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COMBINED UNIT USE EFFICIENCY WITH DUMPLESS WORKING BODIES

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ABSTRACT
It was analyzed active working body installation efficiency on a combined unit with moldboardless working bodies, were considered forces acting on the combined unit and presented its experimental studies results.
Key words: ripper, moldboardless working body, active working body, erosion, tractor, power, propeller.

Introduction
In the agricultural production of the Republic of Uzbekistan, large-scale measures are being taken to reduce labor and energy costs, save resources, cultivate crops based on advanced technologies and develop highly productive agricultural machines, in particular, special attention is paid to technical means development that ensure the technological processes high-quality performance for fields preparation for sowing repeated crops with minimal energy consumption [1-12]. In particular, in this direction, it is relevant to conduct targeted scientific research on the combined machine development and substantiate its working body's technological process, ensuring resource conservation in interaction processes with the soil [13-22]. In this aspect, a unit development with moldboard-free passive and active working bodies installed in series is in demand.

The study purpose is to develop a combined unit with moldboard-free passive and active working bodies.

Research methods

The research object is a ripper with passive and active working bodies. The combined unit technological process study was carried out in laboratory-field conditions, according to literature sources, patents, and developed machine test results. The research was carried out in the Kashkadarya region of Uzbekistan on winter wheat stubble. Soil type is light gray soil. The hardness and moisture content of the soil along the horizons is 0-10, 10-20, 20-30 cm was 2,8; 3,51; 4,46 MPa and 8,1; 10,4; 12,8 %. The amount of crop residues is 0.984 kg / m^2. When determining plow operation quality indicators, we were guided by the program and methodology for testing agricultural machines according to Tst 63.02.2001 "Tests of agricultural machinery. Machines and implements for deep tillage. Program and test methods".

The results discussion

For soils subject treatment to wind erosion, we have developed a combined unit with passive and active working bodies. It consists of a frame 1, a support wheel 2, an active working body in a cutter form with straight arms 3, driven from the power take-off shaft (PTO) of the tractor, passive moldboardless bodies 4 and a support-loosening-leveling roller 5 with hinged-elastic fastening to the frame (Fig.1). The active working body 3, receiving the drive from the tractor PTO, crushes plant residues and loosens soil top layer, thereby preventing working bodies clogging when processing fields with a significant amount of plant residues and improves processing quality. The roller hinge-elastic fastening to the frame allows vertical force use, including ripper weight, to perform useful work – crumbling clods and leveling arable land surface.

To identify active working body influence on movement stability and ripper traction resistance, consider the forces acting on it. It is known that for ripper stable operation in the longitudinal-vertical plane, the following condition must be met:

$$\overline{N} = \overline{G_1} - \overline{P_z} + \overline{R}_{pz} - \overline{R}_{az} - \overline{R}_{\kappa z} > 0, \qquad (1)$$

where N – is total normal soil response on the ripper support wheels; G_1 – is ripper weight with passive and active working bodies; P_z – is vertical component of the tractor pulling force acting on the ripper at the instantaneous center of rotation; R_{pz}, and R_{az} – are respectively, the vertical components of the soil resistance forces acting on the ripper and the active working body; R_{kz} – is vertical component of the roller resistance force acting on the ripper at the point of attachment to the frame.

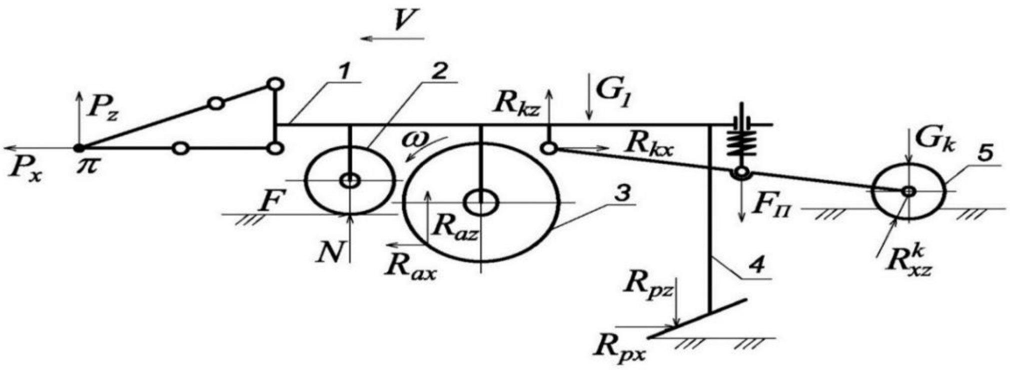

Fig.1. Forces and reactions diagram acting on a ripper with passive and active working bodies

It is known that with ripper stable operation, the force N should have a positive value. If N is negative, the machine will be lifted. In addition, N value determines the loss F for rolling the machine, since, where F is the rolling resistance coefficient [1]. From expression (1) it can be seen that with passive working bodies, N value will be positive and significant. To overcome the force N, it is necessary to apply a significant pulling force P_x. The support wheels of such a machine, as a rule, work in difficult conditions. At shallower passive implements working depths, R_{az} soil vertical reaction can sometimes exceed G_1 value, which leads to the machine lifting.

When mounted on a ripper, an active implement creates moderate normal load on the support wheels. At the same time, unit stable smooth operation with a constant working depth is ensured, since the force R_{az} is insignificant in comparison with the forces G_1 and R_{pz}. This is due to the fact that the active working body 3 loosens the topsoil to a shallow depth compared to the cultivator 4, on the other hand, it loosens the soil in strips. The R_{kz} force is also negligible, since the roller is hinged-elastically attached to the ripper frame.

To analyze the combined unit operation in the longitudinal-vertical plane, we will compose forces balance equation and reactions in general form. The horizontal component of the tractor traction force acting on the unit at the rotation instantaneous center is

$$\overline{P_x} = \overline{F} + \overline{R}_{px} + \overline{R}_{kx} - \overline{R}_{ax}, \tag{2}$$

where R_{px} and R_{ax} – are soil resistance horizontal components acting on the passive cultivator and on the active working body; R_{kx} – is roller resistance force horizontal component acting on the ripper at the attachment point to the frame.

When the unit operates with passive working bodies, to overcome the resistance forces R_{px}, R_{kx} and F, it is necessary to create a significant traction force on the tractor hook, which leads to an increase in its weight. It is known that an increase in the adhesion weight of a wheeled tractor leads to negative consequences: under running devices action, the soil is compacted, the upper soil layer structure is destroyed [1].

When machines with active working bodies are operating, the force R_{ax} often exceeds the force F required to roll the ripper, which leads to energy waste [1]. When active and passive working bodies are installed on the ripper, the required active effort decreases, since the active working body, in addition to performing the technological process, creates a driving force R_{ax}, directed in travel direction. In addition, with a combination of a ripper and an active working body, stress fields of different signs are superimposed on each other, formed in the soil by the chisel and share of the ripper and the knife of the active working body, which contributes to an increase in the degree of soil crumbling and a decrease in energy consumption [2]. Consequently, a ripper with active and passive working bodies is effective with energy-intensive tractors, since it does not require large active effort, is stable and reliable in operation.

As a result of theoretical and experimental studies, a prototype of a combined ripper with passive and active working bodies was manufactured, which unit passive is working bodies' combination (moldboardless bodies) and active working bodies in cutter form with straight blades driven from the tractor PTO shaft.

Combined unit experimental studies were carried out in the Kashkadarya region of Uzbekistan. The experimental unit was aggregated with a T-4A tractor. During tests, the kinematic parameter, i.e. the knife cutting points peripheral speed ratio to cutter forward speed was 2,1, and the loosening depth was 13 cm.

Experimental studies in the field have shown that the unit with active and passive working bodies in terms of the main quality indicators is significantly superior to the unit with passive working bodies. The active working body use on the unit helps to reduce arable land surface ridgeiness by 23.4%, to improve soil crumbling quality and the work stability at soil cultivation 22% and 9.9% depth respectively, and to reduce traction resistance by 17.7%. Due to the decrease in traction resistance, the tractor slipping decreased and the working speed increased by 13.8%, and the specific fuel consumption decreased by 14.4%.

Conclusion

The forces and reactions analysis acting on the combined unit showed that an active working body use contributes to energy-saturated tractors efficient use, an active working body use on the ripper helps to improve the soil crumbling quality and the work stability at 22% and 9.9%, depth of soil cultivation respectively, a decrease in traction resistance by 17.7%, a decrease in traction resistance and specific fuel consumption by 17.7% and 14.4%, respectively.

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