EFFECT OF SEVERAL GROWTH REGULATORS ON GROWTH AND DEVELOPMENT OF SAINTPAULIA

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THESIS

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EFFECT OF SEVERAL GROWTH REGULATORS ON GROWTH AND DEVELOPMENT OF *SAINTPAULIA*

By

EVAN PAUL ROBERTS

AN ABSTRACT

Submitted to the School for Advanced Graduate Studies of Michigan
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DOCTOR OF PHILOSOPHY

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EVAN PAUL ROBERTS ABSTRACT

To determine the effects of various growth regulators on *Saintpaulia*, the African violet, two cultivars were used: 'Star Girl Seedling' and 'Queen's Cushion'. Four hundred and eighty plants were set up in a randomized and replicated design and grown at 65°F night temperature on two benches in the Plant Science greenhouse, Michigan State University.

Treated groups received three spray applications each of 100 parts per million of maleic hydrazide, indoleacetic acid, gibberellic acid, and 25 parts per million of triiodobenzoic acid at three-week intervals. Data were recorded and analyzed statistically for rooting response of leaf-petiole cuttings, lasting quality of flowers, number of flowers and peduncles, and pollen germination. Graphs were made from growth data determined from the measurements of maximum diameters of the rosettes. Observations on the morphological changes of the plant organs were noted.

Rooting response of leaf-petiole cuttings in the control group for each cultivar were as good, and in most cases better, than those from the chemical treated groups for each cultivar. Treatments producing the rooted cuttings arranged in descending order for the largest number of cuttings rooted to the smallest were: control, maleic hydrazide, indoleacetic acid, triiodobenzoic acid, and gibberellic acid.

Pollen germination for cultivar 'Star Girl Seedling' indicated that chemical treatment of plants inhibited pollen germination. Pollen of the cultivar 'Queen's Cushion' was not used since it is a cultivar with low pollen production.

The number of flowers was significantly greater in the gibberellic acid treated groups of cultivar 'Queen's Cushion' than in the untreated and chemical treated groups. The number of flowers was not significantly greater for gibberellic acid treated plants of cultivar 'Star Girl Seedling' than those of the untreated plants. However, the gibberellic acid treated plants produced a significantly greater number of flowers than the flowers from plants treated with indoleacetic acid and triiodobenzoic acid.

The number of peduncles was significantly greater for the gibberellic acid treated group than for all others. This was true for each cultivar.

The untreated flowers of cultivar 'Queen's Cushion' lasted significantly longer than those in any other group, while indoleacetic acid was most effective for making the flowers last longer in cultivar 'Star Girl Seedling'.

Formative modifications resulting from chemical treatments were apparent only in the 100 parts per million gibberellic acid treated groups of each cultivar. Modifications common to both cultivars included: changes in leaf shape; elongation of petioles, peduncles, and leaf blades; an upward movement of leaves toward the vertical axis of the plant.

Modifications specific to cultivar 'Star Girl Seedling' were: changes in style position and shape; separation of anthers; and a tendency toward greater production of peloric flowers.

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TO

MY PARENTS

John Louis and Sophia Roberts

AND

MY FAMILY

Rosa, Katherine, Ronald, Carol and Louis

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INTRODUCTION

Saintpaulia, the African violet, has become an important cultivated plant. Over two and one-half million plants were grown under glass by 992 commercial growers according to Special Reports on Horticultural Specialties of the 1950 United States Census of Agriculture. These plants sold for over one million dollars. They were eighth in rank as compared to potted roses, which ranked ninth in regard to the number of plants produced and sold.

Many plants are grown by amateurs. The second largest specialized plant society in the United States is the African Violet Society of America, Incorporated. Its 15, 000 membership of commercial growers and amateurs represents only a fraction of growers of this plant.

Further interest is indicated by scientific literature concerning *Saintpaulia* found in botanical journals and horticultural periodicals (4, 5, 8, 10, 14, 18, 22, 28, 29, 30, 36).

Since *Saintpaulia* is an important horticultural plant, growers are interested in its response to any factors which modify its growth.

The purpose of this investigation was to study the effect of certain growth regulators on *Saintpaulia*.

REVIEW OF LITERATURE

Innumerable articles concerning plant growth regulators have been reported. Only a few (3, 13, 21, 33, 39) are concerned with the effects of growth regulator application to Saintpaulia.

General Effects of Growth Regulators

The principle modifications induced by plant growth regulators according to Zimmerman (43) are, "changes in flowering habit, size, shape, pattern, and venation of organs". Zimmerman and Hitchcock (45) reported pattern of leaves, flowering habit, and correlation of organs of the plants were modified by application of 2, 3, 5 triiodobenzoic acid (TIBA) to soil in which potted tomato plants were growing.

Beta-naphthoxyaliphatic acids, substituted phenoxyaliphatic acids, and substituted benzoic acids have formative effects on plants (43). "Formative effects may be defined as changes in pattern from that normally resulting from the genetic constitution of the plant under the influence of particular environments. When the environment is more or less constant for a usual habitat, the size and shape of the plant and pattern of organs are said to be constant for a usual habitat, the size and shape of the plant and pattern of organs are said to be normal for a given species. Unusual environments involving temperature, moisture, light or chemical substances bringing

about different expressions of so-called normal characteristics. The results may be referred to as formative effects brought about by a given combination of influences" (43).

Effect of Plant Growth Regulators on Flowering

Attempts have been made to control flowering by the application of growth regulators. Galston (12) tried to initiate flowering in 'Peking' and 'Biloxi' soybeans by soil application, foliar application and intracotyledonary injection of a saturated solution of triiodobenzoic acid. Since flowering was not induced he concluded triiodobenzoic acid did not have "florigenic" properties. Morphological responses, such as shortening of the internodes, loss of apical dominance, and epinasty of young leaves were induced.

The pineapple appears to have been the only plant in commercial production in which flowering has been initiated by external application of growth regulators. Van Overbeek (38) poured 50 milliters of a solution containing .25 to .5 milligram of alpha-naphthaleneacetic acid into the center of the plants to induce flower development in the primordia. This method of flower control is now being used extensively by pineapple growers in South America and Hawaii (2).

Although growth regulators induced flower initiation only in the pineapple, they have been found to modify flower initiation in a large number of plants. In certain plants, _Circaea_, _Kalanchoe_, _Impatiens_ _balsamina_, and

Calendula officinalis, auxin has been reported to have inhibited flower initiation (2). Flower initiation in celery and lettuce has been prevented by foliar application with a solution of 100 parts per million alpha-2-chlorophenoxy-propionic acid (42). Spraying maleic hydrazide on foliage of maize plants with .025 solution caused male flower tassels to be completely sterile but did not affect female flowers (27).

Hitchcock and Zimmerman (17) reported that flowering of Turkish tobacco was hastened by soil application of indolebutyric acid in 3 and 9 milligram doses. At the end of 3 weeks, flower buds were visible on 16 of 36 plants and one of the 12 control plants. Certain dilute foliar sprays of growth regulators have been reported to have no effect on flowering of a range of crop plants, such as winter oats, wheat, string beans, peas, carrots and clover (2).

Effect on Flower Lasting Quality

There are few reports on the use of growth regulators for prolonging blooming of ornamental plants. Wester and Marth (2) sprayed the leaves of oriental cherries (*Prunus serrulata*) with alpha-naphthaleneacetic acid and reported that 25 to 80 percent of the blossoms were retained for 3 to 10 days longer. Dogwood (*Cornus florida*) had blossoms retained 4 to 6 days longer than untreated plants after the foliar application of 4-chlorphenoxyacetic acid. Other species including Azalea, flowering almond, lilac and magnolia were unresponsive.

Lindstrom and Wittwer (24) investigated the effect of foliar application of 10 parts per million gibberellin on the foliage of 'Spartan White' geranium (Pelargonium hortorum) plants when a few florets of the inflorescence were beginning to open and show flower color. They reported that the life of the inflorescence was lengthened as a result of treatment from one to two weeks longer. Inflorescences of another cultivar, 'Brick Red Irene' geranium treated with gibberellin at 10 parts per million were unaffected, thus indicating that different cultivars of a species may respond differently to the same concentration of a growth regulator.

Flowers of Fuchsia hybrida exposed to vapors of napthaleneacetic acid for 10 minutes lasted 5 to 10 days longer than controls while flowers of tomato exposed to vapors of esters of various chlorophenoxy compounds lasted 10 to 30 days longer than the untreated plants (44).

Kelly (20) reported experiments with foliar application of 1000, 2000, and 4000 parts per million maleic hydrazide to the snapdragon (Antirrhinum majus) cultivar 'Snowman'. He applied the various concentrations one and three days before harvest and found no effect on lasting quality of the cut flowers.

Effect on Pollen Germination

Effect of growth regulators on pollen germination and growth has been the subject of experimentation by various investigators (1, 6, 15, 25, 31, 34). Addicott (1) tested 33 pure growth substances for their effect on pollen germination and tube growth. He used Tropaeolum and Milla and found that 16 growth substances significantly increased germination as well as tube growth. He also established that germination of pollen and tube growth are at least in part physiologically independent from each other.

Brock (6) reported interspecific hybrids between pear and apple by using hormones. He applied B-naphthoxyacetic acid to the base of the pear style at the time apple pollen was placed on the stigma. This stimulated apple pollen-tube growth, and allowed fertilization. Viable seedlings developed from these crosses and 37 percent were still alive after four months of growth. The seedlings seemed to be intermediate in phenotypic expression between apple and pear.

Effect on Rooting

Application of auxins by spraying leaves is discussed by Audus (2) who states that some success was obtained by spraying leaves of certain evergreen species with dilute aqueous solutions of auxins before removal of the cuttings from the parent plants. Hildreth and Mitchell (16) found sprays containing 300 milligrams per liter of indolebutyric acid were effective for rooting cuttings of bean, marigold, coleus, marguerite and carnation, but cuttings were sprayed after they had been inserted into the rooting medium.

Kiplinger (21) has discussed propagation of Saintpaulia by means of leaf-petiole cuttings and states that treatment with growth substances will hasten rooting, but has no beneficial effect on formation of new shoots. Jones (19) mentions the use of hormone powders to assist rooting as neither necessary nor beneficial, since the rooting of leaf-petiole cuttings is usually very good, in fact almost 100 percent successful provided that the temperature is at least 60°F and humidity is maintained. Neither Kiplinger nor Jones present experimental evidence or support of their statements with citations.

Warner and Went (39) reported that more roots were produced per cutting by soaking leaf-petiole cuttings in a solution of 50 parts per million indoleacetic acid for 16 hours than in control cuttings, although 100 percent rooted in each group.

Smith (33) working with Saintpaulia cultivar 'Purple Beauty' stood leaf-petiole cuttings one-half inch into a solution of 40 parts per million indolebutyric acid for 24 hours. He found greatly stimulated root-formation on treated cuttings as compared to untreated cuttings, but succeeding shoot growth was inhibited by treatment with 40 parts per million indolebutyric acid.

From the experiments of Smith (33) and those cited by Avery (3) it may be concluded that certain growth regulators are beneficial for producing roots on certain cultivars of *Saintpaulia*, and that certain growth regulators accelerate root production. In these experiments the stems of leaves were either soaked in solutions containing plant growth regulators or were dusted with powders containing them.

Gray (13) applied 16 parts per million gibberellic acid to *Saintpaulia* plants and found leaf blades grew longer and narrower forming an apex much more acute than those of the control plants. The petioles grew longer and more erect, and the flowers seemed larger and more abundant.

MATERIALS AND METHODS

To determine the effect of foliar application of various growth regulator solutions on Saintpaulia two cultivars were selected, 'Star Girl Seedling' and 'Queen's Cushion', which appear to have been derived from Saintpaulia ionantha. Both cultivars were obtained from a commercial grower*, who had propagated them by means of leaf-petiole cuttings. The cultivar 'Star Girl Seedling' was propagated on August 16, 1956, while 'Queen's Cushion' was propagated on May 14, 1956.

The plants were delivered to the Plant Science greenhouse, Michigan State University on November 27, 1956 and were immediately divided, selected for uniformity and vigor, and repotted. A single crown plant was potted in each 6-inch standard clay flower pot.

The plants were grown on benches in the greenhouse (night temperature 65° F). They were arranged in 6 rows of 40 plants on each of two benches, a total of 240 plants of each of two cultivars. They were then labeled according to the randomized design of the experiment. For each variety there were five treatments including the control. Groups of four plants per treatment were randomized in each 40-plant row. There were six replications of each treatment. The outside row of one bench served as a guard row because it

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*Westside Greenhouses, Inkster, Michigan.

was near heating coils located on a side wall. The outside row of the other bench also served as a guard row.

Three plants from each treated group of one bench including the controls were labeled for obtaining data concerning the number of flowers and maximum diameter measurements. As the guard row was not included in these data, these records were based on three plants per treatment; five treatments per cultivar with five replications. Thus, there were seventy-five plants of each of two cultivars included in obtaining data for the number of flowers and the greatest diameter measurements.

In the second bench, three plants from each group, including the controls were labeled for obtaining data on lasting quality of flowers and the number of peduncles. The guard row was not included in data from the second bench, and the records were based on three plants per treatment; five treatments per cultivar with five replications. Thus, there were seventy-five plants of each of two cultivars included in obtaining data for the lasting quality of the flowers.

One plant in each treated group including the replications from both benches was labeled for obtaining leaves for an investigation of the rooting of leaf-petiole cuttings.

After the plants were allowed to grow for five months the treatments consisting of: control, 100 parts per million indoleacetic acid, 100 parts per million gibberellic acid, 25 parts per million triiodobenzoic acid were applied on May 1, 1957. The chemicals were dissolved in 1 milliliter of ethyl alcohol and made up to the proper volume with distilled water. New solutions were prepared for each application.

Plant groups were moved into an adjoining house where the various growth substances were applied by means of a hand sprayer. Each group was shielded so as to prevent the spray from drifting to other plants. The sprayer was carefully cleaned by rinsing in tap water ten times, once in ethyl alcohol and twice with distilled water after each spray material was used.

The plants were then placed in their original positions on the benches. On May 22 a second spray application of growth regulators was applied. On June 12 the third and final application was made.

To determine the effects of various growth regulators on rooting response, fifty uniform leaf-petiole cuttings were obtained from treated plants eight days after the last treatment date. They were inserted in sand contained in trays, which, in turn, were kept in a water bath having a constant temperature of 75° F.

Thirty-four days from insertion date, cuttings were removed from sand medium for evaluation of root development. Data obtained were subjectively divided into four groups: (1) not rooted, (2) lightly rooted, (3) intermediately rooted, and (4) heavily rooted cuttings, based on visual observations. The data were analyzed statistically and results presented in "Experimental Results".

Starting June 1st data were recorded on the number of flowers on each inflorescence and the number of peduncles. Data were also obtained concerning the lasting quality of each flower. Lasting quality was determined by recording the number of days between time of complete opening and time first wilting of petals was visible.

On June 29th, pollen was selected from flowers of cultivar 'Star Girl Seedling' in the various groups to determine if its germination had been adversely affected. Anthers from two flowers per plant per treated group, including control, were selected from both benches. Thus, there were anthers from 20 flowers from each treatment. Pollen from the anthers within a group was mixed together for uniformity of sampling. This was done for all groups. A sample was selected from each group mixture and placed on hanging drops of a 15 percent sucrose solution made with distilled water. Pollen was germinated at room temperature. Germination data were recorded and the results analyzed statistically.

Maximum diameters of the plants were measured every two weeks from May 2 to June 12 to ascertain total growth as represented by the increase in size of maximum diameter of plants every two weeks. Graphs were made from recorded data. In addition to these measurements and recorded data, observations were made regarding changes in shape or form of plant parts.

EXPERIMENTAL RESULTS

Effect of Growth Regulators on Rooting

The rooted cuttings were subjectively divided into the following four groups: (1) not rooted, (2) lightly rooted, (3) intermediately rooted, and (4) heavily rooted, based on visual observation. Drawings of a representative cutting of each class are shown in Figures 1 to 4.

The resulting data presented in Tables I and II show the effect of foliar application of maleic hydrazide, indoleacetic acid and gibberellic acid at 100 parts per million, and triiodobenzoic acid at 25 parts per million on rooting response of leaf-petiole cuttings of two cultivars of Saintpaulia, 'Star Girl Seedling' and 'Queen's Cushion'. Data in Tables I and II are the result of separating and counting the cuttings into the various classes. These numbers are expressed in percentages in Table III and are graphically shown by bar diagrams in Figures 5 and 6.

Chi-square analysis as shown in Tables IV and V indicate totals of all classes of leaf-petiole cutting rooting responses of Saintpaulia cultivar 'Star Girl Seedling' to the various treatments were different than the totals of all classes of leaf-petiole cutting rooting responses of cultivar 'Queen's Cushion'.

However, a comparison between the control groups of cultivar 'Star Girl Seedling' and the control groups of cultivar 'Queen's Cushion' indicates

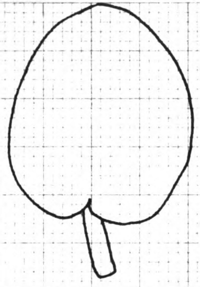

Figure 1

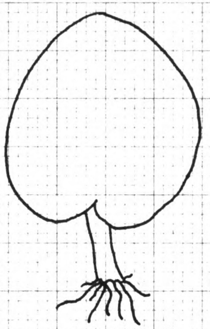

Figure 2

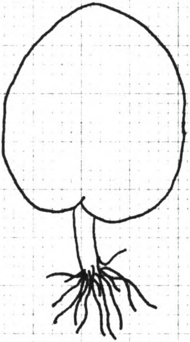

Figure 3

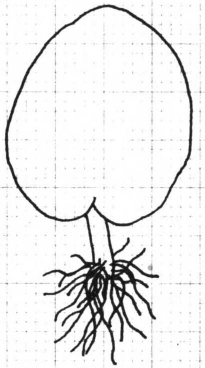

Figure 4

Figures 1 to 4. Drawings of leaf-petiole cuttings representing Saintpaulia cultivars 'Star Girl Seedling' and 'Queen's Cushion'. Drawings illustrate the approximate stage of rooting by which cuttings were classified into groups. Figure 1, not rooted. Figure 2, lightly rooted. Figure 3, intermediately rooted. Figure 4, heavily rooted.

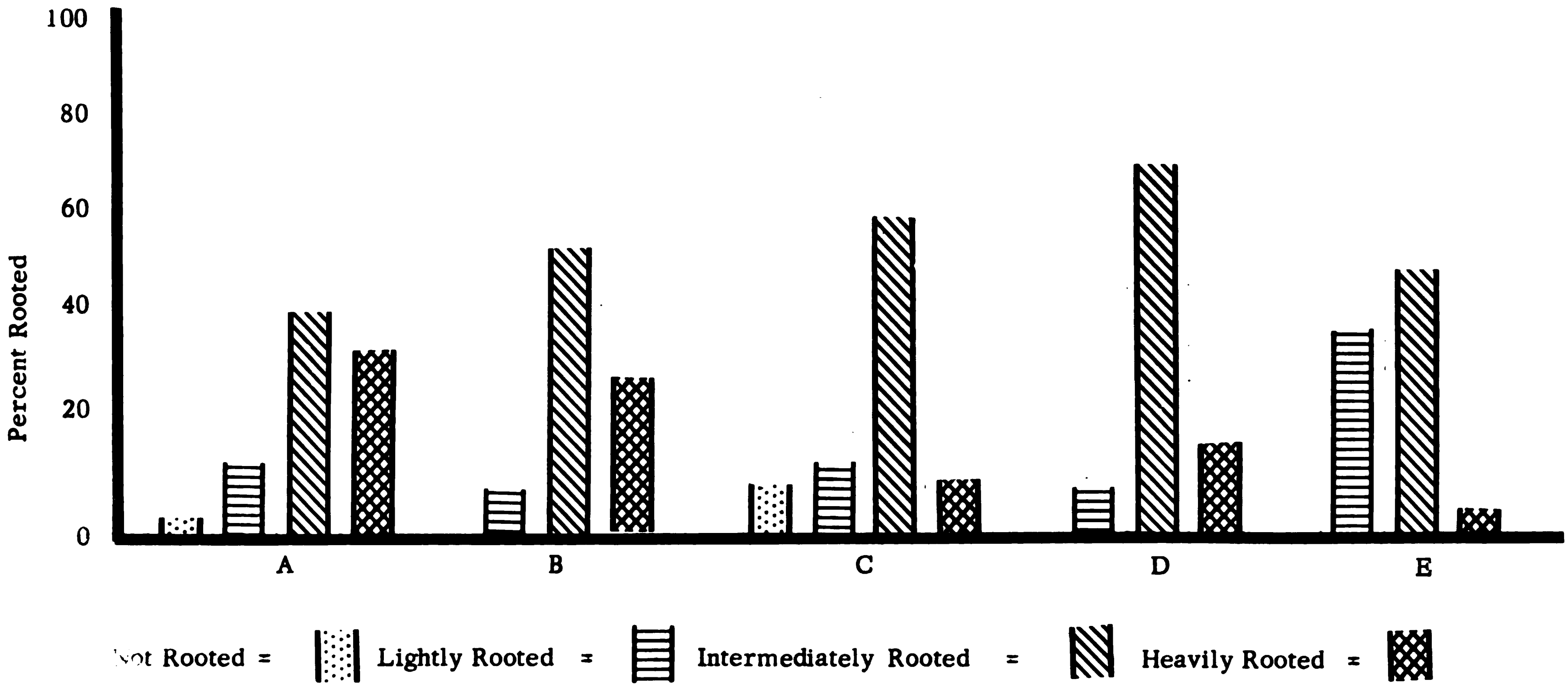

Figure 5. Effects of three foliar sprays of certain chemicals on the rooting of leaf-petiole cuttings of Saintpaulia cultivar 'Star Girl Seedling'. (A) Control, (B) 100 ppm Maleic Hydrazide, (C) 25 ppm Triiodobenzoic acid, (D) 100 ppm Indoleacetic acid, (E) 100 ppm Gibberellic acid.

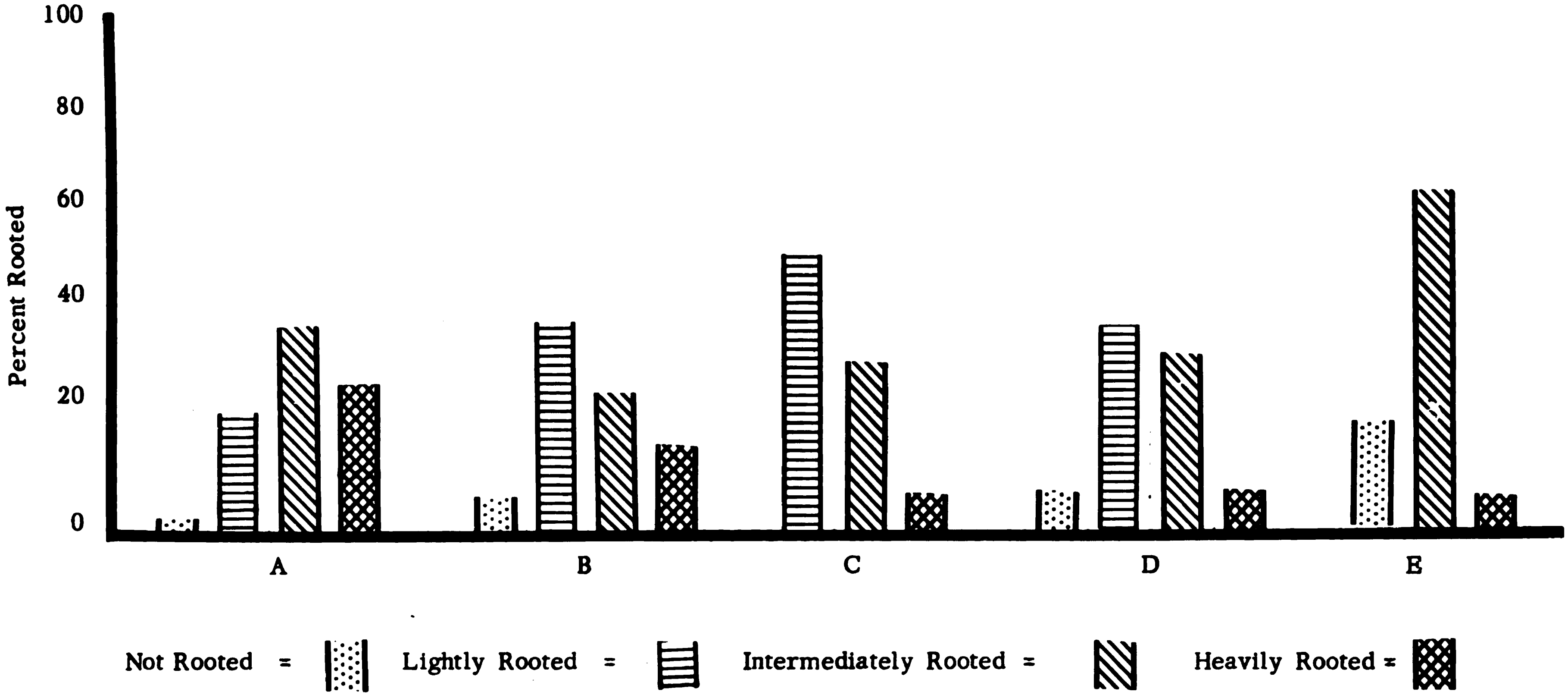

Figure 6. Effects of three foliar sprays of certain chemicals on rooting leaf-petiole cuttings of Saintpaulia cultivar 'Queen's Cushion'. (A) Control, (B) 100 ppm Maleic Hydrazide, (C) 25 ppm Triiodobenzoic acid, (D) 100 ppm Indoleacetic acid, (E) 100 ppm Gibberellic acid.

TABLE I

Effect of Foliar Application of Maleic Hydrazide, Indoleacetic Acid and Gibberellic Acid at 100 parts per million and Triiodobenzoic Acid at 25 parts per million on Rooting Leaf-Petiole Cuttings of *Saintpaulia* Cultivar 'Star Girl Seedling'.

Treatment	Number of Cuttings in Each Class				
	Not Rooted	Lightly Rooted	Intermediately Rooted	Heavily Rooted	Total Cuttings per Treatment
Control	1	7	23	19	50
Maleic Hydrazide	0	5	29	16	50
Triiodobenzoic Acid	6	7	31	6	50
Indoleacetic Acid	0	6	36	8	50
Gibberellic Acid	0	21	27	2	50
Total Cuttings in Each Class	7	46	146	51	250

TABLE II

Effect of Foliar Application of Maleic Hydrazide, Indoleacetic Acid and Gibberellic Acid at 100 parts per million, and Triiodobenzoic Acid at 25 parts per million on Rooting Leaf-Petiole Cuttings of Saintpaulia Cultivar 'Queen's Cushion'.

Treatment	Number of Cuttings in Each Class				
	Not Rooted	Lightly Rooted	Intermediately Rooted	Heavily Rooted	Total Cuttings per Treatment
Control	1	12	22	15	50
Maleic Hydrazide	4	22	15	9	50
Triiodobenzoic Acid	0	29	17	4	50
Indoleacetic Acid	5	22	19	4	50
Gibberellic Acid	11	35	4	0	50
Total Cuttings in Each Class	21	120	77	32	250

TABLE III

Effect of Foliar Application of Maleic Hydrazide, Indoleacetic Acid, and Gibberellic Acid at 100 parts per million, and Triiodobenzoic Acid at 25 parts per million on Rooting Leaf-Petiole Cuttings of Saintpaulia Cultivar 'Star Girl Seedling' (S.G.S.), and 'Queen's Cushion' (Q.C.).

Treatment	Classes of Cuttings							
	Percent Not Rooted		Percent Lightly Rooted		Percent Intermediately Rooted		Percent Heavily Rooted	
	S.G.S.	Q.C.	S.G.S.	Q.C.	S.G.S.	Q.C.	S.G.S.	Q.C.
Control	2	2	14	24	46	44	38	30
Maleic Hydrazide	0	8	10	44	58	30	32	18
Triiodobenzoic Acid	12	0	14	58	62	34	12	8
Indoleacetic Acid	0	10	12	44	72	38	16	8
Gibberellic Acid	0	22	42	70	54	8	4	0

TABLE IV

Chi-Square Analysis of Rooting Between Cultivars

Cultivar and Treatment	F(1)	X2 (2)	P=.05(3)	Significant = *	Cultivar and Treatment	F(1)	X2(2)	P=.05(3)	Significant = *
V1C0 vs. V2Cl	1	14.8	3.84	*	V1C0 vs. V2C0	2	1.7	5.99	
V1C0 vs. V2C2	1	18.2	3.84	*					
V1C0 vs. V2C3	2	16.2	5.99	*					
V1C0 vs. V2C4	1	58.2	3.84	*					
V1Cl vs. V2C0	2	3.7	5.99		V1Cl vs. V2Cl	2	18.8	5.99	*
V1Cl vs. V2C2	2	27.4	5.99	*					
V1Cl vs. V2C3	2	24.4	5.99	*					
V1Cl vs. V2C4	2	73.2	5.99	*					
V1C2 vs. V2C0	2	5.2	5.99		V1C2 vs. V2C3	2	14.0	5.99	*
VlC2 vs. V2C1	2	16.2	5.99	*					
VlC2 vs. V2C3	2	8.2	5.99	*					
V1C2 vs. V2C4	2	50.8	5.99	*					
V1C3 vs. V2C0	2	5.1	5.99		V1C3 vs. V2C3	2	19.0	5.99	*
VlC3 vs. V2C1	1	18.4	3.84	*					
V1C3 vs. V2C2	1	30.4	3.84	*					
V1C3 vs. V2C4	2	184.4	5.99	*					
V1C4 vs. V2C0	2	12.9	5.99	*	V1C4 vs. V2C4	2	33.6	5.99	*
V1C4 vs. V2C1	1	10.2	3.84	*					
V1C4 vs. V2C2	1	2.6	3.84						
V1C4 vs. V2C3	1	1.5	3.84						

(1) F = Degrees of freedom
(2) X^2 = Chi-square
(3) P = Probability

Key To Table

C0 = Control
C1 = 100 parts per million maleic hydrazide
C2 = 25 parts per million triiodobenzoic acid
C3 = 100 parts per million indoleacetic acid
C4 = 100 parts per million gibberellic acid

V1 = 'Star Girl Seedling'
V2 = 'Queen's Cushion'

TABLE V

Chi-Square Analysis of Rooting Within Cultivars

Cultivar and Treatment	F[1]	X^2[2]	P=.05[3]	Significant = *	Cultivar and Treatment	F[1]	X^2[2]	P=.05[3]	Significant = *
V1C0 vs. V1C1	2	1.7	5.99		V2C0 vs. V2C1	2	7.7	5.99	*
V1C0 vs. V1C2	2	9.2	5.99	*	V2C0 vs. V2C2	2	13.0	5.99	*
V1C0 vs. V1C3	2	7.5	5.99	*	V2C0 vs. V2C3	1	79.9	3.84	*
V1C0 vs. V1C4	1	8.2	3.84	*	V2C0 vs. V2C4	1	44.1	3.84	*
V1C1 vs. V1C0	2	1.7	5.99	*	V2C1 vs. V2C0	2	7.7	5.99	*
V1C1 vs. V1C2	2	8.3	5.99	*	V2C1 vs. V2C2	2	2.2	5.99	
V1C1 vs. V1C3	2	4.1	5.99		V2C1 vs. V2C3	2	2.5	5.99	
V1C1 vs. V1C4	2	20.9	5.99	*	V2C1 vs. V2C4	2	19.0	5.99	*
V1C2 vs. V1C0	2	9.2	5.99	*	V2C2 vs. V2C0	2	13.0	5.99	*
V1C2 vs. V1C1	2	8.3	5.99	*	V2C2 vs. V2C1	2	2.2	5.99	
V1C2 vs. V1C3	2	3.2	5.99	*	V2C2 vs. V2C3	2	.2	5.99	
V1C2 vs. V1C4	2	4.0	5.99	*	V2C2 vs. V2C4	2	18.0	5.99	*
V1C3 vs. V1C0	2	7.5	5.99	*	V2C3 vs. V2C0	1	79.9	3.84	*
V1C3 vs. V1C1	2	4.1	5.99	*	V2C3 vs. V2C1	2	2.5	5.99	
V1C3 vs. V1C2	2	3.2	5.99	*	V2C3 vs. V2C2	2	.2	5.99	
V1C3 vs. V1C4	2	10.9	5.99	*	V2C3 vs. V2C4	2	17.0	5.99	*
V1C4 vs. V1C0	1	8.2	3.84	*	V2C4 vs. V2C0	1	44.1	3.84	*
V1C4 vs. V1C1	2	20.9	5.99	*	V2C4 vs. V2C1	2	19.0	5.99	*
V1C4 vs. V1C2	2	4.0	5.99	*	V2C4 vs. V2C2	2	18.0	5.99	*
V1C4 vs. V1C3	2	10.9	5.99	*	V2C4 vs. V2C3	2	17.0	5.99	*
V1 vs. V2	3	65.3	7.81	*					

(1) F = Degrees of freedom
(2) X^2 = Chi-square
(3) P = Probability

<u>Key To Table</u>

C0 = Control
C1 = 100 parts per million maleic hydrazide
C2 = 25 parts per million triiodobenzoic acid
C3 = 100 parts per million indoleacetic acid
C4 = 100 parts per million gibberellic acid

V1 = 'Star Girl Seedling'
V2 = 'Queen's Cushion'

no significant difference. This indicates similarity in rooting response of untreated leaf-petiole cuttings of cultivar 'Star Girl Seedling' and 'Queen's Cushion' as grown under the same environmental conditions.

Leaf-petiole cuttings of cultivar 'Star Girl Seedling' responded differently to the chemical treatments than cultivar 'Queen's Cushion'. One hundred parts per million maleic hydrazide, indoleacetic acid and gibberellic acid and 25 parts per million triiodobenzoic acid produced significantly different responses in the rooting of leaf-petiole cuttings of 'Star Girl Seedling' as compared to 'Queen's Cushion', indicating a difference in response to chemical treatments between different cultivars of Saintpaulia.

However, certain treatments when analyzed by chi-square, indicated no significance in rooting response. They are as follows: (1) 100 parts per million maleic hydrazide treated cuttings of 'Star Girl Seedling' as compared to untreated cuttings of 'Queen's Cushion'; (2) the 25 parts per million triiodobenzoic acid treated cuttings of 'Star Girl Seedling' compared to untreated cuttings of 'Queen's Cushion'; (3) the 100 parts per million indoleacetic acid treated cuttings of 'Star Girl Seedling' compared to untreated cuttings of 'Queen's Cushion'; and (4) 100 parts per million gibberellic acid treated cuttings of 'Star Girl Seedling' as compared to 100 parts per million indoleacetic acid treated cuttings of 'Queen's Cushion'. In all other two-way comparisons between cultivars, chi-square analysis indicated significant differences in rooting response to treatments (Table IV).

Chi-square analysis was also used to compare the various treatments within each cultivar for significant differences (Table V). Following are the results of comparing treatments within cultivar 'Star Girl Seedling':

I. Comparisons Resulting in Significant Differences:

(1) Control compared to 25 parts per million triiodobenzoic acid.

(2) Control compared to 100 parts per million indoleacetic acid.

(3) Control compared to 100 parts per million gibberellic acid.

(4) 100 parts per million maleic hydrazide compared to 25 parts per million triiodobenzoic acid.

(5) 100 parts per million maleic hydrazide compared to 100 parts per million gibberellic acid.

(6) 25 parts per million triiodobenzoic acid compared to control.

(7) 25 parts per million triiodobenzoic acid compared to 100 parts per million maleic hydrazide.

(8) 100 parts per million indoleacetic acid compared to control.

(9) 100 parts per million indoleacetic acid compared to 100 parts per million gibberellic acid.

(10) 100 parts per million gibberellic acid compared to control.

(11) 100 parts per million gibberellic acid compared to 100 parts per million maleic hydrazide.

(12) 100 parts per million gibberellic acid compared to 100 parts per million indoleacetic acid.

II. Comparisons Resulting in Non-Significance:

(1) Control compared to 100 parts per million maleic hydrazide.

(2) 100 parts per million maleic hydrazide compared to control.

(3) 100 parts per million maleic hydrazide compared to 100 parts per million indoleacetic acid.

(4) 25 parts per million triiodobenzoic acid compared to 100 parts per million indoleacetic acid.

(5) 25 parts per million triiodobenzoic acid compared to 100 parts per million gibberellic acid.

(6) 100 parts per million indoleacetic acid compared to 100 parts per million maleic hydrazide.

(7) 100 parts per million indoleacetic acid compared to 25 parts per million triiodobenzoic acid.

(8) 100 parts per million gibberellic acid compared to 25 parts per million triiodobenzoic acid.

The following are the results of comparing treatments within the cultivar 'Queen's Cushion':

I. Comparisons Resulting in Significant Differences:

(1) Control compared to 100 parts per million maleic hydrazide.

(2) Control compared to 25 parts per million triiodobenzoic acid.

(3) Control compared to 100 parts per million indoleacetic acid.

(4) Control compared to 100 parts per million gibberellic acid.

(5) 100 parts per million maleic hydrazide compared to control.

(6) 100 parts per million maleic hydrazide compared to 100 parts per million gibberellic acid.

(7) 25 parts per million triiodobenzoic acid compared to control.

(8) 25 parts per million triiodobenzoic acid compared to 100 parts per million gibberellic acid.

(9) 100 parts per million indoleacetic acid compared to control.

(10) 100 parts per million indoleacetic acid compared to 100 parts per million gibberellic acid.

(11) 100 parts per million gibberellic acid compared to control.

(12) 100 parts per million gibberellic acid compared to 100 parts per million maleic hydrazide.

(13) 100 parts per million gibberellic acid compared to 25 parts per million triiodobenzoic acid.

II. Comparisons Resulting in Non-significant Differences:

(1) 100 parts per million maleic hydrazide compared to 25 parts per million triiodobenzoic acid.

(2) 100 parts per million maleic hydrazide compared to 100 parts per million indoleacetic acid.

(3) 25 parts per million triiodobenzoic acid compared to 100 parts per million maleic hydrazide.

(4) 25 parts per million triiodobenzoic acid compared to 100 parts per million indoleacetic acid.

(5) 100 parts per million indoleacetic acid compared to 100 parts per million maleic hydrazide.

(6) 100 parts per million indoleacetic acid compared to 25 parts per million triiodobenzoic acid.

(7) 100 parts per million gibberellic acid compared to 100 parts per million indoleacetic acid.

Effect on Pollen Germination

Pollen grains of only one cultivar, 'Star Girl Seedling' were used, since it was a single flowering cultivar and produced pollen. Cultivar, 'Queen's Cushion' was not used, since it was a double flowering cultivar and produced very little pollen.

One hundred pollen grains were counted in each sample (Table VI). Since the germination percentages were small, they were converted to angles by a table given by Snedecor (35).

A statistical analysis was carried out on the data in Table VII. The calculated F value indicated that one or more differences among the means were significant. Significance between the means was determined by the use of a Studentized Range Tables by Duncan (9).

The significances of the means were found to be:

Control	significantly greater than TIBA, IAA, MA, GA.
TIBA	significantly greater than MH, GA, IAA
IAA	significantly greater than MH, GA
GA	significantly greater than MH

TABLE VI

Effect of Certain Growth Regulators on Germination of Pollen of 'Star Girl Seedling' Saintpaulia.

Trial	Number Germinating Pollen Grains in 100-Grain Samples				
	MH(1) 100 ppm	TIBA(2) 25 ppm	IAA(3) 100 ppm	GA(4) 100 ppm	CONTROL
1	5	5	8	2	6
2	3	5	5	9	13
3	4	10	6	2	14
4	3	4	4	5	11
5	4	9	3	4	9
Totals	19	33	26	22	53
Averages	3.8	6.6	5.2	4.4	10.6

(1) = maleic hydrazide

(2) = triiodobenzoic acid

(3) = indoleacetic acid

(4) = gibberellic acid

TABLE VII

Percentage Germination of Pollen Grains from Growth Regulator Treated Plants of Saintpaulia Cultivar 'Star Girl Seedling.
(Data from TABLE VI Converted to Angles)

Trial	Number Germinating Pollen Grains in 100-Grain Samples (Numbers Converted to Angles)				
	MH(1) 100 ppm	TIBA(2) 25 ppm	IAA(3) 100 ppm	GA(4) 100 ppm	CONTROL
1	13	13	16	8	14
2	10	13	13	17	21
3	12	18	14	8	22
4	10	12	12	13	19
5	12	17	10	12	17
Averages	11.4	14.6	13.0	11.6	18.6

(1) = maleic hydrazide

(2) = triiodobenzoic acid

(3) = indoleacetic acid

(4) = gibberellic acid

Effect on Growth

To determine the growth of experimental plants, their maximum rosette diameters were measured every two weeks by means of an 18-inch wood caliper, and the data were recorded.

Measurements of each group for each two-week period were averaged. This was repeated for all replicates. These averages were, in turn, averaged, in order to get the averages of replication averages per treatment. This was done for all treatment groups including control (Table VIII). Graphs were made to show growth rates (Figures 7 to 15).

Figures 16 and 17 show representative plants from each treated group as they appeared on July 5, 1957.

Effect on Number of Flowers and Peduncles

To determine the number of flowers and peduncles, flowers and peduncles were harvested, counted, recorded and discarded at two-week intervals from June 1, 1957 to August 23, 1957. The average number of flowers for each treatment and the average number of peduncles for each treatment are shown in Table IX. An analysis of variance was made for each set of data, that is, for average number of flowers per treatment. The results of both analyses showed that the treatments were highly significant to the 1 percent level. Significance among the means was determined according to Duncan's method (9).

TABLE VIII

Effect of Certain Growth Regulators on Maximum Diameters of Two *Saintpaulia* Cultivars

Treatment	Average Maximum Diameters 15 Plants (Inches)					
	Measurement Dates					
	May 2	May 16	May 30	June 13	June 27	July 11
			Cultivar 'Star Girl Seedling'			
MH, 100 ppm	6.0	6.2	6.4	6.6	6.9	7.1
TIBA, 25 ppm	6.4	6.4	6.7	6.8	7.0	7.1
IAA, 100 ppm	5.9	6.1	6.3	6.3	6.6	6.8
GA, 100 ppm	6.1	6.5	8.5	8.5	9.7	10.9
Control	6.2	6.4	6.7	6.9	7.1	7.3
			Cultivar 'Queen's Cushion'			
MH, 100 ppm	8.2	8.5	9.3	9.7	10.1	10.2
TIBA, 25 ppm	9.1	9.2	9.3	9.6	10.0	10.3
IAA, 100 ppm	9.3	9.5	9.7	10.0	10.4	10.7
GA, 100 ppm	9.6	10.3	11.2	11.3	12.7	13.0
Control	9.1	9.1	9.4	10.0	10.9	11.4

MH = maleic hydrazide
IAA = indoleacetic acid
TIBA = triiodobenzoic acid
GA = gibberellic acid

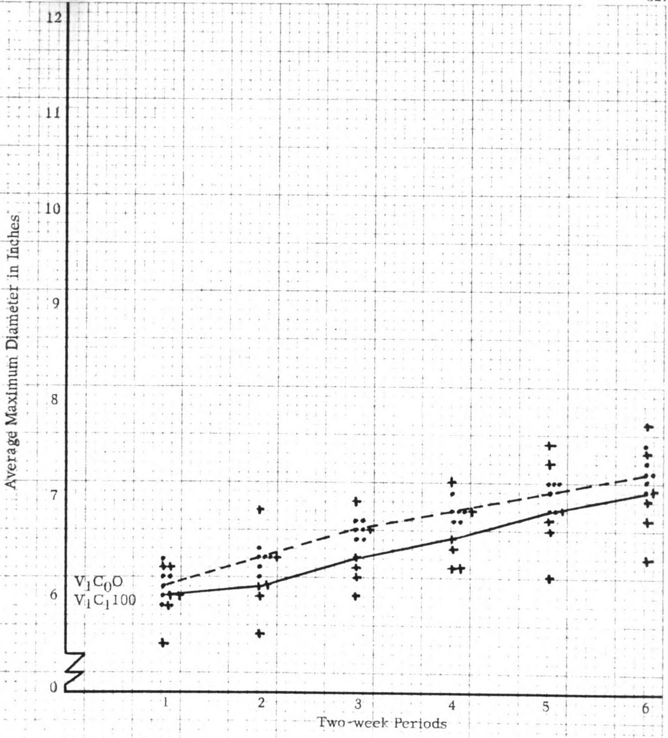

Figure 7. The mean of average maximum diameters of Saintpaulia cultivar 'Star Girl Seedling' control plants (V_1C_0O) compared to the mean of average maximum diameters of 100 parts per million maleic hydrazide treated plants (V_1C_1100) of Saintpaulia cultivar 'Star Girl Seedling'. Each dot represents average maximum diameters of three plants per treatment replicated five times, a total of fifteen plants per treatment.

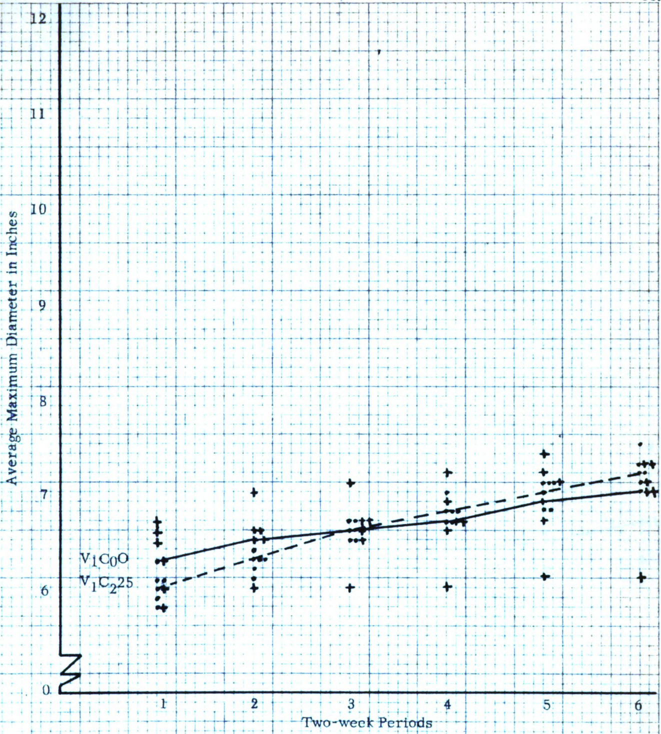

Figure 8. The mean of average maximum diameters of Saintpaulia cultivar 'Star Girl Seedling' control plants (V_1C_0O) compared to the mean of average maximum diameters of 25 parts per million triiodobenzoic acid treated plants (V_1C_225) of Saintpaulia cultivar 'Star Girl Seedling'. Each dot represents average maximum diameters of three plants per treatment replicated five times, a total of fifteen plants per dot.

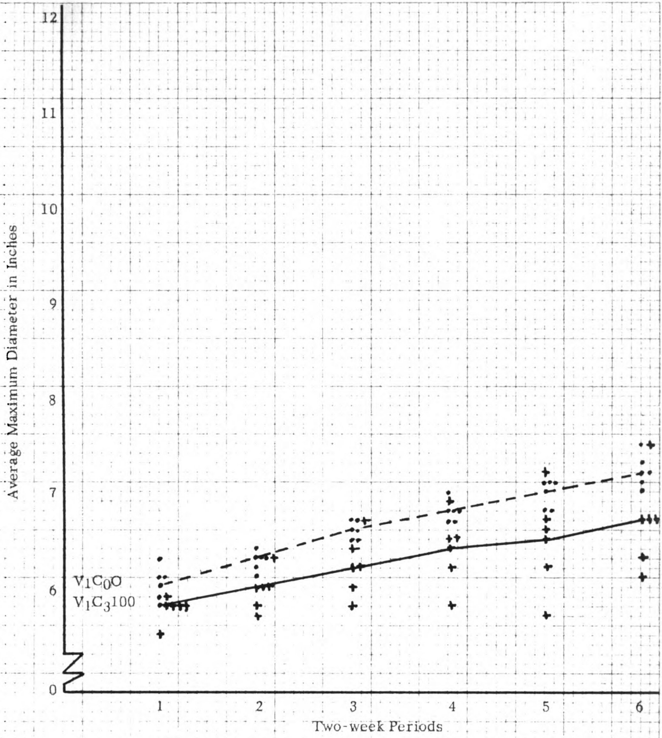

Figure 9. The mean of average maximum diameters of Saintpaulia cultivar 'Star Girl Seedling' control plants (V_1C_0O) compared to the mean of average maximum diameters of 100 parts per million indoleacetic acid treated plants (V_1C_3100) of Saintpaulia cultivar 'Star Girl Seedling'. Each dot represents average maximum diameters of three plants per treatment replicated five times, a total of fifteen plants per dot.

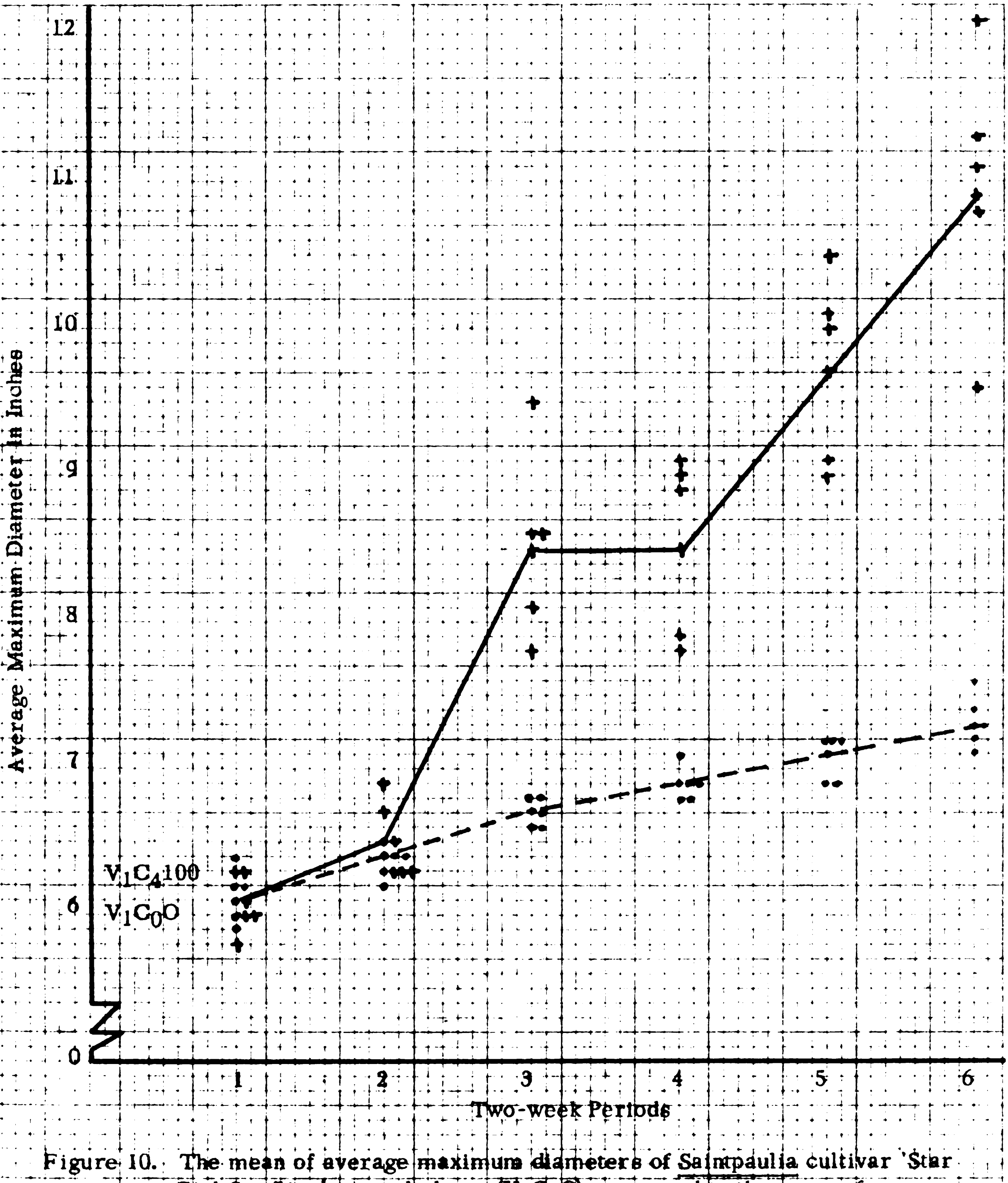

Figure 10. The mean of average maximum diameters of Saintpaulia cultivar 'Star Girl Seedling' control plants (V_1C_0O) compared to the mean of average maximum diameters of 100 parts per million gibberellic acid treated plants (V_1C_4100) of Saintpaulia cultivar 'Star Girl Seedling'. Each dot represents average maximum diameters of three plants per treatment replicated five times, a total of fifteen plants per dot.

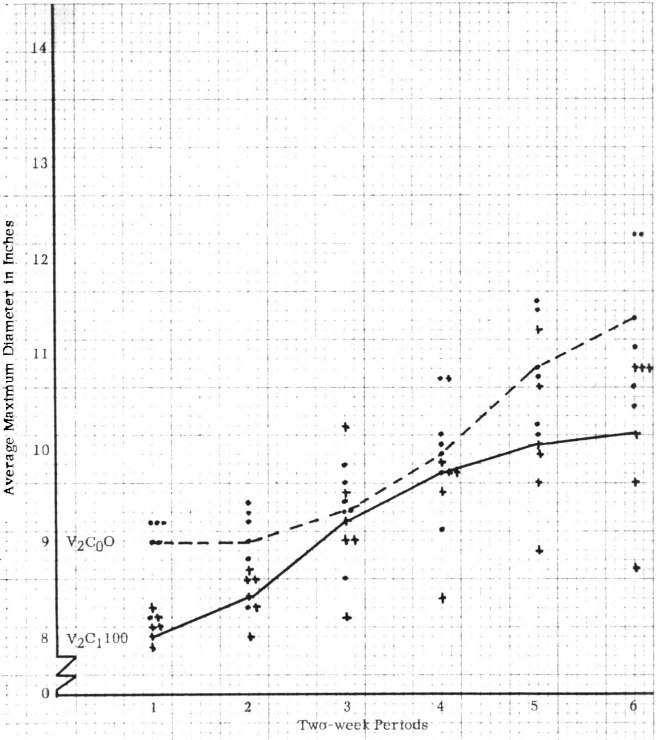

Figure 11. The mean of average maximum diameters of Saintpaulia cultivar 'Queen's Cushion' control plants (V_2C_0O) compared to the mean of average maximum diameters of 100 parts per million maleic hydrazide treated plants ($V_2C_1$100) of Saintpaulia cultivar 'Queen's Cushion'. Each dot represents average maximum diameters of three plants per treatment replicated five times, a total of fifteen plants per dot.

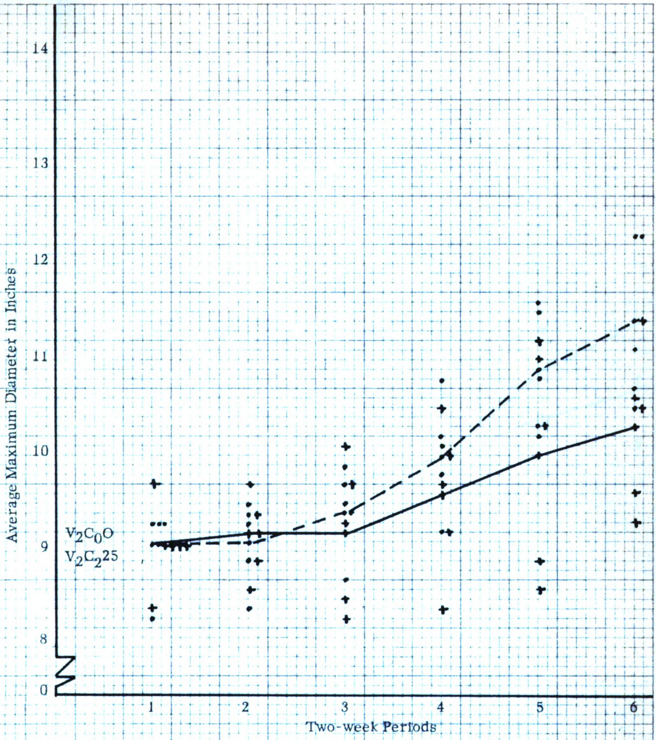

Figure 12. The mean of average maximum diameters of Saintpaulia cultivar 'Queen's Cushion' control plants (V_2C_0O) compared to the mean of average maximum diameters of 25 parts per million triiodobenzoic acid treated plants (V_2C_225) of Saintpaulia cultivar 'Queen's Cushion'. Each dot represents average maximum diameter of three plants per treatment replicated five times, a total of fifteen plants per dot.

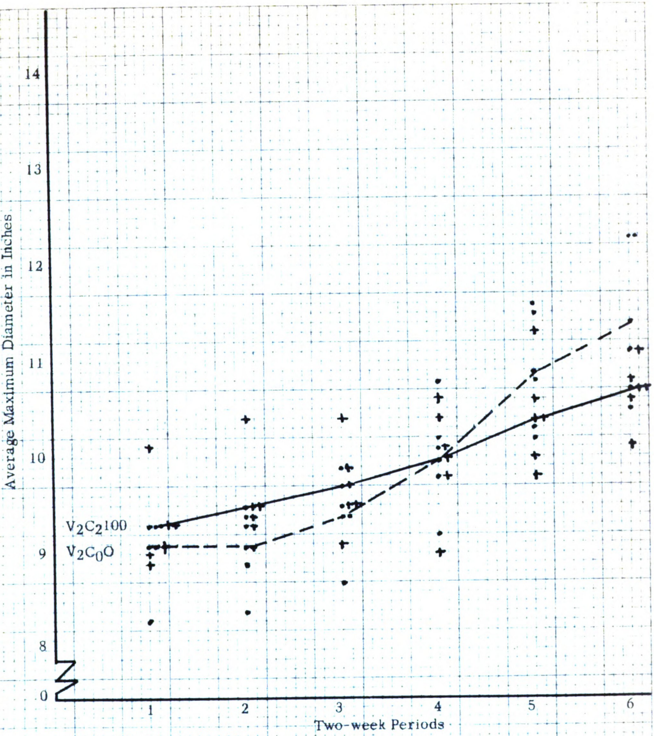

Figure 13. The mean of average maximum diameters of Saintpaulia cultivar 'Queen's Cushion' control plants (V_2C_0O) compared to the mean of average maximum diameters of 100 parts per million indoleacetic acid treated plants (V_2C_3100) of Saintpaulia cultivar 'Queen's Cushion'. Each dot represents average maximum diameter of three plants per treatment replicated five times, a total of fifteen plants per dot.

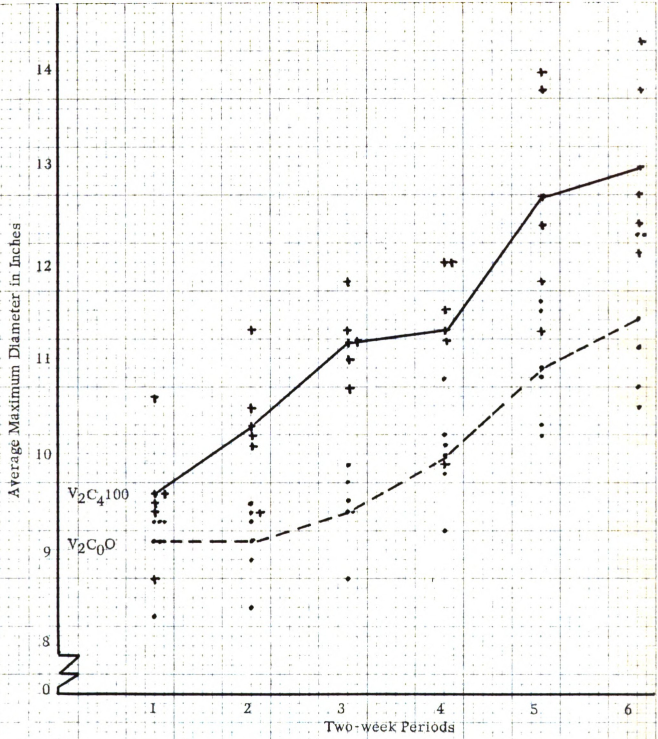

Figure 14. The mean of average maximum diameters of Saintpaulia cultivar 'Queen's Cushion' control plants (V_2C_0O) compared to the mean of average maximum diameters of 100 parts per million gibberellic acid treated plants (V_2C_4100) of Saintpaulia cultivar 'Queen's Cushion'. Each dot represents average maximum diameter of three plants per treatment replicated five times, a total of fifteen plants per dot.

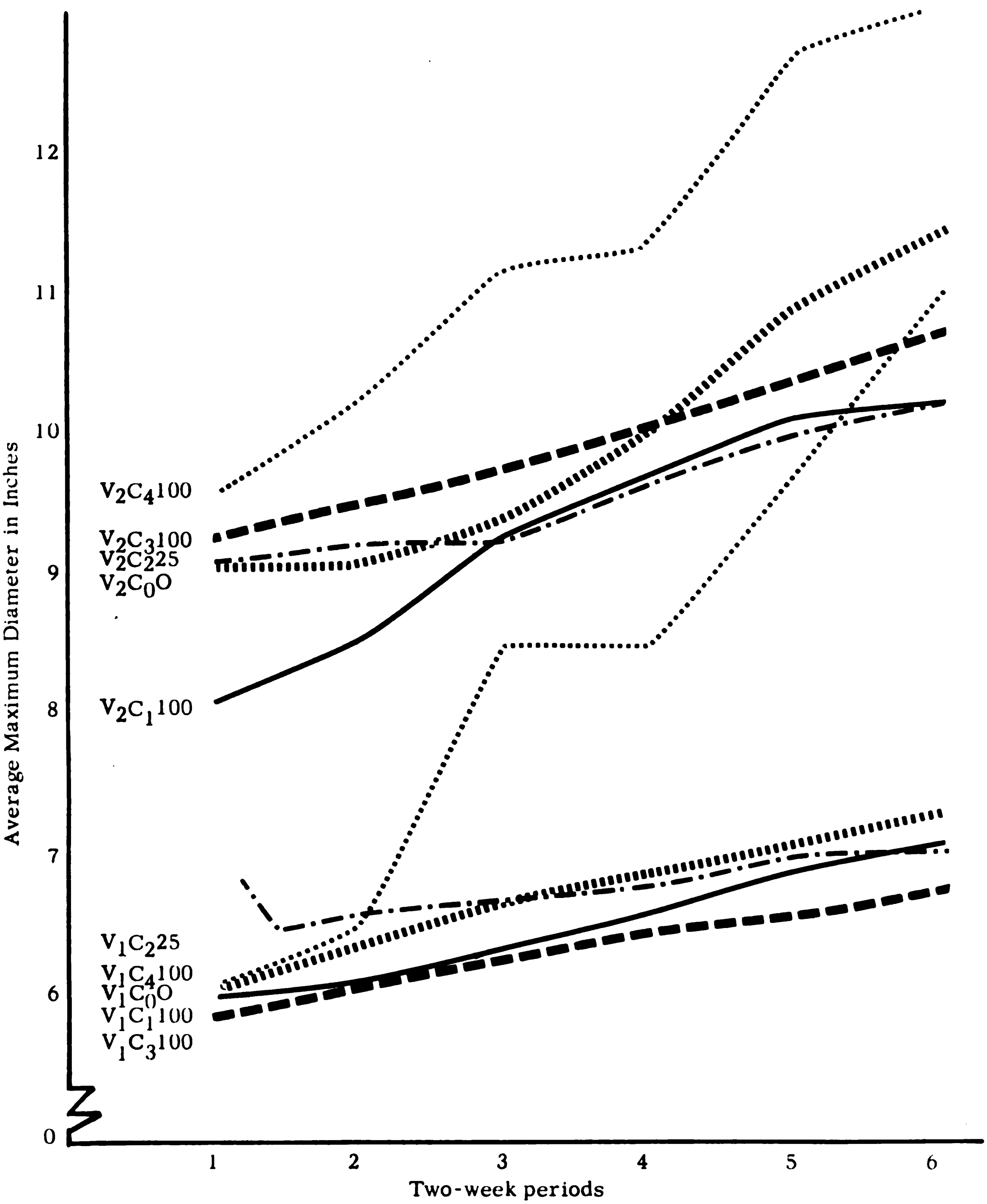

Figure 15. The mean of average maximum diameters of Saintpaulia cultivars 'Star Girl Seedling' and 'Queen's Cushion'.

V_1 = 'Star Girl Seedling'
V_2 = 'Queen's Cushion'
C_0O = Control
C_1100 = 100 parts per million maleic hydrazide
C_225 = 25 parts per million triiodobenzoic acid
C_3100 = 100 parts per million indoleacetic acid
C_4100 = 100 parts per million gibberellic acid

Figure 16. Saintpaulia cultivar 'Star Girl Seedling'.
From left to right: control; treated with three spray applications of 100 parts per million maleic hydrazide; three spray applications of 25 parts per million triiodobenzoic acid; three applications of 100 parts per million indoleacetic acid; three applications of 100 parts per million gibberellic acid. Photograph taken July 5, 1957.

Figure 17. Saintpaulia cultivar 'Queen's Cushion.
From left to right: control; treated with three spray applications of 100 parts per million maleic hydrazide; three spray applications of 25 parts per million triiodobenzoic acid; three applications of 100 parts per million of indoleacetic acid; three applications of 100 parts per million of gibberellic acid. Photograph taken July 5, 1957.

TABLE IX

Effect of Certain Growth Regulators on Number of Flowers and Peduncles of _Saintpaulia_ Cultivars 'Star Girl Seedling' and 'Queen's Cushion' from June 1, 1957 to August 23, 1957.

Cultivar	Average Number of Flowers and Peduncles per Treatment (Means of 15 Replicates)									
	MH (100 ppm)		TIBA (25 ppm)		IAA (100 ppm)		GA (100 ppm)		Control (100 ppm)	
	Flowers	Peduncles	Flowers	Peduncles	Flowers	Peduncles	Flowers	Peduncles	Flowers	Peduncles
'Star Girl Seedling'	238	18.07	217	17.87	199	18.67	281	22.33	231	17.07
'Queen's Cushion'	259	22.07	277	22.93	250	20.87	480	31.80	343	24.47

MH = maleic hydrazide
TIBA = triiodobenzoic acid
IAA = indoleacetic acid
GA = gibberellic acid

The significances of the means for the number of flowers were found to be as follows:

For cultivar 'Star Girl Seedling':

GA significantly greater than IAA, TIBA.

For cultivar 'Queen's Cushion':

GA significantly greater than IAA, MH, TIBA, Control.

Control significantly greater than IAA.

The significances of the means for the number of peduncles were found to be as follows:

For cultivar 'Star Girl Seedling':

GA significantly greater than all other groups.

For cultivar 'Queen's Cushion':

GA significantly greater than all other groups.

Effect on Lasting Quality of Flowers

Lasting quality of the flowers was recorded for each treatment for each variety (Table X). An analysis of variance was made from the resulting data and the significance of each treatment was determined.

The significances of the means were found to be as follows:

For cultivar 'Star Girl Seedling':

Control significantly greater than GA, MH, IAA, TIBA

TABLE X

Effect of Certain Growth Regulators on Lasting Quality of *Saintpaulia* Flowers.

Cultivar	Average Number of Days Flowers Lasted (Means of 15 Replicates)				
	MH 100 ppm	TIBA 25 ppm	IAA 100 ppm	GA 100 ppm	Control
'Star Girl Seedling'	10.0	10.2	10.0	7.8	11.0
'Queen's Cushion'	13.0	13.2	14.2	13.4	13.6

MH = maleic hydrazide
TIBA = triiodobenzoic acid
IAA = indoleacetic acid
GA = gibberellic acid.

TIBA significantly greater than GA.

IAA significantly greater than GA.

MH significantly greater than GA.

For cultivar 'Queen's Cushion':

IAA significantly greater than MH, TIBA, GA, Control.

Control significantly greater than MH, TIBA.

GA significantly greater than MH.

Morphological Changes

In addition to the data presented, observations were made on other external features of the two Saintpaulia cultivars. With the exception of the gibberellic acid treated plants, no other external changes were observed. Growth of the various plant parts seemed normal in the case of untreated plants, 25 parts per million triiodobenzoic acid, 100 parts per million maleic hydrazide, and 100 parts per million indoleacetic acid. Other external changes on gibberellic acid treated plants were very noticeable when they occurred. The first two to three buds showing color at time of spray application seemed to develop into larger flowers, but buds later in developing seemed to produce flowers which were smaller than normal. This seemed to be true of both varieties.

The blue-purple color of the double-flowered cultivar 'Queen's

Cushion', did not seem to be changed. The flower color of the single-flowered cultivar 'Star Girl Seedling' is blue-purple and white. Normally the pattern formed by the colors in the latter cultivar is quite variable. Sometimes all flowers on one inflorescence are white, while those of another inflorescence of the same plant may all be a solid blue-purple. Flowers having various patterns of blue-purple and white are the usual, but patterns may vary. In patterned flowers the blue-purple color is usually toward the edges of the petals.

From observation it was difficult to determine whether or not color pattern of the flowers appeared to have been modified. They did not appear to be when a comparison was made with untreated plants.

The most striking observed change in the gynoecium was a change concerning the style in the cultivar 'Star Girl Seedling'. The style is normally slightly lobed (22). On the 100 parts per million gibberellic acid treated plants, flowers appeared with styles which were deeply split (Figure 19). In normal styles there is a line extending a few millimeters from the grove of the lobed stigma toward the ovary, but there is no distinct separation of the tissue (Figure 18).

Cross sections cut with a razor blade show that these lines of separation were in the same position that the cross walls of the bilocular ovary is in. This suggests a bicarpellate ovary which may have been separated in more primitive forms.

Figure 18. Style of Saintpaulia cultivar 'Star Girl Seedling' from flower of untreated plant. Arrow indicates grove extending a few millimeters above the stigma. X20.

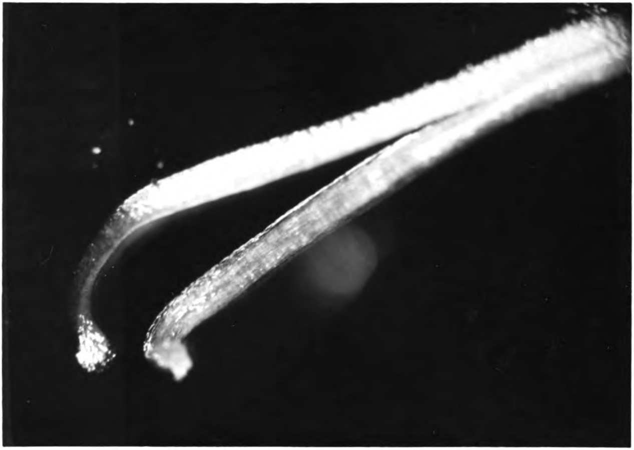

Figure 19. Deeply split style from flower of 100 parts per million gibberellic acid treated Saintpaulia cultivar 'Star Girl Seedling'. X20.

Another change involving the gynoecium is a change of position of the style. H. Wendland (37), who originally described the genus Saintpaulia, noted that the styles were either left-handed or right-handed. Many styles on the gibberellic acid treated plants of cultivar 'Star Girl Seedling' extended straight out of the corolla tube instead of turning either to the right or left.

Changes also occurred in the androecium. Normally the anther apices are united by a small tissue-fusion (39). Many anthers in flowers of gibberellin-treated plants were not united. This change seemed to be associated with change in position of the styles.

A few peloric flowers of cultivar 'Star Girl Seedling' were observed among each group of plants, but the frequency of occurrence seemed greater in the gibberellic acid treated plants.

Pedicels, peduncles and pedicel bracts were very definitely elongated as in Figures 20 and 21, as were leaf blades and petioles. This was observed on both cultivars. Figures 20 and 21 also show the effect on changing the angle of the leaves to the axis. Gibberellic acid treated plants had leaves which tended to angle toward the vertical axis. This effect was noticeable 7 days after the first spray application.

Leaves of both cultivars of Saintpaulia showed the effect of gibberellic acid as in Figures 22 and 23. The general effect was one of elongation of both blade and petiole for each cultivar. Leaf apices became more acute

Figure 20. Saintpaulia cultivar 'Star Girl Seedling' showing the effect of gibberellic acid at 100 parts per million on the growth habit. Left: control. Right: 100 parts per million.

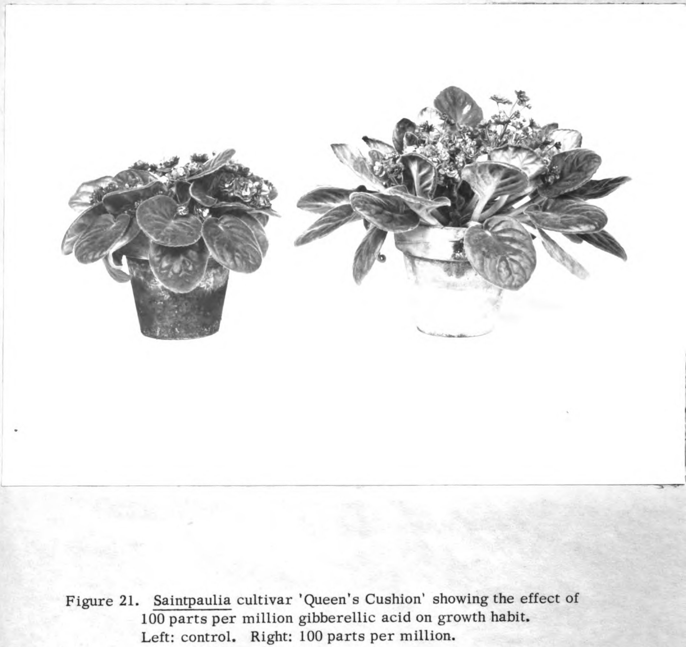

Figure 21. Saintpaulia cultivar 'Queen's Cushion' showing the effect of 100 parts per million gibberellic acid on growth habit. Left: control. Right: 100 parts per million.

than on normal leaves. Leaf bases tended to become narrower. In cultivar 'Star Girl Seedling' leaf bases of the blades tended to gradually narrow into the petiole which, in turn, became leaf-like and gradually merged into a normal petiole as in Figure 23.

Three weeks after the final treatment with gibberellic acid leaves of both cultivars became lighter in color. This was corrected with an application of water soluble commercial fertilizer, which was applied in equal amounts to all plants in the experiment.

Figure 22. Leaves from Saintpaulia cultivar 'Star Girl Seedling' showing the effect of 100 parts per million gibberellic acid. Upper set: control. Lower set: from plants treated with 100 parts per million gibberellic acid.

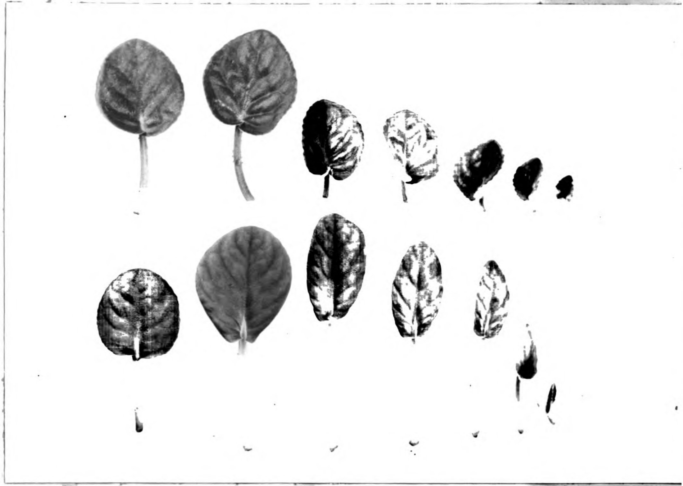

Figure 23. Leaves from Saintpaulia cultivar 'Queen's Cushion' showing the effect of 100 parts per million gibberellic acid. Upper row: control. Lower row: 100 parts per million.

DISCUSSION OF RESULTS

Rooting Leaf-Petiole Cuttings

Rooting response of leaf-petiole cuttings, obtained from plants treated with various chemicals, was significantly different in the two varieties. However, rooting behavior of leaf-petioles of control plants was similar in both cultivars, indicating that chemical treatments were responsible for the induced response as exhibited by treated plants. For example, in cultivar 'Queen's Cushion', the rooting pattern of leaf-petiole cuttings treated with maleic hydrazide, triiodobenzoic acid, indoleacetic acid and gibberellic acid was different in each case.

In the heavily rooted class of cuttings (Table III) the treatments arranged in descending order from the largest number of cuttings rooted to the smallest number rooted were: control, maleic hydrazide, indoleacetic acid, triiodobenzoic acid and gibberellic acid, all of which were found significantly different by chi-square analysis.

In cultivar 'Star Girl Seedling', only gibberellic acid treatment yielded comparatively fewer roots, while there was no significant difference in root growth from other chemicals, although the arrangement of treatments in the heavily rooted class of cuttings was similar in order to those of the cultivar 'Queen's Cushion'.

Leaf-petiole cuttings obtained from the gibberellic acid treated plants of each cultivar produced the least number of rooted cuttings in comparison with the other treatments.

Results indicated that (1) cultivar differences are of major importance in chemical treatments, which tend to influence the morphology of plants; and (2) 100 parts per million of gibberellic acid as used in this experiment, is not conducive to rooting leaf-petiole cuttings of Saintpaulia cultivars 'Star Girl Seedling' and 'Queen's Cushion'.

Pollen Germination

The average germination of pollen from treated plants of 'Star Girl Seedling' was significantly different from the average pollen germination of the controls. Pollen from flowers of control plants averaged 4 percent higher in germination than pollen from the triiodobenzoic acid treated plants; 5.4 percent higher than from the indoleacetic acid treated group; 6.2 percent higher than from the gibberellic acid treated group; 6.8 percent higher than from the maleic hydrazide treated group. Thus, pollen from untreated plants germinated significantly better than pollen from treated plants.

Since pollen of both the treated and untreated plants germinated under the same environmental conditions, it may be postulated that the three spray applications of growth regulators used at their specific concentrations inhibited germination of pollen in some manner, perhaps by affecting the chemical or physical structure of the pollen. Pollen from gibberellic acid treated plants appeared to be smaller than that of any other. No other abnormalities were noted.

Since higher germination percentages have been recorded for other plants, for example, 100 percent for Milla biflora a monocotyledon, and 100 percent for Tropaeolum majus by germinating their pollen in vitro (1) it was reasonable to expect higher germination in the Saintpaulia cultivar 'Star Girl Seedling'. This was not the case. Either the environmental conditions were not optimum for best germination or something inherent in the pollen prevented its germination. It may have been a combination of both factors. Ehrlich (11) found the degree of sterility of pollen from six cultivars of Saintpaulia at anthesis to range from 2.2 percent to 40 percent. The pollen of 'Star Girl Seedling' may be sterile to some extent.

Growth

Growth as expressed by maximum diameter of the rosettes of leaves of each cultivar is shown in a series of graphs (Figures 7 to 15). Unconnected dots represent the average maximum diameter of 15 plants included in each treatment. The line connecting these dots represents the mean of these averages as expressed in inches.

An inspection of the growth curves for cultivar 'Star Girl Seedling' and 'Queen's Cushion' shows that in general all treatments except the gibberellic acid treatment tend to follow the line of the control. The growth rate of gibberellic acid treated plants is much greater.

Thus, the rate of growth as measured by maximum diameter was greatly increased by the gibberellic acid treatment, while the growth rate of all other treated groups tended to follow the growth rate of untreated plants.

Flower and Peduncle Production

An analysis of the flower data shows significantly more flowers produced in the gibberellic acid treated plants of cultivar 'Queen's Cushion' than in any other treated group, including the control plants. There were no significant differences between averages of the maleic hydrazide, triiodobenzoic acid and control group.

The number of peduncles for this cultivar during the same period was found to be significantly greater for the gibberellic acid treated group alone. Thus, there was a significantly greater amount of flowers and peduncles produced by the gibberellic acid treatment in the case of cultivar 'Queen's Cushion'.

For the cultivar 'Star Girl Seedling' the gibberellic acid treated plants produced a significantly greater number of flowers than the indoleacetic acid and triiodobenzoic acid treated groups, but the number of flowers produced was not significantly greater than in the check or in the maleic hydrazide groups. The peduncles of the gibberellic acid treated groups were significantly greater in number than any other treatment, including the check. While there was a significantly greater number of peduncles produced by gibberellic acid treated plants, the total number of flowers produced was not significantly greater than the check.

Lasting Quality of Flowers

The lasting quality of the flowers of 'Star Girl Seedling' was significantly greater in the untreated plants. Triiodobenzoic acid, indoleacetic acid, and maleic hydrazide treated groups produced flowers which lasted a significantly greater time than those of the gibberellic acid treated group. It thus appears that the gibberellic acid treatments were harmful to the lasting quality of flowers of cultivar 'Star Girl Seedling'.

In cultivar 'Queen's Cushion' only the indoleacetic acid treated group of flowers were significantly greater than the untreated group in lasting quality.

Since there is a difference between these two cultivars of *Saintpaulia* in respect to time the flowers last after treatment with maleic hydrazide, triiodobenzoic acid, indoleacetic acid, and gibberellic acid, it follows that different cultivars from the same species of plants may respond differently to chemical treatments.

Morphological Changes

As has been found for other plants (43), the major formative modifications induced by certain growth regulators in two cultivars of Saintpaulia are changes in flowering habit, size, shape, pattern and venation of organs. Thus, shape and position of styles of the cultivar 'Star Girl Seedling' were modified by treatment with gibberellic acid. The position of anthers was also modified.

Leaf shape of both varieties was modified as well as venation of 'Star Girl Seedling'. However, these effects were not noted in the group treated with indoleacetic acid, maleic hydrazide, or triiodobenzoic acid. This must be because the plants were unresponsive in morphological changes to the concentration used. It is probable that higher concentrations would have had more effect in bringing about morphological changes.

The changes brought about by gibberellic acid at 100 parts per million were certainly not desirable in adding to the beauty of the plants. Gibberellic acid at 100 parts per million caused the plants to look ungainly through general elongation of plant parts.

Experimental results with geraniums indicate lower concentrations of gibberellic acid may be beneficial. Thus, Lindstrom and Wittwer (19) found that 10 parts per million of gibberellic acid was beneficial to lasting quality of a white cultivar of geranium.

SUMMARY

The cumulative effect of three foliar applications each of 100 parts per million maleic hydrazide, 100 parts per million indoleacetic acid, 100 parts per million gibberellic acid, and 25 parts per million triiodobenzoic acid on rooting responses of leaf-petiole cuttings of two cultivars of Saintpaulia 'Star Girl Seedling' and 'Queen's Cushion' were studied. Cuttings from sprayed and unsprayed plants were rooted in sand at 75° F, and after 34 days were removed and grouped into four classes (not rooted, lightly rooted, intermediately rooted, and heavily rooted) for evaluation.

Rooting response of leaf-petiole cuttings in the control groups for each cultivar were as good, and in most cases better, than those from the chemical treated groups for each variety.

In each cultivar the 100 parts per million gibberellic acid treated cuttings had the least number of cuttings rooted.

Treatments producing the heavily rooted cuttings arranged in descending order from the largest number of cuttings rooted to the smallest were: control, maleic hydrazide, indoleacetic acid, triiodobenzoic acid, and gibberellic acid.

The cumulative effect of three foliar applications each of 100 parts per million maleic hydrazide, indoleacetic acid, gibberellic acid,

and 25 parts per million triiodobenzoic acid on pollen germination, the number of flowers, number of peduncles, lasting quality of flowers, change of external parts in Saintpaulia plants were also studied.

Germinating responses of pollen in the control group for cultivar 'Star Girl Seedling' were significantly greater than those from the chemical treated groups of the same cultivar. The average percentage germination for the untreated group was 10.6 percent, which was significantly greater than the percentage germination for the following groups: 6.6 percent for the 25 parts per million triiodobenzoic acid group; 5.2 percent for the 100 parts per million indoleacetic acid group; 4.4 percent for the 100 parts per million gibberellic acid group; and 3.8 percent for the 100 parts per million maleic hydrazide group.

Pollen germination responses of the cultivar 'Queen's Cushion' were not investigated because pollen was seldom produced.

Maximum diameter measurements show that growth rate of both varieties was greatly increased by the 100 parts per million gibberellic acid treatment, while all other treated groups tended to follow the normal growth pattern as expressed by the untreated groups.

Flowering response of the two cultivars differed significantly in regard to chemical treatments. Flower production in the cultivar 'Queen's Cushion' treated with 100 parts per million gibberellic acid, with an average

of 489 flowers per plant, was greater than for any other chemical treated group or the untreated group. Flower production in untreated plants, an average of 343 flowers per plant, was only slightly greater than those on the 100 parts per million indoleacetic acid treated plants, which had an average of 250 flowers per plant.

The 100 parts per million gibberellic acid treated plants of cultivar 'Star Girl Seedling' produced a significantly greater number of flowers, an average of 281 flowers per plant, than the 100 parts per million indoleacetic group, an average of 199 flowers per plant, and the 25 parts per million triiodobenzoic acid treated group, an average of 217 flowers per plant. The number of flowers in the gibberellic acid treated group, 281, was not significantly greater than those of the untreated group, 231, or the 100 parts per million maleic hydrazide group with 238 flowers per plant.

The response of number of peduncles per plant in the 100 parts per million gibberellic acid treated groups was significantly greater than those of the other groups in cultivar 'Star Girl Seedling' and in cultivar 'Queen's Cushion'. Therefore, the 100 parts per million gibberellic acid treatment significantly increased the average number of peduncles per plant above those of untreated plants and the other chemically treated plants.

Flower lasting response of the untreated plants of cultivar 'Star Girl Seedling' was significantly greater than the flower lasting response of any of the treated groups. The response of the flowers of cultivar 'Queen's Cushion' to 100 parts per million indoleacetic acid was significantly greater than for all other groups.

Formative modifications resulting from chemical treatment were apparent only as a result of treatment with 100 parts per million gibberellic acid. Modifications common to both cultivars included changes in leaf shape, elongation of petioles, peduncles and lamina, changes in the angle of emergence from the axis of the leaves due to an upward movement of the entire leaf toward the vertical axis of the plant. Modifications specific to cultivar 'Star Girl Seedling' were: changes in style position and shape, separation of anthers, and a tendency toward greater production of peloric flowers.

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