DOI: 10.22620/agrisci.2023.37.004

EFFECT OF COMBINED APPLICATION OF HERBICIDES AND FOLIAR FERTILIZERS ON GROWTH, DEVELOPMENT AND YIELD OF KNEZHA 509 MAIZE HYBRID

Sonia Georgieva Goranovska

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

Abstract

In 2020 and 2021, a block trial was conducted with two herbicide preparations and four foliar feeding products for maize. The studies were carried out with maize, hybrid Knezha 509, grown under non-irrigated conditions after a wheat predecessor. The effect of the combined application of the herbicide preparations Stomp new 330 EK and Hemniko 24 SK and of the foliar microelement fertilizers for maize, Amalgerol, Vertex high N-34 and Foliar extra was studied. The influence of the studied treatment systems on maize height and grain yield was established. For the conditions of the experiment, the plants treated with a tank mixture of Hemniko 24 SC at a dose of 21 ml/da and Amalgerol at a dose of 500 ml/da had the highest height. The increase compared to economic control is 6.46% (for 2020) and 7.3% (for 2021).

The highest grain yield (average for the study period) – 643.9 kg/da was obtained from the same variant of the experiment, and the increase compared to the economic control was 12.91%.

Keywords: maize, herbicides, foliar fertilizers, yield

INTRODUCTION

Climatic changes, problems related to improving the productivity of cultivated plants, as well as food shortages on a global scale, impose the need to update agricultural technologies (Dimitrov et al., 2011). Studies by a number of authors show that depending on the type and degree of weeding, corn yield can be reduced from 24% to 96.7% (Imoloame & Omolaiye, 2016; Jagadish & Prashant, 2016; Dimitrova et al., 2018). Weed losses in maize can be minimized by applying mechanical, cultural, chemical, biological and integrated weed control methods (Gehring et al., 2018; Langdon et al., 2020). In this way, a more complete use of the reproductive potential of cultivated crops is allowed (Bazitov, 1998; Estrande et al., 2010; Grifith et al., 2013).

Maize is one of the main cereals grown in our country. To realize its genetic potential, it is necessary to optimize the main agrotechnical factors - mineral nutrition, water regime, agrotechnical and plant protection measures (Radevska & Delchev, 2014; Kalinova et al., 2014; Liebman M., 1989). The use of herbicides to control weeds in some maize genotypes has negative effects. In order to reduce them, a large number of foliar fertilizers have been implemented in practice for simultaneous application with PRP (Tonev & Vasilev, 2011; Gifford & Jenkins, 1982). Beneze and Futo (2017) conduct an experiment with 64 nutrient combinations, 4 nitrogen prtions (0 kg/ha^{-1}, 70 kg/ha^{-1}, 140 kg/ha^{-1} and 210 kg/ha^{-1}, 4 phosphorus portions (0 kg/ha^{-1}, 40 kg/ha^{-1}, 80 kg/ha^{-1} and 120 kg/ha^{-1}) and 4 potassium portions (0 kg/ha^{-1}, 60 kg/ha^{-1}, 120 kg/ha^{-1} and 180 kg/ha^{-1}) in different combinations. It has been found that phosphorus and potassium have effect mainly to the phylsiological processes of maize. Cheminova at al. (2017) report that there

are significant differences between fertilizers in terms of their effect on weed density and species composition.

According to the studies of some authors (Dimitrov, 1992; Yordanov, 1995), there is a close correlation between the use of products of plant protection and foliar fertilizers and the formation of growth and reproductive manifestations in some maize hybrids. The aim of the present study is to determine the influence of the simultaneous use of herbicide preparations and foliar fertilizers on the growth and reproductive manifestations of the Knezha 509 maize hybrid.

MATERIALS AND METHODS

In order to clarify the set goal, in 2020 and 2021, an experiment was conducted in the field of the Maize Institute - the town of Knezha. The studies were carried out with maize, hybrid Knezha 509 - group 400-500 according to FAO, grown under non-irrigated conditions, after a predecessor wheat. The experiment was laid out according to the block method in four replications, with the size of the experimental plot 25 m^2 (Barov & Shanin, 1973). After the sowing of the maize, before the emergence of the weeds, a soil treatment with Stomp new 330 EK (currently 330 g/l pendimethalin) was carried out in a dose of 400 ml/da, and in the phase 5 leaf of the culture, the vegetation herbicide was introduced Chemnico 24 SC (active in 240 g/l nicosulfuron) in a dose of 21 ml/da.

The spraying was carried out with a backpack sprayer at a working solution consumption of 30 l/da. At the same time as Chemniko 24 SK, as a tank mixture, the following were added: growth stimulator - Amalgerol, microelements for maize and foliar fertilizers Vertex high and Foliar extra. The farm control was kept free of weeds by hoeing, without the use of herbicides. The zero control is without treatments and herbicides.

The trial options are as follows:

1) Stomp new 330 EK – 400 ml/da – after sowing before emergence and Hemniko 24 SK – 21 ml/da – in the 5th leaf phase of the maize;
2) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Microelements for maize – 100 ml/da – in the 5th leaf phase of the maize;
3) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Hemniko 24 SK – 21 ml/da + Microelements for maize – 100 ml/da + Amalgerol – 300 ml/da – in the 5th leaf phase of the maize;
4) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Hemniko 24 SK – 21 ml/da + Microelements for maize – 100 ml/da + Amalgerol – 400 ml/da – in the 5th leaf phase of the maize;
5) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Hemniko 24 SK – 21 ml/da + Microelements for maize – 100 ml/da + Amalgerol – 500 ml/da – in the 5th leaf phase of the maize;
6) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Hemniko 24 SK – 21 ml/da + Vertex high N-34 – 300 ml/da – in the 5th leaf phase of the maize;
7) Stomp new 330 EK – 400 ml/da – after sowing before emergence + Hemniko 24 SK – 21 ml/da + Foliar extra – 250 ml/da – in the 5th leaf phase of the maize;
8) Economic control
9) Zero control.

Fertilizers for foliar nutrition contain a complex of macro- and microelements, stimulate plant growth and help to correct nutrient deficiencies. The following indicators were reported:

- Biometric measurements – 10 pre-marked plants from each replicate were measured in the maize sweep phase
- Grain yield (kg/da). Grain yield was determined from harvest plots in 4 replicates for all variants and was equated to the standard maize moisture content of 14%

RESULTS AND DISCUSSION

The results of a study on the influence of the combined application of foliar preparations and herbicides for the fight against weeds in the Knezha 509 maize hybrid are presented in **Table 1.** Biometric measurements in the sweep phase (when maize growth is stopped) show the following:

For the conditions of 2020, the height of the plants in the studied variants of the experiment was from 147 to 280 cm. The lowest were the plants of the zero control, in which no products of plant protection was used and no mechanized processing was carried out. The highest were the plants of variant 5, in which treatment was carried out with a tank mixture of herbicide preparations, trace elements for maize at a dose of 100 ml/da and Amalgerol at a dose of 500 ml/da. The differences in the height of the plants in the individual variants are from 3.42% to 6.46% and are mathematically proven.

Table 1. Height of maize hybrids Knezha 509 after treatment with protection preparations and foliar fertilizers (2020-2021)

Variants	Height, cm			
	2020 year	% to economic control	2021 years	% to economic control
1. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da	272,0	3,42	234,8	1,4
2. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + micronutrients for maize – 100 ml/da	274,1	4,22	237,5	2,6
3. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + micronutrients for maize – 100 ml/da + Amalgerol – 300 ml/da	276,2	5,02	240,3	3,8
4. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Amalgerol – 400 ml/da	278,0	5,70	243,5	5,2
5. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Amalgerol – 500 ml/da	280,0	6,46	248,3	7,3
6. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Vertex high N-34 – 300 ml/da	276,3	5,06	238,5	3,0
7. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Foliar extra – 250 ml/da	275,5	4,75	236,8	2,3
8. Zero control	147,0	0,56	155,0	0,7
9. Economic control	263,0	-	231,5	-

For 2020 year:
$gDp_{5\%}$ = 8.74 cm
$gDp_{1\%}$ = 23.84 cm
$gDp_{0.1\%}$ = 73.47 cm

For 2021 year:
$gDp_{5\%}$ = 8.15 cm
$gDp_{1\%}$ = 22.80 cm
$gDp_{0.1\%}$ = 45.30 cm

Biometric measurements of maize in the sweep phase, carried out in the second year of the trial, showed the following:

The percentage differences in plant heights in individual variants are from 0.7% to 7.3%. The plants from option 5, which was treated with the foliar product Amalgerol at a dose of 500 ml/da, were the highest. The difference compared to economic control is 7.3% and is mathematically proven. In the variants in which Vertex high N-34 and Foliar extra foliar fertilizers were introduced together with the herbicide preparations, the differences in the height of the plants compared to the farm control were 2.3% and 3%.

Data on maize grain yields obtained from variants with different foliar feeding products applied as a tank mix with PRP show that there is an increasing trend over those obtained from variants without PRP and foliar fertilizers.

Regarding the influence of micronutrients for maize at a dose of 100 ml/da applied together with Amalgerol at doses of 300 ml/da, 400 ml/da and 500 ml/da it was mathematically proven that foliar feeding products increased grain yields on average over the period per survey with 9.09%; 11.02% and 12.91%. The data are mathematically proven at GDp 5% and GDp 1% (**Table 2**). The use of Micronutrients for maize at a dose of 100 ml/da increased grain yield on average over the study period by 7.43% compared to the farm control.

Under the conditions of the experiment, the treatment during the growing season of the maize with a reservoir mixture of herbicide preparations and the foliar fertilizer Vertex High N-34 in a dose of 300 ml/da increased the maize grain yield by an average of 7.43% (variant 6).

The results of the two-year experiment on the influence of the foliar fertilizer Foliar extra in a dose of 250 ml/da (variant 7) are unidirectional and show that the yield increase compared to the economic control (average for the period) is 10.48%.

The weakest increase in grain yield was found in variant one, where only Stomp new 330 EK at a dose of 400 ml/da and Chemnico 24 SK at a dose of 21 ml/da were treated. The yield increase averaged over the study period was 2.17% over the control and was mathematically proven at a GDp of 5%.

In conclusion, it can be summarized that the highest yield (average for the study period) was obtained when using the Amalgerol tank mixture at a dose of 500 ml/da + herbicide preparations for weed control. The increase compared to the economic control is 12.91%.

CONCLUSION

In order to overcome some negative effects due to the use of herbicide preparations to fight weeds in maize, in recent years, in practice, the application of tank mixtures product of plant protection and foliar nutrition products has become necessary.

Treatment with the growth regulator Amargerol, microelements for maize and the foliar fertilizers Vertex high N-34 and Foliar extra in a tank mixture with herbicide preparations has a positive effect on the growth manifestations of maize. During the trial period, an increase in the total height of the plants was observed in all variants of treatment with foliar nutrition products, and the differences compared to the farm control were statistically proven.

The greatest increase in the total height of maize plants (by 7.43%) was found after treatment with herbicide preparations and Amalgerol at a dose of 500 ml/da.

The system of pendimethalin and nicosulfuron, microelements for maize and Amalgerol in a dose of 500 ml/da had the highest positive effect on grain yield. The obtained grain yield (average for the period 2020-2021) is 643,961 kg/da. The increase compared to economic control is 12.91% and is mathematically proven.

Table 2. Maize grain yield after treatment with herbicides and foliar fertilizers (2020-2021 year)

Variants	Grain yield (kg/da, 2020)	Grain yield (kg/da, 2021)	Grain yield (average)	% to economic control	Proof of the differences
1. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da	568,100	597,284	582,692	2,17	+
2. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + micronutrients for maize – 100 ml/da	590,500	634,828	612,664	7,43	+
3. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + micronutrients for maize – 100 ml/da + Amalgerol – 300 ml/da	585,200	659,100	622,150	9,09	+
4. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Amalgerol – 400 ml/da	598,312	668,016	633,164	11,02	+
5. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Amalgerol – 500 ml/da	602,250	685,672	643,961	12,91	++
6. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Vertex high N-34 – 300 ml/da	579,300	646,052	612,676	7,43	+
7. Stomp new 330 EK – 400 ml/da + Hemniko 24 SK – 21 ml/da + Foliar extra – 250 ml/da	585,400	674,752	630,076	10,48	+
8. Zero control	111,500	119,752	115,626	-0,2	-
9. Economic control	555,280	585,344	570,312	-	-

$gDP_{5\%}$=33.2 $gDP_{5\%}$=35.5 $gDP_{5\%}$=41.1
$gDP_{1\%}$=48.3 $gDP_{1\%}$=62.3 $gDP_{1\%}$=62.2
$gDP_{0.1\%}$=72.2 $gDP_{0.1\%}$=78.42 $gDP_{0.1\%}$=82.5

REFERENCES

Bazitov, V. (1998). Promeni v sadarzhanieto na pochveniya sloy na kaneleni gorski pochvi v savisimost ot sistemata za obrabotka na pochvata. [Changes in the content of chromic cambisols depending on the soil tillage systems]. *Soil Science Agrochemistry and Ecology*, 5, 74-76 (Bg).

Barov, V. & Shanin, Y. (1973). Metodika na polskiya opit. [Methodology of the field experiment]. Zemizdat, (Bg).

Bencze, G. & Futo, Z. (2017). Effect of nutrient elements (NPK) to the crop of maize (Zea mays L.) in the year of 2016-2017. *Research Journal of Agricultural Science*, 49 (4), 46-53.

Bilal, M. A., Tanveer, A., Nadeem, M. A., Abbas, T. (2019). Aplication of bromoxynil + MCPA + metribuzin at varied doses for board-spectrum weed control in forage maize (Zea mays L.). *Pakistan Journal of Scientific and Industrial research, Series B: Biological Sciences*, 62 (2), 83-87.

Cheimona, N., Kontopoulou, C. K., Papandreu, A., Tabaxi, I., Travlos, I., Kakabouki, I., Bilalis, D. J. (2017). Effect of N and P fertilization on weed flora of maize (Zea

mays L.) crop. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.* Horticulture, 74 (1), 9-12.

Dimitrov, I. (1992). Fotosintetichna aktivnost i productivnost na tsarevichen hybrid H-708 v savisimost ot usloviyata na otglezhdane. [Photosynthetic activity and productivity of a maize H-708 hybrid depending on growing conditions]. Dissertation IP "N. Pushkarov", Sofia. (Bg)

Dimitrov, I., Nikolova, D., Stratieva, D., & Borisova, M. (2011). Izsledvane na novi agrotehnicheski resheniya za poddarganeto na gorniya pochven sloy. [Investigation of agrotechnical techniques towards surface soil maintenance]. Investigation of new agricultural decisions for the maintenance of the soil fertility of the vertisoil. Proceeding International Conference 100 years Bulgarian soil science, 16-20, May 2011, Sofia, part 2, 514-518 (Bg).

Dimitrova, M., Dimitrov, Ya, Palagacheva, N., Vitanova, M., Minev, N., Yordanova, N. (2018). Maize. Publisher Videnov & Son, Sofia, 14-19 (Bg).

Estrade, I. R., Auger, Ch., Bertr, M., Richard, G. (2010). Tillage and soil ecology: Partners for sustainable agriculture. *Soil and tillage research*, 111, 1, 33-40.

Gehring, K., Thyseen, S., Festner, T. (2018). Efficiency of chemical weed control in maize (Zea mays L.) in Bavaria. *Julius-Kühn-Archiv*, 458, 178-185.

Gifford, R., Jenkins, M. (1982). Photosynthesis, 2, 365-410.

Grifith, D., Steinhardt, G., Cladivko, E., Parsans, S. (2013). Effect of tillage and rotation in agronomic performance of maize and soybean: Twenty years study on dark clay loam soil. *Journal of Production Agriculture*, 9, (2), 241-248.

Golubinova, I., & Marinov-Serafimov, P. (2019). Vliyanie na laktisem varhu kulnyaemostta i purvonachalnoto razvitie na obraztsi *Sorghum vulgare* var. technicum [Körn.] [The effect of lactisem on the germination and the initial development of Sorghum vulgare var. technicum [Korn.] accessions]. *Journal of Mountain Agriculture on the Balkans* , 22 (6), 176–186 (Bg)

Imoloame, E. O. & Omolaiye, J. O. (2016). Impact of different periods of weed interference on the growth and yield of maize (Zea mays L.). *Trop. Agric*., 93 (4), 245-257.

Jagadish, S. & Prashant, C. (2016). A review on weed management on maize (Zea mays L.). *Advances in Life Sciences*, 5 (9), 3448-3455.

Jordanov, G. (1995). A rapid method for determining the leaf area of maize. *Sp. Plant Breeding Sciences*, 5, 40-41.

Kalinova, St., Kostadinova, S., Hristoskov, A. (2014). Nitrogen use efficiency and maize yield response to nitrogen rate and foliar fertilizing. *Bulgarian Journal of Agricultural Science*, 20 (1), 194-197.

Langdon, N. M., Soltani, N., Raedar, A. J., Robinson, D. E., Hooker, D. C., Sikkema, P. H. (2020). Influence of adjuvants on the efficacy of tolpyralate plus atrazine for the control of annual grass and broadleaf weeds in corn with and without Roundup Weather MAX. *American Journal of Plant Sciences*, 11 (3), 465-495.

Liebman, M. (1989). Effects of nitrogen fertilizer, irrigation and crop genotype relationships and yield of an intercrop weed mixture. *Field group research*, 22, 83-100.

Mitkov, A., Yanev, M., Neshev, N., Tonev,T. (2015). Biological efficacy of some soil herbicides at maize (Zea mays L.). Scientific Papers. Series A. *Agronomy*, LXI, 1, 340-345.

Radevska, M. & Deltchev, G. (2014). Effect of some foliar fertilizers and the growth regulator Amalgerol on grain maize yield. *Proceedings of the Jubilee Scientific Conference "Selection-genetic and technological innovations in the cultivation of cultural plants", Knezha, 10-11.09.2014*, 255-263.

Tonev, T. & Vasilev, A. (2011). Selectivity and phytotoxicity of herbicides. *Sp. Plant protection*, 2, 45-47.