Combıned Land Cultıvator Seed Carryıng Machıne Deep Softener Productıon Tests

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ANNOTATİON

Rich natural-climatic conditions and favorable geographical position show that there are wide opportunities for the development of agriculture in Azerbaijan. However, it is impossible to increase the production volume of agricultural products without implementing a rational method of land cultivation. This means the application of energy, resource and soil protection technologies. Such an approach to modern agricultural production is explained by the fact that the productivity of agricultural plants mostly depends on the quality of operations for preparing the soil for sowing [1, 2]. To solve this problem, the development of new theoretical considerations and provisions [3, 4, 5, 6] has become relevant, taking into account many factors, the improvement of combined and direct seeding machines related to soil cultivation. The purpose of the research conducted in this direction was to conduct a theoretical analysis and production test of the operation of the deep-seeding machine of the combined tiller and sowing machine .

RESEARCH OBJECT AND METHOD

The work of a combined tiller and one of its main working bodies - a deep softener - was taken as the research object. Systematic analysis and mathematical modeling methods were used in the development of the constructive scheme. The experimental work was based on the production test methods of a deep-smooth switch equipped with a vibrating device [8, 9, 10] . Processing of recorded values from electronic and mechanical devices in measurements was carried out in the environment of "Math CAD", "Microsoft Office Excel" system.

RESEARCH RESULTS AND THEIR DISCUSSION

Soil cultivation is one of the main elements of the agricultural system. Its most important tasks include: creating the optimal structure of the soil, favorable water, air and nutrient regime, combating littering of the field. In addition, soil cultivation technology must meet the requirements of energy resource conservation. The most important thing in this aspect is the correct selection of parameters and working modes of tillage machines . This is of particular importance for erosion-prone soils of intensive agricultural regions of Azerbaijan.

The application experience of the cultivator with toothed working organs - yadasans has shown a relative decrease in the energy capacity of the process, and an increase in the quality of cultivation of the mentioned soils without a ladder [7]. However, there have been no studies devoted to the study of the effective interaction resources of these working bodies with the soil and the development of recommendations on their application for specific soil conditions.

It is accepted that during the interaction of gear working bodies with the soil, it can be described as a linear deforming medium in the horizontal plane. The periodic contact theory of elastic materials and the principle of elastic analogs were used to analyze the interaction of gear working bodies .

At this time, the mentioned working bodies interact with the soil in α_1, β_1, α_2, β_2 contact areas according to two material analogues. This is expressed by the following equation:

$$\sum_{k=1}^{\ell} \int_{\alpha_k}^{\beta_k} N(x) \ell n \frac{1}{|x-1|} dt = f(x), \quad (1)$$

where $\alpha_k < x\ \beta_k$ (k = 1, 2, 3, ..., ℓ); $f(x)$ – given and working in the interval $\alpha_k \beta_k$
the shape of the body depends on the soil and deformation constants in the horizontal plane function;

N (x) – pressure distribution at the point of contact of the working body with the ground.

$$f(x) = C \cdot f_1(x) - \frac{f_2(x)}{\varphi_1 - \varphi_2}, \quad (2)$$

where $f_1(x)$ and $f_2(x)$ – contour of the working body and the soil in the horizontal plane
expressive functions;

C – any patience;

φ_1 and φ_2 – soil and working body deformation modulus and Poisson
constants that depend on the coefficient.

The pressure distribution law depends on the shape of the contact area. The pressure distribution for the wedge $y_2 = f_2(x) =$

$A(x)$ -shaped shape whose contour is expressed by the equation is as follows.

$$N(x) = \frac{N}{\pi\alpha}\ell n\frac{\alpha - \sqrt{\alpha^2}}{|x|} \quad (3)$$

x = 0, the pressure at the tip of the wedge increases to a maximum. The initial crack occurs at the points of maximum pressure, in our view, at the top of the wedge.

If the working body is in the form of a rectangular protrusion, then the concentration of pressures occurs, which causes a stress-deformation state in the limited volume of the soil.

In this case, the pressure distribution is expressed by the following formula.

$$N(x) = \frac{N}{\pi\sqrt{\alpha^2 - x^2}} \quad (4)$$

The maximum pressure develops when *x = 0 at the first contact point.* The circular part of the contact provides a more even distribution of pressure compared to the rectangular and wedge-shaped ones. which causes several cracks to appear.

Due to the uneven distribution of contact pressure during the interaction of different shaped protrusions with the soil, the process of crack formation does not go over the entire contact surface and this worsens the quality of soil cultivation.

All the protrusions we considered are unevenly eaten during the working process, and the most intense eating occurs at the place of maximum contact pressure. As a result, the geometric shape of the blade changes, the quality of soil cultivation deteriorates, and the draft of the tool increases.

When the working body interacts with the soil, it is necessary to have a different shape of protrusions to evenly distribute the pressure on the contact surface.

functions expressing the contour of the working body and the soil in the horizontal plane have $f_1(x) v\text{ə}\, f_2(x)$continuous first and second derivatives around the point *x = 0, in other words*

$$f_1^{I}(x) = f_2^{I}(x) = 0, \quad (5)$$

$$f_1^{II}(x) = f_2^{II}(x) = 0, \quad (6)$$

We also assume that not only the second derivative of the sum, but also all subsequent derivatives up to dgaha 2ℓ - 1 - are equal to zero at *x* = 0. In this case, taking into account the smallness of the contact area $\alpha < x < \alpha$, it is possible to write approximately:

$$f_1(x) + f_2(x) = \frac{1}{2\ell!}\left[f_1^{2\ell}(0) + f_2^{2\ell}(0)\right]x^{2\ell} \quad (7)$$

If we use (7) in (2), we get

$$f(x) = \nu - A_\ell x^{2\ell}, \quad (8)$$

$$A_\ell = \frac{f_1^{2\ell}(0) + f_2^{2\ell}(0)}{2\ell!\,(\varphi_1 + \varphi_2)}, \quad (9)$$

where ν is any constant.

The solution of the basic integral equation (1) in the flat contact equation is written as

$$N(x) = \frac{N}{\pi\alpha^2}\sqrt{\alpha^2 - x^2}\left[\frac{2\ell}{2\ell!} + \frac{2\ell(2\ell-2)}{(2\ell-1)(2\ell-3)}\cdot\frac{x^2}{\alpha^2} + \right.$$

$$\left. + \frac{2\ell(2\ell-2)\cdots 2}{(2\ell-1)(2\ell-3)\cdots 3+1}\cdot\frac{x^{2\ell-2}}{\alpha^{2\ell-2}}\right]. \quad (10)$$

We consider that a constant force N acts on the working body, and the half-width of contact α is known. We solve the equation (2.2.10) and find the pressure distribution under the protrusion of the winter working body. This gives an even-peaked parabola as ℓ varies from 1 to 5 . A uniform pressure distribution is obtained when N(*x) = const.* We estimate the true distribution of contact pressures according to this ideal variant. We compare the skewness of the obtained distribution with respect to the variance (D) at different values of ℓ.

The minimum value of dispersion coincides with the optimal value of "ℓ".

The pressure in the contact area is as follows.

$$N(x) = \frac{4N}{\pi 3\alpha^4}\left[(\alpha^2 + 2x^2)\sqrt{(\alpha^2 - x^2)}\right]. \quad (11)$$

Analyzing the reported formulas and dependencies, it is possible to come to the conclusion that the shape of the protrusions should form a parabola of the fourth degree and should be directed in the direction of movement of the working body for equal distribution of contact pressures during the impact of the working bodies on the soil. In this case, cracks will be obtained on the entire contact surface of the protrusions. The working body designed with this principle will ensure quality cultivation of the soil with relatively low energy consumption.

The parameters characterizing the experimental conditions are as follows: soil type - gray - chestnut; relief - flat; microrelief – aligned; soil moisture in layers - 15 at 0-10 cm, 23.3% at 10-20 cm, 23.1% at 20-30 cm; soil hardness in layers - 5.3 N/cm ^{2} at 0-10 cm, 14.1 N/cm ^{2} at 10-20 cm, 15.3 N/cm $^{2\ at\ 20\text{-}30\ cm}$; mass of plant residues in a unit volume - 1.57 kg/m ^{3} ; the height of the hub is 10-15 cm; previous cultivation - with yadamasan; the date of measurement - August - September 2019.

The effect of soil hardness (solidity) on the operation of a vibrating deep softener. In order to compare the effect of soil hardness on the drag resistance of the vibratory working body, studies were conducted on three types of soil (clay, light clay, and sand). It was determined that the application of the vibration effect to the deep softener is more effective in cohesive hard soils and least effective in soft sandy soils (table).

Table l. The effect of the type of soil on the hardness of the working body vibration application.

Soil type	Soil moisture, %	Effectiveness of vibrations at different movement speeds (m/sec) of the working body, in %					
		0.5	1.1	1.27	1.55	1.92	2,3
Clay	8.81	59.9	40.2	33.4	31.6	18.5	13.1
Little clay	7.84	51.5	37.4	33.3	28.3	18.8	10.9
Sandy	9.9	45.2	34.2	25.0	22.8	14.8	6,8

The obtained values agree with the theoretical considerations about the reduction of drag resistance of vibrations. In general, it can be noted that the effectiveness of the vibrations of the deep softener is also manifested in soils with high density and hardness.

The increase in the efficiency of vibrations of the working body with the increase in hardness of the cultivated soil can be a reason for applying it to the cultivation of soils with compacted anthropogenic effects and lands to be directly sown.

Research has shown that the specific tensile strength of working bodies decreases during a certain period of time when soil moisture is increased.

The most intensive reduction of the tensile strength in clayey and low-clay soils coincided with the soil moisture value of 18-21%. When the humidity reaches this limit, the resistance decreases more slowly due to the adhesion of the soil to the working surface. When the humidity exceeds 25%, an intense decrease in resistance is observed. Experience shows that if the moisture content of solid soils increases from 3.2 to 28.2%, the tensile strength decreases by 37-42%. When the humidity of the sandy soil changed from 4.75 to 18.5%, the tensile strength decreased by 17-18%.

Overall, the obtained prices show that the vibratory deep softening unit has the ability to work in high moisture soils, which increases its technological capabilities.

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of the combined tillage and seeding machine in production conditions showed that the theoretical considerations about the reduction of the draft resistance of the vibrations are confirmed.

2. The effectiveness of the vibration of the deep -water auger is also manifested in soils with high density and hardness.

3. In general, the results of the tests show that the vibration-applied deep tiller has the ability to work in high-moisture soils, and at this time its technological capabilities increase.

SUMMARY

Emphasizing the relevance of the rational development of land in terms of resource and energy saving in modern agricultural production, the development of theoretical considerations related to the improvement of the working bodies of combined tillage and seeding machines and their practical evaluation has been set as the goal. For this purpose, in the experimental machine of the combined soil cultivator and seeder, the feasibility of the deep-grain plowing working body ¬connected with the seeding mechanism ¬in terms of improving the quality of work on soils with different physical and mechanical properties (dry solid, high moisture) and saving energy was theoretically justified and the workability was evaluated by practical tests. .

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