Optimization of Parameters and Modes of Operation of the Disk of the Working Organ to the Cotton Cultivator to Destroy the Soil Crust

Artikbaev Bakhtiyar

ABSTRACT--- The article presents the results of experimental researches on the optimization of parameters of disk working body of cotton cultivator for destruction of soil crust. On the basis of the results of the received data of experimental researches it is established that at diameter of disks of a working body D=240-250 mm, distance between disks l=50 mm, vertical loading on disks Q=225-250 N and speed of movement of the unit Va=5,2-7,6 km/h the required degree of destruction of a soil crust at the minimum damage of plants of a cotton is provided.

Keywords: soil crust, disk crust, soil crust destruction, plant damage, disk diameter, disk spacing, vertical load on disks, unit speed.

I. INTRODUCTION

1. RELEVANCE OF THE WORK

As is known, abundant precipitation during the sowing of agricultural crops, such as cotton and their sprouting, leads to the formation of strong soil crust. This causes unproductive costs in agriculture, as it requires additional labour and energy to loosen it.

Soil crust reduces the field germination of seeds and worsens the growth conditions of plants. The thicker and denser the soil crust, the more labor and means for its loosening are required. Insufficient fight against soil crust reduces the effectiveness of other measures for cotton care and reduces yields. Therefore, the improvement of methods and parameters of tools for the destruction of soil crust on cotton crops is relevant.

Known working sections do not allow to process soil crust qualitatively, do not provide full safety of sown seeds or underdeveloped and gentle shoots. These drawbacks are connected with the imperfection of technological process of soil crust destruction by the specified working sections.

As a result, at the moment of influence of working sections the destroyed part of a crust of a protective zone can damage poorly developed shoots of a cotton or to extract seeds on a surface that leads to reduction of the quantity of sprouts of a plant on length of a row.

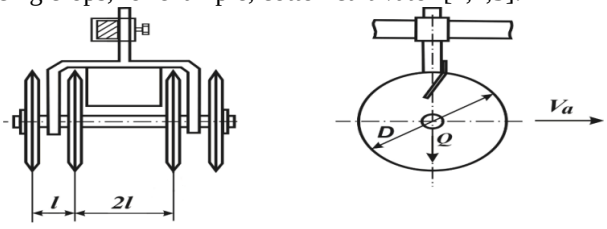
The most widely used working section containing needle discs destroys the soil crust by crushing, splitting and turning it over. The disadvantage of this working organ is a poor quality of soil processing and high damageability of plant shoots at its use. In the process of work, the needle disk makes a complex movement: rotational and progressive. In this connection, at work, its needles in soil enter and leave in soil not on a right corner, and at a certain sharp angle. Therefore, the needle turns the hardened part of the needle into the opposite direction of movement of the machine with its tip when leaving the soil.

Thus, the technological process of destruction of the soil crust with needle discs is as follows: the needle at the initial moment of touching the surface of the soil crushes then splits and turns it over. As a result, underdeveloped shoots or seeds of plants are extracted to the field surface.

In order to ensure the full safety of the seed and crop-growths and to improve the quality of soil crust destruction in crops, it is proposed to use a flat disc battery. In this method, the soil crust is qualitatively destroyed by a continuous strip cutting without overturning it, and sealed seeds and crop sprouts are completely preserved. The use of a flat disc battery increases the straightness of the machine's movement. In this regard, the proposed working section can ensure a continuous cutting of the soil crust without damaging the seed and plant seedlings.

The proposed working section with disk battery can be installed without an angle of attack in front of the main working sections of tillage machines, e.g. a cotton cultivator. In addition, the flat disc battery reduces the lateral oscillation of the working section of the cultivator, which also reduces the damage caused by cotton seedlings

In order to improve the quality (degree) of soil crust destruction in crop rows we have developed (see figure) a section with flat discs (hereinafter referred to as a disc implement). It can be installed in front of the main working sections of machines and tools for the treatment of row-spacing crops, for example, cotton cultivator [1,2,3].



Basic parameters of the disk drive unit

The main parameters and modes of operation that have the greatest impact on the performance of the disk drive unit are (see Fig.):

- disc diameter D;
- is the distance between the discs l;
- vertical load on the discs Q;

Revised Manuscript Received on October 15, 2019

Artikbaev Bakhtiyar, Doctor of Philosophy in Technical Sciences, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan
(Email: artykbaev82@mail.ru)

- unit speed "a.

In order to determine their optimal values, a multifactor experiment, according to the Hartley-4 plan was carried out [4-5].

Based on the results of the literature review, theoretical and one-factor experimental studies, the values of the levels and intervals of variation of factors were selected, which are given in the table.

The degree of plant damage and soil crust destruction were chosen as a response function.

Factor levels and intervals of their variation & Results

№	Factors	U.M.	Shorthand	Variable range	Factors levels		
					lower (-1)	Basic (0)	upper (+1)
1	Disc diameter *D*	мм	X_1	50	200	250	300
2	Distance between discs *l*	мм	X_2	10	40	50	60
3	Vertical load on discs Q	Н	X_3	50	200	250	300
4	Speed of movement V_a	км/ч	X_4	1,2	5,2	6,4	7,6

The received results of experiments have been processed on the personal computer "Pentium-4" under the program "Planexp-2" and the following equations of regression have been received:

- by the degree of plant damage (%)

$$Y_1 = 0{,}412 - 0{,}07\,X_1 - 1{,}059\,X_2 - 0{,}25\,X_3 + 0{,}25\,X_4 - 0{,}095\,X_1 X_2 + 0{,}19\,X_1 X_3 + 0{,}751\,X_2^2 - 0{,}26\,X_2 X_3 + 0{,}151\,X_3^2; \quad (1)$$

- by the degree of soil crust destruction (%)

$$Y_2 = 90{,}378 - 1{,}05\,X_1 - 11{,}25\,X_2 + 7{,}754\,X_3 + 2{,}3\,X_4 + 1{,}26\,X_1 X_2 - 8{,}495\,X_2^2 + 1{,}65\,X_2 X_3 - 3{,}395$$

The results of statistical analysis and adequacy testing of equations showed that the process reproduces equations (1) and (2) adequately describe the process with a confidence probability of 95%, since the actual (calculated) Fisher's criterion values are less than the tabulated one:

$F_{расч} = 0{,}15 < F_{табл} = 2{,}38$ for the equation (1),

and

$F_{расч} = 0{,}027 < F_{табл} = 2{,}23$ for the equation (2)

It follows from the analysis of equations (1) and (2) that the degree of plant damage and soil crust destruction is a complex dependence of varying factors. As the diameter and spacing of the discs increase, they decrease and as the speed of movement increases, they increase. As the vertical load increases, the degree of plant damage and crust destruction increases.

To determine the rational values of parameters of the working body of the equation (1) and (2), we decided by the method of "penalty" functions [4] from the conditions Y1<5% and Y2>90% for the given speed of movement "a = 5,2-7,6 km/h. It is established that to ensure the required quality parameters when working at speeds of 5.2-7.6 km/h, the diameter of the discs of the working body should be 240-250 mm, the distance between the discs 50 mm, the vertical load on the working body is adjustable within 225-250 N.

II. CONCLUSIONS

At a speed of 5.2-7.6 km/h, the diameter of the discs should be 240-250 mm, the distance between the discs - 50 mm, the vertical load on the discs - 225-250 N to ensure the required degree of soil crust destruction with minimal damage to plants.

REFERENCES

1. Patent of the Republic of Uzbekistan № FAP 00670 Working section of the tillage machine for soil crust destruction on crops / Khajiev A.Kh., Auezov O.P., Nurabaev B.U., Artykbaev B.P. // Rasmiy Akhborotnoma. - – 2011. - – №12.
2. Artikbaev B. Substantiation of some parameters of disk working organ for the destruction of soil crust 2nd International Sientific Conference. European Applied Sciences: modern approaches in scientific researches. Conference papers. Volume 3. - Stuttgart (Germany), 2013. - pp. 14-16.
3. Tuhtakuziev A., Artikbaev B. Theoretical determination of the vertical load on the disk work tool for destruction of the soil crust. European Journal of Research. - Vienna, 2018. No. 5-6. - pp. 39-43.
4. augambayev M., Ivanov A.V., Terekhov Y.i. Fundamentals of research experiment planning. - Tashkent: Ўқитувчи, 1993. - – 336 p.
5. Adler, Yu.P.; Makarov, E.V.; Granovsky, Yu.V. Experiment planning in search of optimal conditions. - M.: Science, 1976. - – 278 p.