Stimulation of Basal and Axillary Bud Formation of Container-grown Hybrid Tea Roses[1]

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Abstract

Two plant growth regulators, 6-benzylaminopurine (BA) and sodium salt of 2,3,4,6-bis-O-(1-methylethylidene)-a-L-xylo-2-hexulofuranosonic acid [dikegulac-sodium (DS)], were applied separately to container-grown two-year-old hybrid tea rose cultivars 'Honor', 'Peace', 'Tournament of Roses', 'Touch of Class', and 'Prima Donna' to study the effects on basal and axillary shoot production. Four rates of BA (0, 75, 125 and 250 ppm) or DS (0, 250, 500 and 1000 ppm) were applied as drenching sprays to the graft union or with floral foam applied basally or to the top of a cut cane. 'Tournament of Roses' had the greatest number of basal shoots when BA was applied at 75 ppm to a cut cane with a floral cube. 'Peace' and 'Prima Donna' had the greatest number of basal shoots when BA was applied at 250 ppm to a cut cane with a floral cube. Axillary shoots increased on 'Honor' when BA was applied as a basal floral foam. DS increased axillary shoots for 'Peace' only when applied as a drenching spray to the bud union. Otherwise, DS did not increase basal shoots for any other cultivar regardless of application method and rate. Neither chemical nor application method consistently promoted basal and axillary shoots in all five cultivars.

Index words: *Rosa* sp., cultural practices, plant growth regulators, pruning.

Significance to the Nursery Industry

Nursery growers producing container-grown roses using young, lower-grade, plants to reduce expenses could increase the number of basal and axillary shoots with plant growth regulators. Independent garden center and nursery owners must compete with increased discount mass market enterprises. Better quality rose plants offer a way to compete with these discount vendors. Lower-grade, cheaper dormant rose plants may be improved with plant growth regulator applications offering the independent retailer a means to combine improved quality at a competitive price.

Introduction

Plant growth regulators (PGRs) have been used for more than 60 years to stimulate adventitious buds or induce the growth of preformed bud initials at the union of the bud and understock or axillary buds of roses improving plant vigor and enhancing flower production (1, 5, 14). Non-chemical induction of branching requires manual pinching and pruning (8). Inhibition of bud formation was first attributed to auxin after Asen and Hamner (1) applied 2,3,5-triiodobenzoic acid (TIBA), an auxin transport inhibitor, in a lanolin paste at the base of rose plants to stimulate basal shoots. However, these results have been difficult to repeat (5, 14).

Increased branching and stimulation of axillary bud formation using PGRs has been extensively studied. Owings and Newman (15) reported increased branching of *Photinia x fraseri* three months after application of dikegulac-sodium (DS). Cytokinins, 6-(benzylamino)-9-(2-tetrahydropyran-yl)-9-H-purine (PBA) and N^6-benzyladenine (BA), and (2-chloroethyl) phosphonic acid (ethephon) are three PGRs that have been demonstrated effective in promoting bud formation of roses (14). The most effective treatments were those applied to the base of the plant in either a lanolin paste (5, 16, 8) or a foam spray (5). Carpenter and Rodriguez (5) observed favorable results using floral foam cubes soaked in PGRs and applied to cut-back rose canes. Axillary bud formation and shoot development increased using these application methods for PBA and BA. When applied in a lanolin paste to the base of the plant, TIBA increased shoot development (1). Renewal shoots were not increased by any chemical or application method without TIBA (3, 5, 8, 16), which may indicate that TIBA is required for the formation of initials (1) and subsequent growth of the buds is stimulated by cytokinins (3, 5, 17).

If a rose plant is to remain productive, then it must produce one or two renewal canes and new axillary shoots each year (8). Renewal shoots are those that originate from the union of the bud and understock from either adventitious or preformed bud initials. Axillary shoots are those that originate from buds in the leaf axils. Durkin (7) indicated that renewal (basal) shoots are more common on young rose plants; however, most research has concentrated on the rejuvenation of older greenhouse-grown rose plants. The ability of a plant to produce canes decreases with age and greenhouse growers replace plants every four to six years (11). Since plant replacement is expensive due to plant and labor costs (9), finding a PGR and a method of application that would consistently produce basal and axillary shoots would also benefit greenhouse rose growers. A reliable means of inducing basal and axillary shoots on young rose plants with PGRs would provide growers a means of producing superior plants for retail sale. The objectives of this study were to determine the effects of two branching PGRs, BA and DS, on basal and axillary shoot production in young, lower-

[1]Received for publication September 12, 1994; in revised form December 23, 1994. Mississippi Agricultural and Forestry Experiment Station Journal Series J-8580. This study was supported by Hatch Project MIS-1324 and completed in partial fulfillment of the degree Doctor of Philosophy. The authors gratefully acknowledge the donation of plant materials from Bear Creek Gardens, Medford, OR.

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grade, container-grown rose plants, and to determine a more effective method and rate of application for BA or DS to container-grown rose plants.

Materials and Methods

Five hybrid tea rose cultivars were selected according to their ability to produce basal shoots; 'Honor' and 'Prima Donna' are known to break poorly, while 'Touch of Class', 'Tournament of Roses', and 'Peace' are known to break well (19). Bare-root rose two-year old plants (Grade No. 1½) of each cultivar on 'Dr. Huey' understock were obtained March 16, 1990, from Bear Creek Gardens, Medford, OR. Plants were rehydrated for two days by laying out the plants on a bench under intermittent mist. The roots were then dipped in 50% benomyl fungicide, broken branches pruned, and potted into 11 liter (#3) polyethylene pots. The medium was milled pine bark containing 3.56 $kg \cdot m^{-3}$ (6 lb/yd^3) of 18N-2.6P-10K slow release fertilizer (18-6-12 Osmocote, Sierra Corporation, Milpitas, CA), 37 $g \cdot m^{-3}$ (1 oz/yd^3) of fritted trace elements (Peter's FTE, Grace/Sierra), and 1.78 $kg \cdot m^{-3}$ (3 lb/yd^3) of dolomitic limestone.

Thirteen weeks after transplanting, the plants were moved to a quonset framed structure covered with 47% shade cloth (53% of full sun), and automatically irrigated with one spray stake per pot. Water was applied at three intervals, four-hours apart daily between at 8:00 am and 4:00 pm. At 6-week intervals, plants were fertilized with 74 g (2 oz) per pot of 12N-2.6P-5K (12-6-6 Parker's Sta-Green Nursery Special, Sylacauga, AL).

Basal Foam Application. Established plants of cultivars 'Honor' and 'Touch of Class' were pruned to ⅓ to ½ of their height, and all flower buds and flowers were removed from remaining canes July 19, 1990. Cubes of floral foam (Smithers-Oasis Co., Kent, OH) measuring 2.5 × 2.5 × 2.5 cm (1 × 1 × 1 in) were saturated with either BA (0, 75, 125, or 250 ppm) or DS (0, 250, 500 or 1000 ppm). A 1 cm (0.39 in) wound was made on opposite sides of the base of a randomly chosen cane from each plant. The cubes were applied to the wounds and wrapped in paraffin film for two weeks to prevent drying and improve absorption. The experimental design was a randomized complete block in a factorial arrangement of two cultivars, two PGRs, and four rates arranged in three blocks containing 16 plants each. The number of main canes, basal, and axillary shoots were noted for each plant at the time of treatment and at termination August 23, 1990. Data were analyzed as the difference between the number of basal and axillary shoots initially and at the termination of the experiment. This was done to remove the inherent variability often encountered with field-grown rose plants. A basal (renewal) shoot was defined as a vigorously growing shoot that arose from the area of the graft union. Axillary shoots were defined as vigorously growing shoots arising from a leaf axil.

Terminal Foam and Spray Application. Established plants of 'Tournament of Roses' and 'Peace' and 'Prima Donna' were pruned as previously described. Terminal foam application treatments were accomplished using floral foam cubes 4 × 4 × 4 cm (1.6 × 1.6 × 1.6 in) saturated with either BA (0, 250, 500 or 1000 ppm) or DS (0, 500, 1000, or 2000 ppm). One cube was placed on the cut surface on top of a randomly selected main stem (cut to ⅓ to ½ original height) of each plant. A plastic bag was placed over each cube and stem to reduce drying of the foam cubes permitting absorption over a longer period. Spray applications to run off of either BA (0, 250, 500 or 1000 ppm) or DS (0, 500, 1000, or 2000 ppm) were applied to the bud union July 25, 1990, and followed by a second spray August 1, 1990. Each spray treatment was performed between 8:00 am and 9:00 am CST. No surfactant was used and the medium was shielded from drift.

The number of main canes, axillary, and basal and axillary shoots were noted for each plant at the time of treatment and at termination, 11 weeks after treatment as previously described. The apical foam application study was terminated August 27, 1990, and the spray application study was terminated September 5, 1990. The experimental design was a randomized complete block design in a factorial arrangement of three cultivars, two application methods, two PGRs and four PGR rates in three blocks containing 48 plants each.

Table 1. Effects of benzyladenine (BA) on the number of new basal and axillary shoots of hybrid tea roses 'Tournament of Roses', 'Peace' and 'Prima Donna' when applied to a cut rose cane in a four cm floral foam cube.

Cultivar	Benzyladenine rate (ppm)	Basal shoot (number)	Axillary shoot (number)
'Tournament of Roses'	0	−1.00	2.50
	75	2.00	1.33
	125	1.67	−0.33
	250	−1.00	2.67
Linear		NS[z]	NS
Quadratic		*	*
'Peace'	0	0.67	2.00
	75	3.00	−1.67
	125	4.67	−1.00
	250	4.67	−0.33
Linear		*	NS
Quadratic		NS	NS
'Prima Donna'	0	0.50	0.00
	75	4.67	−1.67
	125	2.67	−1.67
	250	3.33	3.00
Linear		NS	NS
Quadratic		NS	NS
LSD (α =0.05)		2.87	2.60

[z]NS, *, ** = not significant, significant at the 0.05 level, and significant at the 0.01 level, respectively.

Results and Discussion

Young rose plants are prone to produce basal and axillary shoots (7). Growers using young, lower-grade, rose plants to reduce costs could benefit economically by increasing the quality of those plants with PGR applications for retail container sales. Independent garden centers and nurseries must contend with the increase of discount sales in the nursery industry. Low price products offer a way to compete with discount operators (13). Selling lower-grade roses that have been improved by PGR applications offers the independent retailer a means to combine improved quality with low price.

Table 2. **Effects of dikegulac-sodium (DS) on the number of new basal and axillary shoots of hybrid tea roses 'Tournament of Roses', 'Peace' and 'Prima Donna' when applied as a drenching spray to the graft union.**

Cultivar	Dikegulac rate (ppm)	Basal shoot (number)	Axillary shoot (number)
'Tournament of Roses'	0	1.33	0.00
	500	1.00	1.67
	1000	–0.33	–3.00
	2000	0.67	0.67
Linear		NS[z]	NS
Quadratic		NS	NS
'Peace'	0	2.00	–0.25
	500	4.33	1.00
	1000	0.50	3.00
	2000	2.00	4.00
Linear		NS	*
Quadratic		NS	NS
'Prima Donna'	0	3.33	0.00
	500	2.33	–1.67
	1000	3.00	–1.67
	2000	2.67	3.00
Linear		NS	**
Quadratic		NS	NS
LSD (α =0.05)		2.87	2.60

[z]NS, *, ** = not significant, significant at the 0.05 level, and significant at the 0.01 level, respectively.

Basal applications of 75 ppm or 125 ppm BA produced an average of three more axillary shoots than 0 ppm or 250 ppm for 'Honor' only. Basal applications of BA did not increase basal shoots for either cultivar (data not shown). Basal applications of DS had no effect on increasing basal or axillary shoots on either cultivar as well (data not shown). The number of basal shoots for BA applied in foam cubes to cut canes was increased up to 75 ppm for 'Tournament of Roses', and 1000 ppm for 'Peace' (Table 1). DS applied in the same manner did not increase basal or axillary shoots on any cultivar (data not shown). BA applied as a drenching spray did not increase the number of basal or axillary shoots on any cultivars and DS did not increase the number of basal shoots for any three cultivar (data not shown). Spray application of DS increased the number of axillary shoots for 'Peace', but did not increase shoot numbers for 'Tournament of Roses' or axillary shoots of 'Prima Donna' decreased linearly in response to DS (Table 2).

A comparison of application methods using pooled data for PGRs, rates, and cultivars, showed that apical floral foam and drenching spray applications stimulated a similar production of basal shoots for 'Prima Donna', 'Peace', and 'Tournament of Roses' (Table 3). More axillary shoots than basal shoots were produced using the floral foam cubes at the base of 'Honor' and 'Touch of Class' (Table 3).

Benzyladenine and DS had similar capacities to promote the development of basal and axillary shoots on all cultivars, but DS at the higher rates caused greater morphological changes in all cultivars than BA. Plants subjected to 500 and 1000 ppm DS had deformed flowers and leaves. Leaves were smaller, more elliptical, and chlorotic, while flowers were smaller with smaller petals. Multiple crowns were also present in many plants. Leaf chlorosis was noted in both 'Honor' and 'Touch of Class' with the basal foam cube application of DS and BA. Cultivars receiving the drenching spray treatment had better foliage, blooms, and plant shape compared to plants from the other treatments.

Table 3. **Comparison of the plant growth regulator application method on the number of new basal and axillary shoots from pooled data of hybrid tea roses 'Tournament of Roses', 'Peace' 'Prima Donna', 'Honor', and 'Tournament of Roses'.**

Application method	Basal shoot (number)	Axillary shoot (number)
Foam at the base	0.09b[z]	5.19a
Foam at the top of the cane	2.02b	0.58c
Drenching spray at the base	2.18a	1.23b

[z]Means within columns and plant growth regulators followed by the same letters were not different at the 0.05 level according to the Least Significant Difference (LSD) Test.

The drenching spray method produced the most balanced response with an average of 2.2 new basal shoots and 1.2 new axillary shoots per plant. The increases and decreases in basal and axillary shoot activity show that the growth regulating chemicals, BA and DS, were translocated from the sites of application throughout the plants. There was no single chemical or application method that increased basal and axillary shoots in all five cultivars. BA is a cytokinin that stimulates cell division and interacts with auxin (18), whereas, DS is a compound that is translocated to the shoot apex and temporarily arrests apical development stimulating lateral branching (2). The failure to produce basal shoots on 'Honor' with applications of BA that were favorable for an increase in axillary shoots indicates that there may be a different type of inhibition controlling basal shoots (5). More basal shoots were produced on 'Peace' than 'Tournament of Roses' with the apical foam cube application of BA, but axillary shoots did not increase as in 'Tournament of Roses'. This response in 'Peace' also pointed out the difference in basal and axillary shoot inhibitors.

Increased basal shoots on 'Peace' may have been a response to the death of axillary shoots. Death of axillary shoots may result in a hormonal responses similar to decapitation, which removes apical dominance (20). The increases and decreases for each cultivar also indicate differences in the phytotoxicity levels for the cultivars. For example, 250 ppm BA increased basal shoot production, but reduced basal shoots on 'Tournament of Roses'.

Results show that different cultivars respond differently to PGRs and methods of application. Environmental and endogenous factors affecting roses may also influence consistent increases in basal and axillary shoot production (3, 4, 5, 10, 14). Basal and axillary shoots develop naturally during seasons of high light intensity from spring until late summer (1, 12). Carbohydrate supplies would also be at a peak during this period, indicating an adequate carbohydrate supply might enhance the promotion of basal and axillary shoots (5, 17). The Mississippi climate with high humidity and warm summer nights also may interfere with carbohydrate metabolism. High night temperature increases dark respiration (6), which ultimately decreases growth. Therefore, differences in cultivar responses to PGRs could have been due to differences in carbohydrate levels in the cultivars (5), but this was not investigated in this study.

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