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Water-containing ability of cotton leaves under different temperature conditions

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Abstract

This article presents the results of studies on the change in the water-holding ability of leaves of some varieties and lines of cotton under the influence of various high air temperatures (I control option from +24.6 to + 35.4 °C; II option - from +36.4 to +45, 1 °C; III option - from +39.5 to + 48.4 °C). At a high air temperature of + 48.4 °C, the water-holding capacity of the leaves in varieties Surkhan-14, Istiklol-14, Bukhara-102 was 26.2; 24.6; 26.4%, which indicates the relative resistance of these varieties to high air temperatures.

Keywords: Cotton, variety, line, high air temperature, relative humidity, water holding ability

Introduction

Due to the sharp increase in air temperature in the world, its negative impact affects agriculture. Observed worldwide global environmental and climate changes, as well as hot winds in the summer months, lead to a sharp decrease in relative humidity. And this, in turn, negatively affects the formation of the cotton crop and is the reason for the decline in profits by more than 50%. Based on the foregoing, the creation of heat-resistant varieties of cotton, zoning them in areas subject to these factors, as well as the selection of source material with signs of resistance for breeding studies, is a very urgent problem. As you know, the main component of all living organisms is water, which is present in all plant organs according to species and varieties: in leaves –85–90%, stems –70–80%, roots –50–60%, seeds — 8–10% vacuoles 95–98%, cell membrane about 50%. Performing a lot of functions in all biological objects, water also plays an important role in controlling the temperature in plant tissues. Thanks to water in plant tissues, temperature changes gradually ^[1].

Excessive increase in soil moisture leads to a decrease in the water-holding capacity of leaf cells, while the evaporation process is activated, i.e. increased water consumption for transpiration. A change in the amount of water in the composition of leaf cells leads to a change in their water retention capacity. Such a relationship ensures the resistance of plants to adverse environmental conditions ^[2].

In the regulation of plant water exchange, a significant role is played by water-holding forces that influence physiological processes and the overall productivity of plants. Under conditions of equal humidity, some varieties exhibit increased water-holding ability, which indicates their relative resistance to drought ^[2].

When determining the balance of water in the leaves and other organs of plants, one of the main parameters is the determination of the amount of water in conditions of normal and limited humidity. In most plants, a 3-5% reduction in the total amount of water causes stomata to close. As a result, the process of photosynthesis slows down in the leaves ^[3].

A.E. Kholliyev ^[2] notes that the reduced water-holding power of leaf tissues is the reason for the increase in the number of blood vessels, as well as the increase in the area and thickness of the leaf blade. The emergence and activity of all life processes do not occur without the participation of water. The activity of living organisms is associated not only with the amount of water, but also with its state, form, concentration, energy level, reaction characteristics, mobility, etc. ^[4]

A change in the amount of water in the leaves leads to a change in the water holding capacity of the cells. This relationship provides plant resistance to stress factors. The water holding capacity of different varieties depending on the conditions of their growth,

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development and nutrition is different [5]. It is known that a change in the water holding capacity of leaf cells is associated with the degree of water availability of plants. A deficit of moisture in the soil increases the water retention capacity of leaf cells, as a result of which water saturation of cells is normal [6]. The aim of the research is to study the effect of high air temperatures on the water-holding capacity of cotton varieties and lines.

Materials and research methods

The cotton varieties of the species *G. hirsutum* L. Istiklol-14, Sultan, Bukhara-102, the variety of the species *G. barbadense* L. Surkhan-14, lines obtained with the participation of wild forms L-01 (*G. hirsutum* L. x *G. klotzschianum* Anderss) and L-02 (*G. hirsutum* L. x *G. sturtianum* mull.) on the vegetation site of the greenhouse complex "Fitotron" at a temperature of + 25- + 300C (option I control), in special boxes at a high temperature + 35- + 400C (option II) and at an extremely high temperature + 45- + 500C (option III) by the decades of each month phenological observations of each plant were carried out. The fallen and preserved fruit elements were counted and compared with the control. According to the decades of each month, the water retention capacity was determined in the leaves of cotton varieties and lines according to the Arland method [7].

Vegetation experiments in Wagner vessels were carried out according to the "Methods of growing experiments with cotton" [8]. The soil was taken from the 5th circuit of the NISSAVX experimental farm from a depth of 0-30 cm, which included active nitrogen nitrate 1.025 mg / kg, active phosphorus 10.4 mg / kg, the amount of changing potassium elements was 3.28 mg / kg. The full moisture capacity of the soil was established. The annual norm of phosphorus and potassium (P₂O₅ - 5 g, KCl - 3.5 g) was added to the soil substrate of typical serozem a weighing 26 kg for each

Wagner vessel. Nitrogen fertilizers were applied: 2 g when 2-4 true leaves appeared, 2.5 g in the budding phase, 2.5 g in the flowering phase in the form of an aqueous (0.5 L) solution. Each vessel was weighed and the exact mass of soil in it was determined. All plants were grown in the same agricultural background. The irrigation regime was also the same, the provision of soil moisture in the range of 60-70% in relation to the total moisture capacity of the soil.

Air temperature was measured using Thermograph-16, relative humidity using Hygrograph-16, soil temperature was determined using a special thermometer. During the growing season, phenological observations and counts were carried out in accordance with the methodology of UzNIIKh "Methodological recommendations for conducting vegetation and field experiments with cotton" [SoyuzNIIHI, Tashkent 1973]. The digital results obtained during the studies were statistically processed according to B. A. Dospekhov [9].

Research results

In connection with the foregoing, we conducted studies (2014-2018) to determine the water holding capacity (%) of leaf cells in the phases of budding, flowering and accumulation of fruit elements in three periods during the day (in the morning - 8-10 hours, in the afternoon - 12 -14 hours., In the evening - 16-18 hours.). Depending on the temperature, humidity, morpho-physiological properties of varieties and lines of cotton, as well as the phases of their development, various indicators of water holding capacity of plants were observed. During the flowering phase of cotton plants in the I-control version of the growing experiment (at air temperature + 24.6 °C; + 35.4 °C; + 32.3 °C), water loss in varieties and lines was low in the morning, high in the daytime and in evening hours there was a decline. In the morning, the loss of water in plants of the studied varieties and lines of cotton ranged from 7.8% to 13.2%.

Table 1: The water holding capacity of plants of varieties and lines of cotton in the phases of budding and flowering, % (vegetative experience)

| № | Varieties and lines | Hours of observation: | | |
|----------------------|--|-----------------------------------|------------------------------------|------------------------------------|
| | | 8 ⁰⁰ -10 ⁰⁰ | 12 ⁰⁰ -14 ⁰⁰ | 16 ⁰⁰ -18 ⁰⁰ |
| I - option (control) | | Temperature and humidity | | |
| | | +24,6 °C; 60,7% | +35,4 °C; 47,2% | +32,3 °C; 49,0% |
| 1 | Surkhan14 | 8,3±0,5 | 15,3±0,7 | 13,5±0,8 |
| 2 | Istiklol-14 | 7,8±0,6 | 18,6±0,7 | 11,6±0,8 |
| 3 | Sultan | 9,3±0,5 | 20,0±0,7 | 10,7±0,8 |
| 4 | Bukhara-102 | 10,5±0,4 | 21,0±0,4 | 14,0±0,9 |
| 5 | L-01(<i>hirsutum</i> x <i>klotzschianum</i>) | 8,5±0,6 | 15,7±0,7 | 9,7±0,8 |
| 6 | L-02(<i>hirsutum</i> x <i>sturtianum</i>) | 13,2±0,5 | 19,0±0,8 | 15,6±0,3 |
| LDCs 0,5 | | 3,0 | 3,1 | 3,1 |
| X environments | | 9,5 | 17,8 | 12,36 |
| II-option | | Temperature and humidity | | |
| | | +36,4 °C; 52,3% | +45,1 °C; 40,0% | +38,2 °C; 46,4% |
| 1 | Surkhan14 | 21,2±0,4 | 16,5±0,3 | 11,6±0,3 |
| 2 | Istiklol-14 | 18,8±0,3 | 17,3±0,4 | 10,3±0,3 |
| 3 | Sultan | 26,3±0,7 | 17,4±0,5 | 10,3±0,6 |
| 4 | Bukhara-102 | 20,4±0,4 | 15,3±0,5 | 11,3±0,5 |
| 5 | L-01(<i>hirsutum</i> x <i>klotzschianum</i>) | 17,6±0,6 | 10,8±0,8 | 7,8±0,5 |
| 6 | L-02(<i>hirsutum</i> x <i>sturtianum</i>) | 20,2±0,5 | 10,2±0,5 | 9,5±0,7 |
| LDCs 0,5 | | 5,1 | 1,1 | 2,7 |
| X environments | | 20,7 | 14,6 | 9,9 |
| III -option | | Temperature and humidity | | |
| | | +39,5 °C; 40,2% | +48,4 °C; 38,5% | +40,2 °C; 39,0% |
| 1 | Surkhan14 | 13,5±0,6 | 26,2±0,6 | 6,6±0,3 |
| 2 | Istiklol-14 | 20,3±0,5 | 24,6±0,5 | 8,4±0,4 |

| | | | | |
|---|--|----------|----------|----------|
| 3 | Sultan | 25,6±0,6 | 30,2±0,5 | 12,5±0,4 |
| 4 | Bukhara-102 | 24,9±0,8 | 26,6±0,4 | 12,4±0,6 |
| 5 | L-01(<i>hirsutum</i> x <i>klotzschianum</i>) | 28,5±0,5 | 27,6±0,5 | 10,7±0,7 |
| 6 | L-02(<i>hirsutum</i> x <i>sturtianum</i>) | 34,6±0,4 | 33,5±0,6 | 12,8±0,9 |
| | LDCs 0,5 | 1,9 | 2,2 | 3,1 |
| | X environments | 24,3 | 27,8 | 10,2 |

Positive indicators were observed in varieties Istiklol-14, Surkhan-14 and line L-01, which were equal to 7.8 ± 0.6 , respectively; 8.3 ± 0.5 ; 8.5 ± 0.6 . At noon, a decrease in water holding capacity was noted, positive indicators were recorded in plants of varieties Istiklol-14 and Surkhan-14. In the II experimental version, at high air temperatures ($+ 36.4$ °C; $+ 45.1$ °C; $+ 38.2$ °C), a high water loss was already observed in the morning, i.e. low water retention capacity of leaf tissue of the studied varieties and lines of cotton. In the transition to noon and evening hours, a decrease in water loss by leaf tissues and, accordingly, an increase in water holding power was observed. In the III variant, at ultrahigh temperatures ($+ 39.5$ °C; $+ 48.4$ °C; $+ 40.2$ °C), a decrease in water holding capacity was observed during the transition to noon time. Indicators of water loss in varieties Surkhan-14, Istiklol-14 and Bukhara-102 corresponded to 26.2 ± 0.6 ; 24.6 ± 0.5 ; $26.6 \pm 0.4\%$. Water holding force at a certain time is expressed by the amount of water loss. On this basis, with a small percentage of water loss, relatively more water is retained in leaf tissues and resistance to adverse conditions is manifested (table).

As the air temperature increased in the II – III variants of the experiment, depending on the morphophysiological characteristics of the varieties, a gradual increase in water loss was observed by noon and a decrease by evening. Under conditions of very high temperatures, Surkhan-14, Istiklol-14, and Bukhara-102 varieties had water loss indices of 26.2 ; 24.6 ; 26.6% .

Conclusion

According to the results of studies, it was determined that in cotton varieties Surkhan-14, Istiklol-14 and line L-01 (*G. hirsutum* L. x *G. klotzschianum* Anders.) In the phases of budding and flowering, the influence of super high air temperatures on their water-holding ability was insignificant; these varieties showed resistance to high temperatures. Cotton varieties Surkhan-14, Istiklol-14 can be recommended for sowing in areas exposed to high temperatures. Line L-01 (*G. hirsutum* L. x *G. klotzschianum* Anders.) Should be recommended as a starting material for creating heat-resistant varieties of cotton.

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