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EFFECTIVENESS OF BACTERIAL PREPARATIONS AND PLANT GROWTH REGULATORS IN THE SEPARATE AND MIXED CROPS OF OATS, SPRING WHEAT AND NARROW-LEAVED LUPINE DEPENDING ON LEVEL OF NITROGEN NUTRITION

EFEKTYWNOŚĆ PREPARATÓW BAKTERYJNYCH I REGULATORÓW WZROSTU ROŚLIN W SIEWACH CZYSTYCH I MIESZANYCH OWSA, PSZENICY JAREJ I ŁUBINU WĄSKOLISTNEGO W ZALEŻNOŚCI OD POZIOMU ŻYWIENIA AZOTEM

Abstract: The article presents results of research into the influence of bacterial preparations (rizobacterin and sapronit) and plant regulators of growth (epin and homobrassinolid) on the productivity and quality of grain of oat, spring wheat and lupine in the separate and mixed crops depending on level of a nitrogen nutrition. We have established that in the conditions of sod-podzolic soil of average degree cultivation the optimal dose of nitrogen fertilizer for oat, wheat and mixed crops is 40 kg of acting substance per hectare, for lupine – 10 kg of acting substance per hectare (at level $P_{60}K_{90}$). Inoculation of seeds bacterial preparations (rizobacterin and sapronit) and application of growth regulators (epin and homobrassinolid) in technology of cultivation of oats, spring wheat, lupine and their mixed crops allows to reduce doses of mineral nitrogen to 30 kg of acting substance per hectare and to improve quality indicators of grain of studied cultures.

Keywords: oat, spring wheat, narrow-leaved lupine, mixed crops, nitrogen fertilizer, bacterial preparations, plant growth regulators, efficiency

A strategic problem of scientific researches is search and optimisation of ways of reception of biologically high-grade and ecologically safe production at the maximum decrease in negative influence of anthropogenic factors on environment and reduction of expenses of irreplaceable power resources by its reception.

Cultivation of the mixed crops grain with leguminous cultures promotes the decision of variety of problems of an agricultural production: preservation and the expanded reproduction of fertility of soil, ecological, power and albuminous [1]. The mixed crops

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of these cultures allow increasing efficiency of a field, to receive the balanced forage for animals, and also to optimize application of mineral fertilizers. Considering biological advantages of bean cultures, and, in particular, ability to symbiotrophic nitrogen nutrition, their cultivation is more economic in comparison with other kinds of agricultural crops [2].

The problem of nitrogen nutrition is connected not only with expenses of nitrogen mineral fertilizers, but also and that nitrogenous compounds (nitrates) are exposed to washing away. It is dangerous to environment. Accumulation of nitrates in soil leads to essential losses of nitrogen as a result of denitrification, which reach 10–35 % of the total quantity. Unlike nitrogen of mineral fertilizers, the organic nitrogen present in plants, is ecologically harmless.

To strengthen process of nitrogen fixation it is possible also by using microbiological preparations: on leguminous – symbiotic, and on grain crops – associative diazotrophic. Low cost, a high recovery, safety for environment causes their wide application [3]. In the agrarian-developed countries to 1/3 total areas of grain and leguminous cultures bacterize diazotrophic preparations, and at the expense of it to 25–40 % reduce use of expensive and ecologically unsafe mineral nitrogen fertilizers [4].

Also regulators of growth of plants become the important component of modern "know-how" of production of plant growing. Valuable property of regulators of growth is that they strengthen receipt of elements of a food in root system [5, 6]. According to a number of scientists in first half of 21st century by application of physiologically active substances the basic increase of a crop will be received [7, 8].

The insufficient level of scrutiny of joint application of nitric fertilizers, bacterial preparations and growth regulators in crops of oats, wheat and lupine confirms necessity and an urgency of their studying. The purpose of researches: to establish influence of various doses of nitrogen fertilizers, bacterial preparations, plant growth regulators on productivity and high quality grain of oats, summer wheat and lupine in the pure and mixed crops in the conditions of sod-podsolic sandy-loam soils of the north-western of Belarus.

Material and methods

Field experiments with the legume (narrow-leaved lupine) cv. Pershacvet and oats cv. Strelec, spring wheat cv. Kontesa were carried out on experimental plot of the Belarusian state agricultural academy. The soil on experimental plot – sod-podzolic sandy-loam soil with reaction close to neutral pH_{KCl} = 5.9, low content of humus – 1.7 %, average content of mobile phosphate – 188 mg · kg^{-1} soil and average content of mobile potassium – 223 mg · kg^{-1} soil (index of cultivation 0.72).

The experiment scheme provided studying of efficiency of bacterial preparations rizobacterin (R) and sapronit (S), plant growth regulators epin (E) and homobrassinolid (H) depending on doses of nitrogen fertilizers (N_{10}, N_{40}, N_{70}) against $P_{60}K_{90}$ in the separate and mixed crops of oats, wheat and lupine.

Mineral fertilizers were brought under preseeding processing of soil. In the experiment were applied potassium chloride (60 % K_2O), ammophos (12 % N and

42–50 % P_2O_5), urea (46 % N). Seeds of oats, wheat and lupine processed corresponding bacterial preparations (200 $cm^3 \cdot ha^{-1}$) before sowing. We used 2 % solution of sodium salt to stick biopreparations into seeds.

Sapronit (S) is a preparation of symbiotic legume bacteria *Rhizobium lupini*. Organic sapropel is its substrate-carrier. The quantity of legume bacteria has increased power to auxin synthesis. Rizobacterin (R) is associative diazotrophe *Klebsiella planticola* (titre 2–2.5 billion viable cells/cm^{-3}) that affects the fixation of air nitrogen, biosynthesis of indoleacetic acid and suppresses the vital activity of root pathogenesis.

When the legume was in phase of budding and oats and wheat was scooting we applied growth regulators for non-soil dressing in the following doses: epin – 50 $cm^{-3} \cdot ha^{-1}$, homobrassinolid – 25 $cm^3 \cdot ha^{-1}$. Epin, 0.025 % is a solution prepared on the basis of epibrassinolid that belongs to natural phytohormones. It is a bioregulator of the plant growth that decreases the plant stress and increases plant resistance on unfavorable environment conditions (climatic conditions, diseases, pesticides etc). Homobrassinolid 0.125 % is a preparation that belongs to recently discovered new class natural phytohormones – brassinosteroids.

The maintenance of a crude protein paid off multiplication maintenances of the general nitrogen defined by method of Kjeldahl, on recalculation factor – 6.25.

Exit of a crude protein in recalculation on dry matter defined on the basis of percentage of fiber in plants and their productivity, increased by factor 0.86 [10].

The economic estimation of cultivation of studied cultures in experience by us has been spent on the basis of cost of the received crop and actual expenses taking into account existing regulations concerning the technology of cultivation [9]. Agronomical efficiency of fertilizers was defined by the standard method developed at the Institute of Agricultural Chemistry and Soil Science of Belarus [10]. The method essence consists that calculation of a predicted crop taking into account quality of soil and amount of brought fertilizers in the beginning is made, then are defined an increase in crop from the brought fertilizers and an actual reimbursement of fertilizers.

Statistical processing of the received results was carried out by a method of the dispersive analysis with use of computer programs Excel and Statistica 7.0.

Results and discussion

As a result of the researches it is established, that studied cultures positively react to entering of mineral nitrogen. Optimum doses of entering of mineral nitrogen in crops of oats, spring wheat, narrow-leaved lupine and their mixes were defined by a grain yield increase. For one-specific crops of oats by an optimum dose of nitrogen at level $P_{60}K_{90}$ – 70 kg of acting substance per hectare, for wheat of 40 kg, where productivity of these cultures averages 3.83 and 4.01 $Mg \cdot ha^{-1}$, at a reimbursement of grain of 1 kg NPK of 7.9 and 8.7 kg. The productivity increase to N_{10} is received at oats – 0.57 $Mg \cdot ha^{-1}$ and wheat – 0.31 $Mg \cdot ha^{-1}$. For pure crops of lupine an optimum dose of nitrogen is – N_{10} where productivity on the average for three years of researches has made 2.3 $Mg \cdot ha^{-1}$, a reimbursement of 1 kg NPK 5.5 kg grains (Table 1). The further increase in a dose of mineral nitrogen has not led to increase of productivity of this culture.

Table 1

Efficiency of application nitrogen fertilizers, bacterial preparation and growth regulators in crops of oats, spring wheat and narrow-leaved lupine (An average 2006–2008)

Variant (factor A)	Levels of a nitrogen nutrition (factor B)																				
	Background 1 – $N_{10}P_{60}K_{90}$							Background 2 – $N_{40}P_{60}K_{90}$							Background 3 – $N_{70}P_{60}K_{90}$						
	Productivity [Mg · ha^{-1}]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein [Mg · ha^{-1}]	Security feed unit, g digestible protein	Profitability [%]	Productivity [Mg · ha^{-1}]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein [Mg · ha^{-1}]	Security feed unit, g digestible protein	Profitability [%]	Productivity [Mg · ha^{-1}]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein [Mg · ha^{-1}]	Security feed unit, g digestible protein	Profitability [%]
Oats	3.26		7.7	10.5	0.29	64.4	65.8	3.95		8.7	11.1	0.38	61.5	72.6	3.83		7.9	13.1	0.43	62.7	62.2
Oats + E	3.64	0.38	8.6	12.4	0.39	65.0	72.0	4.30	0.35	9.4	12.4	0.46	65.0	86.0	4.24	0.41	8.8	13.5	0.49	63.7	69.2
Oats + H	3.80	0.54	8.9	13.8	0.45	64.8	79.5	4.41	0.46	9.7	13.2	0.5	64.9	90.8	4.12	0.29	8.5	13.9	0.49	64.5	64.4
Oats (R)	3.43	0.17	8.1	12.8	0.38	64.2	71.5	4.12	0.17	9.1	13.4	0.47	63.0	73.2	3.95	0.12	8.2	14.2	0.48	62.8	66.6
Oats (R)+E	3.94	0.68	9.5	12.9	0.45	65.0	88.0	4.26	0.31	9.4	13.5	0.49	64.8	81.8	4.25	0.4	8.8	14.4	0.53	65.0	67.5
Oats (R)+H	3.74	0.48	8.8	13.5	0.43	65.0	74.0	4.15	0.20	9.1	13.7	0.49	65.0	77.1	4.23	0.4	8.7	14.3	0.52	65.0	66.7
Average	3.65		8.6	12.6	0.39	64.7	75.1	4.20		9.2	13.3	0.48	64.1	80.3	4.10		8.4	14.2	0.50	64.0	66.1
LSD_{05}: (A) – 0.42; (B) – 0.74; (AB) – 0.76																					
S. wheat	3.70		9.1	12.5	0.40	103.0	174.8	3.95		9.0	13.2	0.45	103.6	172.5	3.78		8.1	14.4	0.47	103.1	149.1
S. wheat + E	3.94	0.24	9.6	14.6	0.49	102.5	177.5	4.06	0.11	9.2	14.4	0.50	102.6	163.1	4.19	0.41	8.9	14.6	0.53	102.6	119.0
S. wheat + H	3.90	0.20	9.5	14.6	0.49	102.5	174.7	4.17	0.22	9.5	15.4	0.55	102.6	170.2	4.25	0.47	9.1	14.5	0.53	102.5	122.7
S. wheat (R)	3.92	0.22	9.6	13.8	0.47	101.5	186.6	4.05	0.10	9.2	13.3	0.46	103.4	169.3	3.84	0.06	8.2	15.4	0.51	102.8	137.4
S. wheat (R)+E	4.05	0.35	9.9	15.1	0.53	102.6	181.2	4.70	0.75	10.7	14.8	0.60	102.7	200.7	4.57	0.79	9.4	15.7	0.62	102.6	136.6
S. wheat (R)+H	4.18	0.48	10.2	15.9	0.57	102.6	190.2	4.81	0.86	10.9	14.7	0.61	102.6	207.8	4.43	0.65	9.4	15.2	0.58	102.5	129.4
Average	3.95		9.7	14.5	0.49	102.5	180.8	4.29		9.8	14.3	0.53	102.9	180.6	4.18		8.9	14.9	0.54	102.7	132.4
LSD_{05}: (A) – 0.46; (B) – 0.54; (AB) – 0.79																					
N. lupine	2.30		5.5	32.3	0.64	320.7	88.4	2.51		5.5	33.4	0.72	318.6	52.9	2.06		3.5	33.7	0.60	321.9	45.4
N. lupine + E	2.64	0.34	6.3	33.6	0.76	319.8	106.8	2.54	0.04	5.6	33.8	0.74	319.9	88.1	2.20	0.14	3.8	33.5	0.63	320.3	54.5
N. lupine + H	2.32	0.02	5.5	33.5	0.67	320.3	81.7	2.54	0.04	5.6	33.5	0.73	319.9	88.1	2.23	0.17	3.8	33.8	0.65	320.4	56.6
N. lupine (S)	2.47	0.17	5.9	34.4	0.73	322.8	100.2	2.74	0.23	6.1	34.5	0.81	320.4	67.5	2.04	–	3.5	33.8	0.59	319.1	47.7
N. lupine (S)+E	2.49	0.19	5.9	34.9	0.75	319.7	93.2	2.86	0.35	6.3	35.1	0.86	320.4	109.0	2.16	0.1	3.7	34.3	0.64	321.1	50.4
N. lupine (S)+H	2.48	0.18	5.9	34.6	0.74	320.9	92.4	3.23	0.72	7.1	34.7	0.96	320.1	137.0	2.32	0.26	4.0	34.2	0.68	320.3	61.5
Average	2.45		5.8	33.9	0.71	320.7	93.8	2.74		6.1	34.2	0.81	319.9	90.6	2.17		3.7	33.9	0.63	320.5	52.7
LSD_{05}: (A) – 0.47; (B) – 0.65; (AB) – 0.69																					

S. wheat – spring wheat; N. lupine – narrow-leaved lupine.

In our researches for mixed crops (oats + spring wheat + narrow-leaved lupine) an optimum dose of nitrogen in the basic entering is N_{40} where productivity has made 3.89 Mg · ha^{-1} and an increase to N_{10} – 0.37 Mg · ha^{-1} at a reimbursement of 1 kg NPK of 8.9 kg grains (Table 2). The further increase in a dose of nitrogen fertilizers in mixed crops is inexpedient, since, it does not lead to increase in productivity against $P_{60}K_{90}$. On the average for years of researches productivity of a mix of oats, wheat and lupine was at level of one-specific crops of grain crops.

As researches have shown the efficiency of plant growth regulators depended on level of a nitrogen nutrition and bacterial preparations in the one-specific and mixed crops of studied cultures. On the average for three years of researches efficiency of growth regulators in oats crops above against N_{40}, the productivity increase has made from 0.35 to 0.46 Mg · ha^{-1}, a reimbursement of grain of 1 kg NPK of 9.4 and 9.7 kg, profitability of 86.0 and 90.8 %. With increase in a dose of nitrogen fertilizers efficiency of growth regulators decreases, the productivity increase fluctuates from 0.26–0.41 Mg · ha^{-1}, a reimbursement of grain of 1 kg NPK of 8.5 and 8.8 kg, profitability of 69.2 and 64.4 %. Highly effectively joint application of rizobacterin for preseeding processing of seeds and growth regulators in an exit phase in a tube of oats against N_{10}: the increase of productivity from epin has made 0.68 Mg · ha^{-1}, a reimbursement 1 kg NPK 9.5 kg grains, profitability of 88.5 %; homobrassinolid – 0.48 Mg · ha^{-1}, at a reimbursement 8.8 kg grain and profitability at level of 74 %. Whereas with increase in a dose of mineral nitrogen to 40 kg of acting substance per hectare. Additional gathering of grain has made 0.31 Mg · ha^{-1} and 0.2 Mg · ha^{-1}, a reimbursement of grain of 9.4 and 9.1 kg, profitability of 81.8 and 77.1 %; against N_{70} – 0.42 and 0.4 Mg · ha^{-1}, a reimbursement of grain of 1 kg NPK of 8.8 and 8.7 kg, profitability of 67.5 and 66.7 % accordingly.

Thus, in one-specific crops of oats processing of seeds before crops of rizobacterin and spray dressing of epin – the highly effective reception, allowing to increase productivity of oats against N_{10} by 0.68 Mg · ha^{-1}, at a reimbursement 1 kg NPK 9.5 kg grains, profitability of 88.5 %.

The greatest increase of productivity in spring wheat crops at application of studied growth regulators was against N_{70} – 0.1 and 0.47 Mg · ha^{-1}, however on a reimbursement of 1 kg NPK and profitability more effective have appeared regulators of growth against N_{10} (a reimbursement 1 kg NPK 9.6 and 9.5 kg of grain, profitability of 177.5 and 174.7 %). Against N_{40} at inoculation seeds before crops of rizobacterin and spray dressing in an exit phase in a tube epin and homobrassinolid the productivity increase has made 0.75 and 0.86 Mg · ha^{-1}, a reimbursement of grain of 1 kg NPK of 10.7 and 10.9 kg, profitability of 200.7 and 207.8 %. Against N_{70} additional gathering of grain from joint application rizobacterin and epin has made 0.79 Mg · ha^{-1}, homobrassinolid – 0.65 Mg · ha^{-1}, a reimbursement of grain of 1 kg NPK of 9.4 kg, profitability of 136.6 and 129.4 %, whereas, against N_{10} a productivity increase – 0.35 and 0.48 Mg · ha^{-1}, at profitability of 181.2 and 190.2 %. Thus, application of growth regulators stimulating action and bacterial preparations has provided the best indicators of efficiency in variants without additional entering of nitrogen, and also against N_{40}.

Table 2

Efficiency of application of nitrogen fertilizers, bacterial preparation and growth regulators in the mixed crops (Oats + spring wheat + narrow-leaved lupine) (an average 2006–2008)

Variant (factor A)	Levels of a nitrogen nutrition (factor B)																				
	Background 1 – $N_{10}P_{60}K_{90}$							Background 2 – $N_{40}P_{60}K_{90}$							Background 3 – $N_{70}P_{60}K_{90}$						
	Productivity [$Mg \cdot ha^{-1}$]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein [$Mg \cdot ha^{-1}$]	Security feed unit, g digestible protein	Profitability [%]	Productivity [$Mg \cdot ha^{-1}$]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein, [$Mg \cdot ha^{-1}$]	Security feed unit, g digestible protein	Profitability [%]	Productivity [$Mg \cdot ha^{-1}$]	Increase	Reimbursement of 1 kg NPK	Crude protein [%]	Exit of a crude protein [$Mg \cdot ha^{-1}$]	Security feed unit, g digestible protein	Profitability [%]
Oats + S. wheat + N. lupine	3.5		8.6	13.1	0.40	113.0	143.3	3.9		8.9	15.3	0.51	125.6	156.3	3.5		7.5	15.7	0.48	110.8	116.7
Oats + S. wheat + N. lupine + E	3.8	0.3	9.4	14.6	0.48	121.1	157.5	4.4	0.5	10.1	16.4	0.62	121.3	176.3	3.8	0.3	8.1	15.6	0.54	117.3	122.2
Oats + S. wheat + N. lupine + H	3.7	0.2	9.1	14.6	0.47	120.5	149.5	4.1	0.2	9.4	16.3	0.58	125.4	156.4	3.8	0.3	8.2	15.5	0.54	120.1	87.7
Oats (R) + S. wheat (R) + N. lupine (S)	3.6	0.1	8.7	13.8	0.42	115.4	147.7	3.8	–	10.1	15.4	0.50	118.0	150.5	3.7	0.2	7.8	15.9	0.50	120.7	98.4
Oats (R) + S. wheat (R) + N. lupine (S) + E	4.0	0.5	9.1	15.1	0.51	115.7	161.6	4.1	0.2	10.1	16.7	0.58	118.5	150.4	3.9	0.4	8.7	16.4	0.57	120.9	123.3
Oats (R) + S. wheat (R) + N. lupine (S) + H	3.8	0.3	9.1	15.9	0.52	116.4	153.0	4.0	0.1	10.1	16.1	0.53	117.5	147.9	3.7	0.2	8.0	15.8	0.52	116.3	115.8
Average	3.7		9.0	14.5	0.47	117.0	152.1	4.0		9.8	16.0	0.55	121.1	156.3	3.8		8.1	16.2	0.53	117.7	110.7
LSD_{05}: (A) – 0.46; (B) – 0.39; (AB) – 0.64																					

S. wheat – spring wheat; N. lupine – narrow-leaved lupine.

In crops of narrow-leaved lupine the authentic increase in productivity from application of epin has been received against N_{10} – 0.34 Mg · ha^{-1}, at a reimbursement of grain of 1 kg NPK of 6.3 kg, profitability of 106.8 %. Application of sapronit for preseeding processing of seeds and application of growth regulators for spray dressing against $N_{40,}$ an increase of productivity from 0.35 to 0.72 Mg · ha^{-1}, a reimbursement of grain of 6.3 and 7.1 kg, profitability of 109.0 and 137.0 % is highly effective.

Efficiency of regulators of growth in the mixed crops above against N_{40}, the increase of productivity from epin – 0.54, homobrassinolid – 0.22 Mg · ha^{-1}, thus a reimbursement of 1 kg NPK has made 10.1 and 9.4 kg of grain, profitability of 176.3 and 156.4 %. Whereas, against without additional entering of mineral nitrogen, an increase – 0.32 and 0.2 Mg · ha^{-1}, a reimbursement – 9.4 and 9.1 kg of grain, profitability of 157.5 and 149.5 %; against 70 kg of acting substance per hectare.

Nitrogen additional gathering of grain – 0.28 and 0.29 Mg · ha^{-1}, a reimbursement – 1 kg NPK of grain of 8.1 and 8.2 kg, profitability of 122.2 and 87.7 % accordingly. From inoculation of seeds and application of epin against N_{10} in the sum the productivity increase has made 0.43 Mg · ha^{-1}, against N_{70} – 0.53 Mg · ha^{-1}, at a reimbursement of grain of 9.4 and 8.7 kg, profitability of 161.6 and 153.0 %.

Thus, application of bacterial preparations and growth regulators on sod-podsolic soil of average degree cultivation – effective reception in technology of cultivation of oats, spring wheat and narrow-leaved lupine in the pure and mixed crops.

In the conditions of constant deficiency of fodder fiber the albuminous characteristic of forages has great value [11]. On the average for years of researches the maintenance of a crude protein in oats grain has made 11.05–13.01 %, in wheat grain – 11.60–14.35 %, lupine – 31.29–34.29 %, in mix grain – 13.03–15.59 % at gathering accordingly 0.35–0.42, 0.45–0.51, 0.48–0.64 and 0.42–0.51 Mg · ha^{-1} (Table 1–2).

It is necessary to notice, that food conditions, and in more degrees nitrogen, differently influence not only size, but also on quality of a crop. In our researches entering of nitrogen fertilizers also has made essential impact on the maintenance of a crude protein. In oats and spring wheat grain the given indicator increases from 0.93 (between N_{10} and N_{40}) and 1.03 (between N_{40} and N_{70}) to 1.96 % (between N_{10} and N_{70}) in oats grain; from 1.54 (between N_{10} and N_{40}) and 1.17 (between N_{40} and N_{70}) to 2.71 % (between N_{10} and N_{70}) in spring wheat grain. In grain narrow-leaved lupine the tendency of decrease in the maintenance of a crude protein with increase of a dose of nitrogen fertilizers on 1.3–3.0 % (Table 1), on the contrary, is observed. Hence, at inclusion in a mix narrow-leaved lupine updating of doses of nitrogen is necessary. According to researches it is dose N_{40} of acting substance per hectare where the maintenance of a crude protein in grain makes 15.59 %, and an exit of a crude protein – 0.51 Mg · ha^{-1}.

Against N_{70} inoculation of seeds oats rizobacterin and application of growth regulators the maintenance of a crude protein has made 14.4 and 14.3 %, against N_{40} – 13.5 and 13.7, N_{10} – 12.9 and 13.5 %, security of fodder unit of digestible protein – 65 g. The maintenance of a crude protein in wheat grain at inoculation of seeds a bacterial preparations and application epin and homobrassinolid for spray dressing against N_{70}

was 15.7, 15.2 %, security of fodder unit of digestible protein 102.6 and 102.5 g; against N_{40} – 14.8 and 14.7 %, security of fodder unit of digestible protein – 102.7 and 102.6 g.

At application against N_{10} of inoculation seeds and growth regulators the maintenance of a crude protein in grain of narrow-leaved lupine has made 34.9 and 34.6 %, against N_{40} – 35.1 and 34.7 %, security of fodder unit of digestible protein 319.7–321.1 g.

In the mixed crops these indicators above against N_{40} also have made at application of bacterial preparations and growth regulators of 16.1–16.7 % and 117.5–118.5 g of digestible protein. Thus, with increase in the level of nitrogen nutrition in crops narrow-leaved lupine and mixed crops it is not marked improvements of quality of grain. Hence, at application of epin in the mixed crops it is possible to lower nitrogen doses on 30 kg · ha^{-1} of acting substance. And to receive productivity at level of 4.43 Mg · ha^{-1}, at security of 1 fodder unit of digestible protein – 121.3 g.

Conclusions

1. Efficiency of bacterial preparations and growth regulators in the pure and mixed crops of oats, wheat and lupine depends on level of a nitrogen nutrition and crops kind.
2. In pure crops of oats processing of seeds before crops of rizobacterin and spray dressing in an exit phase in a tube epin on background N_{10} is highly effective.
3. For crops of wheat against N_{40} it is highly effective preseeding inoculation rizobacterin and spray dressing homobrassinolid.
4. In technology of cultivation narrow-leaved lupine at processing of seeds before crops sapronit and spray dressing in a phase budding homobrassinolid a dose of mineral nitrogen of 40 kg · ha^{-1} of acting substance it is necessary to consider optimum.
5. In the mixed crops against N_{40} application of growth regulator epin for spray dressing is highly effective.
6. Application of bacterial preparations and growth regulators in technology of cultivation of oats, spring wheat and narrow-leaved lupine in the pure and mixed crops allows to reduce doses of mineral nitrogen to 30 kg · ha^{-1} of acting substance and to improve quality indicators of grain of studied cultures.

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EFEKTYWNOŚĆ PREPARATÓW BAKTERYJNYCH I REGULATORÓW WZROSTU ROŚLIN W SIEWACH CZYSTYCH I MIESZANYCH OWSA, PSZENICY JAREJ I ŁUBINU WĄSKOLISTNEGO W ZALEŻNOŚCI OD POZIOMU ŻYWIENIA AZOTEM

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Abstract: W publikacji zostały przedstawione wyniki badań wpływu bakteryjnych preparatów (rizobakterin i sapronit) i regulatorów wzrostu roślin (epin i homobrassinolid) na plon i jakość ziarna owsa, pszenicy jarej i łubinu w jednogatunkowych i mieszanych siewach w zależności od poziomu nawożenia azotowego.

Ustalono, że w warunkach gleb darniowo-bielicowych o średnim stopniu wzrostu bakterii, optymalna dawką azotu dla owsa, pszenicy jarej i mieszanek tych kultur na poziomie $P_{60}K_{90}$ była 40 kg · ha^{-1}, dla łubinu – 10 kg · ha^{-1}. Inokulacja nasion bakteryjnymi preparatami (rizobakterin i sapronit) i zastosowanie regulatorów wzrostu (epin i homobrassinolid) w technologii uprawy owsa, pszenicy jarej, łubinu i mieszanek tych kultur pozwala zmniejszyć dawki azotu mineralnego do 30 kg · ha^{-1} i poprawić jakościowe charakterystyki ziarna badanych kultur.

Słowa kluczowe: owies, pszenica jara, łubin wąskolistny, mieszane agrofitocenozy, nawozy azotowe, bakteryjne preparaty, regulatory wzrostu, efektywność