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Construction Diagram and Process of Technological Operation of Leveler Equipped with Auger Work Member

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ABSTRACT

The article covers theoretical research on the use of levelers equipped with auger work members in the process of leveling longitudinal irregularities in the current leveling of sowing areas. This work supports the practical solution of using a screw working particle in the current field planning. Significance of the work – reducing traction resistance to soil movement up to 20% enables the tractor unit to work at higher speeds of translational motion, the latter contributes to increased productivity, improved planning quality and reduced cash costs per unit of work performed.

KEYWORDS: auger diameter, auger productivity, auger rotary speed, coefficient of soil softening, bucket coverage, longitudinal distance between the leveler bucket and auger.

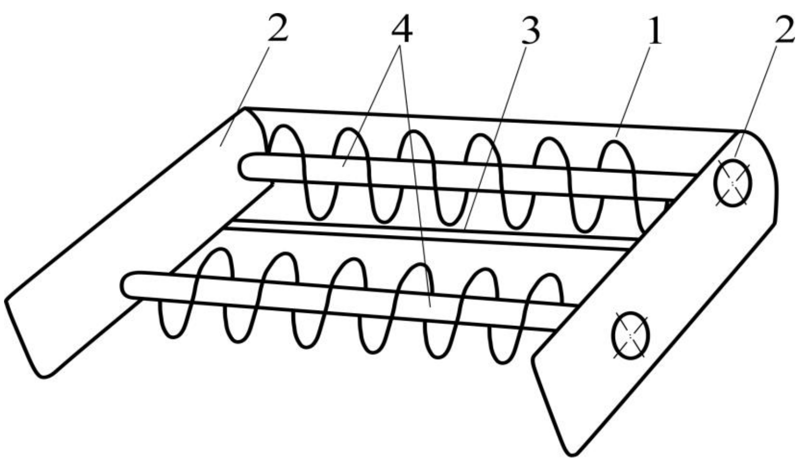
INTRODUCTION

After working the fields with leveling machines, the standard deviation of the heights of the roughness of the field surface is required not to exceed ± cm every 5 m. In a layer of 0-10 cm, the amount of soil fractions smaller than 25 mm in size should not be less than 80 %.

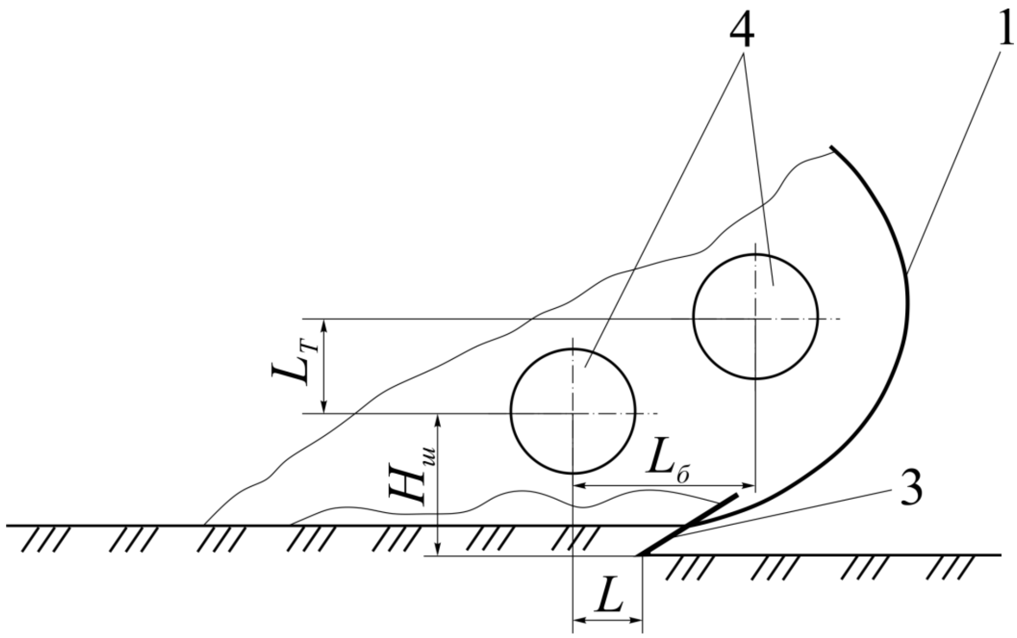
Land leveling works in Bukhara, Navoi and Khorezm regions are carried out mainly after saline leaching and pre-sowing tillage. The main reason for this is that large roughness occurs on the surface of the field because of settling of the soil after saline washing. Therefore, leveling work is carried out after saline washing. This process should be carried out in a very short agronomic period, as it is necessary to avoid loss of soil moisture when sowing seeds in early spring and when sowing wheat in autumn. Severe soil conditions in the fields after plowing, i.e. the formation of large lumps, complicate the subsequent tillage of the soil and require the passage of agricultural machinery 2-3 times across the field. This leads to an increase in energy resources and fuel consumption [1, pp. 100-102].

Based on the review of the literature carried out, we [2, pp. 266-267] were recommended to equip the leveling bucket with an auger work member to ensure that the quality of soil compaction in the field leveling is at the level of agrotechnical requirements (Fig. 1). The auger is mounted inside the bucket and the two augers rotating in opposite directions are mounted at a certain distance from each other in the vertical and horizontal directions. Because of its application, the roughness in front of the leveling bucket is leveled and the soil mass is evenly distributed along the width of the bucket.

The degree of fragmentation of large fractions in the soil increases because of rotational movement of the accumulated soil in the bucket by augers [3].



a)



b)

a) front view; b) side view

1 - back wall of the bucket; 2 - side walls; 3 - cutting knife; 4 - augers

Fig. 1. Schematic of a bucket equipped with augers

The process of technological operation of a leveler equipped with an auger working body is as follows: the soil collected in the bucket of the leveler is pushed in a transverse direction using augers. In this case, the augers push the soil in different directions: one auger pushes the soil to the left of the bucket, and the other pushes it to the opposite side, i.e. to the right. As a result, the soil is evenly distributed over the coverage width of the bucket and has a positive effect on the level and quality of leveling of the plot. The rotation of the soil with the augers and the impact of the cut stalks and large pieces on each other ensures their crushing, improving the structural composition of the soil surface layer before planting and the formation of a soft layer.

The parameters that affect the performance of a leveler equipped with an auger working body are the follow (Fig. 1 and 2):

- type of auger;
- auger diameter $D_ш$;
- auger step $l_ш$;
- auger rotation speed $n_ш$;
- auger length $L_ш$;
- longitudinal distance between the leveling bucket and the auger L ;
- longitudinal distance between augers $L_б$;
- vertical distance between the augers L_T;
- movement speed of the unit V_u .

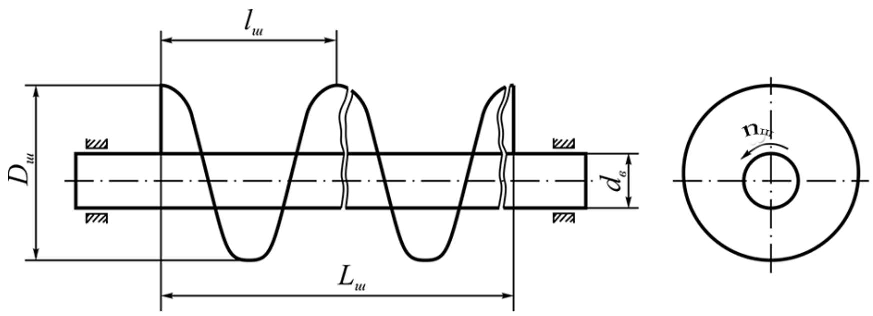


Fig. 2. Parameters of auger work member

RESULTS AND DISCUSSIONS

Let us calculate the diameter of the auger using the following expression, considering the formation of a soil pile in front of the leveling bucket [3]

$$D_ш \geq K_y \sqrt{П_б K_p \left(900 V_a K_\alpha K_н K_\beta\right)^{-1} + d_в^2}, \quad (1)$$

where K_y is the coefficient that considers the formation of a soil pile in front of the bucket of the leveler; [6]

$П_б$ is the specified working capacity of the auger, m^3/sec;

K_p is the soil-softening coefficient;

V_a is the rotational speed of the point on the auger cutting blade, m/sec;

K_α is coefficient that considers the angle of deflection of the cutting blade of auger from the horizon;

$K_н$ is the coefficient that considers the filling of the auger into the soil;

K_β is the coefficient that considers the angle of inclination of the auger relative to the horizon;

$d_в$ is diameter of the auger shaft, m.

We determine $П_б$, the defined work product of the auger included in the expression (1). To do this, we assume that the roughness of the field surface in the transverse direction, i.e. along the axis of the auger, varies according to the following law (Fig 3):

$$Y = h_н \sin\frac{\pi X}{A}, \qquad (2)$$

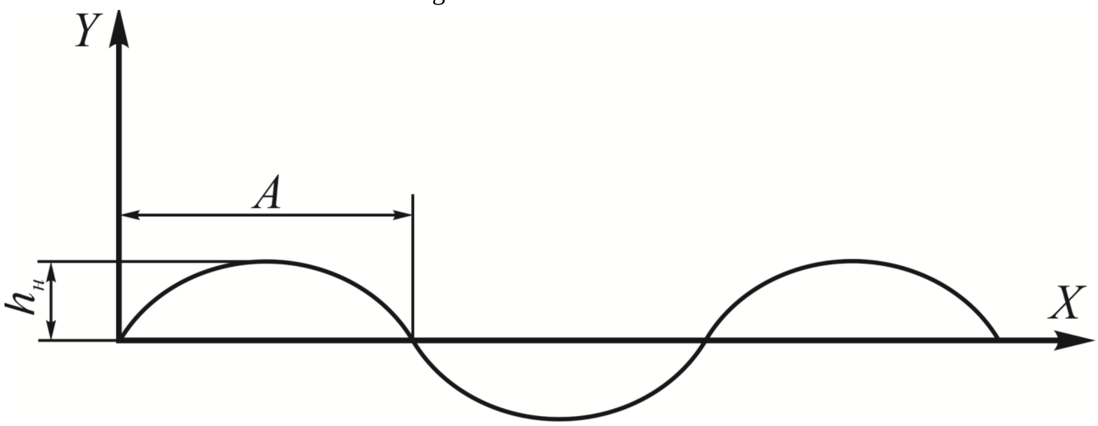


Fig. 3. The law of change in the transverse direction of the profile of the roughness of the field surface

where У, X are coordinate axes;

$h_н$ is half the height of the roughness;

A is the length of the roughness.

(2) Given the expression, the specified performance of the auger is equal to:

$$П_б = \frac{B}{2A}V_u\int_0^A h_н \sin\frac{\pi X}{A}dx = \frac{Bh_н}{2A}V_u\int_0^A \sin\frac{\pi X}{A}dx == \frac{Bh_н}{2A}V_u\left(-\frac{A}{\pi}\cos\frac{\pi}{A}X\int_0^A\right) =$$

$$= \frac{Bh_н}{2A}V_u\left[-\frac{A}{\pi}\left(\cos\frac{\pi}{A}A - \cos\frac{\pi}{A}0\right)\right] = \frac{Bh_н}{2A}V_u\left[-\frac{A}{\pi}(-1-1)\right]$$

or $$П_б = \frac{B}{\pi}V_u \qquad (3)$$

where B is the coverage width of the leveling bucket;

V_u the forward motion speed of the unit.

We determine the number of revolutions of the auger on the condition that its product in the direction along the axis of rotation is greater than the product Pb.

$$П_y > П_б. \qquad (4)$$

Failure to comply with this condition will result in the accumulation of soil in front of the auger, resulting in a violation of the technological process of the machine.

The productivity of the auger in the longitudinal direction is determined by the following expression [6,7,8]:

$$П_y = S_ш V_T K_н K_y, \qquad (4)$$

where the soil is pushed sideways by the auger section surface;

V_T is the speed of soil movement;

Кy - in the longitudinal direction of the profile of the field surface coefficient taking into account the variability.

The surface of the cross-section of the soil pushed sideways by the auger and its transport velocities are as follows [9, 10, 11]:

$$S_ш = \frac{Bh_н}{\pi}, \qquad (5)$$

$$V_T = \frac{l_ш n_ш}{60}. \qquad (6)$$

Substituting (5) and (6) into (4),

$$П_y = \frac{Bh_н l_ш n_ш \varphi}{60\pi}K_н K_y. \qquad (7)$$

We put expressions (3) and (7) into inequality (4):

$$\frac{Bh_H l_ш n_ш K_н K_ў}{60\pi} > \frac{Bh_н}{\pi}V_u. \qquad (8)$$

Solving (8) with respect to nsh, $n_ш$ obtain:

$$n_{ш} > \frac{120V_{u}}{l_{ш}K_{н}K_{у}}. \quad (9)$$

Using the scheme shown in Figure 1, we determine the longitudinal distance L between the leveling bucket and the auger from the condition that there is no soil blockage between the bucket lemex and the auger: To do this, the following condition must be met

$$L \leq (H_{ш} - 0{,}5D_{ш})ctg\psi_{б}, \quad (10)$$

where $H_{ш}$ - is the alignment of the auger relative to the bucket lemex blade height;

$\psi_{б}$ - is the angle of refraction of the soil in the longitudinal direction.

CONCLUSION

1. Analytical connections were obtained to determine the diameter of the auger, the number of step rotations, the longitudinal distance between the bucket and the auger, and the longitudinal and vertical distances between the augers.

2. To ensure good leveling of soils and soil fractions at the level of agrotechnical requirements, auger diameter 30 cm step at least 25 cm and number of rotations should be 270 rpm..

3. When leveling longitudinal irregularities on the field surface, the longitudinal distance between the bucket and the auger should be no more than 20 cm.

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