vidual pots were watered with 250 ml/pot as required to accommodate each medium treatment.

On October 21, 1979, data collected were: plant height measured from the soil surface to the apex; plant width across the top of the plant; stem caliper at soil surface; number of side shoots; foliar color (1 = light green, 3 = medium green and 5 = dark green); plant grade (1 = poor, not salable, 3 = good, salable, and 5 = excellent quality) and fresh weight.

Five months after treatment, plant grown in all media had a larger growth index, stem caliper, and fresh weight when Osmocote 18N-3P-10K was surface applied (Table 1). Plants grown in peat, peat:shavings, and peat:sand varied in the number of side shoots/plant depending on the fertilizer source and application method. Plants grown in the peat:bark medium had an equal number of side shoots/plant with both fertilizer sources and application methods. Foliar color of the plants grown in peat or peat:shavings was better when Osmocote was used in comparison to Pro-Grow regardless of application method (Table 1). Incorporation of Pro-Grow in the peat:bark and peat:sand media significantly reduced foliar color in contrast to Osmocote surface applied, Osmocote incorporated, and Pro-Grow surface applied. Plant grade varied depending upon the fertilizer source and application method used; however, in general the best plant grade occurred when Osmocote was top-dressed. The lowest plant grade resulted when Pro-Grow was incorporated into the media. Overall, the best fertilization method was surface application for both sources.

R. obtusum 'Hinodegiri' appears to be a shallow rooted plant requiring maximum fertilizer distribution in the upper portion of the container media. This may explain why top-dressing gave the best results. By applying the fertilizer on the surface all available nutrients are leached into the root zone. The poor growth response of plants fertilized by the incorporation method may be attributed to fewer nutrients available to the shallow root system. Coleman et al. (1) reported that placement of controlled-release fertilizers either within the medium or on the surface did not affect plant growth. Ticknor (9) top-dressed Osmocote on the media of *Rhododendron* spp. and obtained good growth and flower count.

When incorporating fertilizer, the medium should be thoroughly mixed and fertilizer well distributed. However, leaching may reduce the effectiveness of fertilizer located in the bottom portion of the pot, essentially inexcessible to the roots of newly-planted liners. Our results indicated the best fertilizer response was obtained with a surface application regardless of growing media.

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Factors Affecting Predisposition of Flowering Dogwood Trees to Attack by the Dogwood Borer[1]

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Additional index words. Synanthedon scitula, plant resistance

Abstract. **Factors affecting natural infestation of flowering dogwoods (*Cornus florida* L.) by the dogwood borer, *Synanthedon scitula* Harris (Lepidoptera: Sesiidae), were studied in an urban cemetery in Louisville, Kentucky. Two tree characteristics, severity of trunk wounding and exposure to sun, were most important in determining the probability of borer attack. Degree of crown dieback or color of bloom did not significantly affect the rate of infestation. There was no correlation between tree diameter and probability of attack, but height of attack sites increased linearly with increasing tree size.**

Flowering dogwoods are among the most widely planted woody ornamentals in the eastern United States. Trees in nurseries and in the urban landscape may be severely injured by the dogwood borer, *Synanthedon scitula* (Harris), a clearwing moth whose larvae tunnel feed in the phloem and cambium in living wood. Infestation by borers may result in lowered tree vitality, dieback of individual branches, structural weakness of major limbs or complete girdling and death of young trees. Trees may be disfigured by unsightly callous formation or large areas of cracked, dead bark around the site of attack. Protected by their galleries, borer larvae are virtually invulnerable to chemical controls and are seldom noticed until they have already inflicted serious injury.

Although native dogwoods in the forest understory are rarely infested (1, 3, 4), trees that are transplanted into the landscape or grown in nurseries are often seriously damaged. Environmental stress factors such as moisture deficiency or sunscald can weaken trees and make them more susceptible to infestation (1). Moreover, injuries inflicted by lawn mowers or other equipment may provide ideal oviposition sites or entry points for young larvae. It is a common phenomenon for certain trees to be severely infested, while neighboring trees are unharmed. The objective of the present research was to determine if certain tree and site characteristics are associated with increased probability of infestation by the dogwood borer.

The study was conducted in Cave Hill Cemetery, Louisville, Kentucky, a 122 ha landscaped area with an extensive collection of woody ornamentals. We selected for study 160 dogwood trees, ranging in diameter from 4–32 cm., from 8 adjoining cemetery sections. These trees had received no insecticide treatments for at least 5 years prior to the investigation, and were selected without regard to previous borer infestation.

Trees were tagged and numbered on May 15, shortly before the expected date of first emergence and oviposition of adult dogwood borers in Kentucky. Trunk diameter was measured at 30–cm. height, and then each tree was characterized with regard to exposure to sun, trunk wounding, crown dieback, and color of bloom. With respect to sun exposure, trees were classed as growing in either full sun, partial shade, or full shade. Trunk

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wounding included 3 levels: light = no visible trunk wounds (up to 1.5–m height); moderate = minor trunk wounds in living wood; or severe = extensive wounds (≥20% of tree circumference) in living wood. Crown dieback was characterized as either light (< 5% of terminals); moderate (5–20%); or severe (>20%). Color of bloom was classed as either white or pink.

The dogwood borer has a 1-year life cycle (4), but adult emergence in Kentucky may occur from late May to mid-September. By mid-October, all borers have hatched and larvae of various sizes are feeding in the cambium. Borers are active throughout most of the winter (Potter, unpublished) and can be located by inspecting trees for accumulations of coarse, brown frass, which is expelled from openings in the bark.

On November 12, 1979, trees in the study were inspected from ground level to 2–m height by two observers, and each gallery was excavated enough to confirm the presence of a live borer. Height of each infestation site above the ground was also measured.

To examine the relationships of borer attack to tree and site characteristics, the incidence of borer infestation (denoted as 0 for a non-infested tree, and 1 for an infested tree) was subjected to an iterated weighted least squares analysis. Effects included in the model were linear regression on tree diameter and effects of the classification variables sun exposure, trunk wounds, crown dieback, and color of bloom. At each iteration, each observation was weighted by the reciprocal of its estimated variance, $1/\hat{p}(1-\hat{p})$, where $\hat{p}$ is the expected incidence of infection. After 7 iterations, the parameter estimates converged to 3 digit accuracy. At convergence, the sums of squares for the effects in the model provide approximate chi-square tests for those effects, and the residual sum of squares provides an approximate chi-square test for lack of fit of the model used (R. L. Anderson and P. L. Cornelius, personal communication).

The infestation data suggest that dogwood trees with certain characteristics were particularly susceptible to attack by borers (Table 1). Trees growing in full sun were over 3 times as likely to be infested as those in full shade, while the infestation rate for trees with severe trunk wounds was nearly twice that for non-wounded trees. Trees with severe crown dieback or pink bloom were also somewhat more likely to be infested. Although there were more borers per infested tree in severely wounded than in moderately wounded trees, in general it did not appear that the mean number of active borers per infested tree was affected by sun exposure, trunk wounding, crown dieback, or color of bloom.

Results of the weighted least squares analysis are presented in Table 2. The chi-square tests for significance of effects indicate that borer infestation significantly increased with increasing exposure to sun and with increasing severity of trunk wounding. The expected rate of infection ($\hat{p}$) adjusted for other factors, based on the weighted analysis, was 71.1% for trees in full sun, and 68.6% for trees with severe trunk wounds. When the effects of other variables were removed, crown dieback or color of bloom were not significantly related to the probability of infestation.

The non-significant analysis for linear regression on diameter indicates that the probability that a tree will be infested is not related to tree size (Table 2). There was, however, a significant linear relationship between tree diameter and the height of borer attack (Fig. 1). In younger trees (≤ 15–cm diameter) nearly

Table 1. Relationship of selected tree characteristics of dogwood trees (*Cornus florida*) to probability of infestation by the dogwood borer, *Synanthedon scitula*.

Variable	No. trees	No. trees with borers	Infested trees (%)	Mean no. borers/ infested tree[z]
Exposure to sun				
Full sun	103	70	68.0	3.03 a
Partial shade	34	17	50.0	2.18 a
Full shade	23	5	21.7	1.50 a
Trunk wounding				
Light	81	33	40.7	2.67 ab
Moderate	37	25	67.6	2.24 a
Severe	42	33	78.6	3.27 b
Crown dieback				
Light	96	53	55.2	2.68 a
Moderate	32	17	53.1	3.18 a
Severe	32	23	71.9	2.70 a
Color of bloom				
White	104	53	51.0	3.03 a
Pink	56	39	69.6	2.47 a

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

Table 2. Relationship of selected characteristics of dogwood trees (*Cornus florida*) to probability of infestation by the dogwood borer, *Synanthedon scitula*.

Chi-Square values for tests of significance of effects[z]			Weighted least squares estimates ($\hat{p}$) for probability of infestation	
Source of variation	d.f.	Chi-square	Tree category	$\hat{p}$ (± SE)
Linear Regression on Diameter	1	0.421	Sun	
			Full	0.711 ± 0.040
Sun	2	19.271**	Partial	0.584 ± 0.084
Full vs. None	1	19.007**	None	0.326 ± 0.067
Partial vs. $\bar{x}$ of Full + None	1	0.556	Wounds	
			Light	0.379 ± 0.050
Wounds	2	12.096**	Moderate	0.555 ± 0.081
Light vs. Severe	1	12.085**	Severe	0.686 ± 0.059
Mod. vs. $\bar{x}$ of Light + Severe	1	0.074	Dieback	
Dieback	2	3.273	Light	0.559 ± 0.052
Light vs. Severe	1	0.672	Moderate	0.453 ± 0.061
Mod. vs. $\bar{x}$ of Light + Severe	1	3.146	Severe	0.609 ± 0.056
			Bloom	
Bloom Pink vs. White	1	2.909	Pink	0.598 ± 0.052
			White	0.483 ± 0.048
Residual Error	150	150.078		

[z]Each effect adjusted for other effects in the model.

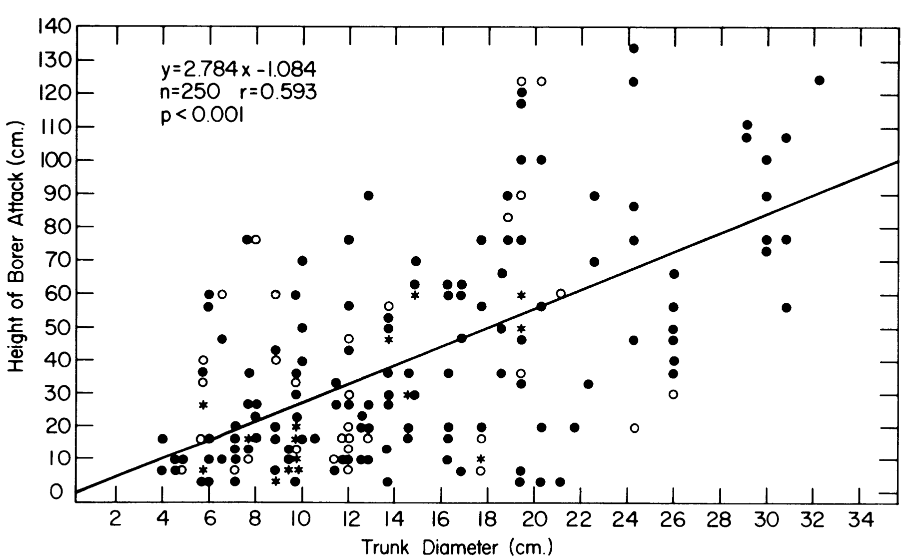

Fig. 1. Relationship between trunk diameter of dogwood trees and height of infestation by the dogwood borer. Open circles represent 2 data points, and asterisks (*) represent 3 or more observations.

all infestation sites were on the main trunk and within 50 cm of the ground. This conflicts with earlier reports that young dogwoods are attacked mostly at the crown (2, 3). It is known that definite breaks in the bark are prerequisite for young borers to gain entry into the cambium (4). In the present study, most infestations in young trees were associated with obvious bark injuries, particularly lawn mower damage. In contrast, most infestation sites in older trees (≥ 20-cm diameter) were higher up in the limb crotches or major branches, and were generally associated with pruning scars, cankers, or areas of cracked and raised bark. It is likely that in older trees, mechanical injuries are usually not severe enough to allow entry of borers through the thick bark.

This study suggests that where borers are a problem, the planting of trees in full sun should be avoided. Care should be exercised to avoid mechanical injuries, particularly during the spring when peak emergence occurs. We have found the use of lawn mower guards around the trunks of small trees to be of considerable value.

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Influence of Temperature, Water Stress and BA on Vegetative and Reproductive Growth of *Schlumbergera truncata*[1]

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Additional index words. Thanksgiving cactus, benzylamino purine

Abstract. **The number of flower buds formed on plants of *Schlumbergera truncata* (Haw.) Moran (Thanksgiving cactus) was reduced by high water stress during flower initiation and was unaffected by night temperature (13° vs. 17°C) under short days. Application of 100 ppm benzylamino purine (BA) increased flower bud number by 40% when sprayed 2 weeks after the initiation of a short day treatment and increased phylloclade number up to 150% when applied during long day photoperiods.**

Grower interest in the cacti commonly referred to as Thanksgiving or Christmas has increased in recent years due to interest in crop diversification (2). Plants with "toothed" phylloclades (segments) and zygomorphic flowers (*Schlumbergera truncata*) are classified as Thanksgiving cactus (3) and plants with smooth-edged phylloclades and zygomorphic flowers (*S. bridgesii*) are called Christmas cactus. Most commercial cultivars grown today are Thanksgiving cactus.

Flowering in Christmas cactus is inhibited under any photoperiod at 21–24°C, promoted by short days (SD) at 17–18° and not influenced by photoperiod at 13° as flowering occurs under both SD and long days (LD) (6). Vegetative growth of Thanksgiving cactus 'Weihnachtsfreude' occurs under LD at temperatures above 20°. At 15°, flower initiation occurs regardless of daylength (up to 18 hr studied), while 10° prevents flower initiation completely (7, 8). Thanksgiving cactus 'Christmas Cheer' flowered under LD after 6 weeks of SD when grown at 22–32° (5). Yonemura (11) found the optimum temperatures for flower initiation to be 15–20° and the critical photoperiod for flower initiation to be 12 hr. Finally, many growers severely water stress *Schlumbergera* plants to induce flower initiation (9).

Yonemura (11) reported that BA promoted the number of flower buds under inductive conditions and increased the number of phylloclades under LD on Thanksgiving cactus. Promotion of axillary shoot formation of *Hylocereus trigonus* by BA has also been reported (10).

Our objectives in these experiments were to investigate the influence of water stress, temperature, and BA on flower bud initiation of *Schlumbergera truncata*.

Expt. 1, water stress. One-year-old vegetative plants of Thanksgiving cactus 'White Christmas' growing in 10 cm clay pots were placed in greenhouses at 13 ± 2°C or 17 ± 2° night temperature with 21 ± 3° day temperature. All plants were irrigated on September 17 and thereafter half of the plants were either watered when the soil surface became dry (normal water) or received no water for 21 days (drought). Short day treatment (9 hr day) was initiated September 17 and terminated November 4, 1980 (6 weeks). Each photoperiod/watering treatment consisted of 3 replications of 4 plants each which were randomized within each greenhouse. The number of flower buds and open flowers were counted on November 20, 1980.

There was little difference in total number of flowers between temperature regimes and maximum total flower number occurred under normal water regimes (Table 1). This is contrary to accepted concepts among commercial growers (9). It may be that dry soil is more directly related to disease prevention rather than flower initiation. In our experience, commercial growers often produce their plants in soils of high water holding capacity (i.e. "heavy" soils), and severe root disease problems involving *Pythium* (4) and *Phytophthora* (1) often occur. Maintaining cool temperatures during the shortening days of fall results in a slow-drying medium which may be the cause of disease problems commonly observed with this plant. Moisture stressing plants may have originated as a process to prevent disease but became associated with flower initiation.

Expt. 2 and 3, BA. Ten vegetative 'Christmas Charm' plants in 10 cm clay pots were placed at 17° and sprayed to runoff with 100 ppm BA (0.1% Aqua-Gro) 2 weeks before, at the start (October 2, 1979), or 2 weeks after the start of SD.

Application of 100 ppm BA to plants 2 weeks after the start of SD stimulated flower bud formation (Table 2, Fig. 1) as reported by Yonemura (11). Some phylloclades on BA-treated plants formed 12–15 buds (Fig. 1) while others formed 2–3. While similar num-

Table 1. Effect of night temperature and water regime on Thanksgiving cactus 'White Christmas.'

Temperature (°C)	Water regime[z]	Flower buds and flowers per phylloclade
17	+	1.4a[y]
	−	1.0b
13	+	1.5a
	−	1.2b

[z](+) = Plants watered when soil was dry.
(−) = Plants received no water for 21 days after initiation of experiment.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.

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