Research Article

NOMOGRAM FOR DETERMINING THE PERFORMANCE PARAMETERS OF THE PRE-SEEDING LEVELER

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ABSTRACT

The article describes the results of research on determining the technical parameters of the pre-sewing land leveling machine on case of the wide o working and working speed.

KEYWORDS

Pre-sewing leveling, land leveling machine ide and speed determination, diagram of its interdependence.

INTRODUCTION

The speed of agricultural machines is determined primarily based on the requirements of the existing technological process. Some processes require slow spreading of the aggregate mass into the soil (or compaction). In this case, the unit with a large weight should move at a low speed. In other cases, especially when leveling the land before planting, a minimum level of soil compaction is required, because the soil density increases as a result of the aggregate entering the field many times in one cycle of agricultural crops. In order to prevent such an adverse situation, it is necessary to reduce the contact time between soil

and aggregate. This is done by increasing the working speed of the aggregates [1-4].

RESEARCH METHODS

The performance of agricultural aggregates can be determined by their coverage width and speed of movement or engine power and specific resistance of the aggregate:

$$W = 0,1BV \tag{1}$$

$$W = \frac{27N_e}{K_v} \varepsilon_{N_e} \eta_{mp} \tag{2}$$

W= unit's hourly productivity ha\h;

B= coverage width of aggregate, m;

Ne = effective power of the engine, kW;

V= working speed of the unit, m\s;

Kv= specific resistance of aggregate, N\m;

ε_{N_e} = engine effective power utilization coefficient;

$\eta_{\text{тр}}$ = useful tractor efficiency.

The sweep width B is a function of a number of uncorrelated variables and the speed of movement.

$$B = F \ (KvNe\eta_{mp}V) \tag{3}$$

The relative resistance Kv, which depends on the speed of movement of the rectifier, is a factor affecting the coverage width and speed of movement of the unit [5-9]. The relative resistance of the rectifier depending on the speed of movement can be expressed as follows;

$$Kv = K_{\text{н}} + a \ (V_{\text{п}} - V_{\text{н}}) \tag{4}$$

Here, Kn is the specific resistance of the rectifier at low speeds, N\m;

Vп- acquired movement speed, m\s;

Vн- low movement speed, m\s;

a- coefficient that takes into account the change in resistivity due to the change in speed.

During the operation of the unit, not all of the effective power generated by the engine is used for useful work [10-17]. The power balance of the soil leveler before planting can be written in the following form:

$$N_e = N_f + N_m + N_n + N_{\text{б}} + N_{\text{кр}} \tag{5}$$

Here Nf = power spent on overcoming friction in mechanisms and gears, kW:

N$_m$ = the power required to carry the leveler is kW;

N$_n$ = power used for climbing, kW;

N_6 = power used for bolting, kW;

$N_{кр}$ = power consumed by the hook of the agricultural machine, kW.

$$Ne = Ne(1-\eta_{mp}) + \frac{vP_f}{270}\cos\alpha \pm \frac{R}{270}\sin\alpha + Ne\eta_{m\delta} + \frac{KBV}{270} \qquad (6)$$

Here P_f- resistance to drag (perekativanie), n\m;

δ – reduction coefficient, %

R- total traction resistance, n\m;

The damping coefficient can be determined by the following expression:

$$\delta = c\mu_1 + d\frac{\mu_1}{V} \qquad (7)$$

where µ1 is the coefficient of utilization of the mass of the frame, the ratio of the resistance on the hook corresponding to the leading drive unit of the tractor

$$\frac{P_{кр}}{C_{сц}}$$

s, d are constant coefficients for the area prepared for planting. S=0.2 and d=3 are acceptable.

It is known that the useful work coefficient of the agricultural machine consists of the useful work coefficient of the tractor and aggregated agricultural machine [18-23].

$$\eta_c = \eta_{mp} \cdot \eta_m \qquad (8)$$

Here η_c = total useful work coefficient of the unit.

$\eta_{тp}$ = useful tractor efficiency

$\eta_т$ = useful duty ratio of the rectifier.

RESEARCH RESULTS

The useful efficiency of the tractor as a function of the speed of movement is a complex function, which depends on the losses in the power transmission, the chain travel, the movement of the tractor itself, and the losses in the crushing [24-29]. Taking into account the common aspects of useful work coefficients of many aggregates and the complexity of the process of its determination, we will be content with determining the useful work coefficient of the leveler. The total resistance of the land leveling machine before planting can be divided into two groups. The component of the total resistance Pf (power spent on the movement of the rectifier) is a useless resistance or "dead" resistance. The components of the total resistance R and R' coch (the reaction force from the deformation resistance of the soil and the resistance force to the movement of the soil pile) are considered useful resistance. Based on the above, the useful work coefficient of the rectifier can be written as follows:

International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 02 ISSUE 11   Pages: 119-126
SJIF IMPACT FACTOR (2021: **5.478**) (2022: **5.636**)
METADATA IF – 7.356

Crossref doi Google Scholar METADATA INDEXING WorldCat MENDELEY ISSN-2750-1396

$$\eta_m = \frac{R + R_{\kappa\ddot{y}\kappa}}{R_f + R + R_{\kappa\ddot{y}\kappa}} \tag{9}$$

From this, the total useful work coefficient of the aggregate

$$\eta_a = \eta_{mp}\left(\frac{R + R_{\kappa\ddot{y}\kappa}}{R_f + R + R_{\kappa\ddot{y}\kappa}}\right) \tag{10}$$

Substituting expressions 4, 6, 10 into 2 and solving expressions 1 and 2 together, we get the mathematical expression of the width coverage of the leveler.

$$B = \frac{\theta 270 N_e \left\{ \varepsilon - \left[1 - \eta_T \left(\frac{R + R_{np}}{R_f + R + R_{np}} \right) \right] \right\} - R_f V}{V + \frac{270 N_e \eta_T \left(\frac{R + R_{np}}{R_f + R + R_{np}} \right)\left(C + \frac{d}{V} \right)}{c_{c\mu}} K_H + a\left(V_n - V_H \right)} \tag{11}$$

Here θ is the bandwidth utilization factor.

When the leveler works, the two lateral passages should cover each other at a distance of 40-50 cm so that there is no unleveled space between the two lateral passages of the leveler. From this

$$\theta = \frac{[B - (0,4...0,5)]}{B} \text{ if } \theta = 0,93....0,96$$

The obtained equation allows to determine the width of the screed by an analytical method, depending on the speed of aggregate movement, physical mechanical properties of the soil, and specific resistance of the screed [30-35].

The resulting equation can be solved much easier by graphoanalytical method. To do this, first, the value of the movement speed is given by the procedure according to equation 11, and the coverage width is determined.
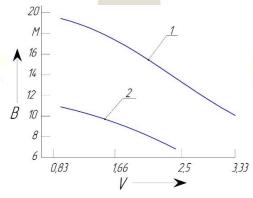

Figure 1. The graph of the change of the leveler coverage width depending on the speed of movement. For class 1-5 tractors. For tractors of class 2-4.

As can be seen from the graph, the coverage width decreases as the speed of movement increases. But as the power of the tractor increases, the coverage width of the leveler increases dramatically. A super wide straightener is clumsy and inconvenient to use due to its large metal capacity. In order to make full use of the power of the tractor, it is advisable to reduce the width of the leveler and use it at higher speeds. When the working speed of the unit is increased, the work productivity increases, as a result of which the specific metal capacity per treated soil surface decreases. This keeps the soil from compacting [34-35]. The resulting graphical relationship allows to determine the coverage width and speed mode in each size of the leveler and to calculate the theoretical performance.

The nomogram shown in the figure allows determining the optimal movement speed of the unit and the coverage width that provides maximum productivity, depending on the power of the tractor.
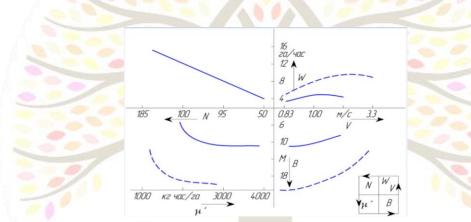

Figure 2. Nomogram for determining the coverage width, movement speed and performance of the leveler.

For leveler aggregated with a class 5 tractor. For leveler aggregated with a class 4 tractor.

CONCLUSION

The top left square of the nomogram shows the variation of maximum productivity as a function of tractor power, the top right square shows the performance of the leveler as a function of the aggregate movement speed, the bottom right square shows the aggregate coverage width as a function of the movement speed, and the bottom right square shows the specific metal capacity as a function of the coverage width and aggregate mass

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