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Induction of Lateral Branching in Chinese Hibiscus with Mefluidide

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Abstract. **Mefluidide was applied as a foliar spray to the point of runoff to plants of *Hibiscus rosa-sinensis* L. 'Pink Versicolor' at 0, 500, 1000, 2000, 4000, and 8000 mg/liter. Mefluidide treatment increased lateral branching, but inhibited the length of lateral growth and plant height as compared to untreated controls. Tip necrosis of young, expanding leaves was seen at the lowest mefluidide concentration, and increased to the point of severe defoliation of plants at the highest concentration. Mefluidide delayed flowering, but increased the number of flower buds produced. In a 2nd experiment, single and double spray applications of 0, 100, 200, 400, and 800 mg/liter mefluidide were evaluated in comparison to hand-pinching the plants. Both pinching and mefluidide application increased the number of lateral shoots, compared to an untreated control. In contrast to pinched plants, mefluidide treatment inhibited the average length of the lateral shoots. Double applications of mefluidide inhibited plant height, lateral shoot number, and shoot length, as compared to single applications. Treatment with 10 mg/liter gibberellic acid following mefluidide applications was ineffective in reversing the effects of mefluidide on hibiscus growth. Chemical name used: *N*-[2,4-dimethyl-5-[[(trifluoromethyl)sulfonyl]amino]phenyl]acetamide (mefluidide).**

Chinese hibiscus is an attractive flowering shrub found in the landscapes of subtropical areas of the United States. Recently interest has increased in its production as a potted floriculture crop (6, 16). Adaptation of the growth habit of hibiscus to pot culture requires extensive chemical and physical manipulation (6, 7, 13, 16). Chlormequat (4, 6, 7, 13) and ancymidol (13) are effective in controlling the height of hibiscus. In addition to height control, good lateral shoot development is essential for producing quality potted hibiscus. Normally the terminal growing point is physically removed to promote lateral branching (6). Growth regulators have been reported to induce lateral growth in many plants. Dikegulac promotes lateral bud development in several woody species (2, 12). Exogenous applications of cytokinins have been shown to activate lateral bud growth (9, 18). This effect is thought to result from an alteration in the endogenous balance between auxin and cytokinin levels controlling apical dominance (11, 15). Preliminary tests of dikegulac and the synthetic cytokinin (6-benzylamino purine), on hibiscus indicated little response.

Mefluidide is a highly active plant growth regulator. Its reported uses include weed control in soybeans, growth retardation of turfgrasses (10) and woody plants, and increased lateral branching of peaches (1, 3). Its mechanism of action is believed to lie it its inhibition of growth and development of active meristematic regions. Recently Wilkinson (17) reported mefluidide interfered with gibberillic acid (GA) biosynthesis in sorghum, suggesting its growth regulatory properties may resemble growth retardants such as ancymidol (5). Here we report the responses of hibiscus to mefluidide and show its potential for inducing lateral shoot growth.

Uniform rooted cuttings of 'Pink Versicolor' were transplanted into 10-cm plastic pots containing a sterilized medium of 2 milled pine bark : 1 sphagnum peak : 1 coarse perlite (by volume). The medium was amended with 3.0 kg/m^3 dolomite, 1.8 kg/m^3 superphosphate, 2.4 kg/m^3 esmigram, and a wetting agent. Plants were fertilized at each watering with 200 mg/liter N from a complete soluble fertilizer containing 15N–10P–14K. Experiments were conducted in a greenhouse covered with a single plastic layer under natural photoperiods, with a minimum night temperature of 20°C. The photosynthetic photon flux density (PPFD) as measured between 1200 and 1300 HR ranged from 800 μmol s^{-1}m^{-2} to 1300 μmol s^{-1}m^{-2} during the experimental period.

Expt. 1. Rooted cuttings were transplanted 26 Nov. 1984. Mefluidide was applied with hand-held sprayer 2 Jan. 1985 to the point of runoff. Treatments were distilled water and 500, 1000, 2000, 4000, and 8000 mg/liter mefluidide. Tween-20 was used as a surfactant in all treatments at the rate of 0.1% (v/v). Plants were harvested 13 Mar. 1985, ten weeks after chemical application. Plant height, number of lateral shoots, average length of lateral shoots, and total number of flower buds were determined upon harvesting plants at the soil level. Shoot dry weight was determined after drying plants for 48 hr at 70°C. Treatments were arranged in a randomized complete block design with 6 single plant replicates per treatment.

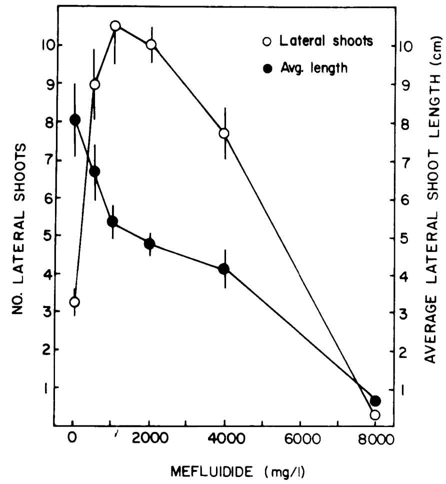

Fig. 1. The influence of mefluidide on the number of lateral shoots and average lateral shoot length of hibiscus. Means of 6 replications. Vertical bars represent ± SE.

Expt. 2. This experiment was designed to test the effect of mefluidide concentration and number of applications on hibiscus growth. Rooted cuttings were transplanted 10 Jan. 1985. Mefluidide was applied as a single or double spray application at 0, 100, 200, 400, and 800 mg/liter. Plants received the first application 18 Feb. 1985 and the 2nd application 4 Mar. 1985. In an attempt to compare mefluidide treatment with hand-pinching, a group of plants was pinched 18 Feb. 1985. Plants were harvested 22 Apr. 1985, nine weeks after the first application of mefluidide. Treatments were arranged in a randomized complete block design with 5 single plant replicates per treatment.

Expt. 3. This experiment tested the reversibility of mefluidide effects by GA_3. Rooted cuttings were transplanted 10 Jan. 1985. Plants were sprayed with distilled water or 500 mg/liter meluidide 18 Feb. 1985. Two

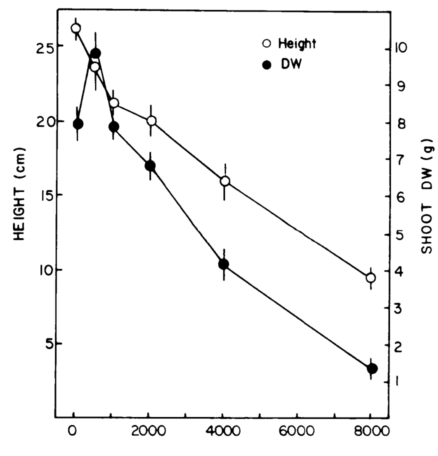

Fig. 2. The influence of mefluidide on plant height and shoot dry weight of hibiscus. Means of 6 replications. Vertical bars represent ± SE.

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days later, plants were sprayed with 10 mg/liter GA_3 or distilled water, both containing 0.1% (v/v) Tween-20. Plants were harvested 22 Apr. 1985, nine weeks after mefluidide application. Treatments were arranged in a randomized complete block design with 5 single plant replicates per treatment.

Mefluidide increased the number of lateral shoots developing on hibiscus when applied as a spray of 4000 mg/liter or less (Fig. 1). A concentration range of 500 to 2000 mg/liter was most effective in promotion of lateral shoot development. While lateral shoot number was increased with mefluidide, the average length of developing shoots was decreased (Fig. 1), and overall plant height was reduced with increasing concentrations of mefluidide (Fig. 2). Applications of mefluidide at concentrations in excess of 500 mg/liter decreased shoot dry weight relative to the control (Fig. 2). Flowering was delayed by mefluidide application (Table 1). Potential flower production, as indicated by unopened flower buds at the time of harvest, was increased by mefluidide concentrations up to 4000 mg/liter (Table 1). Increased flowering was likely the result of increased branching resulting from mefluidide treatment.

Table 1. Effects of Mefluidide on the number of flowers or flower buds at harvest and days to first flower of Hibiscus.

Mefluidide concn (mg/liter)	No. flower buds	Days to 1st flower[z]
Control	10.3 ± 1.2[y]	43.5 (100)[x]
500	17.8 ± 2.0	52.3 (83)
1000	13.0 ± 1.2	66.0 (67)
2000	13.8 ± 1.5	66.0 (33)
4000	4.5 ± 1.4	--- (0)
8000	---[w]	--- (0)

[z]Time from application of chemical.
[y]Means of 6 replications ± SE.
[x]Percentage of plants flowering within the experimental period.
[w]No visible flowers or buds at harvest.

Table 2. Effects of hand-pinching, mefluidide concentration, and number of mefluidide applications on the growth of Hibiscus.

Treatment	No. applications	Height (cm)	Dry weight (g)	No. lateral shoots	Avg lateral shoot length (cm)
Control		24.8[z]	4.7	2.2	11.0
Hand-pinch		18.7	6.1	6.8	8.7
Mefluidide (mg/liter)					
100	1	19.3	7.0	8.8	7.1
	2	18.4	5.8	7.6	5.4
200	1	18.4	5.9	8.0	6.1
	2	15.0	4.8	7.0	5.9
400	1	17.4	5.5	7.6	6.3
	2	13.6	2.9	4.4	4.8
800	1	16.5	4.8	7.0	6.4
	2	11.0	1.3	3.0	2.7
Orthogonal comparisons					
Control vs. pinch		**	*	**	**
Control vs. mefluidide		**	NS	**	**
Pinch vs. mefluidide		*	*	NS	**
Mefluidide					
Concentration					
Linear		**	*	*	**
Quadratic		NS	**	**	*
No. applications		*	**	**	**
Concn vs. no. applications		NS		**	**

[z]Means of 5 replications.
NS,*,**Nonsignificant (NS), significant at 5% (*), or 1% (**) levels.

Table 3. Effects of gibberellic acid on mefluidide-treated hibiscus.

Treatment	Height (cm)	Dry weight (g)	No. lateral shoots	Mean lateral shoot length (cm)
Control	20.1[z]	3.0	1.8	7.5
GA_3 10 mg/liter	19.6	2.5	1.6	6.8
Mefluidide 500 mg/liter	14.4	2.9	5.2	5.3
Mefluidide/GA_3	13.5	2.7	6.0	4.9
LSD (0.05)	2.8	NS	1.0	1.7

[z]Means of 5 replications.

All plants treated with mefluidide in Expt. 1 exhibited symptoms of chemical phytotoxicity. The extent of phytotoxicity was concentration dependent and ranged from slight tip necrosis of young expanding leaves at 500 mg/liter to severe defoliation at 8000 mg/liter. In general, mefluidide concentrations above 1000 mg/liter resulted in complete dieback of the terminal growing point.

In a 2nd experiment, we tested the effects of reduced rates of mefluidide in combination with single or double applications. Application of mefluidide increased the number of lateral branches and decreased the length of lateral shoots, regardless of chemical rate or number of applications, as compared to an untreated control (Table 2). Physically pinching plants also increased the number of lateral shoots developing on hibiscus. In contrast to hand-pinching, mefluidide treatment had a retarding effect on lateral shoot elongation. Decreased plant height, dry weight, number of lateral shoots, and average lateral shoot length was seen when mefluidide concentration was increased from 100 to 800 mg/liter (Table 2). Regardless of mefluidide concentration, a 2nd application inhibited plant height, dry weight, lateral shoot number, and shoot length and increased the extent of phytotoxicity as compared to a single application. Significant interactions were found between chemical concentration and number of applications for plant dry weight, shoot number, and shoot length (Table 2). Lateral branching and average length of lateral shoots were inhibited to a greater extent with 2 applications of mefluidide at the higher concentrations, as compared to a single application.

The mode of action of mefluidide was recently suggested as antigibberellin (17). The effects of other growth regulating chemicals thought to function in a similar way often are overcome with an exogenous application of GA (14). A single application of 10 mg/liter GA_3 was ineffective in overcoming the effects of mefluidide on hibiscus (Table 3). The nature of the response to mefluidide would appear to lie in its inhibition of meristematic activity. In our experiments when the terminal was not killed, terminal growth was suppressed for about 8 weeks, after which growth resumed. Apparently destruction of the meristem was not necessary for increased lateral branching, since at reduced concentrations (100 – 500 mg/liter) branching was induced without terminal dieback. Glenn (8) reported mefluidide interfered with auxin transport in corn. This action may partially explain the chemical's ability to overcome apical dominance.

Mefluidide appears to have excellent potential for manipulation of hibiscus growth for pot-plant production. Single applications of 100 to 500 mg/liter appear to be effective in inducing lateral branching and controlling vegetative growth, resulting in an attractive, compact plant. Use of mefluidide in a potted hibiscus production program could overcome the need for hand-pinching and growth retardant application.

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Trunk Injected Ethephon as a Potential Harvest Aid Mechanism for Pecans

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Additional index words. *Carya illinoensis*, ethylene, shuck disorders

Abstract. **Ethephon was trunk injected into the transpiration stream of pecan trees 10 to 21 days before shuck split in an attempt to expedite shuck opening in 1983. Ethephon concentrations were based on the estimated amount of water flowing through the tree per day. At College Station and Hondo, Texas, a 10 ppm injection significantly increased shuck opening. Leaf drop was only 35% at 10 ppm compared to much higher leaf drop in previous research. There was no difference in number of nuts set and the extent of limb dieback between the control trees and those trunk injected with 10 ppm ethephon. At Ft. Stockton and Midkiff, Texas, injections of 10, 20, and 40 ppm increased nut opening and early leaf drop, but reduced fruit set in the following year (1984). There was no limb dieback at these locations. Injections of trees in El Paso failed to cause shuck opening.**

A shuck disorder known as "sticktights" causes serious problems in pecan orchards throughout Texas. The sticktight phenomenon is a condition in which the kernels are healthy, but the shucks fail to open. Sticktights should not be confused with shuck dieback, a physiological disorder associated with 'Success' (2), or stem end blight, a fungal disease caused by *Botryosphaeria ribis* (7). Sticktights have been reported to occur from early August through November. Nuts affected early in the season drop from the tree. Nuts affected later remain on the tree and fail to form abscission layers at the shuck sutures.

Studies using foliar ethephon have shown erratic amounts of abscission and response time after treatment (5, 8). Abscission is dependent on the environmental and physiological conditions at the time of ethephon application (1, 4, 6). Ethephon activity accelerates in warm weather and decreases in cool weather (1). Field trails with foliar treatments in Texas have resulted in both leaf and fruit abscission with no apparent separation of the 2 responses. However, according to Kays et al. (3) pecan tissue exposed to exogenously applied ethylene varied in sensitivity to the gas. Shuck opening was most sensitive, followed by leaf abscission, then fruit peduncle (3).

Lavee and Martin (5) have suggested that the uptake and effect of ethephon has been rather erratic or unpredictable with limited translocation and localized responses to the chemical. This poor response could be because most applications have been made foliarly.

Ethephon might be used as a harvest aid to avoid this shuck disorder. Trunk-injected ethephon also could be used to control harvest dates, facilitate mechanical harvest, and avoid freeze injury of the shucks surrounding the nuts on the tree. Freeze damaged shucks do not respond to endogenous abscission stimuli.

An attempt was made to induce early shuck opening on pecan without leaf abscission and to avoid uptake problems. Ethephon was placed in the transpiration stream by injection into the secondary xylem. Evaporation data from the National Weather Service was used to estimate the amount of water moving through the trees on the day of injection. An ethephon concentration of 10 ppm was injected into the trunks.

Bearing pecan trees with a canopy of 4.6 to 6.7 m and a cross sectional trunk diameter of 15.24 to 17.78 cm were used in this study. Four 7.9 mm diameter holes, evenly spaced around the tree, were drilled 38 to 50 mm deep in to the trunk 102 to 152 mm above the soil line. Plastic trunk injection trees attached to a polyethylene hose and a hand operated spray pump delivered the ethephon solution in one to 3 hr. Treatments were made 10 to 21 days prior to normal shuck opening. Nontreated nuts opened about 3 weeks after treatments were made. Treatments were evaluated for number of shucks open (the number of shucks out of 100 tagged nuts that were open), percentage of leaf drop (visual subjective rating of each tree), return set,

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