WEED CONTROL IN WHEAT WITH POST-EMERGENCE HERBICIDES

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Abstract


A field study was carried out during the 2011-12 to identify weed species and to investigate the efficacy of post-emergence herbicides on weeds and their effect on wheat grain yield in the region of Podujeva (north-east part of Kosovo). Four different herbicides were applied at the post-emergence stage of wheat, namely Lintur 70 WG (a.i. triasulfuron + dicamba), Granstar 75 WG (a.i. tribenuron-methyl), Mustang (a.i. florasulam + 2,4-D-EHE-ethyl-heptyl ester) and herbicide combination Sekator OD (a.i. iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl) + Furore Super (a.i. fenoxaprop-p-ethyl) in the wheat cultivar Evropa. A total number of 16 weed species was documented in the wheat crop. The highest number of individuals was recorded for Convolvulus arvensis (24.0 plants/m2), Consolida regalis (15.5 plants/m2), Polygonum aviculare (11.5 plants/m2), and Galium aparine (9.8 plants/m2). The most efficient herbicides proved to be combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl (83.0%), triasulfuron + dicamba (75.4%), tribenuron methyl (65.6 %), and florasulam + 2,4-D-EHE-ethyl-heptyl ester (64.6%) was markedly lower. Based on the results presented, it is recommended the use of triasulfuron + dicamba or herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl in the study region for successful weed control and high wheat grain yields.

Key words: wheat; weeds; herbicide; grain yield

Abbreviations: a.i – active ingredient; HSD – Honest Significant Difference

Introduction

Weeds have become an increasing problem in wheat and some weed species such as Cirsium arvense, Consolida regalis, Polygonum aviculare, Consola orientalis, Convolvulus arvensis, Centaurea cyanus, Erodium cicutarium, Bifora radians are widespread in wheat crop in Kosovo (Susuri et al., 2001; Mehmeti et al., 2009; Mehmeti and Demaj, 2010). Moreover, vegetation of cultivated land was species-rich at both the plot and the regional scale in Kosovo (Kojic and Pejcinovic, 1982; Pejcinovic, 1987; Shala, 1987; Pejcinovic and Kojic, 1988). However, on the patch scale, i.e. on the scale of the arable field, only few species occur (Mehmeti et al., 2009). Wheat and maize are the main crops in arable land of Kosovo. Today, wheat is produced on about 90.728 ha (Statistical Office of Kosovo, Agriculture Census 2015) with average yield 3.4 t/ha (Kosovo Agency of Statistics, 2016).

According to Kojic and Pejcinovic (1982) Anthemis arvensis, Bifora radians, Caucaulis platycarpus, Centaurea cyanus, Cichorium intybus, Cirsium arvense, Consolida regalis, Convolvulus arvensis, Fallopia convolvulus, Holcus mollis, Polygonum aviculare, Ranunculus arvensis, Rumex crispus, Scleoranthus annuus, Sinapis arvensis, Trifolium arvense and Vulpia myuros were widespread in winter wheat in the past.

Pests, plant diseases and weeds cause high losses of wheat yield. Yield losses due to weeds have been re-
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ported (Oerke and Dehne, 2004; Oerke, 2006; Dangwal et al., 2010; Pacanoski and Glatkova, 2014; Mehmeti and Demaj, 2012). Thus, in wheat production, it is necessary to undertake control of weeds which cause losses of wheat grain yield. In general, a wide range of various herbicides is available. However, the decision which herbicide can be used principally depends on e.g., the dominant weed species, the weather conditions, the crop stage, the herbicide activity and the weed communities (Šarić, 1991a). The aim of the research presented was to identify weed species, to investigate the efficacy of herbicides and yield of wheat.

Material and Methods

During the winter season 2011-12, an experiment was conducted on a fluvisol soil in the region of Podujeva (north-east part of Kosovo). In the beginning of October, the wheat cultivar Evropa was sown by using 300 kg/ha seeds in good tilled soil, treated with fertilizer NPK 15:15:15 in doses of 250 kg/ha. The previous crop was potato. In spring, a supplementary fertilization with ammonium nitrate in doses 200 kg/ha was applied. Herbicide treatment was carried out using the knapsack sprayer of the capacity of 20 l, and the amount of water used was 400 L/ha. In Table 1, basic data on the applied herbicides is provided. The trial was set in a randomized block design with four replications and elementary plots of 15 m². In the experiment were six treatments, four herbicide treatments, one with hand check of weeds and control (untreated). The estimation of weeds was conducted per 1 m². All four herbicides were applied at the end of tillering, than 40 days after herbicide application, the number and structure of weeds and the efficacy of herbicides were estimated by comparing sprayed plots and control plots (untreated). The yield of wheat and above dry biomass of weeds was estimated in end of experiment per 1 m².

Table 1

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Active ingredient</th>
<th>Product</th>
<th>Rate l/kg/ha</th>
<th>Time of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>iodosulfuron-methyl Na + amidosulfuron + safener mfenpyr-diethyl + fenoxaprop-p-ethyl</td>
<td>Secator OD + Furore super EW</td>
<td>0.150 0.800</td>
<td>post-emergence</td>
</tr>
<tr>
<td>B</td>
<td>triasulfuron + dicamba</td>
<td>Lintur 70 WG</td>
<td>0.180</td>
<td>post-emergence</td>
</tr>
<tr>
<td>C</td>
<td>tribenuron-methyl</td>
<td>Granstar 75 WG</td>
<td>0.015</td>
<td>post-emergence</td>
</tr>
<tr>
<td>D</td>
<td>florasulam + 2,4-D-EHE-ethyl-heptyl ester</td>
<td>Mustang 306 SE</td>
<td>0.600</td>
<td>post-emergence</td>
</tr>
<tr>
<td>E</td>
<td>Hand check (manual weed control)</td>
<td></td>
<td></td>
<td>once during vegetation</td>
</tr>
<tr>
<td>F</td>
<td>Control (untreated)</td>
<td></td>
<td></td>
<td>at the end of tillering</td>
</tr>
</tbody>
</table>

Legend: A: iodosulfuron-methyl Na + amidosulfuron + safener mfenpyr-diethyl + fenoxaprop-p-ethyl; B: triasulfuron + dicamba; C: tribenuron-methyl; D: florasulam + 2,4-D-EHE-ethyl-heptyl ester; E: hand check (manual weed control); F: control (untreated)

The efficacy of herbicides was calculated by the equation (Šarić, 1991a):

\[
\text{CE} \% = \frac{A \times 100}{B} \% ,
\]

where: CE % is the coefficient of efficacy, A is the number of destroyed weeds per m² and B is the number of weeds in the untreated 1 m² plots.

The equation can be applied to weed species individuals (CEind.) and to weed species numbers (CEspec.).

The weeds were determined in the laboratory of the Faculty of Agriculture in Prishtina, Department of Plant Protection, using the atlases Šarić (1991b) and Demiri (1979), and life forms of weed vegetation of wheat crop according to (Ellenberg et al., 1992).

Statistical Analysis

The data were analyzed following Analysis of Variance (ANOVA) technique. To test the significance of differences of mean wheat yield and aboveground dry biomass of weeds, the mean values were calculated and significant differences were tested using Tukey HSD test and the statistical computer programme (JMP, 2010).

Meteorological condition

During the experiment in 2011/12, the air temperatures (Table 2) were slightly higher than in an average year, but not the amount of rainfall (Table 3).

Results and Discussion

In the experiment, the total number of 16 weed species was recorded, 11 of which were annual broad-leaved species, 3 perennials and two annual grass species, indicating a fairly species-rich weed community in the experimental field. This result is in accordance with Susuri et al. (2001), who investigated fields cultivated with wheat in two localities, in west
part of Kosovo and documented in first locality 15 weed species and in second locality 12, respectively. However, Mehmeti et al. (2008) showed that weed flora in wheat crop in Kosovo is species-poor at the field scale (about 9.6 weed species per 25m²).

Furthermore, the number of weed individuals was high in the control plots compared to the herbicide treatments (Table 4). For *Convolvulus arvensis* 24.0 plants/m², *Consolida regalis* 15.5 plants/m², *Polygonum aviculare* 11.5 plants/m² and *Galium aparine* 9.8 plants/m², *Chenopodium album* 9.3

### Table 2
Mean air temperature (°C) in Prishtina, near to the studied field (14 km) in the years of the experiment and between 1951-1980 (‘average year’) according to (Zajmi, 1996). (Δ: difference between 2011/2012 and the ‘average year’)

<table>
<thead>
<tr>
<th>Year</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
<th>XII</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>20.2</td>
<td>9.9</td>
<td>3.4</td>
<td>1.6</td>
<td>-1.7</td>
<td>3.7</td>
<td>7.1</td>
<td>11.1</td>
<td>15.5</td>
<td>22.2</td>
<td>24.9</td>
<td>10.8</td>
</tr>
<tr>
<td>2012</td>
<td>20.2</td>
<td>9.9</td>
<td>3.4</td>
<td>1.6</td>
<td>-1.7</td>
<td>3.7</td>
<td>7.1</td>
<td>11.1</td>
<td>15.5</td>
<td>22.2</td>
<td>24.9</td>
<td>10.8</td>
</tr>
<tr>
<td>Aver. year</td>
<td>16.1</td>
<td>11.0</td>
<td>6.4</td>
<td>1.2</td>
<td>1.5</td>
<td>1.0</td>
<td>4.7</td>
<td>10.4</td>
<td>14.6</td>
<td>18.0</td>
<td>20.2</td>
<td>9.5</td>
</tr>
<tr>
<td>Δ</td>
<td>+4.1</td>
<td>-1.1</td>
<td>-3.0</td>
<td>+0.4</td>
<td>-3.2</td>
<td>+2.7</td>
<td>+2.4</td>
<td>+0.7</td>
<td>+0.9</td>
<td>+4.2</td>
<td>+4.7</td>
<td>+1.3</td>
</tr>
</tbody>
</table>

Source: Hydrometeorology Institute of Kosovo

### Table 3
Rainfall (mm) in Prishtina, near to the studied field (14 km), in the year of the experiment and between 1951-1980 (‘average year’), (Δ: difference between 2011/12 and the ‘average year’)

<table>
<thead>
<tr>
<th>Year</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
<th>XII</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>34.1</td>
<td>48.1</td>
<td>4.5</td>
<td>72.3</td>
<td>105.7</td>
<td>36.1</td>
<td>12.8</td>
<td>51.5</td>
<td>102</td>
<td>6.2</td>
<td>53.3</td>
<td>526.6</td>
</tr>
<tr>
<td>2012</td>
<td>47.0</td>
<td>62.0</td>
<td>55.0</td>
<td>50.0</td>
<td>35.0</td>
<td>34.0</td>
<td>47.0</td>
<td>72.0</td>
<td>55.0</td>
<td>43.0</td>
<td>534.0</td>
<td></td>
</tr>
<tr>
<td>Aver. year</td>
<td>47.0</td>
<td>62.0</td>
<td>55.0</td>
<td>50.0</td>
<td>35.0</td>
<td>34.0</td>
<td>47.0</td>
<td>72.0</td>
<td>55.0</td>
<td>43.0</td>
<td>534.0</td>
<td></td>
</tr>
<tr>
<td>Δ</td>
<td>-12.9</td>
<td>-13.9</td>
<td>-50.5</td>
<td>+22.3</td>
<td>+70.7</td>
<td>+2.1</td>
<td>-21.2</td>
<td>+4.5</td>
<td>+30.0</td>
<td>-48.8</td>
<td>+10.3</td>
<td>-7.4</td>
</tr>
</tbody>
</table>

Source: Hydrometeorology Institute of Kosovo

### Table 4
Species life forms, number of individuals and coefficients of herbicide efficacy (CE) in the investigated wheat crop

<table>
<thead>
<tr>
<th>Life forms</th>
<th>Weed species</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>T</td>
<td>Alopecurus myosuroides Huds.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Chenopodium album L.</td>
<td>0</td>
</tr>
<tr>
<td>G</td>
<td>Cirsium arvense (L.) Scop.</td>
<td>1.8</td>
</tr>
<tr>
<td>G, Hli</td>
<td>Convolvulus arvensis L.</td>
<td>4.0</td>
</tr>
<tr>
<td>T</td>
<td>Consolida orientalis L.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Consolida regalis S.F. (Gray)</td>
<td>1.5</td>
</tr>
<tr>
<td>Tli</td>
<td>Fallopia convolvulus L.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Fumaria officinalis L.</td>
<td>0</td>
</tr>
<tr>
<td>Tli</td>
<td>Gallium aparine L.</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>Lolium perenne L.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Lamium amplexicaule L.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Papaver rhoes L.</td>
<td>1.0</td>
</tr>
<tr>
<td>T</td>
<td>Polygonum aviculare L.</td>
<td>4.8</td>
</tr>
<tr>
<td>G, H</td>
<td>Sonchus arvensis L.</td>
<td>0</td>
</tr>
<tr>
<td>T, H</td>
<td>Sonchus oleraceus (L.) A. Löve.</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>Veronica persica Poir.</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Number of plants/m²: 16.6 24.0 33.5 34.5 18.7 97.4 9.0
CEₜₐ_%: 83.0 75.4 65.6 64.6 80.1 0
Species number/m²: 6.0 10.0 11.0 10.0 9.0 16.0
plants/m², Lamium amplexicaule 5.8 plants/m² and Cirsium arvense 4.3 plants/m² were documented. This low weed density was due to crop rotation used for several years before the experiment. The occurrence of some weed species in wheat crop is in accordance with results of Mehmeti and Demaj (2010); Radivojević et al. (2006); Susuri et al. (2001); Georgiev et al. (2011).

The biological spectrum of wheat crop was dominated by therophytes with 71.9%, hemicryptophytes with 15.6% and geophytes 12.5%. These results for the biological spectrum for the domination of therophytes are similar to the Pejčinović (1987), who also found that therophytes dominated (57.1-74.4%), 78.0% respectively (Nikolich et al., 2012), in wheat crop.

The used herbicides showed satisfactory efficiency on weed plants number reduction. The dominant weed species in control plots was Convolvulus arvensis, also in plots treated with tribenuron-methyl and florasulam + 2,4-D-EHE-ethyl-heptyl ester, while in plots treated with herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl and triasulfuron + dicamba the occurrence was lower.

The dominant weed species in plots treated with herbicides were: Convolvulus arvensis, Consolida regalis, Polygonum viculare, Galium aparine, Lolium perenne, Veronica persica, Chenopodium album and Alopecurus myosuroides.

It is evident from the efficacy results (Table 4) that all four herbicides reduced the weed infestation in the wheat crop in comparison to the control plots. The highest efficiency showed herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl (CE$_{ind}$ =83.0%) and triasulfuron+dicamba (CE$_{ind}$ =75.4%). Less efficient was tribenuron-methyl (CE$_{ind}$ =65.6%) and florasulam + 2,4-D-EHE-ethyl-heptyl ester (CE$_{ind}$ =64.6%). In general all treated herbicides had a low efficacy in the reduction of weed species numbers, beside herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl CE$_{spec}$ 62.5%.

The dominant species Convolvulus arvensis had the highest susceptibility to herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl and triasulfuron + dicamba. The effect of triasulfuron + dicamba for the Convolvulus arvensis is in accordance with Petrova and Sabev (2014). However, Alopecurus myosuroides was proved to be resistant against the tested herbicide tribenuron-methyl and Lolium perenne for the herbicide florasulam + 2,4-D-EHE-ethyl-heptyl ester. Moreover, Veronica persica were proved to be resistant against herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl and triasulfuron + dicamba. Furthermore, herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl and triasulfuron + dicamba showed high efficacy against Alopecurus myosuroides and Lolium perenne.

In comparison to the control plots, all herbicide treated plots showed increased grain yields (Figure 1), and results are in accordance with Mehmeti and Demaj (2010); Kumar et al. (1997); Abbas et al. (2009); Knežević et al. (2010); Khalil et al. (2010). In the study presented here, comparatively high grain yield were found in plots treated with triasulfuron + dicamba (5.6 t/ha) and herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mepenpyr-diethyl + fenoxaprop-p-ethyl (5.33 t/ha). Yields were lower in tribenuron-methyl treated plots (4.9 t/ha) and 2,4-D-EHE-ethyl-heptyl ester (4.87 t/ha).

![Fig. 1. Yield of grain wheat (kg/ha) depending on herbicide treatment (±SD, average with different letters are significant Tukey’s HSD, < p = 0.05)](image-url)
126.4 g/m², while in control plots the above dry biomass of weeds was 254.9 g/m² (Figure 2). The used herbicides have significant differences with control plots for the above dry biomass of weeds (Figure 2), but there were no significant differences between used herbicides.

These results for the effect of herbicides of above dry biomass of weeds are found and from other studies (Knežević et al., 2010; Tanveer et al., 2010). Also, hand check plots has effect in reduction of above dry biomass of weeds.

Conclusions

The wheat community in wheat crop at the locality of Podujeva consisted of 16 weed species, with an average number of 97.4 plants/m² in the control plots of the experiment.

Dominant weeds in the control plots were: *Convolvulus arvensis* 24.0 plants/m², *Consolida regalis* 15.5 plants/m², *Polygonum aviculare* 11.5 plants/m², and *Galium aparine* 9.8 plants/m².

Highly efficient in the reduction of weed individuals (CEind.) were herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl (83.4%) and triasulfuron + dicamba (75.6%); less efficient was tribenuron-methyl (CEind = 65.6%) and florasulam + 2,4-D-EHE-ethyl-heptyl ester (CEind = 64.6%).

In comparison to the untreated plots, the wheat yield was comparatively high in triasulfuron+dicamba (5.6 t/ha) and combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl (5.33 t/ha).

The highest effect in reduction of above dry biomass of weeds showed combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl 65.3 g/m², and triasulfuron + dikamba 68.3 g/m², while in control plots the above dry biomass of weeds was 254.9 g/m².

Based on the results presented, we recommend the usage of triasulfuron+dicamba or herbicide combination iodosulfuron-methyl Na + amidosulfuron + safener mefenpyr-diethyl + fenoxaprop-p-ethyl in the study region for successful weed control and high wheat grain yields.

References


Demiri, M., 1979. Përcaktues bimësh, Libri shkollor (Determina


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