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SECTION FOR A MACHINE OF SEEDLING PLANT IN NUTRITIVE POTS: PRECISE, FAST AND SECURE

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Abstract

Within the technology of vegetables, the plantation represents the most expensive and time-consuming process and requires energetic and quality costs. Time is related to the simultaneous plantation of the seedlings which have the same age and belong to the same variety in the optimal period and in a short interval. The energetic costs are represented by the mechanization of all the work for the preparation of the seedbed and the avoidance of the manual plantation. The quality is referred to keeping the distance between the rows, the distance between the pots within a row, the pot plantation depth, maintaining a slight subsidence of the pots and realizing irrigations after plantation, if they are needed. All these requests can be accomplished by mechanizing the process of plantation of seedlings sowed in pots.

Key words**:** *mechanization, pot, precision, seedling*

INTRODUCTION

The section is provided with a mechanism for the transmission of movement of some pot carriers, whose position related to the soil in a vertical plan remains constant depending on the slope of the terrain [3, 4]. The idea was assimilated by observing the position of the pallets from the reel of combines used for straw cereals during work.

The plantation apparatus of the section receives the rotation movement by Gall chain from a soil-copy wheel and presents the possibility of adjustment of the distance between plants within a row.

The section can be a component part of a machine of seedling plantation in pots on 1-2 rows when the soil is covered with mulch film or on 1-6 rows on uncovered soil.

It can be a component part of an agricultural aggregate used for soil processing, mulch film mounting or mounting hose for drop irrigation. The transmission of movement from the copy wheel presents the possibility of the adjustment of the speed of the cup support in order to adjust the distance between plants within a row and the radial component elements of the pot-bearer part have an adjustable length for the same reason. It was treated especially the action of the soil over the active organs for establishing the most appropriate material to be used for the cup construction, taking into account the number of dents that must be made in the soil using them. The material also depends on the type of planted seedlings and its technology of cultivation.

Within the technology of vegetables, the plantation represents the most expensive and time-consuming process and requires energetic and quality costs. Time is related to the simultaneous plantation of the seedlings which have the same age and belong to the same variety in the optimal period and in a short interval. The energetic costs are represented by the mechanization of all the work for the preparation of the seedbed and the avoidance of the manual plantation. The quality is referred to keeping the distance between the rows, the distance between the pots within a row, the pot plantation depth, maintaining a slight subsidence of the pots and realizing irrigations after plantation, if they are needed. All these requests can be accomplished by mechanizing the process of plantation of seedlings sowed in pots [1,2].

In the literature [4], some general rules for seedling plantation are presented. That is:

-the seedlings are planted on well-prepared soil;

-in the process of planting in field, the seedlings must have at least 45 days of vegetation and must be vigorous, healthy and well-hardened;

-the soil temperature must not exceed 10˚C at a depth of 10-15 cm in the soil;

-the distance of planting between pots within a row and between rows depends on the soil and plant characteristics;

-the depth of plantation of pots is 7-15 cm, depending on the species;

-all the seedlings must be planted at the same level as they were used as seedlings (exception for tomatoes and eggplants);

-the actual plantation is made using the planter, a garden shovel or any other object that can make a large hole, enough to enter the seedling without forcing it;

-the latter rule is the one wanted to be avoided by realizing a section of plantation of seedlings grown in pots.

Table 1. The seedling distance

Species	Distance between plants within a row [cm]	Distance between rows [cm]
Cabbage	30-60	90-100
Eggplant	45-75	60-120
Pepper	30-60	90-100
Tomato	45-120	90-120
Watermelon	60-90	180-240

Source: Own calculation

MATERIALS AND METHODS

This paper is a continuation of the studies and researches made with the purpose of obtaining the seedlings in pots by direct sowing, presented in the paper "Studies regarding the realization of a pneumatic equipment used for sowing small seeds in sockets", published at The International Symposium ISB-INMATEH 2013 by Sărăcin and collaborators and which is the object of the patent request registered at OSIM with the number A/00816/2013. In this paper, the author proposed and made a device for sowing small seeds in pots at depths comprised between 0.6 and 3.3 mm, depending on the species.

The seedling obtained in the pots must be planted after approximately 45 days from sprouting, in the optimal period, in the conditions requested by the technology of cultivation, in greenhouses, solariums or in field, during a short period of time, in order to avoid the staggered growth of the plants.

The idea of the realization of the plantation section started from the work process of the reel, which equips the cereal croppers. The reel pallets, provisioned with fingers used for elevation and sustainment in vertical position of plants, have a fixed position in a vertical plan to the soil. For realizing the section, it is used the sustainment part of the pallets, provisioned with two rotation elements which are mounted in extremities. Their extremity can represent the work depth of the section.

From a constructively point of view, the section is formed of:

-a framework, provisioned with the possibility of attachment to a device of tractor grip by articulation, which permits the copy of soil;

-a pneumatic wheel in the posterior part, which is also articulated at the framework, with the possibility of the adjustment of the position in a vertical plan, used for adjusting the planting depth and its constant maintaining;

-the device with extremity, formed of two octagonal elements which are articulated to one another at the corners, mounted on an arbor which receives the movement by Gall chain;

-cogwheels from the soil-copy wheel, which also makes the slight subsidence of the soil next to the pots which are planted in the soil.

The cups are mounted on the eight corners of the device with extremity. These cups are formed of a fixed part, which makes the dent in the soil, and a mobile part (the bottom of the cup), articulated to the fixed part and provided with a lever on which a resort with special construction is found. This resort keeps the bottom in the position “closed”. During functioning, the lever is actioned by a cam fixed in the inferior part of the device with extremity, which opens the cup, plants the seedling and, after raising (over the height of the seedling), the cam release the lever of the mobile bottom, which is brought to the “closed” position with a certain speed, realizing in this way the removal of the potential soil rests remained in the cup.

The transmission of the machine, which is, besides, simple, can assure at least two ratios of movement transmission to the planting device. That is, the adjustment of the distance between plants can be brought from 20 to 40 cm by the removal of some cups or to larger distances by the modification of the transmission ratio.

RESULTS AND DISCUSSIONS

The section is provided with an arbor on which 3 bows are mounted, bows which are supported by a metallic plate fixed on the arbor. The bows assure the extremity of one of the octagons related to the section arbor. The section arbor receives the rotation movement from the soil-copy wheel and its subsidence next to the pots. The two octagons are linked one to another by articulation elements provided in the interior with squared holes. In these holes, the cups that transport the pots and make the dents in the soil can be mounted, as seen in Figure 1.

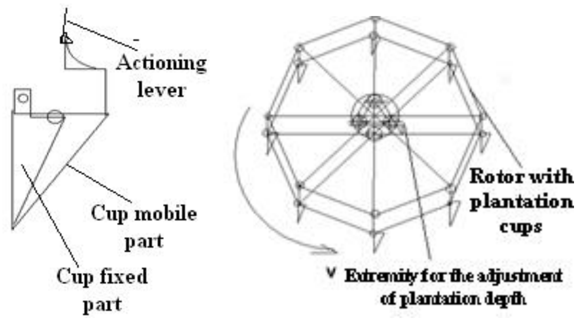

Fig. 1. The scheme of the plantation section
Source: Own determination.

It is provided with a mechanism for the transmission of movements to some pot-bearer elements, whose position to the soil in a vertical plan remains constant, depending on the slope of the terrain. It can be a component part of a machine of seedling plantation in pots on 1-2 rows when the soil is covered with mulch film or on 1-6 rows on uncovered soil.

The transmission of movement from the copy wheel presents the possibility of the adjustment of the speed of the cup support in order to adjust the distance between plants within a row and the radial component elements of the pot-bearer part have an adjustable length for the same reason.

During the work process, the cups have two movements: a translation movement V_t, given by the speed of section movement, and a rotation movement to the arbor of the section, which has the angular velocity ω, as shown in Figure 2.

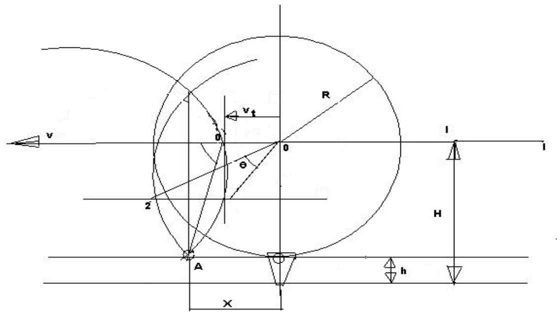

Fig.2. The cinematic scheme of the plantation apparatus: h-working depth; H-distance from the center of the wheel transportation to tip cup cups; x-the distance between plants; v_t-speed; v-direction of travel; R-bucket rotor radius
Source: Own determination.

The angular velocity of the cups will be:

$$\omega = \frac{\pi \times n}{30} / \frac{rad}{sec}$$

where n represents the arbor revolution.

The trajectory described by a cup mounted on the articulation element between the two octagons depends on the ratio between the velocities V_t and V_c.

$$V_c = R \times \omega$$

V_t - v_t-speed; ω- the angular velocity of the rotor; R is the distance from the centre of the section arbor at the point of the grip of the cup on the articulation element and V_c is the peripheral velocity of the cup.

Fig. 3. Demonstrative images during the experiment
Source: Own determination.

Because in the moment of entrance and emergence from the soil the cup must have a vertical position, as well as for the rest of the rotation on the whole 360° circumference, the ratio V_c/V_t must be equal to 1.

In order to study the functioning of the section, the movement of a cup related to the soil is analysed by considering the cup a point A found on the circumference of the circle described by its movement during the work process. Theoretically, the position of a point related to an axis can be considered in this way (Mathematics Encyclopedy): a point P(x,y) is found on an axis d or the axis d passes through the point P(x,y) if the coordinates x and y verify the axis equation, as seen in Figure 4.

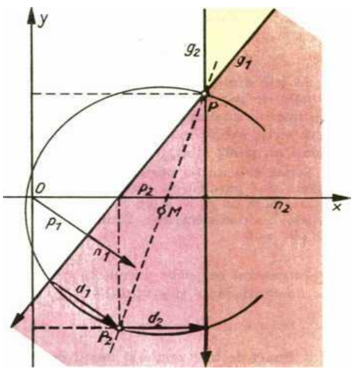

Fig. 4. Position of a point related to an axis, according to [5]
Source: Own determination.

We consider the axis given by the equation y=2x-7 and the point $P_1(4,1)$ from Figure 4. Its equation is verified for $x_1=4$ and $y_1=1$; 1=2×4-7. That is, the point P_1 is found on the axis. The point $P_2(2,4)$ is not on the axis, because its coordinates $x_2=2$ and $y_2=4$ do not verify the axis equation 4≠2×2-7.

A point $P_1(x_1,y_1)$ is found on the axis if its coordinates x_1 and y_1 verify the axis equation.

Examples and possibilities of study of the cups to the soil are:

1. The point (2,3) is not on the axis $2x-\frac{1}{4}y+8=0$ because $2\times 2-\frac{1}{4}\times 3+8\neq 0$.
2. The axis $\frac{x}{2}+\frac{y}{3}-17=0$ does not pass through the origin because $\frac{0}{2}+\frac{0}{3}-17\neq 0$.
3. The point $P_1(57,88)$ is found on the axis y-8=2(x-17) because 88-8=2(57-17).
4. The axis equation which pass through the points $P_x\left(0,\frac{3}{2}\right)$ and $P_2(2,\frac{5}{2})$ is:

$$\frac{\frac{3}{2}-y}{x-0}=\frac{\frac{5}{2}-\frac{3}{2}}{2} \text{ or } y=\frac{x}{2}+\frac{3}{2}.$$

This axis intersects the Ox axis in the point S which has the coordinates -3 and 0. The value $x_1=-3$ nulls the function.

5. The point P_1 with the abscissa $x_1=5$ which is found on the axis $y=\frac{2}{3}x-2$ must have the ordinate $y_1=\frac{2}{3}x_1-\frac{10}{3}-2=\frac{4}{3}$.
6. Through the point $P_1(6,4)$ the axis at the distance d=3 from the point $P_2(3,-5)$ is built.

Geometrically, the problem can be solved using the circle of Thales which has the diameter $\overline{P_1P_2}$. We obtain two axes g_1 and g_2 which have the distance of $d_1=+3$, respectively $d_2=-3$, taking into account the orientation of the perpendicular axis to the origin (Figure 3). In the same time, we find out that the distance d must be lower than the amount of distance $\overline{P_1P_2}$ in order for a solution to exist.

This axis must pass through the point $P_1(6,4)$ and to have the distance d=±3 from the point P_2 (3,-5).

6 cos α + 4 sin α – p=0
3 cos α – 5 sin α – p=±3
cos α+p sin α= ± 3
$\cos^2\alpha + \sin^2\alpha$ =1
cos α=1 – 3 sin α

1± 6 sin€ + sin^2€ + sin^2+sin^2=1
cos€$_1$=1; cos€$_2$= ±4/5
10 sin^2 ± 6 sin € =0
p_1=6;
p_2=±2*2/5
sin€$_1$=0; sin€$_2$= -3/5

By replacing cos€$_1$=1, sin€$_1$=0, p_1=6 and, respectively, cos€$_2$= ±4/5, sin€$_2$= -3/5, p_2=±2*2/5 in the equation, we obtain two equations:

$$\frac{4}{5} * x - \frac{3}{5} * y - 2 * \frac{2}{5} = 0$$

and

$$x - 6 = 0$$

or, written in the implicit form:

$$y = \frac{4}{3} * x - 4$$

and

$$x = 6$$

By introducing the coordinates of the origin x=0, y=0 in the two functions:

$$f_1(x, y) = -\frac{3}{5} * y + \frac{4}{5} * x - 2$$

and

$$f_2(x, y) = x - 6$$

it results that the origin is found to the both axes in the negative part of the plan.
At an arbitrary point, the trajectory of the point A in plan can be described by the equations:

$$x = V_t \times t + R \times \cos \omega t$$
$$y = H + h - R \times \sin \omega t$$

in which:

- H is the height of the axis of the section to the soil;
- R is the radius of the circle described by the cup;
- h is the planting depth;
- ωt=φ is the angle of rotation of the cup after a certain time t.

The equations of the velocity components are:

$$V_x = \frac{dx}{dt} = V_t - \omega R sin\omega t$$
$$V_y = \frac{dy}{dt} = -\omega R sin\omega t$$

V_x represents the horizontal component of the cup velocity in a horizontal plan.
Because the ratio between V_c/V_t=1, it results that $V_c=V_t=R\times\omega$ or, from the equation (), the term ω×R×sinωt=0.
In order for the plant to be let in a vertical position in the soil, the projection of the absolute velocity on the direction of movement of the section in the moment of cup entrance in the soil must be null, that is:

$$V_t - V_c \times sin\varphi_1 = 0$$

, in which φ_1 is the angle of permeation of the cups in the soil, or:

$$sin\varphi_1 = V_t - V_c = 1$$

Taking into account that $\varphi_1=\omega t_1$, it results that ωt_1=arcsin1, which means that is equal to 90˚.
The revolution of the octagon is determined by the peripheral velocity of the cups, which must also be correlated with the movement velocity of the section that is the ratio V_c/V_t=1 must remain constant in any point of the trajectory, as seen in Figure 5.

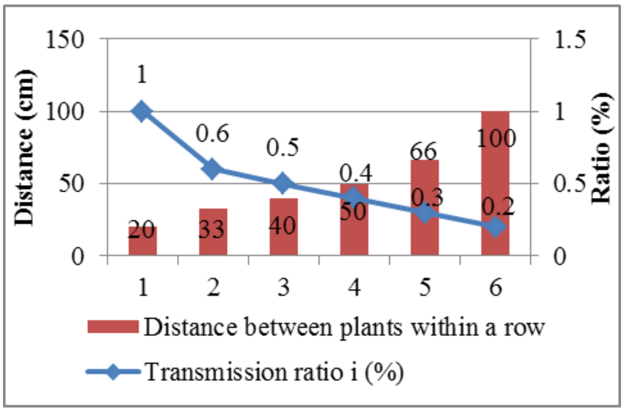

Fig. 5. The variation of the distance between plants within a row, depending on the transmission ratio at the action wheel and the plantation apparatus arbor at the peripheral velocity of 1.5m/min
Source: Own determination.

Note: by (symmetrically) reducing the number of cups of the plantation apparatus, the distances between the plants, presented in Figure 5, are doubling as values, for the same transmission ratio.

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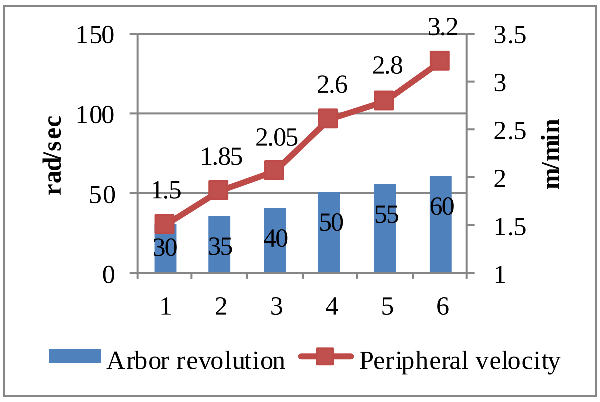

Fig. 6. The variation of the peripheral velocity of cups depending on the arbor revolution
Source: Own determination.

Note: The peripheral velocity influences the uniformity of plantation by the alimentation modality of the cups with seedlings.

CONCLUSIONS

The section of seedling plantation grown in pots assures the uniform plantation on a row regarding the distance between plants and the planting depth.
The uniformity of the plantation depends on the peripheral velocity of the cups and on the reaction speed of the user.
The section of plantation of seedlings grown in crops can be a component part of a planting machine equipped with two, four or six sections.
During the work, the plantation apparatus has the possibility of adjustment of the position of cups in a vertical plan.
The soil-copy wheel has the possibility of adjustment of the planting depth.
By their form, the cups present the possibility of plantation of pots of different sizes and shapes.
The mechanized plantation reduces the plantation time, assures high productivity with minimal costs and also assures the possibility of mechanized effectuation of other works in the vegetation period of the culture.

REFERENCES

[1]Sărăcin, I., Marin, G., Pandia, O., Florea, G., 2009, The enrgetical base for the agriculture. Aius Printed Publishing, Craiova.
[2]Sărăcin, I., Pandia, O., Netoiu, C., 2010, Theoretical study of achieving seeders for forestry nurseries of resinous, Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, Vol. XL/2, pag. 556-560.
[3]Sărăcin, I., Pandia, O., 2010, Sowing for small seeds, Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series, Vol. XL/2, pag. 561-565.
[4]Scripnic, V., Babiciu, P., 1979, Agricultural machines, Ceres Publishing, Bucharest.
[5]Mathematical Encyclopedia