European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 6 No. 02 February 2025
ISSN: 2660-5643

THE EFFECT OF SALINITY ON THE INITIAL GROWTH PARAMETERS OF FINE-FIBRE COTTON VARIETIES (*GOSSYPIUM HIRSUTUM L.*)

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Article history:
Received: 10th November 2024
Accepted: 8th December 2024

Abstract:
This article presents data on the initial growth parameters of fine-fibre cotton varieties under soil salinity conditions. Laboratory experiments were conducted to examine the effects of soil salinity on the fine-fibre cotton varieties Surkhan-16, Surkhan-18, Termez-202, Termez-208, and SP-1607. The experiments were carried out in laboratory conditions using containers with a capacity of 2 kg of soil. The first group of containers contained non-saline soil, while the second group had soil treated with a 0.3% sodium chloride (NaCl) solution to simulate salinity conditions. During the experiments, key growth indicators such as root growth rate, root volume, stem length, leaf surface expansion, fresh weight of the seedlings, and total water content in the plant tissues were analyzed. The results revealed that these parameters varied significantly among the studied varieties, depending on their salinity tolerance and biological characteristics. The findings highlight the importance of selecting appropriate fine-fibre cotton varieties for cultivation in saline soils, as their adaptability and resistance levels play a crucial role in ensuring stable growth and development under salinity stress.

Keywords: fine-fibre cotton, varieties, soil salinity, root growth, root volume, leaf surface area, total water content, stress, tolerance, adaptation.

1. INTRODUCTION

Cotton (*Gossypium spp.*) is a vital fibre crop cultivated worldwide. In recent years, its production has faced significant challenges due to climate change and an increase in abiotic stress factors. These stressors negatively affect the overall yield and quality of cotton fibre and seeds, potentially leading to a 50% reduction in global cotton production [1-5]. Given cotton's essential role in the textile industry and food sector, any decline in yield caused by abiotic stress may result in substantial global economic consequences.

Cotton is a key raw material for the textile industry, household goods, and pharmaceutical products. Additionally, cottonseed contributes to fulfilling human dietary oil needs. However, severe abiotic stresses such as extreme temperatures (both high and low), drought, soil salinity, heavy metals, and radiation significantly disrupt the normal physiological and metabolic processes of cotton plants [6-8].

Plant organisms constantly face multiple environmental stressors, including soil salinity, drought, inadequate or excessive moisture, extreme temperatures, and soil contamination by pesticides. Among these, soil salinity stands out as a major stress factor. Similar to other stressors, salt stress induces oxidative stress by generating and accumulating reactive oxygen species (ROS), which slow down cellular functions [9-11].

At high concentrations, ROS reduces the natural defense mechanisms of cells, leading to oxidative damage to DNA, lipid peroxidation, protein alterations, and various pathological processes that can harm or kill the organism. Ultimately, these processes cause significant yield losses in essential agricultural crops. Therefore, identifying antioxidant and antiradical compounds that enhance plant tolerance to stress, particularly salinity, remains a critical scientific objective [4].

Fine-fibre cotton varieties command higher market prices than medium-fibre varieties due to their unique fibre quality. Fine-fibre cotton is predominantly cultivated in the hottest regions worldwide, with limited cultivation areas. While medium-fibre cotton varieties are grown in 87 countries, producing around 19.5-20 million tons of fibre, only 1.2 million tons come from fine-fibre varieties.

Fine-fibre cotton varieties are primarily grown in Egypt, Uzbekistan, Turkmenistan, Tajikistan, Sudan, Peru, Brazil, and the United States. In Uzbekistan, the southern regions of Surkhandarya, Kashkadarya, Bukhara, and Navoi provide favourable soil and climatic conditions for these varieties. The primary goal of agriculture is to use land resources efficiently to produce abundant and high-quality cotton, grain, and other crops. Fine-fibre cotton varieties are known for their heat-loving characteristics and resilience to drought and hot winds.

Selecting appropriate cotton varieties for each region's soil and climatic conditions and implementing suitable agrotechnologies to manage stress factors are among the most pressing challenges in modern cotton production.

2. MATERIALS AND METHODS

The research focused on five medium-fibre cotton varieties: Surkhan-18, Termez-208, Termez-202, SP-1607, and Surkhan-16. Laboratory experiments were conducted using 2 kg soil containers. The first group of containers contained non-saline soil, while the second group was treated with a 0.3% sodium chloride (NaCl) solution to induce salinity stress. The experiments examined key growth indicators, including root growth rate, root volume, stem length, leaf surface expansion, fresh weight of seedlings, and total water content in plant tissues, using standard analytical methods.

3. RESULTS AND DISCUSSION

Salinity significantly influenced seed germination across the studied varieties. Laboratory experiments revealed that as salinity levels increased, germination percentages decreased. All seeds were sown on March 10, 2021. The germination rate of Surkhan-18 seeds was 39% under non-saline conditions on March 13, which decreased to 33% under saline conditions. By March 16, the germination rates reached 62% and 51%, respectively, clearly showing the adverse effects of salinity at the early stages. However, by March 19, the germination rate reached 90% and 89% for non-saline and saline conditions, respectively, showing minimal final differences. This indicates that while Surkhan-18 initially showed sensitivity to salinity, it recovered at later stages.

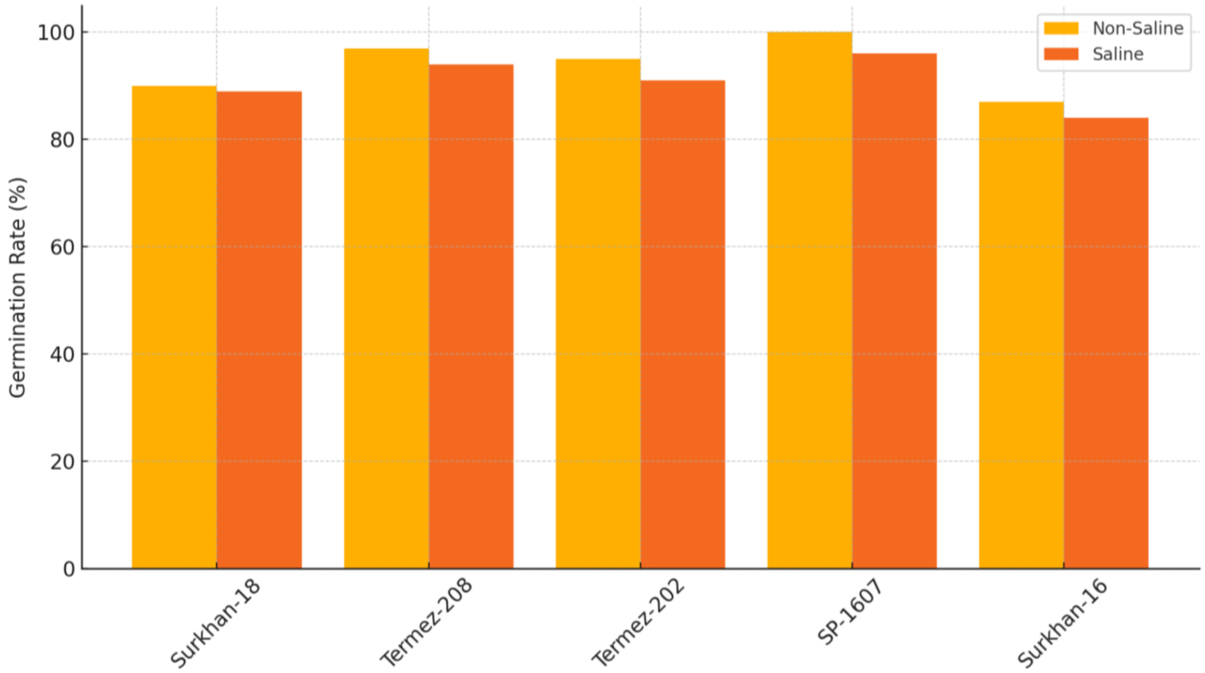

Figure 1. Germination Rates of Cotton Varieties Under Saline and Non-Saline Conditions

Termez-208 displayed high salinity tolerance, with germination rates of 51% (non-saline) and 46% (saline) on March 13. On March 16, the rates were 73% and 68%, and by March 19, they reached 97% and 94%, respectively. This variety showed minimal differences between treatments at all stages, indicating consistent tolerance to salinity stress.

Termez-202 showed moderate tolerance with germination rates of 41% (non-saline) and 37% (saline) on March 13. By March 16, these values reached 64% and 56%, with final values of 95% and 91% by March 19. SP-1607 exhibited the highest germination rates among all varieties, reaching 100% and 96% by March 19 in non-saline and saline environments, respectively. Surkhan-16 demonstrated the greatest sensitivity to salinity, with germination rates significantly lower at all stages.

3.1. Root Growth Dynamics:

Root growth analysis revealed that SP-1607 and Termez-208 maintained the highest growth rates under saline conditions. For example, SP-1607 roots grew from 1.85 cm to 4.73 cm (non-saline) and from 1.39 cm to 4.47

cm (saline) by March 19, with only a 0.26 cm difference. Surkhan-16 and Surkhan-18 showed notable reductions in root growth, indicating lower salinity tolerance.

Table 1. Cotton Varieties Growth Data

Variety	Germination (Non-Saline, %)	Germination (Saline, %)	Root Volume (Non-Saline, cm³)	Root Volume (Saline, cm³)	Fresh Weight (Non-Saline, g)	Fresh Weight (Saline, g)
Surkhan-18	90	89	1.65	1.43	2.47	2.21
Termez-208	97	94	1.77	1.61	2.67	2.45
Termez-202	95	91	1.73	1.5	2.51	2.26
SP-1607	100	96	1.85	1.7	2.74	2.53
Surkhan-16	87	84	1.61	1.4	2.35	2.1

Termez-208 roots grew from 1.36 cm to 3.19 cm under non-saline conditions and from 0.97 cm to 2.8 cm under saline conditions, resulting in a difference of 0.39 cm. Termez-202 roots showed similar moderate tolerance, while Surkhan-16 roots showed the highest sensitivity with a difference of 0.47 cm between conditions.

3.2. Stem Length and Leaf Surface Area:

Salinity reduced both stem length and leaf surface area in all varieties. SP-1607 and Termez-208 exhibited minimal reductions, maintaining high growth potential. For example, SP-1607 stem length decreased by 3.2 cm, and leaf surface area reduced by 5.5 cm² under saline conditions. Conversely, Surkhan-16 and Surkhan-18 experienced more substantial declines, indicating higher sensitivity to salinity stress.

Termez-208 stem length decreased from 22.6 cm to 19.4 cm, and leaf surface area from 108.3 cm² to 102.8 cm² under saline conditions. Termez-202 showed moderate reductions, while Surkhan-16 experienced significant reductions in both stem length and leaf surface area.

3.3. Root Volume, Fresh Weight, and Total Water Content:

SP-1607 and Termez-208 again demonstrated superior tolerance, with minimal reductions in root volume, fresh weight, and total water content under saline conditions. In contrast, Surkhan-16 and Surkhan-18 showed the most significant declines. For example, Surkhan-18 experienced a root volume reduction of 0.22 cm³, a fresh weight decrease of 0.26 g, and a total water content reduction of 1.4% under saline conditions. Termez-208 showed root volume reductions of 0.16 cm³, fresh weight reductions of 0.22 g, and a total water content decrease of 1.0%. Termez-202 demonstrated moderate sensitivity, while Surkhan-16 showed a root volume reduction of 0.21 cm³, fresh weight decrease of 0.25 g, and total water content reduction of 1.6%. These detailed findings highlight the varying levels of salinity tolerance among the studied cotton varieties. The observed differences provide valuable insights for selecting appropriate varieties for cultivation in saline environments, contributing to sustainable cotton production under abiotic stress conditions.

CONCLUSIONS

Overall, the study revealed that salinity stress had a significant impact on all cotton varieties, leading to reductions in germination rates, root volume, fresh weight of seedlings, and total water content compared to the control group. The extent of these reductions varied among the studied varieties, highlighting their differing levels of salinity tolerance.

Among the tested varieties, SP-1607 and Termez-208 exhibited the highest tolerance to salinity. These varieties demonstrated only minimal reductions in the measured growth parameters, maintaining relatively stable root volumes, fresh biomass, and water content under saline conditions. This indicates that SP-1607 and Termez-208 possess adaptive physiological and morphological characteristics that enable them to withstand salinity stress effectively. Their consistent performance suggests that these varieties are suitable candidates for cultivation in saline-prone areas, where soil salinity poses a challenge to cotton production.

In contrast, Surkhan-16 and Surkhan-18 were identified as the most sensitive varieties, showing significant decreases in root volume, fresh biomass, and total water content under saline conditions. The pronounced reductions in these key growth indicators suggest that these varieties may not be suitable for regions with high salinity levels without the implementation of appropriate agrotechnical measures.

These findings are of practical significance for agricultural planning, particularly in selecting salt-tolerant cotton varieties for cultivation in saline soils. The ability of SP-1607 and Termez-208 to maintain growth and water retention under salinity stress highlights their potential in breeding programs aimed at developing resilient cotton varieties. Furthermore, the results underscore the importance of adopting suitable agrotechnical practices to mitigate the effects of salinity stress and sustain cotton productivity in challenging environments.

Future research should focus on exploring the underlying physiological mechanisms that confer salinity tolerance in SP-1607 and Termez-208. Additionally, field trials under varying salinity levels and climatic conditions would provide further insights into the performance of these varieties, supporting the development of region-specific recommendations for sustainable cotton cultivation.

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