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RESEARCH ARTICLE

Influence of mineral fertilization level on productivity of *Camelina sativa* in the conditions of Prycarpattia

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The results of research on studying the influence of mineral fertilization level on the yield of *Camelina sativa* , variety Hirsky, on sod-podzolic soils in the conditions of Prycarpattia. It was found that the highest yield of *Camelina sativa* 1.88 t/ha was obtained by application of mineral fertilizers with a dose of $N_{30}P4_5K_{45}+N_{60}$, which is 0.89 t/ha more than in the control variant. The lowest yield - 0.99 t/ha was obtained on the control variant (without fertilizer application). The highest oil content in the seeds varies depending on the fertilizer dose from 35.25% to 37.65% and fat (0.36-0.6 t/ha). The content of glucosinolates varies from 18.5 mcmole/g to 30.0 mcmole/g. Among the fatty acids which form the basis of *Camelina sativa* oil, the most variable are oleic and linolenic, portion of which accounted for 67.7% of other acids.

Keywords: *Camelina sativa*; Mineral fertilizers; Yield; Seed quality

Introduction

Camelina sativa is a valuable oilseed crop. It contains about 46% of oil and 32% of crude protein. *Camelina sativa* oil has a unique composition of fatty acids (linoleic - 20%, linolenic - 32%, oleic - 17%, eicosene - 15%), which gives reason to attribute it to semi-drying oils, similar to flaxen. The high content of oil in the seeds, the ratio of fatty acids and high iodine number (132-135) provide a wide use range of this oil as technical (Hospodarenko and Rassadina, 2015; Poliakov, 2011). The productivity of *Camelina sativa* , like most oilseeds, is stipulated primarily by the optimal amount of available nitrogen, which determines the levels of yield and mobile phosphorus and metabolism potassium that affect seed quality (Hryhoriv, 2010). As it is known the use of optimal doses in the appropriate ratio of NPK helps to increase yields. Rather important are times and methods of fertilizer application. All calculated doses of nutrients in intensive technology are generally used under basic soil tillage in spring, prior to application of herbicides (Rassadina, 2015). Now-a-days, *Camelina sativa* is grown on the territory of Ukraine in the northern regions of forest-steppe zone, western regions and Polissia (Demydas et al., 2011). *Camelina sativa* is characterized by a number of valuable biological properties which make interest in economic aspect. Seed yield can reach 3.2 t/ha, and its oil content 44% and up to 32% of crude protein (Hetman, 2011). There are data on the presence of samples with enhanced oleic acid content in the oil (up to 32%), which makes it possible to expect on its wide use in the future as an edible oil (Komarova and Rozhkovan, 2003). In addition, this culture is promising for growing in the conditions of steppe zone of our country, because it is unpretentious to the conditions of cultivation, cold and drought resistant, characterized by significant resistance to diseases and pests. It should be noted that *Camelina sativa* oil obtained by hot pressing has a greenish-brown color, with a specific smell and taste of garlic; obtained by cold pressing - golden yellow color and good taste qualities. Semi-dry *Camelina sativa* oil is used in many sectors of economy: metallurgy, paint and varnish production, soap making, cosmetics production. Since *Camelina sativa* oil has unique properties and composition, including polyunsaturated fatty acid composition, high content of vitamins, high resistance to oxidation, it is also used as a therapeutic and prophylactic means and dietary product (Nyzova and Kaluhyna, 1999; Kulakovaet al., 2003, Butenko et al., 2019). First of all, linoleic and linolenic acids can reduce blood cholesterol level, normalize blood pressure, give stability and elasticity to blood vessels, prevent blood clots, are useful for disorders of fat metabolism and inflammatory processes, and reduce the risk of development of atherosclerosis and heart-vessel diseases. A powerful antioxidant complex (vitamins A, C, E) actively protects human body from the action of free radicals and helps to resist aging and diseases. Daily morning consumption of 15 ml of Camelina sativa oil during 2-3 months significantly improves health of the human body. Considering the above mentioned, it is necessary to study which indicators affect productivity of *Camelina sativa* .

Research Methods

Field research was carried out in the technological crop rotation at the department of technology of cultivation, seed production and biochemistry of cruciferous crops of Prycarpattia state agricultural research station of the National academy of agrarian sciences of Ukraine on sod-podzolized soil during 2015-2017.

Soils of the experimental area - sod deep podzolized and gley, with a mechanical composition of large-dusty and heavy-clay with a strong humus horizon up to 75 cm and are characterized by the following indicators: acidity, pH - 5,6, humus content (%) - 2,80, soil provision with main nutrient elements (mg/kg): nitrogen - 79, phosphorus - 103,0, potassium - 139,0.
The precursor is winter wheat. Sowing was conducted according to the scheme of experiment. For the sowing was used the variety Hirsky of selection of the Institute AIP. Taking into consideration the insensitivity of *Camelina sativa* to potassium fertilizers (Poliakov, 2011), only nitrogen and phosphorus fertilizers were studied in the experiment, mineral fertilizers in the form of ammonium nitrate and granular superphosphate were brought under the basic soil tillage according to the scheme:
Control - without fertilizers; Background – ($N_0P_{45}K_{45}$); Background – ($N_{30}P_{45}K_{45}$); Background – ($N_{30}P_{45}K_{45}$) + N_{60}; Background – ($N_{30}P_{45}K_{45}$) + Vympel (500 g/ha) + Oracle multi-complex (1 l/ha) + Oracle colamine boron (1 l/ha) + Oracle sulfur asset (2 l/ha).
The experiment was repeated four times; square of accounting area - 20 m^2.
The control was the variant without fertilizers. Fertilization of *Camelina sativa* crops was performed with nitrogen fertilizers, micro-fertilizers and growth stimulators by appropriate variants of the experiment scheme in the phase of stalking beginning.
In the experiment was sown a variety of *Camelina sativa* Hirsky of Ivano-Frankivsk institute selection of AIP NAAS included in the State register of varieties suitable for extension in Ukraine. The potential seed yield is about 2.0 t/ha, the green mass is 40.5 t/ha (Abramyk et al., 2003; Karpenko et al., 2019).
The technology of *Camelina sativa* cultivation on the study areas was generally accepted for the soil and climatic conditions of Prycarpattia region, except for the factors studied (Syvyryn and Reshetnykov, 1988).
Weather and climatic conditions of the region are one of the main formation factors of crop yield productivity and quality. It can be a decisive criterion for the expediency of growing crops and their introduction in a particular region. Therefore, considerable attention is paid to the analysis of weather conditions during the period of research, the aim of which was to establish the productivity of *Camelina sativa* depending on the variety characteristics and agricultural technology of growing in the conditions of Prycarpattia of Ukraine.
Natural and climatic conditions that have formed in Ivano-Frankivsk region contribute to the development of agriculture and forestry, the cultivation of basic crops.
Analysis of hydrothermal conditions, which were forming in vegetation period of Camelina sativa during the years of research, was carried out according to the data of Ivano-Frankivsk regional meteorological station.
During the vegetative period of *Camelina sativa* during the research the weather conditions differed significantly from the average long-term data both in terms of temperature and amount of precipitation.
The purpose of the research was to study the effect of mineral fertilizers, micro-fertilizers and growth stimulators on the yield and quality of seeds of Camelina sativa variety Hirsky.

Results and Discussion

In our research were studied the effects of fertilizers and growth stimulators on the yield and quality of *Camelina sativa* seeds.
As it is known, the main task of agricultural production in the process of growing crops at modern stage is to improve the production profitability with the increase of agricultural products and minimal energy and resources. The correct combination of these elements gives a yield of 30 c/ha and more (Hryhoriv, 2010). In modern conditions of production intensification, a scientifically substantiated approach for maximum productivity is reduced to the need of application the whole complex of elements of cultivation technology in accordance with the biological characteristics of the crop and soil-climatic conditions of cultivation region.
According to our research, the lowest yield of *Camelina sativa* seeds of Hirsky variety, as expected, was in the variant without fertilizers (control), where it averaged 0.97 t/ha for three years (Table 1). Increasing of mineral fertilizer dose to $N_{30}P_{45}K_{45}$provided a yield increase of 0.43 t/ha or 39.8%. Further increase in doses of mineral fertilizers also contributed to the growth of crop productivity. Thus, in the variant with application of mineral fertilizer dose $N_{30}P_{45}K_{45}$ + N_{60} crop yield increased to 1.9 t/ha, which is higher compared to the control by 1.07 t/ha, and compared to the variant $N_{30}P_{45}K_{45}$ – by 0.3 t/ha. Fertilizer application in the fifth variant with the dose of $N_{30}P_{45}K_{45}$in the main fertilization and in combination with micro-fertilizers and growth stimulators helped to increase the yield to 1.72 t/ha, which is higher than the control by 0.75 t/ha, and in relation to the third variant ($N_{30}P_{45}K_{45}$) yield increased by 0.12 t/ha.

Table 1. Productivity of Camelina sativa depending on the level of mineral fertilization, t/ha (2015-2017).

Variant	Repeating				Increase	
	2015	2016	2017	average	t/ha	%
Without fertilizers (control)	1.03	0.80	1.08	0.97	-	-
$P_{45}K_{45}$	1.42	1.30	1.48	1.40	0.43	39.8
$N_{30}P_{45}K_{45}$	1.62	1.48	1.69	1.60	0.63	54.5
$N_{30}P_{45}K_{45}$ + N_{60}	1.87	1.83	2.01	1.90	1.07	65.7
$N_{30}P_{45}K_{45}$ + micro-fertilizers	1.75	1.60	1.81	1.72	0.75	60.3

HIP05, t/ha 0.14 0.17

Meteorological conditions of the year also affected the level of crop yield. In 2015, the productivity was slightly lower and ranged from 1.03 to 1.87 t/ha, and the average one for backgrounds was 1.67 t/ha. In the second year of research, the productivity of variants varied from 0.8 t/ha to 1.83 t/ha, and the highest yield observed in 2017 was 1.08-2.01 t/ha, which is higher compared to 2015 by 0.14 t/ha.
Obtaining high yields and quality products is the main task of any farming system. 1 kg of *Camelina sativa* seed contains 1.15. f.u., which is approximately the same as rapeseed. However, Camelina sativa predominates over other oilseeds by digestible protein content per one kilogram of seeds and availability of one feed unit. Besides erucic acid there is another component that determines the possibility of using Camelina glabrata for fodder purposes - the presence of glucosinolates (thioglycosides) in their shot. As it is known, glucosinolates - derivatives of thioglycosides, which are harmful sulfur-containing compounds that cause in domestic

animals, when feeding them with *Camelina sativa* oilcake, inhibition of growth, loss of appetite, decrease in live weight gain and also metabolism of iodine that becomes apparent in hypertrophy of thyroid gland (Semenova et al., 2005; Litvinov et al., 2019; Kolisnyk et al., 2019). The main glucosinolates contained in *Camelina sativa* seeds are gluconapine, glucoabrasicanapine and progoitrin. The factors studied in the experiment had a significant effect on the formation of indicators of *Camelina sativa* seed quality (Figure 1).

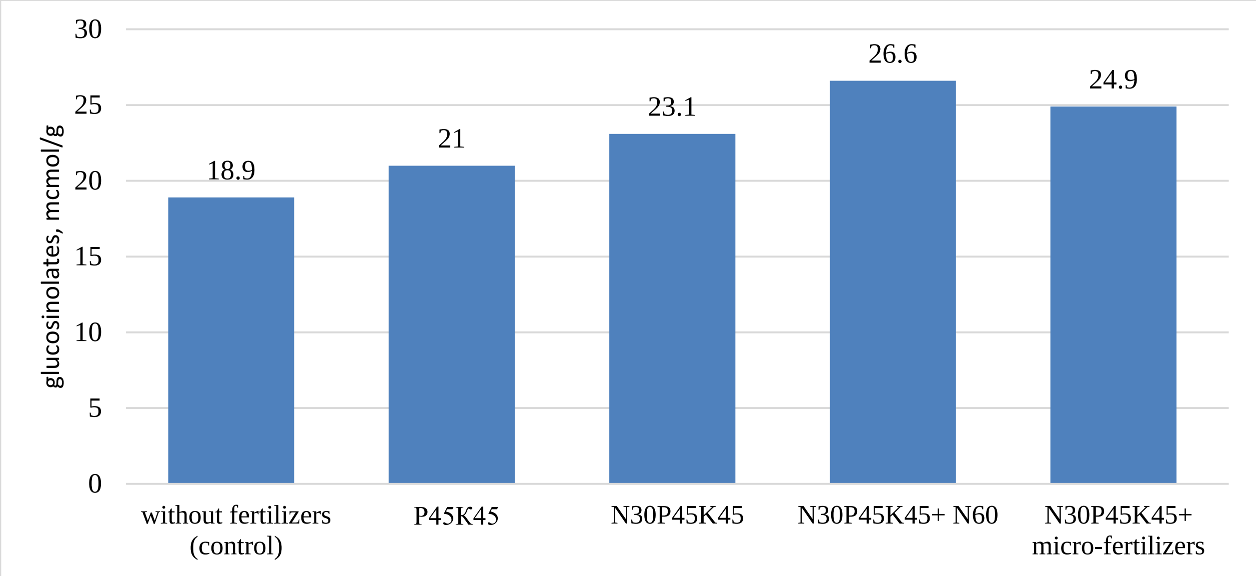

Figure 1. The content of glucosinolates in the seeds of *Camelina sativa* depending on the doses of mineral fertilizers, average for 2015-2017.

Our research shows that with increasing doses of fertilizers has been observed an increase in the content of glucosinolates in the oil of Camelina sativa . The highest content was determined in the variants with the usage of $N_{30}P_{45}K_{45}$+N_{60}, the lowest - in the control variant. According to the results of research it was found that the lowest content of glucosinolates was observed in the control without fertilizers, which was from 18.9 mcmol/g. Application of different doses of mineral fertilizers led to an increase in the content of glucosinolates on average from 2.1 mcmol/g to 7.7 mcmol/g depending on the applied dose of mineral fertilizers.
The highest content of glucosinolates in the seeds of *Camelina sativa* - 26.6 mcmol/g was noted in the variant, where mineral fertilizers were applied with a dose of $N_{30}P_{45}K_{45}$and foliage nitrogen feeding was used with a dose of 60 kg. We should note that with application of phosphorus and potassium fertilizers with a dose of $P_{45}K_{45}$the content of glucosinolates was within 21 mcmol/g, which is 2.2 mcmol/g more than in the control.
Oil is the main product of Camelina glabrata processing. Oil content in the seeds of Camelina glabrata can reach 40-46%. C oil is widely used in many sectors of economy, and due to unique ratio of fatty acids, it has great potential for the use in food industry and medicine (Hospodarenko and Rassadina, 2015;Radchenko et al., 2018).
The oil content in Camelina sativa seeds can vary under the influence of both soil-climatic conditions of a particular region and cultivation technology elements. The study shows that dose increase of nitrogen leads to a decrease of oil content in the seeds (Table 2).

Table 2. Influence of mineral fertilizers on oil content in the seeds of *Camelina sativa* , %.

Variant	Repeating				Increase	
	2015	2016	2017	average	%	%
Without fertilizers (control)	45.04	43.38	45.12	45.18	-	-
$P_{45}K_{45}$	47.40	40.38	45.07	44.28	-0.9	2.3
$N_{30}P_{45}K_{45}$	47.57	39.73	34.68	43.99	-1.19	3.0
$N_{30}P_{45}K_{45}$ + N_{60}	45.66	37.10	44.54	42.43	-2.75	6.7
$N_{30}P_{45}K_{45}$ + micro-fertilizers	46.75	42.55	44.61	44.64	-0.54	1.1

It was found that the maximum oil content in the seeds of *Camelina sativa* - 45.18% was observed in the variant without application of mineral fertilizers. The lowest oil content was observed in the variants with application of mineral fertilizers in a dose of $N_{30}P_{45}K_{45}$in combination with foliage nitrogen fertilization in a dose of 60 kg. Of a.s., which was accordingly 42.43%, and by 2.75% less than the control.
As a result of the research it was determined that application of fertilizer dose of $N_{30}P_{45}K_{45}$+ micro-fertilizers had a positive influence on the oil content of Camelina sativa seeds - 44.64%, which is only 0.54% less than in the control.
As it is known, *Camelina sativa* oil differs sharply from rapeseed and mustard oil due to the higher content of polyunsaturated fatty acids (linoleic and linolenic) and low content of erucic acid (Figure 2).

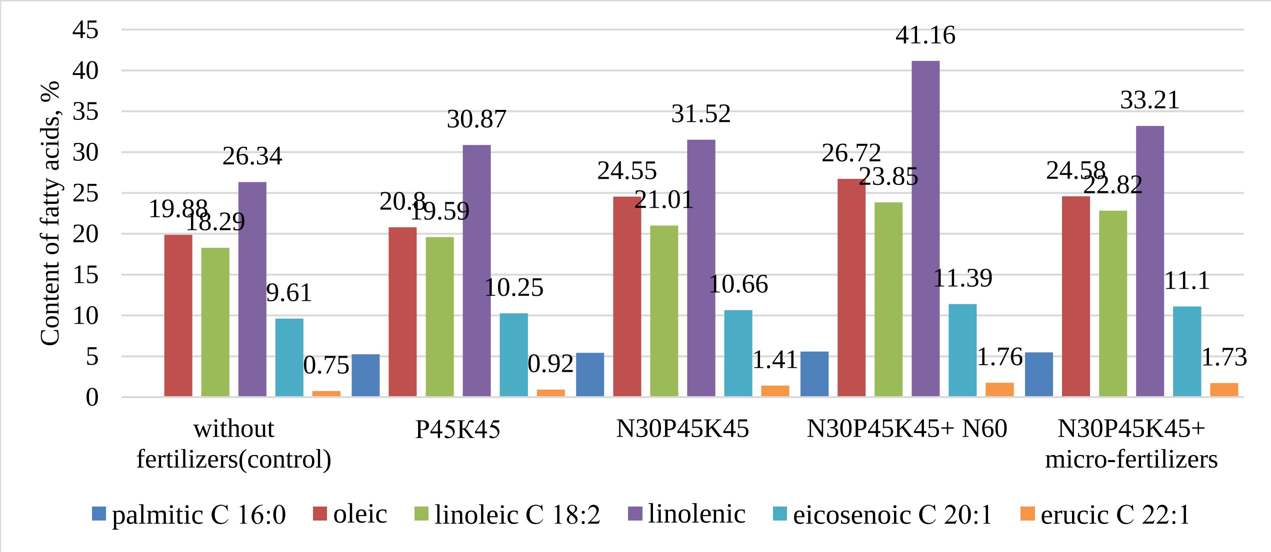

Figure 2. Influence of technology elements of *Camelina sativa* cultivation on fatty acid composition of the seeds, average for 2015-2017,%.

As a result of conducted research it is established that linoleic and linoleic acids are predominant in the oil, the content of oleic and eicosenoic acids is quite high, and erucic acid characteristic to all cruciferous cropsis also present, amount of saturated fatty acids - palmiticis relatively small.

Analysis of the data presented in Figure 2 shows, that the content of unsaturated fatty acids ranged within very wide limits: oleic (C 18: 1) from the lowest value of 19.58% in the variant without mineral fertilizers to the highest 26.72% in the variant with application of mineral fertilizers in a dose of $N_{30}P_{45}K_{45}$and conducting foliage feeding with nitrogen in a dose of 60 kg of a.s.; linoleic (C 18:2) from 18.29% to 23.85% respectively; linolenic (C 18:3) from 26.34% to 41.16%; eicosenoic (C 20:1) was the highest (11.39%) in the variant with application of mineral fertilizers in a dose of N30P45K45 and conducting foliage feeding with nitrogen in a dose of 60 kg of a.s. the lowest 9.61% in the control; erucic (C 22:1) revealed the highest value in the variant with application of mineral fertilizers in a dose of $N_{30}P_{45}K_{45}$ + N60 – 1,76%, the lowest – 0.75% in the control.

Conclusion

The highest yields of *Camelina sativa* of Hirsky variety in the conditions of Prycarpattia region on sod-podzolized soils in amount of 1.9 t/ha were obtained with application of mineral fertilizers in a dose of $N_{30}P_{45}K_{45}$and conducting foliage feeding with nitrogen in a dose of 60 kg. of a.s. The use of mineral fertilizers influences the quality of *Camelina sativa* seeds, in particular, with increasing doses of mineral fertilizers, the content of erucic acid and glucosinolates increases and the oil content decreases. Among fatty acids, which form the basis of Camelina sativa oil, the most variable are oleic and linolenic ones with the ratio 67.7% from other acids.

References

Hospodarenko, H. M., Rassadina, I. Yu. (2015). Quality of *Camelina sativa* seeds depending on fertilizer. Peredgirne ta girske zemlerobstvo i tvarinnictvo. V.58. - P. 55-60.

Rassadina, I. Yu. (2015). Efficiency of application of mineral fertilizers under *Camelina sativa* in black soil podzolized. Agrohimiya i gruntoznavstvo. V.83. - P. 107-110.

Poliakov, O. I. (2011). Agrotechnical and bioclimatic features of formation of productivity and quality of seeds of sunflower, soybean, flax, sesame, *Camelina sativa* , milk weed in the Southern Steppe of Ukraine. avto ref. dis. doktora s.-g. nauk. Dnipropetrovsk. - 38 p.

Hryhoriv,Ya. Ya. (2010). Influence of sowing time and cultivation technologies on the quality of *Camelina sativa.* VisnikNacionalnogouniversitetuvodnogogospodarstva ta pryrodokoristuvannya. Seriya «Silskogospodarskinauky». V. 2 (50). - P. 52-57.

Demydas, H. I., Kvitko, H. P., Hetman, N. Ya. (2011). *Camelina sativa* - oil seed alternative to spring rape seed for biodiesel production. Zb. nauk. pr. VNAU. Vinnytsia. V. 8 (48). - P. 3-8.

Hetman, N. Ya. (2011). Alternative oil seed culture. Zbirnyknaukovykhstatey “III-ho Vseukrainskohoz’izduekolohiv z mizhnarodnoiuuchastyu”. Vinnytsia. V. 2. - P. 465-466.

Komarova, I. B., Rozhkovan, V. V. (2003). *Camelina sativa.* Seeds of oilseeds. Kyiv. V.1. - 614 p.

Radchenko, M. V., Butenko, A. O., Glupak, Z. I. (2018). Effect of fertilizer system and efficiency of growth regulator on buckwheat productivity in the conditions of the northeastern forest-steppe of Ukraine. Ukrainian Journal of Ecology.8 (2), p. 89-94. DOI: http://dx.doi.org/10.15421/2018_314.

Litvinov, D. V., Butenko, A. O., Onychko, V. I., Onychko, T. O., Malynka, L. V., Masyk ,I. M., Bondarieva, L. M., Ihnatieva, O. L. (2019). Parameters of biological circulation of phytomass and nutritional elements in crop rotations. Ukrainian Journal of Ecology, 9 (3), 92-98. DOI: 10.15421 / 2019_714

Karpenko, O. Yu., Rozhko, V. M., Butenko, A. O., Masyk, I. M., Malynka, L. V., Didur, I. M., Vereshchahin, I. V., Chyrva, A. S., Berdin, S. I. (2019). Post-harvest siderates impact on the weed littering of maize, 2019, 9 (3), 300-303. DOI: 10.15421 / 2019_745

Kolisnyk, O. M., Butenko, A. O., Malynka, L. V., Masik, I. M., Onychko, V. I., Onychko, T. O., Kriuchko, L. V., Kobzhev, O. M. (2019). Adaptive properties of maize forms for improvement in the ecological status of fields. Ukrainian Journal of Ecology, 2019, 9 (2), 33-37.

Nyzova, H. K., Kaluhyna, A. F. (1999). Comparative characteristics of *Camelina sativa* in terms of quantity and quality of oil. Lviv: SPb VIR. V. 156. - 116 p.

Kulakova, S. N., Happarov, M. M., Viktorova, E. V. (2003). About the new generation vegetable oils in our diet. Maslozhirovaya promy`shlennost`. № 1. - P. 4-8.
Renzyaeva, T. V., Renzyaev, O. P., Kryvovaz, V. Y. (2003). The quality and fatty acid composition of Camelina oil.Maslozhirovayapromy`shlennost`. № 3. - P. 62-63.
Butenko, A. O., Sobko, M. G., Ilchenko, V. O., Radchenko, M. V., Hlupak, Z. I., Danylchenko, L. M., Tykhonova, O. M. (2019). Agrobiological and ecological bases of productivity increase and genetic potential implementation of new buckwheat cultivars in the conditions of the Northeastern Forest-Steppe of Ukraine. Ukrainian Journal of Ecology, 9 (1), - P. 162-168.
Abramyk, M. I., Mazra, V. O., Kunychak, H. I., Kozak, T. I. (2003). Catalog of varieties of Carpathian breeding. Ivano-Frankivsk, 58.
Syvyryn, A. H., Reshetnykov, V. N. (1988). Crop of saffron milk intensive technology. Tekhnicheskie kul`tury`. Moskva: Kolos, 19.
Semenova, E. F., Buiankyn, V. Y., Tarasov, A. S. (2005). Oilseed *Camelina sativa* : biology, technology, efficiency. Novocherkask: Sintez, 87.

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