










Improvement of the Methodology for the Production of Elite Cotton Seeds Based on Terminology Unification

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Abstract. One of the main goals of cotton production in Uzbekistan is the development of high-yielding cotton varieties resistant to abiotic and biotic factors, as well as the establishment of a sustainable seed industry. A stable seed production infrastructure not only improves yields but also significantly enhances product quality. In this regard, the selection of the most optimal methods for the production of elite (basic) seeds is of great importance. The most widely used method of seed multiplication ensures the quality and longevity of a breeding variety. Standards must be harmonized with international requirements. Maintaining genetic identity through various methods of reproducing registered breeding varieties is one of the key goals to prevent accelerated genetic degradation during seed multiplication. To meet standardization requirements, it is crucial to develop an optimal, scientifically based methodology for producing elite (basic) cotton seeds, which is a mandatory condition in the seed industry. In recent years, great attention has been paid to the intensive development of the textile industry in the Republic of Uzbekistan, which is one of the main sources of employment and foreign currency income. Cultivating high-quality cotton seeds for sowing increases the amount of cotton raw material, ensures the production of fiber with high technological properties, and enables the manufacture of competitive products. One of the main objectives is to organize cotton fiber production, preserve and improve varietal diversity, and enhance seed quality. For this purpose, in the near future it is necessary to improve and introduce modern methods of obtaining original and elite seeds that ensure the dimensional uniformity and quality of promising varieties, and contribute to the preservation and improvement of valuable varietal characteristics under deteriorating environmental conditions and water scarcity.

Keywords: Cotton, seed production, variety, seeds, originator, elite, yield, product quality

1 Introduction

The production of elite (basic) certified seeds for the purpose of propagation and obtaining reproductive cotton seeds is the foundation of the seed production system. It plays an exceptionally important role in maintaining the purity of improved varieties, expanding the reproduction coefficient, and advancing the industrialization of seed production. To achieve high yields, cotton seed producers and ginning factories have gradually become more technologically advanced, which has significantly contributed to the popularization of new varieties and increased cotton output. In the 21st century, a multi-stage seed production system based on breeder-originator seeds has been introduced. This procedure corresponds to the practices of developed countries and is considered the most promising method of certified seed production, based on high-quality elite material.

Maintaining genetic identity through various methods of reproducing registered breeding varieties is one of the primary goals in preventing accelerated genetic degradation during seed multiplication. The development of an optimal methodology for the production of elite (basic) cotton seeds is a mandatory requirement in the seed industry.

It should be noted that international trade in agricultural products, including varietal seeds, requires the use of unified terminology for product identification. Comparative studies of terms and definitions reveal significant differences in the naming of identical products, which leads to difficulties in trade transactions.

For instance, breeder's seed refers to the first batch of a genetically stable variety or parental line produced by the breeder for further multiplication of basic seeds. In local terminology, these are referred to as pre-multiplication seeds.

Basic seeds in Uzbekistan are standardized as elite seeds. These are seeds of the first to third generations, obtained from the originator or produced under technical norms for basic seed production, meeting the quality standards of breeder's seed, and intended for the multiplication of certified (reproductive) seeds.

Stock seed refers to seeds obtained directly from breeder's seed or produced in accordance with the "Rules for the Production Technology of Cotton Stock Seeds," and meeting the quality standards for stock seeds.

The establishment of a base for elite seed production must correspond to the general socio-economic development requirements of agriculture and align with the national policy strategy for cotton industry development. The base should serve the sector, focus on market demand, consider international experience and local cotton variety resources, optimize varietal structure, increase yield per hectare, improve cotton quality, and achieve specialization, scale, standardization, and industrialization of certified (high-quality) seed production.

Researchers and breeders worldwide have proposed various methods for the production and procurement of cotton seeds. In particular, scholars such as Saha S., Bakhsh A., Rehman M., Salman S., Yu.P.Altukhov, and Ya.Meredov conducted scientific research on cotton breeding, seed production, and methods used in seed propagation.

In Uzbekistan, scientists such as O.V.Kratirov, I.I.Iksanov, P.Sh.Ibragimov, Sh.S.Kozubaev, A.A.Narimanov, and A.B.Amanturdiev have carried out research on cotton seed reproduction, simplification of the seed production system, improvement of varietal quality, and enhancement of analysis precision.

2 Materials and methods

The main method for comparison was the “Method for the Production of Zonal Elite and First-Reproduction Cotton Varieties,” approved by the Ministry of Agriculture of the Republic of Uzbekistan.

The objects of research were breeding varieties of cotton — Bukhara-6, S-7510, S-6530, and S-6524 — belonging to fiber types IV and V.

Field experiments were conducted in experimental plots of Tashkent region, as well as in elite seed farms in Bukhara, Fergana, and Khorezm regions of Uzbekistan, whose soil and climatic conditions differ significantly. In addition, the soils of elite seed farms in Bukhara and Kashkadarya regions were characterized by weak to moderate salinity. Statistical analysis of the obtained results and seed multiplication activities aimed at ensuring high homogeneity were conducted according to the methods of B.A. Dospikhov (1985) and the manual of O.V. Kratirov (1981) “Multiplication of Elite and First-Reproduction Cotton Variety Seeds”.

3 Results

In the process of elite seed production, various biological and agrotechnological requirements may change depending on specific conditions. This is due to factors such as reproduction, mutations, mechanical and biological contamination, and plant diseases. For these reasons, during subsequent reproductions, varieties may deteriorate or even degrade. Therefore, the currently existing methods of producing pre-elite and elite seeds do not fully meet modern ecological and economic requirements, making it necessary to improve them through in-depth scientific research.

In the 1950s, in connection with the replacement of cotton variety mixtures with stable varieties, primary and elite seed production work was organized based on a unified mass approach to evaluating and selecting elite material.

In practice, although the approved instruction recommended two methods- (1) using crossing and (2) selection without crossing- the latter has predominated in recent years. The method of selection without intravarietal crossing includes progeny testing in a two-year pre-elite (pre-basic) multiplication cycle. In the first year, 300 selections and 50 family selections are grown on 1 hectare. In the second year, 1,500 selections and 400 family selections are grown on 1 hectare. Based on the results, elite (basic) seed production includes 300 selections, 70 family selections, and 250 family selections for further multiplication.

Usually, a stabilized variety, even after many generations (elite reseeded), maintains its agronomic and biological characteristics that determine productivity. Undesirable hereditary changes in certain traits appear sporadically in some plants and are not immediately visible without prolonged natural selection; thus, varietal deterioration occurs gradually. The issue of elite seed selection methods in Uzbekistan has been debated for many years. Specialists have yet to reach a unified opinion. There are two main reasons for this.

First, unlike other crops, the breeder-originator of a cotton variety typically does not participate directly in elite seed cultivation after its zoning.

Second, the breeder-originator hesitates to assume full responsibility for maintaining varietal purity, as this responsibility is considerable.

To address this issue, we conducted comparative studies of the most common elite seed production methods, since foreign methodologies differ significantly from those used in Uzbekistan. The comparison results are shown below. (Table 1).

Table 1. Comparative analysis of cotton varietal seed production methods

№	Method Name	Seed Production by Year					
		Year 1	Year 2	Year 3	Year 4	Year 5	and so on
1	Mass selection of a large number of typical plants	Selection of 40,000 individual plants	Combining 40.0 thousand individual plants and sowing as elite seed	R ₁	R ₂	R ₃	
2	Field cleaning of atypical plants	Initial field: 10,000 individual plants	Super-elite nursery	Elite nursery	R ₁	R ₂	R ₃
3	Modal sampl system	6,000 individual plants	Original nursery 500 individual plants	Super-elite	Elite	R ₁	R ₂ and so on
4	Progeny row testing	Elite plot, selection and rejection acting.	Nursery 1 year	Nursery 2 year	Super-elite	Elite	R ₂ and so on
5	Repeated progeny and line testing	1,000 individual plants	Nursery 2 year	Super-elite	Elite	R ₁	R ₂ and so on
6	Pedigree system	1,000 individual selections. Field & lab testing	Field and laboratory testing, selection of the best families	Continuing marriages and selecting top families	Continuing	Continuing	Leaving the best line
7	Seed reservation and storage system	A large quantity of e.c. is prepared to obtain 1000 kg of seeds.	100 kg of seed. Original nursery	Super-elite	Elite	R ₁	R ₂ and so on

Method 1. Mass selection of a large number of typical, productive plants of the variety: Farmer's field. Selection of 40,000 individual plants. No analyses are performed. From the 40,000 combined selections, elite fields are established — that is, reproductive fields.

Method 2. Field purification from atypical plants: Main field. 10,000 plants, 10,000 variants. Super-elite and elite nurseries are created, i.e., reproductive fields.

Method 3. Modal sample system: 6,000 plants. Multiplication nursery. 500 individual selections. Super-elite and elite nurseries are established, i.e., reproductive fields.

Method 4. Progeny row testing: First-year nursery, second-year nursery. Super-elite and elite nurseries are established, i.e., reproductive fields.

Method 5. Repeated progeny and line testing: Individual selection of 1,000 plants (0.8 ha). First-year nursery, second-year nursery. Super-elite and elite nurseries are established, i.e., reproductive fields.

Method 6. Pedigree system: Planting of 1,000 individual selections. Year 1 – field and laboratory testing, selection of the best families. Year 2 – continuation of field and laboratory testing, selection of the best families. Year 3 – the best line is retained. Reproductive fields are established.

Method 7. Seed reservation or storage system: 1,000 kg of seeds stored for 10 years. Original seeds, super-elite, and elite generations are produced, i.e., reproductive fields.

It should be noted that in such systems, the potential for improving the initial variety through seed production is naturally lost. In developed countries, specialized seed companies are engaged not only in seed multiplication but also in improving the commercial properties of new cotton varieties. In practice, no single universal method exists for producing high-quality fertile seeds.

To select the most appropriate methods and test them on cotton varieties currently cultivated in Uzbekistan, we considered several approaches proposed by I.S. Varuntsyan (1971).

The Turkmen scientist Ya. Meredov proposed a method for renewing highly reproducible cotton seeds. This method was not previously applied in Uzbekistan. When reviewed in 1984, several shortcomings were identified, and it was decided that the method could be used only for production purposes (O.V. Kratirov, 1988).

After analyzing this method—based on single periodic selections conducted once every few years—we attempted to modify it. According to our adaptation, individual selection should be carried out every five years. This allows the preservation of the original economic indicators and genetic similarity of registered varieties.

In the first year of working with a variety, in collaboration with the breeder-originator, 10–15 thousand individual selections were made. Fiber quality was determined using HVI testing after ginning each sample. Based on these results, inferior lines were discarded, and the remaining seeds were combined and then divided by quartz sterilization into five equal parts. One part was sown in the original nursery that same year, and the remaining parts were sown in subsequent years.

However, changing economic and environmental conditions necessitate further modification of this approach to adapt to evolving realities—an issue that warrants separate discussion.

It should be emphasized that developing a new methodology requires revising existing standards. For instance, in the 1930s, during variety replacement programs, elite seed production was organized using a mass approach to evaluating and selecting elite material. Requirements for varietal purity differed significantly among systems.

According to the national standard O'zDSt 663:2017 “Seed Cotton – Technical Specifications,” the technical requirements for cotton seeds in terms of varietal purity and

quality indicators for the preparation of super-elite and elite (basic) seeds differ considerably from those set by the UNECE Organization Standard S-1 (Economic Commission for Europe).

For sowing, seeds of super-elite, elite, and first (R1), second (R2), and third (R3) reproduction generations of registered cotton varieties were used. These varieties are listed in the State Register and recommended for cultivation in Uzbekistan. With permission from the Ministry of Agriculture, seeds of the fourth reproduction generation (R4) may also be used if necessary.

Table 2. Quality Standards for Cotton Seeds

Seed Reproduction		Varietal Purity (Minimum %)	
According to O'zDSt 663:2017	According to UNECE S-1	According to O'zDSt 663:2017	According to UNECE S-1
Super-elite / Elite	Super-elite / Elite (Basic seed)	100	99.8
R ₁	R1 (Certified seed)	99	99.5
R ₂	R2	98	—
R ₃	R3	96	—

Prepared seeds must meet the norms shown in Table 2 with respect to germination rate, moisture content, contamination (percentage of mineral and organic impurities), fuzziness, mechanical damage, and residual fiber content.

Regarding fuzziness, delinted seeds must correspond to officially approved standard samples. However, according to the UNECE S-1 classification schemes, the requirements differ significantly from those in O'zDSt 663:2017.

4 Conclusion

After analyzing and integrating the results of all the methods described, we conclude that under the current ecological, economic, and social conditions of seed production in Uzbekistan, it is advisable to apply the proposed and improved “Seed Reservation System”.

According to this approach, elite reproduction is conducted once every five years, and annually one-fifth of the reserved stock is used for production.

This system allows longer preservation of the breeder's originally established economically valuable traits and genetic uniformity of varieties. It is important to emphasize that while, under the existing methodology, the decline of initial varietal qualities occurs after approximately five years, under the reservation system it can be delayed up to twenty-five years. This is because mechanical contamination and biological degradation of the variety are minimized.

In the context of Uzbekistan, it is necessary to develop a new method for breeding and producing original, super-elite, and elite seeds using the most effective techniques and approaches to elite preparation, to unify terminology, and to generally advance the production technology.

This should be based on international standards and rules applied in advanced cotton-growing countries.

The above-mentioned field and laboratory experiments have proven to be reliable tools for high-quality reproduction of promising cotton varieties. Moreover, these studies enable seed specialists to more precisely identify specific terminology and methodologies that enhance efficiency in the reproduction and trade of high-quality seeds of competitive breeding varieties.

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