

Canopy Budding: a Method that Reduces *Phytophthora* Problems on *Citrus limon*

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ABSTRACT

Phytophthora is the most serious problem in lemon orchards in wet southern coastal areas of Brazil. Fungus lesions on the trunk and on branch/trunk insertion areas kill the bark, causing high mortality from the third year onwards. In 1985, an experiment was set up with Siciliano lemon budded on three different rootstocks, to compare three budding techniques. No differences were observed up to 1991 for fruit production per canopy projection area and fruit weight regardless of the technique used. However, there were significant differences in the canopy projection areas according to budding heights. The lowest budding technique is not recommended. The best results were obtained with Sour orange rootstock when combined with budding branches from the canopy.

KEYWORDS

Citrus limon,
Phytophthora, Brazil,
grafting, rootstocks.

Le greffage des branches de la frondaison, une méthode qui réduit les attaques de *Phytophthora* sur le citronnier.

RÉSUMÉ

Le *Phytophthora* est le plus grave problème des vergers de citronniers dans les zones humides de la côte Sud du Brésil. Les lésions sur le tronc dues au champignon détruisent l'écorce, provoquant une forte mortalité des arbres depuis 3 ans. En 1985, un essai a été mis en place avec des citronniers "Siciliano" greffés sur trois porte-greffe différents pour comparer trois techniques de greffage. Quelle que soit la technique utilisée, aucune différence n'a été observée jusqu'en 1991 dans la production des fruits rapportée à la surface de projection au sol de la frondaison. En revanche, ces aires de projection varient de façon significative en fonction de la hauteur de la greffe. La technique de greffe la plus basse est la moins recommandée ; le porte-greffe orange "Sour" combiné au greffage des branches de la frondaison a donné les meilleurs résultats.

MOTS CLÉS

Citrus limon,
Phytophthora, Brésil,
greffage, port-greffe.

El injerto en las ramas de la copa, un método que reduce los ataques de *Phytophthora* en el limonero.

RESUMEN

La *Phytophthora* es el problema más grave en los huertos de limonero en las zonas húmedas de la costa sur de Brasil. Las lesiones en el tronco destruyen la corteza provocando la muerte de los árboles con más de tres años. En 1985, se estableció un ensayo con el limonero "Siciliano" injertándolo sobre tres portainjertos diferentes para comparar tres técnicas de injerto. Cualquiera que sea la técnica utilizada, ninguna diferencia fue observada hasta 1991 en la producción de frutos. En contraste, la frondosidad de los árboles varió significativamente en función de la altura a la cual fue realizado el injerto. La técnica de injertar en la parte más baja fue la menos recomendada. El porta injerto naranjo "Sour" combinado con injerto de las ramas de la copa produjo los mejores resultados.

PALABRAS CLAVES

Citrus limon,
Phytophthora, Brasil,
injerto, portainjertos.

●●●● introduction

Phytophthora gummosis is a major problem in *Citrus limon* orchards in the state of Santa Catarina, in southern Brazil (KOLLER *et al.*, 1984; KOLLER, 1988; KOLLER, 1990). The incidence of this disease has increased in the coastal area, where annual mean relative humidity is very high (86.5%). Resistant rootstocks (DORNELLES, 1979; FEICHTENBERGER, 1990; KOLLER *et al.*, 1984; KOLLER, 1988; ROSSETTI *et al.*, 1963) and taller buddings (KOLLER *et al.*, 1984; KOLLER, 1988; PORTO and RECK, 1984) have been recommended to reduce gummosis infections.

However, it was found that even after these techniques were applied the incidence of gummosis on the trunk and at the base the main branches was still very high (Photo 1). Gummosis attacks resulted in early death of lemon plants, decreased productivity and reduced the life of orchards. If whole plant trunks and the beginning of primary branches could be developed on resistant rootstock, it is likely that no further gummosis attacks would be observed on the trunk or in the canopy formation area. This could extend the life of lemon orchards and make them more productive.

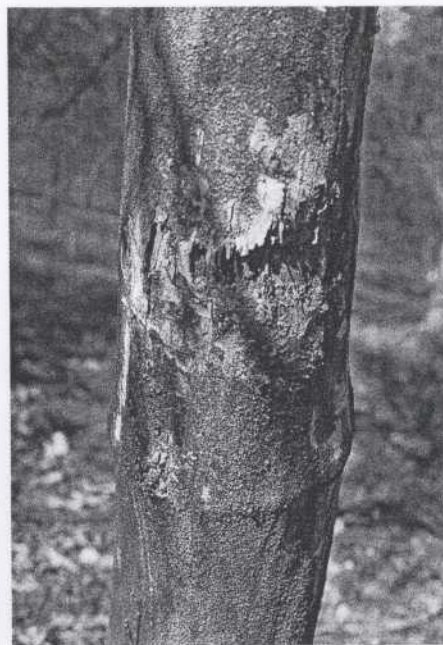


Photo 1
Siciliano lemon plants budded on Sour orange rootstocks, with *Phytophthora* attacks on the portion of the trunk formed by the lemon.

The present study was aimed at determining means of reducing gummosis attacks, improving productivity and increasing the life of plants. An experiment was therefore conducted to compare plants developed by traditional budding on the trunk with plants budded on the branches of rootstocks in the canopy.

●●●● material and methods

Treatments applied to the main plots were represented by the Sour orange (DORNELLES, 1979), Cleopatra mandarin (FEICHTENBERGER, 1990) and C-13 citrange (KOLLER *et al.*, 1984) rootstocks budded to Siciliano lemon. C-13 citrange is a hybrid (Pera orange x *P. trifoliata*) produced by DORNELLES (1979). The treatments applied to the split plots were as follows (Figure 1):

- A. budding height 40 cm and canopy formation height 50 cm (budding = 40, canopy = 50);
- B. canopy formation height 50 cm and budding on the branches of the rootstock 20 cm from the trunk insertion (canopy = 50, budding = + 20);
- C. canopy formation height 70 cm and budding on the branches of the rootstock 20 cm from the trunk insertion (canopy = 70, budding = + 20).

Plants used in all treatments were budded during the same period. In treatments B and C, three to four branches were budded on each plant. The experiment was set up in 1985 in Barra Velha, Santa Catarina coastal area, 30 m above sea level, in a Haplorthox soil, with an annual mean temperature of 20°C mean annual relative humidity of 86.5% and annual average rainfall of 1750 mm.

The soil was lamed to pH 6.0, fertilized with phosphorous and potash after analysis. N-P-K fertilizers were applied annually. A randomized block design with split plots, 4 plants per split plot and 4 replications was used.

A point criterion was used to determine the gummosis attack relative index, both for lesion size and lesion location. A

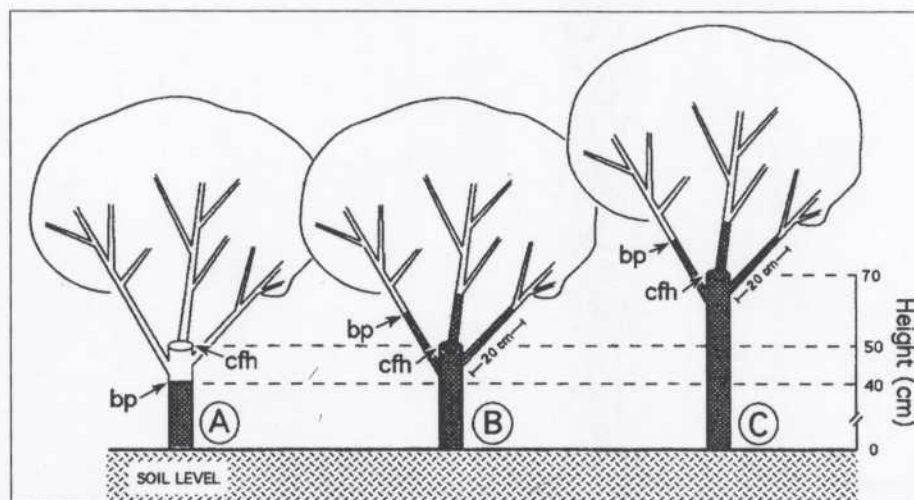


Figure 1
Differences between treatments A, B, and C, indicating the budding point (bp) on the trunk for treatment A, on the branches for treatments B and C, and canopy formation height (cfh) for treatments A, B and C.

value of 1.00 was attributed to represent the total points for Cleopatra at 40 cm budding height. The other values were then transformed proportionally. Treatment means were compared using the Duncan test at the 5% level.

●●●● results and discussion

Table 1 shows the plant development results. It was found that plants budded on the canopy presented lower canopy development. The trunk section was smaller in plants with a canopy formed 70 cm above the ground level. Trials using different budding heights and conducted at many places (KOLLER, 1988; LABANAUSKAS *et al.*, 1976; PORTO *et al.*, 1984; SALIBE *et al.*, 1970) seemed to have contradictory results. Nevertheless, analysis of these different results indicated that in less vigorous rootstocks, such as *P. trifoliata*, Cleopatra and Sour orange, canopy development decreased as budding increased. In contrast, in more vigorous rootstocks this difference was not as great and sometimes even nil.

Fruit production (kg/plant) varied significantly between rootstocks (Table 2). Although the differences in overall fruit production for budding on the trunk and on the canopy were not significant using the Duncan test at the 5% level, in the last two years (1990 and 1991) treatment A (lower budding) produced more fruit per

Table 1
Plant development measurements for Siciliano lemon budded on three rootstocks, at three different heights, six years after planting (1991)*.

Rootstock and budding type	Plant height (m)	Canopy projection area (m ²)	Trunk section (cm ²)
Sour orange	4.53 b	13.7 c	147.3 c
Cleopatra mandarin	4.69 a	15.1 b	179.9 b
C - 13 citrange	4.74 a	16.7 a	263.8 a
Budding 40, canopy 50	4.62 b	16.4 a	205.1 a
Canopy 50, budding + 20	4.64 ab	15.3 b	198.0 a
Canopy 70, budding + 20	4.71 a	13.6 c	187.9 b
VC (%)	2.0	9.2	5.5

* Means followed by the same letter within the same subcolumn do not differ significantly from each other according to the Duncan test at the 5% level.

Table 2
Fruit production in a trial, with six-year-old Siciliano lemon plants budded on three rootstocks, at three different budding heights (*).

Rootstock and budding type	Fruit production (kg/plant)				
	1988	1989	1990	1991	Total
Sour orange	30.8 a	55.6 ab	95.1 b	58.0 a	239.4 b
Cleopatra mandarin	27.9 a	49.1 b	88.3 b	42.7 b	208.1 c
C - 13 citrange	30.2 a	60.8 a	121.7 a	60.0 a	272.7 a
Budding 40, canopy 50	31.6 a	58.2 a	106.9 a	56.9 a	253.6 a
Canopy 50, budding + 20	27.0 b	55.5 a	104.8 a	52.9 ab	240.3 a
Canopy 70, budding + 20	30.3 a	51.7 a	93.3 b	51.0 b	226.3 a
VC (%)	15.7	13.8	12.3	9.7	12.3

* Means followed by the same letter within the same subcolumn do not differ significantly from each other according to the Duncan test, at the 5% level.

plant than treatment C (higher budding). After examining fruit yield in kg/m² of canopy projection area, it was found that differences between various budding types and heights practically disappeared (Table 3). The 1991 production decrease (Table 2) was due to adverse climatic conditions.

Although increased budding height and increased canopy formation result in plants with less developed canopies, spacing between plants in orchards can be reduced and regular productivity obtained with lower plants.

A higher incidence of *Phytophthora* was found in lemon canopies budded on C-13 (Table 4), which was considered to be a good rootstock for lemons (DORNELLES,

1979) and Valencia orange (PORTO *et al.*, 1984), than in lemon canopies budded on Cleopatra and Sour orange. This may be explained by a more vigorous combination obtained by budding lemon on C-13 rootstock (Table 1). More vigorous plants or combinations lead to greater susceptibility to the gummosis fungus (FEICHTENBERGER, 1990; MELLO *et al.*, 1971; ROSSETTI *et al.*, 1963). C-13 citrange can be a good rootstock for lemons since it resulted in high yields in kg/plant (Table 2) and in kg/m² of canopy projection area (Table 3). However, it should only be used under low air humidity conditions, less favorable to *Phytophthora* development. Among the different combinations tested, Sour orange had the best performance (Tables 2, 3 and 4), with canopy formation at 70 cm and budded on the branches (treatment 1C).

Table 3
Average fruit weight and fruit production per canopy projection area in a trial with six-year-old Siciliano lemon plants budded on three rootstocks, at three different budding heights (*).

Rootstock and budding type	Average fruit weight (g)	1991 production per canopy projection area in 1991 (kg/m ²)	Total production per canopy projection area in 1991 (kg/m ²)
Sour orange	148.4 ab	4.24 a	17.50 a
Cleopatra mandarin	152.2 a	2.87 c	13.96 b
C - 13 citrange	139.5 b	3.60 b	16.31 a
Budding 40, canopy 50	146.4 a	3.47 a	15.47 a
Canopy 50, budding + 20	146.6 a	3.58 a	16.11 a
Canopy 70, budding + 20	147.2 a	3.66 a	16.21 a
VC (%)	4.6	8.7	8.6

* Means followed by the same letter within the same subcolumn do not differ significantly from each other according to the Duncan test, at the 5% level.

Table 4
Relative index and percentage of *Phytophthora* attack to the trunk and to the first branches of six-year-old Siciliano lemon plants budded on three rootstocks, at three different budding heights.

Budding type	Relative index of gummosis attack				Percentage diseased plants
	Sour	Cleopatra	C-13	Means	
Budding 40, Canopy 50	1.57	1.00	5.34	2.64	29.2
Canopy 50, budding + 20*	0	0	2.14	0.71	10.4
Canopy 70, budding + 20*	0	0	2.29	0.76	8.3
Mean	0.52	0.33	3.26	1.37	-
Diseased plants (%)	6.2	4.2	37.5	-	16.0

* In C-13 these gummosis lesions have been found on the branches, right above budding point, whereas in Sour orange and Cleopatra no lesions had been detected at this point.

conclusions

1. Increased budding height on low and middle vigor rootstocks, such as Sour orange and Cleopatra mandarin, reduces canopy development, but maintains fruit production per m² of canopy projection area normal.
2. Budding performed on the first canopy branches, on *Phytophthora gummosis* resistant rootstocks, reduces fungus attacks and plant death, thus recommending this technique for lemons in humid climatic areas.
3. Among the different combinations tested, Sour orange with canopy formation at 70 cm above ground level and budding on branches, is the most recommended for humid climatic areas with substantial *Phytophthora* problems. ●

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