

Chilling requirement and budburst uniformity of cultivar Maxi Gala grafted on different rootstocks

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Abstract

In marginal regions to grow apples, where winter not accumulate enough chill hours, it is important know how many chill hours have. This data make easy choose a cultivar more exigent or less exigent in chill hours to plant in that region. The inadequate chill hours have a negative effect on the budburst uniformity in plants. It is already known the necessity of chill hours for the principal cultivars grown in southern Brazil, but is not known the exigency of chill hours of the rootstocks and the influence or interaction of rootstock in the commercial cultivar grafted on the top. The aim of this trial was evaluate the chill requirement and budburst uniformity on rootstocks G.213 and M.9, as well the behavior of the scion grafted on the top of them. The experiment was conducted at the Experiment Station of Temperate Clime Fruit of Embrapa Grapes and Wine, at Vacaria-RS, Brazil. Evaluation of four different chill hour levels was realized: 400, 600, 800 and 1000 hours under 7 °C. The plants were storage in a cold room with temperatures between 2 and 4 °C until met the number of hours stipulated in each treatment, after moved to a controlled environment, with temperature between 20 and 22 °C, 12 hours of photoperiod and relative humidity 70 %, were evaluated the number of budburst buds weekly, staying there until met constant budburst. On field was evaluated the budburst uniformity of MaxiGala apple trees with five years old grafted on G.213, M.9 and Marubakaido with two interstem length 20 cm and 30 cm. The rootstock G.213 induce more bud break on cultivar grafted Maxi Gala when compared with M.9. The chilling requirement for Maxi Gala grafted on rootstocks G.213 and M.9 is around 800 hours below 7 °C. The G.213 rootstock gives to cv. Maxi Gala more budburst than M.9 using more than 800 hours of chilling. The G.213 rootstock gives best budburst uniformity to cv. Maxi Gala than M.9 and Marubakaido with 20 and 30 cm of M.9 interstock. By the results of this work was possible observe that cultivar Maxi Gala grafted on different rootstocks a an rootstocks plants follow a budburst trend, and showing the rootstock influence on grafted cultivar.

Keyword: *Malus domestica* B, chill hours, G series, Marubakaido, interstock.

INTRODUCTION

In Southern Brazil the climatic conditions show a huge variability on hibernal chill distribution, that are essential to insure good commercial pomiculture performance (Cruz et al., 2009). The temperature is considered the most relevant environmental factor acting in the processes of induction and overcoming dormancy in temperate fruit trees (Pérez and Lira, 2005).

Apple trees needs periods with low temperatures (4° a 10°C) during the autumn and winter, in another way the plant will keep in dormancy or will show a long and irregular bloom and budburst (Putti et al., 2003).

Historical data series between 1983 to 2009, shows that the period between May and August, the chill hours average at Vacaria-RS-Brazil was 657 hours (Cardoso et al., 2012). By

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the restriction of hibernal chill, problems associated with buds metabolism are frequently manifested in regions where the chill requirement is inadequate supplied (Jackson, 2003).

The chill requirement is a limitant factor for the commercial production of temperate fruit production in bland winter region (Chariani and Stelbius, 1994). When the hibernal chill requirement is not supplied a not uniformly budburst occurs (Leite et al., 2006), affecting negatively the yield and fruit quality (Botelho et al., 2006). The knowledge of the chill requirement of specie and cultivar is fundamental to obtain success in production (Putti et al., 2003). In addition, scientific data as well as practical experience indicate that the rootstock influences the dormancy of the top. There are rootstocks that start to grow before others, and rootstocks that stimulate early bud break to the grafted scion (Erez, 2000).

In Brazil all know the chill requirement of the principal cultivars commonly used, Gala and Fuji and their clones, whereever is not know the chill hours requirement of rootstocks and the influence of rootstock on the grafted cultivar.

By the presupposed theme the aim of this work was evaluate the chill requirement of different rootstocks and their influence on Maxi Gala cultivar budburst.

MATERIALS AND METHODS

The trials of chill requirement were developed during the years 2014, 2015 and 2016 at experiment station of temperate clime fruticulture of EMBRAPA grapes and Wine, at Vacaria-RS, Brazil. Were testified four accumulation levels of chill, 400, 600, 800 and 1000 hours under 7 °C. The trees was planted in black plastic pots with 20 liters, using an soil mixed with an adequate substrate. After planted trees was moved for a cold chamber with temperatures between 2 and 4 °C until met the chill hour pre-defined. Later, after met the number of hours, were transferred for a controlled environment (Fitotron chamber) with temperatures between 20 and 22 °C, 12 hours photoperiod and 70 % of relative humidity, and stayed there until met constant number of sprouted buds, and evaluated weekly the number of sprouted buds.

Experiment 1: On years 2014 and 2015 was evaluated the chill requirement by the budburst of 'Maxi Gala' plants grafted on rootstocks G.213 and M.9. Was used a completely randomized design with five replications, each grafted plant was an experimental unit. The number of sprouted buds was evaluated by factorial 4 x 2, four cold levels and two rootstocks.

Experiment 2: On spring was evaluated the sprouted buds number in the central leader apex in apple pants cultivar Maxi Gala grafted on rootstocks G.213, Marubakaido with interstock 20 cm length and 30 cm length and M.9. The orchard was planted on 2011 in a virgin area and plants were in the fourth leaf at the time of evaluation. The plants were pruned on tall spindle rules, planted 4 m by 1 m, 2,500 plants per hectare. The experimental design was randomized blocks, with four treatments, five replications and ten plants per plot, being evaluated the five plants.

Experiment 3: In year of 2016 was evaluated the chill requirement by the budburst of rootstock plants G.213, G.874, G.202 and M.9 and also on plants of cultivar Maxi Gala grafted on the same rootstocks. Was used a completely randomized design with five replications, each plant was an experimental unit. The percentage of sprouted buds was evaluated by factorial 4 x 4, four cold levels and four rootstocks.

The experimental data were analyzed by analysis of variance (ANOVA) followed by multiple comparison of means using the Tukey test at 5 % probability of error by the statistical program Sisvar (Ferreira, 2011).

RESULTS AND DISCUSSION

Experiment 1: Is possible observe that cv. Maxi Gala budburst increase by increase of chill hours for both rootstocks evaluated. When is compared plants budburst between rootstocks is possible observe that G.213 provide bigger budburst to the grafted cultivar compared with M.9 for accumulated chill over than 800 hours (Table 1).

Apple trees of Gala group needs approximately 700 chill hours under 7,2°C (Petri et al 2006), when is not supplied this condition is necessary artificial budbreak. The results of this trial corroborate with Petri et al 2006, because is possible observe bigger budburst over 600 chill hours. It is possible observe a bigger budburst of G.213 in relation of M.9, because in a propitious conditions of chill accumulation, over than 800 hours, G.213 have the capacity to proportionate bigger budburst to cultivar Maxi Gala.

Table 1. Number of budbreak on cv. Maxi Gala grafted in G.213 and M.9 rootstocks and submitted to different chilling hours below 7 °C.

Rootstock	Hours of cold 2014			
	400	600	800	1000
G.213	11.0 b A	17.2 b A	28.5 a A	39.7 a A
M.9	13.5 b A	19.7 ab A	22.5 ab A	28.2 a B
C.V (%)	12,2			
Rootstock	Hours of cold 2015			
	400	600	800	1000
G.213	21.6 b A	24.0 b A	40.0 a A	40.4 a A
M.9	16.4 c A	20.2 bc A	27.6 ab B	32.8 a B
C.V (%)	9.7			

*Means followed by the same uppercase letter in the column and by the same lowercase letter in the line do not differ significantly (P > 0.05) by the Tukey test.

Experiment 2: This experiment was conducted under field conditions and between evaluated rootstocks, which resulted in lower bud break bud in the apical part of the plant was the M.9. The Marubakaido with interstock provided better sprouting than M.9, but lower than the G.213. For Marubakaido rootstock, there was no difference in terms of sprouting buds between use interstock of 20 and 30 cm of length (Table 2). This result confirms the technician and growers information, which has been observing the G.213 gives the cv. Maxi Gala greater uniformity of budding and flowering plants in the canopy compared to other rootstocks.

Table 2. Relation between sprouted buds and the total buds number in the apical part of Maxi Gala plants, Spring, 2014.

Rootstock	Bud break on the top (%)
G.213	69.8 a
Marubakaido/M.9 - 20 cm	44.4 b
Marubakaido/M.9 - 30 cm	49.5 b
M.9	23.5 c
C.V (%)	13.2

*Means followed by the same letter in the column do not differ significantly (P > 0.05) by the Tukey test.

Experiment 3: The budburst of cv. Maxi Gala increased with the accumulation of chilling hours, regardless of the rootstock used, with 1000 hours it had the highest budburst. The G.213 rootstocks statistically always have the biggest budburst, by statistical level, always associated with another rootstock. In a situation of lower chill accumulation, 400 chill hours, budburst of G.213 and G.202 was higher than G.814 and M.9 with 600 and 1000 hours of accumulated chill, rootstocks G.213 and G.814 were higher than G.202 and M.9. Rootstocks

M.9 and G.202 gave to the cultivar statistically similar budburst with 800 or 1000 hours of accumulated chill, and have an increment 800 to 1000 hours of chill. With 800 hours of chill all rootstocks of 'G series' were higher than M.9 (Table 3).

Table 3. Percentage of bud sprouted in relation of the total reproductive structures (shoots and spurs) on cultivar Maxi Gala grafted on different rootstocks under different chill hours. Vacaria, 2016.

Rootstock	Hours of cold 2016			
	400	600	800	1000
G.213	40.1 c A	63.4 b A	71.9 b A	94.4 a A
G.814	31.8 c B	73.0 b A	75.2 b A	95.1 a A
G.202	42.6 c A	52.6 b B	71.1 a A	72.8 a B
M.9	30.0 c B	53.5 b B	56.8 ab B	66.5 a B
C.V (%)	3.6			

*Means followed by the same uppercase letter in the column and by the same lowercase letter in the line do not differ significantly ($P > 0.05$) by the Tukey test.

When used just rootstock plants, without graft, is observed a bigger percentage of sprouted buds as bigger is the number of chill hours accumulated. However, over than 800 hours does not verified any difference to all rootstocks. The rootstock G.202 does not show any difference over 600 hours and M.9 does not show difference over 400 hours of accumulated chill (Table 4). When compared rootstocks between them, are possible observe that over 800 hours, the rootstocks G.213, G.874 and G.202 sprout more than M.9 (Table 4).

Table 4. Percentage of sprouted buds in relation to the total buds on different rootstocks submitted to different quantity of chill hours. Vacaria 2016.

Rootstock	Hours of cold 2016			
	400	600	800	1000
G.213	16.1 b A	18.2 b B	25.4 ab A	35.3 a A
G.814	10.3 b AB	12.7 b B	26.1 a A	26.7 a A
G.202	7.1 b B	28.1 a A	29.1 a A	29.2 a A
M.9	13.4 a AB	14.4 a B	15.2 a B	15.7 a B
C.V (%)	12.4			

*Means followed by the same uppercase letter in the column and by the same lowercase letter in the line do not differ significantly ($P > 0.05$) by the Tukey test.

The minimum number of chill hours (500) adopted in the agro climatic zone determination of apple production in the studied region, at Rio Grande do Sul State, Brazil, was met in 80 % of the years monitored, since 1983 to 2009 (Cardoso et al., 2012). It is necessary use rootstocks that proportionate to the canopy cultivar better budburst in warm climate conditions. From the results founded in this work is possible observe that rootstock from the 'G series' proportionate bigger budburst when compared with M.9 rootstock. This trend is observed with the results of Table 3 and Table 4, where basically follow the same budburst trend, showing the influence of rootstock on the grafted canopy.

CONCLUSION

The rootstock G.213 induce bigger budburst on cultivar grafted Maxi Gala if compared with M.9.

The chilling requirement for Maxi Gala grafted on rootstocks G.213 and M.9 is around 800 hours below 7 °C.

The G.213 rootstock gives to cv. Maxi Gala more budbreak than M.9 using more than 800 hours of chilling.

The G.213 rootstock gives best budburst uniformity to cv. Maxi Gala than M.9 and Marubakaido with 20 and 30 cm of M.9 interstock.

The results of experiment 3 shows that cultivar Maxi Gala grafted on different rootstocks and rootstocks plants follow the same budburst trend, showing an influence of the rootstock on grafted cultivar.

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