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# Effect of plant age and methods of stem treatment on the quality of cut roses

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**Abstract**
Cut roses are always valued for their beautiful and outstanding flowers. Apart from the physiological and nutritional features of the plants, there are many other factors which influence the marketable quality of cut roses over the entire period of production phase. Among them we tried to understand how plant age and different methods of stem treatment can modify cut stem physical properties. To do this, the effect of newly stented plants beside the three-year old stented plants combined with four stem training methods were evaluated for their cut flower qualities. The results showed that the time to bud break was shorter (seven days) for young plants while it reached to about 15 days in old plants particularly for the third and fifth buds. In general, young plants performed better for some quality traits such as higher stem length and higher flower and stem diameter. When shoots were bent over the fifth bud, the highest shoot weight and leaf area were produced in the new growing cut flowers. It was concluded that young plants tended to increase their foliage volume by producing more leaves on relatively vigorous shoots, thereby they increased their marketable stem quality.

**Keywords:** Bending; Cut rose; Flower quality; Plant age; Stem treatment

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## Introduction

The role of axillary buds in producing high quality cut flowers in the rose greenhouses has been highly emphasized and focused in recent decades. Operations such as pruning, training, bending and harvesting which are normally practiced in rose greenhouses need sufficient knowledge about the bud morphology and growing behavior of the axillary buds along the mother stem. In addition to the environmental factors which strongly affect bud growth and development, the position of the bud on the mother stem, which is usually referred as topophysis, has a paramount influence on the growing characteristics of the stems (Bredmose *et al*. 2001). It was determined that all the axillary buds in cut roses have the potential to produce flower (Zamski *et al.* 1985), however, sometimes adverse climatic conditions and the competence occurring between stem growing points might prevent normal formation of flower parts and may eventually result in blind shoots (Demotes-Mainard *et al*. 2013).

Other than the important role of apical dominance in controlling growth of axillary buds which is mostly regulated by internal hormone balance and its distribution pattern, paradormancy was also supposed to be another controlling factor (Bris *et al*. 1998). On the other hand, inhibitors may also create a downward inhibitory gradient of bud growth along the rose stem (Zieslin *et al*. 1978). An experiment by Sarkka and Ericsson (2003) indicated an obvious difference among the rose buds situated in the lower part of the stem in the way they respond to the bending treatments. The nodal position of a scion grafted onto a rootstock determines the flower yield harvested from it (Vrise and Dubois 2001). Correspondingly, cuttings taken from different positions of the rose stem indicate varied bud break characteristics and different shoot growth vigor (Bredmose and Hansen 1995). Based on Matloobi *et al*. (2008), any change in source-sink relations (e.g. removing apical flower bud) may alter gas exchange parameters of the leaves remained on the main shoot. They showed that the leaf just below the harvest cut line undergoes an almost sharp decline in photosynthesis rate over the weeks following the stem decapitation. These results imply that there might be a complex involvement of many internal and external factors which probably handle bud release and shoot developmental properties. Sarkka and Eriksson (2003) examined the effect of different bending heights on the quality of emerging cut flowers and observed good relations between bending height and the method of flower shoot harvesting. These authors concluded that there might be a linkage between the root volume inside the media and the amount of assimilates being charged into the root system by the aerial parts. Accordingly, Kajihara *et al*. (2009) documented that higher yield of cut flowers obtained in high-rack system than in the conventional bending system, stems mainly from the way the rose plants re-allocate the photosynthates between the root and plant aerial parts.

In addition to bud position and the place at which the shoot is bent or harvested, plant and bud age may also influence the shoot growing potential (Marcelis-van Acker 1994). It was also determined that the type of species and flower shoot developmental stage can modify the rose petal physio-chemical attributes by affecting cell membrane permeability via lipid peroxidation (Sood *et al*. 2006). Considering these multi-factorial controllers which drive bud growth, hence final stem yield and quality of harvested flowers, still there exist some unanswered questions related to the interaction of plant age and the height at which stems are bent. In this study we tried to answer these questions by examining the simultaneous effects of plant age and bending height on the quality of harvested flowers.

## Material and Methods

The experiment was carried out in a research greenhouse located in Shiraz, Iran (29° 37’ N and 52° 32’ E). Three-year-old rose plants (*Rosa hybrida* ‘Full House’) propagated by stenting method (on Natal Briar as rootstock) were selected from a group of plants growing inside a greenhouse for research and training purposes. For producing young plants, the cultivars were propagated through the stenting method on the ‘Natal Briar’ as rootstock. Both old and young plants were planted in the six-liter pots and then were placed on supporting benches inside the greenhouse aligned in the north-south direction. Greenhouse climatic condition was defined in a way that suited plants' optimum growth. The media was composed of cocopeat mixed with perlite (60% cocopeat and 40% perlite) and the plants were fertigated with a standard solution containing both macro and micro-nutrients throughout the experimental period.

Plant age (young vs. old) and shoot training method (shoot pruning as control, shoot bending above the first (B1B), third (B3B) and fifth buds (B5B)) were the main- and sub-factors, respectively, which were randomized based on the split plot design and repeated four times in blocks with two plants assigned to each experimental plot. In total, 64 plants were subjected to the treatments under study. In each pot only one shoot was allowed to grow and when the shoots reached the pea bud stage, the following treatments were applied: pruning above the first bud (control) and bending above the first, third and fifth buds. Ornamental and marketable characteristics of the grown shoots, number of days before the bud break, time to harvest, shoot length at harvest, flower diameter, stem diameter, stem fresh and dried weight and the shoots total leaf area were measured. The recorded data were then analyzed by the SPSS software.

**Results**

Time to bud break was significantly affected by the plant age and method of shoot treatment (Table 1). It was revealed that some young plants tend to break their buds earlier than older plants by almost one-week difference. The smallest difference between young and old plants appeared in the control treatment in which the shoot was pruned above the first bud. However, when the shoots were bent over the third bud the old plants showed a distinct delay in bud growth (Figure 1). The significant interaction between plant age and method of shoot treatment indicated that the age difference was not consistent in the shoot treatment methods. However, the interaction was of change in magnitude type.

Regarding the time needed to reach the harvest time, no significant difference was seen between the young and old plants, however in one case (B1B) young plants appeared to be rather faster in reaching harvest time. The effect of the method of shoot treatment on this character was significant, but it had an interaction with plant age (Figure 1). Shoot pruning resulted in longer time to flower harvest when compared to shoot bending above the same bud position in young plants.

The length of harvestable stems was influenced by the method of shoot treatment and not by plant age (Table 1). The longest stems were produced in the treatment in which the shoot was bent above the fifth bud only in the younger plants. The treatments that experienced bending or pruning over the first bud generated the shortest stems when compared to other treatments (Figure 1).

Flower diameter was influenced by both the plant age and shoot treatment methods. Young plants produced the highest flower diameter reaching to about 32 mm and this difference was distinct when the shoots were bent above the third and fifth buds. Thus, in the young plants the third and fifth buds appeared roughly to have better performance. Flower shoot diameter was significantly affected by the shoot treatment methods but no significant influence was observed from the side of plant age when averaged over shoot treatments (Table 1). On the other hand, the interaction between shoot treatment methods and age was significant. Shoots grown from the first and third buds on the young plants gave rise to the thickest stems (Figure 1). Pruned shoots above the first bud on the young plants resulted in the lowest diameter of flower stems.

In terms of stem weight, young plants performed well by producing stems with 24.8 g fresh weight in comparison with the old plants

Table 1. Analysis of variance of the effects of different types of stem treatment and age of cut roses for measured

| | | Mean squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SOV | df | TBB | TF | SL | FD | SD | SFW | SDW | LA |
| Block | 3 | 0.93$^{ns}$ | 3.13$^{ns}$ | 22.19$^{*}$ | 7.51$^{*}$ | 0.27$^{*}$ | 52.77$^{*}$ | 2.96$^{*}$ | 8830$^{ns}$ |
| Plant age (A) | 1 | 91.12$^{**}$ | 9.03$^{ns}$ | 4.35$^{ns}$ | 16.9$^{**}$ | 0.19$^{ns}$ | 83.99$^{*}$ | 9.25$^{**}$ | 31242$^{ns}$ |
| Stem treatment (T) | 3 | 22.10$^{**}$ | 16.42$^{**}$ | 78.29$^{**}$ | 4.03$^{*}$ | 1.30$^{**}$ | 71.24$^{**}$ | 7.54$^{**}$ | 38450$^{*}$ |
| A×T | 3 | 11.47$^{**}$ | 11.05$^{*}$ | 22.65$^{*}$ | 12.0$^{**}$ | 1.12$^{**}$ | 22.44$^{ns}$ | 1.92$^{ns}$ | 15842$^{ns}$ |
| Error | 21 | 2.03 | 2.52 | 6.96 | 1.27 | 0.07 | 10.65 | 0.79 | 8909 |

$^{ns}$,*,**: not significant and significant at 0.05 and 0.01 probability levels, respectively.
TBB: time to bud break, TF: time to flower, SL: stem length, FD: flower diameter, SD: stem diameter, SFW: stem fresh weight, SDW: stem dry weight, LA: leaf area

weighted heavier as compared to the shoots originated from the buds of other sources. The same trend was also observed for the dried shoot weight.

A good relationship was observed between leaf area and leaf main central axis length (Figure 1). This relationship was used to estimate the leaf area of all harvested shoots. Shoots originated from the fifth buds had significantly higher leaf area, as much as 61 cm$^2$, when compared to the shoots grown from other positions. However, plant age did not significantly influence this trait (Figure 2).

## Discussion

Many factors are involved in the rose plant axillary bud growth including sink-source relations (Matloobi *et al.* 2008), apical dominance (Zamski and Shlomit Oshri 1985), cytokinin availability (Zieslin and Algom 2004), training systems (Särkkä and Eriksson 2003) and topophysis (Bredmose *et al.* 2001). Our results indicated that there was a difference between young and old plants in terms of time to bud break, being at least six days in young plants and reaching to 14 days in old plants. This implies that buds in young plants are able to overcome internal physiological barriers very easily comparing old plants. It was demonstrated that some internal inhibitors such as abscisic acid may account for this delay especially in those buds situated on the old parts of the stems (Bris *et al.* 1998). Additionally, apical dominance exerted by auxin activity of upper buds presumably influence the germination potential of lower axillary buds in both young and old plants, but the degree the buds are affected is under the control of many complex hormonal interrelations occurring simultaneously inside the plant. Auxins beside the other growth regulators such as cytokinins and gibberellins are normally subjected to many practical operations such as flower harvesting and shoot bending which are common practices in commercial rose greenhouses. There are several studies that indicate shoot treatment methods can highly impact bud break and following shoot growth (Sarkka and Eriksson 2003; Kim *et al.* 2004; Kajihara *et al.* 2009; Ohkaw, 2010). In this study old plants appeared to be affected significantly by the bud position on the mother stem for the number of days they need to begin bud growth. However, such difference was not observed in the young plants. Physiologically, young plants have lower foliage quantity and total

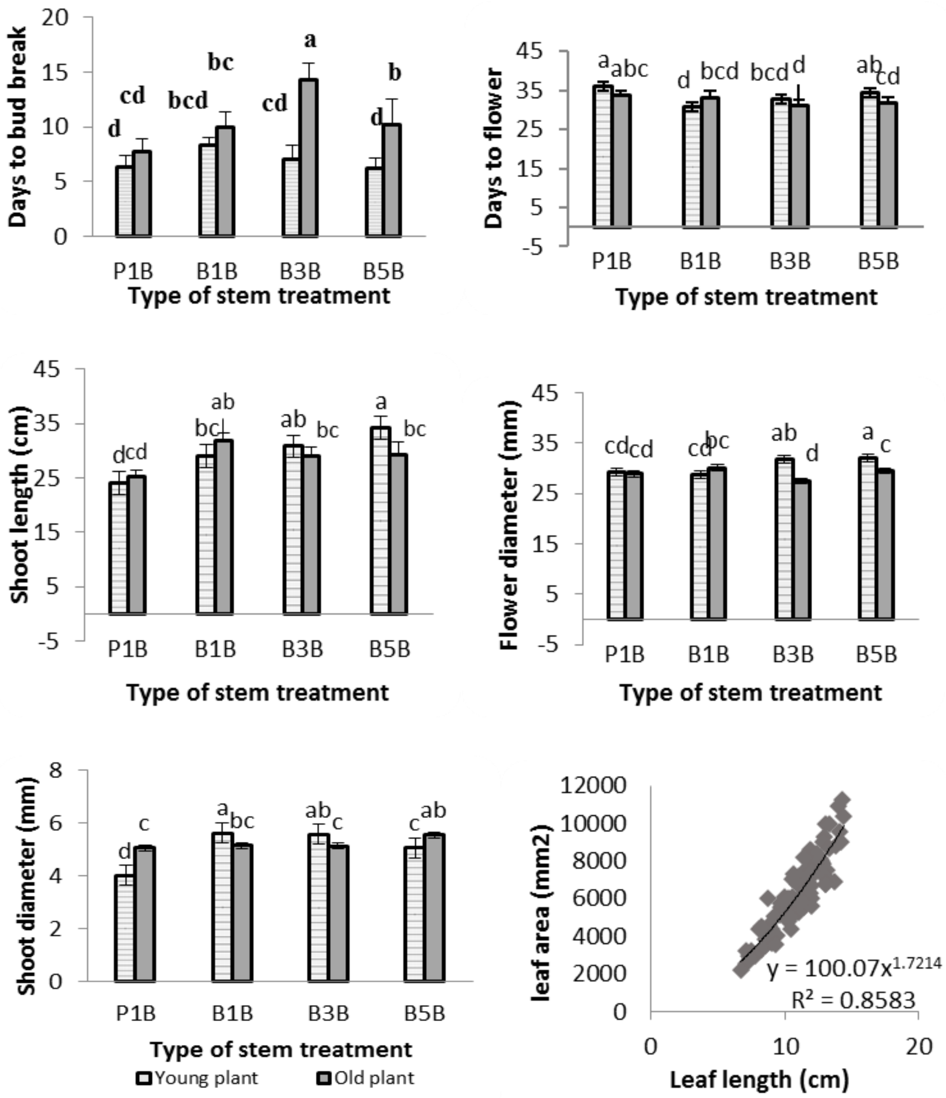


Figure 1. Effects of different types of stem treatment on some traits of young and old cut roses; mother stem pruned above first bud (P1B), bent above first bud (B1B), bent above third bud (B3B), or bent over fifth bud (B5B). Regression between leaf area and leaf length (the graph on bottom right); Treatments with different letters are significantly different at 0.05 probability level.

leaf area which probably stimulate the buds to germinate as soon as possible in order to compensate these shortages. The shoots that bent over the fifth bud produced longer stems in young plants than old plants. Despite of the considerable importance of environmental factors in flowering shoot length, we know that in rose plants topophysis plays a vital role in determining bud growth and final shoot length which was demonstrated mostly in Bredmose works

(Bredmose and Hansen 1995; Bredmose *et al*. 2001). It was proved that rose buds follow a downward gradient from shoot tip to basal part in terms of morphological, anatomical and physiological properties (Zamski *et al*. 1985). These variations were assigned into three main stem layers according to the bud position along the mature stem: top, middle and bottom layer. Buds located at basal parts tend to produce longer stems than the buds situated on upper parts. This condition was more or less observed in our results, however, there were some interactions with plant age. Shoots developed from the buds stimulated by stem pruning, resulted in shorter flowering stems.

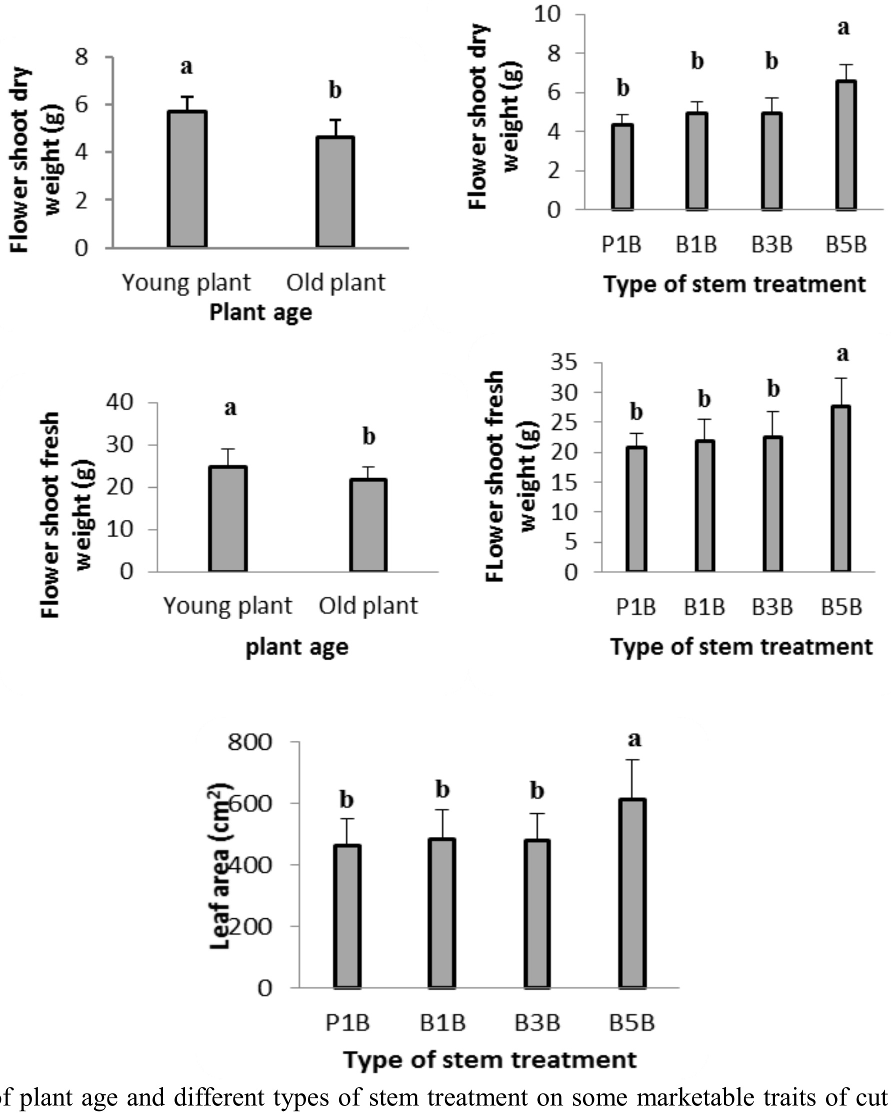


Figure 2. Effect of plant age and different types of stem treatment on some marketable traits of cut rose; mother stem pruned above first bud (P1B), bent above first bud (B1B), bent above third bud (B3B), or bent over fifth bud (B5B); Treatments with different letters are significantly different at 0.05 probability level.

This result may be explained by lower leaf area (photosynthetic organs) remained after cutting off a major part of active stem as pruned shoot which is kept as bent photosynthetic stem in other treatments. Shoot diameter more or less followed the same pattern of shoot length observed among the treatments. Shoots which were longer produced thicker stems, thus stems originated from strong buds stimulated by shoot bending generated longer

and thicker stems. Young plants showed a distinct difference between the shoots stimulated by pruning and those produced by bending technique in terms of shoot length and diameter. Regarding shoot fresh and dry weight, it seems that young plants performed better by producing significantly heavy stems. It was pointed out that in the aged rose plants there would be a relatively long distance of material transportation channel from roots to the leaves which may negatively influence timely deliverance of xylem sap to photosynthetic organs. Shoots originated from the fifth bud produced the heaviest cut flowers. These shoots which were bent above the fifth bud, leaved more intact leaf area beneath the bent part of the stem, thereby probably allowed increased flow of assimilates towards the young growing roots. Flower diameter increased in the shoots produced by young plants when compared to the old plants. In this case, correspondingly, the shoots grown from the fifth buds gave rise to high quality flowers with large diameters. Flower diameter is normally correlated with the number of petals initiated during the flower formation at microscopic scale when the shoot length reaches about 10 cm (Vries *et al*. 1981). Flower diameter besides the characteristics such as shoot length and diameter is one of the most important quality characters of cut roses which is frequently chosen as a quality measuring scale in most flower auction centers. Young plants significantly performed better by producing shoots with higher leaf area as compared with the old plants. Leaf area is usually considered one of the most important characteristics of plants which directly influence quantity and quality of plant growth. It is obvious that young plants prefer those features which are strongly connected with rapid growth and establishment. Hence, young plants adopted in investing the photosynthetic organs to enhance assimilate production in order to charge and stimulate new growth and development.

**Conclusion**

This study tried to illustrate the young and old rose plants' behavior in relation to different methods of shoot treatment. It was shown that young plants tend to increase their foliage volume by producing much more leaves on relatively vigorous shoots. However, there were interactions with bud positions in most traits, indicating that the effect of plant age on bud performance and productivity depends on the shoot treatment methods. Furthermore, it was revealed that the buds situated on the fifth node (almost at the middle of stems) could be very valuable in terms of generating marketable stems.

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# تاثیر سن گیاه و روش‌های تیمار شاخه درکیفیت گل رز بریدنی

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**چکیده**
رزهای بریدنی همیشه به عنوان یک گل زیبا و جذاب مورد توجه بوده‌اند. جدا از عوامل تغذیه‌ای و فیزیولوژیکی، عوامل زیاد دیگری نیز کیفیت گل‌های بریدنی تولیدی را در کل دوره تولید تحت تاثیر قرار می‌دهند. در این آزمایش، نقش و تاثیر سن گیاه و روش‌های متفاوت تیمار شاخه روی مشخصات فیزیکی و ظاهری گل‌های تولید شده مورد مطالعه قرار گرفت. برای این منظور سن گیاه به صورت گیاهان جوان تازه تکثیر شده به روش تیل پیوندی و گیاهان سه ساله تکثیر شده به همان روش به همراه چهار روش متفاوت تربیت شاخه بررسی شد. نتایج حاصل نشان داد که زمان لازم تا رویش جوانه برای گیاهان جوان کوتاه‌تر بود در صورتی که این زمان در گیاهان مسن به ویژه تیمارهایی که روی جوانه‌های سوم و پنجم هرس شدند، طولانی‌تر بود و به حدود ۱۵ روز رسید. به طور کلی گیاهان جوان از لحاظ برخی مشخصات کیفی و بازارپسندی مانند طول شاخه، کیفیت گل و قطر شاخه نسبت به گیاهان مسن برتر بودند. زمانی که شاخه‌های بالای جوانه پنجم هرس شدند، سطح برگ شاخه و وزن شاخه افزایش یافت. در نهایت، گیاهان جوان با تمایل به تولید حجم بیشتر برگ روی شاخه‌های قوی‌تر، صفات بازارپسندی بهتری را از خود نشان دادند.

**واژه‌های کلیدی:** تیمار شاخه؛ خمش شاخه؛ رز بریدنی؛ سن گیاه؛ کیفیت گل