

Efficacy of certain herbicides on weeds in maize

Shtelyana Kalinova^{1*} and Sonya Goranovska²

¹Agricultural University, Faculty of Agronomy, 4000 Plovdiv, Bulgaria

²Agricultural Academy–Institute of Maize, 5835 Knezha, Bulgaria

*Corresponding author: shtelyana57@gmail.com

Abstract

Kalinova, Sh. & Goranovska, S. (2021). Efficacy of certain herbicides on weeds in maize. *Bulg. J. Agric. Sci.*, 27 (Suppl. 1), 150–154

The investigation was carried out at the experimental field of Institute of maize – Knezha on leached chernozem. The following variants were included in the experiment: K_0 (Zero control) – without herbicides and hoeings, weed infested in natural background; K_1 (Economic control) – without herbicides, with 2 hoeings; Merlin flex – 42 g/ha⁻¹, Ekip 4 SK – 250 ml/ha⁻¹, Basis 75 DF – 2.5 g/ha⁻¹. The tested herbicides showed a high selectivity to maize. Herbicide Merlin Flex (izoxaflutol) – 420 g/ha⁻¹ applied after sowing, before crop emergence and Ekip 4 SK (foramsulfuron) in doses 200 ml/ha⁻¹ and 250 ml/ha⁻¹, inserted at a faze 4th–5th plant leaf, showed a good herbicide effect. In the conditions of the field experiment the studied preparations destroyed from 63.33% 76.67% of the weeds, which averted the initial weed infestation at the experimental plots. A very good effect against Jonson grass was reported after treatment with Basis 75 DF (rimsulfuron + thifensulfuron), which destroys up to 96% of the Johnson grass from seeds and up to 90% of the Johnson grass from rhizomes. The highest yield is from maize hybrid Knezha 613 in the variant with the preparation Basis 75 DF in a dose 2.5 g/ha⁻¹.

Keywords: maize; weeds; herbicides; efficacy

Introduction

Under the conditions of the global economic crisis, one of the global problems before human existence remains the one related to the nutrition of the population of the planet. In this sense, the importance of maize as an intensive food crop is vital (Slavova, 2015). One of the problems in consideration is related to the control of weeds. The chemical method is the most common advice in accordance with the previous steps – high efficiency, low fuel costs, selectivity of herbicides to the crop (Chauhan & Mahajan, 2014).

In maize, the use of soil herbicides is mandatory in order to limit the spread of annual deciduous and cereal weeds during the growing season (Tonev et al., 2007; Tonev et al., 2019; Trankov & Koleva, 2002). To control weeding in maize, the action of a number of vegetation herbicides with a

diverse spectrum and mechanism of action has been studied (Dobless & Kapusta, 1993; Fedtke & Duke, 2005; Hanson & Schneider, 2008; Stoimenova et al., 2008; Tonev, 2006; Yamakova & Dimitrova, 2002).

In recent years, the high biological efficacy of a large number of two-component and three-component herbicides with a broad spectrum of action has been demonstrated (Mitkov et al., 2018; Mitkov et al., 2019; Tonev et al., 2016).

Results of research on the effect of soil and foliar herbicides for weed control in maize on the growth, development and yield of the crop reported by a large number of authors (Dimitrova et al., 2018; Isk at al. 2015; Oerke, 2006; Swetha et al., 2018)

The aim of the present work is to study the biological efficacy of soil and foliar herbicides for weed control in maize grown in Northwestern Bulgaria.

Materials and Methods

To clarify the goal in 2015 and 2016, a field experience was conducted in the experimental field of the Institute of maize in Knezha. The studies were performed with maize, hybrid Kneja 613 – group 500-600 according to FAO, grown under non-irrigated conditions after predecessor winter wheat.

The experiment was set by the block method, in four replications, with the size of the experimental plot 21 m² (Barov & Shanin, 1965). The experiment includes 4 variants with herbicides and two controls:

- Merlin flex 480 SK (isoxaflutol) at a dose of 42 ml/ha⁻¹
- Ekip 4 SK (foramsulfuron + antidote) at a dose of 200 ml/ha⁻¹
- Ekip 4 SK at a dose of 250 ml/ha⁻¹
- Basis 75 DF (rimsulfuron + thifensulfuron methyl) at a dose of 2,5 g/ha⁻¹
- K₀ (Zero control) – (without hoeings and without herbicides)
- K₁ (Economical control – (with 1 mechanical and 1 manual hoeing, without herbicides)

Soil herbicides are applied after sowing, before the emergence of maize and weeds, and foliar ones in a phase 5th leaf of maize. The spraying was done with a back sprayer, for each variant and each replications separately.

Weeds were quantified by species counting using 0.25 m² in 4 replications (Dimitrova et al., 2004).

The efficacy of soil herbicides was reported on the 14th and 28th day after application, and of foliar herbicides on the 20th and 40th day after treatment. The percentage of weeds destroyed was calculated on the basis of the zero control. The yield of every variant was determined at a grain moisture content of 14%.

Results and Discussion

The study on the species composition of weeds in the experimental field of the Institute of maize shows that in 2015-2016 the following species were found: large crabgrass (*Digitaria sanguinalis* L. Scop.), green bristle-grass (*Setaria viridis* (L.) P. Beauv), white goosefoot (*Chenopodium album* (L.), black nightshade (*Solanum nigrum* L.), common amarant (*Amaranthus retroflexus* L.), velvetleaf abutilon (*Abutilon theophrasti* Medicus), creeping twistle (*Cirsium arvense* L. Scop.), field bindweed (*Convolvulus arvensis* L.) and johnson grass (*Sorghum halepense* (L.) Pers.).

On average for the two years of study, the density of annual deciduous and perennial weeds was highest in the controls. The density of annual deciduous weeds is the highest in 2015 – 22 pieces/m² and of perennial – 23 pieces/m² in the zero control.

Table 1. Efficacy of the studied soil and foliar herbicides in the first reporting

Variants	Year	Annual cerealls n/m ²	Annual deciduous, n/m ²	Perennial, n/m ²	Total weeds, n/m ²	Efficacy, %
Zero control	2015	8	22	23	53	–
	2016	10	18	19	47	–
	Average	9	20	20.5	49.5	–
Economical control	2015	6	18	15	39	–
	2016	7	13	19	38	–
	Average	6.5	15.5	16.5	38.5	–
Merlin Flex 480 SK – 42 ml/ha ⁻¹	2015	3	10	11	24	54.72
	2016	2	9	9	20	57.45
	Average	2.5	9.5	10	22	56.09
Ekip 4 SK – 200 ml/ha ⁻¹	2015	1	11	14	26	50.94
	2016	2	10	12	24	48.94
	Average	1.5	10.5	13	25	49.94
Ekip 4 SK – 250 ml/ha ⁻¹	2015	1	9	11	21	60.38
	2016	1	6	9	16	65.96
	Average	1	7.5	10	18.5	63.17
Basis 75 DF – 2,5 g/ha ⁻¹	2015	1	10	2	13	75.48
	2016	3	8	8	19	59.57
	average	2	9	5	16	67.52

The soil herbicide preparation Merlin Flex 480 SK, applied in a dose of 42 ml/ha⁻¹, in 2015 destroyed 54.72% of the total number of weeds, and in 2016 – 57.45%. On average for the two years of study the efficacy of the drug reached 56.09%. Merlin Flex 480 SK has a combined action against cereal weeds and deciduous species. The herbicide controls the Jonson grass from seeds and rhizomes. The disadvantage of the preparation is that it is activated when it rains. Its efficiency is higher in 2016, which can be explained by the rains in late April and early May 2016.

The herbicide preparation Ekip 4 SK under the conditions of the experiment was applied in two doses – 200 ml/ha⁻¹ and 250 ml/ha⁻¹.

The results of the reporting of non-dead weed species on the 20th day after treatment show the following:

Ekip 4 SK, imported in a dose of 200 ml/ha⁻¹ in 2015 destroyed 50.94% of the total number of weeds, and in 2016 barely 48.94% of them. The best effect of the preparation is against annual and perennial cereal weeds, including Johnson grass from seeds. Increasing the treatment dose to 250 ml/ha⁻¹ increases the herbicide efficiency to 60.38% in 2015 and to 65.96% in 2016. Ekip 4 SK also shows good action against annual deciduous weeds. Their number in the tested variant is reduced by half (10 pcs/m²) compared to the zero control (20 pcs/m²).

The vegetative preparation Basis 75 DF, applied at a dose of 2,5 g/ha⁻¹ in the first year of testing showed the highest biological efficiency (75.94%) compared to the total number

of weeds, and in 2016 – 59.57%. The difference is partly due to the meteorological conditions during the period of treatment with foliar herbicides. In 2016, high temperatures and lack of rain prevailed in May and June. The combined action of the active substances of the preparation (rimsulfuron and thifen-sulfuron-methyl) leads to the death of a significant part of the annual and perennial weed species, including Johnson grass.

During the period of its active operation Basis 75 DF destroys on average up to 67.52% of the total number of weeds. The second reporting of non-dead weed species was performed on the 40th day after the vegetation treatment (Table 2).

It shows that the number of weeds in the zero control is higher compared to the first reporting, and that in the economical control – lower due to mechanized hoeing.

The biological efficiency of the soil herbicide preparation Merlin Flex 480 SK, applied in a dose of 42 ml/ha⁻¹ in the second reporting is 64.18% in 2015 and 71.67% in 2016. The most affected are the annual cereal species, as and *Johnson grass* from seeds.

Ekip 4 SK, introduced in the higher dose of 200 ml/ha⁻¹, in the period of its active action destroys on average for the two years of study up to 75% of the available weed species in the experimental area. Imported in a higher dose – 250 ml/ha⁻¹, the preparation destroys up to 76.64% of the total number of weeds in the experimental area. Ekip 4 SK shows the best action against annual and perennial weeds.

Table 2. Efficacy of the studied soil and foliar herbicides in the second reporting

Variants	Year	Annual cerealls n/m ²	Annual deciduous, n/m ²	Perennial, n/m ²	Total weeds, n/m ²	Efficacy, %
Zero control	2015	12	26	29	67	–
	2016	13	23	24	60	–
	average	12.5	24.5	26.5	63.5	–
Economical control	2015	2	10	9	21	–
	2016	4	8	5	17	–
	average	3	9	7	19	–
Merlin Flex 480 SK – 42 ml/ha ⁻¹	2015	5	15	4	24	64.18
	2016	6	8	3	17	71.67
	average	5.5	11.5	3.5	20.5	67.93
Ekip 4 SK – 200 ml/ha ⁻¹	2015	1	8	10	19	71.64
	2016	2	5	8	15	75.00
	average	1.5	6.5	9	17	73.32
Ekip 4 SK – 250 ml/ha ⁻¹	2015	1	7	9	17	71.67
	2016	1	5	8	14	76.67
	average	1	6	8.5	15.5	74.17
Basis 75 DF – 2,5 g/ha ⁻¹	2015	3	10	4	17	74.63
	2016	5	7	10	22	63.33
	average	4	8.5	7	19.5	68.98

Table 3. Grain yield from Knezha 613 hybrid on average for 2015-2016 by variants

Variants	Grain yield, kg/ha, 2015	Grain yield, kg/ha, 2016	Average for the period	Difference from economic control	Proof of the differences
Zero control	115.5	121.2	118.4	–	n.s.
Economical control	537.1	548.0	542.6	–	n.s.
Merlin flex 480 SK – 42 ml/ha ⁻¹	610.5	642.0	626.3	15.4	++
Ekip 4 SK – 200 ml/ha ⁻¹	604.1	579.0	591.5	9.01	++
Ekip 4 SK – 250 ml/ha ⁻¹	622.2	603.5	612.9	13.0	++
Basis 75 DF – 2,5 g/ha ⁻¹	742.0	733.3	737.7	36.0	++

Grain yield
(average for the period)

GD p_{5%} = 57.4
GD p_{1%} = 77.5
GD p_{0.1%} = 103.1

The biological efficiency of the foliar herbicide Basis 75 DF on the 40th day after treatment is 74.63% of the total number of weeds. The preparation shows a very good effect against all groups of weed species.

The grain yield from Knezha 613 for the study period is presented in Table 3.

The data on maize grain yields obtained during the experimental period show that there are clear dependences of maize grain yield on the use of different herbicides. The statistical methods established the proof of the differences in yield between the variants treated with different herbicides and the economical control. For the conditions of 2015, the highest yield was obtained as a result of the use of the foliar preparation Basis 75 DF – 742 kg/ha⁻¹.

The preparation has a wide range of action – against annual cereals and deciduous weeds and partly against some perennials. The highest grain yield – 733.3 kg/ha⁻¹ in 2016 was also obtained from the variant of treatment with Basis 75 DF at a dose of 2,5 g/ha⁻¹. The increase in yield compared to economical control is 36% and is statistically proven.

Higher grain yields compared to the economic control were obtained from the other variants with herbicides. The differences in grain yields resulting from the use of herbicides and economic control are mathematically proven.

Conclusion

Merlin Flex 480 SK, applied after sowing before germination of the crop at a dose of 42 g/ha⁻¹ controls the mixed weeding of annual cereals and weeds.

The vegetation herbicide Ekip 4 SK applied at dose of 200 ml/ha⁻¹ and at a dose 250 ml/ha⁻¹ successfully controls annual cereals and annual deciduous weeds in phase 3th-5th leaf of weeds. It shows a good efficiency against self-seeding from the predecessor winter wheat.

The biological efficiency of the foliar herbicide Basis 75 DF on the 40th day after treatment is 74.63% compared to the

total number of weeds. The preparation shows a very good effect against almost all groups of weed species.

The grain yields of the Knezha 613 maize hybrid vary in a very large range depending on the weed density, the manifested herbicidal effect and the differences in precipitation by years.

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Received: May, 19, 2021; *Accepted:* June, 25, 2021; *Published:* September, 2021