PRECISION THINNING OF FRUIT CROPS

L. Damerow, C. Seehuber

Institute of Agricultural Engineering
University of Bonn
Bonn, Germany

M. Blanke

INRES – Horticultural Science
University of Bonn
Bonn, Germany

ABSTRACT

Thinning is a pre-requisite in the majority of fruit crops worldwide in order to overcome or prevent alternate bearing (change of years with large and low yields) and to provide regular yields of high quality fruit in terms of size, taste, colour and constituents, as required by the market. The widely-used chemical thinning often uses compounds, commonly referred to as hormones, temperature-dependent and critised by the consumer.

Hence, a new device was developed to achieve a wide variety of three-dimensional thinning motions in such biosystems, which consists of three variable horizontal rotors with rotating tines. The objective was to remove individual flowers out of the 5 flowers in a cluster; otherwise the large number of fruitlets within a cluster develops into small, hard, green and unripe fruit. Six- year-old apple cv. 'Pinova' trees on M9 rootstock 3.5 m x 1.5 m spacing near Bonn, Germany were mechanically blossomed-thinned in the periphery.

Overall, the success of the selective thinning depended on the interaction between branch angle and singlet portion. Branches facing (45°) the thinning device were more severely thinned. Selective thinning led to removal of individual flowers out of a flower cluster (rather than removing complete clusters) and increased the portion of the desired singlets from , i.e. flower bunches with one single flower with less fruit to fruit competition for photo-assimilates and subsequently better fruit quality.

Keywords: Alternate bearing, Crop load management, Fruit quality, Precision horticulture, Singlets (Sustainability)

INTRODUCTION

Tree fruit crops develop many more flowers than the trees can support through til harvest; ca. 7% of initial flowers are necessary for a full harvest (Untiedt and Blanke, 2001). Flower removal viz thinning is a pre-requisite in the majority of fruit crops worldwide to provide regular yields of high quality in terms of size, colour and constituents (e.g. sugar for flavour) as required today by the trade and consumer (Costa et al., 2013). The widely-used chemical thinning works randomly viz affects both desired and undesired fruit to a similar extent.

The vast majority of fruit crops worldwide, such as almonds, avocado, apple, Citrus, olive, pistachio, etc suffers from alternate or biennial bearing, i.e. change of years with large and small yields (Krasniqi et al., 2013). The only countermeasure is early removal of flower buds or flowers before flower induction occurs for the subsequent year. In both cases, achievement of marketable fruit quality and overcoming alternate bearing is part of a crop load management strategy (Blanke, 2011), early removal of individual flowers out of a flower cluster is a technological engineering challenge for precision agriculture.

In the early stages of flower and fruitlet development, flower stalks (or fruitlet peduncles) are upright, but start to bend down after the fruit weight becomes too heavy for upright support. The engineering challenge was to construct a device, which selectively removes individual flowers (stalks) in a flower cluster at this early stage, using a vertical impact.

The overall objective was to develop a device, which allows selective thinning of flowers in two dimensions, height and depth of a fruit tree, which can be adjusted to the tree form.

MATERIALS and METHODS

A device was developed (Figure 1) for precise mechanical thinning of fruit trees, particularly those trained to slender spindles. It consists of a vertical mast, mounted on the tractor's three-point front hitch with three horizontal rotors, which can be hydraulically adjusted (Figure 2). The rotating tines of the rotors remove flowers as depended on rotor and tractor speed. The objective was to remove individual flowers out of the 5 flowers in a cluster; otherwise the large number of fruitlets within a cluster develops into small, hard, green and slowly maturing fruit. Ten-year-old apple cv. 'Braeburn' and four-year-old 'Pinova' trees on M9 rootstock 3.5 m x 1.0 m spacing) near Bonn, Germany were mechanically blossomed-thinned at the balloon stage (BBCH 63).

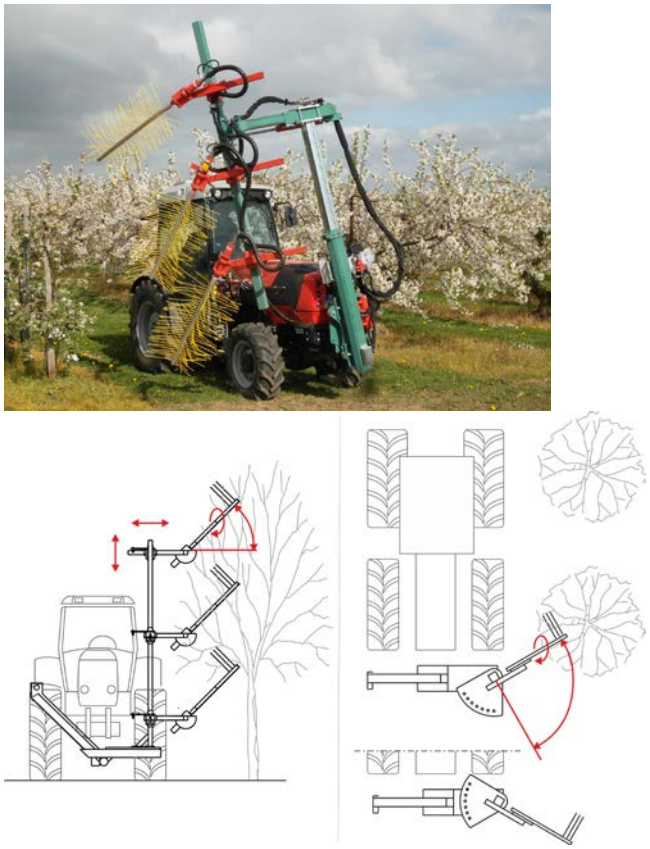

Fig 1a-b: Tractor-mounted precision thinning device for fruit tree crops (left) in a cv. 'Braeburn' orchard on M9 in April 2014, showing the three horizontal rotors with the respective tines, all of which can be adjusted in three dimensions (right)

RESULTS

Figure 2: Selective thinning of three individual flower stalks, leaving two pink flowers in this case

The proposed thinning device removed flowers selectively. This removal of individual flowers out of the flower cluster was by vertical impact of the rotating tines (Figure 1b); removed flowers are marked in figure 2.

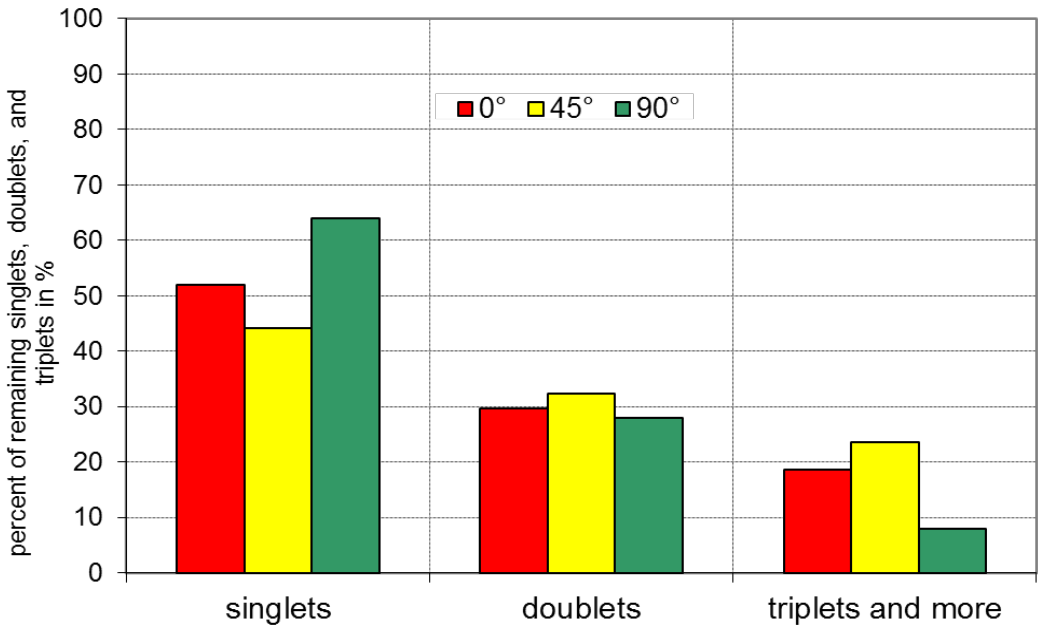

Figure 3: Portion of the type of remaining flower cluster after selective mechanical thinning using the novel device shown in figure 1 in cv. 'Pinova' on M9 rootstock in Bonn, Germany.

Red, yellow and blue represent branch angles of 0° (parallel to..) , 45° and 90° (perpendicular to the tree row)

The portion of remaining flower clusters after selective mechanical thinning using the novel device is shown in figure 3. The objective of the thinning, increase in singlets viz fruits of improved fruit quality, viz fruit size, colour and taste (sugar content) (Costa et al., 2013), was successfully achieved. The most efficient increase in the portion of singlets was in fruits on 90° branches i.e. perpendicular to the tree row, with the largest geometrical impact, and shows optimum adjustment of the thinning device to the tree training.

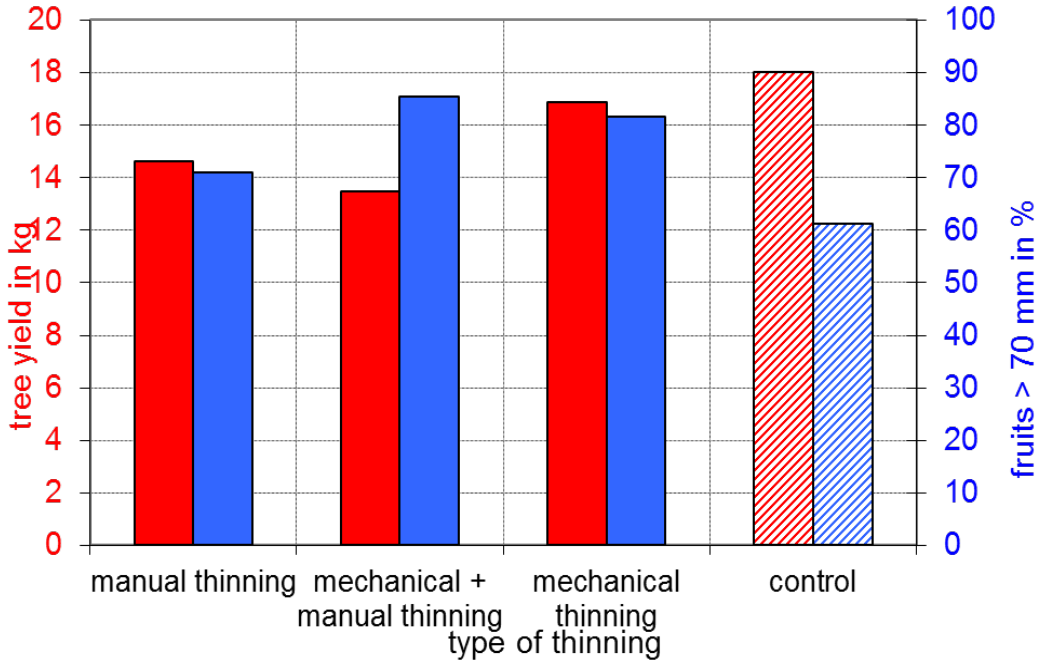

Figure 4: Selective mechanical thinning in cv. Braeburn‘ on M9 in Bonn, Germany.
Selective mechanical thinning increased fruit size, as the major sales determinant, from 60% in the un-thinned control to 80% fruits larger 70 mm, which constitutes a major economic benefit. Any combinations of the mechanical thinning at flowering and subsequent manual thinning after June drop only marginally increased fruit size, was associated with the cost of labor (Figure 4). This crop relation management was associated with only a concomitant slight reduction in yield (Figure 4) and b) overcoming alternate bearing (not shown); the better fruit quality (size and colouration) as market determinants outweighs the minor reduction in tree yield.

Conclusions

The constructed device offers a wide range of adjustments to most tree shapes. Overall, the improved the quality of apple fruit in terms of fruit size and fruit colouration, which constituted a packout of class I from 70% to 86%. While apple served as a model crop here in this original study, the results can be transferred to the majority of tree fruit crops such as pears, plum, apricots and both cultivation systems, IP (integrated fruit production) and bio-organic.

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