Scientific Papers. Series A. Agronomy, Vol. LXII, No. 1, 2019
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

HERBICIDE CONTROL OF THE WEEDS IN MAIZE (*Zea mays* L.)

Anyo MITKOV[1], Mariyan YANEV[1], Nesho NESHEV[1], Miroslav TITYANOV[2], Tonyo TONEV[1]

[1]Agricultural University of Plovdiv, Department of Agriculture and Herbology, 12 Mendeleev Street, 4000, Plovdiv, Bulgaria
[2]Agricultural University of Plovdiv, Department of Chemistry, 12 Mendeleev Street, 4000, Plovdiv, Bulgaria

Corresponding author email: n_neshev85@abv.bg

Abstract

During the period of 2017-2018 a field study with maize (Zea mays L.) was conducted. The experiment was situated on the experimental field of the Agricultural University of Plovdiv, Bulgaria. Variants of the trial were as follows: 1. Untreated control; 2. Equip OD (75 g/l mesotrione + 30 g/l nicosulfuron) - 2500 ml/ha; 3. Elumis OD (75 g/l mesotrione + 30 g/l nicosulfuron) - 2000 ml/ha; 4. Arigo WG (360 g/kg mesotrione + 120 g/kg nicosulfuron + 30 g/kg rimsulfuron) + Trend 90 - 330 g/ha + 1000 ml/ha; 5. Samson Extra 6 OD (60 g/l nicosulfuron) - 750 ml/ha; 6. Samson 4 OD (40 g/l nicosulfuron) - 1250 ml/ha; 7. Principal Plus WG (552 g/kg dicamba + 92 g/kg nicosulfuron + 23 g/kg rimsulfuron) + Trend 90 - 440 g/ha + 1000 ml/ha; 8. Capreno SC (345 g/l tembotrione + 68 g/l thiencarbazone-methyl + 134 g/l isoxadifen-ethyl) + Mero - 290 ml/ha + 2000 ml/ha. The grown maize hybrid was "P 9241". The efficacy of the studied herbicide products against the weeds was evaluated. The highest yield was achieved after the application of Principal Plus WG – 1.53 t/ha average for both years.

Key words*: maize, herbicides, efficacy, yields.*

INTRODUCTION

Maize (*Zea mays* L.) is main grain-forage crop with adaptive ability to different geographical and climatic conditions. That is the reason for the successful growing of this culture in many regions around the globe. In Bulgaria it is strategical field crop. Maize has the highest energy value in comparison to the others forage crops (Tomov & Yordanov, 1984).

One of the main negative factors for agricultural production is the weeds. They decrease the yields and the quality of maize grain (Spasov, 1995; Masqood et al., 1999; Tonev, 2000; Changsaluk et al., 2007).

In Bulgaria, economically the most important weeds at this crop are *Amaranthus retroflexus* L., *Datura stramonium* L., *Xanthium strumarium* L., *Solanum nigrum* L., *Chenopodium album* L., *Abutilon theophrasti* L., *Sinapis arvensis* L., *Echinochloa crus-gali* L., *Setaria glauca* L., *Sorghum halepense* L., *Convolvulus arvensis* L., *Cynodon dactilon* L. and *Cirsium arvense* L. (Hristova et al., 2012; Kalinova et al., 2012).

The maize grain yield can decrease from 24% to 96.7% (Mukherjee and Debnath, 2013; Oerke & Dehne, 2004; Zhalnov & Raikov, 1996).

The monoculture growing of maize can lead to increase of the population of *S. halepense, C. arvense*, *C. arvensis* L., *C. dactilon* and other perennial weed species.

The most efficient and economically most effective and environmentally safest is integrated weed control. It includes applicayion of different weed control means - mechanical, chemical, cultural, biological etc. (Tonev, 2013).

The chemical method is the most often used by the farmers. The method is highly effective, fast and easy to apply. The proper herbicide application reduces the weed management costs up to 60%. The fuel cost as well the soil erosion are also decreased (Valcheva, 2011).

The aim of the study is to evaluate the possibilities for efficient chemical weed control in maize.

MATERIALS AND METHODS

During the 2017 and 2017 a field experiment was carried out in the experimental base of the Department of Agriculture and Herbology of the Agricultural University of Plovdiv,

Bulgaria. The studied maize (*Zea mays* L.) hybrid was "P 9241". The trial was conducted by the randomized block design in 4 replications. The size of the harvesting plot was 28 m^2.

The variants of the trial were: 1. Untreated control; 2. Equip OD (75 g/l mesotrione + 30 g/l nicosulfuron) - 2500 ml/ha; 3. Elumis OD (75 g/l mesotrione + 30 g/l nicosulfuron) - 2000 ml/ha; 4. Arigo WG (360 g/kg mesotrione + 120 g/kg nicosulfuron + 30 g/kg rimsulfuron) + Trend 90 (adjuvant) - 330 g/ha + 1000 ml/ha; 5. Samson Extra 6 OD (60 g/l nicosulfuron) - 750 ml/ha; 6. Samson 4 OD (40 g/l nicosulfuron) - 1250 ml/ha; 7. Principal Plus WG (552 g/kg dicamba + 92 g/kg nicosulfuron + 23 g/kg rimsulfuron) + Trend 90 - 440 g/ha + 1000 ml/ha; 8. Capreno SK (345 g/l tembotrione + 68 g/l thiencarbazone-methyl + 134 g/l isoxadifen-ethyl) + Mero (adjuvant) - 290 ml/ha + 2000 ml/ha.

The herbicide products were applied in BBCH 14-15. The volume of the spraying solution was 250 l/ha.

The efficacy of the studied herbicides against the weeds was performed by the 10 score scale of EWRS (European Weed Research Society) on the 14th, 28th and on the 56th day after application.

The selectivity of the herbicides was evaluated by the 9 score scale of EWRS.

The yield was recorded by harvesting the whole experimental plot of every repetition from each treatment.

Statistical analysis of collected data was performed by using Duncan's multiple range test of SPSS 17 program. Statistical differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSIONS

The existing weeds on the experaimental field were *Setaria viridis* L.*, Echinochloa crus-gali* L., *Sorghum halepense* Pers. developed from seeds, *Chenopodium album* L., *Amaranthus retroflexus* L., *Xanthium strumarium* L., *Abutilon theophrasti* Medic., *Datura stramonium* L., *Solanum nigrum* L., *Portulaca oleracea* L., *S. halepense* developed from rhizomes and *Cynodon dactylon* L.

On Table 1 is shown the dynamics considering the efficacy of the studied herbicide products against *S. viridis*. In both experimental years, on the 14th day after the herbicide application the efficacy is not satisfactory, but the weed is depressed, growth retardation is also observed. On the next evaluation dates very high efficacy is reported. The efficacy ranges from 85 to 100% on the 56th day after treatments.

Table 1. Efficacy of the studied herbicide products against *S. viridis,* average for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	75	85	90
3. Elumis OD	75	85	90
4. Arigo WG + Trend 90	85	95	95
5. Samson Extra 6 OD	85	100	100
6. Samson 4 OD	85	95	100
7. Principal Plus WG +Trend 90	80	90	100
8. Capreno SK + Mero	60	75	85

The efficacy against *E. crus-gali* is on Table 2. The data from the reports showed efficacy percentage close to those of *S. viridis*.

On the first reporting date the results are low and increasing in the next evaluations. The lowest efficacy is recorded to be for treatment 8 (Capreno SK + Mero - 290 ml/ha + 2000 ml/ha).

In previous study Mitkov et al. (2018) observed the highest efficacy against *Echinochloa crus-galli* L. for Merlin Duo at rate of 2.00 l/ha.

Table 2. Efficacy of the studied herbicide products against *E. crus-gali,* average for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	80	90	95
3. Elumis OD	80	90	95
4. Arigo WG + Trend 90	85	95	95
5. Samson Extra 6 OD	85	95	100
6. Samson 4 OD	80	90	100
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	60	75	85

The efficacy against *S. halepense* developed from seeds is on Table 3.

All studied herbicide products sucseffully control *S. halepense* Pers. developed from seeds. On the last evaluation date, the weed is 100% controlled independently the herbicide product.

Table 3. Efficacy of the studied herbicide products against *S. halepense* developed from seeds for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	90	100	100
3. Elumis OD	80	90	100
4. Arigo WG + Trend 90	85	95	100
5. Samson Extra 6 OD	85	100	100
6. Samson 4 OD	80	95	100
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	80	90	100

The efficacy data against *Ch. album* for 2017-2018 is shown on table 4.

Against this weed the efficacy of Arigo WG + Trend 90 and Principal Plus WG + Trend 90 was excellent - 100% on the 3rd evaluation date 56 days after the herbicide treatments. The efficacy of Equip OD, Elumis OD and Capreno SK + Mero is lower and raging from 85 to 90%. Unsatisfactory efficacy from the treatments with Samson 4 OD and Samson Extra 6 OD was recorded - fromт 35 to 40%. If there is high infestation with *Chenopodium album* L. tank mixture of Mustang® 306.25 SC + Nishin® 4 OD at rates of 600 ml/ha + 1300 ml/ha can be successfully applied (Tonev et al., 2016).

Table 4. Efficacy of the studied herbicide products against *Ch. album* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	70	85	85
3. Elumis OD	70	80	90
4. Arigo WG + Trend 90	80	90	100
5. Samson Extra 6 OD	80	60	40
6. Samson 4 OD	75	55	35
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	80	90	90

Independently the applied herbicide product, on the last reporting date the efficacy reached 100% for all treatments (Table 5). It was observed for bot experimental years.

Damalas et al. (2018) report excellent efficacy against *A. retroflexus* after treatment with herbicide mixtures based on tembotrione + rimsulfuron, nicosulfuron or foramsulfuron (label rates for weed control in maize).

Zhao et al. (2017) observed excellent efficacy against *A. retroflexus* after application of Isoxaflutole, Mesotrione and Isoxaflutole + acetochlor in both experimental years of their research.

Table 5. Efficacy of the studied herbicide products against *A. retroflexus* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	85	95	100
3. Elumis OD	80	90	100
4. Arigo WG + Trend 90	85	95	100
5. Samson Extra 6 OD	80	90	100
6. Samson 4 OD	75	95	100
7. Principal Plus WG +Trend 90	90	95	100
8. Capreno SK + Mero	80	90	100

From all annual dicotyledonous weeds present in the study, *Xa. strumarium* was the most difficult to control. The obtained results are shown on table 6.

For none of the studied herbicide products, the efficacy reached satisfactory results. The efficacy of Equip OD, Principal Plus WG + Trend 90 and Capreno SK + Mero the average efficacy for both trial years was fom 85 to 90%. On the first evaluation date the efficacy of Arigo WG + Trend 90 was 70%, but the weed recovered to some extend and on the last reporting date the efficacy decreased to 50%. From the rest three herbicides the efficacy was 0% on last reporting date.

Saflufenacil and saflufenacil + dimethenamid-p applied pre-emergence and dicamba, dicamba + diflufenzopyr, dicamba + atrazine and mesotrione + atrazine applied post-emergence had the potential to provide from good to excellent control of common cocklebur in corn (Soltani et al., 2010).

Table 6. Efficacy of the studied herbicide products against *Xa. strumarium* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	70	80	85
3. Elumis OD	40	10	0
4. Arigo WG + Trend 90	70	60	50
5. Samson Extra 6 OD	20	5	0
6. Samson 4 OD	15	5	0
7. Principal Plus WG +Trend 90	70	85	90
8. Capreno SK + Mero	75	85	90

On Table 7 is shown that the average efficacy of Equip OD, Principal Plus WG + Trend 90 and Capreno SK + Mero for 2017-2018 was 100% on the last reporting date.
The efficacy of the other treatments was with very low differences and also was excellent – from 90 to 95%.
The weed *Abuthilon theophrasti* L. can also be controlled by application of Merlin® Duo (Mitkov et al., 2018)

Table 7. Efficacy of the studied herbicide products against *A. theophrasti* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	80	90	100
3. Elumis OD	80	90	95
4. Arigo WG + Trend 90	75	90	95
5. Samson Extra 6 OD	75	90	90
6. Samson 4 OD	75	85	90
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	80	95	100

After the application of Equip OD, Arigo WG + Trend 90, Principal Plus WG + Trend 90 and Capreno SK + Mero the recorded efficacy against *D. stramonium* on the 56th day after treatments reached 100%.
The efficacy Elumis OD, Samson Extra 6 OD and Samson 4 OD was also excellent reaching from 90 to 95% (Table 8).
The application of nicosulfuron + dicamba + bentazon; nicosulfuron + dicamba + bentazon; nicosulfuron + tritosulfuron + icamba; nicosulfuron + mesotrione; nicosulfuron + mesotrione + atrazine; etc. can have very good results for controlling *D. stramonium* (Torma et al., 2006).

Table 8. Efficacy of the studied herbicide products against *D. stramonium* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	85	95	100
3. Elumis OD	85	95	95
4. Arigo WG + Trend 90	80	95	100
5. Samson Extra 6 OD	75	85	90
6. Samson 4 OD	75	85	90
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	80	95	100

All herbicide products successfully control the weed *S. nigrum* from the first evaluation date to the 56th after the treatments average for both trial years (Table 9).
According to Pannacci and Covarelli (2009), in order to obtain 95% of efficacy against *S. nigrum*, mesotrione could be used at 1/6 of the maximum labelled dose (150 g a.i./ ha).
According to Mitkov et al. (2018) *Solanum nigrum* can be also controlled successfully with Merlin® Duo, Adengo® 465 SC and Lumax® 538 SC.

Table 9. Efficacy of the studied herbicide products against *S. nigrum* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	90	100	100
3. Elumis OD	85	95	100
4. Arigo WG + Trend 90	90	95	100
5. Samson Extra 6 OD	80	90	100
6. Samson 4 OD	80	95	100
7. Principal Plus WG +Trend 90	95	100	100
8. Capreno SK + Mero	85	95	100

The efficacy results against the weed *P. oleracea* average for the period are shown on Table 10. Dogan et al. (2005) reported 90% efficacy against *Portulaca oleracea* when nicosulfuron (Samson) and 2.4 D amine salt (Di Amin) was applied.
In our trial all evaluated herbicide products achieved excellent control of this weed average for both years. The efficacy was very high from the 14th day after application till the last reporting date.

Table 10. Efficacy of the studied herbicide products against *P. oleracea* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	90	95	100
3. Elumis OD	85	95	100
4. Arigo WG + Trend 90	80	90	100
5. Samson Extra 6 OD	85	95	100
6. Samson 4 OD	80	95	100
7. Principal Plus WG +Trend 90	85	95	100
8. Capreno SK + Mero	80	95	100

The efficacy against the *S. halepense* developed from rhizomes is shown Table 11.

None of the evaluated herbicides showed 100% efficacy against this weed average for the period of the experiment.

The highest efficacy is achieved after the application of Equip OD starting from 70% on the 14th day after the herbicide application and reaching 95% on the 56th day. The efficacy of nicosulfuron-containing herbicide products - Samson Extra 6 OD, Samson 4 OD, Principal Plus WG and Arigo WG was lower but good. Very poor efficacy was reported for the products Elumis OD Capreno SK – 40% on the 56th after treatments.

In field experiments were carried out in Greece from by Eleftherohorinos and Kotoula-Syka (1995) the authors also observed satisfactory efficacy against *S. halepense* from rhizomes after application of nicosulfuron.

No efficacy (0%) was found against *S. halepense* after the application of Merlin® Duo, Adengo® 465 SC and Lumax® 538 SC (Mitkov et al., 2018).

Table 11. Efficacy of the studied herbicide products against *S. halepense* developed from rhizomes for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	70	85	95
3. Elumis OD	20	30	40
4. Arigo WG + Trend 90	65	75	85
5. Samson Extra 6 OD	65	85	90
6. Samson 4 OD	60	80	90
7. Principal Plus WG +Trend 90	65	80	85
8. Capreno SK + Mero	20	30	40

On the three evaluation dates the efficacy against *C. dactylon* was 0% independently the studied herbicide product (Table 12).

Table 12. Efficacy of the studied herbicide products against *C. dactylon* for 2017-2018, %

Treatments	Days after application		
	14th	28th	56th
1. Untreated control	-	-	-
2. Equip OD	0	0	0
3. Elumis OD	0	0	0
4. Arigo WG + Trend 90	0	0	0
5. Samson Extra 6 OD	0	0	0
6. Samson 4 OD	0	0	0
7. Principal Plus WG +Trend 90	0	0	0
8. Capreno SK + Mero	0	0	0

No visible signs of phytotoxicity were reported for any of the treatments.

The weeds decrease the yields and the quality of maize grain (Masqood et al., 1999). The results of the comparative analysis of the yield per hectare showed that during the two years of the study, significant differences in the benefit of the individual treated variants compared to the untreated control were demonstrated (Figure 1).

The highest grain yield was recorded for the treatment with Principal Plus WG + Trend 90 – 1.53 t/ha average for both years of the research. The result was with proven difference according to Duncan's multiple range test ($p < 0.05$). The yield from the variants treated with Equip OD, Arigo WG + Trend 90 and Capreno SK + Mero were with lower yields - 1.02, 0.99 and 0.95 t/ha respectively. The treatments with Elumis OD, Samson Extra 6 OD and Samson 4 OD had lower yields. The lowest yield from the study was reported for the untreated control – 0.57 t/ha.

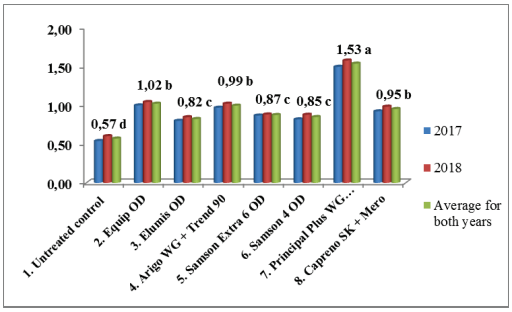

Figure 1. Maize grain yield, t/ha

Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$).

CONCLUSIONS

The herbicide products Principal Plus WG, Samson Extra 6 OD and Samson 4 OD had the highest efficacy against *S. viridis* and *E. crus-galli* L.

The best herbicide effect is against *Ch. album* L. for Principal Plus WG and Arigo WG was observed.

Xa. strumarium was the most difficult to control dicotyledonous weed from the treatments with Arigo WG, Elumis OD, Samson Extra 6 OD and Samson 4 OD.

All herbicide products showed excellent efficacy against weeds *A. theophrasti* and *D. stramonium*.

The lowest herbicide efficacy against *S. halepense* developed prom rhizomes for Elumis OD and Capreno SK was reported.

The most difficult-to-control-weed present in the field was *C. dactylon* L. The efficacy against this weed was 0 % independently the studied herbicide product and evaluation date.

The highest grain yield was recorded for the treatment with Principal Plus WG + Trend 90, and the lowest yield for the untreated control was recorded.

ACKNOWLEDGEMENTS

This research work was carried out with the support of The Center for Biological Examination of Products for Plant Protection at the Agricultural University of Plovdiv, Bulgaria.

REFERENCES

Changsaluk, S., Pornprom, T., Waramitr, N., Suwanmakkha, R., Pathom, N., Lim-aroon, S. (2007). Effect of weed densities of fresh corn yield. Proceedings of the 45th Kasetsart University, Annual. Conference, Bangok, Thailand, 30 January-2 February, on CD.

Damalas, Ch., Gitsopoulos, T., Koutroubas, S., Alexoudis, Ch., Georgoulas, I. (2018). Weed control and selectivity in maize (*Zea mays* L.) with tembotrione mixtures. *International Journal of Pest Management, 64*(1), 11–18, DOI: 10.1080/09670874.2017.1293307

Dogan, M., Boz, O., Unay, A. (2005). Efficacies of Reduced Herbicide Rates for Weed Control in Maize (*Zea mays* L.) During Critical Period. *Journal of Agronomy*, *4*, 44–48. DOI: 10.3923/ja.2005.44.48.

Eleftherohorinos, I., and Kotoula-Syka, E. (1995). Influence of herbicide application rate and timings for post-emergence control of *Sorghum halepense* (L.) Pers. Maize. *Weed Research*., *35*(2), 99–103.

Hristova, S., Nankov, M., Georgiva, I., Tonev, T., Kalinova, Sht. (2012). Influence of Wild mustard (*Sinapis arvensis* L.) on the growth and productivity of maize hybrid KH-613. *Collection of Reports of the 9th Scientific and Technical Conference with International Participation „Ecology and health"*, 277–282.

Kalinova, Sht., Zhalnov, I., Yanchev, I. (2000). Influence of the combined action of Stomp 33 EK and Mistral 4 SK on the weeds in maize. *Journal of Mountain Agriculture on the Balkans, 3*(6), 705–712.

Khan, M., Marwat, K., Khan, N. (2003). Efficacy of different herbicides on the yield and yield components of maize. *Asian J. Plant Sci*., *2*(3), 300–304.

Maqsood, M., Akbar, M., Yousaf, N., Mahmood, M., Ahmed, S. (1999). Studies on weed–crop competition in maize. *International Journal of Agriculture & Biology, 4*, 270–272.

Mitkov, A., Yanev, M., Neshev, N., Tonev, T. (2018). Biological Efficacy of Some Soil Herbicides at Maize (*Zea mays* L.). *Scientific Papers. Series A. Agronomy, LXI*(1), 340–345. ISSN 2285-5785.

Mukherjee, P., and Debnath, P. (2013). Weed control practices in maize (*Zea mays* L.) under conventional and conservation tillage practices. The role of weed science in supporting food security by 2020. *Proceedings of the 24th Asian-Pacific Weed Science Society Conference, Bandung, Indonesia, October 22-25, Bandung: Weed Science Society of Indonesia*, 302–311.

Oerke, E., Dehne, H. (2004). Safequarding production–losses in major crops and the role of crop protection. *Crop Prot*., *23*, 275–285.

Pannacci, E., and Covarelli, G. (2009). Efficacy of mesotrione used at reduced doses for post-emergence weed control in maize (*Zea mays* L.). *Crop Protection*, *28*(1), 57–61.

Soltani, N., Shropshire, C., Sikkema, P. (2010). Control of common cocklebur (*Xanthium strumarium* L.) in corn. *Canadian Journal of Plant Science, 90*(6), 933–938. https://doi.org/10.4141/cjps10065

Spasov, V. (1995). Habilitation for the academic title „Professor". (In Bulgarian).

Tomov, N., and Yordanov, Yo. (1984). The maize in Bulgaria Publisher: "Zemizdat", Sofia (pp. 315) (Book in Bulgarian).

Tonev, T. (2000). *Integrated weed management and proficiency of agriculture*. Publisher "VSI Plovdiv". (pp. 221–222) (In Bulgarian).

Tonev, T., Tityanov, M., Mitkov, A., Yanev, M., Neshev, N., 2016. Control of highly blended weeding at maize (*Zea mays* L.). *Book of Proceedings, VII International Scientific Agriculture Symposium "Agrosym 2016", Jahorina*, October 06th - 09th, 1256–1262.

Tonev, T. (2013). Complexed control of the weeds. *Plant Protection*, *2*, 18.

Torma, M., Kazinczi, G., HÓDI, L. (2006). Postemergence herbicide treatments in maize against difficult to control weeds. *Hungary Journal of Plant Diseases and Protection*, *XX*, 781–786. ISSN 1861-4051.

Valcheva, A. (2011). Efficient control of the weeds in sunflower and maize. *Practical Agriculture*, *2*(4), 13.

Zhao, N., Zuo, L., Li, W., Guo, W., Liu, W., Wang, J. (2017). Greenhouse and field evaluation of isoxaflutole for weed control in maize in China. Scientific Reports 7: 12690, 1–9. DOI:10.1038/s41598-017-12696-7.