Ripping paw tools for preparing the soil for planting

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Abstract. The paper discusses parameters of the loosening paw tool to prepare the soil the strip sowing of melons. Scheme of mutual arrangement of the paired housing and the ripper is given. Formulas were obtained for determining the depth of tillage, the width of the ripper and the degree of loosening of the soil, as well as the longitudinal distance between the body and the ripper. The experiments were carried out using the methods of strain measurement and multifactorial experiment. Experiments have established that with an increase in the width of the ripper, the degree of soil crumbling first increases and then decreases according to the law of the convex parabola, and the traction resistance decreases according to the law of the concave parabola. It was determined that to prepare the soil for strip sowing with a minimum traction resistance, the width of the ripper should be in the range of 18.70-20.37 cm, and the longitudinal distance from the ripper to the leaf housing is 42.87-43.57 cm.

1 Introduction

Universal ripping paws are widely used on cultivators for row-to-row and continuous tillage, as well as on chisel cultivators. In other tillage machines, they can be used as an auxiliary working organ. Studies on the improvement and justification of ripping paws N. Aldoshin [1], D. Chuyanov [4], F. Mamatov [1, 3], K. Ravshanov [8], G. Ergashov [1, 2, 3, 18], , I. Ergashev [1, 2], B. Mirzaev [6], and others. The issues of studying the interaction of the loosening paw with the soil were dealt with by Toshtemirov S [2, 6], N. Rashidov [4]. He justified the parameters of paws for various working conditions. In the tool for strip preparation loosening paw loosens the sub-arable soil layer.

2 Materials and methods

In this tool, a soil loosener 3 is installed behind the paired hulls 1 and 2 along the line of their field trimmings (Figure 1). Ripper 3 loosens the sub-arable soil layer. The main parameters of the ripper include: crumbling, angle of the solution of the wings of the paw, the width of the ripper and the length of its working surface. Based on previous studies, the angle of

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solution of the wings of the ripper's paw γ was determined by a well-known expression from the condition of cutting plant residues and their roots with sliding along the blade of the paw, the angle of crumbling α from the condition of qualitative crumbling. Based on the above, the angle of solution of the ripper's paw wings should be 60o, and the angle of crumbling of the ripper should be 25º.

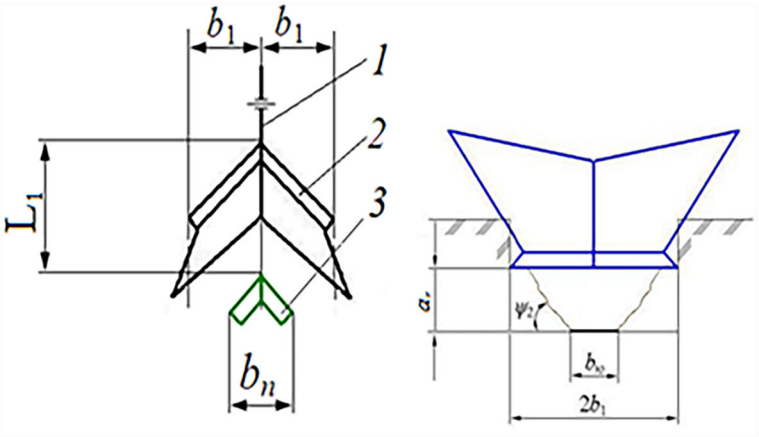


Fig. 1. Diagram of the relative position of the housings and the ripper: 1 and 2 - double housing; 3 – ripper.

The processing depth of the ripper was determined from the condition that its value was equal to the depth of the formed irrigation furrow, while it should be equal to or less than the depth of the irrigation furrow relative to the field surface [3, 7]

$$a_r = \frac{(4Hctg\phi+b_o)-\sqrt{8H^2ctg^2\phi+8Hb_0ctg\phi+b_o^2}}{2ctg\phi}, \quad (1)$$

where φ – angle the natural slope, °; H – formed irrigation furrow, cm; b0 – width the base irrigation furrow, cm.

If H=0,3 m, φ=41º and b0=0,1 m according to formula (1), the depth of processing of the ripper should be no more than 14 cm.

To determine the maximum width of the ripper , the following expression is obtained

$$b_r \leq 2b_1 - 2a_r ctg\psi_2, X \quad (2)$$

where ψ2 – the rock formation of the soil in the longitudinally vertical plane, °.

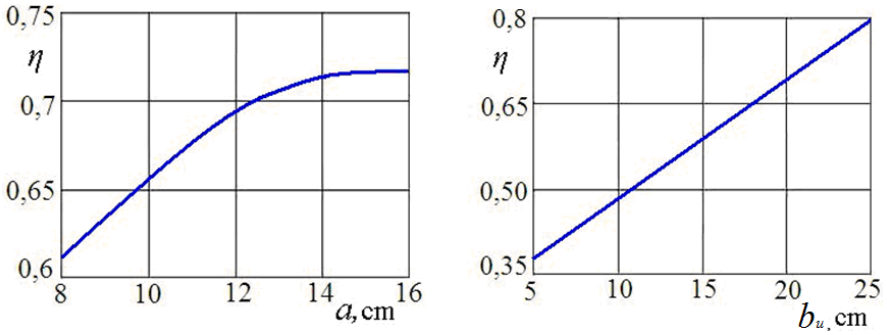
At b1=11,5cm, ar=12cm and ψ2=45º, we determine by expression (2) that for loosening the sub-arable soil layer of the double body, the width of the ripper's paw should be no more than 22 cm.

To determine the degree of loosening of the soil with a ripper , the following formula is obtained

$$\eta = \frac{b_r a_r + a_r^2 ctg\psi_2}{b_1 a_r}. \quad (3)$$

From the graphs (Figure 2), constructed according to formula (3), it can be seen that with an increase in the width of the ripper, loosening straight line, increases according parabola law.

It is known that with an increase in ripper, its traction resistance increases. Therefore, it is impractical to accept a ripper processing depth of more than 13 cm, and its gripping width of more than 20 cm.



a b

Fig. 2. Change charts degree of loosening of the soil η, depending on processing depth ripper a and the width of the gripper by b_u.

The longitudinally between ripper and socks paired housings excluding contact of deformed soil with the elements of the ripper

$$L_к \geq b_1 ctg\gamma + a_r ctg\left(\frac{\pi}{2} - \frac{\alpha+\phi_1+\phi_2}{2}\right). \quad (4)$$

Based on this formula, at α=25º, φ1=25º, φ2=35º, ar=0,12 m, b1=0,115 m and γ=42º, the lengthwise distance between ripper and toes ploughshares paired housings should be at least 0.37 m.

3 Results and discussion

When determining the optimal parameters of the ripper, single- and multifactorial experiments were carried out. Rippers with different gripping widths have been developed and manufactured for experimental studies (Figure 3) and a laboratory and field installation with the possibility of installing paired housings and a ripper on it.

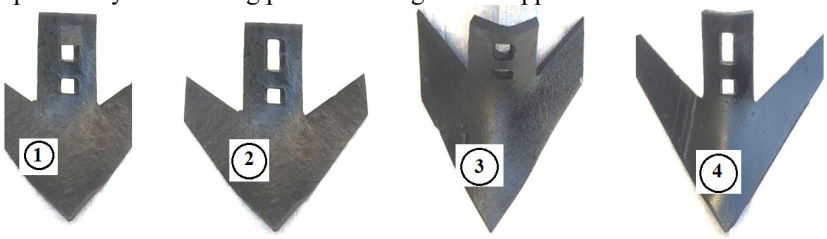


Fig. 3. Experimental rippers: b_r=10 cm (1); b_r=15 cm (2); b_r=20 cm (3); b_r=25 cm (4).

From the results of the experiments it can be seen (Figure 4) that at both speeds of movement with an increase in the longitudinal distance between the lister body and the ripper, the degree of soil crumbling increases according to the law of a convex parabola, and the traction resistance decreases according to the law of a concave parabola. Analysis of the data obtained shows that to ensure the required degree of soil crumbling with minimal traction resistance, the longitudinal distance between the lister body and the ripper should be at least 40 cm.

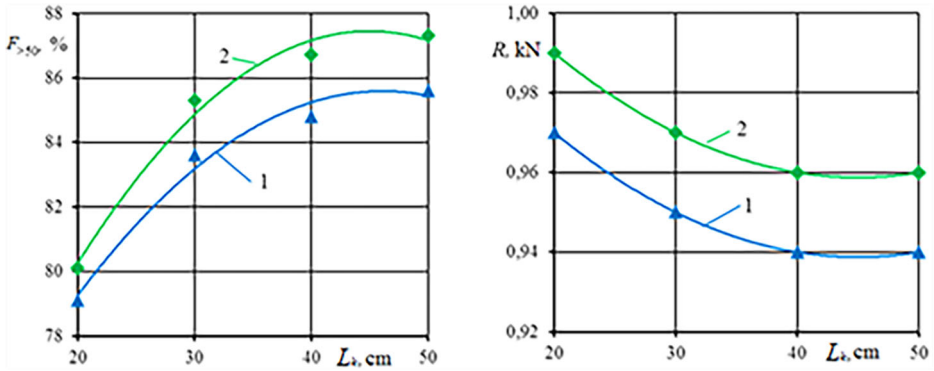


Fig. 4. Influence of the longitudinal distance on the degree of crumbling and draft resistance 1–*V*=1. 66 m/s; 2–*V*= 2. 5 m/s.

Figure 5 shows that with an increase in the ripper's grip width, the degree of ground crush first increases and then decreases according to the law of the convex parabola, and the traction resistance decreases according to the law of the concave parabola.

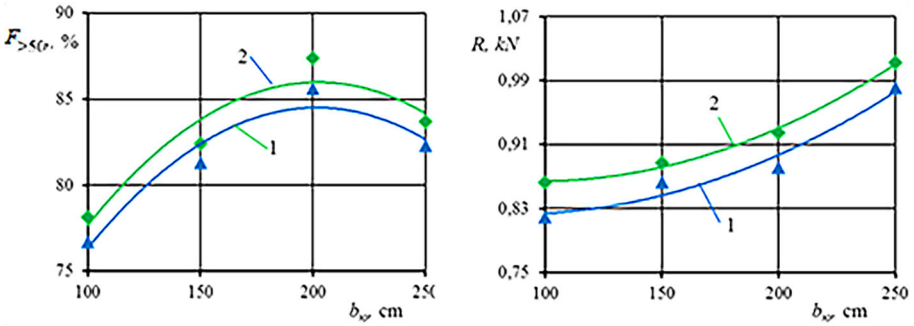


Fig. 5. Effect of ripper working width on (*F*<50) and pulling resistance ripper (*R*) depending on the width of its grip (b_r): 1–*V*=1. 66 m/s; 2–*V*= 2. 5 m/s.

To determine the optimal parameters of the ripper of the developed tool, studied in theoretical studies and single-factor experiments, multifactorial experiments were conducted. During the experiments, the breadth of the rip-up grip, the longitudinal distance from the ripper to the lister body, gun movement were chosen as the main factors. The performance of the ripper was evaluated.

Based on the experimental results, the following regression equations were obtained that adequately describe the evaluation criteria:

– by degree to the grade of crushing soil (F, %)

$$Y2=81,483+3,220X1+1,324X2+1,740X3-2,336X12+1,632X1X2+0,000X1X3-0,594X22-2,068X2X3-1,369X32 \quad (5)$$

– in conformity with to the stand drag installation (R, kN)

$$Y2=1,951+0,040X1-0,015X2+0,163X3-0,036X12--0,036X1X2+0,036X1X3+0,000X22+0,036X2X3+0,051X32 \quad (6)$$

The results of multifactor experiments, it was found that at the speeds of the gun 7 - 9 km / h provides the required quality of work with a minimum traction resistance, the width of the ripper should be in the range of 18. 70-20. 37 cm, and the longitudinal distance from the ripper to the lister body 42.87-43.57 cm. At these values, the degree of soil crumbling (Y1) was 80. 20 - 82. 53%, and the traction resistance (Y2) was 1. 80 - 2. 17 kN.

4 Conclusions

The resulting formulas allow you to determine the parameters of the ripper and the longitudinal distance between the ripper and the bodies, as well as the degree of crumbling of the soil. It has been established that with an increase in the grip of the ripper, it first increases and then decreases, and the traction resistance decreases according to the law of a concaves parabola. It was determined that in order to prepare the soil for strip sowing with minimal resistance, the width of the ripper should be within 18.70-20.37 cm, and the longitudinal length from the ripper to the lister body 42.87-43.57 cm.

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