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Original article

Quantitative and qualitative indicators of the fiber of the new Duru-Gavkhar-4 cotton variety (*Gossypium barbadense* L.)

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Abstract: The currently sown fine-staple cotton varieties are characterized by low yield, late ripening, and resistance to various Fusarium races wilt and other cotton pests. Breeders are faced with the task of providing cotton-textile clusters with raw materials from high-quality cotton fiber. This requires the creation of new fine-fiber varieties of cotton, combining early maturity, high yields with increased number of fruit branches, quantity, and weight of raw cotton in one box. These important elements ensure the yield of fine-staple cotton. This article deals with the creation of the cotton variety Duru-Gavkhar-4 belonging to the genus *Gossypium barbadense* L. using a traditional synthetic breeding method. During many years of individual selection, a new promising fine-staple cotton variety Duru-Gavkhar-4 was created, which was obtained by crossing the Duru-Gavkhar variety with the 9647I variety. The new variety successfully passed the State Variety Test in 2020 with a result of 98 % in terms of varietal purity and uniformity. The fiber of the new cotton variety Duru-Gavkhar-4 belongs to type I. The vegetation period of the variety is 125–128 days, the yield is 33–38 centner/ha, the fiber yield is 33–35 %, the draw weight of one box is 4.0–4.2 g, the fiber length is 39–41 mm, the weight of 1000 seeds is 118.2 g. In terms of quantitative and qualitative indicators, this variety dominates the control variety, that was Termez-31 (*G. barbadense* L.). The micronaire index is 3.8–4.1, which fully meets the requirements of the textile industry. The promising cotton variety Duru-Gavkhar-4 is currently being tested in the cotton-textile cluster of "KOVOTECH" in the Bagat district of the Khorezm region.
Key words: *G. barbadense* L.; cotton; variety; fiber; micronaire; qualitative indicators.

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Оригинальное исследование

Количественные и качественные показатели нового сорта тонковолокнистого хлопчатника Дуру-Гавхар-4 (*Gossypium barbadense* L.)

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Аннотация: Высеваемые в настоящее время сорта тонковолокнистого хлопчатника отличаются низкой урожайностью, поздним сроком созревания, устойчивостью к различным фузариозным увяданиям и другим вредителям хлопчатника. Перед селекционерами стоит задача обеспечения хлопково-текстильных кластеров сырьем из высококачественного хлопкового волокна. Все это требует создания новых тонковолокнистых сортов хлопчатника, сочетающих скороспелость, высокую урожайность с повышенным числом плодовых ветвей, количеством и массой хлопка-сырца в одной коробочке. Данные важные характеристики обеспечивают высокий выход волокна тонковолокнистого хлопчатника. В статье рассмотрено создание сорта хлопчатника Дуру-Гавхар-4, относящегося к роду *Gossypium barbadense* L., традиционным синтетическим методом селекции. В ходе многолетней индивидуальной селекции создан новый перспективный сорт тонковолокнистого хлопчатника Дуру-

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Гавхар-4, полученного методом скрещивания сорта Дуру-Гавхар с сортом 9647И. Новый сорт успешно прошел государственное сортоиспытание в 2020 г. с результатом 98 % по сортовой чистоте и однородности. Волокно нового сорта хлопчатника Дуру-Гавхар-4 относится к I типу. Вегетационный период сорта – 125–128 дней, урожайность – 33–38 ц/га, выход волокна – 33–35 %, масса одной коробочки – 4.0–4.2 г, длина волокна – 39–41 мм, масса 1000 семян – 118.2 г. По количественным и качественным показателям этот сорт доминирует над контрольным сортом Термез-31 (*G. barbadense* L.). Индекс микронейра составляет 3.8–4.1, что полностью соответствует требованиям текстильной промышленности. Перспективный сорт хлопчатника Дуру-Гавхар-4 в настоящее время проходит испытание в хлопково-текстильном кластере «КОВОТЭК» в Багатском районе Хорезмской области.
Ключевые слова: *G. barbadense* L.; хлопчатник; сорт; волокно; микронейр; количественные признаки.

Introduction

The realization of the potential of new varieties is closely related to environmental conditions and agricultural practices of cultivation. Obtaining high yields depends mainly on the growing conditions in a given zone. The new resolution of the Uzbekistan Presidential Administration of 2021 dated October 29, number UA-260, 2-decree in chapter 16 refers to increasing the cultivated area of new varieties and obtaining high yields in the cotton and grain growing system through the introduction of innovative technologies. Decree of the President of the Republic of Uzbekistan dated September 16, 2019, No. 4453 "On the development of the light industry" set the task of developing research on genetics, breeding, and seed production of fine-fibered cotton and expanding the sown area in cotton-textile clusters. A necessity in cotton growing is the creation of new varieties of fine-fibrous cotton. An urgent problem for fine-fibrous cotton is the renewal of cotton varieties with traits that combine high yields.

New varieties and lines being created by us are genetically balanced populations differing from each other by certain economic and biological features. Varieties of the *Gossypium barbadense* L. species have always been the focus of breeders because of their high fiber quality and disease resistance. One of the main disadvantages of previous fine-fiber varieties of cotton is their low yield and late maturation. In recent years, great success has been achieved in the selection of fine-fiber cotton based on various methods of interspecific hybridization (simple, complex, double, convergent hybridization, etc.).

P.Sh. Ibragimov and V.A. Avtonomov (1993) used long-staple cotton varieties (*G. barbadense* L.) 9871I, 9929-I, ASh-24, Termez-16, Giza-45 as a primary source for breeding work. Hybridization was carried out and fiber quality, early maturity, fiber length, and inheritance of yield traits were studied. In the F_2 generation, the plants showed segregation for these traits. In the study of A.R. Tyaminov (1994), a possibility of the combination of early maturity and fiber yield in fine-fiber cotton varieties was investigated, and the following introduced varieties were used as parents: Karshi-7, Karshi-8, Ash-81, 9891I, 9883- I, 9872-I, ML-108. As a result of this research, the following varieties were recommended as donors for early maturity traits: Karshi-7, ML-108, Karshi-8, and 9891I. S.M. Nabiev et al. (2020) studied indicators of the morpho-physiological characteristics of fine-staple cotton. It has been established that the lack (deficiency) of water in various varieties and lines of fine-staple cotton demonstrates different genotypic sensitivity in the morpho-physiological parameters of the leaf.

O.J. Jalilov (1996) crossed fine-fiber varieties to create highly heterotic hybrids and transfer useful features of cotton fiber to cultivated species; they established a high combination ability of the resulting hybrids. M.M. Kiktev (1996) noted that *G. barbadense* L. has high technological qualities of fiber but is inferior to medium-fiber cotton varieties in terms of yield, rate of cotton bolls opening, requires increased effective temperatures, etc. Nevertheless, scientists are working on crossing fine-staple cotton with medium-staple cotton to create highly heterotic hybrids.

The creation and introduction of new cotton varieties into the crop agricultural systems that meet the requirements of the textile industry are important and relevant. The efforts of breeders aim to increase productivity and ripening rates and improve fiber quality. Research performed by Y.A. Alkuddsi et al. (2020), L.V. Hoffmann et al. (2018), N.B. Gubanova et al. (2021) has shown that such quality indicators of fiber as length and micronaire are closely related.

Y.E. Elmogahzy and C.H. Chewning (2002) emphasize that the long fiber, like that of the low-yielding cotton species *G. barbadense* L., is genetically stronger, thinner, and more uniform than the shorter fiber of the widely cultivated early-ripening and high-yielding cotton varieties belonging to the *G. hirsutum* L. species.

One of the ways to solve this problem is the interspecific crossing of *G. hirsutum* L. × *G. barbadense* L. The effectiveness of complex hybridization in improving economically valuable traits of cotton has been studied by several researchers. The role of interspecific hybridization (*G. barbadense* L. × *G. hirsutum* L.) in improving resistance to environmental stress factors was studied by F. Wang et al. (2011). F.N. Kushanov (2017) emphasizes that the problem of obtaining genotypes that are not only resistant to wilt, but also have excellent quality and high yields, remains an urgent one.

G.I.A. Mohamed et al. (2009), M.Kh. Kimsanbaev and V.A. Avtonomov (2009), K.P.M. Dhamayanthi and K. Subashree (2016) studied geographically distant varieties and the inheritance and variability of valuable traits in F_1-F_2 hybrids of Egyptian varieties and of the *G. barbadense* species. Studying the length of the fiber in American cotton on F_1 hybrids, A. Abdullaev (2002) observed the intermediate inheritance of this trait. The intermediate nature of fiber length inheritance was also preserved in F_2. Using varieties of fine-staple cotton 9871I, 9929I, Ash-24, Termez-16, Giza-45, V.A. Avtonomov et al. (2018) studied yield traits in hybrids, the weight of one box, the number of boxes, early maturity, length, and yield of fiber. The authors observed in F_1 a heterotic effect, intermediate inheritance, and depression in some hybrids in the F_2 generations, an intermediate splitting of traits was observed. N.V. Mohan Kumar and I.S. Katageri (2017) studied hybrid populations of varieties

and showed the variety-forming ability in terms of a complex of economically valuable traits, fiber quality, and adaptability of cotton to external environmental conditions.

Thus, from a brief review, it can be seen that the results of numerous studies (Çoban, Ünay, 2017; Gohil et al., 2017; Zhang et al., 2017) on heterosis, the nature of trait inheritance, genetic analysis, as well as the correlation of traits in cotton are rather ambiguous. This is because the researchers worked in different regions and with different genotypes. This suggests that the identification of patterns is not absolute, but largely depends on many factors and mainly on the genotypes that formed the analyzed hybrid material, usually dependent on environmental conditions. Our main goal is to create thin fiber varieties of cotton that meet textile requirements with high fiber quality.

Materials and methods

The primary material for the research was the variety of fine-fiber cotton Duru-Gavkhar, which was crossed with the variety 9647I (Duru-Gavkhar x 9647I). And following multiple individual selections, a new cotton variety Duru-Gavkhar-4 was developed (Fig. 1). The vegetation period of the variety is 125–128 days, the productivity is 33–38 centner/ha, the fiber yield is 33–35 %, the weight of raw cotton per one cotton boll is 4.0–4.2 g, the fiber length is 39–41 mm, the weight of 1000 seeds is 118.2 g. The micronaire index is 3.8–4.1, which fully meets the requirements of the textile industry. Also, the L-5570 line was obtained from the population of the Duru-Gavkhar variety, as a result of multiple individual selections. In this work, the Termez-31 variety was used as a control variable.

The experiment was conducted at the scientific and experimental base of the Institute of Genetics and Plant Experimental Biology of the Academy of Sciences of the Republic of Uzbekistan, which is located in the Zangiata district of the Tashkent region on an area of 1 ha. The experiment started in 2010.

The experimental cotton research station is located 20 km from Tashkent on the upper terrace of the Chirchik River at an altitude of 398 meters above sea level. The climate is sharply continental, summer (June, July +40…+44 °C) is characterized by high temperature, and winter (January, February) is characterized by a decrease in temperature (on average 0…–8 °C) (Fig. 2, *a*). Significant precipitation occurs in autumn, winter, and spring (see Fig. 2, *b*). In summer, precipitation is not enough for the development of cotton, which necessitates artificial irrigation. The soil is a typical sierozem of long-term irrigation. The content of humus in the soil is 0.8–1.2 %, and the degree of mobile phosphorus in the soil is 30–38 mg/kg. In 2021, the amount of precipitation in March and April increased compared to 2020. This affected the sowing time in the field experiments (see Fig. 2, *b*). In this regard, sowing was carried out in late April and early May.

Variants of the experiment were sown in four repetitions, according to the planting scheme 90 × 20 × 1. The agricultural practices adopted for the Tashkent region were used in the experiment, providing normal plants' growth and development throughout the growing season. Each line was planted in 25-hole rows.

During the growing season, the recordings and observations of the following processes and traits were conducted:

Fig. 1. The shape of the bush of fine-staple cotton *G. barbadense* L. Duru-Gavkhar-4 variety and its characteristics

germination, flowering, maturation, the height of the main stem, number of sympodial branches and cotton bolls, wilt infestation level, the weight of raw cotton per one cotton ball, the 1000 seed weight, fiber length, and yield. The harvest of raw cotton was taken into account from the entire area of each plot.

From each, test samples of cotton bolls were taken from the first places of the second part in the fourth sympodia. Concerning test samples, the following quantitative parameters were measured: the weight of raw cotton per one boll, the yield and length of the fiber, 1000 seed weight, the fiber index, etc. Among quality indicators, the following were analyzed: UI – fiber length uniformity index (it is an indication of the distribution of fiber length within the fibrogram); SFI – index of short fibers (a value that is calculated using a sophisticated algorithm); Str – specific breaking load (the bundle strength is the breaking strength of the cotton fibers in grams per tex) was determined by using high-tech equipment HVI Uster 1000 computers to analyze the fiber at the "Sifat" certification center in Tashkent; Mic – the micronaire indicator characterizes the fineness and maturity of the cotton fiber. The upper half average length (UHML) is the mean length by the number of fibers in the largest half by weight of fibers in a cotton sample, usually measured from the fibrogram. Upper half mean length is normally equivalent to the staple length.

All records, observations, and laboratory analyses were carried out according to the methodology adopted for elite seed production (Dospekhov, 1985).

Results

Flowering and maturation rates

The timing of passing through the flowering stage is an important indicator of early maturity, which is relevant for the northern zones of cultivation of fine-fiber cotton. In the process

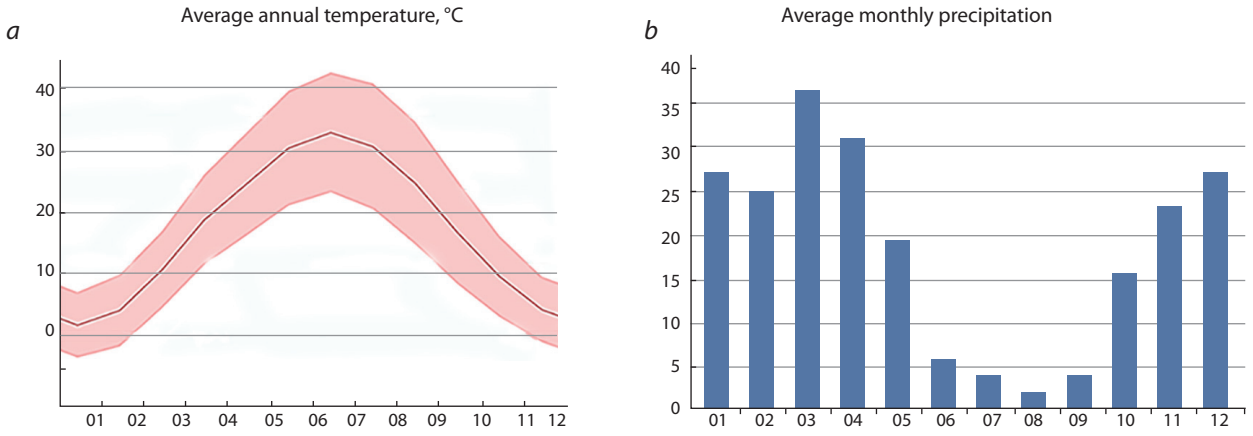

Fig. 2. Average annual temperature (*a*) and precipitation (*b*) at the experimental research station located on the upper terrace of the Chirchik River

Table 1. Flowering and maturation rate

Varieties and lines	Duru-Gavkhar-4			L-5570			Termez-31		
Traits	X ± Sx	ð	v	X ± Sx	ð	v	X ± Sx	ð	v
Flowering, days	71.18 ± 0.34	1.47	1.70	73.06 ± 0.31	1.59	1.64	74.20 ± 0.55	1.52	1.63
Maturation, days	127.48 ± 0.445	1.58	1.27	129.19 ± 0.41	1.34	1.69	130.36 ± 0.61	1.60	1.78

Note. Table 1–3: X mean indicator of signs, S mean variation; ð – an indicator of the variability of signs; v – coefficient of variation of signs (a comparative indicator of several signs among themselves).

Table 2. Fiber length and fiber yield indicators

Varieties and lines	Duru-Gavkhar-4			L-5570			Termez-31		
Traits	X ± Sx	ð	v	X ± Sx	ð	v	X ± Sx	ð	v
Fiber length, mm	41.2 ± 0.19	0.90	1.22	40.5 ± 0.31	0.67	1.22	38.6 ± 0.10	1.09	1.27
Fiber yeld, %	34.6 ± 0.29	0.378	1.60	33.8 ± 0.41	0.284	1.52	32.9 ± 0.28	0.18	1.48

of investigating the parameters of flowering and maturation, it has been revealed that there is a tendency for an accelerated development process in the Duru-Gavkhar-4 variety and the L-5570 line compared to the control Termez-31 variety(Table 1).

Fiber length and fiber yield indicators

In terms of fiber length, the Duru-Gavkhar-4 variety exceeded the L-5570 line and the standard Termez-31 variety by 1.6–2.7 mm. The fiber yield of the Duru-Gavkhar-4 variety was 34.6 %, for the L-5570 line, it was 33.8 %, and for the standard variety Termez-31, it was 32.9 %. According to the results of domestic and foreign researchers, there is a negative correlation between the length and fiber yield, and in this case, the correlation has been compromised to a certain extent.

Quantitative indicators

Yield components are made up of such elements as the number of fruit branches, the number and raw cotton weight per ball, etc. According to this indicator, the Duru-Gavkhar-4 variety and the L-5570 line surpassed the standard Termez-31 variety in the number of fruit branches, and the superiority was provided by some shortening of the internodes along the main stem, the best indicator for this trait was observed in the Duru-Gavkhar-4 variety.

The number of cotton bolls per plant is the most important element that provides the yield of cotton. The realization of the potential of new lines and varieties for fruiting is closely related to environmental conditions and agricultural practices of cultivation. With a comparative assessment of this trait, it becomes clear that the number of bolls set on a bush depends on the growing conditions in a given cultivation zone and characterizes the genotype of the investigated material.

The superiority of the variety Duru-Gavkhar-4 over the line and the standard variety in terms of quantitative traits was undoubtedly established (Table 3).

Quality indicators of fiber of fine-fiber cotton

The micronaire indicator characterizes the fineness and maturity of the cotton fiber. In the variety Duru-Gavkhar-4 and the line L-5570, the micronaire index that characterizes the fineness and maturity of the cotton fiber was 3.7 and 3.8, respectively, in the standard Termez-31 variety this indicator was 4.3 (Fig. 3, *a*). The upper half average length of the Duru-Gavkhar-4 variety and L-5570 line was 41.8 and 41.1 mm, respectively. In the control Termez-31 variety, this indicator was 38.2 mm (see Fig. 3, *b*). The fiber length uniformity index of the Duru-Gavkhar-4 variety and the L-5570 line was 89 and 88 %, respectively, while in the

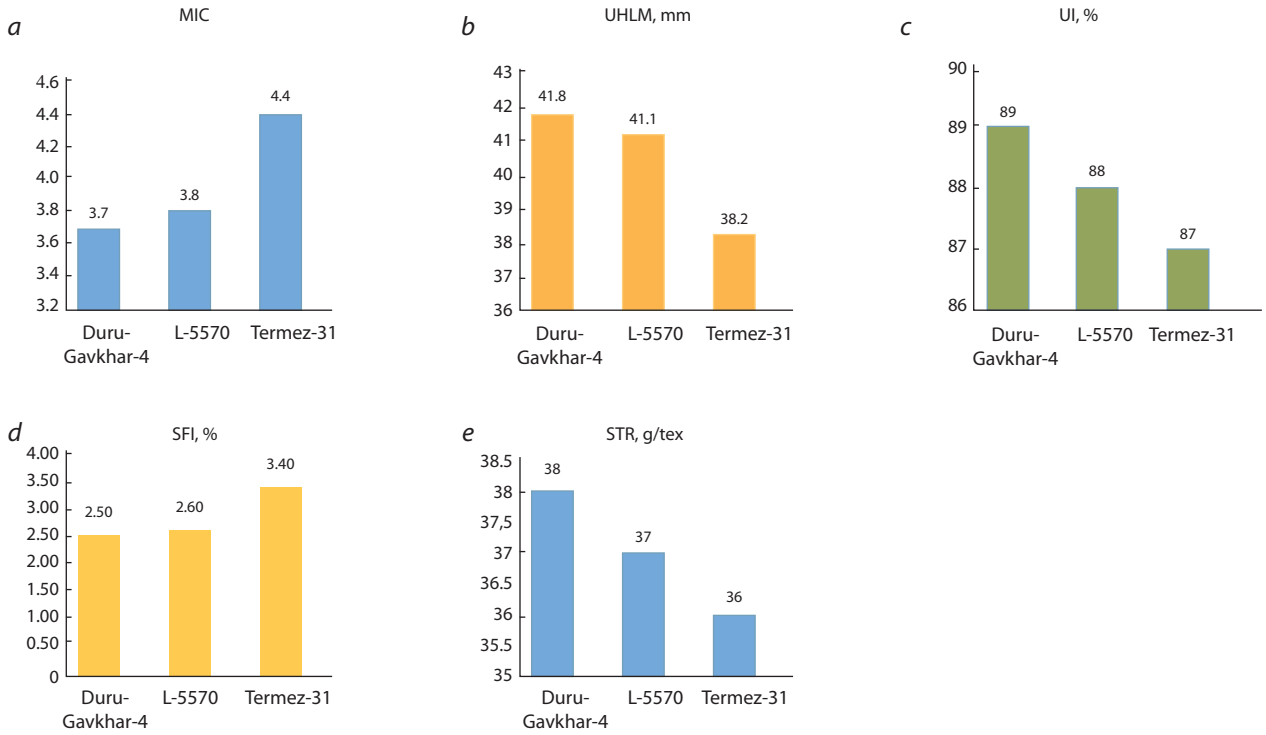

Fig. 3. The quality indicators of fiber of fine-fiber cotton varieties Duru-Gavkhar-4, Termez-31, and line L-5570: *a*, the micronaire indicator (Mic); *b*, index of short fiber (SFI); *c*, specific breaking load (Str); *d*, the upper half average length (UHML); *e*, fiber length uniformity index (UI)

Table 3. Quantitative indicators

Varieties and lines	Duru-Gavkhar-4			L-5570			Termez-31		
Traits	X ± Sx	ð	v	X ± Sx	ð	v	X ± Sx	ð	v
Number of fruit branches in pcs.	23.2 ± 0.47	0.57	3.80	22.8 ± 0.73	0.56	4.95	20.4 ± 1.38	0.42	5.10
Number of cotton balls in Fig. 1	22.6 ± 0.82	1.56	5.66	21.9 ± 0.86	1.19	3.48	18.7 ± 0.74	1.25	4.70

control variety Termez-31 this indicator was at the level of 87 % (see Fig. 3, *c*). The index of short fibers of the Duru-Gavkhar-4 variety and the L-5570 line was 2.5 and 2.6 %, respectively. In the control variety Termez-31, this index was 3.4 % (see Fig. 3, *d*). The relative breaking load is considered to be one of the important indicators of fiber quality in the textile industry. This indicator for the Duru-Gavkhar-4 variety and L-5570 line was 38 and 37 g/tex, respectively. This indicator is the control variety Termez-31 was 36 g/tex (see Fig. 3, *e*).

Discussion

The creation of new fine-fiber varieties of cotton corresponds with the need to continue evolutionary changes in cotton growing. Newly created varieties and lines are equalized populations that differ from each other in certain economic and biological characteristics. Varieties of the *G. barbadense* species have always been the focus of breeders because of their high fiber quality and disease resistance. In recent years, the susceptibility of fine fiber varieties of cotton to new strains of Fusarium oxysporum has increased. One of the main disadvantages of the previous fine-fiber varieties of cotton is their low yield and late maturation. In recent years, great success has been achieved in the selection of fine-staple cotton in the Republic.

The process of passing the flowering rate is an important indicator of early maturity, which is relevant for the northern zones of cultivation of fine-staple cotton. In the process of studying the parameters of flowering and maturation, there was a tendency for an accelerated development process in the Duru-Gavkhar-4 variety and the L-5570 line compared to the control variety Termez-31. Yield indicators are made up of such elements as the number of fruit branches, the number and weight of raw cotton in one box, etc. According to this indicator, the Duru-Gavkhar-4 variety and the L-5570 line surpassed the standard Termez-31 variety in the number of fruit branches, and the superiority was ensured by some shortening of the internodes along the main stem, the best indicator for this trait was observed in the Duru-Gavkhar-4 variety. The superiority of the variety Duru-Gavkhar-4 over the line and the standard variety in terms of quantitative ratio was undoubtedly proven.

Fiber quality indicators are important features required in the textile industry to achieve the final result. The micronaire index of the Duru-Gavkhar-4 variety and the L-5570 line was 3.7 and 3.8, respectively, which is the best fiber index for the

textile industry. The upper average length of the variety Duru-Gavkhar-4 and line L-5570 was 41.8–41.1 mm, respectively. This indicator of the control variety Termez-31 is 38.2 mm. The fiber length uniformity index of the Duru-Gavkhar-4 variety and L-5570 line was 89 and 88 %, respectively. While in the control variety Termez-31 this indicator was at the level of 87 %. The index of short fibers of the Duru-Gavkhar-4 variety and the L-5570 line was 2.5 and 2.6 %. For the control variety Termez-31, it was 3.4 %. The relative breaking load is one of the important indicators of fiber quality in the textile industry is the relative breaking load. This indicator for the variety Duru-Gavkhar-4 and line L-5570 was 38 and 37 g/tex, respectively. This indicator in the control variety Termez-31 is 36 g/tex.

The conducted studies have shown the breeding value and expediency of using the new variety Duru-Gavkhar-4 in the cotton-textile clusters of the southern region of the Republic. Starting from 2022, a production test and laboratory studies of fiber quality are planned in the system of the cotton-textile cluster "KOVOTECH" in the Khorezm region of the Republic of Uzbekistan. The newly created variety Duru-Gavkhar-4 and line L-5570 are valuable in terms of genetic characteristics. But the main value is meeting the increased demands of the cotton-textile clusters and the textile industry.

As a result of the study, the promising line L-5570, that differs from the control varieties in fiber quality, yield, and resistance to diseases and pests of cotton, was also isolated from the population of the Duru-Gavkhar variety by the method of individual selection.

Conclusion

The conducted studies have shown the breeding value and feasibility of using the new Duru-Gavkhar-4 variety and line L-5570 in the cotton-textile clusters of the southern region of the Republic. The created variety and line are valuable in terms of genetic characteristics, but the main value is meeting the increasing demand of the cotton-textile clusters and the textile industry. Starting from 2022, a production test and laboratory studies of fiber quality of the Duru-Gavkhar-4 variety are planned to be implemented in the system of the cotton-textile cluster "KOVOTECH" in the Khorezm region of the Republic of Uzbekistan, while seed selection, breeding, and production research regarding the promising L-5570 line will be continued.

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