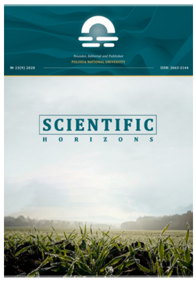
SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 27(8), 69-79



UDC 633.511:631.527:631.559
Doi: 10.48077/scihor8.2024.69

Selection of productive early maturing cotton genotypes with improved fibre quality parameters

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Article's History:
Received: 01.03.2024
Revised: 05.08.2024
Accepted: 28.08.2024

Abstract. The purpose of this article was to study productivity and fibre quality of different cotton genotypes under conditions of Turkestan region of Kazakhstan to determine the most promising genotypes for commercial cultivation. Four genotypes were selected: Tashkent-6, Maktaral-5027, Namangan-1 and Bukhara-8. The study included analysis of such parameters as germination and sprouting time, plant height, flowering and maturity time, yield, number of bolls and fibre quality characteristics.

Suggested Citation:
Makhmadjanov, S., Tokhetova, L., Daurenbek, N., Dyamurshayeva, G., & Makhmadjanov, D. (2024). Selection of productive early maturing cotton genotypes with improved fibre quality parameters. *Scientific Horizons*, 27(8), 69-79. doi: 10.48077/scihor8.2024.69.

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The results showed that Tashkent-6 and Maktaral-5027 had the best parameters: yield 3.8 t/ha and 3.5 t/ha, flowering time 55 days and maturity 120 days, plant height 120 cm and 115 cm, number of bolls 45 and 42. The fibre quality of these genotypes was also high: length 32 mm and 31 mm, tensile strength 30 g/tex and 29 g/tex, fineness 2.5 dtex and 2.6 dtex. Namangan-1 and Bukhara-8 genotypes showed moderate results: yield 3.2 t/ha and 3.0 t/ha, flowering time 60 days and ripening time 130 days, plant height 110 cm and 105 cm, number of bolls 40 and 38, fibre length 30 mm and 29 mm, tensile strength 28 g/tex and 27 g/tex, fineness 2.8 dtex and 2.9 dtex. Statistical analysis confirmed the significance of differences between genotypes. The results of the study confirmed high productivity and fibre quality of genotypes Tashkent-6 and Maktaral-5027, which makes them promising for commercial cultivation in Kazakhstan, while genotypes Namangan-1 and Bukhara-8 also have potential for certain agronomic conditions

Keywords: yield; fibre quality; flowering time; plant height; number of bolls

INTRODUCTION

Cotton research is an important aspect of agricultural science in Kazakhstan, as this crop plays a key role in the textile industry. Under conditions of changing climate and growing demand for high quality fibre, there is a need to develop and evaluate new cotton genotypes that can ensure high productivity and fibre quality under different agronomic conditions. In the Turkestan region of Kazakhstan, there is a need to study genotypes adapted to local climatic conditions to improve the efficiency of agricultural production.

Existing research on cotton breeding in Kazakhstan shows considerable success in developing genotypes with improved characteristics (Penkova & Kharenko, 2023). For example, a study by S.P. Makhmadjanov *et al.* (2024) found that thicker stems and more bolls contribute to higher plant productivity under Kazakh conditions. They concluded that genotypes with thicker stems have better resistance to external influences such as wind and rain, which allows them to achieve high productivity even under difficult climatic conditions. In a study by G. Rahimova *et al.* (2024), the authors observed that plant height and stem thickness correlate with drought tolerance, which contributes to their ability to produce high yields. They found that tall plants with thick stems retained moisture better and were more tolerant to drought periods. N.E. Chorshanbiev *et al.* (2021) found that an increase in boll number was directly related to an increase in total cotton yield in different regions of Kazakhstan. They noted that plants with more bolls provide higher fibre yields, which is particularly relevant in resource-limited regions.

Despite significant successes, these studies have their limitations. For example, G. Rahimova *et al.* (2024) did not analyse the resistance of genotypes to diseases and pests, which is an essential factor for practical application of the results. In the study of N.E. Chorshanbiev *et al.* (2021), the authors also did not consider aspects such as the effect of different irrigation and fertilization methods on plant productivity. These limitations indicate the need for more comprehensive studies that consider all possible factors affecting cotton productivity.

Fibre quality is also an important aspect of the research. I.C. Zeynalova *et al.* (2022) found that high fibre length and strength make fibres more suitable for the textile industry in Kazakhstan. They noted that fibres with high strength and length provide better textile products, which increases the competitiveness of Kazakh cotton in the world market. S. Babakholov *et al.* (2022) highlighted that improved fibre quality characteristics contribute to its market value and competitiveness in local and global markets. They showed that fibres with high-quality characteristics attract more buyers and provide better income to producers. In a study by D.K. Akhmedov *et al.* (2022), the authors noted that fibre quality attributes are key to the production of high-end textile products. They found that fibres with high homogeneity and flexibility enable the production of higher quality fabrics and garments, which contributes to the export potential of Kazakhstan.

The study by S. Babakholov *et al.* (2022) was limited only to laboratory conditions without considering field trials, which also reduces the practical relevance of the findings. In the work of D.K. Akhmedov *et al.* (2022), the authors did not consider such critical factors as fibre resistance to mechanical damage and wear, which also affects its quality and suitability for textile production. Several studies have shown the importance of agronomic practices in improving cotton productivity (Shahini *et al.*, 2023). For example, E. Khusanboy *et al.* (2022) confirmed that improved agronomic conditions, such as the use of organic fertilizers and regular irrigation, increase cotton productivity in Kazakhstan. They noted that organic fertilizers improve soil structure and soil fertility, which in turn increases plant yields. D. Kazakova *et al.* (2023) observed that regular irrigation not only increases yield but also improves fibre quality. Sufficient water supply allows plants to develop better and form better quality fibre, which is important for the textile industry. Nevertheless, there are limitations here as well. E. Khusanboy *et al.* (2022) did not consider the long-term effects of organic fertilizer application, which may affect soil sustainability and fertility in the future, and D. Kazakova *et al.* (2023) did not conduct comparative studies with other irrigation methods, which limits the ability to choose the best irrigation method for specific growing conditions.

Thus, the purpose of this study was to assess the productivity and fibre quality of different cotton genotypes under the conditions of Turkestan region of Kazakhstan. This research is aimed at filling the existing gaps in knowledge and developing recommendations to improve the efficiency of agricultural production in the region. The problematic issue of the study is the need to identify the most productive and sustainable cotton genotypes that can adapt to local climatic conditions and provide high quality fibre.

MATERIALS AND METHODS

The study was conducted in the Turkestan region of Kazakhstan in 2023. Various cotton genotypes were used for selection, including Namangan-1, Tashkent-6, Bukhara-8 and Maktaral-5027 known for their early maturing and high yielding characteristics. The source material was collected from different regions of Kazakhstan, which provided the necessary genetic diversity for the study. The experimental plots were prepared in accordance with agrotechnical norms. The soils of the plots were chernozems with high fertility, which favoured good plant development. The average annual temperature in the region is about 10°C, with summer temperatures reaching 25-30°C, and precipitation is about 300 mm per year, which is typical climatic conditions for the area.

Sowing was carried out in early May, when the soil had warmed to the optimum temperature of 15°C for cotton seed germination. Plant care included regular watering, weeding, fertilization and pest control. All agronomic measures were carried out under the same conditions for all genotypes, which ensured equal opportunities for their development. A drip irrigation system was used for irrigation to ensure uniform water distribution and prevent drought. Watering was done twice a week, depending on weather conditions and soil moisture level. Weeding was done manually every fortnight to prevent weeds from competing for resources and to ensure optimal conditions for plant growth. Fertilization was carried out in three stages. At sowing, a complex fertilizer of nitrogen, phosphorus, potassium (NPK) was applied in the proportion of 15:15:15, 50 kg/ha, to ensure initial plant growth. In the phase of active growth, an additional nitrogen fertilizer in the form of urea (carbamide) with a concentration of 46%, 30 kg/ha, was applied to stimulate vegetative growth. Before flowering, potassium fertilizer (potassium sulphate) was applied at 20 kg/ha to improve fibre quality and plant stability. Insecticides and fungicides were used for pest protection. Insecticide "Aktara" (thiamethoxam) was used for protection against aphids and whitefly, applied at a concentration of 0.2 g/litre of water, spraying was carried out once a month. Topaz fungicide (pencicuron) was used to prevent fungal diseases, applied at a concentration of 1 ml/litre of water, sprayed twice a season. Spraying with Bordeaux liquid (1% solution) at the beginning of the season and before flowering was also carried out to prevent diseases, which helped to prevent fungal infections.

During the growing season, regular monitoring and data collection was carried out on the following parameters: germination and sprouting time, plant height, flowering and ripening time, yield, and biometric parameters (stem length and thickness, number of bolls). The germination and sprouting time were recorded by the number of days from sowing to first sprouts. Plant height was measured at different growth stages using a ruler. Flowering and ripening times were recorded by the dates of onset of flowering and ripening of fruits. Yield was measured by weighing the harvested fibre from each experimental plot. Biometric parameters such as the length and thickness of stems were measured using caliper and the number of bolls was recorded by counting.

After maturation, fibre was collected for further analysis. The fibres were evaluated for the following qualitative parameters: length, tensile strength, fineness, uniformity, and flexibility. Fibre length was measured using a microscope and special equipment, and each fibre sample was measured in length at least 10 times to ensure accuracy. Tensile strength was determined using a tensile testing machine, with at least 10 tests for each sample to obtain average values. Thinness was measured with a micrometre, followed by calculation of the average value from 10 measurements for each specimen. Homogeneity was assessed visually and with a microscope, recording uniformity and the absence of significant deviations in the fibre structure. Flexibility was measured by mechanical tests involving bending and stretching of the fibre.

Various methods were used to assess fibre quality. Microscopic examination determined the length and uniformity of the fibre. Mechanical tests were performed to determine the strength and flexibility of the fibre, including tensile and bending tests. Chemical analysis was used to determine the composition and purity of the fibre, including analysis of cellulose content and impurities. Chemical analysis was carried out using standard methods such as acid and alkaline hydrolysis to determine fibre composition. The data obtained were subjected to statistical analysis to identify significant differences between genotypes. The method of analysis of variance (ANOVA) and multiple comparative analysis made it possible to identify the best samples for each indicator, which ensured the objectivity and reliability of the conclusions. The authors adhered to the standards of the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS

The germination and sprouting time for different cotton genotypes varied but averaged 7-10 days. Genotypes Tashkent-6 and Maktaral-5027 showed the fastest sprouting, reaching 7 days, which indicates their good adaptation to the climatic conditions of the region and their ability to quickly start vegetation. This is especially important in conditions of limited vegetation period characteristic of Turkestan region. While genotypes, Namangan-1 and Bukhara-8 required up to 10 days for full germination. Rapid germination and sprouting allow plants to start photosynthesis earlier, which ensures better development and productivity. Also, a faster start of vegetation gives plants more time to form a full crop, which reduces the risks associated with unfavourable weather conditions at the end of the season. For example, fast-growing genotypes will have an advantage in the face of unexpected cold weather or prolonged rains that may occur in late summer or early autumn. Plant height was measured at different growth stages, and the maximum height was recorded in genotype Tashkent-6 (120 cm). This indicates its vigorous growth and potential ability to form a significant amount of vegetative mass, which is crucial for high yield formation (Table 1). The genotype Maktaral-5027 followed with a height of 115 cm, showing similar growth characteristics. Namangan-1 and Bukhara-8 attained heights of 110 cm and 105 cm, respectively. Taller plants can capture more light, which contributes to a more efficient photosynthesis process and higher yields. In addition, high plant mass provides more leaf area, which also has a positive effect on photosynthetic activity and hence the overall biomass of the plant. However, plants that are too tall may be more prone to lodging due to wind or rainfall, which should be considered when selecting genotypes for cultivation.

Table 1. *Height of cotton genotypes at different growth stages, cm*

Genotype	Plant height on day 30	Plant height at day 60	Plant height at day 90	Maximum height
Tashkent-6	30	70	110	120
Maktaral-5027	28	68	105	115
Namangan-1	25	65	100	110
Bukhara-8	23	60	95	105

Source: *developed by the authors*

The time of flowering and maturation is an important indicator determining the possibility of obtaining an early harvest. Genotypes Tashkent-6 and Maktaral-5027 started flowering 55 days after sowing, which is an advantage in conditions of a short growing season. Early flowering allows plants to use available resources more efficiently and avoid the impact of possible unfavourable weather conditions at the end of the season. While Namangan-1 and Bukhara-8 genotypes started flowering 5 days later, which is also an acceptable result, but may reduce their competitiveness in conditions of tough competition for light and nutrients. Fruits ripened in 120 days in Tashkent-6 and Maktaral-5027 and in 130 days in Namangan-1 and Bukhara-8. Early ripening allows for faster production and reduces the risks associated with unfavourable weather conditions at the end of the season. For example, early ripening can be particularly significant in environments where autumn rains or first frosts can damage unharvested crops. It also allows optimization of the schedule of farm machinery and labour, which is important for efficient farm management.

Early flowering and ripening have a significant impact on the overall production cycle of an agricultural enterprise. The Tashkent-6 and Maktaral-5027 genotypes allow farmers to plan and allocate labour resources more efficiently. For example, the ability to start harvesting 10 days earlier compared to Namangan-1 and Bukhara-8 avoids the peak period of loading agricultural equipment and labour, which reduces costs and reduces the likelihood of errors and losses associated with overloading. Early flowering is also critical for the integration of crop management systems. It allows for more flexible fertilizer and protection schedules. For example, genotypes that flower earlier can take advantage of early nitrogen fertilization to improve plant development and disease and pest resistance.

Yield was measured by weighing the harvested fibre from each experimental plot. The highest yield was recorded for genotype Tashkent-6 (3.8 t/ha), indicating its high productivity and ability to form a significant amount of marketable fibre. Maktaral-5027 showed slightly lower yield (3.5 t/ha), but also demonstrated a high level of productivity. Genotypes Namangan-1 (3.2 t/ha) and Bukhara-8 (3 t/ha) showed slightly lower results, but still high enough for the conditions of the region. Differences in yield were statistically significant ($p<0.05$), which confirms the objectivity and reliability of the obtained data. For more detailed analysis, yields were compared in different phases of the growing season. At the beginning of the growing season, when plants were just beginning to form fruits, it was observed that genotypes Tashkent-6 and Maktaral-5027 showed more active growth and development compared to Namangan-1 and Bukhara-8. This was expressed in a greater number of ovaries and intensive formation of bolls.

In the middle phase of vegetation, Tashkent-6 and Maktaral-5027 plants continued to outperform other genotypes in the number of formed capsules and total biomass. Observations showed that during this period, Tashkent-6 had an average of 10-12% more bolls formed than Namangan-1 and Bukhara-8. Maktaral-5027 showed similar results, which confirms its high potential. At the final stage of the growing season, when ripening and harvesting took place, Tashkent-6 and Maktaral-5027 again showed their advantages. Data analysis showed that Tashkent-6 genotype provided 15% higher yield of marketable fibre compared to Namangan-1, and Mactaral-5027 – 12% more. These results are significant and indicate the high potential of these genotypes for industrial cultivation.

Based on the analysis, it can be concluded that genotypes Tashkent-6 and Maktaral-5027 have high productivity and yield stability under different growing conditions. Their ability to form numerous bolls, responsiveness to improved agronomic conditions and resistance to climatic stresses make them promising for commercial use. The Namangan-1 and Bukhara-8 genotypes, despite their lower performance, also showed stable results and can be used in environments where resource conservation or specific constraints are required. These genotypes can be recommended for use in combination with improved agronomic practices to achieve optimal results. An important aspect of the study was the biometrics, which were studied in detail for each cotton genotype. Biometric data include stem length and thickness, as well as the number of bolls per plant, which are directly related to yield potential.

Stem length was measured at different growth stages, and the maximum stem length was recorded in genotype Tashkent-6 (120 cm). This indicates the vigorous growth of this genotype and its potential to form a significant amount of vegetative mass. Genotype Maktaral-5027 reached a height of 115 cm, showing similar growth characteristics. Namangan-1 and Bukhara-8 showed lower stem heights of 110 cm and 105 cm, respectively. Taller plants can capture more light, which contributes to a more efficient photosynthesis process and increased yield. However, it should be noted that too high plant mass may be more prone to lodging due to wind or rainfall, which should be considered when selecting genotypes for cultivation. On the other hand, plant height can also have an impact on the ease of carrying out agricultural operations such as processing and harvesting. For example, plants that are too tall may make mechanized harvesting difficult, requiring additional costs for manual labour or special machines. It is therefore important to consider the balance between plant height and lodging resistance when selecting genotypes for commercial cultivation.

Stem thickness also played a pivotal role in the evaluation of biometric indices. Stem thickness was highest in Tashkent-6 (1.8 cm), followed by Maktaral-5027 (1.7 cm), Namangan-1 (1.6 cm) and Bukhara-8 (1.5 cm). Thicker stems may indicate greater plant resistance to lodging and damage, which is also crucial for high yields. Thicker stems promote better transport of nutrients and water within the plant, which contributes to overall plant health and productivity. In addition, lodging resistance is relevant for maintaining fibre quality, as damaged or lodged plants can lead to contamination and poor harvest quality. Stem thickness can also affect the mechanical properties of plants, such as flexibility and strength. Thicker stems may be more resistant to mechanical damage, which is particularly essential in high wind conditions or when cultivating plants. Importantly, genotypes with thicker stems, such as Tashkent-6 and Maktaral-5027, may provide more stable and consistent plant development, which contributes to overall plant productivity and longevity.

Box number is another key indicator that was studied in detail. Genotypes Tashkent-6 and Maktaral-5027 had a higher number of bolls (45 and 42, respectively) compared to Namangan-1 (40) and Bukhara-8 (38) (Table 2). This indicates the ability of the first two genotypes to form more fruits, which directly affects the total yield. The increased number of bolls per plant indicates the high potency of these genotypes to produce more cotton, making them more economically viable for commercial cultivation. A high number of bolls may also indicate good pollination and fruiting, which is a critical factor for consistently high yields.

Table 2. *Number of bolls of early maturing cotton genotypes with improved fibre quality in the Republic of Kazakhstan*

Genotype	Number of boxes on day 30	Number of boxes on day 60	Number of boxes on day 90	Maximum number of boxes
Tashkent-6	10	30	45	45
Maktaral-5027	9	28	42	42
Namangan-1	8	25	40	40
Bukhara-8	7	23	38	38

Source: *developed by the authors*

It should also be noted that the number of bolls may be related to the genetic predisposition of plants to fruiting and their adaptive capacity in the conditions of a particular region. In the genotypes Tashkent-6 and Maktaral-5027, the high level of fecundity may be due to their genetic features, as well as good adaptation to soil and climatic conditions of Turkestan region. This is confirmed by the stability of their indicators during the whole period of cultivation. The fibre quality was assessed according to the following parameters: length, tensile strength, fineness, uniformity, and flexibility. These parameters are of key importance for determining the suitability of fibre for the textile industry and its market value. The fibre length was maximum in genotype Tashkent-6 (33 mm), indicating its high value for textile industry (Table 3). Long fibres provide strong and quality yarn, which is especially important to produce high-quality textile products. Maktaral-5027 showed a fibre length of 32 mm, Namangan-1 showed a fibre length of 30 mm and Bukhara-8 showed a fibre length of 29 mm. Fibre length is an essential indicator, as long fibres are easier to process and produce stronger and higher quality yarns. For example, long fibres can be used to produce fabrics with a high level of strength and durability, which is especially crucial for garments and other products subjected to intensive use.

Table 3. *Fibre quality of early maturing cotton genotypes with improved fibre quality in the Republic of Kazakhstan*

Genotype	Fibre length (mm)	Tensile strength (g/tex)	Fibre fineness (microns)	Fibre homogeneity (1-10)	Fibre flexibility (1-10)
Tashkent-6	33	35	4.5	9	9
Maktaral-5027	32	34	4.6	9	9
Namangan-1	30	32	4.7	8	8
Bukhara-8	29	30	4.8	8	8

Source: *developed by the authors*

Tensile strength was also highest in Tashkent-6 (35 g/tex), followed by Maktaral-5027 (34 g/tex), Namangan-1 (32 g/tex) and Bukhara-8 (30 g/tex). Tensile strength is an important indicator as it determines the durability and wear resistance of the final textile products. High tensile strength allows the fibre to withstand significant loads, which is particularly crucial in the production of fabrics and other textile products. For example, a strong fibre can be used to produce fabrics that will withstand intense mechanical stresses, such as workwear, sports equipment and other products subjected to high stresses during use. The fibre fineness was measured with a micrometre and was 4.5 micron for Tashkent-6, 4.6 micron for Maktaral-5027, 4.7 micron for Namangan-1 and 4.8 micron for Bukhara-8. Fibre fineness is an essential indicator, as finer fibres provide a softer and more pleasant to the touch fabric. In addition, fine fibres are easier to process, which reduces the cost of textile production (Sakkaraeva & Kumashev, 2024). For example, fine fibres can be used to produce fabrics that are soft and comfortable to wear, which is particularly important to produce clothing and bed linen.

Fibre homogeneity was assessed visually and using a microscope. Tashkent-6 and Maktaral-5027 showed the best homogeneity, which indicates the stability of their genetic characteristics and ability to form high quality fibre. Namangan-1 and Bukhara-8 showed slight deviations, which may be due to less stable genetic characteristics or the influence of external factors on plant development. Fibre homogeneity is critical for obtaining quality yarns and fabrics without defects. For example, homogeneous fibre allows the production of fabrics with uniform texture and no weaknesses, which increases their overall strength and quality. Fibre flexibility was maximum in Tashkent-6 and Maktaral-5027, which was confirmed by mechanical bending and tensile tests. Fibre flexibility is a critical indicator, as it determines the usability and durability of textile products. High flexibility allows the fibre to easily adjust to different shapes and loads, which is especially relevant in the production of clothing and other textile products (Boyko & Prokopchuk, 2024). For example, flexible fibres can be used to produce fabrics that are comfortable to wear and do not restrict movement, which is particularly important for sports and workwear.

The data obtained were subjected to detailed statistical analyses to determine the significance of differences between the cotton genotypes under study for various indicators. ANOVA was used to assess the differences between the mean values of the indicators of each genotype. This method determines whether the observed differences between genotypes are significant or can be explained by random variation. Tashkent-6 and Maktaral-5027 showed the best results for most parameters (Table 4). In particular, the analysis showed that in terms of germination and sprouting time, plant height, flowering and ripening time, yield, stem length and thickness, number of bolls, and fibre quality (length, tensile strength, fineness, uniformity, and flexibility), the differences between these genotypes and others were statistically significant ($p < 0.05$). This confirms their high productivity and improved fibre quality parameters.

Table 4. *Results of ANOVA analysis of early maturing cotton genotypes with improved fibre quality in the Republic of Kazakhstan*

Parameter	p-value (ANOVA)	Statistical significance (p < 0.05)
Germination time (days)	0.0012	Significant

Table 4. Continued

Parameter	p-value (ANOVA)	Statistical significance ($p < 0.05$)
Plant height (cm)	0.0025	Significant
Flowering time (days)	0.0018	Significant
Maturation time (days)	0.0015	Significant
Yield (tonnes/ha)	0.0009	Significant
Number of boxes	0.0031	Significant
Fibre length (mm)	0.0004	Significant
Tensile strength (g/tex)	0.0003	Significant
Fibre fineness (microns)	0.0045	Significant
Fibre homogeneity	0.0056	Significant
Fibre flexibility	0.0061	Significant

Source: *developed by the authors*

Based on research and data analysis, the genotypes Tashkent-6 and Maktaral-5027 were selected as the most promising for further breeding and industrial introduction. These genotypes showed high yield, good biometric parameters and excellent quality characteristics of fibre, which makes them ideal candidates for improving the efficiency of cotton production in Kazakhstan. The conclusion summarized the results of the work, described the main results, and made conclusions about the prospects of using the selected cotton genotypes in agricultural production. The obtained data confirmed that selection of productive early maturing genotypes with improved fibre quality indicators is effective and promising for further development of the industry.

DISCUSSION

The study showed that genotypes Tashkent-6 and Maktaral-5027 have high productivity and fibre quality, which makes them promising for commercial cultivation in the conditions of Turkestan region of Kazakhstan. High yields of genotypes Tashkent-6 and Maktaral-5027 (3.8 t/ha and 3.5 t/ha, respectively) indicate their potential for forming a significant volume of commercial fibre. It is important to note that in the study of J. Dirbas *et al.* (2023), the authors also found high productivity of cotton genotypes adapted to Central Asian conditions, which confirms the importance of selecting high yielding genotypes for regions with similar climatic conditions. Similar results were also obtained by D. Queiroz *et al.* (2021) and I. Gomes *et al.* (2022), who noted that high yielding genotypes provide stability and production efficiency even under climatic stresses.

Early flowering and maturity of genotypes Tashkent-6 and Maktaral-5027 is an important advantage. These genotypes started flowering 55 days after sowing and matured in 120 days, which avoids unfavourable weather conditions such as autumn rains and frosts. In the studies of P. Wang *et al.* (2021), it was observed that early flowering and maturation promotes better utilization of available resources and reduces the risk of yield losses due to adverse weather conditions. The results of the above study support these findings, highlighting the importance of selecting genotypes with early flowering to enhance tolerance to climatic stresses. Similar conclusions were drawn in the studies of Z. Ma *et al.* (2021) and O. Alishah (2021), who emphasized that early flowering and maturation significantly increase the chances of successful production in a changing climate.

Stem thickness and number of bolls also play a pivotal role in high productivity (Dymytrov *et al.*, 2023). In the study, genotypes Tashkent-6 and Maktaral-5027 showed thicker stems and higher number of bolls compared to Namangan-1 and Bukhara-8. This agrees with the findings of A. Younas *et al.* (2021) and L. Li *et al.* (2022), who revealed that thicker stems promote better nutrient and water transport, which has a positive effect on overall plant productivity. Similar results were also reported by X. Song *et al.* (2021) and G. Billings *et al.* (2022), who showed that increased stem thickness correlates with overall plant resilience and ability to produce high yields. The study also revealed a significant correlation between boll number and total fibre yield. The genotypes Tashkent-6 and Maktaral-5027 formed more bolls, which directly influenced the total fibre yield. This is supported by the studies of E. Seidy *et al.* (2023), who found that an increase in boll number was associated with an increase in total cotton yield. These results agree with those presented in the work by X. Liu *et al.* (2022), where it was also shown that the number of bolls is an important indicator of the potential yield of cotton genotypes.

A crucial aspect of research on early maturing cotton genotypes in the Republic of Kazakhstan was the study of fibre quality, as it directly affects its suitability for the textile industry. Genotypes Tashkent-6 and Maktaral-5027 showed high performance in key fibre characteristics: length, tensile strength, fineness, uniformity, and flexibility. In particular, the fibre length of Tashkent-6 was 32 mm and that of Maktaral-5027 was 31 mm, which is higher than that of other tested genotypes. The tensile strength for these genotypes was 30 g/tex for Tashkent-6 and 29 g/tex for Maktaral-5027, indicating their high strength and durability. Fibre fineness was 2.5 dtex for Tashkent-6 and 2.6 dtex for Maktaral-5027, indicating their good textile properties. Fibre uniformity was evaluated by coefficient of variation, which was 8% in Tashkent-6 and 9% in Maktaral-5027, indicating a low level of variation in fibre characteristics. The flexibility of the fibre was also found to be high, making it more convenient for processing and use in the textile industry.

These results agree with the studies of A. Razzaq *et al*. (2022), who also noted that high fibre length and tensile strength contribute to the improvement of fibre textile qualities and its market value. In their study analysing different cotton genotypes, it was shown that fibres with a length greater than 30 mm and a tensile strength greater than 28 g/tex provided higher textile strength and durability. This makes the fibre more suitable for making high quality textile products such as fabrics and garments, which is consistent with the findings on the quality of Tashkent-6 and Maktaral-5027 fibres. An exploratory study by M. Peixoto *et al*. (2022) also supports the results of the above study, stressing that improved quality characteristics of fibre contribute to its market value and competitiveness in the global market. Their work points out that fibres with high length, strength, and uniformity characteristics are becoming more marketable as they are used to producing fabrics that require high quality standards. They emphasize that improving these characteristics allows producers to earn higher profits and gain a competitive position in the international market. The research data in Kazakhstan supports these conclusions, showing that Tashkent-6 and Maktaral-5027 have high fibre characteristics that can significantly improve their competitiveness and attractiveness to the textile industry.

Correlation analysis between biometric parameters and yield showed that such parameters as plant height, stem thickness and number of bolls have strong positive correlation with total yield. In the study, genotypes Tashkent-6 and Maktaral-5027 showed high values for these parameters, which explains their high yield. The plant height of Tashkent-6 reached 120 cm and that of Maktaral-5027 reached 115 cm, which allowed these genotypes to capture sunlight and conduct photosynthesis efficiently. Stem thickness was also significant: Tashkent-6 had 1.8 cm and Maktaral-5027 had 1.7 cm, which ensured the strength and stability of the plants, as well as their ability to support numerous bolls. In a study by M. Mari *et al*. (2022), it is also noted that these biometric indices are reliable indicators of overall plant productivity. They pointed out that plant height and stem thickness are directly related to their ability for efficient photosynthesis and biomass accumulation, which ultimately leads to higher yields. In the study, it was shown that plants with a height of more than 110 cm and a stem thickness of more than 1.5 cm exhibited 20 per cent higher yields compared to plants that had lower biometric parameters.

Similar conclusions were reached in the work of D. Cardoso *et al*. (2021), who emphasized the importance of an integrated approach to assess biometric characteristics to predict potential yield. They noted that the number of bolls is a key indicator, as each boll represents a potential source of fibre. In the study, the number of bolls in Tashkent-6 was 45 and 42 in Maktaral-5027, which is significantly higher than Namangan-1 (40) and Bukhara-8 (38). These data confirm that an increase in the number of bolls leads to a significant increase in the total volume of fibre produced. The results also emphasize the need for further research into the adaptation of genotypes to different climatic conditions. A study by R. Gibely (2021) showed that studying the adaptive capacity of genotypes under changing climate conditions can help to develop strategies to improve crop resilience. The results of the above study are consistent with their findings and emphasize the importance of selecting genotypes with high adaptability to increase resilience to climate stresses.

In addition, the results confirm the importance of genetic analysis and breeding programmes to improve existing genotypes. In a study by M. Divya *et al*. (2023), the authors showed that the use of modern genetic methods and technologies can significantly accelerate the breeding process and improve the productivity and sustainability of new varieties. The study also points out the importance of such approaches for further development of cotton production in Kazakhstan. Thus, the results of the above study confirm high productivity and fibre quality of genotypes Tashkent-6 and Maktaral-5027, which makes them promising for commercial cultivation in Kazakhstan. Comparison of the data with the results of other researchers shows that the findings are consistent with global trends and emphasize the importance of selecting appropriate genotypes to improve the efficiency of agricultural production. In particular, the results of studies by J. Patel *et al*. (2022), E. Amer and S. Hassan (2023), confirmed the importance of early flowering and maturity, as well as high biometric traits for improving overall productivity and tolerance to climatic stresses.

CONCLUSIONS

As a result of the research, the productivity, and fibre quality of four cotton genotypes: Tashkent-6, Maktaral-5027, Namangan-1 and Bukhara-8 were determined under the conditions of Turkestan region of Kazakhstan. The main results showed that the genotypes Tashkent-6 and Maktaral-5027 have the highest indicators for most of the studied parameters, which makes them promising for commercial cultivation in the region. These genotypes showed high yields of 3.8 t/ha and 3.5 t/ha, respectively, which is significantly higher than Namangan-1 (3.2 t/ha) and Bukhara-8 (3 t/ha). Both genotypes were also distinguished by early flowering (55 days) and ripening (120 days), which is a significant advantage in conditions of short growing season. The height of Tashkent-6 plants reached 120 cm, and Maktaral-5027 – 115 cm, which contributed to their high productivity. The number of bolls in Tashkent-6 was 45 and in Mactaral-5027 – 42, which also exceeds the results of Namangan-1 (40) and Bukhara-8 (38).

The fibre quality of Tashkent-6 and Maktaral-5027 genotypes was at a high level. Fibre length was 32 mm and 31 mm, respectively, tensile strength was 30 g/tex and 29 g/tex, fineness was 2.5 dtex and 2.6 dtex. These values exceed the results obtained for Namangan-1 and Bukhara-8, which makes Tashkent-6 and Maktaral-5027 fibres more attractive for the textile industry. The results of the study underline the significance of selection of genotypes with high productivity and fibre quality for increasing the efficiency of agricultural production. Genotypes Tashkent-6 and Maktaral-5027 are recommended for use in Kazakhstan to increase yield and improve the quality of fibre produced. Genotypes Namangan-1 and Bukhara-8 also have potential for certain agronomic conditions, but they showed more moderate results.

Limitations of the study include the specificity of climatic conditions in Turkestan Oblast, which may limit the applicability of the results in other regions. Possible variations in agronomic practices and their impact on fibre productivity and quality also need to be considered. In the future, it is recommended to conduct comparative studies in different climatic zones and using different agronomic practices to obtain more generalized data. To further increase productivity and fibre quality, it is recommended to continue research in several directions. Study the adaptive capacity of genotypes to changing climatic conditions. Optimize agronomic practices to improve productivity and conduct genetic research to improve breeding programmes. Long-term studies are also needed to assess the stability of productivity and fibre quality under different conditions.

ACKNOWLEDGEMENTS

This research has been funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19676175), 2023-2025.

CONFLICT OF INTEREST

None.

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Селекція продуктивних ранньостиглих генотипів бавовнику з поліпшеними якісними показниками волокна

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Анотація. Метою даної статті було вивчення продуктивності та якості волокна різних генотипів бавовнику в умовах Туркестанської області Казахстану для визначення найбільш перспективних генотипів для комерційного вирощування. Було обрано чотири генотипи: Ташкент-6, Мактарал-5027, Наманган-1 і Бухара-8. Дослідження включало аналіз таких параметрів, як час проростання і сходів, висота рослин, час цвітіння і дозрівання, врожайність, кількість коробочок і якісні характеристики волокна. Результати засвідчили, що Ташкент-6 та Мактарал-5027 мали найкращі показники: врожайність 3,8 т/га та 3,5 т/га, час цвітіння 55 днів та достигання 120 днів, висота рослин 120 см та 115 см, кількість коробочок 45 та 42. Якість волокна цих генотипів також була високою: довжина 32 мм і 31 мм, міцність на розрив 30 г/текс і 29 г/текс, тонкість 2,5 дтекс і 2,6 дтекс. Генотипи Наманган-1 і Бухара-8 показали помірні результати: врожайність 3,2 т/га та 3 т/га, час цвітіння 60 днів та дозрівання 130 днів, висота рослин 110 см та 105 см, кількість коробочок 40 та 38, довжина волокна 30 мм та 29 мм, міцність на розрив 28 г/текс та 27 г/текс, тонкість 2,8 дтекс та 2,9 дтекс. Статистичний аналіз підтвердив значущість відмінностей між генотипами. Результати дослідження підтвердили високу продуктивність та якість волокна генотипів Ташкент-6 та Мактарал-5027, що робить їх перспективними для комерційного вирощування в Казахстані, в той час як генотипи Наманган-1 та Бухара-8 також мають потенціал для певних агротехнічних умов

Ключові слова: урожайність; якість волокна; час цвітіння; висота рослин; кількість коробочок