IMPACT OF SOME SELECTED AGRICULTURAL MEASURES AND SITE CONDITIONS ON ECONOMICALLY SIGNIFICANT CHARACTERISTICS OF CRAMBE*

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In the years 1994–1999 and 2002–2008 the field trials with crambe (*Crambe abyssinica* Hochst. ex R.E. Fries) were conducted at four and two different sites, respectively. The sowing rates were 80 and 140 germinable seeds per square metre and three graded doses of N fertilization (0, 40, 80 kg.ha^{-1}) were applied in these trials. The yields of seed and straw, yield structure, health state and degree of stand infestation by pests were examined. Oil content in seeds and composition of individual fatty acids were determined every year. The length of growing season fluctuated between 110 and 130 days. Colder and damper conditions caused a prolongation and dryer conditions a shortening of vegetation period. The strongest occurrence of pests (flea beetles, blossom beetles) was found at the warmest site at Troubsko. The average seed yields varied between 0.84 t.ha^{-1} and 2.47 t.ha^{-1}. Statistical evaluation showed that seed yields were significantly influenced by the site, year, N fertilization and sowing rates. Average oil content in crambe seeds (pods and pericarp) was 32.05% vol. From individual fatty acids, the erucic acid had the highest content (56.4%) followed by oleic acid (17.6%) and linoleic acid (10.9%). The used nitrogen rates had not any significant effect on oil content. The nitrogen rate 80 kg.ha^{-1} reduced oil content in crambe seeds on average by 1.8% in comparison with non-fertilized plots.

crambe; yields; N fertilization; yield structure; oil content

INTRODUCTION

The development trends in the EU as well as in the Czech Republic indicate, that in the European agriculture comes to the crop overproduction destined for the nutritive purposes. The agriculture in advanced industrial countries follows already the new direction, when there are grown, apart from classic crops intended for the food industry, also alternative plants utilized predominantly for non-food purposes. This trend is unavoidably applied also in our agriculture. With regard to the sustainable development of agriculture we are obliged to make more radical innovations in the soil management system.

In recent years there have been tested experimentally in the world as well as in our country the so-called non-traditional oil plants, which can be grown on set-aside land, can enlarge species composition of plants grown in our agriculture and serve as the raw material in oleochemical industry. These newly tested plants must fulfil certain requirements of the above mentioned industry, which enable their profitable processing. The seeds of these plants must either contain adequately quantity of oil, or must have the demanded spectrum of fatty acids, or high content of one fatty acid, eventually oils and fats with functional groups etc. To these crops belongs also crambe.

The crambe (*Crambe abyssinica* Hochst. ex R.E. Fries) belongs to the old cultural plants. It comes from Ethiopia table lands. It is the annual plant with the short vegetation period, with average demands on soil and nutrients. Crambe seeds content 25 up to 50% oil, the share of oil cakes without shells is 47 till 72% and about 3% shells.

At the present time an increased attention is paid to the crambe above all in the USA (F á b r y et al., 1990), but also in western Europe (S e e h u b e r, 1987). In the Czech Republic crambe was grown successfully on relatively large areas in all production regions in the past in early sixties of the last century (H a n n i c h et al., 1967; F á b r y et al., 1990).

The Crop Research Institute in Prague-Ruzyně in co-operation with other organizations started several years ago the growing of non-traditional industrial and energy crops. The research was aimed partly at screening, it means searching for plant species, eventually plant varieties suitable for industrial and energy utilization, partly at elaboration of their large scale growing technology. At the present time we have at disposal the multi-year results of field experiments from ecologically different sites.

MATERIAL AND METHODS

The aim of this study was to determine the effects of N-fertilization, sowing rate rate (stand density), year and site on the different examined characters.

The field experiments with crambe on small plots have been carried out in the years 1994–1999 on four different

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experimental sites (Ruzyně, Troubsko, Lukavec and Chomutov) in three repetitions and plot size was 5 x 2.5 m^2. Soil and climatic characteristics of individual experimental sites are shown in Table 1. The seed destined for establishment of field trials (variety Indy) was obtained in 1992 from Institut für Pflanzenbau und Pflanzenzüchtung in Braunschweig (Federal Republic of Germany). In the following years we used the seed from the harvest of the previous year. The field trials were performed at two experimental sites (Ruzyně, Lukavec) in the period 2002 up to 2008. The variety "Borowski" was examined in these trials. A cereal (spring barley or winter wheat) was used in all experiments as a preceding crop.

The fertilization in the field trials was as follows: In autumn every year we applied the mineral P and K fertilization in the rate of 60 kg.ha^{-1} P_2O_5 in form of superphosphate and 60 kg.ha^{-1} in potassium salt. In the trials three nitrogen fertilization rates were used (N0 – without fertilization N, N1 – 40 kg.ha^{-1} N before sowing and N2 – 80 kg.ha^{-1} N in two rates: 40 kg before sowing and 40 kg N in the stage of formation of flower buds). Before sowing ammonium sulphate was used and in the course of vegetation ammonium saltpetre with limestone.

Two sowing rates were studied: V1 – 0.8 mil., V2 – 1.4 mil. germinable seeds per 1 ha at row width 25 cm. The other agricultural measures were carried out as it is common in agricultural practice.

During the vegetation period we have monitored the health state, degree of stand infestation by pests and diseases, weed occurrence and plant number before harvest. We also determined the seed and straw yields, weight of thousand seeds (WTS), duration of vegetation period (from sowing up to harvest) and plant length. At selected variants oil content in seeds and composition of individual fatty acids were determined every year. The oil content in seeds was detected by means of the Soxhlet extraction method, individual fatty acids by gas chromatography. Analyses of variance were used for the evaluation of results.

RESULTS AND DISCUSSION

It is generally known that crambe can not compete with weeds in early developmental stages. It lasts 3 up to 4 weeks before the stand becomes closed. This period is particularly prone to weed infestation. The young stands cannot be harrowed due to possible plant damage. From this reason it is necessary to apply pre-emergence or post-emergence herbicides. In case of sowing into broader rows it is possible to utilize row cultivation against weeds. At narrower rows the weed control should be based on the application of similar kinds of herbicides as it is in case of other spring cruciferous oil plants. Every year it was necessary to apply the herbicides at the all experimental sites. The strongest weed pressure was recorded et experimental site in Lukavec. The prevalence of certain weed species was for decisive for the choice of herbicide. In our trials we used pre-emergence way on all experimental sites Butisan 400 SC in rate 2 l.ha^{-1}. Also other herbicides were used and tested. The functioning of used herbicides and interspecific competition between crambe and weeds are mentioned in the article S t r a š i l (2001).

In our field trials conducted at two different sites in the years 1994 – 1997 weed spectrum and effect of weeds on yield traits were studied. Inter-species competition was tested at two different sowing rates of crambe and two doses of N-fertilization in industrial fertilizers: without N fertilization and at the N rate of 80 kg.ha^{-1}. The total number of weeds in conversion into area was lower at the site with better weather conditions in Prague-Ruzyně (on average 70.8 plants.m^{-2}) compared with cooler and moister site at Lukavec near Pelhřimov (234.9 plants.m^{-2}). Average dry matter of weeds in Ruzyně was 62.2 g.m^{-2}, at Lukavec it was 76.4 g.m^{-2}. Higher values found at Lukavec were given by high number of weeds per area, as well as by the fact that crambe stands here were thinner (Ruzyně 145, Lukavec 215 plants.m^{-2}). The number of weeds had significantly negative impact on the grain yields of crambe only on N-untreated plots and also on the plots with higher sowing rate. No significant relationship has been found between number of weeds and other studied parameters (weight of thousand seeds, number of crambe plants per area, yield of crambe total phytomass). In addition higher sowing rate of crambe reduced number of weeds and their phytomass, what had a positive effect on the increase of seed yield. When the plots treated with suitable herbicide (Metazachlor) were compared with identical untreated plots, we observed in untreated plots a decrease in the yield of crambe seeds on average by 16.4% (S t r a š i l , 2001).

Crambe has shown in the majority of years relatively good health state. In some years weaker occurrence of grey mould (*Botritis cinerea* Pers.) and Alternaria (*Alternaria* spp.) was recorded. The occurrence of flea beetles and later blossom beetles was recorded at all experimental sites in early stages of growth. The other diseases and pests have been recorded in the course of monitored period only occasionally and moreover, under threshold of harmful effect. The maximum pest occurrence was monitored on the warmest experimental site in Troubsko. The appropriate applications of insecticides were used in case of higher occurrence of the pests.

The length of vegetation period (from sowing up to harvest, or till full ripeness of stand) varied according to sites and individual years from 100 days in Chomutov in 1998 up to 150 days on the experimental site in Lukavec in 2004. The average length of vegetation period in the years 1994–1999 was in Ruzyně 129 days, in Troubsko 110 days, in Lukavec 130 days, and in Chomutov 116 days (Table 2). Generally, it is possible to state, that the length of vegetation period was prolonged in colder and damper conditions and shortened in warmer and dryer conditions. K u l i g (1997) observed, that high rainfalls in July and August will postpone seed ripening.

The length of vegetation period was mainly dependent on site and year effects. We did not determine any significant differences in the length of vegetation period caused by differential nitrogen fertilization. The vegetation period in

Table 1. Site conditions of experimental localities

Indicator	Experimental locality			
	Praha-Ruzyně	Troubsko	Lukavec	Chomutov
Geographical latitude	50°04′	49°12′	49°37′	49°37′
Geographical longitude	14°26′	16°37′	15°03′	13°23′
Elevation height above sea-level (m)	350	270	620	363
Soil species	clay-loam	loam	sandy-loam	sandy-loam
Soil type	orthic luvisol	chernozem luvisol	orthic cambisol	stagno-gleic cambisol
Average annual air temperature (°C)	8.2	8.4	6.9	7.6
Average annual rainfall sum (mm)	477	547	686	514
Agro-chemical properties of the top-soil layer:				
Humus content (%)	2.3	2.0	1.5	1.9
pH (KCl)	5.57	5.94	5.43	5.03
P content (Mehlich II, mg.kg^{-1} soil)	124.9	112.0	131.0	16.6
K content (Mehlich II, mg.kg^{-1} soil)	126.0	199.7	166.0	44.9

Table 2. Average dry matter seed yields of crambe (t.ha^{-1}) and average vegetation period length (days) from sowing to harvest

Site/indicator	N0	N1	N2	V1	V2	Average	Vegetation period length
Seed yields							
Ruzyně (1994–1999)	1.593	1.645	1.652	1.593	1.667	1.630	129
Troubsko (1994–1999)	2.261	2.398	2.470	2.283	2.466	2.374	110
Lukavec (1994–1999)	1.164	1.384	1.607	1.377	1.409	1.393	130
Chomutov (1994–1999)	0.840	0.915	0.847	0.889	0.846	0.866	116
Average of sites (1994–1999)	1.464	1.586	1.644	1.535	1.597	1.566	121
Ruzyně (2002–2008)	1.043	1.234	1.055	1.053	1.168	1.110	116
Lukavec (2002–2008)	0.915	1.170	1.326	1.044	1.230	1.137	124
Average of sites (2002–2008)	0.979	1.202	1.191	1.049	1.199	1.124	120
Ruzyně (1994–1999, 2002–2008)	1.290	1.389	1.294	1.270	1.379	1.325	122
Lukavec (1994–99, 2002–2008)	1.036	1.288	1.465	1.191	1.335	1.325	126
Average of sites (1994–2008)	1.163	1.339	1.380	1.267	1.357	1.294	122

Note: N doses in industrial fertilizers (kg.ha^{-1}): N0 = 0, N1 = 40, N2 = 80
Number of germinating seeds per m^2: V1 = 80, V2 = 140

Table 3. Average dry matter straw yields of crambe (t.ha^{-1})

Site/indicator	N0	N1	N2	V1	V2	Average
Ruzyně (1994–1999)	2.935	2.935	3.133	2.936	3.072	3.002
Troubsko (1994–1999)	2.419	2.611	2.674	2.587	2.541	2.566
Lukavec (1994–1999)	2.521	2.911	3.330	2.932	2.910	2.921
Chomutov (1994–1999)	1.753	1.647	1.867	1.733	1.777	1.754
Average of sites (1994–1999)	2.407	2.126	2.752	2.547	2.575	2.561
Ruzyně (2002–2008)	4.237	4.419	4.366	4.321	4.361	4.341
Lukavec (2002–2008)	3.546	4.147	5.065	4.053	4.452	4.253
Average of sites (2002–2008)	3.892	4.283	4.716	4.187	4.407	4.297
Ruzyně (average 1994–1999, 2002–2008)	3.581	3.763	3.772	3.652	3.759	3.705
Lukavec (average 1994–1999, 2002–2008)	3.207	3.864	4.599	3.736	4.044	3.890
Average of sites (1994–2008)	3.394	3.814	4.185	3.694	3.901	3.798

Note: N doses in industrial fertilizers (kg.ha^{-1}): N0 = 0, N1 = 40, N2 = 80
Number of germinating seeds per m^2: V1 = 80, V2 = 140

Table 4. ANOVA mean squares of the studied characteristics obtained from experiments at Ruzyně, Lukavec, Troubsko and Chomutov during 1994–1999

Source of variation	df	Seed yield	Straw yield	Plant density	Plant length	WTS
Site	3	62.981**	14.868**	41 249.5**	55 14.0**	116.184**
Year	5	41.098**	8.808**	11 233.6**	3 068.5**	40.889**
N-fertilization	2	0.315**	2.086**	400.3	113.0	5.366*
Sowing rate	1	0.195*	0.284	44 339.4**	50.0	1.748
Two way interactions	41	25.369	4.110	5 886.1	1 216.0	24.033
Site × Year	15	69.221**	10.575**	15 140.1**	3 040.1**	62.078**
Site × N-fertilization	6	0.069	0.622*	834.1	108.5	1.758*
Site × Sowing rate	3	0.076	0.118	1 282.4	211.4*	4.766
Year × N-fertilization	10	0.104*	0.463*	221.6	210.3**	1.160
Year × sowing rate	5	0.019	0.229	664.2	166.2	3.425*
N-fertilization × sowing rate	2	0.014	0.013	555.0	98.2	0.315
Error	81	0.042	0.234	870.6	77.3	1.350

Note: WTS – weight of thousand seeds
* $P < 0.05$, ** $P < 0.01$

Table 5. ANOVA mean squares of studied characteristics obtained at Ruzyně and Lukavec sites during 1994–1999 and 2002–2008

Source of variation	df	Seed yield	Straw yield	Plant density	Plant length	WTS
Site	1	0.263	0.263	1 3828.4**	1676.5**	89.69**
Year	12	3.339**	17.120**	35 736.6**	2 433.9**	5.74**
N-fertilization	2	0.989**	7.088**	89.8	337.0**	0.41
Sowing rate	1	1.006**	0.761	31 023.3**	280.4*	0.96
Two way interactions						
Site × Year	12	1.007**	7.973**	20 419.2**	2 408.1**	6.25**
Site × N-fertilization	2	0.301*	4.237**	795.5	84.3	0.28
Site × Sowing rate	1	0.015	0.760	7 652.2**	19.5	0.40
Year × N-fertilization	24	0.051	0.345	285.7	72.4	0.19
Year × sowing rate	12	0.125	0.245	682.9	183.0**	0.90*
N-fertilization × sowing rate	2	0.011	0.051	1 337.9	15.7	0.57
Error	62	0.069	0.597	565.8	65.7	1.81

Note: WTS – weight of thousand seeds
* $P < 0.05$, ** $P < 0.01$

various years as well as at average for experimental sites (122 days – Table 2) was longer than is indicated for the conditions of the Czech Republic, for example Baranyk et al. (1995) mentioned the vegetation period of crambe to be only 80 up to 90 days long. The American sources (Golz, 1993) state that the length of vegetation period in conditions of Northern Dakota varies between 83 and 95 days in dependence on variety.

In the period 2002–2008 the length of vegetation period from sowing up to harvest varied from 116 (Ruzyně) to 124 days (Lukavec) was determined. If we compare the periods 1994–1999 and 2002–2008 it is evident from the results, that the length of vegetation period in Ruzyně was shorter by 13 days and in Lukavec by 6 days in favour of the period 2002–2008. At this time the average temperatures for the main part of vegetation period (April–October) were in Ruzyně by 1.0 °C and in Lukavec by 0.1 °C higher in comparison with the period 1994–1999. The rainfalls were in Ruzyně and Lukavec, respectively, on average for given periods almost the same. The difference in length of vegetation periods could be also caused to a certain extent by change of variety in trials, because the original variety Indy was replaced in the period 2002–2008 by the variety Borowski.

The number of plants per m^2 varied in the monitored period from 31 up to 157. On average the supposed number of plants when using the sowing rates V1 a V2 was not reached. At Ruzyně 98 plants.m^{-2} was determined on average at sowing rate V1 and 117 plants.m^{-2} at sowing rate V2. At Lukavec the average number of plants per m^2 was 119 for sowing rate V1 and 152 for sowing rate V2. A significant effect on the stand density had site, year and number of plants (sowing rate) (Tables 4 and 5). It was not determined a significant effect of the used nitrogen fertilization on the number of emerged plants. Fábry, Hannich (1964) recommended for stand density of crambe about 200 plants.m^{-2}.

The length of plants varied in the different years and sites on average from 55 cm (Ruzyně, year 2007) up to 127 cm (Lukavec, year 1997). The average length of plants

was in the monitored periods 95 cm at Ruzyně and 90 cm at Lukavec. The length of plants was significantly influenced by site and year in both of monitored periods (Tables 4 and 5). In the period 1994–1999 any significant effect neither of N fertilization or sowing rate on the length of plants was not determined (Table 4).

The weight of thousand seeds (WTS) was on average in the monitored period 7.621 g at the site Lukavec and 6.067 g at Ruzyně site. As shown in Tables 4 and 5, experimental site and year had highly significant effect on WTS, but the effect of the used nitrogen doses and sowing rates was often not significant.

The average seed yields converted into dry matter obtained in different field experiments are shown in Table 2. The seed yields varied very much in dependence on the weather conditions in different years and the used agricultural measures. The seed yield was significantly influenced by the site, weather conditions in individual years, N-fertilization and also by sowing rate (Tables 4 and 5).

The seed yields converted into dry matter were ranged from 0.84 t.ha^{-1} on variants non-fertilized by nitrogen (Chomutov) to 2.47 t.ha^{-1} obtained after the use of 80 kg.ha^{-1} N (Troubsko) (Table 2). The average seed yield in the 1994–1999 period was 1.566 and 1.124 t.ha^{-1} in the period 2002–2008. Seed yields obtained in our experiments are similar as those obtained in the USA (1.4 t.ha^{-1}), where the crambe is grown on the area of several thousands of hectares (Golz, 1993). Fábry et al. (1990) reached in the conditions of the Czech Republic in the period 1962–1965 the average seed yield 1.77 t.ha^{-1}.

The yields of crambe seed in the field experiments in Austria ranged, in dependence on genotype and site conditions, from 0.97 to 3.33 t.ha^{-1} (Vollmann, Ruckenbauer, 1993). The seed yields ranging from 1.95 to 3.80 t.ha^{-1} were obtained in the field trials carried out on degraded black soil near Cracow in Poland (Kulig, 1997). In the contrast to our experiments this author did not find a significant effect of the used nitrogen rates or sowing rates (100 or 200 germinable seeds on square meter) on the seed yields. N fertilization had in our experiments highly influence the seed yields especially at the site Lukavec. At Prague-Ruzyně and Troubsko, where more fertile soils are available, the highest yields were reached already at N rate of 40 kg.ha^{-1}, while in Lukavec at the highest rate of 80 kg.ha^{-1} (Table 2). Similarly Fábry et al. (1990) consider the rates 60 up to 80 kg.ha^{-1} N as sufficient for obtaining high yields. Szczebiot (2002) states that the highest yield of crambe seed was recorded, when 50% of total nitrogen rate (40 kg.ha^{-1}) was applied before sowing and second half of rate in the form of urea was used during the vegetation period.

It is evident from our results that crambe achieved in the examined conditions lower yields than winter rape, which over the past 10 years amounted to 2.75 t.ha^{-1} (Potměšilová, Adamec, 2008). However, it is necessary to mention, that the yields lower than in winter rape were in crambe reached at relatively lower total inputs.

It is much more convenient to make comparisons with the other spring oil plants. According to the Situation and Forecast Report for Oil Plants of the Ministry of Agriculture of the Czech Republic (Potměšilová, Adamec, 2008) the seed yields of white mustard over the past 10 years varied from 0.60 to 1.14 t.ha^{-1}, in oleaginous flax from 0.66 to 1.57 t.ha^{-1}, in sunflower from 1.99 to 2.51 t.ha^{-1} and in poppy from 0.46 to 0.90 t.ha^{-1}, which is lower then achieved average seed yields of crambe.

The average straw yields of crambe reached in our experiments are shown in Table 3. The straw yield was highly influenced by site, weather conditions in different years and also by nitrogen fertilization (Tables 4 and 5). The nitrogen rates N1 and N2, respectively, increased in comparison with non-fertilized variants (1994–2008) the straw yields by 0.42 t.ha^{-1} (12.4%) and 0.79 t.ha^{-1} (23.3%), respectively (Table 3). The used sowing rates did not manifest a significant effect on straw yields (Tables 4 and 5). The influence of observed indicators on other monitored factors (stand density, length of plants, weight of thousand seeds) is statistically depicted in tables 4 and 5. The detailed analysis of the given problems has been mentioned already in article (Strašil, Skala, 1997).

The crambe straw, similarly as cereal straw, can be used for example for combustion. In the harvest time, in full ripeness of seed, we determined the mean water content in crambe straw to be about 30%. Therefore, it is necessary in the majority of cases to get the crambe straw used for burning, storage or for another modifications (pelettes, briquettes) in the fields dried and then the dry straw with water content under 20% take from the field for mentioned utilization. We have determined the average combustion heat of 17.52 GJ.t^{-1} for crambe straw dry matter and 24.68 GJ.t^{-1} for seed dry matter (Strašil, 1998).

The average oil content in crambe seeds (pods with pericarp) was in the monitored period 32.05% per volume. The similar oil content in crambe seeds (29.0%) was in the conditions of the Czech Republic detected by Baranyk et al. (1995). The average oil content of crambe seeds was reported to be 31.4% in the conditions in India (Nagaraj, 1998). In Austria the oil content of seeds ranged from 22.6 to 38.4% (Vollmann, Ruckenbauer, 1993).

The share of individual fatty acids was on average as follows: erucic acid 56.4%, oleic acid 17.6% and linoleic acid 10.9% (Table 6). The oil content in seeds and composition of individual fatty acids were significantly influenced by year more than by the site (Table 7). The used nitrogen rates had not a significant effect on oil content. The nitrogen rate 80 kg.ha^{-1} reduced on average oil content in crambe seeds by 1.8% in comparison with non-fertilized plots (Table 6).

CONCLUSION

Due to relatively lower demands for application of high input agricultural measures crambe can be reckoned to be a promising alternative crop, able to give high seed yields especially when cultivated on productive soils and in warmer regions (Strašil et al., 1995). Under such conditions it can replace some less productive spring oil

Table 6. Oil content (% by volume) and composition of predominant fatty acids (%) obtained at Ruzyně site (average of 1994–1999, 2002–2008) with two levels of N fertilization (N0 = 0, N2 = 80 kg.ha^{-1}) and sowing rate V1 (80 seeds per m^2)

Variant	Oil content	Palmitic acid	Oleic acid	Linoleic acid	Linolenic acid	Erucic acid
N0V1	32.90	2.40	17.30	10.30	6.40	57.80
N2V1	30.20	2.50	17.10	10.40	6.90	57.30
Average	31.55	2.45	17.20	10.35	6.65	57.55

Table 7. ANOVA mean squares for oil content from 2002–2008 experiments at two sites and with two levels of N fertilization (N0 = 0, N2 = 80 kg.ha^{-1}) and sowing rate V1 (80 seeds per m^2)

Source of variation	df	Mean squares	*F*-value	*P*
Site	1	32.386	16.375	0.0068**
Year	6	92.516	46.777	0.0001**
N-fertilization	1	0.917	0.464	0.5214
Two way interactions				
Site × Year	6	11.807	5.969	0.0235*
Site × N-fertilization	1	0.175	0.088	0.7762
Year × N-fertilization	6	6.079	3.074	0.0988
Error	6	1.978		

* $P < 0.05$, ** $P < 0.01$

crops, e.g. white mustard or spring rape. The detected composition of individual fatty acids and also the other here mentioned properties are important prerequisites for an ample utilization of this crop in the chemical industry.

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Vliv některých vybraných agrotechnických opatření a stanovištních podmínek na hospodářsky významné znaky krambe.

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V letech 1994–1999 probíhaly na čtyřech odlišných stanovištích a dále v letech 2002–2008 na dvou stanovištích maloparcelkové polní pokusy s krambe (*Crambe abyssinica* Hochst. ex R.E. Fries). V pokusech byly sledovány varianty s třemi stupni hnojení N (0, 40, 80 kg.ha^{-1}) a dvěma výsevky 80 a 140 klíčivých semen na m^2. Byly sledovány výnosy semene, slámy, struktura výnosu, zdravotní stav a stupeň napadení porostů škůdci. Každoročně byly stanoveny obsah oleje v semenech a zastoupení jednotlivých mastných kyselin. Délka vegetační doby kolísala v rozmezí 110 až 130 dní. Délka vegetační doby se prodlužovala s chladnějšími a vlhčími podmínkami a zkracovala s teplejšími a sušími podmínkami. Nejsilnější výskyt škůdců (dřepčíků, blýskáčků) byl zjištěn na nejteplejším stanovišti v Troubsku. Průměrné výnosy semene kolísaly od 0,84 t.ha^{-1} do 2,47 t.ha^{-1}. Výnos semene byl průkazně ovlivněn všemi sledovanými ukazateli – stanovištěm, počasím v jednotlivých letech, hnojením i výsevkem. Olejnatost v semenech krambe (šešule s oplodím) byla v průměru za sledované období 32,05 % objemových. Z jednotlivých mastných kyselin měla v průměru největší procento zastoupení kyselina eruková (56,4 %), dále následovala kyselina olejová (17,6 %) a kyselina linolová (10,9 %). Hnojení dusíkem nemělo průkazný vliv na obsah oleje v semenech. Dávka dusíku 80 kg.ha^{-1} snižovala v průměru obsah oleje v semenech krambe o 1,8 % v porovnání s nehnojenou variantou.

krambe; výnosy; hnojení N; struktura výnosu; olejnatost

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