

EFFICACY OF HERBICIDES AND HERBICIDE COMBINATIONS AT WINTER OILSEED CANOLA (*BRASSICA NAPUS* L.)

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Abstract

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In the period 2012-2014 a field experiment was carried out with the conventional Maximus hybrid PX113 (*Brassica napus* L.). A total of 16 variants were investigated. They included 8 herbicides: Salsa 75 WG (ethametsulfuron-methyl), Butisan duo (metazachlor + dimethenamid), Butisan max (metazachlor + quinmerac + dimethenamid), Select super 120 EC (clethodim), Targa super 5 EC (quizalofop-P-ethyl), Galera super (clopyralid + picloram + aminopyralid), Modown 4 F (bifenox) and Aramo 50 (tepraloxymid) and 3 adjuvants: Trend 90, Codacide and Silwet L-77. By including a canola hybrid of the Maximus product line, the need of growth regulators is eliminated. Herbicide Salsa has very good efficacy against all broadleaved weeds, including against cruciferous weeds *Sinapis arvensis* L. and *Raphanus raphanistrum* L. and volunteers of *Coriandrum sativum* L. and *Silybum marianum* Gaertn. The efficacy of the herbicide Salsa in single use is higher when applied with the adjuvant Trend compared to the adjuvants Codacide and Silwet. Salsa must be combined with antigraminaceous herbicide at mixed weed infestation with graminaceous and broadleaved weeds. In tank mixtures of Salsa and Butisan max and Butisan duo, the herbicide efficacy and after-action against graminaceous weeds are higher when applied with the adjuvant Codacide. In concomitant use of Salsa and Select super with the adjuvant Codacide synergetic effect is reported. In the tank mixture of Salsa + Targa super, higher efficacy is reported in its combined use with the adjuvant Trend. Vegetation-applied herbicide Galera super has no efficacy against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. and has poorer efficacy against volunteers of *Coriandrum sativum* L. and *Silybum marianum* Gaertn. Autumn treatment by herbicide combination Modown + Aramo cause poor phytotoxicity at canola. Spring treatment with Modown + Aramo leads to a high and more difficult to overcome phytotoxicity.

Key words: winter oilseed canola; herbicides; tank mixtures; efficacy; selectivity; seed yield

Introduction

Integrated weed control in winter oilseed canola fields is a combination of preventative, mechanical and chemical methods. Its aim is to reduce environmental pollution (Klaus, 1992). To be economically efficient, application of herbicides must be done in accordance with the dominant weeds (O'Donovan, 1991; O'Donovan and Newman, 1996). The chemical weed control is more effective than the mechanical soil tillage (Chaudhry et al., 2011).

Cruciferous weeds are the most dangerous weeds in canola crops due to their difficult control (Wall, 1992). *Sinapis arven-*

sis L. and *Raphanus raphanistrum* L. are the dominant cruciferous species (Salimi et al., 2009). Coriander (*Coriandrum sativum* L.) and milk thistle (*Silybum marianum* Gaertn.) significantly increased their areas in the latest years. Coriander became the sixth spread crop in Bulgaria. Its areas are lesser only than that with wheat, sunflower, maize, canola and barley. Currently about 200 000 hectares in Bulgaria are already weeded by volunteers of *Coriandrum sativum* L. Coriander and milk thistle are becoming a big problem in the oilseed canola crops because their seeds remain germinal for a long time in soil. According to Pourazar and Habibiasl (2003), the herbicide Treflan cannot control *Silybum marianum* Gaertn.,

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Coriandrum sativum L. and cruciferous weeds. The Treflan + Lontrel combination is also inefficient against these weeds and volunteers (Shimi et al., 2006).

The purpose of this investigation was to establish the efficacy and selectivity of the new vegetation-applied herbicide Salsa 75 WG in combinations with other complementary products – herbicides and adjuvants, to ensure a continuous and stable herbicidal effect in winter oilseed canola under different meteorological condition.

Materials and methods

The research was conducted during 2012-2014 with the conventional Maximus hybrid PX113 (*Brassica napus* L). It was carried out as a field experiment with block method in 4 repetitions, on a 20 m² harvesting area, on *Pellic Vertisol* soil type, after durum wheat predecessor. A total of 16 variants were investigated. They included 8 herbicides: Salsa 75 WG, Butisan duo, Butisan max, Select super 120 EC, Targa super 5 EC, Galera super, Modown 4 F and Aramo 50 and 3 adjuvants: Trend 90, Codacide and Silwet L-77. The active substances, doses and periods of treatments of the investigated herbicides and herbicide tank mixtures are given in Table 1. All variants are applied with working solution consumption on 200 l.ha⁻¹. With including a canola hybrid from the Maximus product line the need of growth regulators was eliminated and so it was possible to study only the effect of herbicides, adjuvants and their mixtures.

The efficacy and selectivity of combinations between antigrainaceous and antibroadleaved herbicides was investigated. Their influence on seed yield was established. Efficacy of herbicides against weeds and volunteers of coriander, milk thistle and durum wheat was appointed according to 100% scale of EWRS (European Weed Research Society). Selectivity of herbicides to canola 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 by the method of analysis of variance.

Results and discussion

The first weeds in canola crops were mainly late spring weeds *Amaranthus retroflexus* L., *Chenopodium album* L., *Polygonum aviculare* L., *Abutilon theophrasti* Medic., *Xanthium strumarium* L., *Hibiscum trionim* L.

During October germinated winter-spring broadleaved weeds *Anthemis arvensis* L., *Chamomilla recutita* Rauchert, *Galium aparine* L., *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Capsella bursa pastoris* L., *Falopia convolvu-*

lus Leve, *Myagrum perfoliatum* L., *Lithospermum arvense* L., *Papaver rhoes* L., *Thlaspi arvense* L., *Consolida regalis* Gray, *Viola tricolor* L., *Lamium purpureum* L., *Veronica hederifolia* L., *Stellaria media* Cyr.

Winter-spring graminaceous weeds were represented by *Alopecurus myosuroides* L., *Apera spica-venti* P.B., *Lolium multiflorum* L., *Lolium temulentum* L., *Bromus arvensis* L.

Volunteers were represented by durum wheat (*Triticum durum* Desf.), coriander (*Coriandrum sativum* L.) and milk thistle (*Silybum marianum* Gaertn.).

Single application of herbicide Salsa has very good efficacy against all broadleaved weeds, including *Sinapis arvensis* L. and *Raphanus raphanistrum* L., as well as against volunteers of *Coriandrum sativum* L. and *Silybum marianum* Gaertn. (Tables 2 and 3). This herbicide has weak adhesion, due to the necessity to be applied together with adjuvant.

To increase efficacy of herbicide Salsa its tank mixtures were studied with 3 adjuvants - Trend, Codacide and Silwet. At single application of Salsa without other complementary herbicides, its efficacy is higher when applied with adjuvant Trend than with adjuvants Codacide and Silwet.

Differences in the efficacy of Salsa by influence of Trend on one hand and by influence of Codacide and Silwet on other hand are within 1-5%. When Salsa is applied without adjuvant, the efficacy of the herbicide significantly decreases against all broadleaved weeds by 14-20%. This decreasing is particularly emphasized against weeds with wax coating leaves, as *Chenopodium album* L. or weeds with pappus leaves, as *Polygonum aviculare* L.

Absence of adjuvant leads to significant decrease in efficiency of Salsa against volunteers of *Coriandrum sativum* L. with 18% and against volunteers of *Silybum marianum* Gaertn. by 20%. The differences in efficacy against these volunteers under the influence of adjuvant Trend on one hand and adjuvants Codacide and Silwet on other hand are small - up to 2% in coriander and up to 4% in milk thistle.

Salsa is a foliar-applied herbicide and has no soil activity. In case of prolonged wet weather after treatment, secondary weed infestation appears which requires the combination of Salsa with another antibroadleaved herbicide with soil activity. For purpose of expansion and mostly for extension of herbicidal effects the combinations of Salsa with soil-applied herbicides Butizan duo and Butizan max were studied. Tank mixtures Salsa + Butizan duo and Salsa + Butizan max successfully control all broadleaved weeds in winter oilseed canola. They control also basic graminaceous weeds and volunteer of cereals with 80 to 100% rate. Both tank mixtures, especially the second one, have a long after-effect for prolonged control of secondary germinated weeds.

The weak adhesion of Salsa requires the addition of adjuvants in combinations with other herbicides. In concomitant use of Salsa with Butizan duo and Butizan max herbicide efficacy and after-effect of tank mixtures against graminaceous weeds are higher when they have applied with adjuvant Codacide in comparison with adjuvant Trend. Efficacy against

Table 1
Investigated variants

Nº	Variants	Active substance	Doses	Treatment period
1	Control – not treated	-	-	-
2	Salsa 75 WG + Trend 90	ethametsulfuron-methyl *	20 g.ha ⁻¹ 0.1 %	2-4 leaf
3	Salsa 75 WG + Codacide	ethametsulfuron-methyl **	20 g.ha ⁻¹ 1.5 l.ha ⁻¹	2-4 leaf
4	Salsa 75 WG + Silwet L-77	ethametsulfuron-methyl ***	20 g.ha ⁻¹ 100 ml.ha ⁻¹	2-4 leaf
5	Salsa 75 WG	ethametsulfuron-methyl	20 g.ha ⁻¹	2-4 leaf
6	Salsa 75 WG + Butisan duo + Trend 90	ethametsulfuron-methyl metazachlor + dimethenamid *	20 g.ha ⁻¹ 2 l.ha ⁻¹ 0.1 %	2-4 leaf
7	Salsa 75 WG + Butisan duo + Codacide	ethametsulfuron-methyl metazachlor + dimethenamid **	20 g.ha ⁻¹ 2 l.ha ⁻¹ 1.5 l.ha ⁻¹	2-4 leaf
8	Salsa 75 WG + Butisan max + Trend 90	ethametsulfuron-methyl metazachlor + quinmerac + dimethenamid *	20 g.ha ⁻¹ 2 l.ha ⁻¹ 0.1 %	2-4 leaf
9	Salsa 75 WG + Butisan max + Codacide	ethametsulfuron-methyl metazachlor + quinmerac + dimethenamid **	20 g.ha ⁻¹ 2 l.ha ⁻¹ 1.5 l.ha ⁻¹	2-4 leaf
10	Salsa 75 WG + Select super 120 EC + Trend 90	ethametsulfuron-methyl clethodim *	20 g.ha ⁻¹ 800 ml.ha ⁻¹ 0.1%	2-4 leaf
11	Salsa 75 WG + Select super 120 EC + Codacide	ethametsulfuron-methyl clethodim **	20 g.ha ⁻¹ 800 ml.ha ⁻¹ 1.5 l.ha ⁻¹	2-4 leaf
12	Salsa 75 WG + Targa super 5 EC + Trend 90	ethametsulfuron-methyl quizalofop-P-ethyl *	20 g.ha ⁻¹ 1.2 l.ha ⁻¹ 0.1%	2-4 leaf
13	Salsa 75 WG + Targa super 5 EC + Codacide	ethametsulfuron-methyl quizalofop-P-ethyl **	20 g.ha ⁻¹ 1.2 l.ha ⁻¹ 1.5 l.ha ⁻¹	2-4 leaf
14	Galera super	clopyralid-olamine + picloram + aminopyralid	200 ml.ha ⁻¹	2-4 leaf
15	Salsa 75 WG 75+ Galera super + Trend 90	ethametsulfuron-methyl clopyralid-olamine + picloram + aminopyralid *	20 g.ha ⁻¹ 200 ml.ha ⁻¹ 0.1%	2-4 leaf
16	Modown 4 F + Aramo 50	bifenox tepraloxymid	1 l.ha ⁻¹ 1.5 l.ha ⁻¹	4-6 leaf

Table 2
Efficacy of some herbicides and herbicide mixtures against annual broadleaved weeds at canola according to the 100% visual scale of EWRS (2012-2014)

Variants	Weeds							
	<i>Galium aparine</i>	<i>Chamomilla recutita</i>	<i>Papaver rhoeas</i>	<i>Sinapis arvensis</i>	<i>Raphanus raphanistrum</i>	<i>Anthemis arvensis</i>	<i>Falopia convolvulus</i>	<i>Capsella bursa-pastoris</i>
Control – no treated	0	0	0	0	0	0	0	0
Salsa 75 WG + Trend 90	100	100	100	100	100	100	100	100
Salsa 75 WG + Codacide	95	99	98	99	97	99	96	98
Salsa 75 WG + Silwet L-77	96	97	99	98	95	98	99	99
Salsa 75 WG	80	88	85	80	82	86	85	80
Salsa 75 WG + Butisan duo + Trend 90	100	100	100	100	100	100	100	100
Salsa 75 WG + Butisan duo + Codacide	100	100	100	100	100	100	100	100
Salsa 75 WG + Butisan max + Trend 90	100	100	100	100	100	100	100	100
Salsa 75 WG + Butisan max + Codacide	100	100	100	100	100	100	100	100
Salsa 75 WG + Select super 120 EC + Trend 90	100	100	100	99	99	100	100	98
Salsa 75 WG + Select super 120 EC + Codacide	100	100	100	100	100	100	100	100
Salsa 75 WG + Targa super 5 EC + Trend 90	99	100	100	98	98	100	100	99
Salsa 75 WG + Targa super 5 EC + Codacide	98	100	100	95	95	100	100	97
Galera super	100	98	100	15	15	98	99	92
Salsa 75 WG 75+ Galera super + Trend 90	100	100	100	100	100	100	100	100
Modown 4 F + Aramo 50	94	98	100	95	95	98	96	100

Table 3

Efficacy of some herbicides and herbicide mixtures against annual graminaceous weeds and volunteers at canola according to the 100% visual scale of EWRS and selectivity according to the 9-rate scale of EWRS (2012-2014)

Variants	Weeds							Selectivity
	<i>Alopecurus myosuroides</i>	<i>Lolium temulentum</i>	<i>Apera spica-venti</i>	<i>Bromus arvensis</i>	<i>Triticum durum*</i>	<i>Coriandrum sativum**</i>	<i>Silybum marianum***</i>	
Control – no treated	0	0	0	0	0	0	0	1
Salsa 75 WG + Trend 90	0	0	0	0	0	100	100	1
Salsa 75 WG + Codacide	0	0	0	0	0	98	97	1
Salsa 75 WG + Silwet L-77	0	0	0	0	0	98	96	1
Salsa 75 WG	0	0	0	0	0	82	78	1
Salsa 75 WG + Butisan duo + Trend 90	100	88	80	80	80	99	99	1
Salsa 75 WG + Butisan duo + Codacide	100	92	86	82	84	100	100	1
Salsa 75 WG + Butisan max + Trend 90	100	90	80	80	80	100	99	1
Salsa 75 WG + Butisan max + Codacide	100	93	87	82	86	100	100	1
Salsa 75 WG + Select super 120 EC + Trend 90	100	98	100	95	100	100	100	2
Salsa 75 WG + Select super 120 EC + Codacide	100	100	100	100	100	100	100	2
Salsa 75 WG + Targa super 5 EC + Trend 90	100	98	100	95	100	96	96	1
Salsa 75 WG + Targa super 5 EC + Codacide	100	96	100	92	100	94	95	1
Galera super	0	0	0	0	0	60	65	1
Salsa 75 WG 75+ Galera super + Trend 90	0	0	0	0	0	100	100	1
Modown 4 F + Aramo 50	100	100	100	100	100	90	85	3 (4)

* - volunteers of durum wheat (*Triticum durum* Desf.)

** - volunteers of coriander (*Coriandrum sativum* L.)

*** - volunteers of milk thistle (*Silybum marianum* Gaertn.)

(4) - selectivity of herbicide Modown at spring treatment in 2012, during the same stage – 4-6 leaf

broadleaved weeds of herbicide mixtures Salsa + Butizan duo and Salsa + Butizan max is not affected by the type of adjuvant – Codacide or Trend.

Salsa is a typical antibroadleaved herbicide - it has no anti-graminaceous action. In highly mixed weed infestation with graminaceous and broadleaved weeds, for extent spectrum of action of Salsa, it is necessary that this herbicide is combined with antigraminaceous herbicides. For this purpose combinations of Salsa with the vegetation-applied antigraminaceous herbicides Select super and Targa super were studied.

In concomitant use of herbicides Salsa and Select super with adjuvant Codacide a synergistic effect is reported - the effect of this mixture is higher than mixture of these two herbicides with adjuvant Trend. Synergism is more intense against some of the most dangerous weeds in canola - *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Galium aparine* L., from broadleaved weeds; *Lolium temulentum* L., *Bromus arvensis* L. from graminaceous weeds. Herbicide combination Salsa + Select super + Codacide have very strong efficacy also against volunteers of *Coriandrum sativum* L., *Silybum marianum* Gaertn. and *Triticum durum* Desf.

In the tank mixture Salsa + Targa super higher efficiency is reported in its concomitant use with adjuvant Trend. In this mixture there is an additive effect - the effect is equal to the sum herbicidal activity. In the tank mixture of Salsa + Targa super with adjuvant Codacide antagonistic effect mainly against broadleaved weeds is reported - *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Galium aparine* L.; against graminaceous weeds - *Lolium temulentum* L., *Bromus arvensis* L.; as well as against volunteers of milk thistle and coriander, but not against volunteers of durum wheat. As regards those weeds and volunteers, efficacy of herbicide mixture Salsa + Targa super + Codacide is lower than that of mixture Salsa + Targa super + Trend by 2-3%.

Herbicide Galera super is systemic foliar-applied herbicide. Applied during 2-4 leaf stage of canola, it has very good efficacy against most of the available broadleaved weeds in canola. The herbicide is ineffective against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. (efficiency of only 15%) and is less effective compared to Salsa against volunteers of coriander (efficiency of 60%) and against volunteers of milk thistle (efficiency of 65%). Galera super does not have also antigraminaceous effect. Poloznjak (2003) also reports a low efficacy of the herbicide Galera against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. in spring canola crops.

Tank mixture of Salsa and Galera super with adjuvant Trend has very good efficacy against all annual and perennial broadleaved weeds, including against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. and against volunteers of coriander and milk thistle. It is not efficacy against graminaceous

weeds and volunteers of cereals. It requires at mixed weed infestation with graminaceous and broadleaved weeds tank mixture Salsa + Galera super + Trend to be combined with antigraminaceous herbicide. According to Harker et al. (1995) herbicide mixtures of antibroadleaved herbicide Salsa with antigraminaceous herbicides Fouizide forte, Galant super, Targa super and Nabu extra do not show antagonism in their herbicidal action.

Herbicide mixture Modown + Aramo has very good efficacy against all the available in the experiment broadleaved weeds, including against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. It has good efficacy against volunteers of coriander and milk thistle (90% and 85%). The treatment should be performed after 4 leaf stage to allow canola to form a thick wax coating on the leaf mass.

On the fifth day after treatment with Salsa slight signs of phytotoxicity on the leaves of canola were reported. It is weak in single treatment with the herbicide Salsa and its tank mixtures with herbicides Butizan duo, Butizan max, Targa super and Galera super and adjuvants Trend, Codacide and Silvet – had rating 1 by scale of EWRS (Table 3). Phytotoxicity is bigger in concomitant treatment of Salsa with antigraminaceous-herbicide Select super and adjuvants Trend and Codacide as tank mixtures – rating 2 by scale of EWRS. In all variants phytotoxicity was overcome by canola for about 6-7 days after their onset and did not have a negative influence on the canola seed yield. Lichtner et al. (1995) found that herbicide Salsa, applied during 2-6 leaf stage of canola and weeds exhibited high selectivity against a number of cultivars and hybrids of spring canola.

Herbicide Galera super has very high selectivity to winter oil-seed canola. In single treatment with Galera super there wasn't phytotoxicity on canola plants - rating 1 by scale of EWRS.

Autumn treatment with Modown + Aramo during 4-6 canola leaf stage leads to visible signs of phytotoxicity on canola - rating 3 by scale of EWRS. Spring treatment with Modown + Aramo leads to a bigger and more difficult to overcome phytotoxicity - rating 4 by scale of EWRS. Spring treatment with this tank mixture should be done only as a last measure. Modown's higher phytotoxicity has been also reported in our other studies (Delchev, 2014).

The highest seed yield is obtained in treatment with the combinations Salsa + Butisan max + Codacide and Salsa + Butisan duo + Codacide, with 21.1% and 20.0%, respectively, above the non-treated control (Table 4). Good results are also obtained with the tank mixtures Salsa + Butisan max + Trend и Salsa + Butisan duo + Trend. The high yields in these variants are accounted by both the good herbicide efficacy of Salsa and the prolonged aftereffect of Butisan max and Butisan duo for control of the secondary emerged weeds. In

Table 4
Influence of some herbicides and herbicide mixtures on seed yield of canola (2012- 2014)

Variants	2012		2013		2014		Mean	
	kg.ha ⁻¹	%						
Control – no treated	2110	100	3430	100	3822	100	3121	100
Salsa 75 WG + Trend 90	2439	115.6	3917	114.2	4494	117.6	3614	115.8
Salsa 75 WG + Codacide	2405	114.0	3869	112.8	4444	116.3	3570	114.4
Salsa 75 WG + Silwet L-77	2410	114.2	3876	113.0	4444	116.3	3574	114.5
Salsa 75 WG	2344	111.1	3756	109.5	4248	111.1	3452	110.6
Salsa 75 WG + Butisan duo + Trend 90	2507	118.8	4047	118.0	4613	120.7	3720	119.2
Salsa 75 WG + Butisan duo + Codacide	2521	119.5	4065	118.5	4663	122.0	3745	120.0
Salsa 75 WG + Butisan max + Trend 90	2515	119.2	4047	118.0	4640	121.4	3730	119.5
Salsa 75 WG + Butisan max + Codacide	2534	120.1	4102	119.6	4697	122.9	3780	121.1
Salsa 75 WG + Select super 120 EC + Trend 90	2469	117.0	3975	115.9	4548	119.0	3661	117.3
Salsa 75 WG + Select super 120 EC + Codacide	2507	118.8	4034	117.6	4651	121.7	3726	119.4
Salsa 75 WG + Targa super 5 EC + Trend 90	2464	116.8	3975	115.9	4548	119.0	3661	117.3
Salsa 75 WG + Targa super 5 EC + Codacide	2448	116.0	3948	115.1	4506	117.9	3630	116.3
Galera super	2321	110.0	3746	109.2	4281	112.0	3446	110.4
Salsa 75 WG 75+ Galera super + Trend 90	2437	115.5	3920	114.3	4506	117.9	3620	116.0
Modown 4 F + Aramo 50	2344	111.1	3962	115.5	4541	118.8	3595	115.2
LSD 0.5	213	10.1	309	9.0	375	9.8		
LSD 0.1	264	12.5	381	11.1	471	12.4		
LSD 0.01	327	15.5	460	13.4	600	15.7		

all three years of the experiment the addition of the adjuvant Codacide to tank mixtures Salsa + Butisan max and Salsa + Butisan duo results in obtaining higher seed yields compared to adding the adjuvant Trend.

In the herbicide mixture Salsa + Select super + Codacide due to the synergism among the preparations, seed yields are equal to those of the above combinations with Butisan max and Butisan duo. When mixing Salsa with Select super and Trend and with Targa super, Codacide and Trend seed yields are lower due to the weaker control of the secondary weeding in a more humid and warmer autumn.

Seed yields are the lowest when the herbicide is single used without adjuvant – 10.6% above the weeded control. When adding the adjuvants Trend, Codacide and Silwet and the herbicide Galera super to the herbicide Salsa, seed yields increase and are equal to the herbicide combination Modown + Aramo, but still lower than those of the variants of Salsa with Butisan max, Butisan duo, Select super and Targa super due to lack of control on graminaceous weeds.

Conclusions

Herbicide Salsa has very good efficacy against all broad-leaved weeds, including against cruciferous weeds *Sinapis arvensis* L. and *Raphanus raphanistrum* L. and volunteers of *Coriandrum sativum* L. and *Silybum marianum* Gaertn.

The efficacy of the herbicide Salsa in single use is higher when applied with the adjuvant Trend compared to the adjuvants Codacide and Silwet.

Salsa must be combined with antigraminaceous herbicide at mixed weed infestation with graminaceous and broad-leaved weeds.

In tank mixtures of Salsa and Butisan max and Butisan duo, the herbicide efficacy and after-action against graminaceous weeds are higher than when applied with the adjuvant Codacide.

In concomitant use of Salsa and Select super with the adjuvant Codacide, synergistic effect is reported.

In the tank mixture of Salsa + Targa super, higher efficacy is reported in its combined use with the adjuvant Trend.

Vegetation-applied herbicide Galera super has no efficacy against *Sinapis arvensis* L. and *Raphanus raphanistrum* L. and has poorer efficacy against volunteers of *Coriandrum sativum* L. and *Silybum marianum* Gaertn.

Autumn treatment with herbicide combination Modown + Aramo causes poor phytotoxicity at canola. Spring treatment with Modown + Aramo leads to a high and more difficult to overcome phytotoxicity.

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