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Research on Ensuring the Effective Compaction of the Roller of a Universal Device Used in Pre-Planting Tillage

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Summary: The roller of the universal device used in the pre-planting treatment of the land, the roller of the universal device used in the pre-planting treatment of the soil should be in a horizontal or upward position during the work process.

Key word: universal device, reel, frame, pressure force, minimum weight force, traction force.

The roller of the universal device is hinged with its frame by means of a traction device, and during the work, it sinks into the soil to a certain depth. Its main task is to uniformly compact the layer processed by the universal device's arrow-shaped claws and milling cutter at the required level and along the entire surface. In order to achieve this, the depth of immersion of the roller into the soil and its uniformity are important considerations.

When the roller is connected to the frame according to the "a" scheme, the OO1 connecting them takes a horizontal position during the working process, when it is connected according to the "b" scheme, the tension is downwards relative to the horizontal position during the working process. ib works, and when "b" is connected according to the scheme, the tensioner works with an upward deviation from the horizontal position during operation.

Figure 1.1 shows the possible connection schemes of the coil with the frame of the device.

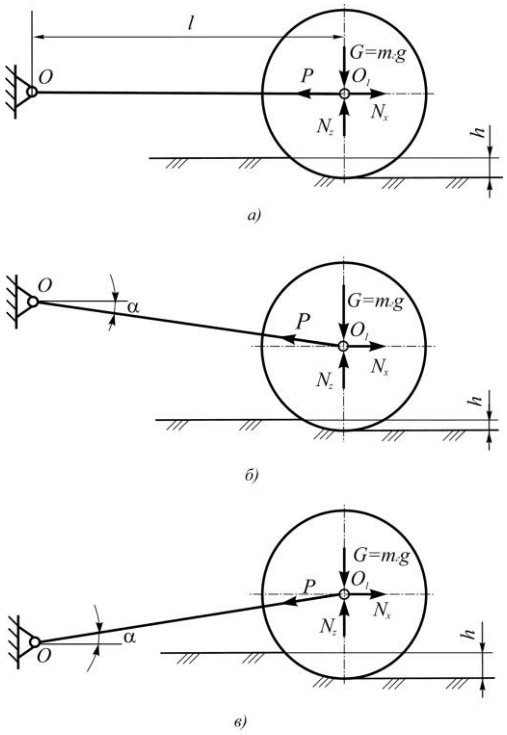

Figure 1.1. Schemes of connection of the universal device coil with its frame.

Using the schemes presented in Figure 1.1, we determine the vertical compressive force exerted by the roller on the soil

$$Q_б = N_z = G \mp P\sin\alpha = m_г g \mp P\sin\alpha, \quad (1.1)$$

in this

Q_b is the vertical pressure force applied to the soil by the roller, N;

N_z is the vertical component of the reaction force acting on the coil by the soil, N;

G is the weight of the reel, N;

P is the pulling force applied to the reel by the tow, N;

α - angle of deviation of the pulley connecting the reel to the frame with respect to the horizon, N;

m_g – mass of the roller, kg;

g - free fall acceleration, m/s2.

In the expression (1.1), the sign "–" is placed when the tow deviates from the horizontal position downwards, and the sign "+" is placed when it deviates upward.

In the first case, i.e., when the tractor is working in a horizontal position, the traction force applied to the roller does not affect the pressure force exerted by it on the soil, and its gravity is fully used to compact the soil.

In the second case, i.e., the traction force exerted on the roller tends to raise it from the ground, even though the drag is working downwards from the horizontal position. Therefore, the pressure force of the roller on the soil is less than its weight, that is, in this case, the weight of the roller is not fully used to compact the soil. It should also be noted that the greater the angle of deviation of the tractor from the horizon, the lower the pressure force of the roller on the soil. Therefore, in this case, to compact the soil at the required level, a greater force of gravity is required than in the first case.

In the third case, the force of gravity presses the roller to the ground. As a result, the compressive force of the roller is greater than the force of its weight. Therefore, in this case, a minimum amount of gravity is required to compact the soil at the required level. This, in turn, leads to a decrease in material volume.

We change the expression (1.1) to the following form

$$Q_б = m_г g \mp \frac{\mu_г \sqrt{N_x^2 + N_z^2}}{\sqrt{1+\mu_г^2}} tg\alpha, \quad (1.2)$$

in this μ_g is the rolling coefficient of the roller;

N_x is the horizontal component of the reaction force acting on the coil by the soil, N.

It is known that the reaction forces N_x and N_z acting on the coil during the work process are constantly changing due to the variability of the physical and mechanical properties of the soil. As can be seen from the expression (1.2), for this reason, when the tension connecting the roller with the frame deviates downward or upward relative to the horizon, the pressure force Q_b of the roller on the soil remains variable, and as a result, the soil is unevenly compacted. This, in turn, has a negative impact on the quality and germination of seeds.

According to the expression (1.2), when the pulley connecting the reel to the frame is in a horizontal position, the forces N_x and N_z do not affect Q_b, that is, it has a constant value. As a result, the soil is compacted at the same level along the whole field, seeds are sown and germinated evenly.

Based on the above, laboratory-field experiments were carried out on the background treated at a depth of 18-20 cm with a chisel-cultivator equipped with a softener and arrow-shaped claws, and the position of the horizontal installation of the pulley connecting the reel to the frame the density and hardness of the soil in the 0-10 cm layer and their effect on the mean square deviations (and therefore uniformity) were studied. In the experiments, the tow truck was installed in 20° tilting and horizontal positions. This is achieved by moving the point O (Fig. 1.1) up and down.

Summary:

In order to ensure uniform and effective compaction of the soil, the roller of the universal device used in the tilling of the land before planting should be in a horizontal or upward position during the work process.

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