ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Share of nitrogen sources in the nutrition of grain legumes.

Alexander Vladimirovich Dozorov*, Mihail Nikolayevich Garanin, and Alexander Yuryevich Naumov.

Ulyanovsk State Agricultural Academy named after P. A. Stolypin, Ulyanovsk, Russian Federation

ABSTRACT

The aim of the research was to study patterns of nitrogen income in the organs of plants of grain legumes and its reutilization in the generative organs during the process of yield formation. The article contains the data about the contribution of nitrogen sources in plant nutrition and seed formation. It is proved that the share of fixed nitrogen in the nutrition of pea plants and vetch is – 5...11%, lupine, broad beans and soybeans – 33...73%. Pre-sowing seed treatment by active strains of rhizobia and micronutrients increases the share of nitrogen in the air by 3...39%.

Keywords: grain legumes, nitrogen nutrition, nitrogen sources, share

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The supply of mineral nutrients is a prerequisite for a normal growth and development of crops and high yields. Nutrients most vigorously enter in plants during active growth. During the early phases of plant development, most plants need enhanced nitrogen nutrition to create the assimilating surface, the formation of the reproductive system need phosphorus and potassium nutrition on the background of moderate nitrogen. Consumption of these elements depends on their content in soil, biological characteristics of the crops and growing conditions (1).

Nitrogen in plant life plays a major role, being a necessary component of proteins, amino acids, nucleic acids, chlorophyll, alkaloids, glucosides, many vitamins, bioactive compounds, enzymes. In this element the plants experiencing the most acute shortage, the lack of nitrogen in the nutrition leads to weakening or cessation of the life processes of the entire plant organism (2, 3).

Due to the fact that plants of grain legumes have the unique ability to fix and use atmospheric nitrogen, the conditions, contributing to its greater accumulation and use, are of scientific and practical interest. The practical significance of biological fixation is determined by the fact that nitrogen is the main biogenic element the reserves of which in the soil are annually decreasing, and the ability of partial refill of them in the process of nitrogen fixation. Biological nitrogen is regarded by many scientists as an important factor of formation of soil fertility (4-10).

Objects and methods of research

Along with traditional crops for Ulyanovsk region, pea and vetch, various legumes according to biological characteristics: broad beans, lupins, soybeans were studied. Optimization of symbiotic activity was carried out by treatment of seeds before sowing, by specific to each culture strain of nodule bacteria and trace elements. The seed treatment with ammonium molybdate and manganese sulphate (0,5% solution at the rate of 2 liters per quintal of seeds), was conducted, taking into account their disadvantage, on the physiological parameters in the soil. In the experiments we used a variety of pea Samarius, for inoculation applied strain 250a, a variety of lupine Snezhet – strain 363a, a variety of vetch Lgovskaya 22 – strain 1-32, a variety of broad beans Penza 16 – 96 strain, a variety of soybean USKhI 6 – 634 b strain.

The studies were conducted in 2010...2012 on the experimental field of Ulyanovsk State Agricultural Academy. The field experiment was laid in a fourfold repetition, in accordance with the methods and techniques of staging field experiments on fixed locations, the accommodation of plots was systematic with offset. Accounting area of the plot is 15 sq. m. The sowing was performed by the selective drill SSFK-6-10. Norms and methods of sowing were established taking into account the biological characteristics of the crops.

The experimental setup

1. pea; 2. lupin; 3. vetch; 4. broad beans; 5. soybean
All cultures were tested in two variants: control and rizotorfine+Mo+Mn

The research results

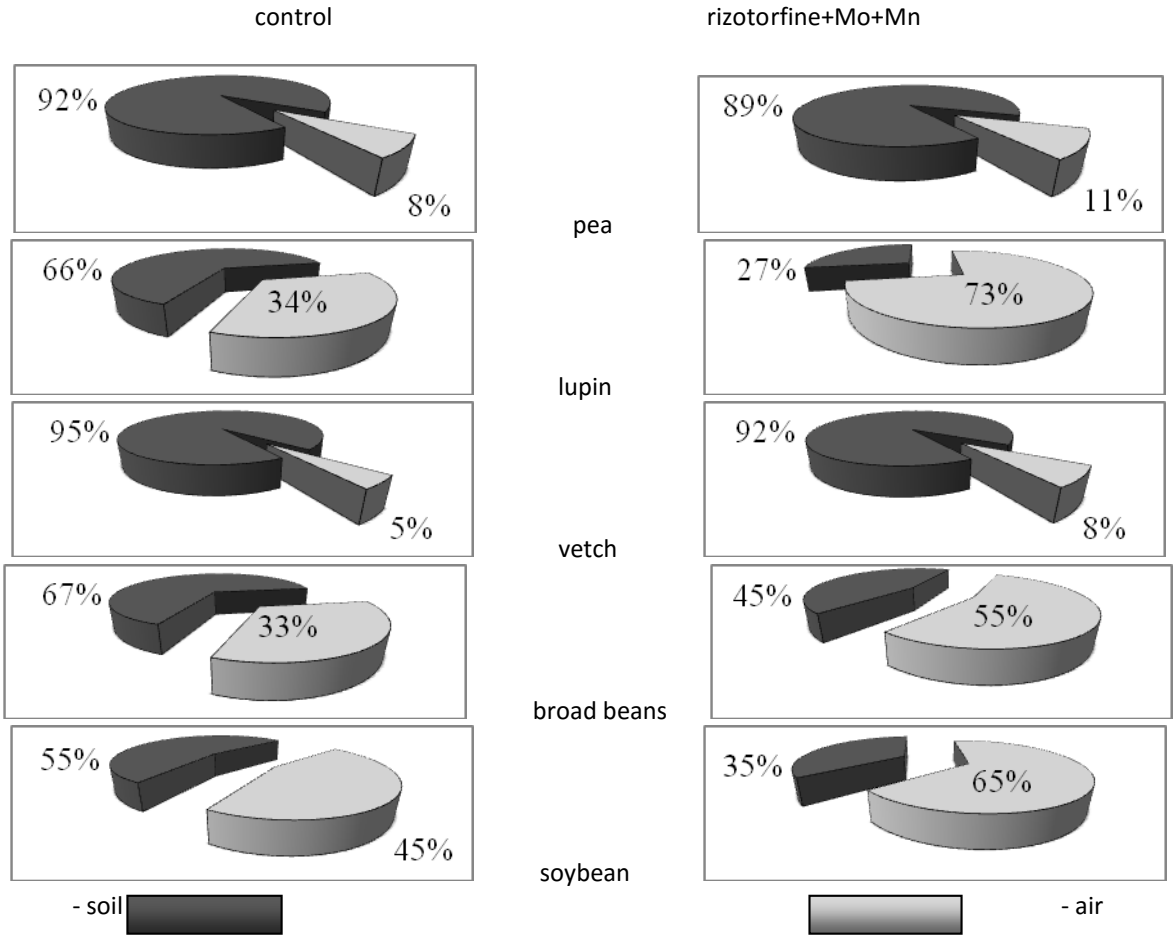
During the research, we obtained the results about the sources from which nitrogen enters the plant body of the studied crops; what is the share of nitrogen sources in plant nutrition; the percentage of participation of individual vegetative organs in the seeds ensuring with that food item; how much of it comes during the ripening of seeds from the soil and as a result of symbiotic activity; what impact the activation of the symbiosis by presowing treatment of seeds with a specific rhizobial strains and micronutrients has on these processes.

From the conducted researches it is established that the share of air and soil nitrogen sources in plant nutrition is mainly dependent on the activity of the symbiosis, the biology of the studied crops and the prevailing soil and climatic conditions.

In average per years of research, cultures differed greatly in the ratio of nitrogen sources in plant

ISSN: 0975-8585

nutrition. Pea and vetch plants were formed mainly at the expense of soil nitrogen, in the proportion of air nitrogen they have 13…24 and 8...and 14 kg/ha, or respectively 8…11 and 5...8%, of the total number (Fig.1). The share of participation of air nitrogen of lupine, broad beans and soybeans is large enough, in the control version, it is 34%, 33 and 45%, or 70 kg/ha, 76 and 109 kg/ha of fixed nitrogen, but soil nitrogen is still prevalent in the diet. In the variant with pre-sowing treatment of seeds, the amount of fixed nitrogen in these crops is much higher than the percentage of the soil source: lupine – 73% (182 kg), broad beans – 55% (139 kg) and soybean – 65% (178 kg) of total consumption.



The participation of nitrogen sources in plant nutrition of grain legumes for 2011 – 2012, % of total consumption

The share of different nitrogen sources in the formation of seeds was determined by the amount of nitrogen in each organ and in the whole plant by phases of development (table 1). Before the phase of budding – flowering there is the increase of nitrogen concentration in vegetative plant organs (leaves, stems, roots). With the beginning of the phase of seed ripening, a large part of the nitrogen enters the generative organs, at the same time there is a reutilization (outflow) of nitrogen from vegetative organs, and most of the reutilizing nitrogen falls on the leaves, less on stems and roots. To the phase of full ripeness very small amount of nitrogen remains in the vegetative organs, as the basic amount was reutilized in seeds. The calculation of the nitrogen sources for the formation of the harvest of the seeds was carried during the phase of maximum accumulation of nitrogen by generative organs.

Table 1: Nitrogen sources for yield formation of seeds of grain legumes, kg/ha

indicators	2010				2011				2012			
	control		rizotorfine + Mo+Mn		control		rizotorfine + Mo+Mn		control		rizotorfine +Mo+Mn	
	a-b*	b-c**	a-b*	b-c**	a-b*	b-c**	a-b*	b-c**	a-b*	b-c**	a-b*	b-c**

ISSN: 0975-8585

Pea												
Interphase period, days	15	7	15	7	13	13	13	13	9	9	9	9
Received to plants or outflows (–), kg/ha	53	5	65	13	77	79	72	120	54	4	67	25
including in the vegetative organs	37	-19	40	-21	55	-36	49	-26	32	-38	43	-30
of them: in leaves	15	-12	18	-16	36	-26	32	-20	21	-20	31	-14
in stems	26	-7	26	-5	18	-8	15	-4	11	-17	12	-14
in roots	-4	0	-4	0	1	-2	2	-2	0	-1	0	-2
in the reproductive organs	16	24	25	34	22	115	23	146	22	42	24	55
including from the vegetative organs	0	19	0	21	0	36	0	26	0	38	0	30
from soil	16	5	25	13	11	77	3	114	13	4	6	25
from air	0	0	0	0	11	2	20	6	9	0	18	0
Intensity of nitrogen supply into seeds, kg/ha per day	1,0	3,4	1,6	4,8	1,6	8,8	1,7	11,2	2,4	4,6	2,6	6,1
lupin												
Interphase period, days	10	14	10	14	15	12	15	12	10	10	10	10
Received to plants or outflows (-), kg/ha	33	52	36	64	63	77	78	102	58	26	81	19
including in the vegetative organs	29	-8	31	-8	48	-38	62	-60	29	-40	44	-45
of them: in leaves	17	-5	17	-6	30	-30	41	-44	10	-42	12	-43
in stems	12	-3	14	-3	16	-6	18	-10	14	-2	23	-3
in roots	0	0	0	1	2	-2	3	-6	5	4	9	1
in the reproductive organs	4	60	5	72	15	137	16	162	29	66	37	64
including from the vegetative organs	0	8	0	8	0	38	0	60	0	40	0	45
from soil	4	52	5	64	0	32	0	0	12	17	0	0
from air	0	0	0	0	15	67	16	102	17	9	37	19
Intensity of nitrogen supply into seeds, kg/ha per day	0,4	4,2	0,5	5,1	1,0	11,4	1,0	13,5	2,9	6,6	3,7	6,4
vetch												
Interphase period, days	12	11	12	11	15	14	15	14	12	6	12	6
Received to plants or outflows (-), kg/ha	30	17	30	17	27	48	42	54	47	20	65	11
including in the vegetative organs	18	-23	18	-26	18	-47	30	-58	32	-19	46	-28
of them: in leaves	20	-19	24	-24	21	-40	29	-49	14	-15	19	-20
in stems	0	-3	-4	-1	-4	-7	-1	-8	17	-2	27	-6
in roots	-2	-1	-2	-1	1	0	2	-1	1	-2	0	-2
in the reproductive organs	13	39	15	40	9	95	12	112	15	39	19	39
including from the vegetative organs	0	23	0	26	0	47	0	58	0	19	0	28

from soil	13	16	15	14	0	48	0	54	15	20	19	11
from air	0	0	0	0	9	0	12	0	0	0	0	0
Intensity of nitrogen supply into seeds, kg/ha per day	1,0	3,5	1,2	3,6	0,6	6,7	0,8	8,0	1,2	6,5	1,5	6,5
broad beans												
Interphase period, days	16	15	16	15	15	15	15	15	13	9	13	9
Received to plants or outflows (-), kg/ha	55	28	66	34	127	74	147	66	75	15	76	18
including in the vegetative organs	43	-5	48	-4	82	-71	95	-83	33	-37	32	-37
of them: in leaves	26	2	30	-1	62	-65	65	-73	20	-21	19	-23
in stems	11	-4	10	-1	18	-2	24	-2	14	-7	18	-9
in roots	6	-3	8	-2	2	-4	6	-8	-1	-9	-5	-5
in the reproductive organs	16	33	18	38	45	145	52	149	42	52	44	55
including from the vegetative organs	0	5	0	4	0	71	0	83	0	37	0	37
from soil	16	28	18	34	0	55	0	14	11	0	0	0
from air	0	0	0	0	45	19	52	52	31	15	44	18
Intensity of nitrogen supply into seeds, kg/ha per day	1,0	2,2	1,1	2,5	3,0	9,6	3,4	9,9	3,2	5,7	3,3	6,1
soybean												
Interphase period, days	23	21	23	21	20	16	20	16	13	19	13	19
Received to plants or outflows (-), kg/ha	46	18	60	18	166	69	178	85	50	76	57	80
including in the vegetative organs	29	-25	34	-22	96	-58	98	-66	44	-19	50	-20
of them: in leaves	19	-18	19	-14	71	-60	81	-75	23	-16	23	-14
in stems	7	-3	10	-3	21	3	16	6	17	-1	20	-2
in roots	3	-4	5	-5	4	-1	1	3	4	-2	7	-4
in the reproductive organs	17	43	26	40	70	127	73	151	6	95	7	100
including from the vegetative organs	0	25	0	22	0	58	0	66	0	19	0	20
from soil	17	18	26	18	40	21	33	12	0	40	0	26
from air	0	0	0	0	30	48	40	73	6	36	7	54
Intensity of nitrogen supply into seeds, kg/ha per day	0,7	2,0	1,1	1,9	3,5	7,9	3,6	9,4	0,4	5,0	0,5	5,2

Note: a-b - the beginning of flowering - plumpness of seeds*
*b-c** - plumpness of seeds - complete plumpness of seeds*

During the early phase of seed filling, all of the nitrogen comes from soil and air. From the phase of full seed ripening in addition to these sources there is a significant reutilization of this element of the vegetative organs, most intensively from the leaves. The highest intensity of nitrogen income in the generative organs is observed in the phase of full seed ripening. The maximum values of this parameter was recorded in 2011. Most intensively nitrogen enters the seeds of lupin – 11,4…13,5 kg/ha per day, pea – 8,8…11,2 kg/ha per day, broad beans and soybeans – 9,6…9,9 and 7,9…9,4 kg/ha per day, slightly less in seeds of vetch – 6,7…8,0 kg/ha per day. The presowing treatment of seeds with rizotorfine and micronutrients contributes to a more

intense flow of nitrogen in forming seeds of the studied crops (by 4...22%).

In the adverse weather conditions of 2010, a large part of the nitrogen received in the generative organs fell on soil nitrogen from 53...93%, the other part was reutilized from vegetative organs. Atmospheric nitrogen was not involved in the formation of seeds in connection with the dramatically dry conditions.

In the cultures that formed a powerful symbiotic apparatus (lupine, broad beans and soybeans), organic nitrogen averaged 33...49% of the share in the flow of nitrogen in the generative organs. Another part of the nitrogen was used from the soil and reutilized from vegetative organs. In pea and vetch the largest income of nitrogen in seeds is from the soil – 47…61%, 24…48% is reutilized form vegetative organs, the share of atmospheric nitrogen is from 4…15%.

CONCLUSION

The study of the processes of accumulation and consumption of mineral nutrients by plants of grain legumes has allowed to establish the patterns of income of mineral nutrients in plant organs and their reutilization in the process of yield formation.

Grain legumes have a high level of consumption of nitrogen, much of which they satisfy at the expense of symbiotic fixed atmospheric nitrogen. The proportion of fixed nitrogen in plant nutrition is determined by the biology of the studied cultures and activities of the symbiotic apparatus. Its share in its nutrition of pea and vetch plants is – 5...11%, lupine, broad beans and soybeans – 33...73%. The optimization of the conditions of the symbiosis increases the share of air nitrogen by 3...39%.

It is proved that the number of reutilized nitrogen depends on its accumulation in the vegetative mass to the phase of budding – flowering. The percentage distribution of nitrogen sources in forming seeds, along with soil and air nitrogen, showed a significant share of this element reutilized from vegetative organs.

Conflict of interest

The author confirms that the represented information does not contain any conflict of interest.

REFERENCES

[1] Posypanov G.S., Dolgodvorov V.E., Zherukov B.K. and others. Plant growing / Edited by. G.S. Posypanov. – M.: KolosS, 2006. - P. 284 – 286.
[2] Dozorov A., Isaychev V., Andreyev N. Influence of presowing treatment of seeds with pectin and micronutrients on crop quality of winter wheat, peas and soy / Grain farming, 2001. - № 7. - P. 31 - 32.
[3] Dozorov A.B. Optimization of production process of pea and soybean in forest-steppe Volga region: author's abstract on competition of a scientific degree of the doctor of agricultural sciences /A.B. Dozorov. - Ulyanovsk, 2003. - 44 p.
[4] Vavilov, P.P., Posypanov G.S. Legumes and the problem of vegetable protein /P.P. Vavilov, G.S. Posypanov. – M.: Rosselkhozizdat, 1983. - 256 p.
[5] Dozorov, A.V. Influence of activation of symbiotic activity on formation of legumes productivity / A. V. Dozorov, M. N. Garanin // Vestnik of Ulyanovsk State Agricultural Academy – 2012. – №4. – P. 4 - 9.
[6] Dozorov, A.V. Dynamics of nitrogen and productivity of grain legumes /A.V. Dozorov, M. N. Garanin // Vestnik of Ulyanovsk State Agricultural Academy – 2013. – №1. – P. 4 - 9.
[7] Dozorov, A.B. Cultivation of soybean in Ulyanovsk region /A.V. Dozorov, A. Yu. Naumov, Yu. V. Yermoshkin, M. N. Garanin, A. V. Voronin, Yu. M. Rakhimova. - Ulyanovsk: USAA n.a. P. A. Stolypin, 2014. - 59 p.
[8] Milto N. I. Nodule bacteria and legumes productivity. - Minsk: Science and Technology, 1982.
[9] Mishustin E. N., Shilnikova V. K. Nodule bacteria and inoculation process /E.N. Mishustin, V. K. Shilnikova. - M.: Science, 1973. - 288 p.
[10] Farniev A. T. Biological air nitrogen fixation, yield and protein productivity of legumes in Alanya /A.T. Farniev, G. S. Posypanov. - Vladikavkaz: Iriston, 1996. - 211 p.