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THE EFFECT OF WEATHER CONDITIONS ON THE YIELD AND MACRONUTRIENT CONTENT IN THE ABOVEGROUND BIOMASS OF WHITE MUSTARD (*Sinapis alba* L.) CULTIVATED AS STUBBLE CATCH CROP

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ABSTRACT

Background. White mustard is a valuable plant as a stubble catch crop due to a relatively cheap seed material, tolerance to delayed sowing date and high yield stability. The aim of this research was determination of thermal and rainfall requirements of white mustard cultivated as stubble catch crop in conditions of sandy loam soil, of the very good rye complex.
Material and methods. The field studies were carried out at the Experimental Station in Mochełek, near Bydgoszcz in the years 2010–2015. White mustard cv. Bamberka was sown on 08–18 August, on lessive soil, belonging to the very good rye complex. The soil was characterized by a very high content of available phosphorus and magnesium, as well as a high content of potassium. The soil reaction in 1M of KCl was 6.48.
Results. Weather conditions played an important role in the formation of white mustard yield and of the content of nitrogen, phosphorus and potassium in the aboveground biomass. Over the years with moderately high rainfall, a greater plant density was obtained as well as longer stems in white mustard, which resulted in this plant's yield. The highest dry matter yields (1.77–2.08 $Mg \cdot ha^{-1}$) were harvested over the years in which the total rainfall in the period from July to October was 218.3–250.4 mm, from which 62-80% occurred in July and August. Poor production results were obtained not only in the years with rainfall deficit in July and August, but also under conditions of excessive rainfall in these months.
Conclusion. Under conditions of lessive soil, belonging to a very good rye complex, an optimal rainfall for white mustard cultivated as stubble catch crop, without fertilization, was 244 mm in the period July – October, from which 172 mm occurred in the period July–August.

Key words: air temperature, rainfall, yield, white mustard

INTRODUCTION

White mustard is a plant which is readily cultivated by farmers as stubble catch crop. This results from a relatively cheap seed material, high tolerance to a delayed sowing date (Kisielewska and Harasimowicz-Hermann, 2008a), dynamic plant growth, and also a relatively high yield stability (Muśnicki *et al.*, 1997; Wilczewski, 2004; Kisielewska and Harasimowicz-Hermann, 2008a). The yield of plants cultivated as stubble catch crop is dependent on the water content in the soil in the period of germination and emergence of plants, as well as on the total rainfall and distribution of rainfall in the growing season of the catch crop (Handlířová *et al.*, 2016). White mustard is a plant which survives periodic water

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deficits relatively well, and is characterized by a high yield stability (Wilczewski, 2004). However, the stress connected with drought in the period of sowing mustard has a significant effect on germination percentage, germination rate, seedling vigor index, coleoptile length, length of radicles and dry weight of a seedling (Taherkhani *et al*., 2013). Short growing season of plants cultivated as a stubble catch crop significantly reduces possibility to compensate for water deficit in the period of germination and plant emergence. Therefore, supplementation of plants with water in the period July-August is a weather factor with the strongest effect on the yield of plants cultivated as a stubble catch crop (Wilczewski *et al*., 2012; Wilczewski and Skinder, 2015). Research hypothesis assumed that total rainfall and air temperatures in the period preceding sowing of the stubble catch crop and during plant growing, comprehensively affect the course of growing and plant yield. Rainfall deficit in one month may be compensated for by water from the earlier rainfall accumulated in the soil.

The aim of this research was to determine thermal and rainfall requirements of white mustard cultivated as stubble catch crop under conditions of sandy-loam soil of a very good rye complex.

MATERIAL AND METHODS

Field experiments were carried out at the Research Station in Mochełek, near Bydgoszcz, in the years 2010–2015. White mustard cv. Bamberka was sown at a rate of 200 seeds per m^2, on 08–18 August, on lessive soil included in a very good rye complex. No fertilization was used when cultivating stubble catch crop.

The soil was characterized by a very high content of available phosphorus and magnesium and a high content of potassium (Table 1). The average soil reaction over these six years of research in 1M KCl was 6.48.

No fertilizers or chemical plant protection products were used in the cultivation of white mustard. Plant harvest was carried out with the use of a scythe mower on 16-26 October. After weighing the green matter yield, a plant sample was collected from each plot of the weight of about 1 kg. The samples were weighed with an accuracy up to 0.5g, and they were placed in a laboratory dryer at a temperature of 50°C. After drying, they were weighed with an accuracy up to 0.05g, and the dry matter yield was calculated from each plot.

Yield stability coefficients were calculated based on the formula:

$$\mathrm{Ww} = \frac{\bar{x}}{\bar{x} + s} \cdot 100\%$$

in which:

$\bar{x}$ – the average yield over the research years,

s – standard deviation in the yield over the years 2010-2015 (Rudnicki and Wasilewski, 2000).

Table 1. The content of mineral components in the soil and its reaction

Year	Nog. %	P $mg \cdot kg^{-1}$	K $mg \cdot kg^{-1}$	Mg $mg \cdot kg^{-1}$	C %	pH in KCl
2010	0.0547	92.8	217.6	60.7	0.530	5.69
2011	0.0722	110.1	143.6	63.6	0.870	6.24
2012	0.0946	92.6	248.4	99.2	0.800	6.23
2013	0.0754	73.9	248.0	96.6	0.790	5.83
2014	0.0840	99.0	169.0	131.0	0.860	7.70
2015	0.0795	70.5	160.0	128.0	0.791	7.18
Mean	0.0767	89.8	198.0	96.5	0.774	6.48

The dried samples were ground and subjected to chemical analysis in order to determine the content of macronutrients in the dry weight. Chemical analyses were carried out after mineralization of the ground plant material through wet combustion with hydrogen peroxide. The determination of the total nitrogen content was carried out with Kjeldahl's method (Hermanowicz *et al*., 1976); phosphorus content was determined with vanadium – molybdenic method (Nowosielski, 1974); potassium and calcium content with flame photometric method (Łoginow and Cwojdziński, 1979), while magnesium content with the use of colorimetric determination with titan yellow (Hermanowicz *et al*., 1976).

The results from plots were subjected to analysis of variance. The significance of differences was determined with the use of Tukey's test, at the significance level of $P < 0.05$ for random block design. Regression equations and correlation coefficients were elaborated with the use of a computer program Statistica for Windows.

RESULTS

Weather conditions in particular years of research differed, both in terms of the total rainfall and average air temperatures (Table 2). Rainfall totals in the growing season were high in 2010 (335.1 mm), quite high in the years 2011–2013 (218.3–250.4 mm), and very low in two last years of the experiment (156.6 and 144.0 mm, respectively). On average, in the six-year period of research the air temperatures in August were by 0.8°C above, and in October by 0.6°C below the long-term mean for these months. The least favorable thermal conditions in September occurred in 2013, and in October in 2010 and 2015. Autumn ground frost, which occurred in the first half of October in 4 out of 6 years of research, did not cause any significant damage in mustard. Only slight damage was observed in upper leaves.

Table 2. Mean air temperatures and rainfall totals in Mochełek in the growing season of white mustard

Years	July	August	September	October	Mean/Total July–October
Mean air temperatures, °C					
2010	21.6	18.4	12.2	5.5	14.4
2011	17.5	17.7	14.3	8.4	14.5
2012	18.8	17.6	13.3	7.4	14.3
2013	18.9	18.1	10.7	8.2	14.0
2014	21.5	17.2	14.4	9.6	15.7
2015	18.5	20.9	13.8	6.4	14.9
Mean 2010–2015	19.5	18.3	13.1	7.6	14.6
Mean 1949–2014	18.1	17.5	13.2	8.2	14.2
Monthly rainfall totals, mm					
2010	107.4	150.7	74.7	2.3	335.1
2011	132.5	67.7	37.0	13.2	250.4
2012	115.6	51.8	25.1	40.3	232.8
2013	79.0	56.6	64.1	18.6	218.3
2014	55.4	57.3	25.9	18.0	156.6
2015	50.4	20.3	52.4	20.9	144.0
Mean 2010–2015	90.0	67.4	46.5	18.9	222.9
Mean 1949–2014	73.6	53.3	41.2	32.1	200.2

White mustard density after emergence ranged from 69.2 plants per m^2 in 2015 to 139.5 plants per m^2 in 2012 (Table 3). It constituted from 34.6% to 69.8% of the planned density. The highest white mustard density after emergence was observed in the years 2011, 2012, 2013 and 2014, while a significantly lower one in 2015. Also a significant effect of the growing conditions of plants was indicated on the stem length before harvest (Table 3). The highest values of this parameter were observed in 2011 and 2013, and significantly lower ones in the years 2010 and 2015.

Significant differences were observed in the yield level in white mustard in particular years (Table 4). In the years 2011, 2012 and 2013 the dry matter yield was significantly higher than in other years of research. The highest green matter yields of white mustard were obtained in the years 2012 and 2013. In 2011 green matter yield was lower than in the years 2012 and 2013, however it was significantly higher than in the years 2010, 2014 and 2015.

No correlation was indicated between the yield of green and dry matter and the total rainfall in particular months. Also, no dependence was indicated between average air temperatures in particular months as well as over the whole growing season of stubble catch crop, and the yield of green and dry matter (Table 5).

Table 3. Plant density and stem length before harvest

Year	Plant density plant·m^{-2}	Stem length before harvest cm
2010	101 ab	47.2 c
2011	134 a	86.3 a
2012	139.5 a	76.2 ab
2013	120.5 a	89.1 a
2014	119.8 a	77.4 ab
2015	69.2 b	60.5 bc
Mean 2010–2015	114.0	72.8

Table 4. The yield of dry and green matter of white mustard cultivated as stubble catch crop

Year	Dry matter yield Mg·ha^{-1}	Green matter yield Mg·ha^{-1}
2010	1.06 b	5.28 c
2011	1.77 a	8.77 b
2012	1.84 a	12.16 a
2013	2.08 a	12.66 a
2014	1.08 b	4.77 c
2015	0.86 b	4.87 c
Mean 2010–2015	1.45	8.1
Ww*	74.0	68.8

* Ww – coeffcient of yield stability, %

Table 5. The coefficient of linear correlation between the yield of green and dry matter and the rainfall totals and air temperatures in particular months of vegetation (n = 6)

Feature	Month			
	July	August	September	October
Monthly rainfall totals				
Green matter yield of mustard	0.45	-0.20	-0.11	0.55
Dry matter yield of mustard	0.54	-0.12	-0.14	0.38
Mean monthly air temperatures				
Green matter yield of mustard	-0.53	-0.38	-0.51	0.20
Dry matter yield of mustard	-0.53	-0.52	-0.44	0.36

A significant correlation was indicated between the year of research and the content of N, P and K in the aboveground dry matter of white mustard (Table 6). The N content in the aboveground biomass was the highest in the years 2013, 2014 and 2015, however it was significantly lower in 2011 and 2012. Nitrogen concentration in the dry matter of mustard in 2010 did not differ significantly from the one observed in other years. P content was the highest in the years 2010 and 2014, and significantly lower in 2013. The lowest P content in the dry matter of white mustard was observed in 2015. In the years 2010, 2013 and 2015 K content in the dry matter of white mustard was significantly higher than in the years 2011 and 2014. Analysis of variance did not indicate any significant effect of the years on the content of calcium and magnesium in the aboveground biomass of white mustard cultivated as stubble catch crop.

The yield of the green and dry matter of white mustard was positively correlated with stem length measured on the day of harvest (Table 7). However, no correlation was proven between the yield and plant density. Also, no correlation was observed between white mustard yield and the content of macronutrients in it. Nitrogen content in the biomass was negatively correlated with plant density after emergence.

The content of particular nutrients in the dry weight of white mustard most frequently was not dependent on the content of other elements (Table 7). Only in the case of calcium and magnesium a positive correlation was found.

During the six-year research no significant correlation was indicated between the dry matter yield of white mustard and the content of N, P, K and Mg in it, and the content of the elements in the soil (Table 8).

Table 6. The content of macronutrients in the aboveground biomass of white mustard cultivated as stubble catch crop, $g \cdot kg^{-1}$ d.m.

Year	N	P	K	Ca	Mg
2010	19.6 ab	4.53 a	37.8 a	15.6 a	2.32 a
2011	13.4 b	3.39 bc	28.1 b	15.7 a	1.69 a
2012	16.6 b	3.80 ab	37.6 ab	19.6 a	2.29 a
2013	21.8 a	3.51 b	45.1 a	17.6 a	2.28 a
2014	22.8 a	4.10 a	21.9 b	20.9 a	2.27 a
2015	27.0 a	2.93 c	39.6 a	16.3 a	2.20 a
Mean 2010–2015	20.2	3.71	35.0	17.6	2.18

Table 7. Coefficient of linear correlation between the yield, plant density, stem length and the content of macronutrients in the dry matter yield of white mustard (n = 18)

Feature	1	2	3	4	5	6	7	8	9
1. Dry matter yield	1.00	***	ns	**	ns	ns	ns	ns	ns
2. Green matter yield	0.96	1.00	ns	**	ns	ns	ns	ns	ns
3. Plant density after emergence	0.45	0.35	1.00	ns	**	ns	ns	ns	ns
4. Stem length	0.71	0.63	0.46	1.00	ns	ns	ns	ns	ns
5. N content	-0.41	-0.33	-0.65	-0.21	1.00	ns	ns	ns	ns
6. P content	-0.06	-0.14	0.22	-0.21	0.03	1.00	ns	ns	ns
7. K content	0.20	0.36	-0.41	-0.12	0.45	0.04	1.00	ns	ns
8. Ca content	0.04	0.03	0.21	0.34	0.27	0.33	0.01	1.00	**
9. Mg content	-0.25	-0.11	-0.13	-0.15	0.45	0.41	0.35	0.61	1.00

** coefficients significant for $P < 0.01$, *** coefficients significant for $P < 0.001$
ns – non-significant

Table 8. Coefficients of linear correlation between the content of macronutrients in the soil and the dry matter yield and the content of a particular macronutrient in it (n = 6)

Feature	Nutrient content in the soil			
	N	P	K	Mg
Aboveground dry matter yield of mustard	0.05	0.42	0.65	0.64
Nutrient content in the aboveground dry matter of mustard	0.26	0.12	0.50	-0.35

DISCUSSION

The success of cultivating plants as stubble catch crop is determined by many factors, among other things climatic and soil conditions, plant selection and method of pre-sowing tillage (Wojciechowski, 1998; Constantin *et al*., 2015; Handlířová *et al*., 2016). In the years 2010–2015 weather conditions in the period July-October were significantly diversified, which affected plant density after emergence, dynamics of plant growth and its yield. The optimal rainfall total for stubble catch crops in the period July-August is 140–170 mm (Wilczewski *et al*., 2012; Wilczewski and Skinder, 2015). Therefore, in our research in three out of six years of research (2011, 2012 and 2013), rainfall totals were on the level which was close to the optimal one. Two years (2014 and 2015) were characterized by an insufficient rainfall total in that period, however in one year (2010) it was excessively high. The effect of this factor significantly translated into plant density after emergence, which beside stem length and degree of its branching, is the basic yield component of plants cultivated as stubble catch crop. Both in the year characterized by a rainfall deficit in the sowing period (2015), and in the year with excessively high rainfall (2010), white mustard density after emergence was lower compared with the one obtained in the years with a rainfall close to the optimal one. In 2010, apart from excessively high rainfall total in July and August, also relatively low air temperatures were observed in September and October. They were by 1.0°C and 2.7°C, respectively, lower than the long-term mean for the area of research (Research Station, Mochełek), and negatively affected stem length. However, low temperatures in September 2013, with average temperatures in October that year, did not cause reduction in the growth of plants, which obtained a significantly greater stem length than in 2010. This confirms the dominant effect of total rainfall on growth and development of plants cultivated as stubble catch crop.

Presented results of our research confirm the curvilinear correlation between total rainfall in the growing season, and the yield of the stubble catch crop (Wilczewski *et al*., 2012; Wilczewski and Skinder, 2015). From the second-degree regression analysis it follows that for white mustard cultivated as stubble catch crop, the optimal total rainfall in the period from July to October equals 244 mm. Such rainfall enables obtaining the yield of the aboveground dry matter of 1.9 Mg·ha^{-1} ($y = -0.000106x^2 + 0.05164x – 4.374$; $R^2 = 0.94$), whereby the optimal total rainfall for the period July-August was 172 mm. However, no correlation was indicated between white mustard yield and the total rainfall in particular months.

The yield of green and dry matter in 2013, in which there occurred an optimal rainfall distribution was approx. 2.5-times higher than in the dry growing season of stubble catch crop in 2015. Malicki and Michałowski (1994) as well as Nowakowski and Kostka-Gościniak (1997) indicated that not only moisture conditions and air temperature have a decisive effect on the success of the stubble catch crop cultivation, but also duration of the growing season and day length, which was also reflected in stem length. The highest value of this parameter was obtained in 2013, when apart from favorable rainfall distribution, there also occurred a longer growing season in plants cultivated as stubble catch crop than in other years (70 days). The coefficient of yield stability calculated based on research results, being 74% for the dry matter yield, was much lower than the expected one. It resulted from a significant diversification in weather conditions in particular research years. In the six-year research period, there occurred two years characterized by a significant rainfall deficit, and one year with an excessively high total rainfall.

Macronutrient content in the aboveground biomass of white mustard was relatively high. In the case of N and P it was by approx. 20%, and for K even by 76% higher than in the research of Wojciechowski and Wermińska (2016). The reason for this diversification might have been different conditions of plant development and different aboveground dry matter yields of mustard. In the research of Wojciechowski and Wermińska (2016), carried out under conditions of good supplementation of plants with rainwater in August, the yield of the aboveground dry matter was on average by 93% higher than in our research. Moreover, the soil on which the research was carried out at the Research Station in Mochełek, was characterized by a very high content of phosphorus and a high potassium content. This content varied in particular years, however this did not significantly affect the concentration of particular macronutirents. High diversification over the years in the concentration of nitrogen, phosphorus and potassium in the aboveground dry matter of white mustard, being 50.4, 35.3 and 51.4%, respectively, resulted from a significant variability in the dry matter yield in particular years (nitrogen), as well as from different accessibility of available nutrients in the soil (phosphorus and potassium). In the study of Miko *et al*. (2016), white mustard cultivated for green manure was characterized by variability in the nitrogen uptake over the years, being 65.2%, while variability of the uptake of phosphorus and potassium was 48.5 and 66.6%, respectively. High variability in the amount of macronutrients accumulated in plants, was also obtained in the research of Kisielewska and Harasimowicz-Hermann (2008b), as well as Wojciechowski and Wermińska (2016).

CONCLUSIONS

For white mustard cultivated as stubble catch crop under conditions of lessive soil, belonging to a very good rye complex, without fertilizer application, an optimal total rainfall in the period July – October is 244 mm, from which 172 mm occurs in the period July-August. No correlation was indicated between average air temperatures in particular months, as well as in the whole growing season, and the yield of green and dry matter. Nitrogen content in the aboveground dry matter of white mustard depended significantly on weather conditions in the growing season. In the years with a low total rainfall in the period July-October (144–218.3 mm) it was significantly higher than the one observed over the years in which the total rainfall was 232.8-250.4 mm. In particular growing seasons, a significant variation was also observed in the content of phosphorus and potassium in the aboveground dry matter of white mustard, however under conditions of different soil content in these nutrients, no significant correlations were indicated between their content and the dry matter yield.

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REFERENCES

Constantin, J., Durr, C., Tribouillois, H., Justes, E. (2015). Catch crop emergence success depends on weather and soil seedbed conditions in interaction with sowing date: A simulation study using the SIMPLE emergence model. Field Crops Res., (176), 22–33.

Handlířová, M., Procházková, B., Smutný, V. (2016). Yields of selected catch crops in dry conditions. Acta Univ. Agric. Silvic. Mendelianae Brun., 64(4), 1139–1148.

Hermanowicz, W., Dożańska, W., Dojlido, J., Koziorowski, B. (1976). Fizykochemiczne badanie wody i ścieków. Warszawa: Arkady, 267–269.

Kisielewska, W., Harasimowicz-Hermann, G. (2008a). Wpływ terminu siewu na plon biomasy gorczycy białej uprawianej w międzyplonie. Fragm. Agron., 25(2), 72–81.

Kisielewska, W., Harasimowicz-Hermann, G. (2008b). Wpływ terminu siewu na gromadzenie składników mineralnych przez gorczycę białą uprawianą w międzyplonie. Rośliny Oleiste – Oilseed Crops, 29, 209–216.

Łoginow, W., Cwojdziński, W. (1979). Chemia rolna. Przewodnik do ćwiczeń. Bydgoszcz: Akademia Techniczno-Rolnicza, 151–154.

Malicki, L., Michałowski, C. (1994). Problem międzyplonów w świetle doświadczeń. Post. Nauk Roln., 4, 3–18.

Miko, P., Kovacs, G.P., Percze, A Gyuricza, C.S. (2016). Effect of different N nutrient contents on biomass of green manure as second crop, under unfavorable climate conditions in Hungary. Appl. Ecol. Env. Res., 14(3), 309–324.

Muśnicki, Cz., Toboła, P., Muśnicka, B. (1997): Produkcyjność alternatywnych roślin oleistych w warunkach Wielkopolski oraz zmienność ich plonowania. Rośliny Oleiste – Oilseed Crops, 18(2), 269–275.

Nowakowski, M., Kostka-Gościniak, D. (1997). Pobranie makroskładników pokarmowych (CaO, MgO, Na_2O) przez rośliny międzyplonu ścierniskowego z gorczycy białej, rzodkwi oleistej i facelii błękitnej. Rośliny Oleiste – Oilseed Crops, 18, 227–234.

Nowosielski, O. (1974). Metody oznaczania potrzeb nawożenia. Warszawa: PWRiL, 1974, 238–239.

Rudnicki, F., Wasilewski, P. (2000). Znaczenie mieszanek zbożowych i zbożowo strączkowych w ograniczaniu ujemnych skutków dużego udziału zbóż w zmianowaniu. Zesz. Probl. Post. Nauk Roln., 470, 127–135.

Taherkhani, T., Rahmani, N., Pazoki, A. (2013). The effect of hydro-priming on germination of mustard seeds under drought stress conditions. Life Sci. J., 10(3), 392–395.

Wilczewski, E. (2004). Wpływ sposobu nawożenia na plon biomasy roślin niemotylkowatych uprawianych w międzyplonie ścierniskowym. Acta Sci. Pol., Agricultura, 3(1), 139–148.

Wilczewski, E., Skinder, Z. (2015). Yielding reliability of legumes grown as stubble catch crop. Am. J. Exp. Agr., 6(3), 140–146.

Wilczewski, E., Skinder, Z., Szczepanek, M. (2012). Effects of weather conditions on yield of tansy phacelia and common sunflower grown as stubble catch crop. Pol. J. Environ. Stud., 21(4), 1053–1060.

Wojciechowski, W. (1998). Międzyplony ścierniskowe jako czynnik zapobiegający negatywnym skutkom wysycenia struktury zasiewów zbożami. Post. Nauk Roln., 5, 29–36.

Wojciechowski, W., Wermińska, M. (2016). Plonowanie i wartość nawozowa międzyplonów ścierniskowych uprawianych zgodnie z zasadami programu rolno-środowiskowego. Fragm. Agron., 33(2), 103–109.

WPŁYW WARUNKÓW POGODOWYCH NA PLONOWANIE I ZAWARTOŚĆ MAKROSKŁADNIKÓW W BIOMASIE NADZIEMNEJ GORCZYCY BIAŁEJ (*Sinapis alba* L.) UPRAWIANEJ W MIĘDZYPLONIE ŚCIERNISKOWYM

Streszczenie

Gorczyca biała jest wartościową rośliną do uprawy w międzyplonie ścierniskowym z powodu relatywnie taniego materiału siewnego, tolerancji na opóźniony termin siewu i wysokiej wierności plonowania. Celem badań było określenie wymagań opadowych i termicznych gorczycy białej uprawianej w międzyplonie ścierniskowym w warunkach gleb gliniasto-piaszczystych, kompleksu żytniego bardzo dobrego. Badania polowe przeprowadzono w Stacji Badawczej w Mochełku koło Bydgoszczy w latach 2010–2015. Gorczycę białą 'Bamberka' wysiewano w terminie 08–18 sierpnia, na glebie płowej, należącej do kompleksu żytniego bardzo dobrego. Glebę cechowała bardzo wysoka zasobność w przyswajalny fosfor i magnez oraz wysoka w potas. Odczyn gleby w 1M KCl wynosił 6.48. Warunki pogodowe odgrywały istotną rolę w kształtowaniu plonu gorczycy białej i zawartości w biomasie nadziemnej azotu, fosforu i potasu. W latach o umiarkowanie wysokich sumach opadów uzyskiwano większą obsadę roślin oraz dłuższe łodygi gorczycy białej, co przekładało się na plonowanie tej rośliny. Najwyższe plony suchej masy (1.77–2.08 $Mg \cdot ha^{-1}$) zebrano w latach, w których suma opadów w okresie lipiec-październik wynosiła 218.3–250.4 mm, z czego 62-80% przypadało na lipiec i sierpień. Słabe efekty produkcyjne uzyskiwano nie tylko w latach o niedoborze opadów w lipcu i sierpniu, ale także w warunkach nadmiernych opadów w tych miesiącach. W warunkach gleby płowej, należącej do kompleksu żytniego bardzo dobrego, optymalna suma opadów dla gorczycy białej uprawianej w międzyplonie ścierniskowym, bez stosowania nawożenia, wynosiła 244 mm w okresie lipiec – październik, z czego 172 mm przypadało na okres lipiec – sierpień.

Słowa kluczowe: gorczyca biała, opady atmosferyczne, plon, temperatury powietrza