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The effect of different amounts of cladode removal on reflowering of cactus pear (*Opuntia ficus-indica* (L.) Miller)

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SUMMARY

The removal of the spring flush of flowers and cladodes at bloom promotes reflowering in cactus pear. Studies were conducted to investigate the influence of different amounts of spring flush cladode removal (100%, 75%, 50%, 25%, 0%) on cactus pear reflowering. A positive linear correlation between the severity of spring flush cladode removal and the degree of reflowering was found. Primary (spring flush) and secondary (second flush) cladodes showed the same fertility in the year after formation. Two year old cladodes showed a significantly lower fertility and have only a marginal effect on plant yield.

CACTUS PEAR is able to reflower, giving different major crops throughout the year if natural favourable conditions prevail, as happens in Chile (Gonzales, 1977), or under the effect of long-established agronomical inductive practices in Italy (Barbera *et al.*, 1992) and recently introduced to Israel (Nerd *et al.*, 1990). It was unintentionally discovered in Sicily during the early 19th century (Barbera *et al.*, 1992) that the removal of the spring flush of flowers and cladodes (primary flowers and cladodes) at bloom, early in June, promotes a second budding, which occurs few weeks after the spring flush removal (SFR). The extent of the SFR induced flush (secondary flowers and cladodes) depends on cultivar reflowering aptitude, environmental conditions, cladode load in the spring flush, and the timing of removal (Barbera *et al.*, 1991). Although the technique has recently been introduced to several countries with the aim of extending the cactus pear fruiting season (Brutsch and Scott, 1991), few aspects of SFR and consequent reflowering have yet been investigated (Barbera *et al.*, 1991). Little information is available on the effect of removal of the primary cladodes on the extent of reflowering. Actually, vegetative and reproductive sinks are distributed in several sites within a mature plant: most flowers are produced by one year old cladodes and new cladodes are produced annually by two-year old or even older cladodes. Fertile cladodes unevenly bear both flowers and cladodes.

A question arises about primary cladode removal: do we really need to remove all of them to promote reflowering or should we leave some to gain a higher yearly production based on both primary and secondary fertile cladodes? Farmers used to remove all primary flowers and cladodes. Portolano (1966) reports that complete removal of the primary cladodes would lead to a progressive decrease of plant productivity by reducing the number of one year old fertile cladodes. He also suggested that primary and secondary cladodes might differ in fertility.

The experiment reported herein was designed a) to ascertain the influence of different extents of primary cladode removal on reflowering and, b) to define cladode fertility as related to age and emergence time (primary and secondary cladodes).

MATERIALS AND METHODS

The experiment was carried out during 1989–1990 in San Cono, 37° 22′ N, on ten year old

TABLE I
Fertility characteristics of cactus pear plants before and after the removal of a different amount of primary cladodes

Extent of primary cladode removal (%)	Primary flowers per fertile cladode	Secondary flowers per fertile cladode	Second flush fertile cladodes vs Spring flush fertile cladodes
100	5.15 n.s.	3.97a	0.87a
75	5.05	3.35a	0.74a
50	5.25	2.77b	0.56b
25	4.88	2.67b	0.50b
0	5.42	2.58b	0.50b

Different letters denote significant differences within a column at $P<0.05$. Tukey's HSD test.

plants of cv. Gialla spaced 7 × 5 m apart. This cultivar is representative of the 80–90% of the whole industry in Italy (Barbera *et al.*, 1992). Primary flowers and cladodes were removed when 50% of the flowers had already opened, during the second week of June. At this time the young primary cladodes reach 20–40% of their fianl size, depending on their emergence time. The experiment was set up in a randomized block design with three replicates and four plants per treatment. Treatments consisted in removing different amounts of primary cladodes as follows: 100%, 75%, 50%, 25%, 0%. Most (90%) of the primary cladodes emerged on two-year old cladodes and they were removed throughout the whole canopy. Flowers were always completely removed. The number of fertile cladodes, flowers per cladode and current year cladodes was counted before and after SFR. Primary cladodes which were not removed were counted and labelled. During 1990, plants were subjected again to SFR but all primary flowers and cladodes were cut off. The number of secondary flowers emerged in one year old primary and secondary cladodes and two year old cladodes was counted at bloom. Data were analyzed by ANOVA, Tukey's HSD test and by regression analysis.

RESULTS

The number of fertile cladodes and cladode fertility were significantly reduced in the second flush when only 50% of the primary cladodes were removed.

Less severe primary cladode removal did not result in any further significant decrease of cladode fertility in the second flush (Table I).

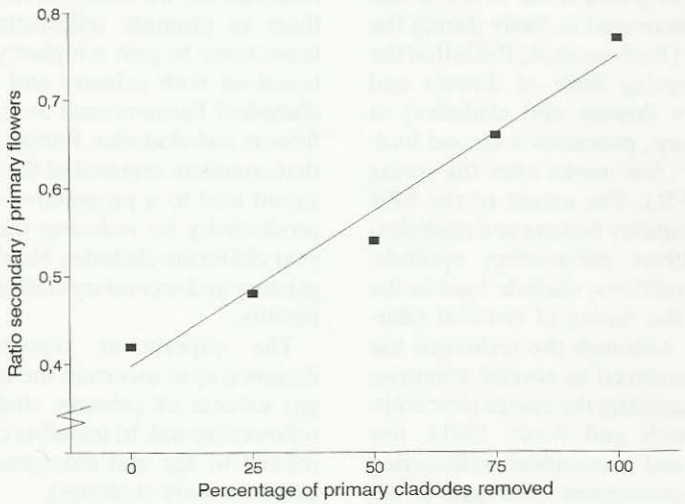

FIG. 1
Relationship between the ratio of secondary flowers to primary flowers and the extent of primary cladode removal. The equation of the fitted line is $y = 0.250 + b\ 0.00284$. $R^2 = 0.921909$. Each point is the mean of 120 observations.

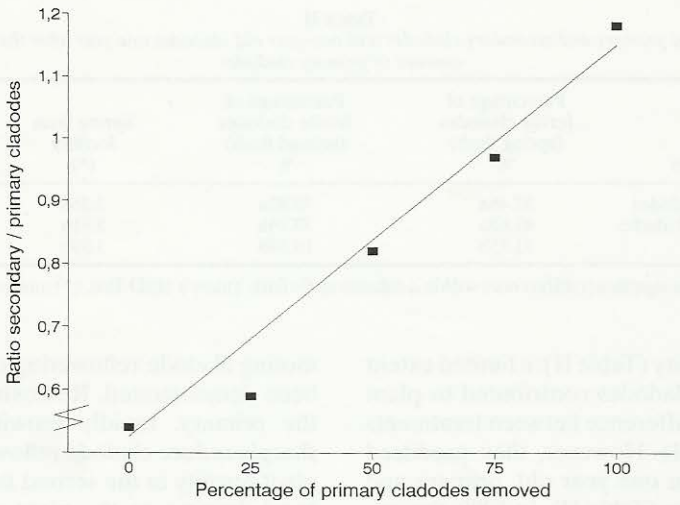

FIG. 2
Relationship between secondary to primary cladode ratio and the extent of primary cladode removal. The equation of the fitted line is y = 0.526 + b 0.00624. R^2 = 0.927863. Each point is the mean of 120 observations.

However, a positive linear correlation was found between the ratio of numbers of secondary and primary flowers (commonly used as a reflowering index) and the severity of primary cladode removal (Figure 1). In other words, more than 50% reduction of whole plant productivity occurred when 25% or none of the primary cladodes were removed.

The production of secondary cladodes was also enhanced by the removal of primary cladodes (Figure 2). Nevertheless, if we consider the summation of primary and secondary cladodes, the total number of current-year cladodes produced by the plant decreased with severity of primary cladode removal (Figure 3). Most primary and secondary cladodes were fruitful in the year after treatment, both in the spring and in the SFR induced flush, with no

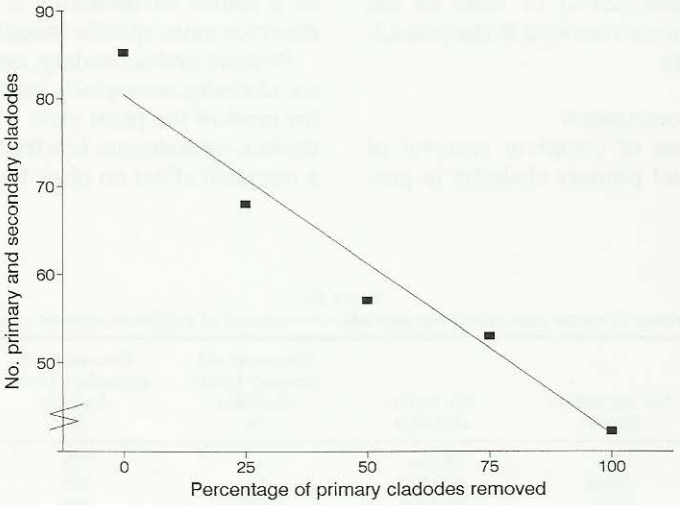

FIG. 3
Relationship between the total production of primary and secondary cladodes and the extent of primary cladode removal. The equation of the fitted line is y = 80,515 – b 0.38572. R^2 = 0.954255. Each point is the mean of 12 replicates.

TABLE II

Fertility of one year old primary and secondary cladodes and two-year old cladodes one year after the removal of a different amount of primary cladodes

Type of fertile cladodes	Percentage of fertile cladodes (spring flush) %	Percentage of fertile cladodes (second flush) %	Spring flush fertility (*)	Second flush fertility (*)
1-year old primary cladodes	87.46a	79.82a	5.35a	4.02a
1-year old secondary cladodes	87.63a	77.99a	5.61a	4.02a
2-year old cladodes	31.15b	18.34b	3.89b	2.06b

Different letters denote significant differences within a column at $P<0.01$. Tukey's HSD Test. (*) number of flowers per fertile cladode.

difference in fertility (Table II); a limited extent of two-year old cladodes contributed to plant fertility, with no difference between treatments (Tables II and III). However, they produced fewer flowers than one year old, primary and secondary cladodes (Table II). In 1990, the origin of fertile cladodes was consistent with the different extent of primary cladode removal in the previous year. Then, primary cladodes gave the greater part of the crop in plants in which they had been either partially removed (25%) or not removed in the previous year, while secondary cladodes were responsible for most of plant yield when all the primary cladodes had been removed in the previous year (Table III).

A higher number of fertile cladodes rather than an increase of cladode fertility was responsible for the higher number of secondary flowers produced in the year after treatment by plants in which few (25%) or none of the primary cladodes were removed in the preceding year (Table III).

DISCUSSION

The effectiveness of complete removal of primary flowers and primary cladodes in promoting cladode reflowering of cactus pear has been demonstrated. Removing 50% or less of the primary, rapidly growing cladodes will sharply reduce cladode reflowering and whole-plant fertility in the second flush. On the other hand, leaving on the plant a limited amount (25%) of primary cladodes has no beneficial effect on plant cropping either in the year of treatment or in the next one. The production of new cladodes in the second flush will be also inhibited by the presence of unremoved primary cladodes. Anyhow, their presence does not inhibit flower initiation in the second flush as much as does the presence of primary flowers, since a reasonable amount of secondary flowers (40% of the primary ones) still occur even if all the primary cladodes are not removed. Whether the remaining cladodes affect reflowering by acting as a stronger sink or as a source of inhibitors is still unclear and deserves more specific investigation.

Primary and secondary, one year old, terminal cladodes are equally fruitful. They account for most of the plant yield while two year old, thicker, cladodes are less fruitful and have only a marginal effect on plant fertility.

TABLE III

Fertility characteristics of cactus pear plants one year after the removal of a different amount of primary cladodes

Extent of primary cladode removal in the previous year (%)	No. secondary flowers	No. fertile cladodes	One-year old primary fertile cladodes %	One-year old secondary fertile cladodes %	Two-year old fertile cladodes %
100	176a	52.19a	—	75b	25 n.s.
75	201ab	60.46a	23a	56b	21
50	224b	68.14ab	37b	39c	25
25	260c	76.14b	55c	25d	20
0	300c	88.43b	63c	16e	21

Different letters denote significant differences within a column at $P<0.05$. Tukey's HSD Test. Data refer to SFR induced flush.

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