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Sowing value of white mustard (*Sinapis alba* L.) seeds collected from plants sown in different times

Wartość siewna nasion gorczycy białej (*Sinapis alba* L.) zbieranych z roślin wysiewanych w różnych terminach

Key words: white mustard, sowing times, harvest times, germination energy, germinating capacity, thousand seed weight

The aim of the research was to define the influence of cultivation time of the white mustard 'Nakielska' cultivar on sowing value of seeds by assessing their germinating energy and capacity. The field experiment was carried out in 2005 on the soil classified as soil quality class IVa. White mustard for seeds was sown at 14 times, starting from 6 April 2005 the sowing was performed every week for 3 months until 6 July 2005. The germinating energy and capacity were determined in accordance with the Polish Standard PN-R-65950:1994, and the significance of differences among the averages was estimated with the Tukey test. No influence of different day length on the time when the crops obtained physiological seed maturity was found. The seeds of white mustard sown in April (the first four sowing times) and harvested on 26 July and 5 August 2005 were distinguished by a significantly higher germinating energy and capacity in comparison with the seeds of white mustard from the sowing times 22 June and 6 July 2005. The conditions of the growth and development of white mustard in 2005 allowed to collect sowing material with a germination capacity of above 87% from sowings done between 6 April and 4 May, between 25 May and 8 June and on 29 June (the threshold value for sowing material in accordance with the Polish Standard PN-R-95023:1999).

Słowa kluczowe: gorczyca biała, terminy siewu, terminy zbioru, energia kiełkowania, zdolność kiełkowania, masa tysiąca nasion

Celem przeprowadzonych badań było określenie wpływu terminu uprawy gorczycy białej odm. Nakielska na przydatność siewną nasion, poprzez ocenę ich energii i zdolności kiełkowania. Doświadczenie polowe przeprowadzono w 2005 roku na glebie płowej zaliczanej do klasy bonitacyjnej IVa. Gorczycę na nasiona siano w 14 terminach poczynając od 6 kwietnia 2005 roku, kontynuując siewy co tydzień przez 3 miesiące do 6 lipca 2005 roku. Energię i zdolność kiełkowania określano zgodnie z Polską Normą PN-R-65950:1994, istotność różnic dla średnich oszacowano testem Tukey'a. Nie stwierdzono wpływu zróżnicowanej długości dnia na czas, w którym rośliny z poszczególnych terminów siewu osiągały dojrzałość fizjologiczną nasion. Nasiona gorczycy pochodzące z siewu roślin w kwietniu (pierwsze cztery terminy), które zebrano 26.07. i 05.08.2005 roku, wyróżniły się istotnie wyższą energią i zdolnością kiełkowania w stosunku do nasion uzyskanych z siewu gorczycy w terminach 22.06. i 06.07.2005. Warunki wzrostu i rozwoju gorczycy białej w 2005 roku pozwoliły na zebranie, z terminów siewu od 6 kwietnia do 4 maja, od 25 maja do 8 czerwca i 29 czerwca, materiału siewnego o zdolności kiełkowania powyżej 87% (wartość progowa dla materiału siewnego wg Polskiej Normy PN-R-65023:1999).

Introduction

White mustard (*Sinapis alba* L.) has been widely used for years in food industry as a spice plant and in chemical industry (Niewiadomski 1984). The interest in white mustard as an alternative oilseed crop has grown recently. In comparison with other spring crops from the oilseed group, the advantages of this species are significant and they include: relatively high yield (at least 10 dt·ha^{-1}), crop stability, low variation in vegetation period length and resistance to weather conditions (Muśnicki 1997, Toboła and Muśnicki 1999, Jankowski and Budzyński 2003). White mustard is marked by good weeding and fungicide properties, which makes it useful in integrated and ecological agriculture (Hruszka 1996). Ploughing in the biomass above the ground and root residue of white mustard has a positive influence on the productivity and structure of the soil. Green fertilizer from white mustard can be used as a source of organic matter which enriches soil with these ingredients (Nowakowski and Kostka-Gościniak 1997). Using stubble intercrops is becoming more and more popular because of the implementation of agri-environmental schemes where specialized farm production is used and due to the lack of manure in numerous farms.

White mustard can be used for re-sowing fields in emergency after failed crops of other species, because of its short vegetation season. This makes possible for a farmer to obtain white mustard seeds even from late sowing times. Those seeds can be used as commercial sowing material, if their sowing value meets the standards but if their sowing value is insufficient, they can be used on a farm as non-qualified material. The best crops are obtained when the sowing material is certified. In accordance with the Polish Standard (1999), the germination capacity for white mustard cannot be lower than 87%. The application of certified material also guarantees good condition of seeds, their healthiness and homogeneity. However, if the standards of cultivation technology are met, the material can be reproduced on a farm for 3–5 years. It should be noted, though, that if the seeds for sowing are not of very good quality, the sowing volume should be increased (Sułek 2004).

The aim of this research was to determine the impact of the cultivation time of the white mustard 'Nakielska' cultivar on the sowing value of seeds by assessing their germinating energy and capacity. The research was supposed to show what delay in the sowing of white mustard is possible in comparison with the optimal time advised by cultivation technology guidelines so far. Dembiński (1962) claims that sowing times after 10 May should be considered delayed; however, he does not say how a delay in sowing affects the sowing value of produced seeds.

The research hypothesis assumed that a delay in the sowing of white mustard in relation to the time currently recommended as optimal will cause changes in the sowing value of produced seeds of the crop which is characterized by a strong photoperiodic reaction and sensitivity to drought at flowering and maturing.

Material and methods

The material for the study was obtained from crop of the white mustard 'Nakielska' cultivar. A one-factorial field experiment was set up in 2005 in four replications on the soil classified as soil quality class IV a. The white mustard was sown at 14 different times, beginning on 6 April 2005, and then sowing was continued every week for 3 months (Table 1).

Table 1

Sowing and harvest times of white mustard in 2005
Terminy siewu i zbioru gorczycy białej w 2005 roku

Sowing time — *Termin siewu*													
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.	06.07.
Harvest time — *Termin zbioru*													
26.07.	26.07.	05.08.	05.08.	18.08.	18.08.	31.08.	09.09.	09.09.	16.09.	22.09.	22.09.	28.10.	28.10.

The sowing rate was so adapted that the crop density was approximately 100 plants per 1 m^2. The following mineral fertilizers were used: 30 kg·ha^{-1} P_2O_5, 80 kg·ha^{-1} K_2O, 100 kg·ha^{-1} N_2 in the form of ammonium saltpeter. The standard protective treatment was applied. The sowing value of the obtained seeds was assessed through the determination of germination energy and capacity. The determination was carried out in accordance with the Polish Standard PN-R-65950:1994. Moreover, the thousand seed weight (TSW) was determined and the hydrothermal conditions during plant vegetation period were analysed. The significance of differences for mean values was evaluated using the Tukey test.

Results and discussion

Analysis of pluviothermal conditions

The average monthly temperature and the total precipitation in the period from April to October 2005 were 13.4°C and 36.8 mm, respectively. The temperature was close to the average from the last 55 years (13.3°C), whereas the precipitation was lower by 8.4 mm. Thus it may be assumed that moisture conditions were unfavourable for the development of crops in that year.

In the experiment, the average air temperature during white mustard vegetation was 15.9°C. The crops from the first five sowings and from the last one developed at the temperature that was below the average. The lowest mean

temperature value was recorded for the vegetation period of the first sowing time, and the highest temperature was observed for the white mustard sown between 8 and 22 June (Table 2).

During the growing period of plants from the first six sowing times, the precipitation exceeded the mean value of 132.7 mm, while the white mustard sown from the second decade of May until the end of June grew in a systematically decreasing amount of water. The most difficult conditions for plant growth occurred on 9 June, which marked the beginning of drought. The Sielianinov hydrothermal index was <1 for June, July, August and October, and 0.4 for September. A period of drought began on 9 September and lasted until 1 October (Table 3).

Table 2

Temperature and precipitation during vegetation — *Temperatury i opady w okresie wegetacji*

Sowing time *Termin siewu*	Sum of temperature *Suma temp.* [°C]	Average temperature *Średnia temp.* [°C]	Sum of precipitation *Suma opadów* [mm]
06.04.	1508.0	13.5	167.7
13.04.	1456.3	13.9	155.9
20.04	1574.8	14.6	187.9
27.04.	1544.7	15.3	187.9
04.05.	1655.4	15.5	180.9
11.05.	1601.1	16.0	135.4
18.05.	1768.3	16.7	127.8
25.05.	1835.6	17.0	110.4
01.06.	1835.6	16.9	107.5
08.06.	1736.6	17.2	105.4
15.06.	1718.9	17.2	97.2
22.06.	1601.9	17.2	95.4
29.06.	1474.5	17.1	89.2
06.07.	1716.0	14.9	109.9

Table 3

Sielianinov hydrotermic index from April to October 2005
Wskaźnik hydrotermiczny Sielianinowa dla okresu kwiecień – październik 2005 roku

Sielianinov hydrotermic index — *Wskaźnik hydrotermiczny Sielianinowa*						
April *Kwiecień*	May *Maj*	June *Czerwiec*	July *Lipiec*	August *Sierpień*	September *Wrzesień*	October *Październik*
1.6	2.2	0.7	0.6	0.9	0.4	0.6

Length of vegetation period

The number of vegetation days from sowing till harvesting white mustard seeds fluctuated between 86 and 115 days and on average it amounted to 103 days (Fig. 1). No effect of changing the day length on the time when the crops reached physiological seed maturity was observed. The longest vegetation period (sowing on 6 July) and the shortest one (sowing on 29 June) were recorded for crops which were sown at subsequent times. The difference in the length of time the crops needed to reach technical maturity was 26 days. The lengths of vegetation periods for the first and last sowing times were similar, 112 and 115 days, respectively (the dates of the sowings were 90 days apart). This does not support the relation demonstrated by Dembiński et al. (1962) where the vegetation period was shortened along as the sowing time was delayed.

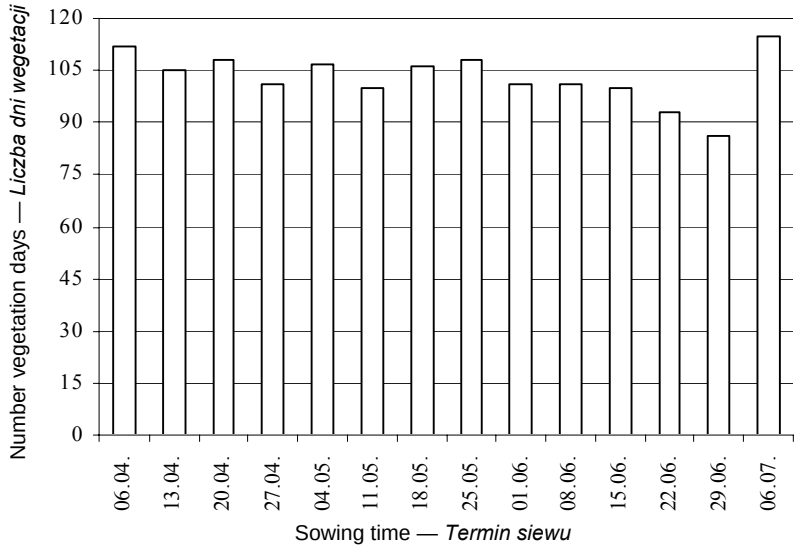

Fig. 1. Number of vegetation days in white mustard sown at different times — *Liczba dni wegetacji gorczycy białej sianej w różnych terminach*

Sowing value of seeds

The seeds of the crops sown on 8 June were the largest (TSW — 8.2 g), whereas white mustard sown at the first sowing time — 6 April — had the smallest seeds (TSW — 5.7 g). In the present study, white mustard had small seeds irrespective of the sowing time (with the exception of the 8 June crops). The seeds were remarkably smaller than those described by Niewiadomski (1984), Muśnicka (1986) and Muśnicki (1997) who defined the lowest limit of TSW for white mustard as 8 g. However, the research carried out by Szymczak-Nowak and Nowakowski

(2002), as well as by Murawa et al. (2004) prove that the thousand seed weight may be decreased and even amount to 5.5 g, depending on the thermal and moisture conditions in a given year.

The seeds harvested from white mustard sown at the first two sowing times had a significantly smaller thousand seed weight than those harvested from plants which were sown between 11 May and 6 July 2005 (with the exception of the 22 June sowing) (Fig. 2). During the plant vegetation the average temperature was the lowest at those earliest times. Their growth from emergence till the beginning of flowering proceeded in conditions characterized by the highest hydrothermal index and the moisture conditions were getting worse as the generative phase progressed. This has been confirmed by the results of Toboła and Muśnicki (1999) who report that the rise in hydrothermal index and the deficiency of warmth have an unfavourable effect on the seed yield. The sowing material collected from the plants sown from early April till early May had no significantly varied size of seeds. Another part of seeds harvested from crops sown for 8 subsequent weeks from 11 May 2005 (with the same exception as above) was not significantly different, either.

The seeds of the highest sowing value (germinating energy 95%, germinating capacity 97%) were those collected from the crops whose vegetation period fell between 13 April and 26 July (Fig 3).

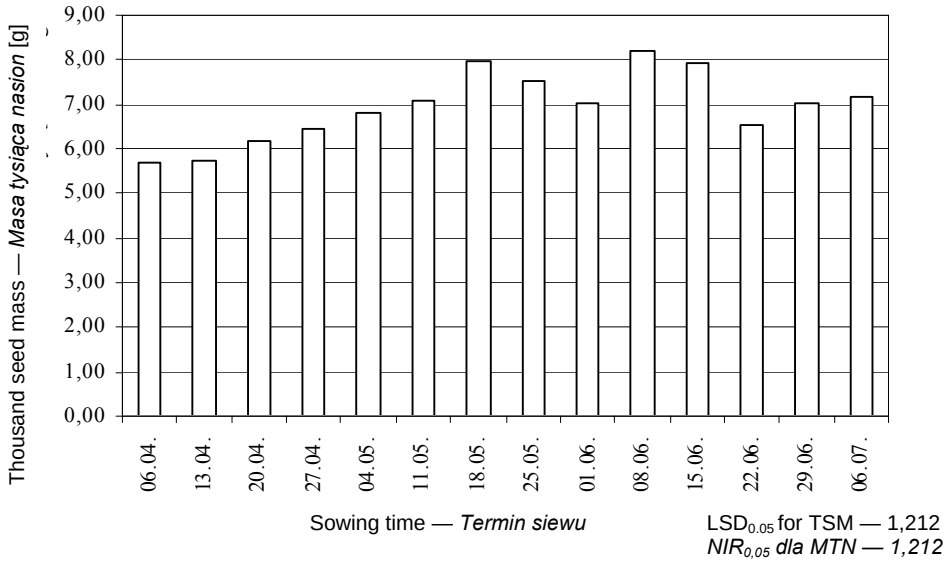

Fig. 2. Thousand seed weight of white mustard from different sowing times — *Masa tysiąca nasion gorczycy białej sianej w różnych terminach*

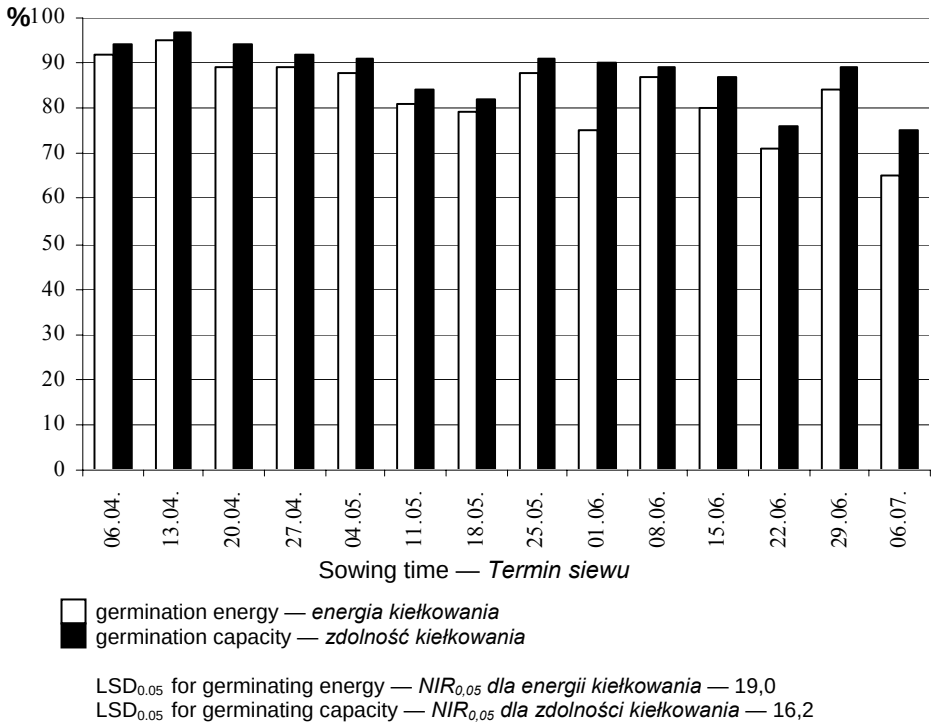

Fig. 3. Germination energy and capacity of white mustard from different sowing times
Energia i zdolność kiełkowania nasion gorczycy białej sianej w różnych terminach

Conclusions

- Although the growth of white mustard crops from sowings carried out for three months between 6 April and 6 July proceeded on days of different length, no effect of changing day length on the period in which crops from different sowing times reached physiological maturity was observed.
- In the pluviothermal conditions of 2005, the seeds collected from sowings between 6 April and 4 May, between 25 May and 8 June, and on 29 June had a high germinating capacity which exceeded the threshold value assumed for sowing material in accordance with the Polish Standard.
- The seeds of white mustard from the April sowing (the first four sowing times) were distinguished by a significantly higher germinating energy and capacity in comparison with the white mustard seeds from the sowing times on 22 June and 6 July 2005.

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