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SELECTIVITY OF SOIL HERBICIDES AT PUMPKINS

Nesho NESHEV[1], Mariyan YANEV[1], Anyo MITKOV[1], Marieta NESHEVA[2], Tonyo TONEV[1]

[1]Agrticultural University of Plovdiv, Department of Agriculture and Herbology, 12 Mendeleev Blvd., Plovdiv, Bulgaria
[2]Fruit Growing Institute of Plovdiv, Department of Breeding, Genetic Resources and Biotechnology, 12 Ostromila St., Plovdiv, Bulgaria

Corresponding author email: n_neshev85@abv.bg

Abstract

In the growing season of 2018, a field pot experiment with the pumpkin (Cucurbita pepo L.) hybrid 'Prince' F1 was conducted. In the trial, the selectivity of soil herbicides was evaluated. The variants of the trial were: 1. Untreated control; 2. Dual Gold (960 g/l S-metolachlor) - 1200 ml/ha; 3. Dual Gold - 1200 ml/ha; 4. Stomp New (330 g/l pendimethalin) - 4000 ml/ha; 5. Stomp New - 5000 ml/ha; 6. Spectrum (720 g/l dimethenamid-P) - 800 ml/ha and 7. Spectrum - 1400 ml/ha. The selectivity of the herbicides was reported by 9-score phytotoxicity scale of EWRS on the 7th and on the 14th day after germination (0 - no damage, and 9 - complete crop destruction). The earliest germination was found for the untreated control – 6 days after sowing, and for the plants of treatment 5 germinated last - 12 days after sowing. For variant 2 the phytotoxicity was score 0 and on both evaluation dates. For variants 4 to 9 the phytotoxicity was from score 2 to score 4 on the first reporting date, but on the second date, the phytotoxicity reached lethal scores of 8 to 9. The earliest flowering time was reported for the control, while the latest flowering time was found to be for treatment 3-10 days after the control. At the end of the vegetation, the control plants were the longest - 3.09 m, and the shortest was the pumpkins from treatment 3-2.46 m. The control had the highest number of fruits - 2.40 per plant.

***Key words**: pumpkins, herbicides, selectivity.*

INTRODUCTION

Pumpkins are grown all around the world for agricultural purposes (animal feed), commercial and ornamental sales (Wolford & Banks, 2008).

The importance of pumpkins is determined by the nutrients contained in their fruits and their valuable dietary and taste qualities. They are a source of carotene, proteolytic enzymes, and sugars, and their seeds contain large amounts of oil (Genkova, 2008).

Between 2011 and 2015 there was an increase in production areas planted with pumpkins in Bulgaria - from 619 da to 27,420 da, respectively (Agrostatistical Reference Book, 2016).

The yields of pumpkin fruits can reach 50-60 t/ha (Shaban et al., 2014).

The weed infestation is one of the main factors leading to a reduction in yields, a deterioration in the quality of the production and an increase in its cost. In the pumpkins, mainly late-spring weeds occur. From the broadleaf weeds the most common are *Amaranthus retroflexus* L., *Capsella bursa-pastoris* Medik., *Chenopodium album* L., *Datura stramonium* L., *Xanthium strumarium* L. The most often observed grass weeds are *Sorghum halepense* (L.) Pers., *Cynodon dactylon* (L.) Pers., *Setaria* spp., etc. (Tonev et al., 2007).

The herbicides used in this crop must meet a large number of requirements. They should be highly efficacious against weeds and safe for pumpkin plants, because Pumpkins are sensitive to herbicides, therefore the chemical control of weeds is limited (Tonev et al., 2007).There are at least three major species differences among the pumpkins. Their response to herbicides differ, so it is important to know which types are sensitive to a particular herbicide to avoid crop injury.

Most herbicides labeled for pumpkins are applied pre-emergence and only provide limited control of broadleaf weeds (Brown & Masiunas, 2002; Grey et al., 2000).

The aim of the study is to evaluate the selectivity of soil herbicides applied at pumpkins in low and higher rates.

MATERIALS AND METHODS

The experiment was carried out in the experimental base of the Department of Agriculture and Herbology of the Agricultural University of Plovdiv, Bulgaria. The studied pumpkin (*Cucurbita pepo* L.) hybrid was 'Prince' F1. The pumpkins were grown in square steel pots without bottom with the size of 625 cm^2. The pots were dug into the ground. The content of available nutrients before the beginning of the experiment was N_{min}- 35.66 mg/kg soil, P_2O_5 - 32.75 mg/100 g soil and K_2O - 31.80 mg/100 g soil. The soil organic matter content is low - 0.96% and the $pH_{(H2O)}$ is 7.1. The sowing was done on the 30th of May 2018.

The experiment was designed to evaluate pumpkin responsiveness to different rates of 3 herbicide products in low and high rates. The variants of the trial were: 1. Untreated control (weed free); 2. Dual Gold 960 EC (960 g/l *S-metolachlor*) - 1200 ml/ha; 3. Dual Gold 960 EC - 1500 ml/ha; 4. Stomp New (330 g/l *pendimethalin*)- 4000 ml/ha; 5. Stomp New - 5000 ml/ha; 6. Spectrum (720 g/l *dimethenamid-P*) - 800 ml/ha and 7. Spectrum - 1400 ml/ha. All treatments were replicated 8 times. The spraying solution was 30 l/ha.

The herbicides were applied at BBCH 00 - just after seeding. The selectivity was evaluated by the 9 score scale of EWRS on the 7th and on the 14th day after the germination of the plants (at score 0 there are no damages on the crop, and at score 9 the crop is completely destroyed).

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

Germination time after seeding is shown in Figure 1. The earliest germination was found to be for the plants from the untreated control - 6 days after sowing. The plants from treatments 2 and 3 (Dual Gold - 1200 ml/ha and Dual Gold - 1500 ml/ha) germinated 8 days after sowing. The difference for the germination time was proved according to Duncan's multiple range test ($p < 0.05$).

After the application of Stomp New (5000 ml/ha) at treatment 5, the latest germination of the plants in the study was reported. The pumpkins from the studied variety germinated 12 days after sowing. The differences of this result were with a proven difference according to all other treatments in the experiment. Song et al. (2006) also found that the application of herbicides at pumpkins can affect the germination.

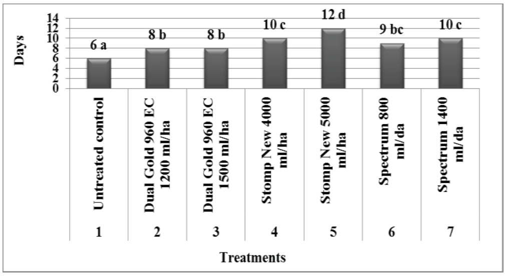

Figure 1. Germination time after seeding - days. Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

The visual evaluation of the phytotoxicity caused by the herbicide application is shown in Figure 2. On the 7th day after the plants' germination the phytotoxicity levels varied from very weak symptoms (score 1) for treatment 2 and 3 (Dual Gold 960 EC- 1200 ml/hand Dual Gold 960 EC – 1500 ml/ha) to better-expressed symptoms - thinning of the crop, strong chlorosis (score 5) for treatment 5 (Stomp New - 5000 ml/ha). On the 14th day after pumpkins germination, the phytotoxicity caused by some of the treatments increased and reached lethal values for some of the treatments.

The lowest herbicide toxicity was found for treatment 2. For this variant, the phytotoxicity score was 1 -very weak symptoms (slight stunt effect).

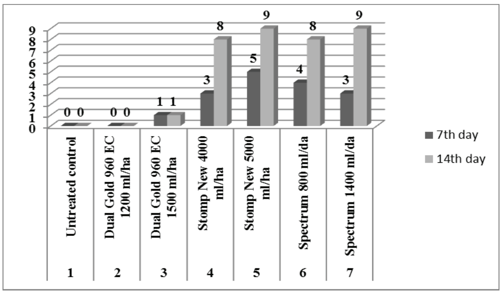

Figure 2. Score of phytotoxicity 7 and 14 days after germination

After treatment with Stomp New 4000 ml/ha (treatment 4) and Stomp New - 5000 ml/ha (treatment 5) the phytotoxicity reached score 9 - Heavy damage (perishing of the plants). The same was observed for after the application of the herbicide product Spectrum. For both application rates, the phytotoxicity score reached the lethal scores - 8 for the treatment at the rate of 800 ml/ha and 9 for the treatment at the rate of 1400 ml/ha.

The observed phytotoxicity levels and the death of the plants from the variants treated with the herbicide products Stomp New and Spectrum is the reason that there is no data shown in the next figures presenting the results of the pot experiment.

The stem length 14 days after germination is shown on Figure 3. The longest stems were found to be for the untreated control - 122.24 mm. This result was not with proved differences according to the statistical analyses used with treatment 2 (Dual Gold - 1200 ml/ha), but it proved with treatment 3 (Dual Gold - 1500 ml/ha).

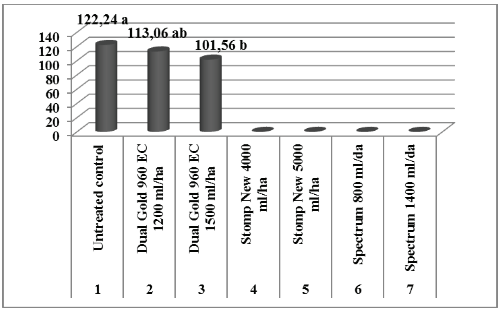

Figure 3. Stem length14 days after germination, mm.
Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

The width of the stems at the plants of the untreated control was the highest (9.88 mm) and was with a proved difference by Duncan's multiple range test ($p < 0.05$) only with treatment 3 (Dual Gold - 1500 ml/ha) (8.01 mm) (Figure 4).

After the treatment with Dual Gold - 1200 ml/ha the stem width (9.47 mm) was found to be only with 0.41 mm lower than those of the untreated control.

The obtained data for these two biometrical parameters showed that the high rate of Dual Gold (1500 ml/ha) led to decrease of the length and width of the stem.

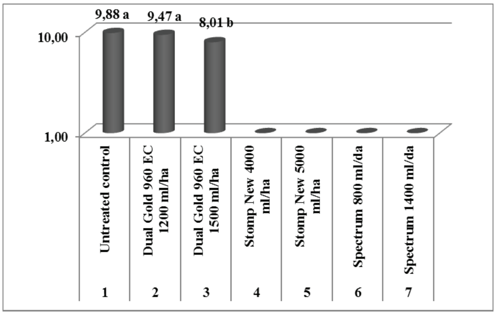

Figure 4. Stem width14 days after germination, mm.
Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

On Figure 5 are shown the results for the number of true leaves 14 days after germination.

It was observed that the untreated control had formed 5.20 true leaves per plant. The statistical test showed proved differences in comparison with the treatments with Dual Gold independently the used application rate. The plants from treatments 2 and 3 had formed one leave less than the untreated control.

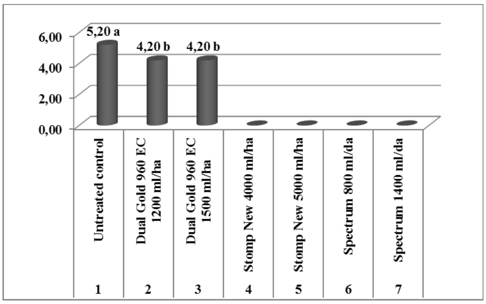

Figure 5. Number of true leaves14 days after germination.
Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

On Figures 6 and 7 are presented the obtained results considering the petiole length and petiole width.

These two parameters were also influenced by the herbicide application.

The petiole length as well as petiole width were with highest values for the untreated control. The petiole length for the control plants was 85.39 mm and the width was 5.60 mm.

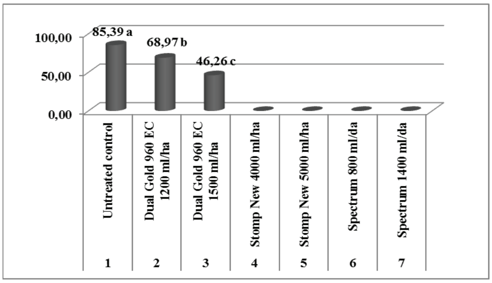

Figure 6. Petiole length 14 days after germination. Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

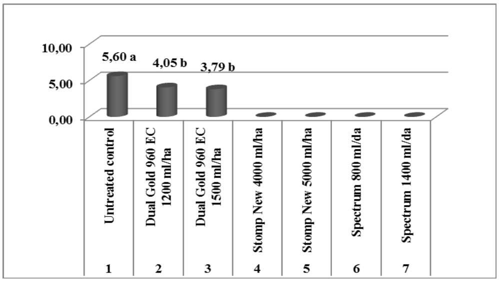

Figure 7. Petiole width 14 days after germination. Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

The earliest flowering time was reported for the control 37 days after the sowing – on the 6th of June 2018 (Figure 8).

The latest flowering time was found to be for treatment 3 - 10 days after the control (47 days after the sowing). The flowering time for treatment 2 (Dual Gold 960 EC - 1200 ml/ha) was recorded to be 4 days after the untreated control (Figure 8).

It was found that injury from herbicides can also stress and lead to the death of flower buds at pumpkins (Maynard & Egel, 2016).

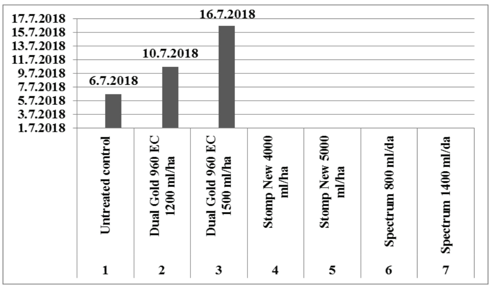

Figure 8. Beginning of flowering. Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

On figure 9 is shown the length of the plants at the end of the vegetation. At the end of the vegetation, the control plants were the longest – 3.09 m. The difference for Length of the plants at the end of the vegetation, was proved according to Duncan's multiple range test ($p < 0.05$) only with treatment 3 (Dual Gold 960 EC - 1500 ml/ha). Varhney et al. (2015) also found that herbicide-induced toxicity affects the growth of crop plants.

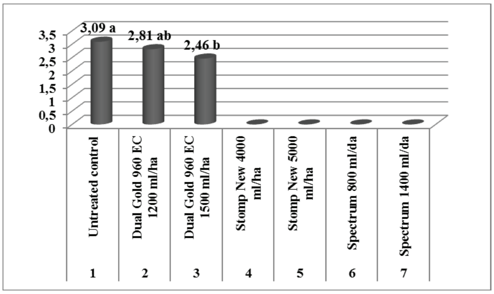

Figure 9. Length of the plants at the end of the vegetation, m. Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

In a study conducted by El-Nahhaland Hamdona (2017) the application of some soil herbicides led to growth retardation of the plants grown in the experiment.

In the trial conducted by Nosratti et al. (2017) pumpkin species have exhibited pronounced differences in tolerance to the different herbicides that were studied. Despite early-season phytotoxicity caused by some of the herbicide applications, the pumpkin plants were able to recover and produce yield, but it was lower than those of the untreated controls.

These results correspond to our trial data. Despite the phytotoxicity caused by Dual Gold 960 EC applied at the rate of 1500 ml/ha (treatment 3) were overcome, the yield was lower in comparison to the untreated control (Figure 10). The control had the highest number of fruits - 2.40 per plant. The difference for the productivity of the control according to treatment 3 was with a proved difference by Duncan's multiple range test ($p < 0.05$) and was not proved with treatment 2 where Dual Gold 960 EC was applied at a rate of 1200 ml/ha.

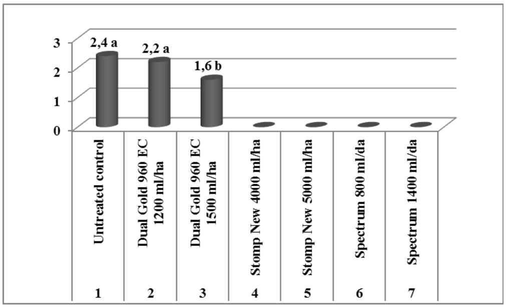

Figure 10. Number of fruits per plant.
Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

The crops are exposed to different biotic and abiotic stress in the production conditions.

The herbicides are very often a stress factor to the crop.

The interaction with other biotic (insects, diseases, nematodes, etc.) and abiotic (temperature, moisture, etc.) stress factors can lead to yield loss (Bagavathiannan et al., 2017). It is also very important to remember that the yield decrease from not controlling the weed infestation is greater than the application of herbicides that can cause different damage symptoms to the crops (Hartzler, 2013).

In our trial the highest weight of one pumpkin fruit for the untreated control was reported – 3.89 kg (Figure 11).

The weight of one fruit from treatment 2 (Dual Gold 960 EC - 1200 ml/ha) was lower - 3.65 kg. The differences in the values were with not proved difference according to the control.

The fruits from the pumpkins treated with the higher rate of Dual Gold 960 EC had fruits weighting 3.16 kg that was 73 grams lower than the control.

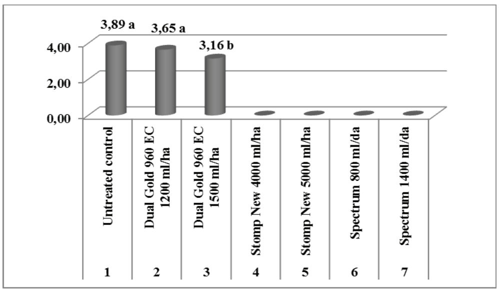

Figure 11. Weight of 1 pumpkin fruit, kg.
Columns with different letters are with a proved difference by Duncan's multiple range test ($p < 0.05$)

CONCLUSIONS

The herbicide application delayed pumpkins germination independently the herbicide product and studied application rate.

The application of Stomp New (330 g/l pendimethalin) and Spectrum (720 g/l dimethenamid-P) lead to high phytotoxicity score causing perishing of the plants.

The studied biometrical parameters of the pumpkins like stem length and width, number of true leaves, petiole length and width 14 days after germination were also influenced by the herbicide application. The highest values were obtained for the untreated (weed free) control.

The flowering time, as well as the length of the pumpkins, was with lowest values after the application of Dual Gold 960 EC at rate of 1500 ml/ha.

The highest productivity was recorded for the untreated (weed free) control and treatment 2 (Dual Gold 960 EC - 1200 ml/ha).

The highest weight of one pumpkin fruit for the untreated (weed free) control was reported, but the difference with treatment two were not statistically proved.

ACKNOWLEDGEMENTS

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