RESEARCH RESULTS FOR ORNAMENTAL HORTICULTURISTS

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Auburn University
Agricultural Experiment Station
Gale A. Buchanan, Dean and Director
Auburn University, Alabama

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Florist Crops

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CONTENTS

Rooting Response of Several Woody Ornamental Cuttings to Ethephon

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Nature of Work:

Initiation of adventitious root primordia as well as the development of latent pre-existing root initials have been achieved with ethylene gas and with saturated aqueous solutions of ethylene mixed with IBA (14). Ethephon (2-chloroethyl phosphonic acid) has been reported to both stimulate (9,10,12,13) and have no effect (8) on the rooting of cuttings from herbaceous plants. Little information is available on ethephon's value as a root-inducing substance for cuttings from woody plants. Ethephon inhibited the rooting of Rosa sp. L. (13) but stimulated the rooting of Juniperus chinensis Mast. cv. Pfitzeriana (19), Hibiscus Rosa-sinensis L. (9), and Salix fragilis L. (6). Early research with ethephon on woody cuttings of azalea conducted at Auburn, Alabama during 1969-72 (7, unpublished) also yielded inconsistent results. The present study was conducted to evaluate the rooting response of woody ornamental stem cuttings treated with ethephon from several other species.

Uniform cuttings, 15 cm long, of current season's growth were used in 2 experiments. After removing the basal leaves, the lower 25 cm of the cuttings were either not treated, soaked for 15 sec. in a liquid rooting substance or dipped in a rooting powder. Propagation was carried out in a lightly shaded (about 40,365 lumens per m^2) glasshouse under mist (2.5 sec/100 sec) at a diurnal air temperature of 21-27° C (thermostatical controlled heating cables). Equal parts of steam pasteurized builders sand and sphagnum peat moss were used as a rooting medium. About 6 to 8 weeks after insertion into the medium, the cuttings were evaluated for rooting as follows: 0 = dead, 1 = callused, 2 = callused, 3 = light rooting, 4 = medium rooting, and 5 = heavy rooting.

The first experiment was designed as a randomized complete block with 2 replications, 6 species or cultivars and 5 treatments. The experiment was initiated on October 11, 10 cuttings per treatment of Ilex cornuta Lindl. cv. Burfordii, Ilex cornuta Lindl. cv. Dwarf Burford, Juniperus conferta Parl., Osmanthus heterophyllus (G. Don), Pittosporum tobira (Thunb.) Ait., and Rhododendron cv. Kingfisher. The treatments are shown in Table 1. Rooting was evaluated on Nov. 29.

Significant differences in root-inducing treatments occurred only with Osmanthus heterophyllus and Rhododendron cv. Kingfisher. Rooting of Osmanthus cuttings treated with 1,000 ppm ethephon and Hormodin No. 2 was comparable and exceeded untreated cuttings (Table 1). Rooting of Rhododendron was increased by Hormodin No. 2 but not by ethephon.

The second experiment was a factorial experiment with 3 replications, 6 species and 9 treatments. Treatments consisted of all combinations of Jiffy Grow No. 2 (a combination 5,000 ppm IBA, 500 ppm NAA, 100 ppm phenymercuri acetate and 17.5 ppm boron) water mixtures 0, 1:1,and 1:4 with ethephon at 0, 500,and 1,000 ppm. A 2,000 ppm ethephon treatment was also included on each species in this experiment. Camellia sasanqua Thunb., Ilex cornuta cv. Burfordii, Juniperus conferta, Pittosporum tobira, Rhododendron cv. Kingfisher and Thuja occidentalis L. cuttings were dipped for 15 sec. in each treatment prior to sticking on Feb. 13.

On April 17, rooting was evaluated as in the first experiment.

Results and Discussion:

Defoliation was observed on Camellia sasanqua cuttings within 24 hr. after treatment with 2,000 ppm ethephon which continued until completely defoliated within 1 week. Other ethephon treatments also dropped some camellia leaves. Defoliation was not observed on untreated or Jiffy Grow - treated cuttings which were randomly positioned among ethephon treated cuttings. The treatment with 2,000 ppm ethephon on Camellia cuttings was repeated with similar results using alternate rows of treated and untreated cuttings. Inconsistant callusing was observed on Camellia cuttings treated with 500 ppm ethephon and bark decay on the treated area of Thuja cuttings receiving 1,000 ppm ethephon.

Rooting values differed for the 6 species as follows: Camellia, 3.7; Ilex, 2.9; Juniperus, 4.6; Pittosporum, 2.5; Rhododendron, 4.3; and Thuja, 2.9. There was no statistically significant interaction between species and treatment. Ethephon treatments were not significantly different in regard to rooting. Both concentrations of Jiffy Grow No. 2 increased rooting of the 6 species.

Ethephon was an effective root-inducing substance for Osmanthus but produced inconsistent results on Rhododendron and was ineffective for stimulating the rooting of other species. These results indicate that the effectiveness of ethephon as a root-inducing substance is limited. Differential sensitivity to ethephon has been observed in other test systems (5) and may similarly be involved in the rooting response. Root growth in Salix cuttings has been stimulated with greater concentrations of ethephon (1760 ppm) and a longer duration of treatment (24 hr.) than used in the present study (6). Treatment time may be more critical than anticipated in this study. Ethephon may act like ethylene in developing root initials (4) and therefore be subject to the physiological state of the cutting, i.e., presence of preformed root initials, buds, cambial dormancy, seasonal dormancy or growth phase (11). Ethephon's release of ethylene is pH sensitive with greater amounts of ethylene produced with increasing pH (3). Consequently, plant tissue pH may be a factor in ethylene release. The presence or absence of natural auxin has been reported to influence ethylene activity (4), and while not determined in this study would be expected to vary between species. Ethylene also has been found to be a normal intermediate in auxin-mediated root growth inhibition (2) which may be an operative system in cuttings. Other changes are also ascribed to ethephon such as: enzyme stimulation; mobilization of food reserves; inhibition of cell division; auxin metabolism and transport and extension of cell expansion (1). Inducing these changes may not be conducive to root growth or initiation (1). Further investigation on these factors may explain the varying response of cuttings to ethephon as a root-inducing substance and lead to its acceptance at least for certain species as a root promoting growth regulator.

Table 1. Mean rooting scores of Osmanthus heterophyllus and Rhododendron cv. Kingfisher stem cuttings treated with Hormodin No. 2 and Ethephon (Experiment 1)[z]

Treatment	Osmanthus heterophyllus	Rhododendron cv. Kingfisher
None	2.5 cd[y]	2.1 cd
Hormodin No. 2[x]	3.8 a	3.0 a
500 ppm Ethephon	1.9 d	2.3 bcd
1,000 ppm Ethephon	3.4 ab	c.1 cd
2,000 ppm Ethephon	2.7 bcd	2.5 cd

[z] Rooting scroing: 0 = dead; 1 = alive, not callused; 2 = callused; 3 = light rooting; 4 = medium rooting; 5 = heavy rooting.

[y] Mean separation, in columns, by Duncan's multiple range test, 5% level. Numbers followed by the same letter(s) are not statistically different.

[x] 3,000 ppm IBA.

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Propagation of Azalea Cuttings Treated with Chemical Pinching Agents Prior to Rooting

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Nature of Work:

Removal of the terminal portion of the plant or "pinching" is a common commercial practice in the propagation of azaleas, Rhododendron cultivars, to influence axillary shoot development. Chemical pinching agents can perform this task, however, until recently, most chemical pinching agents destroyed plant tissue (4) and increased the risk of disease. Atrinal™, a new chemical pinching agent has been found to increase branching in azaleas without destroying plant tissue (2,3,5). Cohen (1) has reported that the treatment of azalea stock plants with Atrinal™ does not affect the rooting percentage of azalea cultivars. Shu and Sanderson (6) applied several chemical pinching agents to cuttings 3 weeks after placement in the propagation bench and found that untreated cuttings produced more roots than chemical treatments. Also, chemical pinching agent treatment generally did not increase the number of shoots on cuttings.

Objectives of the present study were to determine: (1) the effects of several chemicals applied to stock plants on subsequent rooting of cuttings (Experiment 1) and (2) to further evaluate the application of chemical pinching agents to cuttings in the propagation bench (Experiment 2).

Experiment 1. Azalea stock plants, cv. 'Prize', were sprayed on June 21, 1979 with the following chemicals: 0.50% Atrinal™, 0.25% Atrinal™, 4.20% Off-Shoot-O™, 1.00% UBI-P293 (oxathiin), 0.50% Chemshear™, 0.48% Ethrel™ (ethephon), 2.50% Tipnip™, 0.08% Accel™ (PBA), 0.50% B-Nine™, 0.30% Cycocel, and 2.50% Royaltac™. A check or no treatment was included for comparison and treatments were applied in a randomized block design consisting of 1 plant per treatment and 5 replications. Nine weeks after spraying the stock plants, 10 cuttings were randomly removed from each stock plant and propagated in mason's sand. A root inducing substance consisting of 1:1 (V/V) Hormodin™ No. 3 and ferbam was applied to the base of all cuttings. Bottom heat (22.2°C or 72°F) and automatic mist (5 seconds per 5 minutes) were applied to the propagation bench. The experimental design was a randomized block with 12 treatments, 10 cuttings per treatment and 5 replications. Rooting was indexed from dead (0) to heavy rooting (8) 7 weeks after placement of the cuttins in the propagation medium.

Experiment 2. Cuttings of azalea cv. 'Kingfisher' and 'Prize' were propagated in mason's sand. A root inducing substance consisting of 1:1 (v/v) Hormodin™ No. 3 and ferbam was applied to the base of all cuttings. Bottom heat 22.2°C (72°F) and automatic mist system (5 seconds per 5 minutes) were applied to the propagation bench. The experimental design was a randomized block with 10 treatments, 10 cuttings per treatment and 5 replications. Cuttings were sprayed with 2.50 % Tipnip™, 2.50% Royaltac™, 0.48% Ethrel™ (ethephon), 0.50% Chemshear™, 1.00% UBI-P293 (oxathiin), 0.08% Accel™ (PBA), 1.20% Off-Shoot-O™ and 0.50% Atrinal™ (dikegulac sodium) 3 weeks after the cuttings were placed in the propagation media. A non-treatment check was included for comparison. Seven weeks after treatment new shoot numbers were counted and the amount of rooting was indexed from dead (0) to heavy rooting (8).

Results and Discussion:

Experiment 1. Chemical treatment of stock plants prior to subsequent propagation of cuttings did not statistically influence rooting (Table 1). This result agrees with that of other workers (1,4). One week after treatment, Chemshear™ stock plants appeared wilted and some leaves had turned brown. Three weeks after stock plant treatment, some chemically treated shoots exhibited axillary shoot development.

Treatment of cuttings with Tipnip™, Royaltac™, Ethrel™, Chemshear™, Accel™, 4.20% Off-Shoot-O™ and 2.10% Off-Shoot-O™ during propagation, resulted in the destruction of plant tissue within 2 weeks. All chemical treatments except Off-Shoot-O™ and Tipnip™ showed axillary shoot development at this time. Check plants exhibited new leaves. Leaves of Atrinal™-treated cuttings had a reddish coloration. The application of Royaltac™, and 4.20% Off-Shoot-O™ during propagation reduced the number of shoots per cutting of both cultivars (Table 2). Tipnip™ and Chemshear™ treatments reduced the number of shoots on 'Kingfisher' cuttings while UBI-P293 and Accel™ reduced the shoot number of 'Prize' cuttings. With both cultivars, Atrinal-treated cuttings had the same number of shoots statistically as the untreated cuttings. The chemical pinching agents at the concentrations tested in this study do not seem to increase the shoot number of cuttings during propagation. The use of Atrinal™ should be re-examined for its influence on the type of axillary shoot development and plant size obtained. Tipnip™, Royaltac™, Ethrel™ and Off-Shoot-O™ treatments reduced the rooting of cuttings for both cultivars. Chemshear™ treatments reduced the rooting of 'Kingfisher' cuttings but not 'Prize' cutting. Accel™-treated 'Prize' cuttings had lower rooting indexes than the check. Chemshear™ reduced the rooting of 'Kingfisher' cuttings but not 'Prize' cuttings. These results agree with a previous study (6) that showed that chemical pinching agents do not enhance the rooting of azalea cuttings.

Table 1. Rooting Index of 'Prize' Azalea Cuttings Taken from Stock Plants Treated with Various Chemical Pinching Agents and Retardants

Treatment	Rooting index[z/]
Atrinal 0.50%	5.9 a[y/]
Atrinal 0.25%	6.3 a
Off-Shoot-O 4.20%	6.4 a
UBI P-293 1.00%	5.8 a
Chemshear 0.50%	6.2 a
Ethrel 0.48%	6.1 a
Tipnip 2.50%	6.3 a
PBA 0.08%	5.8 a
B-Nine 0.50%	5.9 a
Cycocel 0.30%	6.3 a
Royaltac 2.5%	6.5 a
Check	6.1 a

z/ Rooting was indexed from 0 (dead) to 8 (heavy rooting).

y/ Mean separation in columns by Duncan's multiple range test, 5% level.

Table 2. New Shoot Number and Rooting Index of Azalea Cuttings Sprayed with Chemical Pinching Agents During Propagation

Treatment	New shoot no.		Rooting index[z]	
	Kingfisher	Prize	Kingfisher	Prize
Tipnip 2.50%	5.0 bc[y]	8.8 abc	1.7 d	3.9 d
Royaltac 2.50%	5.4 bc	8.0 bc	3.9 c	4.2 dc
Ethrel 0.48%	8.2 ab	10.2 abc	4.2 bc	4.2 dc
Chemshear 0.50%	5.8 b	11.6 a	4.7 bc	6.8 a
UBI-P293 1.00%	8.4 ab	8.0 bc	5.6 ab	6.0 abc
PBA (Accel) 0.08%	8.2 ab	7.4 c	5.3 abc	4.7 bcd
Off-Shoot-O 2.10%	6.2 ab	11.4 a	3.9 c	4.7 bcd
Off-Shoot-O 4.2%	2.0 c	7.8 bc	1.1 d	4.6 bcd
Atrinal 0.50%	10.8 a	11.6 a	5.6 ab	6.1 ab
Check	10.2 a	11.0 ab	6.6 a	6.5 a

[z]Rooting was indexed from 0 (dead) to 8 (heavy rooting).

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

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Further Studies on Atrinal on Azalea Plants: Concentration and Cultivars

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Nature of Work:

The chemical pinching agent, Atrinal™ or dikegulac sodium (sodium salt of 2,3:4, 5-bis-O-(1-methylethylidene-α -L-xylo-2-hexylofuranosonic acid), has been found to be an effective chemical pinching agent on azaleas (2,3,4,5,6,7,8,9). Sanderson and Martin (9) have also noted that it improves plant shape and reduces the number of by-pass shoots at flowering. Delayed plant growth following treatment (2,3,4,7,8), as well as retardation (2,7,9), has raised serious questions concerning the use of Atrinal™ in the production of azaleas. Researchers have reported growth delays from 7 weeks (4) to 24 weeks (8). Shu and Sanderson (10) found that 5 to 6 weeks after Atrinal™ treatment, shoot length increased normally, indicating that dikegulac sodium did not have a long term depressive effect on azalea shoot growth and development. Atrinal's cost and potential retarding effects may vary with the cultivar and concentration used.

The purpose of the present investigation was to examine the effect of various concentrations of Atrinal on 5 cultivars of azaleas.

Cuttings of azalea cvs. Alaska, Dorothy Gish, Gloria, Kingfisher, and Red Wing were propagated on June 26, grown as liners in 65°F minimum night temperature (MNT) greenhouse, sheared to 5½ inches in height on January 20, and treated with Atrinal™ at concentrations of 0.30 per cent, 0.40 per cent, 0.50 per cent and 0.60 per cent on March 22. Both a check (no treatment) and a 4.20 per cent Off-Shoot-O™ treatment were included for comparison. Approximately 18.3 ml of spray solution was applied to each plant with a low pressure, high volume sprayer. A randomized block design consisting of 5 replications, 6 treatments, and 4 ('Alaska' and 'Dorothy Gish'), 7 ('Gloria'), or 8 ('Kingfisher' and 'Red Wing') plants per treatment was used with each cultivar being a separate experiment. Data on shoot number per plant were collected 8 weeks after treatment.

Results and Discussion:

Atrinal™-treated plants produced more shoots than check plants on all cultivars (Table 1), thus confirming the results of other researchers (2,3,4,5,7,8,9, 10). Apical dominance was rapidly restored on check plants and resulted in new shoots being initiated near the shearing point, confirming Barrick and Sanderson's (1) observations on shoot development. Shoots on Atrinal-treated plants were delayed and retarded but shoots developed further away from the shearing point than shoots on check and Off-Shoot-O™-treated plants. Atrinal at 0.50 per cent seemed to be a satisfactory concentration for maximum shoot number development on all cultivars except 'Red Wing'. A concentration of 0.60 per cent produced the maximum number of shoots on 'Red Wing' plants and was statistically different from lower Atrinal concentration, Off-Shoot-O™, and the check. 'Kingfisher' plants produced a comparable number of shoots at all concentrations of Atrinal™. Generally, Off-Shoot-O™ treatments had more shoots than the check, however Atrinal™-treated plants at 0.50 per cent and 0.60 per cent usually produced more shoots than Off-Shoot-O™-treated plants. This work shows that Atrinal at a concentration of 0.50 per cent will produce the maximum number of shoots on most cultivars.

Table 1. Number of new shoots developed on sheared azaleas cvs. 'Alaska', 'Dorothy Gish', 'Gloria', 'Kingfisher', and 'Red Wing' 8 weeks after treatment with various concentrations of Atrinal.

	Cultivars				
Treatment	Alaska	Dorothy Gish	Gloria	Kingfisher	Red Wing
Atrinal 0.30%	36.6 bc[z/]	43.1 bc	48.7 b	21.5 a	21.2 b
Atrinal 0.40%	41.8 bc	55.8 ab	49.0 b	25.3 a	22.3 b
Atrinal 0.50%	48.6 a	67.5 a	62.3 a	22.1 a	22.2 b
Atrinal 0.60%	45.0 ab	56.0 ab	63.2 a	25.2 a	25.1 a
Off-Shoot-O 4.20%	34.4 c	38.1 dc	37.8 c	15.6 b	16.6 c
Check	23.8 d	25.1 d	23.0 d	8.9 c	8.6 d

[z/]Mean separation in columns by Duncan's multiple range test, 5% level.

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Chemical Pinching of Garden Chrysanthemums with Off-Shoot-O, Tipnip, Chemshear, and UBI-P293

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Nature of Work:

Chemical pinching of Chrysanthemum X morifolium Ramat has been an objective of Auburn researchers for more than a decade (4,8). Early work considered chemicals that selectively destroyed apicial meristems. The problem restricting wide use of destructive chemical pinching agents has been the inadequacy of the safe margin between killing the terminal meristem on one hand and causing injury to non-target tissue on the other (6). This problem is less important on garden chrysanthemums than on florist chrysanthemums because garden chrysanthemums are pinched more than once and subsequent growth following a pinch would obscure damage from earlier chemical pinching. Some success in pinching garden chrysanthemums has been achieved with non-destructive or metabolic inhibitors (9). Recently, three new chemicals have become available for research purposes. Tipnip (n-undecanol and isomeric alcohol) and Chemshear (dimethyldodecylamine caprylate) affect apical meristems in the same manner as fatty acids (1,2). UBI-P293 (2,3-dihydro - 5,6 - diphenyl - 1,4 - oxathiin) is a metabolic inhibitor reported to reduce apical dominance in potted chrysanthemums (3,7) and disbud chrysanthemums (5). Visually, plant tissues are unaffected by UBI-P293 treatment. This paper reports on 2 greenhouse experiments conducted to evaluate Off-Shoot-O, Tipnip, Chemshear, and UBI-P293 as pinching agents for garden chrysanthemums. Chrysanthemums cvs. Jackpot, Stardom, Tango, and Yellow Starlet were grown 2 plants per 6-inch pot in a soil, peat, and bark (v/v/v) medium. Rooted cuttings were planted on March 20 and pinching treatments were applied on April 12 in Exp. 1. Plants received a 4-hour light break between 10 p.m. and 2 a.m. from incandescent light bulbs during March 20 to April 11. Black cloth was applied to the plants from 4:30 p.m. to 7:30 a.m. daily starting on April 12 and ending when flowers showed color. Fertilization consisted of weekly application of 2 lb. per 100 gallons of 20-20-20 fertilizer. Pinching treatments were applied to 6 pots (12 plants) using approximately 20 ml. of spray per plant with no wash-off. Shoot number and plant height above the pot were determined at flowering.

In Expt. 2, cuttings were potted, as in Expt. 1, on August 10. On August 28, all plants were cut to a 3-inch height. Chemical spray treatments were applied on September 12 and reapplied on September 28. Each cultivar (same cultivars as Expt. 1) was established as a separate experiment. A randomized block design with 4 pots per treatment and 3 replications were used in each experiment. Cultural procedures were similar to Expt. 1. Plants received supplementary light in the middle of the night (10 p.m. to 2 a.m.) from August 10 to September 27 were sufficient for flower bud initiation and development. Prevailing greenhouse temperatures under a fan and pad cooling system were used during the day. A minimum night temperature of 62°F. was maintained at night.

Data on plant height and total number of flowers per pot (2 plants) was recorded at flowering.

Results and Discussion:

Expt. 1. Generally more shoots were produced on hand pinched (check), Off-Shoot-O, and Tipnip treated plants (Table 1). Chemshear treatments reduced shoot number. Generally, plants receiving chemical pinching agent treatments were taller

than hand pinched check plants (Table 2). Plants treated with Chemshear exhibited chlorosis and irregular flowering. The results for UBI-P293 were erratic. Other researchers (5,7) have reported that time of application (growth stage) influences the activity of UBI-P293. Menhenett (7) recommends UBI-P293 be applied 1-4 days after planting.

Expt. 2. Plants receiving hand pinching (check), 2.0% Off-Shoot-O, 0.75% Tipnip and 0.3% Chemshear produced the most flowers on 'Jackpot' plants (Table 3). On 'Stardom' plants, hand pinching, 2.0% Off-Shoot-O, 1.25% Tipnip, 0.75% Tipnip, 0.6% Chemshear and 0.3% Chemshear treatments produced the most flowers. Hand pinched and 0.75% Tipnip plants had the most flowers on 'Tango' plants. 'Yellow Starlet' plants had the most flowers when hand pinched or treated with 2.0% Off-Shoot-O, 1.25% Tipnip, 0.75% Tipnip and 0.3% Chemshear. Generally, UBI-P293 treatments produced the fewest flowers for all cultivars. Pinching treatments had no effect on the height of 'Yellow Starlet' plants (Table 4).

UBI-P293 reduced height in the other cultivars. Tallest 'Jackpot' plant received either hand pinching, 0.6% Chemshear or 0.3% Chemshear. 'Stardom' plants hand pinched or sprayed with 2.0% Off-Shoot-O, 1.25% Tipnip, 0.75% Tipnip, 0.6% Chemshear or 0.3% Chemshear were the tallest plants. Treatments of 2.0% Off-Shoot-O, 1.25% Tipnip, 0.75% Tipnip, 0.6% Chemshear and 0.3% Chemshear produced the tallest 'Tango' plants.

Both Off-Shoot-O and Tipnip treatments yielded results comparable to hand pinching in this study. Chemshear caused phytotoxicity while successfully pinching plants. Large scale testing and commercial experimentation is warranted on Off-Shoot-O and Tipnip. Special attention should be given to phytotoxicity, margin of safety, amount of damage, and environmental facotrs.

Table 1. Effect of Chemical Pinching Agents on Shoot Number of Garden Chrysanthemums

Treatment	Cultivar				
	Jackpot	Stardom	Tango	Yellow Starlet	Mean
Check	4.7	7.0	4.6	5.8	5.5
2% Off-Shoot-O	2.8	10.3	5.9	3.5	5.6
0.75% Tipnip	4.5	8.8	4.4	3.6	5.3
1.25% Tipnip	5.7	6.9	3.7	3.4	4.9
0.25% UBI-P293	2.3	1.8	4.6	2.0	2.7
1.0% UBI-P293	5.7	3.7	2.8	3.0	3.8
0.125% Chemshear	1.1	3.6	3.1	1.4	2.3
0.25% Chemshear	1.4	2.1	3.3	1.8	2.2

Table 2. Effect of Chemical Pinching Agents on the Height (cm) of Garden Chrysanthemums

Treatment	Cultivar				
	Jackpot	Stardom	Tango	Yellow Starlet	Mean
Check	23.8	20.8	36.0	35.1	29.0
2% Off-Shoot-O	28.3	27.5	41.2	38.2	33.8
0.75% Tipnip	26.3	28.6	37.6	39.6	33.0
1.25% Tipnip	22.3	23.7	35.0	33.9	28.7
0.25% UBI-P293	25.8	27.0	33.2	39.9	31.5
1.0% UBI-P293	22.4	23.2	31.4	33.0	27.5
0.125% Chemshear	28.8	21.3	32.9	42.2	31.4
0.25% Chemshear	25.6	21.1	35.0	39.7	30.4

Table 3. Effect of Chemical Pinching Agents on the Total Flower Number of Four Garden Chrysanthemum Cultivars

Treatment[z]	Cultivar total flower number			
	Jackpot	Stardom	Tango	Yellow Starlet
Check	78 a[y]	110 a[y]	117 a[y]	139 a
2.0% Off-Shoot-O	74 ab	105 a	104 b	148 a
1.25% Tipnip	67 bc	98 ab	95 bc	134 ab
0.75% Tipnip	78 a	110 a	121 a	147 a
1.0% UBI-P293	55 d	80 b	86 cd	95 d
0.5% UBI-P293	48 d	84 b	82 d	103 dc
0.6% Chemshear	64 c	93 ab	86 cd	117 bc
0.3% Chemshear	71 abc	103 a	100 b	137 a

[z]Plants were cut to a 3-inch height on August 28 and received pinching treatments on September 12 and September 28.

[y]Means in columns followed by the same letter(s) are not significantly different at the 5% level, Duncan's multiple range test.

Table 4. Effect of Chemical Pinching Agents on the Height of Four Garden Chrysanthemum Cultivars

Treatment[z]	Cultivar Height (cm)			
	Jackpot	Stardom	Tango	Yellow Starlet
Check	33.5 ab[y]	27.8 a[y]	32.1 bc[y]	32.0 a[y]
2.0% Off-Shoot-O	29.0 cd	28.3 a	36.5 a	32.8 a
1.25% Tipnip	31.1 bc	27.3 ab	33.4 abc	33.1 a
0.75% Tipnip	31.3 bc	26.7 abc	33.6 abc	32.9 a
1.0% UBI-P293	26.8 d	24.0 c	31.3 c	32.1 a
0.5% UBI-P293	27.5 cd	24.8 bc	30.8 c	30.6 a
0.6% Chemshear	33.7 ab	27.8 a	33.1 abc	31.4 a
0.3% Chemshear	37.3 a	29.7 a	36.0 ab	34.7 a

[z]Plants were cut to a 3-inch height on August 28 and received pinching treatments on September 12 and September 28.

[y]Means in columns followed by the same letter(s) are not significantly different at the 5% level, Duncan's multiple range test.

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