

EVALUATION OF LOW HERBICIDE RATES OF GARDOPRIM® PLUS GOLD 550 SC AND SPECTRUM® 720 EC AT CONVENTIONAL SUNFLOWER (*Helianthus annuus* L.)

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Abstract

The aim of the study is to evaluate the efficacy of the herbicide products Gardoprim® Plus Gold 550 SC (312.5 g/l s-metolachlor + 187.5 g/l terbuthylazine) and Spectrum® 720 EC (720 g/l dimethenamid-p) in low rates. The field trial was conducted in 2016 and 2017 with the conventional sunflower hybrid P64 LL 125. The experiment was stated in the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The trial was conducted by the randomised block design in 4 replications, and the efficacy was recorded by the 10 score visual scale of EWRS. The usage of tank mixtures of both studied herbicides lead to increased efficacy against some dicotyledonous weeds as *Solanum nigrum* L., *Abutilon theophrasti* L. and *Amaranthus retroflexus* L. Average for the period, for the treatments with Gardoprim® Plus Gold 550 SC in rate of 4000 ml ha⁻¹ and the tank mixture of the herbicides the highest seed yields are recorded - 2.00 and 1.90 t ha⁻¹, respectively.

Key words: sunflower, weeds, herbicides, low rates, efficacy.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the main oilseed crop in Bulgaria. In 2016, the harvested area of this crop was 817511 ha with an average yield of 2248 kg ha⁻¹ (www.mzh.government.bg). In order to achieve high yields, along with the optimization of the main vegetation factors, it is necessary to effectively control the weeds.

A number of authors have been investigating the weed infestation of the sunflower fields. The most important weed species occurring in sunflower crops in Slovakia are *Agropyron repens*, *Iva xanthiifolia*, *Echinochloa crus-galli*, *Chenopodium album*, *Chenopodium hybridum*, *Amaranthus* spp., *Abutilon theophrasti*, *Datura stramonium*, *Convolvulus arvensis*, *Panicum miliaceum*, *Cirsium arvense*, *Fallopia convolvulus*, *Persicaria* spp. and *Polygonum* spp. (Týr and Vavřík, 2015). In Hungary, the most common weeds in this crop are *Ambrosia artemisiifolia*, *Chenopodium album*, *Convolvulus arvensis*, *Xanthium italicum*, *Echinochloa crus-galli*, *Panicum miliaceum* ssp. *ruderales* and *Setaria pumila* (Pinke and Karácsony, 2010). In Serbia, the main weed species occurring in the sunflower

are *Amaranthus retroflexus* L., *Ambrosia artemisiifolia* L., *Bilderdykia convolvulus* L., *Cirsium arvense* L., *Chenopodium album* L., *Convolvulus arvensis* L., *Datura stramonium* L., *Echinochloa crus-galli* L., *Hibiscus trionum* L., *Polygonum aviculare* L., *Polygonum lapathifolium* L., *Polygonum persicaria* L., *Setaria glauca* L., *Setaria viridis* L., *Sinapis arvensis* L., *Solanum nigrum* L., *Sorghum halepense* (L.) Pers., *Stachys annua* L. and *Xanthium strumarium* L. (Konstantinovic et al., 2010).

In Bulgaria, the most common weeds in the sunflower fields are *Amaranthus* spp., *Sinapis arvensis* L., *Chenopodium album* L., *Cannabis ruderalis* Janisch, *Setaria* spp., *Echinochloa crus-galli* L., *Sorghum halepense* (L.) Pers., *Cirsium arvense* Scop., *Convolvulus arvensis* L., some new races of *Orobanche cumana* Wallr. etc. (Tonev et al., 2010; Manilov and Zhalnov, 2015). In the region of the cities of Plovdiv and Stara Zagora, Bulgaria it is found that in the sunflower fields *Amaranthus blitoides* L. and *Amaranthus albus* L. occupy much of the total weed infestation with annual weeds. The authors report that the most common perennial weeds is *Convolvulus arvensis* L. (Moskova et al., 2016).

The weed control in sunflower should be performed in the early phenophases of the crop. Reddy et al. (2012) reported that s-metolachlor + sulfentrazone (Broadaxe) imported 21 days before sowing or pre-emergence at 1100 g ha⁻¹ controls *Amaranthus palmeri* S. Wats. and *Kochia scoparia* (L.) Schrad. by 95% and 100%, respectively. Good to excellent control (81-100%) against broadleaf weeds in sunflower is achieved after soil application of oxyfluorfen (Sharoxy 24% EC) (Osman et al., 2014). For the simultaneous control of grass and broadleaf weeds, Pannacci et al. (2007) recommend s-metolachlor + aclonifen and s-metolachlor + oxyfluorfen.

Tonev et al. (2010) found that pendimethalin (Stomp New) controls annual weeds. Oxyfluorfen (Goal 2E) has excellent broadleaf weed control and limited grass weed control efficacy. The tank mixture of s-metolachlor + terbuthylazine (Gardoprim Plus Gold) has higher efficacy against the grass and the broadleaf weeds (Tonev et al., 2010).

With sufficient soil moisture, the herbicides Stop Aqua, Gardoprim Plus Gold, Wing-P, and Pledge 50 had very good control over the annual weeds except for *Xanthium strumarium* L. (Manilov and Zhalnov, 2015).

The aim of the study is to evaluate the efficacy of the herbicide products Gardoprim[®] Plus Gold 550 SC and Spectrum[®] 720 EC applied in low rates.

MATERIALS AND METHODS

The trial is conducted by the randomized block design in 4 replications. The size of the experimental plot is 28 m². The conventional sunflower hybrid P64 LL 125 is grown. Variants of the trial are: 1. Untreated control; 2. Gardoprim[®] Plus Gold 550 SC - 4000 ml ha⁻¹; 3. Gardoprim[®] Plus Gold 550 SC - 3200 ml ha⁻¹; 4. Spectrum[®] 720 EC - 1200 ml ha⁻¹; 5. Gardoprim[®] Plus Gold 550 SC + Spectrum[®] 720 EC - 3200 + 800 ml ha⁻¹ (tank mixture). Gardoprim[®] Plus Gold 550 SC contains 312.5 g/l s-metolachlor + 187.5 g/l terbuthylazine, and Spectrum[®] 720 EC - 720 g/l dimethenamid-p. The experiment is stated on the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The sowing is

performed in the optimal time for the region. Predecessor of the sunflower is winter wheat - for both experimental years. On the trial field deep ploughing, two times disc harrowing and two times cultivation before sowing are done. Basic combine fertilization with 250 kg ha⁻¹ NPK 15: 15: 15 and spring dressing with 200 kg ha⁻¹ NH₄NO₃ is performed. The herbicide treatment is applied after sowing before germination of the crop (BBCH 00). The efficacy of the studied herbicides is recorded by the 10 score visual scale of EWRS (European Weed Research Society) on the 14th, 28th and 56th day after application. The selectivity by the 9 score scale of EWRS is evaluated (at score 0 there are not damages on the crop, and at score 9 the crop is completely destroyed). The weed infestation is presented by *Sorghum halepense* (L.) Pers. (developed from rhizomes), *Sorghum halepense* (L.) Pers. (developed from seeds), *Echinochloa crus-gali* L., *Setaria viridis* L., *Chenopodium album* L., *Amaranthus retroflexus* L., *Xanthium strumarium* L., *Abutilon theophrasti* Medik., *Datura stramonium* L. and *Solanum nigrum* L.

RESULTS AND DISCUSSIONS

The results during both experimental years are corresponding. On the 14th day after the treatments, the highest efficacy against the *S. halepense* developed from seeds, *E. crus-gali*, *S. viridis*, *Ch. album*, *A. theophrasti*, *D. stramonium* and *S. nigrum* was recorded for variant 2, followed by variant 5 (Table 1). The efficacy of Spectrum[®] 720 EC against the species of *C. album*, *D. stramonium*, *A. theophrasti* and *S. nigrum* was the lowest. No efficacy against *S. halepense* developed from rhizomes, for any of the treatments was reported. The results against *X. strumarium* was similar.

On the 28th day after the treatments a decrease of the herbicide efficacy in comparison with the efficacy on the 14th day was recorded. For both experimental years, the highest herbicide efficacy (85-100%) against *S. halepense* developed from seeds was recorded on this reporting date. Very good to excellent efficacy against *A. retroflexus* for the treatment of Gardoprim[®] Plus Gold at the rate of 4000 ml ha⁻¹ was observed (Table 2). For all

treatments, the lowest herbicide efficacy against *C. album* and *D. stramonium* was recorded. The efficacy against *X. strumarium* and *S. halepense* developed from rhizomes was null.

On the 56th day after treatment, there was a high secondary infestation with a *C. album*. Low efficacy against *C. album*, *S. viridis*, *A. theophrasti* and *D. stramonium* was reported (Table 3). For both years satisfactory efficacy was found against *S. halepense* developed from seeds and *A. retroflexus*.

The results for the obtained sunflower seed yield showed that during the two experimental

years there are significant differences between the treated variants and the untreated control (Table 4). By Duncan's multiple range tests was found that the highest seed yield for the treatments with Gardoprim® Plus Gold 550 SC - 4000 ml ha⁻¹ (variant 2) and Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha⁻¹ (tank mixture). The lowest yield was obtained from the alone treatment of Spectrum® 720 EC at rate 1200 ml ha⁻¹, but it is statistically different from the yield reported for the untreated control.

Table 1. Efficacy of the studied herbicides on the 14th day after application (%)

Variants	2016					2017				
	1	2	3	4	5	1	2	3	4	5
Weeds										
<i>S. halepense</i> (rhizomes)	-	0	0	0	0	-	0	0	0	0
<i>S. halepense</i> (seeds)	-	90	90	90	95	-	100	95	95	95
<i>E. crus-gali</i>	-	80	60	60	65	-	90	75	75	80
<i>S. viridis</i>	-	85	65	65	70	-	95	80	80	85
<i>C. album</i>	-	70	55	40	60	-	75	50	25	60
<i>A. retroflexus</i>	-	95	90	75	95	-	100	100	90	100
<i>X. strumarium</i>	-	0	0	0	0	-	5	0	0	5
<i>A. theophrasti</i>	-	90	80	30	90	-	80	65	15	75
<i>D. stramonium</i>	-	75	50	35	60	-	70	45	30	55
<i>S. nigrum</i>	-	100	90	40	90	-	90	80	35	80

Table 2. Efficacy of the studied herbicides on the 28th day after application (%)

Variants	2016					2017				
	1	2	3	4	5	1	2	3	4	5
Weeds										
<i>S. halepense</i> (rhizomes)	-	0	0	0	0	-	0	0	0	0
<i>S. halepense</i> (seeds)	-	90	85	85	90	-	100	90	90	90
<i>E. crus-gali</i>	-	60	45	55	65	-	75	60	70	80
<i>S. viridis</i>	-	65	50	60	70	-	80	65	75	85
<i>C. album</i>	-	50	20	20	45	-	60	20	10	50
<i>A. retroflexus</i>	-	90	70	60	80	-	100	85	75	95
<i>X. strumarium</i>	-	0	0	0	0	-	0	0	0	0
<i>A. theophrasti</i>	-	85	70	20	80	-	70	55	10	70
<i>D. stramonium</i>	-	70	45	30	55	-	60	40	20	50
<i>S. nigrum</i>	-	90	80	35	85	-	80	75	30	75

Table 3. Efficacy of the studied herbicides on the 56th day after application (%)

Вариант	2016					2017				
	1	2	3	4	5	1	2	3	4	5
Weeds										
<i>S. halepense</i> (rhizomes)	-	0	0	0	0	-	0	0	0	0
<i>S. halepense</i> (seeds)	-	85	80	80	85	-	95	80	85	85
<i>E. crus-gali</i>	-	55	40	45	60	-	70	55	60	70
<i>S. viridis</i>	-	60	45	50	65	-	75	60	65	75
<i>C. album</i>	-	10	5	5	10	-	25	0	0	25
<i>A. retroflexus</i>	-	85	65	55	70	-	90	80	70	85
<i>X. strumarium</i>	-	0	0	0	0	-	0	0	0	0
<i>A. theophrasti</i>	-	55	50	5	50	-	45	40	0	40
<i>D. stramonium</i>	-	60	40	25	45	-	50	30	10	40
<i>S. nigrum</i>	-	80	70	20	70	-	75	65	20	65

Table 4. Sunflower seed yield (t ha⁻¹)

Treatments	2016	2017	Average for the period
	Yield (t ha ⁻¹)	Yield (t ha ⁻¹)	Yield (t ha ⁻¹)
1.	0.80 a	0.70 a	0.75 a
2.	2.00* d	1.90* d	1.95* d
3.	1.60* c	1.40* c	1.50* c
4.	1.10* b	1.00* b	1.05* b
5.	2.00* d	1.80* d	1.90* d

All treatments with star (*) are with proved difference with the untreated control, P < 0.05.

CONCLUSIONS

The treatment with Gardoprim® Plus Gold 550 CK at rate of 4000 ml ha⁻¹ had satisfactory herbicide efficacy against *S. halepense* (from seeds), *A. retroflexus* and *S. nigrum*.

The treatment of Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha⁻¹ in tank mixture had satisfactory efficacy against *S. halepense* (from seeds), *A. retroflexus* and *S. nigrum*.

The lowest herbicide efficacy against the dicotyledonous weeds was recorded after the alone treatment with Spectrum® 720 EC - 1200 ml ha⁻¹

The highest seed yield among the treated variants for Gardoprim® Plus Gold 550 SC - 4000 ml ha⁻¹ and Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha⁻¹ (tank mixture) was recorded. The lowest yield was obtained from the untreated control.

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