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ESTIMATION OF RESOURCE-HEALING ROLE LUPINE AND STRAW IN THE GRAIN-ROW CROP ROTATION

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Abstract

In field experiences on soddy-podzolic sandy soil of Meshchersky lowland high agroeconomic efficiency of an adaptive link of a crop rotation with, grown up on grain, a potato and barley is established, at entering winter wheat straw under lupine . Straw in a combination with lupine has proved to be a perspective reserve of reproduction of fertility of soils without participation of nitrogen of mineral fertilizers.

Keywords*: annual (blue) lupine, crop rotation, fertilizer, nitrogen fixation, straw grain*

INTRODUCTION

Feature of bean cultures is their ability partially to satisfy requirement for nitrogen at the expense of its symbiotic fixing with bacteria from atmosphere [1]. By E.P. Trepachev's (1999) estimations, at the expense of atmosphere nitrogen it is formed from 30 to 80 % of a crop of the bean. The sizes of alienation of nitrogen of soil depend on factor symbiotic nitrogen fixation [4]. It is more, the less share of alienated nitrogen from soil and on the contrary.

Straw influence as fertilizers on circulation of nutrients and productivity can be carried out by two ways: first, available in straw and nutrients released as a result of a mineralization can directly raise their stock in soil and be consumed by plants; secondly, thanks to processes of decomposition owing to amplifying microbiological activity availability of nutrients of soil to plants can change [2,3].

Operating ratios of elements of the food which is a part of the vegetative rests (except nitrogen), usually in 3-4 times above, than from mineral fertilizers or from stocks of mobile elements in soil [5,6].

For each bean culture the factor nitrogen fixation in the given concrete conditions is defined [7,8,9]. As the most simple and satisfactory method with reference to field conditions bean and cereals under the maintenance the method of comparison can serve in them of nitrogen counting on unit of the area [4]. Improvement of technology of use of straw under blue lupine in a field crop rotation was the purpose of our researches.

MATERIALS AND METHODS

The investigation took place in the Long-term Fertilization Experiment located in Meshcherskaya Lowland (in the center of the East European Plain) (56° 03’ N, 40° 29’ E) at 150 m above sea level. The site is situated in the zone temperate continental climate, average rainfall for the year - 599 mm, the average temperature for the year - 3.9° C. Soddy-podzolic sandy soil, are low in organic matter (C_{org} content – 0,79 %) and nutrients, unstable water regime, acidity (pH_{kcl} – 5,1).

Researches spent in long field experience in VNIIOU skilled field. Here (in this experience) since 1995 influence application of straw grain on fertility of soddy-podzolic sandy soil and efficiency of cultures grain-row crop rotation is studied: lupine - a potato – barley.

Under a potato and barley mineral fertilizers did not bring, under lupine ploughed an eddish and winter wheat straw under the

following scheme: 1. Eddish: plowing (in the autumn) - the control (EP); 2. Eddish: disking & plowing (in the autumn) (EDP); 3. Eddish + straw: plowing (in the autumn) (ESP); 4. Eddish + straw: disking & plowing (in the autumn) (ESDP); 5. Eddish + straw: disking & plowing (in the spring) (ESDPs).

RESULTS AND DISCUSSIONS

The weight of the ploughed straw on the average has made 4,8 t ha^{-1}, an eddish and roots - 2,7 t ha^{-1}. With straw in soil 19,8 kg of nitrogen, 10,4 kg of phosphorus and 48,5 kg Kalium per 1 ha^{-1}, with an eddish and roots - 8,5 have arrived; 4,7 and 19,5 kg, according to (Table 1). More boldly to estimate efficiency of straw under lupine and it after effect together with lupine on a potato and barley, a winter wheat grain yield at calculations did not consider

Table 1. The agrochemical characteristic of the plant rests of a winter wheat (an average for 3 years)

Plant rest	Weight of air-dry organic substance, t ha^{-1}	The maintenance of elements of a food in a solid, %				
		C	N	C/N ratio	P_2O_5	K_2O
Straw	4,24	47,6	0,47	102	0,25	1,14
Eddish and roots	2,03	47,7	0,43	113	0,23	0,95

Thus, in soil with an eddish and roots 33 kg/hectares NPK (variants 1, 2), and with straw, an eddish and roots - 111 kg/hectares NPK have arrived on the average (variants 3-5).

Research has shown, that at fertilizer straw the factor nitrogen fixation (Table 2) raises. The general carrying out of nitrogen and its carrying out from atmosphere on a straw background considerably increase. So, the general carrying out of nitrogen in the treatments with straw depending on a way and term entering has increased on 31-69 % in comparison with the control, carrying out of nitrogen from atmosphere - on 48-107 %. For the size of carrying out lupine from soil fertilizer influence straw practically has not rendered some nitrogen.

Table 2. Influence of application straw on the maintenance of the nitrogen in a lupine biomass, nitrogen fixation factors and the sizes of consumption by lupine plants (on the average for 3 years)

Variant of experience	General carrying out N, kg ha^{-1}	Carrying out N from soil, kg ha^{-1}	Consumption N from atmosphere, kg ha^{-1}	Nitrogen fixation rate
EP	80,9	28,3	52,6	0,65
EDP	87,5	28,4	59,1	0,66
ESP	106,0	27,9	78,1	0,74
ESDP	118,0	28,1	89,9	0,77
ESDPs	137,0	28,0	109,0	0,80

Processing methods of use of straw on fertilizer were reflected in efficiency of a link of a crop rotation (Table 3). In treatment "ESP" in was the most effective, efficiency of a link of a crop rotation has increased by 23,1 % in comparison with the control. Efficiency of a link of a crop rotation has increased by 18,6 % in treatment "ESDP", at "ESDPs" - on 21,1 %.

Table 3. Efficiency of straw application in a link of a crop rotation with lupine

Variant of experience	Gathering g. u. of a commodity output, dt ha^{-1}	Increase		Level of profitability, %	Rate power it is effective, %
		dt ha^{-1} g.u.	%		
EP	79,8	-	-	154,2	2,40
EDP	83,9	4,1	5,1	160,8	2,51
ESP	98,2	18,4	23,1	213,8	2,99
ESDP	94,5	14,7	18,6	200,9	2,83
ESDPs	96,6	16,8	21,1	199,1	2,86

Least significant difference 05 t ha^{-1} 10,8

The analysis of economic and power efficiency from straw application under blue lupine in a crop rotation link has shown, that level of profitability of cultivation of cultures at straw use on fertilizer has raised on 41,8-58,7 %, the factor of power efficiency in variants with straw has increased by 15,0-21,5 %.

Carrying out NPK from soil on 1 т basic production, taking into account collateral, defined by the laboratory analysis, has shown, that consumption nitrogen by lupine (with a deduction symbiotic) in variants without straw on the average there was above on 19,4 % (Table 4). Carrying out of phosphorus and Kalium has appeared above in variants with straw. Phosphorus consumption at straw entering was more on 15,7-29,8 %, and Kalium - on 16,2-31,5 %.

Table 4. Total balance NPK in a link of a crop rotation with blue lupine, a potato and barley

Variant of experience	N	P_2O_5	K_2O
Has arrived with straw and symbiotic nitrogen kg ha^{-1}			
EP	61,1	4,7	19,5
EDP	67,6	4,7	19,5
ESP	106,4	15,6	68,0
ESDP	118,2	15,6	68,0
ESDPs	137,3	15,6	68,0
Carrying out from soil of three crops kg ha^{-1}			
EP	96,9	67,1	150,0
EDP	106,5	67,1	151,0
ESP	132,3	88,3	204,1
ESDP	116,0	82,5	182,2
ESDPs	90,9	89,5	188,0

Thus, straw entering under Lupine impoverishes its nitrogen and accordingly fiber, increasing the maintenance of Phosphorus and Kalium. The nitrogen "intended" Lupine, is spent soil microbial biota at a straw mineralization. At the same time during straw decomposition a food Lupine Kalium and Phosphorus that promotes their accumulation in a crop improves.

Straw entering after effect on a potato and barley under Lupine did not influence size of carrying out of elements of a food by a unit of production. On the average by five variants of experience the leguminous culture – lupine annual (blue) differed from grain culture - barley three times the smaller expense of soil nitrogen, in 1,6 times - potassium on a unit of production that underlines resource saving a role of lupine in a crop rotation.

In table 5 the parity of three basic elements of the food lupine consumed, by a potato and barley from soil in a crop rotation link is shown. If on all cultures to accept the nitrogen maintenance for unit on phosphorus for lupine it will make 1,1, potato 0,7 and barley - 0,4. And on potassium - 1,8; 1,7; 1,1 accordingly

Table 5. Parity of the elements consumed by cultures in a crop link

Variant of experience	Lupine annual (blue) on grain $N:P_2O_5:K_2O$	Potato $N:P_2O_5:K_2O$	Barley $N:P_2O_5:K_2O$
EP	1:0,9:1,5	1:0,8:2,0	1:0,4:1,07
EDP	1:0,8:1,4	1:0,7:1,7	1:0,4:1,07
ESP	1:1,2:2,0	1:0,7:1,7	1:0,4:1,06
ESDP	1:1,2:2,0	1:0,6:1,7	1:0,4:1,09
ESDPs	1:1,2:2,6	1:0,6:1,4	1:0,4:1,08

At definition of actual carrying out NPK by each culture on the average for 3 years in a crop rotation link it is shown: the potato after lupine consumes nutrients in 1,2-1,6 times more lupine and in 1,5-2 times of more barley following it. Plowing of straw in the spring under lupine its best use of lupine was provided at absence effect on barley. Total carrying out NPK on three cultures in variants with straw has appeared above on 17,5-36,2 % above, than on the control.

Table 6. Condition of balance (kg ha^{-1}) and its intensity (%)

Variant of experience	N		P_2O_5		K_2O	
	Balance	Intensity	Balance	Intensity	Balance	Intensity
EP	-35,8	63,1	-62,1	7,0	-130,5	13,0
EDP	-38,9	63,5	-62,4	7,0	-131,5	12,9
ESP	-25,9	80,4	-72,7	17,7	-136,1	33,3
ESDP	+2,2	101,9	-66,9	18,9	114,2	37,3
ESDPs	+46,4	151,0	-73,9	17,4	120,0	36,2

If to compare the total maintenance of lupine nutrient elements and a potato, including fixed air nitrogen, close enough results turn out. However sources of nitrogen for these cultures the different: its most part lupine was received from air, and row by culture - a potato - from soil, a stubbly root rests and lupine exudates.

Lupine as a crop rotation component - resource saving culture, a potato consuming. Lupine advantage before a potato and barley - its ability positively to react to entering of straw without application of nitrogen fertilizers.

Table 7. Operating ratios of nutrients elements, %

Variant of experience	N	P_2O_5	K_2O
EP	-	-	-
EDP	14,2	0	5,0
ESP	33,2	136,0	54,1
ESDP	16,1	98,7	56,1
ESDPs	4,0	144,0	55,9

Analyzing data of tables 6 and 7 it is possible to draw following conclusions:

- nitrogen balance in a link of a crop rotation with lupine, fertilized by straw, positive only at its preliminary disking before plowing. The operating ratio of nitrogen from straw and soil at the expense of increase in a share of symbiotic nitrogen thus decreased;
- balance of Phosphorus and Kalium deeply scarce by all variants of experience;
- the combination lupine with straw provides increase in carrying out of phosphorus for rotation on size close phosphorus maintenances in straw;
- straw introduction in a link of a crop rotation with lupine saves up resources soil potassium in the quantity, arriving with straw;
- for three-year rotation at straw use under lupine increases intensity of balance on nitrogen on 17.3-87.9 %, on phosphorus - on 10.9 - 11.9 %, on potassium - on 20.3-24.3 %;
- on straw operating ratios of phosphorus and potassium from soil and straw increase.

CONCLUSIONS

As a result of carrying out of researches it is revealed high agroeconomic, agrochemical, resource-healing and energy-saving efficiency of sharing blue lupine and winter wheat straw in a link grain-crow a crop rotation on soddy - podzolic sandy soil. Straw application under blue lupine in a crop rotation link was economically and energetically favourably. It was most effective autumn запашка straw without application disking.

Lupine differed from grain culture - barley three times the smaller expense of soil nitrogen and in 1,6 times -potassium on a unit of production that underlines resource saving a role of lupine in a crop rotation. Total carrying out NPK on three cultures (blue lupine-potato-barley) in variants with straw above on 17,5-36,2 % in comparison with the control that is connected with increase of productivity of cultures.

Nitrogen balance in a link of a crop rotation with lupine, fertilized by straw, positive only at its preliminary disking before plowing (from 2,2 to 46,4 kg ha^{-1}. The operating ratio of nitrogen from soil and straw at the expense of increase in a share and prevalence of symbiotic nitrogen in lupine crop are decreased. At the same time lupine and straw do not compensate some phosphorus and potassium with a crop. The balance on these two elements negative also demands a heavy use of mineral and organic fertilizers.

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