Volume 4, Issue 4, April - 2026
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

NUTRIENT DYNAMICS IN SAND

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Abstract
Research results show that nitrogen losses in the form of nitrates are particularly high in irrigated fields and depend significantly on the soil texture and the rate and timing of irrigation. The nitrogen, phosphorus, and potassium content of the soil fluctuate during the growing season.

Keywords: Nutrients, soil, vegetation, fine earth, sand.

Introduction

The hydrophysical properties of the soil significantly influence the fixation, movement, retention, and availability of nutrients. Losses of nitrogen and potassium can average 30.2-77.4 kg/ha per year. [1] According to [the authors], vertical migration of nutrients reaches 2-3 m. Based on their research, high irrigation rates at long intervals lead to the leaching of significant amounts of NO3 beyond the root zone. With more frequent and reduced irrigation, NO3 migration slows, and it remains within the root zone for a longer period, reducing its loss.

With a balanced application of fertilizers and watering, plant roots absorb nutrients more efficiently, leaving little in the soil to wash out.Nutrient migration in soil was studied. In bare plots, 83.3-91.7% of nitrogen is lost through leaching, denitrification, and possibly NH3 volatilization. In sown plots, nitrogen migration is less pronounced. Nitrate leaching from the 1.8-meter soil layer is greater than that detected at a depth of 1.8-6.2 meters. Research results show that nitrogen losses in the form of nitrates are particularly high in irrigated fields and depend significantly on the mechanical composition of the soil and the rate and timing of irrigation. The content of nitrogen, phosphorus, and potassium in the soil changes during the growing season. Typically, their highest levels occur at the beginning and middle of the growing season, decreasing towards the end due to intensive use by plants. In our experimental plot with an artificial screen, the lowest levels of nutrients were found in the control plot. The addition of fine earth significantly increases nutrient content throughout the profile. The increase is directly proportional to the fine earth rate. The highest nutrient content was observed in the variant with 1,000 t/ha of fine earth. It should be noted that the created screen acted as a film, helping to retain nutrients. The greatest amount of nutrients was concentrated in the layer where the artificial screen was created. It was found that in the variant with 400 t/ha of fine earth applied with plowing to a depth of 70 cm, the nitrate nitrogen content in the 60-70 cm layer was 12.2 mg/kg on the third day after irrigation, whereas with an increase in the fine earth rate to 1,000 t/ha, this figure was 24.4 mg/kg. Nutrient migration in the experimental plot with natural soil was similar. The minimum amount of nutrients in all phases of cotton development was found in the variant with the addition of N 250, P 150, K

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170 kg/ha and sand thickness of 0-110 (130) cm4.

Application of increased rates of mineral fertilizers leads to an increase in nutrient elements throughout the profile. The indicator also increases with decreasing sand thickness. The maximum nutrient elements were revealed in the variant with the application of N 350, P 250 and K 170 kg/ha and a sand thickness of 0-50 (75) cm. The nitrate nitrogen content in this variant on the 3rd day after watering during the flowering phase (1984) in the layers of 0-30, 30-40, 40-60, 60-70, 70-100 cm was 9.2; 7.9; 6.3; 7.7; 8.2 mg/kg. The minimum N - NO3 is observed in the control, i.e. where there is no screen. This pattern persists until the end of the cotton growing season and in subsequent years of the study.

Plant growth and development depend on numerous factors: nutritional conditions, soil moisture, ambient temperature, agrophysical, agrochemical, and microbiological properties of the soil, as well as the level of mineral nutrition. The creation of an artificial screen had a positive effect on cotton growth and development. Cotton seedling emergence dynamics in both experimental plots (Table 1.2) were uniform across all treatments and years of study. Phenological observations of cotton growth and development during the growing season in the experimental plot showed that cotton lagged in growth and development in the control plot. With the creation of an artificial screen, cotton plants in the treatments with fine earth ploughed to a depth of 40 cm had an advantage in growth and development, surpassing those in the treatments with fine earth ploughed to a depth of 70 cm (Tables 1-2).

Table 1 Dynamics of emergence of seedlings depending on the depth of the screen on the sand, %

Experimental option	First year			Second year		
	4.05	9.05	13.05	16.05	18.05	22.05
Control	23.1	57.4	89.6	33.6	65.7	93.3
Screen depth is 40 cm						
400 t/ha	32.7	62.5	91.4	29.5	53.2	91.8
600 t/ha	29.8	57.9	93.6	35.2	52.8	93.6
800 t/ha	36.2	59.2	92.8	36.4	61.8	94.3
1000 t/ha	26.3	64.8	95.3	33.7	57.3	95.7
Screen depth is 70 cm						
400 t/ha	31.5	52.8	87.4	29.8	62.5	92.8
600 t/ha	29.6	57.4	92.6	32.5	57.9	91.3
800 t/ha	33.7	62.5	94.8	37.4	64.7	94.7
1000 t/ha	35.2	59.6	93.8	35.8	62.9	96.5

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webofjournals.com/index.php/8

In the variant with 1,000 t/ha of fine earth applied to a depth of 40 cm, cotton growth by August 1 was 56.8 cm, while with the same fine earth rate but plowing to a depth of 70 cm, it was 52 cm, compared to 24.3 cm in the control. However, by mid-August, cotton growth and development in the variants with fine earth plowing to a depth of 40 cm ceased, while growth and development in the variants with fine earth plowing to a depth of 70 cm began to noticeably increase. Based on boll count by September 1, the variant with 1,000 t/ha of fine earth applied to a depth of 70 cm stood out. This variant had 5.8 bolls, while with the same fine earth rate but plowing to a depth of 40 cm, the number of bolls was 5.7. This is obviously due to the fact that in the early stages of development, plants in variants with a screen depth of 40 cm received more nutrients.

Furthermore, the moisture contained in this layer was more accessible, as the root system had not yet developed. However, toward the end of the growing season, when cotton absorbs maximum nutrients and leaf area and evaporation increase, an advantage was noted in the variants with fine soil tilled to a depth of 70 cm. The superior hydrophysical properties of the soil, as well as the relatively higher nutrient content during the growing season, resulted in better cotton growth and development in these variants toward the end of the growing season. The same pattern was observed in subsequent years of research.

In the experimental plot with natural soil, the treatments with higher rates of mineral fertilizers were superior throughout all study years. Treatments with deep soil also showed significant differences. The optimal treatment was the one in which we applied N-350, P-250, and K-170 kg/ha at a screen depth of 0-50 (75) cm.

If the main stem height on August 1 in the variant with N 350, P 250, K 170 kg/ha at a soil depth of 0-110 (130) cm was 66.6 cm, then at a soil depth of 0-50 (75) cm with the same rates of mineral fertilizers, this figure increased to 74.2 cm. A similar pattern was observed when collecting capsules on September 1. The actual density of the planting in the experimental plots was recorded once a year at the end of the growing season before harvesting.

Summarizing the results of cotton growth and development observations, it can be noted that the addition of fine soil promotes better growth and development of cotton. This is due to improved water and nutrient status of the sands and good root development.

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Table 2 Phenological observations on an experimental plot with an artificial screen

Var.	June		August						September	
				quantity					quantity	
	height of the main stem, cm	number of sheets	height of the main stem, cm	sympodians	buds	flowers	ovaries	boxes	boxes	of which opened up
1	2	3	4	5	6	7	8	9	10	11
First year										
Cont.	9.1	3.4	25.3	3.6	2.5	0.4	0.3	-	2.8	-
Plowing to a depth of 40 cm										
400 t/ha	13.4	5.0	50.8	7.3	7.2	1.0	0.9	0.5	3.1	-
600 t/ha	14.6	5.1	51.6	7.9	6.4	1.1	1.3	0.9	3.2	-
800 t/ha	15.5	5.5	51.0	7.7	6.7	1.0	0.9	0.5	3.8	-
1000 t/ha	17.1	6.2	65.3	9.4	6.9	1.4	1.2	1.5	5.6	-
Plowing to a depth of 70 cm										
400 t/ha	14.5	5.0	28.5	3.6	2.8	-	-	-	3.1	-
600 t/ha	15.3	5.4	30.9	4.0	3.6	-	-	-	3.6	-
800 t/ha	15.8	5.4	50.3	7.3	6.2	0.3	0.9	-	4.5	-
1000 t/ha	17.1	6.1	50.6	7.4	5.8	1.4	038	0.3	5.5	-
1	2	3	4	5	6	7	8	9	10	11
Control	18.1	7.3	24.3	4.2	3.9	0.5	0.5	0.5	2.9	-
Plowing to a depth of 40 cm										
400 t/ha	18.9	7.6	48.8	6.8	6.1	0.8	0.6	0.6	3.2	-
600 t/ha	19.9	8.1	50.4	7.1	6.3	0.9	0.7	0.7	3.5	-
800 t/ha	19.6	7.8	51.4	7.2	6.5	1.0	0.7	0.7	4.1	-
1000 t/ha	20.8	8.2	56.8	8.5	7.6	1.1	0.9	0.8	5.7	-
Plowing to a depth of 70 cm										
400 t/ha	19.4	7.8	28.7	4.7	4.0	0.6	0.5	0.5	3.7	-
600 t/ha	19.4	7.6	31.1	5.3	5.1	0.7	0.5	0.6	4.2	-
800 t/ha	20.2	7.7	52.4	7.3	6.7	0.8	0.6	0.8	4.5	-
1000 t/ha	20.1	7.6	52.0	7.2	6.7	0.9	0.6	0.7	5.8	-

Conclusion

The results of the study show that, under sandy soil conditions, the mobility of nutrient elements—especially nitrate nitrogen—is directly influenced by irrigation regime, soil texture, sand layer thickness, and mineral fertilizer rates. Due to the high water permeability of sandy soils, nitrogen, phosphorus, and potassium can migrate from the root zone into deeper soil layers, which reduces nutrient availability for plants and negatively affects soil fertility.

The experimental findings indicate that the formation of an artificial screen using fine-textured soil has a positive effect on nutrient retention within the soil profile. As the application rate of fine earth increased, the content of nitrate nitrogen and other nutrient elements also rose. The highest efficiency was observed in the treatment where **1,000 t/ha of fine earth** was applied, confirming that this method is an effective ameliorative practice for improving the water-physical and agrochemical properties of sandy soils.

The depth of the artificial screen also had a differentiated effect on cotton growth and development. At the early stages of vegetation, the screen formed at a depth of **40 cm** created more favorable moisture and nutrient conditions for young plants. However, toward the end of the growing season, the screen formed at a depth of **70 cm** showed greater effectiveness. This pattern is associated with the development of the cotton root system and its increased ability to use moisture and nutrient reserves from deeper soil layers during later phenological stages.

Under natural soil conditions, increasing the rates of mineral fertilizers improved both nutrient availability and cotton growth parameters. The most effective treatment was identified as the application of **N-350, P-250, and K-170 kg/ha** under conditions where the sand layer thickness was **0–50/75 cm**. In this variant, plant height, formation of yield components, and overall growth intensity were higher compared with the other treatments.

In general, the combined application of fine earth, the creation of an artificial screen, and the use of scientifically justified mineral fertilizer rates reduce nutrient leaching, improve the water and nutrient regime of sandy soils, and create favorable agroecological conditions for cotton growth and development. Therefore, the integrated use of these agrotechnical and ameliorative measures in irrigated sandy and light-textured soils has significant scientific and practical importance for maintaining soil fertility, increasing fertilizer-use efficiency, and achieving stable crop productivity.

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