THE EVALUATION OF EFFECTIVENESS OF *RHIZOBIUM LEGUMINOSARUM* IN FIELD BEANS *(VICIA FABA)*

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Abstract

The vegetation pot experiment was conducted at the Institute of Soil and Plant Sciences of the Faculty of Agriculture of the Latvia University of Agriculture. The aim of the experiment was to investigate the effectiveness of five *Rhizobium legumonosarum* strains stored in the period from the 18th of August till the 20th of October 2006 in the collection of the Latvia University of Agriculture. Three of the five mentioned *Rhizobium legumonosarum* strains were included in the international *Rhizobium* database 'IBP World Catalogue of *Rhizobium* collections'. Taking into consideration the results of the experiment it has been pointed out that all *Rhizobium* strains were active and inoculated plants formed nodules on the roots. Inoculation with *Rhizobium* strains increased the proportion between shoots and roots' weight. It has been found that the dry matter content of the inoculated plants increased in comparison with the untreated ones. In addition, negative correlation between the dry matter and the protein content has been observed.

Keywords: *Vicia faba*, *Rhizobium leguminosarum*.

Introduction

Only prokaryotes can use nitrogen reserves from the earth's atmosphere. The bacteria of the *Rhizobium* family form nodules on legume roots. When forming symbiosis these bacteria convert the inert form of nitrogen (N_2) to the organic nitrogen. Afterwards, the organic nitrogen incorporates it into proteins, nucleic acids, and other cellular component parts. The encouragement of the development of *Rhizobium*-legume symbioses definitely increases the incorporation of the biologically fixed nitrogen into soil ecosystems. In agricultural systems, the bulk of the biological nitrogen fixation is derived from the cultivation of legumes. These symbioses can be concluded to provide well over half of the biological source of the fixed nitrogen (Tate, 1994).

Each year at the end of the vegetative period and after the decomposition of plants, soil becomes enriched with nitrogen from 100 to 300 kg per hectare (Schiegel, 2000).

It is popularly assumed that the enrichment with the symbiotically fixed nitrogen in soil was detected a long time ago. It is widely known that it could be observed by the employment of different agrotechnical methods, namely the rotation of crop and fallow. By means of symbiosis plants provide bacteria with nutrition elements (mostly sugars) and ensure favourable conditions for the bacteria living in the nodules. After the decomposition of plants, the more viable bacteria return into soil. The fixation of nitrogen occurs in the bacteroids. A total of 95% of fixing nitrogen in the form of ammonia incur into cytoplasm of a host plant (Tate, 1994).

It is known that some problems of fixing biological nitrogen are still current in the intensive conditions under chemical processes. In case of the positive symbiosis, the protein synthesis incorporates the fixed nitrogen, thus, increasing the amount of the yield and its quality. The inoculation of the seed material with active nitrogen fixing bacteria strains before sowing has a significant meaning for the increase of the legume yield. It is also important to note that, nitrogen fixing bacterial treatment appears to be quite profitable for the practical usage in agriculture.

The aim of the investigation was to detect the effectiveness of five *Rhizobium legumonosarum* strains in field beans *vicia faba* for the practical use in agriculture. Three of these strains were included in the international *Rhizobium* database. The tasks were to detect fresh mass, dry matter, and accumulated protein content in the dry matter of field beans. The effectiveness of nitrogen fixing bacteria was expressed in the increase of the fresh mass of the plants and the total amount of nitrogen in the dry matter.

Materials and Methods

the experiment was conducted in the greenhouses of the Institute of Soil and Plant Sciences of the Faculty of Agriculture of the

Latvia University of Agriculture. The purpose of the experiment was to detect the effectiveness of *Rhizobium* strains in field beans. The experiment was performed in four replicas in 5 L Mitcherlich type pots which had been filled with heated washed river sand, fertilized with Kemira GrowHow NPK 0-12-24-(1.5 Mg) – (13 S) and microelements. Nitrogen was added as ammonium nitrate form 0.024 g per 1 kg of sand for inoculated plants and ten times more (0.24 g kg^{-1}) for the control (plants did not inoculate with *Rhizobium leguminosarum* strains in the control variant).

The field beans were sowed in Mitcherlich type pots. Before that, the seeds had been inoculated with *Rhizobium leguminosarum* strains 23, 109, 113, 408, and 501. *Rhizobium leguminosarum* strains No. 23, 109 and 113 were incorporated in the international database (IBP World Catalogue of *Rhizobium* collections, 1973).

All the vegetation pots were placed in a greenhouse with day temperature 20–25 °C and night temperature over 12 °C. Since October, the plants were illuminated by means of artificial light twice a day: in the mornings and in the evenings in order to obtain a total photoperiod of 14 hours.

The experiment was finished at 62–64 (German scale) or at 203 of the development stage (British BCPC scale) for field beans (Latvijas valsts Augu aizsardzības centrs, 1997).

The fresh mass was detected by weighing field beans at 62–64 (German scale) or at 203 of the development stage (British BCPC scale) on electronical scale with ±0.001 error. The dry matter of field bean shoots was detected at 62 – 64 (German scale) or at 203 of the development stage (British BCPC scale) at 80 °C in the thermostat till constant weight (Ермаков, 1972).

The content of protein was determined by Kjeldahl method at the Analytical Laboratory for Agronomy Research of the Latvia University of Agriculture.

For data processing mathematical statistical methods (dispersion and correlation) were used.

Results and Discussion

The activity of *Rhizobium leguminosarum* strains characterizes the yield and nitrogen accumulated in it.

The highest fresh mass was obtained in the variants where strain No. 113 was used (52.78 g), fresh mass was increased by 12% compared with the control (47.1 g). The lowest fresh mass was observed when strain No. 23 (39.14 g) was used; fresh mass decreased by 17% as compared with the control (Fig. 1).

The plants where strain No. 113 (53.98 g) was used, demonstrated the highest root mass. The root mass increased by 10% as compared with the control (49.22 g). The plants where strains No. 408 (38.49 g) were used, demonstrated the lowest root mass. The root mass decreased by 22% as compared with the control. The plants where strain No. 408 was used, demonstrated the highest root and shoot ratio, as compared with the control increased by 25%. The plants where

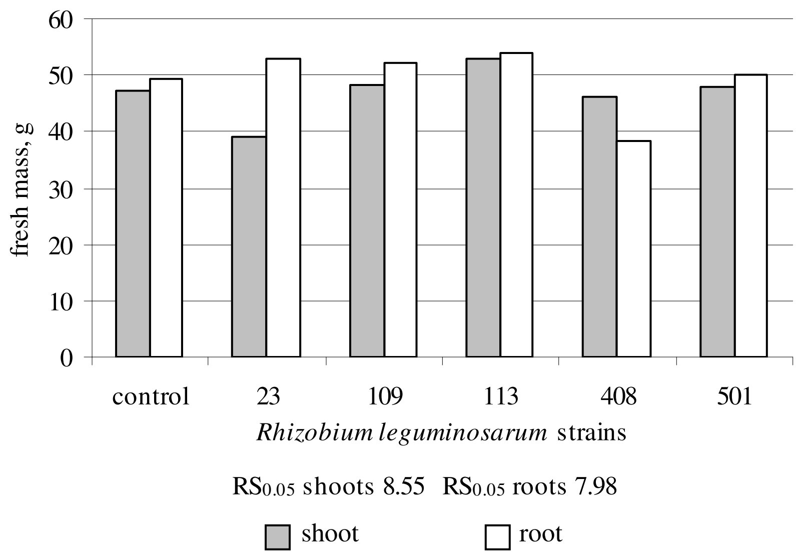


Figure 1. Fresh mass of field beans depending on the used *Rhizobium leguminosarum* strains.

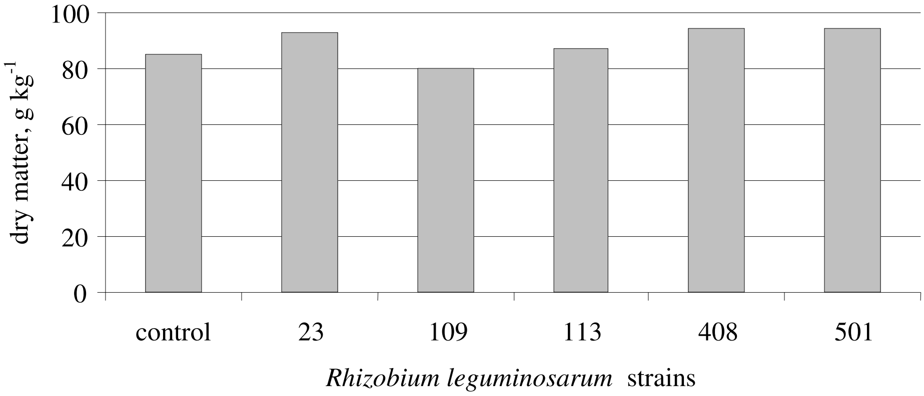


Figure 2. Dry matter of field beans depending on the used *Rhizobium leguminosarum* strains.

strain No. 23 was used, demonstrated the lowest root and shoot ratio, as compared with the control decreased by 23%.

Observation results of field bean roots have illustrated that all *Rhizobium leguminosarum* strains were active and formed nodules on the roots.

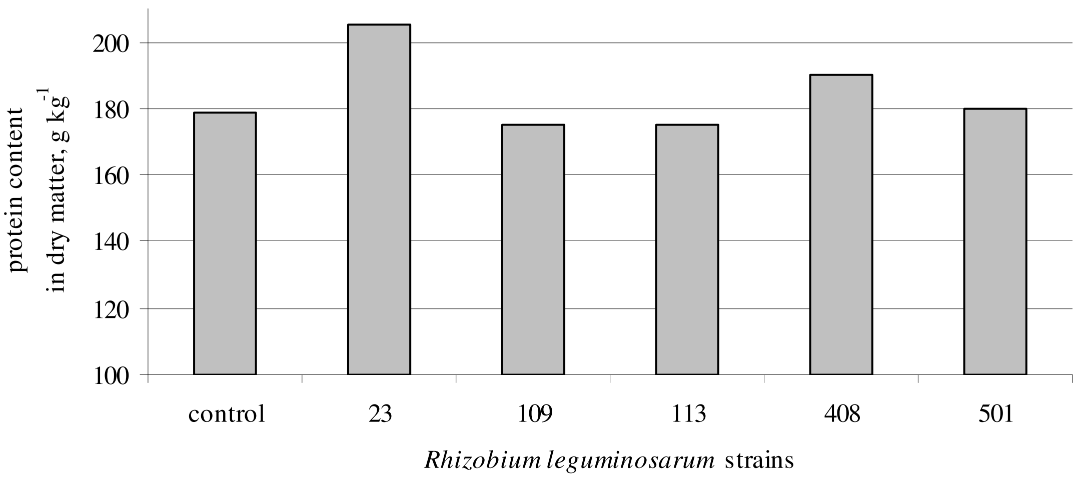
The acquired data processing showed that the fresh mass of the shoots, the mass of the roots and the ratio between shoots and roots were considerably affected by the inoculation.

The dry matter content was dependent on the development stage and the growing conditions.

The field beans where strain No. 408 (94 g kg^{-1}) was treated, demonstrated the highest dry matter content. The dry matter increased by 12%, as compared with the control (85 g kg^{-1}) (Fig. 2.). The lowest dry matter demonstrated plants treated with strain No. 109 (80 g kg^{-1}). The dry matter decreased by 6%, as compared with the control.

Data processing showed that inoculation significantly affected the dry matter content.

The protein content in the dry matter was dependent on the seed treatment of the field beans with different *Rhizobium leguminosarum* strains. The highest protein content was observed in the variants where strain No. 23 (205 g kg^{-1}) was used: as compared with the control (179 g kg^{-1}), the protein content in the dry matter increased by 17% (Fig. 3.). The lowest protein content in the dry matter was observed where strains No.



$RS_{0.05} = 5.88$

Figure 3. Protein content in the dry matter of field beans depending on the used *Rhizobium leguminosarum*.

109 (175 g kg^{-1}) and 113 (175 g kg^{-1}) were used, the protein content decreased by 2%, as compared with the control.

Data processing showed that the protein content in the dry matter was significantly affected by the inoculation. There was also observed the negative correlation between the dry matter of shoots and the protein content. The obtained data proved that the best results have been achieved by the employment of *Rhizobium leguminosarum* strain No. 23, whereas strain No. 109 was less effective.

Conclusions

1. The best results for the practical exploitation in agriculture demonstrated strain No. 23. There was observed the highest protein content in field beans. However, strain No. 109 appeared to be less effective;
2. Seed inoculation with *Rhizobium leguminosarum* increases the ratio between shoots and roots;
3. Seeds of field beans inoculated with *Rhizobium leguminosarum* have higher dry matter content than those of the control.

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