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ANALYSIS OF STUDIES ON THE CHARACTERISTICS OF COTTON PLANTS DURING THE TOPPING PERIOD

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Abstract

The article examines the mathematical modeling of the processes involved in the spontaneous start-up of a D630-90 centrifugal pump. A dynamic model has been developed that incorporates hydraulic, mechanical, and energy equations. It is shown that a smooth start lasting 8–10 seconds reduces pressure fluctuations by 35–40% and increases energy efficiency by 8–10%. The conditions for the occurrence of self-starting have been identified, and measures for its prevention have been proposed.

To reduce pressure fluctuations during pump start-up, it is recommended to increase the start-up time to 8–10 seconds, as well as the length of pipelines, and to use frequency converters. This approach slows the rise of the hydraulic pressure head, prevents abrupt changes in flow velocity, and reduces the force of hydraulic shock.

Keywords: Centrifugal pump, transient process, mathematical modeling, self-starting, hydraulic shock, energy efficiency.

Introduction

In cotton cultivation technology, topping (removal of the growing point) is one of the essential agrotechnical measures. By limiting the plant's upper growth point, it reduces excessive vegetative growth and reinforces the redirection of nutrients and photosynthesis products toward squares, flowers, and bolls. As a result, the formation and ripening of bolls and the process of preparing for harvest are accelerated. The effectiveness of topping depends not only on the agrotechnical timing but also on the height of cotton plants, degree of branching, arrangement of sympodial branches, planting density, varietal characteristics, soil-climatic conditions, and the quality of the technical device used. If the working parts in mechanical topping are not adapted to the plant's actual biometric condition, the growing point may remain uncut in some plants, or conversely, fruiting branches and bolls may be damaged. For this reason, analyzing the morphobiological and technological characteristics of cotton plants during topping has significant scientific and practical importance for substantiating the design parameters of the working parts of topping machines.

The aim of this study is to analyze scientific research conducted on the morphobiological and technological characteristics of cotton plants during topping, and to identify the factors important for substantiating the working parts of mechanical topping machines.

To achieve this aim, the following tasks were defined: analyzing the effect of topping on cotton growth and yield formation; determining the main morphological indicators of cotton plants

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during topping; assessing the effect of planting density, varietal characteristics, and topping timing on plant development; substantiating the technological characteristics of cotton plants during mechanical topping; and generalizing the indicators that must be taken into account when designing the working parts of topping devices.

Research materials and methods

The research was carried out on the basis of an analytical-scientific approach. It generalized scientific sources, experimental results, and agrotechnical recommendations related to cotton morphology, formation of yield elements, planting density, and mechanical topping technique. During the analysis, methodological approaches such as comparison, systematic analysis, generalization, agrobiological assessment, and technological analysis were used.

Research results

Topping cotton regulates the plant's excessive vegetative growth by limiting the upper growth point and redirects the main part of nutrients toward yield elements. This process serves to preserve squares, flowers, and bolls, ensure their full formation, and accelerate the ripening process. In research conducted by N.T. Boboeva, the effect of planting density and topping methods on cotton development, photosynthetic activity, and yield element formation was studied. According to the author's findings, the effectiveness of topping is closely related to plant density; at an optimal planting density, topping improves the physiological activity of cotton and has a positive effect on the preservation and development of bolls [1].

N.Q. Rajabov emphasized the need to take into account the region's soil-climatic and hydrogeological-reclamation conditions, as well as irrigation and fertilization regimes, when obtaining a high and quality cotton yield [2]. This approach is also important for the topping process, since the plant's height, degree of branching, and boll development during topping are directly related to the agricultural background, water supply, and fertilization system.

A. Danatarov, S.R. Rustamov, K. Kurbanov, K. Mergenov, and R.D. Khudayberdiev, studying resource-saving cotton cultivation technologies under Turkmenistan's conditions, substantiated the importance of improving technological processes to increase the effectiveness of agrotechnical measures and raise yield [3]. According to the authors, managing the vegetative growth of cotton — in particular, performing topping in a timely manner — strengthens the direction of nutrients toward yield elements and increases cotton productivity.

In A. Bakasov's research, the effect of sowing dates on the biological characteristics and yield formation of cotton was studied under the conditions of southern Turkmenistan [4]. The research results show that timely limitation of excessive vegetative growth contributes to faster ripening of bolls and increased yield.

Y. Yang and co-authors assessed the effect of topping and pruning measures on cotton growth and yield formation using the COTTON2K computer model. This model makes it possible to simulate the cotton growth process taking into account factors such as temperature, water supply, nitrogen regime, plant height, number of nodes, and boll formation. According to the research results, topping limits the plant's excessive vegetative growth, reducing the number of nodes and height of the main stem, while at the same time contributing to an increase in the number of preserved bolls and yield [5]. The height of the cotton plant, the development of the main stem, and the arrangement of sympodial branches directly affect the quality of mechanical topping.

In research by A.T. Sadiqov and co-authors, the growth dynamics of cotton varieties and genotypes, main stem height, sympodial branch formation, and yield indicators were analyzed. It is shown that in some genotypes, as of August 1 — i.e., before topping — the main stem height ranged from 91.6–106.1 cm [6]. Other studies recorded a main stem height before topping of 75.0–80.6 cm in local varieties and around 67.3–83.3 cm in foreign varieties [7]. This data indicates that the cutting height in mechanical topping should not be set according to a single uniform standard, but rather determined according to the actual biometric condition of the variety and genotype. If the cutting height is set too high, the growing point may not be fully cut; conversely, if set too low, fruiting branches, flowers, and bolls may be damaged.

Discussion

The analysis shows that assessing the topping process merely as mechanically cutting off the plant's upper vegetative part is not sufficient. This agrotechnical measure is a complex technological process that serves to regulate the physiological balance between vegetative and generative development in the cotton plant, strengthen the direction of assimilates and nutrients toward yield elements, ensure the preservation of existing squares, flowers, and bolls, and accelerate the ripening process.

The high agrotechnical effectiveness of topping depends on the mutual harmony of a number of factors. First, the timing of topping should be selected in accordance with the plant's actual developmental phase. Relying solely on the calendar date is not sufficient here; the number of nodes on the main stem, the degree of sympodial branch formation, the developmental state of bolls, and the biological characteristics of the variety should be assessed as the main criteria.

Second, the topping height is determined according to the growth type of the cotton variety, planting density, the morphological state of the plant, and the arrangement of yield elements. Applying a uniform cutting height across all fields may reduce the quality of mechanical topping due to uneven plant development, and may result in the growing point remaining uncut in some plants, or in damage to fruiting branches and bolls.

Third, the working parts of topping machines must correspond to the biometric and technological indicators of cotton plants. In particular, when using rotary or blade-type working parts, the cutting trajectory, rotation frequency, blade placement angle, coverage width, and protective elements should ensure quality cutting of the plant's upper part while exerting minimal mechanical effect on fruiting branches and bolls.

Existing research shows that the height of the cotton plant, degree of branching, and arrangement of yield elements are the main factors determining the quality of mechanical topping. At the same time, since these indicators are not uniform across a field, it is advisable to use adaptable working parts in topping machines. Such an approach makes it possible to perform quality topping of plants of different heights, preserve yield elements, and increase machine productivity.

Conclusion

Analysis of the research shows that the effectiveness of mechanical cotton topping directly depends on the plant's developmental phase, plant height, degree of branching, planting density, varietal characteristics, and working part parameters. In determining the timing of topping, the number of nodes on the main stem, the development of sympodial branches, and the degree of boll formation should serve as the main criteria. When topping is performed in a timely manner, excessive vegetative growth is limited, nutrients are directed toward yield elements, and boll ripening is accelerated.

In mechanical topping, the cutting height must be selected to correspond to the actual height of cotton plants and the arrangement of fruiting branches. Otherwise, the growing point may remain uncut in some plants, or fruiting branches and bolls may be damaged. In substantiating the working parts of topping machines, it is advisable to adopt topping completeness, preservation of yield elements, stability of cutting height, degree of effect of the working part on the plant, machine operating capacity, and energy consumption as the main criteria.

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