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THEORETICAL SUBSTANTIATION OF PARAMETERS OF THE COMPACTING ROLLER OF THE COMBINED SEEDER

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Annotation

Conditions of Uzbekistan, a combined seeder has been developed, which at the same time provides technological processes for sowing autumn grains into row-spacing of cotton and in irrigated open fields are specified in the article. Results of theoretical studies carried out on the basis of compaction parameters of this combined seeder are mentioned, it was determined that the diameter of roller should be at least 17 cm, and vertical load applied to seeder when moving at a velocity of 1.5-2.0 m/s should be within the range of 126.2-131.1 N.

КОМБИНАЦИЯЛАНГАН СЕЯЛКА ЗИЧЛОВЧИ КАТОГИ ПАРАМЕТРЛАРИНИ НАЗАРИЙ АСОСЛАШ

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Аннотация

Мақолада Ўзбекистон шароитида ғўза қаторлари оралари ва суғориладиган очиқ майдонларга кузги донни экишда технологик жараёнларни бир вақтнинг ўзида таъминлайдиган комбинацяланган сеялка ишлаб чиқилганлиги қайд этилган ва ушбу комбинацияланган сеялканинг зичловчи катоги параметрларини асослаш бўйича ўтказилган назарий тадқиқотларнинг натижалари келтирилган ва катокнинг диаметри камида 17 см ва сеялка 1,5-2,0 м/с тезликда ҳаракатланганда унга бериладиган тик юкланиш 126,2-131,1 Н оралиғида бўлиши кераклиги аниқланган.

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ТЕОРЕТИЧЕСКОЕ ОБОСНОВАНИЕ ПАРАМЕТРОВ УПЛОТНЯЮЩЕГО КАТКА КОМБИНИРОВАННОЙ СЕЯЛКИ

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Аннотация

В статье отмечается, что в условиях Узбекистана разработана комбинированная сеялка, которая одновременно обеспечивает технологические процессы посева озимых зерновых в междурядьях хлопчатника и на орошаемых открытых полях, приведены результаты теоретических исследований, проведенных на основе параметров уплотнения этой комбинированной сеялки и определено, что диаметр катка должен быть не менее 17 см, а вертикальная нагрузка, прикладываемая к сеялке при движении со скоростью 1,5-2,0 м/с, должна находиться в пределах 126,2-131,1

Introduction

In cultivation of winter wheat and other grain crops in Uzbekistan, the technology of sowing them between cotton row-spacings and furrow on the irrigated open fields after cotton harvesting has already become traditional as energy-saving technology. However, by means of technical tools used in implementation of this furrow sowing technology, when this technology is performed with repeated motion of assembly across the field, there are many shortcomings in implementation the processes for forming furrows, planting seeds, backfilling the sown seeds with even soil at the level according to requirements. In particular, as it is known, it is important to ensure that seeds sown in ground germinate in a short period of time, to start good growing and developing, and to ensure that they form a mutual contact with soil, that is, covering the seeds that are placed at specified depth by means of seeders, in a row-spacing, completely compacted with soil. However, until now, technical equipment used for planting winter grain between cotton rows and in irrigated open fields does not include technical equipment equipped with a special compaction device that performs this technological process in one way.

In order to solve the technical solution of this problem, in single run of assembly between the cotton row-spacings and in open fields, double-turning opener (hilling plow) 1, which forms a furrow, and disc seeders 2, which form grooves for pinning seeds at a specified depth to the furrows and edges, and bury them. Construction of a universal seeder with a combined operating elements equipped with working sections consisting of 3 increasing thickening rollers were developed (Fig. 1).

In this case, function of compaction rollers, which are installed sequencely in accordance with the position of spherical disc seeders, is to ensure good contact of seeds sown on sides of furrow and edge with soil. [1].

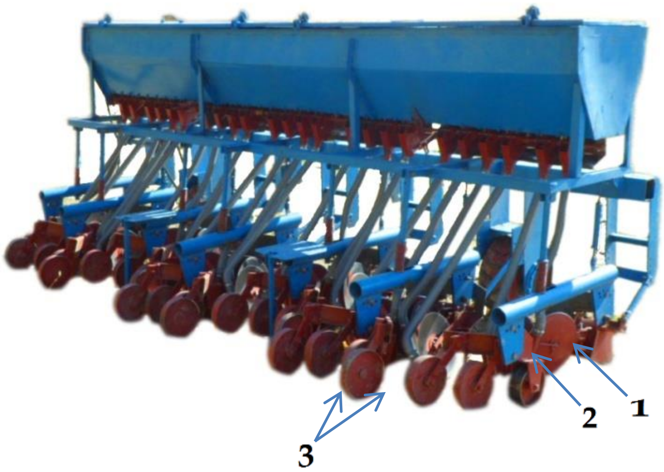
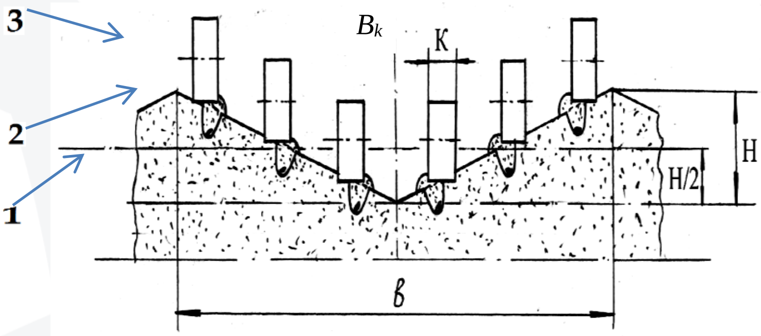


Figure 1. Universal seeder with combined operating element
1-opener (hilling plow); 2nd seeder (ploughshare); 3-compacting roller



B-furrow width; H-height of furrow; B_k – width of compacting roller; 1-furrow; 2-seed; 3- compacting roller

Figure 2. Rollers that backfill and sow the seeds at the same time and scheme of its implementation the technologic process

In technological process of seed burying and compacting rollers, the seeders using spherical disk of seeder to place the seeds 2 (Fig. 2) at depth of 3-6 cm, and the soil in depth of 3-6 cm is released in the form of long piles on upper side of sloping surface of furrow. Compaction roller 3 compacting the soil beads formed in this process (Fig. 2) destruct and crushes the soil crumbs in width Bk, squeezes them together with soil crumbs, drops them on seeds and compacts them at once. In this way, conditions are created for good contact of seeds with soil and for germination and good development in a short period of time.

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In the process of movement these soil compacting rollers on top of soil clays formed when planting seeds to a certain depth (3-6 cm), it deforms the soil over seeds to a certain thickness, crushes and compacts the encountered soil lumps, in order to achieve effect of using the roller necessary to determine its rational parameters.
Main parameters of compacting roller:
- The diameter of roller D_k;
- Coverage width of roller B_k;
- Vertical load Q given to roller.

Usually, when substantiating the diameter of compaction roller such conditions as pressing and crushing of crumbs encountered in its path should be taken into account. When it is contacts the soil crumb, it will be easily passed without pushing forward. In this case, firstly, crumb is crushed under the pressure of roller, and secondly, there is no stacking of pieces in front of it, and thus defined technological process is carried out without disruption.
In accordance with scheme shown in Figure 3, the compaction roller passes through the crumb when the following condition is fulfilled:

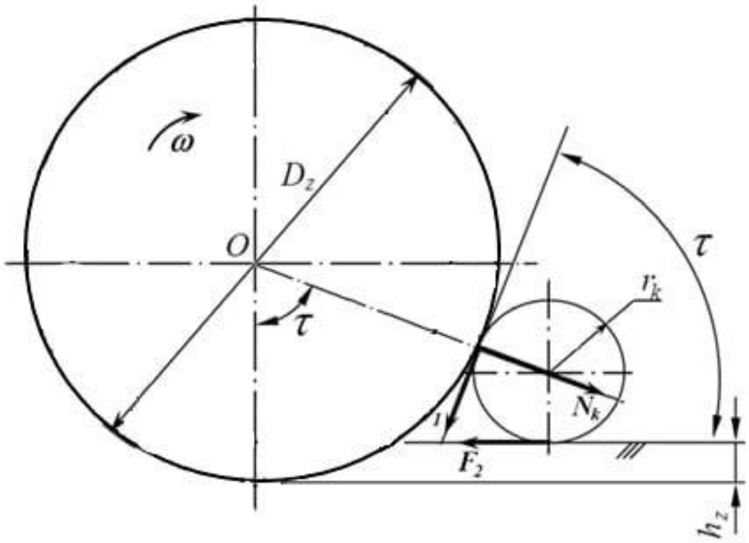

Figure 3. Scheme for determining the diameter of compacting roller

$$\mathbf{F_1 \cos \tau + F_2 > N_k \sin \tau,} \qquad (1)$$

in this case F_1, F_2 –frictional forces generated between the crumb and surface part of roller and soil, respectively; **N_K** - the normal compressive strength of compacting roller; **τ** - angle between applied to the point where compacting roller touches the crumb and horizontal plane (in literature [1,2], this angle is called the compression angle between the roller surface of lump and soil surface).

According to Figure 3 $F_1 = N_k tg\varphi_1$ (here φ_1 – angle of friction of cut to surface of the roller surface) and $F_2 = (N_k \cos\tau + F_1 \sin\tau) \times tg\,\varphi_2 = N_k (\cos\tau + \sin\tau \cdot tg\,\varphi_1)\, tg\,\varphi_2$ (here φ_2 – taking into account (1) formula will have following form

$$\tau < \varphi_1 + \varphi_2. \qquad (2)$$

Therefore, in order to assure normal operation of compacting roller, it is necessary to ensure the compression of crumb, that is, its compaction compression angle τ should be smaller than sum of friction angles φ_1 and φ_2.

Considering the soil crumb as round shape, according to scheme shown in Figure 3, we have the following

$$R_k - R_k \cos\tau = r_k (1 + \cos\tau) + h_k, \qquad (3)$$

in this case R_k –radius of roller surface part; r_k – radius of soil crumb; h_k – depth of sinking the roller surface into the soil.

Considering the formula (2), we solve formula (3) with respect to R_k and get the following formula.

Therefore, for the normal operation of compacting roller, it is necessary to ensure the compression of soil clay, that is, the angle of compression τ friction angles must be less than the sum of φ_1 and φ_2.

Considering the crumb as a round shape, according to scheme shown in Figure 3, we have the following formula:

$$R_k - R_k \cos\tau = r_k (1 + \cos\tau) + h_k, \qquad (3)$$

here R_k –radius of roller surface; r_k – radius; h_k – depth of submergence of the roller surface into soil crumb.

Considering the formula (2), we solve formula (3) with respect to R_K and get the following formula

$$R_k > \frac{r_k[1 + \cos(\varphi_1 + \varphi_2)] + h_к}{1 - \cos(\varphi_1 + \varphi_2)}, \qquad (4)$$

either

$$D_k > \frac{d_k[1 + \cos(\varphi_1 + \varphi_2)] + 2h_к}{1 - \cos(\varphi_1 + \varphi_2)}, \qquad (5)$$

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In this case d_k – diameter of soil pieces.

As can be seen from the expression 5), the diameter of the roller surface depends on the diameter of crumbs that meet with it during the work process and friction angles of crumbs with respect to surface of roller and the soil surface, as well as depth of its immersion into soil.

For this, from the part of roller that interacts with soil (Fig. 4), let's separate the surface at elementary dS = 0,5$B_к D_к$dα (where $B_к$ is the covering width of compacting layer, m; dα - elementary angle, rad.). The following elementary normal force acts on this surface:

Let's determine the vertical load Q to which compacting roller given from the condition that its surface sinks to required depth. For this, from the part of roller that interacts with soil (Fig. 4), we separate the surface at elementary dS = 0,5$B_к D_к$dα (where Bk is covering width of compacting layer, m; dα - elementary angle, rad.). Following elementary normal force acts onto this surface:

$$dN = \sigma \cdot dS = 0{,}5\sigma B_k D_k d\alpha, \qquad (6)$$

In this case σ –comparative resistance to crushing of crumb (pressure onto the compaction roller b), Pa.

Sum of vertical components of the elementary normal forces acting onto the compacting roller will give Q, that means the following:

here d_k – diameter of soil particles.

As can be seen from formula (5), diameter of roller surface depends on diameter of soil crumbs (clay) that comply with it in working process and angles of clays friction with respect to surface of roller surface and soil surface, as well as the depth of its immersion in soil.

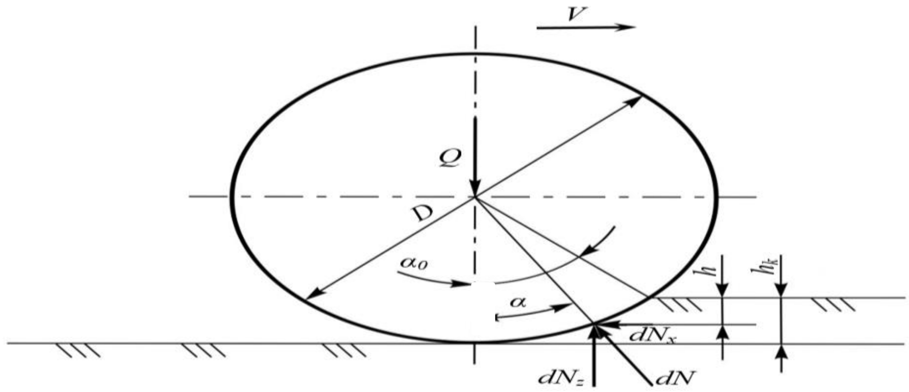

Figure 4. Scheme for determining the direct load to the compacting roller

$$Q = \sum dN_z = \int_0^{\alpha=0} dN \cos\alpha = \int_0^{\alpha=0} 0{,}5\sigma B_k D_k \cos\alpha \cdot d\alpha, \qquad (7)$$

In here dN_z – the vertical component of the elementary normal force acting onto the compacting roller, N; α – the angle of coverage the roller by soil, degrees.
Let's formulate σ in the formula (7) through q_0 volumetric crushing coefficient of soil and its deformation h at considered point [1, 4]:

$$\sigma = q_0 h, \qquad (8)$$

According to the scheme shown on Figure 4,

$$h = \frac{D}{2}(\cos\alpha - \cos\alpha_0), \qquad (9)$$

In this case α –deviation angle relative to straight dN of elementary reaction force, degree.
By taking into account (8) and (9) formulas and integrating (7) we will have the following:

$$Q = \frac{1}{8} q_0 B_k D_k^2 (\alpha_0 - \sin\alpha_0 \cos\alpha_0). \qquad (10)$$

By using the scheme shown in Fig. 4, we formulate α_0, $\sin\alpha_0$ and $\cos\alpha_0$ this formula by diameter of the compacting roller D_k and depth of its penetration into the soil h_k:

$$\sin\alpha_0 = \frac{2\sqrt{D_k h_k - h_k^2}}{D_k}; \qquad (11)$$

$$\cos\alpha_0 = \frac{D_k - 2h_k}{D_k}; \qquad (12)$$

ва

$$\alpha_0 = \arccos\frac{D_k - 2h_k}{D_k}; \qquad (13)$$

Considering the above (10), this formula can be written in the following form [5]:

$$Q = \frac{1}{8} q_0 B_k D_k^2 \left[\arccos \frac{D_k - 2h_k}{D_k} - \frac{2\sqrt{D_k h_k - h_k}\,(D_k - 2h_k)}{D_k^2} \right].$$

Considering the velocity of condenser roller, this formula can be written in the following form [5]:

$$Q = \frac{1}{8} q_c \left(d + mV^2\right) B_k D_k^2 \times$$

$$\left[\arccos \frac{D_k - 2h_k}{D_k} - \frac{2\sqrt{D_k h_k - h_k}\,(D_k - 2h_k)}{D_k^2} \right]. \qquad (14)$$

In this case q_c – coefficient of static volumetric crushing the soil, N/m³; m – proportionality coefficient, s/m; V – operating velocity of the assembly, m/s. d_k = 0,05 m, h_k = 0,025 m, φ_1, =30⁰, φ_2 = 40⁰ , q_c = 1,1·10⁶ Н/м³, d = 0,9, m = 0,08 с²/м² [6-9] B_k = 0,03 m accepted, calculations according to formulas (5) and (6) showed that diameter of compacting roller should be at least 17 cm and vertical load applied to it at velocity of 1.5-2.0 m/s should be within the range of 126.2-131.1 N.

List of Used Literatures

1. Klenin N.I., Sakun V.A. Agricultural and amelioration machines. - Moscow: Kolos, 1980. – p.617.
2. Rudakov G.M. Technologic bases of mechanization the cotton sowing. - Tashkent: Fan, 1974. – p.244.
3. A.Tukhtakuziev, B.Khudoyarov, B.Utepbergenov, R.Kengesbaev. Theoretical substantiation of parameters of the combined machine roller. Herald. No. 2., 2018, p.16.
4. Aminov S. Substantiation of parameters of compacting roller to the pre-sowing tool for cotton growing: Abstract of the thesis. Dissertation of candidate on Technical Sciences. - Yangiyul, 1988. – p.16.
5. Shiryaev A.M. Pre-sowing soil compaction // Mechanization of agriculture. 1988. - No. 3. – pages 33-35.

6. Inoyatov I.A. Substantiation of the parameters of grinding-compacting operating elements of a rotary non-driven ripper: Abstract of the thesis. diss. cand. tech. Sciences. - Yangiyul, 1997. – p.18.
7. Sergiyenko V.A. Technological foundations of mechanization the tillage in row-spacing of cotton. - Tashkent: Fan, 1978. – p.112.
8. Boymetov R.I., Elbaev B.B. Study of the physical and mechanical properties of the soil of the Karshi steppe zone // Substantiation of technological processes, mechanisms and machines for cotton growing: Sat. tr./ SAIME. - Tashkent, 1987. - Issue 29. – pages 17-19.
9. Khadzhi-Muradov A.O., Nuriddinov A. Substantiation the design scheme and some parameters of adaptation to plough for surface tillage simultaneously with plowing // Materials of the Republican Scientific and Practical conference on most important problems of up-to-date science and technology. - Jizzakh, 2004. – p.260.
10. I.N. Bronstein, K.A. Semendyaev. Handbook of mathematics. Moscow, 1980.