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Research Article

Yield and yield component traits of the new Niyat variety of cotton under field conditions in the Khorezm region of Uzbekistan

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Abstract

This article provides information on the valuable economic characteristics of the new and prospective variety of cotton, "Niyat," which is fast-ripening, fertile, resistant to diseases and pests, with fiber type IV, and adapted to various extreme conditions of the Khorezm region. The boll weight per plant was an average of 6.2–6.4 grams over the years of observation, an average of 0.4–0.7 grams higher than that of the control navigator. The weight of 1,000 seeds averaged 122–126 grams over the years of the study, which was found to be 8–11 grams higher than the control navigation. Fiber lengths ranged from 33.3 to 35.1 mm, averaging 34.0 mm. During the years of the study, it was found that the seed yield of the Niyat variety averaged 40.5%, which is 2.1% higher than the control variety. In the future, it has been proved that the Niyat cotton variety can be used as a starting material for future research on the creation of new ridges and varieties of cotton suitable for the soil and climatic conditions of the Khorezm region and suitable for double sowing.

Keywords: *Gossypium hirsutum* L., cotton, variety, fiber, boll, micronaire

Introduction

Cotton is grown in around 105 countries; total cotton production during 2018–2019 was 71.02 million tons. India, China, the United States of America, Brazil, Pakistan, Turkey, Uzbekistan, Australia, Greece, and Benin are the top ten producers (Ishwarappa et al., 2020). Cotton is considered the world's most important fiber-producing crop. It not only supports the textile industry by providing fiber but also supports the oil industry by producing high-quality oil. Cotton is engaging approximately 350 million people around the globe for its production, ginning, transportation, and storage. The world cotton market of $20 billion annually is made possible by the uncommon ability of the cotton genus (Gossypium) to produce lint fibers that are single-celled, epidermal, five to six cm long, and seed-borne (Shavkiev et al., 2023; Narimonov et al., 2023). The top three cotton-producing countries are China, India, and the United States, followed by Pakistan, Brazil, Australia, Uzbekistan, Turkey, Turkmenistan, Burkina, Mali, Greece, and Burma. Cotton (*Gossypium hirsutum* L.) is the major cash crop of tropical and subtropical regions of the world (Shavkiev et al., 2021a, Makamov et al., 2022a; Chorshanbiev et al., 2023). Cotton is the best natural fiber crop, with a large contribution to textiles and an economic impact of 600 billion dollars worldwide (Aslam et al., 2020). In Uzbekistan, cotton is a cash crop mainly grown as a source of fiber, food, and feed. Moreover, cotton fibers play a vital role in uplifting the country's economy (Khamdullaev et al., 2021; Makamov et al., 2022b). Globally, Uzbekistan ranks fourth in cotton area and production. However, the yield per unit area in Uzbekistan is very low compared with that in other cotton-growing countries (Sanayev et al., 2021; Shavkiev et al., 2021b, Amanov et al., 2022; Matniyazova et al., 2022; Chorshanbiev et al., 2022). The farmers of Uzbekistan are investigating and developing cotton with high fiber and lint yields (Nabiyev et al., 2020; Shavkiev et al., 2020, 2021c, 2022; Amanov et al., 2022; Makamov et al., 2023).

Restricted cotton cultivation areas and ongoing increases in cotton consumption necessitated enhancing cotton output. This requires farmers to produce higher quantities and of higher quality from the unit area. The genetic potential of cultivars, environmental factors, and production methods influence the product’s quantity and quality. Regardless of a variety’s potential, environmental factors will significantly impact the quantity and quality of the crop produced. A variety that is successful in one location will not be able to retain the same productivity or quality features in a different location or under changing environmental circumstances (Yuksekkaya, 2002).

All breeding programs strive to produce cultivars with high yield and quality potential while exhibiting minimal variation in different environments. To accomplish this aim, it is crucial to concentrate on selecting stable genotypes that interact less with their growing environment. Since stability or minimum interaction with the environment is a genetic trait, studies may be planned to select stable genotypes. Selecting more stable varieties would help in sustainable production over large areas (Baloch et al., 2015; Orawu et al., 2017). The assessments of quality heavily rely on interactions, which are the link between genotypes and various environmental variables. If a cultivar exhibits significant genotype-environment, genotype years, and genotype-environment years interactions, it is impossible to measure the genetic variation accurately, leading to inaccurate assessments. When more than one variety is tested and compared at different locations, there are differences in the ranking of quality criteria at each location. In addition to the qualitative performance of the variety, it is essential to determine if the variety is stable in terms of quality (Gul et al., 2016). No significant success can be achieved without increasing productivity in cotton growing, as in all agricultural production areas. In particular, the development of selection and breeding gives good results in this regard (Abbas et al., 2015). No significant success can be achieved without increasing productivity in cotton growing, as in all agricultural production areas. In particular, the development of selection and breeding gives good results in this regard (Abbas et al., 2015).

It is known that cotton is mainly enriched based on quantitative characteristics; the selection of valuable economic traits, i.e., forms with fast ripening, yield, number of bolls, seed weight and other indicators, and the appropriate selection of their hybrids. These traits are polygenic and are complexly inherited. The study of the degree of inheritance of quantitative traits is particularly important for practical selection (Djanibekov et al., 2018).

Breeding early-maturity cotton with high yields and high-quality crops is sharply constrained by the genetic complexity of the early-maturity trait (Chengqi Li et al., 2020). In the cotton fields of the Republic of Uzbekistan, primarily two cotton varieties, Upland cotton (*Gossypium hirsutum* L.) and Pima cotton (*G. barbadense* L.) are grown. Pima cotton varieties are characterized by high fiber quality. Moreover, cotton varieties of this species are adapted to hot climates and are grown only in the country's southern regions. At the same time, the fertility and fiber yield is also slightly lower than for medium-fiber cotton varieties. In the Khorezm region, one of the northern regions of Uzbekistan, Upland cotton is grown on an average of 45-50% of the total area, which is more than other crops (Tischbein et al., 2013).

The research aims to study the processes of formation, stabilization, and preservation of morphological characteristics of the L-171-K line in the generations created by targeted replication in populations selected by the method of paired hybridization of *G.hirsutum* L., as well as to study the adaptability of the prospective Niyat variety, which was brought to the level of a new variety based on this ridge, to the soil and climatic conditions of the Khorezm region, through the cultivation and implementation of elite selected seed into production.

Material and methods

Soil and climate conditions of the Khorezm region.

The Khorezm region is situated northwest of Uzbekistan, between the Kyzyl-Kum and Kara-Kum deserts. Its geographical area is located at a width of 60.05 and 61.39 to the east and 41.13 and 42.02 to the north, about 230 km away from the present shores of the Aral Sea. The area is 112-138 m above sea level on average. The total field area of the Khorezm region is 6.3 thousand km2, of which about 2.6 thousand km2 is irrigated land (Conrad et al., 2007). The climate is dry and continental because the Khorezm region is located in Uzbekistan's desert and semi-desert regions. The average annual temperature is 12.3–12.4°C, and the relative humidity ranges from 37–78% in 2018-2020. According to the forecast of the regional chief hydrometeorological center, the highest temperature is from May to August, with the heat reaching 42–44°C above zero, and the coldest days are from December–January, with a temperature of -29–32°C below zero. Such a drop in temperature is due to the influx of cold air through the wind. The average annual rainfall in the region is 94–100 mm, the bulk of which falls in the winter and spring months. The amount of monthly transpiration mainly exceeds the amount of precipitation and averages approximately 1500 mm. The soils of the study area, where the experiments were carried out, are alluvial-meadow. These soils comprise 14.2% of the total cultivated area of the Khorezm region in the lower Amu Darya territory. They were formed in conditions of the modern delta. Groundwater is mineralized, occurring at a depth of 1-3 m. According to the agrochemical properties, the soil is characterized by ubiquitous carbonate content, weak texture, low humus content, and a strong tendency to salinization. The soil is mainly medium saline with chloride sulfate (Abdurakhimov et al., 2020). The fiber quality indicators were determined with a modern HVI (High Volume Instrument) device at the State Unitary Enterprise's "Service Center in the Agro-Industrial Complex."

Data were recorded for the total number of bolls per plant, weight (g), lint %, and fiber length (mm). The mean data were subjected to analysis of variance according to Steel et al. (1997) to test the null hypothesis of no differences among various F_1 hybrid populations and their parental cultivars. In this case, the Fisher criterion (F), the standard deviations (SD), the standard error (SE), and the degree of significant differences ($P \leq 0.05$*, $P \leq 0.01$**, and $P \leq 0.001$***) determined the reliability of the differences among the genotypes for each trait.

Results

Research-investigation work was carried out on 8.2 hectares of farm "Farrukh" in the Urgench district of Khorezm region in 2018-2020 and on 3.5 hectares of land of the elite seed farm "Solay Yakubov" of the first propagation of seeds in Khanka district. The Khorezm-127 variety of cotton was selected as a control variety. It is grown in large areas in the Khorezm region. The annual rate of pure nitrogen fertilizer per hectare of feed was 285 kg per hectare, and it was given three times during the growing season (35% before sowing, 37% during the leaf phase, and 28% during the flowering phase). A total of 230 kg of phosphorus fertilizer was applied, with 60% applied before sowing and 40% applied during the leaf phase.

It was observed that the yield of the Niyat variety compared to the control variety Khorezm-127 was 3.1 c/ha in 2018, 3.5 c/ha in 2019, 2.7 c/ha in 2020, and over the years, the average yield was 3.1 c/ha, and the average yield was 39.1 c/ha in the ‘Farrukh’ farm of Urgench district. The cotton-plant height ranged from 113-117 cm, with an average of 115 cm in 2018-2020. The growing period of Niyat was 118–123 days and 121 days on average. Over three years, boll weight averaged 6.2 grams, varying by 0.2 grams, and was found to be on average + 0.3 gr. higher than that of the control variety. The weight of 1,000 seeds averaged 110 gr. over three years, which was 4.1 gr. higher than the control variety. The difference between the varieties was observed between 33.3 and 35.1 mm in traits of fiber length. The three-year data on ginning percentage % averaged 39.6%, which was 1.3% higher than the control variety (Table 1).

Table 1. The morpho-yield traits of the 'Niyat' cotton variety grown in 'Farruh' farm in Khorezm Region.

Traits	Unit of measure	"Niyat"			Average	"Khorezm-127"			Average
		2018	2019	2020		2018	2019	2020	
Yield	c/ha	39,3	38,8	39,2	39,1	36,2	35,3	36,5	36,0
Plant height	cm	115	113	117	115	116	114	121	117
Growth period	days	123	118	122	121	122	117	118	119
Boll weight	gr.	6,1	6,3	6,1	6,2	5,8	6,0	6,0	5,9
1000 seeds weight	gr.	111	104	114	110	105,8	107,4	104,5	105,9
Fiber length	mm.	33,4	33,3	35,1	34,0	28,5	29,0	31,8	29,7
Ginning percentage	%	39,4	41,1	38,3	39,6	39,0	37,4	38,5	38,3

The yield of the "Niyat" cotton variety grown in the elite seed farm "Solay Yakubov" of first seed propagation in Khonka district was compared with the control variety "Khorezm-127" and it was observed that the fertility of the variety 'Niyat' was -2.5 c/ha in 2018, -2.6 c/ha in 2019, and -3.6 c/ha in 2020, an average of 2.9 c/ha higher than that of the control variety. Plant height fluctuated between 114-118 cm and averaged 116 cm from 2018 to 2020. The growing period of the Niyat variety was 117-124 days and 121 days on average. (Table 2).

Table 2. The morpho-yield traits of the 'Niyat' cotton variety grown in "Solay Yakubov" farm in Khorezm Region

Traits	Unit of measure	"Niyat"			Average	"Khorezm-127"			Average
		2018	2019	2020		2018	2019	2020	
Yield	c/ha	38,2	38,7	39,5	38,8	35,7	36,1	35,9	35,9
Plant height	См	116	114	118	116	115	117	120	117,3
Growth period	Day	124	117	121	121	122	116	117	118,3
Boll weight	gr.	6,3	6,1	6,3	6,2	6,0	5,8	6,0	5,9
1000 seeds weight	gr.	110	104	114	109	107,8	108,4	108,5	108,2
Fiber length	mm.	33,3	33,4	35,1	34,0	29,0	28,5	30,8	29,4
Ginning percentage	%	39,8	41,1	40,5	39,6	39,0	38,5	37,4	38,3

The boll weight averaged 6.2–6.4 gr over the years of observation, which was found to be 0.4–0.7 gr. heavier on average than that of the control variety. The average weight of 1000 seeds per research a year was 122-126 grams, which was found to be 8-11 gr. more than that of the control variety. Fiber lengths ranged from 33.3 to 35.1 mm, averaging 34.0 mm. The fiber yield of the ‘Niyat’ variety averaged 40.5%, which is 2.1% higher than the control variety during the years of the study. (Table 2).

The results of the research were studied in the HVI system on quality indicators by comparing the quality of the Niyat variety and "Khorezm-127" grown in elite seed farms of "Farrukh" in Urgench district of the Khorezm region and "Salay Yakubov" in Khanka district (Table 3). As can be seen from the data in Table 3, the micronaire of the variety "Niyat" is 4.8 high, with an average length of 28.2 mm, a specific tensile strength of 29.9 gs/tex, a uniformity index of 83.7%, a light disposal rate coefficient of 81.7%, and the yellowing rate was 8.4 in the variety grown on the farm of primary propagation of seeds of elite seed farm "Salay Yakubov" in Khonka district. When comparing these indicators in the HVI system, it was found that the indications of micronaire were 4.0 with a high average length of 31.7 mm. Specific tensile strength was 31.1 gc/T, uniformity index was 84.5%, light disposal rate coefficient was 80.8%, and yellowing rate was 7.2 in terms of quality indicators with the control variety "Khorezm-127" and "Niyat" grown on the farm "Farrukh" in Urgench district.

Table 3. Fiber quality indicators of cotton "Niyat" variety.

Variety	MIC	Len		Str	Unf	Rd	+b
		Inch	Mm				
‘Soliy Yakubov’ a/f Khonka district, Khorezm region							
“Niyat”	4,8	1,11	28,2	29,9	83,7	81,7	8,4
“Khorezm- 127”	4,7	1,13	28,7	29,6	81,8	77,4	8,3
‘Farrukh’ a/f Urgench district, Khorezm region							
“Niyat”	4,0	1,25	31,7	31,1	84,5	80,8	7,2
“Khorezm- 127”	4,6	1,17	29,72	29,6	83,7	78,9	7,2

MIC - micronaire (range 3.5 - 4.9 for 1-2 varieties);
Len - upper average length (1 inch - 25.4 mm);
Str - Specific tensile strength, (gc/T);
Unf - uniformity index;
Rd – light disposal rate coefficient, %;
+ b - degree of yellowing;

The variety 'Niyat' was distinguished by its higher yield than the control variety (38.2-40.0 c/ha), fiber staple length (34.5-35.0 mm), micro-naira (4.3-4.5), and high fiber yield (38–40%). When the seeds of the variety ‘Niyat’ were propagated as a result of seed production, the cotton plants of the population retained their originality in traits of morpho-yield and fiber quality.

Discussion

Determination of the high-yielding varieties with the highest quality can be achieved by determining the most suitable environments. Yield and quality of many plants are affected by environmental conditions (Yan, 2014). In addition, genotype, environment, and year-by-trait interactions should be revealed. A realistic strategy is to see a single variety, environment, or year at acceptable levels for more than one trait (Li et al., 2017). Therefore, in recent years, many researchers have evaluated genotypes based on multiple plant traits with genotype, environment, and year by traits (Sofi et al., 2021). Since there is a negative relationship between yield and quality characteristics in cotton, this relationship may vary depending on environmental conditions (Luo et al., 2015). Therefore, it is necessary to determine the environment and year-by-trait relationships to determine high-yielding and high-quality varieties that adapt to all environments. In this study, the cultivars tested varied depending on the multi-traits. It was noted that the variety Niyat produced higher seed yield, boll weight, 100 seed weight, fiber length, and ginning percentage, whereas the variety Khorezm-127 had better HSW and other quality criteria. According to Mukoyi et al. (2018), considerable genotype traits and the correlation of features raise the need for cotton breeding to incorporate a selection index. According to Teodoro et al. (2018), farmers select cultivars for more than simply their high grain production; other traits, such as fiber length, are critical to improving quality. Genotype trait is derived from multivariate approaches since genotype performance is assessed based on various attributes, as noted by Li et al. (2017). This enables the identification of better genotypes that include all desirable traits

Conclusions

The prospective 'Niyat' variety of cotton is adapted to the extreme (saline soils, mineralized groundwater, water deficiency, very high temperatures) conditions of the Khorezm region. This variety has four types that meet the requirements of world standards with their textile content, as well as the yield of the variety 'Niyat' is 3–3.5 c/ha higher than the control 'Khorezm–127' variety and high-quality fiber. It has been proved that the Niyat variety of cotton can be used as a main object in future research on the creation of new ranges and varieties of cotton and is suitable for double sowing in the soil and climate conditions of the Khorezm region. We recommended planting the promising 'Niyat' variety of cotton in large areas of cotton growing clusters and farms due to its suitability to the soil and climate conditions of the Khorezm region and the Republic of Karakalpakstan.

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