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Reaction of winter varieties of false flax (*Camelina sativa (*L.) Crantz) to the varied sowing time

Reakcja ozimych odmian lnianki siewnej (*Camelina sativa* (L.) Crantz) na zróżnicowany termin siewu

Magdalena CZARNIK*, Wacław JARECKI and Dorota BOBRECKA-JAMRO

University of Rzeszow, Faculty of Biology and Agriculture, Department of Crop Production, A. Zelwerowicza 4, 35-601 Rzeszow, Poland, *correspondence: mkuch@ur.edu.pl

Abstract

In the seasons 2012/2013 - 2014/2015 an experiment was conducted in the fields of the Experimental Station Variety Examination in Przecław. The evaluated factors were as follows: (A) - sowing time (early, optimal, delayed) and (B) – Polish winter varieties of false flax (Maczuga, Luna, Przybrodzka). The study showed that early sowing time contributed to the lengthening of the vegetation period of plants, especially in relation to delayed sowing date. During the winter, the plant losses amounted on average to 11.3 pcs.$\cdot$m^{-2}. The highest plant density before harvest was recorded in the plots of the optimal sowing date. The early sowing time contributed to the increase in the value of SPAD (Soil Plant Analysis Development) and the number of silicles per plant as well as seed yield. Sowing the seeds in the optimal time was increased lodging while delayed caused an increase in the MTA (Mean Tip Angle) and LAI (Leaf Area Index) index and plant height as well as the number of seeds per silicle. The thousand seeds weight was 0.85 g and was not significantly modified by experimental factors. The varieties were differed in most of the studied traits, including yield seeds. The results of the research carried out indicate that in the area of the research, the best time sowing the seeds of winter false flax is the first decade of September.

Keywords: *Camelina sativa* L., false flax, seed yield, sowing time, yield components

Streszczenie

W sezonach 2012/2013 - 2014/2015 przeprowadzono eksperyment na polach Stacji Doświadczalnej Oceny Odmian w Przecławiu. Czynnikami doświadczenia były: (A) - termin siewu (wczesny, optymalny, opóźniony) oraz (B) – polskie, ozime odmiany lnianki siewnej (Maczuga, Luna, Przybrodzka). Przeprowadzone badania wykazały, że wczesny termin siewu wpłynął na wydłużenie okresu wegetacji roślin, zwłaszcza w odniesieniu do opóźnionego terminu siewu. W okresie spoczynku zimowego ubytki roślin wyniosły średnio 11.3 szt.$\cdot$m^{-2}. Przed zbiorem najwyższą obsadę roślin odnotowano na poletkach z optymalnym terminem siewu. Wczesny termin siewu wpłynął na wzrost wartości SPAD (Soil Plant Analysis Development), liczby łuszczynek na roślinie oraz plonu nasion. Wysiew nasion w terminie optymalnym zwiększył wyleganie roślin. Z kolei wysiew nasion w terminie opóźnionym spowodował wzrost indeksu LAI (Leaf Area Index) i MTA (Mean Tip Angle), wysokości roślin oraz liczby nasion w łuszczynce. Masa tysiąca nasion wyniosła 0.85 g i nie była istotnie zmodyfikowana czynnikami doświadczenia. Badane odmiany różniły się większością badanych cech, w tym plonem nasion. Wyniki przeprowadzonych badań wskazują, że w rejonie prowadzenia badań najkorzystniej wysiewać lniankę ozimą w pierwszej dekadzie września.

Słowa kluczowe: *Camelina sativa* L., komponenty plonu, lnianka siewna, plon nasion, termin siewu nasion

Streszczenie szczegółowe

Ścisłe doświadczenie polowe z lnianką siewną przeprowadzono w sezonach 2012/2013 - 2014/2015 w Stacji Doświadczalnej Oceny Odmian w Przecławiu (50°11' N, 21°29' E). Eksperyment założony został według układu split-plot w trzech powtórzeniach. Badanymi czynnikami były: (A) - termin siewu (wczesny, optymalny, opóźniony) oraz (B) - ozime odmiany lnianki siewnej (Maczuga, Luna, Przybrodzka). Nasiona siewne pochodziły z Uniwersytetu Przyrodniczego w Poznaniu. Przedplonem corocznie był owies. Powierzchnia poletek do siewu wynosiła 7.5 m^2, zaś do zbioru 5 m^2. Rozstawa rzędów wynosiła 15 cm, zaś głębokość siewu 1.5 cm. Ilość wysiewu wyniosła 300 szt.$\cdot m^{-2}$. Siew nasion przeprowadzono w trzech terminach. Wczesny termin siewu 05 wrzesień 2012, 02 wrzesień 2013 i 01 wrzesień 2014, optymalny termin siewu 17 wrzesień 2012, 12 wrzesień 2013 i 11 wrzesień 2014, opóźniony termin siewu 26 wrzesień 2012, 23 wrzesień 2013 i 22 wrzesień 2014.

Warunki pogodowe były zmienne w latach badań. Wysokie opady deszczu odnotowano w 2013 r. oraz 2014 r. W sezonie 2014/2015 sumy opadów były niższe od średniej wieloletniej. Na przełomie lat 2012/2013 odnotowano najniższe temperatury w okresie zimy oraz najwyższe w okresie od kwietnia do lipca. Wczesny termin siewu wpłynął na wydłużenie okresu wegetacji roślin. W okresie spoczynku zimowego ubytki roślin wyniosły średnio 11.3 szt.$\cdot m^{-2}$. Przed zbiorem najwyższa obsada roślin została odnotowana na poletkach z optymalnym terminem siewu. Wczesny termin siewu wpłynął na wzrost wartości indeksu SPAD. Indeksy LAI i MTA były najwyższe na poletkach z opóźnionym terminem siewu. Najwyższe rośliny uzyskano po wysiewie nasion w terminie opóźnionym, zaś najniższe po wysiewie nasion w terminie wczesnym. Wyleganie roślin było największe po wysianiu nasiona w terminie optymalnym. Wczesny termin siewu zwiększył liczbę łuszczynek na roślinie a opóźniony termin siewu liczbę nasion w łuszczynce. Masa tysiąca nasion wyniosła 0.85 g i nie była istotnie zmodyfikowana. Wczesny termin siewu wpłynął na istotny wzrost plonu nasion w porównaniu do terminu optymalnego i opóźnionego. Pozwala to wnioskować, że wysiew nasion w pierwszej dekadzie września był najkorzystniejszy.

Odmiana Luna odznaczyła się wysokimi roślinami, największym wyleganiem oraz wysokim indeksem SPAD. U odmiany Maczuga stwierdzono najniższą obsadą roślin na wiosnę i przed zbiorem, największą liczbę łuszczynek na roślinie oraz najwyższy plon nasion. Odmiana Przybrodzka charakteryzowała się największą liczbą rozgałęzień na roślinie, wysokim indeksem LAI oraz liczbą nasion w łuszczynce.

Introduction

False flax (*Camelina sativa* (L.) Crantz) is an oilseed crop of the *Brassicaceae* (*Cruciferae*) family. There are two cultivated forms such as winter and spring (Toncea, 2014; Mosio-Mosiewski et al., 2015). Morphological differences between the forms are expressed primarily by the shape and colour of leaves, shape of capsules and seeds and other more specific characters (Zubr, 1997). False flax cultivation occupies a small area in Poland, due to the higher prevalence of yielding rape. Martinelli and Galasso (2011) and Wysocki et al. (2013) claim that there are multiple environmental and agrotechnical benefits of false flax for eg.: small climatic and soil requirements. With the correct agricultural techniques, the winter varieties of false flax can give a yield from 2 to 2.6 $t \cdot ha^{-1}$ (Mosio-Mosiewski et al., 2015). The seeds of false flax can be used universally, eg.: as feed (Waraich et al., 2013) and derived oil from them as food (Vollmann et al., 2007; Mińkowski et al., 2010; Obiedzińska and Waszkiewicz-Robak, 2012) as well as technical oil, including biofuel (Moser, 2010; Karcauskiene et al., 2014).

Many scientific researches have demonstrated that the requirements of agronomic camelina are not large (Martinelli and Galasso, 2011; Wysocki et al., 2013). The crop is flexible and can be grown with success under different climatic and soil conditions (Zubr, 1997; Zubr, 2003). Most plants respond to nitrogen fertilization (Solis et al., 2013; Dobre et al., 2014; Jiang and Caldwell, 2016), as well as the factor important is correct and timely sowing of small seeds. The amount of seed yield (Toncea, 2014) and quality (Toncea et al., 2013) is determined by mainly weather conditions, but also a system of cultivation, sowing dates and variety. In view of the increased interest in cultivation of false flax, it is reasonable to conduct further research to improve agricultural technology.

The aim of this study was to estimate a reaction of the winter varieties of false flax to varied sowing time. In the research hypothesis it was assumed that the varied sowing time modifies evaluation parameters and height of the yield.

Materials and methods

The field research was carried out in the Experimental Station Variety Examination in Przecław (50°11’ N, 21°29’ E) in the seasons 2012/2013-2014/2015. It was a two-factorial experiment (split-plot) conducted in three replications. The first examined factor (A) was sowing time (early, optimal delayed) and the other factor (B) was the Polish winter varieties of false flax (Maczuga, Luna, Przybrodzka). The experiment was established on alluvial soils created from silt loam. The soil was classified in valuation class IIIa of the good wheat complex with pH inert in the range from 7 to 7.11. The content of available forms of phosphorus was high or very high, potassium – high, and magnesium – very high (Table 1). Soil analysis was carried out at the Regional Chemical-Agricultural Station in Rzeszow, according to the accepted methods. Soil test procedures: pH w KCl (PN-ISO 10390, 1997); P_2O_5 (PN-R-04023, 1996); K_2O (PN-R-04022, 1996/Az1: 2002); Mg (PN-R-04020, 1996/Az1: 2004). Weather conditions are given according to Weather Reports from the Experimental Station Variety Examination in Przecław.

Table 1. Chemical soil properties

Tabela 1. Chemiczne właściwości gleby

Year Rok	pH w KCl (1 mol·dm^3)	Content of available nutrients Zawartość przyswajalnych składników (mg·100 g^{-1} soil)		
		P_2O_5	K_2O	Mg
2012	7.11	28.5	20.2	16.1
2013	7	19.7	24	20
2014	7.08	15.2	21.5	13.3

Seeds were received from Poznań University of Life Sciences. Oat was the forecrop of false flax in every year of research. The area of a plot was 7.5 m² (for harvesting 5 m^2). The row spacing amounted to 15 cm, and the sowing depth 1.5 cm. The amount of sown seeds was 300 seeds·m^{-2}.

Seed dressed material was sown in three periods. The first sowing time (early): 05 September 2012, 02 September 2013 and 01 September 2014, the second (optimal): 17 September 2012, 12 September 2013 and 11 September 2014, the third (delayed): 26 September 2012, 23 September 2013 and 22 September 2014. Granular triple superphosphate (40 P_2O_5 kg·ha^{-1}) and potash salt (60 K_2O kg·ha^{-1}) were applied. Ammonium nitrate (100 N kg·ha^{-1}) was used to nitrogen fertilization. The herbicide Butisan SC 400 (2.5 dm^3·ha^{-1}) were applied after sowing. The secondary weed infestation was removed manually. The diseases and pests were not combated.

Plant density per 1 m^2 was calculated after emergence and before harvest. In the vegetation period, occurrence of more important development stages of plants was observed, i.e. emergence, budding, flowering and maturity technical and full. At the technical maturity stage, 20 representative plants were collected from each plot for biometric measurements and yield components. Lodging was evaluated in the scale from 1 ^{o} to 9 ^{o} before harvest. Collection of winter false flax seeds was conducted in full maturity stage (BBCH 89, Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie).

The seed weight obtained from the plots was converted into yield per 1 ha, assuming a humidity of 15%. The seed yield was adjusted for missing plants collected for biometric measurements.

The scope of the study included measurement indices: LAI - Leaf Area Index, MTA – Mean Tip Angle and SPAD - Soil Plant Analysis Development (from 0 to 99.9).

Measurement with Analyzer LAI-2000 LI-COR (USA) was carried out in the period of the beginning stage of false flax flowering (BBCH 60). Chlorophyll Meter SPAD-502P (Konica Minolta, Japan) was used in the same development stage on 30 leaves in the morning.

Significance of difference between trait values were tested based on Tukey's honestly significant difference test, with significance level P=0.05. Statistical program ANALWAR–5FR was used for calculations.

Results and discussion

The weather conditions were diversified in the years of the research and had a significant impact on the course of the growing season of winter false flax plant. In May and June 2013 as well as May and July 2014, rainfalls excessed the average long-term. In the season 2014/2015, rainfalls for most months, were significantly lower than the average long-term. The lowest temperature in winter occurred at the turn of the year 2012/2013. In this season, the highest temperature during the period from April to July was reported (Table 2). Toncea (2014) says that the weather conditions decide to high seed yield of false flax.

The earliest stage of emergence was observed on plots with optimal and early sowing time (Table 3). One day later entered a stage of emergence the plants, which was sown in delayed time. The early sowing time extended period of vegetation, especially in comparison to the delayed sowing time. The varieties of false flax were included in various development stages in approximately the same time. Vegetation period was on average 291 days. According Muśnicki (2002) the winter form of false flax is characterized by high dynamics of growth in the spring and early maturation of oilseed rape. He concludes that the yield of winter form false flax is higher than spring form.

Table 2. Weather conditions in the years 2013-2015

Tabela 2. Warunki pogodowe w latach 2013–2015

Year Rok	Month Miesiąc IX	X	XI	XII	I	II	III	IV	V	VI
					Rainfalls Opady (mm)					
2012/13	55	80.6	16.1	30.4	65.4	32.1	73.6	39.4	111.7	192.4
2013/14	68.6	4.2	98	15.3	24.7	16.1	49.6	34.8	108.9	69
2014/15	39.7	33.4	9.3	30.3	34.2	9.2	44.1	25.4	110.3	29.5
Long-term Wielolecie	54.7	43.4	37.6	35.1	34.3	31.7	35.9	48.1	39.2	79.3
					Air temperature Temperatura powietrza (ºC)					
2012/13	14.3	8.4	5.7	-2.9	-2.9	-0.4	-1.3	8.8	15	18.5
2013/14	11.4	9.6	5.1	1.3	-0.8	1.8	5.4	8.8	13.3	15.1
2014/15	12.2	8.3	4.9	0.7	0.6	-0.4	1.6	6.4	12.4	16.7
Long-term Wielolecie	13.3	8.8	3.6	-0.3	-2.5	-1.2	2.6	8.8	14.2	17.5

Table 3. The course of growing season of false flax in date from sowing date (mean in years 2013-2015)

Tabela 3. Przebieg wegetacji lnianki siewnej w dniach od daty siewu (średnia z lat 2013-2015)

Sowing time Termin siewu	Variety Odmiana	Emergence Wschody	Budding Pąkowanie	Flowering Kwitnienie	Maturity Dojrzałość	
					Technical Zbiorcza	Full Pełna
Early Wczesny	Maczuga	16	231	256	292	301
	Luna	16	230	256	290	300
	Przybrodzka	16	229	261	284	296
Mean Średnio		16	230	257.7	288.7	299
Optimu Optymalny	Maczuga	16	223	246	281	291
	Luna	15	222	245	282	291
	Przybrodzka	16	220	244	281	291
Mean Średnio		15.7	221.7	245	281.3	291
Delaye Opóźniony	Maczuga	17	214	237	275	284
	Luna	17	214	237	274	284
	Przybrodzka	17	211	233	273	283
Mean Średnio		17	213	235.7	274	283.7
Mean total Średnia ogólna	Maczuga	16.3	222.7	246.3	282.7	292
	Luna	16	222	246	282	291.7
	Przybrodzka	16.3	220	246	279.3	290

Plant density after emergence was not diversed. After the growing vegetation in spring plant losses averaged 11.3 pcs.·m^{-2} compared to plant density after emergence. Plant density before harvest was the highest on plots with optimal sowing time (Table 4).

Table 4. Plant density (mean of years 2013-2015)

Tabela 4. Obsada roślin (średnia z lat 2013-2015)

Plant density Obsada roślin (psc.·m^{-2})	Sowing time Termnin siewu (A)	Variety Odmiana (B) Maczuga	Luna	Przybrodzka	Mean for A Średnio dla A
After emergence Po wschodach	Early Wczesny	271	269	270	270
	Optimum Optymalny	276	272	279	275.7
	Delayed Opóźniony	268	270	268	268.7
	Mean for B Średnio dla B	271.7	270.3	272.3	271.4
	$LSD_{0.05}$ A – ns; B – ns; AxB – ns				
After start of vegetation in the spring Po ruszeniu wegetacji na wiosnę	Early Wczesny	254	261	258	257.7
	Optimum Optymalny	255	270	271	265.3
	Delayed Opóźniony	250	263	259	257.3
	Mean for B Średnio dla B	253	264.7	262.7	260.1
	$LSD_{0.05}$ A – 6.69; B – 8.69; AxB – ns				
Before harvest Przed zbiorem	Early Wczesny	251	258	254	254.3
	Optimum Optymalny	252	265	268	261.7
	Delayed Opóźniony	248	261	253	254
	Mean for B Średnio dla B	250.3	261.3	258.3	256.7
	$LSD_{0.05}$ A – 6.53; B – 7.32; AxB – ns				

ns – non - significant differences

The variety Maczuga was characterized by the lowest plant density so in spring and before the harvest. Agegnehu and Honermeier (1997), received a much lower plant density than expected, especially with the high sowing density seeds. Solis et al. (2013) report that plant density determines plant habit, including the height of branches and number of silicles per plant.

The measurements SPAD index showed that the most nourished plants were from the first sowing date (Table 5). Significantly lower values SPAD marked on the plants sown in delayed time. The variety Luna was characterised by more SPAD index in comparison to the variety Przybrodzka. LAI was significantly higher in the treatments with delayed sowing date in comparison to the early. The difference was 0.48 m^2/m^2. The tested varieties were different in measurement of LAI. The highest value of this index was reported in a variety Przybrodzka and the lowest in Maczuga. The delay of sowing time affected on increase index MTA in comparison with the optimal date. The modern measurement techniques (eg. SPAD, LAI) allow for a quick assessment of the plantation. They are especially useful in determining the need for top dressing fertilizer crops, mainly nitrogen (Martinez and Guiamet, 2004; Zheng and Moskal, 2009).

The delay of sowing time was affected on an increase in plant height (Table 6).The lowest plants were obtained after sowing the seeds in the early sowing time. The variety Luna had the highest plants but Przybrodzka significantly lower. Łuczkiewicz and Błaszczyk (1998) report that the plant height of winter false flax is mainly genetical feature.

In provided research, the number of branches per plant was significantly differentiated between the variety Maczuga and Przybrodzka. On average, the difference amounted 1.2 branches per plant. The lodging of plants was the biggest on plots with the optimal term sowing the seeds, especially in variety Luna. Łuczkiewicz and Błaszczyk (1998) reported that the trait of resistance to lodging can be obtained as a result of the breeding mutant line. Gesch and Cermak (2011) recorded a small lodging of camelina plants, but it was dependent on the cultivation system, and years of research.

Table 5. Leaf area index (LAI), value of Mean Tip Angle (MTA) in degrees and chlorophyll content in the leaf (SPAD) - means from 2013-2015 years

Tabela 5. Wskaźnik powierzchni liści (LAI), wskaźnik kąta nachylenia liści (MTA) w stopniach i zawartość chlorofilu w liściu (SPAD) - średnio za lata 2013-2015

Index Indeks	Sowing time Termnin siewu (A)	Variety Odmiana (B)			Mean for A Średnio dla A
		Maczuga	Luna	Przybrodzka	
SPAD	Early Wczesny	38.7	36.1	33.4	36.1
	Optimum Optymalny	33.9	34.7	33.3	34
	Delayed Opóźniony	27.3	35.2	29.1	30.5
	Mean for B Średnio dla B	33.3	35.3	31.9	33.5
		$LSD_{0.05}$ A – 4.87; B – 2.98; AxB – ns			
LAI (m^2/m^2)	Early Wczesny	2.1	2.12	2.28	2.17
	Optimum Optymalny	1.87	2.42	2.88	2.39
	Delayed Opóźniony	2.22	2.65	3.07	2.65
	Mean for B Średnio dla B	2.06	2.4	2.74	2.4
		$LSD_{0.05}$ A – 0.36; B – 0.57; AxB – ns			
MTA (°)	Early Wczesny	47	49	54	50
	Optimum Optymalny	47	50	48	48
	Delayed Opóźniony	54	55	52	54
	Mean for B Średnio dla B	49	51	51	51
		$LSD_{0.05}$ A – 5.23; B – ns; AxB – ns			

Table 6. Selected biometric measurements and lodging (mean of years 2013-2015)

Tabela 6. Wybrane pomiary biometryczne i wyleganie roślin (średnia z lat 2013-2015)

Parameter Parametr	Sowing time Termnin siewu (A)	Variety Odmiana (B) Maczuga	Luna	Przybrodzka	Mean for A Średnio dla A
Plant height Wysokość roślin (cm)	Early Wczesny	84.1	85.4	78.8	82.77
	Optimum Optymalny	87.5	102	79.1	89.53
	Delayed Opóźniony	91.7	104.6	83.1	93.13
	Mean for B Średnio dla B	87.77	97.33	80.33	88.48
	LSD$_{0.05}$ A – 9.34; B – 15.67; AxB – ns				
Number of branches per plant Liczba rozgałęzień na roślinie	Early Wczesny	8.1	9.4	8	8.5
	Optimum Optymalny	8.2	8	9.3	8.5
	Delayed Opóźniony	7.8	8.8	10.4	9
	Mean for B Średnio dla B	8	8.7	9.2	8.7
	LSD$_{0.05}$ A – ns; B – 0.97; AxB – ns				
Lodging Wyleganie (1-9°)	Early Wczesny	7.3	6.3	8	7.2
	Optimum Optymalny	6.8	5.8	7.5	6.7
	Delayed Opóźniony	7.1	6.6	7.8	7.2
	Mean for B Średnio dla B	7.1	6.2	7.8	7
	LSD$_{0.05}$ A – 0.45; B – 0.84; AxB – ns				

Table 7. Yield components (mean of years 2013-2015)

Tabela 7. Elementy struktury plonu (średnia z lat 2013-2015)

Parameter Parametr	Sowing time Termnin siewu (A)	Variety Odmiana (B) Maczuga	 Luna	 Przybrodzka	Mean for A Średnio dla A
Number of silicles per plant Liczba łuszczynek na roślinie	Early Wczesny	157.7	126	143.3	142.3
	Optimum Optymalny	105.1	96.5	91.5	97.7
	Delayed Opóźniony	80.3	72.3	72.6	75.1
	Mean for B Średnio dla B	114.4	98.3	102.5	105
		$LSD_{0.05}$ A – 19.33; B – 10.27; AxB – ns			
Number of seeds per silicle Liczba nasion w łuszczynce	Early Wczesny	10.4	8.9	11.4	10.2
	Optimum Optymalny	11.6	9.7	11.4	10.9
	Delayed Opóźniony	10.3	10.1	12.8	11.1
	Mean for B Średnio dla B	10.8	9.6	11.9	10.7
		$LSD_{0.05}$ A – 0.84; B – 0.97; AxB – ns			
1,000 seeds weight Masa 1,000 nasion (g)	Early Wczesny	0.91	0.89	0.81	0.87
	Optimum Optymalny	0.9	0.9	0.8	0.87
	Delayed Opóźniony	0.83	0.85	0.79	0.82
	Mean for B Średnio dla B	0.88	0.88	0.8	0.85
		$LSD_{0.05}$ A – ns; B – ns; AxB – ns			

The number of silicles per plant was significantly dependent on the time of sowing seeds (Table 7). The resulting difference between early and delayed sowing time was on an average of 67.2 silicles per plant. Therefore, it should be stated that early sowing the seeds of winter false flax caused the best development of plants before winter and, as a result, the formation of the largest number of silicles in the spring. The most silicles per plant had variety Maczuga, however significantly less Luna and Przybrodzka. Solis et al. (2013) obtained significant variations in the number of silicles per plant depending on the area of research. The highest number silicles per plant amounted 369 and the lowest - 113 pcs.

The delayed sowing time contributed to the increase in the number of seeds per silicles compared to early sowing time. It was, however, a little effect on yielding plants on plots with delayed sowing date. Variety Przybrodzka contained significantly more seeds in silicle than the variety Maczuga and Luna. In the research of Łuczkiewicz and Blaszczyk (1998), it was shown that the large variations in the number silicles between varieties, however small for the number of seeds in silicle and 1,000 seeds weight.

The thousand seed weight was not significantly modified. Jankowski and Budzyński (2003) proved that in shaping the spring camelina seed yield the decisive role is MTN. The other yield components in less extent, differentiated the performance of the unit.

Table 8. Seed yield (mean of years 2013-2015)

Tabela 8. Plon nasion (średnia z lat 2013-2015)

Parameter Parametr	Sowing time Termnin siewu (A)	Variety Odmiana (B)			Mean for A Średnio dla A
		Maczuga	Luna	Przybrodzka	
Seed yield Plon nasion ($t{\cdot}ha^{-1}$)	Early Wczesny	3.65	2.48	3.26	3.13
	Optimum Optymalny	2.67	2.13	2.14	2.31
	Delayed Opóźniony	1.6	1.52	1.76	1.63
	Mean for B Średnio dla B	2.64	2.04	2.39	2.36
	$LSD_{0.05}$ A – 0.55; B – 0.45; AxB – ns				

The early sowing time contributed to a significant increase in seed yield in comparison to optimal and delayed time (Table 8).

The yield of Maczuga variety is significantly higher than Luna. Urbaniak et al. (2008) also showed that the yield of the camelina was significantly varied between varieties. Mosio-Mosiewski et al. (2015) report that highly yelding variety is Luna, which in experiments yields amounted to 2.6 t·ha^{-1}.

Conclusions

The early sowing time contributed to: the lengthening of the vegetation period of plants, an increase the value of the index SPAD and a number silicle per plant as well as a seed yield. The optimal sowing date increased plant density before harvest and lodging. Sowing the seeds in delayed time caused: an increase LAI and MTA and plant height as well as the number of seeds in silicle. The thousand seed weight was not significantly modified. It has been demonstrated varietal differences most studied traits, including seed yield. The experiment results show that in the area of research the best time sowing for winter false flax is in the first decade of September.

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