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EFFECT OF DIVERSE FERTILIZATION, ROW SPACING AND SOWING RATE ON WEED INFESTATION AND YIELD OF WINTER OILSEED RAPE

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Abstract. Field experiment with winter oilseed rape cultivation was carried out in 2007--2009. The subject of this study was analysis of weed infestation of winter oilseed rape canopy and seed yield depending on the rate of soil NPK fertilization and foliar application (autumn spraying with solution): 100% and 75% NPK and urea + nickel chelate + $MgSO_4H_2O$; 100% and 75% NPK, as well as urea + Plonvit R + $MgSO_4H_2O$). The control was plots without foliar fertilization (only 100% NPK). Foliar sprayings were carried out as a single rate in autumn between 10th and 20th of October. The second experimental factor was seed sowing rate (2.5 kg·ha^{-1} – row spacing 30 cm; 4 kg·ha^{-1} – row spacing 18 cm). It was found that foliar fertilization of winter oilseed rape in the autumn period contributes to a reduction in quantitative indexes of weed infestation and an increase in seed yield. Application of foliar fertilizers allows for reduction in rates of the basic mineral fertilizers NPK by ¼. From the point of view of production it is justified to reduce the seed sowing rate (2.5 kg·ha^{-1}), since the weed infestation and yield of winter oilseed rape did not differ significantly from the parameters observed under conditions of larger sowing density.

Key words: chelate, foliar fertilization, NPK, seed yield, sowing rate, weed infestation, winter oilseed rape, winter weeds

INTRODUCTION

Winter rape belongs to those agricultural crops which are particularly exposed to unfavorable effect of weeds [Knott 1990, Orson 1993]. Early time of winter rape sowing creates favorable conditions for the development of many weed species, which usually grow faster than agricultural crops, competing with rape seedlings for nutrients and living space. The most serious threat to rape are wintering species, which are difficult to eliminate in the spring period due to their advanced growth [Primot *et al.*

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2006]. Weeds utilize well high air and soil temperatures, temperature fluctuations between the day and night, and favorable soil humidity. Wider row spacing in comparison with cereals, high fertilization with mineral nitrogen, create good conditions for the germination and development of winter and spring weed species [Kostrzewska 1998].

In agricultural practice reduced sowing rates of winter oilseed rape seeds are more often promoted in relation to the recommended standard (sowing rate lowered to 2.5 $kg \cdot ha^{-1}$, and even to 1.5 $kg \cdot ha^{-1}$). The issue of the effect of a smaller sowing rate of seeds on winter oilseed rape productivity is undertaken in many scientific publications [Korbitz 2003, Budzyński 2006, Skrzypczak 2006]. Nevertheless, the question of a canopy weed infestation level under such conditions still remains open. To give a yield on the level of the national mean, winter oilseed rape requires high enough rates of fertilizers. Proper mineral fertilization ensures the normal development and determines overwintering of plants essential for the appropriate development, overwintering and satisfactory productivity. Out-of-root application of fertilizers provides nutrients under conditions of their hindered uptake from the soil solution [Szewczuk and Michałojć 2003] and has a positive effect on growth, development and yield of crops [Wróbel and Sienkiewicz-Cholewa 2003]. In this study the hypothesis was adopted that the application of a smaller sowing rate of winter oilseed rape seeds (2.5 $kg \cdot ha^{-1}$) and a reduction in rates of mineral NPK fertilization by 25% will not have a significant unfavorable effect on stand weed infestation and seed yield of winter rape, thanks to the foliar application in the autumn period of the solution: urea + nickel chelate + magnesium sulfate or the solution: urea + Plonvit R + magnesium sulfate, as compared with the recommended rate of NPK fertilization and seed sowing rate amounting to 4.0 $kg \cdot ha^{-1}$.

The aim of this study was to estimate the quantitative indexes of weed infestation and botanical composition of weeds in the stand of winter rape, as well as the effect of weeds on the crop yield, under conditions of diverse soil and foliar application of fertilizers two sowing rates of seeds.

MATERIAL AND METHODS

Field study with winter oilseed rape cultivation was carried out in 2007-2009 on a farm in Jaroszewice (Lublin voivodeship) – geographic coordinates: 51º10' N; 22°18' E. The experiment was conducted on podsolic soil of the quality class III a. The soil showed the humus content on a level of 1.32% in 0-20 cm layer, the mean content of P (61 mg in 1 kg of soil) and Mg (55 mg) and low of K (83 mg), whereas the soil reaction was pH = 6.0 in 1 mol KCl. Winter oilseed rape of the Kronos cultivar was used in the study. The previous crop of winter rape in each year was spring barley. The experiment was established with the split-plot design in 4 replications. The plot area amounted to 27 m^2.

The following experimental factors were subjected to assessment:

– rates of soil NPK fertilization and foliar application of fertilizers:
  - A – 100% of the NPK rate, without foliar fertilization (control),
  - B – 100% of the NPK rate and autumn spraying with the solution: urea (30 kg $N \cdot ha^{-1}$) + nickel chelate (2 $dm^3 \cdot ha^{-1}$) + $MgSO_4H_2O$ (7.5 $kg \cdot ha^{-1}$),
  - C – 75% of the NPK rate and autumn spraying with the solution: urea (30 kg $N \cdot ha^{-1}$) + nickel chelate (2 $dm^3 \cdot ha^{-1}$) + $MgSO_4H_2O$ (7.5 $kg \cdot ha^{-1}$),

D – 100% of the NPK rate and autumn spraying with the solution: urea (30 kg $N \cdot ha^{-1}$) + Plonvit R (2.0 $dm^3 \cdot ha^{-1}$) + $MgSO_4H_2O$ (7.5 $kg \cdot ha^{-1}$),
E – 75% of the NPK rate and autumn spraying with the solution: urea (30 kg $N \cdot ha^{-1}$) + Plonvit R (2.0 $dm^3 \cdot ha^{-1}$) + $MgSO_4H_2O$ (7.5 $kg \cdot ha^{-1}$);

– sowing density:
  a) 70 seeds per 1 m^2 (row spacing 18 cm, seeding rate – 4.0 $kg \cdot ha^{-1}$,
  b) 40 seeds per 1 m^2 (row spacing 30 cm, seeding rate – 2.5 $kg \cdot ha^{-1}$.

Prior to sowing seeds (from 20th to 31st August) in the variant of 100% NPK (treatments A, B, D): 50 kg N (in the form of ammonium nitrate), 30 kg P (granular triple superphosphate) and 150 kg K (potash salt) per 1 ha was spread every year. In the variant 75% NPK (treatments C and E), 37.5 kg N, 22.5 kg P and 112.5 kg K, respectively, was sown per 1 ha. In early spring from the moment of starting growth ammonium nitrate was used in amounts of 100 kg $N \cdot ha^{-1}$ (treatments A, B, D) and 75 kg $N \cdot ha^{-1}$ (treatments C and E). Rates of 100% of phosphorus and potassium fertilizers were estimated on the basis of nutritional requirements of rape and soil fertility.

Foliar fertilizers were applied as a single rate in autumn (from 10th to 20th October). Concentration of foliar solutions was: urea 10%, monohydrate magnesium sulfate 2.5%, nickel chelate (EDTA-Ni) – 5 g $Ni \cdot dm^{-3}$, Plonvit R – 0.67%.

Prior to sowing winter oilseed rape, seeds were dressed with the preparation Cruiser OSR 322 FS – 11,25 $ml \cdot kg^{-1}$ of seeds. Plant protection against fungal diseases, insects and weeds was carried out once in the spring period. The following plant pesticides were applied:

– fungicides: Sparta 250 EW – 1.0 $dm^3 \cdot ha^{-1}$ (in spring from starting growth) and Matador 303 SE – 1.75 l ha^{-1} (from the stage of dense inflorescence to the end of flowering);
– insecticide Sumi-Alpha 050 EC – 0.25 $dm^3 \cdot ha^{-1}$ (at the beginning of flowering);
– herbicides: Kerb 50 WP + Lontrel 300 SL – 1 kg + 0.4 $dm^3 \cdot ha^{-1}$ – in spring at the moment of starting growth.

The assessment of weed infestation of the oilseed rape canopy was carried out after 60 days from the spring application of herbicides, in the period of the final stage of oilseed rape flowering (BBCH 67). The number and botanical composition of weeds and their air-dry weight from test areas of 1 × 0.5 m^2, were analyzed in two replications on each plot. Collection of winter oilseed rape seeds was performed from 20th to 31st July. After drying the seeds, their yield from a single plot (27 m^2) was determined and counted over an area of 1 ha.

The results of the study were subjected to statistical calculations (analysis of variance for the split-plot design, with the use of package Statgraphic 5.0), and significant differences were assessed using Tukey's test at the level (0.05).

RESULTS AND DISCUSSION

Application of 100% of the mineral NPK fertilization together with foliar fertilization (treatments B and D) had an effect on a significantly larger number of weeds in the winter oilseed rape canopy in comparison with the control A (without foliar application). Moreover, the number of weeds observed on treatments B and D was significantly larger in comparison with treatments C and E, where 75% of the NPK fertilization rate + foliar fertilization was applied (Table 1). Regardless of the sowing density of winter oilseed rape seeds, reducing the recommended rate of mineral NPK fertilization by 25% and its supplementing with foliar fertilization (treatments C and E) resulted in a smaller number of weeds in canopy, on average by 24 plants in comparison with that observed on treatments A, B and D. Regardless of the method of winter oilseed rape fertilization, a decrease in sowing density to 40 seeds per 1 m^2 contributed to a significantly larger number of weeds in canopy (on average by 16%) in comparison with that observed under conditions of a sowing density of 70 seeds per 1 m^2.

Table 1. Number of weeds per 1 m^2 in winter oilseed rape canopy, pcs (mean from 2007-2009)
Tabela 1. Liczba chwastów na 1 m^2 w łanie rzepaku ozimego, szt. (średnia z lat 2007-2009)

Sowing rate Gęstość siewu nasion $kg \cdot ha^{-1}$	Fertilization – Nawożenie					
	A*	B	C	D	E	mean średnia
4.0	45.6	57.4	29.9	60.4	33.6	45.4
2.5	59.9	62.5	36.7	68.6	41.8	53.9
Mean – Średnia	52.7	59.9	33.3	64.5	37.7	–
$LSD_{0,05}$ – $NIR_{0,05}$ for – dla:						
fertilization – nawożenia		4.96				
sowing rate – gęstości siewu		5.23				

A* – 100% of the NPK rate, without foliar fertilization (control treatment) – 100% dawki NPK, bez nawożenia dolistnego (obiekt kontrolny)
B – 100% of the NPK rate and autumn spraying with the solution: urea + nickel chelate + $MgSO_4H_2O$ – 100% dawki NPK oraz oprysk jesienny roztworem: mocznik + chelat niklu + $MgSO_4H_2O$
C – 75% of the NPK rate and autumn spraying with the solution: urea + nickel chelate + $MgSO_4H_2O$ – 75% dawki NPK oraz oprysk jesienny roztworem: mocznik + chelat niklu + $MgSO_4H_2O$
D – 100% of the NPK rate and autumn spraying with the solution: urea + Plonvit R + $MgSO_4H_2O$ – 100% dawki NPK oraz oprysk jesienny roztworem: mocznik + Plonvit R + $MgSO_4H_2O$
E – 75% of the NPK rate and autumn spraying with the solution: urea + Plonvit R + $MgSO_4H_2O$ – 75% dawki NPK oraz oprysk jesienny roztworem: mocznik + Plonvit R + $MgSO_4H_2O$

Air-dry weight of weeds in the winter oilseed rape canopy depended significantly on both experimental factors (Table 2). The largest weight of weeds proved statistically was found on the control (without foliar fertilization) and on treatment D, fertilized with 100% of the NPK rate + urea + Plonvit R + $MgSO_4H_2O$, as compared with the other treatments. Regardless of mineral fertilization, a decrease in seed sowing density affected an increase in the air-dry weight of weeds in canopy, on average by 4.5 $g \cdot m^{-2}$ (30%).

Results similar to those discussed above concerning the canopy weed infestation of winter oilseed rape were recorded by Różyło and Pałys [2011]. The authors observed a higher total number of weeds in oilseed rape grown in a wider row spacing (33 cm), in comparison with a row spacing of 18 cm. Significant differences in the total number of weeds in the study by those authors did not find their reflection in the air-dry weight of the aboveground parts of weeds, where differences between treatments with different row spacing were not statistically significant. The study by Jasińska and Malarz [1989] indicated that wide row spacing creates favorable conditions for higher weed infestation of winter oilseed rape. Moreover, a row spacing of 40 cm in their study caused worse overwintering, more frequent branching and a higher number of siliques per plant as compared with the row spacing amounting to 12 and 20 cm.

Table 2. Air-dry weight of weeds per 1 m^2 in winter oilseed rape canopy, g (mean from 2007--2009)
Tabela 2. Powietrznie sucha masa chwastów na 1 m^2 w łanie rzepaku ozimego, g (średnia z lat 2007-2009)

Sowing rate Gęstość siewu nasion $kg \cdot ha^{-1}$	Fertilization – Nawożenie					
	A	B	C	D	E	mean średnia
4.0	11.8	9.5	8.6	12.1	10.4	10.5
2.5	18.2	12.9	10.7	19.3	14.0	15.0
Mean – Średnia	15.0	11.2	9.6	15.7	12.2	–
$LSD_{0,05}$ – $NIR_{0,05}$ for – dla:						
fertilization – nawożenia		2.66				
sowing rate – gęstości siewu		3.17				

explanations in Table 1 – objaśnienia w tabeli 1

Increasing the sowing rate of winter oilseed rape seeds up to 4.0 $kg \cdot ha^{-1}$ had an effect on a reduction of weed species composition and the number of species most frequently occurring in the canopy as compared with a sowing rate of 2.5 $kg \cdot ha^{-1}$. Mean loss of the weed number was 8 plants, whereas of the species number – 1 (Table 3). Wider sowing of winter oilseed rape seeds favored especially the elimination of such species as: *Viola arvensis*, *Stellaria media*, *Matricaria discoidea* and *Chenopodium album*. Moreover, a slight increase in numbers of *Anthemis arvensis* and a small decrease in the numbers of *Matricaria maritima* ssp. *inodora* was observed under such conditions.

Table 3. Whole number of weeds species and number of specimens of weeds species dominant in winter oilseed rape canopy per 1 m^2 [pcs.] in depend on sowing rate (mean for fertilization method in 2007-2009)
Tabela 3. Łączna liczba gatunków chwastów oraz liczebność osobników gatunków chwastów najliczniej występujących w łanie rzepaku ozimego na 1 m^2 [szt.] w zależności od gęstości siewu (średnia dla sposobów nawożenia w latach 2007-2009)

Species – Gatunek	Sowing rate – Gęstość siewu nasion, $kg \cdot ha^{-1}$		
	2.5	4.0	loss (–) and increase (+) in number of weeds – ubytek (–) lub wzrost (+) liczby chwastów
Whole number of species Łączna liczba gatunków	14	13	-1
Dominant species – Gatunki najliczniej występujące			
Viola arvensis Murray	12.1	10.4	-1.7
Stellaria media (L.) Vill	8.3	7.0	-1.3
Anthemis arvensis L.	7.3	7.6	+0.3
Chenopodium album L.	5.2	4.2	-1.0
Matricaria discoidea DG.	4.0	2.6	-1.4
Capsella bursa-pastoris (L.) Medik	3.1	2.2	-0.9
Matricaria maritima ssp. *inodora* (L.) Dostál	3.5	3.4	-0.1
Galium aparine L.	1.8	0.9	-0.9
Other species Osobniki pozostałych gatunków	8.6	8.0	-0.6
Total – Razem	53.9	45.4	-8.5

The factor differentiating the canopy weed infestation was the level of presowing mineral NPK fertilization + foliar application (Table 4). In comparison with the control, the numbers of *Stellaria media*, *Matricaria maritima* ssp. *indora*, *Viola arvensis*, *Capsella bursa pastoris* and *Anthemis arvensis* were significantly the smallest on treatments C and E (fertilized with the NPK rate reduced by 25% with the application of foliar fertilization). Significant reduction of the occurrence of *Matricaria discoidea* was recorded on all the treatments with foliar fertilization (B-E), in comparison with the control plots (A). Different tendency was observed under conditions of treatments B and D. Application of the recommended 100% rate of mineral NPK fertilization + foliar application resulted in a significant increase in the number of the most often represented weed species, particularly: *Stellaria media*, *Galium aparine*, *Chenopodium album*, *Matricaria discoidea.* Application of 100% of the NPK rate and autumn spraying with the solution: urea + Plonvit R + $MgSO_4H_2O$ (treatment D) affected forming the largest number of weeds in canopy, and at the same time, on the smallest biodiversity. The number of weed species under such conditions appeared to be significantly smaller in comparison with treatments A, C and D.

Table 4. Whole number of weed species and number of specimens of weed species dominant in winter oilseed rape canopy per 1 m^2 [pcs] depending on fertilization method (mean for sowing rate in 2007-2009)

Tabela 4. Łączna liczba gatunków chwastów oraz liczebność osobników gatunków chwastów najliczniej występujących w łanie rzepaku ozimego na 1 m^2 [szt.] w zależności od sposobu nawożenia (średnia dla sposobu gęstości siewu w latach 2007-2009)

Species – Gatunek	Fertilization – Nawożenie				
	A	B	C	D	E
Whole number of species Łączna liczba gatunków	14a	12b	13b	11c	14a
Dominant species – Gatunki najliczniej występujące					
Stellaria media (L.) Vill	11.9a*	18.5b	6.1c	20.2b	7.0c
Matricaria maritima ssp. *inodora* (L.) Dostál	8.5a	7.3a	5.2b	7.9a	6.1b
Viola arvensis Murray	6.9a	5.8a	5.0b	6.2a	4.6b
Capsella bursa pastoris (L.) Medik	6.0a	6.7a	4.3b	7.1a	3.9b
Anthemis arvensis L.	3.9a	4.5a	2.1b	5.3a	2.6b
Matricaria discoidea DG.	3.5a	0.4b	1.8c	1.6c	2.0c
Chenopodium album L.	3.0a	5.4b	1.9a	8.8c	1.5a
Galium aparine L.	0.7a	2.9b	0.6a	3.7b	0.9a
Other species Osobniki pozostałych gatunków	8.3a	8.4a	6.3b	3.7c	9.1a
Total – Razem	52.7a	59.9b	3.3c	64.5b	37.7c

explanations in Table 1 – objaśnienia w tabeli 1
* means within a line followed by various letters (a-c) are significantly different (P = 0.05) – średnie oznaczone w wierszach różnymi literami (a-c) różnią się istotnie (P = 0,05)

Praczyk [2005] evaluates that several dozen weed species occur on oilseed rape plantations in Poland, both spring and winter, annual and perennial. Species that appear already in autumn constitute the biggest problem in cultivation of winter cultivars. They include, among others: *Viola arvensis*, *Matricaria maritima* ssp. *inodora*, *Stellaria media*, *Galium aparine*, *Thlaspi arvense*, *Agropyron repens*, as well as cereal volunteers. According to Frank and Rola [2000], not only winter weeds, i.e.: *Stellaria* *media*, *Galium aparine*, *Thlaspi arvense*, *Capsella bursa-pastoris*, but also freezing species: *Chenopodium album*, *Sinapis arvensis*, *Galinsoga parviflora*, have a significant effect on the yield of winter oilseed rape. The study by those authors indicates that the effect of individual weed species on winter oilseed rape is not the same: 100 pcs.$\cdot$m^{-2} *Galium aparine* decrease seed yield by 42%, whereas the same amount of *Anthemis arvensis* only by 19%. Similar list of dominating weed species in winter oilseed rape canopy is also given by Radecki and Ciesielska [2000]. The weed species mentioned by the above authors were also recorded among the most frequently occurring weeding flora in this experiment.

Paradowski [2009] mentions that recent years create favorable conditions for development of winter weeds. The number of dicotyledonous weeds occurring in winter oilseed rape does not exceed 30 species. There may occur on average 7-10 best known weed species on one field. The quoted observation finds its reflection in discussed results of the study, since 8 dominating weed species were observed, whereas the total number of weed species did not exceed 14. Mrówczyński [2003] reports that increased occurrence of weeds on a winter oilseed rape plantation may result in lowering productivity of this plant, as a result of their competitive effect on the field crop, but also through creating the appropriate microclimate in the canopy, favoring the development of diseases and pests.

A significant negative correlation was observed between air-dry weight of weeds in canopy and the yield of winter oilseed rape seeds under conditions of the control A, at decreasing the seed sowing rate to 2.5 kg$\cdot$ha^{-1} (Table 5). Statistical analysis also confirmed a significant negative correlation on the treatment under discussion between the number of weeds in canopy and the yield of winter oilseed rape (Table 6).

Differentiation of the sowing density of winter oilseed rape seeds (a density of 70 and 40 plants per 1 m^2) did not have a significant effect on the yield of this plant (Table 7), which weighs in favor of the usefulness of decreasing the sowing rate of winter oilseed rape seeds. Irrespective of the method of fertilization, a difference in winter oilseed rape productivity within the compared sowing densities was only 0.12 t$\cdot$ha^{-1} (2,5 %). Statistical analysis confirmed a large usefulness in foliar fertilization of the solution: urea + nickel chelate + magnesium sulfate. An increase in winter oilseed rape yield under the influence of this solution, as compared with that achieved on the control (A), for treatments B and C was on average 0.58 t$\cdot$ha^{-1} (15%) and 0.76 t$\cdot$ha^{-1} (19%), respectively. Significantly the lowest seed yield of winter oilseed rape was found under conditions of the control, with the use of a lower sowing density (40 seeds per 1 m^2).

In the analyzed study a decreased sowing rate of winter oilseed rape seeds (40 seeds per 1 m^2) did not contributed to significantly lower yield of this plant in comparison with that observed under conditions of denser sowing (70 seeds per 1 m^2), with the exception of the control, which confirms the working hypothesis assumed in this study.

Table 5. Simple correlation coefficient (r) between air-dry weight of weeds in canopy and seed yield of winter oilseed rape (mean of 2007-2009)
Tabela 5. Współczynniki korelacji (r) między powietrznie suchą masą chwastów w łanie a plonem nasion rzepaku ozimego (średnia z lat 2007-2009)

Fertilization – Nawożenie	Sowing rate – Gęstość siewu nasion, $kg \cdot ha^{-1}$	
	4.0	2.5
A	-0.48	-0.70*
B	-0.29	-0.41
C	-0.11	-0.33
D	-0.34	-0.44
E	-0.13	-0.37

explanations in Table 1 – objaśnienia w tabeli 1
* significant correlation coefficient (0.05) – istotny współczynnik korelacji (0,05)

Table 6. Simple correlation coefficient (r) between number of weeds in canopy and seed yield of winter oilseed rape (mean of 2007-2009)
Tabela 6. Współczynniki korelacji (r) między liczbą chwastów w łanie a plonem nasion rzepaku ozimego (średnia z lat 2007-2009)

Fertilization – Nawożenie	Sowing rate – Gęstość siewu nasion, $kg \cdot ha^{-1}$	
	4.0	4.0
A	-0.46	-0.54*
B	-0.39	-0.46
C	-0.15	-0.26
D	-0.47	-0.49
E	-0.21	-0.32

explanations in Table 1 – objaśnienia w tabeli 1
* significant correlation coefficient (0.05) – istotny współczynnik korelacji (0,05)

Table 7. Yield of winter rape seeds, $t \cdot ha^{-1}$ (mean from 2007-2009)
Tabela 7. Plon nasion rzepaku ozimego, $t \cdot ha^{-1}$ (średnia z lat 2007-2009)

Sowing rate Gęstość siewu nasion $kg \cdot ha^{-1}$	Fertilization – Nawożenie					
	A	B	C	D	E	mean średnia
4.0	3.51	3.97	4.12	3.62	3.74	3.79
2.5	3.13	3.83	4.04	3.60	3.77	3.67
Mean – Średnia	3.32	3.90	4.08	3.61	3.75	–
$LSD_{0,05}$ – $NIR_{0,05}$ for – dla:						
fertilization – nawożenia (a)	0.349					
sowing rate – gęstości siewu (b)	ns – ni					
interaction – interakcja: a × b	0.372					

explanations in Table 1 – objaśnienia w tabeli 1
ns – ni – non-significant difference – różnica nieistotna

The study by Sztuder and Sienkiewicz-Cholewa [2009] proved that the application of liquid agrochemicals in winter oilseed rape cultivation significantly increased the yields of this crop. Also Kocoń [2009] obtained the highest increase in winter rape seed yield on treatments where foliar application of fertilizers was carried out both in the autumn period (as a single rate) and in the spring (3 times). Jaskulski [2004] studying the yield-forming effect of foliar application of fertilizers of the Sonata series in winter oilseed rape cultivation, found mean increase in seed productivity on a level of 110-260 $kg \cdot ha^{-1}$. Barłóg and Potarzycki [2000] proved that foliar fertilization of winter oilseed rape with magnesium significantly increased the seed and fat yield obtained from this plant.

According to Budzyński [2006], new cultivars of winter oilseed rape are characterized by a high germination capacity and form a large number of branches. Those traits can be fully utilized under conditions of a lower sowing density, since the number of evenly set siliques per plant increases. The author claims that the plant density for hybrid cultivars of winter oilseed rape within the range from 35 to 45 plants per 1 m^2 – depending on the cultivar – is completely sufficient to obtain the maximal seed yield. Winter oilseed rape responds badly to too high plant density and under such conditions it does not reveal its yield potential, which is of particular importance in the case of hybrid cultivars [Korbitz 2003].

The study conducted by Wielebski and Wójtowicz [2001] confirm the significant interaction between the sowing density of winter oilseed rape seeds and the cultivar. According to the authors, the optimal sowing rate, irrespective of the cultivar, is 80 seeds per 1 m^2. A smaller sowing rate contributed to an increased amount of siliques per plant and a higher 1000 seed weight.

CONCLUSIONS

1. Application of the recommended 100% rates of NPK mineral fertilization, enriched with foliar fertilization, caused an increase in quantitative indexes of canopy weed infestation of winter oilseed rape, smaller biodiversity of weeds in canopy, and at the same time compensation of the most frequently occurring species.
2. The most favorable effect on a reduction in the number and air-dry weight of weeds in canopy and on the yield height of winter oilseed rape was exerted by the combination of fertilizers: 75% of the NPK rate and autumn spraying with the solution: urea (30 $kg\ N \cdot ha^{-1}$) + nickel chelate (2 $dm^3 \cdot ha^{-1}$) + $MgSO_4H_2O$ (7.5 $kg \cdot ha^{-1}$).
3. The smaller sowing density (40 seeds per 1 m^2) of winter oilseed rape affected an increase in the number and air-dry weight of weeds in canopy. This, however did not cause a substantial decrease in seed yield of winter oilseed rape in comparison with a sowing density of 70 seeds per 1 m^2.
4. Differentiation of the sowing density of winter oilseed rape had a minimal effect on changes in the number of most frequently represented weed species per area unit.

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WPŁYW ZRÓŻNICOWANEGO NAWOŻENIA ORAZ ROZSTAWY RZĘDÓW I ILOŚCI WYSIEWU NA ZACHWASZCZENIE I PLONOWANIE RZEPAKU OZIMEGO

Streszczenie. Eksperyment polowy z uprawą rzepaku ozimego przeprowadzono w latach 2007-2009 w gospodarstwie rolnym w Jaroszewicach (woj. lubelskie). Przedmiotem badań była analiza stanu zachwaszczenia łanu rzepaku ozimego oraz plonu nasion w zależności od dawki nawożenia doglebowego NPK i dolistnego (oprysk jesienny roztworem): 100% i 75% NPK oraz mocznik + chelat niklu + $MgSO_4H_2O$; 100% i 75% NPK, a także mocznik + Plonvit R + $MgSO_4H_2O$). Obiekt kontrolny stanowiły poletka bez nawożenia dolistnego (wyłącznie 100% NPK). Opryski dolistne przeprowadzano jednorazowo jesienią w drugiej dekadzie października. Drugim czynnikiem doświadczalnym była ilość siewu nasion (2,5 $kg \cdot ha^{-1}$ – rozstawa rzędów 30 cm; 4 $kg \cdot ha^{-1}$ – rozstawa rzędów 18 cm). Stwierdzono, że dolistne dokarmianie rzepaku ozimego w okresie jesiennym przyczynia się do ograniczenia ilościowych wskaźników zachwaszczenia i zwiększenia plonu nasion. Zastosowanie nawozów dolistnych pozwala ograniczyć dawki podstawowych nawozów mineralnych NPK o ¼. Z punktu widzenia produkcyjnego uzasadnione jest zmniejszenie ilości wysiewu nasion (2,5 $kg \cdot ha^{-1}$), ponieważ zachwaszczenie rzepaku ozimego oraz plonowanie nie odbiegały istotnie od parametrów stwierdzonych w warunkach większej gęstości siewu.

Słowa kluczowe: chelat, chwasty zimujące, gęstość siewu, mocznik, nawożenie dolistne, zachwaszczenie rzepaku

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