

EFFICIENCY AND SELECTIVITY OF NEW HERBICIDES ON FODDER MAIZE

Maya DIMITROVA, Ivan ZHALNOV, Ilian ZHELYAZKOV, Dimitar STOYCHEV

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

Corresponding author email: mayadimitrova30@yahoo.com

Abstract

Within the period 2011-2012 in the experimental field of the Agricultural University, Plovdiv, we conducted field experiments using the herbicides Lumux 538 SK, Gardoprim plus gold 500 SK, Wing, Merlin flex, which were applied to the soil after planting the crops and before their germination and also the herbicides Laudis OD, Elumis, Stelar, Kaspar 55 WE, which were applied to the leaves during the vegetation period of the maize. The experiments were made using the block method over an area of 21 m² in four repetitions. It has been established that the herbicides demonstrate excellent selectivity for this crop, which was measured on the EWRS scale in marks and control the existing annual late-spring types: *Amaranthus retroflexus* L., *Chenopodium album* L., *Solanum nigrum* L., *Setaria* spp., *Echinochloa crus-galli* L. and others. The weeds in the control sample without herbicides have a very high density and on the 40th day after treatment their number reaches 602 plants/m².

Key words: fodder maize, herbicides, efficiency, selectivity.

INTRODUCTION

Maize is one of the main fodder crops in our country. Pest cause serious damage to the crop (Dimitrov et al., 2012) Since weeds are the most widely distributed of late spring such as: barnyard grass (*Echinochloa crus-galli*), foxtail (*Setaria* spp.), white goosefoot (*Chenopodium album*), amaranth (*Amaranthus*), black nightshade (*Solanum nigrum*), carline thistle (*Carlina acanthifolia*), abutilon, common purslane (*Portulaca oleracea*) and others (Zhalnov, 1988; Zhelyakov, 2007).

In order to obtain optimal and high-quality yield, it is necessary to fight the weeds using appropriate herbicides (Zhelyakov, 2007; Tonev et al., 2012). Different authors state (Schulte, Steinhener, 2012; Wegener, Kunhold, 2010) that the new herbicides are tolerant to all maize hybrids grown in Europe and control a wide range of annual weeds.

Over the last few years, there has been a change in the composition of weed associations as a result of the improvement of technologies used for growing field crops. This necessitated integrating new efficient herbicides in the fight against the main weeds on maize.

MATERIALS AND METHODS

Within the period 2011-2012 in the experimental field of the Agricultural University, Plovdiv, we made field experiments using new herbicides applied into the soil after sowing and before the germination of the crop and also applied to the leaves during the vegetation period of the maize - a hybrid of Pioneer company: Kolomba (450 FAO). The sowing during the two years of the experiment was performed on 21.04.2011 and 23.04.2012. The experiments were made using the block method over an area of 21 m² in four repetitions (Table 1).

The agrotechnical activities were conducted in accordance with the commonly used technology for growing maize (processing of the soil, fertilization, sowing, rolling). The soil and leaf herbicides were applied using a knapsack sprayer and a solution of 30-40 l/dka. The efficiency of the herbicides was registered in sample areas (2 for each repetition) i.e. 8 per variant.

- for the soil herbicides - on the 28th, 40th and 56th days after spraying

- for the leaf herbicides - on the 20th and 40th days after spraying

Variants	Active substans	Dose
1. Control (K₁)-untreated and not trenched area		
2. Industrial control (K₂) – untreated with 2-3 hoeing		
3. LaudisOD	44 g/l tembotrion	200 cm ³ /dka (folair application)
4. Lumux 538 SK	375 g/l s-metolaxlor 125 g/l terbutilazin 37.5 g/l mezo-trion	400 cm ³ /dka (soil application)
5. Elumis	30 g/l nikosulfuron 75 g/l mezo-trion	200 cm ³ /dka (folair application)
6. Gardoprim plusgold 500 SK	312.5 g/l s-metolaxlor 187.5 g/l terbutilazin	450 cm ³ /dka (soil application)
7. Wing	212.5 g/l dimetenamid-P 250 g/l pendimetalin	400 cm ³ /dka (soil application)
8. Stelar	50 g/l topramezon 160 g/l dikamba	100 cm ³ /dka (folair application)
9. Kaspar 55 WG	50 g/kg prosulfuron 500 g/kg dikamba	30 g/dka (folair application)
10. Merlinflex	240 g/l izoxaflutol	42 cm ³ /dka (soil application)

The year 2011 was characterized by moderately warm and dry spring considering the small quantity of the rainfall during the winter period (in January the rainfall was far below the norm - it barely reached 24.6 l/m² compared with the year 2012 when the quantity of the rainfall was 120.2 l/m²). The summer of 2011 was very hot and the quantity of the rainfall was close to the norm.

In April 2012, the pre-sowing processing of the soil had already been performed in the conditions of extreme drought (the total quantity of the rainfall for the region in March and April barely reached 27.1 l/m²), which did not allow the growth of separate groups of weeds typical for that period. However, in May there were heavy precipitations (160.8 l/m²). This provided conditions for secondary weeding in the experimental areas and contributed to the good efficiency of the soil herbicides.

RESULTS AND DISCUSSIONS

In 2011, the experimental fields planted with maize were significantly weeded by weeds belonging to the group of annual late-spring

types causing the weeding on the maize. The main representatives of this group are the following: *Amaranthus retroflexus* L., *Solanum nigrum* L., *Chenopodium album* L., *Portulaca oleraceae* L., *Datura stramonium* L., *Setaria viridis* L., *Setaria glauca* L., *Sorghum halepense* L., *Xanthium strumarium* L., *Echinochloa crus-galli* L. and others.

In the variants treated with soil herbicides, on the 28th day after their application we registered a very good effect of the used preparations. In the zero control sample the density of the weeds reached 564 plants/m² and in the economic control sample their density reached 458 plants/m². The hoeing of this variant was performed after the first registering of the weeding (stage 5-6 leaves on the maize plant) - Table 2.

A total control of 100% was registered in the lots treated with Lumux 538 SK - 400 ml/dka, Gardoprim plus gold 500 SK - 400 ml/dka and Wing - 400 ml/dka. In the variant treated with Merlin flex in a dose of 42 ml/dka the efficiency was 96.1%.

The soil herbicides retain their efficiency up to the 40th day after spraying. In the zero control sample, the density of the weeds reached 602 plants/m². In the economic control sample (hoed once) we registered 34 plants/m², which constituted 6% compared with the zero control sample. In the lots where soil herbicides were applied, the results were the following: Lumux 538 SK – 99.8%, Gardoprim plus gold 500 SK - 99.7%, Wing - 99.3%, Merlin flex - 97.8%, which shows that they are practically free from weeds - Table 3.

A very good to excellent control over weeding was registered in the variants treated with leaf herbicides. In the zero control sample the density of the weeds on 16.06.2011 (the 20th day after spraying) was 706 plants/m². As a result of the applied leaf herbicides, it was reduced to: 8-plants/m² for Stelar in a dose of 100ml/dka (97% efficiency), 12 - plants/m² in the lots treated with Laudis OD - 200 ml/dka (96% efficiency), 28-plants/m² for Elumis - 200 ml/dka (91% efficiency) and 43-plants/m² for Kaspar 55 WG - 30 g/dka (86% efficiency) - Tables 4 and 5.

In 2012, the areas planted with maize were less weeded, which was due to the drought in April and early May. However, the weed associations

consist mainly of weeds belonging to the group of annual late-spring types mentioned above as well as some perennial types - *Sorghum halepense* Pers. The heavy precipitations within the period from the second half to the end of May (160.8 l/m²) improve the activity and the efficiency of the soil herbicides. The best control over weeds was exercised by Gardoprim plus gold 500 SK - 400 ml/dka (98%) and Lumux 538 SK - 400 ml/dka (97%) -Table 6. The efficiency of the other two herbicides Wing - 400 ml/dka and Merlin flex in a dose of 42 ml/dka on the 28th day after spraying was 94% and 93%, respectively.

In Table 7 shows the composition and the density of the weeds before being sprayed with leaf herbicides. The highest degree of weeding was registered in the zero control sample (574 plants/m²) and of all types, the highest value was registered for *Amaranthus retroflexus* - 292 plants/m². On the 20th day after applying the leaf herbicides, the efficiency was the highest in the variants treated with Laudis OD - 200 ml/dka and Stelar in a dose of 100ml/dka - 99%. The other two leaf herbicides-Kaspar 55 WG - 30 g/dka and Elumis - 200 ml/dka destroy 95% and 97% of the existing weeds. The duration of the herbicide effect lasted to the 40th day after spraying.

CONCLUSIONS

Of all examined soil herbicides, those that exercise excellent control over annual weeds on maize during the period of the experiment are the preparations Gardoprim plus gold 500 SK - 400 ml/dka (99%) and Lumux 538 SK - 400ml/dka (97%) as well as Wing - 400 ml/dka (97%). Very good efficiency was registered for Merlin flex in a dose of 42 ml/dka - 94.6%.

The leaf herbicides Stelar-100ml/dka Laudis OD - 200 ml/dka destroy 96-97% of the existing weeds. The preparations Kaspar 55 WG - 30 g/dka and Elumis - 200 ml/dka demonstrate selectivity of 90.5% to 94%.

The duration of the effect of the examined herbicides is about 40-45 days. The selectivity of the preparations regarding the crop is excellent based on the EWRS scale.

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Table 1. Weeds in number of square meters on the 28-th day after spraying soil herbicides - 24.05.2011

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1.Control (K ₁)	338	6	64	92	2	1	37	9	15	-	564
2.Industrial control (K ₂)	62	9	19	233	1	1	51	23	59	-	458
4. Lumux 538 SK-400 ml/dka	-	-	-	-	-	-	-	-	-	-	-
6 Gardoprimplusgold 500 SK-400 ml/dka	-	-	-	-	-	-	-	-	-	-	-
7. Wing-400 ml/dka	-	-	-	-	-	-	-	-	1	-	1
10. Merlinflex-42 ml/dka	7	-	9	-	1	-	5	-	-	-	22

Table 2. Weeds in number of square meters on the 40-th day after spraying soil herbicides – 06.06.2011

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1.Control (K ₁)	360	16	64	92	8	1	37	9	15	-	602
2.Industrial control (K ₂)	6	3	5	12	1	2	3	1	1	-	34
4. Lumux 538 SK-400 ml/dka	-	-	-	-	-	1	-	-	-	-	1
6 Gardoprimplusgold 500 SK-400 ml/dka	-	-	-	-	-	2	-	-	-	-	2
7. Wing-400 ml/dka	-	-	-	1	-	2	-	-	1	-	4
10. Merlinflex-42 ml/dka	5	-	3	-	-	1	4	-	-	-	13

Table 3. Weeds in number of square meters before making (foliar application herbicides) – 27.05.2011

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1. Control (K ₁)	342	8	64	94	6	1	37	10	15	1	578
2. Industrial control (K ₂) 24.05.2011 year	2	1	-	-	-	1	-	-	-	-	4
3. LaudisOD-200 ml/dka	34	1	54	106	2	-	65	6	-	-	268
5. Elumis-200 ml/dka	49	8	58	106	5	4	65	15	-	1	311
8. Stelar-100 ml/dka	68	1	86	63	1	1	60	15	-	-	295
9. Kaspar 55 WE-30 g/dka	46	9	187	26	1	1	33	7	-	1	311

Table 4. Weeds in number of square meters on the 20-th day after (foliar application herbicides) – 16.06.2011

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1.Control (K ₁)	408	27	73	99	14	6	45	13	18	3	706
2.Industrial control (K ₂) 24.05., 12.06.2011 year	2	1	-	2	-	1	-	-	-	-	6
3. LaudisOD-200 ml/dka	2	-	1	4	2	-	3	-	-	-	12
5. Elumis-200 ml/dka	4	1	5	2	-	5	8	3	-	-	28
8. Stelar -100 ml/dka	1	-	-	2	-	1	1	3	-	-	8
9. Kaspar 55 WE-30 g/dka	3	-	1	22	-	-	11	5	--	1	43

Table 5. Weeds in number of square meters on the 28-th day after spraying soil herbicides, 2012

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1. Control (K ₁)	139	16	17.5	63	7	6.2	13.5	11.2	0.5	10	284
4. Lumux 538 SK-400 ml/dka	-	-	-	-	-	-	-	-	-	9.3	9.3
6. Gardoprimplusgold 500 SK – 400 ml/dka	-	-	-	-	-	1	-	-	-	5.5	6.5
7. Wing-400 ml/dka	0.5	-	-	-	3	4	0.7	0.8	-	7.5	16.5
10. Merlinflex-42 ml/dka	1	0.5	2	1.5	4	2.5	1.2	1.5	-	6.8	21

Table 6. Weeds in number of square meters before making (foliar application herbicides) – 17.05.2012

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1. Control (K ₁)	292	36	71	87	16	8	32	7	19	6	574
2. Industrial control (K ₂) 16.05.2011 year	12	7	3	14	2	3	1	2	2	1	47
3. LaudisOD-200 ml/dka	44	9	44	74	6	3	48	16	3	9	256
5. Elumis-200 ml/dka	37	21	39	77	7	4	53	15	1	3	257
8. Stelar-100 ml/dka	76	17	66	73	7	1	57	15	-	3	315
9. Kaspar 55 WG-30 g/dka	56	13	87	76	6	1	33	13	-	3	288

Table 7. Weeds in number of square meters on the 20-th day after (foliar application herbicides) – 08.06.2012

Variants No. on scale	<i>Amaranthus retroflexus</i> L.	<i>Solanum nigrum</i> L.	<i>Chenopodium album</i> L.	<i>Portulaca oleraceae</i> L.	<i>Dathura stramonium</i> L.	<i>Xanthium strumarium</i> L.	<i>Setaria viridis</i> L.	<i>Setaria glauca</i> L.	<i>Echinochloa grus-galli</i> L.	<i>Sorghum halepense</i> Pers.	Total
1. Control (K ₁)	361	57	73	99	24	11	45	13	28	13	724
2. Industrial control (K ₂) 16.05., 06.06.2011 year	3	-	1	3	-	1	1	-	-	-	9
3. LaudisOD-200 ml/dka	3	-	-	2	-	-	2	-	-	-	7
5. Elumis-200 ml/dka	2	1	4	4	1	2	6	3	-	1	24
8. Stelar-100 ml/dka	1	-	-	3	-	1	1	1	-	-	7
9. Kaspar 55 WG- 30 g/dka	3	-	1	19	-	-	8	5	-	1	37