

THE RESEARCH AND DEVELOPMENT OF MACHINES FOR THE CARE OF CRANBERRY PLANTATIONS

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Abstract. Cultivated cranberries are a valuable marketable product, which has healing qualities and is widely used for the production of various confectionery, beverages, as well as consumed in a freshly frozen way. In the case of mechanised introduction into soil the tendrils of 5-15 cm length root better. The operating tools of the clipper-collector should be designed so that pieces of the tendrils of such length are formed. A higher rooting degree of the tendrils in the peatery can be achieved when they are introduced with a power harrow during their planting.

Key words: cranberry, technologies, machines.

Introduction

Cultivated cranberries are a valuable marketable product, which has healing qualities and is widely used for the production of various confectioneries, beverages, as well as consumed in a freshly frozen way.

In Latvia this crop has been grown for the market only for about 12 years. More than 90% of the world's cultivated cranberries are grown in the USA and Canada, where there are old traditions in growing of this crop. The growing methods, technologies and equipment are correspondingly developed and adapted to the conditions of the USA and Canada, and not always the local agrotechnical requirements are satisfactory. Besides the high transportation charges for their delivery to Latvia are not economically justified.

The efficiency of the cranberry production depends, to a great extent, on the care of plantations. The main operations of the care of cultivated cranberry plantations can be classified as follows:

- operations to ensure the moisture conditions: watering – to ensure moisture and avoid the damage caused by spring frosts, regulation of the level of underground water by regulating the water level in the irrigation system, periodic turfing or sanding;
- fertilisation of plantations: by misting or dusting;
- weed and pest control: by misting or dusting, applying herbicides to the tall weeds with the contact method – by means of the applicator;
- shaping of plantations: mowing and gathering of the horizontal shoots (tendrils) of plants, the plant combing – before or simultaneously with the mowing of the shoots – to gain the mowing quality, after mowing – to ensure more favourable conditions for mechanised gathering of berries.

Methodology of research

The aim of the work was to develop such machines for the care of cranberries, which are adapted to the conditions of Latvia and are not available on the Latvian and EU markets. Standard methods for the assessment of the maintenance indices of agricultural machines were used in the research, as well as a methodology developed just for this purpose to evaluate the work of the cranberry shoot clipper-gatherer. The main criteria of the work of the clipper-gatherer were: the number of the unclipped shoots and the disintegration degree and uniformity of the clipped shoots.

Results and discussion

The structures and devices intended to ensure the moisture conditions and watering are designed and developed already when the plantations are laid out. Since the previous experience in Latvia is not wide, the systems used in the productive cranberry plantations are improved and extended taking into account the acquired experience and the results of research. In most cranberry plantations laid out in used peateries there are insufficient capacities of electric energy to run the pumps. A propeller pump, driven from the take-off of the tractor, has been developed to regulate the water level in the contour ditches. In order to prevent efficiently the damage inflicted to the plantations by spring frosts, a distant

alarm system is needed to signal critical fall in temperature on plantations and the necessity to start operating the watering devices, or, if electrically-driven pumps are installed, to launch them automatically.

Depending on the initial composition of soil, sanding or turfing of plantations is carried out periodically – once in 3 years. Thus the growth of the vertical shoots on which the yield of berries takes place is attained. As a result of sanding and turfing soil aeration is improved, evaporation of moisture decreases and better microclimate is created over the soil. Sanding or turfing is done in winter when the soil is frozen and covered with a layer of snow. For this purpose the Str Inieki farm uses the tractor MTZ-82 and the spreader of organic fertilisers PTU-6.0/14A with a transformed beater system. To minimise the pressure of the wheels of the loaded spreader of organic fertilisers (~ 14 t) on the soil and avoid the damage of the plants, a hydraulically lowered supporting shoe has been developed, made and used between the wheels of the spreader, which allows minimisation of pressure on the soil down to 0.3 kg/cm² without causing lasting damage of the plants [1]. Investigations show that the once turfed plantations reach the desired density of the vertical shoots – about 3000 shoots per m² – in the 4th year after planting.

The plantations are generally fertilised through the leaves by misting a fertiliser in compliance with the recommendations depending on the results of the analyses of the green part of the plants. Depending on the cultivated area there are used portable sprayers or sprayers with a tractor hitch-up running along the technological trail.

The weed control starts already before planting when the field is cultivated and the weeds are exterminated by agrotechnical methods. The plant density in the productive cultivated cranberry plantations is such that the low weeds are overwhelmed. In order to exterminate the high weeds, herbicide application is used by the contact (application) method. The preparation does not come on the cranberries. A hand applicator is used in small plantations. On larger areas applicators are used with a rotary roller moistened in the herbicide. Several roller-type applicators have been developed, tested and used on farms:

- a mobile device moved by human force, the rotary roller being driven from the wheels. Its drawback – when the movement is interrupted at the ends of the field and during the manoeuvres, the moistened application roller does not turn, the herbicide is collected on the lower part of the roller and drips on the soil, which is not acceptable. The drawback can be partly eliminated at the moment of stoppage by pushing a trough specially intended for this purpose under the roller to collect the liquid;
- an applicator moved by human force with a roller driven by a small electric motor from the accumulator. The rotation of the roller does not depend on the applicator movement;
- a self-propelled applicator with a roller and a running wheel drive from the internal combustion engine. It can be applied in larger plantations, it does not need great physical force. The efficiency of the applicator in the weed control is not dependent on the type of the roller.

Every year the cranberry plants produce horizontal shoots – the tendrils, on the average, 55 cm long. They do not give the cranberry yield. The tendrils densify plantations, lower the yield and obstruct the care of the plantations, particularly harvesting. Because of the reasons mentioned the tendrils should be clipped (mowed) every year and removed from the field. This should be done in spring to avoid damage to the ripening berries. The clipped and collected tendrils are used as a material for creating new plantations on the farm or for sale. On small plantations clipping tendrils and their collection is carried out by hand tools but on larger areas it is necessary to mechanise this work. Industrial mowers are not available on the Latvian and EU market, and in Latvia there are no such mowers. Self-made devices and aggregates are used. The operating tool of the clipper is a horizontal block of knives installed perpendicularly to the direction of movement, the knives being fixed to a rotary cylinder. To cut the tendrils completely and obtain the planting material with a more uniform fraction, they should be reoriented (combed) across the direction of the movement of the clipper. The clipped tendrils should be gathered, it is desirable to comb the remaining plants in the direction of the movement to facilitate mechanised berry harvesting in autumn.

Investigations were carried out in the cranberry vegetation season of 2005 in the efficiency of the ways of producing the planting material of the big-berry cranberries – tendrils and application of

machines, their impact on the quality of the planting material, their number and the impact on the development of the plantations.

The investigations show that the following tendrils clipping and collecting methods are applied in Latvia:

- by hand tools (on small areas);
- by a self-propelled clipper, without preliminary combing, the tendrils being collected with a hand tool (rake);
- by a self-propelled clipper, by preliminary combing of the tendrils with another device adapted for this purpose and collecting the clipped tendrils in swaths;
- by a self-propelled clipper with the tendrils being collected in a bunker, which is periodically emptied on the field, and combing the plants with a spring-tine rake fixed at the rear end of the clipper. The tendrils emptied from the bunker in a heap on the field are collected by hand;
- on the basis of the research and the evaluation of the performance of the existing aggregates a structural layout and a design job have been worked out for the development of an experimental specimen of a combined tendrils combing-clipper-collector.

The assessment in the course of the research of the parameters and the results of the performance of the tendrils clipper-collector made in an individual manner on the farm produced the following data.

Description of the tendrils clipper-collector

Operating tools:

- the mower – a cylinder with a rigidly attached knives;
- the comb of the remaining plants – a spring-tine rake at the rear end of the aggregate.

Collection of the clipped tendrils – in a bunker to be emptied by tipping with a lever control from the operator's place. The drive of the running wheel and the mowing cylinder – from the internal combustion engine

Table 1

Technical characteristics of the tested and designed tendrils clippers-collectors

Parameter	Unit of measurement	Value of the parameter	
		Tested specimen	Designed specimen
Performed operations:			
preliminary combing	–	no	yes
tendrils clipping	–	yes	yes
collection of the clipped tendrils	–	yes	yes
field combing after clipping	–	yes	yes
operating width	mm	1600	1600
diameter of the cylinder	mm	240	240
rotation frequency of the cylinder with the knives	min ⁻¹	540	400-600
distance between the knives (step)	mm	100	80-200
capacity of the bunker	m ³	0.6	0.6
speed of operation	km/h	3.3	4
real efficiency of performance	ha/h	0.25	0.3
mass of the clipped tendrils collected in the bunker	kg	18	24
the power of the drive of the running wheels and mowing cylinder of the collector	hp	22	12
drive of the running wheels and operating tools	–	mechanical	hydraulic

Assessment of the performance of the tested specimen:

- the average amount of the collected tendrils 1900 kg/ha;
- the average length of the plants in the field after clipping 12 cm.

When working without a preliminary tendrils orientation (combing) the unclipped tendrils left on the field constitute 43% (Fig. 1). Preliminary combing of tendrils is provided by the design of the

aggregate in cross direction, which will allow minimisation of the losses (unclipped tendrils) and increased degree of disintegration.

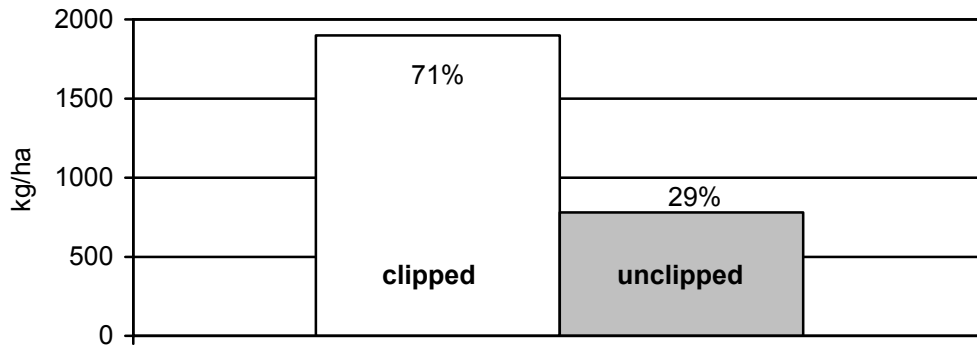


Fig. 1. Ratio of the clipped and unclipped tendrils when operating without preliminary combing of tendrils

After the removal the tendrils are disintegrated (cut with the mowing knives) into pieces of various length (fractions) the size and proportions of which depend on the form of the operating tools and conditions (Fig. 2). With an aim to obtain information about the rooting of the planting material of various sizes and its use to substantiate the parameters of the experimental specimen of the tendril clipper investigations were conducted in the plantations using different methods of tendril introduction.

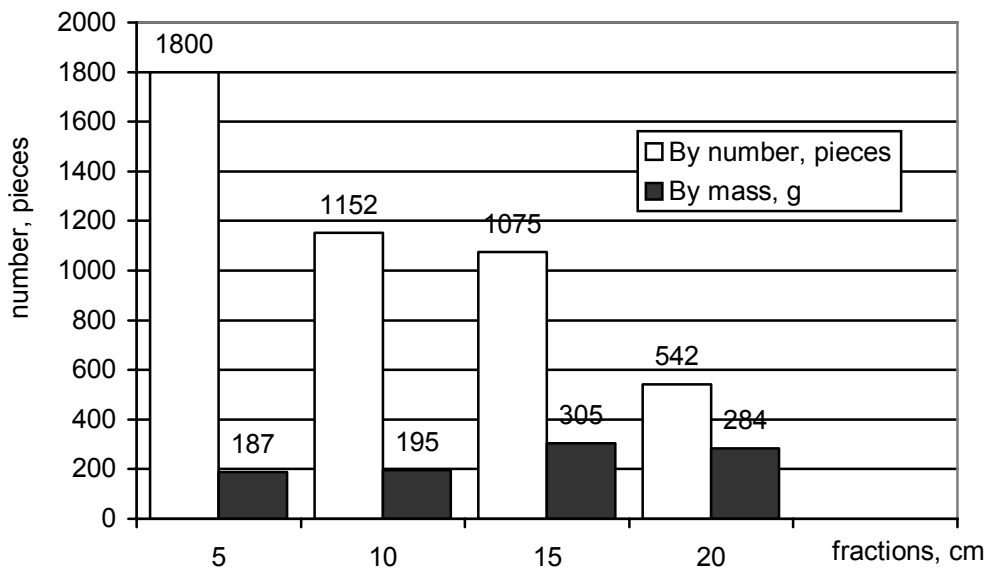


Fig. 2. Distribution of the collected tendrils in fractions by their length (in one kg of tendrils)

The results of the investigations by introducing the tendrils into the peatery using a power harrow and a disk harrow are reflected in the graph (Fig. 3).

It is evident from the graph (Fig. 3 and Fig. 4) that the best-rooted plants in the plantation of the farm were up to 15 cm long. Better results were achieved when the planting material was introduced with a power harrow.

In the reference plantation the planting material was scattered on even soil and covered with a 5 cm layer of peat, thus ensuring favourable rooting conditions for the tendrils of all fractions. In the farm plantations, when the tendrils were introduced with mechanisms, a part of the tendrils remains completely or partly on the surface of the field and dry out. At the beginning of June 4500 kg of the planting material per ha were introduced in the cranberry plantations of the Br v zemnieki farm. On August 20, the average number of shoots was 350 pieces/m². The optimum number of ~ 300 shoots

per m² is to be achieved in the 4th year. On the whole, the tested specimen of the clipper-collector is able to work and perform its main functions. The drawbacks – a great number of the unclipped tendrils and great irregularity of dimensions of the clipped and collected tendrils.

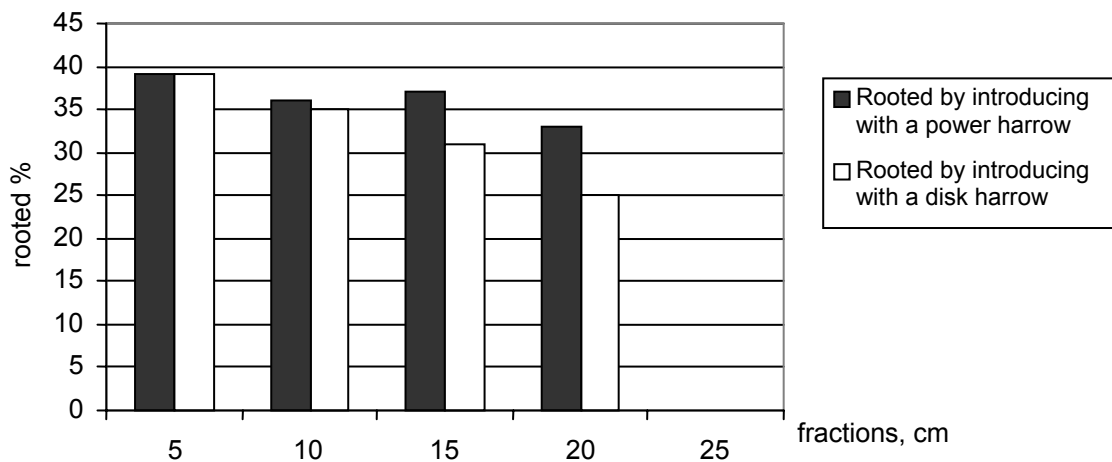


Fig. 3. Distribution of the rooted plants in fractions by introducing into the peatery with a power harrow and a disk harrow on the Brīvzemnieki farm

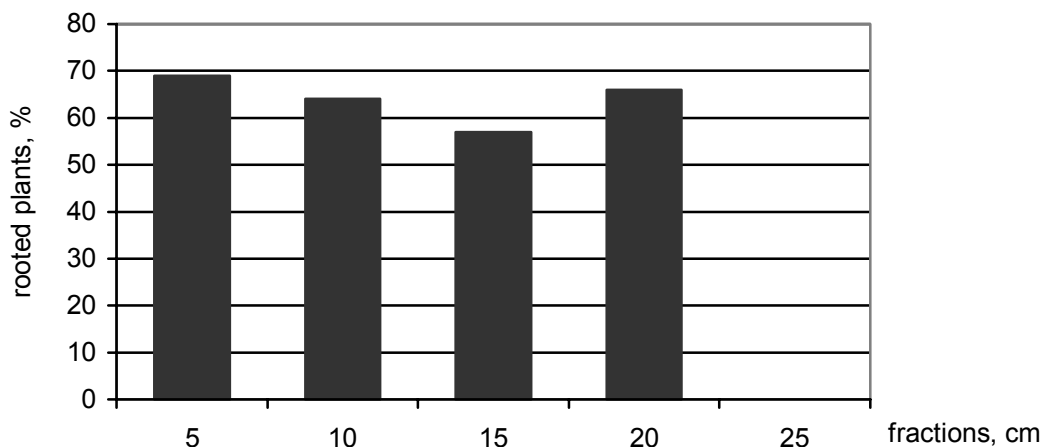


Fig. 4. Rooted plants in the reference plantation

Conclusions

1. The machines for the care of cranberry plantations – a plantation sander-turfer and the tall weed control applicator are, in general, able to operate and perform their functions successfully.
2. In order to decrease the number of the unclipped tendrils, a unit should be provided in the structure of the tendril clipper-collector for preliminary orientation (combing) of tendrils in a cross direction.
3. In the case of mechanised introduction into soil the tendrils of 5-15 cm length root better. The operating tools of the clipper-collector should be designed so that pieces of the tendrils of a such length are formed.
4. A higher rooting degree of the tendrils in the peatery can be achieved when they are introduced with a power harrow during their planting.

Reference

1. S. Ivanovs, J. Bergs, D. Viesturs. Research and designing of machines for sand application and weed control of cultivated cranberries in Latvia. // Ecological aspects of mehanization of plant production. / XI International symposium, 13-14.09.2005. Warszawa, 2005. p. 91-95.