Comparison of the apple variety Topaz cultivated on rootstocks M25 and M9

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Abstract

This study compares the cultivation of the apple variety Topaz grafted on rootstocks M25 and M9 in organic production. In the evaluated seven-year period, vegetative (stem circumference, annual growth of shoot length) and generative (yield amount, fruit quality) parameter as well as time demand (yield, mechanical soil treatment of tree strips) have been recorded and analyzed. Topaz×M9 trees attained first full crop in 2014 (3 years after planting), whereas the yield per hectare developed more slowly with Topaz×M25 trees. In 2016, hectare yield of M25 trees finally approached those of M9 (29,6 t/ha, -7% compared to M9). Moreover, M9 trees revealed bigger fruits with a higher intensity of covering colour. In contrast to that, tree maintenance was 27 man-hours less for M25 trees in 2017. The rootstock M9 proofed its potential in the fast development of yield numbers and good fruit quality. With abandoning mechanical tree strip treatment in 2017 and an approach of yield in 2016, the qualities of Topaz×M25 became apparent in the long-term. Since M25 trees have not yet reached their full bearing potential, a concluding evaluation is still to come.

Keywords: Rootstock, M9, M25, Topaz

Introduction

The reduction in the intensity of farming practices is a major influencing factor to the development in organic agriculture. In the effort to a more extensive form of apple production, the selection of most robust cultivar×rootstock combination[2]s (e.g. scab tolerance) is essential. The study compares the cultivation of Topaz apples on the vigorously growing rootstock M25 with M9 as standard dwarfing rootstock in organic agriculture. The experiment aims at producing first class apples by simultaneously reducing the agricultural input regarding mechanical tree strip treatment, working hours for tree maintenance, and investment costs. To analyze the performance of both variants, parameter regarding tree growth, amount and quality of yield, and cultivation practices, have been perennially recorded. Eventually, the purpose of this experiment is to assess a balance between reducing the intensity of farming practices and economic rationality.

Material and Methods

The trial was conducted in an organically managed orchard at the Kompetenzzentrum Obstbau Bodensee (KOB). The soil is a Luvisol, and mean annual temperature accounts to 8,2°C. The annual precipitation is 949 mm/m^2. In spring 2010, 136 Topaz trees grafted on rootstock M25 were planted in 4 adjoining rows at a distance of 5,50m between rows and 3,60m within row spacing. Next to the M25 trees, 234 Topaz trees grafted on M9 rootstocks were planted in 2 adjoining rows at a row distance of 3,50m and 1,0m within row spacing. Taking this plant design and an additional area loss of 10% for sufficient machinability into account, the assumption for this experiment are 455 M25 trees/ha, and 2571 M9 trees/ha. In the following 7 years, parameter regarding growth (stem circumference, shoot length),

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tree physiology (blossom and cropping intensity), yield and fruit quality were recorded on an annual basis. In addition to that, the time required for harvesting and mechanical soil treatment was recorded in 2017. To analyze these parameter, 10 M25 sample trees, and 20 M9 trees, were selected. Both variants have been treated with the same customary plant protection.

Results

<u>Accumulated yield over a 7-year-period</u>

Topaz×M9 trees overgrew the between tree spacing within the first 3 years after planting. In combination with early bearing, M9 trees reached full crop in 2014 (29,1 t/ha, Figure 1(a.)). M25 trees overgrew the spacing between trees in 2016 - 2 years after M9 trees. M9 trees achieved higher yields per hectare compared to Topaz×M25, particularly in the first 5 years after planting. However, the trend from 2012 to 2016 reveals a more and more shrinking yield gap between the two variants (Figure 2). With only 7% less, Topaz×M25 almost equalled the M9 yield in 2016. During the analyzed period of 7 years, per hectare yield of Topaz×M9 adds up to 124,8t compared to 71,9t for Topaz×M25 (57,6% of the M9 yield). However, these numbers include both first class apples and cider apples. As shown in Figure 1 (b.), the share of first class marketable apples was lower for M25 trees (2016: 76,8%, 2017: 70,8%) as compared to M9 apples (2016: 88,5%, 2017: 77,8%). Due to heavy frost damage of the apple blossoms in 2017, the yield generally was massively reduced. Hence, the 2017 data should not be further interpreted.

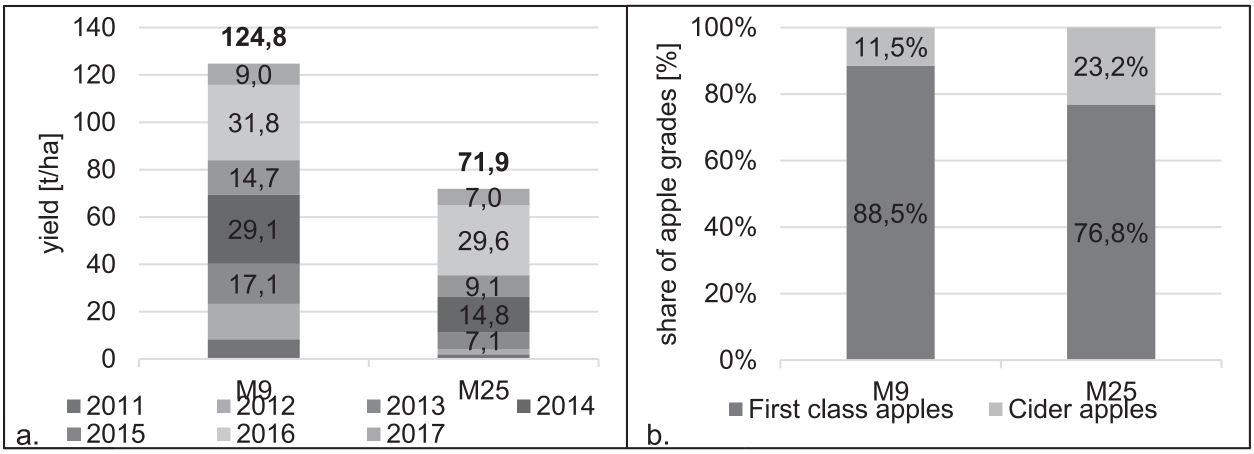

Figure 1: (a.) Summarized yield per hectare from 2011 to 2017, (b.) Share of apple grades in 2016

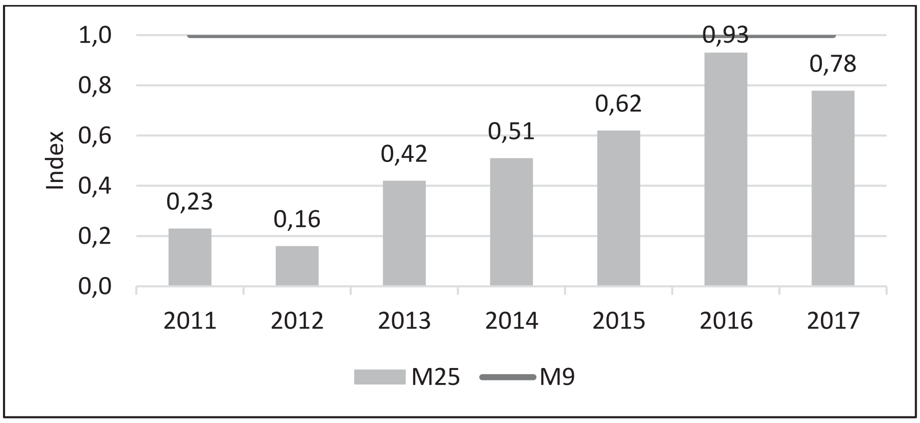

Figure 2: Comparison of Topaz×M25 yield per hectare with Topaz×M9 as reference

Fruit quality

A perennial rootstock effect was observed to the average fruit dimension (Figure 3 (a.)). Thereby M9 apples were on a perennially stable level bigger than M25 apples. Furthermore, a perennial effect was recorded to the covering colour of fruits – particularly for the 2nd passage of picking. For further coloration analysis, fruits of M25 trees were grouped in upper and lower part fruits, according to their position at the tree. Figure 3(b.) shows the evaluation of fruit covering colour from 2nd passage of picking in 2016, which is representative over the course of the experiment. Fruits positioned at the upper tree part of M25 reveal a similar intensity of covering colour as M9 fruits (60-100% covering colour: 47 % M25 upper part fruits, and 41% M9 fruits). In contrast to that, M25 fruits positioned at the lower tree part showed less intensity of covering coloration (32% of fruits show a colour intensity of 60-100%).

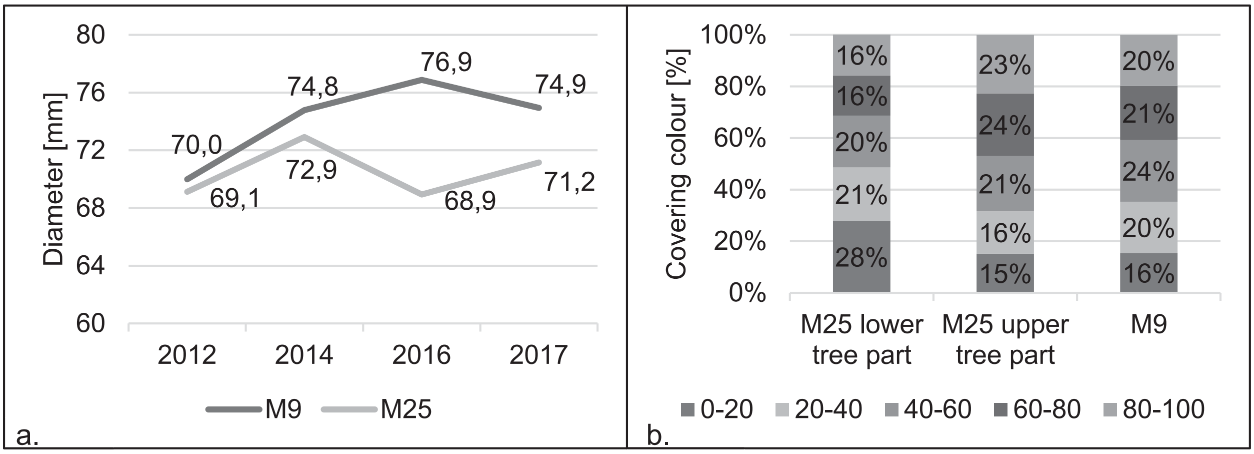

Figure 3: (a.) Average fruit diameter, (b.) Covering colour of apples from the 2nd passage of picking in 2016

Cultivation practices

To maintain weed-free tree strips, strips of Topaz×M9 trees were mechanically treated for six times in 2017. Apart from mowing, soil treatment in M25 strips was abandoned in 2017, due to the full tree development of M25 trees. This resulted in a reduction of 12 man-hours/ha (Kuratorium für Technik und Bauwesen in der Landwirtschaft 2005). Furthermore, the time demand for harvesting Topaz×M25 apples was 15,1 man-hours/ha less compared to Topaz×M9.

Summing up, the maintenance of M25 trees required 27,1 man-hours/ha less in 2017.

Discussion

In the first 3 years after planting, trees grafted on M9 overgrew the between tree spacing and reached full crop, whereas M25 filled the space between trees firstly in 2016 - two years later. Due to the dimension of a fully developed M25 tree, the between tree spacing was 2,60m bigger for M25 trees, which caused a longer period for M25 trees to overgrow this space. This is supposedly the main reason for the slow increase of yield per area for M25 trees compared to M9 trees in the first few years after planting. In 2016, M25 closed the annual yield gap for the first time and there is reason to assume that Topaz×M25 trees have a growing yield potential. Acting on the assumption of only 500 trees/ha, Mayr (2008) reported stable yields of 52 t/ha for Topaz×M25. Moreover, Mayr (2008) particularly stresses that Topaz×M25 does not incline to biennial bearing. In addition to that, an orchard planted with M25 trees can have a rotation length from 35 to 40 years compared to 15 to 20 years for M9 trees (Mayr 2018). Thus, there is some additional economic potential towards the end of a M25 rotation length.

Since this experiment aims primarily towards the production of first class apples, the same customary plant protection program was applied in both variants. Despite that, M25 trees suffered higher losses of first quality apples (averagely 9,4% higher losses than M9). This is mainly attributable to darker lighting conditions in the lower tree part of compact Topaz×M25 trees, which results in fruits that lack the marketability as first class apples due to a lower intensity of covering colour.

In this experiment, both variants were planted on an open field without the protection of hail net. In Lake Constance Region, fruit production protected from hail with nets is very common. In contrast to M9 however, an installation of net constructions to protect fruits from hail is not possible for trees grafted on M25 due to the fully developed tree dimension.

In addition to the parameter analyzed in the course of this experiment, there are still questions that are not (yet) addressed:

1. Are there temporal differences in fruit maturation both at the tree and during cold storage?
2. Are there differences in the occurrence of storage rots?
3. How do both variants perform in a perennially economic comparison?
4. Does a different microhabitat (e.g. mechanically treated tree strips vs. vegetated strips) affect the abundance of beneficial and/or pest organisms?
5. Are M25 trees, due to their tree architecture, more susceptible to the increasingly abundant Marssonina leafspot disease caused by *Diplocarpon mali* Y. Harada & Sawamura?

Despite the need for further research, this study provides data about the first 7-year period of Topaz×M9 and Topaz×M25 comparison. It revealed that Topaz×M9 achieved both higher yields at an early stage and a higher pack out of first class apples. However, investment costs for one hectare of Topaz×M25 trees are approximately 80% less compared toTopaz×M9 trees. In addition to that, with abandoning mechanical soil treatment, a reduction of working hours, growing yields, and a longer rotation length, Topaz×M25 will potentially state an attractive alternative in the ongoing experiment.

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