DOI: 10.22620/agrisci.2022.34.006

THE INFLUENCE OF HERBICIDES AND THEIR COMBINATION ON THE DEVELOPMENT AND YIELD IN MAIZE HYBRID KNEZHA 613

Sonya Goranovska

Maize Research Institute, Knezha, Bulgaria
E-mail: sonq_hristova@mail.bg

Abstract

In 2018 and 2019 an experiment was conducted using the block method with 12 herbicides in the experimental field of the Maize Research Institute – Knezha. The studies were performed with a maize hybrid *Knezha 613* – group 500-600 by FAO, cultivated without irrigation. We studied 8 systems of herbicides which included 6 soil preparations: *Adengo 465 SK* (isoxaflutole) at a dose of 350 ml/ha; *Merlin Flex 480 SK* (isoxaflutole) at a dose of 420 ml/ha; *Spectrum* (dimetenamid – P) at a dose of 1400 ml/ha; *Gardoprim plus gold* (S-metolachlor + terbutilazin) at a dose of 4500 ml/ha; *Dual Gold 960 EK* (S-metolachlor) at a dose of 1500 ml/ha and *Stomp NEW 330 EK* (pendimetalin) at a dose of 4000 ml/ha. The studies included foliar preparations, applied in a phase fourth-fifths leaf of the crop, after the soil ones: *Elumis OD* (nicoslfuron + mesotrion) at a dose of 2000 ml/ha; *Aminopielik 600 SL* (2,4-D amine salt) at a dose of 1200 ml/ha; *Lumax* (S-metolachlor + terbutilazin + mesotrion) at a dose 3000 ml/ha; *Maton 600 EK* (2,4-D ester) at a dose of 1100 ml/ha; *Laudis OD* (tembotrione) at a dose of 2000 ml/ha. Under the test conditions, the herbicidal system *Dual gold 960 EK* at a dose of 1500 ml/ha and *Elumis OD* et a dose of 2000 ml/ha is the most efficient: destroying 94.8% (2018) and 94.4 (2019) of the common weeds.

Keywords: maize, weeds, herbicides, biological efficacy

INTRODUCTION

In the conditions of intensive agriculture the problem of weed control in corn cultivation remains open. Modern technologies, including innovative methods and approaches, have led to the proliferation of resistant forms of weeds, as well as atypical ones. The chemical method remains a leading one in their restriction. The use of herbicides reduces the cost of weed control by up to 60% (Tonev, T., 2000; Buheer D. et al., 1996). A number of authors reported data on the biological effect of soil and foliar herbicides on weeding in maize, as well as their influence on grain yield (Bagrintseva V.N. et al., 2011; Spiridonov Yu. Ya. et al., 1994; Hanson B.D. et al., 2008).

To control some problematic weed species in maize, the action of a number of vegetation herbicides with a diverse spectrum and mechanism of action has been studied (Hakobyan A. H. et al., 2005; Tonev T., 2006; Maric D., 2007, etc.). To combat some perennial weeds - Cirsium arvense (L.) Scop.), Sorghum halepense (L.) Pers.) from rhizomes, etc., the effect of some foliar herbicides with a broad spectrum of action (Yamakova Tsv., etc.) is being studied 2002; Mirskas & Tsolis, 2002).

The aim of the present work is to study the biological efficacy of soil and foliar herbicides in maize hybrid of group 600 according to FAO – *Knezha 613* and their influence on the obtained grain yields.

MATERIALS AND METHODS

To clarify the goal in 2018 and 2019, an experiment was conducted in the field of the Corn Institute – Knezha. The studies were carried out with maize, hybrid *Kneja 613*, FAO

500-600, grown under non-irrigated conditions, after the predecessor wheat. The experiment is based on a block method, in 4 replications, with a size of the experimental plot of 29 m^2. It includes 8 variants with herbicides and two controls. The variants are as follows:

1. *Adengo 465 SK* (izoxaflutol) at a dose 350 ml/ha + *Elumis OD* (nikosulfuron + mezotrion) at a dose 2000 мл/ha.
2. *Merlin flex 480 SK* (izoxaflutol) at a dose 420 ml/ha + *Aminopielik 600 SL* (2,4-Д-amine salt) at a dose 1200 мл/ha.
3. *Spektrum* (dimetenamid-P) at a dose 1400 ml/ha + *Lumax* (S-metolachlor + terbutilazin + mezotrion) at a dose 3000 ml/ha.
4. *Gardoprim plus gold* (S-metolachlor + terbutilazin) at a dose 4500 ml/ha + *Maton 600 EK* (2,4-D-etilhexil ester) at a dose 1100 ml/ha.
5. *Dual gold 960 EK* (S-metolachlor) at a dose 1500 ml/ha + *Elumis OD* (nikoslfuron + mezotrion) at a dose 2000 ml/ha.
6. *Stomp new 330 EK* (pendimetalin) at a dose 4000 ml/ha + *Laudis OD* (tembotrion) at a dose 2000 ml/da.
7. Control – zero (without hoeing and without herbicides).
8. Control – production (with 2 hoeings, without herbicides).

Weeds were quantified by counting by species using 0.25m^2 in four replications (Dimitrova M. et al., 2004). Weeds were counted on the 20th day after treatment with foliar herbicides. The percentage of weeds destroyed was calculated on the basis of zero control.

RESULTS AND DISCUSSION

The results of the study on the species composition of weeds in the experimental field of the Institute of Maize on non-irrigated areas with maize hybrid *Knezha 613* show that in the period 2018-2019 the most common weeds were: *Sorghum halepense* (L.) Pers.), *Cirsium arvence* (L.) Scop*), Setaria viridis* (L.) P. Beauv.), *Amaranthus retroflexus* L.), *Chenopodium album* L.), *Solanum nigrum* L.), *Amaranthus blitoides* (L.).

The density of weeds in the zero control reached 96 pieces / m2 for the two years of study. After treatment with soil and foliar herbicides, the biological efficiency reached 96.8% (2018). During the two years of the experiment, the biological efficacy of the studied herbicides was reported on the 20th day after treatment with the foliar preparation. The results for 2018 are presented in Table 1.

The results of the study of the biological efficiency of the studied systems of soil and foliar herbicides show that they are highly effective against the available weed species in the experimental area. For the conditions of 2018, the highest percentage of destroyed weeds was found after treatment with the soil herbicide *Dual Gold 960 EK* at a dose of 1500 ml/ha and the leafy Elumis at a dose of 2000 ml/ha. Destroyed weeds were 94.8% of the total number compared to zero control. The area was dominated by broadleaf weeds, which is why *Dual Gold 960 EK* as a preparation for control of mainly annual cereal weeds did not show high enough efficiency in the observed type of weeding.

The corrective treatment with Elumis at a dose of 2000 ml/ha destroyed a large part of the annual cereal, including *Sorghum halepense (L.) Pers.)* due to the wide spectrum of action. In a system with the soil preparation *Adengo 465 SK*, applied in a dose of 350 ml/ha, the biological efficiency reached 87.5%. The treatment with the soil herbicide preparation *Stomp new* in a dose of 4000 ml/ha with subsequent foliar treatment with *Laudis OD* has led to the destruction of 88.5% of the total number of weeds in the experimental area.

Table 1. Efficacy of herbicides on the 20th day after the treatment of the foliar herbicide (2018)

Variants	Annual weeds (pcs/m^2)							Multiannual weeds (pcs/m^2)		Total Pcs/m^2	% Efficacy
	Chenopodium album	Amaranthus blitoides (L.)	Amaranthus retroflexus (L.)	Sinapis arvensis (L.)	Portulaka oleracea (L.)	Solanum nigrum (L.)	Setaria viridis (L.)	Convolvulus arvensis (L.)	Sorghum halepense (L.) Pers)		
Adengo 465SK – 350ml/ha + Elumis OD – 2000ml/ha	-	-	1	-	4	2	3	2	-	12.0	87.5
Merlin flex 480 SK – 420ml/ha + Aminopielik 600SL – 1200 ml/ha	1	1	2	-	3	1.5	1	7	9	25.5	73.4
Spectrum – 1400ml/ha + Lumax – 3000ml/ha	1	-	-	-	1.5	3.5	1	8	7	22.0	77.1
Gardoprim plus gold – 4500ml/ha + Maton 600EK – 100ml/ha	-	-	-	-	-	4	2	6.5	8.5	21.0	78.1
Dual gold 960 EK – 1500 ml/ha + Elumis OD – 2000ml/ha	-	-	-	-	1	2	-	2	-	5.0	94.8
Stomp new 330 EK – 4000ml/ha + Laudis OD – 2000ml/ha	1	2	1	1	2	1	1	1	1	11.0	88.5
Control – zero	15	14	13.5	12	11	8	6	7.5	9	96	-
Control–production	1	1	2.5	-	2	-	2	-	4	12.5	87

Table 2 presents the results for the biological efficacy of the tested herbicides for the conditions of 2019. The results of the combinations - soil and foliar herbicide show different biological efficacy compared to the main weed species in the experimental area.

The highest biological efficiency - 94.4%, was shown by the herbicide combination *Dual Gold 960 EK* in a dose of 1500 ml/ha + *Elumis OD* in a dose of 2000 ml/ha. 94.4% of all weeds in the experimental area compared to the control were destroyed.

High biological efficiency for the conditions of 2019 was also shown by the system of the soil herbicide preparation *Stomp new 330 EK* in a dose of 4000 ml/ha and the leafy *Laudis OD*, applied in a dose of 2000 ml/ha. During the period of its active operation, the efficiency of this system reached 91.3% of destroyed weeds compared to the control.

The efficiency of the other systems was significantly lower, nothing that the systems in which *Elumis OD* was included as a vegetative herbicide were more efficient than the others.

The data on the corn grain yields (Table 3) obtained during the experimental period show that there are clear dependences of grain yield on the medium-late hybrid corn *Knezha 613* on the use of various herbicides. The statistical methods established the proof of the differences in the yield between the variants treated with different herbicide combinations and the economic control.

Table 2. Efficacy of herbicides on the 20th day after foliar herbicide treatment (2019)

Variants	Annual weeds (pcs/m^2)							Multiannual weeds (pcs/m^2)		Total Pcs/m^2	% Efficacy
	Chenopodium album	Amaranthus blitoides (L.)	Amaranthus retroflexus (L.)	Sinapis arvensis (L.)	Portulaka oleracea (L.)	Solanum nigrum (L.)	Setaria viridis (L.)	Convolvulus arvensis (L.)	Sorghum halepense (L.)		
Adengo 465SK – 350/ha + Elumis OD – 2000 ml/ha	-	2	1	-	6	4	4	3	-	20	82.6
Merlin flex 480 SK – 420 ml/ha + Aminopielik 600 SL – 1200 ml/ha	1.5	3	1	-	3.5	2	3	6	10	30	74.0
Spectrum – 1400 ml/ha + Lumax – 3000 ml/ha	-	-	-	-	2	4	3	9	9	27	76.5
Gardoprim plus gold – 4500 ml/ha + Maton 600EK – 100 ml/ha	-	-	-	-	1	4.5	3.5	8	12	29	74.8
Dual gold 960 EK – 1500 ml/ha + Elumis OD – 2000 ml/ha	-	1	-	-	1	1.5	-	3	-	6.5	94.4
Stomp new 330 EK – 4000 ml/ha + Laudis OD – 2000 ml/ha	1	2	1	-	3	1	-	1	1	10	91.3
Control – zero	18	19	15	13	12	9	8	9	12	115	-
Control–production	1	1	2	-	2	-	2	5	4	17	85.2

For the conditions of 2018 the highest yield was obtained as a result of the joint use of two herbicides with a wide range of action against both cereals and a large number of broadleaf – *Stomp new 330 EK* at a dose of 4000 ml/ha and *Laudis OD* at a dose of 2000 ml/ha. The increase of the yield compared to the economic control was by 30.8% and was proved at levels of significance of the difference of 5%, 1% and 0.1%.

The results were similar after the use of other herbicides and combinations of them. As a result of their use, a mathematically proven increase in yields compared to economic control has been established.

In 2019, the highest grain yield was also obtained from the variant with treatment with the herbicide combination *Stomp new 330 EK* at a dose of 4000 ml/ha and *Laudis OD* at a dose of 2000 ml/ha and was statistically proven at levels of significance of the difference of 5%, 1% and 0.1%.

After treatment with the other herbicide combinations studied in the experiment, a statistically proven increase in grain yields was also observed compared to the economic control.

Table 3. Grain yield from Knezha 613 hybrid after treatment with soil and foliar herbicides

Variants	Grain yield (kg/da)			Difference between production control	
	2018 year	2019 year	Average for the period	%	Improvement
Adengo 465SK – 350/ha + Elumis OD – 2000 ml/ha	606.7	714.3	660.5	18.7	+++
Merlin flex 480 SK – 420 ml/ha + Aminopielik 600SL – 1200 ml/ha	599.0	709.0	654.0	17.5	+++
Spectrum – 1400 ml/ha + Lumax – 3000 ml/ha	592.7	713.1	652.9	17.3	+++
Gardoprim plus gold – 4500 ml/ha + Maton 600EK – 100 ml/ha	610.0	701.2	655.6	17.8	+++
Dual gold 960 EK – 1500 ml/ha + Elumis OD – 2000 ml/ha	606.7	724.5	665.6	19.6	+++
Stomp new 330 EK – 4000 ml/ha + Laudis OD – 2000 ml/ha	722.0	733.0	727.5	30.8	+++
Control – zero	117.0	121.5	119.3	-	-
Control – production	520.3	592.5	556.4	-	n.s.

$GDP_{5\%}$ = 48.6 $GDP_{1\%}$ = 65.9 $GDP_{0/1\%}$ = 88.4

CONCLUSION

The species diversity of weeds in the experimental field of the Maize Research Institute in Knezha is limited. Only 9 species of weeds have been identified. *Chenopodium album (L.), Amaranthus blitoides (L.), Amaranthus retroflexus (L.), Sinapis arvensis (L.), Portulaka oleracea (L.), Solanum nigrum (L.), Setaria viridis (L.), Convolvulus arvensis (L.)* and *Sorghum halepense ((L. (Pers)).*

Perennial weeds are represented by two species: *Sorghum halepense ((L. (Pers))* and *Convolvulus arvensis (L.).*

The density of weeds is relatively high, reaching 115 pcs/m^2 in the zero control.

Under experimental conditions, the herbicide system *Dual Gold 960 EK* at a dose of 1500 ml/ha + *Elumis OD* at a dose of 2000 ml/ha is the most effective of the studied systems, destroying up to 94.8% of common weeds.

The highest grain yield (average for the study period) was obtained from the variant in which the herbicide system *Stomp new 330 EK* in a dose of 4000 ml/ha + *Laudis OD* in a dose of 2000 ml/ha was used for weed control. The obtained grain yield was 7270.5 kg/ha.

REFERENCES

Akopyan, A. Kh. et al. (2005). Efektivnosty gerbitsidov v sevooborote [The effectiveness of herbicides in crop rotation]. *Plant protection and quarantine*, 5, 29-33.

Bagrintseva, V. N. et al. (2011). Efektivnosty primeneniya gerbitsidov na kukuruze [The effectiveness of the use of herbicides on corn]. *Corn and sorghum*, 1, 24-30.

Buhler, D. et al. (1996). The effect of maize residues and tillage of emergence of Setaria viridis and Sorghum halepense. *Weed Research*, 36, 153-165.

Dimitrova, M. et al. (2004). Methodology for reporting and filing of weed. Infestation in major field crops. Sofia, *National Service for Plant Protection at MAF* (Bg).

Hanson, B. D. & Schneider S. A. (2008).

Evaluation of Weed Control and Crop Safety with Herbicides on Open Field Three Nursery. *Weed Technology*, 22(3), 493-498.

Maric, D. (2007). Testing of efficacy of some herbicides combination in maize. *Herbologia*, 8(1), 177-173.

Mirskaya, M. & T. Tsolis (2002). Interference between corn and Sorghum halepense from seed or rhizomes. *Weed Science* 51, 540-545.

Spiridonov, Yu.Ya. et al. (1994). Gerbitsidnye preparaty novogo pokoleniya v borybe s sornoy rastitelynostyu [New generation herbicides in the fight against weeds]. *Agrochemistry*, 11, 72-79.

Tonev, T. (2000). Rakovodstvo za integrirana borba s plevelite I kultura na zemedelie [Leadership for integrating the fight against chaff and culture for farming]. *Library Agriculture education*, 2.

Tonev, T. (2006). Novoto pokolenie herbitsidi na Bayer [A new generation of herbicides on Bayer - an excellent alternative to weed control under cover]. *Plant protection*, 1, 10-12.

Yamakova, Tsv. and M. Dimitrova (2002). Prouchvane varhu efikasnostta na nyakoi pochveni herbitsidi I vliyanieto im varhu dobiva ot tsarevitsa – hybrid Knezha 614 [Efficasy of soil herbicide and the influence of herbicide from the hybrid Knezha 614]. *Jubilee scientific conference*, Plovdiv, *Nauchni Trudove*, vol. XLVII (1), 185-190.