

Advantages of the rootstock CG 11 for the cultivar 'Natyra'® at the LVWO Weinsberg (site with moderate rainfall)

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Abstract

In March 2015 a small trial with the cultivar 'Natyra'® in four combinations of rootstocks has been planted in the organically cultivated part at the fruit research station of the LVWO Weinsberg. 'Natyra'® had been grafted either directly on rootstock M9 or with interstem 'Santana' on M9 or on rootstock CG 11 (from two nurseries: Netherlands and Italy). Data were evaluated about growth of the stem, flower setting, fruit-setting, yield and sorting of colour and size, the results from 2016-2021 will be described. Scab was found only at a few fruits in this period, here the robustness was very high, no influence of the rootstock was visible. Except for the years with stronger frost one or two times a light thinning by hand was done.

In the first years the combination M9 with the interstem 'Santana' seemed to be interesting because of its more balanced habitus, but the apples remained smaller. Over six years the rootstock CG 11 showed large advantages regarding the yield and size, the differences at the colour of the fruits were not so big, because the colouring of 'Natyra'® is naturally quite good. In 2015 and 2018 there have been long weather periods with extreme hot and dry conditions, which influenced the size of 'Natyra'®, which ripened normally at the beginning of October at this research site.

Keywords: Organic apple growing, variety 'Natyra'®, yield, rootstock CG 11, climate change

Introduction

Since about 20 years in Europe several trials about Geneva-rootstocks for apple-growing have been carried out at different research institutes for fruit-growing. Some results have been presented at Ecofruit-Conferences in the past (Ruess, 2006, Pfeiffer, 2016, Pfeiffer, 2020).

The cultivar SQ 159 'Natyra'® is meanwhile a very important part of the cultivar diversity in organic apple-farms due to its excellent taste and fruit-qualities. But the growing of this cultivar needs some sure instinct to get balanced trees with an adequate relation between leaves and fruits (Brugger et al., 2013, Egger et al., 2013, Rühmer, 2013, Baab et al., 2016). Based on good results with rootstock CG 11 in the combination with cultivar 'GoldRush' the question appeared, if this rootstock could be suitable for the cultivar 'Natyra'®, too, which grows dependent from the site not too strong and which needs a minimum fruit-size of 65 mm for a good fruit-quality and flavour. This publication shows the most important results of six vegetation periods.

Material and Methods

In March 2015 this small trial has been planted in the organically grown part of the Obstversuchsgut Heuchlingen of the LVWO Weinsberg, distance between the rows 3.5 m, within the row 1.2 m, moderate drip irrigation was done. The following combinations were proofed, each with four replications to balance differences in the soil:

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Table 1: List of rootstocks, number of trees per combination, origin

variant	Rootstock	interstem	Number of trees	origin
1	M9	-	7 x 4	NL
2	M9	Santana	7 x 4	NL
3	CG 11	-	7 x 4	NL
4	CG 11	-	7 x 4	IT

The trees of the variants 1 and 3 were at the start of the trial relatively vigorous with a few, but steep branches, forming of the basic structure of the trees was important in general. On the other side the trees of the variants 2 and 4 were more easy to handle. In the first vegetation period the most flower-clusters were removed to enable a good rooting in the ground. 2015 was a year with about 300 mm less rainfall than the long-term-average (see overview about weather conditions in Pfeiffer 2020). Up to now single trees got lost because of damages due to mechanical weed-control or to root-voles.

The following evaluations were done every year from 2016 to 2021 **per tree**: During each winter the diameter of the trunk has been measured. Intensity of flowering was estimated at phenological stage full blossom (1-9, 1 = no flowers at all, 9 = white blossom), close to harvest bearing index (1-9, 1 = no fruits at all), yield (kg/tree) at harvest. In single years the crown volume was calculated as a pyramid based on the measurement of length, width and height of the trees (at end of vegetation period before winter-pruning).

The sorting of the apples with regard to classes of size (5 mm steps) and to colouring (20 %-steps) was done for the yield of each replication with an AWETA-sorting machine. Altogether from combination of colour and size 40 classes of quality were sorted, so that either only the colour or only the size could be estimated or either three groups of quality could be cumulated as clue for marketing value: “bad, only for juice” (< 65 mm / < 20 % colour), middle (> 65 mm / 20-60 % red colour) or excellent (> 65 mm / 60-100 % red colour).

Results

Except for the years 2016 and 2021 the weather during the period of evaluations was characterised by less rain in spring and summer. Nights with light frost during blossom were frequent, the strongest frost incidents happened in 2017 (-3,5 °C) and 2021 (-3,3 °C) and influenced lightly the cumulated yield in this trial, because the cultivar ‘Natyra’® is flowering middle-late (in comparison to ‘Topaz’). 2021 during a thunderstorm on 10th of June hail damaged the fruits considerably, partly they had to be removed before harvest to avoid rot.

Figure 1 shows the development of the flowering and bearing intensity during the period 2016 to 2021. Each year is shown with two columns, the left one is the flower setting, the right one the bearing intensity. Generally the year 2016 started with a moderate flower-setting, a little bit higher for the rootstocks M9 and M9 with interstem ‘Santana’, while both variants with CG 11 had a weaker setting at the beginning of the trial, partly due to the more steep and vigorous branches.

In spring 2017 the flowering intensity was quite good with an average between 5.4 (CG 11 It.) and 6.5 (M9 + interstem Santana). The yellow arrow emphasises the effect of the severe

late frost at beginning of May 2017, which caused a strong reduction of the yield (average for the bearing only between 2.7 and 3.6).

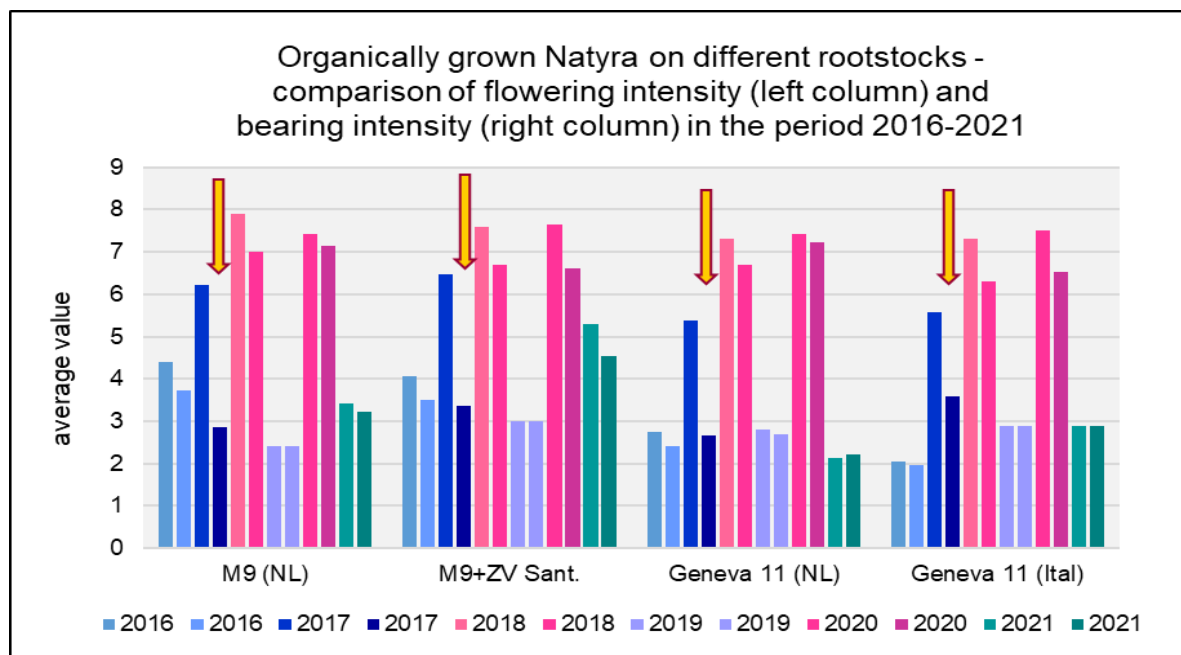


Figure 1: Development of average flowering and bearing intensity of cultivar ‘Natyra’® on different rootstocks in the period 2016-2021, value 1 = no flowers/fruits, 9 = very high setting.

This could be compared to an extreme thinning, so the flowering intensity in spring 2018 was very high with very small differences between the rootstocks. Caused by the late frost in 2017 an alternating bearing could be watched up to the harvest 2021, which was influenced by a frost event again. Even if the differences between the rootstocks seemed to be not too large, the yield/year, the average fruit weight and the results of the sorting should be estimated in the cumulated values (see table 2, no letters = no significant differences).

Table 2: Average fruit weight (g) and unsorted yield (kg/tree) 2016-2021(ANOVA, tukey-test, $\alpha=0.05$)

year	average fruit weight g				yield kg/tree			
	M9	M9+Inter-stem Santana	CG 11 (NL)	CG 11 (IT)	M9	M9+Inter-stem Santana	CG 11 (NL)	CG 11 (IT)
2016	179	177	172	158	1.60	1.20	0.82	0.55
2017	183	173	178	174	1.34	2.11	1.90	2.77
2018	116 ab	108 a	135 c	127 bc	8.28 ab	5.70 a	10.13 b	8.54 ab
2019	184 b	152 a	181 ab	162 ab	1.24	1.82	1.67	2.32
2020	122 ab	103 a	134 b	126 b	12.82 ab	8.91 a	16.53 b	13.96 b
2021	126	105	127	129	2.80	4.21	1.33	3.16
Sum					28.08 ab	23.95 a	32.38 b	31.30 ab

In the years 2016 and 2017 the total yield was low (beginning bearing and heavy frost), so the average fruit weight was high. 2018 was one of the years with higher yield, here both variants with rootstock CG 11 had clear advantages (10-20 g higher fruit weight, significant differences could be shown). The site of the trial lays on the knoll of the experimental

orchard, so some differences between the replications had been visible, partly this influenced the variation. Deduced from the data of sorting the cultivar 'Natyra'® the single fruit needs minimum 125 g to obtain a diameter of 65 mm.

During the period of increasing yield the combination with interstem 'Santana' was estimated as interesting because of the pleasant habitus, not too steep branches, easier to handle. But the extreme hot temperatures and lack of rainfall in summer 2018, which could not be supplemented at all by drip irrigation, showed, that this combination had smaller apples, even in the later years.

Another reason could be, that the late frost in May 2017 caused damages at the bark of the interstem. Here especially thinning by hand should be done carefully regarding the relation between leaves and fruits.

The most favourable size-grading had both variants with rootstock CG 11, see figure 2, they had the most apples in the range 65-80 mm. At the trees with origin in the Netherlands in the first years some more green apple aphids have been watched, which caused little deformations at the fruits.

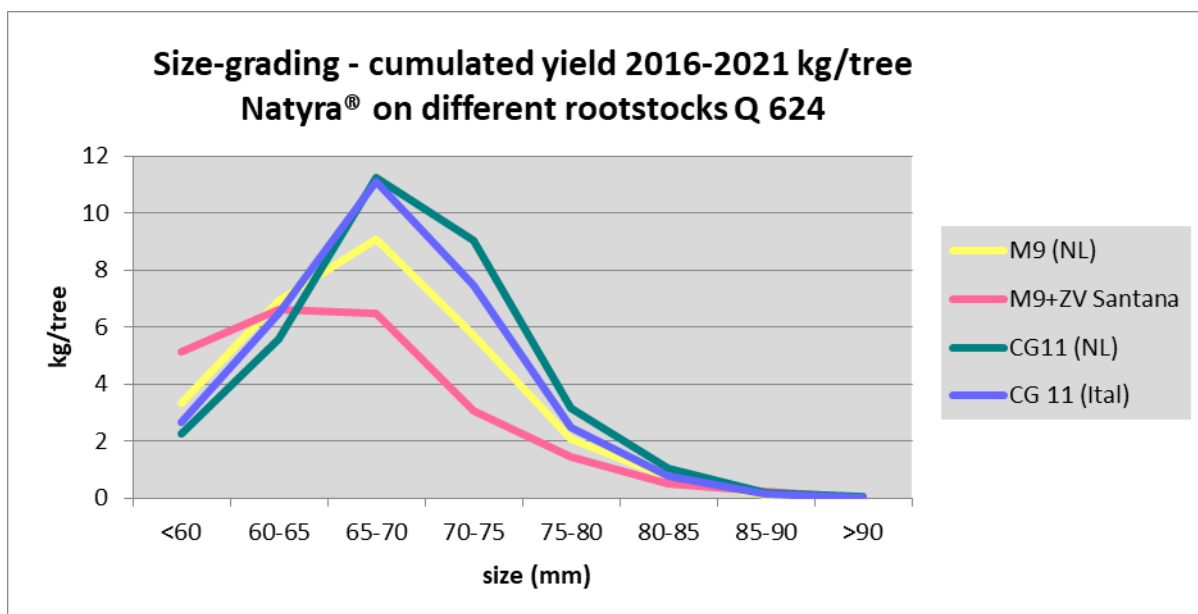


Figure 2: Size grading of organically grown 'Natyra'® on different rootstocks (M9, M9+interstem 'Santana', 2 x CG 11), cumulated yield (kg/tree) 2016-2021

Data from the sorting show, that normally the apples had a good colour, but it can happen, that fruits stay too small (green parts of the columns in figure 3). Here again both combinations with rootstock CG 11 had advantages. One reason can be, that the 'Natyra'®-apple grows not really well, if the number of seeds is too less. Reflecting the results in detail from the single years the higher part of too small fruits mainly was found in the years 2018 and 2019 with more yield or dry and hot conditions during summer.

A rough calculation (based on kg apples < 60 mm and average fruit weight) had the result, that between 25-35 h per ha depending on the rootstock would have been necessary to adjust the yield better in such very hot summers. But the risk is high to cause sunburst, when parts of the fruits turn into the sun because of thinning the other fruit of the cluster. Another

risk is, that the change from a hot and dry macro weather situation to lower temperatures is very often induced by a depression front with heavy thunderstorms, partly with hail. So it makes sense to keep a small reserve of fruits for a late thinning.

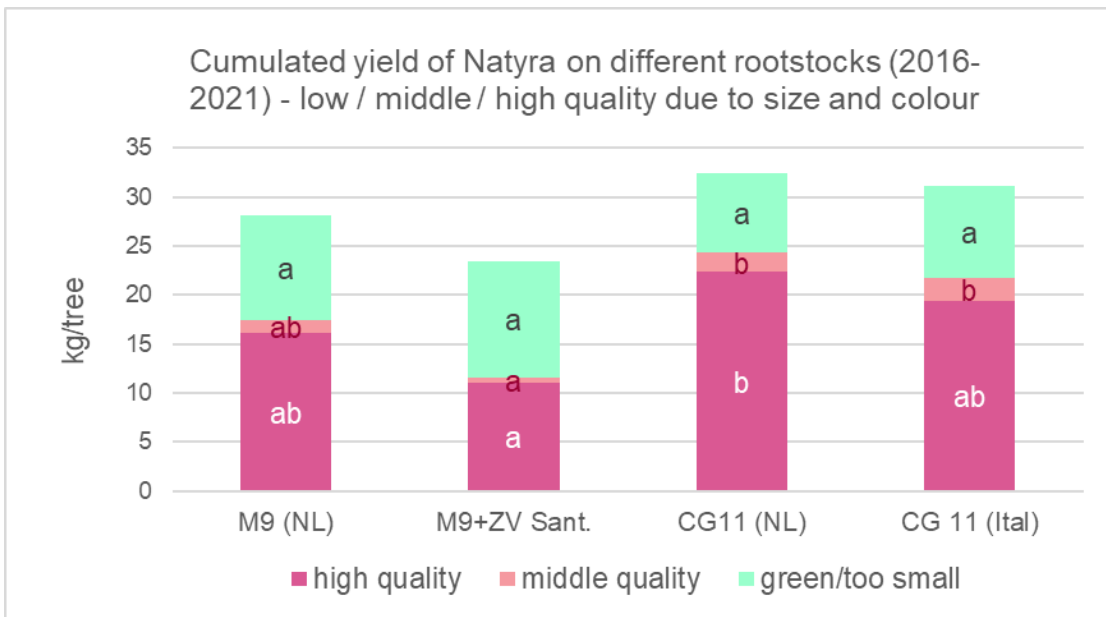


Figure 3: Results of combined evaluation (size and colour sorting) of organically grown 'Natyra'® on rootstocks M9, M9+interstem 'Santana', CG 11 (NL), CG 11 (IT), cumulated yield 2016-2021 (kg/tree).

In figure 4 the crown volume after the vegetation-period 2021 can be compared for each combination and within the four replications to make visible the differences between the replications (the third replication was nearly at all combinations a bit weaker).

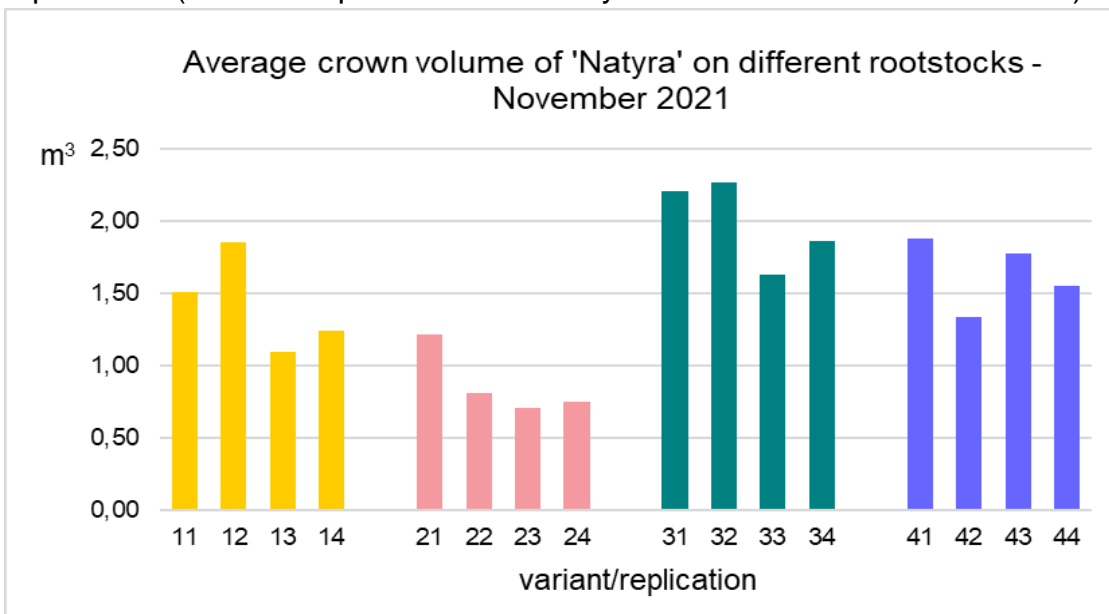


Figure 4: Average crown volume (m³) of organically grown 'Natyra'® on rootstocks M9 (yellow), M9+interstem 'Santana' (red), CG 11 (NL, green), CG 11 (IT, blue). Measurement at end of November 2021.

Nevertheless the strongest growing can be recognised at rootstock CG 11 (NL), these trees could require a slightly larger distance between the single trees in the row. At the other variant with CG 11 (blue columns) the growth and especially the relation between leaves and fruits was quite good. In 2020 the specific yield was high (between 12,5 and 15,0 kg/m³ crown volume), the variation between the replications was too high to find a significant difference. One year later it was very low (between 0,9 and 5,1 kg/m³), here the combination M9+interstem Santana had a significant higher specific yield, but this was combined with too small fruits.

Discussion

Organic fruit-growers in the regions of Germany with moderate rainfall have to face probably to a lower availability of water for their trees during late spring and summer in the next 10-15 years (Minist. Für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, 2015) combined with higher maximum temperatures. So the evaporation will increase the stress for the plants, too, the year 2015 was an example for the conditions, with which the organic grower could have to arrange in future. Regarding the fact, that the installation of an irrigation pond needs diverse approvals, time, money and enough water, which can be used to fill the pond, the selection of rootstocks is an important factor for the planning of orchards. The rootstock CG 11 is an interesting and available alternative, if the combination with moderately growing cultivars is tested. This trial shows advantages for the combination with cultivar 'Natyra'®.

Further experiments with the rootstock CG 11 in different regions of Europe are mentioned in the discussion and in the references of the article of Pfeiffer (Pfeiffer, 2020). 'Natyra'® needs a good balance between leaves and fruits, here the rootstock CG 11 can support the fruit-grower in years with dry and hot conditions. Altogether the level of yield was not really high, due to damages by late frost events in spring. Adequate prices should be demanded in trade. The tendency of 'Natyra'® to alternate bearing can be enhanced by frost, this has to be regarded. A carefully thinning strategy is necessary to reach good fruit-quality on CG 11, too, the influence of treatments with wetting-sulphure or lime-sulphure on the quality and colour of the leaves has to be respected (Hechinger et al., 2019).

Acknowledgements

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