# Comparison of Rootstocks Geneva 16, M9 and CG11 under organic cultivation at the LVWO Weinsberg – actualized results 2009-2015

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**Abstract**

*A comparison of the cultivar 'GoldRush' grafted on the rootstocks Geneva CG16 (weaker than M9), M9 (as standard) and Geneva CG11 (stronger than M9) was going on in the organically cultivated part Q 624 of the LVWO Weinsberg since February 2008. Data were evaluated about growth of the stem, flower setting, fruit-setting, effort for thinning by hand, yield and sorting of colour and size. Effects on level of infections by apple scab, sooty blotch and on russeting of the fruits were proofed. 2013 was the first year, when differences were seen at russeting, trees on CG16 had about 10 % more apples with middle russeting. Breakdown of scab-resistance has been watched in the organic orchard of the LVWO Weinsberg since 2008, 2013 was a year with an extreme infection level of Venturia inaequalis. Over seven years the rootstock CG11 showed large advantages regarding the yield, size and colour of the fruits, the yield was slightly more balanced due to a better relation between growth and yield. Even in the extremely dry and hot year 2015 these positive effects could be affirmed.*

**Keywords:** Rootstocks Geneva 11 and 16, organic apple growing, yield, scab infections

## Introduction

In 2001 a European exact trial started on several research institutes in middle Europe about the comparison of rootstocks, which should be less susceptible against fire blight, in combination with the variety 'Golden 'Delicious' under conventional conditions (Ruess, 2006). Based on good results for the rootstocks CG 16 and CG11 three new trials were planted at research institute in Weinsberg, two conventional trials with the varieties 'Pinova' and 'Gala'. At the same time a third trial started in the organically grown orchard of Obstversuchsgut Heuchlingen with the variety 'GoldRush', which was chosen as a variety, which is only low susceptible for fire blight and which shows changes in average fruit weight and in alternate bearing depending from adjusted crop load either by thinning strategies or by using adequate rootstocks. The actualized results of this trial over seven years will be presented in this article.

## Material and Methods

The unifactorial trial was planted in February 2008 with distance of 3.5 m x 1.2 m in the organic research plot of Obstversuchsgut Heuchlingen. Because of varying grafting success in the nursery only two replications were planted for three rootstocks: 2 x 12 trees on CG16, 2 x 10 trees on M9 and 2 x 8 trees on CG11 (at time of grafting the availability of the rootstock CG11 was not so good). In the tables and figures the abbreviations P1 and P2 mean parcel 1 and parcel 2. In 2008 flower clusters were removed to encourage the growing in the first year after planting. In nearly all following years no thinning by lime sulphur or rope thinner during blossom was done, only thinning by hand one or two times depending from each crop load, at high crop loading first time at end of May. In 2015 for the first scab treatment, which was necessary during blossom, lime-suphur was used.

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The following evaluations were done every year from 2009 to 2015 **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), bearing index (1-9, 1 = no fruits at all), yield (kg/tree) at harvest. The yield of each parcel of the rootstocks was sorted by a GREEFA-sorting machine. In order to make visible the influence of the rootstock in the data, which was clearly observed at harvest in the orchard, special classes were defined to distinguish the single shades of yellow or green: dark green, green-yellow, light yellow and golden, all with/without red cheek.

Size was divided into 8 classes (< 60 mm, 60-65 mm etc. up to 85-90 mm, > 90 mm). Altogether from combination of colour and size 64 classes of quality were sorted, so that either only the colour or only the size could be estimated or either four groups of quality could be cumulated as clue for marketing value: “bad, only for juice” (dark green or < 65 mm), middle (> 65 mm, green-yellow), good (> 65 mm, light yellow) or excellent (> 65 mm, golden colour). The content of acid, sugar and vitamin C was determined of an average sample per rootstock every year.

2013 was an outstanding year concerning the infection level for *Venturia inaequalis*, differences were seen between the rootstocks about infection on the leaves of the young shoots and later on the fruits at harvest, even if the plant protecting measurements were the same on the whole trial. The methods for the evaluations of scab on the leaves and on the fruits were described in an earlier publication (Pfeiffer, 2014). Scab on the fruits was classified in combination with sooty blotch (using a two-dimensional table form, consisting of 4 classes for scab and 5 classes for sooty blotch). The proportions of first and second picking were respected at the calculation of the percentage of infected apples. Russeting was divided into four classes (B1-B4, B1 = no russeting, B2 = 0-10 %, B3 = 10-30 %, B4 = >30 % russeted skin). A sample of 100 fruits was controlled. In the years 2014 and 2015 further examinations about the occurrence of scab and sooty blotch infections of the fruits followed.

## Results

From all years the most important data about flowering setting and yield were described in table 1. In 2009 the trees started with a uniform level of flowering setting of 5.6 to 7.5 and was adjusted to approximately 30-40 per tree by thinning by hand. Regarding all seven years it was important, that in May 2011 there had been a strong frost after blossom, when the apples had a size of 8-10 mm. In 2012 a light frost during the blossom caused some losses, too, when the flowersetting was below average. ‘GoldRush’ is not as susceptible to frost like ‘Topaz’ or ‘Rubinola’, even if some young seeds are still alive, a fruit can develop, but it will be smaller at harvest.

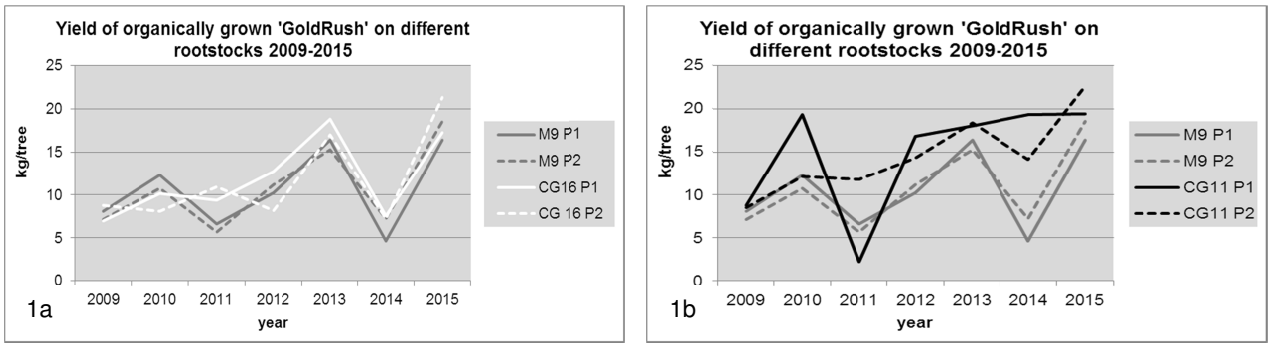


Figure 1: Development of yield kg/tree (total, unsorted) of organically grown ‘GoldRush’ on different rootstocks (1a: M9 and CG 16, 1b: M9 and CG 11), 2009-2015.

In figure 1 the yield per tree over seven years is shown, on the left side M9 in comparison to CG 16 (1a), on the right side M9 and CG 11 (1b). Within the first five years only moderate alternating bearing has been observed, not as heavy as it was seen in the older trial with 'Golden Delicious'. CG 16 showed the same alternating tendencies like M9. On the other side especially in the years 2012 to 2015 the yield on CG 11 was on a higher level and seemed to be more balanced (except for the first 3 years of parcel 1, here the yield in 2010 was too high for the young trees).

Table 1: Flowering intensity (notes 1-9), yield (kg/tree), average fruit weight (g) of organically grown 'GoldRush' on the rootstocks CG16, M9 and CG11 (P1 =parcel 1, P2 = parcel 2) in the years 2009-2015, additional % of fruits with middle + heavy russeting in 2013, 2014 and 2015.

| year | characteristic | G 16 P1 | G 16 P2 | M 9 P1 | M9 P2 | CG11 P1 | CG11 P2 |
|---|---|---|---|---|---|---|---|
| 2009 | flowering intensity | 7.0 | 7.1 | 7.5 | 7.1 | 6.0 | 5.6 |
| | kg/tree | 6.95 | 8.81 | 8.08 | 7.17 | 8.76 | 8.52 |
| | fruit weight (g) | 228 | 221 | 219 | 230 | 260 | 230 |
| 2010 | flowering intensity | 6.4 | 6.6 | 6.7 | 6.8 | 7.1 | 4.4 |
| | kg/tree | 10.20 | 8.10 | 12.34 | 10.73 | 19.33 | 12.15 |
| | fruit weight (g) | 179 | 162 | 170 | 179 | 165 | 186 |
| 2011 | flowering intensity | 5.6 | 6.8 | 5.5 | 5.6 | 3.5 | 6.6 |
| | kg/tree | 9.43 | 10.94 | 6.64 | 5.71 | 2.19 | 11.78 |
| | fruit weight (g) | 128 | 138 | 139 | 141 | 151 | 157 |
| 2012 | flowering intensity | 7.3 | 6.6 | 6.9 | 7.4 | 8.1 | 7.0 |
| | kg/tree | 12.77 | 8.16 | 10.22 | 11.17 | 16.82 | 14.35 |
| | fruit weight (g) | 148 | 150 | 157 | 150 | 146 | 146 |
| 2013 | flowering intensity | 6.9 | 6.8 | 6.5 | 6.6 | 4.8 | 6.0 |
| | kg/tree | 18.81 | 17.02 | 16.42 | 15.29 | 18.06 | 18.40 |
| | fruit weight (g) | 132 | 122 | 120 | 115 | 146 | 116 |
| | russeting % B3+B4 | 19.1 | 14.2 | 4.0 | 3.8 | 4.2 | 3.7 |
| 2014 | flowering intensity | 3.7 | 3.7 | 3.3 | 3.8 | 6.5 | 5.1 |
| | kg/tree | 7.61 | 7.23 | 4.67 | 7.20 | 19.31 | 14.15 |
| | fruit weight (g) | 164 | 151 | 165 | 164 | 158 | 153 |
| | russeting % B3+B4 | 7.9 | 5.2 | 25.0 | 5.1 | 0 | 2.9 |
| 2015 | flowering intensity | 7.0 | 7.7 | 7.0 | 6.7 | 6.5 | 5.8 |
| | kg/tree | 17.28 | 21.31 | 16.35 | 18.58 | 19.45 | 22.57 |
| | fruit weight (g) | 112 | 113 | 106 | 115 | 103 | 119 |
| | russeting % B3+B4 | 7.7 | 8.7 | 3.3 | 2.4 | 5.5 | 5.4 |
| 2009 -2015 | kg/tree total | 83.05 | 81.57 | 74.72 | 75.85 | 103.92 | 101.92 |
| | kg > 65 mm | 62.75 | 59.98 | 54.49 | 55.47 | 82.36 | 77.68 |

From 2008 to 2015 the average of growing of the trunk per year was 3.9 mm for CG16, 2.9 mm for M9 and 3.7 mm for CG 11. Partly in the parcels with rootstock CG16 the trees had more apples in the size 65-70 mm than on M9, but the proportion in size 70-75 mm was higher, too, cumulated over seven years. The trees on rootstock CG 16 had a more compact canopy than M9, but the accumulated total yield from 2009-2015 was higher than M9 (significantly at α=5 %, based on ANOVA oneway, tukey-test), even the proportion > 65 mm (difference not significant). In years with less rain the trees on CG16 grew too weak, the trees on CG11 were adapted better.

In comparison to the preliminary results 2009-2013 (see Pfeiffer, 2014) rootstock CG11 extended its promising position: Adding two years of evaluations CG 11 had a significantly higher total yield and a significantly higher cumulated yield >65 mm than M9 (see table 1, ANOVA oneway, tukey-test, α = 5 %) in the period of 2009 to 2015, in the single years no

significant differences could be seen except for the year 2014. CG11 influenced sorting of size and colour of the apples (figure 2) in a positive way. The higher proportion of golden and yellow apples was a convincing detail, so that the increased percentage of the apples with excellent quality for the market was the most important advantage of this rootstock, it was often combined with an increased content of sugar, too.

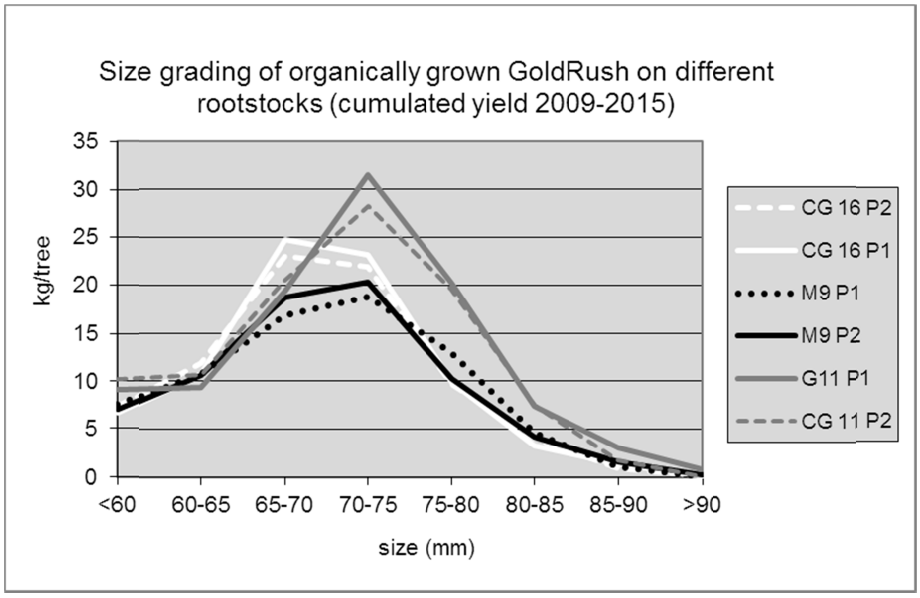


Figure 2: Size grading of organically grown ‘GoldRush’ on rootstocks CG16, M9 and CG11, cumulated yield (kg/tree) 2009-2015

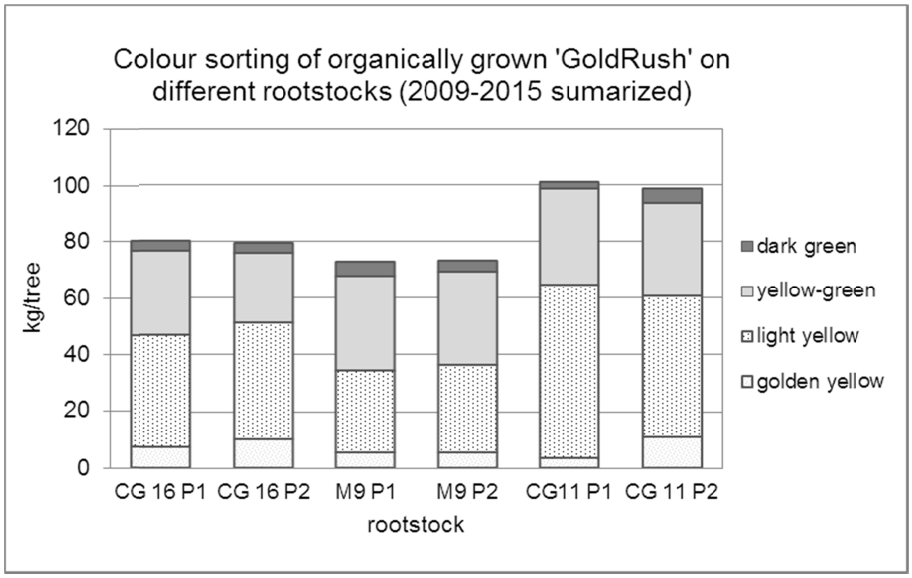


Figure 3: Results of colour sorting (four classes of base colour) of organically grown ‘GoldRush’ on rootstocks CG16, M9 and CG11, cumulated 2009-2015 (kg/tree).

In the years 2009-2012 no differences in scab in infections could be observed in the trial, only single apples had weak symptoms, but in 2013 there were found clear differences at infections on the leaves, because of variation these were only significant at $\alpha$ = 10 % (nonparametric Kruskal-Wallis-test), which can be put down to the stronger growth of the trees on CG11 in the main infection periods this spring (details see Pfeiffer, 2014).

In 2014 the infection level was lower due to stricter plant protection sprayings, here only in the class S2 (small points) some differences were observed. Sooty blotch was a larger problem in 2014, because of the weather conditions in October: Nearly every day small amounts of rain fell combined with high humidity of the air, so that the infection level increased between first and second picking, the proportion of second picking had more influence than the rootstock itself.

In 2015 in spring the ascospore season had lower total potential of ascospore release, followed by a very dry and hot summer, so that despite of the late picking dates the scab level was acceptable, sooty blotch was nearly no problem. Within the complex of assessments of influences of rootstock on the quality there was a light tendency of increased russeting of the apples on rootstock CG 16 (see table 1, grey marked data from 2013-2015), in 2015 russeting occurred like more star-shaped ripped skin round the lenticels. One reason could be the sudden growth of the fruits at the end of the long hot period in summer. In the same year secondary red lenticel spots were very frequent, but they were not evaluated in detail, they were respected in the amount of not marketable fruits.

## Discussion

CG16 seemed to be susceptible for latent viruses in the trials of Guerra (2011). He showed similar trends for CGG 11 and mentioned, that this rootstock is less willing to produce runners in rootstock nurseries. At the moment there are not so much rootstocks of CG 11 available, the propagation fields are increasing step by step. In spite of the results about scab in an extreme scab season 2013, the rootstock CG11 should be tested also in private organic grown orchards, because the previous good results about yield and colour could be affirmed. Especially for cultivars with smaller fruits like ‘Gala’ or weaker growing cultivars and for soils, which offer not so good growing conditions, or for regions with dry weather periods in summer this rootstock should be respected. Combinations with cultivars like ‘Elstar’, ‘Jonagold’ or ‘Santana’ are senseless. Woolly apple aphids (*Eriosoma lanigerum*, Hausm.) were not observed on CG 11 trunks in this organic plot.

Even if the trees grafted on CG11 have to be ordered specifically in the organic nurseries and would be more expensive (approximately 1 € per tree), the system has economic advantages: When a price of 1 € per kg for marketable apples and 16 Cent per kg cider-apples is assumed (based on the data, where the amount of apples, which were sorted out, is respected over seven years), CG 11 had meanwhile about 5200 € higher proceeds than M9 per year and ha. The scab spraying strategies should be adjusted to the growth characteristics of this rootstock.

## Acknowledgements

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## References

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