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Research Article

DETERMINATION OF INSTALLATION ANGLE AND HEIGHT WORKING BODY OF THE PRESEEDING LEVELER

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ABSTRACT

The article defines the installation angle and the height of the working body of the preplant equalizer depending on the movement of the soil in front of the working body and the friction force between the working body and the soil.

KEYWORDS

Working body, installation angle, direction of motion, soil movement, angle of repose.

INTRODUCTION

In order to obtain the required flatness in one pass on the leveling machines before planting, the working parts of the knife-type leveling machines mounted on the existing frame are mounted in three rows. The working parts of the first and second rows are mounted at an angle to the direction of movement of the machine, and the third row is mounted perpendicular to the direction of movement [1-3]. The work pieces, mounted at an angle to the direction of movement, move the soil in two directions, filling the

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microns, and the last row completely flattens the microns. Therefore, researching the installation angle of working parts moving at an angle to the direction of movement of the machine and determining the optimal option will lead to an improvement in the quality of the land leveling process before planting and reduce energy consumption.

MATERIALS AND METHODS

The angle between the projection of the workpiece on the horizontal plane and the forward direction of movement of the unit is called the installation angle of the workpiece. The quality of the alignment depends in many respects on the value of this angle.

A number of researchers surveyed the working part of a leveling machine and set its installation angle at 30-500. The fact that the installation angle of the working part of the leveling machine before planting is in such a large range made it necessary to study the optimal option of the installation angle of the working part of the ground leveling machine before planting this angle [4-9].

In front of the work piece mounted at an angle to the direction of movement, the soil moves in the transverse and longitudinal directions. Assume that the soil moves perpendicular to the direction of motion and at an angle.

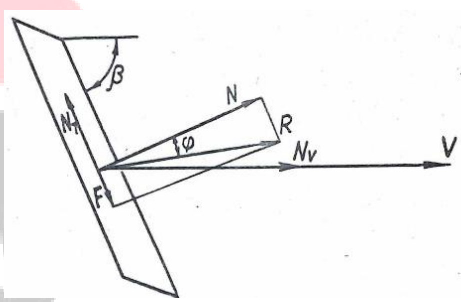

Figure 1. Schematic for determining the installation angle of the leveling workpiece.

We divide the normal force N acting on the ground by the working part into two, Nv and Nt, respectively, which are formed by the movement of the leveler along the direction of movement V and in front of the working part (Fig. 1). In addition to the normal force N, the friction force G on the ground is affected [10-14]. The forces N and G give the resulting force R, which deviates from the normal force at an angle ph. Based on this, it is possible to set the following two operating modes of the leveling unit before planting:

1. The soil slides in front of the working part. In the case of β< $\frac{\pi}{2}$ it can be clearly observed;
2. The soil slides along with the working part and falls asleep in front of the working part. The maximum accumulation of soil in front of the working part can be observed β=90° In this case, there is no transverse movement of the soil in front of the working part.

It is possible to move the soil in front of the working part if the force of friction of the normal compressive force is greater than the frictional force, ie:

$N_T > F_{Max}$, but $N_T = Ntg\left(\frac{\pi}{2} - β\right)$, $F_{Max} = Ntg\varphi$ $\frac{\pi}{2} - β > \varphi$

From this the condition of sliding the soil in front of the working part will have the following appearance.

$$Ntg\left(\frac{\pi}{2} - β\right) > Ntg\varphi \text{ or } \frac{\pi}{2} - β > \varphi$$

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If $\frac{\pi}{2} - β < \varphi$, the forces N_T and F are mutually balanced, no displacement of the soil in front of the working part is observed, and the direction of movement of the soil coincides with the direction of movement of the working part, and the only driving force is N_V. In this case, the soil moves with the working part in the direction of its movement, the working part pushes the formed soil pile in front of it [3-16]. The condition of soil displacement in front of the working part at an angle to the direction of movement can be expressed as follows:

$$\frac{\pi}{2} - β > \varphi$$

Where β - is the installation angle of the working part of the leveler, grad;

φ -is the friction angle of the soil in the steel.

Therefore, β=φ can be taken as the lower limit of the installation angle of the straightening workpiece. Depending on the type and physical-mechanical properties of the soil, the lower limit of the installation angle can be taken β=22-30°. We find the upper limit of the working part installation angle using the soil displacement velocity. Depending on the installation angle of the work piece, the speed at which the soil exits the work area will vary. As a result of friction, the movement of the soil is delayed, resulting in a decrease in the rate of subsidence of the soil along the working part. Assume that the direction of absolute velocity V_A corresponds to the absolute trajectory of ground motion, and divide the velocity V_A in the direction of motion by W and the velocity V_{cx} in front of the work piece to obtain the absolute velocity component (Figure 2). In this case, the VA velocity deviates from the normal working surface friction angle φ. As can be seen in Figure 2.3, V_{cx} and V_T are interconnected as follows:

$$\frac{V_{CX}}{\sin[90-(\beta+\varphi)]} = \frac{V_T}{\sin(90-(+\varphi)]}$$

After the mathematical changes, we get the following.

$$V_{CX} = V_T \frac{\cos(\beta+\varphi)}{\cos\varphi}$$

Table 1 shows the calculated values of the soil exit velocity from the working part depending on the installation angle.

Table 1. Installation angle of V_{cx} and ground leveler values depending on the speed of movement (in the picture φ=22°, in the picture φ=30°)

Installation angle of the working part, grad	*The speed of the working part is m | s*		
	1,66	2,55	3,3
60	0,24\0	0,37\0	0,49\0
55	0,40\0,16	0,60\0,25	0,80\0,33
50	0,55\0,33	0,83\0,5	1,10\0,66
45	0,69\0,49	1,05\0,74	1,39\0,99
40	0,84\0,65	1,25\0,97	1,67\1,30
35	0,97\0,81	1,46\1,26	1,93\1,61
30	1,10\0,40	1,66\1,44	2,19\1,90

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As can be seen from the table, with the decrease of the installation angle, the soil ejection velocity V_{sx} increases independently of the movement speed of the leveler].

Excessive increase of the soil outlet angle causes the soil to pass through the top of the working part and as a result the quality of field leveling is impaired. Therefore, the value of the installation angle should be chosen in such a way that it allows the soil to move normally at high speeds of the leveler. As can be seen from the table, the mounting angle β = 60° and φ=30° soil discharge velocity are 0.

Based on the above, it can be said that the leveling angle of the leveling machine before planting should be in the range of 50...55° when operating at high speeds.

One of the factors influencing the working quality and productivity of the leveling machine before planting is the height of the working part. During the operation of the unit, the working part cuts the soil and moves a certain amount of soil collected in front of it. In order for this soil volume to shift at the required level, the height of the working part must be chosen so that during the work the soil is pushed in front of the working part without passing through the top of the working part.

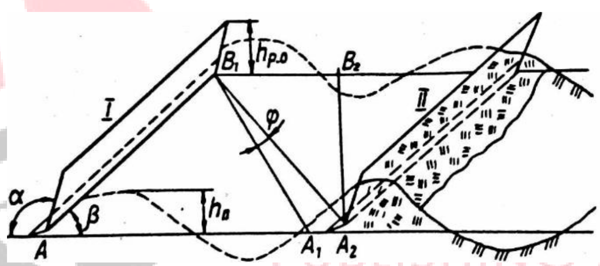

Figure 2. Schematic for determining the height of the working part of the leveler.

The height of the working part of the leveler can be found by equalizing the volume of soil moving in front of it as a result of the movement of the working part, the size of the soil prism that can be placed in front of it. Assume that the working part of the leveler is located at an angle β to the direction of movement and the depth of the moving soil is sunk to h_T.

When the working part passes from state I to state II, the ground triangle changes from state AB_1A_1 to state $A_2B_1B_2$. Thus, in front of the working part there is a pile of soil, which is constantly determined by the size expression. H_t

$$W' = \frac{h_T \, l AA_2 Sin\beta}{2}$$

The amount of soil that can be placed in front of the work piece in the form of a prism:

$$W = \frac{H^2}{tg\mu} lK$$

Where $\frac{H^2}{tg\mu}$)- is the cross-sectional area of the soil prism, M^2;

μ- angle of inclination of the soil prism, grad;

l – the length of one section of the working part, m = 1m.

The cross section of the ground prism in front of the work piece is 2.7

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imagine in the form of a triangle as shown in the figure 3.

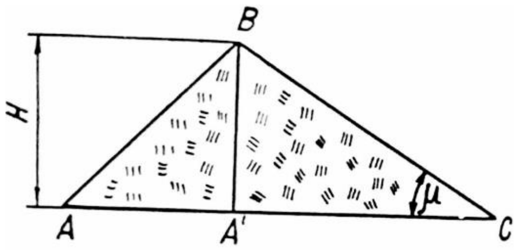

Figure 3.

When the angle of inclination of the working part of the leveler is α=90°, the cross-sectional area of the ground prism is A′ BC, and when the angle of inclination is 90°, the area of the triangle is ABC. From this

$$\varrho = \frac{S\Delta ABC}{S\Delta A'BC}$$

ϱ -correction factor ϱ = 1.3

Equating W to W, we find the height of the ground prism.

$$h = \sqrt{\frac{h_n\ bsin\beta tg\mu}{2\varrho}}$$

Given the angle of inclination of the workpiece, its height can be found from the following expression.

$$h_{ик} = \frac{1}{sin\alpha}\sqrt{\frac{h_т bsin\beta tg\mu}{2\varrho}}$$

It can be seen from this expression that the height of the working part depends mainly on the dimensions of the moving soil layer (h_t) and its physical and mechanical properties (μ).

The angle of inclination of the working part is α=120°, its installation angle

When β=50-55°, μ=30-32°, $h_т$ = 0,06 m, the height of the working part of the leveling machine before planting will be 0.164-0.172 m.

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