The working body of the flat-cutter of the subsoiler-fertilizer

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Abstract. The article discusses issues related to the cultivation of agricultural crops with the simultaneous intrasoil application of mineral fertilizers. The size of the crop depends not only on the amount of fertilizers applied, but also on the quality of their application. Uneven fertilization leads both to a decrease in the biological yield and to inevitable losses during mechanized harvesting, due to the uneven structure of crops and different periods of plant ripening. An original design of a flat-cutter-subsoiler-fertilizer is proposed, the use of which will improve the quality of soil cultivation and crops, as well as the efficiency of intrasoil fertilization.

1. Introduction

One of the reserves for increasing agricultural production with intensive cultivation technology is the creation of high-performance machines and combined units for growing grain and applying fertilizers.

The combination of the main technological operations allows not only to significantly reduce the labor intensity of the process and the energy consumption of machines, but also serves as a necessary agrotechnical method, especially when protecting soil from wind erosion, maintaining and increasing its fertility.

The studies carried out show that at least half of the increase in crop yields is provided by the use of mineral fertilizers. At the same time, the size of the yield depends not only on the amount of fertilizers applied, but also on the quality of their application. For normal development, it is necessary that the plants are equally provided with the introduced nutrients. Uneven fertilization leads both to a decrease in the biological yield and to inevitable losses during mechanized harvesting due to the uneven structure of crops, different periods of plant ripening, etc.

Studies of various methods of applying mineral fertilizers show that their intra-soil application simultaneously with non-moldboard processing is the most optimal. At the same time, the soil is not only enriched with nutrients by applying fertilizers to a depth of stable moisture, which is especially important for arid regions, but also environmental requirements are met.

However, flat-cutters-deep-rippers-fertilizers used in areas prone to wind erosion apply fertilizers with high irregularity [1-6].

Therefore, the study and improvement of the working bodies for the application of mineral fertilizers simultaneously with non-moldboard tillage, allowing the distribution of fertilizers across the working width with unevenness that meets agricultural requirements, is an urgent task [7-10].
2. Materials and methods
The existing method of the main application of mineral fertilizers in the moldboard farming system, which consists in the surface spreading of fertilizers by seeders and spreaders, followed by their embedding into the soil with moldboard-type soil-cultivating implements (plows, plows with spherical discs) is completely unacceptable in soil-protective agriculture. It is unacceptable due to the impossibility of using tools with moldboard working bodies on erosion-hazardous soils, since moldboard-type tools completely embed stubble in the soil, which is the main factor that prevents soil from blowing out and prevents the manifestation of wind erosion. When seeding with moldboard tools, the bulk of the fertilizer remains in the upper drying layers of the soil. Therefore, the value of local deep application of the main dose of fertilizers to the depth of stable moisture increases sharply in areas of insufficient moisture, where the surface layer of the soil dries up and fertilizers in this layer cannot be used by plants.

There are three technological schemes for local intra-soil application of mineral fertilizers:
- pre-sowing local application of the main fertilizer;
- post-sowing local application of the main fertilizer;
- post-sowing root feeding of plants. According to these schemes, mineral fertilizers can be applied in several ways: - with narrow belts; - wide stripes; - solid screen; - inclined tapes; - in one or more layers; - without mixing with the soil; - with partial mixing with the soil.

In most of the numerous domestic and foreign experiments, replacing the surface spreading of the main fertilizer with the subsoil fertilizer increased the yield of agricultural products up to two times. However, in the list of considered methods there is no one that would fully meet the requirements of agricultural technology for the uniformity of fertilizer distribution over the area.

3. Results and discussion
The working body of the flat-cutter of the fertilizer subsoiler has been developed (Fig. 1).

![Figure 1. General view of the working body of the subsoiler of the fertilizer.](image-url)
A wedge-shaped rack 2 with a wedge-shaped chest 3 is installed on the frame 1 of the subsoiler-fertilizer; a feed line 4 with a fertilizer hopper 5, connected to the seeding device 6, is fixed to the rear of the rack. A high-pressure fan 7 is installed above the wedge-shaped rack 2 on the frame 1, the pressure air duct 8 of which is connected to the fuel pipe 4.

Plowshares 9 are fixed to the lower part of the rack 2, above which a fertilizer distributor 10 is mounted, hermetically connected to the collector funnel 5 and the fertilizer pipe 4.

The piping 4 is hermetically connected to the pressure air duct 8 of the fan 7. Leads 11 are fixed to the side walls of the rack 2, on which a disk loosening drum is installed with disks 12 installed at an angle to the direction of movement and consisting of a spherical part mated with a vertical part. The disks 12 are installed at an angle of divergence a and are fixed on the crank axis 13. The front part of the wedge-shaped rack 2 has a wedge-shaped chest 3, which has a variable sharpening angle 12...15°.

A chisel subsoiler 14 is fixed to the lower part of the rack 2, in the rear part of which there is a groove 15 for feeding fertilizers, connected to the pipeline by 4 holes 16. In front of the wedge-shaped rack 2, on the brackets 17 there is a disc knife 18 with flanges 19 providing the necessary deepening of the working body. The leading edge of the chisel furrower is made along a hyperbolic curve and deepened below the cutting plane of the plowshares by the value of the depth of the plowshares. The working body of the subsoiler-fertilizer works as follows. Before starting work, the fertilizer distributor is filled with a mixture of NPK fertilizers with polyacrylamide.

When the working body moves across the field, the circular knife cuts the layer in the vertical plane, the plowshares 4 cut the layer in the horizontal plane and tear it off the bottom of the furrow. In this case, the soil is deformed, partially destroyed and shifted to the sides. When the cut layer moves along the surface of the plowshares, its significant destruction does not occur. Since in the upper part of the wedge-shaped strut the taper angle of 12.15° has a minimum value, the cut layer is cut, and it prevents the strut from enveloping it.

The soil layer coming off the plowshares 4 is exposed to the discs 12 of the loosening drum, which penetrate into the layer and cause it to break down into a fine crumbly structure. In addition, the placement of the discs 12 at an angle of divergence a provides a shift of the soil and closure of the furrow formed by the stand 2. After the passage of the working body, a leveled fine crumbly surface of the field is formed.

Fertilizer 6 provides feeding a mixture of fertilizers with polyacrylamide into the fertilizer hopper 5. At the same time, air is supplied to the fuel line 4 by the fan 7 through the pressure air line 8 under pressure, which captures fertilizers from the collector hopper 5.

In this case, a fertilizer-air mixture is formed, which is fed into the pipeline 4. The pressure flow of the air-fertilizer mixture penetrates into the soil layer destroyed by the discs 12 and ensures uniform saturation of the root layer of the soil with the necessary fertilizers and polyacrylamide.

When interacting with soil moisture, as well as precipitation in the form of rain or irrigation water, fertilizers disperse and form a fertilizing solution, polacrylamide particles absorb the fertilizing solution and form a container of nutrients. Plant roots penetrate these containers, take nutrients together with the accumulated water, thus ensuring accelerated growth, plant development and increased productivity.

Polyacrylamide, by its chemical nature and structure of chemical bonds, is capable of accumulating moisture in a ratio of 1:200 (1 kg of polyacrylamide is capable of absorbing 200 liters of water). Using the working body of the subsoiler-fertilizer flat cutter allows the solution of the above tasks to be carried out and ensures the implementation of the claimed technical result.

Parallelogram sections 3 for surface treatment between ridges and in the ridge. Parallelogram section 3 for surface treatment between the ridges is equipped with toothed disk working bodies 8, which rotate on the rack 9 and are driven by the soil. The toothed disk working bodies 8 are installed at an angle of 34° with respect to the vertical component of the bead 4 to the post 9 for cutting weeds on the ridge arch, and to strengthen and compact the arches, each toothed disk working body 8 on the bead 4 is set at an angle of 5° to the direction of travel to converge to each other. A friend, between the toothed disk working bodies 8, a pointed share 10 with a width of 35 cm is installed, with which
weeds are trimmed between the ridges, and to remove weeds in the inter-row space of the ridge on parallelogram sections 3, a pointed share 11 with a width of 30 cm is installed. 

A cultivator for cultivating seed potato plantings with the option of planting planting in a ridge in two rows can be used, among other things, for ridge and smooth plantings with row spacing of 50 - 75 cm (Figure 2).

![Scheme of cultivation of potatoes for seeds.](image)

**Figure 2.** Scheme of cultivation of potatoes for seeds.

4. **Conclusion**

Tests of the experimental flat-cutter-fertilizer showed that its use allows the application of fertilizers with unevenness that meets agrotechnical requirements, as a result of which the yield of agricultural crops increased in comparison with serial methods. A technical solution has been proposed, the practical application of which has shown a high economic effect, which can serve as a basis for further deeper study of the issues of using the air flow for the intrasoil application of mineral fertilizers and for other purposes.

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