Research condition of soil prepared for sowing cotton

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Abstract. The article presents the results of experiments to determine the structural aggregate of the composition of the soil, fields of cotton prepared for sowing, as well as the design of a cotton seeder equipped with a soil cultivator, for strip soil cultivation of the seed zone. The technical solution to the problem allows strip loosening of the soil in the zone of occurrence of seeds and provides simultaneous sowing of seeds at a given depth, increases the technological stability and efficiency of the cotton seeder.

1. Introduction

Currently, there are a lot of research being carried out on the cultivation, harvesting and post-harvest processing of cereals, soybeans and corn in Uzbekistan [1-6]. Cotton is one of the most important crops in Uzbekistan with cereals, soybeans, maize and others. Therefore, much attention is paid to sowing, cultivation and harvesting machines and technologies [7-13]. The soil and climatic conditions of Uzbekistan are our preparation for sowing various crops, including cotton, they are carried out mainly in two stages. The first stage begins with the autumn harvesting of cotton crops, combing out weeds, applying fertilizers, autumn plowing and leveling of uneven fields caused by plowing. The second stage that such operations are performed as early spring harrowing, disk, chiseling with harrowing or undercutting, fertilizing before sowing, pre-sowing harrowing with undercutting or leveling the arable land with a planner.

Soil cultivation in the second stage changes significantly depending on how the main soil cultivation was carried out, what is the state of the field surface, whether backup or flush irrigation and other operations were carried out. Depending on the state of the field, the following works are carried out: harrowing with mowing; cultivation to a depth of 6-8 cm or chiseling with flat-cutting working bodies to a depth of 10-12 cm, and harrowing with small growing. Under difficult soil conditions and after spare and leaching irrigation, chisel or moldless cultivation is carried out to a depth of 16-18 cm, followed by harrowing and smalling [14].

The preparation of fields for sowing is a rather energy-intensive process, any violation of agrotechnical requirements for each soil cultivation operation sharply reduces the quality and efficiency of these operations and necessitates additional work. This leads to the increase in energy and material costs, damaging crops [15-17].

2. Materials and methods

The purpose of pre-sowing soil cultivation are aimed at creating a loose, crumbly soil layer on the
surface of arable land, capable of retaining moisture accumulated during the autumn-winter period, destroying weeds and providing optimal conditions for uniform sowing, optimal seed placement. Numerous experiences shows that the goal is not always achieved. Thus, during the preparation of fields for sowing, due to the repeated passage of pre-sowing aggregates, the soil is compacted, and also due to the imperfection of the working bodies of machines and tools, those prepared for sowing become coarsely lumpy and, when small, the lumps are introduced into the arable layer. All this leads to disruption of the technological process of sowing seeds, embedding them at a given depth. As a result, about 40-60% of the seeds are not planted to the specified depth. Therefore, the goal was to study the state of the field prepared for sowing and the composition of the structural aggregate of the soil.

When studying the hardness, moisture and density of the soil, prepared for sowing, standard methods and measuring instruments were used.

The degree of loosening of the soil prepared for sowing is determined (with six-fold repetition) using special frames for the depth of processing. The hinge weight was measured with the help, weight RP-100 Sh-13 with an accuracy of ± 10 g.

### 3. Results and discussion.

The research work was carried out in the fields of the training and experimental station of the Tashkent State Agrarian University.

The soil of the educational and experimental farm belongs to the type of "Loamy gray soil", the relief of the field is even, the preceding treatment is autumn plowing, chiseling, harrowing and mallowing. Before carrying out the experiments, the soil moisture and hardness were determined at a depth of 5, 10 and 15 cm in accordance with GOST 20915-11 with 6-fold intervals, in which the working bodies of the sowing units work and immediately surround the seeds embedded in the soil. The results are shown in Table 1.

Table 1 shows that at different depths soil moisture are sharply different. At a depth of 0-5 cm, soil moisture fluctuates between 8.09-13.27% and averages 10.86%, at a depth of 5-10 cm it is

| Depth of soil, cm | Soil moisture, % | Soil hardness, MPa | Soil density, g / cm³ |
|------------------|-----------------|-------------------|----------------------|
| 0.25-5           | 10.68 ± 2.48    | 8.09 - 13.27      | 0.445 - 0.855        |
| 5-10             | 15.6 ± 3.1      | 12.35 - 18.85     | 1.076 - 1.244        |
| 10-15            | 22.28 ± 1.67    | 20.5 - 24.06      | 1.19 - 1.41          |

The results are shown in Table 1.

### Table 1. Moisture, hardness and density of the soil of the crop area prepared for planting

| Depth of soil, cm | Soil moisture, % | Soil hardness, MPa | Soil density, g / cm³ |
|------------------|-----------------|-------------------|----------------------|
| 0.25-5           | 10.68 ± 2.48    | 8.09 - 13.27      | 0.445 - 0.855        |
| 5-10             | 15.6 ± 3.1      | 12.35 - 18.85     | 1.076 - 1.244        |
| 10-15            | 22.28 ± 1.67    | 20.5 - 24.06      | 1.19 - 1.41          |
Table 2. Structural aggregates soil composition of fields prepared for sowing

| Aggregate composition of the soil, mm | Total soil mass, kg |
|--------------------------------------|---------------------|
| 0.25-5.0    | 5-10    | 10-15    | 15-25    | >25 mm    |
| Kg         | %       | Kg       | %       | Kg       | %       | Kg       | %       | Kg       | %       |
| 17.7       | 43.6    | 5.7      | 14.0     | 2.4      | 5.9      | 4.6      | 11.3     | 10.2     | 25.1     | 40.6     |
| 16.1       | 42.8    | 5.0      | 13.3     | 3.1      | 8.2      | 3.5      | 9.3      | 9.9      | 26.3     | 37.6     |
| 15.6       | 43.4    | 4.2      | 11.7     | 3.4      | 9.5      | 4.3      | 12.0     | 8.4      | 23.4     | 35.9     |
| 18.9       | 50.4    | 4.4      | 11.7     | 2.2      | 5.9      | 2.8      | 7.5      | 9.2      | 24.5     | 37.5     |
| 14.1       | 39.9    | 5.1      | 14.4     | 3.2      | 9.1      | 3.1      | 8.8      | 9.8      | 27.8     | 35.3     |
| 16.0       | 44.1    | 5.0      | 13.8     | 3.1      | 8.5      | 4.2      | 11.5     | 8.0      | 22.1     | 36.3     |
| 16.4       | 44.03   | 4.9      | 13.15    | 2.9      | 7.85     | 3.75     | 10.06    | 9.25     | 24.91    | 37.2     |

The mass of soil with dimensions of 0.25-25 mm, 27.95 kg or., Makes up 75.09% of the total mass.

12.35-18.85%, on average 15.6%, and at a depth of 10-15 sm, respectively, 20.5-24.06% and an average of 22.28%. It should be noted that in the horizons of 0-5 and 5-10 sm soil moisture differs little from each other, then in the horizon of 10-15 sm the differences are very large.

Soil hardness has a similar pattern of changes. The results showed that soil hardness varies unevenly and increases with the depth of the horizon. In the 0-5 sm horizon, the hardness is slightly - 0.445-0.855 MPa, at a depth of 5-10 sm. 1.076-1.244 MPa, and at a depth of 10-15 sm 1.19-1.41 MPa. These data show that the moisture content in the soil is sufficient for seed germination and its hardness, as evidenced by the limits of optimal moisture content (13.3%) and soil hardness (1.03-1.35 MPa). Soil density at a depth of 5-15 sm averaged 1.3-1.58 sm3. This is slightly higher than the optimal value.

The results of experiments on the study of the structural aggregate composition of the soil prepared for sowing according to the existing technology (after winter plowing + chiseling + harrowing + malanovation) showed that the soil fraction with dimensions of 0.25-5 mm. made up 16.4 kg., Respectively 44.03% of the total mass, soil with dimensions 5-10 mm. - 4.9 or -13.15%, soil with dimensions 10-15 mm. was 2.9 kg, or 7.85%, soil with dimensions 15-25 mm. was 3.75 kg, or 10.06%, and soil with dimensions > 25 mm. amounted to 9.25 kg or 24.91%. In this case, the total mass of the soil fraction with sizes of 0.25-25 mm. is 27.95 kg, or 75.09%, of the total mass, while the soil fraction with dimensions of more than 25 mm. is 9.25 kg. or 24.91% of the total mass.

The requirements for the structural aggregate composition of the soil are such that the aggregate composition of the soil fraction is prepared for sowing with dimensions up to 25 mm. should be more than 80%, soil fractions with dimensions of more than 25 mm. life is not more than 5%, and soil fractions less than 0.25 mm are not allowed.

The generalization of the results of determining the aggregate composition prepared for sowing cotton using the existing technology showed that it does not meet the requirements of agricultural technology. This state of soil preparation for sowing not only negatively affects the preservation of moisture necessary for seed germination, but also on the quality of the work of the seeding working bodies of the seeder, since this increases the vibrations of the working bodies, and, consequently, the uniformity of the seeding of seeds in depth and width worsens.

To eliminate these shortcomings, we have developed a soil ripper [13, 15] (Figure 1) for a cotton seeder, which provides strip loosening of the soil in the zone of occurrence of cotton seeds, 12-15 sm wide and 8-10 sm deep. The soil ripper includes a share 6, sprocket block 7 and rack.

The block of loosening sprockets of the soil ripper is driven into rotation from the PTO of the tractor using a chain drive, a gearbox and a cardan shaft (Figure 1).
Figure 1. Diagram of a cotton seeder equipped with a soil cultivator: 1-wheel; 2-frame; 3-drive device; 4- sowing section; 5-closing section; 6-share; 7-block loosening stars.

A cotton seeder complete with a soil cultivator works as follows. When the seeding unit moves across the field prepared for sowing, the share is deepened to a depth of 8 - 10 cm, cuts off a layer of soil 12 - 15 cm wide. The layer, moving along the working surface of the share, gets under the influence of a rotating block of sprockets. In this case, the soil layer is deformed, subjected to intensive cultivation in the gap between the ploughshare and the block of sprockets, the soil is loosened, soil lumps are destroyed, acquire an optimal aggregate structure, and then lie down in the same place. The seeding sections of the cotton seeder installed behind the soil ripper plant the cotton seeds on the loosened soil with the optimal structure.

4. Conclusion
As a result of studies of the state of soil and their structural aggregates, prepared for sowing the fields, it was established that the moisture and hardness of the soil is within the optimal state, respectively 15.6% and 1.16 MPa, and the density of 1.3-1.58 cm³ slightly exceeds the optimal values. The aggregate composition does not meet the requirements of agricultural technology.

The proposed soil ripper for a cotton seeder allows the possibility of strip loosening of the soil, the destruction of soil lumps in the zone of occurrence of cotton seeds with a given width and depth, with simultaneous embedding of seeds at a given depth.

It is advisable to conduct further research in the direction of specifying the parameters and operating modes of the soil cultivator and its placement relative to the sowing section of the cotton seeder.

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