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BROADLEAF WEEDS CONTROL IN WINTER WHEAT

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Abstract

During the period of 2018/2019-2019/2020, a field plot trial with the winter wheat variety Avenue was carried out. The experiment aimed to determine the efficacy of herbicide products for broadleaf weeds control. The studied products were Biathlon 4 D (tritosulfuron + florasulam) + Dash (adjuvant), Mustang (2.4 D ester + florasulam), and Sekator OD (iodosulfuron + amidisulfuron). The obtained results were compared with the untreated control. The efficacy of the herbicides against the weeds corn chamomile (Anthemis arvensis L.), common poppy (Papaver rhoeas L.), cleavers (Galium aparine L.), wild mustard (Sinapis arvensis L.), and forking larkspur (Consolida regalis Gray) was evaluated. High herbicide efficacy against all existing weeds was recorded. All evaluated parameters for the treated variants as plant height at the end of the vegetation, absolute and hectoliter seed mass, as well as winter wheat grain yields, had higher values compared to the untreated control.

Key words*: wheat, weeds, herbicides, efficacy.*

INTRODUCTION

Winter wheat (*Triticum aestivum* L.) is main grain crop in Bulgaria. The weeds are great competitors of wheat for nutrients, water, space, and light. The weeds can also cause indirect damages because many of them are hosts of harmful insects and diseases (Kalinova et al., 2012). The high weed infestation can decrease the yields by more than 70% (Atanasova and Zarkov, 2005). In the Modern agriculture the weed control in wither wheat is mainly accomplished by herbicide application. The choice of a proper herbicide, optimal time, and rate of application are one of the most important and responsible moments in wheat management (Abbas et al., 2009; Mitkov, 2014; Titiyanov et al., 2015; Mitkov et al, 2017a; Mitkov et al., 2017b; Petrova, 2017; Mitkov et al., 2018; Mitkov et al., 2020a; Mitkov et al., 2020b; Titiyanov et al., 2020; Yankova et al., 2020; Shaban et al., 2021; Yanev et al., 2021). Most of the herbicide products control only a specific group of weeds, and for assuring wide spectrum of weed control it is recommended to use herbicide combinations (Bostrom and Fogelfors, 2002; Chaudhry et al., 2008; Mitkov et al., 2017; Mitkov et al., 2018; Mitkov et al., 2020). Buctril Super 60 EC at a rate of 835 ml ha^{-1} and Starane-M at a rate of 875 ml ha^{-1} can be applied for broadleaf weed management (Ghulam et al., 2009). After combined application of carfentrazon + mcpp, tritosulfuron + dicamba, piraflufen + isoproturon, and amidosulfuron + iodosulfuron, Cirujeda et al. (2007) reported high efficacy against *G. aparine*.

The application of Atlantis WG - 0.50 kg ha^{-1} + 1.00 l ha^{-1} showed the highest control against *Anthemis arvensis*, *Papaver rhoeas,* and *Sinapis arvensis*. The highest efficacy against the weeds *Lamium purpureum* and *Avena fatua* after the application of Abak + Mero - 0.25 kg ha-1 + 1.00 l ha^{-1} was reported. The treatment with Osprey Extra + Biopower - 0.33 kg ha^{-1} + 1.00 l ha^{-1} showed the highest efficacy against *Lolium rigidum* and *Galium aparine*. The most difficult-to-control weeds were the volunteer of Clearfield® oilseed rape and *Veronica hederifolia* (Yanev et al., 2021).

The experiment aimed to study the herbicide efficacy and selectivity of some herbicides for broadleaf weeds control in winter wheat.

MATERIALS AND METHODS

The experiment was conducted during 2018/2019 - 2019/2020 on the agricultural land of Voyvodinovo village, district Plovdiv, Bulgaria. The trial was performed by the randomized block design in three replications. The size of the harvesting plot was 20 m². The

following treatments were evaluated: 1. Untreated control; 2. Biathlon 4D - 50 g ha^{-1} (54 g/kg florasulam + 714 g/kg triasulfuron) + Dash (adjuvant) - 1.00 l ha^{-1}; 3. Mustang (300 g/l – 2.4 D + 6.25 g/l florasulam) – 800 ml ha^{-1}, and 4. Sekator OD (100 g/l + amidosulfuron + 25 g/l iodosulfuron + 250 g/l mefenpyr-diethyl - antidote) - 150 ml ha^{-1}. The herbicide application was performed in end of the tillering stage of the winter wheat (BBCH 29-30). For the purposes of the trial, the winter wheat variety Avenue was grown. The preceding crop of the winter wheat during the two experimental years was sunflower.

The potential weed infestation of the experimental field was presented by corn chamomile (*Anthemis arvensis* L.), common poppy (*Papaver rhoeas* L.), cleavers (*Galium aparine* L.), wild mustard (*Sinapis arvensis* L.), and field larkspur (*Consolida regalis* Gray).

The herbicidal efficacy was evaluated by the 10-score scale of EWRS (European Weed Research Society). The herbicidal selectivity was recorded by the 9-score scale of EWRS.

The following winter wheat indicators were evaluated:

- Plant height at the end of the growing season (cm). The measurement was performed on 10 plants of each variant in three replications;
- Winter wheat grain yield (t ha^{-1}) - by harvesting the entire experimental plot of all three replicates of each variant.
- Absolute and hectoliter seed mass of 1000 seeds. The evaluation was performed in three repetitions;

For statistical data evaluation of the Duncan's multiple range test by using the package of SPSS 19 software. The statistical differences were considered significant at $p<0.05$.

RESULTS AND DISCUSSIONS

Data regarding the efficacy of the evaluated herbicides on the 14th, 28th, and 56th day after treatment are presented in Tables from 1 to 6. On the 14th day after herbicide application against the corn chamomile, an efficacy of 50 to 80% was reported (Table 1). An efficiency of 50% was recorded only in variant 2 (Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}). At the next reporting date, the efficacy increased and reached 90-98% on average for the period.

On the last reporting date, the efficacy reached excellent values - 98-100%. The results obtained showed that the corn chamomile can be controlled by all herbicides evaluated in the study.

On the 14th day after the herbicide application against common poppy, low efficacy was reported after the application of Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1} (Table 2). Efficacy of 50-78% was established.

On the next reporting date, the efficiency increases and reaches 83-88% on average for the period.

At the last reporting date, the efficiency reached values of 93-100% on average for the period. The results show that common poppy can be controlled from all herbicidal products.

On the first reporting date after the herbicide treatment, low efficiency for the cleavers was reported - from 53 to 85% (Table 3). At the next reporting date, the efficiency increases and reaches 88-93%.

On the last reporting date, the efficiency reaches higher values - 93-100% in all variants on average for the period. The results show that the cleavers is more difficult-to-control than the corn chamomile and the common poppy.

Table 4 presents the efficacy of the tested herbicides against field larkspur. At the first reporting date, an efficacy of 45 to 93% was reported. As on the 14th day, the efficiency is the lowest for Biathlon 4D + Dash (45% average for the period). At the next reporting date, efficiency increased and reached higher values.

At the last reporting date, the efficiency reached 93-98% on average for the period.

At the first reporting date after herbicide treatment against wild mustard, an efficacy of 78 to 90% was reported (Table 5). On the next reporting date, the efficiency increased and reached 88-98%. At the last reporting date, the efficiency reaches values of 100%.

The results show that field mustard is 100% controlled by all studied herbicide products applied for the purposes of the experiment.

In both years of the trial, no visual signs of phytotoxicity to the crop were found for any of the evaluated herbicidal products.

Table 1. Herbicidal efficacy against *A. arvensis* on the 14th, 28th, and 56th day, %

Treatments	2019			2020			Average		
	14	28	56	14	28	56	14	28	56
1. Untreated control	-	-	-	-	-	-	-	-	-
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	55	95	100	45	85	95	50	90	98
3. Mustang - 800 ml ha^{-1}	75	90	100	85	95	100	80	93	100
4. Sekator OD - 150 ml ha^{-1}	75	95	100	85	90	100	80	93	100

Table 2. Herbicidal efficacy against *P. rhoeas* on the 14th, 28th, and 56th day, %

Treatments	2019			2020			Average		
	14	28	56	14	28	56	14	28	56
1. Untreated control	-	-	-	-	-	-	-	-	-
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	55	90	100	45	95	100	50	93	100
3. Mustang - 800 ml ha^{-1}	80	85	95	75	90	95	78	88	95
4. Sekator OD - 150 ml ha^{-1}	65	85	95	55	80	90	60	83	93

Table 3. Herbicidal efficacy against *G. aparine* on the 14th, 28th, and 56th day, %

Treatments	2019			2020			Average		
	14	28	56	14	28	56	14	28	56
1. Untreated control	-	-	-	-	-	-	-	-	-
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	55	90	95	50	95	100	53	93	100
3. Mustang - 800 ml ha^{-1}	55	85	100	90	95	100	85	90	98
4. Sekator OD - 150 ml ha^{-1}	70	80	90	75	95	100	70	90	98

Table 4. Herbicidal efficacy against *C. regalis* on the 14th, 28th, and 56th day, %

Treatments	2019			2020			Average		
	14	28	56	14	28	56	14	28	56
1. Untreated control	-	-	-	-	-	-	-	-	-
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	50	85	95	40	95	95	45	93	98
3. Mustang - 800 ml ha^{-1}	85	95	100	85	85	90	83	85	93
4. Sekator OD - 150 ml ha^{-1}	90	95	100	75	90	95	70	88	95

Table 5. Herbicidal efficacy against *S. arvensis* on the 14th, 28th, and 56th day, %

Treatments	2019			2020			Average		
	14	28	56	14	28	56	14	28	56
1. Untreated control	-	-	-	-	-	-	-	-	-
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	80	90	100	75	85	100	78	88	100
3. Mustang - 800 ml ha^{-1}	95	100	100	85	95	100	90	98	100
4. Sekator OD - 150 ml ha^{-1}	90	95	100	80	90	100	85	93	100

In Table 6 are shown the results for the height of the winter wheat plants at the end of the growing season. The lowest were the plants from the untreated control - 73.43 cm on average for the study period. On average for the period, all variants in which herbicide treatment was carried out were higher - from 87.32 to 88.03 cm.

Table 6. Plant height at the end of the vegetation, cm

Treatments	2019	2020	Average
1. Untreated control	76.35 b	70.50 c	73.43
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	88.71 a	86.36 b	87.54
3. Mustang - 800 ml ha^{-1}	88.90 a	87.15 a	88.03
4. Sekator OD - 150 ml ha^{-1}	88.58 a	86.98 ab	87.78

Values with different letters are with proved differences according to Duncan's multiple range test ($p < 0.05$).

The highest yield was reported in variants 2 (Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}) and 4 (Mustang - 800 ml ha^{-1}) 8.53 and 8.35 t ha^{-1} respectively average for the trial period. After the treatment, Secator OD - 150 ml ha^{-1} the yields were also high - 8.12 on average for the period.

The yield from the control treatment was the lowest for the experimental conditions - 5.75 t ha^{-1} (Table 7).

Table 7. Winter wheat grain yield, t ha^{-1}

Treatments	2019	2020	Average
1. Untreated control	5.17 c	6.33 c	5.75
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	8.15 a	8.91 a	8.53
3. Mustang - 800 ml ha^{-1}	8.24 a	8.45 a	8.35
4. Sekator OD - 150 ml ha^{-1}	7.70 b	8.09 b	7.89

Values with different letters are with proved differences according to Duncan's multiple range test ($p < 0.05$).

Absolute seed mass is a very important quality indicator (Mehmood et al., 2014). The results for this indicator are presented in Table 8. The lowest values for the absolute seed mass were found to be for the untreated control - 41.95 g on average for the period. All treated variants had higher results with a proven difference compared to the untreated control. The lowest absolute seed mass among the herbicide-treated variants was variant 4 (Secator OD - 150 ml ha^{-1}) - 46.09 g on average for the experimental period.

Table 8. Absolute seed mass, g

Treatments	2019	2020	Average
1. Untreated control	42.28 c	41.61 c	41.95
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	46.36 a	47.18 a	46.77
3. Mustang - 800 ml ha-1	46.75 a	47.06 a	46.91
4. Sekator OD - 150 ml ha^{-1}	45.89 b	46.29 b	46.09

Values with different letters are with proved differences according to Duncan's multiple rage test ($p < 0.05$).

Table 9. Hectoliter seed mass, g

Treatments	2019	2020	Average
1. Untreated control	71.80 b	72.30 b	72.05
2. Biathlon 4D - 50 g ha^{-1} + Dash - 1.00 l ha^{-1}	77.50 a	77.20 a	77.35
3. Mustang - 800 ml ha-1	77.10 a	77.40 a	77.25
4. Sekator OD - 150 ml ha^{-1}	77.30 a	77.50 a	77.40

Values with different letters are with proved differences according to Duncan's multiple range test ($p < 0.05$).

The hectoliter mass of seeds is determined by the size of the grains, the presence of impurities, etc (Tonev et al., 2018). The lowest hectoliter seed mass for the untreated control was found - 72.05 kg (Table 9). The indicator for the other treatments varied from 77.25 - 77.40 on average for the period.

CONCLUSIONS

The experimental field was infested with 6 broadleaf weed species, typical for the winter wheat fields corn chamomile (*Anthemis arvensis* L.), common poppy (*Papaver rhoeas* L.), cleavers (*Galium aparine* L.), wild mustard (*Sinapis arvensis* L.), and field larkspur (*Consolida regalis* Gray).

In the treated variants, high herbicidal efficacy was found against *A. arvensis*, *P. rhoeas*, *G. aparine*, *S. arvensis,* and *C. regalis*.

No visual signs of phytotoxicity to the crop were found for any of the herbicides tested.

All studied parameters, such as plant height at the end of the growing season, absolute and hectoliter seed mass, as well as yields, were higher in all treated variants compared to untreated control.

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