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MODELING OF PROCESS OF SEEDING SMALL-SEEDED CROPS TILLAGE SOWING UNIT FOR CALCULATION OF BAND DISPERSION

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Abstract. *Important is to ensure uniform distribution of seeds on the soil surface tillage-sowing unit with the optimization of the design parameters of the lens. Less studied is the analysis of mathematical models of block modeling of the process of seeding with the use of tracesthe of the dispenser to calculate the necessary (out of sight minimize the cost of process material) of the band dispersion of seeds of green manure and optimization of parameters of technological process of seeding to achieve a given seeding rate. The article presents the model of the process of seeding small-seeded crops tillage sowing unit, which allows to calculate the largest distance of the Bouncing of seeds from the point of impact on the plate plate with the aim of ensuring the reduction of consumption of seed at sowing. In this case, as the optimized parameters considering the speed of VC exit of the VAS deferens before the collision with the disc, disc dispenser, and also important for the formation of density distribution of the seeds on the ground the position of the plate feeder: Nd – height of the dispenser above the ground and β – the inclination angle of the plate dissipation. Optimized parameters of karakteriziraju functioning of the system determining the dynamics of the process directly involved in the dispersal of seeds on the soil surface.*

Key words: *uniform distribution, tarelchatyj lens, small-seeded crops, band dispersion*

Introduction. To ensure agronomic requirements of sowing small-seeded green manure crops requires a more precise analysis defines a uniform distribution of seeds on the area of the field that the result should provide reduction of consumption at sowing.

Formulation of problem. It is necessary to calculate the bandwidth of seeding when moving tillage sowing unit in the form of the MTA, identifying the largest distance of the bounce of the seed when dropped on the plate dissipation.

Analysis of recent research results. Given that the exit tube of the VAS deferens is directed downwards (angle φ close to 0), it can be assumed that in General case the distribution of seeds in the cross section at the outlet is normal, and in the limit (φ = 0) is uniform and the seeds will fall on the plate of the plate dispenser with the speed of a beam of seed V_C.

To study the movement of seed will introduce a fixed rectangular coordinate system 0xyz (Fig. 1). Point 0 coincides with the position of the projection of the center of mass of the seeds to the ground plane at time t=0. Axes 0x and 0y is the horizontal (positive axis 0x directed back to the direction of motion of the HPA, and 0y axis perpendicular to the direction of movement HPA) axis 0z is the vertical (positive axis pointing up).

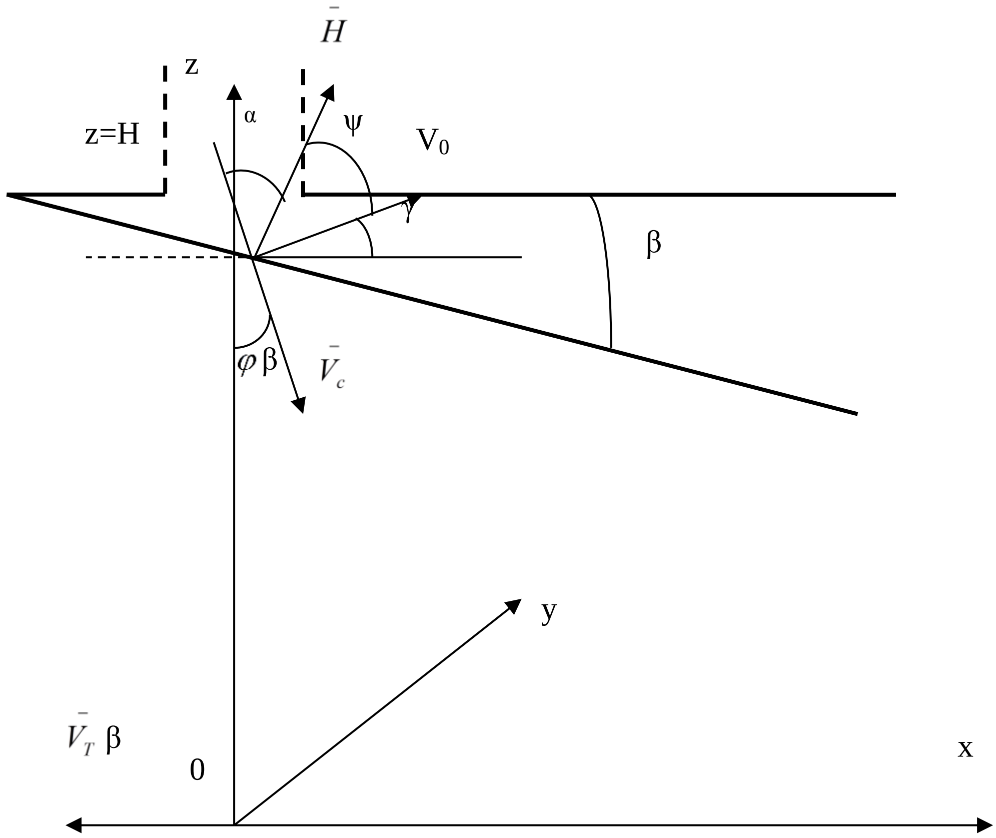

Fig. 1. Layout of elements trenchstop of the lens in the coordinate system Oxyz.

Purpose of research. To determine the size of the band dispersion of finely seeds of seed crops taking into account air resistance, we will use the method of calculations presented in [1] Busankevin G. M. and are based on formulas of the theory of impact [2, 3]. In [1] States that "...to determine the parameters of the reflection taking into account the actual shape of the seeds in an analytical way is practically impossible". Therefore, "...first, we study the motion law of seeds during their free fall, then taking into account the resistance of the medium under the action of a vertically directed initial velocity – the law of reflection seeds..."

Results of research. In the derivation of the formulas for the calculations will take into account: the speed V_C of the seeds falling on the plate from the VAS deferens at an angle φ to the vertical axis 0z (i.e., the output angle of the seeds of the VAS deferens), the tilt angle of the disc plates to the surface of the earth β, speed seed, MTA - V_T, the angle of rebound θ seeds in a horizontal plane x0y regarding the direction of MTA, as well as the height Nd installation disc dispenser above the surface of the field.

Determine the initial speed V_0, purchased seeds after impact with the plate. When determining speed V_0 is taken into account the recovery factor *k*, which characterizes [2, 3] the loss of mechanical energy of the seed at the impact on permanent deformation, oscillation, heat, etc. and is determined experimentally.

Given the inclination of plate dissipation β and angle of exit of the seed from the seed tube of φ, the angle of incidence α formed by the velocity vector of the center of mass of the seed $\overline{V}_c$ and the normal to the surface of the plate, will be equal to $\alpha = \beta + \varphi$. Then, according to the theory of impact [3], the initial velocity of the reflected from the plate of seed dispersion will be calculated according to the formula:

$$V_0 = \frac{k \cdot V_c \cdot cos\alpha}{cos\,\psi}, \qquad (1)$$

where the angle ψ, called the angle of reflection is the angle between the velocity vector $\overline{V}_0$ and the normal to the plate at the point of falling on her seed. The angles of incidence and reflection are the following dependencies $tg\psi = \frac{1}{k} \cdot tg\alpha$ and since $k < 1$, $tg\psi > tg\alpha$. Whence it follows that the angle of reflection greater than the angle of incidence $\psi > \alpha$.

Note that the angle between the vector initial velocity $\overline{V}_0$ and the axis Ox, parallel to the ground surface, equal to $= {}^{\pi}/_{2} - (\beta + \psi)$. Excluding air resistance seeds from a height Nd will move on the ground according to the equations:

$$x = V_0 \cdot t \cdot cos\gamma,\ z = V_0 \cdot t \cdot sin\gamma - \frac{g \cdot t^2}{2} + N_d, \qquad (2)$$

where t – the travel time. Where, except in t, we will obtain the equation of motion of the seed in the form of:

$$z = x \cdot tg\gamma - \frac{g \cdot x^2}{2 \cdot {V_0}^2 \cdot cos^2\gamma} + N_d. \qquad (3)$$

To determine the range of seed (3) at z = 0 we obtain the equation:

$$\frac{g \cdot x^2}{2 \cdot {V_0}^2 \cdot cos^2\gamma} - \cdot\, tg\gamma - N_d = 0, \qquad (4)$$

deciding which *x* computed relative x_{had} – the amount of Bouncing of seeds from the point of impact on plate plate without taking into account the force of air resistance:

$$x_{had} = \frac{V_0 \cdot cos\gamma \cdot \left(V_0 \cdot sin\gamma + \sqrt{{V_0}^2 \cdot sin^2\gamma + 2 \cdot g \cdot N_d}\right)}{g}. \quad (5)$$

Before the square root sign is taken to avoid negative values of dispersion. From (2) and (5) determine the time of contact of the seeds on the ground from a height N_d:

$$t_{\text{had}} = \frac{V_0 \cdot sin\gamma + \sqrt{{V_0}^2 \cdot sin^2\gamma + 2 \cdot g \cdot N_d}}{g}. \quad (6)$$

The speed V_C at the output of the VAS deferens determined by the condition of free movement of seeds (neglect the friction of seeds on the wall of the VAS deferens) at an inclination angle φ of the VAS deferens about a vertical axis with height $H_{\text{Ва}}$ – output of seeds from the seed hopper to fall into the disc dispenser and with an initial speed specified by vozduhonagrevatele at the outlet of the seed hopper $V_{\text{ВН}}$ by the formula:

$$\text{V}_\text{c} = \sqrt{V_{\text{ВН}}^2 \cdot \cos^2\varphi + 2 \cdot g \cdot H_{\text{Ва}}}. \quad (7)$$

Important for the formation of density distribution of the seeds in the soil are the parameters of the position of disc feeder: N_d - height of the dispenser above the ground and β – the inclination angle of the plate dissipation.

Define the contours of the region of maximum dispersion of the seed, using the formula (1), (5) where V_0 is calculated taking into account the value V_c from (7) and taking into account the change in the angle of inclination of the plane of the disc dispenser of β when the bounce of the seeds to the sides at angles θ in the horizontal plane *xOy*, great zero 0^o, i.e., in a hand different from the main direction of movement of the GPA.

Let in this system the x, y – coordinate values of the seeds in the horizontal plane *xOy* bounced off of the plate of the dispenser at an angle θ, β_θ – angle dispersion plate relative to the horizontal plane for these seeds. The measure of the angle β_θ determined by the formula:

$$\beta_\theta = arctg(cos\,\theta \cdot tg\beta), \quad (8)$$

which, if $\theta = 0^o$ gives: $\beta_\theta = \beta$, but if $\theta = \pm 90^\text{o}$: $\beta_\theta = 0$.

Thus, to determine the boundaries of the area of seed dispersion it is necessary to use formula (5), for which the angles α, ψ and γ are calculated with (8):

$$\alpha = \beta_\theta + \varphi,\ \psi = arctg(\tfrac{1}{k} \cdot tg(\beta_\theta + \varphi)),\ \gamma = {}^{\pi}/_{2} - (\beta_\theta + \psi). \quad (9)$$

Consider now the calculation in the presence of forces of air resistance. Let *m* – be the mass of seed, x, y, z – current coordinates of its center of mass, $\overline{R} = (R_x, R_y, R_z)$ is the force vector of air resistance,

$\overline{V} = \left(V_x, V_y, V_z\right) = (\dot{x}, \dot{y}, \dot{z})$ is the velocity vector of the center of mass of the seeds. The velocity vector $\overline{V}$ is collinear to the vector $\overline{R}$ and oppositely directed. The force R depends on the velocity: *R=m·g·f(V)*, where the function f*f(V)≥0*, monotonically increasing, and f(0)=0.

Seeds act the force of its own weight and the force of air resistance. The equations of motion of the seed in this case have the form [4, 5]:

$$m\frac{d^2x}{dt^2} = R_x \quad m\frac{d^2y}{dt^2} = R_y, \qquad m\frac{d^2z}{dt^2} = R_z - mg. \tag{10}$$

Because of the collinearity of vectors $\overline{V}$ and $\overline{R}$ you can record $R_x = \chi\frac{dx}{dt}$, $R_y = \chi\frac{dy}{dt}$, $R_z = \chi\frac{dz}{dt}$, where *χ* – dimensionless coefficient: *χ = const.* Substituting values R_x and R_y in equation (10), we obtain $m\frac{d^2x}{dt^2} = \chi\frac{dx}{dt}$, $m\frac{d^2y}{dt^2} = \chi\frac{dy}{dt}$, therefore, $\frac{d^2x}{dt^2}/\frac{dx}{dt} = k/m$, $\frac{d^2y}{dt^2}/\frac{dy}{dt} = k/m$, where $\frac{d^2x}{dt^2}/\frac{dx}{dt} = \frac{d^2y}{dt^2}/\frac{dy}{dt}$, or

$$\frac{1}{\dot{x}}\cdot\frac{d\dot{x}}{dt} = \frac{1}{\dot{y}}\cdot\frac{d\dot{y}}{dt}. \tag{11}$$

Integrating the expression (7), we obtain the expression $y = C_1x + C_2$, which is the equation of the plane and can be represented in parametric form:

$$x = t, \qquad y = C_1 \cdot t + C_2. \tag{12}$$

The system of equations (4) due to the initial conditions $y_{t=0} = 0$ gives the General solution $y = 0$, whence, summing up, it follows that the seeds move in the plane xOz for any *y*, i.e., their trajectories in flight to the ground are flat curves.

In [1] in sufficient detail lays down the General case, which defines the form of the equation of motion of the center of mass of the scattered groups of seeds. Therefore, we give only the formulae needed for the explanation of the view of the strip dispersion in our case.

In practice, the speed of seeding MTA is in the range of 8.0 to 12.0 km/h. This corresponds to a 0.6 – 3.3 m/s And the speed of vozduhonagrevatelja ranges up to 12 m/s [1] know what has been found experimentally, at speeds of 10-12 m/s grain air resistance is directly proportional to its speed, i.e.

$$f(V) = \lambda \cdot V.$$

Using obtained in [1] formulas for the General case and applying the quadratic approximation to some complex expressions and functions, get the equation of the trajectory of the seed when the above-mentioned linear law of variation of the force of air resistance $f(V) = \lambda \cdot V$. Turns out that with accuracy up to infinitesimals of the third order, it will be recorded, with the selected (Fig. 1) coordinate system, as follows:

$$z = x \cdot \frac{V_{z0}}{V_{x0}} - \frac{g \cdot x^2}{2 \cdot {V_{x0}}^2} + H_{д}, \tag{13}$$

where $V_{x0} = V_0 \cdot cos\gamma, V_{z0} = V_0 \cdot sin\gamma$ – it is a projection vector of the initial velocity V_0 along the axes Ox and Oz, respectively. That is, received a formula similar to expression (3). The abscissa of the point of impact x_{had} and fall time t_{had} will be determined by appropriate formulas (5) and (6). The angle of incidence of the seed on the ground will be determined by the formula:

$$arctg\ \dot{z}\ |_{x=x_{\text{had}}} = arctg\left(\sqrt{V_{z0}^2 + 2gN_d}/V_{x0}\right), \quad (14)$$

which makes it possible to determine the direction of the bounce of the seed when dropped on the ground.

Conclusions. The definition of a model of the process of seeding small-seeded crops tillage sowing unit for calculation of the band dispersion allows one to calculate the largest distance of the bouncing of seeds from the point of impact on the poppet plate, with the speed of seed reflected from the plate of the diffuser.

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МОДЕЛЮВАННЯ ПРОЦЕСУ ВИСІВУ ДРІБНОНАСІННЕВИХ КУЛЬТУР ГРУНТООБРОБНИМ ПОСІВНИМ АГРЕГАТОМ ДЛЯ РОЗРАХУНКУ СМУГИ РОЗСІЮВАННЯ

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Анотація. *Актуальним є забезпечення рівномірності розподілу насіння по поверхні грунту грунтообробним посівним агрегатом з допомогою оптимізації конструктивних параметрів* *розсіювачів. Менш досліджуваними є питання аналізу математичної моделі блоку моделювання процесу висіву із застосуванням тарелчастого дозатора для розрахунку необхідної (з уваги мінімізації витрат технологічного матеріалу) смуги розсіювання насіння сидератів та оптимізації параметрів технологічного процесу посіву для досягнення заданої норми висіву. У статті представлена модель процесу висіву дрібнонасіннєвих культур грунтообробних посівним агрегатом, що дозволяє розрахувати найбільший за відстанню відскік насіння від точки удару по тарельчатой пластині з метою забезпечення зниження витрати насіння при посіві. В даному випадку в якості оптимізуємих параметрів розглядаємо швидкість V_c виходу з семяпровода до зіткнення з платівкою тарілчастого дозатора, а також важливі для формування щільності розподілу насіння на грунті параметри положення тарілчастого дозатора: $H_д$ – висота розміщення дозатора над грунтом і β – кут нахилу пластинки розсіювання. Оптимизуємі параметри характеризують функціонування системи, що визначають динаміку процесу, що безпосередньо здійснює розсіювання насіння по поверхні грунту.*

Ключові слова: ***рівномірний розподіл, тарілчатий розсіювач, дрібнонасіневі культури, смуга розсіювання***

МОДЕЛИРОВАНИЕ ПРОЦЕССА ВЫСЕВА МЕЛКОСЕМЕННЫХ КУЛЬТУР ПОЧВООБРАБАТЫВАЮЩИМ ПОСЕВНЫМ АГРЕГАТОМ ДЛЯ РАСЧЕТА ПОЛОСЫ РАССЕИВАНИЯ

Т. В. Гайдай

Аннотация. *Актуальным является обеспечение равномерности распределения семян по поверхности почвы почвообрабатывающе-посевным агрегатом с помощью оптимизации конструктивных параметров рассеивателей. Менее исследуемыми есть вопросы анализа математической модели блока моделирования процесса высева с применением тарелчастого дозатора для расчета необходимой (из виду минимизации затрат технологического материала) полосы рассеивания семян сидератов и оптимизации параметров технологического процесса посева для достижения заданной нормы высева. В статье представлена модель процесса высева мелкосеменных культур почвообрабатывающим посевным агрегатом, позволяющая рассчитать наибольший по расстоянию отскок семян от точки удара по тарельчатой пластине с целью обеспечения снижения расхода семян при посеве. В данном случае в качестве оптимизируемых параметров рассматриваем скорость V_c выхода из семяпровода до столкновения с пластинкой*

тарельчатого дозатора, а также важные для формирования плотности распределения семян на грунте параметры положения тарельчатого дозатора: $H_д$ – высота размещения дозатора над грунтом и β – угол наклона пластинки рассеивания. Оптимизируемые параметры характеризуют функционирование системы, определяющие динамику процесса, непосредственно осуществляющего рассеивание семян по поверхности грунта.

Ключевые слова: ***равномерное распределение, тарелчастый рассеиватель, мелкосеменные культуры, полоса рассеивания***

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METHODOLOGICAL REQUIREMENTS TO TEST SET OF MACHINES FOR POULTRY

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Abstract. *The article summarizes the existing domestic, European and North American methodological requirements to test a set of machines for poultry. Characterized that the method of comparing the values of indicators in the subject of complex regulatory requirements and with relevant indicators for complex analog.*

It is also established that the results of mathematical processing of measurement data used for comparison with the required values of technical specifications with the state acceptance tests (technical terms, if state periodic testing) for a decision on the conformity of the test complex technical requirements to technical specifications). There are two possible cases. Also, for comparison of parameters obtained in the prototype testing of complex equipment and complex analog calculate the significance of differences in means.

Recommendations from the results of testing complex take on the basis of results of comparison of values of indicators of the test of complex equipment technical requirements for supply, zootechnical requirements and values for complex analog.

Key words: ***methodology, requirement, test, complex, machine for poultry***