

UNIVERSAL DEVICE FOR IMPROVEMENT OF SEEDERS FOR OPERATING IN A REDUCED TILLAGE MODE

УНИВЕРСАЛНО УСТРОЙСТВО ЗА УСЪВЪРШЕНСТВАНЕ НА РЕДОСЕЯЛКИТЕ ЗА РАБОТА ПРИ НАМАЛЕН БРОЙ ОБРАБОТВАНИЯ НА ПОЧВАТА

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Abstract: *The technological processes in growing crops follow specific sequence and every diversion from the quality indicators leads to unintended negative consequences. Sowing is a continuation of the pre-sowing soil treatment, which, in its turn, is a continuation of deep ploughing. In conventional farming, a number of advantages of deep ploughing can be lost unless an appropriate pre-sowing soil treatment is applied, followed by laying the seeds in the ground under optimal conditions.*

In the cases, when the choice of technology for growing and harvesting row crops, and more specifically, the type of tillage applied, is a result of analysis of physical, mechanical, chemical and biological properties of the soil, a reduced number of soil treatments can be suggested, or, in some cases, even implementing the subsequent technological processes after no till treatment.

A great number of farmers do not possess the technological set of machinery for implementing innovative technologies. In such cases, the possibility of quick reconstruction of existing machinery, which should be able to operate following different technological sequence. Sowing is the most important of all technological processes and the preparedness of seeders to work in an integrated mode is of extreme importance, so that they can meet the challenge of reduced number of soil treatments.

KEY WORDS: TECHNOLOGICAL PROCESSES, BASIC SOIL TREATMENT, SOWING, SEEDERS.

1. Introduction

One of the most important and responsible moments in the technology of growing row crops is the pre-sowing soil treatment and the sowing. The activities of preparing the sowing resources and the sowing itself are inseparably linked. Pre-sowing soil treatment should take into consideration the requirements of the different crops. Otherwise, correct sowing would not be possible.

To perform correct sowing, the soil should be in a good structural condition: - for winter crops, optimal size of soil aggregates should be achieved, including stable soil, sufficiently moistened or completely dry, but not “dappled”; - for spring crops, the final loosening should be done immediately before sowing and at a depth, where the seeds will be laid. Contemporary industry offers a large selection of sowing machinery, under the common name seeders, [2]. The seeder is used after pre-sowing soil treatment. Usually the seeders are used for sowing only, regardless of the fact that levelling harrows can be attached to some of them, or press wheels are mounted on others. There are seeders that do the sowing without pre-sowing soil treatment such as:

Seeders for direct sowing — a coulter for opening a furrow for laying the seeds is mounted before the sowing apparatus;

Combined seeders — these machines are mostly designed for sowing, but they contain other organs, so they can perform several operations:

pre-sowing soil treatment + sowing

pre-sowing soil treatment + sowing+ fertilising

pre-sowing soil treatment + sowing+ fertilising+ plant protection (treatment of the crop after sowing)

Traditional seeders are generally two types:

Seeders for merged sowing (drills). They have a simple structure — a seed basket, mechanisms for adjusting the sowing rate and sowing depth, seed pipes and sowing bodies and markers for obtaining garnished sowing.

Seeders for precise sowing of row crops. They have a more complex structure — most often several sowing sections, each with a seed box, sowing disks for precise sowing, sowing „heels“ and gauging press bodies. The common part is an apparatus for vacuum or pressure, conducted via pipes to each sowing section and markers for obtaining garnished sowing.

The agro-meteorological conditions in our country often require a significant number (5÷6) soil treatment operations in order to achieve quality pre-sowing soil treatment. The modern trends for

performing these operations are directed to combining soil tillage and sowing operations by using combined tines and machinery [2].

A common situation before sowing row crops is the formation of soil crust in the fields, as well as the presence of plant residue. To deal with such situations, the working sections of modern seeders increasingly combine tilling working body, followed by a disc type sowing boot. Usually, the tilling working body is of the passive type, simultaneously loosening the soil and levelling the field micro profile. It is known that the disc boots work better when there are more chunks and plant residue. A characteristic moment in the performance of the first working body is the formation of the so called soil hill in front of it, which is a prerequisite for significant increase of its traction resistance. Replacing these passive bodies with needle discs is quite an appropriate technological solution of this problem.

2. Prerequisites and ways of solving the problem

The needle discs (fig.1) are a familiar type of tilling bodies, used in the so called rotary hoes. They are used for loosening the soil, destroying the soil crust and removing the weeds. These processes are the result from the rotation of the discs, stemming from their grip with the soil, while each needle of the discs interacts with it.

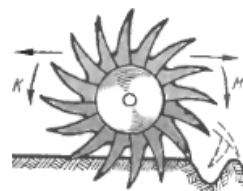


Fig.1. Cultivator disc with sickle pins

On the basis of the advantages of the needle discs, a cultivator section that is attached to each working section of a seeder for precise sowing with double rows has been developed. (fig.2).

In the structure of the cultivator section, two working parts have been incorporated. The first one consists of two cleaning needle discs, mounted by a clamp to the spring pole of the fertilizer boot. A shoulder, on which a battery of four profiling needle discs has been mounted, is hinged to the clamp and makes the second working part. The discs of the first part have a diameter of 300mm

and are arranged at an angle of attack 25° . In the second part, the discs have a diameter of 250mm, and are arranged parallel to the direction of movement of the seeder. All disks are 10mm wide.

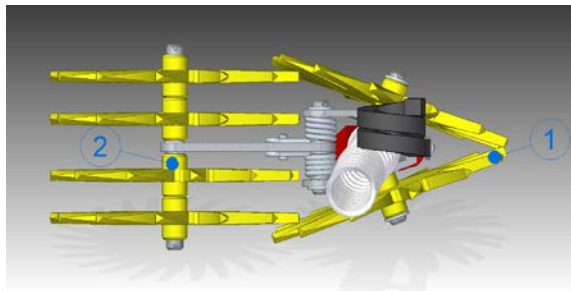


Fig.2. General view of the cultivator section: 1 – cleaning discs; 2 – profiling disc battery

The construction allows each disc to rotate relatively to its rotation axis, thus providing a more aggressive (direction M, fig. 1) or a gentler mode of working (direction K, fig. 1), depending on the conditions of work. The symmetrical construction of the cultivator section eliminates the need to perform specific adjustments for it to work.

The main accents in the design of the six cultivator sections are:

- Possibility to work at a certain depth;
- Forming a strip of soil in front of the sowing section, meeting the agro-technical requirements.

3. Results and discussions

As an output requirement for justifying the depth of work the information model "sowing section – field" is used [1]. According to this model, the minimum depth of tillage can be expressed as:

$$(1) \quad a = 3\sigma + \Delta a,$$

where 3σ is the minimum diversion from the average value of unevenness of the field micro profile;

Δa - supply of treated soil area, considering the inertial disturbances during work, cm.

Through preliminary research on the micro profile of a field, at the end of the winter after strip till loosening of the soil, the deviation obtained is $\sigma = 2,51$. The supply of treated soil area Δa should be 1,5cm [1].

After substitution in formula (1) the minimum depth of pre-sowing treatment obtained is:

$$(2) \quad a = 9,03 \approx 9 \text{ cm}$$

The main tasks of the discs from the first working part are: soil treatment at the required depth and removal of plant residue. To check the fulfilment of the first task the following condition is used:

$$(3) \quad Q_z \geq F,$$

where Q_z is the vertical loading force applied, N ;

F - is the force needed for soil deformation, N .

The soil deformation force is determined by the formula for the coefficient of volume crushing of the soil, presents as:

$$(4) \quad S.a.q = F,$$

where S is the contact area of the needles, located in the working section of the disc, cm^2 ;

a - depth of treatment, cm ;

q - volume crushing of the soil coefficient N/cm^3

For a disc with 30cm in diameter and depth of treatment corresponding to equation (2), the working sector of the disc is of 132° central angle. Thus, during work, three of the twelve needles of each disc will be in this sector of the disc, with contact area $9,5cm^2$. According to reference data [2], the mean coefficient of volume crushing of the soil (q) in untreated soil with plant residue is $17,5N/cm^3$. According to these data from equation (4) for F is obtained :

$$(5) \quad F = 1496,3 \text{ N} \approx 1500 \text{ N}$$

According to the technical characteristics of the seeder, for the vertical load force applied on each disc we obtain:

$$(6) \quad Q_z = 1635 \text{ N}$$

Equations (5) and (6) show that condition (3) has been fulfilled and the discs will be able to work at the depth determined by equation (2).

Arranging the front discs under angle of attack of 25° is aimed at forming a strip, clean of plant residue, whose width corresponds to the width of the sowing section, which is 22cm.

To determine the width of the clean strip of soil, which the discs can form, we use the equation:

$$(7) \quad b = 4.R.\sin \alpha.\sin \frac{\beta}{2},$$

where R is the radius of the needle disc, m;

α - the angle between the tangent point of the disc with the soil and the vertical diameter of the disc;

β - the angle between the two needle discs.

With disc diameter of 30cm and depth of tillage 9cm, the angle α is equal to 66° , and the argument $\frac{\beta}{2}$, corresponds to the assigned angle of attack of the discs, i.e. 25° . Thus, for the width of the strip, determined by equation (7) we obtain:

$$(8) \quad b = 0,23 \text{ m}$$

The result (8) shows that the discs can form a sufficiently wide clean strip in front of the sowing sections.

The main function of the discs from the second working part of the cultivator section is to crush soil aggregates additionally and to level the profile of the strip tilled.

As a prerequisite for a more intensive impact of the needles, comes the choice of discs with a smaller diameter than those in the first part of the cultivator section. This is related to reducing the step between the needles of the disk, which, in its turn, leads to increasing the number of their penetration in the soil for a unit of distance (9).

$$(9) \quad k = \frac{1}{X_z},$$

where X_z is the step of the needle, m.

The disc battery consists of four needle disks, spaced at equal distance from each other and thus providing working width of the disc battery of 20cm.

The work of the second part of the section has been checked through a laboratory experiment. The size distribution of soil before and after the treatment with the disc battery has been studied at a covered soil canal. According to the agro-technical requirements [2], the quantity of soil aggregates sized under 50 mm should be no less than 75%. Using sieve classifier, it has been determined that before the treatment with the disc battery, the quantity of soil aggregates, sized under 50 mm is 55%. After the treatment with the disc battery at a speed of 7k m/h and absolute humidity of the soil 14%, the quantity of soil aggregates sized under 50 mm has increased to 95 %.

A coefficient of variation is used as a criterion for estimating the levelling of the strip tilled. The results from the experiment, conducted in the same soil canal, show that after the treatment of the cultivator section, the profile of the 10 m strip is with a coefficient of variation 6,2 %. The value obtained is smaller than 7 %, allowed when the levelling of the field surface after the treatment [3].



Fig.3. Field, treated with strip till machine and not tilled before sowing



Fig.4. Field sowed by advanced seeder for row crop after a single tillage in the autumn with strip till machine.

4. Conclusion:

1. The seeders for row crops can be improved for working with reduced number of soil treatments by installing a battery with needle discs.
2. The percentage of soil aggregates sized under 50 mm is 95%.
3. The battery with active needle discs forms a strip 0.30 m wide at the depth of 60 mm and provides a suitable seedbed.

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4. Литература

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