INFLUENCE OF SLIPPING OF DRIVE BELT FROM DISTRIBUTION DEVICE AND SLIPPING OF SUPPORTING WHEEL, DRIVING WHEEL OF DISTRIBUTION DEVICES ON SOWING PRECISON, IN CASE OF A SOWING MACHINE FOR EXPERIMENTAL FIELDS

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Abstract

The paper presents the results of the realised tests with a sowing machine for experimental fields, to determine the influence of designing solution for drive transmission of distribution devices and the influence of slipping of supporting wheel which drive the distribution devices, on sowing precision.

Were analysed the possibility to equip the sowing machine for experimental fields with a driving transmission of distribution devices through a Poly V type belt. Was adopted this solution because it have a simple design, an easy exploitation, adjustment and maintenance. The results of the realised tests have the role to offer notions regarding the way in which belt slipping affected the value of the distance between seeds sowed on row and variation which appear regarding the number of sowed seeds per square unit.

At the end of the tests was determining the slipping coefficient of supporting wheel which drives the distribution devices. Also in this case was analysed how affect this coefficient the value of the distance between seeds on row and variations of number of sowed seeds on unit area.

Was also analysed the summed influence of those two slipping coefficients on sowing precision and sowing norm.

At the end of the paper are presented the drawn conclusions after analysis of the obtained data by tests and recommendations for improving of sowing precision of the studied sowing machine.

Key words: sowing, experimental sowing machines, sowing precision

Having in view that sugar beet provides 40...45% from world's sugar production, could be considered that it represents the second source for sugar obtaining, after sugar cane.

Sugar beet crop allow obtaining of high productions only in conditions in which are respected its cropping technologies (incorporation depth of seeds, number of seeds sowed per hectare, etc).

Nowadays could be observed that new breeds of sugar beet appears faster than in old times, which were kept in exploitation a longer time and were improved through one generation to another. The shortage of apparition time for new breeds is due to the fact that the older ones which are improved are considered to be new breeds (Sugar beet technology).

The qualities of new sugar beet breeds lead to retreat from market of older breeds, which impose to sugar beet farmers' continuous information to be connected with the novelties in this domain.

New cropping technologies for sugar beet impose utilisation of pelleted eeds, with a good quality, mono-germ, to assure productions of 80000...100000 plants per hectare.

Sowing of sugar beet seeds must be realised with sowing machines with mechanical or mechanical-pneumatic distributors.

Plants' sugar content is influenced by the distance between plants per row and by the distance between plant rows.

Distance between seeds on row varies from 12 to 20 cm, and distance between plant rows usually is 45 cm (KWS sugar beet – 2016 Catalogue)

Newer, many countries from EU, utilise at sugar beet sowing distances between seeds on row of 18...22 cm, and eliminates thinning (Sugar beet technology).

Having in view that study of sugar beet breeds is usually effectuated on experimental fields, it is necessary to utilise, for sowing, adequate units. In this way, the current paper approach on some aspects regarding driving of

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distributors of a sowing machine which could be utilised in experimental fields.

MATERIAL AND METHOD

Distribution devices were designed to allow an obtained distance between plants per row of 16.5 cm, and distance between rows of 45 cm.

At a complete rotation of sowing machine supporting wheel are introduced in soil 9 seeds.

Experimental sowing machine works on three rows and in the previous mentioned conditions allow sowing of 134680 seeds/ha.

For driving of distribution devices of the analysed sowing machine, movement from one of its supporting wheels is taken through a transmission. Having in view that this transmission is sought only by friction forces which appear in certain bearings, was analysed the possibility of utilisation of a transmission through Poly V belt, Megadyne 864J/340J type (*figure 1*), aiming to observe the way in which is influence the sowing precision by belt slipping.

Was adopted the presented solution due to its simple design and due to the fact that this belt type combine the advantages of wide belts with the ones of trapezoidal belts.

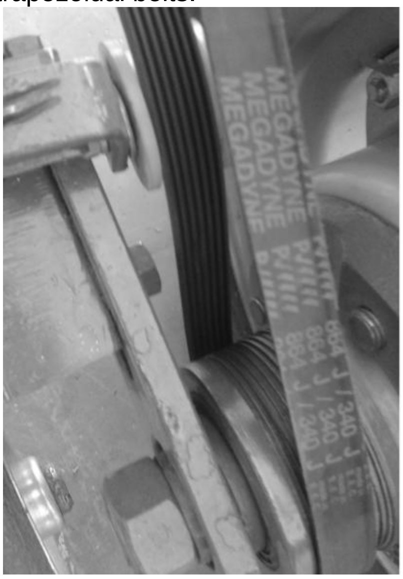

Figure 1 **Poly V belt**

Choosing of belt was realised in according with some constructive characteristics of sowing machine and also on the basis of calculus algorithm (PV Belts Megadyne Catalogue).

Due to the fact that at one rotation of driving wheel, distributors' disc execute also a rotation, then movement transmission rate, **i**, will be 1:1.

Diameter of driving wheel, **d**, must be with 25 mm greater (PV Belts Megadyne Catalogue). From constructive point of view was chose a wheel with exterior diameter d = 74 mm.

Diameter of driven wheel, **D**, is equal with the one of driving wheel because movement transmission rate is 1:1.

Tangential velocity of driving wheel, **v**, must fulfil the condition (PV Belts Megadyne Catalogue):

$$v = \frac{\pi \cdot d \cdot n}{60000} < 50\ m/s$$

in which d is the diameter of driving wheel and n is rotation of driving wheel; n = 19.44 rpm.

Results:

$$v = 0.075 \text{ m/s} < 50\ m/s$$

It could be observed that relation is true.

Calculus of belt length, **L**, is realised with relation (PV Belts Megadyne Catalogue):

$$L = L_p - 2 \cdot h \cdot \pi \ mm$$

in which L_p is (PV Belts Megadyne Catalogue):

$$L_p = 2 \cdot l + 1.57 \cdot (d + D) + (d + D)^2 / 4 \cdot l$$

where:

- *l* is the distance between support wheel axis of sowing machine and axis of the wheel which drives the distribution devices, *l* = 295 mm;
- d = D = 74 mm;
- h in according with the catalogue have the value h = 1.2 mm

Results, L = 814.8mm

Based on this result, will be choose from catalogue the belt, which will have the length very close to the calculated one, but superior to those.

So the chosen belt for transmission of movement from support wheel to drive wheel of distributors will have the length L = 864 mm.

Characteristics of that belt are (*figure 2*): belt width = 16 mm; H_b = 3.4 mm; h = 1.2 mm; h_r = 1.7 mm; S_g =2.34 mm;

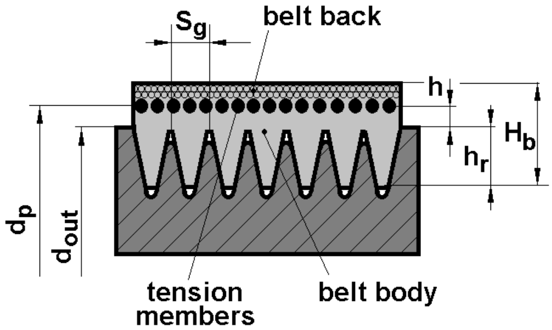

Figure 2 **Belt cross sections and dimensions**
d_p - pitch diameter of pulley; d_{out} – outside diameter of pulley; S_g - the distance between two longitudinal V shaped grooves; H_b - belt height;
h – the diameter difference between the pitch diameter of pulley and outside diameter of pulley;
h_r - longitudinal V shaped grooves height

Having in view that the distance between support wheel axis of sowing machine and the axis of distributors drive wheel is fixed must be utilised an adjustable up lever for belt (*figure 3*).

Power transmitted by belt is low, because during function must be surmounted only friction forces in bearing which sustain drive shaft of discs from distribution device.

For a suitable function, must be realized a right friction force between belt and belt wheels. This thing is possible if is applied a tension force to belt transmission. Tension in belt must assure a function with a low slipping.

A drawback of transmission through this

type of belt is its slipping on belt wheels.

To determine slipping coefficient, **δ_1,** of transmission through Poly V belt, will be used the formula:

$$\delta_1 = (1 - n_{ra}/n_{ad})\cdot 100\%$$

In which n_{ra} is the number of rotations realised by driving wheel and n_{ad} is the number of rotations realised by driving shaft of distribution devices.

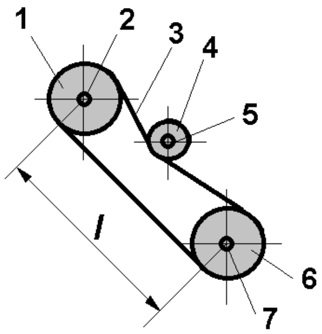

Figure 3 **Placement modality of belt up lever**
1 – driven wheel; 2- shaft of distributors discs; 3 – poly V belt; 4 – belt up lever; 5 – shaft of belt up lever; 6 – driving wheel; 7 – shaft of support wheel; *l* – distance between sowing machine support wheel axis and axis of wheel with drive the distribution devices

During work appears a slipping of support wheel on soil. Determination of coefficient which takes in account the sowing machine wheels slipping, **δ_2** is similar as in the case of determination of slipping coefficient for tractor wheels (Neculăeasa V., 1996).

Coefficient which takes in account sowing machine wheels slipping, δ_2 is determined with relation:

$$\delta_2 = (1 - n_l/n_g)\cdot 100\%$$

In which n_l is the number of rotations realised by driving wheel on a certain distance in real working conditions and n_g is the number of rotations realized by driving wheel, on the same distance, on a concrete platform with distribution devices decoupled.

RESULTS AND DISCUSSIONS

To determine slipping coefficient, **δ_1**, of transmission through Poly V belt, sowing machine was pendent, to be able to rotate the support wheel which drives distribution devices. In this way was simulated the movement of sowing machine during working.

To realise the tests was rotate the support wheel which drive distribution devices for 100 times with an angular velocity close to the one from working process, and were recorded the number of rotations realised by driving shaft of distribution devices.

Using the recorded values were calculated the value of slipping coefficient, **δ_1**, for transmission through Poly V belt.

In this case, slipping of belt on wheels will lead to modification of distance between seeds on row. Face to theoretical calculated distance, **d_c**, will be recorded an increase of it (real distance between seeds of row, **d_r**). Increasing of distance between seeds on row will lead to modification of number of sowed plants per square unit. Theoretically sowing machine allows sowing of 134680 seeds/ha.

Test results are presented in *table 1*.

It could be observed that maximum difference between real distance, between seeds on row and the theoretically calculated one is of 5 mm (3.09%). For this case, difference between number of seeds sowed per hectare, in theoretical case, face to real one is of 4000 seeds/ha, which mean 2.97%.

Minimum difference between real distance, between seeds on row and the theoretically calculated one is 1.6 mm (0.96%). In this case difference between numbers of seeds sowed per hectare, in theoretically case face to the real one is of 1300 seeds/ha, which mean 0.96%.

It could be observed that influence of belt slipping on wheels didn't affect in a great manner the sowing precision.

Differences between values of rotation number of driving shaft of distribution devices, is due to the different rotation velocities of support wheel (which was manually driven). An increasing of driving velocity of support wheel will lead to an increasing of slipping coefficient.

To be able to study the influence of slipping on soil, of support wheel, which drives belt transmission, on sowing precision was, calculated the slipping coefficient for support wheel on soil, **δ_2**.

To determine the rotation number made by support wheel, which drive the belt transmission, in real working conditions, sowing machine was coupled at a motocultor and goes to a field prepared for sowing.

Displacement was realized on a distance of 30 meters and was recorded movement times of this distance and number of rotation of support wheel. Those data are presented in *table 2*.

It could be observed that movement velocities are close as values (0.4 m/s).

The different movement times are due to slipping of motocultor driving wheel on soil.

Also in this case it could be observed that the real distance between seeds on row, **d_r**, is higher that the theoretically calculated one, **d_c**.

It could be observed that maximum difference between real distance, between seeds on row and the theoretically calculated one is 10.4 mm (6.3%). For this case difference between number of seeds sowed per hectare, in theoretical case face to real one is of 8000 seeds/ha, which mean 5.94%

Minimum difference between real distance, between seeds on row and the theoretically calculated one is 3.7 mm (2.24%). In this case difference between number of seeds sowed per hectare, in theoretical case, face to the real one is 3000 seeds/ha, which mean 2.22%.

Table 1

Real distance between seeds on row and number of seeds sowed per hectare taking in account slipping coefficient of transmission belt

Nr.	Rotations number of support wheel (rot)	Rotations number of driving shaft of distribution devices (rot)	δ_1 (%)	d_c (cm)	d_r (cm)	$d_r - d_c$ (cm)	Number of sowed seeds/ha (thousands)
1	100	99	1	16.50	16.66	0.16	1.333
2	100	97	3	16.50	17.01	0.51	1.306
3	100	98	2	16.50	16.83	0.33	1.319
4	100	99	1	16.50	16.66	0.16	1.333

Table 2

Real distance between seeds on row and number of seeds sowed per hectare taking in account slipping coefficient of support wheel on soil

Nr.	Movement distance (m)	Movement time (s)	Movement velocity (m/s)	Rotations number of support wheel (rot)	d_r (cm)	$d_r - d_{c\,r}$ (cm)	Number of sowed seeds/ha (thousands)	δ_2 (%)
1	30	76.23	0.393	19.25	17.31	0.81	1.283	8.33
2	30	72.76	0.413	19.00	17.54	1.04	1.266	9.52
3	30	75.08	0.399	19.75	16.87	0.37	1.316	5.95
4	30	74.10	0.404	19.50	17.09	0.59	1.300	7.14
MEAN	30	74.54	0.402	19.37	17.2	0.70	1.291	7.76

It could be observed that influence of belt slipping on support wheels which drive the distribution devices didn't affect in a great manner the sowing precision.

At determination of rotation number effectuated by support wheel, on horizontal concrete platform, belt transmission was decoupled. In this case are eliminated the influence of friction forces from bearings of belt transmission.

Displacement distance was also of 30 m.

The recorded data during tests are presented in *table 3*.

Table 3

Data recorded on tests effectuated on concrete platform

Nr.	Displacement distance (m)	Displacement time (s)	Displacement velocity (m/s)	Rotations number of support wheel (rot)	Rotations number of motocultor wheel (rot)
1	30	70.11	0.427	21	18
2	30	60.85	0.493	21	18
3	30	65.85	0.455	21	18
4	30	69.71	0.430	21	18
MEAN	30	66.63	0451	21	18

It could be observed that due to adherence, at all four passes, the rotation number of support wheel is the same.

Maximum value for slipping coefficient of sowing machine support wheel, $\boldsymbol{\delta_2}$ is 9.52%

Analysing the influence of those two slipping coefficients, $\boldsymbol{\delta_1}$ and $\boldsymbol{\delta_2}$, it could be observed that in the most unfavourable case, the real distance between sowed seeds will increase with 1.55cm (9.39%) which means the values of 18.05 cm. In this case the difference between number of seeds sowed per hectare, in theoretical case, face to the real one, is of 11200 seeds/ha, which mean 8.32%.

CONCLUSIONS

At the end of effectuated tests with a sowing machine for experimental field, was observed that sowing precision is influenced by transmission belt slipping and by slipping of support wheel, which drives the distribution devices. It was observed that for the most unfavourable case, the established sowing norm decrease with almost 8.5%. Transmission belt slipping affected these norm I a rate of 3%.

For increasing the precision of the analysed sowing machine, it is recommended replacement of Poly V belt with a toothed belt which prevent apparition of slipping phenomena.

Also to decrease the slipping of support wheel which drive the distribution devices is recommended utilisation of some supplementary weights mounted on the wheels of sowing machine. In this way will be increased the slipping coefficient between wheel and soil, fact which will lead to decreasing of slipping.

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