

EFFICACY AND SELECTIVITY OF THE HERBICIDES EXPRESS 50 SG AND PANTERA 40 EC ON SUNFLOWER

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Abstract

In 2024 and 2025, a field trial was conducted with ExpressSun® sunflower, hybrid P64 LE185. The experiment was set up in a production field of the Agricultural University-Plovdiv, Bulgaria. The herbicides Express 50 SG (500 g/kg tribenuron-methyl) for the control of dicotyledonous weeds and Pantera 40 EC (40 g/l quizalofop-P-tefuryl) for the management of monocotyledonous weeds were tested. The herbicides used were applied vegetatively, in the phenophase of the fourth-sixth leaf of the crop (BBCH 14-16). Weeding of the experimental field was represented by: *Sinapis arvensis* L., *Amaranthus blitoides* L., *Datura stramonium* L., *Convolvulus arvensis* L., *Setaria glauca* L. and *Sorghum halepense* (L.) Pers. Weeding with the established weeds is the reason for obtaining a very low average yield from the untreated control (1.05 t ha⁻¹). Herbicidal efficacy was reported on the 10-point EWRS scale. The highest biological grain yield was obtained after the use of Express 50 SG applied in combination with Pantera 40 EC. The 9-point EWRS scale was used to determine the selectivity of the herbicides.

Key words: sunflower, weeds, herbicides, efficacy, selectivity.

INTRODUCTION

Providing the necessary resources for the food sector is one of the key challenges of modern society. In this context, agricultural crops play a leading role as the main source of raw materials. This determines the increased scientific interest and the conduct of numerous studies related to the introduction of new technological solutions aimed at the successful production of agricultural crops (Ahmad et al., 2025; Dulaimy et al., 2025; Thuleau et al., 2025; Tourneur et al., 2025; Panayotov et al., 2024; Panchev & Shopova, 2024; Shevchenko et al., 2024; Balabanova et al., 2023; Önemli & Tetik, 2023; Rankova et al., 2023; Shopova, 2023; Fernández-Aparicio et al., 2022; Komitov et al., 2020; Dimtrova et al., 2019; Marinov-Serafimov et al., 2017; Manolov et al., 2015; Shopova & Cholakov, 2015; Yanev, 2015; López-Bellido et al., 2014; Shopova & Cholakov, 2014; Yanev et al., 2014a). Sunflower is one of the most important crops in Bulgaria and is grown mainly after winter wheat in non-irrigated farming systems. Because sowing is most often done from mid-March to mid-April, this crop is very often weeded by a multispecific weed flora, including dicotyledonous and

monocotyledonous weeds (Fried et al., 2006). Herbicides are a central tool for chemical control in weed management systems. The selection of an appropriate herbicide product is essential as it should meet a number of criteria, including selectivity for the crop, high efficacy against weeds, and safety with respect to crop quality and soil health (Parven et al., 2025; Shopova & Yanev, 2025; Szulc et al., 2025; Yanev, 2025; Yanev, 2024; Yanev & Shopova, 2024; Yanev et al., 2024; Chipomho et al., 2023; Dos Santos et al., 2023; Stefanic et al., 2023; Yanev, 2023; Yakhymuk et al., 2023; Goranovska et al., 2022; Yanev, 2022; Pacanoski & Mehmeti, 2021; Yucel & Saglam, 2021; Yanev, 2021; Mandal et al., 2020; Yanev, 2020; Yanev & Kalinova, 2020; Martinez et al., 2018; Goranovska & Yanev, 2016; Kostadinova et al., 2016; Hristeva et al., 2015; Kalinova & Yanev, 2015; Semerdjieva et al., 2015; Hristeva et al., 2014; Yanev et al., 2014b; Brighenti et al., 2012; Zabaloy et al., 2011; Penescu & Ciontu, 2001). According to research by Pannacci et al. (2007) in sunflower fields the weed flora consisted mainly of *Amaranthus retroflexus* L., *Chenopodium album* L., *Sinapis arvensis* L., *Solanum nigrum* L., *Portulaca oleracea* L., *Polygonum aviculare* L., *Polygonum persicaria* L.,

Heliotropium europaeum L., *Xanthium strumarium* L., and *Lolium multiflorum* L. According to the same author, after treatment with acetonifin and quizalofop-p-ethyl, applied alone, the same types of weeds are not controlled, respectively, while after application of the two herbicides in a tank mixture, good results are reported. Herbicides are part of integrated weed control in sunflower, which is why research is needed on their safe use (Delchev, 2020; Jocić et al., 2011). In recent years, in conditions of increasing drought, serious problems have arisen in the use of soil herbicides, and therefore foliar herbicides are increasingly being used (Delchev, 2021; Zand et al., 2009). Other problems are related to the efficacy and selectivity of foliar herbicides applied under these conditions (Delchev et al., 2021). To reduce the costs of weed control, combined application of herbicides with different mechanisms and spectrum of action is often necessary (Kudsk, 2002). The possibility of growing oilseed sunflower hybrids tolerant to sulfonylurea herbicides contributes to the ease of cultivation of this crop by farmers. Tkalic et al. (2022) investigated the efficacy of the herbicide tribenuron-methyl in combination with the adjuvant Trend 90 in sunflower. They found that the addition of the adjuvant improved the uniformity of herbicide coverage on the plant surface and increased efficacy against sensitive dicotyledonous weeds. Many scientists are studying the efficacy of individual and combined use of herbicides, contributing to the possibility of every farmer to obtain a productive, clean and economical crop (Ciontu et al., 2003; Popescu et al., 1990). Good selectivity towards the hybrid *P64 LE25* was demonstrated when applied in a tank mixture of the herbicides Express 50 SG (500 g/kg tribenuron-methyl) - 40 g ha⁻¹ + Stratos Ultra (100 g/l cycloxydim) - 2.0 l ha⁻¹ (Manilov and Zhalnov, 2018). Regarding selectivity, during foliar treatment of sunflower with acetonifin, slight phytotoxicity can be observed, which is later completely overcome (Pannacci et al., 2007), which has also been found by other scientists such as Mirkovic and Regnault (1996). Although sunflower is relatively more weed-tolerant than most other row crops, yield losses due to weed infestation remain significant (Ivanova &

Neshev, 2023; Neshev, 2022; Ivashchenko et al., 2018; Popescu, 1995).

The aim of the study was to establish the efficacy and selectivity of the herbicide Express 50 SG, applied alone and in a tank mixture with the herbicide Pantera 4 EC to sunflower, hybrid P64 LE185.

MATERIALS AND METHODS

In 2024 and 2025, a field experiment with oilseed sunflower hybrid P64 LE185 (Express Sun®) was conducted at the Agricultural University - Plovdiv, Bulgaria.

The experiment was set up using the block method in 4 replications with a total size of each variant of 112 m².

Before the introduction of herbicides, a survey of the experimental field was carried out. In the reporting field, we identified 7 types of weeds, of which 5 are dicotyledonous and 2 are monocotyledonous. The average density of weeds from the two experimental years per 1 m² is as follows: *Sinapis arvensis* L. - 17.5 pieces; *Amaranthus blitoides* L. - 10 pieces; *Datura stramonium* L. - 5.5 pieces, *Solanum nigrum* L. - 5 pieces; *Convolvulus arvensis* L. - 5.5 pieces; *Setaria glauca* L. - 6 pieces and *Sorghum halepense* (L.) Pers. - 5 pieces.

The experiment included the following variants: 1. Untreated control; 2. Express 50 SG (500 g/kg tribenuron-methyl) - 0.04 kg ha⁻¹ + Trend 90 (adjuvant) - 0.1%; 3. Express 50 SG - 0.04 kg ha⁻¹ + Pantera 40 EC (40 g/l quizalofop-P-tefuryl) - 1.75 l ha⁻¹; 4. Express 50 SG - 0.04 kg ha⁻¹ + Pantera 40 EC - 1.75 l ha⁻¹ + Trend 90 - 0.1%; 5. Two times hoed-up (manual); 6. Express 50 SG - 0.08 kg ha⁻¹ + Trend 90 - 0.2%; 7. Express 50 SG - 0.08 kg ha⁻¹ + Pantera 40 EC - 3.50 l ha⁻¹; 8. Express 50 SG - 0.08 kg ha⁻¹ + Pantera 40 EC - 3.50 l ha⁻¹ + Trend 90 - 0.2%. At lower doses of use of the products, the herbicidal efficacy was determined visually, using the 10-point scale of EWRS (European Weed Research Society). Doubly increased doses were tested to determine possible manifestations of phytotoxicity, using the 9-point scale of EWRS for this purpose.

The herbicides were applied in the 4-6th leaf phase of the sunflower.

The treatment was carried out using a knapsack sprayer with a working solution of 200 l ha⁻¹.

The predecessor of the sunflower experiment was wheat in both years of the study. The area was prepared by deep plowing to a depth of 30 cm, as well as by two cultivations, the first at 12 cm and the second at 8 cm. In spring, pre-sowing fertilization with combined fertilizer (NPK 15:15:15) was carried out with a fertilizer rate of 250 kg ha⁻¹, which was done before the last cultivation. Sowing was carried out at the optimal time of the crop with a "Vaderstad Tempo T6" seeder at a row spacing of 70 cm, with a density of 52000 pcs. germinating seeds per hectare.

Assessment of efficacy against weeds was carried out on the 14th, 28th and 56th days, and to determine the selectivity of herbicides to sunflower on the 7th, 14th and 28th days after their application.

The results for sunflower yields were statistically processed using the Duncan method.

RESULTS AND DISCUSSIONS

In both years of the experiment, on average, the product Express 50 SG had very high to excellent herbicidal efficacy against *Sinapis arvensis* L. (Table 1), reported on the 56th day after its application (95-100%). Here we report a very small difference in the efficacy of the broadleaf herbicide Express 50 SG applied with the adjuvant Trend 90 (100%) compared to its combined use with the product Pantera 40 EC (95%). Despite the lower herbicidal effect (70-75%) reported on the 14th day after treatment, the weed is relatively easily controlled by the herbicide Express 50 SG.

Table 2 shows the dynamics of efficacy against *Amaranthus blitoides* L. For the two years of the experiment, the average percentage of efficacy reported on the fourteenth day after treatment with the herbicide Express 50 SG + Trend 90 is 60%. When applying the same product in a tank mixture with Pantera 40 EC, but without an adjuvant, the efficacy is slightly lower (50%). Although in both variants the herbicidal effect increases on the next two reporting dates, in the combined use of the herbicides, where there is no adjuvant, the efficacy reaches 80%, in the last reporting after

treatment with the products. The percentages of efficacy in the latter variant are close to those reported in the variant treated with Express 50 SG + Trend 90, which showed that when mixing the herbicides and adjuvant, the efficacy does not change significantly.

Table 1. Herbicidal control (%) against *S. arvensis*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	75	95	100
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	70	90	95
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	70	90	100

Table 2. Herbicidal control (%) against *A. blitoides*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	60	80	100
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	50	70	80
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	55	75	95

Table 3. Herbicidal control (%) against *D. stramonium*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	50	70	90
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	40	60	70
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	45	65	85

Table 3 presents the action of the tested herbicides on average for the two years of the experiment against the weed *Datura stramonium* L. The highest percentage of efficacy recorded on the 14th day after the introduction of the products is only 50%. Regarding the increase in the percentages of efficacy at the individual reporting dates on the 56th day, they vary in the range from 70 to 90%. The best result was recorded with the application of Express 50 SG + Trend 90, and the lowest with the variant where we have a combination of the two herbicides Express 50 SG + Pantera 40 EC without adjuvant.

Table 4 shows the dynamics of the herbicidal efficacy against *Solanum nigrum* L. reported on the 14th, 28th and 56th day after treatment. It is noteworthy that with Express 50 SG + Trend 90 and Express 50 SG + Pantera 40 EC + Trend 90 the herbicidal effect on all three reporting dates is almost the same. Only in the variant in which the adjuvant Trend 90 is not applied do we report a relatively lower herbicidal efficacy on all reporting dates. The efficacy reaches only 85% on the 56th day after the application of the herbicides. This proves that the absence of Trend 90 is the reason for the reduction of the herbicidal effect against the weed.

Table 4. Herbicidal control (%) against *S. nigrum*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	65	90	100
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	45	70	85
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	60	85	100

Against *Convolvulus arvensis* L., we report zero efficacy in all three herbicide treatments in the experiment (Table 5).

Table 5. Herbicidal control (%) against *C. arvensis*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	0	0	0
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	0	0	0
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	0	0	0

With the combined use of the herbicides Express 50 SG and Pantera 40 EC on the 14th day after treatment, we report 55% efficacy against the weed *Setaria glauca* L., while with the variant with added adjuvant Trend 90 the herbicidal effect is 65% (Table 6). On the second reporting date, the efficacy in both variants progressively increases and reaches 85% and 95%, respectively. At the last reporting made on the 56th day after the application of the herbicides, the efficacy increases again and reaches 95% in the variant

in which no adjuvant Trend 90 was used. The control over the weed is excellent when we have added adjuvant (100%). From the use of Express 50 SG + Trend 90 we report zero efficacy, since the herbicide has an broad spectrum of action.

Table 6. Herbicidal control (%) against *S. glauca*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	0	0	0
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	55	85	95
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	65	90	100

Table 7. Herbicidal control (%) against *S. halepense*, average for the period

Variants	Days after treatments		
	14	28	56
Untreated control	-	-	-
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	0	0	0
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	60	80	90
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	70	90	100

Against the monocotyledon weed *Sorghum halepense* (L.) Pers. the results of the herbicide used are reflected in Table 7. Only in the variant treated with the herbicides Express 50 SG + Pantera 40 EC + adjuvant Trend 90 we report excellent efficacy of the order of 100% at the last reporting date. The herbicidal effect against this weed is entirely due to the product Pantera 40 EC, which has a completely monocotyledonous spectrum of action. Despite the fact that at the first reporting date in the variants with the application of the herbicide we report from 60 to 70% efficacy against the weed, it progressively increases and reaches from 90 to 100% at the last reporting date. The product Express 50 SG has a completely broadleaf spectrum of action and cannot control the monocotyledon weed.

The tolerance of each plant species to a specific herbicide is within certain limits. When the dose exceeds the recommended limits, negative effects may occur. In the overwhelming number of cases, the presence of a negative effect is judged by the visual manifestations, which may be different, but most often are

chlorosis, necrosis, growth retardation and retardation, and others (Vassilev and Tonev, 2015). No visual manifestations of phytotoxicity were recorded for sunflower, hybrid P64 LE185 (Table 8) from provocatively increased (double) doses of the herbicides Express 75 SG and Pantera 40 EC during the two experimental years in any of the variants.

Table 8. Visual phytotoxicity reading results (score)

Variants	2024	2025
Two times hoed-up (manual)	-	-
Express 50 SG - 0.08 kg ha ⁻¹ + Trend 90 - 0.2%	1	1
Express 50 SG - 0.08 kg ha ⁻¹ + Pantera 40 EC - 3.50 l ha ⁻¹	1	1
Express 50 SG - 0.08 kg ha ⁻¹ + Pantera 40 EC - 3.50 l ha ⁻¹ + Trend 90 - 0.2%	1	1

Table 9. Sunflower grain seed yield, t ha⁻¹

Variants	Yields
Untreated control	1.05a
Express 50 SG - 0.04 kg ha ⁻¹ + Trend 90 - 0.1%	2.31*b
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹	2.40*b
Express 50 SG - 0.04 kg ha ⁻¹ + Pantera 40 EC - 1.75 l ha ⁻¹ + Trend 90 - 0.1%	2.82*c
Two times hoed-up (manual)	2.90*c
Express 50 SG - 0.08 kg ha ⁻¹ + Trend 90 - 0.2%	2.46*b
Express 50 SG - 0.08 kg ha ⁻¹ + Pantera 40 EC - 3.50 l ha ⁻¹	2.81*c
Express 50 SG - 0.08 kg ha ⁻¹ + Pantera 40 EC - 3.50 l ha ⁻¹ + Trend 90 - 0.2%	2.91*c

Legend: All variants with * are significantly different from the untreated control. Values followed by different letters (a, b and c) are significantly different according to Duncan's test at P < 0.05.

Table 9 presents the results of the yields of the individual variants of sunflower grown using the Express Sun technology. The differences in yields are predetermined by the herbicidal efficacy of the products and their ability to control the weeds present in the experiment. The natural background of weeding with highly competitive weed species during the two years of the experiment led to a low average yield of the untreated control (1.05 t ha⁻¹). By the degree of mathematical proof, three separate groups are distinguished here for the different variants (a, b, c). It is also noticeable here that the variants treated with Express 50 SG + Pantera 40 EC + Trend 90, the two times hoed-up control and Express 50 SG - 0.08 kg ha⁻¹ + Pantera 40 EC - 3.50 l ha⁻¹ are from group (c),

the furthest from the untreated control group (a), that is, with the highest yields, followed by the other treated variants.

CONCLUSIONS

The herbicide Express 50 SG applied with the adjuvant Trend 90 has excellent efficacy (100%) against the weeds *S. arvensis*, *A. blitoides* and *S. nigrum*. A relatively high herbicidal effect (90%) is achieved against the weed *D. stramonium*.

Express 50 SG does not control the weed *C. arvensis*, despite the fact that it is applied with Trend 90.

The herbicide Pantera 40 EC has very high (90%) to excellent efficacy (100%) against the weeds *S. glauca* and *S. halepense*.

In the sunflower hybrid *P64 LE185*, no visible signs of phytotoxicity were observed from the combined use of the higher tested double doses of Express 50 SG, Pantera 40 EC and Trend 90. The highest average yield of 2.91 t ha⁻¹ sunflower was obtained with the tank mixture of Express 50 SG - 0.08 kg ha⁻¹ + Pantera 40 EC - 3.50 l ha⁻¹ + Trend 90 - 0.2%.

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