,67	2,4103	65,73	5,00	1,00	5,00
Length of spike (cm)		11,30	2,0805	18,41	11,20	10,30	13,00
Density of spike (spikelet.10cm^{-1})		16,59	3,2431	19,55	15,67	14,65	17,67

Remark: [1]1 = <25º, 3 = 25-40º, 5 = 41-55º, 7 = 56-70º, 9 = >70º; [2;5]1 = <55º, 3 = 15-45º, 5 = 46-90º, 7 = 91-135º, 9 = >135º; [3]1 = <10 cm, 3 = 10-15 cm, 5 = 16-21 cm, 7 = 22-27 cm, 9 = >27 cm; [4]1 = <1,1 cm, 3 = 1,1-1,5 cm, 5 = 1,6-2,1 cm, 7 = 2,2-2,7 cm, 9 = >2,7 cm;[6]1 = awnless, 3 = short awns, 5 = semi - awned, 7 = awned, 9 = very long awned

Table 6: Basic evaluation of 27 varieties of intermediate forms of soft wheat
Tabulka 6: Základní statistické zhodnocení 27 odrůd přesívkové formy pšenice seté

Evaluated characteristic		Mean	SD	VK	Median	Quartile	
						Lower	Upper
Tuft shape (code)[1]		4,70	1,4092	29,96	5,00	4,00	6,00
Position of flag leaf (code)[2]		3,33	1,0742	32,23	3,00	3,00	4,00
Flag leaf (code)	length[3]	6,89	1,7172	24,93	7,00	6,00	8,00
	width[4]	2,48	0,6427	25,90	2,00	2,00	3,00
Distance spike-flag leaf (cm)		18,06	2,6638	14,75	18,65	15,90	20,20
Vegetation (days) – emergence to:	flowering	74,19	2,4343	3,281	74,00	73,00	76,00
	soft dought	107,96	1,4802	1,371	108,00	108,00	109,00
Mildew (points)	DC 39	6,852	1,1995	17,51	7,00	6,00	8,00
	DC 59	6,26	1,3472	21,52	6,00	5,00	7,00
Index of lodging (points)	DC 59	9,00	0,0000	0,00	9,00	9,00	9,00
	DC 87	6,11	2,2656	37,10	6,30	3,60	8,10
Brown rust (points)	DC 77	6,63	2,2896	34,54	6,00	5,00	9,00
Position of spike (code)[5]		1,37	0,5649	41,22	1,00	1,00	2,00
Length of plant (cm)		116,67	10,378	8,90	120,00	110,00	125,00
Awnedness of spike (code)[6]		1,22	0,8006	65,51	1,00	1,00	1,00
Length of spike (cm)		8,84	1,2653	14,32	8,80	7,70	9,60
Density of spike (spikelet.10cm^{-1})		22,17	1,8717	8,44	21,86	21,26	23,77

Remark: [1]1 = <25º, 3 = 25-40º, 5 = 41-55º, 7 = 56-70º, 9 = >70º; [2;5]1 = <55º, 3 = 15-45º, 5 = 46-90º, 7 = 91-135º, 9 = >135º; [3]1 = <10 cm, 3 = 10-15 cm, 5 = 16-21 cm, 7 = 22-27 cm, 9 = >27 cm; [4]1 = <1,1 cm, 3 = 1,1-1,5 cm, 5 = 1,6-2,1 cm, 7 = 2,2-2,7 cm, 9 = >2,7 cm;[6]1 = awnless, 3 = short awns, 5 = semi - awned, 7 = awned, 9 = very long awned

Table 7: Basic statistical evaluation of 2 varieties of soft wheat – control varieties (SW Kadrilj – 5 repetition; Granny – 5 repetition)
Tabulka 7: Základní statistické zhodnocení 2 kontrolních odrůd pšenice seté (SW Kadrilj – 5 opakování; Granny – 5 opakování)

Evaluated characteristic		Mean	SD	VK	Median	Quartile	
						Lower	Upper
Tuft shape (code)[1]		2,60	0,6992	26,89	2,50	2,00	3,00
Position of flag leaf (code)[2]		2,40	0,5164	21,52	2,00	2,00	3,00
Flag leaf (code)	length[3]	5,20	1,9889	38,25	5,50	4,00	7,00
	width[4]	3,30	0,9487	28,75	3,00	3,00	4,00
Distance spike-flag leaf (cm)		12,74	1,6543	12,98	12,78	11,35	13,80
Vegetation (days) – emergence to:	flowering	66,80	1,3166	1,97	67,00	66,00	68,00
	soft dought	102,80	1,3984	1,36	103,00	102,00	103,00
Mildew (points)	DC 39	9,00	0,0000	0,00	9,00	9,00	9,00
	DC 59	8,80	0,4216	4,79	9,00	9,00	9,00
Index of lodging (points)	DC 59	9,00	0,0000	0,00	9,00	9,00	9,00
	DC 87	9,00	0,0000	0,00	9,00	9,00	9,00
Brown rust (points)	DC 77	8,80	0,6325	7,19	9,00	9,00	9,00
Position of spike (code)[5]		2,70	0,6750	25,25	3,00	2,00	3,00
Length of plant (cm)		89,00	7,3787	8,29	87,50	85,00	95,00
Awnedness of spike (code)[6]		3,30	1,2517	37,93	3,50	2,00	4,00
Length of spike (cm)		10,21	1,5531	15,21	10,10	9,20	11,40
Density of spike (spikelet.10cm^{-1})		21,21	2,748	12,95	21,26	19,12	22,94

Remark: [1]1 = <25º, 3 = 25-40º, 5 = 41-55º, 7 = 56-70º, 9 = >70º; [2;5]1 = <55º, 3 = 15-45º, 5 = 46-90º, 7 = 91-135º, 9 = >135º; [3]1 = <10 cm, 3 = 10-15 cm, 5 = 16-21 cm, 7 = 22-27 cm, 9 = >27 cm; [4]1 = <1,1 cm, 3 = 1,1-1,5 cm, 5 = 1,6-2,1 cm, 7 = 2,2-2,7 cm, 9 = >2,7 cm;[6]1 = awnless, 3 = short awns, 5 = semi - awned, 7 = awned, 9 = very long awned

by 32,5 cm shorter. The resistance to lodging was very variable (co-efficient of variation = 37,10 %) and the span of the down and top quartile reached 3,60-8,10 (Table 5). The spring varieties of spelta wheat have unawned mid-long and mid-dense spikes.

The intermediate forms of the soft wheat had the semi-erect or prostate tuft shape which caused a fast coverage of the land by the initial leaves. On the other hand, the intermediate forms of the soft wheat grow very slowly in the growing season, the dense crop stand makes the drying more difficult, they are more often attacked by mildew (lower resistance degree), except the natural disposition. They are also less resistant to brown rust; the median reaches the middle resistance (about 25 % of the leaf surface is attacked by this disease). Concerning the assimilation of the sun shine, they have an erect long (22-27 cm) and narrow (1,1-1,5 cm) flag leaf. The intermediate forms of the soft wheat are the longest (116,67 cm) of all the studied and evaluated varieties and forms and they incline to the lodging. Particular samples were, nevertheless, quite resistant to the lodging (25 % of the varieties had the index of lodging of 8,1 – Table 6). The intermediate varieties had mid-long sparse unawned spikes (low co-efficient of variation shows the stability of this characteristics).

DISCUSSION

The most of the evaluated varieties had the erect or semi-erect tuft shape. The loosely spreading tuft shape is, nevertheless, more suitable for the fast coverage of the land just after the emergence of the crop stand [30][46]. and the increase of the competitiveness to weeds [46]. The most of the intermediate forms of the soft wheat had the loosely spreading tuft shape. Persistence of the plant in the tillering growing stadium (DC 21 - 29) with the loosely spreading tuft shape led, on the other hand, to the development of more favourable conditions for the extension of mildew (Blumeria graminis). The fast growth of the top fytomass and early coverage of the land surface (LAI 1) are also very important for the high level of the competitiveness to weeds [41][40][34][35][2][5]. These characteristics may be expressed by a number of days from the emergence of the crop stand to the flowering stadium. The control varieties grew very fast, whereas the intermediate forms of the soft wheat grew very slowly; there was the difference of seven days between them. The length of plant is another characteristic having a particular effect of the competitiveness to weeds [8][31][20][417][39]. All the evaluated species are very long (eincorn – 101 cm at average, emmer wheat – 107 cm at average, spelta wheat – 112 cm at average, intermediate form of the soft wheat – 116 cm at average, control varieties of the soft wheat – 89 cm at average). In practice, the plants are long enough to be able to compete to weeds. The long stem may be, nevertheless, connected with the lodging [27]. However, the intermediate forms of the soft wheat and emmer wheat were lodged the most, whereas the long stems of the spelta wheat plants were not. [45] explain the differences in the level of lodging in their own study; the varieties having short and strong down internodes and a high number of nodes on the stems are the most resistant of all. Therefore, the length of stems is not important, but the width of stems is [25].

The intensity of the disease infestation is usually lower in the organic farming system than in the conventional one [32] as the tissue of the plants are more ripen thanks to the lower level of the nitrogenous diet [46]. On the other hand, fungicides are forbidden by the organic farming system, therefore, the resistance of the variety plays the most important role in the protection againts diseases. Concerning the evaluated material, the eincorn [18] and emmer wheat [21] are resistant to the brown rust. However, particular material inclining to mildew may be found among the samples of the emmer wheat. The spelta wheat inclined to the attack by both the studied diseases. E.g. [44][24][36] refer to the lower resistance to funga diseases of particular varieties of wheat. The intermediate forms of the land races of the soft wheat inclined more to the mildew and brown rust attack too. This fact had also been confirmed by the previous study [25].

The length and with of the flag leaf are the most important conditions for the high level of the absorbtion of the sun shine. Not only the surface of the flag leaf, but also the position [28] and ability of the conservation of the efficient assimilation aparatus [22] are the important aspects of the assimilation. The flag leaf of the eincorn or intermediate forms of the soft wheat was short and narrow which contributed to the resistance to drought [43]. On the other hand, the emmer wheat and spelta wheat varieties have the mid-long and narrow flag leaves. The length and density of spike are important morphological characteristics influencing the level of the spike produktivity. Lax spike is one of the factors influencing the resistance to fusarioses [37][22] as such spike dried easier and faster. The spelta wheat cultivars had lax and long spikes. The results show the fact that the eincorn and emmer wheat spikes are short but dense (the density of the spikelets compensate the length of the spikes). [45] also confirm this fact.

CONCLUSION

The evaluation of such a large group of the varieties of

the spring wheat forms had never been carried out in the certified organic farming system in the Central Europe. We aimed to evaluate the differences between the selected samples of the material of the gene bank at the RI in Praha-Ruzyně and prove the differences between the morphological and biological characteristics, related to the ideotype of the particular variety for the organic farming.

The results proved the fact that the most of the evaluated varieties inclined to the high level of the competitiveness to weeds. When selecting the perspective varieties, we have to take the resistance to lodging into account. A lodged varieties becomes less competitive to weeds, which may cause significant yields losses. Our study showed the intermediate forms of the soft wheat, emmer wheat and the spelta wheat inclined to the lodging the most. The resistance to funga diseases is as important criterium of the selection of the suitable varieties as the previous one, as the organic farming system does not allow any direct intervences againts them (e.g. fungicides). The intermediate forms and spelta wheat varieties incline to the mildew and brown rust attack. A careful selection of the varieties of emmer wheat is very important, as the most of them are resistant, but there were some of them less resistant. All the land races of eincorn were resistant too. The flag leaves influence the assimilation of the sun shine. The eincorn varieties and intermediate forms of the soft wheat have the narrow and very short flag leaves. We may anticipate the higher level of the assimilation of the eincorn varieties than intermediate forms of the soft wheat (the efficiency of the flag leaf is reduced by the attack by funga diseases there). The length and density of spikes show the fact that the hulled varieties of wheat assure the yield through the productive tillers, whereas the control varieties of the soft wheat assure the yield through the spike productivity.

Our study has brought a lot of valuable observations on the reaction of the land races of wheat on the low-input farming system. We are about to study the perspective materials and elaborate the complete metodology of the evaluation of the suitability of the varieties for the organic farming system, the metodology of growing of such suitable cultivars and selection of the varieties for the organic farming.

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