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EFFECT OF ECOGRAN ON SYMBIOTIC PRODUCTIVITY PERFORMANCE IN KIDNEY BEAN

Based upon research data of three years shown is the effect of organic-mineral fertilizer Ecogran on development of symbiotic apparatus in kidney bean in conditions of the southern part of the west forest-steppe. Application of Ecogran separately or combined with mineral fertilisers was established to contribute to the development of symbiotic apparatus in kidney bean increasing an amount of biologically fixed nitrogen from 67-72 to 90-94 kg/ha.
***Keywords**: kidney bean; variety; Ecogran; mineral fertilizers; tubercles*

Introduction. Kidney bean is one of the most important world food grain legumes crops. Like other legumes, kidney bean is capable of developing a high-performance symbiotic nitrogen-fixing system. Root tubercles in bean plants begin developing on 14th day after emergence; provided favourable conditions, their number increases up to the stage of bean formation [6]. There are tubercle bacteria in soils of Ukraine; however, they do not provide a high level of symbiotic nitrogen fixation [2].

Treatment of seeds before planting with preparations based on nitrogen-fixing bacteria made it possible to create an effective symbiotic apparatus in kidney bean [1, 3]. In particular, the application of strain *Rhizobium phaseoli 8* ensured a rise in the number of tubercles by 23%, of tubercles wet weight by 31% against a variant without seed treatment [5]. When using natural agro ores together with ryzotrophin the positive effect is increasing. Thus, application of Irlit -1 contributed to the increase in tubercles weight by 16%, that of tuff sand by 25%. Kidney bean has its maximum photosynthetic activity at the stage of bean formation. At that time we observe the largest weight of tubercles (200-500 kg/ha) [7].

Share of biological nitrogen in yield formation in kidney bean is significant, but often variable. It is therefore important to identify and create optimal agronomic conditions for exercising the potential nitrogen-fixing activity in kidney bean varieties.

Given this, our goal was to investigate the influence of variety and fertilizers on symbiotic productivity in kidney bean.

Materials and methods. The study was carried out in fodder crop rotation in experimental field of Podilsky State Agrarian Technical University during 2011-2013. We studied the effect of organic fertilizer Ecogran on symbiotic productivity performance in kidney bean varieties. The fertilizer contains 70% of chicken manure, 6 % of gypsum, 6 % of K_2O, and 6% of P_2O_5. Moisture content is less than 12-14 %, grain size is 2-3.5 mm; nutrient content in dry matter: total nitrogen 3.6 %, phosphorus equivalent to P_20_5 3.6 %, potassium equivalent to K_20 3-6 %; microelement content (mg/kg): manganese100-280, zinc 90-290, copper 30-40, iron 270-700, cobalt 8-11; dry organic matter 55-65%.

Soil of experimental field was leached loamy deep thin-humus chernozem. Experimental plot had following agrochemical characteristics (in soil layer 0-30 cm): humus content 4.34%, pH 6.8; readily hydrolyzed nitrogen 124 mg/kg, mobile phosphorus 86 mg/kg, exchangeable potassium 167 mg/kg of soil. The total planted area was 45.0 m^2, accounting area 25.2 m^2, kidney bean varieties under study - Nadia and Bukovynka, four replicates.

To determine the number and weight of tubercles we used monolith method. The number and weight of tubercles we determined by area of the monolith and the average stand density. To determine symbiotic productivity performance of soybean indicator of total and active symbiotic potentials was used. Active symbiotic potential (ASP) was calculated by the formula:

$ASP = (M_1 + M_2)\ T/2$,

where T - period between analyses, days;

$(M_1 + M_2)$ - average weight of tubercles with leghemoglobin at period T, kg/ha [4].

The technologies of soil tillage, planting, and crop care were typical for the area.

Results and discussion. We found that dynamics of the symbiotic apparatus development in kidney bean varieties in control variant (without fertilizing) had parabolic character, i.e. the number of active tubercles was increasing from three ternate leaf stage to flowering stage while falling from flowering stage to seed forming stage. When fertilizing with $N_{30}P_{60}K_{60}$, the number of active tubercles at three ternate leaf stage as well as at budding stage was decreasing. However, at the flowering stage, their number was close to that in control variant, and at the seed forming stage observed was increase in the number of tubercles (Table 1).

Table 1

Changes in the number of tubercles per kidney bean plant, as dependent on variety and fertilizer (mean value for 2011-2013)

Fertilizer	Stages in development of a plant							
	Three leaves		Budding		Flowering		Seed forming	
	Nadia	Buko-vynka	Nadia	Buko-vynka	Nadia	Buko-vynka	Nadia	Buko-vynka
Control variant (without fertilizing)	3.4	2.5	17.,4	15.3	35.5	33.9	29.8	31.2
$N_{30}P_{60}K_{60}$ + Crystallon	1.8	1.7	14.8	12.8	36.1	32.4	32.0	33.4
Ecogran, 1.5 t/ha	3.2	3.0	18.2	16.4	40.7	37.8	33.8	35.1
Ecogran, 1.5 t/ha + Crystallon	3.4	2.8	19.0	18.1	39.2	41.5	32.0	34.6
$N_{30}P_{60}K_{60}$ + Crystallon + Ecogran, 0.3 t/ha	1.6	1.4	15.1	13.2	34.8	32.9	35.9	38.4
$LSD_{0.5}$	0.4	0.3	1.5	1.5	3.4	3.1	2.5	2.6

At the same time, at the plots where Ecogran was applied at the rate of 1.5 t /ha, the number of tubercles increased significantly. In particular, at flowering stage the number of active tubercles increased by 3.7-5.2 pcs. in variety Nadia and by 3.9-7.6 pcs. in Bukovynka, as compared with the variant without fertilizing. During seed filling stage the maximum number of root tubercles (35,9-38,4pcs.) kidney bean developed when applying $N_{30}P_{60}K_{60}$, Crystallon and 0.3 t/ha of Ecogran.

Apart from counting the number of active tubercles, their weight also was defined. The largest weight of tubercles in the experiment was observed during flowering as well. Thus, in the control variant (without fertilizing) the weight of active tubercles during flowering made up 201.5-216.4 mg per plant. When applying 1.5 t/ha of Ecogran, the wet weight of active tubercles per plant at the flowering stage increased from 216.4 to 268.7-274.9 mg in variety Nadia and from 201.5 to 255-260.9 mg in Bukovynka (Table 2).

Applying 0.3 t/ha of Ecogran against the background of $N_{30}P_{60}K_{60}$ has also provided an increase in wet weight of tubercles comparing with the variant without fertilizing.

Table 2

Dynamics of wet weight of tubercles with leghemoglobin in kidney bean, as dependant on variety and fertilizer, mg per plant (mean value for 2011-2013)

Fertilizer	Stages in development of a plant							
	Three leaves		Budding		Flowering		Seed forming	
	Nadia	Buko-vynka	Nadia	Buko-vynka	Nadia	Buko-vynka	Nadia	Buko-vynka
Control variant (without fertilizing)	8.9	7.0	105.1	98.7	216.4	201.5	161.7	163.0
$N_{30}P_{60}K_{60}$ + Crystallon	2.9	2.1	103.4	92.7	209.5	221.3	197.6	201.7
Ecogran, 1.5 t/ha	10.2	6.1	116.8	101.3	274.9	255.0	213.3	226.8
Ecogran, 1.5 t/ha + Crystallon	7.8	6.5	120.4	99.3	268.7	260.9	209.5	230.4
$N_{30}P_{60}K_{60}$ + Crystallon + Ecogran, 0.3 t/ha	1.8	2.0	98.7	91.2	224.6	235.2	203.4	218.3
$LSD_{0.5}$	0.3	0.3	1.5	1.4	3.1	3.1	2.4	2.5

Having determined the dynamics of number and wet weight of active root tubercles in kidney bean we calculated values of active symbiotic potential (ASP) as dependent on the factors under study (Table 3).

Table 3. Effect of Ecogran on the efficiency of symbiotic nitrogen fixation in kidney bean (mean value for 2011-2013)

Fertilizer	Active symbiotic potential, kg days/ha (ASP)		Amount of fixed nitrogen, kg/ha	
	Nadia	Bukovynka	Nadia	Bukovynka
Control variant (without fertilizing)	3613	3405	72	67
$N_{30}P_{60}K_{60}$ + Crystallon	4119	4015	87	84
Ecogran, 1.5 t/ha	4382	4227	91	88
Ecogran, 1.5 t/ha + Crystallon	4255	4301	87	89
$N_{30}P_{60}K_{60}$ + Crystallon + Ecogran, 0.3 t/ha	4447	4325	94	90

Thus, in control variant (without fertilizing) ASP made up 3613 kg days/ha in Nadia and 3405 kg days/ha in Bukovynka variety. Applying $N_{30}P_{60}K_{60}$ at the standard rate increased ASP to 4119 and 4015 kg days/ha, respectively. Applying 1.5 t /ha of Ecogran ensured subsequent increase in ASP up to 4225-4382 kg days/ha in Nadia and up to 4227-4301 kg days/ha in Bukovynka. The maximum ASP value (4447 kg days/ha) showed variety Nadia when applying $N_{30}P_{60}K_{60}$ and 0.3 t/ha of Ecogran.

Varieties of kidney bean differed in accumulation of biologically fixed nitrogen. Thus, variety Nadia showed 72 kg/ha and Bukovynka 67 kg/ha of biological nitrogen in the variant without fertilizing (control). When applying 1.5 t/ha of Ecogran Nadia accumulated 87-91 and Bukovynka 88-89 kg/ha of biological nitrogen that was greater by 19-21 kg/ha, as compared with the control variant. The best conditions for biological nitrogen fixation were ensured when applying $N_{30}P_{60}K_{60}$ and 0.3 t/ha of Ecogran.

Conclusions. It was established that Ecogran application promotes better conditions for developing active root tubercles in kidney bean resulting in an increase in their number as well as in wet weight. The maximum amount of biologically fixed nitrogen showed variety Nadia when applying 0.3 t/ha of $N_{30}P_{60}K_{60}$ together with 94 kg/ha of Ecogran.

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Анотація

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Вплив використання екограну на показники симбіотичної продуктивності квасолі звичайної в умовах південної частини Лісостепу Західного

За результатами трирічних досліджень показано вплив органо-мінерального добрива Екогран на динаміку формування симбіотичного апарату сортів квасолі звичайної в умовах південної частини Лісостепу західного. Встановлено, що внесення Екограну самостійно чи сумісно з мінеральними добривами, створювало сприятливі умови для розвитку симбіотичного апарату квасолі, внаслідок чого кількість біологічно фіксованого азоту зростала з 67-72 до 90-94 кг/га.

Ключові слова: *квасоля звичайна, сорт, Екогран, мінеральні добрива, бульбочки*

Аннотация

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Влияние использования Экограна на показатели симбиотической продуктивности фасоли обыкновенной в условиях южной части западной Лесостепи

По результатам трехлетних исследований показано влияние органо-минерального удобрения Экогран на динамику формирования симбиотического аппарата сортов фасоли обыкновенной в условиях южной части западной Лесостепи. Установлено, что внесение Экограна самостоятельно или совместно с минеральными удобрениями создавало благоприятные условия для развития симбиотического аппарата фасоли, в результате чего количество биологически фиксированного азота возросло с 67-72 до 90-94 кг/га

Ключевые слова: *фасоль обыкновенная, сорт, Экогран, минеральные удобрения, клубеньки*