The formation of *Rhizobium cicer* in pea

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Abstract. The article analyzes the effect of different planting scheme and the effect of inoculants on the mass of nodules in the roots of pea varieties in the conditions of irrigated meadow-gray soils of Samarkand region. Umid variety produces more buds than Yulduz and Zumrad varieties. In all three cultivars, as the feeding area of the plants expands and Planteco Nut MC285 inoculant is applied, numerous root nodules form. The mass of nodules formed in the roots of pea varieties differed by variety, and the mass of nodules was higher in the Umid variety than in other varieties. As the nutritional area of plants expanded, that is, as the thickness of the stem decreased, the mass of nodules increased, especially when the drug Rizolain was used, the mass of nodules in the roots of Pea varieties was ensured.

1 Introduction

Today in the world 12 million per year. tons of peas are grown. India is the world's largest producer of chickpeas with an annual production of 7.82 million tons. The annual production volume is 0.87 mln. Australia is second in tons. Russian Federation 0.32 mln. ranks 7th in tons. Pakistan (1.0 million ha), India (0.84 million ha), and Australia (0.68 million ha) are the leaders in terms of cultivated area. In the following years, the volume of growing peas increased by 26%. Based on the demand, the volume of production and the cultivated area are increasing. One of the main problems of agriculture, increasing soil fertility and meeting the demand for plant protein, is also being solved by this crop. Currently, in the world agricultural practice, through the cultivation of peas, it is possible to save valuable mineral fertilizers, especially nitrogen fertilizers, to enrich the soil with organic matter, and to improve the structural condition of the soil. In this regard, one of the urgent issues is the wide application of the scientifically-based crop rotation system, the development of resource-saving technologies that allow to grow ecologically clean products, and increase the profitability of the field. In our republic, in order to satisfy the needs of the population for food and livestock, poultry, and to increase the productivity of crops in the field of rotation, the planting of peas is being widely implemented. In the Action Strategy of the Republic of Uzbekistan for 2017-2021, "... consistent development of agricultural production, further strengthening of the country's food security, expanding the production of ecologically clean products, significantly increasing the export potential of the agrarian sector" are defined as important strategic tasks. For this reason, scientific research on the cultivation of pea varieties

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grown in the irrigated areas of our republic, taking into account the regional soil-climatic conditions, variety characteristics, and the use of inoculants and planting schemes are urgent [1-10].

It is known that in the roots of leguminous plants, bacteria are formed, they absorb free nitrogen from the air and play an important role in increasing soil fertility. Peas, like other leguminous plants, use nitrogen-fixing bacteria (Rhizobium cicer) in their roots to enrich the soil with nitrogen compounds and increase soil fertility. Currently, in world agricultural practices, by growing peas, it is possible to save valuable mineral fertilizers, especially nitrogen fertilizers, to enrich the soil with organic matter, and to improve the structural condition of the soil. In this regard, one of the urgent issues is the wide application of scientifically based crop rotation system, the cultivation of environmentally friendly products, and the development of resource-saving technologies that allow to increase the profitability of the field [3].

Biological nitrogen increases crop yields and neutralizes nitrogen's harmful effects on the environment. One such biological nitrogen-fixing legume is the pea plant. When peas are grown on irrigated land, 1800-2100 m3/ha of water is consumed during the season, the soil is enriched with biological nitrogen, and part of the population's need for protein is satisfied, that is, the protein in the food products consumed by a person per day should be 90-100 grams, this is the daily food 12% of the calorie content of the products [5], [6].

According to the data of P.Sh.Shukurullaev (1969), I.Khamdamov, S.Mustanov (2003), the buds have different sizes and shapes. The more and larger they are in the plant root, the more nitrogen accumulates in the soil [5].

Plants absorb 75% of the nitrogen produced and leave the remaining 25% in the soil. In addition, the protein content formed in the seed is on average 5-7% due to the budding bacteria. The formation of nodules in the roots of plants is observed during the branching phase and continued almost throughout the growing season until maturity [2].

The mass of nodules in the roots of pea varieties is 85-112 mg in dry years [1].

In the pea samples, the number of nodules in the plant root was 94-169, and the mass of the nodules was 0.42-1.02 g. The highest number of buds was recorded in the S8-Alexandrite variety (169 pieces), and the least in the Volgogradsky 10 variety (94 pieces) [4].

According to I.Khamdamov, M.Khaitova (2005), the volume of tubers per 100 plants planted in autumn is 40 cm3, and when planted in spring it is equal to 10 cm3, or when planted in early February, the weight of tubers formed on pea roots is 5 times higher than the weight of tubers when planted in late April. 6 m3 was found to be less. However, budding bacteria are not always present in the roots. The most favourable conditions for their reproduction are 60% soil moisture level [5].

Bacteria develop well in fertile soil, and in warm conditions, the formation of bacteria decreases sharply by 30-35%. The optimum temperature for the formation of most fungi is 20-220C. Budding bacteria in pea roots develop until the flowering period. After flowering, the bacteria die, the buds decay, and organic matter begins to accumulate at its base [1,2].

However, according to I.Khamdamov, M.Khaitova (2005), Polikarpova (2008), the formation of budding bacteria in pea roots continues until the podding phase. The largest number of nodules corresponded to the phases of podding in peas (for example, according to them, the number of nodules in the root was equal to 154 units in the flowering phase when 06 million seeds per hectare were planted on 1 m2 area, and this indicator was 134 units during the period of padding) [7].

It has the property of enriching the soil with nitrogen with the help of nodule bacteria in the pea roots [7].

Pea buds do not always develop, their formation depends on environmental conditions. In places where peas have not been grown before, the buds develop little or not at all.

Nodules are formed on pea roots even without inoculation, but the use of bacterial preparations helped them to form earlier and in greater numbers. They are distinguished by a longer period of active work [Balashov V.V., 2016, pp. 14-15].

Experiments conducted by Russian scientists on improving the technology of pea cultivation show that it is very effective for planting standards, doses of mineral fertilizers, foliar feeding with micro fertilizers and biological preparations, seed treatment and inoculation before planting [4].

The use of bio stimulants is one of the ways to improve crop cultivation technology. They contribute to the full realization of the production potential of modern varieties. Growth regulators not only affect the efficient use of mobile forms of nutrients by plants, but also increase the resistance of plants to stress, diseases and pests [4,6,7].

One of the important ways to increase the yield of peas is to treat the seeds with biologically active substances that regulate plant growth and development.

2 Material and research methodology

We have conducted research in order to determine the optimal planting scheme and the effect of innoculant strains on the high yield of pea varieties in the spring period, to develop the optimal planting scheme and the use of the inoculant strain, field fertility, bush thickness and storage before harvesting, and to apply it to production. The effects of planting scheme and inoculant Plantego Nut MS285, Rizolaine strain on field fertility, stem thickness and storage of pea cultivars until harvesting were studied under conditions of irrigated gray soils.

Rizolaine is a strain inoculant in the form of a liquid gel preparation, which is used in the pre-sowing treatment of Pea seeds.

The composition consists of viable cells of Mesorhizobium ciceri and their spores, which have a unique symbiotic activity with peas. There are also biologically active products of life activity of tuganac bacteria (vitamins, phytohormones: heteroauxins, gibberellins). It maintains macro- and micronutrients, etc., as important components of the nutrient medium. Main features: atmospheric nitrogen fixation (in symbiosis with legumes) and converting it into a form that can be absorbed by plants; coordinates the synthesis of growth regulators (vitamins, heteroauxin, gibberellin, etc.).

1.5 kg per ton of seed or 200 g per 1 ha is used.

Mechanism of action: the drug contains active strains of Mesorhizobium ciceri bacteria capable of forming root nodules in peas and providing plants with nitrogen in the amount of 60-120 kg due to active symbiotic fixation of atmospheric nitrogen. Planteco nut MC285 is a complete alternative to the use of nitrogen mineral fertilizers in the technology of growing peas.

Recommendations for use: seeds can be inoculated directly on the day of sowing. Treated (inoculated) seeds should be sown within 24 hours. When storing seeds for a long time, they should be processed with an inoculating agent. Seed treatment should be carried out in places protected from sunlight (in the shade, in a warehouse). Planteco nut MC285 can be used together with seed treatments.

As a result of the use of the drug, a high titer of the drug ensures an increase in the number of bacteria in the seed compared to analogues; 2.0 kg per ton of seed or 200 g per 1 ha is used.

In the field experiments, Umid, Zumrad and Yulduz varieties of peas were planted as the main crops in spring (March 10, 2021, March 14, 2022, March 16, 2023) when the soil temperature was +6+7 °C, using a manual template with a width of 60 cm between the rows. from seed spacing of 5 cm, 10 cm and 15 cm planted. 20 (60x5-1 cm), 10 (60x10-1), 7 (60x15-1 cm) seeds per meter were achieved in proportion to the planting schemes (Table 2). In the field experiments, three planting schemes and two inoculants (Planteco Nut MC285

and Rizolain) for each variety were tested in comparison to the control-water (no inoculant) option. Thus, in the field experiments, each variety was placed in one layer with 9 variants, a total of 27 variants in 4 replications (108 plots). The total area of each option is 120 m2 (2.4x50 m), and the area to be considered is 60 m2 due to the two rows in the middle. The total allocated area for the experiment was 12,960 m2, together with the protective corridors (5 meters) on the sides, it was 16,140 m2.

In field experiments, seeds were inoculated with a strain of Mesorhizobium cicero each year. placement of field experiments, calculations and observations were carried out on the basis of methodology.

Pea varieties were irrigated 3-4 times during the experimental years at soil moisture levels of 60-70-60% SMC. From the results of the experiments, it is known that increasing the number of irrigations, as well as reducing them, reduces the seed yield. The rate of irrigation is 600-700 m3/ha.

Care of peas. Peas were cultivated 2-3 times between rows, furrows were removed before watering. The annual rate of nitrogenous fertilizers was given in the first treatment during the germination phase.

In the conducted field experiments, the crop of pea varieties was harvested by hand separately for each variant and repetition, the crop was cleaned, dried, and the data was recorded in the field logbook with a moisture content of 14%.

3 Results and Discussion

Taking into account this situation, we found it necessary to study the effects of different planting schemes and inoculants on the growth, development and productivity of chickpea varieties in field experiments conducted in the conditions of irrigated meadow-gray soils of Samarkand region. From the analysis of the obtained results, it is known that 16.6-18.2 nodules were formed in the roots of the control Yulduz variety, while 17.8-19.6 nodules were formed in the Zumrad variety, which was 1.2-1.4 more than in the Yulduz variety, in the Umid variety and 20.1-23.1 tubers were formed, which was 3.5-4.9 more than the control Yulduz variety. According to the increasing number of nodules in the roots of pea varieties, they were placed in the order of Yulduz→ Zumrad →Umid. According to the analysis of the formation of nodules in the roots of pea varieties according to the planting schemes, in the control Star variety, 16.6-17.2 nodules were formed in the plants of the 60x5-1 (control) scheme, and 16.8-17.5 in the 60x10-1 scheme variants. grains and 60x15-1 scheme variants, and it was found that the grains were formed more and made up 17.6-18.2 grains. It should be noted that under the influence of inoculants, the number of tubers increased by 0.3-0.7 units, especially the effect of the drug Planteco Nut MC285 was high.

Table 1. Effect of planting scheme and inoculants on the formation of nodules in the roots of pea varieties, grain (2021-2023)

№	Planting scheme	Inoculants	The number of dry nodules per plant in the 0-30 cm layer of the soil during the flowering phase of plants, pcs.			
			2021 y.	2022 y.	2023 y.	average
A variety of Umid						
1	60x5-1 (control)	control-no inoculant	19,9	19,1	21,4	20,1
2		Planteco Pea MC285	20,9	19,7	22,8	21,1
3		Risoline	20,2	19,3	21,9	20,5
4	60x10-1	control-no inoculant	21,6	21,0	22,3	21,6

5		Planteco Pea MC285	22,1	21,7	23,6	22,5
6		Risoline	21,6	21,2	22,7	21,8
7	60x15-1	control-no inoculant	21,9	21,6	23,4	22,3
8		Planteco Pea MC285	22,8	22,0	24,5	23,1
9		Risoline	22,0	21,5	23,6	22,4
A variety of Zumrad						
1	60x5-1 (control)	control-no inoculant	17,7	17,4	18,2	17,8
2		Planteco Pea MC285	18,1	17,7	19,1	18,3
3		Risoline	17,9	17,6	18,7	18,1
4	60x10-1	control-no inoculant	17,9	17,6	18,4	18,0
5		Planteco Pea MC285	18,6	18,0	19,7	18,8
6		Risoline	18,1	17,8	18,8	18,2
7	60x15-1	control-no inoculant	18,9	18,0	19,1	18,7
8		Planteco Pea MC285	19,7	18,9	20,2	19,6
9		Risoline	19,1	18,3	19,4	18,9
A variety of Yulduz (control)						
1	60x5-1 (control)	control-no inoculant	16,3	16,1	17,5	16,6
2		Planteco Pea MC285	16,9	16,6	18,1	17,2
3		Risoline	16,6	16,4	17,8	16,9
4	60x10-1	control-no inoculant	16,7	16,3	17,5	16,8
5		Planteco Pea MC285	17,1	16,8	18,5	17,5
6		Risoline	16,9	16,5	17,9	17,1
7	60x15-1	control-no inoculant	17,2	17,3	18,3	17,6
8		Planteco Pea MC285	17,9	17,5	19,1	18,2
9		Risoline	17,5	17,4	18,8	17,9

The formation of nodules in the Zumrad variety is the same as in the control Star variety, 17.8-18.3, corresponding to the above; 18.0-18.8; It was found to be 18.7-19.6 units and increased by 0.3-1.3 units under the influence of inoculants. Planteco Nut MC285 produced more nodules than Risoline.

It was found that more buds are formed in the Umid variety than other varieties, and as the feeding area of plants expands, favorable conditions for symbiotic activity are provided, and finally, many buds are formed.

The number of buds of the Umid variety was 21.4-22.8 units in the 60x5-1 scheme (control), i.e. when planted thickly, 22.3-23.6 units in the 60x10-1 scheme and 23.4-23.4 in the 60x15-1 scheme. 24.5 grains, how sparsely the plants are placed (60x15-1). it was noted that the more nodules were formed, and vice versa, the thicker the plant, the less nodules were formed. In all varieties and planting schemes, it was found that under the influence of inoculants, more nodules were formed. It was noted that the effect of Planteco Nut MC285 inoculant was higher than Risoline inoculant.

Table 2. Planting scheme and the effect of inoculants on the mass of nodules in the roots of pea varieties, mg/bush (2021-2023)

№	Planting scheme	Inoculants	The number of dry nodules per plant in the 0-30 cm layer of the soil during the flowering phase of plants, pcs.			
			2021 y.	2022 y.	2023 y.	2021 y.
A variety of Umid						
1	60x5-1 (control)	control-no inoculant	65,1	92,4	76,4	78,0
2		Planteco Pea MC285	101	128,5	98,3	109,3
3		Risoline	95,6	147,3	101,8	114,9
4	60x10-1	control-no inoculant	93,9	133,3	97,6	108,3
5		Planteco Pea MC285	101,7	144,9	103,4	116,7
6		Risoline	124,5	170,9	118,9	138,1
7	60x15-1	control-no inoculant	98,5	129,6	107,5	111,9
8		Planteco Pea MC285	119,5	169,8	116,5	135,3
9		Risoline	133,8	190,2	126,4	150,1
A variety of Zumrad						
1	60x5-1 (control)	control-no inoculant	57,3	83,5	69,1	70,0
2		Planteco Pea MC285	93,2	119,6	91	101,3
3		Risoline	87,8	138,4	94,5	106,9
4	60x10-1	control-no inoculant	86,1	124,4	90,3	100,3
5		Planteco Pea MC285	93,9	136	96,1	108,7
6		Risoline	116,7	162	111,6	130,1
7	60x15-1	control-no inoculant	98,7	120,7	100,2	106,5
8		Planteco Pea MC285	111,7	160,9	109,2	127,3
9		Risoline	126	181,3	119,1	142,1
A variety of Yulduz (control)						
1	60x5-1 (control)	control-no inoculant	63,6	90,9	76,4	77,0
2		Planteco Pea MC285	99,5	127	98,3	108,3
3		Risoline	94,1	145,8	101,8	113,9
4	60x10-1	control-no inoculant	92,4	131,8	97,6	107,3
5		Planteco Pea MC285	100,2	143,4	103,4	115,7
6		Risoline	123	169,4	118,9	137,1
7	60x15-1	control-no inoculant	105	128,1	107,5	113,5
8		Planteco Pea MC285	118	168,3	116,5	134,3
9		Risoline	132,3	188,7	126,4	149,1

In field experiments (2021-2023), the mass of nodules formed in the roots of the Yulduz variety taken as a control was 77.0-149.1 mg on average according to the experimental options, while it was 70.0-142.1 mg in the Zumrad variety and the control Yulduz 7.0-7.0 mg less than in the Umid variety, and 78.0-150.1 mg in the Umid variety it was taken into account that the control was 1.0-1.0 mg more than that of Star variety.

In the control, the Yulduz variety was 77.0-113.9 mg in the 60x5-1 (control) scheme options, 1073-137.1 mg, 113.5-149.1 mg in the 60x10-1 scheme options, while in the Zumrad variety, the indicators correspond to the above respectively 70.0-106.9; 100.3-130.1; 106.5-142.1 mg and 78.0-114.9 in Umid variety; 108.3-138.1; It was found that it was 111.9-150.1 mg, that is, as the feeding area of plants expanded, the mass of tubers increased.

In the Umid variety studied in field experiments, compared to the options with the 60x5-1 (control) scheme, i.e. when the plants are planted thickly, the mass of tubers is 33.9 mg according to the options with the 60x15-1 scheme, i.e. when the plants are planted sparsely; 26.0 mg and 35.2 mg were found to be higher. So, it was found that as the feeding area of plants expands, i.e., as the number of stems decreases, the mass of nodules increases.

From the mathematical-statistical analysis of the obtained results, it is known that the dependence of the mass of nodules on the thickness of the stem has a straight-line description, the regression equation obeys $y = a+bx$, it was found that the coefficients of correlation (r) and determination (R2) are high (1,2,3- pictures). The same trend was observed for Yulduz and Zumrad varieties.

4 Conclusion

In the conditions of irrigated meadow-gray soils of Samarkand region, Umid variety produces more buds than Yulduz and Zumrad varieties. In all three cultivars, as the feeding area of the plants expands and Planteco Nut MC285 inoculant is applied, numerous root nodules form. The mass of nodules formed in the roots of pea varieties differed by variety, and the mass of nodules was higher in the Umid variety than in other varieties. As the nutritional area of plants expanded, that is, as the thickness of the stem decreased, the mass of nodules increased, especially when the drug Rizolain was used, the mass of nodules in the roots of Pea varieties was ensured.

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