УДК 631.316

CULTIVATOR MOTION CONTINUITY STUDY

S. Kolomiyets, Ph. D., Associate Professor, Tavrian State Agrotechnological University (city Melitopol, Ukraine)

This article represents analysis of tilling machines' cultivator motion continuity study, study of factors with most influence circular motion continuity and cultivator's draught resistivity.

Cultivator, steering pole, circular motion continuity, speed, width of cut.

INTRODUCTION. Providing high quality soil engineering with minimal energy consumption according agro-technical requirements guarantees effective run of cultivator aggregate. Quality of soils engineering and energy consumption depend on the degree of aggregate's motion continuity. Factors influenced on rectilinear motion continuity in horizontal plane and draught resistivity include cultivator stetting pole's length and tractor's push-on shoe construction [1].

Steel intensity does not change while using push-on shoe which does not provide mechanic but velocity cultivator's steering pole extension. The moment of the lag time does not increase due to its mass but for increasing its radius of gyration. As a result all of this leads to increase cultivator's dynamic stability and reduce energy consumption [2, 3].

As a result the study of tractor's push-on shoe effect on its motion continuity in horizontal plane and draught resistivity through velocity cultivator's steering pole extension is important.

Numerous scientific works were dedicated to soil engineering equipment's dynamic stability. Basic scientific research on the agriculture machines' dynamic stability theory belong to the academics A.M. Lyapunov and V.P. Goryachkin. Further development of the dynamic stability theory is recorded in works of G.N. Synyeokov, A.B. Lurie, I.I. Artobolyevskiy, P.M. Vasilenko, L.V. Hyachev, M.D. Lucinschiy, A.I. Timofeev and other researchers.

Increasing the dynamic stability movement through the use of push-on shoe is of great importance because improving the quality of soil engineering and reducing energy costs guarantee increased productivity and reduced prime cost. Push-on shoe have different effects on performance indicators, including motion continuity due to different designs [4].

Increasing steering pole's velocity extension has a very significant impact on the cultivator's dynamic stability [5]. Questions of push-on shoe influence on rectilinear dynamic stability in horizontal plane through velocity cultivator's steering pole extension and specific draught resistance are insufficiently studied and illuminated in the literary sources. That is why it requires further research.

SUBJECT AND METHODS. The push-on shoe provides the possibility of trailed segment's relative movement around the working area wryness during the working motion. As a result the segment of articulation units carried forward, which is equivalent to steering pole extensions and mounting it in the wryness center [7].

Therefore there is a need for the justification of push-one pole's working areas radius of wryness or in other words the optimal value of steering pole velocity extension.

Thus the trailed ciltivator's velocity extension $\ell_{сн}$ depends on push-on shoe and is provided by the radius of its working areas' wryness.

The optimum value of steering pole's velocity extension derives from the solution of differential equation of circular cultivator's variations in horizontal plane

$$A_2^2 = 4A_1A_3, \qquad (1)$$

in which A_1, A_2, A_3 are the differential equation coefficients of cultivator's damped vibrations [6].

After the coefficients value substitution [6] and manipulations we get such equation form

$$B_1\ell_{сн}^4 + B_2\ell_{сн}^3 + B_3\ell_{сн}^2 + B_4\ell_{сн} + B_5 = 0. \qquad (2)$$

After the number value substitution of coefficients, B_2, B_3, B_4, B_5 [1] equation gets the form

$$\ell_{сн}^4 - 4\ell_{сн}^3 - 13\ell_{сн}^2 + 28\ell_{сн} + 12 = 0. \qquad (3)$$

The equation solution (3) gives an opportunity to determine the steering pole velocity extension.

In order to test the adequacy of mathematical models for determining the optimal values of the steering pole velocity extension laboratory bench testing were held. The planning matrix implementation and processing results gave the following regression equation (in the coded form) which dive adequate description of trailed cultivator's run

$$Y_1^D = 1{,}118 - 0{,}126X_1 + 0{,}285\,X_2 + 0{,}006\,X_3 + 0{,}051\,X_1X_2 - 0{,}014\,X_1X_3 + +0{,}022\,X_2X_3 - 0{,}108\,X_1^2 + 0{,}204\,X_2^2 + 0{,}075\,X_3^2; \qquad (4)$$

$$Y_2^D = 20{,}38 - 0{,}42\,X_1 + 2{,}75\,X_2 - 0{,}16\,X_3 - 0{,}36\,X_1X_2 - 0{,}05\,X_1X_3 + 0{,}81\,X_2X_3 - 1{,}4\,X_1^2 - 0{,}21\,X_2^2 - 1{,}07\,X_3^2, \qquad (5)$$

where Y_1^D – circular cultivator's motion continuity (σ , hail);

Y_2^D – cultivator's draught resistivity (R_x/hB, кН/м^2);

X_1 – cultivator's steering pole extension, $\ell_{сн}$, м;

X_2 – cultivator's speed, V, м/с;

X_3 – cultivator's width of cut, B, м.

RESEARCH RESULTS. The influence of steering pole extension $\ell_{сн}$, speed V and the width of cut B on circular motion continuity σ_φ (fixed factor of 2 to 0) is shown on Pic. 1.

From Pic. 1 it follows that:

- increasing width of cut to certain amount causes decrease of cultivator's variations root-mean-square deviation σ_φ and further increase of width of cut the slight increase σ_φ is observed;
- increasing width of cut causes decrease of cultivator's variations root-mean-square deviation σ_φ.

The influence of steering pole extension $\ell_{сн}$, speed V and width of cut B on the on the resistivity R_X/hB (fixed factor of 2 to 0) is shown on Pic. 2.

From Pic. 2 it follows that:

- with increasing steering pole extension $\ell_{сн}$ draught resistance R_X/hB is decreasing;

- increasing width of cut to certain amount causes increase of draught resistance R_X/hB, and further increase of with of cut causes a decrease in the degree of growth.

The influence of cultivator's steering pole extension $\ell_{сн}$, speed V and width of cut B on the on the circular cultivator's dynamic stability (fixed of 1 factor to 0) is shown on Pic. 3.

From Pic. 3 it follows that:

- the circular cultivator's variations' root-mean-square deviation σ_φ increase with growth of speed;

- increasing cultivator's width of cut to certain amount causes decrease of σ_φ, and further increase of width of cut - a slight increase.

circular cultivator's motion continuity (fixed factor of 3 to 0) is shown on the Pic. 4.

From Pic. 4 it follows that:

- increasing speed causes growth of cultivator's circular variations root-mean-square deviation σ_φ;

- increasing steering pole extension causes decrease of growth root-mean-square deviation $\sigma_{\varphi\ growth}$.

Achieving minimum σ_φ requires increasing the steering pole extension to its optimal value at which the motion continuity reaches the degree when soil engineering meets all agro-technical requirements. Velocity lengthening of steeping pole which increases the cultivator's mass is rationa.

The influence of the steeping pole extension $\ell_{сн}$, швидкості руху V and cultivator's width of cut B on the draught resistivity (fixed factor of 1 to 0) is shown on Pic. 5.

From the Pic. 5 it follows that:

- increasing speed causes growth of cultivator's draught resistivity R_X/hB;

- increasing cultivator's width of cut to certain amount causes growth of its draught resistance, and further increase of width of cut causes a slight decrease because its motion trajectory gets more straightforward and its motion gets more even.

The influence of the steering pole extension $\ell_{сн}$, швидкості руху V and cultivator's width of cut B on the draught resistivity (fixed factor of 3 to 0) is shown on Pic. 6.

From the Pic. 6 , the following conclusions can be made:

- cultivator's draught resistance increases with growing speed;

- increasing steering pole extension to certain amount causes growth of cultivator's draught resistivity and further increase of steering pole extension causes the decrease of draught resistivity R_X/hB.

Resistivity (R_X/hB, кН/$м^2$) can be reduced with increasing the cultivator's width of cut and velocity steering pole lengthening.

CONCLUSIONS. The acquired regression equations allow widely range rational values of the steering pole extensions for different cultivator's width of cut and speed which meet the conditions of getting minimal draught resistivity and cultivator's circular motion continuity.

Reference list

1. **Погорілий Л.В.** Сучасні проблеми землеробської механіки і машинознавства при створенні сільськогосподарської техніки нового покоління / Техніка АПК.-2003.-№11.-С.4-7.
2. **Горячкин В.П.** Об устойчивости пахотных орудий / Собр. соч.- М., 1965.-т.2.- С. 416 – 438.
3. **Ляпунов А.М.** Общая задача об устойчивости движения.- 2-е изд.- Л.- М.: ОНТИ. Гл. ред. общетехн. лит., 1935.-386 с.
4. **Гячев Л.В.** Устойчивость движения сельскохозяйственных машин и агрегатов.- М.: Машиностроение, 1981.- 206 с.
5. **Коломієць С.М.** Дослідження умов повернення культиватора в стан рівноваги / Вісник / Сумського державного аграрного університету: Науково-методичний журнал. Вип. 9. Механізація та автоматизація виробничих процесів.- Суми, 2002.- С. 123-126.
6. **Рогач Ю.П., С.М. Коломієць.** Диференціальне рівняння кутових коливань культиватора при рівномірному прямолінійному русі / Вісник / Сумського державного аграрного університету: Науково-методичний журнал. Вип. 8. Механізація та автоматизація виробничих процесів.- Суми, 2002.- С. 28-31.
7. **Патент на корисну модель №2000116547 України.** Тягово-зчіпний пристрій С.М. Коломієць. Пат. 941А Україна, МПК^7 В6001ЛЮ.- заявл. 21.11.2000; опубл. 16.07.2001, Бюл. № 6.

Сергей Матвеевич Коломиец, канд. техн. наук, доцент, Таврический государственный агротехнологический университет (г. Мелитополь, Украина)

С.М. Коломиец

Исследования устойчивости движения культиватора

В статье приведен анализ исследований устойчивости движения почвообрабатывающих машин, исследования факторов, которые в наибольшей степени влияют на угловую устойчивость движения и удельное тяговое сопротивление культиватора.