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ORIGINAL ARTICLE

Effect of different ratios of chemical fertilizers on cotton yield (*Gossypium hirsutum* L.)

M.M. Darmanov*, **S.E. Narmatov, N.R. Rahmatova, R.R. Akhmedov, Kh.A. Ubaydullaeva, A.S. Imamkhadjaeva, M.S. Ayubov, Z.T. Buriev**

Center of Genomics and Bioinformatics of the Academy of Sciences, Republic of Uzbekistan

**Corresponding author E-mail: muxtordarmanov@gmail.com*

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Cotton is one of the most important cash crops in the world. Cotton plants cultivated in more than 80 countries around the world within 30 million hectares of land. In recent years, global climate change, shrinking water resources, deteriorating reclamation of arable land, and growing demand for food have led to a reduction in cotton plantations. At the same time, this requires new approaches for cotton cultivation. In particular, it is necessary to develop and implement new fertilization standards/methods. It needs research on the achievements of modern science. In this article, data were obtained by treating the Porlok-4 cotton variety with various ratios of chemical fertilizers and their effect on yield and other agronomic characteristics. The Porlock-4 were fertilized with chemical fertilizers in 3 different ratios (NPK 1:0,7:0,5, NPK 0,7:1:0,5 and control) and observed during vegetative period. According to the observation, the yield and other agronomic characteristics in the variant NPK 0,7:1:0,5 showed a higher yield compared to the control sample when the ratio was NPK 1:0,7:0,5.

Keywords: Cotton, fertilizers, yield, vegetative period.

Introduction

The use of fertilizers is the main cost item in cotton growing. Fertilizers account for 50% of the cost of growing cotton. It is an effective way to provide the growing crops with essential nutrients. Nitrogen (N) is essential for plant growth and development because it is one of the main components of amino acids and proteins. Potassium is essential to cotton for characteristics such as early flowering, early ripening, increased yield, and fiber quality. Early maturing cotton varieties have a higher demand for potash fertilizers than late maturing cotton varieties. That is, potassium deficiency in early maturing genotypes leads to negative consequences. Lack of phosphorus in cotton leads to stunted growth, thick green leaves, necrosis of flower buds, and yellowing of old leaves. Phosphorus deficiency directly leads to growth buds, a decrease in nitrogen and magnesium absorption, and a slowdown in plant growth.

Nitrogen (N) is the most abundant essential mineral in plants, accounting for 1.5% to 2% dry matter in plants and approximately 16% plant protein (Frink, C.R., et al., 1999). Thus, the presence of nitrogen is a key factor in plant growth and productivity. Plants can use a wide range of volatile types of ammonia (NN_3), nitrogen oxide (NO_2), mineral (NO_3 and NN_4), and organic (amino acid, peptide) nitrogen (Von Wirén, N., et al., 2000). However, nitrate (NO_3) is the most important source of nitrogen in soils grown by many crops (Crawford, N.M., et al., 1998). Due to the high nitrogen demand of plants for growing crops, nitrogen fertilizers are the most widely used in agriculture worldwide, with 80 million tons of nitrogen fertilizers (in the form of nitrate or ammonia) being used annually (Frink, C.R., et al., 1999). The widespread use of nitrogen fertilizers in agriculture also has negative environmental consequences since two-thirds of the nitrogen used is saved, and undigested nitrogen can subsequently pollute the environment (Frink, C.R., et al., 1999).

Due to the high cost of using nitrogen fertilizers in agriculture and the harmful effects of nitrogen fertilizers on the environment, it is necessary to develop a strategy to reduce nitrogen use while maintaining productivity. Complete knowledge of the molecular and physiological bases of nitrogen absorption and metabolism in plants allows us to define the above strategy. The accumulation of nitrates in plants is strictly regulated by many means of transport and metabolic pathways (Crawford, N.M., 1995), and several genes associated with the assimilation and assimilation of nitrates have also been identified and described (Forde, B.G., 2000).

Research on several different crop species has focused on determining the relationship between leaf SPAD values and plant N content at different growth stages. This information can be used to quickly and accurately diagnose the N requirements of a crop and allow for appropriate levels of N fertilizer application.

The increase in agricultural production is influenced by various biotic and abiotic stresses and can be reduced by nutrient management. Potassium (K) is one of the main micronutrients required for plants and is involved in many physiological and biochemical processes that affect plant growth and development. Potassium significantly contributes to reducing biotic or abiotic stresses, and its deficiency increases the severity of these stresses (Wang, M., et al., 2013). The functions of potassium in plants are to maintain the balance of cell membranes, maintain osmotic pressure, regulate water binding, activate enzymes, and combat biotic and abiotic stresses. Potassium is required in large quantities when fertilizing crops such as cotton. Potassium plays an essential role in ensuring drought resistance of plants, participating in processes such as water flow and osmotic pressure in plant cells (Tsonev, T., et al., 2011).

To increase the productivity of each crop, cultivating crop varieties using individual, integrated approaches is one of the most pressing problems facing agriculture. For each variety, the characteristics of this variety, the development of new approaches, and methods based on the climatic conditions of the soil in which it is grown are of scientific importance.
Today, using new methods of fertilizing cotton varieties is important to study the need for mineral fertilizers for these cotton varieties at the molecular level (changes in gene expression) and NPK rates and the level of influence of mineral fertilizers applied to this variety.

Materials and Methods

The cotton variety "Porlock-4" was developed based on RNA interference technology (gene knockout) and by crossing with the local variety Namangan-77 and the unicellular line Cocker-312.

Field studies

Field experiments were conducted at an experimental farm at the Center of Genomics and Bioinformatics, Academy of Sciences, Republic of Uzbekistan, in 2020. In the field studies, cotton varieties "Porlock-4" were fertilized in 3 different ratios (NPK 1:0,7:0,5, NPK 0,7:1:0,5 and control) and performed in 3 replications.

Morpho-biological observations and laboratory analysis

During the cotton growing season, phenotypic observations were carried out at the flowering stage until 50% of the plants bloomed, and 50% of the buds opened. In addition, laboratory tests were implemented to measure the fiber length and yield and weight of 1000 seeds in the collected samples.

SPAD analyzes

Were done in 3 replicates in 30 plants in each replication. The number of chlorophylls was measured with SPAD-502 on fully formed leaves in the upper tier of the cotton plant. Statistical analysis of the data was performed using the Mann-Whitney test and t-Student's test method.

Results

During the study, the cotton variety Porlock-4 was planted in three biological replications, *in vivo*, morphobiological observation (50% of plants before flowering and 50% of buds before opening) and laboratory analysis of cotton yield (fiber length, fiber yield, 1000 seeds weight and yield) was held. Early flowering in this variant of phosphorus fertilizer when feeding N-250, P-175, K-125 kg/ha, N-175, P-250, K-125, and control (without fertilization), as a rule, with mineral fertilizers of Porlock-4 cotton cultivar, early opening boll was observed (Table 1).

S. No	Options	Flowering 50% (in a day)	Opening of bolls 50%. (in a day)
1	NPK 1:0,7:0,5,	56 ± 1,0	120 ± 3,0
2	NPK 0,7:1:0,5	53 ± 3,0	115 ± 2,0
3	Control	54 ± 2,0	117 ± 2,0

Table 1. Cotton variety Porlock-4 has an indicator of flowering 50% and opening of bolls 50%.

In experimental samples, it was also found that the average number of bolls per sympodial branch and the weight of cotton per boll were higher in the high-nitrogen variant than in the high-phosphorus variant and controls (Table 2).

S. No	Options	Total number of cotton boll	Number of cotton bolls per bush	Boll weight g.

1	NPK 1:0,7:0,5,	951 ± 17	18,1 ± 2,1	7,6 ± 0,8
2	NPK 0,7:1:0,5	937 ± 15	17,8 ± 1,8	7,4 ± 0,6
3	Control	920 ± 10	12,9 ± 2,8	6,5 ± 0,8

Table 2. The quantitative traits of Porlock-4 cotton variety.

In addition, we analyzed fiber length, boll weight, 1000 seed weight, and lint percentage in the fiber measuring laboratory. According to the results, any significant changes did not observe in fiber length, while the fiber yield, the weight of 1000 seeds, and yield indicators were higher than the control in both variants (Table 3).

S. No.	Options	Staple FL mm.	Fiber yield,%	1000 seed weight g.	yield ts/ha
1	NPK 1:0,7:0,5	36,9 ± 0,21	36,1 ± 0,8	134,5 ± 1,7	39,5 ± 3,4
2	NPK 0,7:1:0,5	37,4 ± 0,14	36,0 ± 0,7	133,9 ± 1,8	38,5 ± 2,4
3	Control	36,9 ± 0,20	35,8 ± 0,9	128,7 ± 4,2	28,7 ± 3,2

Table 3. The quantitative traits of Porlock-4 cotton variety.

The results of the study were analyzed using the statistical test of Mann-Whitney. According to it, the boll weight, fiber yield, and the weight of 1000 seeds were higher than in the control sample in this variant of mineral fertilizers when the ratio was NPK 0,7:1:0.5 (Tables 4-6).

Compared option		N	Statistics	Significance P
NPK 1:0,7:0,5	NPK 0,7:1:0,5	9	33,000	0,505
NPK 1:0,7:0,5	Control	9	27,500	0,246
NPK 0,7:1:0,5	Control	9	33,500	0,533

Table 4. Statistics Mann-Whitney test fiber yield.

Compared option		N	Statistics	Significance P
NPK 1:0,7:0,5	NPK 0,7:1:0,5	9	34,000	0,566
NPK 1:0,7:0,5	Control	9	0,000	0,0001
NPK 0,7:1:0,5	Control	9	4,000	0,001

Table 5. Statistics Mann-Whitney test, number of buds.

Compared option		N	Statistics	Significance p-Value
NPK 1:0,7:0,5	NPK 0,7:1:0,5	9	36,500	0,724
NPK 1:0,7:0,5	Control	9	0,000	0,0001
NPK 0,7:1:0,5	Control	9	0,000	0,0001

Table 6. Statistics Mann-Whitney test of weight of 1000 seeds.

In the fertilizer experiment, SPAD values were measured in the upper leaves of Porlock-4. Values were higher on NPK 1:0,7:0,5 than on NPK 0,7:1:0,5 and control. In the NPK 0,7:1:0,5 and control plants, the SPAD values of upper leaves were lower than the values measured in the upper leaves of NPK 1:0,7:0,5, plants. Between August 13 and September 2, SPAD values of the first leaf of two medium-maturing cotton cultivars were significantly higher than the other three leaves (Table 7, 8).

		N	Average	Std. deviation	Std. Error
Result	NPK 1:0,7:0,5	90	49,4133	2,50111	0,26364
	NPK 0,7:1:0,5	90	48,4711	2,29568	0,24199
	Control	90	46,2778	1,56369	0,16483

Table 7. Descriptive statistics, SPAD values, and number of chlorophylls in Porlock-4 cotton variety.

Compared option		N	T-Statistics	Significance P
NPK 1:0,7:0,5	NPK 0,7:1:0,5	90	2,633	0,009
NPK 1:0,7:0,5	Control	90	10,085	0,0001
NPK 0,7:1:0,5	Control	90	7,491	0,0001

Table 8. t- Student's test.

Measuring chlorophyll content is a nondestructive way to obtain accurate time information on crop plants' chlorophyll and N content. We sought to study the dynamic changes in chlorophyll a and N of cotton plants to diagnose the plants' physiological and nutrient status (Wang, L., et al., 2010). This study showed that in samples fertilized with NPK 1:0.7:0.5, a diagnosis of the amount of nitrogen assimilated could be made based on changes in the SPAD values relative to NPK 0.7: 1: 0.5 and control.

Conclusion

According to the study results, it can be concluded that it is possible to determine the number of mineral fertilizers required for growing the cotton variety "Porlock-4". This will lead to such problems as the ratio of fertilization when growing the cotton variety "Porlock-4" and the early ripening of these varieties, and a further increase in yield. The effect of mineral fertilizers on cotton varieties will be studied at the molecular level.

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