

## ANALYSIS OF DESIGN AND TECHNOLOGICAL SCHEMES OF DISK AND ANCHOR COULTERS FOR DIRECT SOWING OF GRAIN

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*The paper presents constructive and technological schemes of modern disk and anchor coulters designed for direct sowing, a comparative analysis of their advantages and disadvantages in the operation of sowing units under different agrotechnical conditions. Analogs and a prototype for development and directions for further research have been selected.*

**Keywords** - disk coulters, anchor coulters, sowing section, direct sowing, seeds, seedbed.

**Statement of the problem.** It is known that the zero-till technology of growing grain crops is energy-saving, because such energy-intensive tillage operations as plowing, harrowing and cultivation, unlike the classical technology, are carried out directly during the sowing process. However, this is possible mainly due to the improvement of the parameters of the working bodies of seeders, especially the coulters.

When designing coulters, it is necessary to take into account a number of factors (the presence of plant residues, stubble, soil hardness, moisture, viscosity) that significantly affect the processes of covering, furrow and seedbed formation, distribution, closure and compaction of seeds). Therefore, the substantiation of the design and technological scheme of the sowing section of a seeder for direct sowing of cereals, the study of the process of interaction of its working bodies with the soil and the influence of design parameters on the quality of seed sowing is an urgent scientific and technical task and an important economic problem of increasing field germination of seeds.

**Analysis of recent research.** Article [1] notes that well-known machine-building firms produce a variety of modern seeders and sowing complexes with anchor or disk coulters for direct sowing of grain, which are designed to form a seedbed with minimal disturbance of the primary state of the soil.

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It has been proved [2] that the smaller the angle of inclination of the loosening disk in relation to the direction of movement, the less damage to the surface soil layer. Some designers [3] place a depth control wheel in the area where the disk coulter exits the soil, which prevents the soil from swelling under the action of the disk and prevents damage to its integrity. The anchor coulters of the domestic (Kropyvnytskyi) Elvorti CZS-2.1 seeder (Table 2, Fig. b) and the German Horsch Sprinter ST (Table 2, Fig. a) create a furrow in the soil with a dense bed for seeds without disturbing the structure of the surface soil layer and mulch, due to which moisture is well preserved [4]. The chisel-shaped coulter of the Primera DMC seeder (Table 2, Fig. c) is designed for direct and mulch sowing in arid regions. The fundamental difference is that the seeds are placed under the crop residues, which ensures good contact with the soil and improves the conditions for seed germination [5].

The main criterion for this analysis of direct seeding coulters is to ensure the prerequisites for uniformity of seeding both along the length of the row and the depth of seeding into the soil.

**The aim of the study is to** increase the efficiency of a direct seeder by improving the design and technological scheme and working bodies of the sowing section.

**The main part.** As a result of laboratory and field studies and observations of the operation of seeders and sowing complexes in the field, the following was found.

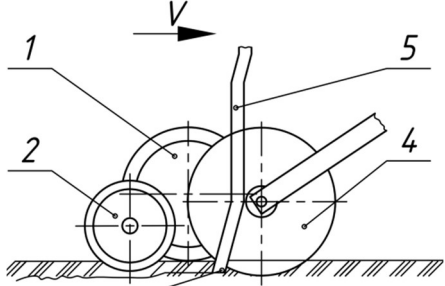
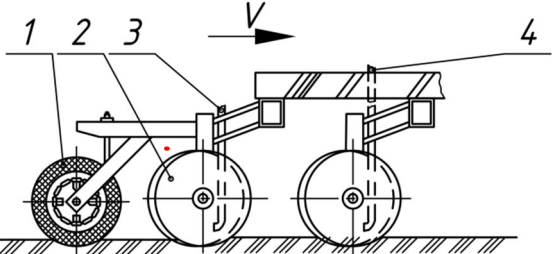
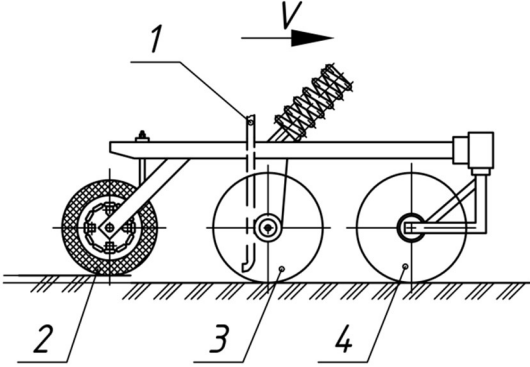
*Disc coulters.* The double-disc coulter of the Salford 520 seeder (Table 1, Fig. a), using a parallelogram mechanism of attachment to the frame, copies the unevenness of the field surface well and adheres to the set seeding depth at high speeds. The 6.35 mm offset sowing discs 1 penetrate the soil better, and the plastic seal located between them levels the seed in the furrow and improves its contact with the soil. The elastic parallelogram lever mechanism 2 creates pressure on the coulter, which is concentrated on the rubber roller 3, so that the depth of the discs and, accordingly, the seeding depth can be adjusted by changing the position of the roller. The articulated coulter and roller connection ensures precise pressing even in fields with complex contours and frequent turning. A disk knife (wavy disk) 4 is mounted on the front of each coulter. It cuts a slit in the stubble, destroys the compaction of the surface soil layer, crushes plant residues, preventing them from falling to the bottom of the furrow, i.e. to the seedbed. The depth of the disk knife should be 2.5 cm deeper than the sowing depth, as a result of which the root system of plants develops vertically, and moisture and nutrients from the lower soil layers are more accessible to it.

The American-made John Deere 730 seeder is also equipped with a double-disc coulter (Table 1, Fig. a), and the sowing Disks 1 are also offset along the direction of travel. Behind the sowing machines are wheels 2, which roll the surface, ensuring increased contact of the seed with the soil, and allow you to control the depth of its incorporation in the furrow.

The disadvantage of disc coulters, depending on the method of their use and the previous crop grown in a given crop rotation, may be the penetration of stubble or other plant residues into the seedbed, which impairs seed contact with the soil and, as a result, leads to a decrease in field germination [6]

Table 1.

**Disk coulters and brands of seeders (sowing complexes)**

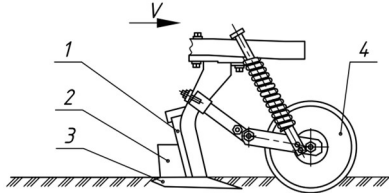
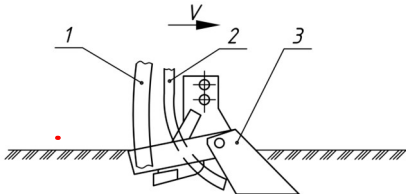
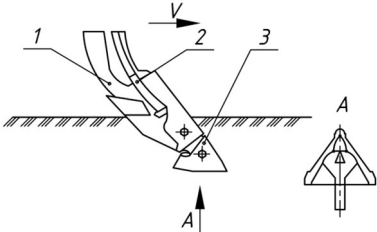
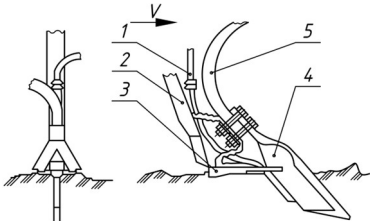
<i>The coulters design</i>	<i>Manufacturer</i>
<p>a)</p>  <p>1 - double-disc coulters; 2 - packer wheel; 4 - copying wavy disk knife; 5 - seed pipe</p>	<p>Salford 520, John Deere 730, Bourgault 5725-30, Morris Never Pin, John Deere 750A, Gaspardo Gigante 900, Great Plains STA-4000, SPP-4.2, SZS-400, MPK-12, Crucianelli PIONERA III / IV, DolbiFX 7000,</p>
<p>b)</p>  <p>1-packing wheel; 2-double-disc coulters with offset disks; 3-seed conduit; 4-fertilizer conduit</p>	<p>SS-6 "Buster", SZK-4.5, "Bereginya", Kuhn SD3000P (4000P; 6000P)</p>
<p>c)</p>  <p>1 - seed conduit; 2 - packer wheel; 3 - double-disc coulters; 4-copy wheel</p>	<p>John Deere 1895, Great Plains STA-4000, Crucianelli PIONERA III / IV, DolbiFX 7000, Amazone Citan</p>

Anchor coulters (especially chisel-shaped ones) better compact the seedbed and are able to move crop residues from the row zone to the inter-row zone, which contributes to the simultaneous and rapid germination of seeds [6].

Seed drills with anchor coulters include Amazone Primera DMC-601 (Table 2, Fig. a), Amazone AD3 Special (Germany) (Table 2, Fig. c), Elvorti C3C-2.1 (Ukraine) (Table 2, Fig. b), Seed Master (France), etc. The chisel-shaped coulters leave a clean furrow for the seed, and the double packer rollers ensure uniform depth of travel and soil coverage of the sown seeds.

Table 2.

**Anchor coulters and brands of seeders (sowing complexes)**

<i>The coulters design</i>	<i>Manufacturer</i>
<p>a)</p>  <p>1 - seed conduit; 2 - reflector; 3 - anchor (tine) coulters; 4 - copy disk</p>	<p>Horsch Sprinter ST, Horsch ATD 12.30, Flexi CoilST 820, Bourgault 8810, Morris Maxim II, Ezee On7550, Rogro, Haybuster 8000, Amazone Primera DMC-601.</p>
<p>b)</p>  <p>1 - seed pipe; 2 - fertilizer pipe; 3 - Anchor coulters</p>	<p>Elvorti CPS-2.1, FlexiCoil (CASEIH)ATX 400, Bourgault 8810 (5710), Morris Maxim II (Maxim III), Amazone NT-37.</p>
<p>c)</p>  <p>1 - seed pipe; 2 - fertilizer pipe; 3 - anchor chisel coulters</p>	<p>Amazone Primera DMC, AD3 Special, Flexi Coil5000, Morris Concept 2000.</p>
<p>d)</p>  <p>Rear view Right view 1 - fertilizer line; 2 - seed line; 3 - cutting edge; 4 - anchor coulters; 5 - cultivator stand</p>	<p>SKP-2, John Deere 1820 (1830, 1840), Bourgault 8810, Morris Maxim II</p>

The Amazone AD3 Special coulters are used for small amounts of straw, e.g. after beet or rape. The sufficient longitudinal spacing between the adjacent coulters protects them from clogging with crop residues.

**Conclusions** Disc coulters that form a V-shaped furrow are the least destructive to the integrity of the soil composition, copy its surface well, and follow the depth of cultivation more accurately at higher speeds, but are able to capture and draw plant residues into the seedbed, which reduces the field germination of seeds.

Anchor coulters cut a U-shaped furrow, creating a dense seedbed that promotes faster seed germination, but do not control the sowing depth sufficiently. They also provide a more even distribution of seed nutrition areas than disc coulters, which ultimately leads to higher grain yields. The disadvantage of anchor coulters is their ability to bring boulders and large clods to the surface, especially when working on soils of high hardness.

Based on the analysis of the features of the two types of direct seeding coulters, research is planned to develop mathematical models of their interaction with the soil.

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