Effect of Harvest Methods on Yield and Quality of Marketable Flowers of Greenhouse Rose Cultivars of Different Growth Habits

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Abstract

This study was carried out to determine the effects of harvest methods (proximal and median harvests) on yield and quality of marketable flowers of greenhouse hybrid tea rose (Rosa hybrida L.) cultivars of different growth habits. The cultivar 'Grand Galla' represented cultivars of vigorous growth habit whereas 'Vivaldi' represented those of non-vigorous growth habit. The proximal harvest method significantly reduced the number of marketable flower stems of non-vigorous cultivars but did not significantly affect the number of flower stems of vigorous cultivars. The proximal harvest method also improved flower quality in terms of grades, lengths and weights of individual flower stems of both vigorous and non-vigorous cultivars. According to market studies, the prozimal harvest method would increase revenue from vigorous cultivars and decrease revenue from non-vigorous ones. The median harvest method should be applied to non- vigorous Rose cultivars.

Key words: Greenhouse rose, harvest methods, growth habits, yield and quality of flowers

Introduction

A hybrid tea rose (*Rosa hybrida* L.) stem can be divided morphologically into three major positions:- the proximal, median and distal position. The proximal position is located at the base of the stem and is characterised by the presence of stipular buds and leaves with one to three leaflets. The median position is situated at the middle of the stem and is distinguished by the presence of leaves with five to seven leaflets. On the other hand, the distal position is identified by lower leaves with three-leaflets and upper leaves with one-leaflet (Zamski *et al.*, 1985; Le Bris *et al.*, 1996).

Traditionally, greenhouse roses are harvested by cutting marketable flowers above the second five-leaflet leaf of the median position, and removing non-marketable flowers. Flower stems harvested by this method are shorter and thinner, thus poor quality (Champeroux *et al.*, 1996; Morisot, 1997). Morphogenetical studies report that length and diameter increase as stems are cut downwards along the mother stem (Le Bris *et al.*, 1996; 1998). Likewise, pruning off or bending down non-marketable flower stems is reported to increase flower quality in terms of weight, diameter and length (Morisot, 1996a; 1997). However, no research has been conducted on the effects of harvesting at proximal position combined with bending down non marketable flower stems on yield and quality of marketable flowers of greenhouse rose cultivars of different growth habits.

The objective of this study was to determine the effects of harvest methods on flower yield and quality of vigorous and non-vigorous greenhouse roses.

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Materials and Methods

The study was carried out at "l'Unité des Recherches Integrées en Horticulture de l'Institut National des Recherches Agronomiques" in Antibes. France. Two cultivars (one with vigorous and the other with non-vigorous growth habits) of hybrid tea rose were grown in a glasshouse on soilless culture. The cultivar 'Grand Gala' or taxonomically 'Meiqualis' has vigorous growth habit whereas Vivaldi or taxonomically 'Ruidriko' has non-vigorous growth. These cultivars were grafted on rose rootstock (*Rosa indica* L. cv. Major) two years prior to the experiment, and planted in one-litre containers filled with perlite. The planting density was eight plants/m^2.

The computer-controlled greenhouse maintained an average minimum/ maximum night and day temperatures of 16/22.7 °C and 23/31.3 °C respectively. The relative humidity was maintained above 50 %. Plants received an average solar radiant energy of 2057 J/cm^2/day. The concentration of the nutritive solution was as recommended by Champeroux *et al.* (1996) and consisted of K^+ = 3.7, Ca^{2+} = 6.7, Mg^{2+} = 1.5, S= 1.0, N-NO_3^- = 9.1, N-NH_4^+ = 1.5 and P = 0.2 meq/litre. The solution electric conductivity varied between 1.2 and 1.4 mS/cm and pH between 6.0 and 6.5. Fertigation was controlled by computer based on global solar radiation, and was not recycled. Plants were irrigated when the cumulated global solar radiation reached 150 J/cm^2.

Prior to initiation of the experiment, marketable flower stems from both cultivars were harvested by cutting at the basal position (2 cm above the base of the mother stem) and by bending down non-marketable flower stems. Each mother plant in a container consisted of two main branches. Thereafter the following harvest methods were evaluated:

(i) Proximal harvest method: The previously bent mass of non-marketable flower branches was left untouched. The two upright stems, arising from basal buds, were cut above the first three-leaflet leaf (about 2-3 cm) from the base of the stem. The buds which developed from these stems were later harvested by cutting above the first three leaflet leaf in a gradual ascending order. Thin and distorted shoots were bent down at flower bud formation stage in order to constitute a mass of photosynthetically active tissues (Figure 1).

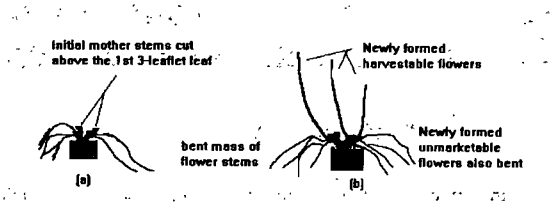

Figure 1: Proximal harvest method: (a) two initial mother mother branches with bent mass of unmarketable flowers at the beginning of the experiment and (b) newly formed marketable flowers

(ii) Median harvest method: The previously bent non-marketable flower stems were pruned off. The two upright stems arising from basal buds were cut above the second five-leaflet leaf of the median position. The subsequent marketable flower stems were also harvested by cutting above the second five-leaflet leaf in an ascending order. All blind shoot, thin and malformed stems were removed away (Figure 2).

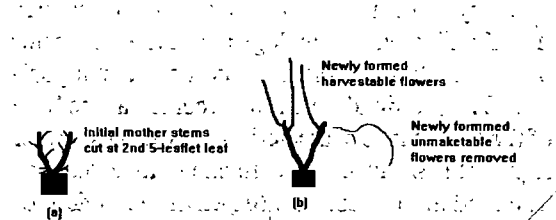

Figure 2: Median harvest method (a) Two mother with mass of previously bent non-morketable flowers removed at the beginning of the experiment and (b) newly formed potentially marketable flowers.

The experimental design was 2x2 factorial combination superimposed on a Randomised Completely Block Design. The treatment combinations were (i) proximal harvest method on Vivaldi, (ii) proximal harvest method on Grand Galla, (iii) median harvest method on Vivaldi and (iv) median harvest method on Grand Galla.

Each treatment combination consisted of a plot of 12 plants, replicated four times. The experimental plants were surrounded by border rose plants. Data included yield (fresh weight and number of stems) and quality (flower grades, flower weight and length) of marketable flowers. The analysis of variance and mean separation of the data were performed using "General Linear Models Procedure" and "Duncan's Multiple Range Test" respectively of a statistical package SAS - 1992.

Results and Discussion

Yield of Marketable Flowers

The proximal harvest method significantly (p 0.05) reduced the fresh weight yield and number of marketable flowers of non-vigorous cultivars. It produced 8.00 tons/ha and 250,000 stems/ha of Vivaldi whereas the median harvest method produced 10.75 tons/ha and 420,000 stems/ha of the same cultivar. On the contrary, the proximal and median harvest methods statistically produced equal (P 0.05) fresh weight and number of marketable flower stems of vigorous cultivars. The fresh weight yield and number of marketable flowers from the proximal harvest method were 11.68 tons/ha and 310,000 stems/ha of Grand Galla whereas the median harvest method produced 10.13 tons/ha and 320,000 stems/ha of the same cultivar (Table 1).

Table 1: Yield of marketable flower stems of vigorous and non-vigorous cultivars of greenhouse roses from proximal and median harvest methods.

Cultivar	Harvest method	Weight of flower stems (tons/ha)	Number of flower stems/ha) x 1000
Grand Galla	Proximal	11.68^{b}	310^{b}
	Median	10.13^{b}	320^{b}
Vivaldi	Proximal	8.00^{a}	250^{a}
	Median	10.75^{b}	420^{c}

a,b,c=numbers in a column bearing different letters are statistically different (p<0.05).

It is reported that bending down of non-marketable flowers increases yield and quality of flowers by improving biomass production (Morisot, 1997). Although sprouting is partly improved by food reserve (Kool *et al.*, 1997). bending down of non-marketable flowers does not increase sprouting rate of proximal buds of non-vigorous cultivars. In this study, the non-vigorous cultivar formed fewer shoots when harvested by the proximal harvest method than by the median harvest method. On the other hand, vigorous cultivar excessively formed more shoots when harvested by the median harvest method than by the proximal harvest method. However, the excessive sprouting did not improve yield, for part of the shoots became blind. When sprouting is excessive, blind shoot formation is mainly due to competition for resources among shoots (Berninger, 1994; Byrne and Doss, 1981).

Flower Quality

Grades of Marketable Flowers

The proximal harvest method produced 150,000, 70,000 and 90,000 stems of Grand Galla and 160,000, 50,000 and 40,000 flower stems of Vivaldi in grade super, grade one and grade two per hectare respectively. On the other hand, the median harvest method produced 80,000, 100,000 and 140,000 flower stems of Grand Galla and 170,000, 120,000 and 130,000 of Vivaldi in grade super, grade one and grade two per hectare respectively (Table 2).

Table 2: Quality of marketable flowers of vigorous and non-vigorous cultivars of greenhouse roses from proximal and median harvest methods.

Cultivar	Harvest method	Number of flower stems/ha/grade x 1000			Flower size	stem
		Grade Super	Grade one	Grade two	Weight (g/cm)	Legth (cm/stem)
Grand Galla	Proximal	150^{b}	70^{b}	90^{b}	38^{c}	73^{b}
	Median	80^{a}	100^{b}	140^{c}	32^{b}	67^{ab}
Vivaldi	Proximal	160^{b}	50^{a}	40^{a}	32^{b}	71^{b}
	Median	170^{b}	120^{b}	130^{c}	25^{a}	61^{a}

a,b,c=numbers in a column bearing different letter are statistically different (P ≤0.05).

Compared to the median harvest method, it is considered that the proximal harvest method increased flower stems in grade super at the expense of flower stems in grade two of Grand Galla. The increase in number of flowers in grade super was 87.5 % while the decrease in number of flower stems in grade two was 35.7 % of the total number of marketable flowers. Moreover, the proximal harvest method reduced the number of flower stems in grade one and grade two of Vivaldi while the number of flowers in grade super statistically remained equal (P 0.05) to that from the median harvest method. The reduction in number of flowers of Vivaldi in grade one and grade two was 58.3 and 69.2 % of the total number of marketable flowers respectively. Flowers in grade super are usually sold two and four times more expensive than those in grade one and grade two respectively (Morisot, 1996b). As a result, growers using the proximal harvest method on vigorous rose cultivars would increase revenue whereas those applying the harvest method to non-vigorous cultivars would lose their revenue.

Weight of Marketable Flowers

The proximal harvest method produced bigger flower stems of both Grand Galla and Vivaldi than the median harvest method (P 0.05). The proximal harvest method produced flowers with weights of 38 and 32 g/stem of Grand Galla and Vivaldi respectively. On the contrary, the median harvest method produced flowers with weights of 32 and 25 g/stem of Grand and Vivaldi respectively (Table 2).

Greenhouse roses are uncommonly sold based on weight of individual stem. However, bigger flower stems are normally positively related to grade quality (Morisot, 1997). Flower weight has also a big influence on transport charges. For instant, in 1998 the transport charge for a kilo of rose cut-flowers from Tanzania to Europe was 2 US$ (Semboja & Mbelwa, 1999). Where the difference in grade quality between bigger and smaller flowers is small, the production of the former in remote areas might require further analysis.

Length of marketable flowers

The proximal harvest method produced longer flower stems of both Grand Galla and Vivaldi than the median harvest method (P = 0.05). The proximal harvest method produced flowers with length of 73 cm/stem whereas the median harvest method produced flowers with length of 67 cm/stem of Grand Galla. On the other hand, the proximal harvest method significantly produced longer flowers (P= 0.05) of Vivaldi. This harvest method produced flowers with length of 71 cm/stem while those from the median harvest method were 61 cm long (Table 2).

The quality of flower stems often increases

with their lengths. Selling prices of individual flowers may also increase with their lengths. However, a study conducted in France (Nice and Hyères flower auction markets) reveals that only one-third of the flowers are sold according to their lengths. In this case, rose flower stems of 85 and 35 cm were sold at 0.46 and 0.2 US$ respectively (Morisot, 1996b). Studies show that majority of clients (mainly low and average income classes) prefers small flower stems to big ones. Small rose flowers are cheap and also used in large quantities in preparation of flower bouquets.

Conclusion

The application of the proximal harvest method on vigorous greenhouse rose cultivars increases the quality without concurrently affecting the yield of marketable flowers. As a result of the improved flower quality, application of the proximal harvest method to vigorous cultivars would be more profitable than median harvest method. On the other hand, the use of the proximal harvest method on non-vigorous rose cultivars increases flower quality at the expense of the yield of marketable flower stems. As the consequence, the application of this method to non-vigorous rose cultivars would be unprofitable as compared to the median harvest method. It is therefore recommended that the proximal harvest method should only be applied to vigorous rose cultivars. Conversely, the median harvest method should be applied to non-vigorous rose cultivars.

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