WINTER RESISTANCES OF OILSEED CANOLA AND RESEEDING OF DAMAGED BY FROST AREAS WITH SPRING CROPS

G. DELCHEV*

Trakia University, Faculty of Agriculture, 6000, Stara Zagora, Bulgaria
**Corresponding author: delchevgd@dir.bg*

Abstract: *During 2016 - 2018 was conducted a field experiment. It was investigated 8 winter oilseed canola hybrids (Brassica napus L.): 3 conventional hybrids - PT271, Dariot and Cesario; 1 conventional Maximus hybrid – PX113; 3 Clearfield hybrids - PT279CL, Fenix CL and Aquarelle CL; 1 Clearfield Maximus hybrid - PX125CL. On areas with damaged by frost winter canola, at the spring were sowed and investigated: 1 conventional spring oilseed canola hybrid - Axana; 1 forage pea cultivar - Mir (Pisum sativum L.); 1 chickpea cultivar - Kabule (Cicer arietinum L.); 1 coriander cultivar - Lozen (Coriandrum sativum L.); 1 milk thistle cultivar - Silmar (Silybum marianum Gaertn.). Conventional hybrids PT271 and Dariot, conventional Maximus hybrid PX113, Clearfield hybrids PT279CL and Fenix CL and Clearfield Maximus hybrid PX125CL, overwinter successfully despite of adverse weather conditions, due to its very good winter resistance and the applied chemical treatments. Through some agricultural activities adverse weather conditions can be reduced to an acceptable minimum. Seed yields of spring oilseed canola hybrid Axana with optimal sowing density are lower than the yields of winter hybrids Cesario and Aquarelle CL with minimum sowing densities. It is recommended to harvested crops of winter canola hybrids with minimum density to 15 plants / m^2 instead they reseeding with spring canola hybrids. After plowing areas with damaged by frost winter canola hybrids without any problems can be sown forage pea. After plowing of canola crops, it is more appropriate to sow chickpea in which weed control is carried out by soil treatment with herbicide Merlin flex, followed by foliar treatment with herbicide tank mixture Challenge + Shadow. Coriander and milk thistle are suitable crops for sowing on areas after damaged by frost winter oilseed canola.*

Key words: *winter resistance, oilseed canola, forage pea, chickpea, coriander, milk thistle*

INTRODUCTION

During recent years the oilseed canola increases significantly the areas in Bulgaria. It becomes the fourth crop in the country after wheat, sunflower and maize. There are many problems in control of cruciferous weeds such as *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Geranium dissectum* L., *Capsella bursa pastoris* L., and the self-sown plants *Coriandrum sativum* L. and *Silybum marianum* Gaertn. It necessitated the introduction of ClearField technology in winter oilseed canola (WALL, 1992; SHIMI ET AL., 2004; NIKOLOVA AND CHIPEVA, 2007; SALIMI ET AL., 2007; SALIMI ET AL., 2009; DRAPALOVA AND PLUHACKOVA, 2014: MATHUKIA ET AL, 2014; TIDEMANN ET AL., 2014; DELCHEV, 2018, 2020). They were created canola hybrids of Maximus product line to meet the requirements of the agriculture. No necessity of using plant growth regulators at these canola hybrids.

The large numbers of canola hybrids in adverse weather conditions some hybrids have low yields because they are characterized by different winter resistance (DANN ET AL., 1987; LUKACS AND HALASZ, 1987; O'DONOVAN, 1991; KLAUS, 1992; O'DONOVAN AND NEWMAN, 1996; IVANOVA AND KOLEV, 2004).

The purpose of this experiment is to investigate the winter resistance of some conventional, ClearField and Maximus winter oilseed canola hybrids and possibilities for reseeding of damaged by frost crops with spring oilseed canola, forage pea, chickpea, coriander and milk thistle.

MATERIALS AND METHODS

A field experiment on pellic vertisol soil type was conducted during 2016 - 2018. It was carried out a field experiment as a block method in 4 repetitions, on a 15 m^2 harvesting area. It was tested 8 hybrids winter oilseed canola (*Brassica napus* L.): 3 conventional hybrids - PT271, Dariot and Cesario; 1 conventional Maximus hybrid – PX113; 3 Clearfield hybrids - PT279CL, Fenix CL and Aquarelle CL; 1 Clearfield Maximus hybrid - PX125CL.

On areas where winter oilseed canola was damaged by frost, at the spring were sowed and tested: 1 conventional spring oilseed canola hybrid - Axana; 1 forage pea cultivar - Mir (*Pisum sativum* L.); 1 chickpea cultivar - Kabule (*Cicer arietinum* L.); 1 coriander cultivar - Lozen (*Coriandrum sativum* L.); 1 milk thistle cultivar - Silmar (*Silybum marianum* Gaertn.). All of these variants have been sown also on the areas with traditional for each of those crops soil tillage.

At the conventional hybrids PT271, Dariot, Cesario and PX113 the weed control was carried out with herbicide combination Modawn 4 F (bifenox) - 1 l/ha + Aramo 50 (tepraloxydim) – 1.5 l/ha. Herbicide Modawn was applied 5 days before herbicide Aramo applying. Canola ClearField hybrids PT279CL, Fenix CL, Aquarelle CL and PX125CL was carried the weed control at out by ClearField technology with herbicide Cleranda (imazamox + metazachlor) at dose 2 l/ha. Herbicides Modawn, Aramo and Cleranda were treated in 4 - 6 leaf stage of winter canola. Spring oilseed canola was treated with herbicide Butizan max (metazachlor + quinmerac + dimethenamide) at dose of 2.5 l/ha after sowing - before emergency period (ASBE).

At the forage pea the weed control was carried out with herbicide combinations Dual gold 960 EC (S-metolachlor) - 1.5 l/ha + Listego 40 (imazamox) - 1.2 l/ha and Stomp aqua (pendimethalin) - 3 l/ha + Korum (bentazone + imazamox) - 1.25 l/ha. Soil-applied herbicides Dual gold and Stomp aqua were treated during the period after sowing before emergence. Foliar-applied herbicides Listego and Korum were treated during 6 - 8 real leaf stage of the pea.

At the chickpea the weed control was carried out with herbicide combinations Dual gold 960 EC (S-metolachlor) - 1.5 l/ha + Listego 40 (imazamox) - 1.2 l/ha and Merlin flex 480 SC (isoxaflutole) - 420 g/ha + herbicide tank mixture Challenge 600 SC + Shadow 3 EC (aclonifen + clethodim) - 4 l/ha + 1.6 l/ha. Soil-applied herbicides Dual gold and Merlin flex were treated during the period after sowing before emergence. Foliar-applied herbicides Listego, Challenge and Shadow were treated during 6 - 8 real leaf stage of the chickpea.

At the coriander the weed control was carried out with herbicide combination Stomp aqua (pendimethalin) - 3 l/ha + Stratos ultra (cycloxydim) - 2 l/ha and herbicide tank mixture Zencor 70 WG + Shadow 3 EC (metribuzine + clethodim) - 500 g/ha + 1.6 l/ha. Soil-applied herbicide Stomp aqua was treated during the period after sowing before emergence. Foliar-applied herbicides Stratos ultra, Zencor and Shadow were treated during rosette stage of the coriander.

At the milk thistle the weed control was carried out with herbicide combination Stomp aqua (pendimethalin) - 3 l/ha + Stratos ultra (cycloxydim) - 2 l/ha and herbicide tank mixture Zencor 70 WG + Shadow 3 EC (metribuzine + clethodim) - 500 g/ha + 1.6 l/ha. Soil-applied herbicide Stomp aqua was treated during the period after sowing before emergence. Foliar-applied herbicides Stratos ultra, Zencor and Shadow were treated during rosette stage of the milk thistle.

Herbicides Cleranda, Listego and Korum were used in addition with adjuvant Dash HC – 1 l/ha, due to of low adhesion.

It was tested the changes occurring in seed yields under the influence of weather conditions in all variants. Mathematical data processing was done by the method of analysis of variance.

RESULTS AND DISCUSSION

During the years of testing weather conditions were disparate and relatively unfavorable for the development of winter oilseed canola. On the other hand, they were good for exploring winter resistance of oilseed canola hybrids.

The wet and warm autumn of 2015 during the first harvest year (2015 – 2016) created conditions for autumn development of plant stem. Untreated with growth regulator hybrids formed stem, not be inured well and most of the plants were damaged by frost during the winter months. These areas during the spring were sowed with spring oilseed canola, forage pea, chickpea, coriander and milk thistle. Canola hybrids by product line Maximus were not treated with growth regulator, but they did not form stem and overwinter successfully. The most difficulty is overwinter hybrids Cesario and Aquarelle CL.

The second harvest year of the experiment (2016 - 2017) was extremely unfavorable. Canola germination of delayed by 35 - 40 days due to big drought during the summer and the autumn. Winter canola grows in the last days of October. They were done some additional treatments with herbicides, fungicides, insecticides, growth regulators, fertilizers and adjuvants during the canola vegetation, to overcome extremely adverse weather conditions during this harvest year. During 2 - 4 leaf stage - autumn was done extra treatment with foliar fertilizer Rapsin - 2 l/ha and growth regulator Toprex - 500 ml/ha to accelerate hardening of plants. During 4 - 6 leaf stage - spring (immediately after permanent renewal of vegetation) was done standard treatment with foliar fertilizer Lactofol O - 5 l/ha, fungicide Folicur - 1 l/ha and insecticide Karate zeon - 150 ml/ha. Weed control was carried out as in the previous years during 6 - 8 leaf stage, but the spring. Later grow canola into this stage in March, but due to severe drought and low temperatures in autumn, weeds grown mass in early spring. During the beginning of stem growth was done extra feeding with foliar fertilizer Zoom - 3 l/ha. During the beginning of flowering stage was done standard treatment with foliar fertilizer Lactofol canola - 10 l/ha, fungicide Caramba - 700 ml/ha and insecticide Vastak - 200 ml/ha. Due to non-concurrent plants ripening 10 days before the harvest was carried out desiccation with total herbicide Valsaglif - 5 l/ha, in combination with adjuvant Flexy - 1 l/ha, in order to prevent bursting of the early ripe pods.

During the third harvest year (2017 - 2018) the short-term decrease in the temperature below -10 °C in March cause a complete destruction of the plant foliage, and at hybrids Cesario and Aquarelle CL and the death of the whole plants and the crop thinning.

Hybrids PT271, Dariot, PX113, PT279CL, Fenix CL and PX125CL in the three years remain optimal density of 40-45 plants/m^2. They overwinter of 95 - 100 %, despite adverse weather conditions during the years of the experiment, due to its very good winter resistances and the applied chemical treatments. This ensures high seed yields (Table 1). Hybrids Cesario and Aquarelle CL have the minimum of canola crop density of 15 - 20 plants/m^2 due to damages by frost about 50 - 60 % in the three harvest years.

Seed yield of winter hybrids PT271, Dariot, PX113, PT279CL, Fenix CL and PX125CL with optimum density of 40 - 45 plants/m^2 are the highest. Even during very unfavorable 2017 seed yields are in the range from 2384 kg/ha to 2537 kg/ha. Yields of winter hybrids Cesario and Aquarelle CL with a minimum density of 15-20 plants/m^2 are lower by 21 – 23 % compared to other canola hybrids. The biggest difference in 2017, the decrease was 29 – 31 %.

The results show that due to the above agricultural activities unfavorable weather conditions can be reduced to an acceptable minimum. These treatments can be applied only to canola hybrids with good cold and winter resistances. Canola hybrids with low winter resistance are impossible to be saved. They 100 % die and their areas it is necessary to sowing with spring crops.

Table 1

Seed yields of winter and spring oilseed canola hybrids (2016 - 2018)

Hybrids	2016		2017		2018		Mean	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Winter Conventional hybrids								
PT271 - Standard (40 - 45 plants/m^2)	3567	100	2495	100	4216	100	3426	100
Dariot (40 - 45 plants/m^2)	3538^{ns}	99.2	2525^{ns}	101.2	4344^{ns}	103.0	3469	101.3
Cesario (15 - 20 plants/m^2)	2683^{000}	75.2	1767^{000}	70.8	3773^{000}	89.5	2741	80.0
Winter Conventional Maximus hybrid								
PX113 (40 - 45 plants/m^2)	3531^{ns}	99.0	2347^{ns}	94.1	4371^{ns}	103.8	3416	99.7
Winter ClearField hybrids								
PT279CL (40 - 45 plants/m^2)	3574^{ns}	100.2	2485^{ns}	99.6	4437^{+}	105.2	3497	102.1
Fenix CL (40 - 45 plants/m^2)	3693^{ns}	103.5	2537^{ns}	101.7	4538^{ns}	107.6	3589	104.8
Aquarelle CL (15 - 20 plants/m^2)	2630^{000}	73.7	1725^{000}	69.1	4193^{000}	99.5	2849	83.2
Winter ClearField Maximus hybrid								
PX125CL (40 - 45 plants/m^2)	3517^{ns}	98.6	2384^{ns}	95.6	4338^{ns}	102.9	3413	99.6
Spring Conventional hybrid								
Axana (80 - 90 plants/m^2)	2030^{000}	56.9	1654^{000}	66.3	3113^{000}	73.8	2266	66.1
Axana (110 - 120 plants/m^2)	2376^{000}	66.6	1700^{000}	68.1	3407^{000}	80.8	2494	72.8
LSD 0.5	235	6.6	180	7.2	215	5.1		
LSD 0.1	289	8.1	222	8.9	333	7.9		
LSD 0.01	346	9.7	270	10.8	404	9.6		

Spring oilseed canola hybrid Axana was sown on the area with frost 100 % of winter canola oilseed hybrids. It was done a pre-sowing cultivation with harrowing and two rolling - pre-sowing and after-sowings. Sowing was done in late February - early March at the earliest opportunity to work in the field. The crop was with two densities recommended for spring canola: 80 - 90 plants/m^2 and 110 - 120 plants/m^2.

Seed yields of spring canola hybrid Axana in both densities of 80 - 90 plants/m^2 and 110 - 120 plants/m^2 are lower than the yields of winter hybrids Cesario and Aquarelle CL with minimum density of 15 - 20 plants/m^2. The mean yields of Axana in both densities are respectively 2266 kg/ha and 2494 kg/ha as opposed to 2741 kg/ha and 2849 kg/ha of Cesario and Aquarelle CL. The less and mathematically unproven are differences in 2017, when decisive for the yields of spring canola hybrids was rainfalls during May. They extended flowering and contributed to the formation of a greater number of pods. In 2016 and 2018 the differences between these two groups of canola hybrids are mathematically proven.

These results show that it is better to harvested crops of winter canola hybrids with minimum density 15 plants/m^2 instead they are resewed with spring canola hybrids.

On the area of frozen winter canola was sown in early spring forage pea cultivar Mir. The cultivar was sowed as soon as possible to enter in the field. It was done a pre-sowing cultivation accompanied with harrowing. Weed control was done with two herbicide combinations: Dual gold + Listego and Stomp aqua + Korum. Seed yields of forage pea in sowing after canola are lower than those in normal sowing from 1.9 % to 2.5 % (Table 2). The mean yields at herbicide combination Stomp aqua + Korum less in compared to mean yields at

Table 2

Seed yields of forage pea, chickpea, coriander and milk thistle (2016 - 2018)

Variants	2016		2017		2018		Mean	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Forage pea – Sowing after canola								
Dual gold + Listego	3007 ns	98.0	2793 ns	98.3	3380 ns	96.5	3060	97.5
Stomp aqua + Korum	3063 ns	98.6	2882 ns	99.0	3501 ns	97.1	3149	98.1
Forage pea – Normal sowing								
Dual gold + Listego	3068	100	2841	100	3503	100	3137	100
Stomp aqua + Korum	3106	100	2911	100	3606	100	3209	100
Chickpea – Sowing after canola								
Dual gold + Listego	1897 ns	91.6	1355 ns	93.0	2208 ns	90.1	1820	91.3
Merlin flex + Challenge + Shadow	2202 ns	96.0	1602 ns	96.9	2568 ns	94.5	2124	95.5
Chickpea – Normal sowing								
Dual gold + Listego	2071	100	1457	100	2451	100	1993	100
Merlin flex + Challenge + Shadow	2294	100	1660	100	2717	100	2224	100
Coriander – Sowing after canola								
Stomp aqua + Stratos ultra	2455 ns	97.2	2350 ns	97.6	2624 ns	95.3	2476	96.7
Zencor + Shadow	2434 ns	98.0	2337 ns	98.0	2607 ns	96.5	2459	97.5
Coriander – Normal sowing								
Stomp aqua + Stratos ultra	2526	100	2408	100	2753	100	2562	100
Zencor + Shadow	2481	100	2385	100	2702	100	2523	100
Milk thistle – Sowing after canola								
Stomp aqua + Stratos ultra	1086 ns	96.9	1062 ns	97.8	1215 ns	95.4	1121	96.6
Zencor + Shadow	1156 ns	97.7	1107 ns	98.5	1268 ns	96.2	1177	97.4
Milk thistle – Normal sowing								
Stomp aqua + Stratos ultra	1121	100	1086	100	1274	100	1160	100
Zencor + Shadow	1183	100	1124	100	1318	100	1208	100
LSD 0.5	222		292		260			
LSD 0.1	444		535		493			
LSD 0.01	620		747		671			

herbicide combination Dual gold + Listego. The reason for this is the longer effect of Korum and its longer control over the secondary-emerged weeds until the pea plants cover the whole soil surface, competes with weeds and almost prevents secondary weed infestation. Lower yields at sowing after canola are mainly due to the lower values of indexes beans number per plant, seeds number per plant, seed weight per plant as a result of the more compacted soil. Unproven differences in seed yields indicate that after plowing of areas with frozen canola hybrids without any problems can be planted forage pea.

On the area of frozen winter canola was sown chickpea cultivar Kabule. Sowing was done in late February. The same cultivar was sown at the same time and on area with traditional chickpea soil tillage. Weed control was done with two herbicide combinations: Dual gold + Listego and Merlin flex + herbicide tank mixture Challenge + Shadow. It was found that the reduction in seed yield at sowing after canola compared to normal sowing is mathematically proven only at herbicide combination Dual gold + Listego. Reduction is 7 % - 9.9 %. When combining of soil-applied herbicide Merlin flex with herbicide tank mixture Challenge + Shadow, the yield reduction is less and not proved mathematically. The main reason for these differences in yields is the stronger phytotoxicity of herbicide Listego against the chickpea plants, although Listego provides better control of perennial broadleaf weeds compared to the herbicide tank mixture Challenge + Shadow. At combining of soil-applied herbicide Merlin flex with herbicide tank mixture Challenge + Shadow the lesser decrease in yields is due only to the negative influence of shallow tillage and compacted soil after canola. At these two technologies, the high efficiency of the using herbicides is the reason for a good control of weeds in both sowing - after canola and after deep plowing. These results lead to the conclusion that after plowing canola crops is appropriate to sow chickpea in which weed control should be carried out by soil treatment with herbicide Merlin flex, followed by foliar treatment with the herbicide tank mixture Challenge + Shadow.

On the area of frozen winter canola was sown coriander cultivar Lozen. The cultivar was sowed as soon as possible to enter in the field. The same cultivar was sown at the same time and on area with traditional coriander soil tillage. Weed control was done with herbicide combination Stomp aqua + Stratos ultra and with herbicide tank mixture Zencor + Shadow. It was found that in both weed control variants the decrease in seed yield in sowing after frozen canola compared to normal sowing is approximately the same. When combining soil-applied herbicide Stomp aqua with foliar-applied herbicide Stratos ultra, yield reduction varies from 2.4 % to 4.7 %. At herbicide tank mixture Zencor + Shadow, the yield reduction varies from 2.0 % to 3.5 %. In both weed control variants the yield reductions compared to normal sowing and mathematically unproven. This means that coriander is a suitable crop for sowing on areas after damaged by frost winter oilseed canola.

On the area of frozen winter canola was sown milk thistle cultivar Silmar. The cultivar was sowed as soon as possible to enter in the field. The same cultivar was sown at the same time and on area with traditional coriander soil tillage. Weed control was done with herbicide combination Stomp aqua + Stratos ultra and with herbicide tank mixture Zencor + Shadow. It was found that in both weed control variants the decrease in seed yield in sowing after frozen canola compared to normal sowing is approximately the same. It varies from 2.6 % to 3.4 %. Due to its powerful root system, the milk thistle is less demanding to the tillage depth than pea, chickpea and coriander. Used herbicide combination and herbicide tank mixture enable effective weed control during crop growing against graminaceous and broadleaf weeds. This makes the milk thistle a suitable crop for sowing on areas after frozen winter oilseed canola.

CONCLUSIONS

Conventional hybrids PT271 and Dariot, conventional Maximus hybrid PX113, Clearfield hybrids PT279CL and Fenix CL and Clearfield Maximus hybrid PX125CL, overwinter successfully despite of adverse weather conditions, due to its very good winter resistance and the applied chemical treatments.

Through some agricultural activities adverse weather conditions can be reduced to an acceptable minimum.

Seed yields of spring oilseed canola hybrid Axana with optimal sowing density are lower than the yields of winter hybrids Cesario and Aquarelle CL with minimum sowing densities.

It is recommended to harvested crops of winter canola hybrids with minimum density to 15 plants / m^2 instead they reseeding with spring canola hybrids.

After plowing areas with damaged by frost winter canola hybrids without any problems can be sown forage pea.

After plowing of canola crops, it is more appropriate to sow chickpea in which weed control is carried out by soil treatment with herbicide Merlin flex, followed by foliar treatment with herbicide tank mixture Challenge + Shadow.

Coriander and milk thistle are suitable crops for sowing on areas after damaged by frost winter oilseed canola.

BIBLIOGRAPHY

DANN P.R.; THOMAS A.G.; CUNNINGHAM R.B.; MOORE P.H. 1987 – Response by wheat, rape, and field peas to pre-sowing herbicides and deep tillage. Australian Journal of Experimental Agriculture, 27 (3): 431-437.

DELCHEV, G. 2018 – Chemical control of weeds and self-sown plants in eight field crops. Monograph, ISBN: 978-613-7-43367-6, LAP LAMBERT Academic Publishing, Saarbrücken, Germany, pp. 397.

DELCHEV, G. 2020 – Winter resistance of oilseed canola and reseeding with spring crops. Monograph, ISBN: 978-620-2-68306-7, LAP LAMBERT Academic Publishing, Saarbrücken, Germany, pp. 129.

DRAPALOVA, I.; PLUHACKOVA, H. 2014 – Effect of herbicide treatment on milk thistle (*Silybum marianum* Gaertn.) germination. Conference MendelNet, 19-20 November 2014. Mendel University in Brno, Czech Republic, 33-38.

IVANOVA, R.; KOLEV, T. 2004 – Testing of Introduced Canola Lines and Hybrids in Southern Bulgaria. Plant Science, 6: 504-509.

KLAUS, M. 1992 – Integrated weed control illustrated in the case of winter rape. Gesunde Pflanzen, 44 (8): 251-254.

LUKACS, P.; HALASZ, G. 1987 – Realization of the research results achieved in the cultivation of oil-seed plants [sunflower and rape]. Olaj, Szappan. Hungary, 36 (4): 97-101.

MATHUKIA, R.; SAGARKA, B.; PANARA, D. 2014 – Efficient and economical weed management in coriander (*Coriandrum sativum* L.). Journal of Crop Science and Technology, 3 (3): 30-33.

NIKOLOVA, V.; CHIPEVA S. 2007 – Resistance of weeds *Sinapis arvensis* herbicide based on 2.4-D. Plant Science, 44 (4): 349-353.

O'DONOVAN, J.T. 1991 – Quackgrass (*Elytrigia repens*) interference in canola. Weed science, 39 (3): 397-401.

O'DONOVAN, J.T.; NEWMAN, J.C. 1996 – Manipulation of canola plant density and herbicide rate for economical and sustainable weed management. Proceedings: Second international weed control congress, 3, Brown, H. Cussans, G. Devine, M. Duke, S. Fernandez-Quintanilla, C. Helweg, A. Labrada, R. Landes, M. Kudsk, P. Streibig, J.C. (eds.).- Slagelse (Denmark), 969-974.

SALIMI, H.; AHMADI, M.; BARJASTEH, A.; HATAMI, S.; DELGHANDI, M.; FEREIDOONPOUR, M.; GHANBARI, D.; NARIMANI, V.; UNES ABADI, M.; NAZER KAKHKI, H. 2009 – Cruciferous weeds (*Brassicaceae*) of canola fields in ten provinces of Iran. Pajouhesh And Sazandegi, 22 (1): 25-36.

SALIMI, H.; SAMAVAT, S.; SHIMI, P. 2007 – Investigating efficacy of flaming in decreasing wild mustard (*Sinapis arvensis* L.) seed bank in canola. Plant Protection Reseach, (Iran), 1: 15-19.

SHIMI, P.; JAHEDI, A.; BAGHERANI, N.; GHANBARI B., DARIOOSH; A., 2004 – Testing new Herbicides for Weed Control in Oilsee rape fields with Emphasis on the Control of Wilde Mushard (*Sinapis arvensis* L.). Plant Pests and Diseases, 1: 1-9.

TIDEMANN, B.D.; HALL, L.M.; JOHNSON, E.N.; BECKIE, H.J.; SAPSFORD, K.L.; RAATZ, L.L. 2014 – Efficacy of fall- and spring-applied pyroxasulfone for herbicide-resistant weeds in field pea. Weed Technology 28 (2): 351-360.

WALL D.A. 1992 – Flurtamone for wild mustard (*Sinapis arvensis*) control in canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 6 (4): 878-883.