Changes of Nutritive Elements in Soils That Medium-Supplied With Phosphorus, Depending on Fertilizers Used in Cotton Agrocenosis

Djurakul Sattarov*, *Samad* Mahammadiev, and *Dilafruz* Makhkamova

National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan

Abstract. The aim is to increase the mobile nutrient content in the soil by applying optimal nitrogen and potassium fertilizers without the use of phosphorus fertilizers on irrigated typical gray soils moderately supplied with mobile phosphorus. Significant differences are observed in the amount of mobile phosphorus in the soil from the beginning and till the end of the vegetation. It ranged between 24.28-27.15 mg / kg in the driving layer and between 15.20-19.05 mg / kg in the sub-driving layer. The amount of N-NO3 increased during the vegetation to 29.1-34.4 mg / kg in the driving layer, N-NH4 in the driving layer changed to 3.1-4.2 mg / kg. Exchangeable potassium was found to fluctuate between 148.72–177.82 mg / kg in the driving layer at the end of the vegetation period and varied between 179.2–182.75 mg / kg in the sub-driving layer.
Keywords: Soil, plant, new, mineral fertilizer, nitrogen, phosphorus, potassium, mobile, nitrate.

1 Introduction

It is possible to increase the rate of agricultural production and to produce high quality products by increasing highly using of soil resources by reducing labor and cost [1,2,3]. It is also necessary to make efficient use of mobile phosphorus reserves in the soil at a time that the cost of phosphorus fertilizers is increasing [4,5]. This is due to the fact that, 15-30 t / ha of various phosphorus compounds of $Ca_3(PO_4)_2$ were found in the driving layer of the gray soils of Uzbekistan. These amounts allow to grow cotton without the use of phosphorus fertilizers for several decades [6].

The utilization rate of nutrients in the soil depends on the genetics, mechanical composition and other factors of the soil. In micro-field experiments conducted by the all Union Institute of Fertilizers and Agro-Soil Science, it was found that the coefficient of use of phosphorus fertilizers varies from 20 to 7% [7].

Chemical analysis of the soil revealed that a certain amount remains in the soil due to the full release of mobile phosphorus and the plant's own assimilation. It is known that more than 10% of the mobile phosphorus in the soil is absorbed. This amount is variable and is influenced by the level of soil supply, mechanical composition, acidity, calcium, iron and other factors.

* Corresponding author: samad3182@mail.ru

A favorable environment must be created in the soil for the cultivation of agricultural crops [8]. To do this, the soil must be enriched with these nutrients or make effective use of existing ones. Plants have different demands on the nutrient environment due to their biological properties. Their diet should contain macro and micro elements in known quantities and proportions. In particular, the latter should prevail.

The use of nitrogen fertilizers not only improves the nitrogen regime in the soil, but also increases the amount of mobile phosphorus in the soil. The use of phosphorus fertilizers increases the nitrification of nitrogen in the soil [9].

Therefore, it is necessary today to develop a basis for the effective use of mobile phosphorus in the soil by applying nitrogen and potassium fertilizers in optimal ratios. This is due to the fact that, in some cases, farmers try to get the harvest without the use of phosphorus fertilizers.

2 Materials and methods

Field experiments were conducted in 2021 on cotton S-711 variety. In the experiment carbamide containing 46% pure nitrogen as a nitrogen fertilizer and 60% KCl salt as a potassium fertilizer were used.

Field experiments are carried out according to the methods described in Dospekhov's manual "Methods of field experiments" [10]. The field experiment scheme included 5 variants. The variants differ in the amount and ratio of mutual nitrogen and potassium. The experiment was studied in 3 repetitions and 5 different diets. In the experiment, each located variant was 10 m long and 4.2 m wide, with a surface of 42.0 m2, a calculated area of 28.0 m2, and the variants that were systematically arranged in a single tier.

Experimenting, conducting biometric observations, taking soil and plant samples, determining various compounds of nitrogen, phosphorus, potassium in them by the methods given in "Methods of agrochemical, agrophysical and microbiological research in irrigated cotton areas" the manual of the Uzbek Cotton Institute, determining mobile nitrogen (nitrates) was carried out by the Gramvald-Lyaju method, mobile phosphorus and potassium carried out in 1% solution of ammonium carbonate by B.P.Machigin [11], P.V.Protasov [12] methods [13-14].

The soils of the Botanical Garden of the National University of Uzbekistan are typical gray soils that have been irrigated for a long time.

3 Results and discussion

Dynamics of mobile phosphorus. Mobile phosphorus is one of the factors that determine soil fertility [15]. According to K.E.Ginzburg et al. [16], the level of uptaking phosphorus for plants depends on the chemical, physicochemical, physical properties of the soil, water regime, air and heat regime, biological activity, type of agricultural and horticultural crops and etc. [17]

S.A.Kudrin [18-19]; M.V.Kaziev [20]; B.P.Machigin [11] and others [21-22] conducted the research on seasonal variation and migration of phosphorus. They found that as a result of constant and long-term application of phosphorus fertilizers, phosphorus accumulate not only in the driving layer, but also in the sub-driving layers. In the development of cotton, changes in mobile phosphorus increased during the summer and decreased at the end of the vegetation, to be precise in autumn.

We conducted our research on typical irrigated gray soil conditions. Analyzing the data obtained, it was found that in the control variant, the amount of mobile phosphorus before sowing in the driving layer was 31.3 mg / kg, while in the sub-driving layer it was 19.8 mg

/ kg. Fertilizers were not applied in this variant, it can be said that the amount of mobile phosphorus changed under the influence of the natural reaction of the soil (Table 1).

The amount of mobile phosphorus in the soil fluctuated between 31.3-31.8 mg / kg before planting, while in the subsoil layer it fluctuated between 19.8-20.9 mg / kg. In this case, samples were analyzed separately for each variant.

Table 1. Changes in the amount of mobile phosphorus under the influence of fertilizers in gray soils with a moderate-supplied mobile phosphorus, mg / kg

№	Variants	Layer depth, см	P_2O_5	
			Before sowing	At the end of vegetation
1.	Control	0-30	31,3	27,15
		30-50	19,8	19,05
2.	$N_{150}K_{75}$	0-30	31,8	24,28
		30-50	20,1	15,20
3.	$N_{150}K_{100}$	0-30	32,0	24,73
		30-50	20,9	17,65
4.	$N_{200}K_{100}$	0-30	31,7	25,65
		30-50	19,6	17,52
5.	$N_{200}K_{150}$	0-30	31,5	24,28
		30-50	20,6	18,82

At the end of the vegetation, significant differences in the amount of mobile phosphorus are observed. It ranged between 24.28-27.15 mg / kg in the driving layer and between 15.20-19.05 mg / kg in the sub-driving layer. This may have been influenced by the variety of variants. The lowest figure was 24.28 mg / kg in variant 2, and the highest was recorded in the control variant as 27.15 mg / kg. In variants 3, 4, and 5, both figures were average.

Phosphorus accumulation occurs mainly in the upper horizons, but in some cases it also occurs in the lower horizons. According to Larsen, it occurs when high water pressure applied, the cause of diffusion and as a result of microorganisms.

In our study, it was found that under the influence of cotton, the mobile phosphorus reserves of the soil are reduced from the driving and sub-driving layers. So this corresponds to the opinion of scientists [23-24].

Dynamics of mobile nitrogen. The high biological activity of Central Asian soils, high temperature, sufficiently moistened (irrigated) soils for most of the year, and richness of carbon salts lead to rapid disruption of gas exchange. The microorganisms in these soils are significantly abundant in the upper layers, so the organic mass is "burned" - decomposed into CO2, NO3-, PO43-, SO42-. This process plays an important role in the presence of nutrients in the soil.

According to S.A.Kudrin, N.K.Balyabo [25], P.V.Protasov [26], G.I. Yarovenko [27-28] and other authors reports that mineral nitrogen occurs in gray soils as a nitrate. Their amount fluctuates on a large scale depending on the years. Then the activity of nitrifying bacteria in winter decreases [29]. It rises slowly in early spring. It reaches its highest peak in summer.

Nitrates are quickly washed into the lower layers of the profile because they are well soluble in water. Changes in mobile nitrate and ammonium nitrogen in irrigated typical gray soils were studied in 2021-2022 on the basis of field experiments conducted with cotton variety C-711. The data obtained are presented in Table 2. Based on our goal, the amount of mobile nitrogen was determined at the end of the vegetation and before planting [30].

In the control variant, before planting, N-NO_3 was 28.32 mg/kg in the driving layer, 5.1 mg/kg in the sub-driving layer, N-NH_4 3.2 mg/kg in the driving layer, and 2.2 mg/kg in the sub-driving layer. At the end of the vegetation, N-NO_3 was 8.23 mg / kg in the driving layer, 4.36 mg/kg in the sub-driving layer, N-NH_4 8.5 mg/kg in the driving layer, and 1.6 mg/kg in the sub-driving layer.

In variant 2, that nitrogen fertilizers were applied at a rate of 150 kg/ha, it was found that the amount of N-NO3 in the driving layer was 28,21 mg/kg and 6,3 mg/kg at the end of vegetation and it was decreased 5 to 3,9 mg/kg in the sub-driving layer. Nitrogen in the form of N-NH_4 decreased to 2.6–1.3 mg / kg at the end of the vegetation in the driving layer, and to 2.2–1.2 mg / kg in the sub-driving layer. However, it was confirmed that nitrogen of nitrate reduced more than nitrogen of ammonium.

Table 2. Changes in the amount of mobile nitrogen under the influence of fertilizers in gray soils with a moderate-supplied mobile phosphorus, mg / kg

№	Variants	Layer depth, см	Before sowing		At the end of vegetation	
			N-NO_3	N-NH_4	N-NO_3	N-NH_4
1.	Control	0-30	28,32	3,2	8,23	2,5
		30-50	5,1	2,2	4,3	1,6
2.	$N_{150}K_{75}$	0-30	28,21	2,6	6,3	1,3
		30-50	5,0	2,2	3,9	1,2
3.	$N_{150}K_{100}$	0-30	29,9	2,6	11,2	1,1
		30-50	6,0	1,9	2,1	1,3
4.	$N_{200}K_{100}$	0-30	28,76	3,7	3,1	4,8
		30-50	5,3	1,9	2,4	1,6
5.	$N_{200}K_{150}$	0-30	29,1	3,1	34,4	4,2

In variant 3, where $N_{150}K_{100}$ kg / ha fertilizers were applied, a different tendency was observed in the reduction of mobile nitrate nitrogen and ammonium nitrogen. The amount of N-NO_3 in the driving layer was 29.9, 11.2 mg / kg, respectively, before sowing and at the end of the growing season. In the sub-driving layer, 6.0, 2.1 mg / kg were recorded. It was found that it increased compared to the period before planting. Nitrogen content in the N-NH_4 form decreased to 26.2-1.1 mg / kg in the driving layer before planting and at the end of the vegetation, and to 1.9-1.3 mg / kg in the sub-driving layer.

In variant 4, that $N_{200}K_{100}$ kg / ha of fertilizers were applied, it was found that the amount of mobile nitrate increased by the end of the vegetation in the driving layer compared to the initial state (28.76-3.10 mg/kg), however, it was increased to 5,3-2.4 mg/kg in the sub-driving layer. It can be explained as this: This is probably due to the deterioration of the nitrogen-phosphorus ratio due to the sharp increase in the amount of nitrogen in the soil.

Increasing the amount of potassium by 50 kg / ha ($N_{200}K_{150}$ kg/ha) compared to variant 4 changed the amount of nitrate nitrogen and ammonium nitrogen in the soil. In this case, the amount of $N\text{-}NO_3$ during the vegetation in the driving layer was 29.1-34.4 mg / kg, while the increase in $N\text{-}NH_4$ was 3.1-4.2 mg / kg in the driving layer, it changed 1.7-2,7 in the sub-driving layer, respectively. In the soils of this variant, the condition of the above variant was also noted, to be precise mobile nitrogen was not assimilated. Their ratio plays an important role when plants assimilate all substances.

Dynamics of exchangeable potassium. In the typical irrigated gray soils the amount of potassium changed depending on the application of potassium fertilizers and soil properties. Soils that moderate-supplied with mobile phosphorus vary depending on the rate and proportion of NK fertilizer application. The data are presented in Table 3.

In the control variant, it was found that 187.9-177.82 mg / kg varied from the sub-driving layer to 192.3-182.75 mg / kg depending on the end of the vegetation before sowing in the driving layer.

Table 3. Altering of exchangeable potassium content in gray soils that moderate- supplied with mobile phosphorus by fertilizers influence, mg/kg

№	Variants	Layer depth, см	K_2O	
			Before sowing	At the end of vegetation
1.	Назорат	0-30	187,9	177,82
		30-50	192,3	182,75
2.	$N_{150}K_{75}$	0-30	186,3	148,72
		30-50	191,8	179,40
3.	$N_{150}K_{100}$	0-30	188,4	155,62
		30-50	190,9	181,07
4.	$N_{200}K_{100}$	0-30	186,8	160,61
		30-50	193,3	182,22
5.	$N_{200}K_{150}$	0-30	187,7	149,83
		30-50	192,6	182,47

In variant 2, that K_{75} kg/ha was applied before sowing in the driving layer changed between 186.3-148.72 mg/kg during the vegetation, while in the sub-driving layer of it fluctuated between 191.8-179.40 mg/kg.

In variant 3, where 100 kg/ha of potassium fertilizer was applied, it decreased between 188.4 and 155.62 mg/kg in the driving layer before sowing and at the end of the vegetation between 190.9 and 181.07 mg/kg in the sub-driving layer.

In variant 4, where K_{100} kg / ha fertilizer was applied, it was 186.8 mg / kg before sowing in the driving layer, 161.61 mg / kg at the end of the vegetation, and 193.3-182.22 mg / kg in the sub-driving layer.

It was found that the application of potassium fertilizer K_{150} kg / ha varied from 187.7 to 149.83 mg / kg in the driving layer and 192.6-182.47 mg / kg in the sub-driving layer.

If we compare between the variants, before sowing it was fluctuated between 186.3-188.4 mg / kg in the driving layer and 190.9-193.3 mg / kg in the sub-driving layer.

At the end of the vegetation, the rate was fluctuated between 148.72-177.82 mg / kg in the driving layer and 179.2-182.75 mg / kg in the sub-driving layer.

4 Conclusion

Significant differences in the amount of mobile phosphorus in the soil are observed from the beginning to the end of the vegetation. It was found that it varied between 24.28-27.15 mg / kg in the driving layer and between 15.20-19.05 mg / kg in the sub-driving layer. The lowest value was found to be 24.28 mg / kg in variant 2, and the highest value was recorded in the control variant as 27.15 mg / kg.

It was found that the amount of N-NO_3 increased during the vegetation to 29.1-34.4 mg / kg in the driving layer, while N-NH_4 changed to 3.1-4.2 mg / kg in the driving layer, respectively.

In terms of the amount of exchangeable potassium, it was found that at the end of the vegetation it fluctuated between 148.72-177.82 mg / kg in the driving layer and varied between 179.2-182.75 mg / kg sub-driving. The highest rates of potassium content in the soil were found to be the greatest decrease in the driving and sub-driving layer (Variant 2). This was found that it was decreased more than control (conditions where fertilizer was not applied). In conclusion, the norm and ratio of mineral fertilizers increase the mobility of nutrients.

References

1. E.A. Osadchy. Accounting and control of indirect costs of organization as a condition of optimizing its financial and economic activities. International Business Management, **9(7),** 1705-1709(2015). doi:10.3923/ibm.2015.1705.1709
2. B.A. Voronin, I.P. Chupina, Ya.V. Voronina, V.S. Kukhar, N.N. Simachkova. About agricultural products, raw materials and food with improved characteristics (scientific commentary on the Federal Law). IOP Conference Series: Earth and Environmental Science, **949(1),** 012025 (2022).
3. G. Singh, N. Kalra, N. Yadav, A. Sharma, M. Saini. Smart agriculture: a review. Siberian Journal of Life Sciences and Agriculture, **14(6),** 423-454(2022). doi: 10.12731/2658-6649-2022-14-6-423-454
4. V.A. Ionas, I.R. Wildflush, S.P. Kukresh. *Fertilizer system for agricultural crops*. (Minsk: Urajay, 1998).
5. E.N. Pasynkova, A.V. Pasynkov, S.A. Balandina. The effectiveness of mineral fertilizers in the cultivation of filmy and naked oats. Agro XXI. **10-12,** 36-39 (2012).
6. S. Makhammadiev, D. Sattarov, B. Atoev, Z. Jabbarov, B. Jobborov, M.M. Turgunov, K.G. Muydinov. The Formation of the Nutrient Medium in the Soil is Influenced by Varieties and Fertilizer and Its Impact on Grain Yield of Winter Wheat. Annals of the Romanian Society for Cell Biology, 5218–5230 (2021). URL: http://annalsofrscb.ro/index.php/journal/article/view/3072.
7. T.P. Pirakhunov. Phoophoric nutrition of cotton in various soil conditions: (Tashkent, Fan, 1977) 165.
8. O. Tsuglenok, M. Abushenkova, R. Akhmadeev, K. Tyupakov. Cluster as the basis for the sustainable functioning of enterprises in the agro-industrial complex. Siberian

Journal of Life Sciences and Agriculture, **15(1),** 416-434 (2023). doi: 10.12731/2658-6649-2023-15-1-416-434

9. B. Atoev, J. Kaypnazorov, M. Egamberdieva, S. Makhammadiev, M. Karimov, D. Makhkamova. Technology of nutriating winter wheat varieties in variety-soil-fertilizer system. E3S Web Conf. **244** 02040 (2021). doi: 10.1051/e3sconf/202124402040.
10. B.A. Dospekhov, B.A. Armor. *Methods of field experience.* (Moscow, Agropromizdat, 1985) 351.
11. B.P. Machigin. *Agrochemical properties of soils and the effect of fertilizers on the development of cotton. Scientific tr. /Union nihi*. (Tashkent., 1957) 172.
12. P.V. Protasov. *Nitrogen in cotton growing in Central Asia*. (Tashkent, 1961) 165.
13. I.M. Bogdevich. Agrochemical ways to improve the fertility of soddy-podzolic soils: dis. ... Dr. S.-x. sciences in the form of scientific. report - Minsk, 73 p. (1993).
14. V.G. Mineev. Agrochemistry: Textbook. (2nd ed.), Perer. and add. Moscow: Publishing House of Moscow State University, (Publishing House "Kolos", 2004) 520-545.
15. B.N. Nasiyev. The role of organic fertilizers in increasing the fertility of west kazakhstan soils, Polish Journal of Soil Science, **46(2),** 115-146 (2013).
16. K.B. Ginzburg. Phosphorus in the main types of soils of the USSR. (Moscow, Science, 1981) 8, 242.
17. L.A. Gafurova, R.M. Madrimov, A.M. Razakov, G.M. Nabiyeva, D.Y. Makhkamova, T.R. Matkarimov. Evolution, transformation and biological activity of degraded soils. International Journal of Advanced Science and Technology, **28(14),** 88-99 (2019).
18. S.A. Kudrin. Agrochemical characteristics of the soils of Uzbekistan. In the book: Soils of the Uzbek SSR. (Vol. I.) Tashkent, 294-315(1949).
19. S.A. Kudrin. Phosphorus in gray soils. Izd.AN UzSSR, 97-108 (1947).
20. M.Z. Kaziev. On the question of the forms of phosphorus in gray soils: Docks. VASKHNIL, **17**, 23-24 (1940).
21. T.P. Pirakhunov. Phosphorus nutrition of the cotton plant and ways to improve it in various soil conditions. Abstract … Doctor of Agricultural Sciences (Moscow, 1977) 47.
22. V.A. Prudnikov. Provision of soil with phosphates and efficiency of phosphorus fertilizer / V.A. scientific articles / National Academy of Sciences of Belarus, Research Center for Agriculture of the National Academy of Sciences of Belarus, Institute of Flax. (Minsk: Belarusian science, 2015) 101-111.
23. R.I. Sharafutdinov, V.O. Gerasimov, A.V. Yumashev, A.V. Pavlyuk, T.V. Luzina. Inclusive growth index assessment in the regions of the Volga Federal District of the Russian Federation. Paper presented at the Proceedings of the 31st International Business Information Management Association Conference, IBIMA 2018: Innovation Management and Education Excellence through Vision 2020, 3890-3902 (2018).
24. E.M. Akhmetshin, R.H. Ilyasov, E.A. Sverdlikova, A.A. Tagibova, A.V. Tolmachev, A.V. Yumashev. Promotion in emerging markets. European Research Studies Journal, **21**(Special Issue 2), 652-665 (2018).
25. N.K. Balyabo. *Agrochemical characteristics of soils*. (Moscow, 1961) 291.
26. P.V. Protastov. Fertilisers and harvest. (Taskent: "Mehnat", 1969).
27. G.I. Yarovenko. Physiological and agrochemical bases for increasing the efficiency of nitrogen fertilizers in cotton growing. Tashkent: Uzbekistan. 282 p. (1969).

28. B. Nasiyev, A. Dukeyeva. Influence of Mineral Fertilizers and Methods of Basic Tillage on the Yield and Oil Content of Sunflower, OnLine Journal of Biological Sciences, **23 (3),** 296-306 (2023). doi: 10.3844/ojbsci.2023.296.306
29. J.S. Sattarov, S.K. Makhammadiev. Interaction of varieties of winter wheat and fertilizers on old irrigated typical gray soil. Journal of Plodorode, **2(89),** 17-20 (2016).
30. N.V. Zakharchenko, S.L. Hasanov, A.V. Yumashev, O.I. Admakin, S.A. Lintser, M.I. Antipina. Legal rationale of biodiversity regulation as a basis of stable ecological policy. Journal of Environmental Management and Tourism, **9(3),** 510-523 (2018). doi:10.14505/jemt.v9.3(27).11