



EXPERIMENTAL DEVICE FOR THE RESEARCHES ON THE PRECISION OF THE TUBERS PLANTING DISTANCE WITHIN THE ROW FOR DIFFERENTS POTATO PLANTERS

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Abstract. *The paper presents the construction of the equipment for potato planter used for experimental researches on the precision of the planting distance of the tubers within the row. The equipments is made up of two distinct potato planter sections mounted in parallel on a common frame: a section equipped with a tubers distribution devices with vertical disc with alveoli and gripping flaps and another section equipped with a distributing device with chain and bucket (cups). In order to carry out the comparative analysis on the precision of tubers distance within the row, the equipment was tested during the working process and was adjusted for different distances of tubers between the rows as well as for different work speeds. The statistical measurements and processing enabled the analysis of the working conditions upon the planting precision of the two different distribution devices planting sections.*

Keywords: *potatoes planter, tubers distribution devices, experimental research, tubers distance within the row, tuber planting precision*

1. INTRODUCTION

Agrotechnical requirements of potato planting have imposed the tuber distribution systems which ensure the placement uniformity on row, avoidance of empty nests and duplicates, avoidance of injuries during planting, the possibility of planting to all potato varieties regardless of the shape and the tubers size, the possibility of planting the precutted or presprouted tubers, all at working speeds determined by the agrotechnical conditions. At the operation of these distribution systems be permitted an injury on a depth up to 5 mm of a max. 2% of the tubers [1, 2].

Analysing the construction and operation mode of potato planting machines manufactured on the international market, the tubers distribution devices can be grouped into three main types: with elements having a rotational motion in the vertical plane, with elements having elevators with movement in the vertical plane and with elements having elevators with movement in the horizontal plane [1, 3].

2. MATERIAL AND METHODS

The main objectives of experimental research are: establishing an experimental research method and a testing programme such as to allow relevant results related to the main quality indicators: planting uniformity and planting precision regarding the tubers distance between within the row and comparison of the quality indicators for the two cases of tubers distribution devices under identical soil, adjustment and working conditions, in order to formulate the necessary conclusions and recommendations.

For a comparative analysis of functional behavior in identical working conditions of the two types of sections of planters (with tubers distribution devices described above), to determine the quality indicators of their work, was designed and built an experimental device consisting of two different sections for potato tubers planting: one section with vertical disc and flap pockets and a section of chain with spoons (mounted in a single row).

To the achievement of experimental equipment was used a section from a tuber planter towed machine equipped with planting device with disc with flaps (model SA 2-070, made of company Agrostroy Prostějov from Czech

Republic), hereinafter section type *MARS* and a section of a carried tuber planting machine equipped with a planting device with chain and spoons mounted on a single row, (model: SD 55, made by the company RAMR from Germany), hereinafter section *CRAMER* type. The two sections were mounted on a common frame, the coupling to the tractor being made via the 3-point linkage of the tractor.

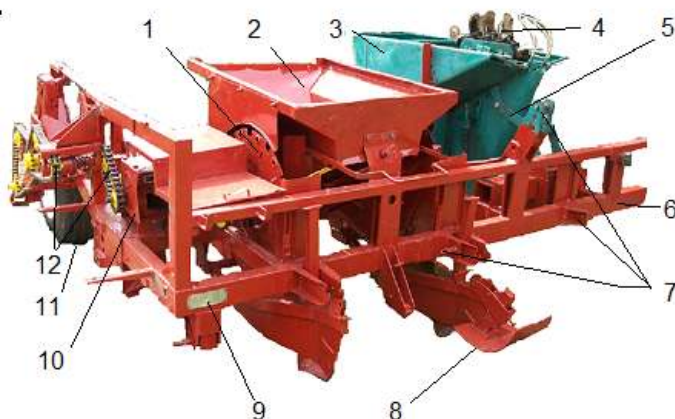


Figure 1. Construction of experimental equipment



Figure 2. The view from the back of the tractor with the experimental equipment in operation

From planter with vertical disc and flaps (*MARS* type) has been kept the ensemble of disc 1 (Fig. 3) and all kinematic elements: transmission chains 24 and 18 (see Fig. 2), Norton gearbox 10 (with 8 steps), driving wheel 11 and distribution shaft shortened 17 with bearing 16 (see Fig. 2), and the traction device was changed with the three-point suspension device 7. From the planting section with chain with spoons mounted in a single line (*CRAMER* type), with own driving from the driving wheels with blades 14 (see Fig. 2), was mounted on the support (the frame) 6 of the other machine by independent coupling through the mechanism parallelogram 5, maintaining the driving through the chain box 12 and the independent driving delimited by the bar 15 (see Fig. 2). In this way the two different structural-functional sections can operate simultaneously in the same conditions and independently by the driving of one relative with the other. Each of the sections kept the original driving kinematic chain with degrees of freedom previously had and with the possibility of supply from bags for different tests and were able to make the necessary adjustments as in their original form.

The original bunker of feeding the *MARS* machine was modified to be able to feed only one section (of the dual) by filling with an elastic element of the other opening of the dosing chamber. From the original *MARS* towed machine have been removed all elements which had no longer functional role (big bunker with the supports, the coulters, the legs of transport wheel, the tow bar), in order to reduce as much as possible the weight of the experimental equipment. The distribution shaft 17 (see Fig. 2) from the two original sections was shortened and modified, by positioning of bearing housing 16 in order to match the transmission with chain 18. For safety, on the genuine frame 6 of the machine was mounted by welding a spacer 15 to maintain the distance to the station *CRAMER*, ensuring the unhindered driving of it from the driving wheels 14 and through the gearbox 13 (see Fig. 2).

Experimental tests were conducted on field, on a soil prepared for sowing. The field was properly prepared by carrying out the spring plowing followed by successive disking in multiple passes, the land surface has been parceled and picketed realizing four consecutive working plots with travel lengths of 50 m separated by areas of 10 m length each one for changing the speed of a moving of the machine for the next tests and with turning area at the ends. According to the preset program, the experimental tests were performed in different working conditions: with tuber of various shapes and sizes, with different planting distances on row and with different planting speeds.

Measurements were made by moving of the experimental equipment coupled at the tractor on four consecutive plots for four different determined working speeds (1.5 km/h, 2.2 km/h, 3 km/h and 3.5 km/h). At each adjusted planting distance within the rows and for each established type of planted material (tubers of certain shapes and size fractions) has carried out a series of four passes at different speeds. After the first adjusted planting distance on the row and after performing of the four successive passages, the aggregate returned at the original end of the test field, where the feed bins there were emptied, was changed the type of planting material then run again the four successive passages align the initially planted rows. These series of experiments were repeated until all prepared combinations of shape and size of tubers have been planted with the two sections. After that the necessary measurements were made, after which both sections were adjusted at another value of the planting distance. Using the new planting distance adjusted, all experiments were repeated under the same conditions described above, followed of the necessary measurements. Similarly, these experiments were repeated and for the third adjusted planting distance, followed by the appropriate measurements.

The bunkers of tubers for the two distribution devices have been fed from the bags prepared in advance, marked and grouped at end of the test field. The tubers for planting have been previously prepared by sorting according to the following fractions of sizes: 30...40 mm, 40...50 mm and 50...60 mm, respectively after the geometrical forms as follows: round, oval and long. In the tests was not used the long tubers group, from the fraction of 50 ... 60 mm, testing being performed in all with eight distinct groups of tubers. Thus, the experimental conditions used have been as follows: the shape and size of tubers assort the size of the planting distance on row, the travel (working) speed of the equipment. For performance of the experiments and taking measurements have been considered the following issues:

- the possibility of regulating of the planting distance to be as close for the two types of the sections of planters (CRAMER/MARS). For these were chosen the following of the plantation distances: 20/21 cm, 28/27 cm, and 33/33 cm;
- achieving of a correlation of the values of planting speeds with those given in the machine manuals, choosing the following four values of speeds: 1.5 km/h, 2.2 km/h, 3 km/h and 3.5 km/h. The achievement of these values was possible by using of modern tractors: JOHN DEERE 4755 and JOHN DEERE 4040S;
- grouping ability by different geometric shapes of tubers: round, oval and long, using characteristic varieties of these geometrical forms, such as: Chips, Ostara and, respectively, Laura;
- grouping of tubers by the following size fractions: 30...40 mm, 40...50 mm and 50...60 mm.

For each experiment combination carried out on the 50 m plots, was made the measurement of the actual planting distances between the tubers, thus resulting for each experimental case parallel values for 151...250 real planting distances. The results of measurements were included into sheets with tables previously prepared, which were subsequently entered into the computer and were processed in EXCEL to achieve the following quality indices: actual planting distance, uniformity distribution of of tubers into row, the frequency of nest failure, frequency of nest with tuber double, the average number of tubers into the nest, precision planting, the standard deviation of the planting distance, variation, the coefficient of variation of the distance between the tubers. These calculated indexes have been introduced into tables for the graphical representation.

3. RESULTS AND DISCUSSION

Analysis and interpretation of the acquired results have led to the construction of charts that are allowed the elaboration of some conclusions on functional comparison of the 2 types of potatoes planters: one with planting section with vertical disc and flap pockets and another with planting section of chain with spoons (mounted in a single row).

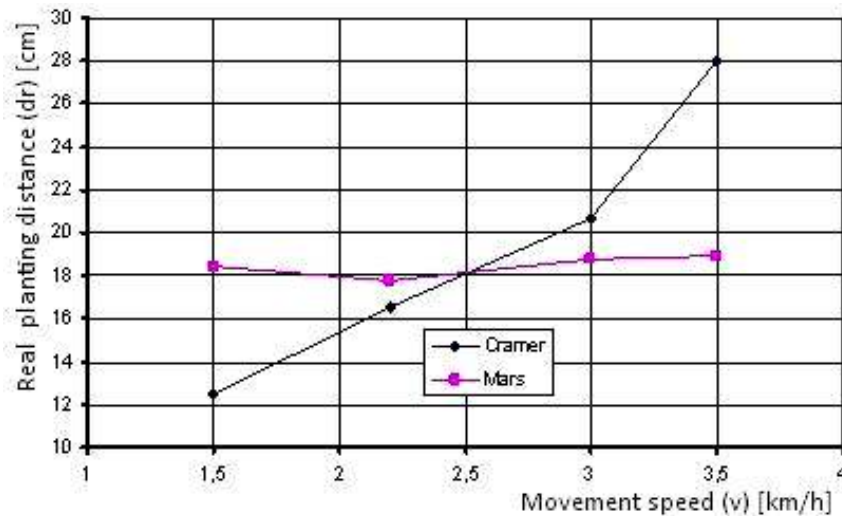


Figure 3. Graphical representation of the real planting distance variation at the two types of sections (CRAMER and MARS) depending on the working speed, for round-shaped tuber from fraction: 30...40 mm and the planting distance set to 20 cm (CRAMER)/21 cm (MARS)

For example, for the adjustment to planting distance on row (20 cm for CRAMER section and 21 cm for MARS section), at the use of tubers from 30...40 mm fraction and round sort, is observed that at the increasing of working speed from 1.5 km / h to 3.5 km / h, the value of the real distance (the average distance of the measured distances) growth faster at CRAMER section compared the MARS section (Fig.3)..

Generally, the actual planting distance values are more stable, more uniform in case of section MARS. In case of CRAMER section at smaller speeds the actual distance values are smaller than those of the MARS section. In conclusion, at these adjustments, at increasing of work speed, the actual distance values in case of CRAMER section exceed those of the of MARS .

At section CRAMER (with chain and spoons) for reduced planting speeds (1.5 km/h) with small tubers from 30...40 mm sort, there are more plantings in into nests as duplicates, because they are not very well removed or discarded from the spoons of chain due to the small size of the tubers, and smaller vibration of the conveyor chain. At increasing of speed over 3 km/h, for same conditions, Cramer section has no longer the planting precision as stable as MARS section because the cup type chain begin to throw the tubers outside the ascendent chute feeder and not enough tubers remain in the distribution mechanism. As a result, after the measurements performed, it is found the increasing of the real planting distance and there are more nests with missing tubers

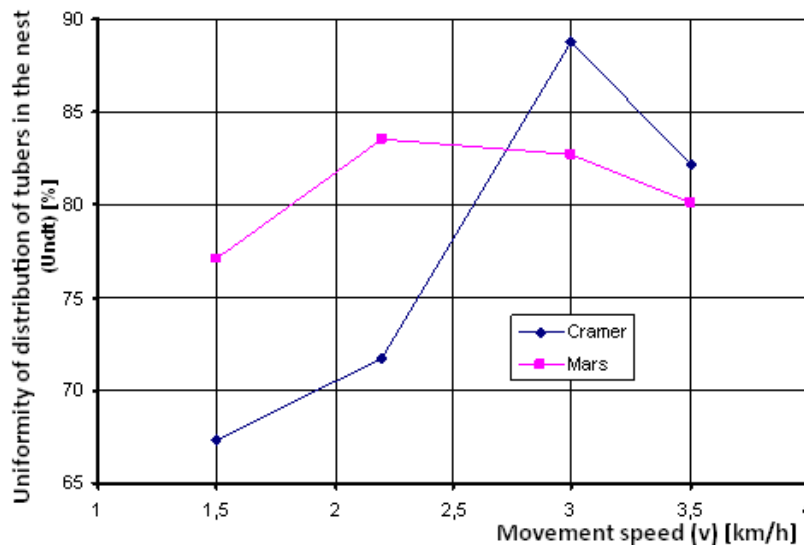


Figure 4. Variation of uniformity of distribution of tubers into the nest at the two types of sections (CRAMER and MARS) depending on the working speed for the fraction 30...40 mm and the planting distance adjusted at 33 cm

With respect to the uniformity of distribution of tubers into the nest, from the graph presented in figure 4 is observed that at the planting distance set at 33 cm to both types of sections having as planting material round tubers from 30...40 mm fraction, the uniformity of distribution at the section MARS is higher and shows a greater stability, and to the section CRAMER the uniformity has lower values and is of a lower stability.

4. CONCLUSIONS

- A simple, quick and objective method for comparing technical, technological and working performance of various types of tuber planting equipment (sections) developed by various manufacturers of potato planting machines consists in developing experimental equipment on the frame of which the sections subjected to comparative testing are mounted;
- Comparing the qualitative work indicators determined for the operation of the two types of planting sections under identical soil, adjustment and motion conditions allows the formulating of conclusions and recommendations useful for both manufacturers and users of potato planting machines;
- For small planting distances in a row (20...21 cm) and round tubers of 30...40 mm it could be noticed that by increasing working speed from 1.5 km/h to 3.5 km/h the average value of the planting distance increases more in section CRAMER than MARS;
- For a greater planting distance (30 cm) and the same form and dimensions of tubers, it could be noticed that the functioning of the MARS type section remains approximately stable, while in the CRAMER type section a small increase of the real planting distance can be noticed (compared to that corresponding to the 20...21 cm adjustment);
- For planting distances adjusted to 33 cm and small round tubers (30...40 mm), while the uniformity of tuber distribution in nests has a greater functional stability in both types of planting sections, the distribution uniformity in the MARS section has greater values than that in the CRAMER section.

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