DOI: 10.21005/AAPZ2017.43.3.09

FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2017, 336(43)3, 75–82

Andriy LYKHOCHVOR

YIELD AND SEED QUALITY OF SPRING OILSEED CROPS

WYDAJNOŚĆ I JAKOŚĆ NASION ROŚLIN OLEISTYCH FORM JARYCH

Institute of Agriculture in the Carpathian region NAAS, Lviv, Ukraine

Streszczenie. Celem badań było określenie plonów roślin oleistych form jarych, a zwłaszcza rzepaku, lnicznika zwyczajnego, gorczycy białej i sarepskej, rzodkwi oleistej, lnu oraz określenie konkurencyjności lnu zwyczajnego w porównaniu z tymi uprawami. Badania terenowe przeprowadzono na ciemnoszarych słabogliniastych glebach. Najwyższa wydajność w przypadku roślin jarych dotyczyła rzepaku (2,45–2,50 t/ha). Wysoką zawartością oleju charakteryzują się len (51,5%), gorczyca sarepska (45,8%) i lnicznik siewny (44,3%). Wyniki analizy składu kwasów tłuszczowych wskazują, że najbardziej wartościowy pod względem fizjologicznym jest olej z lnicznika siewnego i lnu zwyczajnego. Olej tych roślin zawiera cenne dla ludzkiego organizmu kwasy tłuszczowe, z których jedynie 10% stanowią kwasy nasycone, a 90% nienasycone. Rośliny te zawierają kwasy omega-3 (50,2–57,8%), omega-6 (19,3–19,8%) i omega-9 (15,8–17,0%). Ich olej skutecznie obniża poziom cholesterolu i ma inne ważne właściwości prozdrowotne.

Key words: spring oilseed crops, varieties, yield, quality.
Słowa kluczowe: formy jare roślin oleistych, odmiany, plon, jakość.

INTRODUCTION

Oil market of Ukraine is one of the perspective sectors of agricultural production. Oil is used by growing demand in the world market due to two main factors: reorientation in the structure of human nutrition of oils and fats of vegetable origin because of their physiological advantages and more reasonable prices compared with animal fats; by dynamic growth of manufacturing biodiesel from vegetable oils (Mohylianska et al. 2014). Increased cultivation of oilseed crops solve a number of economic, energy, food problems.

In Ukraine, the largest sown areas with oilseed crops are occupied by sunflower (4.5–5.0 million hectares), rape (0.7–1.2 million hectares) and mustard (50–70 thousand hectares). One of the important oilseed crop is spring false flax (*Camelina sativa*). The potential of this crop is not yet fully disclosed in connection with small sown areas and the lack of intensive technologies of cultivation.

In Ukraine is an urgent search for alternative kinds of oil crops that could compete with the traditional ones. They are the following ones; flax oil, kinds of mustard, oil radish, false flax spring. They are differed by high plasticity to agroecological growing conditions and the current level of selection makes them economically attractive. Besides in crop rotations such crops as false flax, flax and mustard, not only create less stress on the soil, compared with

Corresponding author – Adres do korespondencji: Andriy Lykhochvor, Institute of Agriculture in the Carpathian region NAAS, Grushevskogo 5, Obroshyno 81115, Pustomytivs'kyi distr., Lviv, Ukraine, e-mail: agandriy87@ukr.net

sunflower, but in the conditions of Ukraine they did not yield to sunflower as to the profitability. Alternative of sown false flax to spring rape is in excessive agro-ecological plasticity to growing conditions compared to other spring oilseed crops of cabbage family. It provides a constant seed productivity in different soil and climatic zones (Kozlenko et al. 2010; Moskva et al. 2016). Flax false sowing has a short vegetative season, allowing efficient use of moisture supplies. Unlike other cabbage family crops, it is not practically populated by pests and are not affected by diseases. Unlike rape, it is characterized by high resistance to cracking pods and seed shattering, it guarantees direct harvesting by combine harvesting providing less seeds losses (Lykhochvor et al. 2010).

Interest to false flax as valuable crop is restored during recent years due to oversaturation crop rotations by cereals, sunflower, and the increasing demand for different quality of vegetable oils. False flax oil is a very valuable composition of polyunsaturated fatty acids: namely, linoleic (omega-6) – 15–25% and alpha-linolenic (omega-3) – 50–55%, causing its wide use as an important food, healthcare and dietary oils (Yakovlieva-Nosar et al. 2015).

Mustard as a strong competitive crop leaves a clear field of weeds, mustard, roots well absorb less soluble phosphorus and potassium (Lykhochvor et al. 2010).

Oil radish is a relatively new crop, it has spread during 70 years. The average yield of seeds is 15–18 kg/ha, oil content – 37% –27% of protein.

The average yield of oil seed radish on farms of Ukraine is negligible and varies 1.0–1.5 t/ha. This is due to the failure of technology. The application of fertilizers is one of the key elements of growing technology that guarantees optimal conditions for crop nutrition and as a result of its high productivity (Radchenko et al. 2008).

Flax is very demanding to soil fertility. With the introduction of new varieties of oil flax causes the necessity to establish optimal parameters for them of basic elements of technology (Ruchka et al. 2012; Shpar et al. 2012).The most yield oil crop among spring ones from cabbage family is spring rape (Lykhochvor et al. 2005; Kharenko et al. 2012). The expediency of growing other oil cabbage crops is determined by comparing with the yield and economic efficiency of spring rape.

MATERIAL AND METHODS

The aim of researches was to establish the yield of spring oilseed crops, namely: rape, false flax, mustard and brassica juncea, radish oil and flax and to identify the competitiveness of false flax compared with these crops. The researches were conducted on the area of the western forest-steppe on the farm of Ahro Ekspres Servis, Mlyniv district of Rivne region. Soil of research areas is dark grey light loamy. The content of humus in the plow layer is 2.1%, alkaline hydrolytic nitrogen by Kornfildom – 101 mg/kg soil (low), mobile phosphorus – 243 mg/kg (high) and exchangeable potassium (by Chirikov) – 130 mg/kg (high). The reaction of soil solution (pH – 6.0) is neutral.

Experiment was laid by systematic allocation of plots by threefold repetition. The total area of plot is 60 m^2 the registerd one is 50 m^2. The technology of growing was typical for this soil-climatic zone. The previous one was – winter wheat. After its harvesting, plowing and disking were done. In spring pre-sowing was carried out by means of cultivation. They sown by the drill SN-16 2 April. After sowing for improving conditions for seed germination and providing high field germination was done by rolling. The rate of fertilizers application was $N_{80}P_{40}K_{80}$. Threshing was carried out by combine Sampo 500 by plots.

RESULTS AND DISCUSSION

The results of researches show that the yield of various oilseed crops varies under the same growing conditions, depending on the crop and variety. The lowest yield was obtained during the cultivation of two varieties of oil radish – 1.51–1.52 t/ha (Table 1). The yield of some kinds of mustard was higher. The yield of white mustard varieties of Carolina was 1.58 t/ha, and the yield of New Brown mustard variety was – 1,69 t/ha, which is higher compared to oil radish varieties Zhuravka by 0.18 tonnes / ha or 12%.

As to the yield of false flax and flax it was almost the same. The yield of spring false flax varieties Girskiy and Mirage was, respectively, 2.16 and 2.25 t/ha, but as to the flax oil varieties Aisberg and Orphei – 2.18 and 2.23 t/ha. The yield increase compared to oil radish of these two crops is 0.65–0.74 t/ha, or 43–49%.

In our researches the rape variety Dobrobut obtained the highest yield – 2.45 t/ha, but the variely Ataman – 2.50t/ha. The increase of yield compared with oil radish varieties Zhuravka is the hidhest 0.94–0.99 t/ha. Highaer yield of rape compared to other crops, can be explained as more potential productivity of this crop, and perhaps to a greater extent, the existence of improved growing production technologies.

Yield of all crops and varieties also depended upon the hydrothermal conditions, and it was higher in 2016 y by – 1.56–2.70 t/ha, while in 2015 it was only 1.40–2.31 t/ha.

Table 1.The impact of crop and variety on seed yield
Tabela 1. Wpływ uprawy i odmiany na plon nasion [t/ha]

Crop Roślina uprawna	Variety Odmiana	Yield – Plon		Average Średnia	Increase[a] Zwiększenie	
		2015	2016		t/ha	%
Spring rape – Rzepak jary (*Brassica napus*)	‘Dobrobut’	2.26	2.64	2.45	0.94	62.0
	‘Ataman’	2.31	2.70	2.50	0.99	65.0
False flax – Lnicznik siewny (*Camelina sativa*)	‘Girskiy’	2.01	2.32	2.16	0.65	43.0
	‘Mirazh’	2.16	2.35	2.25	0.74	49.0
White mustard – Gorczyca biała (*Sinapis alba*)	‘Carolina’	1.35	1.81	1.58	0.07	4.6
Indian mustard – Gorczyca sarepska (*Sinapis juncea*)	‘Novynka’	1.53	1.86	1.69	0.18	12.0
Radish oil – Rzodkiew oleista (*Raphanus sativus v.oleifera*)	‘Zhuravka’	1.40	1.62	1.51	–	–
	‘Raidugg’	1.49	1.56	1.52	0.01	0.7
Flax – Len zwyczajny (*Linum usitatissium*)	‘Orpheus’	2.05	2.42	2.23	0.70	46.0
	‘Aisberg’	2.11	2.25	2.18	0.67	44.0

[a] related to radish oil cv. ‘Zhuravka’ – względem rzodkwi oleistej odmiany ‘Zhuravka’.

The indices of seed quality of spring crops, namely the oil content and glucosinolates were different. The flax – 51.5% was characterized by the highest oil content (Table 2). As to the other crops oil content was significantly lower. The lowest oil content had white mustard – 40.6%. As to the oil radish and spring rape oil content increased respectively to 43.2% and 43.8%, higher compared to white mustard by 2.6% and 3.2%. The oil content of false flax increased compared with white mustard by 3.7% and was 44.3.

Table 2. Glucosinolanes and oil content in studied crops. The average for 2015–2016
Tabela 2. Obecność glukozynolanów i zawartość oleju w badanych gatunkach roślin uprawnych. Średnia z lat 2015–2016

Crop Roślina uprawna	Varitey Odmiana	Glucosinolates Glukosynolany [mmol/g]	Increase of glucosinolates[a] Wzrost zawartości glukozynolanów		Oil content Zawartość oleju [%]	Increase of oil[b] Wzrost zawartośći oleju [%]
			mmol/g	%		
Spring rape – Rzepak jary (*Brassica napus*)	'Dobrobut'	20.4	–	–	43.8	1.07
False flax – Lnicznik siewny (*Camelina sativa*)	'Mirage'	21.5	1.1	0.05	44.3	1.09
Whita mustard – Gorczyca biała (*Sinapis alba*)	'Carolina'	35.0	14.6	0.71	40.6	–
Indian mustard – Gorczyca sarepska (*Sinapis juncea*)	'Novelty'	56.4	36.0	1.76	45.8	1.12
Radish oil – Rzodkiew oleista (*Raphanus ativus v.olifera*)	'Zhuravka'	54.3	33.9	1.66	43.2	1.06
Flax – Len zwyczajny (*Linum usitatissium*)	'Orheus'	–	–	–	51.5	1.26

[a] related to spring rape cv. 'Dobronut' – względem rzepaku jarego odmiany 'Dobronut'.
[b] related to white mustard cv. 'Carolina' – względem gorczycy białej odmiany 'Carolina'.

The highest oil content had the Brassica juncea – 45,8% among the oil crops of cabbage family. If oil contains high content of glucosinolates (> 25 mmol/d) it is unfit for the use for food purposes. The lowest content of glucosinolates had spring rape and false flax, so these oil crops are used as food.

In flax oil glucosinolates are absent. As to the oil of oil radish, mustard white and brassica juncea the content of glucosinolates exceeds the permitted limit, so it can be used only as a technical or for biodiesel purporses.

The results of the analysis of fatty acid composition show that the most valuable in physiological, respect is the oil from flax and false flax. The composition of essential fatty acids of false flax oil is similar to oil from flax. In the oil of these plants contain extremely healthy human composition of fatty acids, of which only 10% saturated fatty acids and more 90% unsaturated.

Most contain omega-3 acids – 50.2–57.8%, omega-6 – 19.3–19.8% and omega-9 – 15.8–17.0% (Table 3). This composition of acids can reduce cholesterol levels effectively and has other important medical properties.

Table 3. Fatty acid content in the oil, depending on the crop average for 2015–2016
Tabela 3. Zawartość kwasów tłuszczowych w oleju w zależności od uprawy. Średnia z lat 2015–2016

Fatty acids Kwasy tłuszczowe	Spring rape Rzepak jary (*Brassica napus* L.)	False flax Lnicznik siewny (*Camelina sativa*)	White mustard Gorczyca biała (*Sinapis alba*)	Indian mustard Gorczyca sarepska (*Sinapis juncea*)	Oil radish Rzodkiew oleista (*Raphanus sativus oleif era*)	Flax Len zwyczajny (*Linum usitatissium*)
	%					
Polyunsaturated fatty acids – Wielonienasycone kwasy tłuszczowe						
A-linolenic acid Kwas linolenowy C18:3, n-3	13.2	50.2	22.5	27.1	27.1	57.8
Linoleic acid Kwas linolowy C18:2, n-6	22.3	19.3	8.5	22.2	18.8	19.8
Monounsaturated fatty acids – Mononienasycone kwasy tłuszczowe						
Oleic acid Kwas oleinowy C18:1, n-9	58.4	17.0	21.2	21.2	34.1	15.8
Erucic acid Kwas erukowy C22:1, n-9	0.3	4.1	44.8	24.5	13.5	0.2
Eicosenoic acid Kwas eikozoenowy C20:1, n-9	0.1	1.5	0.1	0.4	0.2	0.1
Saturated fatty acids – Nasycone kwasy tłuszczowe						
Palmitic acid Kwas palmitynowy C16:0	5.2	6.4	2.8	4.2	6.1	5.5
Stearic acid Kwas stearynowy C18:0	0.5	1.5	0.1	0.4	0.2	0.8

The most spread vegetable oils (sunflower, corn) do not have in their composition omega-3. Incidentally, in olive oil, which is positioned as one of the most valuable, there are no omega-3 and very little omega-6. Oils from rape, mustard and radish had less valuable fatty acid composition.

CONCLUSIONS

1. The highest yield of spring crops had spring rape – 2.45–2.50 t/ha. As to the flax and false flax, it was lower respectively, 2.16–2.25 t/ha and 2.18–2.23 t/ha. Other crops had much lower yields.
2. Flax is characterized by high oil content (51.5%), Brassica juncea (45.8%) and False flax (44.3%).
3. Oil from flax and false flax has the best fatty acid composition with predominance of linolenic (50.2–57.8%), linoleic (19.3–19.8%) and oleic (15.8–17,0%) acids.
4. In order to increase the yield of flax and false flax is to improve the technology of their cultivation.

REFERENCES

Kozlenko O.M. 2010. Stabilnist ta plastychnist oliinykh kultur v umovakh Pravoberezhnoho Lisostepu [Stability and plasticity of oilseeds crops in the conditions of the Right Bank Forest-steppe]. Zbirnyk Naukovykh Prats NNTs Instytutu Zemlerobstva NAAN 4, 137–142. [in Ukrainian]

Kharenko A.O., Burliai, O.L. 2012. Vyrobnytstvo nasinnia oliiny kultur u silskohospodarskykh pidpryiemstvakh Cherkaskoi oblasti. Materialy IV Vseukr. zaochnoi nauk. konf. Aktualni pytannia suchasnoi ekonomiky. Vol. 1. Uman, Vydvo SPD Sochinskyi, 218–221. [in Ukrainian]

Lykhochvor V.V., Petrychenko V.F., Ivashchuk P.V., Korniichuk O.V. 2010. Roslynnytstvo. Lviv, NVF Ukrainski tekhnolohii, 711–833. [in Ukrainian]

Lykhochvor V.V. 2005. Ripak. Lviv, NVF Ukrainski tekhnolohii. [in Ukrainian]

Moskva I.S. 2016. Stan ta perspektyvy vyroshchuvannia ryzhiiu yaroho na Pivdni Stepu Ukrainy [The state and prospects of growing false flax on the southern steppe of Ukraine]. Visnyk Ahrarnoi Nauky Prychornomor´ia 1, 99–109. [in Ukrainian]

Mohylianska N. 2014. Suchasnyi stan i perspektyvy pererobky oliinykh kultur [Current state and prospects of processing oilseeds crops]. Zernovi produkty i Kombikormy 1(53), 22–25. [in Ukrainian]

Radchenko M.V. 2008. Nasinnieva produktyvnist redky oliinoi zalezhno vid umo v mineralnoho zhyvlennia [Current state and prospects of processing oilseeds crops]. Selektsiia i nasinnytstvo 95, 28–32. [in Ukrainian]

Ruchka V.O. 2012. Vplyv strokiv posivu ta norm vysivu na urozhainist ta yakist nasinnia novykh sortiv lonu oliinoho selektsii IOK «Aisberh» i «Orfei» [Influence of sowing dates and seed rates on yield and quality of seeds of new varieties of flax oilseed of breeding IOC Iceberg and Orpheus]. Naukovo Tekhnichnyi Biuleten Instytutu Oliinykh Kultur UAAN 17, 139–143. [in Ukrainian]

Shpar D. 2012. Ripak i suripytsia (vyroshchuvannia, zbyrannia, zberihannia,vykorystannia). Kiev, Vydavnychyi dim Zerno. [in Ukrainian]

Yakovlieva-Nosar S.O., Tereshchenko K.A. 2015. Pokaznyky produktyvnosti ryzhiiu yaroho za riznykh hustot stoiannia [Indicators of productivity of spring false flax for different densities of standing]. Aktualni Pytannia Biolohii, Ekolohii ta Khimii 2, 4–11. [in Ukrainian]

Abstract. The aim of researches was to establish the yield of spring oilseed crops, namely, rape, false flax, white mustard and Brassica juncea, oil radish and flax and to define the competitiveness of false flax comparing with these crops. The researches were carried out on dark-grey light loamy soils. Besides, field, chemical, counting-weight methods of researches were used. The data of field researches of yield and seeds quality of oilseed crops are presented. The highest yield of spring crops was observed in spring rape – 2.45–2.50 t/ha as to flax and false flax, respectively, it was 2.16–2.25 t/ha and 2.18–2.23 t/ha. It should be noted that flax (51.5%), Brassica juncea (45.8%) and false flax (44.3%) is characterized by high oil content. The analysis results of fatty acid composition shows that the most valuable in physiological respect is the oil from flax and false flax. The oil of these crops contains extremely healthy human composition of fatty acids, from which only 10% saturated fatty acids and 90% unsaturated ones. These crops contain omega-3 – 50.2–57.8%, omega-6 – 19,3–19,8% and omega-9 – 15.8–17.0%. That's why the oil can effectively reduce cholesterol level and has other important medical properties.