

## BIOLOGICAL EFFICACY AND SELECTIVITY OF HERBICIDES FOR BROADLEAF WEEDS CONTROL IN MAIZE (*Zea mays* L.)

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### Abstract

In 2017 and 2018 a field trial with the maize hybrid "P 9537" on the experimental field of the Agricultural University of Plovdiv, Bulgaria was conducted. The following herbicide products were evaluated: Kabadex Extra (267 g/l mesotrione + 16.7 g/l florasulam), Starane Gold SE (1 g/l florasulam + 100 g/l fluroxypyr), Derby Super WG (300 g/kg aminopyralide-potassium + 150 g/kg florasulam), Mustang 306,25 SC (300 g/l 2,4D + 6.25 g/l florasulam), Casper 55 WG (500 g/kg dicamba + 50 g/kg prosulfuron) and Arat WG (500 g/kg dicamba + 250 g/kg tritosulfuron). The application of Kabadex Extra + Dasoil, Derby Super WG (in rates of 0.033 kg ha<sup>-1</sup> alone, 25 and 0.033 kg ha<sup>-1</sup> + Dasoil), as well as Starane Gold in rate of 1.5 l ha<sup>-1</sup> caused low phytotoxicity symptoms for the crop. The highest maize yield (984.19 kg da<sup>-1</sup>) as well as the highest herbicide efficacy against *Chenopodium album* L., *Amaranthus blitoides* L., *Xanthium strumarium* L., *Abutilon theophrasti* Medic., *Datura stramonium* L. and *Solanum nigrum* L. after the application of Kabadex Extra in rate of 0.033 l ha<sup>-1</sup> + Dasoil -1.0 l ha<sup>-1</sup> were found.

**Key words:** maize, weeds, herbicides, selectivity, efficacy.

### INTRODUCTION

To obtain high yields from the spring crops it is necessary to apply all agro technical measures effectively.

Such measures are proper crop, rotation, combine fertilization, effective pest control and especially efficient weed control (Dimitrova et al., 2019; Tonev et al., 2018; Neshev and Manolov, 2016; Manolov et al., 2015; Hristeva et al., 2014; Tonev et al., 2007). Weeds occur everywhere every year and cause enormous damage to cultivated plants, reducing yields and the production quality (Kostadinova et al., 2016; Kalinova and Yanev, 2015; Yanev, 2015; Yanev et al., 2014a; Yanev et al., 2014b; Tonev et al, 2007).

Studies by a number of authors show that, depending on the type and degree of weed infestation, the maize grain yield may be decreased from 24% to 96.7% (Dimitrova et al., 2013; Mukherjee and Debnath, 2013; Najafi and Tollenar, 2005; Oerke and Dehne, 2004; Khan et al., 2003; Zhaltov and Raikov, 1996)

A great number of weed species infest the maize fields. Some of the most distributed are *Amaranthus* spp., *Chenopodium album* L., *Abutilon theophrasti* Medik., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., etc (Tonev

et al., 2011; Tonev T., 2008; Nikolov et al., 2005; Mousavi, 2001).

Today, high-yield agriculture is highly dependent on herbicides as they are a vital and integral component of weed control practices (Goranovska and Yanev, 2016; Rao, 2000).

In maize, chemical weed control is usually done using broad-leaved and soil herbicides. In recent years weed control in maize with post emergence herbicide application is increased (Whaley et al., 2006; Airoldi, 2000) because of several reasons: 1. Restrictions on the use of terbutylazine; 2. Low efficacy of soil herbicides applied before germination because of not enough soil moisture; 3. Spread of triazine resistant weeds; 4. Introduction of effective broad-spectrum post-emergence herbicides. Considering the herbicides used in monoculture cultivation of maize, mesotrione is an interesting triketone that inhibits the HPPD enzyme (p-hydroxyphenyl pyroxygenase) and provides control of the major annual broad leaf weeds (Armel et al., 2003a; Johnson et al., 1999). Mesotrione provides a useful and flexible addition to the products already available, as it allows good control of some noxious weeds (Sutton et al., 2002).

Phytotoxicity data indicate that mesotrione can be considered relatively safe for the crop,

which appears to be significantly related to herbicide doses. However, the symptoms of phytotoxicity were always transient and dissipated after 4-5 weeks, without reducing maize grain yields. Similar results are obtained by Whaley et al. (2006), Stephenson et al. (2004) and Waltz et al. (1999). Nicosulfuron, for example is a postemergence sulfonylurea herbicide that even in low rates can control many difficult-to-control weeds at maize (Green and Hale, 2005). Integrating the intercrop tillage with contemporary herbicides at maize is a perspective way for obtaining high efficacy of weed control and decreasing the harmful after-effect of the products for plant protection (Ljubenov, 1988).

Travlos and Apostolidis (2017) found that Lancelot 450 WG (aminopyralid 300 g/kg + florasulam 150 g/kg) could be proposed as a very efficient herbicide for the control of the major broadleaf weeds, as well as alien and invasive species in the maize crop.

In a two year study conducted by Arnold et al. (2005) it was found that when nicosulfuron plus rimsulfuron and foramsulfuron were applied in combination with diflufenzopyr plus dicamba, dicamba plus atrazine, mesotrione, or dicamba the control of broadleaf weeds increased significantly.

The objective of the study is to determine the efficacy and selectivity of combined herbicides for broadleaf weeds control in maize.

## MATERIALS AND METHODS

The experiment was situated in the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The trial was conducted by the randomized block design in 4 replications. In both experimental years the grown maize hybrid was P9537. The maize was grown as monoculture under irrigated conditions. The size of the experimental plot is 28 m<sup>2</sup>. The study included the following treatments: 1. Untreated control; 2. Kabadex Extra (267 g/l mesotrione + 16.7 g/l florasulam) - 0.3 l ha<sup>-1</sup>; 3. Kabadex Extra + Dasoil (adjuvant) - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>; 4. Starane Gold SE (1 g/l florasulam + 100 g/l fluroxypyr) - 1.2 l ha<sup>-1</sup>; 5. Starane Gold SE - 1.5 l ha<sup>-1</sup>; 6. Derby Super WG (300 g/kg

aminopyralide-potassium + 150 g/kg florasulam) - 0.025 kg ha<sup>-1</sup>; 7. Derby Super WG - 0.033 kg ha<sup>-1</sup>; 8. Derby Super WG + Dasoil - 0.025 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>; 9. Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>; 10. Mustang 306,25 SC (300 g/l 2,4D + 6.25 g/l florasulam) - 0.5 l ha<sup>-1</sup>; 11. Casper 55 WG (500 g/kg dicamba + 50 g/kg prosulfuron) - 0.3 kg ha<sup>-1</sup>; 12. Arat WG (500 g/kg dicamba + 250 g/kg tritosulfuron) - 0.2 kg ha<sup>-1</sup>.

The herbicides were applied in 3<sup>rd</sup>-5<sup>th</sup> true leaf stage of maize (BBCH 13-14). The size of the spraying solution was 250 l ha<sup>-1</sup>.

On the trial field deep ploughing, two times disc harrowing and two times cultivation before sowing were done. On the whole experimental area basic combine fertilization with 250 kg ha<sup>-1</sup> NPK (15:15:15) and dressing with 300 kg ha<sup>-1</sup> NH<sub>4</sub>NO<sub>3</sub> was performed. The efficacy of the herbicides was recorded by visual scale of EWRS (European Weed Research Society) on the 14<sup>th</sup>, 28<sup>th</sup> and 56<sup>th</sup> day after application. The selectivity of the studied herbicide products was evaluated by the 9-score scale of EWRS - at score 0 - no damage on the crop and at score 9 - Severe damage up to complete destruction of the crop is found. The maize grain yield is determined by harvesting the whole experimental plot of each treatment in all four replications. On the trial field 6 dicotyledonous weeds typical for the maize crop were found. Their average density per 1 m<sup>2</sup> was as follows: *Chenopodium album* L. - 39 specimens; *Amaranthus blitoides* L. - 9 specimens; *Xanthium strumarium* L. - 11 specimens; *Abutilon theophrasti* Medic. - 7 specimens; *Datura stramonium* L. - 6 specimens and *Solanum nigrum* L. - 21 specimens or 93 weeds per 1 m<sup>2</sup> in total.

Statistical analysis for the yield data was performed by using Duncan's multiple range test by the software SPSS 19. Statistical differences were considered proved at p<0.05.

## RESULTS AND DISCUSSIONS

On Table 1 is shown the dynamics for the efficacy of the studied herbicide products against the weed *Ch. album* average for both years of the study. Average for the period, on the 14<sup>th</sup> day after treatments 100% efficacy only for the combine application of Kabadex

Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> was recorded. After the application of Casper 55 WG - 0.3 kg ha<sup>-1</sup> and Arat WG - 0.2 kg ha<sup>-1</sup> the efficacy on the 14<sup>th</sup> day after treatments was 90% and 95%, respectively. Lower efficacy for the treatments with Kabadex Extra - 0.3 l ha<sup>-1</sup>, Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> and Mustang 306,25 SC - 0.5 l ha<sup>-1</sup> was recorded - 75-85%. For the other treatments the efficacy was very low and varied from 10 to 55%. On the last reporting date (56<sup>th</sup> day after application) the herbicide efficacy increased and reached 100% for treatments Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>, Casper 55 WG - 0.3 kg ha<sup>-1</sup> and Arat WG - 0.2 kg ha<sup>-1</sup>. The other two treatments with satisfactory efficacy on the 56<sup>th</sup> day were Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> and Mustang 306,25 SC - 0.5 l ha<sup>-1</sup> - 95%.

Table 1. Efficacy of the evaluated herbicide products against *Ch. album* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra - 0.3 l ha <sup>-1</sup>	75	75	85
3. Kabadex Extra + Dasoil - 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE - 1.2 l ha <sup>-1</sup>	40	60	60
5. Starane Gold SE - 1.5 l ha <sup>-1</sup>	50	70	75
6. Derby Super WG - 0.025 kg ha <sup>-1</sup>	10	40	40
7. Derby Super WG - 0.033 kg ha <sup>-1</sup>	25	50	70
8. Derby Super WG + Dasoil - 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	55	70	85
9. Derby Super WG + Dasoil - 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	85	90	95
10. Mustang 306,25 SC - 0.5 l ha <sup>-1</sup> ;	80	90	95
11. Casper 55 WG - 0.3 kg ha <sup>-1</sup>	90	95	100
12. Arat WG - 0.2 kg ha <sup>-1</sup>	95	100	100

Table 2. Efficacy of the evaluated herbicide products against *A. blitoides* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra - 0.3 l ha <sup>-1</sup>	100	100	100
3. Kabadex Extra + Dasoil - 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE - 1.2 l ha <sup>-1</sup>	50	80	90
5. Starane Gold SE - 1.5 l ha <sup>-1</sup>	50	85	95
6. Derby Super WG - 0.025 kg ha <sup>-1</sup>	50	80	90
7. Derby Super WG - 0.033 kg ha <sup>-1</sup>	60	85	95
8. Derby Super WG + Dasoil - 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
9. Derby Super WG + Dasoil - 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
10. Mustang 306,25 SC - 0.5 l ha <sup>-1</sup> ;	100	100	100
11. Casper 55 WG - 0.3 kg ha <sup>-1</sup>	100	100	100
12. Arat WG - 0.2 kg ha <sup>-1</sup>	100	100	100

On Table 2 is shown the efficacy of the studied herbicides against *A. blitoides*. On the 14<sup>th</sup> day after the herbicide application unsatisfactory efficacy only for the products Starane Gold SE - 1.2 l ha<sup>-1</sup>, Starane Gold SE - 1.5 l ha<sup>-1</sup>, Derby Super WG - 0.025 kg ha<sup>-1</sup> and Derby Super WG - 0.033 kg ha<sup>-1</sup> was achieved - 50-60%. On the next evaluation dates the efficacy for these treatments increased and reached 90-95% on the 56<sup>th</sup> day. In all other variants 100% efficacy in the three reporting dates was observed.

In the filed crop rotation, one of the most difficult to control late spring weeds is *Xanthium strumarium* L. (Tonev et al., 2007; Tonev et al., 2011). All studied herbicide products in the study showed excellent control of this difficult-to-control dicotyledonous weed species. The results are shown on Table 3. Although the lower efficacy of Starane Gold SE - 1.2 l ha<sup>-1</sup> and Starane Gold SE - 1.5 l ha<sup>-1</sup> on the 1<sup>st</sup> evaluation date - 80%, on the last reporting date the efficacy reached 95%. All other treatments showed excellent efficacy against this weed.

Table 3. Efficacy of the evaluated herbicide products against *Xa. strumarium* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra - 0.3 l ha <sup>-1</sup>	90	95	100
3. Kabadex Extra + Dasoil - 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE - 1.2 l ha <sup>-1</sup>	80	90	95
5. Starane Gold SE - 1.5 l ha <sup>-1</sup>	80	90	95
6. Derby Super WG - 0.025 kg ha <sup>-1</sup>	90	100	100
7. Derby Super WG - 0.033 kg ha <sup>-1</sup>	95	100	100
8. Derby Super WG + Dasoil - 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
9. Derby Super WG + Dasoil - 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
10. Mustang 306,25 SC - 0.5 l ha <sup>-1</sup> ;	100	100	100
11. Casper 55 WG - 0.3 kg ha <sup>-1</sup>	100	100	100
12. Arat WG - 0.2 kg ha <sup>-1</sup>	100	100	100

The weed *A. theophrasti* was relatively resistant to some of the tested herbicide products of the experiment in both trial years (Table 4). After the application of Kabadex Extra - 0.3 l ha<sup>-1</sup>, Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> and Casper 55 WG - 0.3 kg ha<sup>-1</sup> the efficacy of 100% was found on the three reporting dates. The application of Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> showed 95% efficacy on the 14<sup>th</sup> day after application, but its efficacy also reached 100%

on the next reporting dates. The other treatments had lower efficacy that varied from 80 to 95% on the 56<sup>th</sup> day after treatments.

Table 4. Efficacy of the evaluated herbicide products against *A. theophrasti* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra – 0.3 l ha <sup>-1</sup>	100	100	100
3. Kabadex Extra + Dasoil – 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE – 1.2 l ha <sup>-1</sup>	50	70	80
5. Starane Gold SE – 1.5 l ha <sup>-1</sup>	50	75	85
6. Derby Super WG – 0.025 kg ha <sup>-1</sup>	60	85	85
7. Derby Super WG – 0.033 kg ha <sup>-1</sup>	75	90	90
8. Derby Super WG + Dasoil – 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	90	90	95
9. Derby Super WG + Dasoil – 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	95	100	100
10. Mustang 306,25 SC – 0.5 l ha <sup>-1</sup> ;	60	75	85
11. Casper 55 WG – 0.3 kg ha <sup>-1</sup>	100	100	100
12. Arat WG – 0.2 kg ha <sup>-1</sup>	80	85	85

Against the weed *D. stramonium* the efficacy of Starane Gold SE in both evaluated rates as well as that of Mustang 306,25 SC - 0.5 l ha<sup>-1</sup> was 70-80% on the 14<sup>th</sup> day after herbicide application. The efficacy against the concrete weed data is shown on Table 5. The efficacy of these treatments was increased on the next reporting days and reached 95-100% on the 56<sup>th</sup> day. For all other treatments, the obtained efficacy was 100% on the three reporting dates.

Table 5. Efficacy of the evaluated herbicide products against *D. stramonium* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra – 0.3 l ha <sup>-1</sup>	100	100	100
3. Kabadex Extra + Dasoil – 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE – 1.2 l ha <sup>-1</sup>	70	85	95
5. Starane Gold SE – 1.5 l ha <sup>-1</sup>	70	95	95
6. Derby Super WG – 0.025 kg ha <sup>-1</sup>	100	100	100
7. Derby Super WG – 0.033 kg ha <sup>-1</sup>	100	100	100
8. Derby Super WG + Dasoil – 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
9. Derby Super WG + Dasoil – 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
10. Mustang 306,25 SC – 0.5 l ha <sup>-1</sup> ;	85	95	100
11. Casper 55 WG – 0.3 kg ha <sup>-1</sup>	100	100	100
12. Arat WG – 0.2 kg ha <sup>-1</sup>	100	100	100

The efficacy results against the weed *S. nigrum* are presented on Table 6. The treatments from 2 to 9 had efficacy reaching 90%-100% against this weed. On the first reporting date the efficacy of Mustang 306,25 SC - 0.5 l ha<sup>-1</sup> was

70%, but on the next two days of reporting the efficacy reached 90%. The application of Casper 55 WG - 0.3 kg ha<sup>-1</sup> and Arat WG - 0.2 kg ha<sup>-1</sup> low efficacy ranging from 55 to 75% on the tree dates of evaluation.

Table 6. Efficacy of the evaluated herbicide products against *S. nigrum* average for 2018-2019 (%)

Treatments	Days after treatment		
	14 <sup>th</sup>	28 <sup>th</sup>	56 <sup>th</sup>
1. Untreated control	-	-	-
2. Kabadex Extra – 0.3 l ha <sup>-1</sup>	100	100	100
3. Kabadex Extra + Dasoil – 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
4. Starane Gold SE – 1.2 l ha <sup>-1</sup>	90	95	100
5. Starane Gold SE – 1.5 l ha <sup>-1</sup>	100	100	100
6. Derby Super WG – 0.025 kg ha <sup>-1</sup>	100	100	100
7. Derby Super WG – 0.033 kg ha <sup>-1</sup>	100	100	100
8. Derby Super WG + Dasoil – 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
9. Derby Super WG + Dasoil – 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	100	100	100
10. Mustang 306,25 SC – 0.5 l ha <sup>-1</sup> ;	70	90	90
11. Casper 55 WG – 0.3 kg ha <sup>-1</sup>	55	60	60
12. Arat WG – 0.2 kg ha <sup>-1</sup>	70	75	75

Regarding the selectivity of the studied herbicide products it was found that some of them caused temporary phytotoxicity. For the treatments with Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>, Derby Super WG - 0.033 kg ha<sup>-1</sup> and 8. Derby Super WG + Dasoil - 0.025 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> the visual phytotoxicity on the 14<sup>th</sup> day after the herbicide application was found to be score 1. For the treatments with Starane Gold SE - 1.5 l ha<sup>-1</sup> and Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> the phytotoxicity was score 2. The phytotoxicity symptoms were expressed in twisting of the leaves of single maize plants and in stunting the growth of the crop. On the 28<sup>th</sup> day after application the phytotoxicity was completely overcome. In all other variants visual symptoms of phytotoxicity were not observed. On Table 7 are presented the results for the obtained maize grain yield average for the period of the study. The differences in yields are determined by the herbicidal efficacy of the products and by their ability to control the weeds available in the experiment. The natural weed infestation with highly competitive weed species for 2017 and 2018 resulted in the lowest average yield for untreated control - 616.34 kg da<sup>-1</sup>).

Table 7. Maize grain yield average for 2017 and 2018

Treatments	Yields, kg da <sup>-1</sup>
1. Untreated control	616.34 a
2. Kabadex Extra – 0.3 l ha <sup>-1</sup>	855.60* d
3. Kabadex Extra + Dasoil – 0.3 l ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	984.19* g
4. Starane Gold SE – 1.2 l ha <sup>-1</sup>	758.13* b
5. Starane Gold SE – 1.5 l ha <sup>-1</sup>	760.49* b
6. Derby Super WG – 0.025 kg ha <sup>-1</sup>	766.91* b
7. Derby Super WG – 0.033 kg ha <sup>-1</sup>	808.06* c
8. Derby Super WG + Dasoil – 0.025 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	895.75* e
9. Derby Super WG + Dasoil – 0.033 kg ha <sup>-1</sup> + 1.0 l ha <sup>-1</sup>	940.08* f
10. Mustang 306,25 SC – 0.5 l ha <sup>-1</sup> ;	851.60* d
11. Casper 55 WG – 0.3 kg ha <sup>-1</sup>	898.51* e
12. Arat WG – 0.2 kg ha <sup>-1</sup>	854.14* d

Legend: All values with a \* sign have significant differences with the result of the untreated control. All values followed by different letters are with proved difference according to Duncan's test at P < 0.05.

In terms of mathematical proof, seven distinct groups of herbicides are distinguished (a, b, c, d, e, f, g). Here is also noted that the treatment with Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> is from group - g, and the most distinct group is for the untreated control - a. That means that this treatment has the highest yield.

## CONCLUSIONS

The highest herbicide efficacy against all weeds in the study after the application of Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> was recorded

The herbicide product Starane Gold SE in both evaluated rates showed lower efficacy against *Xa. strumarium* and *D. stramonium* in comparison to the other evaluated herbicide products in the study.

The addition of the adjuvant Dasoil to the herbicide product Derby Super WG applied in rates of 0.025 and 0.033 kg ha<sup>-1</sup> increased the efficacy against the weeds *Ch. album*, *A. blitoides* and *A. theophrasti*.

The application of Kabadex Extra + Dasoil - 0.3 l ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>, 7. Derby Super WG - 0.033 kg ha<sup>-1</sup>, Derby Super WG + Dasoil - 0.025 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup>, Derby Super WG + Dasoil - 0.033 kg ha<sup>-1</sup> + 1.0 l ha<sup>-1</sup> and Starane Gold SE - 1.5 l ha<sup>-1</sup> caused temporary phytotoxicity that was completely overcome.

Mathematically proven differences in maize grain yield were reported in favor of all herbicide-treated variants versus the untreated control.

The highest maize grain yield after the application of Kabadex Extra in rate of 0.033 l ha<sup>-1</sup> + Dasoil – 1.0 l ha<sup>-1</sup> was recorded - 984.19 kg da<sup>-1</sup>.

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