Complex Agrotechnical Measures and Their Effect on the Number of Bolls, Cotton Yield per Boll, 1000-Seed Weight and Fiber Output in Cotton Varieties

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Abstract. Depending on the application of complex agrotechnical measures, in the “Ganja-182” cotton variety, under the planting scheme of 74,000 plants per hectare (90x15x1), with sowing carried out on April 25, application of $N_{120}P_{75}K_{50}$ fertilizer per hectare, thinning on May 15, and irrigation regime 1-4-0, the number of fruiting bodies was 14, of which 4 (32,7%) were shed. This indicator was 5–7 units higher compared to other variants. In the “Beyaz-Altun” variety, the results were slightly lower. The highest performance in this variety was also obtained under the planting scheme of 74,000 plants per hectare (90x15x1), sowing on April 25, application of $N_{120}P_{75}K_{50}$ fertilizer per hectare, thinning on May 25, and irrigation regime 1-4-0, where the number of fruiting bodies was 9, of which 4 (44,4%) were shed.

The weight of raw cotton per boll, the number of bolls per plant, fiber yield, and the weight of 1000 seeds were higher in both varieties under the planting scheme of 74,000 plants per hectare (90x15x1), with sowing on April 25, application of $N_{120}P_{75}K_{50}$ fertilizer per hectare, thinning on May 15, and irrigation regime 1-4-0.

Keywords: Complex Agrotechnical Measures, Cotton, Boll, Raw Cotton Yield Per Boll, Fiber Yield, 1000-Seed Weight.

1 Introduction

Cotton is a leading cash crop and is regarded as “white gold,” being cultivated in more than 80 countries worldwide. According to the International Cotton Advisory Committee (2018), cotton production in Asia and the Americas accounts for over 80% of total global output, with Asia alone producing 70% of the world’s cotton, making it the largest cotton-producing continent. At present, more than half of the clothes worn by people are made from cotton. For better growth and higher productivity, cotton requires a wide range of macro- and microelements. Nitrogen is the primary essential macronutrient in agricultural production, and fertilizers based on nitrogen are vital for cotton cultivation. Since nitrogen is more expensive than other fertilizers, it is considered one of the most limiting factors in cotton production.

Soil and climatic conditions leave a significant imprint on the dynamics of nutrient transformations in the soil. In irrigated cotton-growing soils, the ammonium form of nitrogen in fertilizers rapidly undergoes nitrification, and due to the upward flow of water, nitrates accumulate in the upper soil layers (1–5 cm). Therefore, when fertilizers are applied before sowing, the amount of nitrogen in the root zone decreases sharply by the flowering stage, creating a need for additional nitrogen supplementation. Moreover, reducing nitrate accumulation in the soil surface layer can be achieved through the combined use of organic and mineral fertilizers.

In calcareous soils, water-soluble phosphorus compounds are quickly transformed into tricalcium phosphates. The formation of such hardly accessible phosphorus compounds occurs more intensively in meadow and meadow-swamp soils with higher amounts of sesquioxides. Due to the low mobility of phosphates in the soil, most of the annual dose

A. M. Bozdoğan et al. (eds.), *Proceedings of the 5th International Conference on Research of Agricultural and Food Technologies (I-CRAFT 2025)*, Atlantis Highlights in Sustainable Development 8,
https://doi.org/10.2991/978-94-6239-666-1_30

of phosphorus fertilizers should be applied before plowing, while a smaller portion should be applied at maximum possible soil depths.

On average, to produce one ton of raw cotton, plants consume 40–50 kg of nitrogen (N), 15–20 kg of phosphorus (P_2O_5), and 50–60 kg of potassium (K_2O). The highest nutrient uptake occurs from the beginning of flowering until the stage of mass boll opening. Although nutrient uptake in the early development stages is relatively low, cotton is highly sensitive to phosphorus and nitrogen deficiencies, as these elements are easily absorbed from the soil. The greatest vegetative growth in early stages is observed when phosphate fertilizers are applied. During flowering and fruit formation, plants supplied with nitrogen, and especially a combination of nitrogen and phosphorus, grow and develop more intensively.

The first stage of cotton development is characterized by nutrient consumption from the soil to build vegetative mass. In the second stage (from budding), the decisive factor is the redistribution of nutrients within the plant from vegetative to reproductive organs. However, nutrient uptake from the soil continues and can significantly affect yields.

From the perspective of nitrogen and phosphorus nutrition, the critical period for cotton is the initial development stage. Delays in the application of these fertilizers lead to the postponement of budding, flowering, and boll opening.

Research is currently being conducted to determine the optimal sowing methods and fertilizer application rates to develop more effective agrotechnical practices for farmers.

At present, one of the main challenges of agriculture in Azerbaijan is the application of resource-saving innovative technologies in cotton production. Their implementation helps reduce total and production costs, increase productivity and quality, and improve the population's standard of living. Resource-saving technologies include zero tillage, stubble sowing, drip irrigation, sprinkler irrigation, mulching, and others. The introduction of innovative technologies in cotton production allows water savings of over 30% and increases cotton yield by 3–5 quintals per hectare.

According to [11], the global demand for fertilizers increased annually by 1.8% between 2017 and 2019. Plants absorb nitrogen in the forms of NO_3^- and NH_4^+. Nitrogen is an element that supports plant growth, increases yield and quality, enhances photosynthesis and leaf development, and accelerates vegetative growth. Reduced nitrogen content leads to premature aging and affects boll formation. Nitrogen deficiency first appears in older leaves, with chlorosis as the main symptom due to its connection with chlorophyll molecules. This deficiency slows cotton growth, causing stunted plants.

Nitrogen deficiency also negatively affects cotton productivity. Shedding of bolls within the first 10–12 days after flowering is a sign of nitrogen deficiency. Reduced fruiting on branches, reddening of the middle canopy at the end of the season, shortened flowering duration, accelerated leaf aging, and weakened stems are all indicators of nitrogen shortage in cotton.

The "State Program on the Development of Cotton Production in the Republic of Azerbaijan for 2017–2022" was aimed at strengthening state support for cotton growing and addressing challenges in the sector.

Furthermore, with the adoption of the Law of the Republic of Azerbaijan "On Cotton Growing" (No. 1012-IIQ, May 11, 2010), the President of Azerbaijan, Mr. Ilham Aliyev, issued official instructions to relevant organizations to accelerate the development of this field [1].

Sowing methods and fertilizer application rates play a crucial role in the life cycle of cotton. Each of these factors contributes significantly to increasing yield, improving fiber quality, and enhancing overall production efficiency.

2 Materials and Methods

A comparative study was conducted to investigate the effects of different sowing schemes, plant densities, sowing and thinning dates, fertilizer application rates, and irrigation regimes on the number of fruiting organs, the weight of raw cotton per boll, fiber yield, and the weight of 1000 seeds in the cotton varieties Ganja-182 and Beyaz-Altun.

The research was carried out in the Beylagan district, in the farm of Vagif Ahmadov, located in the settlement of Guneshli. In setting up the field experiments, methodologies developed by B.A. Dospekhov, N.N. Baranova, and S.Z. Allahyarov were applied.
The experiment consisted of 8 variants, with each variant replicated four times. Each replication had a length of 20 meters and a width of 2,4 meters, making the area of one replication 48 m^2. Consequently, the area of one variant was 192 m^2, and the total experimental field covered 1152 m^2.

3 Results and Discussion

In the conditions of the Mil plain, the effects of sowing methods, fertilizer application rates, irrigation, and harvesting times on the structural indicators of cotton varieties were studied. The results showed that these indicators differed depending on the agrotechnical measures applied. The number of bolls, the weight of raw cotton per boll, and the weight of 1000 seeds varied among the studied varieties under different treatments.
Reported that sowing dates play an important role in all growth phases of the cotton plant. A comparative study was carried out with the varieties Ganja-2 and Ganja-80 under different sowing dates. It is well known that the optimal sowing period for cotton is when the soil temperature reaches 12–14°C. However, recent climate variability has required certain adjustments in sowing times. In the referenced study, sowing was performed on April 10, April 20, and April 30 for both varieties. The best results were observed when sowing was conducted on April 20 [4].
According to [6], the ability of each plant to provide high and quality yields depends on the proper execution of breeding activities, the productivity of selected varieties and hybrids, and their resistance to diseases and pests. Any cultivated plant variety must preserve its genetic characteristics for a long time. In recent years, greater emphasis has been placed on innovative technologies in the creation of new plant varieties [6].
[10] emphasized that the basis of high yields lies in the variety itself. The more resistant the variety, the higher its productivity. Newly developed cotton varieties should be correctly zoned, taking into account soil and climatic conditions. In subtropical regions and the southern temperate zones, cultivated varieties are usually of short-stemmed forms. Therefore, when selecting parent forms, their biological and morphological traits should be carefully considered. Breeding, as an evolutionary process, is based on general laws of genetics. When breeding is carried out, the principles of genetics are applied, and this process replaces natural selection with artificial selection [10].
[7] concluded that the genetic potential of varieties is not identical. Both fine-fibered and medium-fibered cotton types have their specific genetic capacities. Their vegetation periods, productivity, fiber yield, and technological traits vary significantly. Natural and climatic conditions, as well as stress factors, sometimes influence the structural characteristics of varieties. However, under optimal agrotechnical conditions, any given variety can preserve its genetic traits for an extended period [7].
[8] stated that optimizing fertilizer application rates can significantly increase raw cotton yield per unit area.
[8] also emphasized that fertilizers should be applied in two forms: as base fertilizers and as top-dressing during the vegetation period. Experiments on the use of nitrogen and phosphorus at different growth stages showed that cotton absorbs nutrients most intensively during the budding and fruit formation stages. This is because these stages coincide with the rapid growth of both vegetative (stem, branches) and generative (fruiting) organs. As with other crops, cotton fertilization should be carefully coordinated with root system development [8].
Found that in the Ganja-103 variety, under ridge sowing and application of $N_{120}P_{75}K_{50}$ kg/ha, the weight of 1000 seeds ranged from 114–118 g. In the same sowing method, when $N_{150}P_{100}K_{75}$ fertilizer was applied, the weight increased to 116–122 g. In the Ganja-110 variety, ridge sowing with $N_{120}P_{75}K_{50}$ kg/ha resulted in a 1000-seed weight of 115–119 g, while $N_{150}P_{100}K_{75}$ application increased this to 122–126 g. The indicators for the Ganja-110 variety were higher compared to Ganja-103, showing that both ridge sowing and increased fertilizer rates had positive effects [5].

[2] highlighted that, according to long-term observations, all planned agrotechnical activities must be carried out at optimal times in line with the annual agrotechnical calendar. In cotton production, the first activity begins with cleaning crop residues from the fields. In January, preparation for spring fieldwork is conducted, temporary irrigation channels are created, and winter plowing is performed to collect moisture in the soil, ensure timely seed germination, and support normal plant development during the growing season. In February, sowing machinery is prepared, and seed treatment is completed in centralized facilities. In March, fields are leveled, and if necessary, irrigation is performed at a rate of 1300–15900 m^3 per hectare. Along with sowing, 100–120 kg of decomposed manure per hectare is applied. Sowing begins in April when soil temperatures reach 12–14°C. After emergence, thinning is performed at the 2–3 leaf stage. Subsequent agrotechnical measures—cultivation, fertilizer top-dressing, irrigation, weed control, pest and disease management, topping, harvesting, and transportation—are all carried out at optimal times according to the calendar [2].

[9] noted that cotton is highly demanding in terms of water and nutrients. Depending on the biological and morphological traits of cultivated varieties, plant density must be properly regulated. When this requirement is met, it becomes possible to obtain high yields with superior fiber quality per unit area [9].

[3] Apart from the main nutrients, various microelements also play a significant role in the life of the plant. These elements accelerate biochemical reactions within the plant, thereby enhancing the absorption of nitrogen, phosphorus, and potassium, and consequently increasing productivity. Since plants absorb microelements from the soil in very small quantities, they are also applied to the soil in limited amounts. These fertilizers may be introduced simultaneously with the seeds, before sowing in combination with the main fertilizers, during sowing, or during top-dressing. In order to increase the germination energy of seeds, they should be soaked in a 0.01–0.05% solution of microelements prior to sowing.

In modern practice, the following micronutrient fertilizers are applied per hectare in terms of active substance: boron-containing fertilizers such as borax and boric acid (1–1.5 kg); zinc-containing fertilizers such as zinc sulfate (3–4 kg); copper-containing fertilizers such as copper sulfate and copper ammonium phosphate compounds (2–3 kg); and molybdenum-containing fertilizers such as ammonium molybdate (0.5 kg) [3].

As can be seen from Table 1, depending on the biological and morphological characteristics of the varieties, the sowing scheme, plant density, sowing dates, thinning periods, fertilizer rates, and irrigation regimes had different effects on the number of bolls per plant, cotton yield per boll, 1000-seed weight, and fiber output.

For the Ganja-182 variety:

In the 90x15x1 (74,000 plants/ha) scheme, sown on April 15, with $N_{100}P_{50}K_{40}$, thinning on May 5, and irrigation 1-3-0, the number of fruiting organs per plant was 12, yield per boll was 5,9 g, fiber output 37,1%, and 1000-seed weight 122–124 g.

In the 90x10x1 (111,000 plants/ha) scheme, sown on April 25, with $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0, the number of fruiting organs per plant was 8, yield per boll 5,5 g, fiber output 36,6%, and 1000-seed weight 115–120 g.

In the 90x15x1 (74,000 plants/ha) scheme, sown on April 25, with $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0, the number of fruiting organs per plant was 14, yield per boll 6,2 g, fiber output 37,8%, and 1000-seed weight 124–127 g.

For the Bayaz-Altun variety:

In the 90x10x1 (111,000 plants/ha) scheme, sown on April 15, with $N_{100}P_{50}K_{40}$, thinning on May 5, and irrigation 1-3-0, the number of fruiting organs per plant was 5, yield per boll 3,6 g, fiber output 39,2%, and 1000-seed weight 78–81 g.

In the 90x15x1 (74,000 plants/ha) scheme, sown on April 15, with $N_{100}P_{50}K_{40}$, thinning on May 5, and irrigation 1-3-0, the number of fruiting organs per plant was 7, yield per boll 4,2 g, fiber output 41,6%, and 1000-seed weight 82–84 g.

In the 90x10x1 (111,000 plants/ha) scheme, sown on April 25, with $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0, the number of fruiting organs per plant was 6, yield per boll 3,9 g, fiber output 40,4%, and 1000-seed weight 81–83 g.

In the 90x15x1 (74,000 plants/ha) scheme, sown on April 25, with $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0, the number of fruiting organs per plant was 9, yield per boll 4,8 g, fiber output 42,7%, and 1000-seed weight 84–87 g.

4 Conclusion.

1. In the Ganja-182 variety, under the 74,000 plants/ha (90x15x1) sowing scheme, sown on April 25, with fertilizer rate $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation regime 1-4-0, the number of fruiting organs reached 14, with 4 aborted (32,7%). Compared to other variants, this was 5–7 organs higher. In the Bayaz-Altun variety, the indicators were somewhat lower. The highest performance in this variety was observed under the 74,000 plants/ha (90x15x1) scheme, sown on April 25, with

Table 1. Complex agrotechnical measures and their effect on the number of bolls, cotton yield per boll, 1000-seed weight, and fiber output in cotton varieties

Options						The number of bolls per plant	The cotton yield per boll, gram	Fiber output, %	1000-seed weight, gram
Varieties	Sowing scheme and plant density	Sowing dates	Thinning periods	Fertilizer rates (kg/ha)	Irrigation regime				
Ganja-182	111,000 plants/h (90x10x1)	April 15	May 5	$N_{100}P_{50}K_{40}$	1-3-0	7	5,2	36,0	114-119
	74,000 plants/ha (90x15x1)	April 15	May 5	$N_{100}P_{50}K_{40}$	1-3-0	12	5,9	37,1	122-124
	111,000 plants/h (90x10x1)	April 25	May 15	$N_{120}P_{75}K_{50}$	1-4-0	8	5,5	36,6	115-120
	74,000 plants/ha (90x15x1)	April 25	May 15	$N_{120}P_{75}K_{50}$	1-4-0	14	6,2	37,8	124-127
Bayaz-Al-tun	111,000 plants/h (90x10x1)	April 15	May 5	$N_{100}P_{50}K_{40}$	1-3-0	5	3,6	39,2	78-81
	74,000 plants/ha (90x15x1)	April 15	May 5	$N_{100}P_{50}K_{00}$	1-3-0	7	4,2	41,6	82-84
	111,000 plants/h (90x10x1)	April 25	May 15	$N_{120}P_{75}K_{50}$	1-4-0	6	3,9	40,4	81-83
	74,000 plants/ha (90x15x1)	April 25	May 15	$N_{120}P_{75}K_{50}$	1-4-0	9	4,8	42,7	84-87

$N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0, where the number of fruiting organs was 9, with 4 aborted (44,4%).
2. The cotton yield per boll, number of bolls per plant, fiber output, and 1000-seed weight in both varieties were higher in the variants with 74,000 plants/ha (90x15x1), sown on April 25, with $N_{120}P_{75}K_{50}$, thinning on May 15, and irrigation 1-4-0.

References

1. Aliyev, I.H. State Program for the Development of Cotton Growing in the Republic of Azerbaijan for 2017–2022. Baku, July 13, (2017).
2. Jumshudov, I.M., Shabandaiyev, D.Z., Dunyamaliev, S.A., Abbasov, R.A., Mustafayev, R.I. What Farmers Should Know in Agriculture. Baku, 320 p. (2018)
3. Seyidaliyev, N.Y. Fundamentals of Cotton Growing. Textbook. “Sharq-Qarb” Publishing House, Baku, 325 p. (2012).
4. Seyidaliyev, N.Y., Khalilov, Kh.Q., Mammadova, M.Z. Influence of Different Sowing Methods and Fertilizer Norms on the Number of Bolls, Cotton Yield per Boll, 1000-Seed Weight, and Fiber Output in Cotton Varieties. Proceedings of the Republican Scientific Conference “New Directions in the Development of Agricultural Enterprises and Environmental Protection”. Western Caspian University Publishing and Printing Center, Baku, pp. 34–36. (2021)
5. Tagiyeva, S.B. The Effect of Sowing Method and Fertilizer Norms on 1000-Seed Weight in Cotton Varieties. Scientific Works of ADAU (Supplement-1, Young Researchers’ Tribune). Ganja, pp. 10–11. (2022)
6. Dragavtsev, V.A., Yakushev, V.P. Innovative Plant Breeding Technologies for Increasing Productivity and Yield. Proceedings of Kuban State Agrarian University, **3**(54), 130–137. (2015)
7. Kumar, K.S., Ashokkumar, K., Ravikesavar, R. Genetic Effects of Combining Ability Studies for Yield and Fibre Quality Traits in Diallel Crosses of Upland Cotton (*Gossypium hirsutum* L.). African Journal of Biotechnology, **13** (1), 119–126. (2014)
8. Mammadova, M.Z. Effect of Fertilizers on Raw Cotton Weight. In: Fundamentals of Rational Nature Use. Proceedings of the V International Scientific-Practical Conference, Saratov, pp. 119–124. (2016)
9. Seyidaliyev, N., Khalilov, Kh., Mammadova, M. Influence of Different Methods and Fertilization Rates on the Structural Performance of Cotton Varieties. Research in Agricultural & Veterinary Sciences, **5**(3), 117–120. (2021)
10. Balcı, Sh., Cınar, V.M., Unay, A. A. Study on Genetic Advance and Heritability for Quantitative Traits in Cotton (*Gossypium hirsutum* L.). ADU Ziraat DCRC, **17**(1), 1–4. (2020)
11. FAO. https://www.fao.org/faostat/en/#data/QCL (2015)