TESTING OF SUITABILITY OF IDEOTYPE AND VARIETIES OF WHEAT FOR ORGANIC AND LOW INPUT AGRICULTURE

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Nowdays, wheat is the most important crop for organic farming system in the Czech republic. However, the varieties breeded and tested in the conditions of organic farming system are still missing. It gives rise to very low level of yield (less than 50% of level of convention one). That´s why the working version of the methodical procedure has been conceived. The methodology takes the different ideotype of plant that´s suitable for the environment-friendly farming systems into account. The methodology is being tested at several varieties and species of genus Triticum L. (wheat – winter wheat, spring wheat, landraces, conventional varieties and the varieties recommended for organic farming system, emmer wheat). It´s based on the Methodology of Central institute for Supervising and Testing in Agriculture of Czech republic for tests of VCU (Value for Cultivation and Use) (part of biological characteristics – resistance to diseases), the Classificator of genus Triticum L., which is used for the international evaluation of genetic ressources (part of morphological and economic characters). Some characters are also evaluated according to the handbook of Cereal variety testing for organic and low input agriculture (especially most problematic ones which have been defined by Wolfe, 2002 – competitivness to weeds, nutrient uptake and use efficiency, etc.). The methodology is divided into four parts: morphological, biological, economic and quality characters. It has been conceived to permit the testing of varieties on several levels. First level is proposal of features for screening of genetic ressources. The second level is testing of suitability of varieties for above mentioned farming systems. The third and very important is possibility of testing varieties directly in organic farm conditions by the farmers.

Keywords*: wheat, ideotype, variety testing, organic farming.*

All the species of cultural crops may be grown in organic farming systems. Efficiency of the growing is limited by the limits set up by the Law on organic farming and the relevant Implementary regulation (MOUDRÝ, 2003). Since 2004, organic farms are obliged to use seeds coming from organic farming conditions (EC Regulation No. 2092/91). The Regulation sets up the fact that the last

generation of parent plants (at least) of annual crops must be grown in organic farming conditions (LAMMERTS van BUEREN, 2002).

Absence of breeding programmes adapted to organic farming specifics means the first problem when varieties being chosen. The actual varieties are breeded in order to have a favourable genetic base for intensive method of growing - when considerable amounts of industrial fertilizers are used - soluble nitrogenous ones (ZÍDEK *et al*., 1992), herbicides, fungicides, insecticides, regulators of growth etc. (ANONYM, 2006). The varieties are adapted to the technologies of growing, harvest and processing (ZÍDEK *et al*., 1992). The ideotype of a variety suitable for organic farming is different from the conventional one. According to WOLFE (2002), when testing the varieties suitable for organic farming system, we have to take note of the questions of a sufficient nutrient supply, high competitivness to weeds, resistance to diseases and pests and qualitative parametres of the production.

Organic farming may be characterised as a system of a limited amount of nutrients (nitrogen, specially) and absence of the separate nitrogen application (KÖPKE, 2005). Accepability of nitrogen in early spring poses the main problem of the growing of winter varieties. Soil is cool and wet yet and it still proves the low microbial activity then. The genotypes characterised by high efficiency of nitrogen supply and use in the first stages of growth are more suitable for organic farming system. Well-developped root system and positive reaction to the interaction with soil edaphone are efficient for the nutrient supply (LAMMERTS van BUEREN, 2002). The choice of an efficient root system (adapted to the soil nutrient supply) should take note of the limited competitivness for assimilates and good positioning of root system. Long roots with a high percentage of young roots lead to a well-developped rich rot system (high percentage of capillary roots). Deeper roots guarantees a sufficient water and nutrient supply from deeper layers of the soil profile (KÖPKE, 2005).

Weed plants represent a serious problem of organic farming system (LAMMERTS van BUEREN, 2002). Thanks to an availability of herbicides in the last 50 years, the plant competitivness to weeds has been ignored for a long time WOLFE (2002). A sufficient capacity of tillering belongs to the complex of the characters responsible for the high competitivness to weeds (KRUEPL et al., 2006). It should be considered as one of the main parametres of the selection. Considering cereals, the structure of plant has a huge impact on it too – length of stalk, level of coverage of the plant by leaves, situation, shape and solidity of leaves (REGNIER, RANKE, 1990) Average tall varieties are the most suitable ones (MOUDRÝ, 2003).Fast growth of plants in the first stages of growth is very important too. It assures a fast achievement of high LAI figures (LAMMERTS van BUEREN, 2002). Planofile position of leaves (>45º) in the first stages of growth provides a higher degree of shading of soil. It worsens conditions of growth for weeds (at the stations with worse nutrient state and slower growth of plants too). Erectofile position of leaves is preferred in later stages of growth (HOAD, NEUHOFF, DAVIES, 2005).

A certain level of resistance is not the main criterium of the selection of suitable varieties for the breeding. It is their ability to provide a sufficient yield level in spite of the pressure of infectious diseases (LAMMERTS van BUEREN, 2002). The breeding for a higher resistance to diseases is carried out in case of winter wheat. The diseases may not be eliminated by staining there (rust, spike heel diseases, eyespot disease, white leaf spot disease, fusariosis). Non-stained seeds which are used in organic farming system are more resistant to *Tilletia caries* (MOUDRÝ, 2003). The main purpose is to choose particular morphological characteristics of crops (robust plant habitus, it prevents crops from the affection by diseases) (LAMMERTS van BUEREN, 2002). Occurrence of *Septoria nodorum* may serve as an example of such a prevention. It is influenced by a structure of crops (KUNZ, 2002). If the distance between spike and flat leaf is longer, it may make the transfer of spores by raindrops from leaves to spike more difficult (KÖPKE, 2005). Therefore, high varieties of crops are more resistant ones (KUNZ, 2002).

When organic and conventional farming system compared, organic one provides lower yield (by 20-30%) (MOUDRÝ, 1997; MÄDER *et al*., 2002; LAMMERTS van BUEREN, 2002). Even it is usually lower in practise. Farmers need „reliable“ varieties able to tolerate and resist to fluctuations of weather and pressure of diseases without any considerable difference in spike and straw yield level (LAMMERTS van BUEREN, 2002). Thanks to the interaction of the genotype and environment, the variety has characteristic features. Thanks to them, it may be sold as a regional product. There is a basic rule: taste and favour gives a strong character to a variety (LAMMERTS van BUEREN, HULSCHER *et al*., 1999). Organic farming method may influence the technologic value of the variety in a negative way, especially if the protein content is crucial there (MOUDRÝ, PRUGAR, 2002). Amount of protein complex of wheat grains depends on the envrionmental factors, not on the genotype. TRIBOI *et al*. (2000) states the variety has a negligable impact on the content of nitrogenous elements (4 %). On the other hand, (KÖPKE, 2005) refers to the fact that the breeding of varieties for a high protein content leads to a reduction of yield.

MATERIAL AND METHOD

In 2006, a concept of “the methodology of variety testing of wheat varieties for organic and low input agriculture“ has been conceived. The methodology is based on the methodology of tests of the efficiency value of the varieties before the registration process in the conditions of conventional farming system of the Central Institute for Supervising and Testing in Agriculture (UKZUZ, 2005). Nevertheless, the part concerning the biological characteristics (resistance to diseases and pests) is very well done in the methodology. The second background is Clasificator of Genus *Triticum* L. (BAREŠ *et al*., 1985) It is used for the international evaluation of the genetic ressources. The part concerning the morphological and economic characteristics is very well done there. Handbook Cereal variety testing for organic and low input agriculture (DONNER, OSMAN, 2006) is the other possibility. The methodoogy is not

complexe, but it proposes very good methods of the evaluation of the main problem topics in organic farming (according to WOLFE, 2002).

The methodology has been tested for several groups of varieties in 2006 and 2007. Modern varieties of winter wheat (10 varieties and strains from Austria), landraces and obsolete cultivars of soft wheat (42 landraces, obsolete cultivars and facultative wheats), modern varieties of spring wheat (10 modern cultivars) and emmer wheat (10 varieties of emmer wheat has been chosen from the gene sources of wheat).

RESULTS AND DISCUSSIONS

Concerning organic farming, yield is much more influenced by the interaction of genotype and the environment than yield in conventional farming system. Therefore, an evaluation of a suitability of certain varieties for a particular station is the most important principle of the choice of varieties. Nevertheless the testing of the varieties for the concrete station conditions would be very expensive. Therefore, it is not necessary to set up a methodology of the evaluation of suitability of varieties only on breeders' level, but also in conditions of organic farms. Therefore, the evaluation of the suitability of certain varieties for a particular station is the most important principle of the choice of varieties. According to WOLFE (2002), the varieties suitable for organic farming are characterised by good absorbtion of nutrients, high competitivness to weeds, resistance to diseases and pests and the required qualitative parametres of production.

Methodology of variety testing of wheat varieties for organic and low input agriculture: The main aim was to create the methodology for evaluation of different reaction of varieties and suitability of varieties for land and climate conditions in different regions in organic and low input farming systems. Methodology is divided into 4 parts: morfological, biological, economic a quality features. The article does not deal with the evaluation of the quality parametres in details.

Morphological characters

The methodology containing the particular morphological features at plant, steam, leaf, spike and caryopsis level has been conceived (Table 1). The morphological characteristics on the level of the plant are characterised as follows: tuft shape at tillering. Loosely spreading or prostate tuft shape seems to be optimal from the point of view of the fast coverage of the soil surface (KRUEPL et al., 2006). Size of the root system is very important but hardly evaluated characteristic. The method of Newman (1966) is strongly recommended. Length of the plant is evaluated from the point of view of its competitive ability and affection by diseases. E.g. M4 feature (distance between flag leaf and spike) has an effect on the possibility of the transfer of *Septoria nodorum* from leaves to spike (KÖPKE, 2005). The characteristics of the level of flag leaf are very important in organic farming system because they has a positive effect of the supply of assimilates. The characteristics of spike level influence the awdness, spike microclimate and they may serve as a instrument of the protection of plants againts the affection by diseases.

Table 1

List of suggested and evaluated morphological characters

Plant level	M1 tuft shape (at tillering)	Spike level	M8 position
	M2 root system-size		M9 shape
	M3 length of plant		M10 length
Flag leaf level	M5 position		M11 density
	M6 length		M12 awdness
	M7 width	Caryopsis level	M13 shape
Stem level	M4 distance between flag leaf and spike		M14 surface
			M15 colour
			M16 crease shape

Modern varieties of winter wheat: The evaluated genotypes have an loosely spreading-prostate tuft shape. The varieties comply with the requirements for the length and density of spike. On the other hand, 6 varieties are not able to create semi-erect or erect spike in the stage of at full ripeness. 7 varieties are not able to provide pyramidal or cylindrical shape of spike. Almost all the genotypes fulfill the requirements concerning the shape of caryopsis. Just a half of the varieties and strains meet the criterium of smooth and matted or glossy caryopsis surface. Light brown or yellow colour was achieved just in case of a few varieties.

Modern varieties of spring wheat: Semi erect or erect tuft shape was prevailing. A part of the varieties proved an average length of the plant, the other ones proved short length of the plants. Flag leaf was usually long and narrow. Spike position at the full ripeness was supposed to be negative in most cases, apart from two varieties. The spike was usually short and dense (favourable microclimate conditions for the development of spike diseases). The caryopsis characteristics were supposed to be positive.

Landraces: According to the previous evaluation of the morphological characteristics of the varieties, a lot of them are more suitable for organic farming system than modern ones. These varieties usually have loosely spreading or prostate tuft shape at tillering, they are tall and some of them have very well situated wide and long flag leaves. Spike shape is (especially intermediate and awned ones) also supposed to be very good.

Emmer wheat: Generally, emmer wheat is suitable for organic farming system from the point of view of its morphological characters. Plants usually have loosely spreading tuft shape, they are of an average tallness or they are tall. The position and surface of flag leaf is optimal at the most of the varieties. The spike is usually awned and dense (it is not problematic in case of emmer wheat – from the point of view of a possible proliferation of spike diseases; emmer wheat is very resistant variety).

Biological characters

The biological features are characterised by the vegetation period and resistance to the most common diseases caused by natural infections (Table 2). Growth level is characterised by vegetation period sprouting-heading (it is important in relation to the competitivness to weeds) (KRUEPL et al., 2006),

heading-ripeness (the length of this period has an effect on the filling of grains with assimilates) (PETR *et al*., 1997) and sprouting-ripeness (early varieties seem to be much more suitable for organic farming system for several reasons).

Table 2

List of suggested and evaluated biological characters

Growth level		B1 vegetation period (sprouting – heading)
		B2 vegetation period (heading – ripeness)
		B3 vegetation period (sprouting – ripeness)
Lodging level		B4 combination of intensity and range
Ear sprouting level		B5 ear sprouting - resistance
Diseases (resistance) level		
Evaluated part of plant	*BBCH scale*	NAME OF DISEASE
Leaf	37	B6a *Erysiphe gramminis* D.C.
	37	B7a *Puccinia striiformis* WEST.
	51-61	B6b *Erysiphe gramminis* D.C.
	69-71	B10 *Drechslera tritici-repentis*
	71	B11 Leaf spot complex (*Septoria nodorum*, *Helmintosporium* spp., *Ascochyta* spp.)
	71-75	B7b *Puccinia striiformis* WEST. (in case of late occurrence)
Spike	73	B14 *Ustilago tritici* (PERS.)JENS.
	73	B15 *Tilletia caries* (D.C.)TUL.
	75	B13 *Fusarium* spp.
	77	B6c *Erysiphe gramminis* D.C.
	77-83	B12 Spike spot complex (*Septoria nodorum*, *Ascochyta* spp.)
Leaf and spike	77	B9 *Puccinia graminis* PERS. subsp. *graminis*
	77	B8 *Puccinia persistans* PLOW.

Lodging is evaluated as a combination of intensity (the angle of the plant and soil surface) and range (percentage of the lodged crop stand on a certain parcel) (WAES, 2006). The evaluation of a degree of the affection by diseases is an important part of it; it depends on the stage of growth (BBCH stage).

Modern varieties of winter wheat: Considering the development of summer weather and low infection pressure, any diseases were not noticed in the crop stands of these varieties. It is necessary to take into account the fact of a lower pressure of diseases in organic farming system than in conventional one (LAMMERTS van BUEREN, 2002).

Modern varieties of spring wheat: Growth of the varieties is characterized by a slower development in the vegetative growing stage. The varieties do not lodge but some of there are predisposed to the sprouting. They are resistant to *Erysiphe graminis*. Some of them may be seriously affected by *Puccinia* spp. They are quite resistant ti leaf and spike spot diseases (*Septoria nodorum*).

Landraces: When evaluating the biological characteristics, we ascertain considerable differences between the varieties, especially the difference in the affection by *Erysiphe graminis* a *Pucinia* spp. In 2006 and 2007, we noticed a slight pressure of diseases. *Erysiphe graminis* was noticed in the first stages of the growth (especially at the intermediate wheat varieties because of the slow developement of plant at the start of vegetation period and prostate tuft shape). *Pucinia recondita* was noticed in later stages of the growth.

Emmer wheat: There was not any occurrence of diseases noticed in field trials either in 2006 or 2007. But important yields loss could be caused by lodging (because long and thin stem of the most varieties).

Economic characters

The economic characters are the characters evaluated on the stand, plant, spike and spikelet level (Table 1). It may be divided into two groups: the characters showing the yield level of the crop stand and the characters of the spike productivity.

Table 3

Economic characters

Stand level	H1 harvest index	Spike level	H8 1000 grain weight (TGW) (g)
	H2 number of plants		H9 grain mass (g)
	H3 number of spikes		H10 number of grains
	H4 grain yield (kg.ha^{-1})		H11 number of spikelets
Plant level	H5 uptake efficiency	Spikelet level	H12 number of grains
	H6 utilization efficiency		
	H7 number of productive tillers		

Modern varieties of winter wheat: The evaluated and tested varieties are characterized by the average TGW (almost 46 g). Spike grain mass – 2 g and 44 grains per spike. Harvest index is optimal.

Modern varieties of spring wheat: TGW is about 40 g. Harvest index is supposed to be high (0,47-0,50). Graing weight is average (1,5-1,7) and number of grains in the spike is average or high (26-42).

Landraces: Considerable differences may be noticed between the varieties of this group. Generally, when harvest index of landraces and modern varieties compared, harvest index of landraces is usually lower. TGW is lower – 33 g. Grain weight in the spike is about 1 g and number of grains per spike is 30. These figures mean the lower productivity of the spike.

Emmer wheat: The tested varieties of TGW of 31,1 g. Harvest index – 0,35 on average. Spike grain mass is a fluctuating feature – 0,95 g on average. Number of grains per spike reaches 30,19 and number of spikelets reaches 20,24. On the other hand, number of grains per spikelet is the most stable feature (1,5).

CONCLUSIONS

The article defined the ideotype of the wheat varieties for organic farming. The methodology of the evaluation of wheat varieties for organic farming system was successfully conceived and tested during the experiments on the basis of the ideotype. The methodology proposes the features and characters of plants which may serve as a simple indicator of the suitability of varieties for organic and low input farming. The evaluation of these features and characters is easy and they are suitable for the on farm research (active contribution of the farmers is anticipated). The following statements were found out from the first evaluation: landraces of wheat, organic varieties and emmer are supposed to be better from the point of

view of their morphological characteristics. Conventional varieties are supposed not to be good. Emmer wheat is the most predisposed variety to the affection by diseases (the biological characters). A considerable variety reaction was noticed at the other ones. When comparing the economic characteristics, we find out that organic and conventional varieties are the best. Some varieties of emmer and landraces achieve good results too. A need of the evaluation of the suitability of varieties for organic farming and low input farming systems is obvious. Larger range of suitable and tested varieties will lead to a support and higher efficiency of farming on arable land and it will have a direct effect on the sustainable development of the region, landscape management function of farming and trends of good and healthy diet.

A*cknowledgement:* *This work was supported by the MSM 6007665806.*

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