

EFFICACY OF HERBICIDES, HERBICIDE TANK MIXTURES AND HERBICIDE COMBINATIONS ON EXPRESS SUN OIL-BEARING SUNFLOWER (*Helianthus annuus* L.)

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ABSTRACT

During the period 2018-2020 a field experiment has been carried out with the oil-bearing sunflower hybrid P64LE121 (*Helianthus annuus* L.). It is a sulfo tolerant hybrid by ExpressSun technology. A total of 25 variants were investigated. They included untreated control, 2 herbicides applied alone in addition with adjuvant Trend 90, 10 herbicide tank mixtures and 10 herbicide combinations. Soil-applied combined herbicides were performed during after sowing before emergence period of the sunflower. Foliar-applied herbicides were performed during 3-4 leaf sunflower stage. Full control of annual broadleaved weeds in ExpressSun oil-bearing is provided by a single treatment with herbicide Fluence at a dose of 40 g/ha or with herbicide Evorelle express at a dose of 60 g/ha applied during 3-4 leaf sunflower stage. Full controls of perennial broadleaved weeds is provided by two treatments with herbicide Fluence in doses of 20+20 g/ha or with herbicide Evorelle express in doses of 30+30 g/ha, applied during 3-4 leaf and 7-8 leaf sunflower stages. In the presence of annual and perennial broadleaved and graminaceous weeds, it is necessary to apply Fluence and Evorelle express as herbicide tank mixtures together with foliar-applied antigraminaceous herbicides Fusilade forte, Stratos ultra or Targa max. In the absence of perennial graminaceous weeds, it is necessary to apply herbicides Fluence and Evorelle express as herbicide combinations with soil-applied antigraminaceous herbicides Dual gold or Indipen. The highest seed yield is obtained by herbicide tank mixture Fluence + Fusilade forte, followed by herbicide tank mixture Evorelle express + Stratos ultra. High seed yields are also obtained by use of herbicide combinations Indipen + Evorelle express and Dual gold + Fluence.

Keywords: oil-bearing sunflower, herbicides, herbicide tank mixtures, herbicide combinations, efficacy, selectivity.

INTRODUCTION

Herbicides will remain in future agriculture efficient tool for control of weeds as part of an integrated weed control in sunflower, which is why there is need for research for optimization of their use (Mitric and Vuckovic, 2008; Jocić et al., 2011; Knežević et al., 2011; Delchev, 2018, 2020). It should to consider a number of factors that determine the effective application of these complex organic compounds. During creating situation of increasingly louder and more frequent drought occur serious problems that must be solved (Saskevich et al., 2009; Zand et al., 2009; Suresh and Reddy, 2010; Delchev, 2021). One of these problems is for the efficacy and selectivity, i.e. the behavior of foliar-applied and soil-applied herbicides under these conditions.

The purpose of this investigation was to establish the efficacy and selectivity of some herbicides, herbicide tank mixtures and herbicide combinations on ExpressSun oil-bearing sunflower by influence of different meteorological conditions.

MATERIAL AND METHODS

During the period 2018-2020 a field experiment has been carried out with the oil-bearing sunflower hybrid P64LE121 (*Helianthus annuus* L.). It is a sulfo tolerant hybrid by ExpressSun technology. It was carried out a field experiment as a block method in 4 repetitions, on a 20 m² harvesting area, on pellic vertisol soil type, after durum wheat predecessor.

A total of 25 variants were investigated. They included *untreated control*, 2 herbicides:

ROMANIAN AGRICULTURAL RESEARCH

Fluence SG and Evorelle express; *10 herbicide tank mixtures*: Fluence SG + Fusilade forte 150 EC, Fluence SG + Targa max, Fluence SG + Shogun 100 EC, Fluence SG + Stratos ultra, Fluence SG + Centurion super, Evorelle express + Fusilade forte 150 EC, Evorelle express + Targa max, Evorelle express + Shogun 100 EC, Evorelle express + Stratos ultra, Evorelle express + Centurion super; *10 herbicide combinations*: Dual gold

960 EC + Fluence SG, Indipen SC + Fluence SG, Fen 24 EC + Fluence SG, Pledge 50 WP + Fluence SG, Modown 4 F + Fluence SG, Dual gold 960 EC + Evorelle express, Indipen SC + Evorelle express, Fen 24 EC + Evorelle express, Pledge 50 WP + Evorelle express, Modown 4 F + Evorelle express.

Active substances of the herbicides and their doses are shown in Table 1.

Table 1. Investigated variants

№	Variants	Active substance	Doses	Treatment period
1	Control - untreated	-	-	-
Herbicides				
2	Fluence SG	tribenuron-methyl	40 g/ha	3-4 leaf
3	Fluence SG	tribenuron-methyl	20 g/ha + 20 g/ha	3-4 leaf 7-8 leaf
4	Evorelle express	tribenuron-methyl + thiphensulfuron-methyl	60 g/ha	3-4 leaf
5	Evorelle express	tribenuron-methyl + thiphensulfuron-methyl	30 g/ha + 30 g/ha	3-4 leaf 7-8 leaf
Herbicide tank mixtures				
6	Fluence SG + Fusilade forte 150 EC	tribenuron-methyl fluzifop-P-butyl	40 g/ha 1.30 l/ha	3-4 leaf 3-4 leaf
7	Fluence SG + Targa max	tribenuron-methyl quizalofop-P-ethyl	40 g/ha 750 ml/ha	3-4 leaf 3-4 leaf
8	Fluence SG + Shogun 100 EC	tribenuron-methyl propaquizafop	40 g/ha 800 ml/ha	3-4 leaf 3-4 leaf
9	Fluence SG + Stratos ultra	tribenuron-methyl cycloxydim	40 g/ha 2 l/ha	3-4 leaf 3-4 leaf
10	Fluence SG + Centurion super	tribenuron-methyl clethodim	40 g/ha 1.6 l/ha	3-4 leaf 3-4 leaf
11	Evorelle express + Fusilade forte 150 EC	tribenuron-methyl + thiphensulfuron-methyl fluzifop-P-butyl	60 g/ha 1.30 l/ha	3-4 leaf 3-4 leaf
12	Evorelle express + Targa max	tribenuron-methyl + thiphensulfuron-methyl quizalofop-P-ethyl	60 g/ha 750 ml/ha	3-4 leaf 3-4 leaf
13	Evorelle express + Shogun 100 EC	tribenuron-methyl + thiphensulfuron-methyl propaquizafop	60 g/ha 800 ml/ha	3-4 leaf 3-4 leaf
14	Evorelle express + Stratos ultra	tribenuron-methyl + thiphensulfuron-methyl cycloxydim	60 g/ha 2 l/ha	3-4 leaf 3-4 leaf
15	Evorelle express + Centurion super	tribenuron-methyl + thiphensulfuron-methyl clethodim	60 g/ha 1,6 l/ha	3-4 leaf 3-4 leaf
Herbicide combinations				
16	Dual gold 960 EC + Fluence SG	S-metolachlor tribenuron-methyl	1,5 l/ha 40 g/ha	ASBE 3-4 leaf
17	Indipen SC + Fluence SG	pendimethalin tribenuron-methyl	5 l/ha 40 g/ha	ASBE 3-4 leaf
18	Fen 24 EC + Fluence SG	oxifluorfen tribenuron-methyl	625 ml/ha 40 g/ha	ASBE 3-4 leaf
19	Pledge 50 WP + Fluence SG	flumioxazin tribenuron-methyl	80 g/ha 40 g/ha	ASBE 3-4 leaf
20	Modown 4 F + Fluence SG	bifenox tribenuron-methyl	1,5 l/ha 40 g/ha	ASBE 3-4 leaf
21	Dual gold 960 EC + Evorelle express	S-metolachlor tribenuron-methyl + thiphensulfuron-methyl	1,5 l/ha 60 g/ha	ASBE 3-4 leaf
22	Indipen SC + Evorelle express	pendimethalin tribenuron-methyl + thiphensulfuron-methyl	5 l/ha 60 g/ha	ASBE 3-4 leaf
23	Fen 24 EC + Evorelle express	oxifluorfen tribenuron-methyl + thiphensulfuron-methyl	625 ml/ha 60 g/ha	ASBE 3-4 leaf
24	Pledge 50 WP + Evorelle express	flumioxazin tribenuron-methyl + thiphensulfuron-methyl	80 g/ha 60 g/ha	ASBE 3-4 leaf
25	Modown 4 F + Evorelle express	bifenox tribenuron-methyl + thiphensulfuron-methyl	1,5 l/ha 60 g/ha	ASBE 3-4 leaf

Herbicides Fluence SG and Evorelle express were used in addition with adjuvant Trend 90 - 0.1%.
ASBE - after sowing, before emergence.

Soil-applied herbicides were performed after sowing before emergence period of the sunflower. Foliar-applied herbicides were performed during 3-4 leaf sunflower stage. All of herbicides, herbicide tank mixtures and herbicide combinations were applied in a working solution of 200 l/ha. The mixing of the herbicide mixtures is done in tank of the sprayer. Due to of low adhesion of the herbicides Fluence SG and Evorelle express were used in addition with adjuvant 0.1% Trend 90.

It was investigated efficacy and selectivity of herbicides, herbicide tank mixtures and herbicide combinations. It was established their influence on seed yield. Efficacy of herbicides against weeds was appointed according to 100 % scale of EWRS (European Weed Research Society). Selectivity of herbicides to sunflower plants was followed according to the 9-rate scale of EWRS (rating 1 - without damages, rating 9 - crop is completely destroyed). The mathematical processing is done with analysis of variance method.

RESULTS AND DISCUSSION

Dominant weeds in our experiment were annual broadleaved species *Amaranthus retroflexus* L., *Amaranthus albus* L., *Chenopodium album* L., *Xanthium strumarium* L., *Polygonum aviculare* L., *Solanum nigrum* L., *Datura stramonium* L., *Abutilon theophrasti* Medic., a lesser amount of *Amaranthus blifoides* W., *Hibiscum trionum* L., *Tribulus terrestris* L., *Portulaca oleracea* L.

Annual graminaceous weeds are represented by *Echinochloa crus-galli* L., *Setaria viridis* Beauv., *Setaria glauca* Beauv., *Panicum sanguinale* L. In a lesser amount are *Avena fatua* L., *Setaria verticillata* Beauv., *Echinochloa coarctata* Vas.

Perennial species in experiment are broadleaved weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L. and graminaceous

weeds *Cynodon dactylon* Pers., *Agropyrum repens* L. and *Sorghum helepense* Pers. by rhizomes and by seeds.

Herbicides Fluence and Evorelle express, applied once or twice, control 100% of all annual broadleaved weeds - *Xanthium strumarium* L., *Amaranthus retroflexus* L., *Amaranthus albus* L., *Chenopodium album* L., *Sinapis arvensis* L., *Solanum nigrum* L., *Datura stramonium* L., *Abutilon theophrasti* Medic., *Polygonum aviculare* L., *Hibiscum trionum* L., *Tribulus terrestris* L., *Portulaca oleracea* L. To the herbicides Fluence and Evorelle express is absolutely necessary adding adjuvant 0.1% Trend, for better control of weeds with wax coating leaves, as *Chenopodium album* L. or of weeds with pappus leaves, as *Polygonum aviculare* L.

A single treatment with herbicide Fluence at a dose of 40 g/ha and with herbicide Evorelle express at a dose of 60 g/ha during 3-4 leaf stage, provides incomplete control of 95 to 98% of perennial broadleaved weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L. (Table 2).

The double treatment with herbicide Fluence in doses of 20+20 g/ha and herbicide Evorelle express in doses of 30+30 g/ha during 3-4 leaf and 7-8 leaf stages, provides complete control of these two perennial broadleaved weeds. Herbicides Fluence and Evorelle express are typical antibroadleaved herbicides. They do not have antigraminaceous effect. At presence of graminaceous weeds it is necessary to combine them with antigraminaceous herbicides. The tank mixtures of herbicides Fluence and Evorelle express with foliar-applied antigraminaceous herbicides Fusilade forte, Targa max and Stratos ultra control successfully also and all annual graminaceous weeds - *Echinochloa crus-galli* L., *Panicum sanguinale* L., *Setaria viridis* Beauv., *Setaria glauca* Beauv., as well as perennial graminaceous weeds - *Cynodon dactylon* Pers., *Agropyrum repens* L. and *Sorghum helepense* Pers. by rhizomes (Table 3).

ROMANIAN AGRICULTURAL RESEARCH

Table 2. Efficacy of some herbicides, herbicide tank mixtures and herbicide combinations against annual broadleaved weeds at sunflower according to the visual scale of EWRS (mean 2018-2020)

Variants	Weeds							
	<i>Xanthium strumarium</i>	<i>Amaranthus retroflexus</i>	<i>Chenopodium album</i>	<i>Solanum nigrum</i>	<i>Datura stramonium</i>	<i>Abutilon theophrasti</i>	<i>Polygonum aviculare</i>	<i>Sinapis arvensis</i>
Control - untreated	0	0	0	0	0	0	0	0
Herbicides								
Fluence - 40 g/ha	100	100	100	100	100	100	100	100
Fluence - 20+20 g/ha	100	100	100	100	100	100	100	100
Evorelle express - 60 g/ha	100	100	100	100	100	100	100	100
Evorelle express - 30+30 g/ha	100	100	100	100	100	100	100	100
Herbicide tank mixtures								
Fluence + Fusilade forte	100	100	100	100	100	100	100	100
Fluence + Targa max	100	100	100	100	100	100	100	100
Fluence + Shogun	96	100	95	100	100	100	94	100
Fluence + Stratos ultra	100	100	100	100	100	100	100	100
Fluence + Centurion super	97	100	100	100	100	100	100	100
Evorelle express + Fusilade forte	100	100	100	100	100	100	100	100
Evorelle express + Targa max	100	100	100	100	100	100	100	100
Evorelle express + Shogun	97	100	96	100	100	100	96	100
Evorelle express + Stratos ultra	100	100	100	100	100	100	100	100
Evorelle express + Centurion super	95	100	100	100	100	100	100	100
Herbicide combinations								
Dual gold + Fluence	100	100	100	100	100	100	100	100
Indipen + Fluence	100	100	100	100	100	100	100	100
Fen + Fluence	100	100	100	100	100	100	100	100
Pledge + Fluence	100	100	100	100	100	100	100	100
Modown + Fluence	100	100	100	100	100	100	100	100
Dual gold + Evorelle express	100	100	100	100	100	100	100	100
Indipen + Evorelle express	100	100	100	100	100	100	100	100
Fen + Evorelle express	100	100	100	100	100	100	100	100
Pledge + Evorelle express	100	100	100	100	100	100	100	100
Modown + Evorelle express	100	100	100	100	100	100	100	100

Herbicide tank mixtures Fluence + Shogun and Evorelle express + Shogun have been shown to reduce their effectiveness against some annual broadleaved weeds such as *Xanthium strumarium* L., *Polygonum aviculare* L. and *Chenopodium album* L. and against perennial graminaceous weed *Sorghum helepense* Pers. In herbicide tank mixtures Fluence + Centurion super and Evorelle express + Centurion super, a decrease in their efficiency is reported only

against *Xanthium strumarium* L. This decrease is probably due to antagonism of the active substances tribenuron-methyl and thifensulfuron-methyl by the one hand with the active substances propaquizafop and cletodim by the other hand. The use of foliar-applied herbicides Fluence and Evorelle express after soil-applied herbicides Dual gold, Indipen and Pledge provides good control of 90 to 98% of annual graminaceous weeds in sulfo-tolerant sunflower hybrids.

GROZI DELCHEV ET AL.: EFFICACY OF HERBICIDES, HERBICIDE TANK MIXTURES AND HERBICIDE COMBINATIONS ON EXPRESS SUN OIL-BEARING SUNFLOWER (*Helianthus annuus* L.)

Table 3. Efficacy of some herbicides, herbicide tank mixtures and herbicide combinations against perennial broadleaved, annual and perennial graminaceous weeds at sunflower according to the visual scale of EWRS and selectivity according to the 9-rate scale of EWRS (mean 2018-2020)

Variants	Weeds							Selectivity
	<i>Cirsium arvense</i>	<i>Convolvulus arvensis</i>	<i>Echinochloa crus-galli</i>	<i>Setaria viridis</i>	<i>Setaria glauca</i>	<i>Digitaria sanguinalis</i>	<i>Sorghum helepense</i>	
Control - untreated	0	0	0	0	0	0	0	1
Herbicides								
Fluence - 40 g/ha	98	96	0	0	0	0	0	1
Fluence - 20+20 g/ha	100	100	0	0	0	0	0	1
Evorelle express - 60 g/ha	97	95	0	0	0	0	0	1
Evorelle express - 30+30 g/ha	100	100	0	0	0	0	0	1
Herbicide tank mixtures								
Fluence + Fusilade forte	98	96	100	100	100	100	100	1,5
Fluence + Targa max	98	96	100	100	100	100	100	1,5
Fluence + Shogun	98	96	100	100	100	100	95	2,5
Fluence + Stratos ultra	98	96	100	100	100	100	100	1,5
Fluence + Centurion super	98	96	100	100	100	100	100	2
Evorelle express + Fusilade forte	97	95	100	100	100	100	100	1,5
Evorelle express + Targa max	97	95	100	100	100	100	100	1,5
Evorelle express + Shogun	97	95	97	100	100	100	94	2,5
Evorelle express + Stratos ultra	97	95	100	100	100	100	100	1,5
Evorelle express + Centurion super	97	95	100	100	100	100	96	2
Herbicide combinations								
Dual gold + Fluence	98	96	94	96	96	95	50*	1
Indipen + Fluence	98	96	97	98	98	95	50*	1
Fen + Fluence	100	100	85	80	0	0	0	1
Pledge + Fluence	98	96	90	90	90	90	0	1
Modown + Fluence	98	96	0	0	0	0	0	1
Dual gold + Evorelle express	97	95	94	96	96	95	50*	1
Indipen + Evorelle express	97	95	97	98	98	95	50*	1
Fen + Evorelle express	100	100	85	80	0	0	0	1
Pledge + Evorelle express	97	95	90	90	90	90	0	1
Modown + Evorelle express	97	95	0	0	0	0	0	1

* - only against *Sorghum helepense* Pers. by seeds.

Herbicide combinations of Fluence and Evorelle express with Dual gold and Indipen (excluding Pledge) also control the perennial graminaceous weed *Sorghum helepense* Pers. by seeds.

Herbicide combinations Fen + Fluence and Fen + Evorelle express completely control perennial broadleaved weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L.,

as well as some annual graminaceous weeds such as *Echinochloa crus-galli* L. and *Setaria viridis* Beauv.

Herbicide combinations Modown + Fluence and Modown + Evorelle express are not effective against annual and perennial graminaceous weeds. This is due to the fact that none of these herbicides have an antigraminaceous effect.

Visual observations of phytotoxicity show that in herbicide tank mixtures of antibroadleaved herbicides Fluence and Evorelle express with the antigraminaceous herbicides Fusilade forte, Targa max and Stratos ultra, weak phytotoxic manifestations on sunflower 2-3 days after treatment were reported - rate 1.5 according to the scale of EWRS (Table 3). In herbicide tank mixtures Fluence + Centurion super and Evorelle express + Centurion super they are initially stronger - rate 2 according to the scale of EWRS. Phytotoxic effects are strongest in herbicide tank mixtures Fluence + Shogun and Evorelle express + Shogun - rate 2.5 according to the scale of EWRS. Signs of phytotoxicity disappear 8-10 days of treatment.

The weak phytotoxic effects on sunflower plants at the mixtures of Fluence and Evorelle express with Fusilade forte, Targa max and Stratos ultra are overcome faster than at the mixtures of Fluence and Evorelle express with Shogun and Centurion super. The term of full recovery of the affected plants is directly dependent on the agro-meteorological conditions.

The damages are stronger and longer in conditions of extreme drought during the period after treatment with herbicides and weaker - in cold and humid weather during this period. Subsequently, no signs of phytotoxicity were observed during the growing season by influence of the above-mentioned herbicide tank mixtures.

Single and double treatment with foliar-applied herbicides Fluence and Evorelle express, as well as their use in combination with the soil-applied herbicides Dual gold, Indipen, Fen, Pledge and Modown show very high selectivity for the sulfo-tolerant sunflower hybrid P64LE121 - rate 1 according to the scale of EWRS.

The seed yields obtained by treatment with the respective herbicides, herbicide tank mixtures and herbicide combinations were evaluated (Table 4). The results show that there is a positive correlation between their biological efficacy against weeds and seed yields.

The largest increase of seed yield was obtained by herbicide tank mixture Fluence + Fusilade forte - 129.9% above the untreated control, followed by tank mixture Evorelle express + Stratos ultra - 129.6% above the control. High yields are also obtained by the other mixtures of Fluence and Evorelle express with Fusilade forte, Stratos ultra, as well as with those with herbicide Targa max. The differences between these variants are small and have not been mathematically significant. These herbicide tank mixtures have very high herbicide efficacy against all annual and perennial broadleaved and graminaceous weeds.

Seed yields are lower by herbicide tank mixtures of Fluence and Evorelle express with Shogun and Centurion super. This is due to the higher phytotoxicity of sulfo-tolerant sunflower hybrid P64LE121 after treatment for these herbicide tank mixtures.

The highest seed yields by herbicide combinations are obtained by the use of foliar-applied herbicides Fluence and Evorelle express after soil-applied herbicides Dual gold and Indipen - from 126.6% to 127.6% above the untreated control. In these variants, not only perennial graminaceous weeds from rhizomes can be controlled, but those germinated from seeds as well.

Herbicidal combinations of Fluence and Evorelle express with the soil-applied herbicides Fen and Pledge produce lower seed yields. Apart from perennial graminaceous weeds, some of annual graminaceous weeds cannot be controlled. Herbicide combinations Modown + Fluence and Modown + Evorelle express have even lower yields. The reason for this is the lack of an antigraminaceous effect in these variants.

The single use of foliar-applied herbicides Fluence and Evorelle express in a single or double treatment, without foliar-applied antigraminaceous herbicides or soil-applied herbicides, significantly increased seed yield compared to the untreated control from 121.9 to 123.8%. This increase of yields is lower than the increase of yields obtained in variants with herbicide tank mixtures and herbicide combinations. The reason for this is

GROZI DELCHEV ET AL.: EFFICACY OF HERBICIDES, HERBICIDE TANK MIXTURES
AND HERBICIDE COMBINATIONS ON EXPRESS SUN OIL-BEARING SUNFLOWER (*Helianthus annuus* L.)

the lack of effective control of annual and perennial graminaceous weeds. It is therefore necessary to apply herbicides Fluence and Evorelle express as herbicide tank mixtures

together with foliar-applied antigraminaceous herbicides or as herbicide combinations with soil-applied antigraminaceous herbicides.

Table 4. Influence of some herbicides, herbicide tank mixtures and herbicide combinations on sunflower seed yield (2018-2020)

Variants	2018		2019		2020		Mean	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/da	%
Control - untreated	2070	100	1944	100	2222	100	2079	100
Herbicides								
Fluence - 40 g/ha	2443	118.0	2327	119.7	2835	127.6	2535	121.9
Fluence - 20+20 g/ha	2474	119.5	2376	122.2	2869	129.1	2572	123.7
Evorelle express - 60 g/ha	2449	118.3	2333	120.0	2840	127.8	2541	122.2
Evorelle express - 30+30 g/ha	2484	120.0	2360	121.4	2871	129.2	2574	123.8
Herbicide tank mixtures								
Fluence + Fusilade forte	2583	124.8	2475	127.3	3044	137.0	2701	129.9
Fluence + Targa max	2552	123.3	2453	126.2	3011	135.5	2672	128.5
Fluence + Shogun	2525	122.0	2372	122.0	2955	133.0	2617	125.9
Fluence + Stratos ultra	2554	123.4	2459	126.5	3022	136.0	2678	128.8
Fluence + Centurion super	2540	122.7	2401	123.5	2989	134.5	2643	127.1
Evorelle express + Fusilade forte	2556	123.5	2455	126.3	3022	136.0	2678	128.8
Evorelle express + Targa max	2552	123.3	2449	126.0	3018	135.8	2673	128.6
Evorelle express + Shogun	2521	121.8	2362	121.5	2962	133.3	2615	125.8
Evorelle express + Stratos ultra	2577	124.5	2469	127.0	3037	136.7	2694	129.6
Evorelle express + Centurion super	2525	122.0	2393	123.1	2997	134.9	2638	126.9
Herbicide combinations								
Dual gold + Fluence	2540	122.7	2413	124.1	3000	135.0	2651	127.5
Indipen + Fluence	2521	121.8	2401	123.5	2980	134.1	2634	126.7
Fen + Fluence	2476	119.6	2346	120.7	2911	131.0	2578	124.0
Pledge + Fluence	2488	120.2	2356	121.2	2942	132.4	2592	124.7
Modown + Fluence	2453	118.5	2313	119.0	2867	129.0	2544	122.4
Dual gold + Evorelle express	2511	121.3	2399	123.4	2984	134.3	2631	126.6
Indipen + Evorelle express	2542	122.8	2414	124.2	3003	135.2	2653	127.6
Fen + Evorelle express	2467	119.2	2333	120.0	2900	130.5	2567	123.5
Pledge + Evorelle express	2484	120.0	2362	121.5	2935	132.1	2594	124.8
Modown + Evorelle express	2461	118.9	2321	119.4	2871	129.2	2551	122.7
LSD 5%	119	5.7	107	5.5	121	5.4		
LSD 1%	135	6.5	122	6.3	138	6.2		
LSD 0.1%	149	7.2	136	7.0	154	6.9		

CONCLUSIONS

Full controls of annual broadleaved weeds in ExpressSun oil-bearing is provided by a single treatment with herbicide Fluence at a dose of 40 g/ha or with herbicide Evorelle express at a dose of 60 g/ha applied during 3-4 leaf sunflower stage.

Full control of perennial broadleaved weeds is provided by two treatments with

herbicide Fluence in doses of 20+20 g/ha or with herbicide Evorelle express in doses of 30+30 g/ha, applied during 3-4 leaf and 7-8 leaf sunflower stages.

In the presence of annual and perennial broadleaved and graminaceous weeds, it is necessary to apply Fluence and Evorelle express as herbicide tank mixtures together with foliar-applied antigraminaceous herbicides Fusilade forte, Stratos ultra or Targa max.

In the absence of perennial graminaceous weeds, it is necessary to apply herbicides Fluence and Evorelle express as herbicide combinations with soil-applied antigraminaceous herbicides Dual gold or Indipen.

The highest seed yield is obtained by applied of herbicide tank mixture Fluence + Fusilade forte, followed by herbicide tank mixture Evorelle express + Stratos ultra.

High seed yields are also obtained by use of herbicide combinations Indipen + Evorelle express and Dual gold + Fluence.

REFERENCES

- Delchev, G., 2018. *Chemical control of weeds and self-sown plants in eight field crops*. Monograph, LAP LAMBERT Academic Publishing, Saarbrücken, Germany: 397. ISBN: 978-613-7-43367-6
- Delchev, G., 2020. *Winter resistance of oilseed canola and reseeding with spring crops*. Monograph, LAP LAMBERT Academic Publishing, Saarbrücken, Germany: 129. ISBN: 978-613-7-43367-6
- Delchev, G., 2021. *Efficacy and selectivity of some herbicides in five field crops*. Monograph, LAP LAMBERT Academic Publishing, Saarbrücken, Germany: 225. ISBN: 978-613-7-43367-6
- Jocić, S., Malidža, G., Cvejić, C., Hladni, N., Miklič, V., Škorić, D., 2011. *Development of sunflower hybrids tolerant to tribenuron methyl*. Genetika, 43(1): 175-182.
- Knežević, S., Malidža, G., Elezović, I., Simić, M., Glamočlija, Đ., 2011. *Critical periods for weed control and obtaining yield increase in sunflower (Helianthus annuus L.) tolerant to imidazolinones*. 11th Conference about Plant Protection, Zlatibor (Serbia): 111-112.
- Mitric, S., and Vuckovic, B., 2008. *Preliminary bioassay for determination of threshold doses of herbicides*. Acta Herbologica, 17(2): 161-166.
- Saskevich, P.A., Tibets, J.L., Gurikova, E.I., 2009. *Agro-ecological assessment of plant protection products in the cultivation of spring rape*. Bulletin of the Belarusian State Agricultural Academy, Scientific Methods Journal, 2: 83-87.
- Suresh, G., and Reddy, B., 2010. *Effect of weed control practices on weed dry matter, production potential and nutrient uptake of sunflower (Helianthus annuus) in Vertisols*. Indian Journal of Agricultural Sciences, 80(1): 33-37.
- Zand, E., Khaymi, M., Diaji, R., Yavari, H., Yazdi, M., 2009. *Response of rotational crops of wheat to soil residues of sulfonylurea herbicides*. Iranian Research of Plant Protection, 100: 20-22.