



## Results of Multi-Factor Experiments Conducted to Base the Parameters of the Combined Machine Quantification Apparatus for Organic Fertilizers

**Imomkulov Kutbiddin  
Bokijonovich**

Doctor of Science, professor

**Muydinov Umid  
Makhkamovich**

Doctoral-student

**Rasuljonov Abdurakhmon  
Ravshanbek ugli**

Philosophy of Doctor

### ABSTRACT

The article presents the results of multi-factor experimental studies conducted on the justification of the optimal values of the parameters of the combined machine for applying organic fertilizers to pomegranate orchards, then, in order for the combined machine to ensure the required quality of work at 3-5 km/h working speeds, the surface of the fertilizer drop slot of the metering device should be 849.4-938.0 cm<sup>2</sup>, the number of revolutions of the star of the metering device should be in the range of 60.2-63.1 r/min. At these values of the factors, the mass of the fallen fertilizer was 3.64-4.75 kg, and the distance of the fertilizer falling was 40.5-57.6 cm.

### Keywords:

combined machine, metering device, the surface of the fertilizer drop slot, the number of revolutions of the star of the metering device, the mass of the dropped fertilizer, the distance of the fertilizer drop.

**Introduction.** Due to the lack of development of special technical means for fertilizing pomegranate orchards, energy-intensive organic fertilizer spreading machines and manual labor are currently being used. Currently, organic fertilizer spreaders (ROU-5, PTU-10D, etc.) [1-3], if the organic fertilizer spread by the soil is not buried as soon as possible, the nitrogen contained in it will fly into the air. For this reason, it is necessary to quickly bury the spread organic fertilizer in the soil with the help of plow or disc harrow. This leads to an increase in energy density.

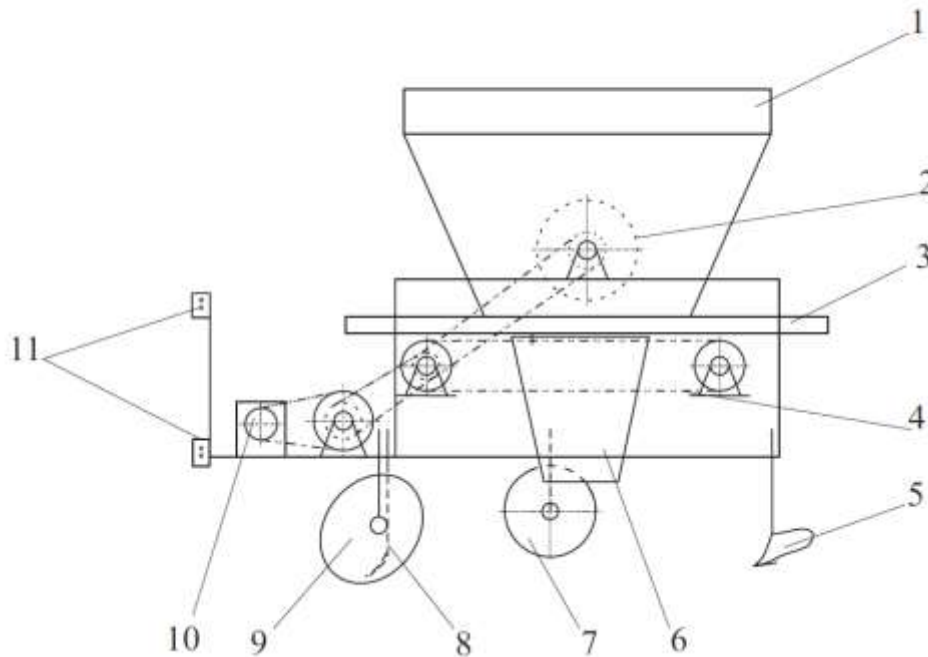
On the basis of the above, the construction scheme of the machine implementing the technology of portioning organic fertilizers to the area where the root system of trees develops was developed and studies were conducted to justify its parameters

[4-7].

The technological operation of the machine is as follows (Fig. 1): The machine is assembled to the tractor. The hoses connected to the hydraulic motor are connected to the hydraulic distributor of the tractor. The working parts of the machine are adjusted to the specified depth. The processing depth is carried out by the support wheel installed on the machine. Organic fertilizer is loaded into the hopper, the machine is adjusted according to the bush standing at the beginning of the first row in the pomegranate orchard. A special pusher is installed on the chain drive, and the pusher is brought closer to the lever for opening the fertilizer drop-off hole of the machine. The operator (tractor driver) stands in the cab of the tractor near the opening lever and presses the hydraulic distributor lever for a while). The

pusher comes to the opening lever of the fertilizer opening and pushes it along the rail

(the track of movement of the fertilizer opening to close



1 – bunker; 2 – adjuster; 3 – rail; 4 – chain drive; 5 – open the irrigation gates;  
6 – fertilizer transfer channel; 7 – support wheel; 8 – softening working body;  
9 – spherical disc; 10 – hydromotor; 11 – suspension device

**Figure 1. Technological scheme of the combined machine**

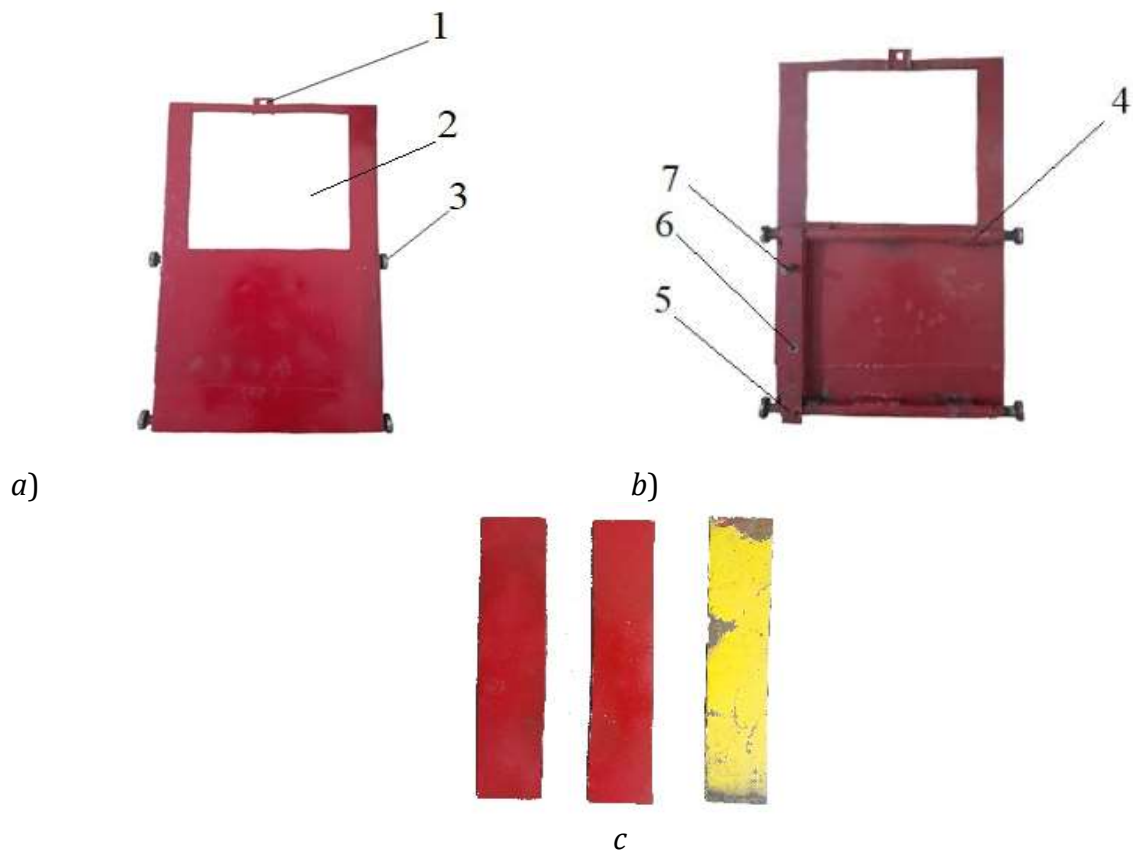
after unloading the fertilizer). As a result of pushing, it overcomes the impact force of the spring. Through the opened window, organic fertilizer falls down by its own gravity, i.e., to the fertilizing rod. After the fertilizer falls, the spring closes the window. Fertilizer moves along the conveyor and falls into the groove opened by the spherical disk. Then, the organic fertilizer that fell into the ditch is buried with the help of the working body that opens the irrigation ditches and opens the irrigation ditches. The process continues every three meters in this order [8, 9].

The surface of the fertilizer drop slot of the combined machine measuring device developed in the article (Figure 2), the number of rotations of the star of the measuring device (Figure 3) and the distance of the fertilizer falling distance of the aggregate speed and were

selected as factors affecting the mass of fallen fertilizer, and the results of multi-factorial experimental studies conducted to justify their optimal values are presented.

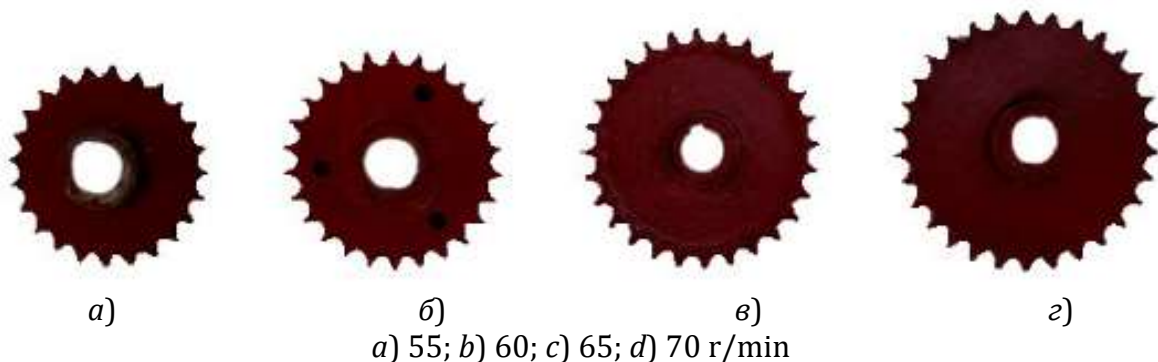
**Methods.** For conducting experimental studies, a special laboratory field device (further device) was developed (Fig. 4).

A special laboratory-field device was prepared for conducting experimental studies on the basis of the parameters of the fertilizing apparatus. Experimental research was carried out on the device shown in Fig. 4 with the possibility of changing the surface of the fertilizer transfer slot, determining the distance of the push finger of the fertilizer transfer slot (Fig. 2) and changing the number of rotations of the star of the metering device (Fig. 3). In addition, it was prepared with



1 – a hole for a spring; 2 – fertilizer transfer slot; 3 – wheel;  
4 – wheel axle; 5 – plank; 6 – finger hole; 7 – finger

**Figure 2. Experimental measuring device (a), back (b) and plates for changing the surface of the fertilizer drop slot (c)**



**Figure 3. Asterisks that change the number of revolutions of the quantizer asterisk**

the possibility of equipping with strain gauges to determine the energy indicators of the device.

It is considered that the effect of the factors on the evaluation criteria is fully described by the second-order polynomial, and

the experiments were conducted according to the Hartli-3 plan [10]. Table 1 lists the factors, their designations, measurement units, and levels of change.



1 – tractor; 2 – fertilizer bunker; 3 – quantification device; 4 – fertilizer transfer channel; 5 – support wheel; 6 – spherical disc; 7 – transmission star; 8 – hydromotor; 9 – suspension device

**Figure 4. Front (a) and side (b) views of the device**

**Table 1**

**Factors, their definition, change intervals and levels**

| Factors and their units of measurement   | Conditional designation | Change intervals | Levels     |          |           |
|--|-------------------------|------------------|------------|----------|-----------|
|  |                         |                  | lower (-1) | main (0) | high (+1) |
| 1. The surface of the fertilizer drop slot of the metering device, cm <sup>2</sup> . | X <sub>1</sub>          | 200              | 600        | 800      | 1000      |
| 2. The number of rotations of the star of the measuring device, r/min.               | X <sub>2</sub>          | 5                | 55         | 60       | 65        |
| 3. Aggregate speed, km/h.  | X <sub>3</sub>          | 1                | 3          | 4        | 5         |

When conducting multifactorial experiments, the falling fertilizer mass ( $Y_1$ , kg) and the distance of fertilizer falling ( $Y_2$ , cm) were accepted as evaluation criteria.

The data obtained from the experiments were processed by the "PLANEX" program. In this case, Cochran's test was used to evaluate the homogeneity of variance, Student's test was

used to evaluate the value of regression coefficients, and Fisher's test was used to evaluate the adequacy of regression models.

**Results and Discussion.** The following regression equations were obtained that adequately represent the evaluation criteria:

- by the mass of fallen fertilizer

$$Y_1 = 3,871 + 1,422X_1 - 1,596X_2 + X_3 + 0,462X_1^2 - 0,110X_1X_2 - 0,109X_1X_3 + 0,385X_2^2 + 0,109X_2X_3 + X_3^2 \quad (1)$$

- fertilizer drop distance

$$Y_2 = 47,458 + 9,850X_1 - 11,743X_2 + 12,873X_3 + 7,125X_1^3 - 1,842X_1X_2 + 4,158X_1X_3 + 1,525X_2^2 - 1,850X_2X_3 + 1,508X_3^2 \quad (2)$$

Параметрларнинг талаб даражасидаги иш сифатини таъминлайдиган қийматларини аниқлашда (1)-(2) тенгламалар ПК «Pentium» компьютерида Excel дастурини «ечимни қидириш» (поиск решения) амали бўйича биргаликда ечилди. Регрессия тенгламаларини биргаликда ечишда  $Y_1$

мезон, яъни тушган ўғит массаси,  $Y_2$  мезон, ўғит тушиш масофаси бўлиши қабул қилинди.

The above regression equations and the data analysis in Table 2 show that the factors had a significant effect on the evaluation criteria. It can be seen that the quantity device is the surface of the fertilizer drop slot, that is, the mass of the fertilizer dropped by the criterion  $Y_1$  increases with the increase of factor  $X_1$ . The increase in the number of revolutions of the metering device star  $X_2$ , the distance of fertilizer falling  $Y_2$  decreased according to the law of the curve, if we connect these indicators with the speed of the unit, and if we see the effect of the increasing speed of the metering device fertilizer falling gap  $X_1$ , then the distance of fertilizer falling  $Y_1$  criterion increased at all three speeds

Table 2.

**Optimal values of the parameters of the combined aggregate working bodies**

| $X_3$ |      | $X_1$   |       | $X_2$  |      |
|-------|------|---------|-------|--------|------|
| coded | real | coded   | real  | coded  | real |
| -1    | 3    | 0,69047 | 938,0 | 0,2756 | 61,4 |
| 0     | 4    | 0,489   | 897,8 | 0,0311 | 60,2 |
| 1     | 5    | 0,247   | 849,4 | 0,6197 | 63,1 |

The  $X_2$  factor, that is, the increase in the number of rotations of the quantizer star, was observed to decrease the criteria at all three speeds.

**Conclusion.** So, in order for the unit to ensure the required level of work quality at operating speeds of 3-5 km/h, the surface of the fertilizer drop slot of the metering device should be 849.4-938.0 cm<sup>2</sup>, and the number of revolutions of the star of the metering device should be in the range of 60.2-63.1 rev/min. At these values of the factors, the mass of fallen fertilizer was 3.64-4.75 kg, the distance of falling fertilizer was 40.5-57.6 cm. This meets the initial requirements.

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