DETERMINATION OF THE DIAMETER OF THE DISC WORKING TOOL OF A COTTON CULTIVATOR

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Abstract. This article presents the design and technological operation of an improved section equipped with a disc working tool of a cotton cultivator developed for the soil and climatic conditions of the Bukhara region.

Keywords. Tool bar, support wheel, disc working tool, loosening tine, flat-cutting arrow-shaped sweep, pressure spring, frame.

It is well known that cotton production in the cotton-growing regions belonging to the third agricultural zone of the Republic of Uzbekistan, including the Bukhara, Navoi and Khorezm regions, as well as the Republic of Karakalpakstan, is carried out under specific soil-climatic and agrotechnical conditions. In these regions, taking into account the slopes and irregularities of the microrelief of cultivated fields, longitudinal and transverse field bunds are formed between cotton rows to ensure uniform distribution of water throughout all parts of the field. Cotton is then irrigated using the flooding method. This irrigation technology causes significant changes in soil moisture, density, structural composition and physical and mechanical properties throughout the growing season.

In particular, after flood irrigation, an increase in moisture content in the upper soil layer, together with changes in soil adhesion and deformation properties, creates certain technological difficulties during mechanized inter-row cultivation of cotton. Specifically, when conventional inter-row cultivation tools are used, soil may be displaced into the zones where cotton seedlings and their root systems develop, resulting in damage to the seedlings.

To eliminate the above-mentioned problems, an improved working section equipped with disc working tools was designed, taking into account the soil and climatic conditions of the cotton-growing regions of the third agricultural zone, the changing physical and mechanical properties of the soil after flood irrigation, and the agrotechnical requirements for inter-row cotton cultivation [1].

When the inter-row cultivation unit moves between cotton rows, the disc working tools penetrate the soil to a specified depth and cut through it at a certain distance from the cotton rows. As a result, the soil is prevented from spreading into the zones where cotton seedlings and their root systems develop under the action of the subsequent loosening tines and flat-cutting sweeps, thereby preventing damage to the plants and their roots. Sections equipped with disc working tools are primarily used for inter-row cultivation during the cotton growing season, particularly after flood irrigation.

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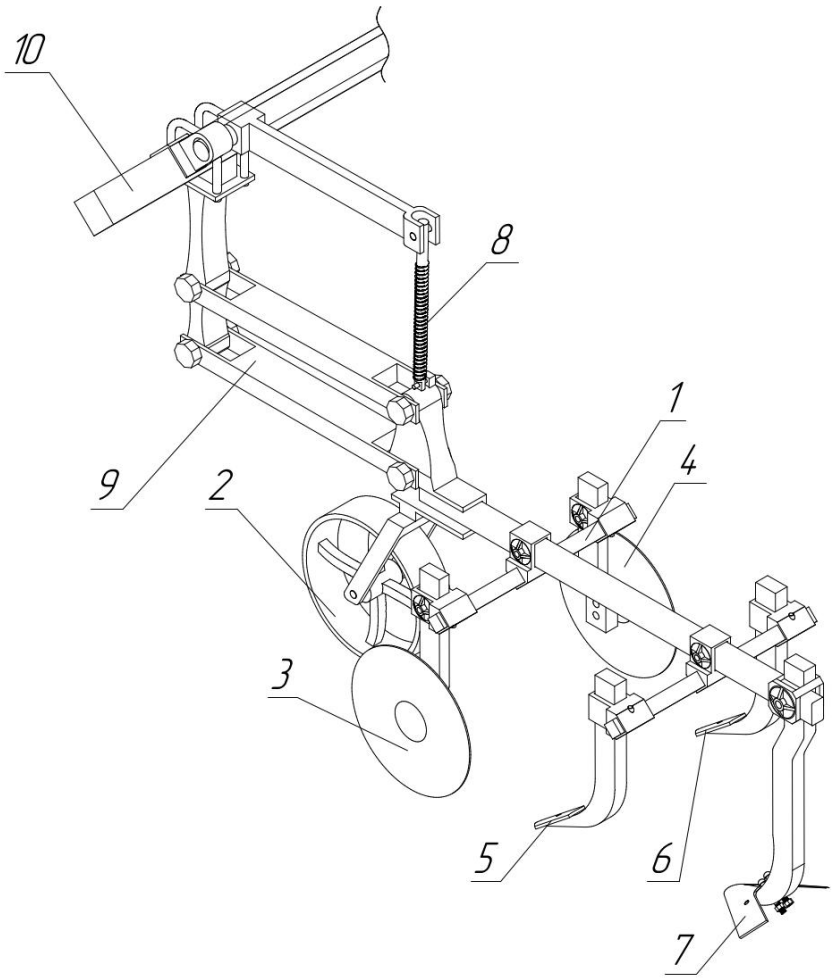


Fig. 1. Structural Diagram of the Section Equipped with Disc Working Tools

1 – Tool bar; 2 – support wheel; 3, 4 – disc working tools; 5, 6 – loosening tines; 7 – flat-cutting (arrow-shaped) sweep; 8 – pressure spring; 9 – parallelogram mechanism; 10 – cultivator frame.

For the improved cotton cultivator to perform the technological process reliably without causing damage to cotton seedlings, the diameter of its disc working tools is one of the key design parameters.

The diameter of the disc working tools is determined based on the requirement that they must be capable of pressing down and cutting through plant residues and weed stems encountered along their path. Otherwise, plant residues and weed stems may accumulate in front of the discs, damaging cotton seedlings and disrupting the technological process.

To ensure that the disc working tools do not push plant residues and weed stems forward, but instead press down and pass over them, the following condition must be satisfied [2]

$$D_d \quad \frac{1+\cos\left(\varphi_1+\varphi_2\right)\ \ d_q+2h_d}{1-\cos\left(\varphi_1+\varphi_2\right)},$$

where φ_1, φ_2 – the friction angles of plant residues and weed stems against the disc cutting edges and the soil, °;

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d_q – the diameter of plant residues and weed stems., m.

The analysis of the above expression shows that the diameter of the disc working tools of the section depends on the external (metal-to-soil) and internal (soil-to-soil) friction angles, the diameters of plant residues and weed stems encountered along their path, and the penetration depth of the discs into the soil.

Taking φ_1=30°, φ_2=40°, d_q = 0,02 m va h_d=8 cm [3, 4, 5, 6], it was determined that the diameter of the disc working tools should be at least 25 cm.

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