THE EFFECT OF NITROGEN FERTILIZATION, SOWING RATES AND WEATHER CONDITIONS ON YIELDS AND YIELD COMPONENTS OF *LALLEMANTIA IBERICA* (L.) FISCH. ET MEY.*

Z. Strašil, M. Káš

Research Institute of Crop Production, Prague-Ruzyně, Czech Republic

Field trials with *Lallemantia iberica* were carried out in the period 1994–2003 at the site Prague-Ruzyně. The field trials were mainly aimed at observing the impact of weather conditions, sowing rate and different N fertilization on yield and yield components of lallemantia. The oil content in seeds and the proportion of individual fatty acid were established each year. Seed yield was significantly influenced by conditions of the growing year. Seed yields ranged on average from 0.212 $t.ha^{-1}$ (calculated in dry mass) in 1998 up to 1.872 $t.ha^{-1}$ in 1999. The average seed yield in the monitored period was 0.904 $t.ha^{-1}$. Used N doses and sowing rates had no significant influence on seed yields. Lower V_1 sowing rate increased the seed yield in average by 3.1% in comparison with the higher V_2 sowing rate. The low seed yield was also influenced by strong incidence of grey mould disease (*Bortytis cinerea* Pers.:Fr.). During the whole experiment period (except grey mould disease) any stronger occurrence of diseases or pests was not found. The shoot yield was significantly influenced by year conditions and sowing rates. The average of dry matter of shoot yield in the monitored period was 2.642 $t.ha^{-1}$. The used V_2 sowing rate increased the shoot yield on average by 7.6% in comparison with the V_1 sowing rate. A year significantly influenced all observed components. N fertilization significantly influenced on average the thousand seed weight and number of branches per plant. Higher N-doses caused falling of thousand seed weight but on the contrary the number of branches per plant increased. The V_2 sowing rate significantly decreased number of capsules on average by 36.4% in comparison with the V_1 sowing rate. Other observed components significantly influenced neither N fertilization, nor sowing rates. The oil content in seeds was variable in the experimental years. The average oil content in seeds during experimental period was 30.6%. The content of individual fatty acids varied in the years less than the oil content. Linolenic acid prevailed in seeds and the average content of this one was 62.2%. More than 10% of individual fatty acid content was represented by oleic and linoleic acid.

Lallemantia iberica; dragons head; N fertilization; sowing rate; yield; yield components; oil content; fatty acids

INTRODUCTION

Lallemantia iberica (dragons head) is plant from the family *Labiatae*. It is an annual herb with strong branches growing up to 0.6 m of height. The capsule with four seeds is its fruit. Relatively short vegetation period varies according to climatic and weather conditions from 65 to 140 days.

The plant prefers light (sandy) or medium (loamy) soils and they should be well-drained. The plants have no special demands for soil pH. It cannot grow in a shade.

Lallemantia is grown for its oily seeds from which a drying oil is extracted or also for essential oils (Alireza, Behzad, 2003; Baser et al., 2000). The oil is used for lighting, as a varnish, in paints and as a lubricant. It is also used for fabrication of linoleum. Oil rich in linolenic acid is a renewable feedstock for environment-friendly crosslinkers in powder coating (Matthaus, 1997; Overeem et al., 1999). Due to low yields there is, however, currently little market interest in lallemantia.

Field trials with *Lallemantia iberica* were carried out at the site Prague-Ruzyně. The field trials were concentrated especially on observation of impact of weather conditions, sowing rate and different N fertilization on the yield and yield components of lallemantia.

MATERIAL AND METHODS

Field trials were carried out in the period 1994–2003 at the site Prague-Ruzyně. The site characterization is mentioned in Table 1. The weather course in individual years and months was evaluated using the system described by Kožnarová and Klabzuba (2002) – Table 2. Comparing with long term average the year 2000 can be characterized as an extra warm during the vegetation period and the years 2001, 2002 extremely wet and 2003 extraordinarily dry.

The forecrop of lallemantia was winter wheat in all years. Agricultural measures recommended for small grain crops were applied when preparing the soil for lallemantia. After the forecrop harvest stubble ploughing

* This study was financially supported by the National Agency for Agricultural Research (Project Reg. No. QD 1209).

Table 1. Site conditions of experimental locality

Experimental site	Prague-Ruzyně
Latitude	50°04'
Longitude	14°26'
Height above sea level (m)	350
Soil texture	clay-loam
Great soil group	Orthic Luvisol
Average annual air temperature (°C)	8.2
Average annual precipitation sum (mm)	477
Agrochemical properties of topsoil:	
Humus content (%)	3.00
pH (KCl)	6.22
P content (Mehlich III, $mg.kg^{-1}$ soil)	129.1
K content (Mehlich III, $mg.kg^{-1}$ soil)	362.0

and mean ploughing (deep 22 cm) succeeded. Usual pre-sowing soil preparation was done in spring. In autumn, P and K fertilization was applied every year – it was the same for all variants in doses 26 kg P per hectare in superphosphate and 50 kg K per hectare in potassium chloride. For N fertilization, the following doses were used: N_0 – without N fertilization, N_1 – 30 $kg.ha^{-1}$ (one dose in ammonium sulphate before sowing), N_2 – 60 $kg.ha^{-1}$ (two doses – 30 $kg.ha^{-1}$ N in ammonium sulphate before sowing and 30 $kg.ha^{-1}$ N in ammonium nitrate with limestone in the period of flower buds formation).

Lallemantia was sown by Oyord drill machine into rows of 125 mm spacing in two different sowing rates: V_1 – 300 germinable seeds per m^2, V_2 – 450 germinable seeds per m^2.

The following parameters were observed during vegetation period: health conditions (degree of pest and diseases infestation), plant density before harvest, seed and shoot yield, thousand seed weight (TSW), the duration of the vegetation period (from sowing to harvest), the number of branches per plant, number of capsules per plant, number of internodes per plant and the plant length were determined for each variant. The oil content in seeds and the proportion of individual fatty acid were established each year. UNISTAT 5.0 package was used for statistical analyses of experimental data.

RESULTS AND DISCUSSION

Seed yield was significantly influenced by the year of growing. It ranged on average from 0.212 $t.ha^{-1}$ (calculated in dry mass) in 1998 up to 1.872 $t.ha^{-1}$ in 1999 (Table 3). The average seed yield in the monitored period was 0.904 $t.ha^{-1}$ (calculated in dry matter) (Table 3). The weather was cold during all vegetation period and also during the ripening of seeds in 1996. One of the factors

Table 2. Weather in the years 1994 to 2003 at the site of Prague-Ruzyně (deviations from 50 years' average)

Year	Temperature (**year**, months)
1994	**warm**, extraordinary cold – V, cold – III, normal – IV, VI, IX, warm – VIII, extraordinary warm – VII
1995	**normal**, cold – VI, normal – III, IV, V, IX, warm – VIII, very warm – VII
1996	**normal**, extraordinary cold – III, IX, very cold – VII, normal – V, warm – VI, VIII, extraordinarily warm – IV
1997	**normal**, extraordinary cold – IV, normal – VI, VII, IX, warm – V, very warm – VIII, extraordinary warm – III
1998	**normal**, normal – VII, VIII, IX, very warm – VI, extraordinary warm – III, IV, V
1999	**normal**, normal – VI, VIII, very dry – IV, extraordinary dry – III, V, VII, IX
2000	**extraordinary warm**, normal – III, IX, extraordinary warm – IV, very warm – V, warm – VI, VIII, cold – VII
2001	**warm**, normal – III, IV, VII, VIII, warm – V, cold – VI, very cold – IX
2002	**very warm**, normal – III, IV, VI, IX, warm – VII, very warm – V, VIII
2003	**warm**, normal – III, IV, very warm – V, VII, extraordinary warm – VI, VIII, very cold – IX
Year	**Precipitation** (**year**, months)
1994	**very dry**, extraordinary dry – VI, VII, very dry – V, IX, dry – VIII, wet – III, IV
1995	**very wet**, normal – III, IV, VII, VIII, wet – V, VI, very wet – IX
1996	**normal**, extraordinary dry – III, IV, normal – VIII, wet – V, VI, VII, IX
1997	**normal**, extraordinary dry – V, IX, dry – VI, VIII, normal – IV, extraordinary wet – III, VII
1998	**normal**, extraordinary dry – IV, V, VIII, dry – VII, normal – III, extraordinary wet – VI, IX
1999	**normal**, extraordinary dry – VIII, very dry – IV, VI, dry – III, V, very wet – VII, IX
2000	**normal**, very dry – IV, normal – V, VI, VII, extraordinary wet – III, vet – VIII, IX
2001	**extraordinary wet**, normal – V, VI, wet – III, VII, VIII, very wet – IV, IX
2002	**extraordinary wet**, normal – III, IV, V, VI, wet – VII, IX, extraordinary wet – VIII
2003	**extraordinary dry**, extraordinary dry – IX, very dry – III, VI, dry – VIII, normal – IV, V, VII

Table 3. The length of the vegetation period in days (from the sowing to the harvest) and influence of N fertilization, sowing rate and weather conditions on dry matter yields of seed ($t.ha^{-1}$) in 1994–2003

Year	N_0	N_1	N_2	V_1	V_2	Average	Length of vegetation period
1994	1.055	0.945	1.055	0.953	1.083	1.018	104
1995	0.662	0.494	0.659	0.678	0.518	0.605	120
1996	0.298	0.210	0.136	0.212	0.216	0.214	123
1997	1.652	1.715	1.599	1.793	1.518	1.655	120
1998	0.186	0.201	0.249	0.188	0.235	0.212	134
1999	1.726	1.845	2.045	1.899	1.845	1.872	120
2000	0.837	0.829	0.811	0.883	0.768	0.825	116
2001	1.175	1.237	1.212	1.186	1.229	1.208	125
2002	0.450	0.395	0.361	0.402	0.401	0.402	142
2003	1.011	1.049	1.009	0.975	1.071	1.023	116
Average 1994–2003	0.905	0.892	0.914	0.917	0.889	0.904	122

Notes: nitrogen fertilizing: N_0 – no fertilizing, N_1 – 30 $kg.ha^{-1}$, N_2 – 60 $kg.ha^{-1}$
V_1 – sowing rate of 300 germinable seeds per m^2, V_2 – sowing rate of 450 germinable seeds per m^2

which caused the low yield was also strong incidence of grey mould disease (*Bortytis cinerea* Pers.:Fr.). The occurrence extent of grey mould disease was determined every year except the years 1994 and 2003, when there was hot and dry weather during ripening period.

The spray against grey mould disease was applied only after detection of the disease. Very strong infestation of grey mould disease was found in years 1995, 1998 and 2002. This infestation, in spite of fungicide applied immediately after disease incidence, showed strong reduction yield of seed. It is also one of the reasons why average yield of seed (Table 3) is so low. From presented conclusions followed that as long as we want to achieve good yields of seed, it is necessary to spray against grey mould disease annually and in time. During the whole experimental period, we did not observe (except of grey mould disease) any stronger occurrence of diseases or other pests.

Wurl et al. (2002) presented yields of seed of *Lallemantia iberica* from the site Dornburg (Germany) in the period 1995–2002. Seed yields (91% DM) ranged from 1.08 $t.ha^{-1}$ in 1997 to 2.35 $t.ha^{-1}$ in 2000; average yield was 1.68 $t.ha^{-1}$. It responds to 1.53 $t.ha^{-1}$ of dry matter. These results also confirm our conclusion that seed yields were significantly influenced by year conditions of growing.

No statistically significant difference was found in seed yields on average in comparison with N_0 (no N fertilization), N_1 fertilization (30 $kg.ha^{-1}$ before sowing) and the N_2 one (60 $kg.ha^{-1}$ in two doses) (Tables 3, 5). Insignificance of effects of N fertilization on seed yield of lallemantia could be explained by high soil fertility at the site Ruzyně. Besides this lallemantia has a short vegetation period and, therefore, N fertilization could not be in particular years (at dry weather conditions) fully utilized. Simona and Borcean (2000) studied the influence of P and N fertilization on yields of *Lallemantia iberica* on a damp chernozem soil in western Romania. This study showed, that the seed yield of lallemantia increased by 16 and 39% with the dosage of phosphorus P 40 and P 60 $kg.ha^{-1}$, respectively. Nitrogen rates of N 50 and N 100 $kg.ha^{-1}$ increased the yield by 38 and 55%, respectively.

Khan et al. (1999) tested supplemental P fertilizer applied 60 days after sowing as a foliar spray (1, 2 and 4 $kg.ha^{-1}$) or top-dressing (10 and 20 $kg.ha^{-1}$) to lallemantia to improve growth, yield and quality. They concluded that after the best foliar spray application of 2 $kg.ha^{-1}$ to plants seed yields were higher in comparison with top-dressing.

No statistically significant difference of average yield was also found between both sowing rates V_1 (300 germinable seeds per m^2) and V_2 (450 germinable seeds per m^2) (Tables 3, 5). V_1 sowing rate increased the seed yield on average by 3.1% comparing with the V_2 sowing rate. Observed plant density before harvest was lower than assumed and on average there were 225 $plants.m^{-2}$ in V_1 and 309 $plants.m^{-2}$ in V_2 (Table 4). It suggests that average plant density of 225 $plants.m^{-2}$ is sufficient for given soil-climate conditions.

The shoot yield was also as a seed yield significantly influenced by the year of growing (Table 5). The average shoot yield in the monitored period, was 2.642 $t.ha^{-1}$ (calculated in dry matter) (Table 4). The used V_2 sowing rate increased the shoot yield on average by 7.6% in comparison with the V_1 sowing rate.

The length of the vegetation period was also largely influenced by the weather course in individual years and on average there were 122 days from the sowing to the harvest (Table 3). The vegetation period in the dry and warm year 1994 lasted only 104 days from the sowing to the harvest. In this year it was only 8,2 mm of precipitation from flowering to harvest of lallemantia (during June and July). In 2002 142 days lasted the longest

Table 4. Seed and straw yields from the different variants on dry basis and other parameters investigated at lallemantia (average values for the years of observation)

Variant	N_0V_1	N_1V_1	N_2V_1	N_0V_2	N_1V_2	N_2V_2	Average
Seed yield ($t.ha^{-1}$)	0.908	0.925	0.920	0.902	0.859	0.907	0.904
Shoot yield ($t.ha^{-1}$)	2.459	2.638	2.708	2.581	2.634	2.833	2.642
Thousand seed weight (g)	4.600	4.488	4.280	4.526	4.416	4.465	4.463
Dry weight of shoot (g)	2.6	2.4	2.6	2.4	2.1	2.5	2.4
Plant length (cm)	43.4	42.7	45.6	44,0	45.3	47.3	44.7
Plant density ($No.m^{-2}$)	226	242	208	303	310	314	267
No. of buds per plant	75	72	84	61	51	64	68
No. of branches per plant	3.6	4.1	4.9	4.1	3.2	4.5	4.1
No. of internodes per plant	15.9	16.3	17.8	15.9	13.8	14.4	15.7

Notes: nitrogen fertilizing: N_0 – no fertilizing, N_1 – 30 $kg.ha^{-1}$, N_2 – 60 $kg.ha^{-1}$
V_1 – sowing rate of 300 germinable seeds per m^2, V_2 – sowing rate of 450 germinable seeds per m^2

Table 5. ANOVA mean squares of different observed characters

Source of variability	df	Seed yield ($t.ha^{-1}$)	Shoot yield ($t.ha^{-1}$)	Plant density ($No.m^{-2}$)	Plant length (cm)	Thousand seed weight (g)	No. of capsules per plant	No. of branches per plant	No. of internodes per plant
Year	18	1.952^{**}	6.280^{**}	$48\ 261^{**}$	620.3^{**}	2.333^{**}	3546.8^{**}	19.48^{**}	588.8^{**}
Fertilization	18	0.002	0.168	1 267	45.2	0.182^{**}	791.9	5.68^{**}	6.6
Sowing rate	18	0.012	0.096	$105\ 815^{**}$	39.8	0.002	5249.4^{**}	1.49	58.5^{*}
Year x fertilization	18	0.005	0.025^{**}	2 016	4.5	0.111	83.5	2.15	15.8
Year x sowing rate	18	0.023^{*}	0.368^{**}	$6\ 449^{**}$	25.6	0.015	1577.0^{**}	0.98	33.9^{**}
Fertilization x sowing rate	18	0.005	0.349	1 397	23.9	0.037^{*}	376.1	1.37	15.1
Error		0.07	0.068	1 076.0	16.9	0.029	425.6	0.71	7.91

* statistically significant influence ($P < 0.05$)
** statistically significant influence ($P < 0.01$)

vegetation period. The weather in this year was very cold and rainy during the growing season. The difference of length of the vegetation period between mentioned years was 38 days.

Year conditions significantly influenced all observed components (Table 5). N fertilization significantly influenced TSW and the number of branches per plant. Growing doses of N decreased TSW, but on the contrary, the number of branches per plant went up (Table 4). Sowing rates significantly influenced number of capsules per plant. The V_2 sowing rate decreased the number of capsules on average by 36.4% in comparison with the V_1 (Table 4). Other observed components were significantly influenced by neither N fertilization nor sowing rates.

The oil content in seeds varied in individual experimental years. The average oil content in seeds during experimental period was 30.6% (Fig. 1). The average oil content recorded over the years of study was higher than average values of oil content of *Lallemantia iberica* from some localities of the Czech Republic as reported by Baranyk et al. (1995). They presented average oil content 26,4%. Wurl et al. (2002) presented average oil content in seeds of *Lallemantia iberica* 31.9% for conditions of Germany.

The lowest content of oil in seeds was found in 2002 and 1996 (22.9 and 24.6%, resp.), when the weather was cold during vegetation period and also during the ripening of seeds. Also the vegetation period of lallemantia was very long in these years. Low seed yields correspond with conditions of these years as well. The highest oil content was ascertained in 2003, 2000 and 1994, when weather was warm and the vegetation period of lallemantia was short. The oil content was 36.7%, 35.9% and 34.3% in these years. The content of individual fatty acids varied during the years less than the oil content. Linolenic acid prevailed in seeds (on average 62.2% – Fig. 1). Oleic and linoleic acid content represented more than 10% of all fatty acids content.

The thousand seed weight (TSW) was, similarly as seed yield, significantly influenced by the year of growing (Table 5). TSW ranged in average from 3.447 g in 1995 up to 5.220 g in 1997. The average TSW in the monitored period was 4.463 g (Table 4). TSW values were also unfavourable affected by grey mould disease in some years. There was found reduction of TSW under growing doses of nitrogen. N_2 dose, resp. N_1 dose, reduced the TSW on average by 4.2%, resp. 2.4% comparing to the non-fertilized variant. No statistically signifi-

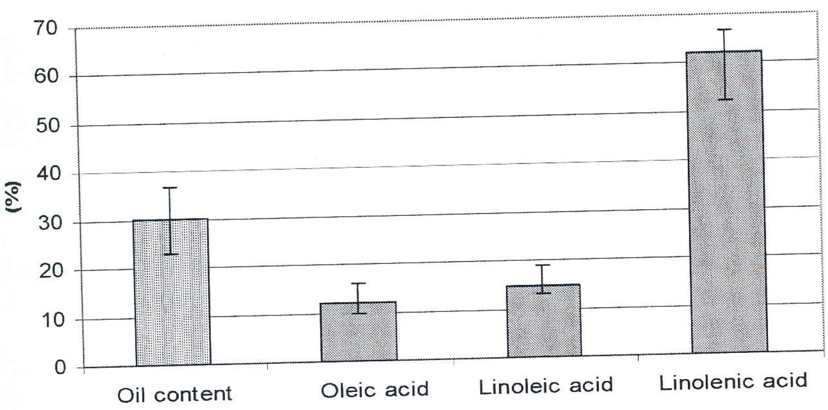

Fig. 1. Average oil content (%), composition of fatty acids (%) and confidence intervals in the seeds of lallemantia in the years 1994–2004

cant difference of TSW was found in comparison with the sowing rates V_1 and V_2.

Our results showed that lallemantia can be successfully grown in the sugar beet growing region of Prague-Ruzyně. To achieve good yields of seed of lallemantia, it is necessary to apply spray against grey mould disease annually and in time. Certain difficulties in reaching higher seed yields can cause cold and rainy periods during summer.

REFERENCES

ALIREZA, B. – BEHZAD, Z.: Compositional analysis of the Essentials oil of *Lallemantia royleana* (Benth. in Wall.). Flavour and Fragrance J., *18*, 2003: 237–239.

BARANYK, P. – ZELENÝ, V. – ZUKALOVÁ, H. – HOŘEJŠ, P.: Oil content of some species of alternative oil plants. Rostl. Výr., *41*, 1995: 9, 433–439.

BASER, K. H. C. – KURKCUOGLU, M. – OZEK, T.: Steam volatiles of *Lallemantia peltata* (L.) Fisch. et Mey. from Turkey. J. Essentials Oil Res., *12*, 2000: 689–690.

KHAN, M. M. A. – SAOOD, H. – AZAM, Z. M. – HUSAIN, S.: Application of phosphorus through foliar spray improves the productivity and quality of Tukhm-e-balanga (*Lallemantia royleana* Benth.). Hamdart Medikus, *42*, 1999: 94–98.

KOŽNAROVÁ, V. – KLABZUBA, J.: Doporučení WMO pro popis meteorologických, resp. klimatologických podmínek definovaného období (Recommendation of World Meteorological Organization to describing meteorological or climatological conditions). Rostl. Výr., *48*, 2002: 190–192.

MATTHAUS, B.: Antinutritive compounds in different oilseeds. Fett. Lipid, *99*, 1997: 170–174.

OVEREEM, A. – BUISMAN, G. J. H. – DERKSEN, J. T. P. – CUPERUS, F. P. – MOLHOEK, L. – GRISNICH, W. – GOEMANS, C.: Seed oils rich in linolenic acid as renewable feedstock for environment-friendly crosslinkers in powder coatings. Industrial Crops and Products, *10*, 1999: 157–165.

SIMONA, N. – BORCEAN, A.: *Lallemantia iberica* a possible source of siccative oil. Lucrai Stiintifice Agricultura, Universitatea de Stiinte Agrocola si Medicina Veterinara a Banatului Timisoara, *32*, 2000: 477–482.

WURL, G. – GRAF, T. – BIERTÜMPFEL, A. – VETTER, A.: Ergebnisse mehrjähriger Anbauversuche mit Iberischen Drachenkopf (*Lallemantia iberica*) als Linolensäurelieferant. www.tll.de/info/pdf/aidr0403.pdf.

Received for publication on October 21, 2004
Accepted for publication on November 16, 2004

STRAŠIL, Z. – KÁŠ, M. (Výzkumný ústav rostlinné výroby, Praha-Ruzyně, Česká republika):

Vliv hnojení dusíkem, výsevků a povětrnostních podmínek na výnosy a výnosové složky olejničky iberské *Lallemantia iberica* (L.) FISCH. et MEY.

Scientia Agric. Bohem., *36*, 2005: 15–20.

V polních pokusech v Praze-Ruzyni byl v letech 1994 až 2002 sledován vliv hnojení dusíkem, výsevku a meteorologických podmínek na výnosy a výnosové složky olejničky iberské. V daném období byly každoročně stanoveny obsah oleje v semeni a složení jednotlivých mastných kyselin. Výnos semene byl průkazně ovlivněn rokem pěstování. Za sledované období bylo dosaženo průměrného výnosu semene přepočteného na sušinu 0,904 t.ha^{-1}. Výnosy semen přepočtené na sušinu kolísaly v průměru od 0,212 t.ha^{-1} v roce 1998 až po 1,872 t.ha^{-1} v roce 1999. Použité dávky dusíku se v průměru průkazně neprojevily na výnosech semene v porovnání s nehnojenou variantou. Při vyšším výsevku (V_2) bylo zjištěno v průměru za sledované období neprůkazné snížení výnosů semene o 3,1 % v porovnání s výsevkem nižším (V_1). Výnosy semene byly ve většině sledovaných let také nepříznivě ovlivněny výskytem plísně šedé (*Bortytis cinerea* Pers.:Fr.). Během celého období sledování nebyl zjištěn (kromě plísně šedé) silnější výskyt chorob nebo škůdců. Výnos stonků olejničky byl průkazně ovlivněn ročníkem a výsevkem. Při vyšším výsevku V_2

bylo dosaženo o 7,6 % vyšších výnosů stonků v porovnání s výsevkem V_1. V průměru za sledované období bylo dosaženo výnosu 2,64 $t.ha^{-1}$ přepočtených na sušinu. Počasí průkazně ovlivňovalo všechny sledované ukazatele. Použité hnojení mělo průkazný vliv na HTS a počet větví na rostlinu. S rostoucími dávkami dusíku klesala v průměru HTS, ale naopak rostl počet větví na rostlinu. Výsevek průkazně ovlivňoval počet tobolek na rostlinu a počet pater na rostlinu. Při výsevku V_2 bylo zjištěno v průměru o 36,4 % méně tobolek v porovnání s výsevkem V_1. Ostatní sledované ukazatele nebyly hnojením nebo výsevkem průkazně ovlivněny. Obsah oleje v semenech kolísal podle jednotlivých let od 22,9 % v roce 2002 do 36,7 % v roce 2003. Obsah oleje v průměru za sledované období byl 30,6 %. Obsah jednotlivých mastných kyselin kolísal v závislosti na ročníku méně než obsah oleje. Z jednotlivých mastných kyselin převažovala kyselina linolenová, u které byl zjištěn v průměru za sledované období obsah 62,2 %. Více než 10% obsah byl zjištěn také u kyselin olejové a linolové.

olejnička iberská; hnojení dusíkem; výsevek; výnosy; struktura výnosu; olejnatost; mastné kyseliny

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Contact Address:

Ing. Zdeněk S t r a š i l , MA, Ph.D., Výzkumný ústav rostlinné výroby, Drnovská 507, 161 06 Praha 6-Ruzyně, Česká republika, tel.: +420 233 022 464, fax: +420 233 311 591, e-mail: strasil@vurv.cz