Influence of herbicide residues in winter rapeseed on subsequently sown spring barley

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Abstract

In the Czech Republic winter rapeseed is grown at about 280 thousand hectares (10 %) of arable land. Plowing in due to non-emergence or bad wintering reaches up to 10 %. Alternative crop after plowed in rapeseed is very often spring barley. Some herbicides used in rapeseed influence with their residues yield ability and quality of subsequently sown spring cereals. The aim of our experiment is to find out response of spring barley to herbicide residues used in winter rapeseed, in case of malting barley sowing after plowed in winter rapeseed.

Using two types of soil preparation - tillage and non-tillage system - we established small plot trials with winter rapeseed in August with following combinations: 1) control without herbicide, 2) *trifluralin + napropamid*, 3) *trifluralin*, 4) *alachlor + clomacone*, 5) *metazachlor + quinmerac*. In spring we terminated the experiment by disk tillage (simulation of winter rapeseed frost damage) and sew spring barley.

The worst emergence rate of spring barley was found in option *napropamid + trifluralin* (65,7 %), on the contrary the best emergence rate was found in option *alachlor + clomazone* (81,5 %) and in control without herbicide (76,5 %). The highest number of spikes was formed by barley in varinats: *alachlor + clomazone* and *metazachlor + quinmerac*, on the contrary the lowest was in option *napropamid + trifluralin*. In variant *napropamid + trifluralin* grain yield decreased significantly (by 31 %). The highest yield was obtained in variants: control without herbicide and *alachlor + clomazone*. Variants with tillage have better results in most monitored traits in comparison with non-tillage variants.

Key words: winter rapeseed, malting barley, herbicides, herbicide residues, soil preparation, variety, yield components, yield, quality

Introduction

Harvest areas of the winter rapeseed exceeded after 1998 in the Czech Republic 300 000 ha. In the last years harvest areas slightly decreased - 251 000 ha (2003), 259 000 (2004), 267 000 ha (2005) and 292 000 ha (2006). Besides economic reason for this decrease also high plowing in plays an important role in some years (2003 - 30 %, 2004 - 16 %), in average of the last years it is about 10 %. High plowing in is mostly caused by bad over wintering (year 2002/03), problematic stands emergence in autumn due to drought (year 2003/04) or massive occurence of some autumnal pests (slug, turnip moth, flea beetle etc.) (ŠEDIVÝ, 2000). Substitution for plowed in rapeseed are often spring cereals, i.e. malting barley. Problem with herbicide residues used in rapeseed can happen easily, especially with shallow soil preparation. Barley emerges unevenly and its production abilities decrease (VAŠÁK et al., 2001). ŠTRANC et al. (2004) also present possibilities of minimalization establishing of spring cereals stands, i.e. spring barley with regard to used herbicide in forecrop, amount of winter precipitations, soil type and sort.

Herbicides used in winter crops represent cumulation of many risk factors from the view of substitutional sowings. According to KLEM - ŠKUBALOVÁ (2003) these factors are following:

- cold weather in autumn and frost during winter practically inhibit biological degradation of herbicides,
- lower intensity of solar radiation limits photodegradation and evaporation of active substances,
- some herbicides with slow detoxication in plant can be released from plant remnants of crops killed by frost,
- often used shallow soil processing keeps high concentration of herbicides in surface layer of soil.

According to OSMOND in KOSTREJ et al. (1992) stress is every factor, which decreases growth and reproduction under required level. Such stress factors are also potential residues of herbicides. Plants response to this stress shows itself by decrease of yield and production quality.

Materials and Methods

At the experimental station of Czech Agriculture University in Červený Újezd* we have established during 2004/2005 and 2005/2006 experiments with herbicide residuals activity, which we applied to winter rapeseed at consequently sown malting barley. The experiment was sown at the end of August at two soil preparations – tillage (18-20 cm) and non-tillage (up to 15 cm). In each soil preparation we applied four herbicide combinations, which are showed in Table 1. As a reference variant was established control without herbicide. Other agrotechnical practices in autumn were: graminicide application (twice), protection against voles and in 2005/06 also growth regulation.

Winter rapeseed stand was in spring discontinued by disk tillage by which we simulated frost damage of rapeseed. For

discontinuing of experiment we used disc harrow with working depth of 8-12 cm. By sowing combination we sown into row of 9,5 cm 350 of seeds of barley per m^2. For malting barley we chosen cultivar Jersey. Barley was standardly treated: nitrogen fertilization – 60 kg/ha, herbicide against dicotyledonous weeds – Mustang (0,5 l/ha), herbicide against monocotyledonous weeds - Puma Extra (0,8 l/ha), fungicide (Artea 330 EC- 0,5 l/ha), Terpal C (1,5 l/ha).

*altitude 398 m n. m., average year temperature 7,7 °C, year total of precipitations 549 mm, per vegetation 13,9 °C and 361 mm

Table 1: Survey of Herbicide Variants in Winter Rapeseed, Červený Újezd 2004/2005 and 2005/2006.

Number	Soil preparation for rapeseed	Variants	Dose ($l.ha^{-1}$)	Application term
1	tillage non-tillage	Control without herbicides	-	-
2	tillage non-tillage	*trifluralin* 480 g/l and *napropamid* 450 g/l (tank mix)	2,0+2,5	-before sowing with embedding into 4-6 cm
3	tillage non-tillage	*trifluralin* 480 g/l	2,5	-before sowing with embedding into 4-6 cm
4	tillage non-tillage	*alachlor* 480 g/l and *clomazone* 480 g/l (tank mix)	4,5+0,1	-immediately after sowing on soil surface
5	tillage non-tillage	*metazachlor* 333 g/l + *quinmerac* 83 g/l	2,0	-immediately after sowing on soil surface

Harmonogram of experiments:

- end of August - soil preparation for rapeseed – tillage and non-tillage
- end of August - winter rapessed sowing (80 seeds per m^2)
- end of August - herbicides application into rapeseed (table 1)
- March –experiments with rapeseed discontinuation after winter (disk harrows)
- April – spring barley sowing (350 seeds per m^2)
- end of July and beginning of August – spring barley harvest

Results and Discussion

Residual activity of herbicides used in winter rapeseed significantly influenced field emergence rate of consequently sown malting barley (Table 2). The worst emergence rate was found in variant 2 (*trifluralin* + *napropamid*) - 65,7 %, on the contrary the best emergence rate was in variants 4 (*alachlor* + *clomazone*) – 81,5 % and 1 (non-treated control) – 76,5 %. With herbicides *trifluralin* + *napropamid* field emergence rate decreased by 14 % in comparison with non-treated control. Other variants had minimum differences. In 2005 emergence rate was higher at non-tillage soil preparation, probably due to faster residues washout into lower soil layers. On the contrary in 2006 barley in variant with tillage had better emergence rate.

The highest number of spikes was found in options 4 (*alachlor* + *clomazone*) (tillage – 541 spikes/m^2, non-tillage 524 spikes per m^2) and 5 (*metazachlor* + *quinmerac*) (tillage – 514 spikes/m^2, non-tillage 504 spikes/m^2). The lowest number of spikes was found in variant 2 (*trifluralin* + *napropamid*) (tillage – 366 spikes/m^2, non-tillage – 411 spikes/m^2). In comparison with non-treated control in this variant with tillage number of spikes decreased by 10 % and in non-tillage variant it was by 12 %. In variants 4 and 5 barley formed more spikes in tillage option and on the contrary in variants 1, 2 and 3 barley formed more spikes in non-tillage variant (graph 1).

Results in field emergence rate and observation during vegetation correspond to differences obtained in grain yield (graph 2). Significant yield loss was found in variant 2 (*trifluralin+napropamid*), which is statistically confirmatively different from other variants. In tillage was higher yield decreasement in comparison with control - 2,239 t/ha (it is 31 %). Non-tillage option did not have such significant decreasement in yield – 0,939 t/ha (it is 14 %). Other variants have statistically non-confirmative differences. The highest yield was found in control (tillage – 7,144 t/ha, non-tillage – 6,629 t/ha). The second most yielding variant with tillage was variant 3 (*trifluralin*) – 6,817 t/ha and in non-tillage options it was variant 4 (*alachlor* + *clomazone*) – 6,549 t/ha. In all variants with herbicides more yielding are options with tillage. The only exception is herbicide *trifluralin+napropamid*, where yielding difference is 0,785 t/ha in favour of non-tillage variant. This fact could be explained by higher washout of herbicide residues in tillage option into lower soil layers, where residues negatively influenced root system of malting barley. Results correspond with conclusions of KUDRNA-VAŠÁK (2005), which declare, that after some herbicides *metazachlor+quinmerac* there is no yielding decreasement in consequently sown spring barley. The worst emergence rate of spring barley, the worst yield formation elements and also yield decreasement is caused by herbicide combination *trifluralin* and *napropamid* (especially in minimalizations).

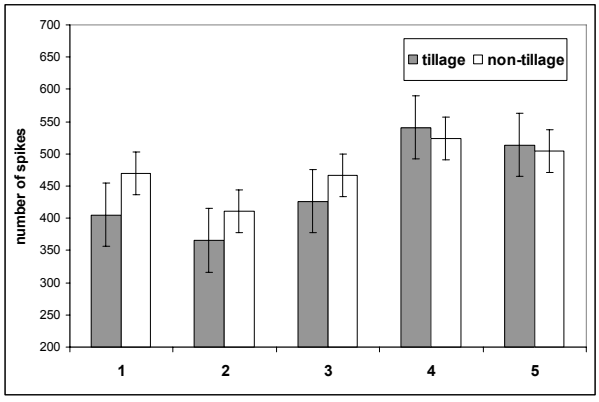
The highest thousand grains weight (TGW) was found in variant 2 (*trifluralin+napropamid*) with tillage (46,95 g) and also with non-tillage preparation (46,05 g). This variant is statistically confirmatively different from other options. The lowest TGW was found in non-treated control (variant 1). All variants except variant 5 had higher TGW in tillage option compared to non-tillage option (graph 3).

In grains moisture (graph 4) there is apparent negative influence of herbicides residues *trifluralin* + *napropamid* (variant 2), which prolonged vegetation and caused increasement of moisture in harvested grain. The lowest moisture was found in variants 3 – *trifluralin* (tillage – 14,2 %, non-tillage - 14,3 %) and 4 – *alachlor* + *clomazone* (tillage - 14,3 %, non-tillage -

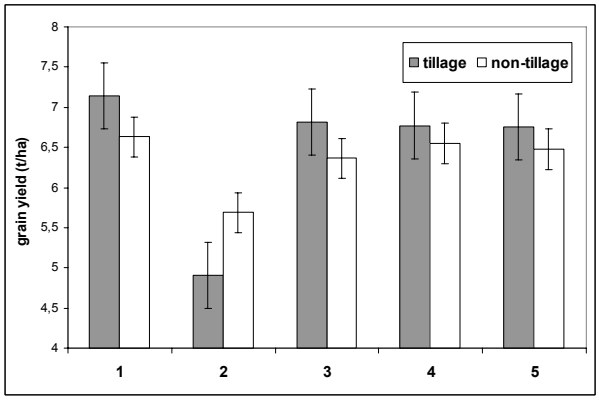
14,4 %). In variants with tillage barley matured earlier, which is also proved by lower grain moisture. Only in variant 2 (*trifluralin+ napropamid*) the grain had higher moisture in tillage option.

Table 2: Field emergence rate of malting barley (%) after plowed in winter rapeseed in relation to soil preparation and variant with herbicide, Červený Újezd, 2004/05 and 2005/06.

Date	Soil preparation for rapeseed	Field emergence rate (%) according to herbicide options				
		1 control	2 *trifluralin+napropamid*	3 *trifluralin*	4 *alachlor+ clomazone*	5 *metazachlor+ quinmerac*
3.5.2005	tillage	77,1	53,4	58,2	87,2	77,9
	non-tillage	93,4	69,7	75,2	87,5	78,4
5.5.2006	tillage	78,3	73,9	78,0	81,8	75,3
	non-tillage	57,3	65,6	83,5	69,5	53,2
average	tillage	77,7	63,7	68,1	84,5	76,6
	non-tillage	75,4	67,7	79,4	78,5	65,8
	average	76,5	65,7	73,7	81,5	71,2



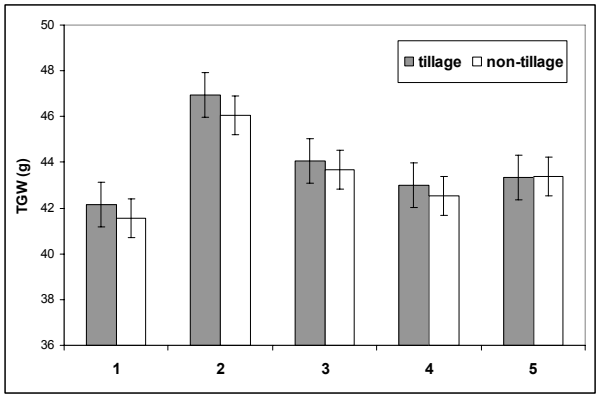
Graph 1: Number of spikes (piece/m^2) of malting barley based on soil preparation and herbicide variants, Červený Újezd, averages of years 2004/2005 and 2005/2006, Tukey, 95 %.



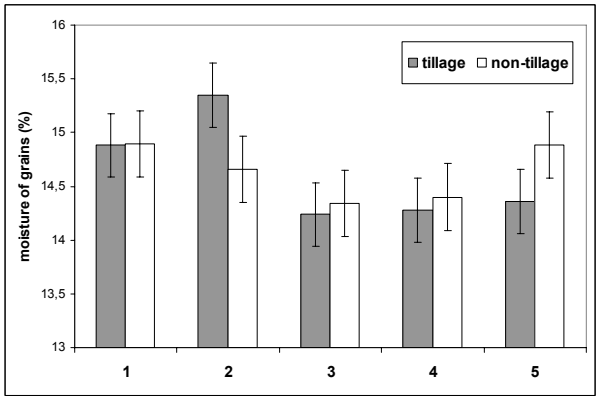
Graph 2: Grain yield (t/ha) of malting barley based on soil preparation and herbicide variants, Červený Újezd, averages of years 2004/2005 and 2005/2006, Tukey, 95 %.

Conclusions

Results of our experiments show, that residues of some herbicides used in rapeseed significantly decrease emergence rate, yield formation markers, yield and quality of consequently sown malting barley. Herbicide variant (*trifluralin+napropamid*) with its residues significantly decreased field emergency rate (by 14 %), number of spikes (by 12 %) and malting barley yield (by 31 %). Barley harvested in this variant had the highest TGW and seeds moisture. Most of monitored traits (yield, TGW) have better results in variants with tillage compared to non-tillage options.



Graph 3: Thousand grains weight (TGW in g) in malting barley based on soil preparation and herbicide variants, Červený Újezd, averages of years 2004/2005 and 2005/2006, Tukey, 95 %.



Graph 4: Moisture of harvested grains (%) in malting barley based on soil preparation and herbicide variants, Červený Újezd, averages of years 2004/2005 and 2005/2006, Tukey, 95 %.

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