Comb Former Parameters for a Cotton Seeder

Farmon Mamatov, Bakhadir Mirzaev, Mukhayo Shoumarova, Parakhat Berdimuratov, Dadakhon Khodzhaev

ABSTRACT---Success in cultivating cotton largely depends on the timing and quality of soil preparation for sowing and sowing, and the latter, in turn, depends on how it is carried out and on the perfect design of the machines. The aim of the study is to justify the shape of the ridges and the parameters of the moulder to the cotton seeder. The authors proposed a new technology for sowing with the simultaneous formation of ridges. The shape and parameters of the ridge are theoretically substantiated. When performing the shape of the ridge in the form of an isosceles trapezoid and, accordingly, with a height and width of the ridge surface of at least 100 mm and 160 mm, the seed bed is protected from flooding by rain streams. The design of the developed comb moulder to a cotton seeder for the implementation of the proposed technology is given. Theoretically substantiated the main parameters of the crest moulder. It was found that when the input edge of the moulder is 290-320 mm wide, the output edge is 160 mm, the angle of inclination of the side blade to the direction of movement is 20°, the length of the runner of the moulder is 203-215 mm, the height of the side blade is 100 mm and the angle of installation of the side blade to horizon 42-45° ensures high-quality implementation of the technological process of formation of ridges. When sowing cotton seeds on the ridges with the simultaneous formation of the ridge, the seedlings of the plants increase, and the cotton yield increases compared to the smooth sowing method of 9.9%.

Keywords: cotton, sowing machine, technology, rake-forming machine, rain stream, seed bed, comb.

I. INTRODUCTION

It is known that the existing traditional technology of sowing cotton over a smooth field is the simplest and least expensive. However, it is very sensitive to weather changes. When sowing cotton on a smooth field during heavy rains, flooding of the seed bed occurs, which leads to a decrease in seed germination and crust formation [1]. At present, ridge technology for sowing row crops is widely distributed [2, 3, 4, 5]. With ridge sowing, favorable water and temperature conditions are created for a quick and complete germination of cotton seeds. For sowing cotton, cutting ridges is mainly done in autumn. At the same time, the crest cut in autumn loses its shape before sowing (in spring), which requires an additional operation to restore its shape. Based on the foregoing, the formation of ridges simultaneously with sowing is a necessary operation.

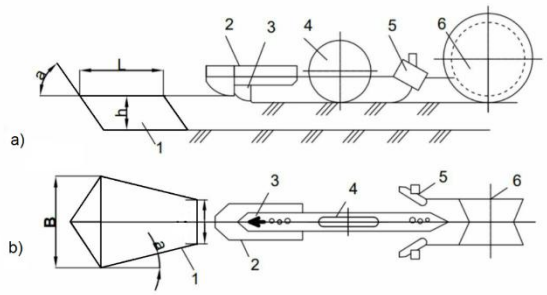
The aim of the study is to justify the shape of the ridges and the parameters of the moulder to the cotton seeder.

II. MATERIALS AND METHODS

The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study.

To eliminate the negative effect of heavy rainfall on seed germination, the authors developed a sowing technology with the simultaneous formation of ridges [6, 7]. The proposed technology is implemented as follows (Fig. 1): the moulder 1 moves along the field, forms and compacts the ridge, then the creeper opener 2 following it opens the groove in the middle of the ridge, the compactor 3 compacts its bottom, and the reel 4 after placing the seeds in the groove partially closes it and compacts the soil. Gortachki 5 close up the seeds to the set depth, and the coil 6 with a conical rim compacts the soil.

The comb moulder 1 is made in the form of a metal box in the form of an isosceles trapezoid with an open bottom and side edges tapering in length. The upper base of the moulder in the output narrowed part is equipped with a mechanism for compaction of the soil of the ridge. The formation of the ridge with the required density is ensured, respectively, by the output structural geometric parameters of the duct.



a - view from the side; b-view from the top;

Fig. 1. Sowing technology with the simultaneous formation of ridges: 1 - molder; 2 - seeder coulter; 3 - a sealant; 4 - a coil; 5 - gortach; 6 - conical roller

Fig. 1. Sowing technology with the simultaneous formation of ridges: 1 - molder; 2 - seeder coulter; 3 - a sealant; 4 - a coil; 5 - gortach; 6 - conical roller One of the main requirements for the crest parameters is the ability to protect the seed bed from flooding by rain flows and therefore protect it from crust formation. As you know, during the formation of ridges, their side walls crumble at an angle of repose. Therefore, when filling the soil on the field, a bed is formed in shape resembling an isosceles triangle.

Revised Manuscript Received on 22 September, 2019.

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However, for the working bodies of the seeders to work at the top of such a ridge, it is necessary to have a platform, which should be 160-170 mm wide [1]. To do this, it is necessary to cut off its top, therefore, after this, such a ridge before sowing turns into an isosceles trapezoid (Fig. 2). The form that we take as the basis for subsequent calculations.

Literature review. Studies on improving the technology of preparing the soil for sowing row crops on ridges, creating machines for forming ridges, substantiating designs and parameters of their working bodies were carried out by G. M. Rudakov [1], E. Ponamarev [2], V. I. Kurdyumov and E. S. Zykin [3, 4], F. M. Mamatov and W. Kh. Kadirov [5], H. G. Abdulkhaev [10, 11] and others.

RESULTS & DISCUSSIONS

G.M. Rudakov [1] and A.G. Ponamarev [2] substantiated the parameters of the comb-divider for sowing cotton on the ridges. V.I. Kurdyumov, E.S. Zykin [3, 4] substantiated the technology and means of mechanization of ridge cultivation of row crops for the conditions of the Russian Federation. F.M.Mamatov and U.Kh. Kadirov [5] developed a technology for preparing the soil for sowing potatoes on ridges. F. Mamatov and B. Mirzaev [8, 9] considered the issues of anti-erosion tillage before sowing row crops. The studies of Kh.G. Abdulkhaev [10, 11] are aimed at developing tools for loosening ridges and destroying weed vegetation, as well as the formation of a mulching layer on their surface. All these studies are aimed at improving traditional technologies and technical means for preparing the soil for sowing industrial crops, including cotton, which does not meet the modern requirements of agricultural production. In these studies, issues of the formation of ridges and sowing of cotton in one pass of the unit were not considered. The above disadvantages can be eliminated by developing a moulder moulder to a cotton seeder, forming ridges and sowing cotton in one pass of the unit.

Results and discussions. To determine the minimum permissible parameters of the formed crest, we proceed from the fact that they are not flooded by rain streams. It can be seen from Fig. 2 that, in order to protect the seed bed from flooding, the cross-sectional area of the groove of the row spacing S_{CDKM} should be larger than the area of the cross-section of the sediments in the row-spacings per day (Q_dB_r). Based on the foregoing, the parameters of the ridge were determined from the conditions of placement in the groove of the aisle of the aisle of daily precipitation.

$$H_1 = \frac{1}{2K_s}[(B_r - b_c)tg\beta - \sqrt{[(B_r - b_c)tg\beta]^2 - 4Q_d B_r tg\beta}] + h, \quad (1)$$

$$b_{bc} = 2H_1 ctg\beta + b_c; \quad (2)$$

$$S_c = (B_r - b_{bc})H_1 + H_1^2 ctg\beta, \quad (3)$$

where H_1 is the minimum permissible height of the ridge; Q_d - the amount of rainfall per day; β is the angle of repose; B_r - row spacing; b_c is the width of the crest apex; K_s - coefficient taking into account the shrinkage of the soil; h is the height of the irregularities of the field surface; S_c is the cross-sectional area of the grooves.

The calculations performed by expressions (1) - (3) at Q_d=34 mm, b_c=160 mm, h=36 mm, K_s=0.90 and β=36° [12] showed that the minimum allowable height of the ridge $h_1$should be not less than 100 mm; the permissible width of the lower base of the crest bog should be at least 435 mm; the permissible cross-sectional area of the groove s_g must be at least 306 sm^2 at V_m=900 mm and 204sm^2 at V_m=600 mm.

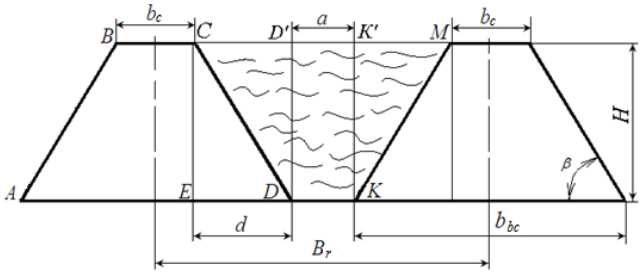

Fig. 2. Scheme for determining the parameters of the ridge

The shape and parameters of the crest is the basis for determining the parameters of the moulder. The main parameters of the moulder are the width of the input B_m and the output b_m of the edge of the moulder, the angle of installation of the side dumps to the direction of movement α and to the horizontal plane βy, the length of the runner L. The optimal angle of installation α of the side dumps to the direction of movement was determined from the condition of ensuring free sliding and soil compaction dumps, i.e. α≤(π/4-φ/2), where φ is the maximum angle of friction of the soil along the dump. With a known value of φ=30° we get α≤30°.

To determine the length and width of the input edge of the moulder runner, the following expressions are obtained.

$$L = \frac{1}{2}(B_p - b_{bc})ctg\,\alpha, \quad (4)$$

$$B_m = 2Ltg\alpha + b_c. \quad (5)$$

Substituting in (4) and (5) the values of B_p=554 mm, b_c=160 mm, b_{bc}=435 mm and α=14-16°, we obtain that the length of the moulder's run should be within L=183-238.9 mm. And the width of the input edge of the moulder B_m=292-334 mm.

The angle of inclination of the lateral faces to the horizontal was determined from the condition of eliminating shedding of the crest soil according to the following well-known expression $\beta_y \le \beta$, where β is the angle of repose. Based on this, in order to eliminate the shedding of the lateral faces of the ridge, it is necessary to position the lateral dumps of the moulder at an angle β=42-45° to the horizontal plane of the field.

The blade height h is taken equal to the minimum permissible height of the ridge, h=H_1=100 mm.

During operation, the moulder visor acts on the soil to deform the soil (Fig.1). The installation angle α_1 of the visor is determined from the condition for ensuring the sliding of the soil along it, i.e.

$$\alpha_1 \le \frac{\pi}{4} - \frac{\varphi}{2}. \quad (6)$$

Substituting the known value φ=25-300 into this expression, we obtain α_1=30-340.

The blade height h is taken equal to the minimum permissible height of the ridge H1. Then h=100 mm.

To verify the results of theoretical studies, as well as to study the influence of various factors on the quality of the crest formation, we made a prototype of a moulder for a cotton seeder and conducted its comparative laboratory field studies. The experiments were carried out in the following options: sowing cotton on a smooth field (control); sowing on ridges formed simultaneously with cotton sowing.

Studies have shown that when sowing, the moulder provides the formation of ridges with the required parameters: the height of the ridges was 10.1–10.7 sm, and after seeding with seedlings and rolling-in - 12.0–13.0 sm. Observations showed that when sowing at ridges eliminates the ingress of rain into the seed bed. As a result, the emergence of seedlings and the development of plants is accelerated, and the reseeding of cotton is excluded.

The proposed method of sowing created favorable temperature, water and air conditions. Sowing cotton on ridges prepared simultaneously with sowing compared to sowing on a smooth field provides optimal soil temperature in early April at a depth of 4.0–5.0 sm within 12–14 ° C with a soil moisture content of 12–13% and soil density within 1.04–1.16 g/sm^3, which contributed to the good development of plants. As a result of the application of the proposed technology with the developed seeder, the number of plant sprouts increases by 17.8%, and the cotton yield - by 9.9% compared to the productivity of cotton sown on a flat field.

II.CONCLUSIONS

1. When performing the shape of the ridge in the form of an isosceles trapezoid and, accordingly, with a height and width of the ridge surface of at least 100 mm and 160 mm, the seed bed is protected from flooding by rain streams.

2. When making the input edge of the moulder with a width of 290-320 mm, the output edge of 160 mm, the angle of inclination of the side blade to the direction of movement of 20°, the length of the runner of the moulder 203-215 mm, the height of the side blade of 100 mm and the installation angle of the side blade to the horizon 42-45° ensures high-quality implementation of the technological process of formation of ridges.

3. When sowing cotton seeds on the ridges with the simultaneous formation of the ridge, the seedlings of the plants increase and the cotton yield increases by 9.9% compared to the smooth sowing method.

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