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Influence of the technological aspects growing on quality composition of seed white lupine (*Lupinus albus* L.) in the Forest Steppe of Ukraine

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The article is a scientifically substantiated value of growing lupine white. The ecological value of crops of this culture, which is able to capture atmospheric nitrogen and is a favorable predecessor to other crop rotation crops, is proved. The importance of applying pre-sowing seed treatment and extra-root crops to increase is proved level of yield and quality of grain depending on variety and weather conditions. The specificity of the increase of grain productivity of white lupine varieties of Veresnevyi and Makarovskyi was established. Positive effect of application in pre-sowing seed treatment of bacterial preparation Risogumin and growth stimulator Emistim C in combination with two non-root nutrients Emistim C on indicators individual productivity. The statistically significant increase in the yield parameters of white lupine varieties at the application of pre-sowing seed treatment of a bacterial preparation and a growth stimulator in combination with two non-root nutrients. However, these factors significantly less affect the yields of this crop compared with the weather conditions of growing years and, above all, the availability of their precipitation during the critical period of vegetation.

Keywords: Lupine white; pre-treatment of seeds; foliar nutrition; grain productivity; grain quality

Introduction

Stability of crop production, the formation and functioning of the grain market, especially grain legume crops, at the present stage and in the future, can be successfully realized only if the crop yields increase through further development and implementation of competitive cultivation technologies with a high level of return on invested resources. Important scientific researchers results in the technology of growing were made by national and foreign scientists A. O. Babych, V. F. Petrychenko, S. M. Kalenska, V. G. Myhailov, M. I. Bahmat, M. J. Shevnikov, O. M. Bahmat, H. V. Pantsyreva, K. Novák, B. Furseth etc. (Mazur V.A., 2018, Vdovenko S.A., Prokopchuk V.M., Palamarchuk I.I., Pantsyreva H.V., 2018).

Lupine is a valuable feed and shederal culture, and white lupine is also food. Its unique ability in two or three months of the growing season to record a hectare of sowing to 300 kg or more of atmospheric nitrogen, which corresponds to an average of 0.5 tons, and in the best case - to one and even more tons of ammonium nitrate, and to be independent not only from nitrogen, but also from phosphate fertilizers and soil fertility, sets this culture into a special range among all legumes. Given the high content of protein - 30-48% and fat - up to 14% in the seeds of lupine, it is called the second northern soybean (Furseth, B. J., Conley, S. P., & Ané, J. M., 2011).

One of the main problems of the agricultural sector of the country is a significant increase and stabilization of the production of legumes, which are the main source of balanced amino acid composition and content of environmentally friendly protein. Achieving high yields of these crops, including white lupine, requires new approaches and a modern awareness of the ways of solving growing problems (Furseth, B. J., Conley, S. P., & Ané, J. M., 2012).

White lupine is unpretentious to soil fertility, cold-resistant, high-yielding culture, which, on the poor, uncooled and acidic soils of Polissya and Forest-Steppe, can provide high, enriched grain yields and green mass. Conducting research on the study of

the peculiarities of the formation of yield and quality of white lupine grain, depending on the technological methods of cultivation, in particular from pre-sowing processing of seeds and extra-root crops in the conditions of right-bank forest-steppe, is of great importance in modern crop production.

Materials and methods

Field research was carried out during 2013-2015 on the basis of the research farm «Agronomichne» of the Vinnytsia National Agrarian University in the village Agronomichne of the Vinnytsia region. The soils are gray forest, medium loamy. In the experiment, the effect and interaction of three factors were studied: A - variety, B - pre - sowing seed treatment, C - endocrine nutrition. Explored varieties - Veresnevyi and Makarovskyi. The technology of cultivating white lupine varieties commonly used for the forest-steppe zone of Ukraine and foresees the pre-seed treatment of seeds with the bacterial preparation Risogumin in combination with growth stimulator Emistim C and endocrine feeding by Emistim C. The area of the registration area is 25 m^2. Repeatability of the experiment - four-time, placement of options - systematic in two tiers. Determination of biochemical indicators of grain quality was carried out in accordance with generally accepted methods on the basis of complete zootechnical analysis of feed. The grain yield was determined on the part of the plot by the method of continuous harvesting and weighing the grain of each site, with further determination of moisture and debris.

Results and discussion

The problem of the deficiency of plant proteins caused an increased interest in the cultivation of lupine. Due to the high protein content of the plant and its adaptation to different soil-climatic conditions, lupine is an indispensable fodder crop. The criterion for assessing the activity of the functioning of symbiotic systems can be not only the seed yield of legumes, but also the content of crude protein in the grain (Pantsyreva, 2018).

Yield - a complex complex feature, which manifests itself on the basis of the functional activity of various organs of plants, which make up their morphological and physiological structure. Each organ (root, stem, leaf, beans) is formed at a certain stage of ontogenesis. Their livelihoods are limited to different temporal periods and are regulated by the genetic apparatus of organisms in complex interaction with the environment (Brelles-Mariño & Boiardi, 1996; Elkins, et al., 1996; Pantsyreva, 2017).

The maximum yield is formed for the optimal ratio of all elements of its structure. Sometimes, due to the weak development of one element of the structure of the crop, the total yield is to some extent compensated by other elements. This is due to the fact that separate elements of the crop are formed at different stages of organogenesis and for the optimal development of them, different conditions are required (Davis & Narenda, 1986; Mazur, et al., 2018).

Investigation of the characteristics of the formation of indices of raw protein content in white lupine grains and its output per unit area, depending on the elements of cultivation technology, has an important theoretical and practical significance for substantiation of the possibilities and feasibility of growing this leguminous crop in the conditions of right-bank Forest Steppe (Djekoun & Planchon, 1991).

The level of lupine yield was determined by the individual productivity of plants, which, in turn, depends on the amplitude of the change in the number of beans per plant and the mass of seeds on the stalk (Mazur, 2018; Novák, et al., 2005; Pantsyreva, 2016).

Our research has found that the individual productivity of white lupine plants depended on varietal characteristics and investigated factors (Mazur & Pantsyreva, 2017). Thus, the maximum individual productivity of plants of lupine of white varieties was fixed on a variant with pre-seed treatment with a bacterial preparation with a growth stimulator in combination with two non-root crop supplements. In this case, the indicators of individual productivity were as follows: the number of beans per plant - 6.5 pcs., the number of grains per plant - 20.3 pcs., the weight of 1000 grains - 335.1 grams, the weight of grain from one plant - 6,8. In control study areas where seed pre-planting and root-crop feeding were not used, individual productivity indicators were the lowest, and accordingly they were: the number of beans per plant was 4.9 pcs, the number of seeds per plant was 15.5 pct., the mass of 1000 grains - 317.2 g, the mass of grains from one plant and - 4.9 g (Table 1).

Table 1. Individual productivity of white lupine plants depending on technological methods of cultivation (average for 2013-2015).

Variety	Factors		Number of beans per plant, pcs.	Number of grains per plant, pcs.	Mass 1000 grains, pcs.	Weight of grains of a plant, g.
	pre-sowing seed treatment	Foliar nutrition by Emistim C				
Veresnevyi	Without pre-sowing seed treatment	without feeding ©	4.9	15.5	317.2	4.9
		one feedings	5	16	318.1	5.1
		two feedings	5	16.3	319.4	5.2
	Ryzohumin	without feeding	5.1	16.2	314.9	5.1
		one feedings	5.2	17.3	317	5.5
		two feedings	5.5	17.5	319.4	5.6
	Emistim C	without feeding	5.2	16.3	317.6	5.2

		one feedings	5.4	17.6	320.1	5.6
		two feedings	5.8	17.9	323.7	5.8
	Ryzohumin+Emistim C	without feeding	5.4	16.6	321.6	5.3
		one feedings	6.1	18.1	325.9	5.9
		two feedings	6.5	20.3	335.1	6.8
Makarivskyi	Without pre-sowing seed treatment	without feeding ©	4	14.2	280.1	4
		one feedings	4	14.6	282.4	4.1
		two feedings	4.1	14.9	286.5	4.3
	Ryzohumin	without feeding	4.1	14.6	284.6	4.2
		one feedings	4.6	14.9	287.9	4.3
		two feedings	4.8	15.5	289.8	4.5
	Emistim C	without feeding	4	15.8	287.8	4.5
		one feedings	4.4	16	289.9	4.6
		two feedings	4.9	16.9	290.1	4.9
	Ryzohumin+Emistim C	without feeding	4.4	16.1	292.9	5.1
		one feedings	5	17.2	296.1	5.3
		two feedings	5.3	18.8	304.9	5.7

It should be noted that the use of growth stimulator Emistim C in conjunction with seed precipitate treatment with the complex interaction of the bacterial preparation Risogumin and the growth stimulator Emistim C positively impacted the individual productivity of white lupine, which contributed to an increase in the number of beans per plant, a mass of 1000 grains and mass of grains from one plant (Dorcinvil, Sotomayor-Ramírez & Beaver, 2010; Vdovenko, et al., 2018).
We have found that there is a close relationship between individual productivity of plants and the level of yield of agricultural crops, including white lupine. The revealed dependencies between the formation of indices of individual productivity and the magnitude of grain yield in white lupine varieties can be expressed by the following regression equations:

У=7,881678+0,066816x1+0,196308x2-0,026010x3 for the variety Veresnevyi;
У=-10,6228+0,417809x1+0,31046x2+0,057075x3 for the variety Makarovskyi:

where U-grain yield, t/ha; x1 - number of beans per plant, pcs / plant; x2 - the number of grains per plant, pcs .; x3 - weight 1000 seed, g.
The years in which the research was carried out (2013-2015) under the hydrothermal conditions, were characterized by some deviations from the average long-term data, but they were generally quite favorable for the growth, development of plants and the formation of high productivity grain yield and the output of crude protein of white lupine (Table 2).

Table 2. Productivity of grain and the output of crude protein of white lupine depending on technological methods of cultivation, t/ha (average for 2013-2015).

Factors			**Productivity of grain**	**Output of crude protein**
Variety	**Pre-sowing seed treatment**	**Foliar nutrition by Emistim C**		
Veresnevyi	Without pre-sowing seed treatment	without feeding ©	2.96	1.07
		one feedings	3.02	1.14
		two feedings	3.17	1.19
	Ryzohumin	without feeding	3.25	1.23
		one feedings	3.38	1.31
		two feedings	3.45	1.36
	Emistim C	without feeding	3.2	1.17
		one feedings	3.27	1.2
		two feedings	3.35	1.3
	Ryzohumin+Emistim C	without feeding	3.19	1.17
		one feedings	3.32	1.27
		two feedings	3.61	1.44
Makarivskyi	Without pre-sowing seed treatment	without feeding ©	2.63	0.83

	one feedings	2.71	0.95
	two feedings	2.81	0.98
Ryzohumin	without feeding	2.88	1.02
	one feedings	3.05	1.11
	two feedings	3.15	1.18
Emistim C	without feeding	2.58	0.87
	one feedings	2.62	0.94
	two feedings	2.73	0.99
Ryzohumin+Emistim C	without feeding	2.91	1.12
	one feedings	3.01	1.19
	two feedings	3.23	1.3

LSD $_{0,5}$ t/ha: A-0,07; B-0,10; C-0,08; AB-0,14; AC-0,12; BC-0,17; ABC-0,24

2013p. $HIP_{0,5}$ t/ha: A-0,04; B-0,05; C-0,04; AB-0,07; AC-0,06; BC-0,08; ABC-0,12

2014p. $HIP_{0,5}$ t/ha: A-0,05; B-0,06; C-0,06; AB-0,09; AC-0,08; BC-0,11; ABC-0,16

2015p. $HIP_{0,5}$ t/ha: A-0,04; B-0,06; C-0,05; AB-0,08; AC-0,07; BC-0,10; ABC-0,14

The maximum value of the grain yield of white lupine varieties was obtained on variants of the experiment with pre-sowing seed treatment with inoculum Risogumin and growth stimulator Emistim C in combination with feedings Emistim C. In this case, the grain yield was 3.61 t/ha, and exceeded the control variant on 0.65 t/ha, and in percents, respectively-18%.

It was established that the maximum yield of crude protein in the variety of Veresnevyi - 1.44 t/ha, and in the Makarovskyi variety - 1.30 t/ha was obtained on the experimental variants, where the bacterial preparation Risogumin and growth stimulator Emistim C in combination were used in pre-planting seed treatment with two non-root nutrients Emistim C, correspondingly greater than 0.37 and 0.35 t/ha, when compared with the control variants. The lowest yield of crude protein - 1.07 t/ha in the Veresnevyi and 0.83 t/ha in the Makarivskyi variety was obtained on experimental variants without pre-sowing seed treatment and foliar feeding.

The dependences established in our studies between the formation of the grain yield and the content of the raw protein of white lupine are reflected in the regression equations:

У=2,697037-0,05907x1+2,271583x2 for the variety Veresnevyi;
У=2,574726-0,06316 x1+2,472766x2 for the variety Makarivskyi:

where U-grain yield t/ha; x1-content of crude protein,%; x2 is the yield of crude protein, t/ha.

The multiple correlation coefficients of the above regression equations were respectively for the varieties Veresnevyi and Makarivskyi R=0,976503 and R=0,970203. The pair correlation coefficients (r) between the grain yield and the content and yield of crude protein were respectively for the varieties of Veresnevyi 0,019318 and 0,210412, and for the Makarivskyi variety 0,014511 and 0,248891. Consequently, there is a close relationship between the grain yield and the yield of raw white protein lupine.

As the question of the quality of white lupine seeds at the expense of pre-sowing processing of seeds and extra-root crops on gray forest soils on the right bank of the Forest Steppe is poorly understood, therefore, there was a need for scientific research in this direction.

The factors studied in the experiment had a significant effect on the formation of white lupine grain quality indices (Table 3).

Table 3. Quality indicators of white lupine grains depending on technological methods of cultivation (average for 2013-2015).

Factors			**Fat, %**	**Ash, %**	**Cellulose, %**	**BES, %**
Variety	**Pre-sowing seed treatment**	**Foliar nutrition by Emistim C**				
Veresnevyi	Without pre-sowing seed treatment	without feeding ©	6.56	3.64	13.9	41.98
		one feedings	6.95	3.91	13.75	41.24
		two feedings	7.4	4.04	13.67	41.03
	Ryzohumin	without feeding	7.32	3.52	12.31	37.03
		one feedings	7.52	3.7	12.11	36.24
		two feedings	8.27	3.84	11.98	36.01
	Emistim C	without feeding	7.19	3.51	12.34	37.98
		one feedings	7.68	3.69	12.22	37.12
		two feedings	8.14	3.84	12.08	36.97

	Ryzohumin+Emistim C	without feeding	7.67	3.44	9.27	35.62
		one feedings	8.01	3.62	9.15	34.95
		two feedings	8.63	3.77	9.01	34.81
Makarovskyi	Without pre-sowing seed treatment	without feeding ©	6.12	3.92	14.63	43.42
		one feedings	6.42	4.21	14.59	42.72
		two feedings	6.97	4.38	14.47	42.5
	Ryzohumin	without feeding	7.35	3.49	11.87	38.19
		one feedings	7.78	3.92	11.69	37.61
		two feedings	8.28	4.11	11.59	37.42
	Emistim C	without feeding	6.78	4.02	12.97	40.49
		one feedings	7.22	4.16	12.84	40.01
		two feedings	7.66	4.25	12.71	39.86
	Ryzohumin+Emistim C	without feeding	7.68	3.87	8.98	37.12
		one feedings	8.01	3.95	8.85	36.39
		two feedings	8.49	4.08	8.74	36.28

Thus, the maximum content of raw fats in white lupine grains of Veresnevyi -8,63% and 8,49% in the Makarivskyi variety was noted in variants where the bacterial preparation Risogumin and the growth stimulator Emistim C in combination with two non-root nutrients Emistim C used in pre-sowing seed treatment in the phases of budding and the onset of seeding.

Conclusion

The grain yield of white lupine was determined by the individual productivity of plants, which, in turn, depends on the amplitude of the change in the number of beans per plant and the mass of seeds on the stalk. Optimization of technological methods of cultivation due to pre-sowing treatment of seeds with the bacterial drug Risogumin and growth stimulator Emistim C in combination with two non-root nutrients Emistim C in the phases of budding and seeding, ensures the formation of a high level of grain yield and the yield of raw protein. Established that the conduct foliar fertilizing Emistim C helped to improve the quality of grain white lupine.

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