apples harvested in two periods - with the onset of harvest maturity (mass picking) and a week later (late pick) – from intensive orchard on dwarf (M.9) rootstock and a traditional one, on semi-vigorous (MM.106) rootstocks was studied. The fruits were cooled to 5 °C and then treated with 1-MCP and preserved to seven months at a temperature of 2±1 °C and relative humidity 85–90 % (no treatment - control).

The ground color of the skin was determined with help of spectrocolorimeter «Spekol» by the reflection of light on the typical wave 675 nm of chlorophyll absorption, and the flesh fimness – by penetrometer FT–327 with plunger diameter 11 mm (a peel was cut before the measurement).

It was found out that the best preservation of flesh firmness was typical for the apples from intensive orchard. Postharvest treatment of 1-MCP provides 1.2 times higher firmness of fruit from both types of orchards (at the end of seven-month storage). The index of apples from intensive orchard, unprocessed fruit of mass collection (and treated with 1-MCP fruits from traditional orchard) were on 0.1–1.5 kg/cm^2 higher than the minimum of 5.5 kg/cm^2, which is necessary for supply to supermarkets.

After seven-month storage, the reflection of light from the fruit skin on a wave of chlorophyll absorption was lower for the produce of traditional orchard, regardless of the harvest term. With the use of post-harvest treatment of 1-MCP, the level of this indicator was by 8 % lower only for the fruit of mass harvesting from intensive orchard.

Key words: *Golden Delicious, 1-Methylcyclopropene, Smart Fresh, rootstock, harvest date, storage, fresh firmness, reflection of light*

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YIELD AND AGROCENOSIS PRODUCTIVITY ELEMENTS OF SPRING FALSE FLAX DEPENDING ON ITS DENSITY

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Наведено результати вивчення впливу різних норм висіву на особливості динаміку щільності агроценозу, тривалість міжфазних періодів рослин, урожайність та елементи її структури у рижію ярого сорту Сеповий 1 в умовах нестійкого зволоження Правобережного Лісостепу України.

Ключові слова: *рижій ярий, норма висіву, щільність агроценозу, міжфазний період, урожайність, елементи структури врожаю.*

Problem statement. Realization of the crop biological potential mostly is determined by technological methods of the cultivation. False flax is a valuable but little-studied and little-spread oilseed crop. Insufficient knowledge of peculiarities of its biology slows the development and implementation of efficient technologies for the cultivation of large and qualitative seeds. Thus, until now, issues of the growth, development and formation of high-quality yield at different density of agrocenosis of this crop in the regional conditions of the southern part of the Right Bank Forest-Steppe of Ukraine remain unexplored. In addition, the biological

features of false flax as an oilseed crop for biodiesel production can become an alternative to rape due to the environmentally safe cultivation technology in all soil-climatic zones of Ukraine [1]. All this determined the relevance and direction of our studies.

Actual scientific researches and issue analysis. The optimum seeding rate is one of the main conditions for obtaining a high yield of seeds of cruciferous crops. The amount of moisture, carbon dioxide and light depend on the density of agrocenosis that crops will be provided throughout the period of vegetation [2]. The analysis of publications of domestic and foreign sources regarding determination of optimal seeding rates for false flax indicates a significant divergence in the recommendations regarding the optimal level of this indicator. Depending on the region of research, it can vary from 0.8 to 8.0 million of similar seeds per hectare of sowing [3–6]. At the same time, according to the researchers, false flax shows a low dependence of productivity on the change in the norm of seeding. Thus, it was found [7] that with an increase in the seed rate from 1.5 to 3.0 million similar seeds per 1 hectare yield practically did not change and was at the same level of 1.76–1.78 t/ha. With an increase in seed rates of up to 4.0 million seeds this indicator decreased to 1.60 t/ha. At the same time, other researchers [8] argue that high seeding rates of oilseed cruciferous crops in different ways of cultivation lead to a decrease in their productivity.

These data show that the existing technologies are outdated for seed growing. Researchers provide different information and there are no definite limits on the choice of seeding rates. In addition, the use of the latest scientific discoveries in genetic engineering and regulation of biochemical processes in plants made it possible to create high-yielding varieties of false flax with valuable biochemical parameters. This gave a new impetus to the introduction of this crop into agricultural production and was one of the reasons for revision and supplementation of the existing technology of growing false flax for seeds under the conditions of Right Bank Forest-Steppe in Ukraine.

The research purpose is to study the influence of technological methods of cultivation on the yield and quality of false flax seeds under the conditions of Right Bank Forest-Steppe in Ukraine.

The research objective is to improve the technology of growing false flax under the conditions of Right Bank Forest-Steppe.

Research methods. In order to study the effect of sowing norms of seeds on the productivity of spring false flax in 2015 and 2016 the field experiment was carried out on the experimental field of the educational and production department of UNUH.

By the amount of precipitation, the region of conducting research is characterized by periodic droughts and refers to the subzone of unstable moisture. The predominant types of soils are chernozems and grey podzolized soils. The parent rock material is coarse-pored light loamy rich in carbonates.

The experimental design included four norms of false flax seeding: 3; 4; 5 and 6 million seeds/ha. The variants were systematical (sequential) in a three-time replication. The sown area of the plot was 144 m^2 and the registration plot was 80

m^2. The check variant was the one with the norm of sowing of 5 million seeds/ha. Records, analyzes and observations were conducted in accordance with generally accepted methods [9, 10].

Experiments were carried out in the crop rotation after winter wheat. The fertilizer system of spring rape included 60 kg/ha of nutrients in the form of 18% ammonium nitrate phosphate fertilizer in spring in the pre-sowing cultivation. Sowing was carried out by C3T – 3.6 drill machine by the usual row method with a row width of 15 cm. The sowing date is optimally early, simultaneously with spring cereal crops. For sowing Sepovyi 1 false flax variety was used.

Research results. One of the crops promoting the optimal solution of the problem of over-saturation of field crop rotations with sunflower, preservation of the level of oil production and the effective use of occupied fallow lands is false flax. Compared to others, this crop is the least demanding for growing conditions. Thus, false flax seeds can sprout already at + 1 ... 2°C and shoots can withstand frosts easily to –12°C. In addition to clay soils, it grows well on all other types of soils, has a relatively short vegetation period, is characterized by high drought tolerance and therefore it can be successfully cultivated in all regions of Ukraine [3, 4]. Such biological features enable after its harvesting to grow other crops and using it after occupied fallow land will promote good soil preparation and accumulation of moisture to sow winter crops [5].

The obtained results of two-year studies indicate that the density of false flax agrocenosis and the dynamics of its changes during the growing season strongly depend on the studied norms of seed sowing (Table 1).

1. Influence of seed sowing norms on the formation of density of false flax agrocenosis, *seeds/m^2*

Seed rate, million seeds/ha	Field germination rate ,%	Number of plants per phase		Preservation of plants,%
		shoots	maturation	
2015				
3.0	91.0	273	235	86.1
4.0	91.5	366	309	84.4
5.0 (*check variant*)	91.6	458	383	83.6
6.0	92.2	553	457	82.6
HIP_{05}	*3.4*	–		*3.3*
2016				
3.0	97.0	291	257	88.3
4.0	96.8	387	335	86.6
5.0 (*check variant*)	97.0	485	405	83.5
6.0	96.8	581	474	81.6
HIP_{05}	*3.2*	–		*3.3*

Thus, in general, according to the experiment, the field germination rate was higher by the amount of precipitation in the spring of 2015. Thus, in more drought-

conditioned spring conditions of 2016 the field germination rate in the experimental variants was at the level of 91.0–92.2%. In 2015 this indicator was higher by 4.6–6.0% (HIP_{05} at the level of 3.2–3.4%). However, in the future the weather conditions of the growing season in 2016 improved significantly due to the optimal flow of moisture into the soil. This was reflected both in the phases of growth and development of the crop and the overall productivity of false flax agrocenosis.

It is found [7] that crucials are yielded crops and, under the conditions of excessive thickening, they are capable of self-liquation, especially after supplying with mineral nutrients. A similar pattern has been observed in our studies and in the conditions of intraspecific competition for mineral nutrition elements, light and moisture the plant density during the period of harvesting also decreased.

So, at the time of crop harvesting the number of plants per $1m^2$ in 2015 by seeding rate of 3 million was 235 seeds/m^2; 4 million – 309 seeds/m^2; 5 and 6 million – 383 and 457 seeds/m^2, respectively. At the same time, preservation of plants was 86.1; 84.4; 83.6 and 82.6% (on average, 84.2%). In this case, we can note the tendency for increasing the number of dead plants in variants with increased density of agrocenosis.

A similar situation was in 2016. Thus, on average, during the period of harvesting, the preservation of false flax plants was 85.0% – from 81.6% in the variant with the maximum seed rate (6 million seeds/ha) to a significantly higher level of 88.3% with the minimum seed rate (3 million seeds/ha).

Consequently, it can be concluded from the observations that only the extreme seed rates (3 and 6 million seeds/ha) have significant differences by the final indicator of the agrocenosis density. At the same time, there is a tendency towards self-liquation of false flax agrocenosis with an increase in the seeding rate.

An important indicator in the formation of crop productivity is the ability of plants to pass all phenological phases fully and in time. In the future it affects both crop yield and its qualitative indicators. At the same time, the beginning of some phenological phases and their duration directly depend on the weather conditions of the vegetation year.

The conducted studies showed that under the conditions of the southern part of Right Bank Forest-Steppe in Ukraine plants grew normally with all stages of organogenesis and had full seeds (Tabl. 2). During observations certain regularities were found regarding the progress of each stage of organogenesis. Thus, getting even false flax sprouts requires the optimal temperature regime of the soil with sufficient reserves of moisture in it. At the same time, the period of sowing – false flax shoots had the same duration which did not depend on the weather conditions of the year and the studied seed rates and it was 8 days.

Interphase periods of shoots – first true leaf were characterized by almost identical duration – 8–9 days in 2015 and 7–9 days in 2016. At the same time, the duration of the phase in most depended on the sum of effective temperatures than the amount of precipitation during this period. During both years of research an extension of the duration of this period was noted in variants with maximally increased seed rate. The duration of the interphase period of the first true leaf – leaf rosette was from 7–9 days (in 2015) to 8–10 days (in 2016). Also, there was a

tendency to extend the duration of this period for plants sown with check and maximum seed rates (5 and 6 million seeds/ha). In contrast, the duration of the period of shooting stage – budding longer for 1–2 days was caused by sowing with seed rates less than the check variant (3 and 4 million seeds/ha) – 9–10 days (in 2015) and 10–11 days (in 2016) compared with 8–9 and 9 days, respectively.

2. Duration of interphase periods of false flax plants, *days*

Sowing rate, million seeds/ha of similar seeds	Sowing – shoots	Shoots – first true leaf	First true leaf – leaf rosette	Leaf rosette – shooting stage	Shooting stage – budding	Budding – flowering	Flowering – fruiting	Fruiting – ripening	Duration of the growing season
2015									
3.0	8	8	7	7	10	11	7	16	66
4.0	8	8	7	7	9	12	7	18	68
5.0 (*check variant*)	8	8	8	8	9	11	8	18	70
6.0	8	9	9	7	8	12	7	20	72
2016									
3.0	8	7	8	8	11	12	7	19	72
4.0	8	7	8	8	10	12	7	21	73
5.0 (*check variant*)	8	8	9	9	9	11	8	23	77
6.0	8	9	10	9	9	11	8	24	80

The clear effect of some indicators that characterized the weather conditions in this period was not observed. However, most representatives of Cruciferae family have a delay in plant growth due to insufficient rainfall during the shoot formation. This leads to a decrease in the formation of the vegetative mass, leaf-area duration and premature flowering.

The interphase period of budding – flowering was longer than previous periods. At this time plants require a significant amount of moisture and its absence leads to both shortening the duration of development phases and lowering the crop productivity. Depending on the research variants during both years of research, the duration of this period remained almost unchanged – 11–12 days. As a result, we were unable to detect the clear influence of any factors on its duration.

The duration of the flowering period – fruiting compared with the previous one was shorter by 4–5 days in both years of research. During dry weather of this period representatives of Cruciferae family can have dropping of flowers which significantly reduces their yield [33].

The last interphase period of fruiting – ripening was the most prolonged – 16–20 days (in 2015) and 19–24 days (in 2016). Cruciferae family representatives during the setting of seedpods and seed ripening at this time require a sufficient amount of moisture that is frequent and moderate rains. Since, an excessive amount of moisture during this period leads to the formation of new shoots in the lower part of the stem that impede the harvesting. We had a tendency towards some extension of the period of fruiting – ripening when increasing sowing rates.

In general, the duration of the vegetation period of false flax plants varied from 66–72 (in 2015) to 72–80 days (in 2016) in the experiment and depended on both the conditions of the vegetation year and the studied seeding rates. As a result of observations and records, it was noted that the decrease in the seed rate from 6 to 3 million resulted in precipitation of separate interphase periods and the whole crop vegetation period.

The main indicator of growing crops is their yield that is an integrative indicator which depends to a large extent on many elements of the harvest structure, weather conditions during the growing season and other factors of the environment.

It is found [4] that the optimization of sowing density and plant nutrition area starts with determining the seed sowing rate and its spatial distribution. The more uniform the plants are distributed along the surface in the form of a circle, the more rationally plants use soil moisture and nutrients.

Analyzing studied seed sowing rates (Table 3), it should be noted that the lowest yield of spring false flax was obtained at the seeding rate of 6 million similar seeds/ha (1.37 c/ha in 2015 and 14.5 c/ha in 2016).

3. Yield of spring false flax depending on the seeding rate, *t/ha*

Sowing rate, million similar seeds/ha	2015		2016		Average for two years	
	Indicator level	Deviation from the check variant	Indicator level	Deviation from the check variant	Indicator level	Deviation from the check variant
3.0	1.53	+0.13	1.61	+0.09	1.57	+0.11
4.0	1.65	+0.25	1.69	+0.17	1.67	+0.21
5.0 (*check variant*)	1.40	–	1.52	–	1.46	–
6.0	1.37	-0.03	1.45	-0.07	1.41	-0.05
Average	*1.49*	–	*1.57*	–	*1.53*	–
HIP_{05}	–	*0.14*	–	*0.13*	–	

Moreover, if the excess of the recommended quantitative seed rate in the region of studies for 1 million similar seeds/ha caused inappropriate overcrowding of false flax agrocenosis, aggravation of interspecific competition for factors of life and, consequently, a decrease in its productivity by 0.03 (in 2015) and 0.07 t/ha (in 2016) compared with the check variant of 1.4 and 1.52 t/ha, respectively. Optimizing the cenosis density by reducing the seed rate to the level of 4 million similar seeds/ha allowed an average of two years to get an additional 0.21 t/ha significantly higher yield (HIP_{05} = 0.13–0.14 t/ha).

On average, by the research variants higher yield was achieved in 2016, under its weather conditions it was 0.08 t/ha or 6% higher than in 2015.

So, under the conditions of unstable moisture of Right Bank Forest Steppe false flax yield is largely dependent on the optimal density of its agrocenosis. An essential advantage of the variant with a seed rate of 4.0 million similar seeds/ha is, on average, 0.21 t/ha. At the same time, the weather conditions of the harvesting year – 0.08 t/ha had much less influence on the agrocenosis productivity of the studied crop which, in our opinion, shows its high ecological plasticity.

The data analysis showed (Table 4) that the highest indicators of the harvest structure were at the minimum seed rate (3 million similar seeds/ha).

4. Influence of density of spring false flax agrocenosis on the elements of the harvest structure, *2015–2016*

Sowing rate, million similar seeds/ha	Quantity			Thousand-kernel weight, g
	Seedpods of the plant, seedpods	Seeds in a seedpod in a pod, piece	Seeds from $1m^2$, thousand seeds	
3.0	52	7.8	100	1.83
4.0	48	6.7	103	1.81
5.0 (*check variant*)	46	5.9	105	1.69
6.0	44	5.3	107	1.57
Average	*48*	*6.4*	*104*	*1.73*
HIP_{05}	*4*	*1.6*	*5*	*0.11*

So, on average, over the years of research, the number of seedpods per plant in this variant was 52 seedpods that are 6 seedpods significantly more compared to the check variant. With the increase of the quantitative seed rate from the minimum one (3 million seeds/ha) to the maximum one (6 million seeds/ha), there is an inverse close correlation dependence ($r = 0.98 \pm 0.00$) to reducing the number of seedpods per plant. Similarly, plants reacted to individual seeding of seedpods – with the increase in the cenosis density less number of seeds were formed in seedpods. Although, there was larger number of plants per unit area, seeds in pods were less weighty. In general, in this regard, exceeding recommended in the region quantitative seed rate of 1 million similar seeds/ha was the worst for the formation of the productivity elements of false flax plants. A significant deterioration was noted for all the analyzed indicators. At the same time, some significant differences over the years of research have not been determined.

Conclusions.

1. There is a tendency towards self-liquation of false flax agrocenosis with an increase in the seeding rate from 3.0 to 6.0 million similar seeds/ha.

2. The duration of the vegetation period of false flax plants depends on both the conditions of the vegetation year and seed rates. Reducing the seed rate from 6.0 to 3.0 million causes acceleration of both some interphase periods and the

whole vegetation period.

3. False flax yield is more dependent on the optimal density of its agrocenosis. An essential advantage of the variant with a seed rate of 4.0 million similar seeds/ha is, on average, 0.21 t/ha.

4. The weather conditions of the year of yield formation have a significantly less impact on the productivity of false flax agrocenosis (0.08 t/ha) which can indicate a high ecological plasticity of the crop.

5. Exceeding recommended in the region (5 million similar seeds/ha) quantitative seed rate for 1 million similar seeds/ha is the least useful for the formation of the productivity elements of false flax plants in comparison with its decrease for the same amount.

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Аннотация

Кононенко Л. М., Полторецький С. П., Яценко А. А.

Урожайность и элементы продуктивности агроценоза рыжика ярового в зависимости от его плотности.

До ныне остается неизученным вопрос роста, развития и формирования высококачественного урожая за разной плотности агроценоза рыжика ярового в региональных условиях южной части Правобережной Лесостепи Украины, что и предопределяет актуальность и направление исследований. Анализ публикаций отечественных и зарубежных источников по установлению оптимальных норм высева рыжика ярового указывает на значительное расхождение в рекомендациях относительно оптимального уровня этого показателя, который в зависимости от региона выращивания может изменяться от 0,8 до 8,0 млн шт. всхожих семян на гектар посева. Цель исследования – изучение влияния технологических приемов выращивания на урожайность и качество семян рыжика ярового в условиях Правобережной Лесостепи Украины. Задача исследования – усовершенствовать технологию выращивания рыжика ярового в условиях Правобережной Лесостепи. По количеству осадков регион проведения исследований характеризуется периодическими засухами и относится к подзоне неустойчивого увлажнения. Преобладающим типом почв являются черноземы и серые оподзоленные. Схема опыта включала четыре нормы высева семян рыжика ярового 3; 4; 5 (контроль) и

6 млн шт. семян/га. Учеты, анализы и наблюдения проводили согласно общепринятых методик. С увеличением нормы высева от 3 до 6 млн шт/га всхожих семян установлена тенденция к снижению плотности агроценоза рыжика ярового. Продолжительность периода вегетации растений рыжика зависит как от условий года вегетации, так и нормы высева. Уменьшение нормы высева семян с 6 до 3 млн влечет ускорение прохождения как отдельных межфазных периодов, так и всего вегетационного периода культуры в целом. Урожайность рыжика ярового более существенно зависит от оптимальной плотности его агроценоза – существенное преимущество варианта с нормой высева 4,0 млн шт/га всхожих семян в среднем составляет 0,21 т/га. Значительно меньшее влияние на продуктивность агроценоза рыжика ярового осуществляют погодные условия года формирование урожая – 0,08 т/га, что может свидетельствовать о высокой экологической пластичности культуры. Наименее целесообразным для формирования элементов продуктивности растений рыжика ярового является превышение рекомендуемой в регионе (5,0 млн шт/га всхожих семян) количественной нормы высева на 1,0 млн шт/га по сравнению с ее уменьшением на такое же количество.

Ключевые слова: *рыжей яровой, норма высева, плотность агроценоза, межфазное период, урожайность, элементы структуры урожая.*

Annotation

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Yield and agrocenosis productivity elements of spring false flax depending on its density

Until now, issues of the growth, development and formation of high-quality yield at different density of agrocenosis of this crop in the regional conditions of the southern part of the Right Bank Forest-Steppe of Ukraine remain unexplored. The analysis of publications of domestic and foreign sources regarding determination of optimal seeding rates for false flax indicates a significant divergence in the recommendations regarding the optimal level of this indicator. Depending on the region of research, it can vary from 0.8 to 8.0 million of similar seeds per hectare of sowing. The research purpose is to study the influence of technological methods of cultivation on the yield and quality of false flax seeds under the conditions of Right Bank Forest-Steppe in Ukraine. The research objective is to improve the technology of growing false flax under the conditions of Right Bank Forest-Steppe. By the amount of precipitation, the region of conducting research is characterized by periodic droughts and refers to the subzone of unstable moisture. The predominant types of soils are chernozems and grey podzolized soils. The experimental design included four norms of false flax seeding: 3; 4; 5 (check variant) and 6 million seeds/ha. Records, analyzes and observations were conducted in accordance with generally accepted methods. There is a tendency towards self- liquation of false flax agrocenosis with an increase in the seeding rate from 3.0 to 6.0 million similar seeds/ha. The duration of the vegetation period of false flax plants depends on both the conditions of the vegetation year and seed rates. Reducing the seed rate from 6.0 to 3.0 million causes acceleration of both some interphase periods and the whole vegetation period. False flax yield is more dependent on the optimal density of its agrocenosis. An essential advantage of the variant with a seed rate of 4.0 million similar seeds/ha is, on average, 0.21 t/ha. The weather conditions of the year of yield formation have a significantly less impact on the productivity of false flax agrocenosis (0.08 t/ha) which can indicate a high ecological plasticity of the crop. Exceeding recommended in the region (5 million similar seeds/ha) quantitative seed rate for 1 million similar seeds/ha is the least useful for the formation of the productivity elements of false flax plants in comparison with its decrease for the same amount.

Keywords: *false flax, sowing rate, agrocenosis density, interphase period, yield, elements of the harvest structure.*