WEED MAPPING AND INFLUENCE OF THE WEED INFESTATION ON SUNFLOWER PRODUCTIVITY

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Abstract. *Sunflower is a major field oilseed crop in Bulgaria. Uncontrolled weed flora is the main competitor during sunflowers' vegetation. The present study aims to determine the weed infestation in different growth stages of sunflowers and to determine their influence on the productivity of the crop. The study was conducted during two sunflower growing seasons with the sunflower hybrid „Coloris" CL in 2022 and 2023. The experiment was carried out on the agricultural land of Novoseltsi village, in the region of Vidin city, Bulgaria. The weed mapping was determined by the ΠΙ-method for weed survey in spring field crops. A comparison of the weed infestation was determined between untreated plot and plot with an application of the tank mixture of the herbicidal products Pulsar Plus (25 g/l imazamox) – 1.60 l* ha^{-1} *+ Stratos Ultra (100 g/l cycloxydim) – 2.00 l* ha^{-1}*. The herbicides were applied in the* 4^{th}*-*6^{th} *true leaf stage of sunflower. In the two experimental years, the sunflower was grown after preceding crop winter wheat. During the two years of the study, and during the two survey periods (*I^{st} *– in growth stage* 8^{th} *-* 10^{th} *true leafs stage of sunflower, and* II^{nd} *- during the flowering of the crop) the predominant weed species were ragweed (Ambrosia artemisifolia L.) and wild hemp (Cannabis ruderalis Janisch.), followed by the weed Rough cocklebur (Xanthium strumarium L.). During the trial, no visual signs of phytotoxicity were detected in sunflower after the application of Pulsar Plus + Stratos Ultra in tank mixture. Sunflower seed moisture content was higher for the plants from the untreated plot. Statistically higher results for the studied indicators, such as seed yield, absolute and hectoliter seed mass were established after the application of Pulsar Plus + Stratos Ultra.*

Keywords*: weeds, sunflower, yield*

INTRODUCTION

Sunflower is considered the fourth oilseed crop in the world (NISAR et al., 2011). According to HRISTOV et al. (2019), Bulgaria and Romania are the largest sunflower producers in the European Union.

For achieving high and stable sunflower seed yields effective weed management has to be performed. The control of the weeds in this crop is performed mainly by chemical herbicidal applications (PRASHANT et al., 2017). Weed management at sunflower has to be done in the optimal phases of the crop (SIMIC et al., 2011). GOLIPOUR et al. (2009) found that the critical period for applying weed control measures is from 1 to 9.5 weeks after the crop's emergence.

According to NESHEV et al. (2017) the most distributed weeds in the Bulgarian sunflower fields are *Amaranthus retroflehus* L., *Sinapis arvensis* L., *Chenopodium album* L., *Xanthium strumarium* L., *Setaria* spp., *Echinochloa crus-galli* L., *Sorghum halepense* L., *Cirsium arvense* L., *Convolvulus arvensis* L. and the root parasite *Orobanche cumana* Wallr. The data analyses from a 20-year research conducted by TONEV et al. (2021) showed that in the Bulgarian sunflower fields, significant dynamics of the weed species and densities have occurred and on separate fields *Cannabis ruderalis* Janisch. in high densities was prevailing.

A great number of scientists are working on the chemical weed management issues in sunflowers (TONEV et al., 2009; KOSTADINOVA et al., 2016; MITKOV et al., 2016; JURSIK et al., 2016; MITKOV et al., 2019; NESHEV et al., 2020; MITKOV, 2021).

The current research aims to determine the weed infestation in different growth stages of sunflower and weeds' influence on the crop's productivity.

MATERIAL AND METHODS

The trial is part of the bachelor's thesis of Kristiyana Ivanova, a sudent at the Agricultural University of Plovdiv, Bulgaria.

The research was conducted during the sunflower vegetation in 2022 and 2023. The experiment was carried out in the land of Novoseltsi Village, Vidin Region.

The cultivated sunflower hybrid was "COLORIS CL". Sowing rate 56000 plants/ha.

Main characteristics of the sunflower hybrid from the experience:

COLORIS CL is a Mid-early Clearfield® hybrid with stable yields under stressful conditions (www.agro.basf.bg). The advantages of the hybrid are excellent resistance to temperature and water stress; High tolerance to verticillium and rust; Fast initial start and rapid development in first phases; Effective weed control with Clearfield® or Clearfield® Plus herbicides.

The weed species survey was carried out according to the U-shaped method for surveying crops from spring trench crops (Dimitrova et al., 2004). Weed were reported in 5 randomly chosen spots.

Weed infestation in two variants was compared:

1. Untreated control plot;

2. Pulsar Plus (25 g/l imazamox) – 1.60 l/ha + Stratos Ultra (100 g/l cycloxidim) – 2.00 l/ha. The herbicides were applied in a tank mixture in the crop growth stage 4th - 6th pair of leaves. The survey areas were 0.1 hectares each.

The preceding crop of sunflower was winter wheat in the two experimental years. The entire field was fertilized with 250 kg/ha combined N:P:K (8:15:15) fertilizer, followed by deep plowing. Before the sowing of the sunflower, two cultivations were carried out. Spring dressing with 200 kg/ha of ammonium nitrate was also carried out.

The following sunflower indicators were reported:

- Biological grain yield (t/ha) - by manually harvesting 20 sunflower heads, weighing the grain, averaging their weight, and recalculating the yields in t/ha. It was performed in 3 replicates.

- Seed moisture, %. The measurement was made with a grain moisture meter;

- Absolute seed mass (g) (Dimitrova et al., 2006). The assay was performed in three replications;

- Hectoliter seed mass (kg) (Dimitrova et al., 2006). The assay was performed in three replications;

For statistical analysis of the collected data, the independent samples t-test was applied by the software IBM SPSS Statistics 26.

RESULTS AND DISCUSSIONS

Table 1 shows the developing weeds in the sunflower field in 2022. During the first survey period, when the plants are in the stage of the 8-10th pair of leaves, 8 weeds from different groups were reported, as follows: Annual grass species – Johnson grass developed from seeds - 3 specimens/m^2; Annual broad-leaved species - Rough cocklebur - 4 specimens/m^2, Cleavers - 2 specimens /m^2, Ragweed - 21 pieces/m^2, Common knotgrass - 13 specimens/m^2, wild hemp - 11 specimens/m^2; Perennial grass weeds - Johnson grass developed from rhizomes - 6 specimens/m^2; Perennial deciduous weed species – Creeping thistle - 4 specimens/m^2.

During the second survey period, when the plants were in the flowering stage, the same 8 weeds from different groups were reported, but their number per square meter increased as follows: Annual grass weeds - Johnson grass from seeds - 9 specimens/m^2; Annual

broad-leaved - Rough cocklebur - 17 specimens/m^2, Cleavers - 3 pieces/m^2, Ragweed - 37 specimens/m^2, Common knotgrass - 18 specimens/m^2, Wild hemp - 21 specimens/m^2; Perennial cereals - Johnson grass developed from rhizomes - 14 specimens/m^2; Perennial dicotyledonous - Creeping thistle - 7 specimens/m^2.

In 2022 and during both survey periods, Ragweed and Wild hemp were the predominant weed species, followed by Rough cocklebur.

Table 1.

Weed species on the field in 2022

English	Latin	First reporting – 8^{th} – 10^{th} leaf pair of sunflower	Second reporting – in full flowering of sunflower
I. Annual – grass weed species			
1. Johnson grass	*Sorghum halapense*	3	9
II. Annual – broadleaf weed species			
2. Rough cocklebur	*Xanthium strumarium*	4	17
3. Cleavers	*Galium anarine*	2	3
4. Ragweed	*Ambrosia artemisifolia*	21	37
5. Common knotgrass	*Poligonum aviculare*	13	18
6. Wild hemp	*Canabis sativa*	11	21
III. Perennial – grass weed species			
7. Johnson grass	*Sorghum halapense*	6	14
Perennial – broadleaf weed species			
8. Creeping thistle	*Cirsium arvense*	4	7

Table 2 shows the developing weeds in the sunflower field in 2023. The weeds observed were the same as in 2022, but differed in density. In this year, no development of the annual weed Cleavers (*G.anarine*) was observed.

Table 2.

Weed species on the field in 2023

English	Latin	First reporting – 8^{th} – 10^{th} leaf pair of sunflower	Second reporting – in full flowering of sunflower
I. Annual – grass weed species			
1. Johnson grass	*Sorghum halapense*	5	11
II. Annual – broadleaf weed species			
2. Rough cocklebur	*Xanthium strumarium*	7	21
3. Cleavers	*Galium anarine*	1	0
4. Ragweed	*Ambrosia artemisifolia*	26	44
5. Common knotgrass	*Poligonum aviculare*	3	5
6. Wild hemp	*Canabis sativa*	15	31
III. Perennial – grass weed species			
7. Johnson grass	*Sorghum halapense*	7	16
Perennial – broadleaf weed species			
8. Creeping thistle	*Cirsium arvense*	2	5

During the first survey period in 2023, when the plants are in the growth stage of the 8-10th pair of leaves, 7 weeds from different groups were recorded: Annual grass weeds - Johnson grass developed from seeds - 5 weeds/m^2; Annual broad-leaved - Rough cocklebur - 7 specimens/m^2, Ragweed - 26 specimens/m^2, Common knotgrass - 3 specimens/m^2, Wild hemp - 15 specimens/m^2; Perennial grass weeds - Johnson grass developed from rhizomes - 7 weeds /m^2; Perennial dicotyledonous - Creeping thistle - 2 pieces/m^2.

On the second observation period, when the plants were in the flowering stage, the same 7 weeds species were found, but their number per square meter increased as in 2022: Annual grass weeds - Johnson grass developed from seeds - 11 weeds/m^2; Annual broad-leaved - Rough cocklebur - 21 specimens/m^2, Ragweed - 44 specimens/m^2, Common knotgrass - 5 specimens/m^2, Wild hemp - 31 weeds/m^2; Perennial grass weeds - Johnson grass developed from rhizomes - 16 specimens/m^2; Perennial dicotyledonous - Creeping thistle - 7 weed/m^2.

In 2023, as well as in the previous trial year 2022, in both survey periods, the weeds Ragweed and Wild hemp were the predominant species, followed by the weed Rough cocklebur.

CARRANZA et al. (1995) reported that depending on the weed density, duration of the concurrence, and weed spectrum the sunflower yield losses can be up to 81%. Figure 1 shows the results related to yields in the untreated section and after treatment with Pulsar Plus + Stratos Utra. In the first year (2022), the yields obtained from the untreated area were 1.39 t/ha, and those from the treated area – 2.67 kg/ha. The increase in yield in the treated area was 52% more compared to the untreated one.

In the second year (2023), the yields obtained from the untreated plot were 1.12 t/ha, and those from the treated area – 2.08 t/ha. The increase in yield in the treated area was 54% more compared to the untreated plot.

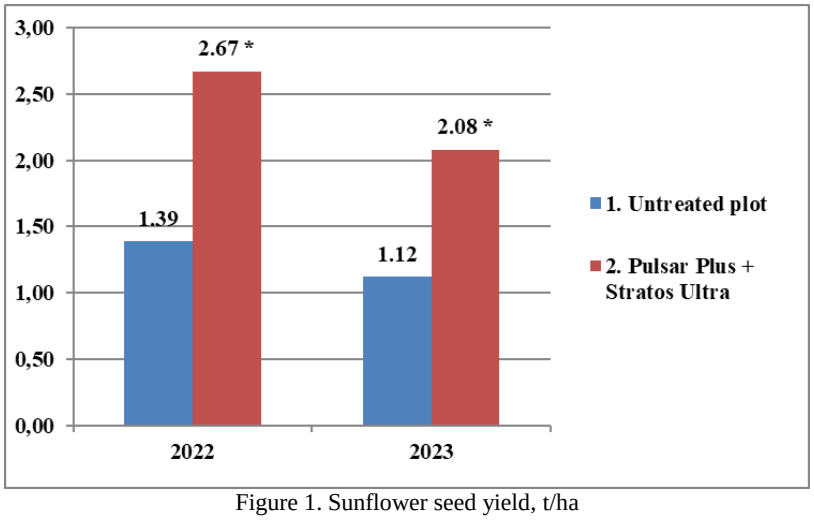


Figure 1. Sunflower seed yield, t/ha

Asterisks (*) indicate significant differences between the averages of both variants by t-test at $P \leq 0.05$

Figure 2 shows the results for the seed moisture content in the untreated plot and the treatment with Pulsar Plus + Stratos Utra. In the first year (2022), seed moisture in the untreated area was 12.80%, and in the treated area - 8.40%. In the second year (2023), seed moisture in the untreated area was 11.50%, and in the treated area - 9.10%.

The obtained results of the analysis show that the weed plants that "cohabit" with the sunflower in the untreated plot increase the humidity of the sunflower seeds.

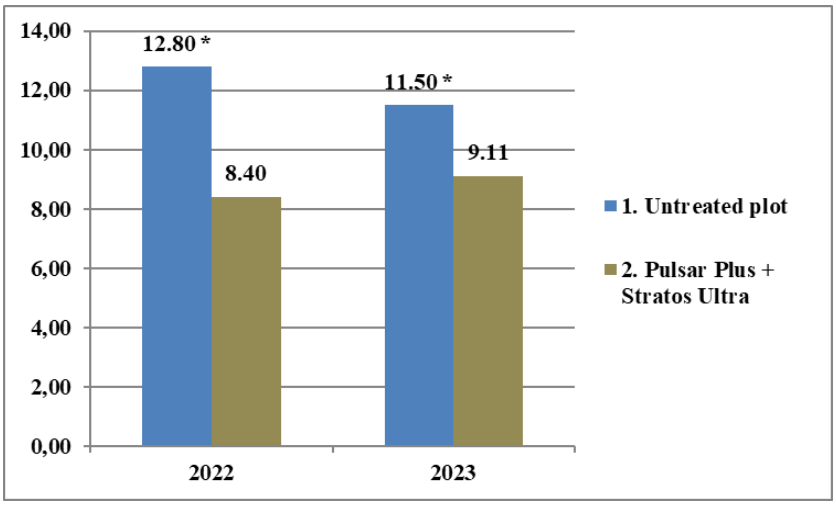
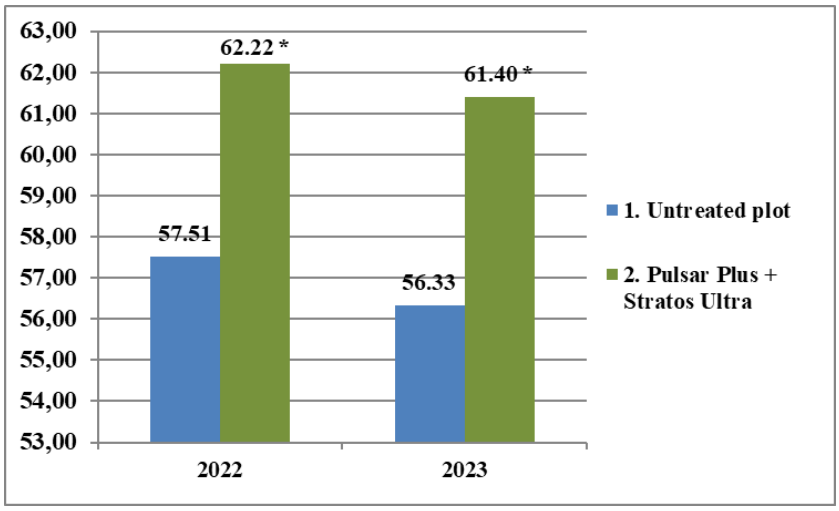


Figure 2. Seed moisture at sunflower harvest, %
Asterisks (*) indicate significant differences between the averages of both variants by t-test at $P \leq 0.05$

Figure 3 shows the results obtained regarding the absolute mass of sunflower seeds in the untreated plot and the treatment with Pulsar Plus + Stratos Utra.



Fugure 3. Absolute seed mass, g
Asterisks (*) indicate significant differences between the averages of both variants by t-test at $P \leq 0.05$

The 1000-grain weight (absolute seed mass) is of great importance for yield formation (GEORGIEV et al., 2014). In the current trial, in the first year (2022), the absolute seed mass of the plants from the untreated area was 57.51 g, and that of the plants from the treated area -

62.22 g. In the second experimental year (2023), the absolute seed mass of the plants from the untreated plot was 56.33 g, and that of the plants treated with Pulsar Plus + Stratos Utra – was 61.40 g.

Figure 4 presents the obtained results for the hectoliter weight of the seeds. Higher values for the given indicator were found in plants treated with Pulsar Plus + Stratos Utra – 41.28 and 40.45 kg for the first (2022) and second (2023) experimental years, respectively. NESHEV et al. (2020) recorded the lowest hectoliter seed weight for the untreated controls highly infested with weeds. It was confirmed in the current research. The plants from the untreated area have proven lower values for the hectoliter seed mass indicator – 36.52 and 34.67 kg for the first (2022) and second (2023) years of the experiment, respectively.

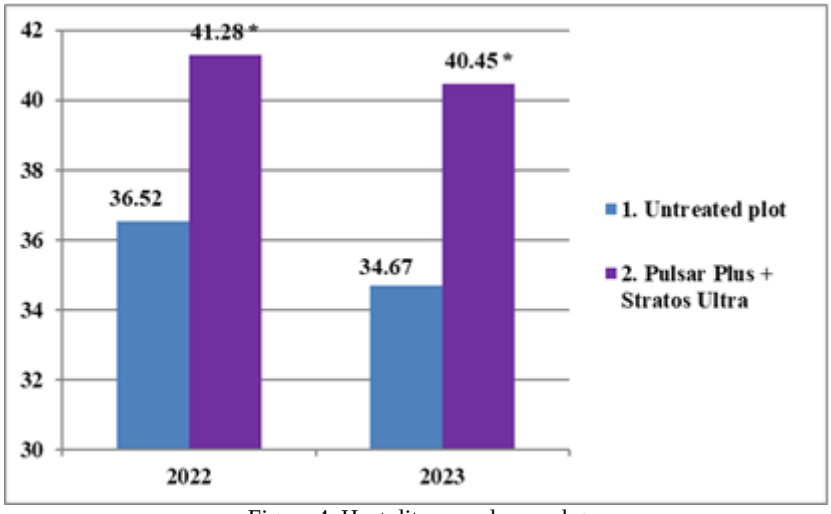


Figure 4. Hectoliteer seed mass, kg

Asterisks (*) indicate significant differences between the averages of both variants by t-test at $P \leq 0.05$

CONCLUSIONS

During the two years of the study, and both survey periods (1st - 8th - 10th pair of sunflower leaves and 2nd - during the flowering of the crop) the predominant weeds were ragweed and wild hemp, followed by weed rough cocklebur.

During the experiment, no visual signs of phytotoxicity were detected in sunflower after the application of Pulsar Plus + Stratos Ultra in tank mixture.

Sunflower seed moisture content was higher for the plants from the untreated control plot.

Higher results for the studied indicators, such as biological yield, and absolute and hectoliter seed mass after the application of Pulsar Plus + Stratos Ultra in a tank mixture were found.

BIBLIOGRAPHY

CARRAZA, P., SAAVEDRA, M., GARCIA-TORRES, L., 1995. Competition between *Ridolfia segetum* and sunflower. Weed Research, 35: 369–375, United Kingdom.

DIMITROVA, M., KALINOVA, SHT., ZHALNOV, I., TONEV, T., ZHELYAZKOV, IL., 2006. Handbook for exercises on general agriculture. Academic publisher of Agricultural University - Plovdiv, 109. (In Bulgarian), Bulgaria.

GHOLIPOUR, H., MIRSHEKARI, B., MOGHBELI, A., HANIFIAN, S., 2009. Critical period of weeds control in sunflower, *Helianthus annus* L. Journal of New Agricultural Science, 5 (17).

JURSIC, M., FENDRYCHOVA, V., KOLAROVA, M., ANDR, J., SOUKUP, J., 2017. Optimising clearfield and express sun sunflower technologies for central European conditions. Plant Protection Science, 53 (4): 265–272, Czech Republic. https://doi.org/10.17221/2/2017-PPS.

KOSTADINOVA, S., KALINOVA, SHT., YANEV, M., 2016. Sunflower productivity in response to herbicide diflufenican (Pelican 50 SC) and foliar fertilizing. Agriculture and Food, 4 (1): 122-128, Bulgaria.

MITKOV, A., 2021. Weed control in sunflower by separate and combined herbicide application. Scientific Papers. Series A. Agronomy, 64 (1): , Romania.

MITKOV, A., YANEV, M., NESHEV, N., TONEV, T., JOITA-PACUREANU, M., COJOCARU, F., 2019/. Efficacy against broomrape and selectivity of imazamox-containing herbicides at sunflower. Rom. Agric. Res. 36: 201–207, Romania.

MITKOV, A., YANEV, M., TONEV T., TITYANOV, M., 2016. Weed control in sunflower fields by Clearfield technology. Agricultural Sciences, 8 (19): 167–173, Bulgaria.

NESHEV, N., YANEV, M., MITKOV, A., TITYANOV, M., TONEV T., 2017. Current Technological Solutions for Weed Management at Sunflower. Proceedings of the "International Scientific Conference of Young Scientists and Specialists, dedicated to the 100th anniversary of I. S. Shatilov": 43-44, Russia.

NESHEV, N., YANEV, M., MITKOV, A., TONEV, T., 2020. Efficacy and selectivity of imazamox-containing herbicides at clearfield and clearfield plus sunflower hybrids. Papers. Series A. Agronomy, LXIII (1): 450–457, Romania.

NISSAR, M., HUSSAIN, S., NAUSHEEN, S. KHAN, N, SIDDIQUE, M., 2011. Chemical composition of open pollinated and hybrid population of sunflower (*Helianthus annus* L.), Pakistan Journal of Botany, 43(1): 157-163, Pakistan.

PRASHANT, S., SHRINVAS, M., JAGADISH, C., 2017. Weed management in sunflower - a review. Trends in Biosciences, 10 (34): 7201-7207, India.

SIMIC, M., DRAGICEVIC, V., DOLIANOVIC, Z., JUG, D., BRANKOV, M., STIPESEVIC, B., 2011. Effect of applied herbicides (fluchloridone + s-metolachlor) on weeds in different stage of sunflower growth. Proceedings of 46th Croatian and 6th International Symposium on Agriculture, Opatija, Croatia, 14-18 February, 2011. Zagreb: 704-708, Croatia.

TONEV, T., KALINOVA, SHT., YANEV, M., MITKOV, A., NESHEV, N., 2021. Weed association dynamics in the oilseed rape fields. Scientific Papers. Series A. Agronomy, LXIV (1): 591-599, Romania.

TONEV, T., MITKOV, A., DOCHEV, CH., TITYANOV, M., 2009. Possibilities of SU technology for effective control of the weeds in sunflower. Crop Science, 2: 161–166, Bulgaria.