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POSSIBILITIES FOR CHEMICAL WEED CONTROL AT OIL SEED RAPE

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Abstract

During the period from 2014 to 2016, a field trail with the oilseed rape (Brassica napus L.) hybrid "PX 111 CL" (Clearfield® hybrid) was conducted. The experiment was carried out in the experimental base of the department of "Agriculture and Herbology" of the Agricultural University of Plovdiv, Bulgaria. The aim of the study was to establish the possibilities of chemical weed control during the vegetation of the oilseed rape with perspective herbicides. The following 6 herbicide product were evaluated: Salsa 75 WG (750 g/kg Ethametsulfuron-Methyl), Galera Super (240 g/l clopyralid + 80 g/l picloram + 40 g/l aminopyralid), Modaon 4 F (480 g/l bifenox), Fusilade Forte 150 EC (150 g/l fluazifop-p-butyl), Stratos Ultra (100 g/l cycloxydim + tenzid) and Cleranda SC (17.5 g/l imazamox + 375 g/l metazachlor). The efficacy of the products was recorded by the 10 score scale of EWRS (European Weed Research Society). The productivity of the oilseed rape was also studied. The dispersion analyses showed that there were proved differences between the variants of the tail. The highest herbicide efficacy against the existing weed infestation as well as the highest yield (4.098 t.ha^{-1}) was recorded for the variant with the combine application of the herbicide products Galera Super + Fusilade Forte 150 EC.

Key words*: oilseed rape, weeds, herbicides, efficacy.*

INTRODUCTION

Every year the agricultural production has enormous losses because of the concurrence of the cultural plants with the weeds. They deservedly could be qualified as "The green enemy of humanity" (Tonev et al., 2007). The appearance and amplicon of the weeds are due to different factors as the soil type, crop rotation, soil tillage, crop density, fertilization levels etc. (Hanzlik and Gerowitt, 2011). There are a large number of literature sources that prove the harmful consequences caused by the weeds and also the huge amount of mechanical and chemical weed control (Fetvadzieva et al., 1991; Spasov, 1995). To be economically proved, the herbicide treatment should be performed in accordance with the existing weeds (Klaus, 1992). The winter oilseed rape is slow-growing crop and is also very sensitive to weed infestation (Roshdy et al., 2008). The high weed infestation with *Raphanus raphanistrum*, *Sinapis arvensis*, *Stellaria media*, *Solanum nigrum* and *Chenopodium hybridum* decreased the yields and quality of the production because their development is faster than the development of rapeseed (Pavlović, 2015). Salsa® is selective herbicide for the rapeseed that controls the broadleaf weeds, started their vegetation in the autumn (Drobny and Schlang, 2012). By the Clearfield® technology, the herbicide product Cleranda® shows very high efficacy against grass and broadleaf weeds, as well as volunteer crop plants. The herbicide products Salsa® and Modaon® have very good efficacy against *Sinapis arvensis* and *Raphanus raphanistrum* (Delchev, 2014).

The aim of the study is to establish possibilities for chemical weed control at winter oilseed rape.

MATERIALS AND METHODS

During 2014 - 2016 field experiment with winter oilseed rape hybrid PX 111 CL (Clearfield® hybrid) was conducted. The experiment was carried out in the experimental base of the department of "Agriculture and Herbology" of the Agricultural University of Plovdiv, Bulgaria. The following 6 herbicide product were evaluated: Salsa 75 WG (750 g/kg Ethametsulfuron-Methyl), Galera Super (240 g/l clopyralid + 80 g/l picloram + 40 g/l aminopyralid), Modaon 4 F (480 g/l bifenox), Fusilade Forte 150 EC (150 g/l fluazifop-p-

butyl), Stratos Ultra (100 g/l cycloxydim + tenzid) and Cleranda SC (17.5 g/l imazamox + 375 g/l metazachlor). The trial field was infested with typical weeds for the crop: common poppy (*Papaver rhoeas* L); cleavers (*Galium aparine* L.); corn chamomile (*Anthemis arvensis* L.); ryegrass (*Lolium rigidum* L.) and winter wheat (*Triticum aestivum* L.) as volunteer. The trial was conducted by the randomized block design in 4 replications. The size of the harvesting plot was 33 m². The herbicide treatment was done at BBCH 14-15 with spryer for plot trails. The expense of spray solution was 300 l ha^{-1}.

The herbicide efficacy was recorded on the 14th, 28th and 56th day after treatments by the 10 score scale for efficacy of EWRS (European Weed Research Society). The results were compared with untreated control. The selectivity of the herbicides to the oilseed rape was measured by the 9 score scale for phytotoxisity of EWRS (at score 0 there is no damage, at score 9 the crop is completely destroyed).

Table 1. Variants of the experiment

V1	Untreated control
V2	Salsa 75 WG - 25 g/ha (750 g/kg ethametsulfuron-methyl)
V3	Galera Super - 200 ml/ha (240 g/l clopyralide + 80 g/l picloram + 40 g/l aminopyralid)
V4	Modaon 4 F - 1000 ml/ha (480 g/l bifenox)
V5	Galera Super + Fusilade Forte - 200 ml/ha + 500 ml/ha (150 g/l fluazifop-P -butyl)
V6	Salsa 75 WG + Stratos Ultra - 25 g/ha + 1000 ml/ha (100 g/l cycloxydim)
V7	Modaon 4 F + Stratos Ultra - 1000 ml/ha +1000 ml/ha
V8	Cleranda SK - 2000 ml/ha (375 g/l metazachlor + 17.5 g/l imazamox)

The oilseed predecessor for both experimental years was winter wheat. After harvesting of the wheat on the experimental field shallow plowing at 15 cm, followed by two surface tillages was done. Fertilization with 200 kg ha^{-1} $N_{15}P_{15}K_{15}$ was achieved before sowing of the crop. The sowing was performed with seeder for plot trials. After sowing the field was rolled. In spring, dressing with 300 kg ha^{-1} NH_4NO_3 was performed. The rapeseed yield was recorded by harvesting plants from area 50x50 cm of the experimental plots for each replication and the results were recalculated to yields per hectare.

Statistical analysis of the yields was performed by using Duncan's multiple range test of SPSS 17 program. Statistical differences were considered significant at $p<0.05$.

RESULTS AND DISCUSSIONS

The average density of the weeds per 1 m^2 on the experimental field was as follows: common poppy – 8.5 specimens, cleavers – 5.5 specimens, corn chamomile – 6.5 specimens, ryegrass - 22 specimens and winter wheat volunteer - 24 specimens, average for the period of investigation. These weed species are typical in rapeseed fields. The quantitative method for recording the weeds number per 1 m^2 after treatments is not precise enough, because at the time of reporting the efficacy, the weeds were with depressed development. That is the reason we recorded the herbicide efficacy by the 10 score scale of EWRS.

Berry et al. (2014) reported that the possibilities of chemical control of the common poppy are limited to application of metazachlor before germination or in the early stages of development of the crop. On Table 2 is shown the dynamic of the efficacy of the studied herbicides against the common poppy (*P. rhoeas*). In a study conducted by Dimitrova et al. (2014) Butizan S (metazachlor) applied at rate 2000 ml ha^{-1} had 82% efficacy against this weed. The results from our study showed that the alone herbicide applications of Galera Super, Salsa 75 WG and Cleranda SK successfully control the common poppy. The herbicide product Modaon 4 F showed limited efficacy against the common poppy 70-75%.

At the combine usage of Galera Super + Fusilade Forte, Salsa 75 WG + Stratos Ultra and Modaon 4 F + Stratos Ultra, the efficacy was excellent against the weed.

The cleavers are among the most resistant weeds to herbicides. The control should be performed in the early development stages. The developed specimens could be depressed by the herbicides, but later they overcome the damages and regrow again.

On Table 3 is shown the efficacy against the cleavers (*G. aparine*). After application of Salsa 75 WG, Galera Super, Galera Super +

Fusilade Forte, Salsa 75 WG + Stratos Ultra and Cleranda SK the efficacy on the 56th day after the treatments was from 90 to 97.5% average for the period. On the first date of reporting (14th day after treatments) the cleavers was relatively sustainable of these herbicides. The herbicide efficacy varied from 72.5 to 85%. On the 28th day after the treatments with these herbicides the efficacy was average from 82.5 to 90 %, and on the 56th day the weed was highly depressed in its development. Only for the herbicide product Galera Super, the efficacy reached 97.5%. After the application of the herbicide products Maton 4 F and its combine usage with Stratos Ultra non satisfactory efficacy was recorded (75%). On the next reporting dates, the efficacy decreased to 70%. The reason is that Maton 4 F has contact mode of action, and Stratos Ultra controls the grass weeds.

Average for the the period on 56th day after the treatments, the herbicide products Salsa 75 WG, Galera Super, as well as at the variants with combined application of broadleaf + grass herbicides, the efficacy against the corn chamomile (*A. arvensis*) was 100% (Table 4). The efficacy of Cleranda was 97.5%.

The ryegrass (*L. rigidum*) is among the grass weeds that are very often observed in the winter oilseed rape fields (Mitkov et al., 2015). The natural level of infestation with this weed can lead to high concurrence interactions with the oilseed crop. The efficacy of the herbicide combinations Galera Super + Fusilade Forte, Salsa 75 WG + Stratos Ultra and Modaon 4 F + Stratos Ultra against this weed was approximately equal with the efficacy of Cleranda SK (Table 5). On the 56th day after treatments, the variants with combine herbicide application, the efficacy was 100%. For Cleranda SK the efficacy was 95% average for the period. at the variants with alone application of Salsa 75 WG, Galera Super and Modaon 4 F the recorded efficacy was 0%. That is because of the mode of action of the herbicides which is only against the broadleaf weeds.

The winter wheat very often can be in a concurrent relationship with the next crop in the crop rotation and is usually in high density (Ogg and Parker, 2000). In our trial the winter wheat volunteer was the easiest to control, but before tillering. Still on the 14th day after the treatments with Salsa 75 WG, Galera Super and Modaon 4 the efficacy was from 92.5% to 97.5%. On the next two reporting dates the efficacy was 100% (Table 6).

At variants V2, V3, V5, V6 and V8 the used herbicide products in the study were selective for the crop. On the 14th day after treatments at variant V4 phytotoxicity signs (score 2) expressed in local spitting of the crop's leafs were observed. At variants V7 the phytotoxicity signs were more severely expressed (score 4). On the 56th day after herbicide application, the phitotoxicity signs totally disappeared.

The unsuccessful weed control at the winter oilseed rape can lead to total yield losses (Pacanoski, 2014). The oilseed rape seed yields are presented on Table 7. The differences in the yields were overcome by the herbicide efficacy and the selectivity of the studied herbicide products and their ability to control the existing weeds. The natural weed infestation leads to very low yields for the untreated control, 2.00 t ha^{-1}. By the degree of statistical provement five groups (a, b, c, d, e) average for the period were formed. It was recorded that variant V6 (Galera Super + Fusilade Forte) was from group (e) with the highest yield (3.99 t ha^{-1}) and was the most distant from the group of the untreated control (a). Because of the fact, that the herbicide products Galera Super and Salsa 75 WG controlled only broadleaf weeds, the yields after these treatments were lower. The yields from the variants treated with Modaon 4 F and the combination of Modaon 4 F + Stratos Ultra were very low (2.33 and 2.26 t ha^{-1}). The decrease was a consequence of the phytotoxicity that was recorded.

Table 2. Efficacy of the studied herbicide products against the common poppy (*Papaver rhoeas* L.)

Treatments		2015			2016			Average		
		14 day	28 day	56 day	14 day	28 day	56 day	14 day	28 day	56 day
V1	Untreated control	-	-	-	-	-	-	-	-	-
V2	Salsa 75 WG	70	80	90	75	85	95	72.5	82.5	92.5
V3	Galera Super	80	90	100	90	95	100	85	92.5	100
V4	Modaon 4 F	75	70	70	80	75	75	77.5	72.5	72.5
V5	Galera Super + Fusilade Forte	80	90	100	90	95	100	85	92.5	100
V6	Salsa 75 WG + Stratos Ultra	70	80	90	75	85	95	72.5	82.5	92.5
V7	Modaon 4 F + Stratos Ultra	75	70	70	80	75	75	77.5	72.5	72.5
V8	Cleranda SK	85	90	100	90	95	100	87.5	92.5	100

Table 3. Efficacy of the studied herbicide products against the clevers (*Galium aparine* L.)

Treatments		2015			2016			Average		
		14 day	28 day	56 day	14 day	28 day	56 day	14 day	28 day	56 Day
V1	Untreated control	-	-	-	-	-	-	-	-	-
V2	Salsa 75 WG	70	85	90	75	85	90	72.5	85	90
V3	Galera Super	85	90	95	85	90	100	85	90	97.5
V4	Modaon 4 F	75	70	70	75	70	70	75	70	70
V5	Galera Super + Fusilade Forte	85	90	95	85	90	100	85	90	97.5
V6	Salsa 75 WG + Stratos Ultra	70	85	90	75	85	90	72.5	85	90
V7	Modaon 4 F + Stratos Ultra	75	70	70	75	70	70	75	70	70
V8	Cleranda SK	75	80	90	80	85	95	77.5	82.5	92.5

Table 4. Efficacy of the studied herbicide products against the corn chamomile (*Anthemis arvensis* L.)

Treatments		2015			2016			Average		
		14 day	28 day	56 day	14 day	28 day	56 day	14 day	28 day	56 day
V1	Untreated control	-	-	-	-	-	-	-	-	-
V2	Salsa 75 WG	70	85	100	75	85	100	72.5	85	100
V3	Galera Super	80	90	100	85	95	100	82.5	92.5	100
V4	Modaon 4 F	75	85	90	80	90	90	77.5	87.5	90
V5	Galera Super + Fusilade Forte	80	90	100	85	95	100	82.5	92.5	100
V6	Salsa 75 WG + Stratos Ultra	70	85	100	75	85	100	72.5	85	100
V7	Modaon 4 F + Stratos Ultra	75	85	90	80	90	90	77.5	87.5	90
V8	Cleranda SK	80	90	95	85	95	100	82.5	92.5	97.5

Table 5. Efficacy of the studied herbicide products against the ryegrass *(Lolium rigidum* L.*)*

Treatments		2015			2016			Average		
		14 day	28 day	56 day	14 day	28 day	56 day	14 day	28 day	56 day
V1	Untreated control	-	-	-	-	-	-	-	-	-
V2	Salsa 75 WG	0	0	0	0	0	0	0	0	0
V3	Galera Super	0	0	0	0	0	0	0	0	0
V4	Modaon 4 F	0	0	0	0	0	0	0	0	0
V5	Galera Super + Fusilade Forte	80	90	100	85	95	100	82.5	92.5	100
V6	Salsa 75 WG + Stratos Ultra	75	85	100	80	90	100	77.5	87.5	100
V7	Modaon 4 F + Stratos Ultra	85	95	100	90	95	100	87.5	95	100
V8	Cleranda SK	75	85	95	80	90	95	77.5	87.5	95

Table 6. Efficacy of the studied herbicide products against the wheat volunteer (*Triticum aestivum* L.)

Treatments		2015			2016			Average		
		14 day	28 day	56 day	14 day	28 day	56 day	14 day	28 day	56 day
V1	Untreated control	-	-	-	-	-	-	-	-	-
V2	Salsa 75 WG	0	0	0	0	0	0	0	0	0
V3	Galera Super	0	0	0	0	0	0	0	0	0
V4	Modaon 4 F	0	0	0	0	0	0	0	0	0
V5	Galera Super + Fusilade Forte	95	100	100	100	100	100	97.5	100	100
V6	Salsa 75 WG + Stratos Ultra	95	100	100	100	100	100	97.5	100	100
V7	Modaon 4 F + Stratos Ultra	90	100	100	95	100	100	92.5	100	100
V8	Cleranda SK	90	100	100	95	100	100	92.5	100	100

Table 7. Yields of oilseed rape seeds, t ha^{-1}

Treatments		2015		2016		Average	
		With U.c.	By Duncan	With U.c.	By Duncan	With U.c.	By Duncan
V1	Untreated control	1.95	a	2.06	A	2.00	A
V2	Salsa 75 WG	3.80*	c	3.88*	D	3.84*	C
V3	Galera Super	3.82*	c	3.91*	D	3.86*	C
V4	Modaon 4 F	2.28*	b	2.38*	C	2.33*	B
V5	Galera Super + Fusilade Forte	4.03*	e	4.17*	F	4.10*	E
V6	Salsa 75 WG + Stratos Ultra	3.94*	d	4.04*	E	3.99*	D
V7	Modaon 4 F + Stratos Ultra	2.20*	b	2.31*	B	2.26*	B
V8	Cleranda SK	3.94*	d	4.03*	E	3.98*	D

Legend: All variants with star (*) do not have considerable difference with the untreated control. The numbers followed by different letters are with proved differences at $p<0.05$; U.c. – Untreted control

CONCLUSIONS

The herbicide products Galera Super, Cleranda SK, and Salsa 75 WG exceeded Modaon 4 F in their control of *P. rhoeas*, *G. aparine* and *A. arvensis*. Galera Super and Cleranda SK showed higher efficacy CK. In comparison with Salsa 75 WG against *P. rhoeas*, Salsa 75 WG and Galera Super were more efficient against *A. arvensis*. Fusilade Forte and Stratos Ultra were more efficient against *L. rigidum*, than Cleranda SK.

The highest average yield was recorded after the combined treatment with Galera Super + Fusilade forte – 4.10 t ha^{-1}. After the combine usage of Modaon 4 F + Stratos Ultra the obtained yields (2.26 t ha^{-1}) were very close to the yields of the variant treated only with Modaon 4 F (2.33 t ha^{-1}).

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