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In the article thepromising trend of production and technical practices and environmental clean plant products in the organic farming. As determined scientific and organizational measures effective use of drones in biological plant protection technologies.

Eco-friendly products, Organic farming, drones, efficiency.

In this article Trends solved perspektyvnuyu development is industrial-technical practices and ecologically chystыh rastytelnыh produktov in the system of organic agriculture. How determynyrovannыh nauchnыh and orhanyzatsyonnыh meropryyatyy эffektyvnoho Using bespylotnыh letatelnыh apparatov byolohycheskoy protection technology in plants.

Ecologically chystыe produkty, orhanycheskoe zemledelye, bespylotnыe letatelnыe Apparatuses, effectiveness.

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ABOUT BENDS HARD EARNED RODS

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Stated results of studies determining the line deflection rod and the stress distribution in any section of the rod. Our results can be used in solving problems related to the operation that is working in the design of agricultural, forestry and other machinery.

Bend rod deformation, the line deflection, stress distribution.

Problem. In many problems to be solved in the mechanization of agriculture and agricultural engineering problem of there hard earned deflection rod with variable cross-section height, and with different geometry section. One of these problems is the deviation of plants under the action of movement (kinematics initial conditions) and under the influence of (dynamic initial conditions).

Analysis of recent research. Known from the strength of materials solutions [1] can be used only in the case of small displacements and can not be used to analyze the deflection rod because of problems observed considerable largest deflection. There are solutions to large deflections of thin rods [2], but these problems are not considered stress-strain state in many rods. Therefore, the analysis of which is provided here may be relevant for professionals.

To the task studied plants deviation under the action moving and under the influence of using the method napivzvorotnoho Saint-Venant. It is that the assumption of some form of stress or displacement functions.

The purpose of research. Identify dependence of the line deflection rod. Identify dependent stress distribution in any section of the rod, which will determine the strength that must apply for a certain deflection or stress state in the variable section rod sections with some elastic constant.

Results. Assume the assumptions distribution of stresses. Suppose that the normal stress at some distance to the intersection x from the point of earning distributed in the same manner as in the case of pure bending:

$$\sigma_x = -\frac{P(h-x)z}{J}, \qquad (1)$$

where J - Moment of inertia, which depends on x.

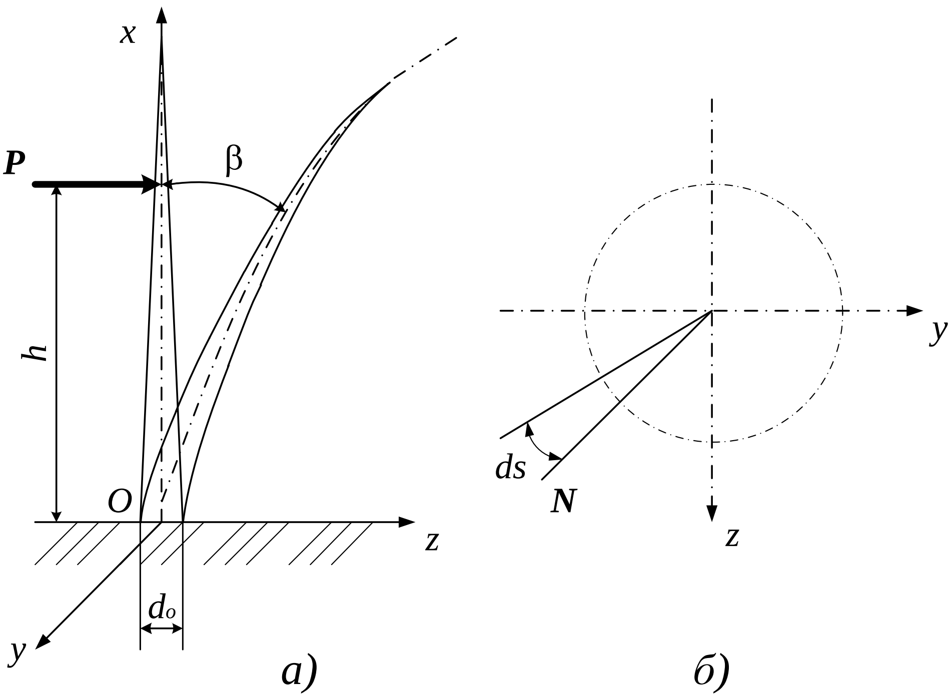


Fig. 1. Diagram bending rod (a), section rod (b).

For example, in the same cross section are tangent $\tau_{xy,}\tau_{xz}$.
Assume that the other three components of stress $\{\sigma_z, \sigma_y, \tau_{yz}\} = 0$.

At such assumptions load distribution P at $x = h$ **and reactions** in section $x = 0$ must satisfy all dynamic equations of elasticity theory [4].

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} + X = 0;$$

$$\frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} + Y = 0;$$

$$\frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \sigma_z}{\partial z} + Z = 0,$$

where X, Y, Z - Three-dimensional effect.

When assumptions $\{\sigma_y = \sigma_z = \tau_{yz}\} = 0$ And by neglecting the volume $X = Y = Z = 0$ balance equation (Speakers)take the form:

$$\frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} = \frac{\partial \sigma_x}{\partial x} = -\frac{P z}{J}; \qquad (2)$$

$$\frac{\partial \tau_{xy}}{\partial x} = 0; \frac{\partial \tau_{xz}}{\partial x} = 0. \qquad (3)$$

Group Equations (2) and (3) denote (a). From equation (3) shows that the tangent does not depend on x. Let to conditions to surface (boundary conditions) [4]:

$$\begin{aligned} &\sigma_x l + \tau_{xy} m + \tau_{xz} n = \overline{X}; \\ &\tau_{xy} l + \sigma_y m + \tau_{xz} n = \overline{Y}; \\ &\tau_{xz} l + \tau_{yz} m + \sigma_z n = \overline{Z}, \end{aligned} \qquad (4)$$

where $\overline{X}, \overline{Y}, \overline{Z}$ - Surface forces l, m, n - Direction cosines of the normal to the outer surface of the rod.

Given that lateral surface of the rod is free from external forces and that $\{\sigma_y = \sigma_z = \tau_{yz}\} = 0$ **come before** that (4) is one equation:

$$\tau_{xy} m + \tau_{xz} n = 0.$$

From rice. 1b direction cosines can be represented as follows:

$$m = \cos N\hat{y} = \frac{dz}{ds}; n = \cos N\hat{z} = -\frac{dy}{ds},$$

where ds - Element of the curve that limits the cross section.

Then the condition of the surface takes the form:

$$\tau_{xy} \frac{dy}{ds} - \tau_{xz} \frac{dz}{ds} = 0.$$

Consider the equation compatibility to stresses [4]:

$$\begin{aligned} &(1+\nu)\Delta\sigma_x + \frac{\partial^2 \theta}{\partial x^2} = 0; (1+\nu)\Delta\sigma_y + \frac{\partial^2 \theta}{\partial y^2} = 0; (1+\nu)\Delta\sigma_z + \frac{\partial^2 \theta}{\partial z^2} = 0; \\ &(1+\nu)\Delta\tau_{xy} + \frac{\partial^2 \theta}{\partial x \partial y} = 0; (1+\nu)\Delta\tau_{xz} + \frac{\partial^2 \theta}{\partial x \partial z} = 0; (1+\nu)\Delta\tau_{yz} + \frac{\partial^2 \theta}{\partial y \partial z} = 0, \end{aligned} \qquad (5)$$

where $\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ - Laplace operator, $\theta = \sigma_x + \sigma_y + \sigma_z$.

The equations (5) The first three containing normal stress components are satisfied identically, similar to the latter containing τ_{yz} Also satisfied identically. Then the remaining two equations:

$$\Delta\tau_{yz} = 0; \Delta\tau_{xz} = -\frac{P}{J(1+\nu)}.$$

Through function stresses $\varphi(y,z)$ (In a flat statement - function Erie) stress components are expressed dependencies:

$$\sigma_z = \frac{\partial^2\varphi}{\partial y^2};\sigma_y = \frac{\partial^2\varphi}{\partial z^2};\tau_{yz} = -\frac{\partial^2\varphi}{\partial y\partial z}. \qquad (6)$$

Given that $\frac{\partial\tau_{xy}}{\partial y} = \frac{\partial^3\varphi}{\partial x\partial y\partial z}$ And (6), equation (2) and (3) of (a) (after integration over x) Take the form:

$$\tau_{xz} = \frac{\partial\varphi}{\partial y} - \frac{P\,z^2}{J} + f(y)\;;\frac{\partial\varphi}{\partial x} = -\tau_{xy}, \qquad (7)$$

where $f(y)$ - A function that depends on y and must be determined from the initial conditions.

Substituting (7) into equation compatibility (d) is obtained:

$$\frac{\partial}{\partial z}\left(\frac{\partial^2\varphi}{\partial z^2} + \frac{\partial^2\varphi}{\partial y^2}\right) = 0;$$

$$\frac{\partial}{\partial y}\left(\frac{\partial^2\varphi}{\partial z^2} + \frac{\partial^2\varphi}{\partial y^2}\right) = \frac{P}{(1+\nu)J} - \frac{d^2 f}{dy^2}. \qquad (8)$$

or

$$\frac{\partial^3\varphi}{\partial z^3} + \frac{\partial^3\varphi}{\partial z\partial y^2} = 0;$$

$$\frac{\partial^3\varphi}{\partial y\partial z^2} + \frac{\partial^3\varphi}{\partial y^3} = \frac{P}{(1+\nu)J} - \frac{d^2 f}{dy^2}.$$

Integrating the latest of (8) by y out:

$$\frac{\partial^2\varphi}{\partial z^2} + \frac{\partial^2\varphi}{\partial y^2} = \frac{Py}{(1+\nu)J} - \frac{df}{dy} + c, \qquad (9)$$

where c - Constant of integration, which can be obtained from the analysis of the rotation unit area in the plane of the cross-section rod, ie in the plane YOZ.

The rotation around the axis OX defined relationship:

$$w_x = \frac{1}{2}\left(\frac{\partial w}{\partial y} - \frac{\partial \upsilon}{\partial z}\right).$$

Derived from angle of rotation axis rod x can be written as:

$$\frac{\partial w_x}{\partial x} = \frac{1}{2}\frac{\partial}{\partial x}\left(\frac{\partial w}{\partial y} - \frac{\partial \upsilon}{\partial z}\right) = \frac{1}{2}\left(\frac{\partial^2 w}{\partial x \partial y} - \frac{\partial^2 \upsilon}{\partial x \partial z}\right).$$

If you add the two components of the last expression $\frac{\partial^2 u}{\partial y \partial z}$, Then:

$$\frac{\partial (2w_x)}{\partial x} = \frac{\partial}{\partial y}\left(\frac{\partial w}{\partial x} - \frac{\partial u}{\partial z}\right) - \frac{\partial}{\partial z}\left(\frac{\partial \upsilon}{\partial x} + \frac{\partial u}{\partial y}\right) = \frac{\partial \gamma_{xz}}{\partial y} - \frac{\partial \gamma_{xy}}{\partial z}.$$

Using law Hooke to shear strains $\gamma_{ij} = \frac{1}{G}\tau_{ij}$ You can add the function of rotation as follows:

$$\frac{\partial}{\partial x}(2w_x) = \frac{1}{G}\left(\frac{\partial \tau_{xz}}{\partial y} - \frac{\partial \tau_{xy}}{\partial z}\right),$$

and, given equation (7), taking into account the fact that $-\frac{\partial \tau_{xy}}{\partial z} = \frac{\partial^2 \varphi}{\partial z^2}$

You can get: $\frac{\partial \tau_{xz}}{\partial y} = \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial f}{\partial y}$ Then

$$\frac{\partial}{\partial x}(2w_x) = \frac{1}{G}\left(\frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial f(y)}{\partial y} + \frac{\partial^2 \varphi}{\partial z^2}\right)$$

or $G\frac{\partial}{\partial x}(2w_x) - \frac{\partial f}{\partial y} = \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2}$.

After substitution last expression to (9), out:

$$G\frac{\partial}{\partial x}(2w_x) = \frac{P}{(1+v)J} + c. \qquad (10)$$

If z - The axis of symmetry of the cross section of the rod, which is bent by the force P, The right rotation w_x elements of the cross-section corresponds to negative curvature, while the average for the entire cross section is zero. Then the average value $\frac{\partial w_x}{\partial x}$ must also be zero. In this case, the constant of integration c in equity (10) also must be equal zero.

At $c = 0$, Equation (9) takes the form:

$$\frac{\partial^2\varphi}{\partial z^2}+\frac{\partial^2\varphi}{\partial y^2}=\frac{Py}{(1+v)J}-\frac{\partial f}{\partial y}.(11)$$

Substituting (7) into the boundary conditions (a) can be found $\tau_{xy}\frac{\partial z}{\partial s}-\tau_{xz}\frac{\partial y}{\partial s}=0$:

$$\frac{\partial\varphi}{\partial s}=\left(\frac{P\,z^2}{2J}-f(y)\right)\left(\frac{dy}{ds}\right).(12)$$

If you set the function $f(y)$Then from equation (11) we can determine the value φ along the contour of the cross section.
Where circular cross section, corresponding to the intersection of the stem, the circuit equation will look like:

$$y^2+z^2=r^2,(13)$$

where r - radius crossing rod.

The right side of equation (12) equals zero, if assume that $f(y)=\frac{P}{2J}(r^2-y^2)$. Substituting this expression in (11) can be obtained for the function φ the following expression:

$$\frac{\partial^2\varphi}{\partial z^2}+\frac{\partial\varphi^2}{\partial y^2}=\frac{P\,y}{(1+v)J}-\frac{\partial}{\partial y}\left(\frac{P}{2J}\left(r^2-y^2\right)\right)=\frac{P\,y}{(1+v)J}+\frac{P\,y}{J}=\frac{(2+v)P\,y}{(1+v)J},(14)$$

to whose to circuit rod $\varphi=0$.

In this way function defined transverse voltage load intensity is proportional to $\frac{(2+v)P\,y}{(1+v)J}$.

Equation (14) and boundary conditions (13) are satisfied in the case $\varphi=m(z^2+y^2-r^2)y$.(15)

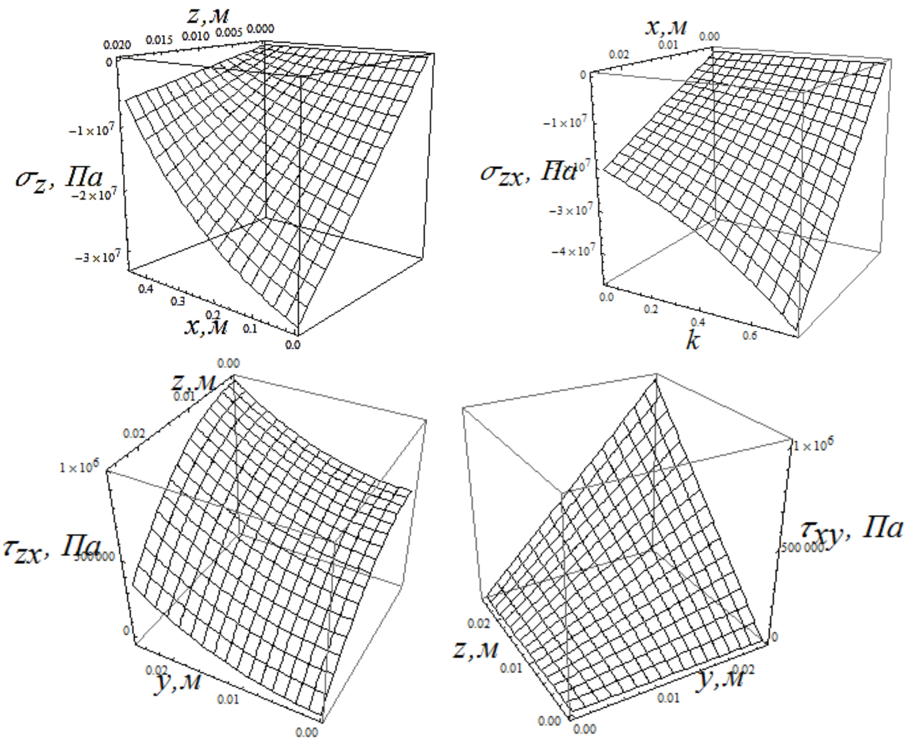
Herewith $m=\frac{2+vP}{8(1+v)I}$Then equation (15) takes the form:

$$\varphi=\frac{(2+v)P}{8(1+v)J}(z^2+y^2-r^2)y.$$

In this therefore, Set unknown potential function φ. At known features φ using equation (7) are determined by the unknown components of shear stresses:

$$\tau_{xz} = \frac{P(-y^2(-2+\nu) + r^2(2+3\nu) - z^2(2+3\nu))}{8J(1+\nu)};$$
$$\tau_{xy} = \frac{Py\,z(2+\nu)}{4J(1+\nu)};\ \sigma x = \frac{-P(h-x)z}{J}. \qquad (16)$$

Graphically dependence (16) are illustrated in Fig. 2.



Rice*. 2. Graphs* dependence (16) at a variable diameter rod.

At known values of the stress components found moving is easy. To find the displacement can be used geometric Cauchy:

$$\varepsilon_x = \frac{\partial u}{\partial x};\varepsilon_y = \frac{\partial v}{\partial y};\varepsilon_z = \frac{\partial w}{\partial z};\gamma_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x};$$
$$\gamma_{xz} = \frac{\partial u}{\partial z} + \frac{\partial w}{\partial x};\gamma_{yz} = \frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}. \qquad (17)$$

To find movement in the direction of the force, ie axis *OZ* You can use five of equation (17) as: $\frac{\partial w}{\partial x} = \gamma_{xz} - \frac{\partial u}{\partial z}$. Given that

$u = \int \varepsilon_x dx = \varepsilon_x\, x + c$ Where the constant of integration $c = 0$, We can write $\frac{\partial w}{\partial x} = \gamma_{xz} - \frac{\partial\left(\varepsilon_x\, x\right)}{\partial z}$.

Then, using Hooke's law, under certain stress components: $\varepsilon_x = \frac{1}{E}\sigma_x; \gamma_{xy} = \frac{\tau_{xy}}{G}; G = \frac{E}{2(1+\nu)}$ Taking into account (16), by integrating $\frac{\partial w}{\partial x}$ on x Determined displacement function:

$$w = \frac{h\,P\,x^2}{2E\,J} - \frac{P\,x^3}{3E\,J} + \frac{P\,x\left(-y^2\left(-2+\nu\right) + r^2\left(2+3\nu\right) - z^2\left(2+3\nu\right)\right)}{2G\,\pi\,r^4\left(1+\nu\right)} + C \text{ .(17)}$$

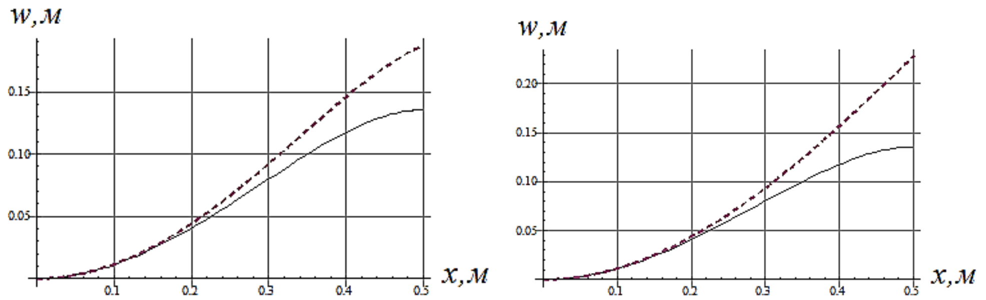
Expression (18) is written when the moment of inertia of the rod J does not depend on the coordinates x. In the case of variable diameter rod, that is, when $J \to \frac{\pi r^4}{4}$ Where $r = r_0\left(1 - k\,x\right)$ (r_0 - Half the diameter of the rod in the initial section, that is the point of earning; k - Change section rod), the expression for the displacement takes the form:

$$w = P\left(\begin{array}{l} \frac{2E\left(2 - 6k\,x + 6k^2 x^2 + h\left(k - 3k^2 x\right)\right)}{3E^2 k^3 \pi\, r_0^{\,4}\left(-1 + k\,x\right)^3} + \\ + \frac{E\,k^2\left(y^2\left(-2+\nu\right) - 3r_0^{\,2}\left(-1+k\,x\right)^2\left(2+3\nu\right) + z^2\left(2+3\nu\right)\right)}{3E^2 k^3 \pi\, r_0^{\,4}\left(-1+k\,x\right)^3} \end{array}\right) + C \text{ .(18)}$$

Fixed Depending integration (18) and (19) are determined from the initial conditions, namely: $w\big|_{x=0} = 0$. In the first case the constant cross section constant of integration $C = 0$ and expression remained unchanged (18).

Where a variable cross-section, constant of integration $C \neq 0$ and expression (19) takes the final form:

$$\begin{array}{l} w = \frac{1}{3E\,\pi\,r_0^{\,4}(-1+k\,x)^3} P \times \\ \times x(-6(y-z)(y+z) + 2x(2x + (-3+k\,x)(h + k(-y^2 + z^2))) + \text{ .(19)} \\ +(3 + k\,x(-3+k\,x))(y^2 + 3z^2)\nu - 3r_0^{\,2}(-1+k\,x)^2(2+3\nu)) \end{array}$$



and to

Fig. 3. a) *solid line* - Variable diameter rod, dashed - a constant diameter, b) solid line - the relation (20), dashed - depending on materials accepted in the resistance.

Conclusions

Received dependence (20) to determine the force that must apply for a certain deflection or stress state in the variable section rod sections with some elastic constant.

Received Depending components for stress and displacement rod round section variable stiffness have significant differences from the results that may be obtained by strength of materials and methods of large deflections of thin rods. Thus, none of these methods makes it impossible to determine the stress distribution arbitrary cross-section rod.

Received solutions can be used in solving problems related to the operation that is working in the design of agricultural, forestry and other machinery.

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Yzlozhenы Results definitions of research LINES prohyba rod and apportionment of tense in arbitrary cross-section rod. Results Poluchennыe us mogut bыt yspolzovanы in decision problems svyazannыh Decommissioning, zaklyuchayuschyysya to workers Designing bodies selskohozyaystvennыh, lesohozyaystvennыh a second machine.

Shyb rod deformation, Linia prohyba, the apportionment tense.

The results of research line identification rod deflection and stress distribution in any section of rod. Our results can be used in solving problems related to operation that is working in design of agricultural, forestry and other machinery.

Rod bending, deformation, line deflection, stress distribution.

UDC 631,331

Laboratory results From seed, providing stabilization water-air regime in the root layer of soil

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The article presents a method of seeding cereals, which stabilizes the water-air regime in the root layer and observations on seed germination in boxes of freshly loosened soil and compacted its surface layer and cutting slits in the center of each line, and the development of germs they are released to the surface.

Box, tray, ground, line, seeds, bar, compaction, surface layer crack.

Problem. Water and air are the main components of the soil and they play an important role in its formation and shaping fertility [1]. Regulation of water regime often the most important technique improve productivity of farmland. Stated that peat and sod-podzolic soils Polesie stocks of productive moisture in the root layer of soil (0 ... 50 cm) during the year vary over a wide range and at the end of summer in most cases almost completely exhausted [2].

Particularly acute lack of water is felt during sowing during drought and dry winds [3]. Due to lack of moisture topsoil is dry to a depth of seeding, causing it not take sufficient moisture for nabubnyavinnya and consequently the onset of biochemical processes. As a result of seed not gaining enough strength for friendly germination and seed the part that still swollen and gave seedlings die in the soil from overheating and has not appeared on the surface. Therefore there is a need to develop a new