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TRANSPORT-MANIPULATION TECHNOLOGIES FOR COLLECTION OF VEGETABLE RESIDUES FROM *ROSA DAMASCENE* MILL PRODUCTION IN REPUBLIC OF BULGARIA FOR THE PURPOSE OF FOLLOWING USE FOR ENERGY NEEDS

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Abstract

There are considered three options for harvesting from the field of plant biomass from Rosa damascene Mill after picking the flowers. To limit of Agrilus damage to plantations, the cut biomass must be taken out of the massifs. In order to avoid its rot in the form of energy chips, it is necessary that it has reached an air-dry state before the "shredding" operation. The influence of the field area and its distance from the place for storage of energy chips on the efficiency of the used equipment was observed. Depending on the location and size of the planted areas, it is appropriate to apply one of the considered options.

Key words: *Rosa damascene Mill, technology, energy, transport.*

INTRODUCTION

In the Republic of Bulgaria, the cultivation of a *Rosa damascene* Mill for the production of rose oil, rose water and others is the main livelihood of entire areas, popularly called the Rose Valley or the Valley of Roses. Bulgarian rose oil is well known on international markets (EU, USA, Australia, Japan, Middle East, etc.) https://www.mzh.government.bg/bg/(1February 2021); Zarev, K. (2008), where it has been exported since 1820 to this day.

According to data from the Ministry of Agriculture and Food of the Republic of Bulgaria https://www.mzh.government.bg/ (1 February 2021) the areas occupied with *Rosa damascene* Mill have increased from 3,290 ha (32,900 da) in 2013 to 4,189 ha (41,890 da) in 2018.

According to Implementing Regulation (EU) № 1020/2014, the geographical area of production of "Bulgarian rose oil" includes the municipalities:

- Brezovo, Kaloyanovo, Karlovo, Sopot, Stamboliyski, Saedinenie and Hissarya from the administrative district of Plovdiv,
- Bratya Daskalovi, Gurkovo, Kazanlak, Maglizh, Nikolaevo, Pavel Banya and Stara Zagora from the administrative district of Stara Zagora,
- Belovo, Bratsigovo, Pazardzhik, Panagyurishte, Peshtera and Strelcha from the administrative district of Pazardzhik,
- Ihtiman, Koprivshtitsa and Mirkovo from the administrative district of Sofia.

Apart from this geographical region defined by EU Regulation № 1020/2014, there are other areas in which small areas of *Rosa damascene* Mill are grown.

The *Rosa damascene* Mill are shrubs, branched to varying degrees, and belong to the Rosaceae family (Popov, A. et al., 1968; Terziev, J., 2006; Balinski, K. et al., 2010; Neshev, G. and Landzhev, I., 1994; Staneva, D., 1982). The height of the bushes of the individual species varies in wide ranges from 0.3-0.4 m to 2.5-3.0 m Topalov, V. et al. (1994).

The rose is very resistant to soil and air droughts Nedkov, N. (2014). The culture develops successfully on light, ventilated and deep soils Marinov, H. (1961). There are special requirements for the climate when growing for the production of rose oil Baeva, G. (2018). Only oil-bearing flowers are used, without the rods remaining during pruning Zahariev, I., Kehayov, D. (2015). The stems of *Rosa damascene* Mill has a high energy potential Zahariev, I. and Kehayov, D. (2016), which remains insufficiently studied and not fully used up to the moment \so far\.

The analysis of the areas shows that for 2015 the residual plant biomass after the contour pruning is about 20,000 t and is to increase Zahariev, I. and Kehayov, D. (2015).
According to Zahariev, I. (2018) the leaf-stem mass of *Rosa damascene* Mill enters the air dry state (18-22%) only after the 6965th minute (116th hour) after cutting and drying of atmospheric conditions without precipitation. It is also imperative to end the traditional practice of burning these piles when they reach an air dry state. In this way, thousands of tons (about 20,000 t for 2015) of residual plant biomass to be used for heat production will be saved from destruction every year. At a bulk density of 174.6 kg/m^3 at a humidity of 18% (air dry state) 114,547 m^3 are obtained.
According to Asenov, L. and Vidinova, E. (2007) the technologies for utilization of residual plant biomass can be divided into three subcategories:
- technologies for its collection from the field;
- technologies for its storage and preservation;
- technologies for its utilization as a raw material for obtaining products for energy production.
The purpose of the present study is to determine the techniques and technologies for harvesting from the field of residual plant biomass of *Rosa damascene* Mill in a state of energy fever.
To achieve the above purpose, various publications on technologies for harvesting plant residues and machines of different crops, visited companies producing and/or importers of agricultural machinery to collect the necessary information.

MATERIALS AND METHODS

The residual plant biomass of *Rosa damascene* Mill, after harvesting the oil-bearing flowers and subsequent contour pruning, consists of young shoots, perennial stems, leaves, inflorescences and prickly thorns. In order to be able to collect and utilize this biomass, it must not be crushed and scattered in the field for green manure. It must be extracted at the end of the massif and left in piles until it reaches an air-dry state (Figure 1).
Technologies for harvesting from the massif with *Rosa damascene* Mill of the residual plant biomass in the form of energy chips in air-dry state generated during the contour pruning, after harvesting of the oil-bearing flowers.

Figure 1. Pile of plant remains of *Rosa damascene* Mill reaching an air-dry state to the rose array

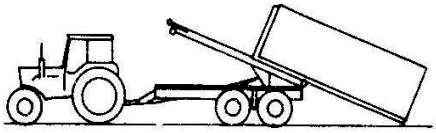
The conversion into energy chips (wood chips) is done with a forage harvester (Figure 2) or a chopping machine.

Figure 2. Shredding of plant residues of *Rosa damascene* Mill with silage harvester KPI-2,4

RESULTS AND DISCUSSIONS

According to Kehayov, D. et al. (2017) have 15 variants of technologies for harvesting residual plant biomass from the field are substantiated. Of interest are mainly three of them:
The proposed technologies are for harvesting the plant residues of *Rosa damascene* Mill generated during contour pruning and chopped into energy chips in air dry condition. These technologies differ in the means of transport used and the type of transport packaging.
The first technology is: *"Direct collection of biomass in the state of energy chips with vehicles for interchangeable bodies\frame\ and containers".*

According to Panayotov, J. (1987) vehicles for interchangeable bodies\frames\ and containers are implemented in the transport systems of developed countries, such as the United States, England, Germany, France, Sweden, Finland and others. They use the latest ways to quickly change bodies\frames\ (Figure 3).



CL

Figure 3. Container system "Multilift",
CL - container vessels with loading and unloading equipment, Panayotov, J. (1987)

When using the container system is appropriate to apply a combination of tractor and road vehicles.

The main advantage is that the container truck can leave an empty container in the field and load itself full, without the need for an additional machine.

Another positive feature of most variants of the Multilift container system is that unloading at recycling points can be done not by removing the container body, but by pouring the energy chips back, as in dump trucks. Thanks to this specific feature of the system, there is no need for an unloading device at the checkpoints.

Due to the fact that a large part of the massifs are located in hard-to-reach places for highway container trucks, the most suitable option for transporting energy chips from the field to the processing centers is a combination of tractor and road transport. In this case, the container is delivered to the base of a rose producer by an ordinary highway container truck. From there it is transported to the massifs with a *Rosa damascene* Mill on a trailer towed by a tractor. Fill up and vice versa. According to https://freeline.bg/shema-na-tovarene (1 February 2021), the volume of a 20-footcontainer is 28-30 m^3, which makes 4.9-5.2 t.

Second technology: *"Transportation of oil rose residues in the form of energy chips with specialized vehicles for the transport of containers with gantry cranes."*

The technological scheme is shown in Figure 4.

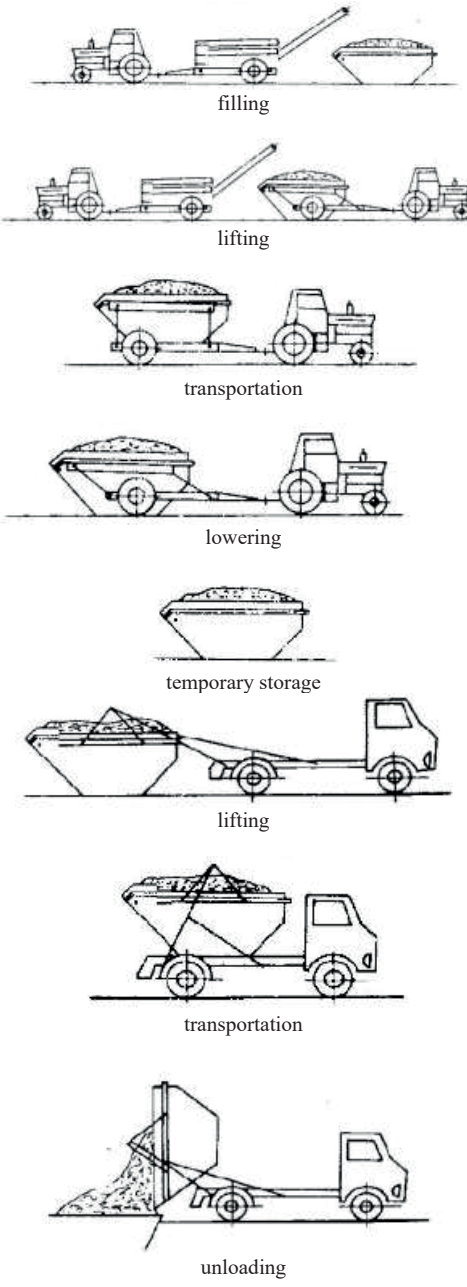


Figure 4. Technological scheme of container system.

This type of transport has been introduced in agriculture, construction and utilities since the 1970s. The gantry crane is characterized by a simple and reliable construction. The containers used have a capacity of 5.1 m^3, with

dimensions 2,580 x 2,195 x 1,150 mm and are made of steel sheet with a thickness of 3 mm.
At a bulk density of 174.6 kg/m^3 at 18% moisture content, 174.6 x 5.1 = 890.5 kg will fit in one container.
Another advantage is that the container truck can load 2 or 3 empty containers. Such an organization reduces the downtime of the vehicle waiting for the container to be filled with energy chips.
Glushkov, S. et al. (2015) found that with prolonged storage, the cods subside. For this reason, the storage time of energy chips in the container needs to be limited to reasonable limits.
In this organization, empty containers can be delivered in advance to the rose grower's farm and lifted from there at a time convenient for the transport company.
According to https://agri.bg/agrosaveti/lozarstvo/beritba-na-vineni-sortove-grozde–2(1February 2021)the grapes are harvested at the end of September - beginning of October. The grapes are transported from the vineyards to the wineries \wine factory\ in special containers. During the rest of the year, these containers are stored \ are not used\.
The plant remains of a *Rosa damascene* Mill in the form of energy chips are transported at the end of July - the beginning of August.

From the above, it is clear that the containers for wine grapes can also be used to transport energy chips, because at that time they are in standby mode.
The main disadvantage is the need for equipment for lifting and pouring these wine grape containers in the processing centers when they are loaded on platform cars without the possibility of self-unloading.
Third technology: *"Transportation of oil rose residues in the form of energy splinters by dump trucks and dump trailers".*
The technology includes the following operations: bringing in the form of energy chips and loading of the cut plant remains of *Rosa damascene* Mill in a highway car dump truck and dump trailer, transportation to the collection point for further processing.
The main disadvantage of this technology is the fact that many of the arrays are located in places inaccessible to highway dump trucks.
In order to eliminate the need for stopping and to minimize the downtime of the forage harvester or chopping machine, it is necessary to provide the so-called buffer trailer. It is an intermediate link between the shredder and the vehicle (trailer, dump truck or container). Thanks to it, the chopping machine does not have to stop when filling the vehicle and wait for the arrival and positioning of another one, as shown in Figure.5.

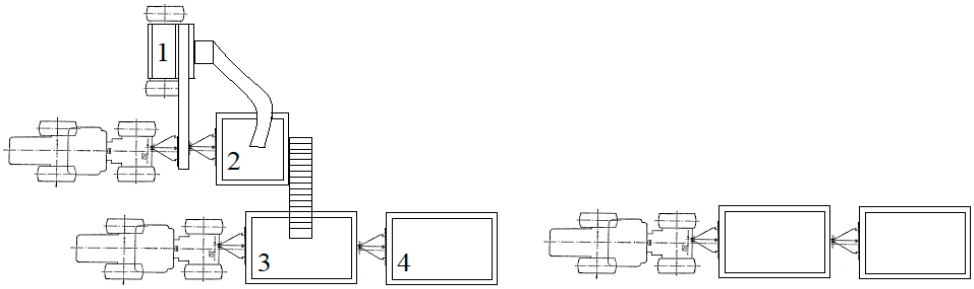


Figure 5. Technological scheme of loading of tractor trailers using an intermediate unit-buffer trailer;
1 - crushing machine; 2 - buffer trailer; 3 - loaded trailer; 4 - waiting trailer.

During the positioning time of the next trailer of one train or other vehicle, the buffer trailer absorbs the crushed mass in its own free volume and thus there is no need to stop the crushing machine. The buffer trailer is used as an intermediate in technological schemes for harvesting different crops.

CONCLUSIONS

Based on the above, the following conclusions can be drawn:
1. Three technologies for the transport from the field of residual plant biomass of Rosa

damascene Mill to air-dried state and converted into energy splinters are substantiated;
2. Depending on the location and size of the planted areas, it is appropriate to use one or another technology;
3. Due to the low volumetric density of energy chips, it is necessary to complete specialized vehicles for the transport of containers with gantry cranes with a trailer in order to achieve maximum use of the traction qualities of the machine;
4. With the use of an intermediate unit - buffer trailer with conveyor there is no need to stop the crushing machine when moving the trailers in one composition or when positioning another composition.

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