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Correlative Effects of Bench Chip Budded 'Mirandy' Roses[1]

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Abstract. **Bench chip budding was tested as an alternative to T-budding of roses in field bush production. Greater than 90% success was obtained when 'Mirandy' scions (*Rosa hybrida* L.) were bench chip budded to rooted 'Brooks 56' *R. multiflora* Thunb. rootstocks with a Liliput budding tool. Growth of chip budded scions was inhibited by the presence of rootstock lateral shoots. This correlative inhibition was overcome by selected forcing, girdling, and pruning treatments to promote vigorous scion growth. Best chip bud growth was obtained when scions were budded onto the same side as rootstock lateral shoots and rootstock stems were partially cut or girdled. A positive correlation existed between 'Mirandy' scion shoot growth and flowering.**

New techniques are needed to reduce the 2-year production cycle and increase the yield of field rose bushes. Under present practices, many Texas growers harvest less than 65% of cuttings planted. The conventional T-budded method has limitations under nonirrigated Texas field conditions, since insufficient rainfall limits vascular cambial activity, which is critical for successful field grafting. Simultaneously bench chip budding and rooting dormant cuttings has potential advantages of eliminating production steps since cutting switches, de-eying cuttings (removing lower buds to prevent suckering), and budding can be done at the same time indoors during the "downtime" of winter, reducing time and discomfort to the worker who would bud on a bench vs. conventional T-budding in the field (1). In addition, simultaneously chip budding and rooting cuttings can potentially reduce the 2-year production cycle since a 3- to 6-month advantage may be gained in the development of the scion.

Rose producers traditionally fall-plant dormant *Rosa multiflora* cuttings for understock with all but 2–3 axillary buds removed to reduce suckering; the remaining axillary buds are later used as propagules for next year's rootstock generation. Rootstock axillary buds are also necessary for adequate initial root-system establishment. If the use of dormant, unrooted bench chip budded grafts is to be successful, the correlative inhibition of rootstock axillary buds on chip budded scions must be broken soon after grafted cuttings have rooted to maximize scion development and reduce production time.

It has been postulated that the correlative signal in apical dominance has a hormonal basis (4) and that downward transport of auxin through the internode was the cause of apical dominance (3). In addition, growth factors such as cytokinins are reported to be involved in budbreaks on rose branches (8). In greenhouse roses, upper shoots on each branch were found to yield more cytokinin-like activity than lower shoots (5), while 6-benzylamino purine (BA) was more effective in promoting bottom breaks (2). However, the relationship of endogenous cytokinins to apical dominance is not clearly understood, since cytokinins are either involved in the development of axillary bud growth or are required for the growth process itself (5).

The objectives of this research were to study the correlative effects of bench chip budded roses used for field bush production and to regulate apical dominance imposed by understock axillary buds utilizing selected chip bud positions, forcing, girdling, pruning, and chemical treatments to promote vigorous scion growth and reduce production time.

Materials and Methods

One-year-old dormant *Rosa hybrida* 'Mirandy' budwood and rootstock cuttings (4 mm diameter, 20 cm long) from *R. multiflora* 'Brooks 56' were collected in November from commercial fields of East Texas and stored in a dark growth chamber for 2 weeks at 0° and 5°C, respectively. All except the uppermost 2–3 lateral buds were removed by knife from rootstock cuttings to prevent suckering. Cuttings were then rooted under intermittent mist in a medium of sterilized blasting sand (Bryco). Within 21 days rooted cuttings were transplanted to 6.4 × 25.4 cm black plastic deepots (McConkey and Co., Inc.) containing sterilized media of 2 sphagnum peatmoss: 1 vermiculite: 1 perlite (v/v/v) with 4.86 g/liter dolomite limestone and 0.07 g/liter Peters fritted trace elements. Twenty-seven days after transplanting to deepots, rootstocks were chip budded in the medial position with dormant 'Mirandy' scions utilizing a Liliput budding tool (J. E. Heitz, Inc.).

The 18 treatments (Fig. 1) were as follows: 1) *Control I*—scion chip bud grafted on the same side as the rootstock lateral shoot system; 2) *Control II*—scion chip bud grafted on the opposite side of the rootstock lateral shoot system; 3) *Girdling I*—same as trt. 1 but with a 0.5-cm wide half-ring girdle at 1 cm above each chip bud; 4) *Girdling II*—same as trt. 1, but with a 0.5-cm wide half-ring girdle at 1 cm below each chip bud; 5) *Girdling III*—same as trt. 1, but with a 0.5-cm wide half-ring girdle at 1 cm above on the opposite side of each chip bud; 6) *Girdling IV*—same as trt. 1, but with a 0.5-cm wide half-ring girdle at 1 cm below on the opposite side of each chip bud; 7) *Girdling V*—same as trt. 2, but with a 0.5-cm wide half-ring girdle at 1 cm above on the opposite side of each chip bud; 8) *Girdling VI*—same as trt. 2, but with a 0.5-cm wide half-

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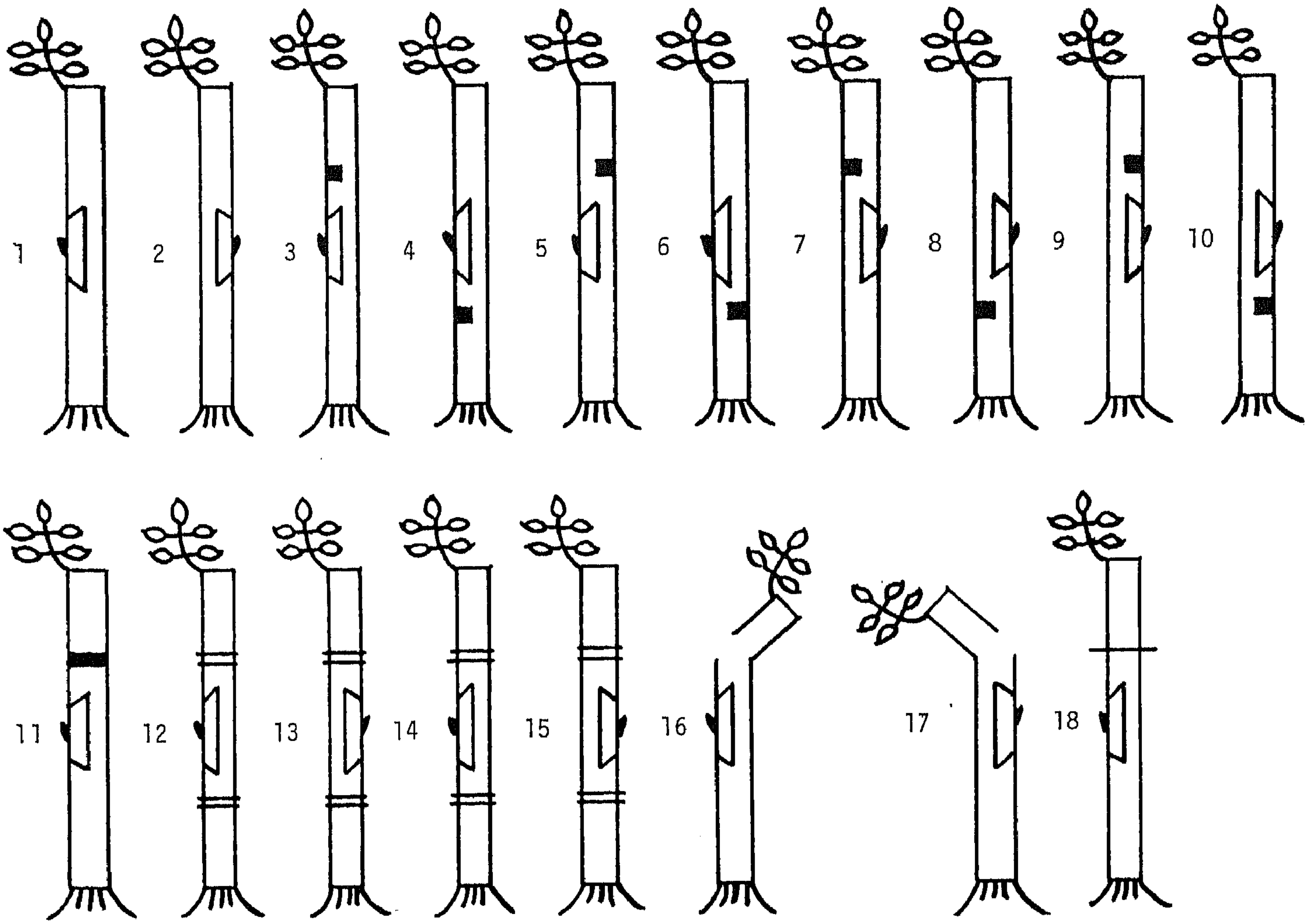

Fig. 1. Diagram of 18 selected budding positions: control (1–2), girdling (3–9), BA (12–15), and forcing (16–18) treatments of 'Mirandy' scions chip budded to 'Brooks 56' rootstock. Chip buds were grafted either on the same side or opposite the rootstock lateral shoot. Girdling of understock was done either above or below and on the same side or opposite the chip bud. BA was applied in lanolin paste at 1 (trt 12, 13) or 2 (trt. 14, 15) g/liter. Forcing consisted of transversely cutting and bending the understock on the same side or opposite the chip bud or completely removing the rootstock 1 cm above the chip bud.

ring girdle at 1 cm below on the opposite side of each chip bud; 9) *Girdling VII*—same as trt. 2, but with a 0.5-cm wide half-ring girdle at 1 cm above each chip bud; 10) *Girdling VIII*—same as trt. 2, but with a 0.5-cm wide half-ring girdle at 1 cm below each chip bud; 11) *Girdle IX*—same as trt. 1, but with a 0.5-cm wide whole-ring girdle at 1 cm above each chip bud; 12) *BA I*—same as trt. 1, but with lanolin paste containing 1 g/liter BA applied around the stem at 1 cm above and below each chip bud; 13) *BA II*—same as trt. 2, but with 1 g/liter BA lanolin paste application; 14) *BA III*—same as trt. 12, but with 2 g/liter BA; 15) *BA IV*—same as trt. 13, but with 2 g/liter BA; 16) *Forcing I*—same as trt. 1, but each rootstock was transversely cut half way through at 1 cm above the chip bud and the top of rootstock was subsequently bent at the cut to the opposite side of the chip bud; 17) *Forcing II*—same as trt. 16, except scion chip bud grafted on the opposite side of the rootstock lateral system; and 18) *Forcing III*—same as trt. 1, but the top of each rootstock was cut off at 1 cm above the chip bud.

There were 20 grafts per treatment replicated 4 times in a randomized complete block design. Only one lateral shoot was retained on each rootstock and subsequently trimmed to 5 nodes long after all treatments to unify its influence. The top of each rootstock was then pruned off at 1 cm above the chip bud 30 days after chip budding to enhance scion growth. Long days were maintained in the greenhouse with supplental incandescent light from 1800 to 0100 HR (6 μE m^{-2}s^{-1}). All plants were fertilized weekly with 400 mg/liter 15N–15K–15P soluble fertilizer and monthly with Peters trace element mix at 0.6 g/liter. Data taken every 10 days after chip budding included stem length, lateral bud growth, and flowering of scions. As an indication of rootstock shoot system growth, the rootstock was measured 30 days after scions were chip budded.

Results

After 30 and 50 days, girdling above the chip bud on the same side of the rootstock shoot (trt. 3) was more effective in promoting scion chip bud growth than controls (trt. 1, 2; Table 1). Other girdling methods (trt. 4–11) either had no effect or reduced scion shoot length. After 50 days, forcing buds by partly cutting the rootstock between the scion bud and rootstock shoot and subsequently bending the rootstock (trt. 16) stimulated greater scion shoot growth than controls (trt. 1, 2; Fig. 2). BA lanolin paste application and other forcing treatments did not effectively enhance scion shoot growth.

Table 1. Effect of 18 selected budding positions, girdling, BA, and forcing treatments on budding success, flowering, and growth rates of scion and rootstock shoots of *R. hybrida* 'Mirandy' bench chip budded to *R. multiflora* 'Brooks 56' understock. See Fig. 1 and text for explanation of treatments.

							Brooks 56 understock
		Mirandy scion			Budding success (%)	Plants flowering (%)	Mean length of the stock shoot (cm)
Treatment		Mean length of scion shoot (cm)					
No.	Description	10 days	30 days	50 days	50 days	60 days	30 days[z]
1	Control I	1.2a[y]			90ab	10cd	42.3a
2	Control II	1.0ab	3.1bcd	12.3bcde	90ab	25bc	34.6bcde
3	Girdling I	1.3a	9.3a	21.2a	90ab	40ab	30.8cde
4	Girdling II	0.8bcde	1.2d	4.0e	90ab	0d	41.4ab
5	Girdling III	0.8bcde	2.6cd	6.2de	70b	10cd	35.1abcde
6	Girdling IV	0.6de	1.5d	4.6e	90ab	0d	36.4abcde
7	Girdling V	0.9abcd	6.7abc	16.4abcd	95a	40ab	30.2cde
8	Girdling VI	0.6de	2.4d	7.1de	85ab	5d	29.0de
9	Girdling VII	0.6de	1.6d	4.6e	90ab	5	39.3abc
10	Girdling VIII	0.6cde	0.6d	1.2e	95a	0d	38.2abcd
11	Girdling IX	0.5e	2.6cd	13.4abcde	20c	0d	22.8ef
12	BA I	0.7bcde	1.9d	4.7e	90ab	5d	41.2ab
13	BA II	0.8bcde	3.9bcd	13.1bcde	95a	15cd	32.1bcde
14	BA III	1.0ab	2.8cd	8.2de	95a	5d	32.5cde
15	BA IV	0.9abcde	4.8bcd	16.4abcd	95a	25bc	27.0e
16	Forcing I	1.1ab	7.0ab	23.9a	90ab	50a	15.8f
17	Forcing II	0.5de	4.4bcd	18.3abc	85ab	30bc	28.0e
18	Forcing III	0.6cde	1.0d	3.0e	5c	0d	---

[z] The top of each rootstock was pruned off 30 days after chip budding.

[y] Mean separation within columns by Duncan's multiple range test, 5% level.

Greater rootstock shoot growth occurred in controls with chip buds grafted on the same side of the rootstock lateral shoot system (trt. 1) compared to controls with grafts on the opposite side of the rootstock (trt. 2). Completely girdling above the chip bud (trt. 11) or applying 2g/liter BA (trt. 14) reduced rootstock shoot growth when buds were grafted on the same side of the rootstock system. The most effective girdling and forcing methods (trt. 3, 16) for stimulating scion growth conversely caused large reductions in understock shoot development (Fig. 2).

Most treatments resulted in 90% or higher budding success, while in comparison completely girdling (trt. 11) or decapitation (trt. 18) decreased budding success to 20% and 5%, respectively (Table 1). Girdling (trt. 3, 7) and forcing (trt. 16) promoted flowering of scions.

Discussion

The most effective techniques for promoting scion growth was either girdling (trt. 3) or partially pruning (trt. 16) between the scion and lateral rootstock shoot. This may be due to blocking the downward transport of inhibitors or auxin produced by the rootstock lateral shoots (4, 5). However, these treatments caused a decrease in rootstock lateral shoot growth possibly due to competition for metabolites and nutrients. Partially pruning with the bud opposite the rootstock shoot (trt. 17) also broke apical dominance induced by rootstock lateral shoots for better scion development but did not break the vascular continuity between rootstock lateral shoots and the root systems; subsequently, rootstock lateral shoots obtained better growth than those of trt. 16. Decapitation (trt. 18) caused the poorest response, since pruning off rootstock tops drastically reduced photosynthetic capability of rootstocks and increased stress resulting in 95% death of plants (Table 1).

Girdling below the bud (trt. 4) inhibited scion growth, possibly from an accumulation of inhibitors, but did not inhibit rootstock growth suggesting that competition for metabolites from the root system was of lesser importance. Girdling (trt. 5, 6) done on the opposite side of chip buds was not effective in breaking apical dominance of rootstock lateral shoots; chip buds were consequently inhibited as in the control (trt. 1). Girdling (trt. 7) was not better than the control (trt. 2) which may be due to the vascular system on the opposite side of the rootstock lateral shoots being less active than that on the same side of the rootstock lateral shoots. Active buds induce differentiation of vascular tissue (6, 7) which is important for vigorous scion growth. In addition, the position of the girdle opposite and above the chip bud may not have allowed for sufficient cytokinins and other metabolites from the root system to accumulate. Girdling and forcing (trt. 3, 5, 9, 16) suggest that uninterrupted phloem tissue along the side of rootstock lateral shoots is required for maintaining apical dominance. Uninterrupted downward transport of inhibitors and/or metabolites from rootstock lateral shoots inhibited chip bud growth and ensured the dominance of rootstock lateral shoots. The poor growth of chip buds girdled below (trt. 10) may be due to disruption of the vascular connection between chip bud and root systems.

BA did not enhance scion shoot growth which may be due to inadequate absorption, too low a concentration, or cytokinins not being a limiting factor in scion development. However, 2000 mg/liter BA (trt. 14) reduced rootstock shoot growth, when buds were grafted on the same side of the rootstock shoot system. Mixed reports exist in which lateral bud growth is enhanced by low cytokinin levels in some plants, while in other systems increasing cytokinin levels enhanced lateral bud growth (6). Our results indicate that rootstock shoot development was reduced

Fig. 2. Optimal 'Mirandy' scion growth (arrow) was obtained when 'Brooks 56' understock was partially cut and bent over between the graft and rootstock shoot (trt. 16).

at higher cytokinin levels whereas axillary bud development of dormant scions was not affected.

Girdling and forcing (trt. 3, 16) effectively broke apical dominance imposed by rootstock shoots when compared to control (trt. 1); consequently, dormancy of chip buds was broken and maximum flowering occurred, suggesting a positive correlation between scion shoot growth and flower development. In field production of rose bushes we observe that transversely cutting and bending the rootstock 1 cm above the chip bud (as trt. 16) is an effective technique for breaking correlative inhibition (unpublished). Removal of correlative inhibition both by initially pruning rootstocks and later pruning elongated scions to encourage axillary scion budbreaks must occur early in the growth cycle to reduce production time.

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Auxin Transport in *Dracaena marginata* Stems[1]

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Abstract. **Basipetal auxin transport occurred in intact and excised *Dracaena marginata* stem sections at an apparent velocity of about 5 mm/hr. Application of 20 µl of 0.1 mM 2,3,5-triiodobenzoic acid (TIBA) to the basal cut end of a 3-cm stem segment excised 20 cm from the apex of 1-m-tall plants reduced basipetal auxin transport by 60%. Similar application to the apical end had no effect on acropetal auxin movement. Lateral auxin movement was observed 24 hours after application of radioactive auxin to decapitated stems which had grown horizontally for at least 30 days.**

Many woody ornamental plants would be more valuable and more esthetically pleasing if their branching could be controlled. Branching and growth of axillary buds is often stimulated either by removal of the stem apex, or by girdling or sharply bending the stem (2). These practices are commonly used to promote the breaking of inactive axillary buds in *D. marginata*. Bud growth usually occurs immediately below the treatment site. These treatments seem to act either by removing the source of, or interfering with the basipetal transport of compounds from the apex which promote or inhibit bud growth. Auxin is known to inhibit axillary bud growth in many species (2, 3), and many of the treatments which promote branching are known to interfere with the basipetal transport of this plant hormone (3).

Over the past 3 years, we have tried various means to stimulate branching in *D. marginata*. Repeated applications of either aqueous

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