THE USE OF A TRACTOR UNIT WITH A WIDE-CUT CULTIVATOR ON INTER-ROW PROCESSING OF COTTON

Kunduzov Sodirjon Ayubovich,
Candidate of the Technical Sciences, Ph. D., Chief the Laboratory,

Tulanov Isomiddin Otabekovich,

Khazhiev Absattor
Ph.D., Senior Researcher, Head of the Certification Laboratory, Senior Researcher,

Khamzayev Mumin Kayumovich,
Senior researcher,

Khalmatova Zulfiya Turdukulovna
Chief of the laboratory Centre for Certification and testing of agricultural machinery and technology, Tashkent Region, Gulbahor, Republic of Uzbekistan

Abstract
Based on the analysis and experimental research, the paper presents the materials of testing tractor units during inter-row processing of cotton. The theoretical relationships for determining the displacements of the frame with the working bodies when aggregating tractors with cultivators according to the scheme on the rear hinged system are given. Based on the results of comparative field experiments of experimental wide-cut and serial cultivators, operational and technological indicators of tractor units were obtained. An assessment of the efficiency of a tractor unit with a rear hitch of an 8-row wide-cut cultivator is given.

Key words: wide-grip unit, protective zone, displacement, working bodies, unit deviation, and rear hinged system.

Introduction
Science and practice have established that increasing the yield of field crops largely depends on improving the quality of soil cultivation, which provides not only preservation but also an effective increase in soil fertility.
The use of interchangeable universal, combined working bodies, regulation of the width of capture and the speed of movement, the use of non-coupling schemes for the preparation of wide-cut aggregates and the combination of operations for (pre-sowing) soil preparation is typical for agricultural machines of the new generation.

It is known that the movement of the tillage unit is determined by the quality of the technological process. In normal operation, cultivators should be limited in movement, speed and acceleration without affecting the working quality of the working width. Therefore, the task of ensuring the stability of the movement of cultivators is paramount. The work of cultivators takes place in the changing conditions of external influences depending on various factors. Determination of the most realistic operating conditions for soil cultivation units is of current importance.

The quality of work of soil cultivating machines for inter-row cultivation is assessed by the ability to ensure the constancy of the established protective zone, the size of which is determined, on the one hand, by the requirements to leave a minimum uncultivated area and, on the other hand, to ensure that the roots are not damaged or the root system of plants is not mechanically damaged.

When working in row spacing's, the unit does not move in a straight line, but deviates to the right and left sides of it, and the direction, speed and amount of displacement of the working parts of the machine depend on its location relative to the tractor. This circumstance is especially important when performing tilling work, since the size of the installed protective zone is associated with this, which in turn determines the volume of subsequent manual processing.

Research methodology

To find out how to ensure compliance with agrotechnical requirements when aggregating cultivators, it is possible to determine the value and direction of the lateral displacements of their working bodies by calculating the value and direction of the lateral displacements of their working bodies when the front steering axle of the tractor deviates at an angle ∝ from the rectilinear movement (Fig. 1).

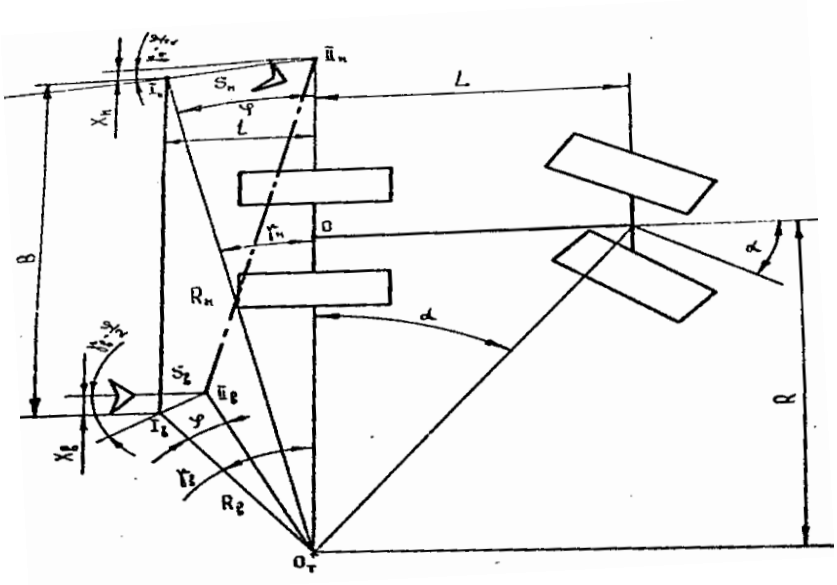

Fig. 1 Scheme for determining lateral displacements of extreme working organs of the cultivator when aggregated on the rear hinged system.

After deflecting the steering axle by an angle ∝, the tractor starts moving along an arc, the center of which 0т is located at the point of intersection of the geometric axes of the front and rear wheels. After turning the tractor through an angle φ, the working bodies of the mounted machine (in this case, the cultivator tines) will move from position 1 to position 2 (в – internal working bodies, н – external), while deviating in the lateral direction by the value Хв and Хн, respectively. Designating the radius of rotation of the internal and external working bodies around 0т through Rв and Rн and the angles of their inclination to the axis of the rear driving wheels of the tractor, respectively, through γв and γн, we derive the dependences of the displacements Хв and Xn of the working bodies on the size of the tractor base L, the width of capture of the unit B, the distance from the working bodies to the driving axis of the tractor l, the angle of rotation of the guide wheels ∝ and aggregation schemes.

There is a relationship between the turning radii of the cultivator's extreme working bodies around the center 0m and the angle of their inclination to the axis of the driving wheels [1, 2, 3, and 4]:

$$R_в = \frac{l}{sin\ T_в}; \qquad R_н = \frac{l}{sin\ T_н}. \quad [\ I\ ]$$

The magnitude of the lateral displacements of the internal and external working bodies is determined by the following equations:

$$X_в = 2l\ sin\frac{\varphi}{2} cos\frac{\varphi}{2} - 2L\ ctg \propto sin^2\ \frac{\varphi}{2} + B\ sin^2\ \frac{\varphi}{2};$$

$$X_н = 2l\ sin\frac{\varphi}{2} cos\frac{\varphi}{2} - 2L\ ctg \propto sin^2\ \frac{\varphi}{2} - B\ sin^2\ \frac{\varphi}{2}.$$

Having the above expressions, we can determine the dependence of the displacement of the extreme working bodies as a function of the angle of rotation of the tractor when aggregating the cultivator on the rear hinged system. For example, we can calculate with the following conventional values of the tractor in the unit, if we have: the angle of rotation of the front wheels of the tractor - ∝ = 20 °; tractor base - L = 1500 mm; working width of the unit - B = 5400 mm; the distance from the working bodies to the axis of the driving wheels of the tractor - l = 1000 mm.

From the data obtained by calculation, it can be established (Fig. 2) that when the machine is aggregated on the rear hinged system, the lateral displacement of the outer working bodies occurs less than the inner ones. It was also determined that the dependence of the magnitude of the displacement of the internal working organs on the angle of rotation of the tractor has a linear character of change, and the external working organs is nonlinear.

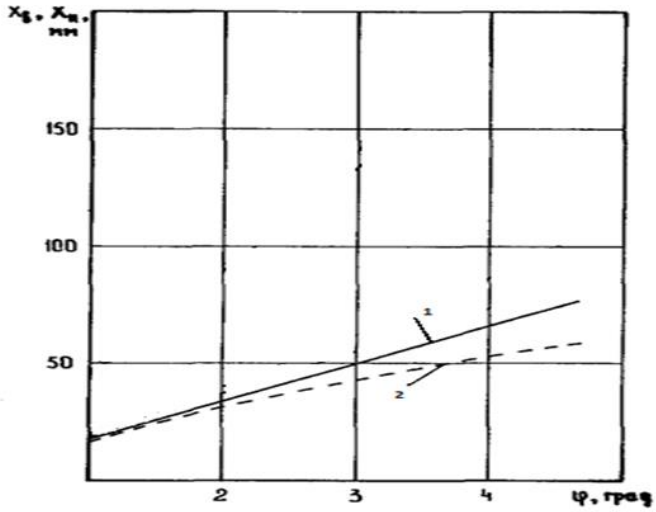

Fig. 2. Dependence of lateral displacements of internal (1) and external (2) working, bodies when aggregating the cultivator on the rear hitch of the tractor.

Research results

A field check of a tractor in a unit with a cultivator was carried out in the fields of the test farm of the CITT (Centre for Certification and testing of agricultural machinery and technology) with inter-row processing of cotton. The operational and technological indicators of tractor units with cultivators were determined by loosening the soil in the aisles of cotton (II cultivation) [5,6]. The soil of the field of the CITT test site is a typical gray soil with a flat relief. Before cultivation, soil moisture in the 0-15 cm horizon was 4.95-15.9%, according to the initial requirements, 14-20% is allowed, the height of the cotton averaged 5.74 cm (Table 1). The analysis showed, according to the results of calculating the displacements of the internal working organs of the cultivator Xv, mounted on the tractor from behind (Fig. 2) [2,3,4], the following was established: with a turning radius of R = 30m, even with slight deviations of the tractor from the centerline up to 1 cm, the cultivator working bodies approach the rows by 5 cm, and with a sharper turn (R = 10m) by 9 cm.

Agro technical indicators of the quality of the tractor unit for inter-row processing of cotton with the rear hitch of the cultivator.

Table 1.

Indicator name	According to the initial data	The value of the test indicator	
date	-	20.06.2019 г.	
Machine brand	-	Tractor Arion 630 with 8-row cultivator	Tractor TTZ 100 HC with cultivator KKHU-4B
Test site		Proving ground CITT	
Type of work		Cultivation with fertilization	
Travel speed, km / h	-	2,7	3,2

Depth of tillage, ripper 1, cm:			
Average depth, cm	-	4,76	5,25
Standard deviation, ± cm	-	1,1	1,1
The coefficient of variation, %		23,3	21,4
Depth of tillage, ripper 2, cm:			
Average depth, cm	-	7,57	7,71
Standard deviation, ± cm	-	1,2	1,4
The coefficient of variation, %		15,4	17,8
Working depth of the duckfoot share:	14-18		
Average depth, cm	-	12,26	8,16
Standard deviation, ± cm	-	2,1	1,7
The coefficient of variation, %	-	16,9	20,3
Soil crumbling,% mass fraction of lumps by fraction:			
- more than 50 mm	no more 10%	10,9	11,85
-50-25 mm	no more 20%	12,57	13,11
-25-10 mm	no more 60%	76,49	75,03
Damage to cultivated plants, total,%	-	0,4	0,35
The quantitative share of destroyed (cut) weeds,%	-	99,0	98,5
The size of the protective zone, actual, cm	-	8,46	9,29
Average depth, cm	± 2,0	0,28	0,67
Standard deviation, ± cm	-	3,37	7,22
The coefficient of variation, %	-	11,10	10,0
Distance of fertilizer positioning relative to the row axis, cm	-	14,0	12,0

Conclusions

It has been established that when aggregating a tractor with a cultivator using the rear hinged system, the deviation of the working bodies occurs in the direction opposite to the rotation of the tractor and there is a danger of their approaching the row and subsequent cutting of cultivated plants. The nature of the change in the displacement values from the angle of rotation of the front axle wheels is revealed. When the tractor turns, the values of the displacements of the internal organs show a linear dependence, and the displacement of the external organs occurs according to a non-linear relationship. As the results of experiments have shown, for reliable operation of a row-crop unit with a rear hitch of an 8-row wide-cut cultivator, a tractor is required with satisfactory controllability and stability of movement [6,7]. The Arion 630 tractor with all steerable wheels meets these requirements to a greater extent. This circumstance makes it necessary to abandon the need for a significant increase in the protective zone (over 18-22 cm, 9-11 cm on one side) when using tractor wide-cut units with a rear hitch of cultivators.

During the operation of cultivating units in row spacing of 60 cm, with the setting size of the protective zone from 8 to 10 cm, the actual value was 8.4 ... 9.2 cm. During operation of a

tractor unit with an 8-row cultivator, complete cutting and damage of cultivated plants does not occur within 99.6%, weeds are destroyed up to 99%, versus 98.5%, compared with inter-row cultivation with a tractor unit in a composition with a conventional four-row cultivator.

References

1. Bhatia, N.P.; Szegő, G.P. Stability Theory of Dynamical Systems; Springer: Heidelberg, Germany, 2002; ISBN 978-3-540-42748-3.
2. Chudakov DA, Fundamentals of the theory of agricultural attachments, M., 1954;
3. Dreizler, R.M.; Ludde, C.S. Theoretical Mechanics; Springer: Berlin, Germany, 2010.
4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos, 2nd ed.; Springer: New York, NY, USA, 2003; ISBN 0-387-00177-8.
5. Development of mounted units [Electronic resource]. - Access mode: http: www.iolitm.ru/library/23-poleznye-materialy/734-razvitie-navesnyh-agregatov, 2020
6. Protocol No. 24-2017 (IS) of type tests of the cultivator-plant feeder KHU-4V under contract No. 42-2017 (IS) / UzGCITT, Gulbahor, - 2017, - 27p.
7. Development of a wide-cut cultivator with a universal frame. Development of a draft program and methodology for laboratory-field experiments of a wide-grip cotton cultivator [Text]: Research report FA-Ateh-2018 - 334 (intermediate) / Uzbek State Center for Certification and Testing of Agricultural Machinery and Technologies (UzGCITT); otv. execution Khalmatova Z.T. : [and etc.]. - Gulbahor, UzGCITT, 2019. - 180s.