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THE SELECTIVITY, EFFICACY AND INFLUENCE OF FIVE HERBICIDE TREATMENTS ON THE YIELD AND CROP HEIGHT IN MAIZE

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ABSTRACT

The use of herbicide treatments is an important method for reducing the competition between crop and weeds.

The main objective of this paper is to investigate the degree of selectivity and the effectiveness of five new herbicides applied early post-emergently (stage of development of crop 2-4 leaves; stage of development of weeds 1-3 leaves) in the control of the annual and perennial monocotyledonous and dicotyledonous weed species from the maize crop.

The study was performed on cambic chernozem in the experimental) fields of the National Agricultural Research and Development Institute Fundulea in the years 2017 and 2018.

The herbicide treatments were: Adengo [isoxaflutol 225 g/l + tiencarbazon-metil 90 g/l + ciprosulfamide (safener) 150 g/l] + Lontrel 300 (300 g/l clopyralid); Adengo [isoxaflutol 225 g/l + tiencarbazon-metil 90 g/l + ciprosulfamide (safener) 150 g/l], Merlin Duo (isoxaflutol 37,5 g/l + terbutilazin 375 g/l), Akris (dimetenamid-P 280 g/l + terbutilazin 250 g/l) and Arigo (nicosulfuron 12% + rimsulfuron 3% + mezotrione 36%) + Adj. (Trend).

In this study, best control of annual and perennial weeds was achieved in the experimental variants: Adengo + Lontrel; Arigo + Adj. The herbicides application must be correlated with: the infestation degree of weeds, the spectrum and dominance of weeds, the time of application, the type of soil, the local climatic conditions.

Keywords: maize, herbicides, selectivity, efficacy, time of application, weeds.

INTRODUCTION

The Maize (*Zea mays* L.) is one of the most important and valuable cultivated plants due to high productivity and multiple uses of its products to feed people, livestock and industry.

The areas cultivated with maize show a high degree of infestation over 80% with annual and perennial monocotyledonous and dicotyledonous weeds, highly differentiated, depending on the zone pedoclimatic conditions.

The most significant weed species are: monocotyledonous *Setaria* sp*., Echinochloa crus-galli, Sorghum halepense* (from seed and rhizomes), *Elymus repens, Eriochloa villosa* and dicotyledons*: Amaranthus retroflexus, Chenopodium album, Xanthium strumarium, Solanum nigrum, Sinapis arvensis, Raphanus raphanistrum, Stellaria media, Thlaspi arvensis, Hibiscus trionum, Datura stramonium, Abutilon theophrasti, Cirsium arvense, Convolvulus arvensis, Sonchus arvensis*.

The floral composition of the weeds in the maize crop in Romania is very varied. It is related to the number of species present, especially of the many combinations between the different biological groups. This variety is explained by the great diversity of the pedoclimatic conditions existing in the areas where this crop is grown.

The weeds are dangerous in the maize crops, as this crop has a low capacity of competition with the segetal species, especially during the first vegetation period (Anghel et al., 1972).

The weeds are harmful plants for agriculture; they produce high damages by decreasing the

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yield of cultivated plants and by depreciating the crops (Anghel et al., 1972).

In the field of weed controlling, the main objective has permanently been to eliminate, during all the vegetation period, the weed competition, by reducing the infestations below the level of the damage threshold, i.e. the consumption of water and nutrients by the weeds, contributing finally to obtaining high quality and high yields, corresponding to the level of biological potential of maize hybrids (Bârlea and Segărceanu, 1985; Șarpe, 1987; Guș et al., 2001).

The rich assortment of herbicides approved for the conditions of Romania, at the optimal doses and application times, depending on the soil type, the degree of infestation, the spectrum and the dominance of the weeds and, last but not least, the climatic conditions, allows the establishment of "optimal strategies for weed control in the maize crop", on agricultural areas, for obtaining superior results in the control of weeds (over 90%) (Popescu, 2007).

In the last years, numerous researches have been carried out regarding the application of the new types of herbicides combined (based on 2-3 active substances), applied early post-emergently (maize 2-4 leaves), with the effect of controlling the annual weeds, under the conditions of the optimum phase of weed development at the time of treatment (Popescu, 2007).

In a modern agriculture, in the integrated weed management, the use of the chemical control method remains a very important link contributing to the increase of yields by reducing the weed competition (Șarpe et al., 1975; Vlăduțu et al., 1988). Although the nature of crop production varies widely around the world, herbicides have become a primary tool for weed control in most areas. (Peterson et al., 2017).

The purpose of the work carried out during the research period was to identify technological solutions regarding weed control for maize crop by applying herbicides (combinations and associations of herbicides), with the objective of broadening the control spectrum, synergism, persistence and without negative impact on the environment.

MATERIAL AND METHODS

The research was carried out in the experimental field from NARDI Fundulea. The experiment was placed on a cambic chernozem type of soil with a pH of 6.5, a clay content of 37% and a humus content of 3.2%. The biological material used in the experimental field was the maize hybrid Olt.

The experiment was in randomized block design in 4 replications. The size of the experimental plot was 25 m^2 (3.20 x 7.80 m).

The moment of herbicide treatment application was early post emergently.

The treatment variants for which the herbicide effectiveness was tested, using the water volume 400 l/ha are presented in Table 1.

Table 1. The herbicide treatments applied in maize crop.
Experimental variants

No. var.	Herbicide treatments	Active ingredient	Dose (g, l/ha)	Time of application
1	UNTREATED	-	-	-
2	Adengo + Lontrel	isoxaflutol 225 g/l + tiencarbazon-metil 90 g/l + ciprosulfamide (safener) 150 g/l + 300 g/l clopyralid	0.35 l + 0.4 l	Early postemergently; maize (BBCH 12-14 2-4 leaves)
3	Adengo	isoxaflutol 225 g/l + tiencarbazon-metil 90 g/l + ciprosulfamide (safener) 150 g/l	0.35 l	
4	Merlin Duo	isoxaflutol 37.5 g/l + terbutilazin 375 g/l	2.0 l	
5	Akris	dimetenamid-P 280 g/l + terbutilazin 250 g/l	2.5 l	
6	Arigo + Trend (Adj.)	nicosulfuron 12% + rimsulfuron 3% + mezotrione 36%	330 g + 0.25 l	

The maize hybrid Olt is part of the FAO 450-500 group, with a vegetation period of 135-138 days. It is resistant to breaking and falling, resistant to drought and heat, resistant to *Ostrinia nubilalis* and *Helicoverpa zeae*. It is noted for its high ecological plasticity.

The main objective of this paper was to determine the degree of selectivity and the effectiveness of the herbicides applied in the early postemergence (stage of development of crop 2-4 leaves; stage of development of weeds 1-3 leaves) in the control of the annual and perennial monocotyledonous and dicotyledonous weed species from the maize crop.

Following the application of herbicide treatments, observations were made regarding the degree of selectivity (%) at intervals of 7-14-28 days after treatment and the degree of control (%) of weeds at intervals of 14-28-56 days from treatment.

RESULTS AND DISCUSSION

The results of the experiment showed an infestation degree of 65-70% (the ratio mono 55%/45% dicots), extremely diversified monocotyledonous and dicotyledonous annual and perennial weeds being present, depending on: the preceding crop and the local pedoclimatic conditions.

In the experimental field, in 2017-2018 years, the most representative weed species (Figure 1) were annual monocotyledons: *Setaria viridis (SET), Echinochloa crus-galli (ECHCG), Sorghum halepense (SORHA)* and annual dicotyledons*: Amaranthus retroflexus (AMARE), Solanum nigrum (SOLNI), Chenopodium album (CHEAL), Xanthium strumarium (XANST), Polygonum convolvulus (POLCO)* and perennials: *Cirsium arvense (CIRAR)*.

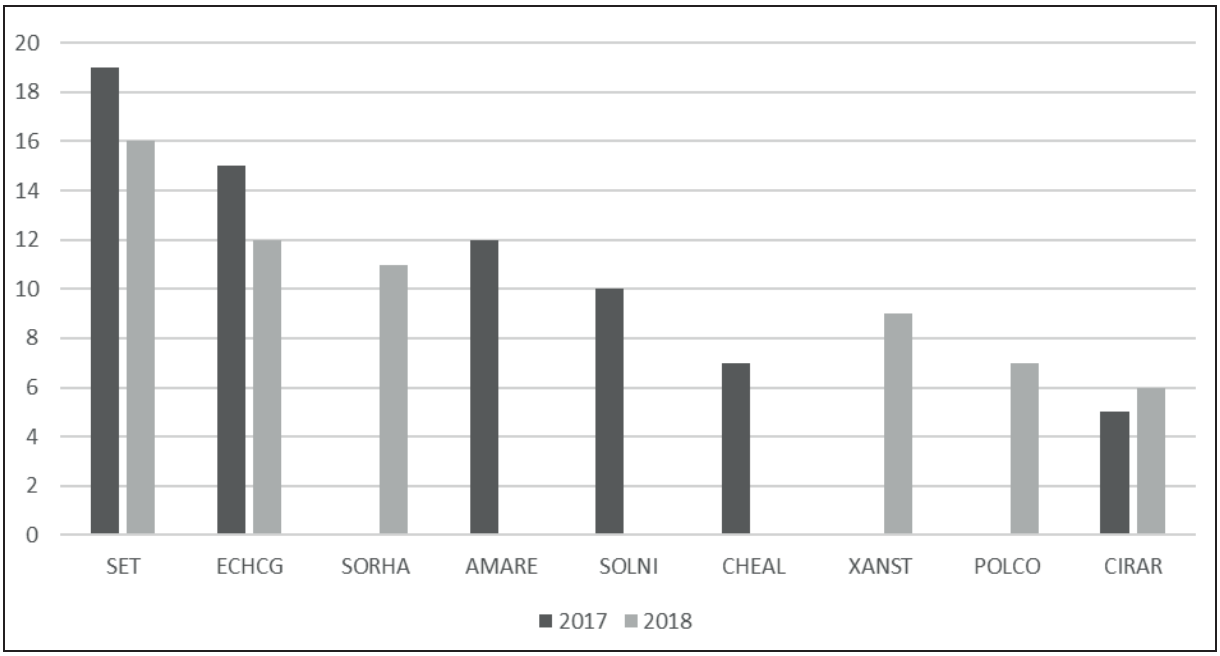

Figure 1. The weed species (%) present in maize crops

In the two years of research, the spectrum of weeds in maize was different because of the reserve of weeds seeds in the soil and their staggered emergence influenced by the climatic conditions (Figure 2).

In the maize crop, the weeds from the soil reserve make their appearance even before the emergence of the crop or concomitantly with the crop, leading to: water loss, consumption of nutrients, the stress on the cultivated plant. Therefore, it is necessary to apply herbicide treatments in the early stages of weed development.

Good results were obtained this way regarding the control of the weeds, their elimination in the early stage of development proved to be a good management measure.

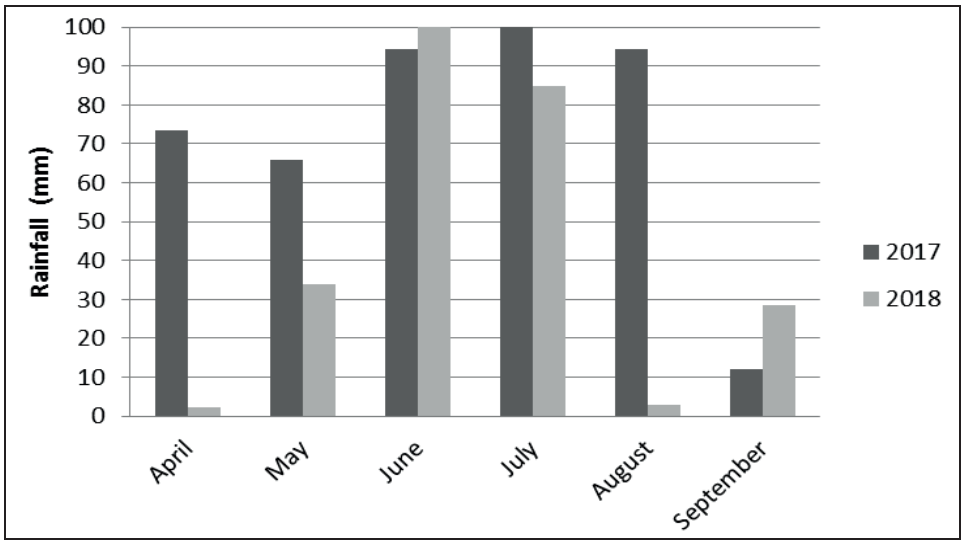

Figure 2. The weather conditions (rainfall) of the years 2017 and 2018

In 2017, the weather conditions were normal. The sum of precipitations along the entire vegetation period was 453.8 mm (April - 73.4 mm; May - 65.8 mm; June - 94.4 mm, July - 113.6 mm, August - 94.4 mm, September - 12.2 mm). The year 2018 was drier, the amount of precipitations didn't exceed a total of 271.2 mm and this quantity was unevenly distributed throughout the vegetation period.

The large difference in sum of precipitation along vegetation seasons (182.6 mm) and especially the drought from April-May 2018 may influenced the presence of some annual monocotyledon species.

In each year the results from the efficacy evaluations from 14, 28 and 56 days after treatments applications (including replicates) were averaged. These averages were used further in this paper.

The application of herbicide treatments had a significant control of the annual and perennial weed species, in accordance with the products used, compared with the untreated control.

Herbicide association: Adengo (0.35l) + Lontrel (0.4 l) applied early post emergence had a good efficiency of 90% for the weeds: *Setaria viridis, Echinochloa crus-galli, Sorghum halepense*. For annual dicots *Amaranthus retroflexus, Chenopodium album, Solanum nigrum, Xanthium strumarium, Polygonum convolvulus,* a superior effect 97% was registered. On the perennial weed *Cirsium arvense*, the effect was of 92% (Figure 3).

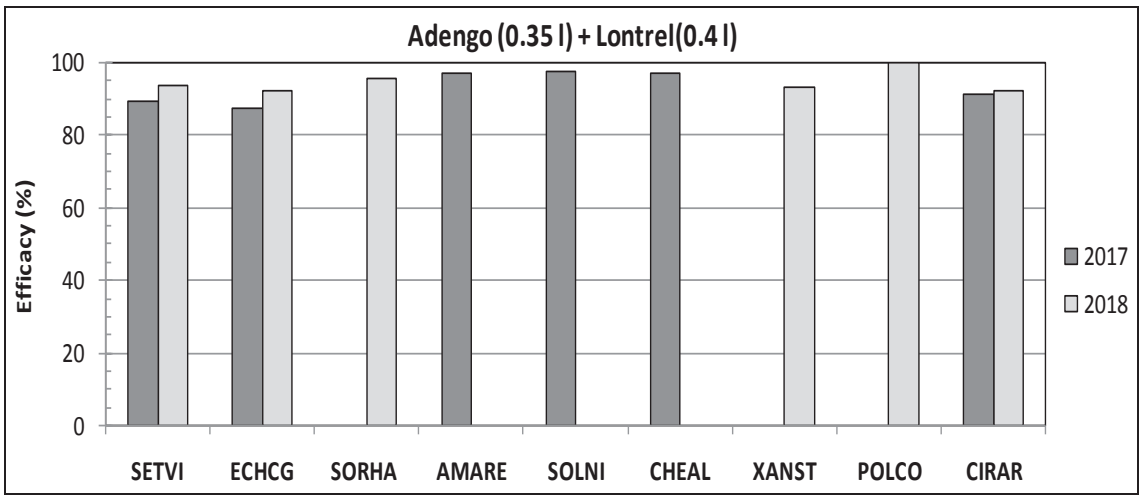

Figure 3. The efficacy (%) of the herbicide associations: Adengo + Lontrel in annual and perennial weeds from the maize crop

The results obtained on the efficacy of the combined herbicide Adengo (isoxaflutol 225 g/l + tiencarbazon-metil 90 g/l + ciprosulfamide (safener) 150 g/l) applied in 0.35 l/ha**,** showed a good control for the annual weeds. The exception was the perennial species *Cirsium arvense*, that was not controlled, because it does not enter the product's control spectrum (Figure 4).

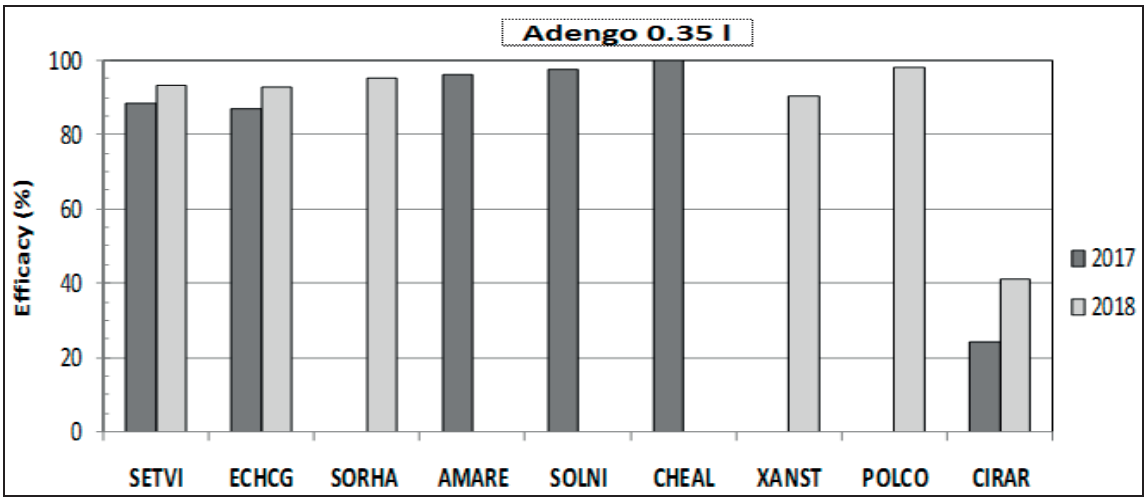

Figure 4. The efficacy (%) of the herbicide Adengo in annual weeds from the maize crop

The herbicides Merlin Duo (2.0 l/ha) and Akris (2.5 l/ha), by their very good synergy of active substances and by their persistence, eliminated most weeds.

According to the data obtained (Figures 5 and 6), these herbicides had a good efficacy (85-93%) for annual monocotyledons: *Setaria viridis, Echinochloa crus-galli, Sorghum halepense.*

For the control of sensitive annual dicotyledons: *Amaranthus retroflexus (AMARE), Solanum nigrum (SOLNI), Chenopodium album (CHEAL), Polygonum aviculare (POLCO)* there was a 90% control effect. The most resistant species: *Xanthium strumarium (XANST*) and *Cirsium arvense (CIRAR)* proved to be tolerant to the application of the two products: Merlin Duo and Akris.

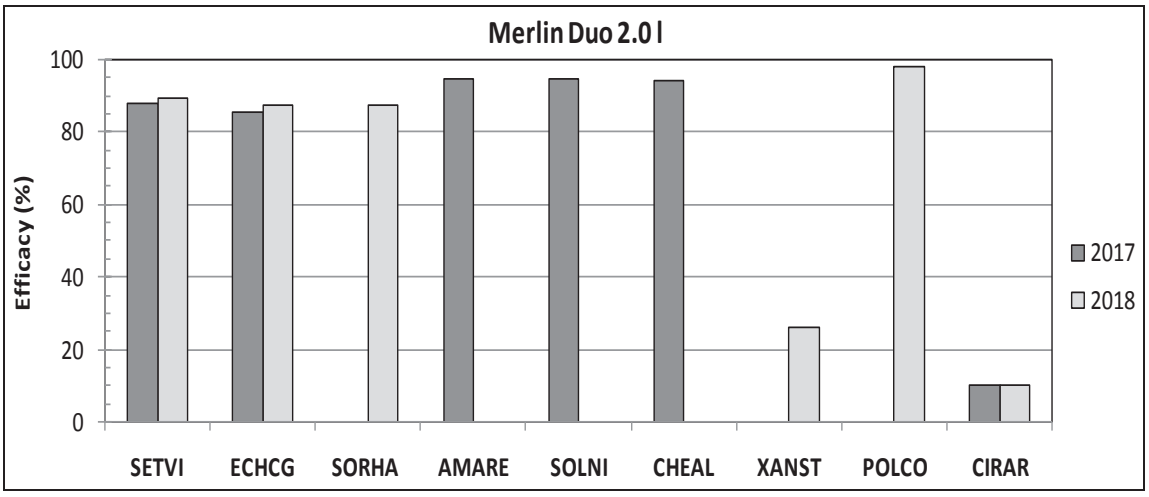

Figure 5. The efficacy (%) of the herbicide Merlin Duo in annual weeds from the maize crop

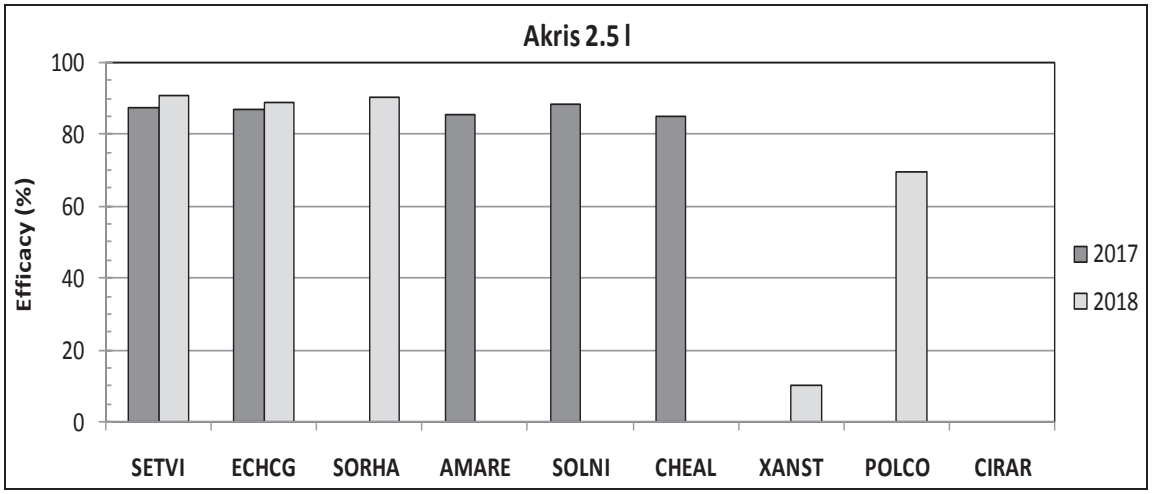

Figure 6. The efficacy (%) of the herbicide Akris in annual weeds from the maize crop

Regarding the herbicide combined Arigo (0.330 g/ha) + Trend (0.25 l/ha) applied early post-emergent (BBCH 12-14, maize 2-4 leaves) a superior control was registered for the resistant annual weeds: *Xanthium strumarium (XANST*) and *Sorghum halepense (SORHA)* (Figure 7). For the *Cirsium arvense (CIRAR)* species, an efficiency of 50-70% was obtained, this being classified in the moderately tolerant weed class.

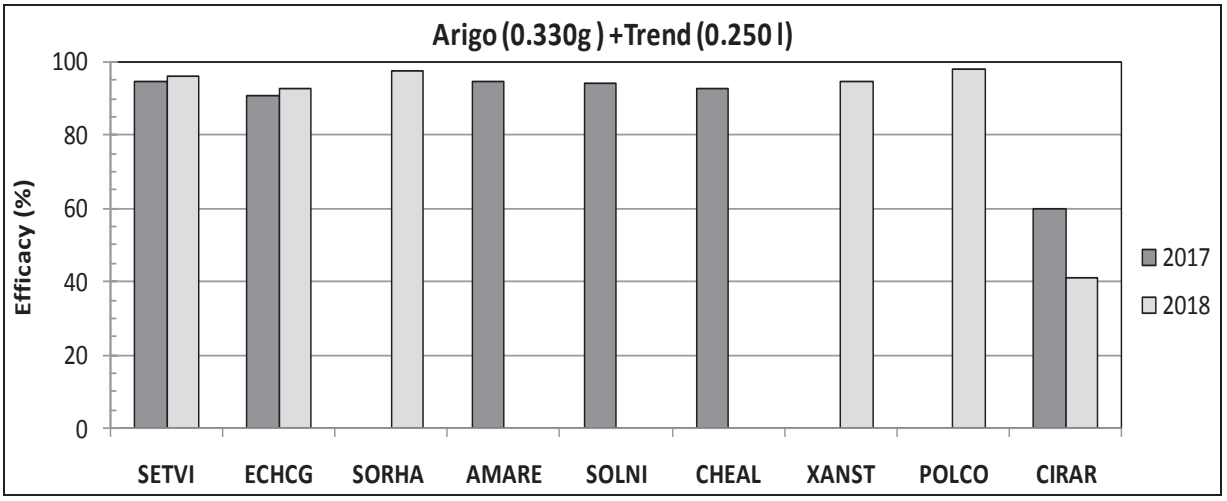

Figure 7. The efficacy (%) of the herbicides Arigo + Trend (Adj.) in annual and perennial weeds from the maize crop

In all the selectivity observations (at 7, 14 and 28 days after treatment) for hybrid Olt wasn't recorded any phytotoxic phenomena (EWRS scale = 0). Of course, a good selectivity is conditioned by herbicide application in the optimum phase specified by producer.

During the research period, the yield obtained from maize crop was closely correlated with the efficiency of the products. The highest yields were registered for herbicide treatments: Adengo + Lontrel and Arigo + Trend (Adjuvant).

The yields obtained after application of the other products (Adengo, Merlin Duo, Akris) were lower. In the untreated control, the yield was significantly affected, with losses of approximately 75-85% (Figure 8).

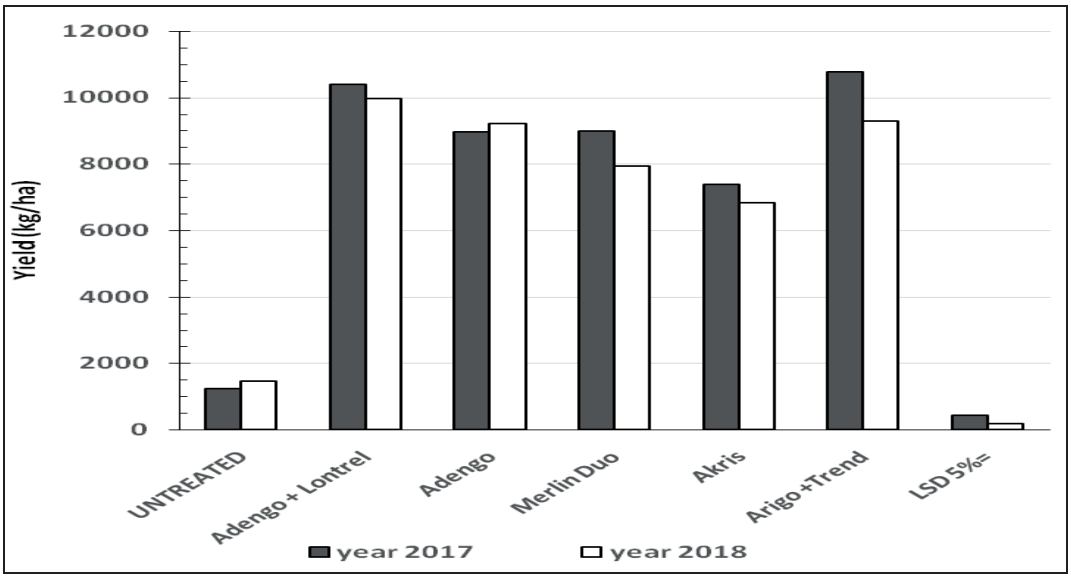

Figure 8. The influence of herbicide treatments on maize crop yields

The herbicide treatments influenced the growth and development of the maize plants (Figure 9).

The measurements made before harvesting revealed significant differences in maize crop height.

These measurements were closely correlated with herbicide efficiency, yielding capacity and climatic conditions.

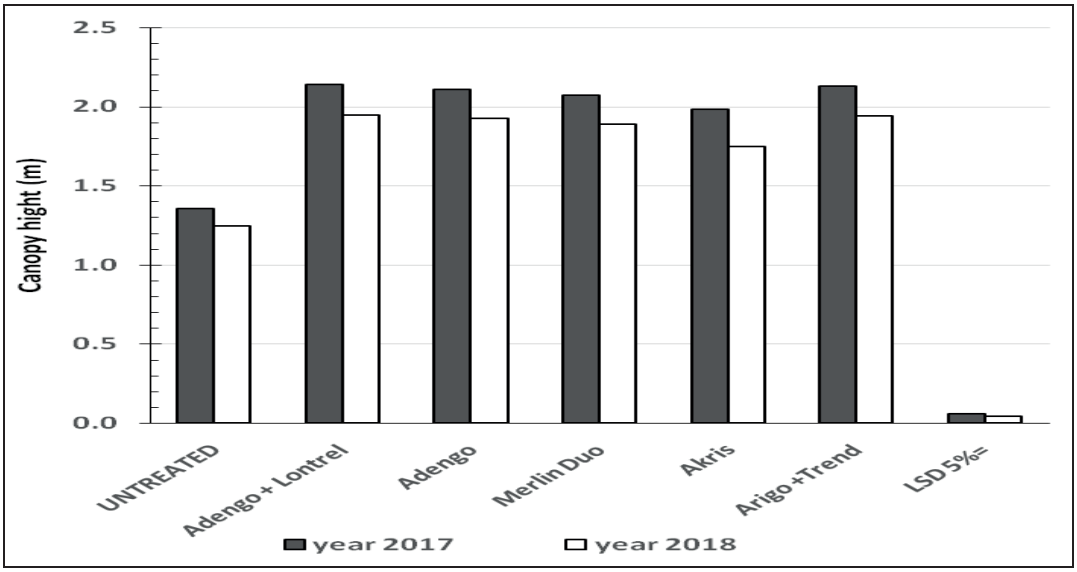

Figure 9. The canopy height of maize crop

CONCLUSIONS

1. The maize crop presented a diversified infestation degree of annual and perennial weed species, depending on the location area, the crop management applied, the preceding crop.

2. The new herbicides Adengo + Lontrel, Adengo, Merlin Duo, Akris, Arigo + Trend (Adjuvant), applied early post emergently, showed a very good selectivity (EWRS = 0 scale) for the cultivated maize hybrid, Olt.

3. Eliminating the competition from the first stages of vegetation ensured a good growth and development of the crop.

4. In the case of moderate infestations with sensitive annual weeds (*SETVI, ECHCG, AMARE, CHEAL*) the application of

herbicides was sufficient: Akris (2.5 l/ha) and Merlin Duo (2.0 l/ha) obtained a good control effect.

5. The best results regarding annual and perennial weed control were obtained in the experimental variants: Adengo + Lontrel; Arigo + Trend (Adjuvant).

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