Scientific Papers. Series A. Agronomy, Vol. LX, 2017
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

OPPORTUNITIES FOR SINGLE AND COMBINE APPLICATION OF HERBICIDES AT WINTER WHEAT

Anyo MITKOV, Mariyan YANEV, Nesho NESHEV, Tonyo TONEV

Agricultural University of Plovdiv, 12 Mendeleev Blvd., 4000 Plovdiv, Bulgaria, 4000

Corresponding author email: n_neshev85@abv.bg

Abstract

A field trial with winter wheat (Triticum aestivum L.), variety "Enola" was conducted in 2015. The trial was state don the experimental field of the Dobroudja Agricultural Institute, General Toshevo, Bulgaria.
The study was performed by the randomized block designin 4 replications. Theaim of the study was to establish the opportunities for singleand combine application of herbicides for weed management at winter wheat. The efficacy of the following 6 herbicides applied alone and in combinations was evaluated: Derby Super (150.2 g/kg florasulam + 300.5 g/kg aminopyralid-potassium), Secator OD (100 g/l amidosulphuron + 25 g/l iodosulfuron + 250 g/l mefenpyr-diethyl), Maton 600 EC (600 g/l 2.4 D ester), Pallas 75 WG (75 g/kg pyroxsulam), Hussar Max OD (7.5 g/l mezosulfuron + 7.5 g/l iodosulfuron + 22.5 g/l mefenpyr-diethyl) and Puma Super 7.5 EW (69 g/l fenoxaprop-p-ethyl + antidot). The herbicides were applied in the spring at phenophase end of tillering – beginning of spindling of the winter wheat (BBCH 29-31). The efficacy of the studied products was recorded by the 10 score visual scale of EWRS (European Weed Research Society). The obtained results were compared with un treated control. The selectivity of the single and combine application of herbicides against the wheat was established by the 9 score scale for phytotoxicity of EWRS. At the particular weed infestation the highest herbicide efficacy and the highest yield (5.78 t.ha^{-1}) were recorded at the variant with combine application of Pallas 75 WG + Derby Super.

Key words*: winter wheat, weed management, herbicides, selectivity, efficacy.*

INTRODUCTION

The effective weed control at winter field crops is a main part of successful and profitable agriculture production. The weeds concur the crops for water, nutrients and light that lead to yield decrease (Brookeand McMaster, 2016). The high weed infestation at winter wheat (*Triticum aestivum* L.) can decrease the yields up to 70% (Tonev et al., 2007; Tonev et al., 2011). In dependence of the crop management and the climatic conditions, the different weed species can bein different density and are forming different weed associations (Dimitrov et al., 2016). In modern agriculture the weed control is performed mainly by chemical means. The choice of proper herbicide, optimal time and rate of application are one of the most important and responsible moments for the winter wheat agrotechnique (Sherawatand, 2005). To solve the problem of weed infestation at winter wheat large numbers of trials are conducted. After the application of the herbicide combination Derby Super (150 g/kg florasulam + 300.5 g/kg aminopyralid-potassium (33 g ha^{-1}) + Puma Super (69 g/l fenoxaprop-p-ethyl) (1000 ml ha^{-1}) 90% of the broad leaf and 83.3% of the grass weeds were controlled, and for the concrete variant the highest yield was achieved 5.568 t ha^{-1} (Delibaltova et al., 2009). Semenovetal (2009) established that the biggest part of the resistant dicotyledonous weeds at winter wheat and barley are controlled by the herbicide products Logran (riasulfuron), Magnum (prosulfuron) and Secator (amidosulfuron + iodosulfuron). For control of *Descurainiasophia, Capsella bursa-pastoris and Galiumaparine* in wheat the herbicides fluroxypyr + carfentrazone-ethyl, florasulam+carfentrazone-ethylcan be applied (Wang et al., 2016).
The aim of the study was to establish the opportunities for single and combine application of herbicides at winter wheat.

MATERIALS AND METHODS

In 2015 a field trail with the winter wheat variety "Enola" was conducted. The trial was stated on the experimental field of the Dobroudja Agriculture Institute, General Toshevo, Bulgaria.

The efficacy of the following six herbicides applied alone and in combinations was evaluated: DerbySuper WG (150.2 g/kg florasulam + 300.5 g/kg aminopyralid), Secator OD (100 g/l amidosulphuron + 25 g/l iodosulfuron + 250 g/l mefenpyr-diethyl), Maton 600 EC (600 g/l 2.4 D ester), Pallas 75 WG (75 g/kg pyroxsulam), HussarMax OD (7.5 g/l mezosulfuron + 7.5 g/l iodosulfuron + 22.5 g/l mefenpyr-diethyl) and PumaSuper 7.5 EW (69 g/lfenoxaprop-p-ethyl + antidot). The study was performed by the randomized block design in 4 replications. The size of the harvesting plots was 25 m². On the trial field six typical weed specimens were recorded: common poppy (*Papaver rhoeas* L.), corn chamomile (*Anthemis arvensis* L.), charlock-mustard (*Sinapis arvensis* L.), creepingthistle (*Cirsium arvense* L.), wild oat (*Avena fatua* L.) and bromes (*Bromus arvensis* L.).

Table 1. Variants of the trial

1. Derby Super WG - 33 g ha^{-1}
2. Secator OD– 100mlha^{-1}
3. Maton600 EK– 1500ml ha^{-1}
4. Pallas 75 WG – 250g ha^{-1}
5. Hussar Max OD - 1000 ml ha^{-1}
6. Puma Super 7.5 EW – 1000ml ha^{-1}
7. Pallas 75 WG + Maton 600 EK - 250 g ha^{-1} + 1500 ml ha^{-1}
8. Pallas 75 WG + Derby Super WG- 250g ha^{-1} + 33 g ha^{-1}
9. Secator OD + Puma Super 7,5 EW - 100ml ha^{-1} + 1000ml ha^{-1}
10. Untreted control

The studied herbicide products were applied at the registered rates in Bulgaria. The applications were done in spring at phenophase of the crop tillering-beginning of spindling - BBCH 29-31. The spray solution was 300 l ha^{-1}. The herbicide efficacy was reported three times during the vegetation - on 14th, 28th and 56th day after treatments. For evaluating of the efficacy the 10 score scale of EWRS (European Weed research Society) was used. For evaluation of the selectivity of the products the 9 score scale for phytotoxicity of EWRS was used (at score 0 - there is not damage on the crop, andat score 9 the crop is totally destroyed). The obtained data was compared with untreated control. The grain yield was recorded by harvesting the whole plot from each variant. After harvesting the four plots the grain yields were recalculated to yields per hectare.

RESULTS AND DISCUSSIONS

The average density of the existing weeds on the experimental field was as follows: common poppy - 4, corn chamomile - 4; charlock-mustard - 8; creeping thistle - 4; wild oat - 5 and bromes 10 specimens per 1 m^2.

On table 2 is shown the efficacy of the studied herbicides against the common poppy (*P. rhoeas*). The weed was very successfully controlled by the herbicide products Derby Super WG, Secator OD and Hussar Max. From the 14th day after treatments to the end of the vegetation, the efficacy of these herbicides was 100%. The efficacy of the product Maton 600 EK was with low efficacy (50%). The most unsatisfactory efficacy (from 20 to 40%) against the poppy was recorded after the treatment with Pallas 75 WG. Puma Super showed 0% efficacy, because the mode of action of the active substance (fenoxaprop-p-ethyl) is only against the grass weeds. The efficacy of the combine application of Pallas 75 WG + Maton 600 EK was even lower than the results recorded after the alone application of the both products. This was probably due to antagonism of the active substancec of the herbicide products (pyroxsulam + 2.4 D ester). For the combinations of Pallas 75 WG + Derby Super and Secator OD + Puma Super there was a synergism observed and the efficacy was 100%.

The herbicide products Derby Super WG, Secator OD and Hussar Max showed 100% efficacy against corn chamomile (*A.arvensis*) at the three dates of reporting (Table 3). A lot of studies have been performed for establishing the efficacy of different herbicides against the broadleaf weeds. The results showed high efficacy of amidosulfuron + iodosulfuron (Secator 6.25 WG; Secator andSekator Progress) against the corn chamomile and other broadleaf weeds (Adamczewski and Miklaszewska, 2001; Sorokaand Soroka, 2003; Vilau, 2010).In our study, after the treatments with Maton600 EK unsatisfactory efficacy against the corn chamomile was recorded. That was due to resistance of the weed to the active substance of the herbicide product. Puma Super

7.5 EW has grass weed control spectrum that was the reason for the 0% efficacy for this variant. At the combine application of Pallas 75 WG + Maton 600 EK the efficacy against the corn chamomile decreasedto 70 – 75%. This indicates that the active substances of the herbicide products (piroksulam and 2.4 D) should not be combined because of the observed antagonism. At the variant with combine usage ofPallas 75 WG + Derby Super WG and Secator OD + Puma Super 7.5 EW 100% efficacy was recorded (Table 4). These combinations should not be performed, because if on the field the control is only against this weed, the cost of production will be increased rapidly.

In our trial conditions, secondary infestation with corn chamomile was not observed. This was probably due to the fact that winter wheat hadvery competitive abilities with the weed at time of phenophases spindling and ear formation. That led tolimitedliving space for a new germination of the weed.

The lowest efficacy from all evaluated herbicides was observed for the root sprouting weed creeping thistle (*C. arvense*). After the treatment with Pallas 75 WG the efficacy against the weed varied from 75 to 80%, but on the last reporting date, secondary growth of the thistle was recorded (Table 5). For the alone application of Derby Super WG and Secator OD sustainable efficacy against the creeping thistle was reported - from 85 to 90% on the 14^{th} and 100% on the 28^{th} day after treatments. On the 56^{th} day the efficacy was decreased with 10%. The efficacy of Hussar Max ODwas 85%. The lowest efficacy against the weed was recorded for the variant treated with Maton 600 EK65 - 70%. For this variant the secondary growth was 30-35%. At the combine usage of Pallas 75 WG + Maton 600 EK the efficacy was decreased to 55 - 60%. After the combination of Pallas 75 WG + Derby Super WG, the active substances were synergetic and were very effective for the control of this root sprouting weed - to 100%. The efficacy of the combination of Secator OD + Puma Super 7.5 EW was also excellent – 100%.

Against the wild oat (*A. fatua*) was not observed efficacy of the herbicide products Derby Super WG, Secator OD and Maton 600 EK. On Table 6 is shown that the herbicide products Pallas 75 WG and Hussar Max OD, that have mixed mode of action, had approximately equal efficacy against this grass weed. The efficacy of both products was sharply decreased when the weed started phenophase spindling. In a trial conducted by Aslam et al. (2007) the efficacy of Puma Super had 80% efficacy against the grass weeds. In our experiment Puma super showed excellent efficacy against the weed 90-100%. After combining Pallas 75 WG with Maton 600 EK unsatisfactory efficacy was reported.

Pallas 75 WG was the most efficient against the bromes (B.arvensis) - 100% (Table 7). Hussar Max OD showed very low efficacy - 40 – 60%. Derby Super WG, Secator OD, Maton 600 EKand Puma Super 7.5 EW had 0% efficacy against this weed. The tank mixture of Pallas 75 WG + DerbySuper WG showed excellent 100% efficacy against the bromes.

On Table 8 are shown the winter wheat grain yields. Because of the concurrent relationship of the crop plants with the weeds, the yields from the untreated control (2.34 t ha^{-1}) and the variant treated only with Puma Super 7.5 EW (2.33t ha^{-1}) were the lowest. By degree of statistical provement 5 treatment groups were formed (a,b,c,d,e). It was recorded that the treatment with Pallas 75 WG + Derby Super WG was from group (e) and had the highest yields in the study - 5.78t ha^{-1}. The yield from the variants treated Derby Super WG and Secator OD were lower. After the treatments with Maton 600 EK alone or in combination the yields were more decreased.

Table 2. Efficacy (%) of the studied herbicides against the common poppy (*P. rhoeas*)

Treatments	Days after treatments		
	14 day	28 day	56 day
Derby Super WG	100	100	100
Secator OD	100	100	100
Maton 600 EK	50	50	45
Pallas 75 WG	20	30	40
Hussar MaxOD	100	100	100
Puma Super 7.5 EW	0	0	0
Pallas 75 WG + Maton 600 EK	20	25	25
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	100	100	100

Table 3. Efficacy (%) of the studied herbicides against the corn chamomile (*A. arvensis*)

Treatments	Days after treatments		
	14 day	28 day	56day
Derby Super WG	100	100	100
Secator OD	100	100	100
Maton 600 EK	40	35	30
Pallas 75 WG	100	100	100
Hussar Max OD	100	100	100
Puma Super 7.5 EW	0	0	0
Pallas 75 WG + Maton 600 EK	70	70	75
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	100	100	100

Table 4. Efficacy (%) of the studied herbicides against the charlock mustard (*S. arvensis*)

Treatments	Days after treatments		
	14 day	28day	56day
Derby Super WG	100	100	100
Secator OD	100	100	100
Maton 600 EK	100	100	100
Pallas 75 WG	100	100	100
Hussar Max OD	100	100	100
Puma Super 7.5 EW	0	0	0
Pallas 75 WG + Maton 600 EK	80	80	85
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	100	100	100

Table 5. Efficacy (%) of the studied herbicides against the creeping thitle (*C. arvense*)

Treatments	Days after treatments		
	14 day	28day	56day
Derby Super WG	85	100	90
Secator OD	85	100	90
Maton 600 EK	70	70	65
Pallas 75 WG	75	80	75
Hussar Max OD	90	85	85
Puma Super 7.5 EW	0	0	0
Pallas 75 WG + Maton 600 EK	55	60	60
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	100	100	100

Table 6. Efficacy (%) of the studied herbicides against the wild oat (*A. fatua*)

Treatments	Days after treatments		
	14 day	28day	56day
Derby Super WG	0	0	0
Secator OD	0	0	0
Maton 600 EK	0	0	0
Pallas 75 WG	80	100	100
Hussar Max OD	85	90	100
Puma Super 7.5 EW	90	95	100
Pallas 75 WG + Maton 600 EK	70	70	70
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	100	100	100

Table 7. Efficacy (%) of the studied herbicides against the bromes (*B.arvensis*)

Treatments	Days after treatments		
	14 day	28 day	56day
Derby Super WG	0	0	0
Secator OD	0	0	0
Maton 600 EK	0	0	0
Pallas 75 WG	100	100	100
Hussar Max OD	40	60	60
Puma Super 7.5 EW	0	0	0
Pallas 75 WG + Maton 600 EK	65	70	70
Pallas 75 WG + Derby Super WG	100	100	100
Secator OD + Puma Super 7.5 EW	0	0	0

Table 8. Winter wheat grain yield, t ha^{-1}

Treatments	Yields	ByDuncan
Derby Super WG	4,90*	c
Secator OD	4,90*	c
Maton 600 EK	3.55*	b
Pallas 75 WG	5.22*	d
Hussar Max OD	5.20*	d
Puma Super 7.5 EW	2.33	a
Pallas 75 WG + Maton 600 EK	3.56*	b
Pallas 75 WG + Derby Super WG	5.78*	e
Secator OD + Puma Super 7.5 EW	5.22*	d
Untreated control	2.34	a

All variants with star (*) do not have considerable difference with the untreated control.

CONCLUSIONS

Hussar Max OD prevailed Pallas 75 WG with the efficacy against the common poppy. Pallas 75 WG was more efficient for control of the bromes.

Derby Super WG and Sec OD showed higher efficacy against the common poppy, corn chamomile and creeping thistle.

The herbicide product Puma Super 7.5 EW had efficacy only against the wild oat. That was the reason for the lowest grain yields among the all treated variants of the trail - 2.33 t ha^{-1}. The grain yield of this variant was even lower from the yield of the untreated control - 2.34 t ha^{-1}.

After the application of the herbicide products that control both grass and broadleaf weeds – Pallas 75 WG and Hussar Max WG, the grain yields were higher in comparison with the applied herbicide products that control only broadleaf weeds – Derby Super WG, Secator OD and Maton 600 EK.

The highest grain yield in the study was recorded after the combine application of Pallas

75 WG + Derby Super WG – 5.78 t ha^{-1}, followed by Secator OD + Puma Super 7.5 EW – 5.22 t ha^{-1}).

After the combine treatment of the products Pallas 75 WG + Maton 600 EK the obtained grain yield (3.55 t ha^{-1}) which was 32% lower in comparison with the yield of the variant treated only with Pallas 75 WG (5.22 t ha^{-1}).

REFERENCES

Aslam M., Hussain M., Hussain G., Rashid A., 2007. Efficacy of Herbicides for Weed Control in Wheat crop. Pak. J. Weed Sci. Res. 13 (1-2). p. 1-7.

Adamczewski K., Miklaszewska K., 2001. Evaluation of iodosulfuron and amidosulfuron mixture to control broad-leaved weeds in winter and spring cereals. Journal of Plant Protection Research 41 (2) Poznan: InstytutOchronyRoślin (Institute of Plant Protection), 101-108.

Brooke G., McMaster C., 2016. Weed control in winter crops. NSW DPI Management Guide. 132 pp. http://www.dpi.nsw.gov.au.

Delibaltova V., Zheljazkov I., Tonev T., 2009. Effect of some herbicides on the weeds and productivity of the *Triticum aestivum* L., winter wheat. Agricultural Sciences, Volume I, Issue 2, pp. 19-24.

Dimitrov Ya., Dimitrova M., Palagacheva Ne., Vitanova M., Yordanova Ne., Minev N., 2016. Wheat and Barley. Pests, Diseases, Weeds, Fertilization. Academic Publisher: Videnov and Son. 172 pp (In Bulgarian).

Semenov D., Galapova V., Vasilev A., 2009. Sulfonylurea herbicides in crops of barley and winter wheat. Zashchitai Karantin Rastenii (3) Moscow: Izdatel'stvoKolos, 31

Sherawat I., Ahmad M., 2005. Bio-efficacy of different graminicides and their effect on the growth and yield of wheat crop. International Journal of Agriculture & Biology, 7, (6) 438-440.

Soroka S.V., Soroka L. I., 2003. Chemical weeding is also required in the autumn. Belorusskoe Sel'skoe Khozyaistvo (9) Minsk: Ministerstvo Sel'skogo Khozyaistvai Prodovol'stviya Minsk, 18-19.

Tonev T., Dimitrova M., Kalinova Sht., Zhalnov I., Spasov V., 2007. Herbology (Textbook). Academic publisher of Agricultural University of Plovdiv. (In Bulgarian).

Tonev T., Tityanov M., Vasilev A., 2011. Guide to Integrated Weed Management and Proficiency of Agriculture. Publisher: "Biblioteka Zemedelsko Obrazovanie". 108 pages.

Vilau F., Vilau N., Rosculete C.A., Mutafa I., 2010. Research concerning wheat crop weed control and herbicide influence on bread quality. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series 40 (1) Craiova: Faculty of Agriculture, University of Craiova, 251-254

WangCang S., QianQian Z., Ren Hai W., Fei X., Chang'an M. Jun J., YaFang Q., ChuanTao Lu, 2016. Control effect of several herbicides and mixtures on broadleaf weeds in wheat field. Journal of Henan Agricultural Sciences 45 (5) Zhengzhou: Henan Agricultural Sciences, 106-110.