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INFLUENCE OF MINERAL FERTILIZERS APPLIED TO COTTON AFTER CROPS ON MINERAL NITROGEN IN THE SOIL AND COTTON HARVEST

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Annotation. The article highlights the possibilities of obtaining a high (34.6 centners per hectare) yield of raw cotton in result of applying $N_{200}P_{140}K_{100}$ kg / ha of mineral fertilizers, according to scientifically grounded recommendations of cotton planted after repeated crops of sunflower and mung bean ($N_{60}P_{80}K_{60}$ kg / ha) in southern part of the Republic of Karakalpakstan at the backdrop of short crop rotations. It is noted that in the soil accumulates more ammonium form than nitrate form.

Key words: mung beans, sunflower, cotton, mineral fertilizer, mineral nitrogen ($N\text{-}NH_4 + N\text{-}NO_3$), yield

Introduction

Today, approximately 40 percent of the world's degraded lands are located in countries with the highest poverty rates, negatively impacting the health and livelihoods of around 1.5 billion people.

To address this issue, countries such as the United States, Brazil, Canada, Australia, Turkey, India, and many others across Europe and Asia are placing significant emphasis on the use of resource-saving and innovative agricultural technologies. These efforts focus on preserving, restoring, enhancing, and protecting the fertility of soils where major agricultural products are cultivated.

Therefore, finding scientifically grounded solutions for achieving high and quality yields-while simultaneously preserving and improving soil fertility-is a pressing challenge. This includes implementing minimal tillage, protecting soils through the use of plant residues, and applying fertilizers at optimal rates and appropriate times.

In the region where the Republic of Uzbekistan is situated, the combination of high annual air temperatures and the intensive tillage methods used to obtain high agricultural yields is causing the soil's natural humus reserves to decline rapidly.

In addition, negative factors such as deterioration in the ameliorative state of irrigated fields, intensifying deflation-erosion processes, compaction of both the plough layer and the underlying horizons, increased contamination by various agrochemicals, the near-absence of crop rotation, and continual disruption of crop-nutrient schedules are frequently observed.

Among the mobile forms of nitrogen in soil, nitrate and ammonium predominate; their ready uptake by plants is well documented in the literature [5; 4; 7; 6]. In Central Asian soils, nitrogen fertilisers applied to the soil are quickly converted from NH_4^+ to NO_3^- within a few days [4]. Nitrates do not adsorb to soil particles but dissolve readily in water. Studies show that rainfall and irrigation can leach nitrates into the lower or deeper soil layers [8; 4]. Experiments on irrigated hydromorphic soils have also demonstrated the transfer of nitrates into drainage waters [9].

However, the influence of nitrogen fertilisers applied to cotton grown after repeat (preceding) crops on the dynamics of mineral nitrogen in the soil has not been fully investigated [1; 2; 3]. Consequently, the present research examined changes in soil mineral-nitrogen content during the cotton vegetation period..

Research object and methods

The field experiment was conducted in the Republic of Karakalpakstan, in the Turtkul district, on the fields of the farms named "Yonboshqalali Xasan Xusan" and "Siroj."

The soil of the experimental field is meadow-alluvial, which has been irrigated for a long time. In the plough layer (0–30 cm), the humus content is 0.517%, total nitrogen is 0.047%, and total phosphorus and potassium are 0.042%, respectively. The mobile forms of nutrients were measured as follows: N-NH_4^+ – 10.7 mg/kg, N-NO_3^- – 7.1 mg/kg, P_2O_5 – 25 mg/kg, and K_2O – 120 mg/kg. These values indicate that the soil of the experimental field is poorly supplied with nutrients.

The cotton experiment was conducted in three replications. Each treatment plot was 4.8 meters wide and 20 meters long, with a total area of 576 m².

In the experiment, mung bean and sunflower were used as preceding crops: mung bean was fertilized at a rate of N30-60P80K60 kg/ha, and sunflower at N120-180P80K60 kg/ha. During the research, cotton was fertilized with mineral fertilizers at rates of N160P100K75 and N200P140K100 kg/ha. The experimental field was initially divided into appropriate replicates and variants, and the following fertilizers were applied according to the experimental design: ammonium nitrate (34% N), superphosphate (N – 10%, P_2O_5 – 22–23%), and potassium chloride (60% K_2O).

All observations, analyses of soil and plant samples, and calculations were carried out in accordance with the following methodological guidelines: "Metodika polevykh opytov" (Dospekhov, 1985), "Metodika gosudarstvennogo sorta ispytaniya selskokhozyaystvennykh kultur" (1964), and "Methods for conducting field experiments" (2007).

The total and mobile forms of humus, nitrogen, phosphorus, and potassium in the soil were determined using the methodological manuals: "Methods of agrochemical, agrophysical, and microbiological research in irrigated cotton-growing regions" (1963) and "Methods of agrochemical analysis of soils and plants in Central Asia" (1977)..

Experimental Results

The obtained data show that at all growth stages of cotton, the amount of ammonium nitrogen in the soil was higher than that of nitrate nitrogen. For example, during the early 2–4 true leaf stage of cotton, when mung bean was used as the preceding crop and fertilized at a rate of $N_{30\text{-}60}P_{80}K_{60}$ kg/ha, and cotton was fertilized with mineral fertilizers at a rate of $N_{160}P_{100}K_{75}$ kg/ha, the mineral nitrogen ($N\text{-}NH_4^+$ + $N\text{-}NO_3^-$) content in the 0–30 cm soil layer was 15.5 + 10.8 and 15.8 + 11.3 mg/kg, respectively. When cotton was fertilized at a higher rate of $N_{200}P_{140}K_{100}$ kg/ha, the levels were 16.4 + 11.0 and 17.0 + 12.1 mg/kg.

In contrast, when sunflower ($N_{120\text{-}180}P_{80}K_{60}$ kg/ha) was used as the preceding crop, the mineral nitrogen content in the cotton fields fertilized with $N_{160}P_{100}K_{75}$ and $N_{200}P_{140}K_{100}$ kg/ha was lower compared to those where mung bean had been grown. The values recorded were 10.6 + 9.7 and 11.0 + 10.4 mg/kg; 13.6 + 10.4 and 14.0 + 11.4 mg/kg, respectively.

The highest accumulation of mineral nitrogen in the soil was observed during the budding and flowering-fruiting stages of cotton, which is likely due to the application of mineral fertilizers during this period.

During the flowering-fruiting stage, in the variant where mung bean was used as the preceding crop and fertilized at $N_{30\text{-}60}P_{80}K_{60}$ kg/ha, and cotton was fertilized at $N_{160}P_{100}K_{75}$ kg/ha, the mineral nitrogen content in the 0–30 cm soil layer was 26.5 + 22.3 and 28.2 + 24.6 mg/kg. When the fertilization rate was increased to N200P140K100 kg/ha, the content was higher by 1.7 + 1.4 and 1.8 + 1.4 mg/kg compared to the lower fertilization rate.

The amount of mineral nitrogen in the soil under cotton grown after sunflower (preceding crop), when fertilized at $N_{160}P_{100}K_{75}$ (26.3 + 21.6 and 26.0 + 22.3 mg/kg) and $N_{200}P_{140}K_{100}$ (27.7 + 22.1 and 28.0 + 23.7 mg/kg) kg/ha, was lower than in variants 1–4 of the experiment, which can be directly linked to the type of preceding crop used (see Table 1).

Table 1

Mineral nitrogen accumulated in the plow layer (0-30 cm), mg/kg (2023)

			$N\text{-}NH_4$	$N\text{-}NO_3$	

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Order of variants	Applied mineral fertilizer to the preceding crop, kg/ha	Applied mineral fertilizer to cotton, kg/ha	05. VI	10. VII	25. VII	14. IX	05. VI	10. VII	25. VII	14. IX	Yield, t/ha
1	Mung bean $N_{30}P_{80}K_{60}$	$N_{160}P_{100}K_{75}$	15,5	22,7	26,5	12,3	10,8	20,5	22,3	10,5	3,33
2		$N_{200}P_{140}K_{100}$	16,4	27,0	28,2	12,7	11,0	22,5	23,7	11,2	3,40
3	Mung bean $N_{60}P_{80}K_{60}$	$N_{160}P_{100}K_{75}$	15,8	24,5	28,2	14,0	11,3	21,4	24,6	11,4	3,39
4		$N_{200}P_{140}K_{100}$	17,0	27,6	30,0	13,3	12,1	23,2	26,0	12,8	3,46
5	Sunflower $N_{120}P_{80}K_{60}$	$N_{160}P_{100}K_{75}$	10,6	21,3	26,3	11,2	9,7	19,2	21,6	9,2	2,88
6		$N_{200}P_{140}K_{100}$	13,6	25,6	27,7	11,9	10,4	20,8	22,1	9,6	3,01
7	Sunflower $N_{180}P_{80}K_{60}$	$N_{160}P_{100}K_{75}$	11,0	22,7	26,0	12,4	10,4	20,7	22,3	10,0	3,15
8		$N_{200}P_{140}K_{100}$	14,0	26,8	28,0	12,4	11,4	21,4	23,7	10,4	3,27

In the study, following the autumn wheat crop, mung bean was grown as a repeated crop and fertilized with N30P80K60 kg/ha. Cotton sown the following year and fertilized at a rate of N160P100K75 kg/ha yielded 33.3 centners/ha. When the fertilization rate was increased to N200P140K100 kg/ha, the yield reached 34.0 centners/ha, an increase of 0.7 centners/ha.

Although the above pattern was also reflected in the field where mung bean was fertilized with mineral fertilizers at a rate of N60P80K60 kg/ha, compared to the field where mung bean was fertilized with mineral fertilizers at a rate of

$N_{30}P_{80}K_{60}$ kg/ha ($N_{160}P_{100}K_{75}$ and $N_{200}P_{140}K_{100}$ kg/ha), it amounted to 33.9 and 34.6 c/ha, respectively.

After sowing sunflower as a repeated crop ($N_{120}P_{80}K_{60}$ kg/ha), in the variants where cotton was fertilized with mineral fertilizers at a rate of $N_{160}P_{100}K_{75}$ and $N_{200}P_{140}K_{100}$ kg/ha, the raw cotton yield was 28.8 and 30.1 c/ha, and in the variants where cotton was fertilized with mineral fertilizers at a rate of $N_{160}P_{100}K_{75}$ and $N_{200}P_{140}K_{100}$ kg/ha in the areas of the repeated crop - sunflower ($N_{180}P_{80}K_{60}$ kg/ha), these indicators were 31.5 and 32.7 c/ha..

Conclusion. In the south of the Republic of Karakalpakstan, in short-rotation crop rotation systems, the use of mineral fertilizer rates based on scientifically and practically substantiated recommendations is an effective measure, which positively affects the predominance of the ammonium form of nitrogen in the soil compared to the nitrate form.

The highest indicators of cotton yield (34.0-34.6 c/ha) were observed in the variants where cotton was fertilized with mineral fertilizers at a rate of $N_{200}P_{140}K_{100}$ kg/ha in the areas sown with repeated crops (mung bean $N_{30\text{-}60}P_{80}K_{60}$ kg/ha).

When obtaining an economically inexpensive yield of cotton in the prescribed amount while preserving soil fertility, the use of short-rotation crop rotation is an effective agrotechnical measure, in which it is recommended to sow mung beans after winter wheat as a preceding crop for cotton.

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