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Substantiation the Parameters of Universal operating Element on Row Crop Cultivator

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ABSTRACT: The results of scientific-research activities on substantiation the angles chisel crumbling and blades of the universal operating element of row crop cultivator, their installation angles in the direction of motion and width, as well as the solution angle of its wings are specified.

KEYWORDS: universal operating element, chisel, blades, operating element wings, row crop cultivator, working body.

I. INTRODUCTION

The Republic of Uzbekistan pays special attention to development of technical means to reduce labor and energy efficiency, to save resources and to ensure high quality of cultivation.

One of the most important agro-technical measures for rich harvest of agricultural crops is processing of their row spacing in time. In order to do so, cotton cultivators are adjusted loosening and flattening pads, one-way desiccating knives and furrowsloosening depending on time of plant growth and mechanical properties of soil. Thus, depending on type of tillage and the width of row spacing, to the cotton cultivators are set up working bodies from 24 up to 36. When to take turning from one technological operation to another, they are replaced entirely or partially, and each working body is manually adjusted to operate at appropriate depth relative to the transverse profile of the furrow. Therefore, many manual labor is required for replacement and adjustment of existing working bodies of cultivators. This, in turn, leads to decline in work efficiency and material costs.

II. RELATED WORK AND DISCUSSION

In effort to reduce the material consumption of tillage cultivators, as well as the cost of manual labor for installation and dismantling of their operating elements, we have developed a universal operating element and conducted studies to justify its parameters. It consists of 4 racks (see Fig.) and the chisels 1, right 2 and left 3 blades installed on it, as well as the wings 5 and 6 for cutting irrigation furrows. It can be used for cutting weeds and loosening the soil in the aisles of different agricultural crops, cutting irrigation furrows and deep loosening of the middle of the aisles. When using the operating element for cutting weeds and loosening the soil on its rack are installed chisel and blades (left and right), when cutting furrows – chisel and wings, and with deep loosening of the middle of the aisles – only a chisel.

Main parameters of designed operating element, having an impact on its performance indicators are as in the following:
β_1, β_2– appropriately the corners of chopping chisels and blades;
γ_1– angle of installation of the blades in the direction of movement;
$2\gamma_2$–solution angle of the wings of the operating element;
b_u–the width of chisel;
B–capture of the operating element width.

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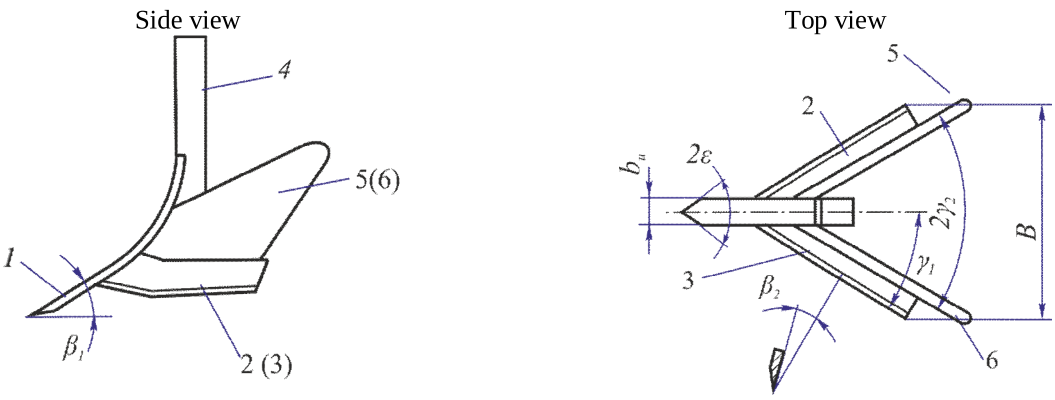

Fig: Scheme of the universal operating element.

The crumbling angles of the chisel and blades were determined from the condition that the resistance arising from the movement and lifting of the treated layers on their working surfaces was minimal [1]. The following formula is obtained

$$\beta_1 = \beta_2 = arctg\left[\sqrt[3]{-\frac{q}{2}+\sqrt{\left(\frac{p}{3}\right)^3+\left(\frac{q}{2}\right)^2}}+\sqrt[3]{-\frac{q}{2}-\sqrt{\left(\frac{p}{3}\right)^3+\left(\frac{q}{2}\right)^2}}-\frac{b}{3a}\right] \quad (1)$$

where $p = \frac{3ca - b^2}{3a^2}$; $q = \frac{2b^3}{27a^2} - \frac{bc}{3a^2} + \frac{d}{a}$; $a = 1 + tg^2\varphi_1$; $b = tg\varphi_1$; $c = 2tg^2\varphi_1$;

$d = -tg\varphi_1$; φ_1 – angle of external friction of the soil.

The angle of installation of the blade in the direction of movement was determined by the formula [2]

$$\gamma = \frac{\pi}{4} - \frac{\varphi_c}{2}, \quad (2)$$

where φ_c – the angle of friction of the weeds roots on blade of the blades of the operating element.

While ensuring the condition (2) is achieved by first cutting the roots of weeds with the blade and chisel with the slide and the second number of weeds, enveloping the blade will be minimal.

The solution angle of wings of the operating element was determined from the condition of exclusion of soil unloading in front of them. This is possible when

$$2\gamma_2 = \frac{\pi}{2} - \varphi_1. \quad (3)$$

The width of the chisel was determined from the condition of excluding the formation of a layer of groove with compacted walls at the bottom of the loosened layer. Simultaneously, on the basis of studies conducted by Plushev G.V. [3] and Panov I. M., Suchkov I. V., Vetokhin V. I. [4] the following formula is obtained.

$$b_д \geq \frac{(m + ctg\,\beta_1)h_1[\tau_к]}{0{,}1T(1 + 3tg\,\varepsilon) - n[\tau_к]}, \quad (4)$$

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where m , n – dimensionless coefficients depending on the physical and mechanical properties of soil; h_1 – tillage depth in the middle of row spacing; $[\tau_к]$ – specific resistance of soil to destruction (shear); T – the resistivity of the soil horizontal bearing strength; ε – angle of inclination to horizon of the resulting force acting on chisel from the soil.
The capture width of the operating element was determined from the condition that in the process of work the operating element did not damage roots and aboveground part of the plants. The final formula for its definition is as follows

$$B = B_м - 2l_{pz} - 2h_2 \cos\left[\gamma_1 - arctg\frac{tg\left(\frac{\pi}{4}-\frac{\varphi_2}{2}\right)}{\sin 0{,}5(\beta_2+\varphi_1+\varphi_2)}\right]:$$

$$:\left[\cos 0{,}5(\beta_2+\varphi_1+\varphi_2)\sqrt{\sin^2 0{,}5(\beta_2+\varphi_1+\varphi_2)+tg^2\left(\frac{\pi}{4}-\frac{\varphi_2}{2}\right)}\right], \quad (5)$$

where $B_м$ – width of row spacing; l_{pz} – width of protecting zone; h_2 – depth of blades running of the operating element; φ_2 –angle of external friction of the soil.

III. RESULTS

The calculations are carried out base on the formulas (1)–(5) in case if φ_1=25–35°;φ_c=28–36°;h_1=0,15 m;m=4,2;n =2,5;$[\tau_к]$ = $2\cdot10^4$Pa;T = $1{,}44\cdot10^6$Pa; $\varepsilon = 90 - (\beta_1+\varphi_1)$;$B_м$ = 0,9m; l_{pz} = 0,10 –0,15m; h_2 = 0,10–0,18 m;φ_2 = 40°[3,4,5] showed that the angle of crumbling of the chisel and blades of the developed operating element should be within24–26^o, the angle of installation of bladesin the direction of movement – within27–31^o, the solution angle of the wings – within55–65^o, chisel width – at least 80 mm and width of the operating element is adjustable in the range of 300–500 mm, depending on the plant development phase, with first header row spacing treatments used operating element with a large width, and next – operating element with a smaller width.

IV. CONCLUSIONS

The results of the studies showed that the angle of crumbling of the bit and knives developed working body should be within 24–26°, installation angle of the knives blade to the direction of movement is within 27–31^o, the angle of the wing solution is within 55–65^o, the width of bit is not less than 80 mm and the working width of working body is adjustable within 300–500 mm depending on phase of plant development, and at the first inter-row treatments working body with a large working width is used, and the following working body with a smaller working width.

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