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Effect of Alfalfa Inoculation with Associative Rhizobacteria Strains on Yield of Green Biomass and Soil Fertility in Central Yakutia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The article gives long-term experimental data of studies on the effect of associative nitrogen-fixing microorganisms on alfalfa biomass yield, quality parameters, and soil fertility of permafrost soils of Central Yakutia.

Keywords: Alfalfa; associative rhizobacteria strains; green mass yield of alfalfa.

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1. INTRODUCTION

One of the main tasks of reconstruction and improvement of soil fertility is increasing of alfalfa yield, this can be made possible through application or incorporation of environmental friendly products such as using the biological bacterial agents. The associative rhizobacteria strains help to enhance the biological productivity of plants, especially in the early stages of plant development. Cultivation of legumes improves the microbiological composition of the soil, changes a number of its physicochemical properties resulting in significantly increased soil productivity.

2. AIM OF RESEARCH

The aim of research is to study the influence of nitrogen-fixing microorganisms (associative rhizobacteria) on physicochemical and microbiological composition of permafrost soils of Yakutia.

3. METHODS OF RESEARCH

Investigations were carried out from 1997 to 2011 at Pokrovsky stationary of SSI Yakut Scientific Research Institute of Agriculture RAAS. Area of account plots - 7 m^2, accommodation - the systematic, repetitive - fourfold. Sowing was carried out manually in aisles of 15 cm with the planting depth of 3-4 cm. Treatment of alfalfa seeds carried semi-dry. For this purpose the seed was wetted with water (1.5 - 2% of their body weight), was added the required amount of a biological preparation (based on 200g hectare seed rate) and mixed thoroughly. Treated seeds by biologics should be sown on the same day in moist soil, and they must be protected from direct sunlight. Observations of plant growth and development were performed as described by Posypanova (1983) [1]. Analyses of agrochemical composition of the soil made by infrared analyzer “NIR SCANNER” model 4250, calibrated on the basis of generally accepted standard chemical methods: soil pH according to 26483-85 State Standard, method CINAO, 26428-85 State Standard in the laboratory of biochemistry and mass analysis of the SSI Yakut Scientific Research Institute of Agriculture RAAS.

Soil of experimental area - permafrost taiga, fawn, medium loamy. Humus content in the topsoil was - 2.67%, which declined with the increase in depth of its content to 0.44%. Nitrate nitrogen content ranging from 0.44-0.50 mg/g, total nitrogen - 0.24 to 0.12%. Objects of study are also associative rhizobacteria strains from the National Collection of All-Russian Research Institute for Agricultural Microbiology in St. Petersburg. Associative rhizobacteria includes: Arthrobacter mysorens (7) or mizorin, Pseudomonas fluorescens psevdomonos (extrasol), Agrobacterium radiobacter (10) or agrofil, Serratia (seratsil) [2,3].

Vegetation period in 1997-1998 was characterized by a late and cold spring. High temperatures in June with a lack of moisture in the soil negatively affected the development of plants. Relative humidity was between 16-24%. Rainfall was 73,6-104,5 mm, 139 mm at a rate that negatively affected the growth and development of alfalfa.

Weather conditions in 1999-2000 were generally favorable for the growth and development of perennial grasses. Late, but warm spring, favorable humidification conditions (hydrothermal coefficient for the growing season 1,29-0,55) were favorable for the growth and development of alfalfa.

Vegetation period in 2001-2003 was characterized by a cold windy spring. In July, at a high temperature air moisture deficit was 30,2-33,6 mm that negatively affected the formation of a crop of forage crops. The second half of the growing season was favorable for plant growth and development.

Vegetation period in 2004-2005 was characterized by an early and warm spring, wet summer and the beginning of a warm September. These years were favorable for the formation of surface mass of perennial grasses.

Weather conditions in 2006-2010 were uncharacteristic of the temperature conditions and the distribution of rainfall compared to average meteorological data, which largely affected the yield of perennial grasses.

The 2011 growing season was characterized by a warm spring and transient high enough heat supply in May-August, the nature and distribution of precipitation loss was also favorable for plant growth and development [4]. (Table 1)

Table 1. Agro-climatic conditions from 1997 to 2011

Years	Decade average temperature, gr	Amount of precipitation, mm	SAD05
1997	14	35	7.0
1998	13	47	
1999	11	35	
2000	11	11	
2001	12	20	
2003	11	46	
2004	10	30	
2005	11	36	
2007	12	42	
2009	12	19	
2011	12	40	

4. RESULTS

The experimental studies on the effect of associative rhizobacteria on yield of alfalfa found that the action of associative rhizobacteria under permafrost taiga fawn medium loamy soil is largely determined by weather conditions, during its growing season (Table 2). Experimental studies have also shown that inoculation of alfalfa seeds 7 and 10 in the 15th year of life provide the maximum productivity of green biomass of 28t/ha that is about 2 t/ha or 8% above control [5].

Further the investigations was also carried out on the effect of inoculation of associative rhizobacteria on physic-chemical properties of soil composition.

The humus content in comparison with the control without inoculation, the humus content in the topsoil with bi inoculation +412b and 10+412b is above 0.36 - 0.4% strain of associative rhizobacteria 7 in pure form is above 0.3% of the control option (whereas in the control soil without inoculation had 2.93%). An increase of available phosphorus content is 8 - 66 mg/kg, the content of exchangeable potassium 3 - 8 mg/kg compared with uninoculated control.

In comparison with the data of the agrochemical composition of the soil before planting seeds (1997), the difference in average humus content experience is 1.9%. Depending on

options, the humus content in the topsoil under alfalfa herbage after 15 years has exceeded 1.5%.

Table 2. Agrochemical soil composition of alfalfa on 15th year of alfalfa growth (year - 2011)

Strain	Yield, t/ha	Humus, %	N %	P (mg/kg)	K (mg/kg)	pH (1:2.5)
Absolute control	-	1.43	0.22	146	145	8.2
Control	26	2.93	0.11	149	255	6.17
412б	24	3.23	0.32	215	261	7.78
7	28	3.22	0.33	149	258	7.81
ПС+412b	25	3.29	0.26	157	262	7.71
7+412b	23	3.27	0.30	145	263	7.66
10+412b	24	3.33	0.30	129	259	7.50
С+412b	25	3.21	0.25	144	261	7.77
SAD0.5 (The smallest average difference)	0.1					

5. CONCLUSION

From the above studies it is concluded that different strains of associative rhizobacteria inoculation after 15th years of their application do not always have a positive effect on the yield of green biomass of alfalfa but it has positive effect of soil physicochemical properties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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