MECHANISATION OF FRESH MARKET APPLE PRODUCTION BASED ON A SPECIAL TRELLIS

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Abstract

The aim of the above project is to develop an experimental growing system to improve the level of mechanisation of high quality apple production and the same time to decrease the amount of pesticide used. The apple tree hedge is grown on a Y shape trellis which is new in Hungary. The limb with the fruits grows in 20 grade angle to the horizontal and is fixed to wires. Micro irrigation is built up in each row. As the amount of light is much the same for each fruit uniform quality product is expected. As apples hang underneath the plane of limb they are easy to treat and harvest. The uniform position of apples enables also the high level mechanisation of the production. The „umbrella" of the trellis eliminates the sunburn of fruits, and also decreases the desiccation of soil. Due to micro irrigation a micro climate of higher vapour content is also to be expected underneath the canopy.

Effective spray penetration is facilitated by the shallow canopy. Simple nozzles without air blast can be used. Superfluous droplets can be collected underneath the limb which means saving in chemicals and environment-protection. The Y shape trellis enables partly the mechanisation of pruning and cutting. Using an appropriate mower built on a tractor most of the vertical sprout above the limb can be cut. Even the harvest can be mechanised meanwhile keeping the fruit undamaged (fresh market quality).

Keywords

fresh market apple, trellis, mechanical fruit harvest

Introduction

The aim to mechanise fresh market apple production has got a long history. The two technological elements requiring the most manpower are the pruning and harvesting. Harvesting with shaker machine causes damages to the fruit for three main reasons:

- during shaking the fruits swing and hit each-other
- the detached fruits fall on lower branches
- the detached fruits hit each other on the catching surface

For a successful mechanical harvest of fresh market apples these three sources of damage must be eliminated.

The first of them can be minimised by growing short stem variety apples. It has been proved, that stem length and detaching force are among the most important factors influencing damage due to swinging of fruits (Láng, 1989).

To avoid damages due to lower branches special shaped trellises were formed and tested. Among those the so called Lincoln Canopy, introduced by Dunn (1976) was the most remarkable initiative. Due to its T shape the fruits grow under the same circumstances, which leads to uniform size and quality apples. It also enables the mechanical harvest of fruits from above and their collection underneath the canopy on a soft surface. The canopy is also suitable for the mechanical pre-cut of limb.

Many attempts were made to mechanise the harvest of Lincoln Canopy apples. Beside experiences impacting the wires of the trellises a static and a shaker type method is worth to mention.

Peterson and Kornesky, (1987) have built a frame with parallel rods. Each rod could move independently in axial direction when the acting force overcomes a preset value. The frame with the rods was pushed through the limb of Lincoln canopy. The rods contacting fruits detached them. Contacting branches or the frame of the canopy, they slept back. No report of further development of the first experimental model was published.

Shaker harvest with rubber-tees discs was reported by Láng (1989). Built on a self-propelled machine frame it harvested the canopy with acceptable percentage of damaged fruits.

In the 80's Lincoln Canopy apple growing technology was spread in many countries of the Word. By now, because of its high plantation costs (expensive trellises, high manpower demand to form the canopy) and of the long period to the firs harvest, Lincoln Canopy became less competitive.

Materials and methods

Our aim in this project was to design and study a new trellis, which maintains the advantages of Lincoln Canopy but at the same time it is competitive with the up-to date apple-growing technologies concerning yield, fruit uniformity and quality. In surplus we wanted to raise the level of mechanisation in the production. To fulfil these

1. An experimental orchard was planted of which 3 row with the new Y shape trellis, 3 row in V system and 3 row in conventional central leader form. Each row was supplied wit top and bottom micro irrigation.
2. A boom sprayer with droplet collecting plates was designed and tested. The plates had to collect the chemical droplets not adhered on the leaves.
3. A mower adaptor was designed and tested. It had to help hand pruning by cutting the new branches heading upwards.
4. A harvester platform for hand and mechanical harvest was designed and tested. The tractor pulled unit is able to carry either two seated harvester and 12 buckets, or a shaker harvester unit and a container bin for collecting the apples.

Figure 1. The arrangement of the Y shape trellis

Fig. 1 shows the arrangement of the Y shape trellis. Above 1.1 m height the central leaders are bended and fixed to the wires on the left and right side respectively. The main branches are also fixed to the wires. The trees are planted in 50 cm distance from each-other, four times as dense as at the Lincoln Canopy.

Yield was measured and compared with that of control arrangements.

Fig. 2. shows the boom sprayer with droplet collecting plates in transport and work position. Two sets of sprayers are applied each side: one on the top and one on the bottom. The distance of sprayer head from the limb was 50 cm at a system pressure of 5

bars. Tests were carried out in orchard and outside of it to measure the ratio of collected fluid volume to the total sprayed one at different working speeds.

Figure 2. The experimental boom sprayer with droplet collecting plate

The mower adaptor in working position is shown on Fig. 3. Parallelogram frames allow the blades to follow the surface of the main branches. Working height is set up by the tractor linkage arms. The frequency of the hydraulically driven mower was set to 30 Hz. The mass of cut and uncut new brunches was measured and evaluated.

Fig. 4. shows the working principle of the tractor pulled harvesting platform. One harvester worker sits on each side and picks the fruits from underneath the canopy into a bin in front of him/her. The filled bins are than pushed to a transport line where from two other workers, walking along the platform, are putting them on the ground or empting them into the pallet bin. These two workers are also picking apples from the inner edge of the canopy. Working capacity of the pickers is aimed to be measured and compared with the output in conventional orchard.

Figure 3. The mower adaptor in working position at the end of the row

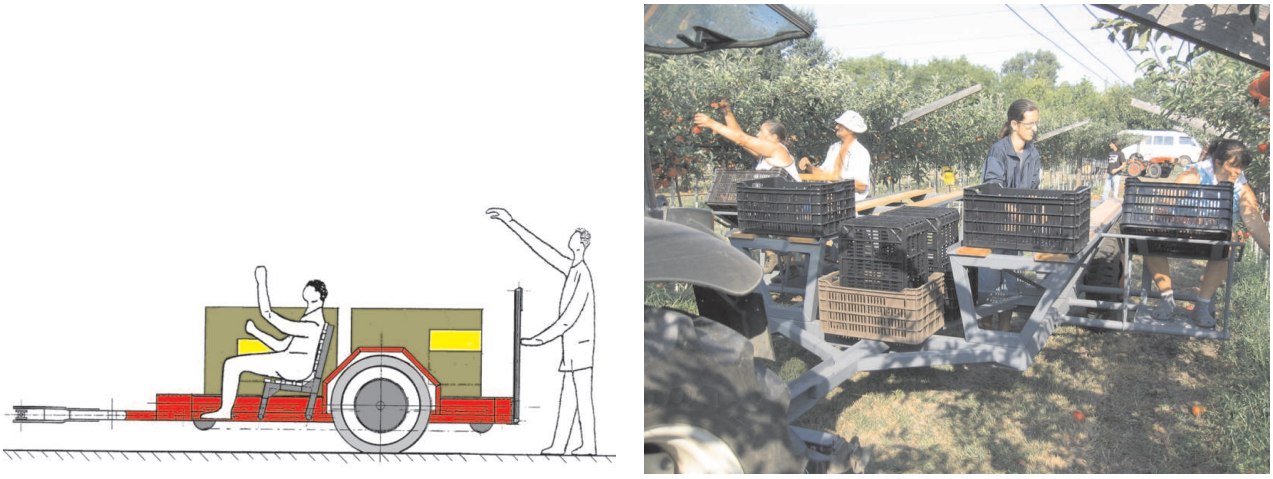

Figure 4. The tractor pulled harvesting platform with the seated and walking picker

The platform can be transformed to a mechanical harvester. Instead of the seats a shaker unit will be mounted with a transport conveyor underneath. A pallet bin lift will also be connected to the main frame of the platform. The lift will be sunken in accordance with the filling of the pallet bin, this way damage will be avoided.

Results and discussion

The yield of the experimental orchard in the 2nd year, compared with the two references was lower: 14.8 t/ha vs. 15.2 t/ha and 16.8 t/ha. Higher yield is expected in the 3rd year, when the main branches – fixed to the canopy – bear fruits in their total length.

Test results of the sprayer experiences on free land resulted in average 33.6% recovery rate at 2.5 km/h working speed.

As expected, droplet collection is more effective for the sprayers above the canopy: 41.7% versus 11.9% recovery rate for the bottom sprayers.

The recovery rate for lower vertical sprayer arrangement and for the case, when they were tilted forward in 15 degree was 11.9% and 18.5% respectively.

The pre-cutting rate compared with the total limb mass to remove resulted 65%. The rest must be pruned by hand.

The first experiences with the harvesting platform will be carried out in autumn 2009. Based on earlier experiences it is to be expected that the capacity of the hand pickers will reach the 250 kg/h value.

The same applies for the experiences with the shaker harvester: they will take place after the hand picking tests. Transforming the

platform by connecting to it the container lift, the shaker unit and container filling conveyor, it will be able for continuous detachment and collection of fruits.

Although final comparison of conventional and the experimental apple growing system will be available by the end of the year, it can be concluded from the first experiences that spraying and pre-cutting saves money and manpower. It can be expected that hand picking will improve by 66%, compared to the conventional 150 kg/h rate. Based on earlier experiences in Lincoln Canopy the new trellis may enable the mechanical harvest of fresh market apples.

References

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