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THE EFFECT OF HERBICIDES ON THE CHEMICAL CONTENT OF WHEAT GRAIN

SUMMARY

The importance of herbicides for weed control in wheat crop is extensively studied, but there is limited research about their impact on the chemical content of wheat grain. With the aim to analyse the effect of five commonly used herbicides on the chemical content of winter wheat crop (cv. Euclide) grown on Vertisol soil, field trial was carried out during 2012-13 in the central part of Kosovo. The five applied post-emergence herbicides were: Sekator WG (a.i. iodosulfuron-methyl-natrium + amidosulfuron + mefenpyr-diethyl-protectant), Lintur 70 WG (a.i. triasulfuron + dicamba), Granstar 75 WG (a.i. tribenuron-methyl), Mustang (a.i. florasulam + 2,4-D 2-EH) and a combination of Sekator WG (a.i. iodosulfuron-methyl-natrium + amidosulfuron + mefenpyr-diethyl-protectant) + Furore super EW (a.i. fenoxaprop-P-ethyl). There were seven treatments: five herbicide treatments, mechanical control (hand check) and an untreated control. The field trial was set in a randomized block design with four replications and elementary plots of 9 m^2. The chemical content of wheat grain (crude proteins, crude fibre, fat, starch, ash and moisture) was analysed using NIRS technique. Milled samples of 20 g were placed in special boxes and sealed with a lid of cardboard and placed in the NIRS's apparatus for the analyses. Three replications for each treatment were used for the statistical analysis. There was significant effect of herbicides for crude proteins ($F_{2.21} = 5.10$, $p < 0.05$), fat content ($F_{2.21} = 5.36$, $p < 0.05$), crude fibre ($F_{2.21} = 13.0$, $p < 0.05$) and ash ($F_{2.21} = 2.84$, $p < 0.05$). However, no significant effect of the herbicides on starch content was observed. Based on our results we suggest to additionally consider the effects of herbicides on the chemical content of wheat grain in the process of choosing appropriate herbicides for weed control.

Keywords: food quality, crude proteins, crude fibre, fat, starch.

INTRODUCTION

The winter wheat is one of the most important crops in Kosovo and is produced on about 102.000 ha with an average yield of 4.0 t/ha (KAS, 2014), but this depends and from wheat cultivars (Fetahu et al. 2013). Pests, plant diseases

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and weeds cause high crop loss. Yield losses due to weeds have been reported to range from 5% up to 26% (Oerke, 2006; Dangwal et al. 2010). Thus, in wheat production, it is necessary to undertake control of weeds, and herbicide use is common to reduce weed infestation and thus crop loss.

The importance of herbicides for wheat control in wheat crop is extensively studied, but there is very limited research about the effects of herbicides on the chemical content of wheat grain. However, the dietary value of wheat is enormously important as wheat takes an important place among the crop species being widely grown as staple food sources. Many researchers investigated the chemical content of wheat grain (Demaj et al. 2009; Hala and Ibrahim 2011; Šramková et al. 2009, Kastrati, 1997; Kryeziu, 2008) or the content of protein in wheat grain (Bramble et al. 2002; Horvatic et al. 1981), other cereals and maize (Gellrich et al. 2003; Kastrati, 1997; Kryeziu, 2008; Mehmeti et al. 2010). However, to our knowledge, the effects of herbicides on the chemical content of wheat grain were only studied by Demaj et al. (2009) and Hala and Ibrahim (2011). Given this background, the aim of our study is to analyse the effect of applied herbicides on the chemical content of wheat grain.

MATERIAL AND METHODS

Field trial was carried out during 2012-13 on Vertisol soil in the central part of Kosovo to analyse the effect of five commonly used herbicides on the chemical content of winter wheat grain (crude proteins, crude fibre, fat, starch, ash and moisture). The chemical content was analysed using NIRS technique (Near Infrared Reflectance Spectroscopy; FOSS 6500) and the software WIN ISI III at department in Biotechnology in Zootechny. There were seven treatments: five herbicide treatments were applied at the end of tillering, mechanical weed control (hand check) and an untreated control (Tab.1). The field trial was set in a randomized block design with four replications and elementary plots of 9 m2. The winter wheat crop (Euclide cultivar) was sown in beginning of November, by using 300 kg/ha seeds in good tilled soil, apparently treated with fertilizer NPK 15:15:15 in doses of 200 kg/ha.

During the vegetation of wheat crop in spring the supplementary fertilization with ammonium nitrate in doses 200 kg/ha was used. Field trial was treated using the Farmate special knapsack sprayer of the capacity of 20 l was used, and amount of water used was 400 l/ha.

For the chemical analysis around 2 kg sample of wheat grain were taken, which were milled into the grinder. Milled samples of 20 g were placed in special boxes and sealed with a lid of cardboard and placed in the NIRS's apparatus for the analyses. Three replications for each treatment were used for the statistical analysis.

Statistical Analysis

The data were analyzed following an Analysis of Variance (ANOVA) technique, and the mean values of treatments were calculated and significant

differences were determined by the Fisher's least significant differences (LSD) test,using the statistical computer programme VVStat (Vukadinović, 1994).

Table 1. Basic information on the applied herbicides

Treatments	Product	Active ingredient	Rate l, kg/ha	Time of application
1	Sekator OD	iodosulfuron-methyl Na+ amidosulfuron mefenpyr-diethyl-protectant	0.150 l/ha	Post-emergence
2	Lintur 70 WG	triasulfuron + dicamba	0.180 kg/ha	Post-emergence
3	Granstar 75 WG	tribenuron-methyl	0.015 kg/ha	Post-emergence
4	Mustang SE	florasulam + 2,4- D-2-EHE	0.600 l/ha	Post-emergence
5	Sekator OD + Furore super EW	iodosulfuron-methyl Na+ amidosulfuron mefenpyr-diethyl-protectant fenoxaprop-P-ethyl	0.150 l/ha 0.800 l/ha	Post-emergence
6	mechanical control (hand check)			once during vegetation
7	Control			

Agroecological conditions

In general, the climate of Kosovo is characterised by warm summers and cold winters, and the air temperature may range from −20°C to 35°C. How¬ever, in the western part of Kosovo, the average air tem¬perature (11.0°C) and the annual rainfall are higher (about 780 mm), and the frost-free period (up to 225 days) is longer than in the eastern part (9.8°C; 635 mm; 170 to 220 days, respectively). Data presented in (Tab. 2) were obtained from the meteorological station of Prishtina. The amount and distribution of rainfalls as well and temperature define the main characteristic of the climate and directly affect the germination and growth of wheat.

Table 2. Mean air Temperature (°C) and Rainfall (mm) in Prishtina 2012/13 and and between 1951-1980 ('average year') based on (Zajmi, 1996)

Year	Months											
	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Ave.
Temperature												
2013/14	20.0	13.8	8.6	-0.6	1.6	3.9	6.6	12.8	16.7	19.0	21.6	11.8
Long term aver.	15.8	10.5	5.8	0.7	-1.2	1.3	4.8	9.8	14.4	18.0	19.7	9.1
Rainfall												
2013/14	13.7	60.4	29.6	65.9	38.7	5.8	70.3	40.4	122	55.3	32.6	48.6
Long term aver.	47.5	56.1	64.2	53.5	36.7	37	35.3	51.4	75.3	56.9	48.6	51.1

RESULTS AND DISCUSSION

According to achieved results, the chemical content of the harvested wheat grain differed between the herbicide treatments (Tab. 3). There were significant effects of the herbicides on crude proteins ($F_{2.21} = 5.10$, $p < 0.05$) and on the fat content ($F_{2.21} = 5.36$, $p < 0.05$). Also, significant differences were observed for crude fibre ($F_{2.21} = 13.0$, $p < 0.05$), ash ($F_{2.21} = 2.84$, $p < 0.05$) and moisture ($F_{2.21} = 5.67$, $p < 0.05$). In contrast, no significant effect of the herbicides on the starch content was found.

In the plots treated with triasulfuron + dicamba, the content of crude proteins in wheat grain was (15.25%) higher than in all other treatments (Tab. 3). The lowest content of crude proteins in wheat grain was measured in plots with mechanical control (13.72%). However, compared to the other treatments and beside the plots treated with the herbicide tribenuron-methyl significant differences were also found between the plots treated with the herbicide triasulfuron+dicamba (crude protein content 15.25%).

The results for the content of crude proteins are in accordance with Demaj *et al.* (2009), wherein the average content of proteins was 14.83%, in comparison with our results (14.14%). But, the results do not match with Krasniqi (2011), wherein the average content of proteins was lower (12.72%). However, according to Kastrati (1997), the crude protein content in winter wheat grain may range between 9 to 17%.

Moreover, the results achieved by Kryeziu (2008) for the winter wheat, using two different methods for analyses of crude proteins, showed that the crude protein contents are almost similar using the Kjeldah method (11.63%) or the NIRS apparatus (11.66%).

Table 3. The chemical content of winter wheat grain (% of dry matter)

Treatments	CP	Fat	CF	Ash	Moisture
iodosulfuron-methyl-natrijum + amidosulfuron mefenpir-diethyl +(protectant)	13.87^{b}	2.18^{a}	1.12^{b}	1.74^{a}	10.59^{b}
triasulfuron + dikamba	15.25^{a}	2.04^{c}	0.74^{a}	1.84^{b}	10.74^{a}
tribenuron-methyl	4.68^{ac}	2.13^{b}	1.10^{b}	1.85^{b}	10.64^{ac}
florasulam + 2,4- D-2-EHE	13.94^{b}	2.14^{b}	1.10^{b}	1.82^{b}	10.66^{a}
iodosulfuron-methyl-natrijum + amidosulfuron +mefenpir-diethyl +(protectant) + fenoxsaprop-P-ethyl	13.74^{b}	2.21^{a}	1.26^{c}	1.79^{ab}	10.49^{b}
mechanical control (hand check)	13.72^{b}	2.12^{b}	1.23^{c}	1.81^{b}	10.66^{a}
control	14.33^{bc}	2.10^{b}	1.13^{c}	1.84^{b}	10.72^{a}

Legend: CP-Crude Proteins; CF-Crude Fibber; LSD-Least Significant Difference; Means within columns that do not share a letter are significantly different.

Compared to all other treatments, the wheat grain of the plots treated with the herbicide triasulfuron + dicamba had the lowest content of fat (2.04%; Tab. 3). Additionally, compared to the other treatments and beside the plots treated with the herbicide iodosulfuron-methyl-natrium + amidosulfuron mefenpyr-diethyl significant differences were also found between the plots treated with the herbicide combination iodosulfuron-methyl-natrium, amidosulfuron + mefenpyr-diethyl + fenoxaprop-P-ethyl (fat content 2.21%).

Again our results are in accordance with Kastrati (1997), who found a range of fat contents in winter wheat grain from 0.85 to 4.0%. However, the mean total fat content of the winter wheat grain of our study (2.13%) differs from results of Demaj et al. (2009), where the average content of total fat was (1.67%).

The content of crud fibre was higher in the plots treated with a combination of the herbicides iodosulfuron-methyl-natrium, amidosulfuron + mefenpyr-diethyl + fenoxaprop-P-ethyl (1.26%), while the lowest content of crude fibre (0.74%) was found in the plots treated with triasulfuron + dicamba.

In general, the differences in the chemical content of wheat grain between the studies cited above could be due to different cultivars tested in these studies (e.g. we analysed the wheat cultivar 'Euclide', while Demaj et al. (2009) used the variety 'Novosadska rana 1'), since cultivar-specific protein contents are well known for wheat (cf. e.g. Yahata et al. 2005).

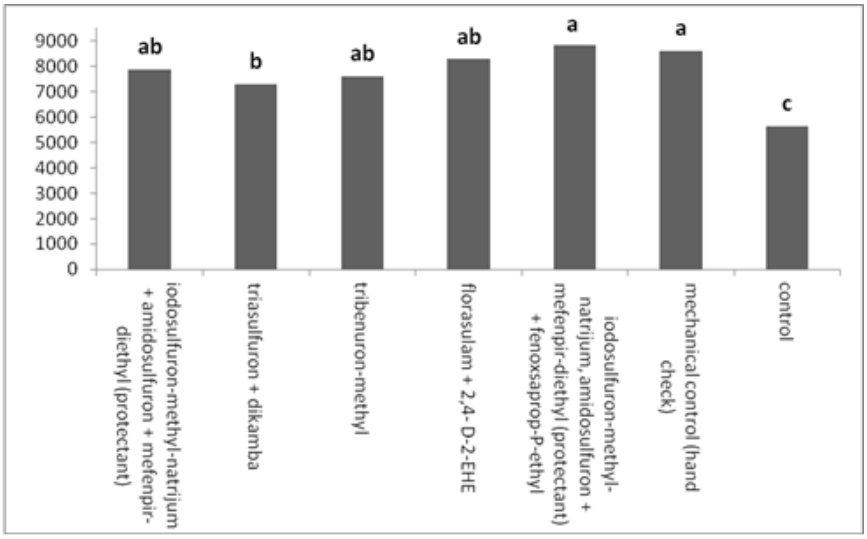

Figure. 1. Yield (kg/ha) of winter wheat depending on treatments.
LSD0.05 = 822; Means that do not share a letter are significantly different.

Moreover, climatic conditions may also affect the quality of grains and grain yields (cf. Cesevičienė et al. 2009; Tarakonavas and Ruzgas 2007; Mehmeti and Demaj 2010; Lalić et al. 2007), and may influence the amount of proteins of wheat grain. In this context, precipitation and temperature are particularly important (Benzian and Lane 1986). Finally, also soil type and

structure, water amount and nutritional mineral substances may impact the chemical content of wheat grains (Kirkman et al. 1982; Moss et al. 1981; Smika and Greb 1973).

In our study, the used herbicides also affected the yield of wheat (Fig. 1). These results are in accordance with Mehmeti and Demaj (2010), Knežević et al. (2014), Abbas et al. (2009), and Kika (2012). Furthermore, it is important that besides choosing appropriate herbicides to control weeds and affect the yield of wheat in future herbicides should be selected in base of their impact on the chemical content of wheat grain.

CONCLUSIONS

The conclusions of the study are:

-The applied herbicides affected the chemical content of the wheat grain.

-The highest content of crude proteins was found in plots treated with the herbicide triasulfuron + dicamba (15.25%), and the lowest in the plot with mechanical control (hand check) with (13.72%).

-The highest grain yield has found in the plots treated with the herbicide combination iodosulfuron-methyl-natrium + amidosulfuron mefenpyr-diethyl-protectant + fenoxaprop-p-ethyl (8.825 kg/ha).

-These results are based on a one-year field trial. Thus, additional research considering more than one year and more than one parcel are needed to come to more accurate conclusions. However, given the results of our study, the future process of choosing appropriate herbicides for weed control may additionally consider the effects of herbicides on the chemical content of wheat grain and thus on food quality.

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