Organic Nitrogen in Soy Nutrition

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Abstract
The article aims at finding ways to control the symbiotic fixation and study methods for activating legumes-rhizobia symbiosis. The article provides the results of studies on the effect of bacterial fertilizers, micronutrients, growth regulators and planting date on the activity of the biological fixation of soybeans. The article shows the effect of pre-planting treatment and different planting dates for the duration of symbiosis, symbiotic organs sizes, and the amount of fixed air nitrogen. It is found that inoculation of soybean seeds with active rhizobia strains, especially together with micronutrients and growth regulators, significantly increases the proportion of fixed nitrogen in its total consumption to 40–49% for the UAI 6 variety and up to 34–38% for the Mageva variety. The obtained data give reason to believe that the use of active rhizobia strains, bacterial fertilizers, micronutrients and growth regulators in soybean cultivation can be an essential tool for agriculture biologization.

Keywords: Biological Fixation Activity, Share of Fixed Nitrogen in the Total Consumption, Soybeans, The Amount of Fixed Nitrogen

1. Introduction
The transition to resource efficient and low-cost technologies for cropping highlights one of the most difficult objectives in terms of economic and environmental terms: minimizing the amount of fertilizers for each additional unit of crop. In this regard, great prospects are opened by the use of biological nitrogen fixation, which is becoming increasingly important in the global crop research. The practical significance of the biological fixation is defined by the fact that nitrogen is the main nutrient, reserves of which in the soil are reduced each year. The ability to replenish nitrogen partially also defines the process of nitrogen fixation. Organic nitrogen was regarded by many scholars as an effective factor in the formation of soil fertility.

According to the effective legumes-rhizobia symbiosis requires a certain set of conditions: optimum soil moisture (not below discontinuous capillary moisture); sufficient aeration; reaction of the environment and soil temperature, corresponding to the requirements of the culture biology; specific active virulent rhizobia strain; sufficient level of available phosphorus, boron, molybdenum, exchangeable potassium, calcium, magnesium, sulfur, and iron, and low for nitrogen. When non-compliance of any of the factors to the requirements of symbiotic systems is observed, biological nitrogen fixation sharply reduces or is absent. At the present stage of science development, much in this matter is beyond doubts. However, the use of modern technologies for cultivating leguminous crops, breeding new varieties, and introducing crops require a deep understanding of all the features of legumes-rhizobia symbiosis and further study of activating methods. In this regard, the experimental field of the Ulyanovsk State Agricultural Academy n.a. P. A. Stolypin, was used to conduct experiments to find ways to control symbiotic nitrogen fixation on soybean crops in order to draw attention to those that can be the main ones and still unresolved for the conditions of forest-steppe of the Volga region.
2. Objects and Methods of Research

The researches were carried out in 1992–1994, 2001–2003 and 2004–2006 in the form of field experiments. Field experiments were laid in a fourfold repetition, with randomized placement, in accordance with the methods and techniques of field experiments at fixed locations. The experiments studied soybean varieties of UAI 6 and Mageva belonging to different groups of plumpness. The seeding rate is 700 ths/ha of germinating seeds.

In 1992–1994, soy was used to study the effect of different rhizobia strains produced by VNIISKHMb (St. Petersburg). In preliminary studies of the 10 strains (22; 23; 24; 25; 26; 27; 28; 626a, 634b, 635b), the most active 3 strains were selected - 25; 626a; 634b.

2.1 The Experimental Setup

1. Control; 2. Inoculation with strain 25; 3. Inoculation with strain 626a; 4. Inoculation with strain 634b; 5. Inoculation with strain 634b + Mo.

Inoculation with rhizotorfine and seed treatment with ammonium molybdate (0.5% solution in the amount of 2 litres per 1 c) was conducted on the day of planting.

In 2001–2003, soy varieties of UAI 6 and Mageva were used to study the effect of pre-planting treatment.

2.2 The Experimental Setup

1. Control; 2. Rizotorfine+Mo+Mn; 3. Pectin; 4. Pectin+Mo+Mn; 5. Extrasol; 6. Extrasol+Mo+Mn

Pre-planting treatment of seeds involved micronutrients essential for physiological parameters, taking into account the lack of them in the soil (ammonium molybdate, manganese sulphate (0.5% solution in the amount of 2 litres per quintal of seeds), rizotorfine (strain 634 b), extrasol produced by VNIISKHMb (1 L/c), pectin with a molecular weight of 20,000 cu (0.05% solution in the amount of 2 L/c).

In 2004–2006, varieties of UAI 6 and Mageva were used to study the effect of planting date and pre-planting treatment.

2.3 The Experimental Setup

- Early planting date (1st decade of May);
- Optimal planting date (2nd decade of May);
- Late planting date (3rd decade of May).

3. The Research Results

Soybeans in the Volga steppe are an introduced culture, and the soil has no spontaneous specific nodule bacteria strains. In addition, nodule bacteria on the plants of soybean have a pronounced varietal specificity. In connection with this, inoculation during the cultivation of soybeans shall be mandatory.

Studies conducted in 1992–1994 on the effectiveness of the inoculation of soybean seeds with active strains showed that the soil of the experimental plot was lacking spontaneous strains. An exception was the year of 1994 when the field experiments were placed at the site having soybean crops in 1990 and where inoculation was performed. Even if there are spontaneous nodule bacteria in soil, inoculation of seeds with active strains had a positive impact on the timing for nodule formation, duration and size of symbiosis for the symbiotic apparatus.

Experiments have shown that during the inoculation, nodules were formed on 8–16 day after germination. In 1994, in options where the inoculation was not carried out, nodules appeared on day 24, when inoculated with active rhizobia strains - on day 16 after germination. In 5–7 days after the formation of nodules, leghemoglobin appeared in them. During the phase of seeds plumpness, nodules started to green and after 8–10 days, usually died. The duration of the active symbiosis in 1992 was 50 days in 1993 - 68–72, and in 1994 - 58–67 days.

The resulting data of the field experiments show that the stable tendency to increased mass of nodules on soybean plants is observed from phase of 3 trifoliate leaves to seeds plumpness phase, then reduction is observed (Table 1).

The studied rhizobia strains by the years of research have different effects on the nodules weight. Thus, in 1992 and 1993 all phases of soybean nodules showed the highest weight with the strain 634b in comparison with other rhizobia strains. In 1994, during the period of 3 trifoliate leaves - early formation of beans, nodule weight was highest in the option with inoculation with strain 634b, and in phase of seed plumpness - with strain 25.

To calculate the amount of fixed air nitrogen in soybeans in 1992–1993, the method of comparison with non-inoculated option was used. In 1994, the soil contained spontaneous nodule bacteria. Thus, in order to calculate the amount of fixed nitrogen in the air, the method of calculating the value of active nitrogen fixing symbiotic potential and specific symbiosis activity was applied.
Table 1. Dynamics of wet weight of active nodules on soybean plants, kg/ha

| Phenological stage | Date     | Control | Inoculation with strain 25 | Inoculation with strain 626a | Inoculation with strain 626b | Inoculation with strain 25 + Mo |
|-------------------|----------|---------|----------------------------|----------------------------|----------------------------|-------------------------------|
|                   |          |         | 1992                       | 1993                       | 1994                       | Average                       |
| 3rd trifoliate leaf | 15.06    | 0       | 120                        | 102                        | 166                        | 156                           |
| Budding           | 3.07     | 0       | 154                        | 119                        | 156                        | 179                           |
| Flowering         | 13.07    | 0       | 376                        | 327                        | 407                        | 449                           |
| Beginning of beans formation | 21.07 | 0       | 607                        | 470                        | 626                        | 710                           |
| Plumpness of seeds | 5.08   | 0       | 337                        | 265                        | 383                        | 413                           |
|                   |          |         | 1993                       | 1994                       | 1994                       | Average                       |
| 3rd trifoliate leaf | 18.06    | 0       | 152                        | 164                        | 118                        | 166                           |
| Budding           | 5.07     | 0       | 319                        | 312                        | 380                        | 435                           |
| Flowering         | 12.07    | 0       | 497                        | 456                        | 600                        | 651                           |
| Beginning of beans formation | 20.07 | 0       | 678                        | 660                        | 703                        | 741                           |
| Plumpness of seeds | 5.08   | 0       | 801                        | 775                        | 828                        | 906                           |
|                   |          |         | 1994                       | 1994                       | 1994                       | Average                       |
| 3rd trifoliate leaf | 12.06    | 0       | 0                          | 0                          | 0                          | 0                             |
| Budding           | 5.07     | 33      | 158                        | 148                        | 157                        | 165                           |
| Flowering         | 16.07    | 195     | 268                        | 248                        | 286                        | 305                           |
| Beginning of beans formation | 1.08  | 328     | 479                        | 468                        | 508                        | 541                           |
| Plumpness of seeds | 10.08  | 357     | 643                        | 503                        | 590                        | 657                           |
|                   |          |         | 1994                       | 1994                       | 1994                       | Average                       |
| 3rd trifoliate leaf | 15.09    | 70      | 155                        | 91                         | 109                        | 133                           |

(Table 2). Inoculation of soybean seeds with active rhizobia strains, regardless of the prevailing weather conditions, activates nitrogen fixation by air, and the best among the tested is strain 634b.

In the forest steppe of the Volga region, inoculation with active rhizobia strains in the cultivation of soybeans shall be mandatory. Even if there are spontaneous nodule bacteria in the soil, inoculation improves not only the size of the symbiotic system, but its activity.

The yield for legume seeds is highly dependent on the supply of plants with nitrogen, since its content is sufficiently large in vegetative organs and seeds. In this connection, there is theoretical and practical interest in

Table 2. Amount of fixed air nitrogen by soybeans, kg/ha

| Option                      | 1992 | 1993 | 1994 | Average |
|-----------------------------|------|------|------|---------|
| Control                     | 0    | 0    | 61   | 20.3    |
| Inoculation with strain 25  | 26   | 94   | 109  | 76.3    |
| Inoculation with strain 626a| 21   | 78   | 93   | 64.0    |
| Inoculation with strain 626b| 29   | 106  | 104  | 79.7    |
| Inoculation with strain 25 + Mo | 40   | 128  | 115  | 94.3    |
getting information about the sources from which nitrogen is supplied into the plants and seeds, what is the share of nitrogen sources participation in plant nutrition and the share of individual vegetative organs in providing seeds with this element, how much of it is supplied during plumping of seeds directly from the soil and as a result of symbiosis, what is the impact on this process from increased symbiotic nitrogen fixation, as well as soil and climatic conditions.

As shown by our studies, the share of nitrogen sources in the air and the soil was largely dependent on the prevailing weather conditions during the vegetation period and symbiotic activity. In 1992-1994, soybeans due to spontaneous inoculation accumulated only 19% of total consumption, inoculation raised this share to 42–47% or by 2.2–2.5 times.

The share of different nitrogen sources in the formation of peas and soybeans was evaluated by the amount of nitrogen in each organ and in all phases of development of the plant. It is found that all the nitrogen accumulation in the plant reaches its maximum during the complete seed plumpness phase, and then the total amount of nitrogen in the plant is reduced.

Increase in the amount of nitrogen in the vegetative organs continues up to budding-flowering phase, and then it stops. By the phase complete plumpness of seeds, this value in vegetative organs is significantly reduced, and the reduction in the amount of this element was mainly due to the leaves. Nitrogen losses by stems and roots in this period were not significant. Reproductive organs start to receive nitrogen with the formation of beans. Basic amount usually enters the beans during the beginning of plumpness - complete plumpness of seeds.

Based on the data of nitrogen supply in plants and its distribution on its organs, we found the sources and the way it was received by the forming soybean seeds (Table 3). In the period from the beginning to the complete plumpness of seeds, all the nitrogen received by the plant is sent to the generative organs. Furthermore, intensive reutilization of vegetative organs is continued at that time. The maximum intensity of nitrogen in the generative organs in our experiments was observed in the period from the beginning to the complete plumpness of seeds.

Calculation of total nitrogen supply from various sources in the forming seeds by options showed that the proportion of nitrogen in the formation of soybean seed yield due to reutilization of the vegetative organs averaged to: in the option of control - 12%; inocul. pcs. 634b - 14%; inocul. pcs. 634b + Mo - 15%. The rest comes from the nitrogen of the soil and air.

In 2001–2003 there were studies dedicated to the influence of a new bacterial preparation (extrasol), and growth regulator (pectin) on the formation of symbiotic apparatus and its activity. The studies by a number of scientists proved the effectiveness of pectin and extrasol for the cultivation of legumes.

The studies have shown that in cases where the inoculation was not carried out, there was the formation of nodules due to spontaneous rhizobia strains present in the soil. The reason is that in the experimental field of the Ulyanovsk State Agricultural Academy at the time of the experiments have soybeans cultivated for over 10 years, and spontaneous nodule bacteria, becoming part of the soil microflora, under conditions favorable for their activities, actively infect plants. However, even with the formation of nodules due to spontaneous strains, inoculation of seeds with active strains, processing them with pectin and extrasol separately and together with micronutrients has a positive impact on the timing of nodule formation, duration of symbiosis and size of symbiotic apparatus.

The results of calculation of active symbiotic potential for soybean UAI 6 and Mageva varieties show that the highest value was achieved in the option with the treatment of seeds with extrasol using Mo and Mn - 19,794 and 9,534 kg per day/ha, respectively, the lowest value was achieved in the control option - 10167 and 4,518 kg per day/ha. Effect of pre-planting treatment of seeds on the activity of symbiotic soybean depended largely on the weather conditions. Correlation and regression analysis shows that there is a close relationship between active symbiotic potential and seed yield:

for the UAI 6 variety: \[ C = 16.824 + 0.0709x; \quad R = 0.84, \quad D = 70.7\% \]
for the Mageva variety: \[ C = 14.996 + 0.095x; \quad R = 0.92, \quad D = 83.9\% \]

Studies have shown that under favorable conditions, soybeans in the Ulyanovsk region form large enough symbiotic potential (up to 27 thousand kg per day/ha).

In all the years of studies, regardless of the weather conditions, the maximum amount of nitrogen was assimilated in the option with seed treatment with extrasol and micronutrients: The UAI 6 variety showed fixed amount of nitrogen higher compared to the control on average by 1.9 times, the Mageva variety - by 2.2 times (Figure 1). The amount of fixed nitrogen, except for the option of pre-planting treatment, was strongly influenced by
Table 3. Nitrogen source for the formation of soybean seed yield (kg/ha)

| Indicator | control | Inoculation with strain 634b | Inoculation with strain 25 | Inoculation with strain 626a | Inoculation with strain 634b + Mo |
|-----------|---------|-------------------------------|---------------------------|-------------------------------|---------------------------------|
|           | a-b*    | a-b*                          | a-b*                      | a-b*                          | a-b*                            |
|           | b-c**   | b-c**                         | b-c**                     | b-c**                         | b-c**                           |
| 1         | 2       | 3                             | 4                         | 5                             | 6                               |
| 1992      | 2       | 3                             | 4                         | 5                             | 6                               |
| Interphase period, days | 26      | 17                            | 26                        | 17                            | 26                              |
| Received to plants or outflows (-), kg/ha | 46      | 16                            | 62                        | 17                            | 58                              |
| including in the vegetative organs | 16      | -14                           | 26                        | -20                           | 24                              |
| of them: in leaves | 13      | -10                           | 17                        | -10                           | 17                              |
| in stems | 2       | -1                            | 4                         | -2                            | 4                               |
| in roots | 1       | -3                            | 3                         | -8                            | 3                               |
| in the reproductive organs | 30      | 30                            | 39                        | 37                            | 34                              |
| including from the vegetative organs | 0       | 14                            | 0                         | 20                            | 0                               |
| from soil | 30      | 16                            | 23                        | 16                            | 22                              |
| from air | 0       | 0                             | 16                        | 1                             | 12                              |
| Intensity of nitrogen supply into seeds, kg/ha per day | 1.2     | 1.8                           | 1.5                        | 2.2                           | 1.3                             |
| 1993      | 1.2     | 1.8                           | 1.5                        | 2.2                           | 1.3                             |
| Interphase period, days | 36      | 12                            | 36                        | 12                            | 36                              |
| Received to plants or outflows (-), kg/ha | 100     | 61                            | 168                       | 56                            | 156                             |
| including in the vegetative organs | 25      | -16                           | 44                        | -30                           | 47                              |
| of them: in leaves | 18      | -13                           | 27                        | -23                           | 34                              |
| in stems | 3       | -1                            | 11                        | -2                            | 6                               |
| in roots | 4       | -2                            | 6                         | -5                            | 7                               |
| in the reproductive organs | 76      | 77                            | 124                       | 86                            | 109                             |
| including from the vegetative organs | 0       | 16                            | 0                         | 30                            | 0                               |
| from soil | 76      | 61                            | 56                        | 56                            | 53                              |
| from air | 0       | 0                             | 68                        | 0                             | 56                              |
| Intensity of nitrogen supply into seeds, kg/ha per day | 2.1     | 6.4                           | 3.4                        | 7.2                           | 3.0                             |
| 1994      | 2.1     | 6.4                           | 3.4                        | 7.2                           | 3.0                             |
| Interphase period, days | 28      | 31                            | 28                        | 31                            | 28                              |
| Received to plants or outflows (-), kg/ha | 42      | 37                            | 62                        | 46                            | 49                              |
| including in the vegetative organs | 11      | -5                            | 19                        | -7                            | 13                              |

Note: a-b* and b-c** indicate statistically significant differences.
of them: in leaves 8 -3 13 -3 8 -2 14 -2 17 -6
in stems 2 -1 4 -2 3 -1 5 -1 5 -1
in roots 1 -1 2 -2 3 -2 1 -2 3 -2
in the reproductive organs 31 42 43 53 35 49 43 55 46 66
including from the vegetative organs 0 5 0 7 0 5 0 5 0 9
from soil 0 22 0 19 0 23 0 26 0 30
from air 31 15 43 27 35 21 43 24 46 27
Intensity of nitrogen supply into seeds, kg/ha per day 1.1 1.4 1.5 1.7 1.3 1.6 1.5 1.8 1.6 2.1

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

The UA1 6 variety

The Mageva variety

Figure 1. Amount of fixed air nitrogen by soybeans, kg/ha.
Traditionally, soy is considered to be thermophilic plant with late date of planting, when the temperature at a depth of seeding reaches 12–14°C. In recent years, with appeared new quickly plumping cold-resistant soybean varieties, the opportunity to plant them at an earlier date appeared. Obviously, soybean planted with a gap of even a few days will develop in the environment differing in the temperature and water conditions. Shifting planting dates, it is possible to change the vital conditions for soybeans in the desired direction and to increase its productivity.

Planting soybeans in the earliest date when the soil enhances the use of hydrothermal resources, increases the period of its vegetation, the duration of activity of leaves and nodules on the roots, and can be one of the reserves for increasing its productivity. When planting at a later date, seeds fall into the parched soil, which reduces the rate of germination and field germination rate.

At the same time, soybean plants planted in the early stages have the risk of being affected by returning spring frosts, which leads to a delay in development, inhibition of symbiotic activity, thinning of crops and ultimate decrease of productivity. Short frosts during the early stages of planting of soybeans can cause a decrease in the level of yields on 3–4 t/ha; crops of late sowing, with short growing season and the lack of moisture in the initial stages of growth also show a decrease in productivity.

Our research found that planting terms significantly affects the formation of nodules. Thus, early planting of crops promoted earlier by 9–10 days formation of nodules in comparison with the optimal period and by 13–14 days compared to later date. In 3–6 days after the formation of nodules, red pigment - leghemoglobin - appears in them providing energy centers with oxygen and promoting the release of energy to fix nitrogen from the air.

The value of symbiotic apparatus is adequately characterized by the number and weight of nodules. Their formation is largely determined by the timing of planting of soybean and its variety characteristics (Table 4).

The studied options for soybean planting dates have different effects on the weight of nodules. The maximum weight for active nodules was reached in 2006 and was for the options of UAI 6 - 283–369 kg/ha, for Mageva - 251–339 kg/ha. At that, the UAI 6 variety showed better development of symbiotic apparatus at the optimal planting dates. In this option, the initial period of development showed the nodules mass, which was consistently higher, in the beginning phase of seed plumpness the largest number of them was formed and weight was by
93 kg/ha more compared to late planting dates. Northern ecotype of the Mageva variety formed large mass of active nodules in early planting dates, by 6–36% higher than other options. It should be noted that despite the individual characteristics of the studied options and different weather conditions, there is a general, for UAI 6 and Mageva tendency to reduce the mass of active nodules when shifting planting dates to later. Thus, on average for 2004–2006, the UAI 6 variety with late planting dates showed in the beginning phase of seed plumpness the lower mass of active nodules than in the early and optimal timing, 23% and 35%, respectively, and for the Mageva variety - 28% and 16% respectively.

The influence of pre-planting treatment of seeds on the activity of symbiotic soybean depended largely on the weather conditions. Studies have shown that under favorable conditions of the year 2006, soybean formed large enough symbiotic potential from 11.8 to 18.1 thousand kg per day/ha for the UAI 6 variety and from 8.7 to 13.5 thousand kg per day/ha for the Mageva variety. However, under adverse weather conditions due to a decrease in soil moisture, extreme temperature fluctuations, deterioration of soil aeration, there is a sharp decrease in the activity of the symbiotic potential.

Largest average active symbiotic potential for the studied years was observed on crops of soybean of the UAI 6 variety in the option with the optimal planting dates, which, respectively, comprise 15,383 and 12,566 kg per day/ha, the lowest in the option with a later date – 10,496 and 8,349 kg per day/ha, which is 32–33% less than the maximum values (Table 5). The conducted experiments show that, in the Volga steppe the timing of planting of varieties differing in planting for the soybean cultivation shall be mandatory. The established optimal period is important for obtaining high and stable yields of this culture and is a powerful factor that can affect a number of physiological processes of plants in particular, such as: formation, development of nodules, and the symbiotic activity.

### Table 4. Number (million units/ha) and weight (kg/ha) of active nodules on soybean roots average for 2004–2006.

| Phase of development       | Amount of nodules | Weight of nodules |
|---------------------------|-------------------|-------------------|
|                           | early | optimal | late | early | optimal | late |
| UAI 6                     |       |         |      |       |         |      |
| 3rd trifoliate leaf        | 8.2   | 9.2     | 7.9  | 38.9  | 48.7    | 36.2 |
| Budding-flowering          | 17.2  | 19.9    | 18.6 | 301.0 | 315.6   | 267.4|
| Start of seeds plumpness   | 16.6  | 20.0    | 14.6 | 275.5 | 328.2   | 212.1|
| Mageva                    |       |         |      |       |         |      |
| 3rd trifoliate leaf        | 9.1   | 8.2     | 7.9  | 46.1  | 38.3    | 32.3 |
| Budding-flowering          | 14.3  | 14.2    | 13.3 | 283.6 | 280.9   | 217.0|
| Start of seeds plumpness   | 22.0  | 18.6    | 15.7 | 319.5 | 273.8   | 230.1|

### Table 5. Active symbiotic potential of soybeans during the growing season, kg*day/ha

| Planting method | 2004   | 2005   | 2006   | Average |
|-----------------|--------|--------|--------|---------|
| UAI 6           |        |        |        |         |
| Early           | 11,642 | 12,438 | 15,552 | 13,211  |
| Optimal         | 13,459 | 14,547 | 18,145 | 15,384  |
| Late            | 8,731  | 10,870 | 11,889 | 10,497  |
| Mageva          |        |        |        |         |
| Early           | 11,529 | 12,670 | 13,500 | 13,503  |
| Optimal         | 8,733  | 12,102 | 12,240 | 11,025  |
| Late            | 7,788  | 8,545  | 8,714  | 8,349   |

4. Conclusion

The studies examined methods, adapting soybeans to soil and climatic conditions of forest-steppe of the Volga region and increasing its symbiotic activity. It is proved
that at the introduction of soybean, the inoculation with active rhizobia strains shall be mandatory. Even if there are spontaneous nodule bacteria in the soil, inoculation improves not only the size of the symbiotic system, but its activity. To inoculate soybean seeds, it is necessary to use strain 634b, which is the most virulent and active among the studied ones. Seed pre-treatment with synergistic micronutrients (Mo and Mn) in conjunction with bacterial fertilizers and growth regulators is a promising reception in preparation seeds for planting. It shall be recommended for introduction to the technology of soybean cultivation. Overall, the analysis of experimental data obtained on the black soils of forest-steppe of the Volga region gives the reason to believe that bacterial fertilizer, pre-treatment of soybean seeds with micronutrients and growth regulators, as well as the selection of the optimal planting dates can be an essential tool for biologization of agriculture. Due to spontaneous inoculation, especially in adverse weather conditions, soy is not realizing its potential as a nitrogen fixer, so search for factors that ensure the activation of symbiosis, increasing its duration is of great importance to obtain high and stable yields of this crop. To achieve profitability of soybean cultivation, biologization and greening of intensification processes are require to ensure resources and energy saving, environment protection and environmental reliability.

5. Conflict of Interest

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

6. References

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