Scientific Papers. Series A. Agronomy, Vol. LVIII, 2015
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# ACHIEVEMENTS AND PROBLEMS IN THE WEED CONTROL IN OILSEED CANOLA (*Brassica napus* L.)

**Grozi DELCHEV, Mitko GEORGIEV**

Department of Plant Production, Faculty of Agriculture, Trakia University, 6000, Stara Zagora, Bulgaria

Corresponding author email: delchevgrd@dir.bg

***Abstract***

*Herbicides combinations and tank mixtures of herbicides with adjuvants, fertilizers, growth regulators, fungicides, insecticides, are more effective than when they are applied alone in canola crops. Their combined use often leads to high synergistic effect on yield. Data regarding herbicide for effective control of cruciferous weeds in crops of oilseed canola are quite scarce even in worldwide. It is still search effective herbicides for their control in this culture. Problem is a post-effect of some herbicides used in the predecessors on succeeding crops, which is directly related to the weather conditions during their degradation. Most of the information in canola relates to conventional technology for the weed control. There is not information about the new Clearfield technology in oilseed canola and used hybrids resistant to imazamox. A serious problem is also the volunteers of the Clearfield canola. They have resistance to herbicides different from that one of conventional canola hybrids. There is no information still in the scientific literature to control of these volunteers.*

***Key words:*** *canola, herbicides, seed quality, seed yield, weed control.*

## REVIEW

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

Adamczewski and Selmeczi (1994) found that herbicides Amadeus, Kresopur and their combinations with Lontrel do not exhibit phytotoxicity to the winter canola, and provide better control of broadleaf weeds. Amadeus has fewer efficacies against *Galium aparine* L., *Chenopodium album* L., *Lamium purpureum* L. and *Lamium aplexicaule* L. Seed yield increases from 9 to 25% after application of these herbicides. Leyhe et al. (1994) also reported a high herbicidal efficacy and selectivity of Lontrel in oilseed canola. Lontrel control perennial broadleaf weeds 85% (Wei et al., 2010).

According to Nagy and Ador (2000) herbicide combination Starane + Lontrel + Perenal has excellent efficacy against all weeds in the canola crops. Herbicide mixture Lontrel + Galant Super is more effective than herbicide mixture Butizan Star + Galant Super (Shimi et al., 2009). The combination Lontrel + Treflan is not effective against *Malva sylvestris* L. and *Silybum marianum* Gaertn. (Shimi et al., 2006). The combined herbicide Lontrel Grand is more effective than the combined herbicide Galera against perennial broadleaf weeds (Gadzhieva and Poloznyak, 2006).

According to data of Ali (2001) the use of S-metolachlor, alone and in combination with other herbicides in reduced doses decreased the density of weeds in canola crops by 50-60%.

Arif et al. (2001) found in experiments in Pakistan that isoproturon is the most effective herbicide for the control of the majority of weeds in winter canola compared with other herbicides, and conventional methods of weed control. Number of weeds per $m^2$ is the smallest and plant height, number of pods per plant, number of seeds in a pod, 1,000 seeds weight and grain yield were the highest at treatment Isoproturon 75 WP at a dose of 520 g/ha.

Many authors in their experiments establish the efficacy of various herbicides and herbicide

combinations in weed control in canola crops and their positive effect on the yield of seeds (Chow et al., 1983; Blackshaw and Harker, 1992; Blackshaw et al. 1992; Brennan et al., 1992 and 1992a; Brennan and Thill, 1993 and 1993; Davis et al., 1993; Kirkland, 1995 and 1996; Downey, 1997; Shaw, 1997; Oliveira Junior, 2001; Pérez Fernández et al., 2001; Skuryat and Maslakova, 2002; Tsyuganov et al., 2004; Bulavin et al., 2007; Luzhinskiy et al., 2011).

Chaudhry et al. (2011) investigated five herbicides: Stomp (pendimethalin), Partner (isoproturon), Zenkor (metribuzin), and Dual Gold (S-metolachlor) applied after sowing and before emergence and Topic (clodinafop-propargyl) attached vegetation. The application of Stomp, Zenkor, Partner and Dual Gold lead to reduce of broadleaf weeds by 98%, 97%, 96% and 94% and Topic does not affect at these weeds. The highest grain yield is obtained at Stomp, followed by Dual Gold and Partner. Zenkor decreased grain yield, although high herbicidal efficacy against weeds.

Similar results were reported by Khan and Hassan (2003) and by Khan et al. (2008). The authors found significant phytotoxic effect of Zenkor on canola. Herbicides Treflan, Dual Gold and Stomp have high selectivity to the culture. Grain yield, number of branches and number of pods per plant, number of seeds in a pod and 1000 seeds weight are highest in the application of Treflan. Majid et al. (2003) also reported a high herbicidal efficacy of the trifluralin. Annual broadleaf weeds are controlled more effectively than trifluralin compared to the other weed species.

In a similar vein are research of Pourazar and Habibiasl (2003). According to the authors, combining Treflan and Sonalen leads to more successful weed control compared with multiple soil processing. In were used alone both herbicides their effectiveness against weeds is much lower. Treflan herbicide cannot control *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Silybum marianum* Gaertn, *Geranium macrorrhizum* L. and other cruciferous weeds.

Wyszkowski and Wyszkowska (2004) reported that the use of Treflan change the chemical composition of oilseed canola and *Sinapis arvensis* L. Treflan leads to accumulation of more $N_2$ and trace elements such as Na and Mg in the above-ground weight and seeds. This is associated with reduced enzyme activity and generally has a negative effect on canola plants.

Cruciferous weeds are the most dangerous weeds in canola, because of their difficult control in its crops. Polish mustard is dominant among these species (Wall, 1992; Shimi et al., 2004; Salimi et al., 2009). In the absence of adequate herbicides, most efficient way to control these weeds is the burning of the stubble after the predecessor. Thus, it is killed all weeds emerged and 43% of seeds of cruciferous weeds in the soil. According to those alleging in Iran experiments burning does not have a serious effect on soil microorganisms or on other physicochemical aspects of soil (Salimi et al., 2007).

Research of Nikolova and Chipeva (2007) indicate that there are a large number of resistant biotypes of *Sinapis arvensis* L., which cannot be destroyed with the herbicide 2.4-D (Maton).

According to data of Khan et al. (2003) herbicide Fuzilad has the best antigraminaceous effect compared with Ronstar, Topic, Puma Super and Azhil. Grain yield and the values of the abovementioned structural elements are the highest at Fuzilad. Targa Super also has high efficacy against graminaceous weeds in canola crops (Millet, 1986). According to data of Ziminska et al. (1991 and 1994) in oilseed canola, vegetation herbicides Alatrif and Propalin are more effective than soil herbicides Lasso and Triflurotox. According Jabran et al., (2010) the addition of plant extracts to Stomp (pendimethalin) increase the herbicidal efficacy and allows reduction in dosage in view of environmental protection.

Poloznyak (2002, 2003, 2008 and 2010) reported about a high efficiency of herbicides Argon, Zelek Super, Galera and Sirius in crop of spring canola. Tsyuganov and Klochkova (2006), Tibets and Saskevich (2006) and Saskevich et al. (2009) reported for high efficacy of herbicides Lontrel, Teridoks, Butizan, Trophy, Roundup Max, Fuzilad Forte and Targa Super and different combinations between them in oilseed canola crops.

Miklaszewska et al. (2000) reported that the preparation Olbras 88 used as adjuvant to 28

herbicides in winter canola and maize increases their efficiency more compared with adjuvants Tsitovet, Adbios, Atpol and Atplus.

Concomitant use of herbicides and insecticides in canola does not reduce their effectiveness and fat and protein contents and increases the glucosinolate content (Mrowczynski et al., 1991; Leonov and Yurgel, 2002; Murawa and Warminski, 2004 and 2005).

The investigations of Fletcher et al. (1996) on the persistence of the four different herbicides - atrazine, chlorsulfuron, glyphosate and 2.4-D in canola, sunflower and soybean showed that persistence of chlorsulfuron leads to a lower yield of grain in canola and soybean, in comparison with sunflower. Persistence of atrazine on these three cultures was lower. Kim and Vanden (1997) and Kim et al. (1997) also found a high phytotoxicity of residues amounts at chlorsulfuron in the soil to canola. According Paradowski (1994) herbicides Glean (chlorsulfuron) and Logran (triasulfuron) applied to optimal doses and terms of wheat have a negative persistence on oilseed canola and sugar beet.

Wall et al. (1995) and Wall (1997) researching the tolerance of conventional canola and sunflower hybrids to tribenuron-methyl + thifensulfuron-methyl (Granstar super) from 2 leaf stage to 7 leaf stage of ccanola found that phytotoxic events are weakest in stage 2-3 leaf.

Treatment of canola immediately after germination during cotyledons stage is possible phytotoxic effect under the influence of many herbicides applied in optimal doses (Lemerle and Hinkley, 1991).

Zand et al. (2009) study the persistence of several containing sulfonylurea herbicide used in wheat on subsequent in the rotation maize, sunflower, canola, chickpeas and soybeans. Were studied herbicides Apirus (sulfosulfuron) Megaton (chlorsulfuron) Bromitsid + Topic (bromoxynil + MCPA + clodinafop-propagril), Total (sulfosulfuron + mesosulfuron) and Atlantis (mesosulfuron + iodosulfuron). The authors found that herbicides Atlantis and Megaton reduce yield canola by 13 and 20%.

In a similar vein are the studies of Dongiovanni et al. (2000) according to which after the use of triasulfuron and metsulfuron in wheat crops, the safe interval to sowing of canola is 3 to 6 months depending on weather conditions. According Bulavin at al. (2009) residues of the used in wheat herbicide Laren (metsulfuron), can reduce seed yield in canola by 9-21% and oil content in the seeds can reduce by 27-28%. The losses are maximal in hot weather and dry soil, which impede the normal degradation of the herbicide in the soil.

The use of herbicides Triflurotox and Butizan in spring canola leads increase in the fat content in the seeds. Used herbicides do not affect the protein, phytin, phosphorus, phenolic compounds or macronutrients (P, K, Mg) in canola oil (Adomas, 2003 and 2005). The same author, exploring the influence of herbicide substances trifluralin (Triflurotoks), alachlor + trifluralin (Alatrif), metazachlor (Butizan), clopyralid (Lontrel), in several cultivars of spring canola found that weather conditions have a significant impact on the content of glucosinolates in the seeds. Their content is influenced more by the weather than by the application of herbicides (Adomas, 2004). According Kivachitskaya (2007) treatment of spring canola with Teridoks leads to minimal residual amounts of the herbicide in the seeds.

According to data of Treikale et al. (2006) treatment with herbicide Sultan (metazachlor) against dicotyledonous weeds in vegetation period of canola is more efficient than its treatment after sowing before emergence of the crop. Dimitrova and Ivanova (2007) researching some herbicides for weed control in oilseed canola, found that the Sultan is highly efficient against broadleaf weeds and Fuzilad and Azhil - against graminaceous weeds.

Blackshaw (1989 and 1989) reported that the new sulfonylurea herbicide DPX A7881 (ethametsulfuron-methyl) controls weeds from the family *Brassicaceae*, as *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Capsella bursa-pastoris* L., that are not controlled with the existing soil herbicides for weed control in winter canola. Weed control is most effective when DPX A7881 is supplied in stage 2-6 leaf of canola and weeds. This herbicide treated in this stage, shows high selectivity to series varieties and hybrids spring canola (Lichtner et al., 1995). Herbicide mixtures of vegetation herbicide DPX A7881 with antigraminaceous herbicides Fuzirad Forte, Galant Super, Targa Super and Naboo Extra do not exhibit

antagonism in its herbicidal activity (Harker et al., 1995). Fuzilad herbicide can be applied in a tank mixtures with a large number antibroadleaved herbicides in oilseed canola and oilseed sunflower (Hemmen and Konradt, 1991).

There are triazine-resistant (TR) spring canola cultivars that allow efficient chemical control of weeds with triazine herbicides. These cultivars usually give 20 to 30% lower yield than normal, triazine-sensitive (TS) canola varieties. Lower crop yields TR varieties due to impaired electron flow between II and I photo systems in the process of photosynthesis. Triazine-resistant hybrids will enter the production if created TR parental genotypes with normal photosynthetic capacity (Beversdorf et al., 1988; McMullan et al., 1994).

Compared to traditional soil and foliar herbicides, the use of contact total herbicide glufosinate-ammonium (Basta) in canola provides better control of the all weeds. It is used in the established in Canada by way of genetically engineering; transgenic glufosinate ammonium tolerant lines spring oilseed canola (Kumar et al., 1998; Rieger et al., 1999).

The use of biologically active substances in stage of flowering oilseed canola increased seed yield (Todorov et al., 2010). Preharvest desiccation of canola increased seed yield. Their qualitative parameters do not change the use of desiccant before harvest (Marchiori et al., 2002).

## CONCLUSIONS

Literature review demonstrates the views of cited authors formulated a series of laws. Chemical control has emerged as the most efficient method of weed control.

Herbicides combinations and tank mixtures of herbicides with adjuvants, fertilizers, growth regulators, fungicides, insecticides, are more effective than when they are applied alone in canola crops. Their combined use often leads to high synergistic effect on yield.

It gave information about the canola hybrids resistant to glufosinate-ammonium and triazine. However, these hybrids are GMOs and are banned within the European Union including and in Bulgaria.

Although without claim to be exhaustive literature review should be noted, data regarding herbicide for effective control of cruciferous weeds in crops of oilseed canola are quite scarce even in worldwide. It is still search effective herbicides for their control in this culture.

Problem is the persistence of some herbicides used in the predecessors on succeeding crops, which is directly related to the weather conditions during their degradation.

Literature review gives an idea that most of the information in canola relates to conventional technology for the weed control. It is published opposing views even for them on some issues, due primarily to the different conditions under which the experiments were conducted and the biological characteristics of the tested cultivars and hybrids.

There is not information about the new Clearfield technology in oilseed canola and used hybrids resistant to imazamox.

A serious problem is also the volunteers of the Clearfield canola. They have resistance to herbicides different from that one of conventional canola hybrids. There is no information still in the scientific literature to control of these volunteers.

## REFERENCES


Adamczewski K., Selmeczi J., 1994. Spring weed control in winter rape by herbicide Amadeus 46.25 WP. Materials of the 34-th Research Session of Institute of Plant Protection. Part 2, Pruszynski, S.; Lipa, J. (eds.), Poznan (Poland), p. 125-128.

Adomas B., 2003. The yield and quality of seeds of spring rape (*Brassica napus* var. *oleifera* F. *annua*), yellow lupin (*Lupinus luteus* L.) and narrow-leaved lupin (*Lupinus angustifolius* L.) depending on the pesticides used. Dissertation.

Adomas B., 2004. The glucosinolates content in spring rape seeds under the influence of herbicides. Journal of Plant Protection Research, 44(3): 259-265.

Adomas B., 2005. Content of selected minerals in the seeds of spring rape and white mustard treated with herbicides. Acta Scientiarum Polonorum. Agricultura, 4(2): 5-15.

Ali A., 2001. Effectiveness of different weed control methods in canola (*Brassica napus* L.). Dissertation, 100-106.

Arif M., Ihsanullah K., Khan S., 2001. Effect of various weed control methods on the performance of canola. Sarhad Journal of Agriculture, 17(3): 321-324.

Beversdorf W.D., Hume D.J., Donnelly-Vanderloo M.J., 1988. Agronomic performance of triazine-resistant

and susceptible reciprocal spring canola hybrids. Crop science, 28(6): 932-934.
Blackshaw R.E., 1989. Synergistic mixes of DPX-A7881 and clopyralid in canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 3(4): 690-695.
Blackshaw R.E., 1989. Control of Cruciferae weeds in canola (*Brassica napus*) with DPX A7881. Weed science, 37(5): 706-711.
Blackshaw R.E., Harker K.N., 1992. Combined post emergence grass and broadleaf weed control in canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 6(4): 892-897.
Blackshaw R.E., Kanashiro D., Bekkaoui F., Cosby W.L., Babic I., Moloney M.M., 1992. Development of canola (*Brassica napus*) expressing resistance to acetolactate synthase inhibiting herbicides. Proceedings of the First International Weed Control Congress, Volume 2. Melbourne, Vic. (Australia): Weed Science Society of Victoria Inc. 90-92.
Brennan J.S., Thill D.C., 1993. Evaluation of postemergence herbicides and herbicide additive combinations for weed control in canola. Research progress report - Western Society of Weed Science. Meeting held March 9-11, 1993, Tucson, Arizona, III/77-III/79.
Brennan J.S., Thill D.C., 1993a. Evaluation of preplant incorporated, preemergence, and postemergence herbicides for weed control in canola. Research progress report - Western Society of Weed Science. Meeting held March 9-11, 1993, Tucson, Arizona, III/80-III/81.
Brennan J.S., Thompson C.R., Thill D.C., 1992a. Evaluation of preplant incorporated and postemergence herbicides for weed control in canola. Research progress report - Western Society of Weed Science, Meeting held on March 9-12, 1992, Salt Lake City, Utah, III/59-III/60.
Brennan J.S., Thompson C.R., Thill D.C., 1992. Evaluation of postemergence herbicides for weed control in canola. Research progress report - Western Society of Weed Science, Meeting held on March 9-12, 1992, Salt Lake City, Utah. III/61-III/62,
Bulavin L.A., Nebyshinets S.S., Belanovsky M.A., Gerdovich S.W., Kankevits V.A., 2007. The effect of the terms of tillage and herbicides on weed infestation and yield of spring rape. Agriculture and breeding in Belarus: collection of scientific papers, no 43: 205-213.
Bulavin L.A., Nebyshinets S.S., Belanovsky M.A., Gerdovich S.W., Kankevits V.A., Apresian O.G., 2009. The aftereffect herbicide Laren on spring rape. Agriculture and breeding in Belarus: Collection of scientific works, no 45: 63-73.
Chaudhry S.U., Hussain M., Iqbal J., 2011. Effect of different herbicides on weed control and yield of canola (*Brassica napus*). Journal of Agricultural Research, 49(4): 483-489.
Chow P.N.P., O'Sullivan P.A., Hunter J.H., Kirkland K.J., 1983. Control of barley and wheat in canola with BAS 9052. Canadian Journal of Plant Science, 63(4): 1099-1102.
Davis E.S., Stougaard R.N., Fay P.K., 1993. Herbicides for weed control in canola: what are the options? Montana agresearch, 10(2): 6-10.
Dimitrova M., Ivanova R., 2007. Efficiency and selectivity of herbicides in winter rape. Plant Science, 44 (4): 365-367
Downey R.K., 1997. Present status of herbicide tolerant canola in Canada. GCIRC Bulletin, (no 13): 41-42.
Fletcher J.S., Pfleeger T.G., Ratsch H.C., Hayes R., 1996. Potential impact of low levels of chlorsulfuron and other herbicides on growth and yield of nontarget plants. Environmental toxicology and chemistry, 15(7): 1189-1196.
Hajiyev G.I., Poloznyak E.N., 2006. The effectiveness of new herbicides against perennial dicotyledonous weeds in crops of sugar beet and oilseed rape. Agroecology, no 4: 21-24.
Harker K.N., Blackshaw R.E., Kirkland K.J., 1995. Ethametsulfuron interactions with grass herbicides on canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 9(1): 91-98.
Hemmen C., Konradt M., 1991. Fusilade 2000 - selektives Grasherbizid fuer Raps und andere breitblaettrige Kulturen. Gesunde Pflanzen, 43(6): 179-192.
Jabran K., Cheema Z.A., Farooq M., Hussain M., 2010. Lower doses of pendimethalin mixed with allelopathic crop water extracts for weed management in canola (*Brassica napus*). International Journal of Agriculture and Biology, 12(3): 335-340.
Khan I.A., Hassan G., 2003. Efficacy of pre-emergence herbicides on the yield and yield components of canola. Asian Journal of Plant Sciences, 2(3): 251-253.
Khan I.A., Hassan G., Khan M.A., 2003. Efficacy of post-emergence herbicides for controlling weeds in canola. Asian Journal of Plant Sciences, 2(3): 294-296.
Khan, I.A., Hassan G., Marwat K.B., Daur I., 2008. Efficacy of some pre and post-emergence herbicides on yield and yield components of canola. Pakistan Journal of Botany, 40(5): 1943-1947.
Kim S.M., Hur J.H., Han D.S., William H.V.B., 1997. Chlorsulfuron-induced phytotoxicity in Canola (*Brassica napus* L.) seedlings. Korean Journal of Weed Science, 17(2): 199-206.
Kim S.M., Vanden W.H., 1997. Carbon allocation and translocation in chlorsulfuron-treated canola (Brassica napus). Weed science, 45(4): 466-469.
Kirkland K.J., 1995. HOE 075032 for wild mustard (Sinapis arvensis) control in canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 9(3): 541-545.
Kirkland K.J., 1996. Use of incorporated non-incorporated granular trifluralin for annual grass control in barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), and canola (*Brassica napus*). Weed technology: a journal of the Weed Science Society of America, 10(4): 907-913.
Kivachitskaya M.M., 2007. Determination of residual amount of herbicide Teridox chromatography method

in seeds and canola oil. Plant Protection, no 31: 346-353.
Klaus M., 1992. Integrated weed control illustrated in the case of winter rape. Gesunde Pflanzen, 44(8): 251-254.
Kumar A., Rakow G., Downey R.K., 1998. Genetic characterization of glufosinate-ammonium tolerant summer rape lines. Crop science, 38(6): 1489-1494.
Lemerle D., Hinkley R.B., 1991. Tolerances of canola, field pea, lupin and faba bean cultivars to herbicides (*Brassica napus; B. campestris; Pisum sativum; Lupinus albus; L. angustifolius; Vicia faba*). Australian Journal of Experimental Agriculture, 31(3): 379-386.
Leyhe A., Trozelli H., Knaus K., 1994. Lontrel 100 - new prospects for selective weed control in beet, oilseed rape and maize. Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz, 14: 577-581.
Lichtner F.T., Dietrich R.F., Brown H.M., 1995. Ethametsulfuron methyl metabolism and crop selectivity in spring oilseed rape (*Brassica napus* L.). Pesticide biochemistry and physiology, 52(1): 12-24.
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.
Luzhinsky D.V., Pilyuk Y.E., Bulavin L.A., 2011. The fight against the contamination of crops crop of volunteer canola. Zemlyarobstva i APB raslin: navukova-praktychny chasopis, no 4: 36-37.
Majid A., Nawaz N., Hazara R., Yousaf M., Baig D., 2003. Weed dynamics, growth and yield of rapeseed canola in response to trifluralin efficacy under rainfed conditions. Pakistan Journal of Arid Agriculture, 6(2): 53-63.
Marchiori Júnior O., Inoue M.H., Braccini A.L., Oliveira Júnior R.S., Avila M.R., Lawder M., Constantin J., 2002. Quality and yield of canola (*Brassica napus*) seeds after pre-harvest desiccant application. Planta Daninha, 20(2): 253-261.
McMullan P.M., Daun J.K., DeClerq D.R., 1994. Effect of wild mustard (*Sinapis arvensis*) competition on yield and quality of triazine-tolerant and triazine-susceptible canola (Brassica napus). Canadian journal of plant science, 74(2): 369-374.
Miklaszewska K., Adamczewski K., Stachecki S., 2000. Olbras 88 EC - nowy dodatek olejowy do herbicydow. Monograph.
Millet J.C., 1986. Targa. Son interet en culture de colza et tournesol [quizalofop - ethyl; antigraminee de postlevee]. Defense des Vegetaux, 40(2-4): 17-20.
Mrowczynski M., Dorna J., Grala B., Adamczewski K., Paradowski A., Urban M., Palosz T., Stepniewski J., 1991. Effectiveness and rentability of separate use of insecticides and herbicides as compared to the use of insecticides in tank mix with herbicides in oilseed rape. Materials of the 30-th Research Session of Institute for Plant Protection. Part 2. Pruszynski, S. (ed.), p. 273-279.
Murawa D., Warminski K., 2004. Yielding of spring rape exposed to different plant protection agents. Acta Scientiarum Polonorum. Agricultura, 3(2): 221-233.
Murawa D., Warminski K., 2005. Effect of varied plant control on the chemical composition of spring rapeseed. Acta Scientiarum Polonorum. Agricultura, 4(1): 77-87.
Nagy I., Ador Sz., 2000. Provoked trial with Starane 250 EC for weed control options in winter rape. Növényvédelem Hungary, 65: 245-250.
Nikolova B., Chipeva S., 2007. Resistance to weed Sinapis arvensis to herbicides based on 2.4-D. Plant Sciences, 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), p. 969-974.
Oliveira Junior R.S., 2001. Carryover of imazaquin and alachlor + atrazine to the successional canola crop. Ciencia Rural, 31(2): 219-224.
Paradowski A., 1994. Carryover effect of chlorsulfuron and triasulfuron applied to winter wheat on yield of winter rape and sugar beet. Materials of the 34-th Research Session of Institute of Plant Protection. Part 2, Pruszynski, S.; Lipa, J. (eds.), Poznan (Poland), p. 129-134.
Pérez Fernández M.A., Calvo Magro E., López Martín M., 2004. Biological control of Briza maxima L. and Raphanus raphanistrum L. using rhizobacteria. 44th Scientific Meeting of Spanish Society for the Study of Pastures, Salamanca (Spain), p. 151-156.
Poloznyak E.N., 2002. Argon in crops of spring rape. Integrirannye system for plant protection. Present and future. Soroka, S.V.; Supranovich, R.V.; Bug S.F.; Trepashko, L.I.; Zhukova, M.I.; Timofeev, N.N. (ed.), Minsk, Balarus, p. 58-60.
Poloznyak E.N., 2003. Highly protivozlakovy herbicide in crops of spring rape. Plant Protection, no 27: 170-172.
Poloznyak E.N., 2008. Regulation of the number of plants dvudolnyh weeds in rape. Plant Protection, no 32: 65-70.
Poloznyak E.N., 2010. The effectiveness of domestic girbitsida Sirius 400 in crops of winter and spring rape. Zemlyarobstva i APB raslin: navukova-praktychny chasopis, no 5: 57-59.
Pourazar R., Habibiasl J., 2003. Control of weed in canola (*Brssica napus* L.) by Chemical and Mechanical Methods, Agricultural and Natural Resources Research, p. 40-43.
Rieger M.A., Preston C., Potter T., Powles S.B., 1999. Gene flow from transgenic canola to wild radish (*Raphanus raphanistrum*) - a model system to determine the risks. Proceedings of a symposium held at Keele, UK, p. 131-136.
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), p. 15-19.

Saskevich P.A., Tibets J.L., Gurikova E.I., 2009. Agroecological assessment of plant protection products in the cultivation of spring rape. Bulletin of the Belarusian State Academy of Agriculture: Scientific-methodical magazine, no 2: 83-87.

Shaw C., 1997. Herbicide tolerant canola, a farmer perspective. Western Society of Weed Science, v. 50: 11-12.

Shimi P., Din F., Pur R., 2009. Investigating efficacy of clopyralid produced by two different manufacturers and their over dose effect on canola. Plant Protection Research, p. 10-17.

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, p. 1-9.

Shimi P., Poorazar R., Jamali M., Bagherani-Torshiz N., 2006. Evaluating clopyralid as a broad leaf herbicide in canola fields of Iran. Pakistan Journal of Weed Science Research, 12(4): 307-311.

Skuryat A., Maslyakova S.V., 2002. Agroecological features the use of pesticides in the protection Yawovi Oz and rape. Integrirannye system for plant protection. Present and future. Soroka, SV.; Supranovich, R.V.; Bug S.F.; Trepashko, L.I.; Zhukova, M.I.; Timofeev, N.N. (ed.), Minsk, Belorussia, 284-287.

Tibets J.L., Saskevich P.A., 2006. Comparative efficacy of herbicides with vozdelivanii spring rape. Agroecology, no 4: 182-185.

Todorov G., Ivanova P., Delibaltova B., Kolev T., Nenkova D., 2010. Influence of some biologically active substances on the development and productivity of winter canola. Plant Sciences, 47 (1): 41-45.

Treikale O., Pugacova J., Afanasjeva I., 2006. Efficiency of the herbicide Sultan 50 sSK. in spring rape sowing. Latvijas Lauku konsultataciju un izglitibas centrs, Ozolnieki, Jelgava reg. (Latvia), p. 66-68.

Tsyuganov A.R., Saskevich P.A., Vildflush I.R., Prokopenko D.B., 2004. Efficacy sovmestnoto use of fertilizers and plant protection products at vyraschivaniiyarovoy wheat and spring rape. Svremenni problems on rastenievdstvoto in Republika Belarusians and Hungary. Tsyuganov, A.R. (ed.), p. 11-17.

Tsyuganov A.R., Klochkova O.S., 2006. Comparative efficacy of herbicides in spring rape. Agroecology. Number 4: 197-202.

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.

Wall D.A., 1997. Effect of crop growth stage on tolerance to low doses of thifensulfuron:tribenuron. Weed science, 45(4): 538-545.

Wall D.A., Derksen D.A., Friesen L.F., 1995. Canola (*Brassica napus*) response to simulated sprayer contamination with thifensulfuron and thifensulfuron: tribenuron (2:1). Weed technology: a journal of the Weed Science Society of America, 9(3): 468-476.

Wei Y., Guo Q., Feng J., 2010. The occurrence regularity of weeds and its chemical control techniques in spring rape fields of no tillage with furrow sowing. Journal of Northwest Agriculture and Forestry University, 38(2): 184-190.

Wyszkowski M., Wyszkowska J., 2004. Chemical composition of spring rape and white mustard and the enzymactic activity of soil contaminated with Treflan 480 EC. Annales Universitatis Mariae Curie-Sklodowska. Sectio Agricultura, 59 (4): 1631-1638.

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, v. C: 20-22.

Ziminska Z., Turos M., Bakuniak E., Kroczynska H., 1994, Nowy ekonomiczny i skuteczny preparat do zwalczania chwastow w rzepaku (New more efficient herbicide for oil seed rape production.), Monograph.

Ziminska Z., Bakuniak E., Krawczyk M., 1991. Alatrif 38 EC and Propalin 60 WP - combined herbicides for pre-emergence weed control in oilseed rape. Materials of the 31-st Research Session of Institute for Plant Protection. Part 2. Pruszynski, S. (ed.), p. 171-175.