Dependences of the yield of common beans on agrotechnical factors in the zone of chestnut soils of the Astrakhan region

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Abstract. The article presents the results of agroecological study of the common bean collection, not only under the conditions of the subtype of light chestnut soils of the Astrakhan region, but also worked out the mode of irrigation of this crop, inoculation of seeds with rhizotorphin on a drip irrigation method. The need for research was primarily due to the insufficient number of bean varieties ideally adapted to the specific climatic conditions of the region, which is associated with insufficient study of both the morphology and biology of the culture. As objects of study, a test culture of beans and the drug rhizotorfin were chosen. The study showed that when cultivating common beans under irrigated Astrakhan region in the subzone of light chestnut soils, it is advisable to carry out pre-sowing inoculation of seeds with rhizotorphin, which ensures a stable yield of common beans on drip irrigation, and also contributes to the accumulation of biological nitrogen. Thus, based on the data obtained, on drip irrigation in the subzone of light chestnut soils, it is economically feasible to sow in a wide-row method (0.70 m) with a seeding rate of 500,000 germinating seeds per hectare and carry out pre-sowing seed inoculation with rhizotorphin.

1 Introduction

Common bean (genus Phaseolus L.) vulgaris - belongs to the legume family and subtype Moth. Bean grain is distinguished by increased taste and special nutritional value. Basically, beans are valued for their high availability of proteins, and they are superior to other legumes in terms of the quality of dietary protein (Table 1) [1].

The protein contained in beans has a specific property to dissolve in water at a very high rate, as a result of which the protein is quickly absorbed by the body. A person, when eating beans, depending on the culinary processing, is able to absorb up to 75 ... 80% of the protein contained in the beans. The composition of the protein contained in beans includes 30 amino acids, some of which are irreplaceable [2].

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Table 1. The content of nutrients in the seeds of leguminous crops (according to Prof. Slovtsov) (in %).

Culture	Content in %		
	protein	fat	carbohydrates
Beans	25.6	1.8	47.3
Beans	23.1	2.1	52.0
Peas	23.2	1.9	58.3

Flour is produced from beans (mainly white seed varieties), which is added to wheat flour in the amount of 5 ... 15% for the purpose of baking bread. The addition of flour from white-seed varieties of beans increases the nutritional value and protein content of bread, which is extremely useful for baby food. In the Caucasus, dry bean grain is widely used for the preparation of canned pork and legumes; the addition of bean flour to corn flour is common [3-4]. For freezing, unripe beans (shoulders) are used as a whole. Lima beans are particularly suitable for this purpose, but they have not yet become widespread. Crops, it is available in the Krasnodar Territory, Moldova and Armenia. Raw beans, neither in the form of green shoulder blades, nor in immature seeds, cannot be eaten in order to avoid poisoning.

Increasing the yield of agricultural crops per unit area, while minimizing costs, is a priority task aimed at ensuring food security in the country. Much attention is paid to pre-sowing treatment of seeds [5], which is due to the minimum cost of work, the application of mineral fertilizers [6-7], the introduction of improved methods of tillage, etc. [8]. Plant growth regulators [9-11], mechanical and electrophysical influences [12] are used as methods of presowing seed treatment of agricultural crops.

The analysis of literary sources testifies to the prevailing objective conditions that prevent the spread of beans in the regions of the Lower Volga region. The main factors hindering the larger-scale production of beans are the lack of a sufficient number of varieties adapted to the climate of the region, insufficient seed production, and the lack of perfect agricultural technology. For a stable increase in crop yields, seed inoculation with rhizotorphin is successfully used, which increases the yield of beans, reduces the dose of mineral fertilizers, and produces high-quality grain at low cost (this is especially true under irrigation conditions).

The purpose of the study was to select promising varieties of beans in the conditions of cultivation of the Astrakhan region, practiced the inoculation of seeds with rhizotorphin, the mode of irrigation of this crop, using the drip irrigation method.

2 Materials and methods

Experiments with the development of the inoculation of common bean seeds, the mode of irrigation of beans were carried out from 2019 to 2021 in the conditions of field stationary experiments on the lands of the FGBNU "Caspian Agrarian Federal Scientific Center of the Russian Academy of Sciences".

The soils at the place of the experiments are light chestnut, with a low content of humus (1.1%), and loamy in terms of granulometric composition. Soils of the experimental plot with a low supply of easily hydrolysable nitrogen, an average supply of mobile phosphorus, and an increased supply of exchangeable potassium.

The initial material for the agroecological study was 10 samples from the VIR catalog and three varieties selected by us in previous studies: Oka, Nerussa and Gornal.

As a control, the Oka variety was taken, which was bred at the All-Russian Research Institute of leguminous and cereal crops, Orel. Field measurements, observations and records were carried out according to the method of field experience Dospekhov B.A.

Table 2. The chemical composition of the soil of the experimental plot (2019 ... 2021).

Horizon thickness, m	Humus content, %	mg/100g dry soil		
		N easily hydrolysable	P_2O_5 mobile phosphorus	K_2O potassium exchange
0.00…0.20	1.06	3.57	2.65	35.37
0.20…0.35	0.91	2.44	2.86	30.90
0.35…0.65	0.70	0.57	2.04	16.20
0.65…1.20	0.25	0.10	1.61	20.45

3 varieties selected for the study - Oka, Nerussa and Gornal were sown on two backgrounds:

- Background No. 1 - without seed inoculation (control).
- Background No. 2 - with seed inoculation with rhizotorphin without inoculation (control).

Sowing was carried out in a wide-row way with a row spacing of 0.70 m, plant density of 500 thousand plants/ha. The area of plots is 21 m^2, accounting plots are 14 m^2. Repetition four times. On the day of sowing on May 5...10, the seed material was inoculated with a bacterial preparation (rhizo-torphin) - strain 634 (titer $2...3^x10^9$ CFU/ml).

Statistical processing of the results of the analysis was carried out by the method of dispersion analysis using programs for Microsoft Excel.

3 Results and Discussion

When conducting experiments on variety testing of a collection of beans with a drip irrigation system during the entire growing season, soil moisture was within the specified limits:

- Phase seedlings - budding - 65-70% HB.
- Phase budding - flowering - 70-75% HB.
- Phase flowering - maturation - 65-70% HB.

To maintain the planned soil moisture in the period 2019-2021, 16 irrigations were carried out during the growing season with a norm of 150 m^3/ha (4 in May, 8 in June, and 4 in July). The total irrigation rate for the period of the growing season was 240 mm, the water consumption of beans was 361.6 mm (Table 3).

Table 3. Water balance of bean crops in agrobiological variety testing, (2019…2021).

Index	Meaning
Productive moisture reserve, beginning of vegetation, mm	86.4
Productive moisture reserve, end of vegetation, mm	52.2
Precipitation, sprouting-harvesting period, mm	87.4
Irrigation water, mm	240.0
Total water consumption, m^3/ha	3616.0

The scheme of total water consumption was determined as follows:

- Accepted irrigation rate - 2400 m3/ha - 66.2%.
- Precipitation - 874 m3/ha - 21.3%.
- Water consumption from the soil - 4.6%.

Conducted 3-year experiments showed that on all varieties of common beans: Oka, Gornal and Nerussa, we carried out a preliminary study of the effect of rhizotorphin, the results of which radically proved the need to find this operation before sowing the crop, even in years with a lack of moisture supply (Table 4).

Table 4. Influence of presowing inoculation with rhizotorfin on bean yield and economically useful traits (2019…2021).

Variety	Vegetation period, days	Density of plants for harvesting, pcs/m^2	Safety for cleaning, %	Plant height, m	Attachment height of lower bobs, m	Weight of grain per plant, g	Weight of 1000 grains, g	Yield, t/ha
Background I (no seed inoculation)								
Oka-St	92	24.4	96.4	0.32	0.11	9.1	235.5	2.42
Nerussa	101	23.7	94.2	0.33	0.13	8.8	226.7	2.29
Gornal	96	25.2	95.7	0.31	0.10	8.6	220.4	2.37
Background II (with seed inoculation)								
Oka-St	90	25.1	98.7	0.35	0.11	10.2	245.5	2.76
Nerussa	98	23.9	96.4	0.37	0.12	9.4	232.6	2.45
Gornal	95	26.6	96.6	0.33	0.11	9.0	225.0	2.59
NSR_{05}								0.7

According to the materials obtained, shown in Table 6, the degree of impact of seed treatment with rhizotorphin on vital signs and the final product, the yield of the crop itself, is quite clearly noted.

Table 5. Efficiency of seed inoculation by common bean varieties, (2019…2021).

Index	Background I (no seed inoculation)			Background II (with seed inoculation)		
	Oka	Nerussa	Gornal	Oka	Nerussa	Gornal
Total costs, thousand rubles/ha	40.7	40.7	40.7	40.7	40.7	40.7
Bean yield, tons/ha	2.42	2.29	2.37	2.76	2.45	2.59
The cost of 1 ton of sold beans, thousand rubles / t	27.0	27.0	27.0	27.0	27.0	27.0
Earned profit, thousand rubles/ha	24.64	21.13	22.59	33.84	25.45	29.23
Cost of bean production, thousand rubles/t	18.42	25.33	24.39	15.48	19.13	18.31
The total cost from the sale of 1 ha, thousand rub.	65.34	61.83	63.29	74.52	66.15	69.93
Profitability, %	60.54	51.92	55.50	83.01	62.53	71.82
Economic efficiency, rub./rub. costs	1.61	1.49	1.56	1.87	1.65	1.71

A reduction in all varieties of beans during the growing season was experimentally established, the safety of plants, grain mass increased by 1.5-2%, and as a result, higher yields. According to the dynamics of the increase in the mass of 1000 grains, the Oka bean variety distinguished itself - plus 10.0 grams, the yield increased by 0.34 t/ha. A positive effect on the yield after treatment of sowing seeds with rhizotrophin was found in the varieties Nerrussa and Gornal (by 0.16 t/ha and 0.22 t/ha, respectively).

The threshold of profitability increased by grades up to 83.01% for the Oka standard, up to 62.53% for the Nerussa variety and up to 71.82% for the Gornal variety. The highest level of economic efficiency is 1.87 rubles / rub. costs obtained for grade Oka. A similar efficiency indicator for the Gornal variety is 1.71 rubles / rub. costs.

4 Conclusion

Numerous results of the study showed that the experiments of pre-sowing treatment of bean seeds with rhizotorphin reflect the high efficiency of this technique for the studied varieties: the yield increased, the profit received, as well as economic efficiency (Table 5). The

analysis of the experimental data obtained allows us to conclude that in the presence of thermal resources, with the optimization of the level of water consumption and the improvement of mineral nutrition at the microbiological level through the use of the rhizotorphin strain, it is possible to achieve stable high yields of the bush bean form on light chestnut soils of the semi-desert zone with irrigation: from 2 0 to 2.5 t/ha of grain, which is a reliable additional reserve for obtaining food protein.

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