Influence of nitrogen and mineral fertilizer application on technological quality indicators of winter wheat harvest and grain in repeated soy crop

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Abstract. Pre-sowing nitrogen treatment of Soybean grown as a repeated crop had a positive effect on the grain yield of winter wheat. In the control, which was not treated with nitrogen before planting soybean seeds, winter wheat in the next year provided a higher grain yield of 1.7-2.1 quintals/ha compared to treated options. Also, the use of P90 K60 fertilizers in Soybean grown as a repeated crop helped to increase the grain yield by 2.8-2.9 quintals/ha compared to the control options where no mineral fertilizers were applied. It was determined that the most optimal norm of mineral fertilizers N60 P90 K60 kg/ha was used in the maintenance of Soybean seeds grown as a repeated crop, inoculated with nitragin and in non-inoculated controls. Compared to the control options, the protein content of winter wheat grain was higher by 0.7-0.8%, the gluten content by 1.1-1.3%, and the natural index of the grain by 30.9-32.1 g/l. The highest yields of winter wheat were inoculated with nitragin prior to planting soybean seeds. In the control, the norm of mineral fertilizers N60 P90 K60 kg/ha was used as a follow-up crop, and it was taken from the variant treated with winter wheat, and it was 61.7 quintals/ha. It was determined that the amount of protein was 14.2-15.0%, the amount of gluten was 27.9-28.4%, and the natural (volumetric) weight of the grain was 806.4-813.1 g/l.

1. Introduction

Currently, in the world agricultural practice, it is important to plant leguminous crops as a repeat crop in the areas freed from winter wheat, early potatoes, vegetables, and pulse crops in order to grow a higher and better quality grain crop than winter wheat. When determining the norms of feeding crops, it is important to determine the norms of mineral fertilizers used in the previous crop, to use resource-saving agrotechnologies in their cultivation, and to reduce the norms of nitrogen fertilizers used in its maintenance by treating soybean seeds with nitrogen before sowing [1, 2].

Due to the increasing needs of the population for food and livestock feed in Uzbekistan, the efficiency of using our existing irrigated areas is also increasing sharply [3]. The basis of the agricultural crops grown in Uzbekistan is cotton and autumn cereals, and now autumn cereals are planted annually on more than one million hectares of our irrigated lands. It can be seen that after the harvest of autumn grain and early vegetable crops, there is an opportunity to grow a variety of repeated crops on such a large area [4]. Therefore, the main attention should be paid to the cultivation of leguminous grains, cereals, vegetables and fodder crops, which satisfy the needs of the population for food and livestock feed, as repeated crops, in areas freed from autumn grain and early vegetable crops, which will help to further strengthen food security in Uzbekistan [4-9].

In the research carried out in the conditions of meadow soils of Samarkand region, the norms of mineral fertilizers were increased from N150 P75 K50 to N210 P105 K70 kg/ha in feeding winter wheat varieties "Yaksart", "Krasnodarskaya-99" and "Jasmina". In this case, 1000 pieces of grain weight increased from 36.2 to 43.0 g, grain nature from 771 g/l to 810 g/l, and grain vitreousness from 57.3% to 82.3%. It contributed to the high content of protein (14.2-14.9%) and gluten (28.8-30.2%) in grain [10].

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In conditions of grassland alluvial soils of the Republic of Karakalpakstan, in short-rotational cropping systems, after winter wheat, a repeated crop of mush was fed with mineral fertilizers at the rate of N30 P80 K60 kg/ha. Feeding cotton with mineral fertilizers at the rate of N160-200, P100-140, K75-100 kg/ha in such areas provided a cotton yield of 33.3-34.0 quintals/ha [11-13].

The average grain and hay yields were 12.5 and 40.1 quintals/ha, respectively. In another study, winter wheat was planted after repeated crops. It was determined that 15.1% or 0.88 t/ha of protein, 28.1% were used at the rate of N150 P105 K75 kg/ha. Or 1.8 t/ha of gluten and 68.4 kg/ha of nutritive value and 6.9 kg/ha of digestible protein were taken into account [14].

32.5-34.8 quintals/ha were obtained from millet grown as a repeated crop in the research conducted in the conditions of meadow soils of Samarkand region. He recommended planting millet as a repeat crop on June 20 at the rate of 2.5 million units/ha of fertile seeds to produce 69.4-72.6 quintals/ha of winter wheat. In other studies, planting of mash and rape crops as a repeated predecessor crop to produce a higher and better grain yield than winter wheat has been determined to produce a moderate yield of winter wheat. It was determined that the increase in the number of productive stems, the creation of favorable conditions for the good growth and development of the plant, provided an average grain yield of 62.3-65.1 quintals/ha [15].

Humus content in the 0-30 cm soil layer increased by 0.03% after maize, 0.19%, 0.14%, and 0.16% after mung bean, soybean, and soybean, respectively, compared to the no-cropped control (1.780%). It was determined that the yield of winter wheat increased by 5.3-7.7 quintals/ha after beans and mash, and decreased by 6.8 quintals/ha after corn [8].

When Soy was planted as a repeated crop on the fields freed from autumn grain crops, 15.8 centners of grain yield per hectare was obtained, 4.5 t/ha of root and shoot residues and 67 kg of nitrogen, 18 kg of phosphorus and 10 kg of potassium elements remained as a result of their decay. Double grain yield in one field, 64.9 quintals/ha in control (wheat+wheat), 80.7 quintals/ha in wheat+Soy, 79.6 quintals/ha in wheat+mash, 81.1 quintals/ha in wheat+bean and it has been proven that it is possible to get a total of 78.0 quintals/ha from wheat+peanut [10].

The amount of protein in the grain of "Tanya" variety of winter wheat without fertilizers was 8.2%, in "Hasildor" and "Polovchanka" varieties it was 8.63 and 8.58%, respectively. In the options where the norm of mineral fertilizers N150 P100 K50 kg/ha was used, these indicators were 10.7-11.2% and 10.8%, respectively. When using the norm of mineral fertilizers N200 P150 K100 kg/ha, it was 11.96, 12.3 and 11.67%, and compared to the norm of mineral fertilizers it was 12.7, 11.6 and 11.01%. If the rates of phosphorus and potassium of the used fertilizers did not significantly affect the amount of protein in grain, it was found that there is a correlation between the rate of nitrogen fertilizer and the accumulation of protein in grain [11].

2. Materials and Methods

Our research was conducted during 2019-2022 in Andijan region (Uzbekistan) in the conditions of light-colored gray soils that are irrigated by skeet. The following rates of mineral fertilizers without fertilizer, P90 K60, N30 P90 K60, N60 P90 K60 and N90 P90 K60, kg/ha were tested in controls inoculated and not inoculated with Nitragin of *Bradyrhizobium japonicum* SB5 strain before planting Soybean seeds planted as a repeated crop. Winter wheat was maintained in these established controls. In winter wheat, the norm of mineral fertilizers N200 R140 K100 kg/ha was applied.

Researches were carried out in field and laboratory conditions, in which placement of field experiments, calculations and observations were carried out on the basis of "Methods of conducting field experiments", plant analysis [1, 2, 11].

Of the mineral fertilizers used in field experiments for the care of all agricultural crops: ammonium nitrate (N 33-34%), ammophos (N 11-12%, P2O5-46%), suprephos (N 5-6%, P2O5-32%), potassium chloride (K2O-60%) was used.

Soybean grown as a repeated crop was inoculated with Nitragin preparation of Bradyrhizobium japonicum SB5 strain before sowing. This nitragin strain is one of the nitragins stored in the collection of the Research Institute of Microbiology of the Academy of Sciences of the Republic of Uzbekistan, and the bacteria are stored in a lyophilized form. Bacteria have a cell count of 107 or 108. Prechatkas were used if they were used. Pathogenic bacteria are not considered [3].

3. Results and Discussion

It is known that the wheat plant, like other plants, is affected by changes in external environmental factors and agrotechnical measures used in its care. As a result, its growth, development and productivity will change. One of the main factors affecting the growth, development and productivity of winter wheat was considered to be the previous crop. All agrotechnological measures used in the maintenance of the previous crop, in turn, cannot fail to show an effect on the yield obtained from it. In our research, the effect of inoculation of soybean seeds grown as a repeated

crop with nitrogen before sowing and the use of mineral fertilizers in different rates on the yield of winter wheat was determined.

Winter wheat grown as a repeat crop after sowing at the rate of 200-225 kg per hectare ensured the highest grain yield (59.0-61.1 quintals/ha). As a repeat crop, 9.2-11.7 quintals/ha were plowed after corn, followed by winter wheat, compared to the options planted at a rate of 200-225 kg per hectare. It was determined that in the control, where no repeated crop was planted, it was possible to get an additional grain yield of 8.8-9.3 quintals/ha compared to the options planted with winter wheat at the rate of 200-225 kg per hectare. Also, winter wheat was plowed without any repeat cropping. It was found that the protein content of its grain was increased by 0.4-0.5%, and the amount of gluten by 0.2-0.4% in the variants planted at the rate of 200 kg per hectare after sowing [5].

According to the data obtained on the yield of winter wheat, the highest performance was treated with nitrogen before sowing of soybeans grown as a repeated crop. The norm of mineral fertilizers N60 P90 K60 kg/ha was used in the control, next year winter wheat was obtained from the treated variant. As a result, the yield was 61.7 quintals/ha. Before sowing the seeds of Soybean grown as a repeated crop, the norm of mineral fertilizers N60 P90 K60 kg/ha was used in the control, and the grain yield of 59.7 quintals/ha was obtained from the option treated with winter wheat next year. Soybean grown as a repeated crop was treated without nitrogen fertilizer before sowing, and winter wheat was planted next year. Winter wheat grown as a repeat crop, treated with nitrogen before planting, and planted to control without fertilizer, yielded 52.7 quintals/ha (Table 1).

Before sowing the seeds of Soybean grown as a repeated crop, only phosphorus and potassium (P90 K60) fertilizers were used in the control, without treating with nitrogen, the grain yield of 53.8 quintals/ha was obtained from the winter wheat cultivated option next year. Repeated crop The same rate of mineral fertilizers was used in Soy, and nitrogen treatment of its seeds ensured grain yield of 55.5 quintals/ha of winter wheat.

It was determined that the most optimal norm of mineral fertilizers N60 P90 K60 kg/ha was used in the maintenance of Soybean seeds grown as a repeated crop, inoculated with nitragin and in non-inoculated controls. Winter wheat planted as a follower crop provided an additional grain yield of 8.8-9.0 quintals/ha compared to control options.

Table 1. Effect of application of nitrogen and mineral fertilizers in repeated cropping on winter wheat grain yield, quintals/ha (2020-2022)

#	Standards of mineral fertilizers used in repeated soy crop, kg/ha (NPK)	Years			Average
		2020	2021	2022	
1	No fertilizer	51.4	48.2	53.2	50.9
2	$P_{90}K_{60}$	53.8	51.0	56.5	53.8
3	$N_{30}P_{90}K_{60}$	57.7	54.5	59.9	57.4
4	$N_{60}P_{90}K_{60}$	59.9	56.7	62.4	59.7
5	$N_{90}P_{90}K_{60}$	58.4	55.4	61.5	58.4
6	Nitragin (no fertilizer)	52.8	49.8	55.5	52.7
7	$P_{90}K_{60}$ + Nitragin	55.6	52.9	58.0	55.5
8	$N_{30}P_{90}K_{60}$ + Nitragin	59.8	56.6	62.1	59.5
9	$N_{60}P_{90}K_{60}$ + Nitragin	61.7	58.4	64.9	61.7
10	$N_{90}P_{90}K_{60}$ + Nitragin	60.6	57.0	62.8	60.1

It is known that the price of wheat is determined not only by the quantity of the harvest obtained from it, but also by the high technological quality indicators of the grain. The quality of wheat grain is always evaluated by laboratory analysis. In our research, the effects of nitrogen inoculation and application of mineral fertilizers on the technological quality indicators of winter soft wheat grain before planting soybean seeds grown as a repeated crop were studied. After harvesting the grain yield of winter wheat in the experimental variants, the amount of protein and gluten in it, as well as the nature indicators of the grain, were studied in laboratory conditions.

The ratio of the amount of protein and gluten, which determines the main quality indicators of wheat grain, changes very sharply depending on the conditions of its cultivation and the agrotechnical measures used in the maintenance process.

According to the data obtained from our research, it was found that the protein content, raw gluten content, and the nature indicators of the grain, which are the main technological quality indicators of winter wheat grain, differed significantly under the influence of nitrogen and mineral fertilizer standards used in the soybean crop grown as a repeated crop.

The highest values of protein and gluten contents of winter wheat grain were treated with nitragin before sowing of soybeans grown as a repeated crop. The norm of mineral fertilizers N60 P90 K60 kg/ha was used in the control, and next year, winter wheat was observed in the treated option. In this case, the amount of protein was 14.0-14.5%, and the amount of gluten was 27.4-27.9%. It was found that the protein content was 14.2-15.0%, and the gluten content

was 27.9-28.4% in the control, where the rate of mineral fertilizers N60 P90 K60 kg/ha was used without treatment with nitragin. Soybean grown as a repeated crop was treated without nitrogen fertilizer before sowing, and in the control variant, where winter wheat was planted next year, the protein content was 13.2-13.5%, and the gluten content was 26.3-26.8%. . Soybean, grown as a recurrent crop, was treated with nitrogen before planting. It was found that the amount of protein was 13.4-13.9%, and the amount of gluten was 26.6-26.9% in the variant planted in the control without fertilizers (Table 2).

The protein content of next year's autumn wheat was 13.5-14.0% in the controlled case where only phosphorous and potassium (P90 K60) fertilizers were applied without treating with nitrogen before planting soybean seeds grown as a repeated crop. Besides if the amount of gluten was 26.7-27.1%, the same rate of mineral fertilizers was used in the repeated crop Soy. Nitragin treatment of its seeds ensured that the protein content of winter wheat grain was 13.6-14.2%, and the gluten content was 26.8-27.4%.

It was determined that the nitrogen and mineral fertilizer standards used in the Soy crop, grown as a repeated crop, affected the bulk weight of winter wheat grain.

Table 2. Effect of nitrogen and mineral fertilizers application in repeated crop on the quality indicators of winter wheat grain, % (2020-2022)

#	Standards of mineral fertilizers used in repeated soy crop, kg/ha (NPK)	2020		2021		2022	
		Protein, %	Gluten, %	Protein, %	Gluten, %	Protein, %	Gluten, %
1	No fertilizer	13.4	26.6	13.2	26.3	13.5	26.8
2	$P_{90}K_{60}$	13.8	26.9	13.5	26.7	14.0	27.1
3	$N_{30}P_{90}K_{60}$	14.0	27.4	13.7	27.0	14.1	27.6
4	$N_{60}P_{90}K_{60}$	14.3	27.6	14.0	27.4	14.5	27.9
5	$N_{90}P_{90}K_{60}$	14.1	27.5	13.9	27.2	14.2	27.8
6	Nitragin (no fertilizer)	13.7	26.8	13.4	26.6	13.9	26.9
7	$P_{90}K_{60}$ + Nitragin	13.9	27.2	13.6	26.8	14.2	27.4
8	$N_{30}P_{90}K_{60}$ + Nitragin	14.2	27.5	13.9	27.3	14.6	27.7
9	$N_{60}P_{90}K_{60}$ + Nitragin	14.7	28.1	14.2	27.9	15.0	28.4
10	$N_{90}P_{90}K_{60}$ + Nitragin	14.4	28.0	14.1	27.6	14.8	28.2

Soybean, which was grown as a repeated crop, treated with nitrogen before planting, the highest values of winter wheat grain in-kind index. In the control where the norm of mineral fertilizers N60 P90 K60 kg/ha was used, it was 794.3-801.2 g/l. Before sowing the seeds of Soybean grown as a repeated crop, the rate of mineral fertilizers N60 P90 K60 kg/ha was used in the control, and it was found that the natural index of the winter wheat grain was 806.4-813.1 g/l in the option where winter wheat was cultivated next year. Soybean, grown as a repeated crop, was treated without nitrogen fertilizer before planting, and in the control option, where winter wheat was planted next year, the grain content was 766.2-775.6 g/l. Soybean seeds grown as a repeated crop were treated with nitragin before planting, and in the case of the control, which was treated without fertilizers, it was found that the grain content was 775.5-781.5 g/l (Table 3).

Table 3. Effect of application of nitrogen and mineral fertilizers in repeated cropping on grain weight of winter wheat, g/l (2020-2022)

#	Standards of mineral fertilizers used in repeated soy crop, kg/ha (NPK)	2020	2021	2022
1	No fertilizer	770.3	766.2	775.6
2	$P_{90}K_{60}$	781.0	778.4	785.3
3	$N_{30}P_{90}K_{60}$	789.2	785.6	794.0
4	$N_{60}P_{90}K_{60}$	798.5	794.3	801.2
5	$N_{90}P_{90}K_{60}$	793.6	790.2	798.1
6	Nitragin (no fertilizer)	778.2	775.5	781.5
7	$P_{90}K_{60}$ + Nitragin	785.6	782.4	789.2
8	$N_{30}P_{90}K_{60}$ + Nitragin	801.4	797.3	806.0
9	$N_{60}P_{90}K_{60}$ + Nitragin	809.8	806.4	813.1
10	$N_{90}P_{90}K_{60}$ + Nitragin	805.2	803.5	810.5

Before sowing soybean seeds grown as a repeated crop, only phosphorus and potassium fertilizers (P90 K60) were applied from mineral fertilizers before sowing, and the grain quality was 778.4-785.3 g/l. The repeated crop, using the same rate of mineral fertilizers and treating its seeds with nitrogen before planting, ensured that the grain size of winter wheat was 782.4-789.2 g/l.

The relationship between the content of protein and gluten in the grain of winter wheat is straight-line when it is treated with intragyn before planting the seeds of Soybean grown as a repeated crop, and the mineral fertilizers are used in different rates of control. It is characterized by the fact that it has a positive characteristic, it is found that they obey the regression equation (y=a+bx). The correlation coefficient has a straight line character. In this, r=0.97 (year 2020), r=0.99 (year 2021) and r=0.94 (year 2022) were found, indicating a high degree of linear relationship between them.

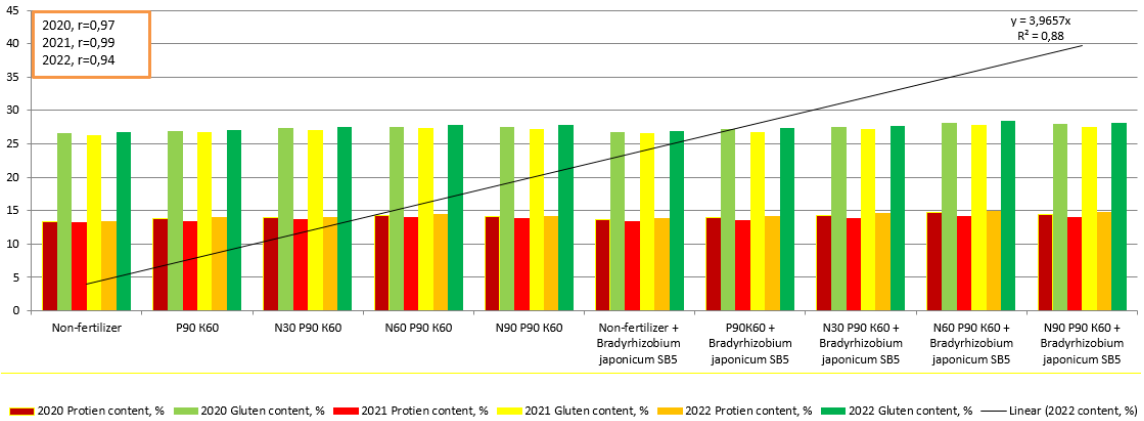

Fig. 1. Effect of mineral fertilizer rates and nitrogen application in repeated crop soybean on the correlation coefficient between the protein and gluten content of winter wheat grain

4. Conclusions

Pre-sowing nitrogen treatment of Soybean grown as a repeated crop had a positive effect on the grain yield of winter wheat. Soybean crop seeding in the control untreated with nitrogen provided 1.7-2.1 quintals/ha higher grain yield compared to winter wheat treated options the following year. Also, the use of P90 K60 fertilizers in Soybean grown as a repeated crop helped to increase the grain yield by 2.8-2.9 quintals/ha compared to the control options where no mineral fertilizers were applied.

Nitrogen treatment of Soybean seeds grown as a repeated crop before sowing had a positive effect on the change of technological quality parameters of winter wheat grain. Soybean seeding in the untreated control provided 0.2-0.6% higher protein content and 0.1-0.9% higher gluten content than the next-year winter wheat treated variants.

It was determined that the most optimal norm of mineral fertilizers N60 P90 K60 kg/ha was used in the maintenance of Soybean seeds grown as a repeated crop, inoculated with nitragin and in non-inoculated controls. Compared to the control options, the protein content of winter wheat grain was higher by 0.7-0.8%, the gluten content by 1.1-1.3%, and the natural index of the grain by 30.9-32.1 g/l.

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