WHITE LUPIN (*LUPINUS ALBUS* L.): A PLANT FIT TO IMPROVE ACID SOILS IN SOUTH-WESTERN ROMANIA AND AN IMPORTANT SOURCE OF PROTEIN

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Abstract *Research was carried out in the hill area of western Caras-Severin County, on the Slatina Nera territory, an area with a moderate temperate-continental climate, the sub-Banat type, with Mediterranean influences. The annual mean temperature is 11^0C and seasonal mean temperatures meet the requirements of most crops. Annual mean precipitations reach 680 mm. The soil type is stagnic luvisol, with a pH 5.80 and a low moisture potential. In the experimental cycle 2011-2013, we carried out research on the possibility of introducing in the area the cultivation of white lupin cultivated for beans to reduce the area protein deficit in animal feed and to introduce a legume in the crop rotation. The improving effect of white lupin on acid soils depends on nodosities formation. Research results concerning the influence of fertilisation on nodosities formation because of the activity of symbiotic bacteria (Rhizobium lupini) show that the best variant (the largest number of nodosities per plant) is the one fertilised with $N_{40}P_{60}K_{60}$. Increasing the rate of nitrogen from N_{60} to N_{80}, the number of nodosities diminished to 31 and 24, respectively. Among the fertilisation variants, the highest yield was in the variant fertilised with $N_{60}P_{60}K_{60}$, i.e. 3,033 kg/ha, 45% larger than in the control variant. Protein content increased with the nitrogen rate from 33.8% (the control variant, N_0) in the Medi cultivar, a trend obvious also in the Serbian cultivar). Protein yield showed the same increasing trend with the increase of the nitrogen rate. The highest values of 1,077 kg/ha in the Medi cultivar and over 990 kg/ha in the Serbian cultivar were in the variant fertilised with $N_{60}P_{60}K_{60}$. Cultivating the wheat cultivar Alex after ban white lupin produced an increase of the yield with 26%, i.e. 748 kg/ha, a difference close to the variants fertilised with 20 t/ha of animal manure (an increase of 29%) and with chemical fertilisers $N_{60}P_{60}K_{60}$ (i.e. 32%). This means that white lupin ensures the most economically advantageous increase in yield*.
Key words: *Lupinus albus L., fertilizers, protein yield.*

INTRODUCTION

Intercalation of legumes in rotation in general, and in the hilly area with acid soils and low potential fertility in particular, plays an important role in national agricultural technique and is one of the principal means to maintain soil fertility.

One of the species which is suitable to be grown in acidic soil requirements, judging by the vegetation factors, is the white lupine (*Lupinus albus L.*), species of particular importance that due to high protein content of about 33-37% of the grains provides large amounts of protein for feeding and at the same time is a very important crop prior for plants which are follow in rotation, b because lupin is leaving in the soil large amounts of nitrogen, up to 200 kg / ha.

Currently white lupins used in animal feed, in industry, in human nutrition, as ameliorative plant growth and soil fertility of the sandy acid soils, in medicine and as an ornamental plant.

Worldwide cultivated area exceeds 2 million hectares, but in our country this plant is cultivated on a few hundred hectares.

MATERIALS AND METHODS

The research was conducted on soil type stagnic luvisol with acid reaction (pH 5.8) and a low state of fertility (humus 2,12%; N total 0,120; 16,0 ppm P_2O_5, 60 K_2O assimilable ppm), located in the hilly area of Caras-Severin, territory Slatina Nera .

The climate of the area is temperate continental moderate, Banat's subtype with Mediterranean shades. The average annual temperature is 110 °C and the average annual rainfall of 680 mm.

Researches were performed on:

- influence of fertilization on the number of nodules formed by *Rhizobium lupine* on pivot root, on white lupine variety Media;
- research on fertilizer response of two varieties of white lupine;
- evolution of protein content and protein yield depending on the fertilization at two varieties of white lupine;
- MMB variation by fertilization;
- effect of chemical, organic and white lupine fertilization on yield of winter wheat.

RESULTS AND DISCUSSION

In table 1 is shown the influence of various doses of nitrogen fertilization applied on constant background of $P_{60}K_{60}$, the number of nodules formed on the roots of white lupine pivot.

Measurements were carried out at the buds development stage of plants.

Table 1

The evolution of the number of nodules in the bud stage, depending on the fertilizer.

N_0 P_{60} K_{60}	N_{50} P_{60} K_{60}	N_{60} P_{60} K_{60}	N_{80} P_{60} K_{60}
42±0.35	49±0.43	31±0.87	24±0.67

The results show a negative effect of nitrogen fertilizers applied at a rate of N_{60} and N_{80} with a constant background of $P_{60}K_{60}$, on the number of lupine root nodules formed on the pivot.

The results are consistent with worldwide data obtained in the inhibitory effect of nitrogen present in the soil solution effect on the formation of root nodules. Application of small doses of nitrogen were positive, explained by inactivity of symbiotic bacteria in the early stages of vegetation, and most obvious effect on acid soils with low fertility.

In table 2 are presented crop results depending on applied fertilizers, obtained from Medi variety and from a Serbian origin variety.

The response of the two varieties on fertilization was close, so that on average, the fertilization with various nitrogen doses applied on the constant background $P_{60}K_{60}$, there were obtained increases on the yield of 20% at the dose of N_{40} and increases almost equal 44 - 45% at doses of N_{60} and N_{80}. There were differences in yield of 470 kg / ha in the variant fertilized with N_{40}, 903 kg / ha in the variant fertilized with N_{60} and 890 kg / ha in the variant fertilized with N_{80}, all provided statistically as very significant. Harvest increase for 1 kg nitrogen active substance was 11,75 kg grains on N_{40} variant, 15,05 kg grains on N_{60} variant and 11,12 kg grains on variant N_{80}.

The results lead to the conclusion that the amount of nitrogen economically motivated.is of 60 kg/ha active substance.

Table 2

The sintesis of yield rezults of white lupine crop on experimental cycle 2009 – 2011 obtained according to fertilization

Factor A Fertilizer amounts	Factor B – Variety		Averages of factor B			
	Medi	Serbia	Yield (kg/ha)	%	Difference (kg/ha)	Relevance
$N_0P_{60}K_{60}$	2155	1880	2017	100	-	-
$N_{40}P_{60}K_{60}$	2606	2368	2487	120	470	xxx
$N_{60}P_{60}K_{60}$	3033	2808	2920	145	903	xxx
$N_{80}P_{60}K_{60}$	3020	2795	2907	144	890	xxx

DL 5% =131 DL 1%= 183 DL 0,1%=246

Averages of factor B

Specification	Medi	Serbia
Yield(kg/ha)	2703	2462
%	100	91
Diference	-	-241
Relevance	-	000

DL 5% = 91 DL 1% = 127 DL 0,1% = 143

The data presented show the growing trend of protein content with increasing nitrogen dose, until the nitrogen dose 60 kg/ha active substance. Increasing the dose above 60 kg/ha active substance is not motivated.

The amount of protein is shown in Table 3. Results presented in table 3 state that the amount of protein increased as the nitrogen amount increase from a dose of N_0 to N_{40} and N_{60}.

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Table 3

The sintesis of protein yield rezults of white lupine crop on experimental cycle 2009 – 2011 obtained according to fertilization

Factor A Fertilizer amounts	Factor B – Variety		Averages of factor B			
	Medi	Serbia	Protein yield (kg/ha)	%	Difference (kg/ha)	Relevance
$N_0P_{60}K_{60}$	728	650	689	100	-	-
$N_{40}P_{60}K_{60}$	917	826	871	126	182	xxx
$N_{60}P_{60}K_{60}$	1077	991	1034	150	345	xxx
$N_{80}P_{60}K_{60}$	1072	995	1033	150	344	xxx

DL 5% = 58 kg/ha DL 1% = 81kg/ha DL 0,1% = 143 kg/ha

Averages of factor B

Specification	Medi	Serbia
Yield(kg/ha)	948	865
%	100	92
Diference	-	-123
Relevance	-	000

DL 5% = 37 kg/ha DL 1% = 155 kg/ha DL 0,1% = 73 kg/ha

The trend of data point out that the dose of nitrogen N_{80} is not justified because the amount of protein at 60 kg/ ha active substance is over the protein yield for the variant where was applied 80 kg/ ha.

Of the two genotypes we have in the experience field, at variety Media, the amount of protein was 8% higher than the origin of Serbia.

Table 4 presents the results of harvest obtained of winter wheat Alex variety in the experimental cycle 2009-2011 grown in different rotationsTable 3 presents the results of harvest obtained at winter wheat Alex variety in the experimental cycle 2009-2011 grown in different rotations.

The results show that in rotation where wheat came after white lupine, wheat yield increase with 26% than the variant where wheat follow after unfertilized maize, which is the witness of the experience.

Note that the difference in yield of 748 kg / ha obtained in wheat after white lupine rotation is close to the difference obtained in rotation of wheat after corn fertilized with 20 t/ha manure and also close as result of the variant where wheat came after corn fertilized with $N_{60}P_{60}K_{60}$. These results demonstrate that the economic yield is obtained after lupine rotation.

Table 4

Wheat harvest obtained by rotation obtained on a stagnic luvisol soil

Variant		**Yiedl (kg/ha)**	**%**	**Difference (kg/ha)**	**Significance**
Previous plant corn	witness unfertilized	2850	100	-	-
	$N_{60}P_{60}K_{60}$	3576	125	726	xxx
	20 t/ha manure	3682	129	832	xxx
Previous plant white lupin	$N_0P_{60}K_{60}$	3598	126	748	xxx

DL 5% = 264 kg/ha DL 1% = 355 kg/ha DL 0,1% = 505 kg/ha

CONCLUSIONS

1. White lupin (Lupinus albus L.) is a plant adapted to acid soils and can ensure grain yields that can provide over 3000 kg / ha meaning over 1000 kg / ha protein.
2. Fertilization with nitrogen, applied at a dose of N_{40} and N_{60} increased the protein content and the amount of protein / ha between 26% and 50%. Increasing the nitrogen dose to N_{80} is not justified, the values are almost equal to those at the dose of N_{60}..
3. Growth of the winter wheat yield, when wheat come after lupins, was 26 %, close to that obtained in the variant fertilized with 20 t/ ha manure (29%) and that obtained by fertilization wheat with $N_{60}P_{60}K_{60}$ in rotation corn-wheat.
4. The main lupine crop diseases reported were: *Colletotrichum lupine, Sclerotinia sclerotiorum, Rhizoctonia solani* and *Cladosporium sp.* but any of this diseases reaches economic damage threshold so there was no need to intervene with treatments.

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