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THE GLUCOSINOLATES CONTENT IN SPRING RAPE SEEDS UNDER THE INFLUENCE OF HERBICIDES

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Abstract: Field experiment with spring rape (*Brassica napus* var. *oleifera* f. *annua*) cultivars Star and Lisonne was conducted in the years 1995–1999 at the vicinity of Olsztyn, Poland.
The herbicides trifluralin (Triflurotox 250 EC), alachlor + trifluralin (Alatrif 380 EC), metazachlor (Butisan 400 SC) and clopyralid (Lontrel 300) were applied in spring rape according to recommendations (Zalecenia 1993). The aim of this study was to estimate the effect of the herbicides on glucosinolates content in spring rape seeds.
The obtained results revealed significant effect of meteorological conditions on glucosinolates content. The Star cv. was characterized by higher level of these compounds in comparison with Lisonne cv. The adequate values were 15.96 μmol g^{-1} of d.m. and 12.32 μmol g^{-1} of d.m., respectively. It is evident on the base of the statistical analyses of the obtained results that herbicides modified glucosinolates content in seeds of both cultivars. The level of these compounds was increased as the effect of Triflurotox 250 EC use (data obtained from three years investigations) and Alatrif 380 EC (four years) while Butisan 400 SC activity was unfavourable (four years).

Key words: spring rape seeds, herbicides, glucosinolates

INTRODUCTION

The quality and nutritional value of the rapeseed depend on the chemical composition and particularly on the content of anti-nutritious substances such as glucosinolates, phenolic compounds, phytinians, crude fiber and erucic acid. The glucosinolates content in the seeds is a quantitative trait determined by a genotype of the mother plant and modified by the environmental conditions (Champolivier and Marrien 1990; Bilsborrow et al. 1993; Mendham 1995; Bouchereau et al. 1996; Jensen et al. 1996; Rosa et al. 1997). Successful cultivation of spring rape to a great degree is determined also by weed control (Murawa et al. 1996). Currently used pesticides have a wide variety of biological activity. They may have an effect on physiological activity of seeds, the content of proteins, fats, fatty acids, amino acids, structural carbohydrates, mineral components and anti-nutritious compounds (Cobb 1992; Greiner and Domoney 2004).

The aim of the research work (field and laboratory) was to estimate the effect of herbicides applied in spring rape cultivars on glucosinolates content in the seeds.

MATERIAL AND METHODS

Field experiments with spring rape (*Brassica napus* var. *oleifera* f. *annua*) cv. Lisonne and Star were conducted in the Northern part of Poland in 1995–1999. The following herbicides were used: before spring rape sowing – Triflurotox 250 SC (trifluralin) at dose of 3.5 dm^3 ha^{-1} which equals 1.82 kg a. i. ha^{-1} and Alatrif 380 EC (alachlor + trifluralin) at dose of 4.0 dm^3 ha^{-1} which equals 1.82 kg a. i. ha^{-1}; after sowing – Alanex 480 EC (alachlor) at dose of 3.5 dm^3 ha^{-1} which equals 1.68 kg a. i. ha^{-1} and Butisan 400 SC (metazachlor) at dose of 3.0 dm^3 ha^{-1} which equals 1.2 kg a. i. ha^{-1}; as well at 4–6 leafs stage – Lontrel 300 SL (clopyralid) at dose of 0.3 dm^3 ha^{-1} which equals 0.09 kg a. i. ha^{-1}.

The content of glucosinolates in spring rape seeds was determined by liquid chromatography following samples preparation according to Heaney et al. 1988.

The results were evaluated statistically using analysis of variance (test F) for two factors experiments (split–plot). The mean values of the plots were compared using test q SNK (Student-Newman-Keuls).

RESULTS AND DISCUSSION

The synthesis of results showed that the content of glucosinolates in spring rape seeds of both cultivars was significantly dependent on weather conditions (Tab. 1). The greatest content of glucosinolates in the seeds of the Star cv. (average 20.41 μmol g^{-1} fat-free d.m.) was observed in the dry and warm year 1999 (Tab. 2, Fig. 1). The weather conditions of 1998 and 1999 (low precipitation and high temperatures during rape seed ripening) were also favourable for the accumulation of glucosinolates in the seeds of the Lisonne cv. (Fig. 1, Tab. 2).

The obtained results are consistent with those reported by Jensen et al. (1996) and Zilenaite and Zakarauskaite (2000) who demonstrated that dry and warm summers favoured the accumulation of glucosinolates in the seeds of spring rape.

The statistical analysis of the results indicated that the applied herbicides were the factor modifying the content of glucosinolates in the seeds of spring rape (Tab. 2). A significant increase in glucosinolates in the seeds of both rape cultivars was found after the application of herbicides: trifluralin (Triflurotox 250 EC) in 1995, 1996, 1997 and 1998 (on the average by 13%) and alachlor + trifluralin (Alatrif 380 EC) in 1995, 1996, 1997 and 1998 (on the average by 10%). A decrease in their content (on the average by 8%) was observed after the application of Butisan 400 SC herbicide in 1995, 1996, 1997 and 1999 (Tab. 2). The varied effect of herbicides on the content of glucosinolates in the seeds of the tested rape cultivars was found also by Rotkiewicz et al. (1998).

The statistical evaluation of the results showed that in the subsequent experimental years the examined rape cultivars differed in the content of glucosinolates in

Table 1. Synthetic analysis of variance of glucosinolates (μmol g^{-1} fat-free d.m.) in spring rape seeds

Years	Variability	Value of test F
		Glucosinolates
1995	Herbicides	24.89^{xx}
	Cultivars	2839.05^{xx}
	Herbicides × Cultivars	7.61
1996	Herbicides	152.33^{xx}
	Cultivars	49.71^{xx}
	Herbicides × Cultivars	163.44^{xx}
1997	Herbicides	44.71^{xx}
	Cultivars	288.13^{xx}
	Herbicides × Cultivars	170
1998	Herbicides	0.11
	Cultivars	10.47^{xx}
	Herbicides × Cultivars	0.99
1999	Herbicides	0.32
	Cultivars	162.89^{xx}
	Herbicides × Cultivars	0.90
Synthesis 1995–1999	Years	55.18^{xx}
	Herbicides	4.86^{xx}
	Years × Herbicides	0.48
	Cultivars	6.47^{xx}
	Herbicides × Cultivars	1.91
	Years × Cultivars	94.87^{xx}
	Years × Herbicides × Cultivars	1.92^{x}

^{x} p=0.05
^{xx} p=0.01

the seeds (Tab. 1). It was found that the seeds of the Star cv. accumulated on the average by 29% more glucosinolates than the seeds of the Lisonne cultivar. (Tab. 2).

The level of glucosinolates in the seeds of the Star cv. was similar to that reported by Butkute et al. (2000) and Zilenaite and Zakarauskaite (2000). According to Mendham (1995) this level could be modified by the maternal factor and the 1000 seed weight. A linear increase in the content of glucosinolates in the seeds of this cultivar in correlation with the increasing 1000 seed weight was also observed by Butkute et al. (2000) and Jensen et al. (1996).

The quality of industrial seeds of double low rape is specified in Poland with Polish Norm PN-90/-R66151. The norm determines the acceptable content of glucosinolates in rape seeds at the level of 25 μmol g^{-1} fat-free d.m. This value is twice as low as the one accepted in other countries of the European Union. The present study revealed an increase in the glucosinolates content in the seeds of both spring-rape cultivars after application of Triflurotox 250 EC (on the average by 13%, to the value of 13.52 μmol g^{-1} fat-free d.m.) and Alatrif 380 EC (on the average by 10%, to the value of 13.00 μmol g^{-1} fat-free d.m.). The increased glucosinolates level does not exceed the level accepted by the norm. Moreover, it was shown that herbicide Butisan 400 SC decreased the content of the tested anti-nutritional compounds in seeds of both examined spring-rape cultivars, on the average, by 8%.

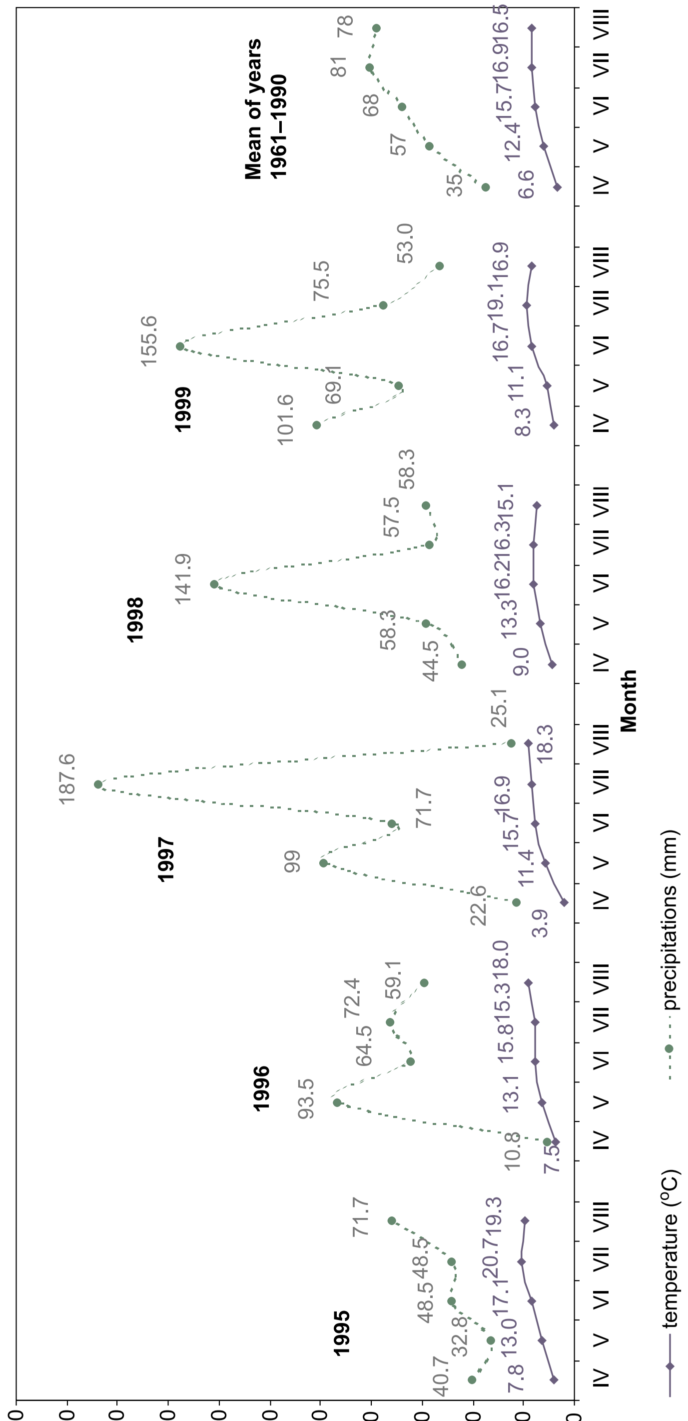

Fig. 1. Mean monthly temperatures and precipitation total in the experimetal period by the meteorogical point Bałcyny

Table 2. Glucosinolates (μmol g^{-1} fat-free d.m.) of spring rape seeds

			Glucosinolates			
Years	Factors	Objects	X	±	SEM	SNK
1995	Herbicides	Control	12.66	±	1.98	cBC
		Triflurotox 250 EC	15.2	±	2.17	aA
		Alanex 480 EC	11.81	±	1.87	cC
		Butisan 400 SC	10.86	±	1.55	dD
		Lontrel 300 SL	14.11	±	2.21	bAB
		Alatrif 380 EC	13.84	±	1.85	bAB
	Cultivars	Star	17.04	±	0.6	X
		Lisonne	8.83	±	0.31	Y
1996	Herbicides	Control	11.34	±	0.53	bB
		Triflurotox 250 EC	10.92	±	0.56	cCD
		Alanex 480 EC	10.73	±	0.09	cD
		Butisan 400 SC	10.16	±	0.13	dF
		Lontrel 300 SL	11.2	±	0.52	bBC
		Alatrif 380 EC	12.66	±	0.15	aA
	Cultivars	Star	11.37	±	0.3	X
		Lisonne	10.96	±	0.23	Y
1997	Herbicides	Control	11.45	±	0.49	B
		Triflurotox 250 EC	12.51	±	0.58	A
		Alanex 480 EC	10.35	±	0.53	C
		Butisan 400 SC	10.2	±	0.37	C
		Lontrel 300 SL	11.15	±	0.68	B
		Alatrif 380 EC	12.29	±	0.51	A
	Cultivars	Star	12.47	±	0.25	X
		Lisonne	10.19	±	0.21	Y
1998	Herbicides	Control	16.46	±	1.22	a
		Triflurotox 250 EC	18.39	±	1.29	a
		Alanex 480 EC	17.4	±	1.35	a
		Butisan 400 SC	17.39	±	2.21	a
		Lontrel 300 SL	17.42	±	1.39	a
		Alatrif 380 EC	18.52	±	1.25	a
	Cultivars	Star	18.52	±	0.95	X
		Lisonne	16.67	±	0.6	Y
1999	Herbicides	Control	18.00	±	1.41	a
		Triflurotox 250 EC	17.93	±	1.29	a
		Alanex 480 EC	17.14	±	1.46	a
		Butisan 400 SC	17.77	±	1.19	a
		Lontrel 300 SL	17.5	±	1.6	a
		Alatrif 380 EC	17.67	±	1.45	a
	Cultivars	Star	20.41	±	0.44	X
		Lisonne	14.94	±	0.3	Y

SEM – standard error of mean
Letters following mean q SNK test homogeneus groups: small letters mean significant differences at p=0.05; while capital letters at p=0.01
A, b, c... A, B, C ... for comparison of herbicides
x, y, z ... X, Y, Z ... for comparison of cultivars
Source: Owen elaboration

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POLISH SUMMARY

KSZTAŁTOWANIE SIĘ ZAWARTOŚCI GLUKOZYNOLANÓW W NASIONACH RZEPAKU JAREGO POD WPŁYWEM HERBICYDÓW

Badania polowe z rzepakiem jarym (*Brassica napus* var. *oleifera* f. *annua*) odmian Star i Lisonne prowadzono w latach 1995–1999 na terenie ZPD Bałcyny pod Ostródą, należącego do Uniwersytetu Warmińsko-Mazurskiego w Olsztynie.

Celem badań było określenie wpływu herbicydów stosowanych w rzepaku jarym na zawartość glukozynolanów w nasionach. Użyto następujące herbicydy zgodnie z zalecanymi dawkami: Triflurotox 250 SC, Alatrif 380 EC, Butisan 400 SC oraz Lontrel 300 SL.

Synteza uzyskanych wyników wykazała istotny wpływ warunków pogodowych na zawartość glukozynolanów w nasionach obu odmian rzepaku jarego. Nasiona odmiany Star gromadziły istotnie więcej glukozynolanów, w porównaniu z odmianą Lisonne, odpowiednio 15,96 i 12,33 μmol g^{-1} s.m.b. Analiza statystyczna wykazała, że herbicydy modyfikowały zawartość glukozynolanów w nasionach obu odmian rzepaku jarego. Istotny wzrost zawartości glukozynolanów (w porównaniu z obiektem kontrolnym) w nasionach obu odmian rzepaku jarego stwierdzono po zastosowaniu herbicydów: Triflurotox 250 SC (z 3 lat badań), Alatrif 380 EC (z 4 lat), a ich obniżenie po zastosowaniu preparatu Butisan 400 SC (z 4 lat badań).

Book Review

Spaar, D. (ed.). 2003. Zashchita Rastenii v Ustoichivykh Sistemach Zemleispolzovaniya [Plant Protection in Sustainable Systems of Land Use]. OOO "Variant", Torzhok, Vol. 1, 391 pp.; Vol. 2, 374 pp. (In Russian)

This two volume multi-authored book has been prepared and published as a result of a German-Russian program titled "Adaptation of Agricultural Education and Elevating Qualification in Russian Federation" financed by the German Federal Ministry of Consumer Protection, Food and Agriculture.

The book editor prof. Dieter Spaar invited the following twenty five authors from Byelorussia, Germany and Russia: W. Burth, F. Ellmer, C. Gienapp, V. Gutsche, V. Dolshenko, V. Isaitschev, M. Jahn, V. Kirjushin, D. Kuehne, A. Lysov, K. Novozhilov, V. Pavlyushin, B. Pallut, A. Postnikov, S. Soroka, L. Sorochinskii, V. Shchkalikov, P. Schumann, V. Shcxherbakov, T. Wetzel, G. Witt, A. Zakharenko, and V. Zakharenko to contribute to the book that is very well constructed and contains a great volume of valuable information concerned with plant protection.

Volume 1 starts with "Introduction" (p. 7) that explains the aim and scope of the book.

Chapter 1 "Pathogens and pests of cultivated plants" (p. 8–351) provides detailed characteristics of abiotic and biotic factors influencing growth and yield of cultivated plants. The chapter contains many figures, tables and voluminous useful information on taxonomy, biology and noxiousness of viruses, bacteria, fungi, nematodes, insects, mites, slugs, birds and rodents.

Chapter 2 "Population ecology of noxious organisms" (p. 352–387) provides basic information allowing to understand mass occurrence and population dynamics of plant pests and their control.

Volume 2 starts with the continuation of Chapter 2 (p. 7–43) covering topics of population dynamics of plants pests and methods of monitoring plant pests abundance. The chapter provides very clear overview on facts important for integrated pest management.

Chapter 3. "Significance and problems of plant protection" (p. 44–148 should read every plant protection specialist as it contains – in several tables and illustrations – extremely important and useful information concerning e.g. preventing of development of pests resistance to pesticides, pests spread to new territories etc.

Chapter 4 "Plant protection and sustainable systems of land use" (p. 149–201) provides definition of "sustainable land use", its criteria and various indicators. This is a very interesting and convincing discussion of necessity for "sustainable development" illustrated with several tables and drawings.

Volume 2 contains several useful appendices:

Appendix 1 Symptoms in cultivated plants of deficiency of mineral elements (p. 202–205)

Appendix 2. Scales of phenological development of plants (p. 206–239)

Appendix 3. Families and genera of viruses and viroids important for agriculture (p. 240–252)

Appendix 4. Phytopathogenic bacterial and diseases caused in cultivated plants (p. 253–262)

Appendix 5. Taxonomic groups of phytopathogenic fungi and diseases caused (p 263–275)

Appendix 6. Important phytonematodes noxious to plants (p. 276–277)

Appendix 7. Taxonomy of arthropods and their characteristics (p. 278–318)

Appendix 8. Rodents noxious for plant crops (p. 319)

Appendix 9. Classification of herbicides according to mechanism of activity and HRAC (p. 320–322)

Appendix 10. Laws and other acts concerning plant protection measures: A. Russian Federaton. B. European Union and Germany (p. 323–325).

The literature cited in the book is impressive as it contains 761 references.

I recommend this book to all plant protection specialists.

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