Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 1, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH REGARDING THE CONTROL OF DICOTYLEDONOUS WEEDS IN RAPESEED CROPS, IN CALARASI COUNTY

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Abstract

Rapeseed crop is one of the most profitable agricultural investments, very wide opened to development in Romania. In the latest years, rapeseed has been cultivated on larger surfaces, as this plant may produce quality oil. It is also known as a biodiesel plant, more and more requested for fuel, so that the total area cultivated with rapeseed was 632 thousand ha in 2018. Of this surface, 63,389 ha were grown in Calarasi County. New agricultural technologies and new hybrids have allowed it to grow successfully under our country`s climatic conditions. Beside of this, this crop has its own particularities that must be carefully taken into consideration in order to obtain high yields. To give best results, rapeseed needs to be carefully protected, just because this plant can hardly bear weeds infestation, which is one of the limiting factor of yield. In recent years, due to weather evolution, with very mild winters, many weeds species (Galium sp., Lamium sp., Matricaria sp., Thlaspi arvense, Veronica sp., etc.) have grown, even propagated, so that they became a problem more and more often. On the contrary, under normal winter conditions, even during freezing winters, this fact would have never happened. These weeds, among which some invasive species (Veronica persica) become immune to the cold and enter the spring well-developed and compete with the crops for water, air, light and nutrients. In this context, the paper reveals aspects regarding the control of the annual and perennial dicotyledonous weeds in the rapeseed crop grown in two distinct locations in Calarasi County, where post-emergence treatments with clopyralid herbicides formulated in the form of a soluble concentrate (SL) and of water soluble granules (SG) were applied in spring. Herbicides were applied at different rates and at different crop and weeds stages. The assessments concerned the effectiveness in control, the safety of the crop as well as a comparative analysis between the two formulations SL vs. SG respectively, regarding the mode of action on weeds and the level of weeds control. The research results indicated that clopyralid-based herbicides had good efficacy in controlling dicotyledonous weeds depending on the rate applied, the time of application and the degree of weed infestation.

Key words*: rapeseed, weeds, herbicides, efficacy, Calarasi.*

INTRODUCTION

Canola (*Brassica napus* L.) is one of the most economically important oilseed crop worldwide which is grown mainly for edible vegetable oil and biodiesels production as well as animal feed (Mohamed, 2017). Canola seeds are a rich source of oil (about 40-45%) and protein (25%) and it is cultivated in more than 120 countries mostly in Asia, Europe, North America and Australia (Roshdy et al., 2008). Weeds are one of the most problematic pests of canola all over the world which cause considerable loss in quantity and quality of canola yield production (Khan et al., 2003, Berca, 2004, Singh et al., 2001, Mekki et al., 2010, Kaur et al., 2015, Grădilă, 2017). There are many various grass and broadleaved weeds species infesting canola fields in the world and resulting in yield loss of 20-50% (Kaur et al., 2015). Weed control was relatively simple for monocotyledonous species, but was more challenging for some dicotyledonous species, especially *Brassicaceae* weeds related to canola (Blackshaw, 1989).

Integrated weed control in oilseed canola is a combination of preventative, mechanical and chemical methods to reduce environmental pollution. (Delchev & Georgiev, 2015). To be economically efficient, application of herbicides must be done in accordance with damage thresholds prevailing weeds (Lukacs & Halasz, 1987; O'Donovan, 1991; Klaus, 1992; O'Donovan & Newman, 1996). Chemical weed control is more effective than mechanical processing.

In the spring, after the weather warming up, there is an overwhelming development of winter rapeseed plants, but at the same time, of the weeds that survived through the winter, too.

As emerged, weeds compete with crops and deprive them of nutrients. Therefore, management control should be taken as soon as possible, when the weeds are still in low stages of vegetation.

One of the important aspects of the location technology and the maintenance of the autumn crops is the spring herbicide application.

One of the most used spring - applied herbicides in rapeseed crop is Lontrel (with clopyralid as active ingredient). Clopyralid does not exhibit phytotoxicity to the winter rape and provides better control of annual and perennial broadleaf weeds (Wei et al., 2010). Leyhe et al. (1994) reported a high herbicidal efficacy and selectivity of Lontrel in oilseed canola, too. In this context, the paper reveals aspects regarding the control of the annual and perennial dicotyledonous weeds in the rapeseed crop grown in two distinct locations in Călăraşi county, where post-emergence treatments with clopyralid herbicides formulated in the form of a soluble concentrate (SL) and of water soluble granules (SG) were applied.

MATERIALS AND METHODS

The trials have been carried out at S.C. Profarma Holding S.R.L. Tămădău and SC Ghinea Prod. S.R.L., Călăraşi county on experimental plots (Figure 1 and Figure 2). The experiments were conducted in 2018-2019, in 4 repetitions with plot area of 30 m² on loamy clay soil with a pH of 6.5 and an organic matter content of 2.5%. Each experimental block included an untreated plot and one standard reference. The herbicide Clopyralid 30 SL (300 g/l active ingredient) was applied in a dose of 0.2, 0.3 and 0.4 l/ha and Clopyralid 72 SG (720 g/kg active ingredient) at 0.083, 0.125 and 0.167 kg/ha. The hybrids taken into account were DK Exprit at Dâlga and Hybrirock at Tămădău. The planting density was 450000 plants per hectare. Sowing was performed on August 24 at Dâlga and September 21 at Tămădău. The previous crop was wheat. The following agro-technical measures have been applied: systematic crop rotation, rational choice of the preceding plant, deep plowing up to 30 cm depth in summer, seedbed tillage by 2 passes with disc harrow followed by milling, high quality hybrids, and sowing at the right time at appropriate densities in accordance with crop technology. At the same time 200 kg/ha of complex fertilizer (40 N + 13 SO3) was applied. The pathogens were controlled by two insecticides applications with cipermetrin 100g/l (Faster 10 CE 0.2 l/ha) and cipermetrin 25% (Cyperguard 25 EC 0.1 l/ha) at Dâlga, and by one fungicide application with tebuconazol 250g/l (Orius 25 EW 0.2 l/ha) and one insecticide application with alfa-cipermetrin 50 g/l (Fastac Active 0.2 l/ha) at Tămădău, respectively. All treatments were applied in the autumn, both at Dâlga and Tămădău.

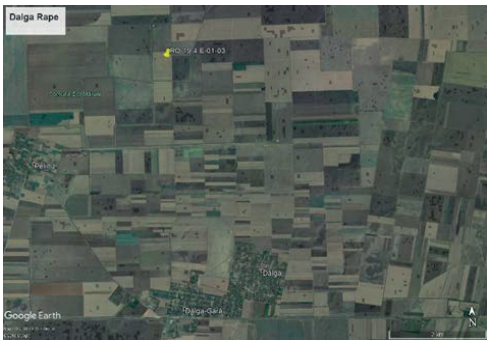

Figure 1. Location of rapeseed plots at Dâlga

Figure 2. Location of rapeseed plots at Tămădău

The herbicides were applied in postemergence when rape was on the stage of 7 and 8 visibly extended internodes at BBCH 37-38 and weeds on the stage of two to four leaves at BBCH 12-14. Weeds density was assessed in ground % and in number of plants per square meter. Weed control (efficacy) was assessed at 10, 28, and 40 days after each application in % control in comparison with the untreated plots. Also, there were observations on the weeds found in the experimental plots before treatment, and selectivity - at each date of the efficacy

assessments. Determination of segetal flora was performed on one square meter using a metric frame. Statistical data - processing of the assessments was based on the analysis of ARM-9 software (P=.05, Student - Newman - Keuls).

RESULTS AND DISCUSSIONS

Generally, the important weeds to occur in oilseed rape can be ordered into several groups as follows: dicotyledonous species (excluding *Brasicaceae* family), dicotyledonous species belonging to the *Brasicaceae* synonim *Cruciferae*, annual grasses (including volunteer), and perennials.

As for the experimental plots the previous crop was wheat, the weed species spectrum on rapeseed crops looks like those on grain crops.

Thus, in the experimental field at Dâlga the predominant weeds were annual dicotyledonous: *Papaver rhoeas* L., *Galium aparine* L., *Polygonum persicaria* Gray. and perennial dicotyledonous *Cirsium arvense* (L.) Scop. and *Sonchus* species. The common poppy is a hard to control weed that became resistant to herbicides in recent years.

At Tămădău the predominant weeds were annual dicotyledonous: *Viola arvensis* Murray., *Galium aparine* L., *Euphorbia cyparissias* L., *Matricaria* inodora L., and perennial dicotyledonous *Cirsium arvense* (L.) Scop. and *Raphanus raphanistrum* L.

There were present also the species: *Fumaria officinalis, Lamium spp., Descurainia sophia, Chenopodium album, Thlaspi arvense, Centaurea cyanus, Veronica persica* but in a low number. Canola plants during its initial growth stages are very sensitive to weeds interference (Kaur et al., 2015). The critical weed-free period for oilseed rape is from emergence to early flowering stages (Deligios et al., 2018). The growth stage of dominant weeds in experimental plots is presented in Table 1.

Table 1. Growth stage of dominant weeds in rape crops

	Dâlga			Tămădău		
Assessment	Weeds	BBCH[1]	Description	Weeds	BBCH	Description
1st assessment	PAPRH (*Papaver rhoeas*)	16	6 true leaves unfolded	VIOAR (*Viola arvensis*)	16	6 true leaves unfolded
2nd assessment		25	5 side shoots visible		30	Beginning of stem elongation
3rd assessment		42	First young plant visible		51	Inflorescence or flower buds visible
4th assessment		55	First individual flowers visible		63	30% of flowers open
1st assessment	GALAP (*Galium aparine*)	14	4 true leaves unfolded	*GALAP* (*Galium aparine*)	14	4 true leaves unfolded
2nd assessment		24	4 side shoots visible		32	2 visibly extended internode
3rd assessment		36	6 visibly extended internode		51	2 side shoots visible
4th assessment		51	Inflorescence or flower buds visible		60	First flowers open (sporadically
1st assessment	POLPE *(P. persicaria)*	18	8 true leaves unfolded	EPHCY *(Euphorbia cyparissias)*	18	8 true leaves unfolded
2nd assessment		26	6 side shoots visible		42	First young plant visible
3rd assessment		28	8 side shoots visible		59	5 true leaves unfolded
4th assessment		59	First flower petals visible		65	Full flowering
1st assessment	CIRAR (*Cirsium arvense*)	14	4 true leaves unfolded	MATIN Matricaria inodora	14	4 true leaves unfolded
2nd assessment		24	4 side shoots visible		34	4 visibly extended internode
3rd assessment		42	First young plant visible		42	First young plant visible
4th assessment		59	First flower petals visible		65	Full flowering
1st assessment	SONSS (*Sonchus* species)	14	4 true leaves unfolded	CIRAR (*Cirsium arvense*	16	6 true leaves unfolded
2nd assessment		24	4 side shoots visible		36	6 visibly extended internode
3rd assessment		42	First young plant visible		42	First young plant visible
4th assessment		60	First flowers open		65	First young plant visible
1st assessment				*RAPRA (Raphanus raphanistrum)*	23	3 side shoots visible
2nd assessment					42	First young plant visible
3rd assessment					60	First flowers open (sporadically
4th assessment					71	Fruits begin to develop

[1]BBCH scale= is a scale used to identify the phenological stages of a plant development

Coverage with weeds species in the experimental field was high: *P. rhoeas* 22.0%, *G. aparine* 17.5% at Dâlga and 15% at Tămădău, *P. persicaria* 12.2%, *C. arvense* 15.5% at Dâlga and 19% at Tămădău, S. species 19% and *R. raphanistrum* 10.3%, as a ground % at 42 days after treatment application (Table 4).

In these infestation conditions, herbicides Clopyralid 30 SL and Clopyralid 72 SG provided a good efficacy control on annual and perennial dicotyledonous weeds in rape, at Dâlga and Tămădău. At 10 days after treatment

the herbicide had a good efficacy in control of weeds at all tested doses, both at Dâlga and Tămădău, except *R. raphanistrum* species from *Brassicaceae* family, whose efficacy was lower (Table 2). Clopyralid is a pyridinecarboxylic acid, absorbed in the leaves and roots, ceasing plant growth. This unique mode of action makes Clopyralid excellent for use in control strategies and resistance against broadleaved weeds (Leyhe et al., 1994). Once the herbicide is applied, it is quickly absorbed and translocated throughout the whole plant, including the roots, flowing to increased metabolic activity areas. This ability makes Clopyralid effective against weeds with deep roots that are difficult to fight against, such as *Galium aparine*, *Sonchus* species and *Cirsium arvense* (Grădilă & Jalobă, 2018). Weeds do not die immediately, but their growth and development are stopped. When finally translocated throughout the whole weed, Clopyralid interrupts water absorption and nutrients included, plant metabolism being affected. The leaves dry out and lose their functional properties and at last plants die, even their deep roots. Besides, there are others trials or results that report high efficacy of herbicides Lontrel in oilseed canola crops (Tibets & Saskevich, 2006; Saskevich et al., 2009).

Table 2. The efficacy of herbicides in crop after 10 days of treatment

Treatment name	Dose l or kg/ha	Weeds										
		Efficacy - % control in comparison with the untreated plots										
		Dâlga					Tămădău					
		PAPRH	*GALAP*	*POLPE*	*CIRAR*	*SONSS*	*VIOAR*	*GALAP*	*EPHCY*	*MATIN*	*CIRAR*	*RAPRA*
Untreated (ground %)		8.75	10	7	6.50	9.50	12.5	9	6	12	10	8
Untreated	-	0.0e	0.0c	0.0b	0.0b	0.0b	0.0c	0.0c	0.0b	0.0b	0.0b	0.0d
Clopyralid 30 SL	0.2	87.6d	95.5b	97.9a	98.1a	94.0ab	82.2b	96.1ab	99.3a	92.9a	89.7a	72.9c
	0.3	94.6bc	96.9ab	99.6a	99.6a	95.5ab	87.5ab	97.5ab	100a	97.7a	96.1a	76.6bc
	0.4	97.9b	99.4ab	100a	100a	99.3a	92.8a	98.8ab	100a	99.7a	97.5a	83.0a
Clopyralid 72 SG	0.083	87.2d	93.7b	99.3a	99.3a	89.3b	82.2b	91.1b	99.5a	93.4a	94.4a	71.5c
	0.125	89.5cd	95.5ab	100a	100a	95.1ab	91.0ab	96.9ab	100a	96.8a	941a	76.8bc
	0.167	100a	98.6ab	100a	100a	99.2ab	91.2ab	100a	100a	99.1a	987a	84.0a
Lontrel 300 SL	0.4	97.6b	100a	100a	100a	98.1a	95.4a	100a	100a	99.4a	99.0a	81.5ab
LSD (P=.05)		**1.0-6.1**	**2.2-5.3**	**1.4-1.9**	**1.3-1.8**	**3.5-6.4**	**5.5-7.4**	**1.9-6.2**	**0.6-1.0**	**3.9-5.6**	**5.4-7.4**	**45-2.1**
Standard Deviation		**4.002t**	**5891t**	**4.679t**	**4.542t**	**4.873 t**	**4.21t**	**5.39t**	**4.04t**	**5.88t**	**6.13t**	**2.28t**

Subsequent observations (28 and 40 days after treatment) confirmed the good results of the clopyralid herbicide in control of annual and perennial dicotyledonous weeds in rape (Tables 3 and 4). At the dose of 0.4 l/ha Clopyralid 30 SL and at the dose of 0.167 kg/ha Clopyralid 72 SG the herbicidal effect was preserved throughout the growing season of rape. At the dose of 0.2 l/ha Clopyralid 30 SL, the weeds species are not entirely controlled and control rate decreased. For exemple, in case of *V. arvense* from 70.7% at 28 days to 53.8% at 42 days after treatment and at the dose of 0.3 l/ha from 76.9% at 28 days to 61.3% at 42 days after treatment. The results were also similar to those of Clopyralid 72 SG, applied at the doses of 0.083 and 0.125 kg/ha (Tables 3 and 4). Overall, the effectiveness of clopyralid in controlling annual and perennial dicotyledonous weeds was slightly lower at Tămădău, being compared to Dâlga trial efficacy, as the density of weeds on square meter and the ground cover of the weeds were higher. No phytotoxicity symptoms have been shown in the experimental plot. No symptoms of chlorosis, necrosis, leaf deformation, height reduction, distortion and delay at flowering in plots treated with clopyralid were seen (*, 2014).

Table 3. Efficacy of herbicides in rape crop after 28 days of treatment

Treatment name	Dose l or kg/ha	Weeds										
		Efficacy - % control in comparison with the untreated plots										
		Dâlga					Tămădău					
		PAPRH	*GALAP*	*POLPE*	*CIRAR*	*SONSS*	*VIOAR*	*GALAP*	*EPHCY*	*MATIN*	*CIRAR*	*RAPRA*
Untreated (ground %)		17.5	13.7	10	11.2	12.7	20.5	12	6.5	16.2	15	10
Untreated	-	0.0c	0.0d	0.0d	0.0c	0.0c	0.0c	0.0b	0.0b	0.0c	0.0e	0.0c
Clopyralid 30 SL	0.2	75.2b	86.9bc	89.3c	83.4b	82.6b	70.7b	86.0a	98.6a	79.8b	75.9d	62.5b
	0.3	83.1ab	90.4bc	94.0bc	90.9ab	87.3ab	76.9ab	89.8a	99.0a	85.4b	83.4bcd	68.3b
	0.4	93.3a	94.1abc	98.5ab	94.8a	94.5a	84.1a	94.8a	100a	94.5a	93.0a	75.8a
Clopyralid 72 SG	0.083	75.4b	82.8c	88.1c	83.6b	82.9b	70.5b	90.8a	98.8a	78.9b	75.4d	64.3b
	0.125	80.1b	87.1b	95.2bc	90.3ab	88.8ab	76.0ab	89.3a	99.4a	83.3b	81.3cd	69.05
	0.167	92.8a	98.1a	100a	95.3a	93.6a	82.3ab	96.3a	100a	93.4a	89.1abc	80.0a
Lontrel 300 SL	0.4	92.7ab	95.3ab	100a	97.2a	94.0a	83.0ab	96.9a	100a	92.3a	91.3.ab	79.2a
LSD (P=.05)		**7.8-10.2**	**4.9-8.4**	**1.3-6.4**	**5.7-8.4**	**4.7-6.2**	**8.0-8,7**	**6.3-8.0**	**1.3-3.6**	**5.4-7.6**	**6.4-8.6**	**4.9-5.6**
Standard Deviation		**5.074t**	**4.958t**	**4.580t**	**5.067t**	**3.503t**	**3.966t**	**5.32t**	**7.44t**	**3.94t**	**4.233t**	**2.333t**

Table 4. Efficacy of herbicides in rape crop after 40 days of treatment

Treatment name	Dose l or kg/ha	Weeds										
		Efficacy - % control in comparison with the untreated plots										
		Dâlga					Tămădău					
		PAPRH	*GALAP*	*POLPE*	*CIRAR*	*SONSS*	*VIOAR*	*GALAP*	*EPHCY*	*MATIN*	*CIRAR*	*RAPRA*
Untreated (ground %)		22	17.5	12.2	15.5	17.2	27.5	15	7.5	20.5	19	10.3
Untreated	-	0.0d	0.0c	0.0b	0.0c	0,0d	0.0c	0.0c	0.0c	0.0c	0.0c	0.0c
Clopyralid 30 SL	0.2	70.0c	72.3b	73.7a	69.4b	73.4c	53.8b	72.8b	86.2b	69.3b	63.0b	60.6b
	0.3	74.9 bc	78.8ab	78.0a	74.3b	78.0bc	61.3ab	78.0ab	91.1ab	74.1ab	69.4ab	62.1b
	0.4	97.9b	88.2a	88.5a	81.6	83.8abc	70.2a	82.5a	96.3a	82.8a	77.9a	70.7a
Clopyralid 72 SG	0.083	81.7a	71.4b	74.3a	68.5b	72.9c	54.6b	73.6b	85.7b	68.6a	63.5b	58.1b
	0.125	71.1c	78.2ab	83.2a	74.6b	77.9bc	60.9ab	75.9ab	91.9ab	73.6ab	68.6ab	62.9b
	0.167	82.0a	83.7ab	88.8a	83.7a	89.4a	73.0a	80.2ab	91.7ab	82.9a	76.8a	71.4a
Lontrel 300 SL	0.4	79.9 ab	87.8	87.8a	83.0a	86.4ab	70.3a	83.3ab	92.1ab	79.3ab	75.6a	71.76
LSD (P=.05)		**4.7-5.2**	**8.6-9.9**	**11.1-12.0**	**5.4-6.3**	**7.3-8.8**	**8.3-8.9**	**5.1-5.5**	**3.5-5.0**	**7.6-8.3**	**7.1-7.7**	**4.5-5.6**
Standard Deviation		**2.306t**	**4.609t**	**5.907t**	**2.735t**	**4.134t**	**3.529t**	**2.536t**	**3.072t**	**3.689t**	**3.203t**	**2.980t**

Figure 3. Experimental plot Dâlga, 2018

Figure 4. Experimental plot Tămădău, 2019

CONCLUSIONS

The herbicides Clopyralid 30 SL and Clopyralid 72 SG provided a good result in rape against dicotyledonous weeds similar to standard reference.

At the dose of 0.4 l/ha Clopyralid 30 SL and at the dose of 0.167 kg/ha Clopyralid 72 SG, the herbicidal effect of active ingredient was maintained throughout the growing season of rapeseed.

In the case of *R. raphanistrum* from *Brassicaceae* family, the efficacy was lower.

This unique mode of action makes Clopyralid excellent for use in control strategies and resistance against broad-leaved weeds.

No phytotoxicity symptoms have been shown in experimental plots (Figures 3 and 4).

No symptoms of chlorosis, necrosis, leaf deformation, height reduction, distortion and delay at flowering in plots treated with clopyralid.

The research results indicated that the efficacy in controlling weeds of clopyralid formulated as soluble granules was slight higher than soluble concentrate.

ACKNOWLEDGEMENTS

Special greetings to S.C. Ghinea Prod. S.R.L. and S.C. Profarma Holding SRL Tămădău, Călăraşi county, for making our research possible.

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