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The effect of sowing date and meteorological elements on the quantity and structure of seed yield of white mustard (*Sinapis alba* L.)

Wpływ terminu siewu i elementów meteorologicznych na ilość i strukturę plonu nasion gorczycy białej (*Sinapis alba* L.)

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ABSTRACT

Three-year field experiment with white mustard grown for seeds was carried out as a single factor experiment in the completely randomized block design with four replications. White mustard was sown at intervals of seven days, from the beginning of April until the turn of June and July, and harvested after reaching seed maturity. The field experiment was established at the Luvisol with reaction close to neutral (pH in 1 M KCl 6.0) and average abundance in macroelements. The previous crop for white mustard was spring barley, and after its harvest, classic tillage was used. Favorable for yielding were conditions with dry and cool weather during germination of seeds. Sowings of white mustard after 10 May caused a decrease in seed yield from 38% to 79% (turn of June and July) in relation to the yield from sowing in the first ten days of April. Sowing delay by one day in relation to the common adopted date of 1 April resulted in a reduction in white mustard seed yield by 0.012 tons per hectare. White mustard gave a higher yield if its growing period was moderately long, precipitation amount was higher and the value of hydrothermal coefficient K slightly lower, and plant development took place in the season with a systematically increasing day length. Due to low plant density, number of seeds per silique and TSW, the seed yield of white mustard sown later than in the first half of June decreased permanently below the profitability limit.

Keywords: seed yield, sowing date, white mustard, yield structure components

STRESZCZENIE

Trzyletnie doświadczenie polowe z gorczycą białą uprawianą na nasiona przeprowadzono jako jednoczynnikowe, w układzie losowanych bloków, w czterech powtórzeniach. Gorczycę białą wysiewano w odstępach co siedem dni, od początku kwietnia do przełomu czerwca i lipca a zbierano po osiągnięciu dojrzałości nasion. Eksperyment polowy założono na glebie płowej typowej o odczynie zbliżonym do obojętnego (pH w 1 M KCl 6,0) i średniej zasobności w makroelementy. Przedplonem dla gorczycy białej był jęczmień jary, a po jego zbiorze zastosowano klasyczną uprawę roli. Korzystne dla plonowania były warunki z suchą i chłodną pogodą, podczas kiełkowania nasion. Siewy gorczycy białej po 10 maja powodowały spadek plonu nasion od 38% do 79% (przełom czerwca i lipca) w stosunku do plonu z zasiewów w pierwszej dekadzie kwietnia. Opóźnienie siewu o jeden dzień w stosunku do przyjętej wspólnej daty 01. kwietnia skutkowało zmniejszeniem polu nasion gorczycy białej o 0,012 tony z hektara. Gorczyca biała wydała wyższy plon jeżeli okres jej wegetacji był średnio długi, była wyższa ilość opadów i wartość współczynnika hydrotermicznego K nieco niższa, a rozwój roślin odbywał się w porze roku o systematycznie wzrastającej długości dnia. Niska obsada roślin, liczba nasion w łuszczynie i MTN powodowały, że plon nasion gorczycy białej wysiewanej później niż w pierwszej połowie czerwca spadał trwale poniżej granicy opłacalności.

Słowa kluczowe: elementy strukturalne plonowania, gorczyca biała, plon nasion, termin siewu

INTRODUCTION

In Poland, the annual production of white mustard seeds before EU accession amounted to about 15 – 20 thousand tons (Kurowski and Jankowski, 2003). Currently, due to the use for sowing in catch crops, their production has increased significantly. White mustard is sometimes used as an emergency plant for sowing fields after winter plants destroyed by frost, often performed at delayed dates. Of the spring plants from the family *Brassicaceae* grown in Poland, it is characterized by the most faithful yielding and considerable resistance to drought (Krzymański et al., 1991; Toboła and Muśnicki, 1999). According to Brandt (1992), this resistance is dependent on the sowing date of mustard. For plants from later sowing dates, drought stress that occurs at the end of growth is more acute than for plants from the early sowing. Delaying the sowing date of white mustard leads to plant loss in the stand and shortening of the growing period, and in consequence, to a decrease in seed yield (Toboła and Muśnicki, 1999; Zielonka and Szczebiot, 2001). Jankowski and Budzyński (2003) report that plant density, in addition to the number of siliques per plant, has a predominant effect on white mustard yield. The occurrence of drought in the growing period causes a decrease in seed yield by about 2.5%, and during flowering by 13%. White mustard plants show a higher susceptibility to water shortages in the period from the beginning of flowering to reaching full maturity, resulting in considerable reduction in yield (Zielonka and Szczebiot, 2001; McKenzie et al., 2006). Also, excess rainfall is not desirable in this period. Toboła and Muśnicki (1999) observed a decrease in seed yields along with an increase in the hydrothermal coefficient over the period flowering – technical maturity and they suggest that this may result from simultaneous higher plant infestation by diseases, worse pollination of flowers or warmth insufficiency.

The research hypothesis assumed that the sowing date is one of significant factors determining the quantity of white mustard yield. It was supposed to believe that white mustard, as a long-day plant with strong photoperiodic response would react to a delay of the sowing date in relation to the early spring date with lower seed yields.

The aim of this study was to determine the effect of the sowing date of white mustard cultivar 'Nakielska' on the yield structure components and seed yield. This study was supposed to explain what delay in sowing of white mustard grown for seeds in relations to the optimal date is possible, and what dates should be regarded as too late for seed production.

MATERIALS AND METHODS

The experiment was established as a single-factorial in the complete randomized block design, with four replications. The experimental factor was the sowing date. The distance between consecutive sowing dates was seven days (Table 1). The seeding rate was adjusted to reach a density of about 120 plants per m^2. The yield from a plot (for harvest 13 m^2) was calculated per 1 ha.

Prior to harvest, the plant density of white mustard was calculated (in plants per 1 m^2), and on a sample of 20 plants from a replication, the mean number of siliques and seeds per silique were determined. After harvesting plants, the seed yield (at a constant humidity of 13%) and thousand seed weight (TSW) were determined. The results of these measurements were subjected to the analysis of variance according to the way of establishing the experiment in the field. Synthesis of variance analysis was performed in the mixed model, assuming the effects of years and blocks as random. Tukey`s multiple comparison test was used to study the differences between treatment means. For analyzes of relationships between the plant yield and meteorological parameters of the development stages, sowing dates were transposed to the same linear scale where the value 1 means the date 1^{st} April, after which sowings were carried out each year. Thanks to that, it was possible to evaluate the weather conditions preceding the sowing of white mustard seeds and to perform the correlation and regression analysis between all traits, including – the sowing date treated as a continuous variable. To find the relationships between the individual characteristics, the values of Pearson's correlation coefficients were calculated. Evaluation of

Table 1. Sowing dates of white mustard grown for seeds

Symbol of sowing date	1	2	3	4	5	6	7	8	9	10	11	12	13
						2005							
Sowing date	06.04.	13.04.	20.04.	27.04.	04.05.	11.05.	18.05.	25.05.	01.06.	08.06.	15.06.	22.06.	29.06.
						2006							
Sowing date	12.04.	19.04.	26.04.	02.05.	10.05.	17.05.	24.05.	31.05.	07.06.	14.06.	21.06.	28.06.	05.07.
						2007							
Sowing date	04.04.	11.04.	18.04.	25.04.	02.05.	09.05.	16.05.	23.05.	30.05.	06.06.	13.06.	20.06.	27.06.

the simultaneous interaction of various meteorological elements on the seed yield of white mustard was based on the results of multivariate regression analysis, conducted by the stepwise elimination of irrelevant elements.

The field experiment was established at the Experimental Station in Mochełek (53°13’ N, 17°52’ E), in the Luvisol with reaction close to neutral (pH in 1 M KCl 6.0) and average abundance in macroelements. The previous crop for white mustard was spring barley, and after its harvest, classic tillage was used. Fertilization with phosphorus 50 kg/ha P and potassium 70 kg/ha K – was performed prior to sowing and with nitrogen 103.5 kg/ha N divided into 3 equal parts, prior to sowing, at the beginning of stem elongation and at the flowering stage.

Mean daily air temperature and total precipitation in the period from April to October were considerably varied in the consecutive years of the study (Table 2).

Table 2. Meteorological conditions over the period April – October in 2005-2007 at the Research Station Mochełek

Year	Month							
	IV	V	VI	VII	VIII	IX	X	
	Mean daily air temperature (°C)							Mean temperature IV-X
2005	7.4	12.1	14.9	19.4	16.2	14.9	8.7	13.4
2006	7.1	12.5	16.8	22.4	16.7	15.2	9.6	14.3
2007	8.5	13.7	18.2	18	17.9	12.4	7	13.7
1949-2006	7.3	12.8	16.3	17.9	17.5	13.1	8.3	13.3
	Total precipitation (mm)							Total precipitation IV-X
2005	34.8	82.6	30.5	33.6	43.4	17.8	15.1	257.8
2006	77	58.7	21.8	24.2	129	40.6	10.1	362.6
2007	17.6	73.1	105.5	104.7	42.1	37.6	19.9	400.5
1949-2006	27.8	41.6	54.5	71.7	50.7	41.7	32.2	320.2

In the first year of the study the precipitation totals over the period April-October were lower than the long-term means for this period by 62.4 mm, and in consecutive years they were higher by 42.4 mm (2006) and 80.3 mm (2007).

In 2005, May, June and August were characterized by the lower mean daily temperature than the temperature value for the long-term period. High temperatures and at the same time small amounts of precipitation occurred in September that year.

In 2006, long-term periods of low temperature and high precipitation in early spring caused a delay of the first sowing date by about a week, in relations to 2005. June and July of this year were characterized at the same time by very low precipitation and high temperature. After this period of drought, there were intensive rainfalls in August. Plants sown in 2006 at all the sowing dates developed in a higher temperature as compared with the other years of the study.

At the beginning of the growing season in 2007, unfavorable moisture conditions occurred. They were improved in May, and in successive months – June and July – there were very high amounts of rainfall (more than three times higher than in the other years of this study). The mean daily temperature in the period from April to October was higher by 0.36 °C than the long-term mean for this period. In this year, very high temperatures were recorded in June, where the mean daily temperature was higher as compared with the long-term data by 1.9 °C.

RESULTS

Prior to harvest, significantly more plants were in the stand from the first sowing date – the beginning of April – than in those sown at the beginning of June (dates 9, 10), or at the turn of June and July (date 13) (Table 3).

White mustard had on average 89 siliques per plant (Table 3). The plants sown from the beginning to the third week of April (dates 1, 2) and from the last week of May to the first week of June (dates 8, 9) contained significantly more siliques than those sown at dates 6, 7, and 12. White mustard from 10 sowing date – about the middle of June it set significantly more siliques than at dates 7 and 12.

The mean number of seeds per silique of white mustard from the studied sowing dates was 4.5 (Table 3). Plants sown at dates from the end of April to the middle of May (dates 4-6) had the most seeds, and plants from the last four weeks of sowing (dates 10-13) formed the least seeds per silique. Moreover, the first three sowing dates in April (1-3) and from the middle of May until the beginning of June (7-9) contained more seeds per silique than plants from the last three sowing dates.

A yield of above 1 t seeds per hectare was harvested from plants sown between 04 April and 02 May (dates 1-4) and it was significantly higher than that obtained from plants sown at the turn of June and July (12-13) (Table 4). Sowing mustard at 09-17 May (date 6) or later resulted in significantly lower yields than at early sowing (04-12 April).

The mean thousand seed weight (TSW) of white mustard was 5.96 g (Table 4). Plants from crops established from the beginning of April to the middle of July formed seeds that varied in weight from 4.77 g to 6.62 g. The seeds of plants sown about the middle of April (date 2), from the end of April to 24 May (4-7) and from 13-21 June (11) had a significantly higher TSW, as compared with those sown at the latest (12, 13).

The correlation coefficient r = -0.686 between the sowing date and seed yield indicates a significant, negative relationship between these traits. From the regression equation of seed yield relative to the sowing date (Figure 1), it may be concluded with 47% probability that each delay of sowing by one day in relations to the adopted common date 1st April resulted in a decrease in white mustard seed yield by 0.012 ton per hectare.

Multivariate regression analysis showed that the factors of greatest importance for affecting the seed yield of white mustard were the sowing date and the meteorological conditions in the period from sowing until budding (Table 5). The form of the regression equation calculated for the period preceding sowing means that

Table 3. Plant density of white mustard (plants per 1 m^2) prior to seed harvest and the number of siliques per plant and of seeds per silique – mean from the years

Symbol of sowing date[1]	Plant density prior to harvest	Number of siliques per plant	Number of seeds per silique
1	66.1[a]	103.4[a]	4.81[ab]
2	41.8[ab]	108.6[a]	4.83[ab]
3	53.1[ab]	87.1[abc]	4.75[ab]
4	37.8[ab]	93.1[abc]	5.04[a]
5	38.2[ab]	79.6[abc]	4.98[a]
6	37.3[ab]	68.6[bc]	5.28[a]
7	42.6[ab]	63.4[c]	4.85[ab]
8	33.3[ab]	106.8[a]	4.56[ab]
9	27.1[b]	108.5[a]	4.67[ab]
10	24.1[b]	102.2[ab]	4.12[bc]
11	33.8[ab]	76.8[abc]	3.66[cd]
12	36[ab]	66.9[c]	3.43[cd]
13	21.6[b]	93.5[abc]	3.2[d]
Mean	37.9	89.1	4.48
$LSD_{0.05}$	37.5	34.3	0.854

[1] Description given in Table 1. Values of observation marked with the same small letter within the column do not differ significantly at P<0.05.

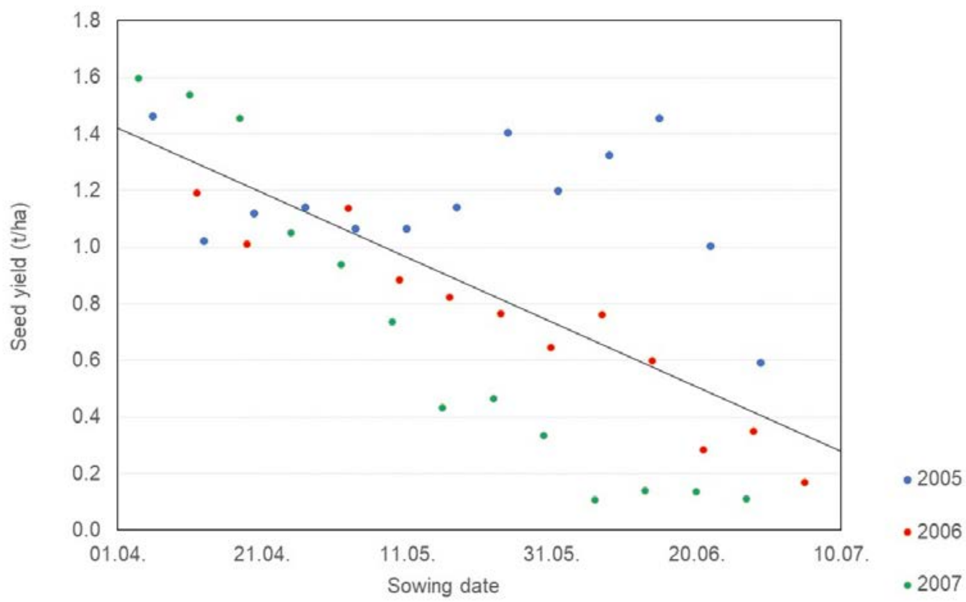

Figure 1. Relationship between seed yield (t/ha) of white mustard and sowing date according to the equation $y = 1.424-0.012x$, $r = -0.686$, where x – the number of days from the date 1st April in consecutive years

Table 4. Seed yield (t/ha) and thousand seed weight (TSW) of white mustard – mean from the years

Symbol of sowing date[1]	Seed yield (t/ha)	Thousand seed weight (g)
1	1.416[a]	6.07[ab]
2	1.189[abc]	6.33[a]
3	1.229[ab]	6.06[ab]
4	1.109[abcd]	6.52[a]
5	0.961[abcde]	6.48[a]
6	0.873[bcde]	6.4[a]
7	0.777[bcdefg]	6.52[a]
8	0.836[bcdef]	5.68[ab]
9	0.763[bcdefg]	5.4[ab]
10	0.676[cdefg]	5.76[ab]
11	0.625[defg]	6.62[a]
12	0.495[efg]	4.88[b]
13	0.291[g]	4.77[b]
Mean	0.865	5.96
$LSD_{0.05}$	0.529	1.38

[1] Description given in Table 1. Values of observation marked with the same small letter within the column do not differ significantly at P<0.05.

the highest seed yields of white mustard were harvested when the period between starting growth and the sowing date was as short as possible and the air temperature was higher, that is – at early sowings and during a warm early spring. These interrelations were proved with 61% probability. A similar effect (R^2 – 60%) on yield resulted from a long period of plant emergences at simultaneous low air temperature and small amount of precipitation in that period.

The regression equation describing the relationship of the white mustard seed yield and the meteorological conditions in the period of rosette formation until the end of budding explained occurring interrelationships with a probability of 71.5%. The total day hours in this period of plant development did not have a significant effect on the seed yield. The stage from rosette formation until the end of plant budding from individual sowing dates fell at different day lengths. The relationship between the seed yield and chosen meteorological parameters during white mustard flowering was weak and the regression equation explains it with a probability of 21%. It is essential that flowering occurs during the prolongation of daylight. Shortening of the time from the beginning of seed maturing until seed harvest significantly increased their yield, but the yield also increased when there was a higher temperature and higher total day hours at that period.

In this study, white mustard gave a higher yield if its growing period was moderately long, the precipitation amount was higher and the value of the hydrothermal coefficient K was slightly lower, and plant development took place in the season with a systematically increasing day length (Table 5). The regression equation describing the relationship between the white mustard seed yield and the meteorological conditions prevailing throughout the growing period explained occurring interrelationships with a probability of 53.4%.

Plant density prior to harvest, seed yield and percentage of seeds in the total yield were significantly negatively correlated with the sowing date (Table 6).

A significant rather strong correlation was proved between the seed yield and the plant density prior to harvest as well as the percentage of seeds in the total yield (Table 7). In the present study, the seed yield was significantly correlated with TSW and the number of seeds per silique, but not with the number of siliques per plant.

Table 5. Multiple regression equations describing dependence of seed yield (t/ha) of white mustard on meteorological parameters[1] in the period preceding sowing and subsequent agrophenophases of the plant

Period	Regression equation	R^2 %
Preceding sowing (from 1st April to sowing)	$Y = 1.225^{*} + 0.009x_1^{*} - 0.002x_2^{*}$	60.9
From sowing to full emergences	$Y = 0.923^{*} + 0.106x_1^{*} – 0.007x_2^{*} – 0.007x_3^{*}$	59.8
From rosette formation to the end of Budding	$Y= 1.454^{*} + 0.059x_1^{*} – 0.004x_2^{*} – 0.311x_4^{*}$	71.5
Flowering	$Y = 0.450 – 0.038x_1 – 0.012x_3 +0.488x_4 + 0.003x_5^{*}$	21.4
Maturing to date of harvest	$Y = 0.028 – 0.044x_1^{*} + 0.002x_2 + 0.002x_5$	41.4
In full growing period	$Y = 2.066 – 0.003x_2 + 0.012x_3 – 2.551x_4 + 0.002x_5^{*}$	53.4

* Words of equation with statistically significant partial correlation. x_1 – the number of days of the period; x_2 – total mean daily air temperature in the period (°C); x_3 – total daily precipitation in the period (mm); x_4 – the hydrothermal coefficient K of the period; x_5 – total day hours in the period.

Table 6. Coefficients of simple correlation between sowing date of white mustard grown for seeds (measured with the number of days from 1st April to the day of sowing) and plant density prior to harvest, seed yield, percentage of seeds in the total yield and chosen biometric traits

Specification	r
Plant density prior to harvest	-0.554*
Seed yield	-0.686*
Percentage of seeds in total yield	-0.444*
Total number of siliques	-0.097

* Values of correlation coefficients statistically significant at $P<0.05$.

Table 7. Coefficients of simple correlation between seed yield (t/ha) of white mustard and selected plant characteristics

Specification	r
Plant density prior to harvest	0.759*
Thousand seed weight	0.602*
Total number of siliques	0.029
Number of seeds per silique	0.666*
Percentage of seeds in total yield	0.736*

* Values of correlation coefficients statistically significant at $P<0.05$.

DISCUSSION

Toboła and Muśnicki (1999) report that the mean seed yield of white mustard sown from the beginning of April to the beginning of May over 10 years amounted to 1.85 t/ha, and the minimal yield was 1.07 t/ha. These yields are much lower than those obtained in favorable environmental and cultivation conditions by Jankowski and Budzyński (2003), McKenzie et al. (2006) and by DuVal (2015) – 2.6-2.7 t/ha. In the present study it was documented that a delay of sowing date from the beginning of April until the beginning of July caused a decrease in white mustard seed yield from 1.4 to 0.3 t/ha. However, summing up data by different authors, it may be stated that in spite of maintaining the sowing date according to the date commonly adopted as the optimal, there is always a risk of low yields, which results from a strong impact of the weather conditions on the yield level of white mustard. The results obtained by Toboła and Muśnicki (1999), Zielonka and Szczebiot (2001), Jankowski and Budzyński (2003), Angadi et al. (2004), Paszkiewicz-Jasińska (2005) and DuVal (2015) prove that pluvio-thermal conditions affect plant growth and development at individual stages as well as the traits which directly determine the seed yield. In the study by Zielonka and Szczebiot (2001), a delay of the sowing date until the middle of May caused a decrease in yield by 42% as compared with the yields from sowings within the last ten days of April. In the experiment by McKenzie et al. (2006) postponing sowing from April to the first half of May resulted in a reduction of yields by 37%. In the present study, a delay of sowing from the beginning of April until the middle of May resulted in a decrease in yield by 7.6% per week, whereas a delay of sowing from the middle of May until the beginning of July led to a decrease in yield by 5.9% per week. Also the results of studies by other authors indicate that a delay of sowing from April until the middle of May results in a higher reduction in yield per the time unit – 9.2-14.3% weekly (Jankowski and Budzyński, 1999; Zielonka and Szczebiot, 2001; McKenzie et al., 2006) than sowing delay from the beginning of May until the beginning of June – 8.1% weekly (Brandt, 1992). However, there is no results in the literature concerning the effects of further delay in sowing of white mustard grown for seeds. According to Angadi et al. (2004), the benefits of early spring sowing are particularly significant under conditions of good soil moisture during this period. In years that were characterized by worse moisture conditions in early spring, the sowing date has a lower impact on white mustard yield. In the present study it was proved that a reduction in yield resulting from a delay of sowing was mostly the effect of the reduced plant density. This was especially true for sowing delays from the beginning of April to the beginning of May. At that time, other yield structure components changed to a small extent, and sometimes even increased with the delay of sowing (the number of seeds per silique and TSW). According to Brandt (1992), white mustard has a high ability to compensate low plant density by creating a larger number of siliques on the plant. In the present study this was particularly noticeable after a delay of sowing from 1 to 2 date, from 7 to 8 and from 12 to 13 date. The number of siliques per plant was most reduced as a result of sowing delay from the middle of April (2 date) until the middle of May (7 date). Further sowing delay (from the middle of May until the beginning of June) resulted in an increase in the number of siliques per plant, which resulted from the low plant density as compared with the earlier sowings. The effect of sowing delay on the number of seeds per silique was observed only from 10 sowing date (06-14 June), whereas TSW was reduced only from 12 sowing date (20-28 June). Analysis of the literature data shows that the effect of sowing date on particular yield structure components depends on the study conditions. Jankowski and Budzyński (1999) in the study conducted in favorable environmental conditions showed a positive effect of a delay of sowing from the end of April until the middle of May on the plant density prior to harvest, resulting in a negative effect of this factor on the number of siliques per plant and the thousand seed weight. Also, Brandt (1992) and Zekaite (1999) indicated a positive relationship between a delay of the sowing date and the plant density, but their works did not show the influence of this factor on other components of white mustard yield.

When sowing white mustard as an emergency plant (e.g. winter crops destroyed by frost), the farmer should carry out a cropping cost calculation. In the present study, the value of a seed yield of 0.625 t/ha was within the limits of the expenditure incurred to obtain it and, on average in the long-term period, such yield was harvested from crops sown still in the middle of June. The yields above this level were accepted as thresholds in the cost-effectiveness of growing for seeds. As shown in the present study, favorable conditions for yielding were those that did not force rapid seed germination, with dry and cool weather – and this weather prevailed when white mustard was sown at the April dates. To obtain high seed yields of white mustard, it was necessary to provide plants with both sufficiently long time to produce the optimal vegetative mass as well as to form flower buds, which follows the biology of the plant, in parallel with the expansion of the leaf rosette. The pluvio-thermal conditions which accelerate the transition of plants into the generative phase were unfavorable. A higher seed yield was determined by a short time of flowering with a gradually lengthening day and a smaller amount of precipitation in that period, as well as shortening the maturing stage of white mustard at higher temperatures and a longer day. White mustard sown from the beginning to the end of April, with flowering lasting until 24 June, started the flowering stage at a shorter day and ended at a longer day. Plants sown from May started flowering at a longer day and ended at a shorter day.

In the present study, the plant density of white mustard prior to harvest decreased in consecutive sowing dates from 66.1 to 21.6 plants per m^2 causing a reduction in seed yield. These results confirm the opinion of Jankowski and Budzyński (2003) that plant density has a predominant effect on white mustard yield. When comparing the present results and the evaluation of the above-mentioned authors about a considerable effect of the number of siliques per plant on yield as well, the conclusions are not consistent. In the study by Paszkiewicz-Jasińska (2005), plants of the same species sown until 20 April formed a total of 143 siliques per plant, and in the present study, from sowings at the same time, about 100, but differences in the number of siliques on plants sown from April to July did not affect variability of yields.

In the experiments by Zielonka and Szczebiot (2001) and Barczak et al. (2011), TSW of white mustard was 7.6-9.1 g. However, the studies by Szymczak-Nowak and Nowakowski (2002), Ryant (2009) and Zając et al. (2011) prove that depending on the pluvio-thermal conditions in a given year TSW may be reduced and amount to even 5 g. In the present study, white mustard sown at typical dates formed seeds with TSW within the range from 6.07 g to 6.52 g, whereas from the latest sowings, at the turn of June and July, seeds were harvested with TSW below 5 g. Reduction of TSW did not significantly affect their seed value (Kisielewska and Harasimowicz-Hermann, 2006). Because of the low values of TSW, plant density and the number of seeds per silique, the seed yield of white mustard sown later than in the first half of June fell permanently below the profitability limit.

CONCLUSIONS

A delay of one day in sowing resulted in a decrease in white mustard seed yield by 0.012 tons per hectare. White mustard gave a higher yield if its growing period was moderately long, the amount of precipitation was higher and the value of hydrothermal coefficient K was slightly lower, and plant development took place at the time of the year with a systematically increasing day length. Favorable for yielding were conditions that did not force rapid germination of seeds, with dry and cool weather – and such weather prevailed when white mustard was sown at April dates. To obtain high yields of white mustard seeds, it was necessary to provide the plants with sufficiently long time to produce the optimum vegetative mass as well as to form flower buds, which occurs in parallel with the development of leaf rosette. Pluvio-thermal conditions accelerating the transition of plants into the generative phase turned out to be unfavorable. Higher seed yield was determined by a short time of flowering with gradually increasing day and a lower precipitation at this period, as well as shortening of the maturation stage of white mustard at higher temperatures and a longer day. White mustard sown from the beginning to the end of April, with flowering lasting until 24 June, started the flowering stage with a shorter day and ended with a longer day. Plants sown from May started flowering with a longer day and ended with a shorter day. So, a variable length of the daylight at the examined sowing dates caused that the plants which ended flowering at a shorter day had a smaller number of set siliques, less seeds in the silique and the seeds were smaller. When deciding on a late sowing, the farmer has to take into account a lower harvest, but even sowings in May and June allow for harvesting seeds. Individual loss of yield at late sowings will be dependent on the course of the weather conditions.

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