SELECTION CRITERIA OF WHEAT WITH RESPECT TO WEED COMPETIVENESS

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Weed plants are one of the main factors limiting the level of agricultural yield. Because of the availability of herbicides in the last 50 years, the competitiveness of field crops to weeds has been overlooked. The relationship between the cultured and the weed plant was supposed to be negative. However this relationship could contribute to the formation of a stable agroecosystem as the weeds can play a positive role in the agroecosystem. Modern conventional varieties are not selected in accordance with their indirect morphological or biological features; however, these features - the shape of a tuft, the length of a plant or the position of leaves - contribute to a increase in competitiveness,. Nevertheless, the competitiveness of the currently bred conventional varieties can be tested in the conditions of an organic farming system. Sufficient tillering is one of the complex of characteristics responsible for high competitiveness against weeds. The architecture of a plant has an important effect also. The taller varieties have the higher competitiveness Fast growth of the plant in the first stages of life is a very important aspect as it allows an early achievement of a high LAI value. A planofile position of leaves (>45º) in the first stages of growth assures a higher degree of coverage of the soil surface, and a deterioration in the growing conditions for weeds. An erectofile position of leaves is a more favourable feature for the later stages of the plant's growth. The competitiveness of plants also depends on the speed of collumning, LAI, capacity of the upper phytomass and the tallness of plants in the DC 31-75 stage.

Key words*: weeds, organic farming, wheat.*

Regulation of weeds is not easy and smooth thing in organic farming system, because the methods of chemical regulation of weeds are limited by the restrictions and legislative regulations. The protection againts weeds is based on the complexe measures. Preventive measures, e.g. use of seeds without weed seeds, regulation of spreading of weeds (reproduction via root system, rhizomes, tillers, etc.) by the mechanization processes, minimalization of ripening and spreading of weed seeds, are the most important points. Crop rotation in the cropping is the most efficient method of the weed regulation. Organic farming does not allow any herbicides, it

implies any other methods of the regulation, e.g. physical methods, thermic or mechanic methods and biological methods of the weed regulation.

The diagnostic of the rate of weeds is the crucial condition for a selection of an efficient method of the weed regulation. It is important to indicate the harmfulness of each species of weeds; it helps to choose an efficient way of the weed regulation. The fytocenological analysis of each cultural crops and weeds is the basic method of the indication of the rate of weeds in research and practice [PETR, 1989]. Four methods may be used for the indication of the rate of weeds, spread in the crop stand: estimation, counting, weighting or combined method. The method of estimation is one of the oldest, fastest and easiest methods of the indication of the rate of weeds in the crop stand; however, it is less exact. Therefore, it may be used for a rough indication of the rate of weeds in ordinary practice. This method is subjective, it need special training, experience and it requires the caution of estimation. It does not provide any picture of amount of weight of weeds in relation to cultural crops; it is not suitable for basic research of weeds. The counting method is mor exact, in comparison with the previous one. It provides the amount of weeds and cultural crops - the rate of weeds may be counted on various parts of the parcel. However, it does not express the sufficient rate of weeds, because the figures and numbers do not express the ratio between weeds and cultural crops on the parcels. The efficiency of the weighting method is similar to the counting one. However, it provides more exact ratio between weeds and cultural crops on the parcels. The results do not show us the number or rate of each species of weeds on the parcels. The combined method is the most efficient and the most objective one; it expresses the rate of weeds and the division of each species of weeds on the whole parcel. It is used especially on small experimental parcels (the most exact method). However, it also has some disadvantages; it requires very good experience and it is quite toilsome too [HRON & KOHOUT, 1974].

Wheat has a weak root system. It is not too competitive to weeds. More competitive varieties must be chosen at the initial selection (wide root system, faster initial growth, higher rate of tillering, etc.) [MOUDRÝ *et al*., 2007]. Einkorn, emmer wheat and spelta wheat are characterized by better ability of tillering, therefore, they are more competitive to weeds, even if the seeding rate or emergence are lower.

Some root systems produce aleopatic substances which influence the growth of the other crops [LAMMERTS van BUEREN, 2002]. he aleopathy was detected in many cases of higher crops (cultural and weed crops too). E.g. *Agropyron repens* L. and *Chenopodium album* L. were affected by the aleopathy (agrophyren – natural glycoside) [MIKULKA *et al*., 2005]. The studies of wheat showed the aleopathy together with the morphological features may cause the variability of the competitiveness to weeds [OLOFSDOTTER *et al*., 2002, LEMERLE *et al*., 2001, BERTHOLDSSON, 2005].

MATERIAL AND METHOD

The proposed methodology takes the various characters of organic wheat species (*Triticum aestivum* L.) into account. New methodology provides the most information; it was formed as an outcome called COST860 "Handbook of cereal variety testing for organic and low input agriculture". The monography titled "Breeding and evaluation of the suitability of varieties of wheat (*Triticum aestivum* L.) for organic and low-input farming systems". It was formed as an output of the Interreg III.A project, conceived at the Faculty of agriculture of the University of South Bohemia in České Budějovice.

Current methods of the evaluation of the rate of weeds on the fields are not exact. Each variety may be evaluated from the point of view of the morphological, biological and economic features. After that, the competitiveness of the variety to weeds may be evaluated too. Each feature is evaluated during the growing season (when the crop is growing on the field).

When evaluating land races and obsolete cultivars, we must use a modern variety, suitable for organic farming conditions as a testing variety. The proposed methodology for the evaluation of competitiveness to weeds may be applied for the evaluation of wheat varieties (*Triticum aestivum* L.), einkorn varieties (*Triticum monococum* L.) and emmer wheat varieties (*Triticum dicoccum* SCHUEBL). These species of wheat may be grown in organic farming conditions.

RESULTS AND DISCUSSIONS

Good competitive varieties must be chosen for organic farming system. High costs on the removing of weeds may be reduced by the selection of the competitive varieties (mechanic and thermic regulation of weeds). The method of the direct evaluation of certain features in the agroecosystem in the growing season may be also used for the evaluation of the suitability of wheat varieties (*Triticum aestivum* L.). This method is more exact and objective than the subjective method of the rate of weeds. There is a proposal of the evaluated features in the following (*table 1*).

Table 1

Proposal of the selected features

Morphological features	
Evaluated feature	*DC period*
Tuft shape	23-39
Position of flag leaf	51
Length of plant	69
Length of flag leaf	77
Width of flag leaf	77
Length of the upper internode	83
Biological features	
Growing season: initial growth - speed	10 – 59
Growing season: from sweeping stage till ripeness	10 – 92
Lodging degree	59 and 87
Economic features	
Number of plants per area unit	after the emerging
Number of productive sprouts	61 or 92
Number of spikes per area unit	before the harvest

The optimal amount of plants per area unit is the most important condition, leading to higher competitiveness of the crop stand. The optimal amount of plants (spring wheat varieties grown in organic farming conditions) varies from 301 to 400 plants/m^2. Scarce crop stand is not so competitive to weeds; it the variety is able to form more tillers, it increases the competitiveness to weeds. The coverage of the land is influenced by the agronomic factors, e.g. the width of rows, grain size, etc. [LEMERLE *et al*., 2004].

The ability of formation of tillers also belongs to the features influencing the competitiveness of the spring wheat crops to weeds [KRUEPL *et al*., 2006].

Tuft shape in the tillering stage also increases the competitiveness to weeds in the initial growing stages; the cereal plant reaches LAI 1 earlier and it makes the spreading of weeds more difficult. This feature is evaluated from the beginning of the tillering stage (DC 23 – 3 sprouts developed) till the end of the tillering stage (DC 29 – the end of the tillering, the maximum of sprouts) [KONVALINA *et al*, 2007].

Drooping and loosely spreading are the most suitable tuft shapes, which increase the competitiveness to weeds (*figure 1*).

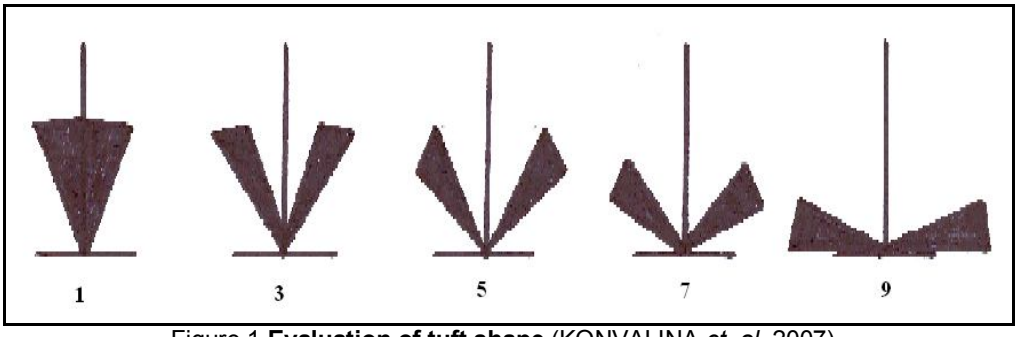

Figure 1 **Evaluation of tuft shape** (KONVALINA *et. al*, 2007)

The length of crops in the collumning stage depends on the level of the competitiveness to weeds. The crops are evaluated after the flowering stage (DC 29); the length of the crop is measured from the top of spike [KONVALINA *et al*, 2007]. The modele-sized varieties are the most suitable ones [MOUDRÝ, 2003]. KUNZ, KARUTZ (1991); EISELE, KÖPKE (1997); MÜLLER (1998); KÖPKE (2005) also agree with the fact that the higher varieties are more competitive than the low ones. The optimal length of the crop varies from 81 to 125 cm (the highest competitiveness to weeds). The length of the crops is considered to be an important condition of the competitiveness to weeds [GOODING *et al*., 2003]. The reduction of the length of the crop must be compensated by other suitable features [CUDNEY *et al*., 1991]. Short genotypes with planofile position of leaves and fast coverage of the land and high leaf surface index may be more competitive than long genotypes without these features [WOLFE *et al*., 2008].

Higher varieties may suffer from other problems, as lodging (KRUEPL *et al*., 2006]. The lodging has a negative effect on the total level and quality of the yield. It causes serious problems at the harvest. It provokes the spreading of diseases. The lodging in various stages of growth leads to the spreading of weeds

in the crop stand. The level of lodging (*table 3*) is expressed by a combination of the intensity (*figure 2, table 2*) and range of the lodging. We evaluated % of lodged plot 1-100 % in disregard of intensity of lodging. ng. DC 59 (the whole swept spike) and DC 87 (yellow ripeness) should be evaluated twice in the growing season [KONVALINA *et al*., 2007].

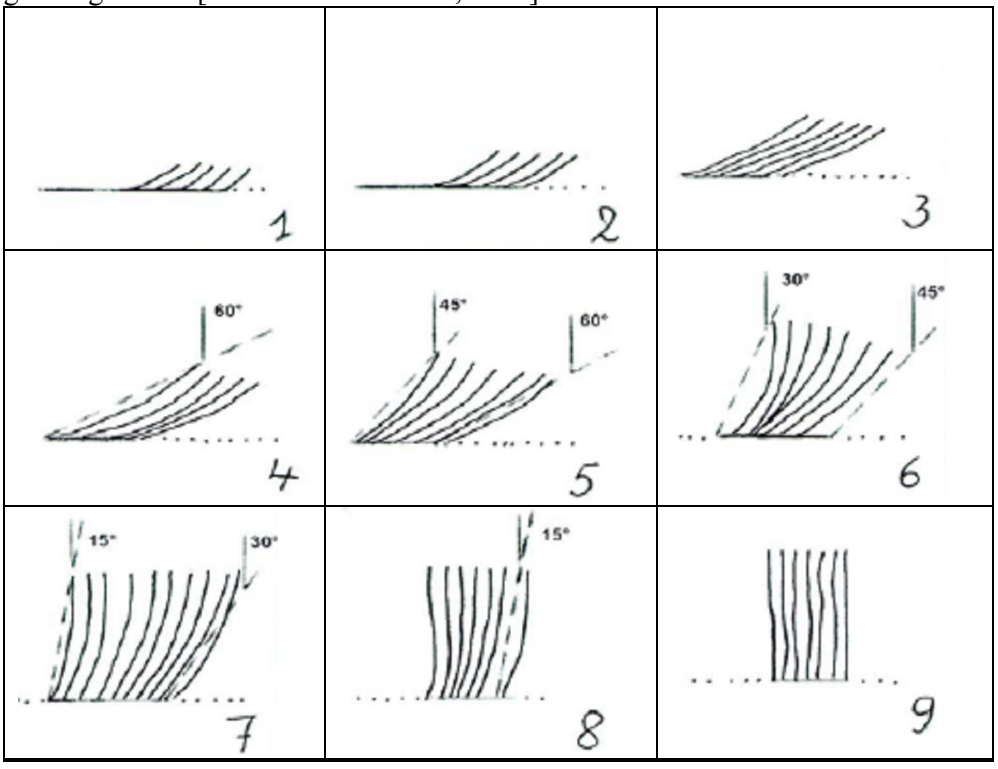

Figure 2 **Evaluation of intensity** [arranged according to Van WAES and De VLIEGHER, 2000]

Table 2

Comments to intensity of lodging [KONVALINA *et al*., 2007]

1. straw fully down to the ground
2. straw for more than 50 % touching the ground with only the stem ends upright
3. for less than 50 % touching the ground, the rest is upright
4. stems sloping for more than 60° but not touching the ground, expect at the basis
5. stems sloping between 45° and 60°
6. stems sloping between 30° and 45°
7. stems sloping between 15° and 30°
8. stems lightly sloping (<15º)

Table 3

Index of lodging [dle WAES, 2006]

Range of lodging	Intensity of lodging								
	9	8	7	6	5	4	3	2	1
96-100	9,0	8,0	7,0	6,0	5,0	4,0	3,0	2,0	1,0
81-95	9,0	8,1	7,2	6,3	5,4	4,5	3,6	2,7	1,8
76-80	9,0	8,2	7,4	6,6	5,8	5,0	4,2	3,4	2,6
51-75	9,0	8,3	7,6	6,9	6,2	5,5	4,8	4,1	3,4
31-50	9,0	8,4	7,8	7,2	6,6	6,0	5,4	4,8	4,2
21-30	9,0	8,5	8,0	7,5	7,0	6,5	6,0	5,5	5,0
11-20	9,0	8,6	8,2	7,8	7,4	7,0	6,6	6,2	5,8
6-10	9,0	8,7	8,4	8,1	7,8	7,5	7,2	6,9	6,6
1-5	9,0	8,8	8,6	8,4	8,2	8,0	7,8	7,6	7,4
<1	9,0	8,9	8,8	8,7	8,6	8,5	8,4	8,3	8,2
0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0	9,0

Fast growth of the crop is very important in the initial stages of the growth. It is about to lead to high LAI figures [LAMMERTS van BUEREN, 2002] Fast growth is connected with the growing competitiveness to weeds [REBETZKE & RICHARDS, 1999, PESTER *et al*., 1999, LEMERLE *et al*., 2001, ACCIARESI *et al*., 2001, BERTHOLDSSON, 2005]. Number of days, needed for the evolution of a plant (from the emerging of the crop stand – DC 10 – till the sweeping of the spike – DC 59) [KONVALINA *et al*, 2007].

Middle (72 – 73 days), high (70 – 71 days) and extremely high (69 days) speed of the growth are suitable for spring wheat varieties. The varieties which grow fast in the initial stage become more competitive to weeds, they cover the land fast and they prevent the land against weeds.

The growing season is comprehended as the period between the emerging of the crop stand (DC 10) and ripeness (DC 92); the competitiveness to weeds in evaluated in this period. The speed of the growth is also very important figure. Early varieties are the most suitable ones (they are the most competitive). The period of the pressure of diseases and pests shortens too [KONVALINA *et al*, 2007]. Short period (123 – 124 days) and middle period (125 – 126 days) are the most suitable ones.

Planofile position of leaves (>45º) in the initial stages of growth assures higher coverage of the land and it causes worse growing conditions for weed plants on the stations characterized by worse nutritive state and slower growth of the plants. Erectofile position of leaves is more suitable in later stages of growth

[HOAD, NEUHOFF, DAVIES, 2005]. When evaluating the competitiveness of the crops, we indicate the position of the flag leaf at the beginning of the sweeping stage. Erect and horizontal flag leaf is able to absorb the maximum of sunlight; it contributes to the sufficient sheltering and it helps to increase the competitiveness of the crops to weeds. It is evaluated by the comparison with the others (according to the picture guide) at the beginning of the sweeping stage (DC 51) [KONVALINA *et al*, 2007] (*figure 3*).

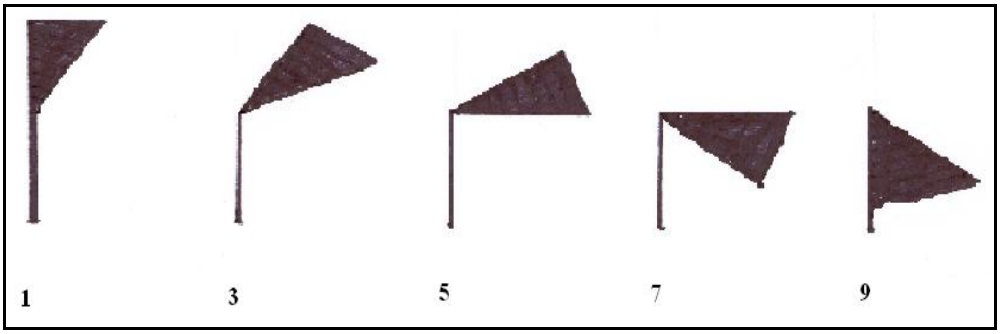

Figure 3 **Flag leaf evaluation – position** (KONVALINA *et al*, 2007)

Wide flag leaf contributes to higher level of the competitiveness of the crops to weeds, because it provides enough shade to the upper parts of the crop stand. It is evaluated in DC 77 (the stage of late milk ripeness) (KONVALINA *et al*, 2007). Middle-wide (1,6 – 2,1 cm), wide (2,2-2,7 cm) and very wide (>2,7 cm) flag leaf is the most suitable one.

CONCLUSIONS

The regulation of weeds has very complex character in organic farming system; it aims to reduce the amount of weed plants on the parcel (the weed plants as accompanying plants do not cause any considerable economic losses, they contribute to the balance and stability of the agroecosystem).

The rate of weeds is considerably reduced by a good selection of varieties which are competitive to weeds. We may avoid too high rate of weeds in such way. Early coverage of the land (in the initial stages of growth) is very important aspect of the increase of the competitiveness to weeds. There are the features, connected with high ability of the coverage of the land: fast and early growth, high ability of tillering, planofile position of leaves, high leaf area index (LAI).

The proposal of the methodology is about to allow the selection of competitive varieties of *Triticum* L. The evaluation of direct and indirect features, e.g. tuft shape, leads to the prediction of the competitiveness of crops in the agroecosystem. The competitiveness of crops depends on tuft shape till the sweeping stages of growth (DC 51). The length of crops influences the competitiveness till the sweeping stages of growth, because the crops become higher than weed plants, they become more competitive. Favourable position of flag leaf allows better absorbtion of sunlight and it provides shade to lower parts of the crop stand (there are some weed plants in lower levels of the crop stand).

Favourable width and length of flag leaf allows better absorbtion of sunlight and it helps to extend the assimilation surface. If the flag leaves are narrow and small, the sunlight comes to lower parts of the crop stand and it allows the weeds to use the sunlight well. Wide, long flag leaves in a good position provide shade to lower levels of the crop stand; the crops which have such leaf shape are more competitive to weeds than the others. Some biological features, e.g. lodging, have also been proposed for the evaluation of the crop stand. The lodging of the crop stand in early stages of growth leads to the spreading of weed plants. The lodging has a negative effect on the quality and level of yield. Fast growth in the growing season has a positive effect on the competitiveness of the crops. Slow growth of the cultural crops is a negative indicator; weed plants grow faster than cultural crops in the initial stages of growth. The cultural crops become very weak and less competitive to weeds in such cases.

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