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The effect of nitrogen fertilisers, sowing time and seed rate on the productivity of *Camelina sativa*

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Abstract

Camelina sativa (L.) Crantz is one of the most promising crops for biofuel production, which can be grown on less fertile soils than oilseed rape. To validate this proposition, research was carried out in the crop rotation of the Vėžaičiai Branch of the Lithuanian Institute of Agriculture and Forestry during 2008–2009 on a *Bathihypogleyi-Dystric Albeluvisol* (*ABd-gld-w*). We explored the effects of nitrogen fertilisers (N_0, N_{30}, N_{60}, N_{90} and N_{120}), sowing time (as soon as soil conditions allow, 5 days later and 10 days later) and seed rates (6, 8 and 10 kg ha^{-1}) on Camelina seed yield and yield components.

Camelina seed yield was found to depend on nitrogen fertilisation, sowing time and weather conditions. During 2008–2009, the seed yield of the Camelina variety 'Borowska' ranged from 0.38 t ha^{-1} in unfertilised plots to 0.83 t ha^{-1} in the plots applied with N_{60}. Nitrogen fertilisation increased the yield by 1.1–1.6 times (in 2008) and by 1.4–2.2 times (in 2009), compared to that in unfertilised plots. The highest seed yield (0.67 and 0.74 t ha^{-1}) was achieved for the first (28 04 and 08 04) sowing date with a seed rate of 8 kg ha^{-1}, due to the highest number of plants m^{-2} (in 2008) and the highest number of branches per plant and 1000 seed weight (in 2009). Increased seed rate did not cover the decrease in seed yield when sowing had been delayed. The relatively low Camelina seed yield in Western Lithuania region resulted from the unfavourable weather conditions, i.e. droughts which persisted throughout the spring season.

Key words: Camelina, nitrogen fertilisers, sowing time, seed yield, yield components.

Introduction

One of the most important objectives of the EU policy is environmental protection. Solutions to this problem encompass development of measures for promoting biofuels (Padari et al., 2009) and replacement of mineral fuel by biofuel. It is necessary to look for alternative feed-stocks for the production of biodiesel including potential utilisation of new kinds of oilseed crops. Camelina (*Camelina sativa*) could be one of such crops (Zubr, 1997).

Camelina sativa (L.) Crantz is an ancient oilseed crop that belongs to the *Brassicaceae* family. Camelina is also known as Dutch flax, German sesame, Siberian oilseed and Gold of pleasure. The recent focus on this crop was inspired by finding new sources of essential fatty acids, especially vegetable sources of omega-3 fatty acids (Karvonen et al., 2002) and its use as a source of biofuel (Cardone et al., 2003; Lebedevas et al., 2010).

Considering the broad range of Camelina uses in feed and food production, cosmetics, pharmaceutical, biofuel and bio-oil industry, it is important to establish its genetic potential and cultivation peculiarities for maximum yield (Bonjean, Le Goffic, 1999). Oil content in Camelina seeds has been reported to range from 25% to 48%. The adaptability of crops to the environment causes considerable variation in the oil content of the seeds from different locations (Zubr, 2003; Vollmann et al., 2007).

The summer type of Camelina is usually grown in Europe. The plant is not too demanding for soil and climate conditions and can be grown together with legume cover crops in conventional and organic farms (Akk, Ilumae, 2005). As compared to oilseed rape, mustard, flax and sunflower, Camelina summer type is more tolerant of cold and drought; it can grow in less fertile sandy and light loamy soils, with minimal fertilisation and without pesticide use (Zubr, 1997; Lafferty et al., 2009). Camelina is a short-season crop, generally requiring 85 to 100 days to mature (Zubr, 1997).

Tests have indicated that the nutrient requirement for Camelina is moderate to low, but it is necessary to apply approximately 30 kg ha^{-1} of phosphorus and 50 kg ha^{-1} of potassium before sowing (Zubr, 1997). An important factor in Camelina growing technology for both winter and summer types is mineral and organic fertilisation (Ryant, 2003; Jackson, 2008). Camelina crop deficient in nitrogen looks poor, the leaves are small, greenish yellow, the crop matures earlier, it does not form many pods, and the seeds are small (Zubr, 1997). Generally, the maximum seed yield can be achieved with nitrogen application of approximately 75 kg ha^{-1}. However, other studies have shown a linear response of seed yield to N rates of up to 120 kg ha^{-1} (Urbaniak et al., 2008). The yield forming elements of Camelina summer type – the number of productive stems and pods per plant increase with increasing nitrogen fertilisation. Research conducted in Germany showed that the highest yield of Camelina summer type (2.28 t ha^{-1}) in loamy soil was produced with 80 and 120 kg ha^{-1} nitrogen fertilisation and a sowing rate of 400 seeds m^{-2} (Agegnehu, Honermeier, 1996). Research conducted in England and France showed that the recommended rate of nitrogen fertilisers for the Camelina summer type is 100 kg ha^{-1}, when sowing rate is 350 seeds m^{-2}. Some authors suggest more intensive (120–130 kg N ha^{-1}) use of nitrogen fertilisers (Person et al., 1999).

Camelina needs for soil fertility is similar to those of other *Brassicaceae* with the same yield potential. Camelina has been shown to respond to nitrogen similarly to mustard or flax. Some authors indicate that Camelina summer type is a plant which requires less expenses and its demand for nitrogen is moderate to very low it does not need chemical protection and produces a seed yield of 2.6 t ha^{-1} (Zubr, 1997; Jackson, 2008). Camelina crops which grow in the soils moderate in nutrient status do not need nitrogen fertilisation (Strašil, 1997). Research conducted in Germany, Estonia, England, the United States of America (Minnesota, Colorado) and Canada showed that Camelina seed yield varied from 0.8 to 4.0 t ha^{-1}, depending on the type, sowing rate and timing, nitrogen and sulphur fertilisation, and the efficiency of all these means for seed yield depended on the local soil and climate conditions (Honermeier, Aggenehu, 1996; Akk, Ilumae, 2005; Wysocki, Sirovatka, 2007). The seed production and formation of yield components of Camelina is mainly influenced by sowing time and seed rate. The best time to sow is when the soil has warmed to about 10°C, which occurs between mid April and mid May. The seed rate of 7 kg ha^{-1} gives the best plant population density of around 220–250 plants m^{-2} (Rathke et al., 2006).

The controversial data on Camelina requirements for climatic and soil conditions, fertiliser management and sowing time show that further studies are needed.

The study was designed to estimate the effects of different nitrogen fertiliser rates, sowing time and seed rates on Camelina seed yield and its components under moraine loamy soil and humid climatic conditions of Western Lithuania.

Materials and methods

Experimental site. The research was carried out in 2008 and 2009 in the crop rotation of the Vėžaičiai Branch of the Lithuanian Institute of Agriculture (Western Lithuania, the eastern edge of the coastal lowland 55º43′N, 21º27′E).

Study object. Camelina sativa L. Crantz summer type, var. 'Borowska'.

Site conditions.

Soil is acidic (pH_{KCl} 4.6–5.2) moraine loamy *Bathihypogleyi-Dystric Albeluvisol* (*ABd-gld-w*) with moderate phosphorus, high potassium and low carbon and nitrogen contents (Table 1).

Table 1. Soil chemical properties of the Camelina field trials
Vėžaičiai Branch, 2009

pH_{KCl}	P_2O_5 mg kg^{-1}	K_2O mg kg^{-1}	Organic C %	Total N %	Mobile sulphur mg kg^{-1}	Ca mg kg^{-1}
			2008			
5.2	122	216	1.46	0.12	1.08	1645
			2009			
4.6	146	263	1.39	0.13	1.04	1077

Thickness of arable layer was 20–28 cm. Soil texture – light moraine loamy soil (clay (<0.002 mm) fraction – 15%). Stable aggregates accounted for 48–51% of the total aggregates. Such soil does not ensure good aeration and moisture conditions for plants. Under extreme natural conditions (downpours or droughts) the soils become boggy or too thick, a crust forms on the surface, which makes the aeration of the soil and oxygen supply to the roots of plants more difficult.

General agroclimatic conditions. The region's mean annual amount of precipitation is more than 800 mm, about 62% of which occurs during the warm period (between May and August) during the growing season of plants (Table 2).

Table 2. The climatic conditions during Camelina growing period
Vėžaičiai Branch, 2009

Month	Air temperature °C			Precipitation mm		
	2008	2009	average 1947–2008	2008	2009	average 1947–2008
April	–	8.4	5.7	1.5	2.1	42.5
May	11.7	11.5	11.2	10.2	43.8	44.1
June	15.5	14.3	14.8	59.6	68.6	63.7
July	17.7	17.9	16.9	69.8	137.6	88.5

The mean daily temperature in May is 11.2°C, in June 14.8°C, in July 16.9°C. The weather conditions for plant growth were more or less favourable, but the drought in spring (in April and May), during the seed emergence and establishment periods exerted a negative effect on the productivity of Camelina in 2008 and 2009.

Field experiments.

Study design. To evaluate the effects of nitrogen fertilisers on Camelina productivity the following trial design was used: 1) $N_0P_0K_0$, 2) $N_{30}P_{60}K_{60}$, 3) $N_{60}P_{60}K_{60}$, 4) $N_{90}P_{60}K_{60}$ and 5) $N_{120}P_{60}K_{60}$.

The study on the effects of seed rate (factor A) and sowing date (factor B) on Camelina seed yield followed the design:

Sowing date (factor A):

1) sowing, when the soil conditions allow tillage (28 04 2008, 08 04 2009), 2) 5 days later (05 05 2008, 13 04 2009), 3) 10 days later (10 05 2008, 18 04 2009).

Seed rate (factor B): 1) 6 kg ha^{-1}, 2) 8 kg ha^{-1}, 3) 10 kg ha^{-1}.

The following mineral fertilisers were used: calcium ammonium nitrate, granular superphosphate and potassium chloride. A seed rate of 6 kg ha^{-1} was sown at the 1–1.5 cm depth. The soil was prepared with a germinator. The crop was rolled after sowing. In 2008, Camelina was sown on 28 April, and in 2009 on 8 April. Using a "Sampo-500" harvester the yield was taken separately from each plot. The trial design was established in a randomized bloc with 4 replications. Plot size was 3.0 x 15 = 45 m^2 and the sampled one 26 m^2.

Soil sampling. Soil samples for chemical, texture and structure analyses were collected from the experimental fields before setting up a test for soil characteristics. During the vegetation of Camelina, soil moisture tests (0–20 cm) were carried out every seven days in all field trials in 2008 and 2009.

Yield component analysis. The following yield component tests of Camelina were carried out during the vegetation period: number of plants m^{-2}, plant height, number of branches per plant, number of seeds per pod and 1000 seed weight.

Analytical methods. Soil moisture was determined using weight method. Mineral nitrogen in soil – colorimetrically with 1 M KCl extraction, mobile phosphorus (P_2O_5), potassium (K_2O) and calcium – by spectrometrical method from the Egner-Riem-Domingo (A-L) extract, pH – KCl extract – electrometric method, mobile sulphur – turbidimetric method (1 M KCl) (ISO 10390, 2001). The chemical qualities of soil and texture analyses were carried out at the Agrochemical Research Centre of the Lithuanian Institute of Agriculture.

The research data were statistically processed by the correlation-regression analysis methods, using the statistical package *Anova* (Tarakanovas, Raudonius, 2003).

Results and discussion

Nitrogen fertiliser effect on Camelina yield components and seed yield. Nitrogen fertilisers have the strongest influence on the productivity in most natural and agricultural ecosystems as well as on Camelina yield components and seed yield (Rathke et al., 2006). The yield components of Camelina are: number of plants m^{-2}, number of branches per plant, number of pods per plant, number of seeds per pod and 1000 seed weight (Agegnehu, Honermeier, 1996). Steer and Harrigan (1986) suggest that nitrogen deficiency inhibits plant growth, reduces yield and yield components such as the number of seeds per plant and number of branches per plant, and seed weight.

The data averaged over the two experimental years indicate that in moraine loam soil the yield components of Camelina were affected by nitrogen fertilisers, especially in 2009 (Table 3).

Table 3. The effect of various nitrogen rates on the formation of yield components of Camelina
Vėžaičiai Branch, 2008–2009

NPK rate kg ha^{-1}	Yield components				
	plants m^{-2}	branches per plant	height of plant cm	seeds per pod	1000 seed weight g
2008					
1. $N_0P_0K_0$	329	11	50.4	11	1.05
2. $N_{30}P_{60}K_{60}$	293	12	50.4	12	1.04
3. $N_{60}P_{60}K_{60}$	316	11	52.6	11	1.09
4. $N_{90}P_{60}K_{60}$	350	13	53.6	13	1.08
5. $N_{120}P_{60}K_{60}$	357	13	52.4	13	1.12
LSD_{05}	**72.6**	**2.1**	**4.47**	**2.1**	**0.05**
2009					
1. $N_0P_0K_0$	102	5	66.3	10	1.23
2. $N_{30}P_{60}K_{60}$	132	6	69.4	12	1.15
3. $N_{60}P_{60}K_{60}$	117	10	78.7	11	1.20
4. $N_{90}P_{60}K_{60}$	97	9	77.4	10	1.12
5. $N_{120}P_{60}K_{60}$	122	8	77.9	10	1.09
LSD_{05}	**28.2**	**2.2**	**5.2**	**2.2**	**0.06**

In 2008, the trend towards increase of all yield components – the number of plants per square meter, branches per plant, plant height, number of seeds per pod and 1000 seed weight in the plots with the application of 90 and 120 kg ha^{-1} of nitrogen was determined. In this plot, the seed number per pod was 13, while in unfertilised it was 11, moreover, in this soil the 1000 seed weight was 1.08–1.12 g or by 3–6% higher than that in unfertilised soil and in the soil applied with 30 kg ha^{-1} of nitrogen. It is likely that this had a positive effect on the seed yield of Camelina, whereas in 2009, the yield component – number of branches per plant significantly depended on the nitrogen supply. The highest number of branches per plant (10) was recorded in the soil with N_{60}. Also, the yield formation elements of Camelina were influenced by the amount of precipitation in spring. The highest number of plants m^{-2}, branches per plant and seeds per pod was determined in 2008.

In 2008, the seed yield of Camelina varied depending on the rate of nitrogen fertiliser and ranged from 0.44 t ha^{-1} in unfertilised soil to 0.71 t ha^{-1} in the soil fertilised with the highest N_{120} rate (Figure 1). Nitrogen fertilisation increased Camelina seed yield by 27–61 percentage points, as compared to the yield obtained in unfertilised soil. This was determined by a higher seed number per pod and a higher 1000 seed weight (3–6%).

In 2009, depending on the rate of nitrogen fertiliser, the seed yield of Camelina ranged from 0.38 t ha^{-1} in unfertilised soil to 0.83 t ha^{-1} in the N_{60} fertilised soil. Significantly highest seed yield of Camelina was obtained when 60–120 kg ha^{-1} had been applied. The yield increased by 1.4–2.2 times compared with that produced in unfertilised plots.

Sowing time and seeding rate effect on Camelina seed yield. The yield components and seed yield of Camelina were influenced by the sowing time in 2008 and 2009 (Figures 2 and 3). In 2008, the highest number of plants per square meter (174) was determined in the crop of the first (28 04) sowing date, while the number of plants per square meter in the plots of the latest sowing dates (03 05 and 08 05) amounted to 78 and 49 respectively, or it was by 55–71% lower in comparison with the first sowing date (Table 4).

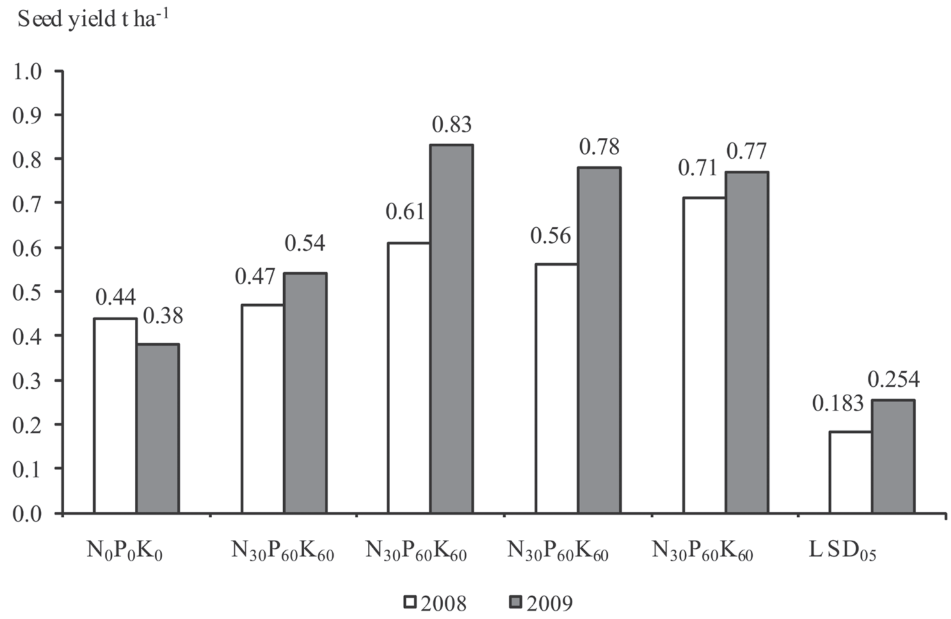

Figure 1. The effect of nitrogen fertiliser on Camelina seed yield

Table 4. The effect of sowing time and seed rate on the formation of yield components of Camelina
Vėžaičiai Branch, 2008–2009

Sowing time and seed rate	Yield components				
	plants m^{-2}	branches per plant	height of plant cm	seeds per pod	1000 seed weight g
			2008		
			Sowing time (factor A)		
28 04	174	9.0	59.2	13.0	1.24
05 05	78*	8.50	58.2	12.7	1.18**
10 05	49**	8.33	61.8	12.7	1.23*
			Seed rate (factor B)		
6 kg ha^{-1}	75	9.83	60.0	12.5	1.20
8 kg ha^{-1}	79	7.77	57.3	12.8	1.22**
10 kg ha^{-1}	146	8.33	61.8	13.0	1.22**
			2009		
			Sowing time (factor A)		
08 04	181	5.05	66.5	10.6	1.07
13 04	106**	5.32	68.3	10.4	0.88**
18 04	247**	4.03*	63.3*	11.4	0.98**
			Seed rate (factor B)		
6 kg ha^{-1}	110	5.3	67.6	10.8	1.01
8 kg ha^{-1}	220**	4.55	65.1	10.5	0.92**
10 kg ha^{-1}	205**	4.55	65.4	11.1	1.01

Note: * – significant at $P < 0.05$, ** – significant at $P < 0.01$.

The sowing time and seed rate did not have any effect on the number of branches per plant, plant height and 1000 seed weight. The trend towards increasing was established for the number of branches per plant in the plots with the lowest (6 kg ha^{-1}) seed rate.

Some studies of Steer and Harrigan (1986) suggest that the maximum seed yield (4.0 t ha^{-1}) of Camelina in productive clay soil was obtained with 54 branches per plant, 94 pods per plant and 13 seeds per pod. Agegnehu and Honermeier (1996) have reported a strong relationship between yield components and seed yield. The Camelina seed yield was 2.3 t ha^{-1} at a population density of 182 plants m^{-2}, 6.4 branches per plant, 194 pods per plant.

Our results agree with their conclusions. The relatively low Camelina seed yield in 2009 was due to a low number of branches per plant (4–5) and 1000 seed weight (0.82–1.07 g). The same trend was determined in 2008. The best Camelina yield components were in the crop of the first (28 04) sowing date at 8 kg ha^{-1} (2008) or 6 kg ha^{-1} (2009) seed rate. There were observed significant (0.33–0.51 t ha^{-1}) Camelina seed yield differences between the treatments of the first and last sowing dates both in 2008 and 2009.

The highest Camelina seed yield (0.67 t ha^{-1}) in 2008 was produced when sown as soon as soil conditions allow, (in early spring – 28 04) at a seed rate of 8 kg ha^{-1} due to the highest number of plants (174) per square meter (Figure 2, Table 4).

Compared with this yield, a little (7%) lower seed yield (0.63 t ha^{-1}) was obtained at a seed rate of 10 kg ha^{-1} at the same sowing date. The same trend of seed yield dependence on sowing time and seed rate was obtained in 2009 (Figure 3).

The highest seed yield (0.74 t ha^{-1}) was obtained at a seed rate of 8 kg ha^{-1} at the first (08 04) sowing date, it was by 39% and 33% higher compared with that obtained at the later sowing dates (13 04 and 18 04) at the same seed rate. The seed yield depended on the number of branches and pods per plant. In terms of seed yield, the best seed rate of Camelina was 8 kg ha^{-1} both in 2008 and 2009.

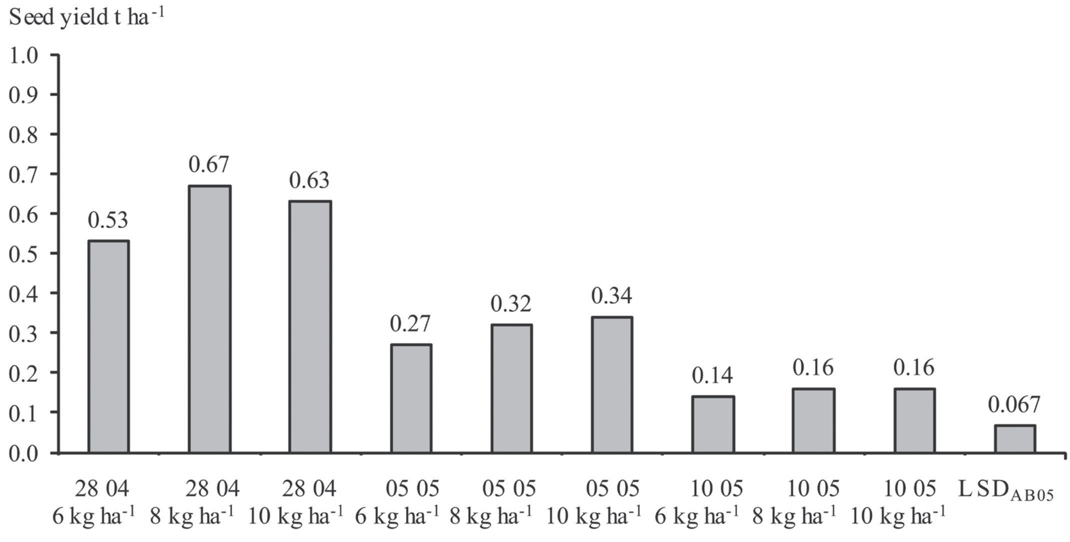

Figure 2. The effect of sowing time and seed rate on the seed yield of Camelina, 2008

Increased seed rate did not cover the decrease in seed yield when sowing time was delayed. Some studies of Bramm (1993) suggested that a seed rate of 400 vigorous seeds per square meter and application of 120 to 130 kg ha^{-1} of nitrogen fertiliser are most effective for maximum seed production. Our results did not support their findings. The highest seed yield (0.83 t ha^{-1}) of Camelina was obtained with the application of 60 kg ha^{-1} nitrogen fertiliser, at 316 plants per square meter at the earliest sowing time (08 04).

Compared with the seed yield of Camelina obtained (0.8–2.6 t ha^{-1}) in Europe (Agegnehu, Honermeier, 1996; Merrien, Chatenet, 1996; Gliožeris, 2009; Žilėnaitė, Sliesaravičius, 2009) the yield obtained in our trials (0.83 t ha^{-1}) was markedly lower. The relatively low seed yield, especially of latest sowing dates in 2008 and 2009 resulted from the unfavourable climatic conditions – drought in spring (April–June). It is known that the optimal soil moisture for good seed germination and leaf formation is 16–18%, whereas in all our treatment the soil moisture in the upper (0–5 cm) topsoil layer during the seed emergence period was 2.9–9.6% (Table 5).

The plants suffered the greatest moisture stress during the period of their most intensive development and formation of the yield-determining components: soil moisture at the 0–10 cm layer was 8.6–9.3%. Such moisture in the moraine loam soil is considered to be close to plant wilting moisture, and at the 0–5 cm layer it was 2.9–4.8%. These data show the moisture stress of plants during drought period which had a negative effect on Camelina seed yield.

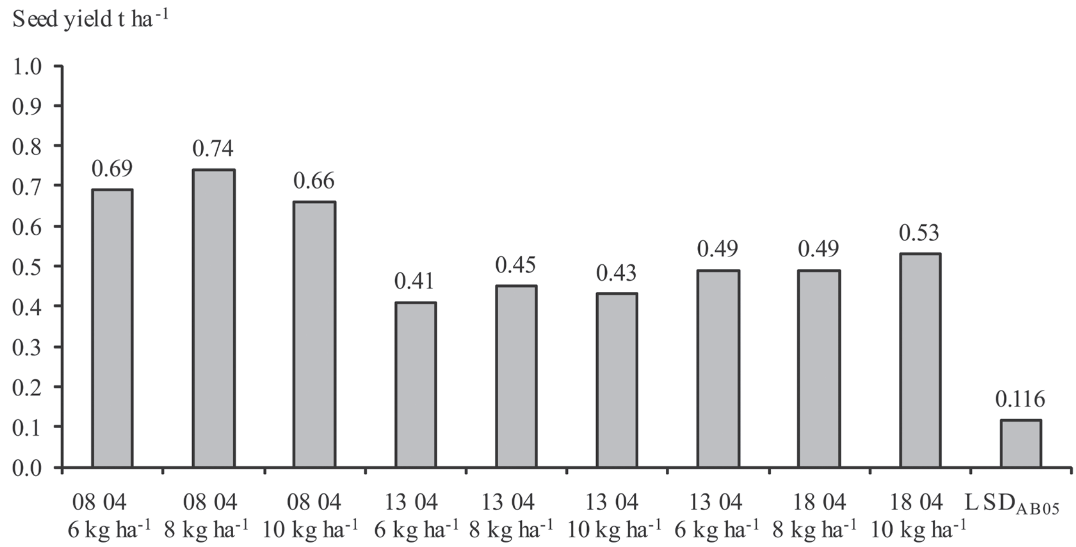

Figure 3. The effect of sowing time and seed rate on the seed yield of Camelina, 2009

Table 5. Dynamics of soil moisture during Camelina growing season
Vėžaičiai Branch, 2008–2009

Soil layer depth cm	Soil moisture %											
	2008											
	stage of 2–8 true leaves				stage of bud formation and flowering				maturity			
	13 05	20 05	27 05	02 06	11 06	18 06	25 06	01 07	08 07	14 07	23 07	28 07
0–5	–	9.6	7.2	4.8	2.9	–	–	–	–	–	–	–
0–10	16.3	14.8	16.5	8.6	9.3	20.1	15.8	13.7	11.3	15.7	20.3	10.2
10–20	20.6	16.5	18.7	18.7	14.0	20.6	16.6	16.1	13.0	12.1	18.2	14.7
	2009											
	stage of emergence and germination			stage of 2–8 real leaves formation					stage of bud formation and flowering			
	08 04	14 04	21 04	27 04	04 05	11 05	18 05	25 05	01 06	08 06	15 06	–
0–5	11.12	9.2	5.5	2.5	2.9	16.4	–	–	–	–	–	–
0–10	17.14	16.80	17.38	15.94	16.18	18.34	15.08	13.96	13.87	16.62	23.56	–
10–20	24.30	22.30	20.84	19.00	19.01	19.75	18.68	17.50	17.19	17.09	22.32	–

The relatively low seed yield (0.83 t ha^{-1}) especially that of the latest sowing dates both in 2008 and 2009 resulted from the unfavourable climatic conditions – drought in spring (April–June) and the lack of soil moisture during the seed germination and leaf formation stages. Moreover, acid soil reaction exerted a negative effect on the productivity of *Camelina sativa*.

Conclusions

1. In moraine loam soil (*Bathihypogleyi-Dystric Albeluvisol*) under humid Western Lithuania's climatic conditions the yield components and seed yield of *Camelina sativa* L. Crantz variety 'Borowska' depended on the nitrogen rate, sowing time and seed rate.

2. Nitrogen fertilisation increased the seed yield of Camelina by 1.1–1.6 times (in 2008) and 1.4–2.2 times (in 2009) compared to that obtained in unfertilised soil. The highest seed yield 0.71 t ha^{-1} (in 2008) and 0.83 t ha^{-1} (in 2009) in the soil applied with 120 and 60 kg ha^{-1} of nitrogen fertilisers was produced due to the higher number of seeds per pod and higher 1000 seed weight (in 2008) also higher number of branches and 1000 seed weight (in 2009).

3. The findings from the two experimental years (2008 and 2009) indicated that the highest seed yield (0.67 and 0.74 t ha^{-1}) had been achieved at the first (08 04) sowing date with a seed rate 8 kg ha^{-1}, due to the highest number of plants per square meter and the highest 1000 seed weight. Increased seed rate did not cover the decrease in seed yield when sowing time had been delayed.

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Azoto trąšų, sėjos laiko ir sėklos normos įtaka *Camelina sativa* vasarinės formos produktyvumui

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Santrauka

Sėjamoji judra (*Camelina sativa* (L.) Crantz) yra vienas svarbiausių augalų biodegalų gamybai, galinčių augti mažiau derlinguose dirvožemiuose nei rapsai. Siekiant pagrįsti šį teiginį, Lietuvos žemdirbystės instituto Vėžaičių filiale 2008–2009 m. buvo atlikti tyrimai.

Tyrimų dirvožemis – giliai glėjiškas nepasotintasis balkšvažemis (JIn-g), *Bathihypogleyi-Dystric Albeluvisol* (*ABd-gld-w*). Buvo vertinta azoto (N_0, N_{30}, N_{60}, N_{90} ir N_{120}), sėjos laiko (sėta, kai dirvožemis buvo tinkamas dirbti, praėjus 5 ir 10 dienų) ir sėklos normų (6, 8 ir 10 kg ha^{-1}) įtaka sėjamosios judros produktyvumui.

Nustatyta, kad sėjamosios judros derlius ir jį lemiantys derliaus rodikliai priklausė nuo sėjos laiko, sėklos normos ir kritulių kiekio pavasarį. 2008–2009 m. sėjamosios judros derlius netręštame dirvožemyje svyravo nuo 0,38 t ha^{-1} iki 0,83 t ha^{-1}. Azoto trąšos 2008 m. derlių padidino 1,1–1,6 karto, 2009 m. – 1,4–2,2 karto, palyginti su netręštu dirvožemiu. Tyrimų laikotarpiu (2008–2009 m.) sėjamosios judros didžiausias derlius (0,67 ir 0,74 t ha^{-1}) nustatytas pasėjus, kai tik dirvožemį buvo galima įdirbti (balandžio 28 ir balandžio 8 d.), išsėjus 8 kg ha^{-1}. Didesnį derlių lėmė didesnis augalų skaičius kvadratiniame metre ir 1000-čio grūdų masė. Sėklos normos didinimas sėklų derliaus sumažėjimo nekompensavo.

Santykinai nedidelis sėjamosios judros vasarinės formos derlius Vakarų Lietuvos regione gautas dėl nepalankių meteorologinių sąlygų – pavasarį užsitęsusios sausros. Augalai svarbiausiais jų vystymosi (skrotelės susidarymo, šakojimosi, butonizacijos ir žydėjimo pradžios) tarpsniais dėl drėgmės trūkumo negalėjo panaudoti dirvožemyje esančių maisto medžiagų.

Reikšminiai žodžiai: sėjamoji judra, sėklų derlius, azoto trąšos, sėjos laikas, derliaus komponentai.