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Production Systems

Effect of application of foliar herbicides on the productivity and physical parameters of triticale cultivars (x*Triticosecale Wittm*.)

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Abstract. *The aim of this research was to determine the effect of application of herbicides on productivity and physical parameters of triticale cultivars. The research was carried out in 2018 –2021 at Dobrudzha Agricultural Institute, General Toshevo (DAI). The following herbicides were used: Ergon WG (50 g/ha), Starane Gold (1800 ml/ha), Biatlon 4D+Desh (50 g/ha+500 ml/ha) and Korelo Duo+Das Oil (260.5 g/ha +500 ml/ha) from the group of sulfunylureas with various mechanisms of action. The preparations were applied at stage 29 and 37 (according to Zadoks) of three triticale cultivars, Akord, Kolorit and Dobrudzhanets. The herbicide effect was determined by the quantitative weight method and evaluated by the EWRS scale. The parameters were the following: productivity (ha), weight of 1000 grains (g) and hectoliter (kg). Four-factor dispersion analysis was applied. The factors considered were year conditions, cultivar, herbicide and stage of treatment. The factors with the highest strength of effect were the year conditions (60%) and the used cultivar (31%). Significantly lower was the effect of the factors stage of treatment (5%) and applied herbicide (4%).*

Keywords: triticale, cultivars, herbicides, application stage, productivity

Introduction

Triticale (x *Triticumsecale Wittm.*) is a close relative of wheat that results from pollinating durum wheat with rye pollen. That cross is then used in a breeding program to produce stable, self-replicating varieties (Faizabad, 1993). Triticale is also used in grain production or more commonly as forage (Kumlehn et al., 2010). Triticale is used as feed for swine, cows and poultry and is generally higher in protein and amino acids than wheat or barley. The use of corn is reduced when triticale is used as finishing diet for livestock. Triticale is becoming a major part of nutritional management plans for dairies. The use of triticale can provide dairies with a good alternative to wheat silage, permitting year round silage feeding (Stankowski and Maciorowski, 1996).

Despite the use of costly inputs and improved cultural practices, the average yield of wheat is very low. The reasons for low yield are many, but one of the most serious, though less obvious, is the competition of weeds (Qureshi et al., 2002). Weeds compete with crop plants for nutrients, moisture,

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space, light, and many other growth factors. Such competition not only reduces crop yield but also deteriorates the quality of farm produce and thereby reduces the market value of the produce (Qureshi, 1982). For hundreds of years, the fight against weeds has been mainly based on controlling them using mechanical and agrotechnical methods (Adamczewski and Praczyk, 1999). Herbicides have been shown to be a beneficial, very effective and efficient means of controlling weeds in wheat (Azad et al., 1997). The herbicides used for controlling these weeds are sulfonylurea herbicides such as sulfosulforon, metsulfuron methyl+sulfosulfuron, clodinafop-propargyl, diclofop-methyl, fenoxaprop-p-ethyl+mefen-pyper-ethyl (Zand et al., 2008).

The main method for the control of weeds in cereal crops on the surface continues to be the use of herbicides. The number of grains per spike and weight of 1000 grains are important biometric indicators. A significantly higher number of grains per spike (55.7) was established after treatment with Puma super (1235 l/ha), followed by Bristol EV69 (1250 ml/ha), Topic 15VP (247 g/ha), Safener 15VP (247 g/ha). The minimum number of grains per spike (45.7) was in the untreated control. The highest weight of 1000 grains was established in variant Safener 15VP (247 g/ha) - 35.3 g, and the lowest one in a variant with weeded control - 32.0 g (Mehmood et al., 2014). Maximum mass of 1000 grains (39.8 g) was detected after treatment with Eim 40DF (34.7 g) used post emergemce, a minimum one in a weeded variant (22.3 g) (Fahad et al., 2013). After treatment of cereal crops with herbicides applied post emergence with Buktril super 60EK (1.5 l/ha), a considerable number of grains per spike - 104 grains was established. The untreated control group had the lowest number of grains per spike – 42 grains (Hussain et al., 2013).

This research aimed to determine the effects of herbicide application on the productivity and physical parameters of triticale cultivars.

Material and methods

The research was carried out in 2018 – 2021 at DAI – General Toshevo. The field trial was designed according to the block method in three replications, the size of the trial area being 10.5 $m^{2.}$ Two control variants were involved: K_1 – weed-free variant manually cleaned till stage heading of wheat, and K_2 – control variant infested with weeds till the end of the crop vegetation period.

The following herbicides were used: Ergon WG (metsulfuron-methyl+thifensulfuron-methyl) - 50 g/ha, Starane Gold (florasulam+fluroksipir) - 1800 ml/ha, Biatlon 4D+Desh (tritosulfuron+florasulam) - 50 g/ha+500 ml/ha, Korelo Duo+Das Oil (pyrox sulam+florasulam+cloquintocet-mexyl) – 260.5 g/ha+500 ml/ha. The preparations were applied at stage “end of tillering”, “stage 29” and stage “emergence of flag leaf”, “stage 37” according to Zadoks et al. (1974) of three triticale cultivars: Akord, Kolorit and Dobrudzhanets.

Before planting triticale, artificial background of weed infestation was created using the most widespread weeds in the region of DAI – General Toshevo: the annual broad-leaf weeds ivy-leaved speedwell - *Veronica hederifolia* (L.), wild mustard - *Sinapis arvensis* (L.), cleavers - *Galium tricorne Stok*, the German chamomile - *Matricaria chamomila* (L.), field chamomile - *Anthemis arvensis* (L.), Royal knight’s spur - *Consolida orientalis J. Gay*; and the perennial broad-leaf weeds creeping thistle - *Cirsium arvense* (L.) Scop and field bindweed - *Convolvulus arvensis* (L.). Weed density was measured quantitatively per unit area by species using ¼ frame in four replications prior to introduction of herbicides.

The herbicide efficiency was estimated 25-30 days after the use of the preparations according to species, by amount and weight, using ¼ frame in four replications, measuring the weight of the weeds in fresh and dry condition. The effectiveness of the herbicides was assessed using the EWRS 9-degree scale for reading the herbicide activity and selectivity, 1 corresponding to 100% efficiency of the preparation, without symptoms of phytotoxicity on the cultural plants; and 9 corresponding to 29.9% - 0% effect of the preparation and complete perishing of the plants (Table 1).

Table 1. Herbicide activity and selectivity according to 9-degree scale of EWRS

Rank	Herbicide efect %	Damage symptoms	General evaluation
1	100	No symptoms – healthy plants	Excellent
2	99.9-98	Very weak symptoms – slight stunt effect	Very good
3	97.9-95	Weak but discernible symptoms	Good
4	94.9-90	Better expressed symptoms (eg. chlorosis) which do not affect yield	Satisfactory
5	89.9-82	Thinning of the crop, strong chlorosis or stunt. Lower yield expected	Indefinite
6	81.9-70	Heavy damage or perishing of plants	Unsatisfactory
7	69.9-55	Heavy damage or perishing of plants	Poor
8	54.9-30	Heavy damage or perishing of plants	Very poor
9	29.9-0	Heavy damage or perishing of plants	Extremely poor

Cultivar Akord is characterized with 125-140 cm stem height, high resistance to lodging and spike which is awned, with high number of grains and complete resistance to lodging. The cultivar is medium early, with high cold and winter resistance and high drought tolerance.

Cultivar Kolorit has stem height 103-126 cm and possesses excellent resistance to lodging and high number of productive tillers. The cultivar is awnless and completely resistant to shedding. It is medium early, with high cold and winter resistance and high drought tolerance.

Cultivar Dobrudzhanets is 115-145 cm high, with high resistance to lodging and good number of productive tillers. The spike is awned and highly resistant to shedding. The cultivar is also early maturing and tolerant to drought.

The following parameters were observed: productivity (ha), weight of 1000 grains (g) and hectoliter (kg). Four-factor dispersion analysis was applied. The factors year conditions, cultivar, herbicide and stage were monitored. The data were analyzed by statistic software SPSS 13.0.

No significant differences were observed in the meteorological elements compared to the previous four years of investigation, including the long-term period (1960-2010) (Figure 1).

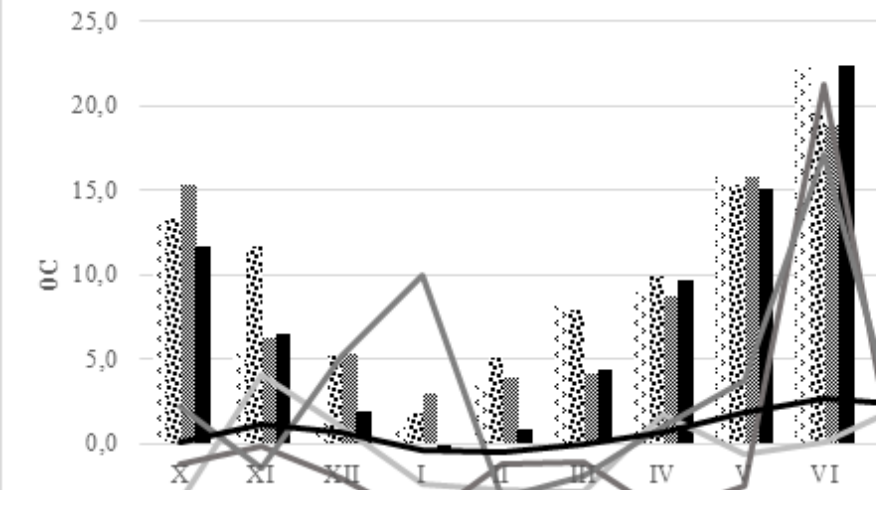

Figure 1. Air temperature and rainfull in the growing season of winter wheat, accordimg to Meteorological Station at DAI - General Toshevo, 2019-2021

Results and discussion

Cultivar Akord was characterized with the highest production (4.6 t/ha) after treatment with florasulam+fluroxypyr at "stage 29" (Table 2). The decrease in the yield compared to the control (100%)

was the lowest – by 21.4%. After the application of pyroxsulam+florasulam+cloquintocet-mexyl high yield was also achieved. The decrease in the yield in comparison with the cleaned control was 17.8%.

Table 2. Effect of the herbicides on the productivity of cultivar Akord according to the stage of treatment mean 2018-2021, t/ha

	Zadoks 29		Zadoks 37	
Variants	2018-2021	% - K_1	2018-2021	% - K_1
Cleaned control -K_1	5.9	100	5.9	100
metsulfuron-methyl+thifensulfuron-methyl-50 g/ha	4.5	77.2	4.1	69.5
florasulam+fluroxypyr-1800 g/l	4.6	78.6	4.1	70.0
tritosulfuron+florasulam +Desh – 50 g/ha+500 ml/ha	4.3	73.0	4.5	77.1
pyroxsulam+florasulam+cloquintocet-mexyil+Das Oil-260.5 ml/ha+500 ml/ha	3.8	65.8	4.8	82.2
Weeded control - K_2	3.9	67.2	3.9	67.2

Cultivar Kolorit demonstrated the hightest yields after using metsulfuron-methyl+thifensulfuron-methyl at stage Zadoks 29 and piroksulam+florasulam+klokvintotset-meksil at stage Zadoks 37 (5.5 t/ha and 5.2 t/ha). The decrease in the yield in comparison with the clean control was 13.7% and 18.2%.

Table 3. Effect of the herbicides on the productivity of cultivar Kolorit according to the stage of treatment mean 2018-2021, t/ha

	Zadoks 29		Zadoks 37	
Variants	2018-2021	% - K_1	2018-2021	% - K_1
Cleaned control - K_1	6.4	100	6.4	100
metsulfuron-methyl+thifensulfuron-methyl-50g/ha	5.5	86.3	4.8	75.3
florasulam+fluroxypyr-1800 g/l	4.8	76.0	4.6	72.7
tritosulfuron+florasulam +Desh – 50 g/ha+500 ml/ha	4.6	72.2	5.0	78.7
pyroxsulam+florasulam+cloquintocet-mexyl+Das Oil-260.5 ml/ha+500 ml/ha	4.8	75.4	5.2	81.8
Weeded control - K_2	4.1	64.1	4.1	64.1

Active substances metsulfuron-methyl+ thifensulfuron-methyl applied at stage 29 and florasulam+fluroxypyr at stage Zadoks 37 achieved the hightest production on cultivar Dobrudzhanets (Table 4). The decrease in yield compared to the clean control was 18.15% and 21.5%.

Table 4. Effect of the herbicides on the productivity of cultivar Dobrudzhanets according to the stage of treatment mean 2018-2021, t/ha

	Zadoks 29		Zadoks 37	
Variants	2018-2021	% - K_1	2018-2021	% - K_1
Cleaned control - K_1	6.1	100	6.1	100
metsulfuron-methyl+thifensulfuron-methyl-50g/ha	5.0	81.9	4.5	73.5
florasulam+fluroxypyr-1800 g/l	4.4	71.3	4.8	78.5
tritosulfuron+florasulam +Desh – 50 g/ha+500 ml/ha	4.9	80.5	4.7	76.7
pyroxsulam+florasulam+cloquintocet-mexyl+Das Oil-260.5 ml/ha+500 ml/ha	4.6	74.5	4.5	73.2
Weeded control - K_2	3.9	63.5	3.9	63.5

The analysis of the variances for physical parameters revealed strongly expressed correlations of the values of the index with the independent and combined effect of the factors

tested in the experiment (Table 5).

The results from this study are in contradiction with the results of Fernandez-Quintanilla et al. (2006). They reported that these herbicides have a good effect on narrow leaves such as wild oat. On the other hand, several studies indicate that the effect of herbicides on wild oat is described which is consistent with the result of that study. The studies of Vencill (2002) and Tomlin (2003) proved that a total herbicide treatment controlled narrow-leaved weeds such as wild oat very well. It was reported by Tabib et al. (2007) and Jamali et al. (2010) that these herbicides from the group of sulfunylureas with various mechanism of action have a high capacity to control narrow-leaved weeds. It was reported that clodinafop-propargyl was the most important and the most consumed herbicide and it controled wild oat very well (Montazeri et al., 2005).

Table 5. Productivity and physical parameters of triticale cultivars - analysis of variances (p-0,005)

Factors	df	Productivity		Weight of 1000 grains		Hectoliter	
		F	Sig.	F	Sig.	F	Sig.
Year	3	140.611	.000	352.615	.000	13740.555	.000
Cultivar	2	8.922	.002	29.844	.000	987.522	.000
Herbicide	3	5.555	.020	3.666	.058	882.003	.000
Stage	1	5.699	.000	16.777	.000	1525.522	.000

Meteorological conditions were characterized with the hightest strenght of effect (60%) on the parameter productivity. This was followed by the factor of cultivar. A smaller part of the variation was attributable to the factors of treatment stage and applied herbicide. Year conditions were characterized with the strongest effect (88%) on the parameters weight of 1000 grains. The factors stage of treatment and applied herbicide had a lower effect. Meteorological conditions had the hightest strenght of effect on the hectoliter (80%). The tested factors cultivar, applied herbicide and stage of treatment were characterized with a low impact (6%, 5%, 9%) (Figure 2).

Yassin et al. (2010) reported that sulfunylureas increased grain yield in the product. Vaici et al. (2008) also proved that the performance of the crops which have been contaminated by wild oat increased after application of herbicides pinoxaden and clodinafop-propargyl, 218% and 181%, respectively, which confirms our results.

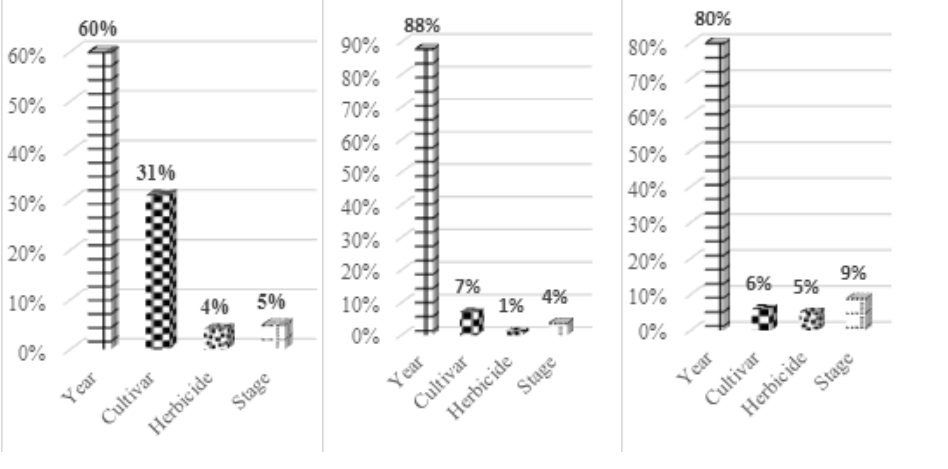

Figure 2. Strength of factors' effect on the productivity, weight of 1000 grains and hectoliter

Conclusion

Visible symptoms of phytotoxity on the spike of cultivars Akord, Kolorit and Dobrudzhanets after treatment at stage 29 and stage 37 with a foliar set of herbicides from the group of sulfunylureas were not observed. The factor with the highest strength of effect on the productivity and physical parameters

were year conditions (60%, 88%, 80%). There was a significantly lower effect from the factors cultivars, treatment stage and applied herbicide.

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