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## НАСІННЄВА ПРОДУКТИВНІСТЬ ЛЮПИНУ БІЛОГО (*LUPINUS ALBUS L.*) ЗАЛЕЖНО ВІД ГЕРБІЦИДНОГО ВПЛИВУ

**Анотація.** Через незначну кількість наукових публікацій з впливу гербіцидів на посівні якості насіння люпину та практично повну відсутність даних з їх впливу на врожайні властивості актуальним є проведення таких досліджень. Метою досліджень було встановлення особливостей формування і реалізації посівних якостей та врожайних властивостей насіння сортів люпину білого залежно від внесення гербіцидів в умовах правобережної зони північного Лісостепу України. Методика досліджень включала використання польового, лабораторного і статистичного методів. Результати досліджень дозволили встановити, що рослини люпину білого на забур'яненних ділянках (без прополювання і гербіцидів) виявилися найменш продуктивними – 65,6% (сорт Серпневий) і 67,7% (сорт Чабанський). Найвищу врожайність насіння серед варіантів із внесенням гербіцидів забезпечило застосування Харнесу і бакової суміші Прометрекс + Юпітер (сорт Серпневий – 3,50 і 3,49 т/га, сорт Чабанський – 3,83 і 3,87 т/га відповідно). Внесення гербіцидів по сходах негативно вплинуло на формування урожайності – вона була істотно нижчою серед варіантів із застосуванням гербіцидів і становила у сорту Серпневий – 2,80 і 2,75 т/га, а у сорту Чабанський – 3,03 і 3,06 т/га. На ділянках цих варіантів також спостерігали затримку росту й розвитку рослин люпину, що особливо прослідковувалося в першій половині вегетації.

**Ключові слова:** люпин білий, насіння, сорт, гербіцид, посівні якості, врожайні властивості.

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## СЕМЕННАЯ ПРОДУКТИВНОСТЬ ЛЮПИНА БЕЛОГО (*LUPINUS ALBUS L.*) В ЗАВИСИМОСТИ ОТ ГЕРБИЦИДНОГО ВЛИЯНИЯ

**Аннотация.** В связи с небольшим количеством научных публикаций по влиянию гербицидов на посевные качества семян люпина и практически полное отсутствие данных по их влиянию на урожайные свойства актуальным является проведение таких исследований. Целью исследований было установление особенностей формирования, а также реализации посевных качеств и урожайных свойств семян сортов люпина белого в зависимости от внесения гербицидов в условиях правобережной зоны северной Лесостепи Украины. Методика исследований включала использование полевого, лабораторного и статистических методов. Результаты исследований позволили установить, что растения люпина белого на засоренных участках (без прополки и гербицидов) оказались наименее продуктивными – 65,6% (сорт Августовский) и 67,7% (сорт Чабанский). Наивысшую урожайность семян среди вариантов с внесением гербицидов обеспечило применение Харнес и баковой смеси Прометрекс + Юпитер (сорт Августовский – 3,50 и 3,49 т/га, сорт Чабанский – 3,83 и 3,87 т/га соответственно). Внесение гербицидов по всходам люпина негативно повлияло на формирование урожайности – она была существенно ниже среди вариантов с применением гербицидов и составила у сорта Августовский – 2,80 и 2,75 т/га, а у сорта Чабанский – 3,03 и 3,06 т/га. На участках этих вариантов также наблюдали задержку роста и развития растений люпина, особенно это прослеживалось в первой половине вегетации.

**Ключевые слова:** люпин белый, семена, сорт, гербицид, посевные качества, урожайные свойства.

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## WHITE LUPIN SEEDS YIELD (*LUPINUS ALBUS L.*) DEPENDING ON HERBICIDAL EFFECT

**Abstract.** Due to small amount of scientific publications on the herbicidal effect on sowing qualities of lupine seeds and almost complete lack of data on their effect on yield properties, it is relevant to carry out such studies. The research objective was to determine the peculiarities of the formation and implementation of sowing qualities and yield properties of seeds of white lupine varieties depending on herbicides use under the conditions of the right-bank zone of the northern forest-steppe of Ukraine. The research methodology included the use of field, laboratory and statistical methods. Research results allowed to establish that white lupine plants on weedy grown areas (without crop weeding and herbicides) turned out to be the least productive – 65.6 % (Serpnevyyi variety) and 67.7 % (Chabanskyi variety). The highest seed yield among variants with herbicides use showed that the usage of Harnes and tank mixture of Prometrex + Jupiter (Serpnevyyi variety – 3.50 and 3.49 tons/ha, Chabanskyi variety – 3.83 and 3.87 tons/ha respectively). Herbicides use while sprouting period negatively affected yield formation – it was the lowest among herbicide variants and was 2.80 and 2.75 tons/ha in Serpnevyyi variety, and for Chabanskyi variety it was 3.03 and 3.06 tons/ha. On the plots of these variants, there was also growth and developmental delay of lupine plants, which was especially observed in the first half of the vegetation.

**Key words:** white lupine, seeds, variety, herbicide, sowing qualities, yield properties.

**Problem statement.** It is common knowledge that potential power of variety can be realized only by high-quality seeds. Modern industrial seed production should ensure the creation of conditions for obtaining high-quality sowing material, pure of clogging seeds by weeds, that involves the obligatory herbicides use in the cultivation of crops. Thereby, there is a problem of study of herbicides effect on sowing qualities and yield properties of seeds of agricultural crops.

**The state of studying the problem.** Depending on herbicides type, culture, doses and terms of use and other factors, the results of studying herbicides effect on sowing qualities of seeds are quite controversial. Thus, some scientists noted that herbicides use on different crops caused a worsening of the qualitative characteristics of the cultivated seeds [1, 2]. Other scientists have not established such regularities [3, 4].

There is very little data on herbicides effect on sowing qualities and yield properties of lupine seeds in the scientific literature. Thus, according to the results of V. I. Vahin's research [5], it was established that pre-emergence treatment of lupine seeds by soil herbicides does not have a negative effect on sowing qualities and yield properties of the seeds, but on the contrary – the energy of germination and similarity fairly increase.

L. I. Yalovyk [6] studied the results of the graminicide usage on the narrow-leaved lupine crops. It was established

that systematic annual herbicide treatment of crops did not increase the sensitivity of the following generations of lupine.

According to D. V. Rusakov [7], use of herbicides positively influenced the formation of elements of the structure of productivity and yield of narrow-leaved lupine. It was also found that the use of treatments did not have a negative effect on the amount and weight of **root tubers**, sowing qualities and chemical composition of the seeds.

Taking into account a small amount of scientific publications on herbicides influence on sowing qualities of lupine seeds and almost complete lack of data on their effects on yield properties, it can be concluded that these issues have not been studied sufficiently and completely, and therefore, further detailed research is **relevant**.

The research objective was to determine the peculiarities of the formation and implementation of sowing qualities and yield properties of seeds of white lupine varieties depending on herbicides use under the conditions of the Right-Bank zone of the northern Forest-Steppe of Ukraine.

**Research methodology.** Experimental researches on the theme of dissertation work were carried out in the period from 2013 to 2015 years at Educational and Scientific Center "Agriculture Institute of the National Academy of Agrarian Sciences of Ukraine". Field experiments were laid in the crop rotation of the State Enterprise Investigative Household "Chabany", that territorially is related to Kyiv-Sviatoshyn

district of Kyiv region and is located in the Right-Bank zone of the northern Forest-Steppe of Ukraine.

Soils of experimental areas – sod-podzolic sandy-loam and gray podzolic dust-sandy-loam. The humus content in the arable layer (0–20 cm) in sod-podzolic soil was up to 1.28 %, in gray podzolic – up to 1.38 % (by Tiurnyn), the quantity of readily soluble forms of phosphorus – up to 3.7 mg, potassium – up to 13.2 mg and to 9.1 mg and 3.4 mg per 100 g of soil, respectively (according to Arenius), the pH of the salts varied within the range of 5.5–6.1. Ground water lay is at a depth of 3.0–3.5 m and does not influence the water availability.

The climate is moderately continental with rather hot summer and relatively mild winter, characterized by unstable

moisture supply. The best weather conditions for growing lupine were in 2013, 2014, but in 2015 they were much worse and were characterized by very hot and dry weather, which had a negative effect on general development of lupine plants and the formation of seed yields.

The determination of the influence of herbicides use on sowing qualities of lupine seeds of white lupine of Serpnevyy and Chabanskyi was carried out during 2013–2015. The scheme of the experiment included 12 variants (Table 1).

The forecrop were frumentaceous winter crops, the technology of growing white lupine is commonly used for the research area. Sown area is 23.4 m<sup>2</sup>.

Accounts, analyzes and observations were conducted in accordance with generally accepted methods [8, 9].

Таблиця 1

## 1. Effect of use of herbicides on seed yield plants of white lupine, 2013–2015

Variant of the experiment		Elements of the structure of productivity			Weight of seed from a plant	
		number of beans per plant, pcs.	number of seeds per plant, pcs.	number of seeds in a bean, pcs.	grams	% before control 1
Serpnevyy variety						
Manual weeding ( <i>control 1</i> )		9.8	31.4	3.2	9.0	100.0
Without herbicides and weeding ( <i>control 2</i> )		7.0	23.2	3.3	5.9	65.6
Treflan *		8.0	25.6	3.2	7.5	83.3
Fronter Optima *		8.4	27.1	3.2	7.9	87.8
Harnes *		8.9	30.8	3.5	8.7	96.7
Prometrex *		8.5	28.7	3.4	8.3	92.2
Stomp 330*		8.3	26.4	3.2	7.2	80.0
Jupiter **		7.6	25.2	3.3	6.7	74.4
Treflan + Jupiter **		7.7	25.4	3.3	6.9	76.7
Treflan + Jupiter *		8.4	26.6	3.2	7.9	87.8
Harnes + Jupiter *		9.0	29.2	3.2	8.4	93.3
Prometrex + Jupiter *		9.2	28.7	3.1	8.5	94.4
Average		8.4	27.4	3.3	7.7	-
Lim		7.0–9.8	23.2–31.4	3.1–3.5	5.9–9.0	
Chabanskiy variety						
Manual weeding ( <i>control 1</i> )		9.7	29.9	3.1	9.9	100.0
Without herbicides and weeding ( <i>control 2</i> )		7.5	21.9	2.9	6.7	67.7
Treflan *		7.7	24.0	3.1	8.1	81.8
Fronter Optima *		8.0	25.3	3.2	8.3	83.8
Harnes *		8.8	27.9	3.2	9.1	91.9
Prometrex *		8.2	26.5	3.2	8.8	88.9
Stomp 330*		7.8	24.6	3.2	7.8	78.8
Jupiter **		7.9	22.8	2.9	7.3	73.7
Treflan + Jupiter **		7.8	23.1	3.0	7.4	74.7
Treflan + Jupiter *		8.1	25.8	3.2	8.7	87.9
Harnes + Jupiter *		8.6	28.4	3.3	9.1	91.9
Prometrex + Jupiter *		8.9	29.0	3.3	9.4	94.9
Average		8.3	25.8	3.1	8.4	-
Lim		7.5–9.7	21.9–29.0	2.9–3.3	6,7–9,9	
LSD <sub>05</sub>	Variety	-			0.3	
	Variant				0.6	

Note: \* – before sprouting; \*\* – upon sprouting of lupine.



**Research results.** Indicators of elements of the structure of seed yield of lupine plants varied depending on the herbicide and level of indigestion. In both varieties, the largest number of beans per plant was formed on a manual weeding control: Serpnevyi variety – 9.8, Chabanskyi variety – 9.7 pcs. (Table 1). In the best variants, using Harnes herbicides and Harnes + Jupiter and Prometrex + Jupiter mixture, the number of beans was 8.6–9.2 pcs. per plant. The lowest rates of this characteristic were obtained without use of herbicides and propagation (7.0–7.5 pcs. of beans). Also, lower rates were noted for the introduction of herbicides upon sprouting of lupine.

Similar to variations in the number of beans, changes in the number of seeds per plant were noted with changes of indices. The highest indices (29.9–31.4 pcs.) were obtained in manual crop weeding, while the lowest ones – in the variant without herbicides and without crop weeding (21.9–23.2 pcs.) using herbicides, the reduced amount of seeds was received introducing preparations upon sprouting of lupine and Treflan (22.8–25.6 pcs.). In general, slightly larger number of seeds was formed by the plants of Serpnevyi variety, but due to a larger seed, Chabanskyi variety was distinguished by higher seed yield. By the number of seeds per one bean, all variants differed much from each other. In Serpnevyi variety, this indicator ranged from 3.1 to 3.4 pcs., and in Chabanskyi variety – from 2.9 to 3.3 pcs.

As a result of determining the weight of seeds from one plant, it has been established that their productivity in various variants, on average, in three years ranged from 5.9 to 9.0 g in Serpnevyi variety and from 6.7 to 9.9 g in Chabanskyi variety. The largest seed yield was obtained for control.

However, the best options for introducing herbicides, which recorded high percentages of deaths of weeds, were

partially inferior to control. In Serpnevyi variety, the productivity of plants was 93.3–96.7 %, while in Chabanskyi variety it was 91.9–94.9 % of the control. Plants of lupine on weed-grown area (without weeding and without herbicides) were found to be the least productive: 65.6 % (Serpnevyi variety) and 67.7 % (Chabanskyi variety) from the control variant (Fig. 1).

When using herbicides, the highest weight of seed from a plant in Serpnevyi variety (8.7 g) was obtained at plots with the introduction of Harnes, in Chabanskyi variety (9.4 g) – when introducing tank mixture Prometrex + Jupiter. The lowest productivity is determined when introducing herbicide Jupiter and tank mixture Treflan + Jupiter upon sprouting: Serpnevyi variety – 6.7 and 6.9 g, and Chabanskyi variety – 7.3 and 7.4 g, respectively. This is due to the fact that there was a suppressing effect of herbicides on plants of lupine. They lagged behind in the development of both control plants and variants with the introduction of herbicides before sprouting. Also noteworthy is the use of herbicide Stomp 330, despite fairly high death of weeds (an average of about 70,0 %), lower seed yield of plants of lupine is recorded.

The yield of seeds of white lupine is to a large extent determined by the conditions of cultivation. In different years, differing in temperature conditions and rainfall, especially in periods critical to the development of lupine plants, it can vary massively. During the research period, yields varied significantly and reached 4.06 tons/ha for Serpnevyi variety in control with manual weeding in 2013 and up to 4.45 tons/ha in Chabanskyi variety (Table 2). In 2014, the yields in control were 3.78 and 4.18 tons/ha, and in 2015 – to 2.99 and 3.36 tons/ha, and averaged over three years – 3.61 and 4.00 tons/ha (Serpnevyi and Chabanskyi varieties, respectively). All other experimental variants were

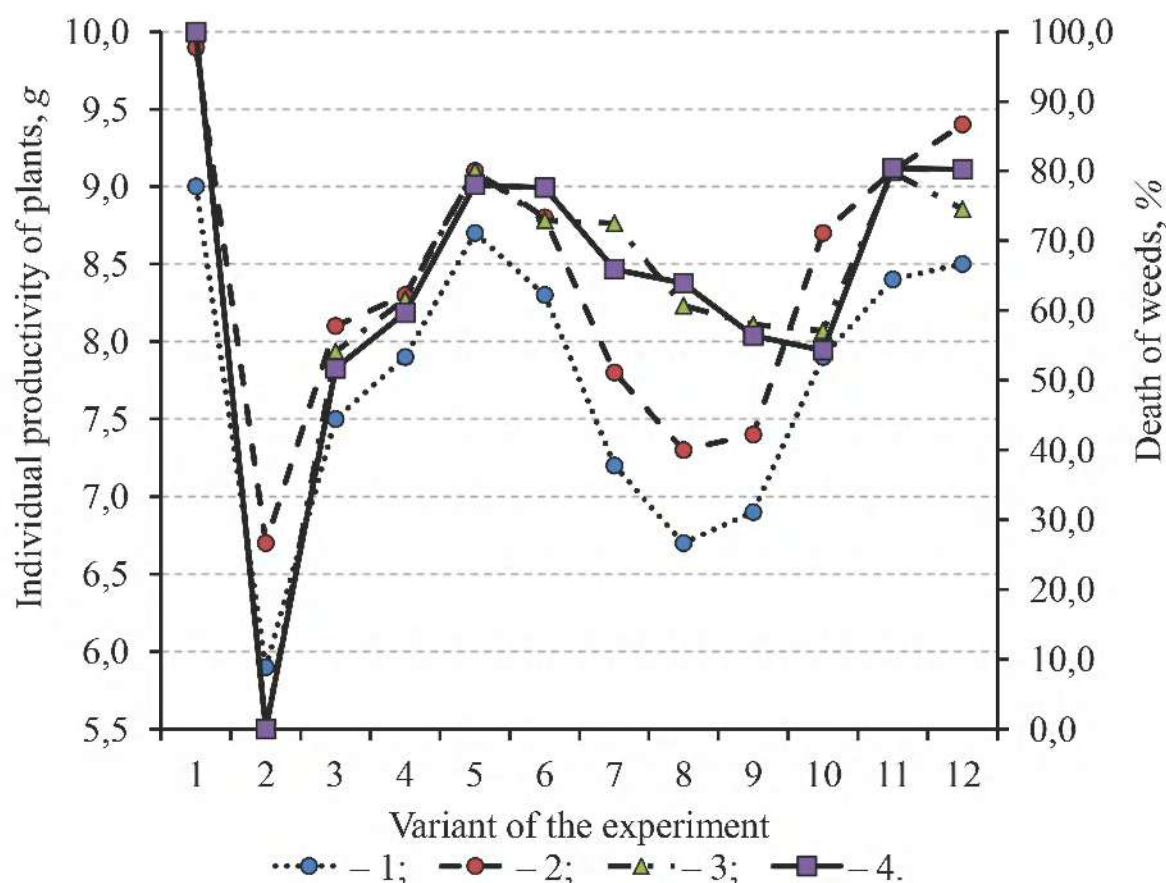


Fig. 1. Efficiency of phytotoxic action of herbicides and productivity of plants of lupine, 2013–2015:  
1 – Serpnevyi variety; 2 – Chabanskyi variety (productivity of plants);  
3 – Serpnevyi variety; 4 – Chabanskyi variety (death of weeds).

Таблиця 2

## 2. White lupine seeds yield, tons/ha

Variant of the experiment		Serpneviy variety					Chabanskiy variety				
		Year			Average	% before control 1	Year			Average	% before control 1
		2013	2014	2015			2013	2014	2015		
Manual weeding (control 1)		4.06	3.78	2.99	3.61	100.0	4.45	4.18	3.36	4.00	100.0
Without herbicides and weeding (control 2)		2.91	2.62	1.74	2.42	67.0	3.09	2.86	2.22	2.72	68.0
Treflan *		3.55	3.17	2.49	3.07	85.0	3.71	3.60	2.69	3.33	83.3
Fronter Optima *		3.62	3.38	2.80	3.27	90.6	3.90	3.81	2.90	3.54	88.5
Harnes *		3.98	3.57	2.94	3.50	97.0	4.22	3.99	3.27	3.83	95.8
Prometrex *		3.72	3.51	2.82	3.34	92.5	4.10	3.90	3.06	3.69	92.3
Stomp 330*		3.34	3.18	2.31	2.94	81.4	3.65	3.42	2.58	3.22	80.5
Jupiter **		3.25	3.12	2.04	2.80	77.6	3.45	3.20	2.43	3.03	75.8
Treflan + Jupiter **		3.04	2.99	2.22	2.75	76.2	3.40	3.24	2.53	3.06	76.5
Treflan + Jupiter *		3.67	3.41	2.67	3.25	90.0	3.95	3.71	2.88	3.51	87.8
Harnes + Jupiter *		3.85	3.70	2.83	3.46	95.8	4.28	3.85	3.05	3.73	93.3
Prometrex + Jupiter *		3.98	3.59	2.90	3.49	96.7	4.32	4.03	3.27	3.87	96.8
Average		3.58	3.34	2.56	3.16	-	3.88	3.65	2.85	3.46	-
Lim		2.91–4.06	2.62–3.78	1.74–2.99	2.42–3.61		3.09–4.45	2.86–4.18	2.22–3.36	2.72–4.00	
LSD <sub>05</sub>	Year	0.06									
	Variety	0.03									
	Variant	0.08									

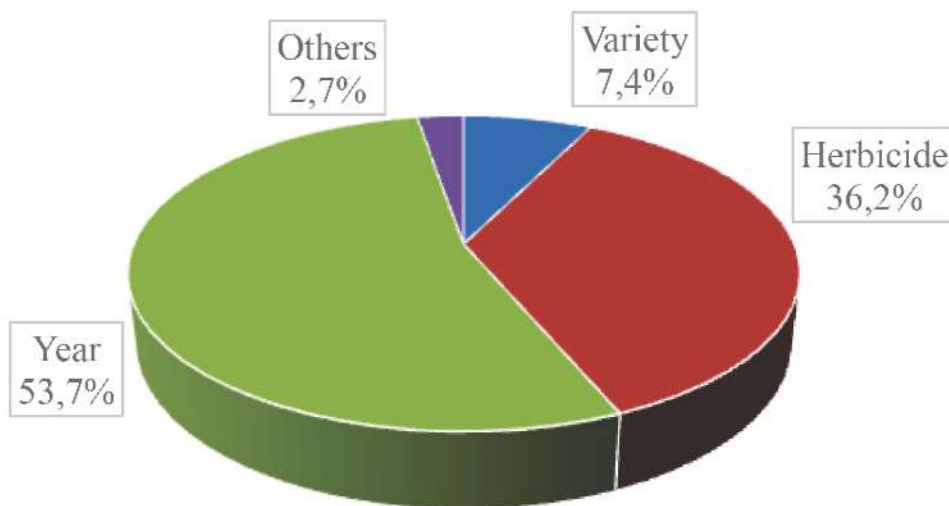


Fig. 2. The part of influence of factors in the formation white lupine seeds yield, 2013–2015.

inferior to controls with manual weeding and yields varied from 2.42 to 3.50 tons/ha in Serpneviy variety and from 2.72 to 3.87 tons/ha in Chabanskiy variety. The first and second places on the average of three years yields when using herbicides was the introduction of Harnes and tank mixture Prometrex + Jupiter (Serpneviy variety – 3.50 and 3.49 tons/ha, Chabanskiy variety – 3.83 and 3.87 tons/ha); and inferior to controls at 0.11–0.12 and 0.17–0.13 tons/ha, respectively. Good results also ensure the introduction of Prometrex herbicide and Harnes + Jupiter tank mix.

The lowest results were also obtained on plots without mechanical and chemical weeding, that is, on the most weed-grown. The yield of seeds on these plots was 2.42 tons/ha in Serpneviy variety and 2.72 tons/ha in Chabanskiy variety or only 67.0 % and 68.0 % of control.

Yield of lupine seeds depended on the effectiveness of herbicides for the destruction of weeds. In variants with the maximum percent of death of weeds the highest yield was obtained.

In some variants, the suppressing effect of herbicides

on lupine plants was noted. The introduction of herbicides upon sprouting negatively affected both the development of lupine plants and the formation of yield: it was the lowest among the variant with the introduction of herbicides and 2,80 in Serpnevyy variety and 2,75 tons/ha, and in Chabanskyi variety – 3,03 and 3,06 tons/ha. In the variant with the introduction of the herbicide, Stomp 330, the yield was the lowest among the variants with the introduction of herbicides before sprouting, its value was 2.94 tons/ha (Serpnevyy variety) and 3.22 tons/ha (Chabanskyi variety).

Thus, white lupine seeds yield greatly depended on growing conditions, namely on both weather conditions of the year and on the elements of technology, in particular, the use of herbicides. The part of the influence of the factor "the conditions of the year" was the largest and amounted to 53.7 %, and the part of influence of the factor "herbicide" – 36.2 % (Fig. 2). The part of the "variety" factor reached only 7.4 %, while the others – 2.7 %.

Serpnevyy variety of white lupine is fast-growing with the duration of the period of vegetation 100–105 days, and Chabanskyi mid-season – 110–115 days. Use of herbicides on the crops did not affect the duration of the entire period of vegetation, as well as its individual phases. The experiment reflected the simultaneous passage of lupine developmental phases. Only on weed-grown plots of the variant without the use of herbicides and without manual weeding is determined to be delayed (on average for 5 days) and disjointed achievement of the seeds.

Thus, when choosing herbicides, it is necessary to comprehensively evaluate the effectiveness of their action, that is, to take into account both the effectiveness of the destruction of weeds and the impact on plants of lupine. The main criterion for evaluation, especially in seed crops, should be the magnitude of the yield of the seed and the quality of the seed material.

### Conclusions

1. The largest weight of seed from a plant was obtained in control with manual weeding: Serpnevyy variety – 9.0 g; Chabansky variety – 9,9 g; on the best variants with the introduction of herbicides – up to 8.7 g and 9.4 g, respectively.

Plants of lupine on weed-grown plots (without weeding and herbicides) turned out to be the least productive: 65.6 % (Serpnevyy variety) and 67.7 % (Chabanskyi variety).

2. The highest yield of seeds among variants with the introduction of herbicides was ensured by the use of Harnes and tank mixture Prometrex + Jupiter (Serpnevyy variety – 3.50 and 3.49 tons/ha, Chabanskyi variety – 3.83 and 3.87 tons/ha respectively). The introduction of herbicides upon sprouting negatively affected yield formation – it was the lowest among all variants with the use of herbicides, and it was 2.80 and 2.75 tons/ha in Serpnevyy variety, while in Chabanskyi variety it was 3.03 and 3.06 tons/ha. On the plots of these variants, there was also a delay in the growth and development of lupine plants, which was especially observed in the first half of vegetation.

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