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Effects of some growth-regulating substances
on the germination, growth, and sucrose
content of sugarcane

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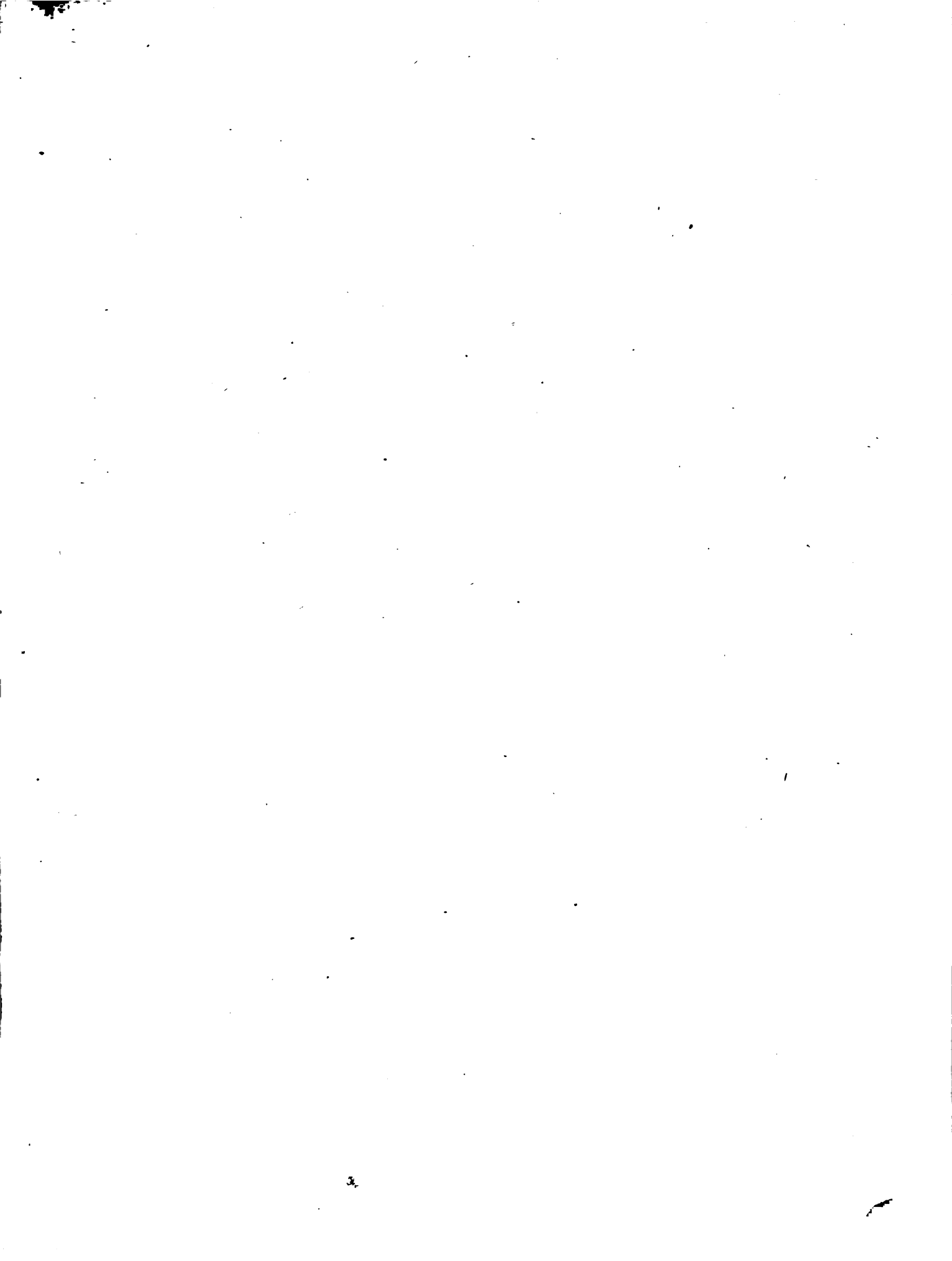
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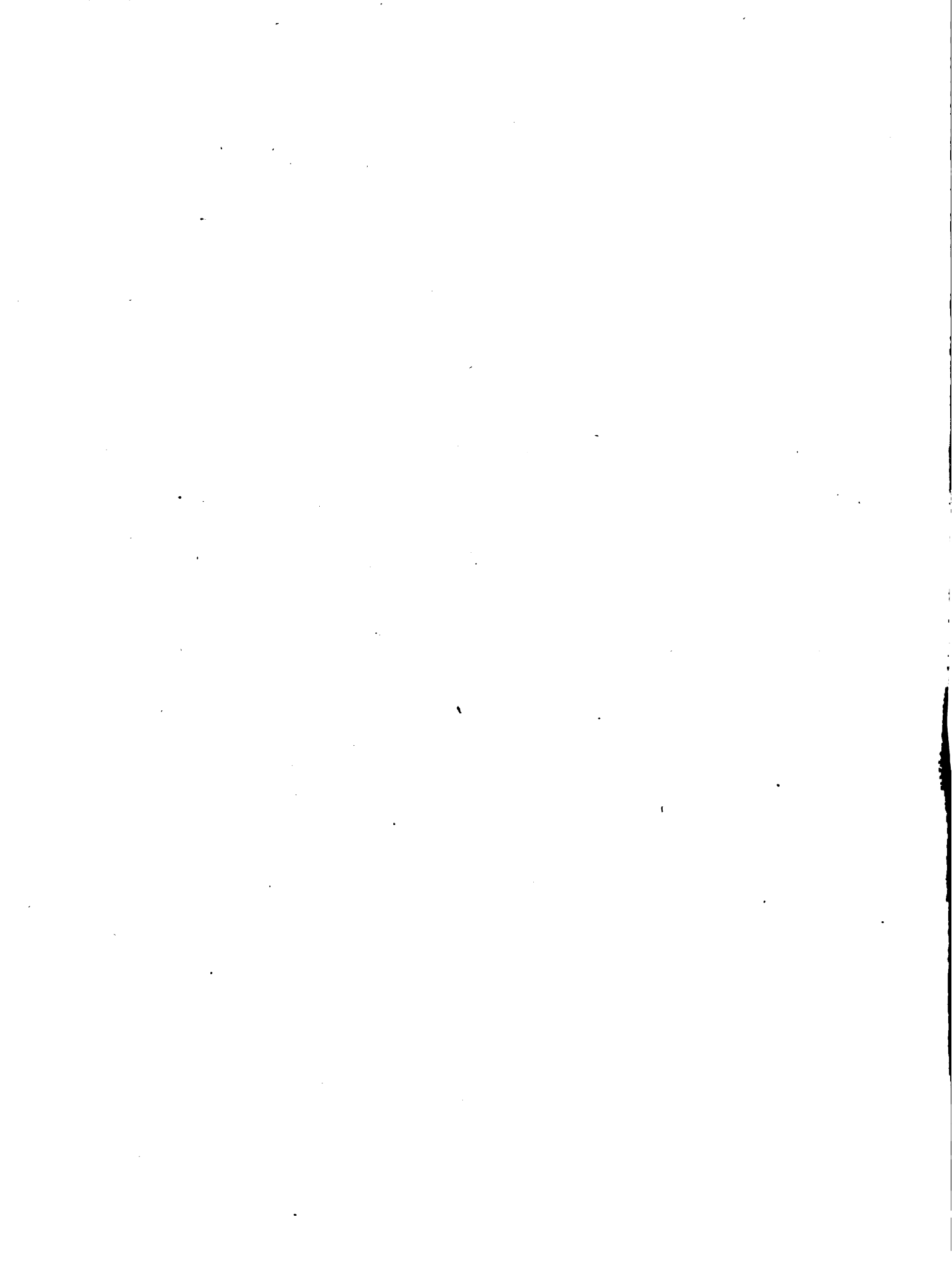
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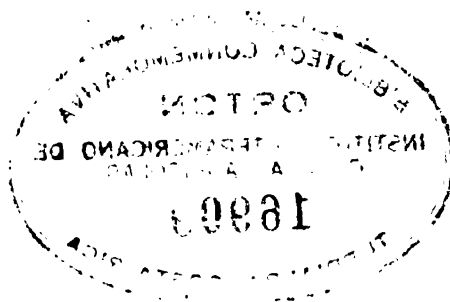






**EFFECTS OF SOME GROWTH-REGULATING SUBSTANCES
ON THE GERMINATION, GROWTH, AND SUCROSE
CONTENT OF SUGARCANE**

by
✓
Guillermo Esteves, Jr.



**INTER-AMERICAN INSTITUTE OF AGRICULTURAL SCIENCES
TURRIALBA, COSTA RICA**

August, 1953

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A Thesis

Submitted to the Faculty Committee in
partial fulfillment of the requirements for
the degree of

Magistri Agriculturae

at the

Inter-American Institute of Agricultural Sciences

APPROVED:

Kenneth L. Olsen
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Committee

Date August 28, 1953

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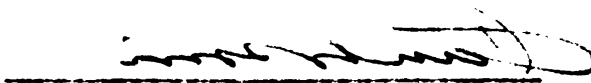
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BIOGRAPHY OF AUTHOR

Guillermo Esteves, Jr., was born in Santurce, Puerto Rico. He received the degree of Bachelor of Sciences in Agronomy from the University of Maryland, College Park, Maryland, in 1951. That same year he entered the Inter-American Institute of Agricultural Sciences for graduate work in Plant Physiology. In August, 1951, he was awarded a Research Fellowship by the Shell Development Co., Modesto, California, for work on agricultural chemicals, during the course of which the present study was completed.

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INTRODUCTION

The discovery that the growth and behavior of many plants could be altered by the application of certain substances possessing unique properties has brought about a revolution in the agricultural world and opened a vast new field of research.

Today, for the first time in the history of agriculture, man can change the pattern of growth and development of plants. Already the practical applications of growth-regulating substances are many. However, unlimited possibilities for their application still exist, and many more are being added as new growth substances are discovered in research laboratories over the world.

The present study was undertaken to evaluate the effects of a number of growth-regulating substances when applied at three different stages in the growth of sugarcane: (1) As pre-planting treatment to sugarcane seed-pieces, (2) In herbicidal and hormonal concentrations at an early stage in the growth of a ratoon crop of sugarcane, and (3) To a mature crop of sugarcane prior to harvest.

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EFFECTS OF SOME GROWTH-REGULATING SUBSTANCES ON THE GERMINATION OF SUGARCANE

Review of Literature

Germination constitutes a critical stage in the development of the cane plant. During this period changes take place in the food reserves, enzyme activity and growth-regulating substances in the seed material. Germination is influenced by many factors, such as variety of cane, origin of the seed stock, age of seed, nutrient supply in the cuttings, size of cuttings, depth of planting, orientation of the buds at planting, soil moisture and temperature, soil aeration, etc. When germination is delayed by one or more of these factors, the seedpieces are subject to attack by microorganisms which in a short time may cause decay of the seedpiece, bud, or young shoots.

In areas where the growth of sugarcane is limited by a short growing season the importance of hastening the growth and maturity of the crop is fully realized. The uniformity of development resulting from early germination will allow the plants to close-in earlier in their competition with weeds. Faster multiplication of the seed stock of new varieties could also be achieved.

The amount of seed stock used to plant one acre of cane in the different cane producing areas of the world

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varies from 0.25 acre to 0.12 acre or less of standing cane (78). When the conditions necessary for good germination are present, and when planting stock of good quality is used, there is evidence that the amount of seed can be reduced considerably (3, 10, 18, 86). Any factor which might stimulate the germination and early production of shoots would be of importance to the economic production of sugarcane.

Increased germination as a result of hot-water treatment was observed by Brandes and Klaphaak (13) in 1923. They reported that immersion of cuttings in water for 20 minutes at 52° C. resulted in rapid development of buds and increased growth of the young cane stools. When the entire stalk was subjected to hot water treatment prior to planting, nearly all of the buds on the stalk developed, indicating that their dormancy had been broken by the treatment. There is, however, a very narrow range of temperatures and duration of treatment that is effective.

Similar treatments with hot or cold water have been investigated in many countries (18, 23, 53, 85, 89). Soaking cane pieces in solutions containing chemical compounds has been tried also (19, 52, 64, 68, 69, 73, 74). Other possibilities that have been investigated are treatment with fungicides (27, 38, 51, 52, 89), insecticides (12), and with growth-regulating substances (14, 44, 72,

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85). Compounds such as chlorohydrin and acetylene have been utilized also (85).

Apical dominance is clearly exhibited in sugarcane. Normally, a bud will not develop as long as it forms part of a standing stalk due to the inhibiting effect of the growing point on the lateral buds. This dominant effect of the uppermost bud is strongest in cuttings from the upper sections of the stalk, and diminishes in cuttings from the middle and basal sections of the stalk (78). It is assumed that this inhibition is due to the formation and translocation of a growth-regulating substance or substances from the growing point of the stalk (18, 78). Removal of the top, or cessation of its function as a result of injury by natural or mechanical means, or flowering, results in breaking the dormancy of the upper lateral buds.

The effect of auxin relations on the development of sugarcane was reviewed by Van Overbeek in 1943 (79). In a series of experiments in Puerto Rico (81, 85, 86) he succeeded in isolating a growth substance from sugarcane nodes which behaves like synthetic indoleacetic acid. A small part of this substance (about 3 parts per billion parts of fresh tissue) is found "free", while approximately 40 times this amount is held in storage

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In a series of experiments in Puerto Rico (81, 82, 86) he succeeded in isolating a growth substance from sugarcane nodes which behaves like synthetic indoleacetic acid. A small part of this substance (about 3 parts per billion parts of fresh tissue) is found "free", while approximately 40 times this amount is held in storage

and can be released by special methods. He concluded that auxin controls the development of buds and roots, and that a high concentration of auxin will tend to inhibit the development of these buds. He suggested that the increased rooting and decreased tillering of horizontally oriented stalks as compared to vertically oriented stalks may be due to the increased auxin concentration at the nodes of horizontally oriented cane.

Engard and Nakata (24) reported extraction of at least two different substances from sugarcane tissue: a growth-promoting substance of the acid type and an inhibitor. Van Overbeek et al. (81) also reported extraction of an inhibitor from boiled tissue. Brandes and Van Overbeek (14), elaborating on the work of Brandes and Klaphaak (1923) found that immersion of seed in water at 52° C. for 20 minutes stimulated bud development, but the same effect on single-bud cuttings could be inhibited by application of cotton plugs soaked in 100 mg. per liter naphthaleneacetic acid to the basal cut surfaces. They concluded that the stimulation of bud growth by hot-water treatment and a lowering of the auxin level are correlated.

Van Overbeek et al. (85) found that the application of indolebutyric acid in talc (Hormodin) to seed pieces

generally increased the number of set roots especially on slow-rooting varieties, such as 'Sugarcane 272'. They pointed out that auxin applications made to seedlings will promote root growth from the root band, but will inhibit the development of the buds.

Loi, Tseng and Cheng (1954) applied indoleacetic acid and 2,4-dichlorophenoxyacetic acid to single-bud seedlings by soaking in solutions ranging from 10 to 100 ppm. IAA at 100 ppm induced formation and elongation of the set roots. Shoot growth was slightly retarded during the first week, but caught up during the second week. Fast-growing varieties gave better response to applications than slow-growing clones. 2,4-Dichlorophenoxyacetic acid at 100 ppm had toxic effects. The set roots took a short clipped form apparently from injury to the terminal meristem.

Stamper et al. (1952) working in Louisiana analyzed cane with 2,4-D and maleic hydrazide at the rate of 1 lb. per acre 10 and 15 days before harvesting for seed. Germination and stand counts showed that maleic hydrazide gave an increase in germination of fall planted sugarcane and better stands the following spring. 2,4-Dichlorophenoxyacetic acid did not seem to have any effect on the germination or density of stands.

Experiment 1: Treatment of seedpieces in the furrow.

This experiment was designed to test the desirability of applying growth-regulating substances to cane seedpieces in the field just prior to planting.

Materials and Methods

The experimental layout consisted of plots 19' x 19' (approximately 1/120 acre) each in a 4 x 4 Latin Square design. Each plot included four furrows which had been opened the previous day.

Freshly cut P.O.J. 2878 seedpieces were used for this trial. The seedpieces were laid out and sprayed thoroughly with solutions consisting of (1) 0.005% 2,4-D acid equivalent (Isopropyl Ester), (2) 0.05% indolebutyric acid, (3) 0.05% naphthaleneacetic acid, and (4) control (distilled water). Eclipse "Warley" Knapsack-type sprayers were used for this purpose at a pressure of 45 pounds. The seed was covered to a depth of approximately one inch.

Results

One month after planting, the plots treated with naphthaleneacetic acid and with 2,4-D seemed to be retarded in growth. No effects were observed on the indolebutyric acid and control plots. At one and one-half months, counts of the number of primary and secondary

Experiment I: Treatment of seedlings in the furrow.

This experiment was designed to test the desirability of applying growth-regulating substances to cane seedlings in the field just prior to planting.

Materials and Methods

The experimental layout consisted of plots 19' x 19' (approximately 1/10 acre) each in a 4 x 4 Latin square design. Each plot included four furrows which had been opened the previous day. Freshly cut E.C. 1. 2878 seedlings were used for this trial. The seedlings were laid out and sprayed thoroughly with solutions consisting of (1) 0.02% 2,4-D acid equivalent (Isopropyl ester), (2) 0.02% indolebutyric acid, (3) 0.02% naphthaleneacetic acid, and (4) control (distilled water). "Wester" backpack-type sprayers were used for this purpose at a pressure of 45 pounds. The seed was covered to a depth of approximately one inch.

Results

One month after planting, the plots treated with naphthaleneacetic acid and with 2,4-D seemed to be retarded in growth. No effects were observed on the indolebutyric acid and control plots. At one and one-half months, counts of the number of primary and secondary

shoots in each plot were made. Results are presented in table 1.

Table 1. Stooling count one and one-half months after treatment.

Number of primary and secondary shoots per plot.							
Treatments		Replications				Total	Ave.
		1	2	3	4		
0.005% 2,4-D	Prim.	106	62	73	122	363	91
	Sec.	55	26	28	46	155	39
0.05% IBA	Prim.	92	86	94	99	371	93
	Sec.	30	35	55	52	172	43
0.05% NAA	Prim.	137	63	87	94	381	95
	Sec.	46	21	38	43	148	37
Control	Prim.	107	104	96	89	396	99
	Sec.	40	45	46	35	166	42

At this time the control plots had a larger number of primary shoots, but the indolebutyric acid plots had the greatest number of secondary shoots per plot. However, these differences were not significant.

At three and a half months after treatment another count was made of the total number of shoots in each plot (table 2). No differences could be observed at this time.

At six and a half months after planting a last count was made, but this time only vigorous shoots were taken

shoots in each plot were made. Results are presented in Table I.

Table I. Stooling count one and one-half months after treatment.

Number of primary and secondary shoots per plot.

Treatments	Replications				Total	Ave.
	1	2	3	4		
0.00% IBA-D	Prim. 100	92	73	122	363	91
	Sec. 72	28	46	175	39	
0.02% IBA	Prim. 92	66	94	99	371	93
	Sec. 30	32	22	122	43	
0.02% NAA	Prim. 137	63	87	94	381	95
	Sec. 46	21	36	43	148	37
Control	Prim. 107	104	99	89	399	99
	Sec. 40	42	46	32	160	42

At this time the control plots had a larger number of primary shoots, but the indolebutyric acid plots had the greatest number of secondary shoots per plot. However, these differences were not significant.

At three and a half months after treatment another count was made of the total number of shoots in each plot (Table 2). No differences could be observed at this time. At six and a half months after planting a last count was made, but this time only vigorous shoots were taken

(table 3). No differences could be observed between treatments.

Table 2. Number of shoots per plot three and one-half months after treatment.

Treatments	Total number of shoots per plot				Total# Shoots	Ave.# Shoots
	Plot 1	Plot 2	Plot 3	Plot 4		
0.005% 2,4-D	145	115	105	162	527	132
0.05% IBA	144	120	126	126	516	129
0.05% NAA	152	114	130	129	525	131
Control No treatment	149	131	130	127	537	134

Table 3. Number of vigorous shoots per plot six and one-half months after treatment.

Treatments	Total number of shoots per plot				Total# Shoots	Ave.# Shoots
	Plot 1	Plot 2	Plot 3	Plot 4		
0.005% 2,4-D	114	99	88	120	421	105
0.05% IBA	109	104	110	101	427	107
0.05% NAA	114	97	113	108	429	107
Control No treatment	113	102	100	102	417	104

(table 3). No differences could be observed between treatments.

Table 2. Number of shoots per plot three and one-half months after treatment.

Treatments	Total number of shoots per plot			Total # Ave. # Shoots
	Plot 1	Plot 2	Plot 3	
0.00% S, #-D	142	112	102	132
0.02% IBA	144	120	122	138
0.02% IAA	122	114	120	131
Control No treatment	142	131	130	137

Table 3. Number of vigorous shoots per plot six and one-half months after treatment.

Treatments	Total number of shoots per plot			Total # Ave. # Shoots
	Plot 1	Plot 2	Plot 3	
0.00% S, #-D	114	82	120	107
0.02% IBA	102	104	101	107
0.02% IAA	114	82	103	107
Control No treatment	113	102	102	107

Experiment 2: Application of growth-regulating substances to the upper cut end of terminal, middle, and basal single-bud cuttings.

Materials and Methods

The following hormone-type materials were used for this test:

1. b-Naphthoxyacetic Acid.3,000 ppm.
2. a-2,4-Dichlorophenoxypropionic Acid . . 200 ppm.
3. Maleic Hydrazide.1,000 ppm.
4. a-Naphthaleneacetic Acid.3,000 ppm.
5. 2,3,5-Triiodobenzoic Acid 500 ppm.
6. Indole-3-acetic Acid. 10,000 ppm.
7. Naphthaleneacetamide.2,000 ppm.
8. Indolebutyric Acid.4,500 ppm.
9. a-(2-Chlorophenoxy)propionic Acid . . .2,000 ppm.
10. Trans-cinnamic Acid1,000 ppm.

The concentrations employed were derived from a review of the literature on the use of growth regulators for the rooting of cuttings of various types.

Each material was incorporated into three different carriers, lanolin, talcum and quick-dip solution.

Two seedbeds measuring 5' x 35' were used for planting. Both beds had been treated with Shell Emulsible CBP-55 soil fumigant two weeks prior to planting.

Experiment 2: Application of growth-regulating substances to the upper cut end of terminal, middle, and basal stipe-bud cuttings.

Materials and Methods

The following hormone-type materials were used for

this test:

1. p-Naphthoxyacetic acid 2,000 ppm.
2. a-2,4-Dichlorophenoxypropionic acid 200 ppm.
3. Maleic Hydrate 1,000 ppm.
4. a-Naphthaleneacetic acid 2,000 ppm.
5. 2,3,5-Trihydrobenzoic Acid 500 ppm.
6. Indole-3-acetic Acid 10,000 ppm.
7. Naphthaleneacetamide 1,000 ppm.
8. Indolebutyric acid 4,500 ppm.
9. a-(2-Chlorophenoxy)propionic acid 2,000 ppm.
10. Trans-cinnamic acid 1,000 ppm.

The concentrations employed were derived from a review of the literature on the use of growth regulators for the rooting of cuttings of various types.

Each material was incorporated into three different

carriers, lanolin, talcum and quick-dip solution.

Two seedbeds measuring 2' x 3' were used for planting.

Both beds had been treated with Shell Mulchite CBP-25 soil

fungicide two weeks prior to planting.

Sixty-six stalks of P.O.J. 2878 one-year-old plant cane were collected in the morning and kept in the shade until sectioning and treatment. Three single-node seedpieces were cut from each stalk as follows: One terminal seedpiece (node No. 2 or 3 from the top of the harvested cane stalk), one from the middle section of the stalk, and one basal seedpiece (node No. 2 or 3 from ground level). The seedpieces were obtained by cutting the stalk approximately 1/2 inch above the desired bud, and near the base of the internode below this bud. The seedpieces were cut, weighed individually, treated, and planted immediately. In all cases the material was applied to the uppermost cut end of the seedpieces.

The method of application varied somewhat for the different treatments. For the talcum applications the upper cut end of the pieces were dipped in distilled water, excess water allowed to drain and then dipped in the talc preparation. The pieces were then tapped gently against the side of the container to remove excess material. The material in lanolin form was applied to the upper cut end of the seed by means of a steel spatula. For the quick-dip treatments the seedpieces were immersed in the solution for approximately 10 seconds, and then allowed to drain for a few seconds before planting.

All cuttings were planted horizontally with the bud

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material in liquid form was applied to the upper cut end
of the pieces by means of a steel spatula. For the quick-
dip treatments the seedpieces were immersed in the solu-
tion for approximately 10 seconds, and then allowed to
drain for a few seconds before planting.
All cuttings were planted horizontally with the bud

to the side at a depth of 2 inches. The distance between cuttings within the bed was one foot laterally and eight inches longitudinally. Both materials and treatments were randomized. All treatments were replicated twice.

A record sheet was kept for each individual seed-piece. Growth measurements were taken 14, 28, 42, and 56 days after treatment. The number of secondary shoots was recorded. On the last date of measurement the plants were removed carefully from the bed, washed under a stream of water and taken to the laboratory where surface moisture was removed. The plants were then segregated into set roots, shoot roots, aerial parts, and seedpiece, and fresh weights recorded. All material was placed in a forced-draft oven where it was dried to constant weight at a temperature of 80° C. The per cent dry weight was calculated from these figures.

Results

Table 4 shows the per cent germination and the number of days required for germination by each treatment presented according to carrier. This data shows that the carrier effect was negligible, since none of the materials employed as carriers exhibits consistent differences. For this reason the per cent germination and number of days required for germination are compared on the basis of the

to the edge at a depth of 2 inches. The distance between cuttings within the bed was one foot laterally and eight inches longitudinally. Both materials and treatments were randomized. All treatments were replicated twice. A record sheet was kept for each individual seed-piece. Growth measurements were taken 14, 28, 42, and 56 days after treatment. The number of secondary shoots was recorded. On the last date of measurement the plants were removed carefully from the bed, washed under a stream of water and taken to the laboratory where surface moisture was removed. The plants were then segregated into sets of roots, shoot roots, aerial parts, and seedpieces, and fresh weights recorded. All material was placed in a forced-draft oven where it was dried to constant weight at a temperature of 80° C. The per cent dry weight was calculated from these figures.

Results

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Table 4. Per cent germination and number of days required for germination of terminal, middle and basal single-bud pieces, by treatment.

Treatment	% Germination				No. days for germ.			
	Talc	Lan.	Dip	Ave.	Talc	Lan.	Dip	Ave.
b-Naphthoxy-acetic acid	67	100	50	72	12	15	17	15
a,2,4-Dichloro-phenoxy-propionic acid	50	83	83	72	14	13	14	14
Maleic hydrazide	83	83	83	83	14	12	13	13
a-Naphthalene-acetic acid	67	67	67	67	18	14	16	16
2,3,5-Triiodo-benzoic acid	50	50	100	67	18	13	16	16
Indole-3-acetic acid	83	50	100	78	17	15	21	18
a-Naphthalene-acetamide	100	83	100	94	14	14	14	14
Indolebutyric acid	67	83	33	61	15	17	16	16
a-(2-Chloro-phenoxy)-propionic acid	67	83	67	72	13	18	19	17
Trans-cinnamic acid	33	100	67	67	15	14	17	15
Control	67	100	100	89	16	14	15	15

Table 6. Per cent germination and number of days required for germination of terminal, middle and basal single-rod pieces, by treatment.

Treatment	Germination			No. days for term.		
	Germination %	Germination No.	Germination Ave.	Days for term. No.	Days for term. Ave.	Days for term. No.
Control	67	100	100	14	15	15
Trans-cinnamic acid	33	100	67	14	15	15
propionic acid (phenyl)- a-(2-chloro-	67	33	67	13	18	17
acetic acid Indole-3-	67	33	33	15	17	18
acetic acid a-Naphthalene-	100	33	100	14	14	14
acetic acid Indole-3-	67	33	67	15	17	18
acetic acid a-Naphthalene-	67	67	67	14	16	16
acetic acid 2,3,5-Trifluoro-	50	50	100	13	16	16
acetic acid Maleic hydrazide	33	33	33	14	15	13
propionic acid phenoxy- a, a', H-Dichloro-	50	33	50	14	13	14
acetic acid p-Naphthoxy-	67	100	50	15	17	15

average for each treatment.

Seedpieces treated with naphthaleneacetamide had the highest germination with 94%, while the control ranked second with 89%. Maleic hydrazide and indoleacetic acid treatments ranked third and fourth with 83 and 78%, respectively. All other materials were about the same, with indolebutyric acid treatment showing the lowest per cent germination, 61. These differences are not significant, however.

Seedpieces treated with maleic hydrazide required the least average number of days for germination with 13, followed by alpha-2,4-dichlorophenoxypropionic acid and naphthaleneacetamide with 14 days, respectively. The control required 15 days to germinate, as well as the naphthoxyacetic acid and trans-cinnamic acid treatments. The seed treated with indoleacetic acid required 18 days to germinate, the longest for all treatments.

Per cent germination and number of days required for germination are presented according to origin of seed in table 5. Terminal pieces exhibited the highest per cent germination, while the basal pieces showed the lowest. The same held true for the number of days required for germination, top pieces requiring 13 and basal pieces 17 days.

average for each treatment.

Seeds treated with naphthalenesulfonamide had the highest germination with 94%, while the control ranked second with 82%. Maleic hydrazide and indoleacetic acid treatments ranked third and fourth with 63 and 70%, respectively. All other materials were about the same, with indolebutyric acid treatment showing the lowest per cent germination, 61. These differences are not significant, however.

Seeds treated with maleic hydrazide required the least average number of days for germination with 13, followed by alpha-2,4-dichlorophenoxypropionic acid and naphthalenesulfonamide with 14 days, respectively. The control required 15 days to germinate, as well as the naphthoxyacetic acid and trans-2-naphthoic acid treatments. The seed treated with indoleacetic acid required 16 days to germinate, the longest for all treatments.

Per cent germination and number of days required for germination are presented according to origin of seed in Table 5. Terminal pieces exhibited the highest per cent germination, while the basal pieces showed the lowest. The same held true for the number of days required for germination, top pieces requiring 13 and basal pieces 17 days.

Table 5. Per cent germination and average number of days required for germination of terminal, middle and basal single-bud pieces, by origin.

Origin of Seed	% Germination				No. days for germ.			
	Talc	Lan.	Dip	Ave.	Talc	Lan.	Dip	Ave.
Terminal	77	100	96	91	13	12	14	13
Middle	68	82	73	74	16	15	17	16
Basal	55	59	64	59	15	17	17	17

Average height per plant in centimeters at 14, 28, 42 and 56 days after planting, and the number of secondary shoots produced during this period are shown in table 6. At two weeks the control was superior to all of the treatments in average height per plant. At four weeks, however, naphthaleneacetamide and trans-cinnamic acid treatments were higher than the control. At six weeks only one treatment, maleic hydrazide equalled the control. At the end of the experiment (8 weeks) three treatments showed superiority. These were maleic hydrazide, with an average height per plant of 15.3 cm., and naphthaleneacetamide and naphthaleneacetic acid, both with 14.8 cm. against 14.3 cm. for the control. The lowest growth at this time was exhibited by indoleacetic acid with an average height per plant of 11.9 cm. These differences were not significant, however.

Table 2. Per cent germination and average number of days required for germination of terminal, middle and basal single-bud pieces, by origin.

Origin of Seed	Germination			No. days for term.		
	Per cent	Days	Ave.	Per cent	Days	Ave.
Terminal	77	100	91	13	14	13
Middle	68	82	74	12	12	16
Basal	52	59	64	12	12	12

Average height per plant in centimeters at 14, 26, 42 and 56 days after planting, and the number of secondary shoots produced during this period are shown in Table 6. At two weeks the control was superior to all of the treatments in average height per plant. At four weeks, however, the control and the trans-aminic acid treatments were higher than the control. At six weeks only one treatment, maleic hydrazide equalled the control. At the end of the experiment (6 weeks) three treatments showed superiority. These were maleic hydrazide, with an average height per plant of 15.3 cm., and naphthaleneacetamide and naphthaleneacetic acid, both with 14.6 cm. against 14.3 cm. for the control. The lowest growth at this time was exhibited by indoleacetic acid with an average height per plant of 11.9 cm. These differences were not significant, however.

Table 6. Growth and number of seconda middle and basal single-bud

Treatments		Growth in g	
		14	28
2-Naphthoxy-acetic acid	Ter.	5.8	11.0
	Midd.	2.5	12.0
	Basal	5.0	7.8
	Ave.	4.4	10.3
2,4-Dichloro-phenoxy-propionic acid	Ter.	8.0	13.5
	Midd.	2.9	11.7
	Basal	2.5	6.7
	Ave.	4.5	10.6
Maleic hydrazide	Ter.	7.5	12.4
	Midd.	3.1	11.5
	Basal	4.6	9.0
	Ave.	5.1	11.0
2-Naphthalene-acetic acid	Ter.	7.8	12.5
	Midd.	2.1	10.8
	Basal	0.0	8.8
	Ave.	3.3	10.7
Trifluorobenzoic acid	Ter.	6.4	12.2
	Midd.	4.7	10.7
	Basal	1.9	10.0
	Ave.	4.3	11.0
Indole-3-acetic acid	Ter.	4.0	8.5
	Midd.	2.2	8.5
	Basal	0.3	8.6
	Ave.	2.2	8.5
Naphthalene-acetamide	Ter.	6.9	12.9
	Midd.	3.5	12.1
	Basal	1.7	9.5
	Ave.	4.0	11.5
Indolebutyric acid	Ter.	7.0	11.7
	Midd.	0.0	11.6
	Basal	0.0	9.1
	Ave.	2.3	10.8
2-(2-Chloro-phenoxy)-propionic acid	Ter.	7.7	13.4
	Midd.	3.7	10.5
	Basal	3.2	8.4
	Ave.	4.9	10.8
Trans-cinnamic acid	Ter.	4.2	12.0
	Midd.	3.9	10.9
	Basal	3.5	10.6
	Ave.	3.9	11.2
Control	Ter.	9.2	11.3
	Midd.	5.3	10.5
	Basal	2.9	10.5
	Ave.	5.8	10.8

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Table 3. Growth in cm. of primary and secondary xylem in the stem of Pinus strobus L. in the first year of growth.

Treatment	Growth in cm. (Days)				Total
	15	30	45	60	
Control	1.1	1.5	1.1	1.8	5.5
100 mg/l. IAA	1.2	1.6	1.2	1.9	5.9
200 mg/l. IAA	1.3	1.7	1.3	2.0	6.3
400 mg/l. IAA	1.4	1.8	1.4	2.1	6.7
800 mg/l. IAA	1.5	1.9	1.5	2.2	7.1
1600 mg/l. IAA	1.6	2.0	1.6	2.3	7.5
3200 mg/l. IAA	1.7	2.1	1.7	2.4	7.9
6400 mg/l. IAA	1.8	2.2	1.8	2.5	8.3
12800 mg/l. IAA	1.9	2.3	1.9	2.6	8.7
25600 mg/l. IAA	2.0	2.4	2.0	2.7	9.1
51200 mg/l. IAA	2.1	2.5	2.1	2.8	9.5
102400 mg/l. IAA	2.2	2.6	2.2	2.9	9.9
204800 mg/l. IAA	2.3	2.7	2.3	3.0	10.3
409600 mg/l. IAA	2.4	2.8	2.4	3.1	10.7
819200 mg/l. IAA	2.5	2.9	2.5	3.2	11.1
1638400 mg/l. IAA	2.6	3.0	2.6	3.3	11.5
3276800 mg/l. IAA	2.7	3.1	2.7	3.4	11.9
6553600 mg/l. IAA	2.8	3.2	2.8	3.5	12.3
13107200 mg/l. IAA	2.9	3.3	2.9	3.6	12.7
26214400 mg/l. IAA	3.0	3.4	3.0	3.7	13.1
52428800 mg/l. IAA	3.1	3.5	3.1	3.8	13.5
104857600 mg/l. IAA	3.2	3.6	3.2	3.9	13.9
209715200 mg/l. IAA	3.3	3.7	3.3	4.0	14.3
419430400 mg/l. IAA	3.4	3.8	3.4	4.1	14.7
838860800 mg/l. IAA	3.5	3.9	3.5	4.2	15.1
1677721600 mg/l. IAA	3.6	4.0	3.6	4.3	15.5
3355443200 mg/l. IAA	3.7	4.1	3.7	4.4	15.9
6710886400 mg/l. IAA	3.8	4.2	3.8	4.5	16.3
13421772800 mg/l. IAA	3.9	4.3	3.9	4.6	16.7
26843545600 mg/l. IAA	4.0	4.4	4.0	4.7	17.1
53687091200 mg/l. IAA	4.1	4.5	4.1	4.8	17.5
107374182400 mg/l. IAA	4.2	4.6	4.2	4.9	17.9
214748364800 mg/l. IAA	4.3	4.7	4.3	5.0	18.3
429496729600 mg/l. IAA	4.4	4.8	4.4	5.1	18.7
858993459200 mg/l. IAA	4.5	4.9	4.5	5.2	19.1
1717986918400 mg/l. IAA	4.6	5.0	4.6	5.3	19.5
3435973836800 mg/l. IAA	4.7	5.1	4.7	5.4	19.9
6871947673600 mg/l. IAA	4.8	5.2	4.8	5.5	20.3
13743895347200 mg/l. IAA	4.9	5.3	4.9	5.6	20.7
27487790694400 mg/l. IAA	5.0	5.4	5.0	5.7	21.1
54975581388800 mg/l. IAA	5.1	5.5	5.1	5.8	21.5
109951162777600 mg/l. IAA	5.2	5.6	5.2	5.9	21.9
219902325555200 mg/l. IAA	5.3	5.7	5.3	6.0	22.3
439804651110400 mg/l. IAA	5.4	5.8	5.4	6.1	22.7
879609302220800 mg/l. IAA	5.5	5.9	5.5	6.2	23.1
1759218604441600 mg/l. IAA	5.6	6.0	5.6	6.3	23.5
3518437208883200 mg/l. IAA	5.7	6.1	5.7	6.4	23.9
7036874417766400 mg/l. IAA	5.8	6.2	5.8	6.5	24.3
14073748835532800 mg/l. IAA	5.9	6.3	5.9	6.6	24.7
28147497671065600 mg/l. IAA	6.0	6.4	6.0	6.7	25.1
56294995342131200 mg/l. IAA	6.1	6.5	6.1	6.8	25.5
112589990684262400 mg/l. IAA	6.2	6.6	6.2	6.9	25.9
225179981368524800 mg/l. IAA	6.3	6.7	6.3	7.0	26.3
450359962737049600 mg/l. IAA	6.4	6.8	6.4	7.1	26.7
900719925474099200 mg/l. IAA	6.5	6.9	6.5	7.2	27.1
1801439850948198400 mg/l. IAA	6.6	7.0	6.6	7.3	27.5
3602879701896396800 mg/l. IAA	6.7	7.1	6.7	7.4	27.9
7205759403792793600 mg/l. IAA	6.8	7.2	6.8	7.5	28.3
14411518807585587200 mg/l. IAA	6.9	7.3	6.9	7.6	28.7
28823037615171174400 mg/l. IAA	7.0	7.4	7.0	7.7	29.1
57646075230342348800 mg/l. IAA	7.1	7.5	7.1	7.8	29.5
115292150460684697600 mg/l. IAA	7.2	7.6	7.2	7.9	29.9
230584300921369395200 mg/l. IAA	7.3	7.7	7.3	8.0	30.3
461168601842738790400 mg/l. IAA	7.4	7.8	7.4	8.1	30.7
922337203685477580800 mg/l. IAA	7.5	7.9	7.5	8.2	31.1
1844674407370955161600 mg/l. IAA	7.6	8.0	7.6	8.3	31.5
3689348814741910323200 mg/l. IAA	7.7	8.1	7.7	8.4	31.9
7378697629483820646400 mg/l. IAA	7.8	8.2	7.8	8.5	32.3
14757395258967641292800 mg/l. IAA	7.9	8.3	7.9	8.6	32.7
29514790517935282585600 mg/l. IAA	8.0	8.4	8.0	8.7	33.1
59029581035870565171200 mg/l. IAA	8.1	8.5	8.1	8.8	33.5
118059162071741130342400 mg/l. IAA	8.2	8.6	8.2	8.9	33.9
236118324143482260684800 mg/l. IAA	8.3	8.7	8.3	9.0	34.3
472236648286964521369600 mg/l. IAA	8.4	8.8	8.4	9.1	34.7
944473296573929042739200 mg/l. IAA	8.5	8.9	8.5	9.2	35.1
1888946593147858085478400 mg/l. IAA	8.6	9.0	8.6	9.3	35.5
3777893186295716170956800 mg/l. IAA	8.7	9.1	8.7	9.4	35.9
7555786372591432341913600 mg/l. IAA	8.8	9.2	8.8	9.5	36.3
15111572745182864683827200 mg/l. IAA	8.9	9.3	8.9	9.6	36.7
30223145490365729367654400 mg/l. IAA	9.0	9.4	9.0	9.7	37.1
60446290980731458735308800 mg/l. IAA	9.1	9.5	9.1	9.8	37.5
120892581961462917470617600 mg/l. IAA	9.2	9.6	9.2	9.9	37.9
241785163922925834941235200 mg/l. IAA	9.3	9.7	9.3	10.0	38.3
483570327845851669882470400 mg/l. IAA	9.4	9.8	9.4	10.1	38.7
967140655691703339764940800 mg/l. IAA	9.5	9.9	9.5	10.2	39.1
1934281311383406679529881600 mg/l. IAA	9.6	10.0	9.6	10.3	39.5
3868562622766813359059763200 mg/l. IAA	9.7	10.1	9.7	10.4	39.9
7737125245533626718119526400 mg/l. IAA	9.8	10.2	9.8	10.5	40.3
15474250491067253436239052800 mg/l. IAA	9.9	10.3	9.9	10.6	40.7
30948500982134506872478105600 mg/l. IAA	10.0	10.4	10.0	10.7	41.1
61897001964269013744956211200 mg/l. IAA	10.1	10.5	10.1	10.8	41.5
123794003928538027489912422400 mg/l. IAA	10.2	10.6	10.2	10.9	41.9
247588007857076054979824844800 mg/l. IAA	10.3	10.7	10.3	11.0	42.3
495176015714152109959649689600 mg/l. IAA	10.4	10.8	10.4	11.1	42.7
990352031428304219919299379200 mg/l. IAA	10.5	10.9	10.5	11.2	43.1
1980704062856608439838598758400 mg/l. IAA	10.6	11.0	10.6	11.3	43.5
3961408125713216879677197516800 mg/l. IAA	10.7	11.1	10.7	11.4	43.9
7922816251426433759354395033600 mg/l. IAA	10.8	11.2	10.8	11.5	44.3
15845632502852867518708790067200 mg/l. IAA	10.9	11.3	10.9	11.6	44.7
31691265005705735037417580134400 mg/l. IAA	11.0	11.4	11.0	11.7	45.1
63382530011411470074835160268800 mg/l. IAA	11.1	11.5	11.1	11.8	45.5
126765060022822940149670320537600 mg/l. IAA	11.2	11.6	11.2	11.9	45.9
25353012004564588029934064107200 mg/l. IAA	11.3	11.7	11.3	12.0	46.3
50706024009129176059868128214400 mg/l. IAA	11.4	11.8	11.4	12.1	46.7
101412048018258352119736256428800 mg/l. IAA	11.5	11.9	11.5	12.2	47.1
202824096036516704239472512857600 mg/l. IAA	11.6	12.0	11.6	12.3	47.5
405648192073033408478945025715200 mg/l. IAA	11.7	12.1	11.7	12.4	47.9
811296384146066816957890051430400 mg/l. IAA	11.8	12.2	11.8	12.5	48.3
1622592768292133633915780102860800 mg/l. IAA	11.9	12.3	11.9	12.6	48.7
3245185536584267267831560205721600 mg/l. IAA	12.0	12.4	12.0	12.7	49.1
6490371073168534535663120411443200 mg/l. IAA	12.1	12.5	12.1	12.8	49.5
1298074214633706907132624082286400 mg/l. IAA	12.2	12.6	12.2	12.9	49.9
2596148429267413814265248164572800 mg/l. IAA	12.3	12.7	12.3	13.0	50.3
5192296858534827628530496329145600 mg/l. IAA	12.4	12.8	12.4	13.1	50.7
10384593717069655257060992658291200 mg/l. IAA	12.5	12.9	12.5	13.2	51.1
20769187434139310514121985316582400 mg/l. IAA	12.6	13.0	12.6	13.3	51.5
41538374868278621028243970633164800 mg/l. IAA	12.7	13.1	12.7	13.4	51.9
83076749736557242056487941266329600 mg/l. IAA	12.8	13.2	12.8	13.5	52.3
166153499473114484112975882532659200 mg/l. IAA	12.9	13.3	12.9	13.6	52.7
332306998946228968225951765065318400 mg/l. IAA	13.0	13.4	13.0	13.7	53.1
664613997892457936451903530130636800 mg/l. IAA	13.1	13.5	13.1	13.8	53.5
1329227995784915872903807060261273600 mg/l. IAA	13.2	13.6	13.2	13.9	53.9
2658455991569831745807614120522547200 mg/l. IAA	13.3	13.7	13.3	14.0	54.3
5316911983139663491615228241045094400 mg/l. IAA	13.4	13.8	13.4	14.1	54.7
10633823966279326983230456482090188800 mg/l. IAA	13.5	13.9	13.5	14.2	55.1
21267647932558653966460912964180377600 mg/l. IAA	13.6	14.0	13.6	14.3	55.5
42535295865117307932921825928360755200 mg/l. IAA	13.7	14.1	13.7	14.4	55.9
85070591730234615865843651856721510400 mg/l. IAA	13.8	14.2	13.8	14.5	56.3
170141183460469231731687303713443020800 mg/l. IAA	13.9	14.3	13.9	14.6	56.7
340282366920938463463374607426886041600 mg/l. IAA	14.0	14.4	14.0	14.7	57.1
680564733841876926926749214853772083200 mg/l. IAA	14.1	14.5	14.1	14.8	57.5
1361129467683753853853498429707544166400 mg/l. IAA	14.2	14.6	14.2	14.9	57.9
2722258935367507707706996859415088332800 mg/l. IAA	14.3	14.7	14.3	15.0	58.3
5444517870735015415413993718830176665600 mg/l. IAA	14.4	14.8	14.4	15.1	58.7
10889035741470030830827987437660353331200 mg/l. IAA	14.5	14.9	14.5	15.2	59.1
21778071482940061661655974875320706662400 mg/l. IAA	14.6	15.0	14.6	15.3	59.5
43556142965880123323311949750641413324800 mg/l. IAA	14.7	15.1	14.7	15.4	59.9
87112285931760246646623899501282826649600 mg/l. IAA	14.8	15.2	14.8	15.5	60.3
174224571863520493293247799002565653299200					

The control produced 34 secondary shoots during the experiment. Three treatments compared closely, maleic hydrazide and alpha-(2-chlorophenoxy)propionic acid with 30 secondary shoots each, and naphthaleneacetamide with 28. Treatment with indolebutyric acid seemed to inhibit the development of secondary shoots with a total of 7, as did naphthoxyacetic acid, trans-cinnamic acid and triiodobenzoic acid with 14, 15 and 17 secondary shoots, respectively.

Yield data is presented in table 7 according to treatment and origin of the seedpieces.

Several treatments stimulated the production of set roots. Seedpieces treated with IAA showed the greatest effect, producing 4.6 grams of fresh set roots per plant. Alpha-2,4-dichlorophenoxypropionic acid and triiodobenzoic acid treatments were second with 3.6 gm. each, while the control had 3.0 gm. When comparing the data for fresh weight of set roots by position, the normal growth ratio is reversed. With two exceptions, all treatments including the control show greater production of set roots by basal pieces, with middle pieces intermediate, and terminal pieces lowest.

The control produced 37 secondary shoots during the experiment. Three treatments compared closely, maleic hydrazide and alpha-(2-chlorophenoxy)propionic acid with 30 secondary shoots each, and naphthaleneacetamide with 26. Treatment with indolebutyric acid seemed to inhibit the development of secondary shoots with a total of 7, as did naphthoxyacetic acid, trans-cinnamic acid and triiodo-benzoic acid with 14, 15 and 17 secondary shoots, respectively.

Field data as presented in table 7 according to treatment and origin of the seedlings.

Several treatments stimulated the production of set roots. Seedlings treated with IAA showed the greatest effect, producing 4.6 grams of fresh set roots per plant. Alpha-2,4-dichlorophenoxypropionic acid and triiodo-benzoic acid treatments were second with 3.6 gm. each, while the control had 3.0 gm. When comparing the data for fresh weight of set roots by position, the normal growth ratio is reversed. With the exception, all treatments including the control show greater production of set roots by basal pieces, with middle pieces intermediate, and terminal pieces lowest.

Table 7. Mean data obtained from collection of growth records

Treatment	Mean weight (g) per bird		
	1951	1952	1953
Control - no treatment	1.1	1.1	1.1
Threo-dimethyl acid	1.1	1.1	1.1
alpha-(S-Galoro-phenoxyl) propionic acid	1.1	1.1	1.1
Indolebutyric acid	1.1	1.1	1.1
Naphthaleneacetamide	1.1	1.1	1.1
Indoleacetic acid	1.1	1.1	1.1
Trihydroxyacetic acid	1.1	1.1	1.1
Naphthaleneacetic acid	1.1	1.1	1.1
Valeric hydrazide	1.1	1.1	1.1
alpha-S, alpha-Dichloro-phenoxyl propionic acid	1.1	1.1	1.1
Naphthoxyacetic acid	1.1	1.1	1.1

The average fresh weight, average dry weight and per cent dry matter per plant for the aerial parts is presented. There was considerable variation between treatments as to the amount of fresh matter produced on a per plant basis. Only two treatments showed a slight superiority over the control: maleic hydrazide, with an average fresh weight per plant of 77.4 gm., and alpha-2,4-dichlorophenoxypropionic acid with 76.9 gm. The control averaged 74.6 gm., while naphthoxyacetic acid was the lowest with 47.6 gm. These differences are not significant, however.

The same relation was maintained when the treatments were ranked on the basis of dry weight of aerial parts per plant. The per cent dry matter varied from 14.9 to 20.1. In general, those treatments which produced the least amount of dry matter per plant had higher per cent dry matter, while those which ranked highest in the amount of dry matter produced per plant had a lower per cent dry matter. With the exception of a-2,4-dichlorophenoxypropionic acid, it can be said that those treatments which stimulated the production of set roots had less growth of aerial parts on a per plant basis.

The production of shoot roots is correlated very closely with the primary shoot growth.

The average fresh weight, average dry weight and per

cent dry matter per plant for the serial parts is presented. There was considerable variation between treatments as to the amount of fresh matter produced on a per plant basis. Only two treatments showed a slight superiority over the control: 2,4-dichlorophenoxyacetic acid with 7.6 gm. and 7.6 gm. The control averaged 7.6 gm., while 2,4-dichlorophenoxyacetic acid was the lowest with 7.6 gm. These differences are not significant, however.

The same relation was maintained when the treatments were ranked on the basis of dry weight of serial parts per plant. The per cent dry matter varied from 12.9 to 20.1. In general, those treatments which produced the least amount of dry matter per plant had higher per cent dry matter, while those which ranked highest in the amount of dry matter produced per plant had a lower per cent dry matter. With the exception of 2,4-dichlorophenoxyacetic acid, it can be said that those treatments which stimulated the production of set roots had less growth of serial parts on a per plant basis. The production of shoot roots is correlated very closely with the per cent dry matter growth.

Experiment 3: Effects of lanolin application of naphthaleneacetamide and maleic hydrazide on the germination of terminal, middle and basal single-bud seedpieces.

A third experiment was undertaken using the two materials which had given the most promising results.

Materials and Methods

Maleic hydrazide and naphthaleneacetamide were applied in lanolin to the bud of P.O.J. 2878 single-bud pieces from the terminal, middle and basal sections of cane stalks.

The treatments were as follows:

1. Maleic hydrazide in lanolin at 500, 1,000, 2,000, and 4,000 parts per million.
2. Naphthaleneacetamide in lanolin at 500, 1,000, 2,000 and 4,000 parts per million.
3. Control - straight lanolin.

Each treatment was replicated four times. The material was applied to the bud by means of a steel spatula and planted immediately at a depth of 1 inch with the bud to the side. Distance between cuttings within the bed was 1 foot laterally and 8 inches longitudinally.

The per cent germination was taken 2 and 4 weeks after planting. Following the last germination count the plants were dug out, washed, and taken to the laboratory

Experiment 3: Effects of lanolin application on the germination of terminal, middle and basal sections of the shoot.

A third experiment was undertaken using the two materials which had given the most promising results.

Materials and Methods

Lanolin hydrates and methylmercaptan were applied in lanolin to the end of P.O.S. 2078 single-bud pieces from the terminal, middle and basal sections of cane stalks.

The treatments were as follows:

1. Lanolin hydrate in lanolin at 500, 1,000, 2,000, and 4,000 parts per million.
2. Methylmercaptan in lanolin at 500, 1,000, 2,000 and 4,000 parts per million.
3. Control - straight lanolin.

Each treatment was replicated four times. The water-

lanolin was applied to the bud by means of a steel spatula and planted immediately at a depth of 1 inch with the end to the side. Distance between cuttings within the bed was 1 foot laterally and 3 inches longitudinally.

The per cent germination was taken 2 and 4 weeks after planting. Following the last germination count the plants were cut out, washed, and taken to the laboratory

where the aerial parts plus shoot roots were placed in paper bags. The fresh weights were recorded. All material then was placed in a forced-draft oven where it was dried to constant weight at a temperature of 80° C. The per cent dry weight was calculated from these figures.

Results

Table 8 shows per cent germination two and four weeks after treatment. At 2 weeks all treatments except maleic hydrazide at 500 and 2,000 ppm. were superior to the control in number of plants germinated. At four weeks all treatments showed superiority in germination over the control. However, these differences are not significant statistically.

The fresh and dry weights of the aerial parts plus shoot roots are presented in table 9. Of the maleic hydrazide treatments, 2,000 ppm. gave the best results with an average fresh weight per plant of 17.6 gm. At 4,000 ppm. the weight per plant was the same as that of the control, 14.3 gm. Of the naphthaleneacetamide treatments, 500 ppm. gave best results with an average fresh weight per plant of 21.4 gm. while 1,000 ppm. with 15.0 gm. was slightly better than the control.

Data for the dry weight per plant fall in the same order, and are not significant statistically.

where the serial parts plus shoot roots were placed in paper bags. The fresh weights were recorded. All material then was placed in a forced-draft oven where it was dried to constant weight at a temperature of 60°C. The per cent dry weight was calculated from these figures.

Results

Table 3 shows per cent germination two and four weeks after treatment. At 2 weeks all treatments except maleic hydrazide at 500 and 2,000 ppm. were superior to the control in number of plants germinated. At four weeks all treatments showed superiority in germination over the control. However, these differences are not significant statistically.

The fresh and dry weights of the serial parts plus shoot roots are presented in Table 4. Of the maleic hydrazide treatments, 2,000 ppm. gave the best results with an average fresh weight per plant of 17.6 gm. At 4,000 ppm. the weight per plant was the same as that of the control, 14.3 gm. Of the naphthaleneacetamide treatments, 500 ppm. gave best results with an average fresh weight per plant of 21.4 gm. while 1,000 ppm. with 11.0 gm. was slightly better than the control.

Data for the dry weight per plant fall in the same order, and are not significant statistically.

Table 8. Germination of terminal, middle, and basal single-bud seedpieces, according to treatment and origin.

Treatments	P E R C E N T G E R M I N A T I O N											
	2 Weeks				4 Weeks							
	Term.	Midd.	Basal	Ave.	Term.	Midd.	Basal	Ave.	Term.	Midd.	Basal	Ave.
Maleic hydrazide	500 ppm.	100	50	0	50	100	100	100	100	100	100	100
	1,000 ppm.	100	100	25	75	100	100	100	100	100	75	92
	2,000 ppm.	100	100	50	83	100	100	100	100	100	75	92
	4,000 ppm.	75	75	0	50	100	100	100	100	100	100	100
Naphthaleneacetamide	500 ppm.	100	100	50	83	100	100	100	100	100	75	92
	1,000 ppm.	100	75	25	67	100	100	100	100	100	50	83
	2,000 ppm.	100	75	25	67	100	100	100	100	100	50	83
	4,000 ppm.	75	100	50	75	100	100	100	100	100	100	100
Control	Lanolin	100	50	25	58	100	75	100	75	25	67	

Control	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Control	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
3	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
4	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 8. Comparison of treatment and origin. According to treatment and origin. Comparison of treatment, origin and yield (mg/kg).

Table 9. Yield data for terminal, middle, and basal single-bud seedpieces, according to treatment and origin.

Treatments	Weight of aerial parts plus shoot roots						% Dry Weight			
	Fr. wt. in gm. per pl.	Dry wt. in gm. per pl.		Dry wt. in gm. per pl.						
	Term.	Midd.	Basal	Ave.	Term.	Midd.	Basal	Ave.		
Maleic hydrazide	500 ppm.	18.3	9.9	10.4	12.9	2.2	1.3	1.2	1.5	11.9
	1,000 ppm.	15.9	12.8	4.8	11.8	2.0	1.7	0.6	1.5	12.9
	2,000 ppm.	19.2	21.1	10.7	17.6	2.5	2.6	1.4	2.3	12.8
	4,000 ppm.	13.8	20.2	3.3	14.3	1.7	2.5	0.6	1.8	12.5
Naphthalene-acetamide	500 ppm.	23.1	22.9	17.2	21.4	3.0	3.0	2.0	2.7	12.5
	1,000 ppm.	22.1	11.2	8.3	15.0	2.8	1.6	1.4	2.0	13.6
	2,000 ppm.	13.0	15.3	11.6	13.6	1.7	2.0	1.4	1.7	12.8
	4,000 ppm.	15.6	13.3	4.8	11.2	2.0	1.6	0.8	1.5	13.1
Control	Lanolin	13.5	15.4	13.9	14.3	2.0	2.0	1.7	2.0	13.7

Control	13.2	12.2	12.4	13.2	14.2	15.2	16.2	17.2	18.2	19.2	20.2
2000 blm	12.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
3000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
4000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
5000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
6000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
7000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
8000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
9000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0
10000 blm	13.0	12.3	11.8	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0

Treatment _____ Temp. in spool _____ Wt. in spool _____ Wt. in spool _____ Wt. in spool _____ Wt. in spool _____
Weight of spool _____ Wt. in spool _____ Wt. in spool _____ Wt. in spool _____ Wt. in spool _____ Wt. in spool _____

According to treatment and weight. The data for treatment, weight, and weight are as follows:

Experiment 4: Effects of lanolin applications of maleic hydrazide and naphthaleneacetamide on the germination of terminal, middle and basal single-bud seedpieces.

This experiment was designed to find the optimum concentrations for maleic hydrazide and naphthaleneacetamide when applied in lanolin to the bud of single-bud seedpieces.

Materials and Methods

Materials and methods were the same as for Experiment 3 except for the treatments, which included a larger number of concentrations and an untreated control.

These were: (1) maleic hydrazide at 125, 250 and 8,000 ppm., (2) naphthaleneacetamide at concentrations of 125, 250, and 8,000 ppm.

Results

Per cent germination at two and four weeks is shown in table 10. At two weeks five maleic hydrazide treatments (125, 250, 4,000 and 8,000 ppm.) were superior to the lanolin control, while four (125, 250, 2,000 and 4,000 ppm.) were superior to the untreated control. Five naphthaleneacetamide treatments were superior to the lanolin control at this time: 250, 1,000, 2,000, 4,000 and 8,000 ppm. Four (250, 1,000, 2,000 and 8,000 ppm.) were superior

Experiment 4: Effects of lanolin application of maleic hydrazide and naphthaleneacetamide on the germination of terminal, middle and basal single-bud seedpieces.

This experiment was designed to find the optimum concentrations for maleic hydrazide and naphthaleneacetamide when applied in lanolin to the bud of single-bud seedpieces.

Materials and Methods

Materials and methods were the same as for Experiment 3 except for the treatments, which included a larger number of concentrations and an untreated control. These were: (1) maleic hydrazide at 100, 250 and 8,000 ppm., (2) naphthaleneacetamide at concentrations of 100, 250, and 8,000 ppm.

Results

Per cent germination at two and four weeks is shown in table 10. At two weeks five maleic hydrazide treatments (100, 250, 1,000 and 8,000 ppm.) were superior to the lanolin control, while four (100, 250, 1,000 and 8,000 ppm.) were superior to the untreated control. Five naphthaleneacetamide treatments were superior to the lanolin control at this time: 100, 1,000, 2,000, 4,000 and 8,000 ppm. Four (250, 1,000, 2,000 and 8,000 ppm.) were superior

Table 10. Germination of terminal, middle, and basal single-bud seedpieces, according to treatment and origin.

Treatments	P E R C E N T G E R M I N A T I O N											
	2 Weeks				4 Weeks							
	Term.	Midd.	Basal	Ave.	Term.	Midd.	Basal	Ave.	Term.	Midd.	Basal	Ave.
Maleic hydrazide	100	75	50	75	100	100	100	100	100	100	100	100
	125 ppm.											
	250 ppm.	100	100	83	100	100	100	75	100	100	100	92
	500 ppm.	50	0	25	25	100	75	100	100	100	100	92
	1,000 ppm.	50	0	0	17	100	50	100	100	100	100	83
Naphthaleneacetamide	100	50	0	50	100	100	100	100	100	100	100	100
	2,000 ppm.	75	25	42	75	100	75	100	100	100	100	92
	4,000 ppm.	100	50	25	58	100	100	100	100	100	100	92
	8,000 ppm.	100	50	25	58	100	100	100	100	100	100	92
Control	25	25	25	25	50	100	75	100	100	100	100	75
	125 ppm.											
	250 ppm.	100	50	25	58	100	100	100	100	100	100	100
	500 ppm.	50	0	25	25	100	75	100	100	100	100	100
	1,000 ppm.	100	50	75	75	100	75	100	100	100	100	83
Control	100	50	0	50	100	100	100	100	100	100	100	100
	2,000 ppm.	75	25	33	75	100	75	100	100	100	100	92
	4,000 ppm.	75	100	50	75	100	75	100	100	100	100	83
Control	50	25	0	25	100	100	100	100	100	100	100	100
	Untreated	100	25	0	42	100	75	100	100	100	100	75

to the untreated check.

At two weeks it seemed that germination was somewhat inhibited in the control by the application of pure lanolin to the bud. However, at four weeks the lanolin control had reached 100% germination, while the untreated control remained at 75%. Two maleic hydrazide treatments, 125 and 2,000 ppm., equalled the lanolin check in germination, although all seven concentrations were superior to the untreated control. Two naphthaleneacetamide treatments, 250 and 5,000 ppm., equalled the lanolin check in germination with 100%, and five out of seven concentrations tried were superior to the untreated control. None of the aforementioned differences are significant, however

Similar results were obtained from the yield data expressed in fresh and dry weight of aerial parts plus shoot roots (table 11).

Although the untreated control had lower per cent germination, the fresh weight on a per plant basis was higher (10.1 gm.) than that of the lanolin control (6.5 gm.) Five concentrations of maleic hydrazide gave yields superior to that of the lanolin control, while four were superior to the untreated check. All concentrations of naphthaleneacetamide were superior to the lanolin check, while only three gave higher yields per plant than the untreated control. The same relations held true when the

to the untreated check.

As two weeks it seemed that germination was somewhat inhibited in the control by the application of pure lanolin to the roots. However, at four weeks the lanolin concentration had reached 100% germination, while the untreated control remained at 75%. Two maleic hydrazide treatments, 125 and 250 ppm., equalled the lanolin check in germination, all other concentrations were superior to the untreated control. Two naphthaleneacetamide treatments, 250 and 500 ppm., equalled the lanolin check in germination with 100%, and five out of seven concentrations tried were superior to the untreated control. Some of the aforementioned differences are significant, however, similar results were obtained from the field data expressed in fresh and dry weight of aerial parts plus shoot roots (table II).

Although the untreated control had lower per cent germination, the fresh weight on a weight basis was higher (10.1 gm.) than that of the lanolin control (6.1 gm.). Five concentrations of maleic hydrazide gave yields superior to that of the lanolin control, while four were superior to the untreated check. All concentrations of naphthaleneacetamide were superior to the lanolin check, while only three gave higher yields per plant than the untreated control. The same relations held true when the

Table 11. Yield date for terminal, middle, and basal single-bud seedpieces, according to treatment and origin.

Treatments		Weight of aerial parts plus shoot roots						% Dry Weight		
		Fr. wt. in gm. per pl. Term.	Midd. Ave.	Dry wt. in gm. per pl. Term.	Midd. Basal Ave.	Basal Ave.	Weight			
Maleic hydrazide	125 ppm.	15.5	11.3	8.9	11.9	2.1	1.5	1.2	1.6	13.4
	250 ppm.	16.6	17.0	14.5	16.2	2.5	2.4	2.4	2.4	14.8
	500 ppm.	8.6	0.6	3.9	4.7	1.5	0.1	0.6	0.8	17.0
	1,000 ppm.	10.1	3.2	2.2	5.6	1.5	0.5	0.4	0.8	14.2
	2,000 ppm.	16.5	15.9	3.1	11.8	2.5	2.7	0.4	1.8	15.3
Naphthalene-acetamide	4,000 ppm.	21.8	6.8	4.6	10.1	3.0	1.0	0.7	1.4	13.9
	8,000 ppm.	17.8	16.6	16.5	17.0	2.6	2.3	2.1	2.3	13.5
Control	125 ppm.	7.5	7.4	6.6	7.6	1.1	1.2	0.9	1.1	14.5
	250 ppm.	11.7	9.7	8.2	9.8	2.4	1.4	1.1	1.6	16.3
	500 ppm.	10.8	4.8	9.2	8.3	1.5	0.6	1.3	1.1	13.3
	1,000 ppm.	21.9	18.4	21.7	20.8	3.2	2.9	3.0	3.1	14.9
	2,000 ppm.	18.4	15.9	9.2	15.0	2.7	2.1	1.1	1.7	11.3
Control	4,000 ppm.	10.3	10.6	5.1	8.2	1.4	1.4	0.8	1.2	14.6
	8,000 ppm.	18.9	8.6	7.4	11.0	2.9	1.7	1.0	1.8	16.3
Control	Lanolin	7.1	6.9	5.5	6.5	1.0	0.9	0.9	0.9	13.8
	Untreated	13.9	10.5	4.0	10.1	2.0	1.4	0.5	1.4	13.9

treatments were compared on a dry weight per plant basis. These differences are not significant, however.

Summary and Discussion

When applied to the cut end of the seedpieces at the concentrations used, maleic hydrazide and naphthaleneacetamide increased the rate of germination, but the differences obtained were not significant. Indolebutyric acid exhibited an inhibitory effect over both per cent and rate of germination. This is an agreement with the findings of Van Overbeek (85). Naphthaleneacetic acid also seemed to have an inhibitory effect on germination. Similar effects were obtained by Brandes and Van Overbeek (14). When seedpieces were grouped according to origin a germination gradient was observed. Terminal pieces exhibited the highest per cent and rate of germination, with lowered rates from middle and basal pieces. This agrees closely with the findings of Clements (18).

Growth measurements taken during the early stages of the experiment showed that the control was superior to all treatments in overall height per plant. At four weeks, however, some treatments equalled or were slightly better, and at eight weeks three treatments, maleic hydrazide, naphthaleneacetamide and naphthaleneacetic acid were superior, although not significantly so. Similar results

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When applied to the cut end of the seedlings at the concentrations used, maleic hydrazide and naphthaleneacetamide increased the rate of germination, but the differences obtained were not significant. Indolebutyric acid exhibited an inhibitory effect over both per cent and rate of germination. This is in agreement with the findings of Van Overbeek (19). Naphthaleneacetic acid also seemed to have an inhibitory effect on germination. Similar effects

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Growth measurements taken during the early stages of the experiment showed that the control was superior to all treatments in overall height per plant. At four weeks, however, some treatments equalled or were slightly better, and at eight weeks three treatments, maleic hydrazide, naphthaleneacetamide and indolebutyric acid were superior, although not significantly so. Similar results

were obtained by Loh, Tseng and Cheng (44), where shoot growth was slightly retarded during the first week by the application of 100 ppm. indoleacetic acid by soaking, but caught up during the second week. These initial differences, however, may be temporary in nature.

Except for maleic hydrazide and naphthaleneacetamide, all treatments inhibited the development of secondary shoots to some extent. Indoleacetic acid reduced the number of secondary shoots by 80% as compared to the control.

For all materials used the fresh weight of the set roots was equal to or superior to the control. At the concentration used indoleacetic acid was superior to all treatments, although not significantly so. This effect of indoleacetic acid is in agreement with the findings of Loh, Tseng and Cheng (44), who induced formation and elongation of set roots by the application of 100 ppm. indoleacetic acid to single-bud seedpieces by soaking. Indolebutyric acid at 4,500 ppm. did not stimulate the production of set roots. This might be due to the high concentration used in this experiment. Van Overbeek (85), using this material obtained root stimulation and but inhibition. Irrespective of treatment, basal pieces produced the greatest amount of set roots, followed by middle pieces, with the least amount emerging from terminal pieces.

In general, the application of maleic hydrazide and

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Except for maleic hydrazide and naphthaleneacetamide, all treatments inhibited the development of secondary shoots to some extent. Indoleacetic acid reduced the number of secondary shoots by 60% as compared to the control. For all materials used the fresh weight of the set

roots was equal to or superior to the control. At the same concentration used indoleacetic acid was superior to all treatments, although not significantly so. This effect of indoleacetic acid is in agreement with the findings of Loh, Tseng and Cheng (44), who observed formation and elongation

of set roots by the application of 100 ppm. indoleacetic acid to single- and seedpieces by soaking. Indolebutyric acid at 500 ppm. did not stimulate the production of set roots. This might be due to the high concentration used

in this experiment. Van Overbeek (32), using this material obtained root stimulation and not inhibition. Irrespective of treatment, basal pieces produced the greatest amount of set roots, followed by middle pieces, with the least amount emerging from terminal pieces.

In general, the application of maleic hydrazide and

naphthaleneacetamide in lanolin to the bud of single-bud pieces resulted in increased germination. As pointed out before, results from the last experiments were not consistent. While 4,000 ppm. maleic hydrazide seemed to cause some inhibition in the third experiment, 8,000 ppm. maleic hydrazide gave the highest yields in Experiment 4. Possibly the optimum concentration for maleic hydrazide when applied in this manner lies at or beyond this point. For naphthaleneacetamide the optimum concentration seems to lie between 750 and 2,000 ppm. If so, the application of naphthaleneacetamide for increasing the rate of germination does not seem to be effective.

If advantages are found from the application of growth-regulating substances to sugarcane seedpieces, other methods of application should be investigated.

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If advantages are found from the application of
growth-regulating substances to ergot and seedlings,
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**EFFECTS OF HERBICIDAL AND HORMONAL APPLICATIONS OF GROWTH-
REGULATING SUBSTANCES ON THE GROWTH OF RATOON CANE**

Review of Literature

The use of growth-regulating substances for the control of weeds in sugarcane has created interest in relation to their effect on the cane plant.

The introduction of 2,4-D as a selective herbicide gave cane growers an effective tool with which to combat the large variety of weeds typical of the areas where sugarcane is grown. Its use was so rapidly adopted as a general practice in many areas that little attention was paid to possible toxic effects on the cane plant (59).

Of the materials used for the control of weeds in sugarcane the salts and esters of 2,4-dichlorophenoxyacetic acid are the most outstanding (9, 11, 20, 28, 57, 58). Trichloroacetic acid as the sodium or ammonium salts has proven effective in the control of grass weeds (46, 70). More recently maleic hydrazide has been introduced which shows selectivity for grass weeds (21, 76).

In 1946 Van Overbeek and Vélez (83) reporting on the use of 2,4-D in Puerto Rico stated that this material had no effect on the growth or stooling of young plant cane in concentrations as high as 0.3%. In other publications

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Of the materials used for the control of weeds in sugarcane the salts and esters of 2,4-dichlorophenoxyacetic acid are the most outstanding (9, 11, 20, 22, 23, 24, 25). Trichloroacetic acid as the sodium or ammonium salts has proven effective in the control of grass weeds (26, 27). More recently maleic hydrazide has been introduced which shows selectivity for grass weeds (21, 28).

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that same year (82, 84) Van Overbeek, et al, again reported that concentrations up to 0.3% were entirely harmless to sugarcane.

In 1947 (80) Van Overbeek stated that "the selective action of 2,4-D as herbicide for sugarcane is such that it would require special conditions, which rarely exist in practical agriculture, to kill or even seriously damage a cane plant with 2,4-D." That same year Brown and Holdeman (15) reported injury to sugarcane from the use of 2,4-D. They found that some formulations were more toxic than others and that sprays of the esters at concentrations of 0.5% into the spindle of cane 18 inches tall produced chlorotic lesions. Abnormal nodes resulted from applications of the ethyl and butyl esters at 0.2% four days after flame cultivation.

Arceneaux (4) reported an average reduction of 9% in yield and a corresponding decrease in the rate of stalk elongation from sprays at the rate of 3 lbs. of 2,4-D per acre repeated three times. Guiscafré-Arrillaga (29) found that the injection of 2,4-D into the terminal bud of cane produced galls at the base of the youngest leaves visible in the spindle and in the mature internodes.

Nolla (59) found that 2,4-D injury to sugarcane is exhibited in various ways, bending of the stalks at the point of injury on the growth ring being the most common.

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Arnesen (4) reported an average reduction of 2% in yield and a corresponding decrease in the rate of stalk elongation from sprays at the rate of 3 lbs. of 2,4-D per acre repeated three times. Guisclairé-Arriaga (22) found that the injection of 2,4-D into the terminal bud of cane produced galls at the base of the youngest leaves visible in the spindle and in the mature internodes.

Holla (23) found that 2,4-D injury to sugarcane is exhibited in various ways, bending of the stalks at the point of injury on the growth ring being the most common.

Hypertrophy of the root bank occurred when the tops of cane were soaked with a solution consisting of 50 ml. of 0.1% 2,4-D. Temporary dwarfing of the plant always followed injury, the affected culms being set back as much as 6 inches in the 4 weeks subsequent to treatment. He found that cane is most susceptible to injury after 3 months of age and that younger plants seem to be more resistant to injury, the reason being largely mechanical. When two-month-old plant cane was treated with 0.1% 2,4-D and measured for a period of eleven months it was shown that even when no symptoms of injury were apparent the growth was retarded significantly.

Havis (32) found that the isopropyl ester and triethanolamine salt of 2,4-D at 2 lbs. per acre had an adverse effect on the growth of one-month-old plant cane when sprayed over the tops. Greatest effects were exhibited two to three weeks after treatment. However, the same rates applied to the base of the plants had almost no effect on the growth rate.

Burr and Ashton (16) reported that the roots of sugarcane are quite sensitive to 2,4-D. Akamine (1) reported that pre-emergence applications to ratoon crops did not interfere with the emergence of the cane. When used on plant cane, however, the emergence of the cane was somewhat hindered. Arceneaux (4) found an unfavorable effect

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on the germination of the cane in pre-emergence treatments with 2,4-D if the material was placed less than 4 inches from the cuttings.

Hance (31) reported that the effects of pre-emergence applications of 2,4-D were dependent on soil characteristics, climatic conditions, and type of solution applied. On some Hawaiian soils application of 2 lbs. of 2,4-D to the soil surface with seed planted at a depth of 3 inches may arrest the germination of the seed pieces or destroy the young cane shoots. On other soils, however, as much as 25 lbs. of 2,4-D applied similarly will have no visible effect on the germination and growth of the cane.

Injury to corn from 2,4-D applications has also been reported (2, 37, 40, 63, 66, 67), the effects ranging from morphological abnormalities such as severe stalk bending, leaf rolling and brace-root stimulation to stalk brittleness, temporary retardation of growth with reduced stands, stunting, chlorosis and death of seedlings in pre-emergence applications.

On the effect of trichloroacetic acid on sugarcane and related plants, Leonard (43) found that the application of 40 lbs. of TCA per acre to corn produced no injury, but the plants looked somewhat smaller and lighter green. Stamper and Chilton (71), working in Louisiana, found that TCA at 15 lbs. in pre-emergence applications to

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sugarcane followed by 30 lbs. in the spring and 30 lbs. at layby gave sufficiently lower yields in some of the plots to indicate a possible injurious effect. Hagood (30) working with TCA on cane at rates of 20, 27 and 36 lbs. per acre found that sugar per ton of cane was lower in the treated plots. He interpreted this in part as a delay in maturity due to the retarded growth of sugarcane in the 2 months subsequent to application of the chemical. Loustalot (46) reported no injurious effects on the germination of seedpieces from pre-emergence applications of TCA at the rate of 100 lbs. per acre.

Maleic hydrazide has shown some selectivity for grass weeds. Crafts (21) found MH particularly toxic to grass species, affecting plants at concentrations ranging from 0.1 to 0.8% and producing growth abnormalities. Eskew and Willard (26) found that MH applied to corn at 2, 4, 6 and 8 lbs. per acre produced growth inhibition, while Beard (6) found that 0.05% MH applied at different growth stages produced effects ranging from complete inhibition of growth to no observable effect. Tatum and Curme (75) sprayed MH into the leaf whorl of corn 25 days old at concentrations ranging from 1,000 to 8,000 ppm. (0.1 to 0.8%). The lowest concentration inhibited the growth of all strains tested during the period of measurement, the effect increasing with the concentration. At 0.8% growth

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was almost completely inhibited and most plants died before the end of the experiment.

The following experiment was undertaken to determine the effect of herbicidal applications of 2,4-D and TCA alone and in combination, and the effect of hormonal applications of maleic hydrazide alone and in combination with 2,4-D directly on the cane foliage.

Materials and Methods

The field selected for this experiment consisted of 0.85 hectare of two-month-old first-year ratoon C.P. 29-116 cane. The cane was planted in single rows $5\frac{1}{2}$ feet apart with alternate clean and trash rows. Plots 19' x 19' ($\frac{1}{120}$ acre each) in a randomized block design included 3 rows of cane.

Two stools at approximately one-third and two-thirds the length of the center row of cane in each plot were marked. In order to obtain a representative selection of plants from each of these two stools, the largest, third, fifth and seventh plants in size were tagged. This gave a total of four plants per stool or eight plants per plot, with a total of 32 plants per treatment.

The treatments consisted of:

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Materials and Methods

The field selected for this experiment consisted of 0.5 hectares of two-month-old first-year ratoon C.I. 619-

the cane was planted in single rows 2 feet apart with alternate clean and trash rows. Plots 12' x 12' (1/16 acre each) in a randomized block design included 3 rows of cane.

Two stools at approximately one-third and two-thirds

the length of the center row of cane in each plot were marked. In order to obtain a representative selection of plants from each of these two stools, the largest, third, fifth and seventh plants in size were tagged. This gave a total of four plants per stool or eight plants per plot, with a total of 32 plants per treatment.

The treatments consisted of:

1. 30 lbs. TCA per acre.^a
2. 60 lbs. TCA per acre.
3. 2 lbs. 2,4-D per acre.^b
4. 2 lbs. 2,4-D plus 30 lbs. TCA per acre.
5. 0.05% maleic hydrazide.^c
6. 0.1% maleic hydrazide.
7. 0.2% maleic hydrazide.
8. 0.1% maleic hydrazide plus 0.05% 2,4-D.
9. Control - No treatment.

DuPont Spreader-Sticker was added to the sprays at the rate of 0.05%. Each treatment was replicated four times. Treatments 1 to 4 were applied as in weed control practices, while treatments 5 to 8 were applied directly to the cane foliage. Knapsack-type sprayers equipped with Spraying Systems 650015 tips were used at a pressure of 45 lbs.

The 288 plants tagged for growth measurements were measured the day following treatment, and every week thereafter for a period of three months, when the measurements

^a Sodium trichloroacetate (90%). Dow Chemical Co., Midland, Mich.

^b Esteron 44 (Isopropyl ester of 2,4-dichlorophenoxyacetic acid, 44% by weight acid equiv.) Dow Chemical Co., Midland, Michigan.

^c MH-30, maleic hydrazide, diethanolamine salt 50% (30% maleic hydrazide). United States Rubber Co., Naugatuck Chemical Division, Naugatuck, Conn.

1. 30 lbs. TCA per acre.^b
2. 60 lbs. TCA per acre.
3. 2 lbs. 2,4-D per acre.^b
4. 2 lbs. 2,4-D plus 30 lbs. TCA per acre.
5. 0.02% maleic hydrazide.^c
6. 0.1% maleic hydrazide.
7. 0.2% maleic hydrazide.
8. 0.1% maleic hydrazide plus 0.02% 2,4-D.
9. Control - no treatment.

Diluent sprayer-sticker was added to the sprays at the rate of 0.02%. Each treatment was replicated four times. Treatments 1 to 4 were applied as in seed control practices, while treatments 5 to 8 were applied directly to the cane foliage. Backpack-type sprayers equipped with Spraying Systems (SS) tips were used at a pressure of 45 lbs.

The 30 plants tagged for growth measurements were measured the day following treatment, and every week thereafter for a period of three months, when the measurements

^a Sodium trichloroacetate (S.T.C.A.) Dow Chemical Co., Midland, Mich.

^b Esteron 44 (Isopropyl ester of 2,4-dichlorophenoxyacetic acid, 44% by weight acid equiv.) Dow Chemical Co., Midland, Michigan.

^c MH-30, maleic hydrazide, diethanolamine salt 99% (30% maleic hydrazide). United States Rubber Co., Easton, Conn. Chemical Division, Easton, Conn.

were continued on a bi-weekly basis for four additional months. Overall height was recorded by measuring the distance from ground level to the last visible ligule on the stalk. Notes were taken on the weed control obtained from the herbicidal treatments.

Results

Good control of both broad-leaved weeds and grasses was obtained with 60 lbs. TCA to the acre and with the mixture of 2,4-D and TCA. Fair control was obtained with 30 lbs. TCA, and with 2 lbs. 2,4-D to the acre. However, these results may have been influenced by the dry weather experienced during the period following treatment which delayed germination and growth of the weed population.

Mortality among selected plants at the end of the experiment is presented in table 12. The plots treated with TCA at 60 lbs., and with 2,4-D at 2 lbs. had the highest mortality with 56.3 and 40.6 per cent respectively. Control plots had the least number of dead plants, 12.5 per cent. Although some of these deaths were undoubtedly caused by competition and/or disease, the differences in mortality observed especially at the higher rates of application appear to be due in a large part to the effects of the treatments.

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Table 12. Plant mortality 26 weeks after treatment.

<u>Treatments</u>	<u>No. of Dead Plants</u>	<u>Per cent Mortality</u>
30 lbs. TCA	12	37.5
60 lbs. TCA	18	56.3
2 lbs. 2,4-D	13	40.6
2 lbs. 2,4-D plus 30 lbs. TCA	12	37.5
0.05% MH	7	21.9
0.1% MH	7	21.9
0.2% MH	10	31.3
0.1% MH plus 0.05% 2,4-D	12	37.5
Control	4	12.5

Figure 1 shows cumulative growth for the herbicidal treatments at bi-weekly intervals based on all of the plants initially selected for measurement. Although the average height of the plants in the control plots was lower at the beginning of the experiment, they were superior in height to those treated with TCA, and with the mixture of 2,4-D and TCA 7 weeks after treatment, and to those treated with 2,4-D fifteen weeks after treatment. These differences, however, are not significant.

Figure 2 also shows cumulative growth for the herbi-

Table 12. Plant mortality 25 weeks after treatment.

Treatments	No. of plots	Per cent mortality
Control	4	12.5
0.2% TCA plus 0.02% S, 4-D	12	37.5
0.2% TCA	10	31.3
0.1% TCA	7	31.9
0.02% S, 4-D	7	31.9
0.2% TCA plus 0.02% S, 4-D	12	37.5
0.2% TCA plus 0.02% S, 4-D	12	40.8
0.2% TCA	12	37.5
0.2% TCA plus 0.02% S, 4-D	12	37.5

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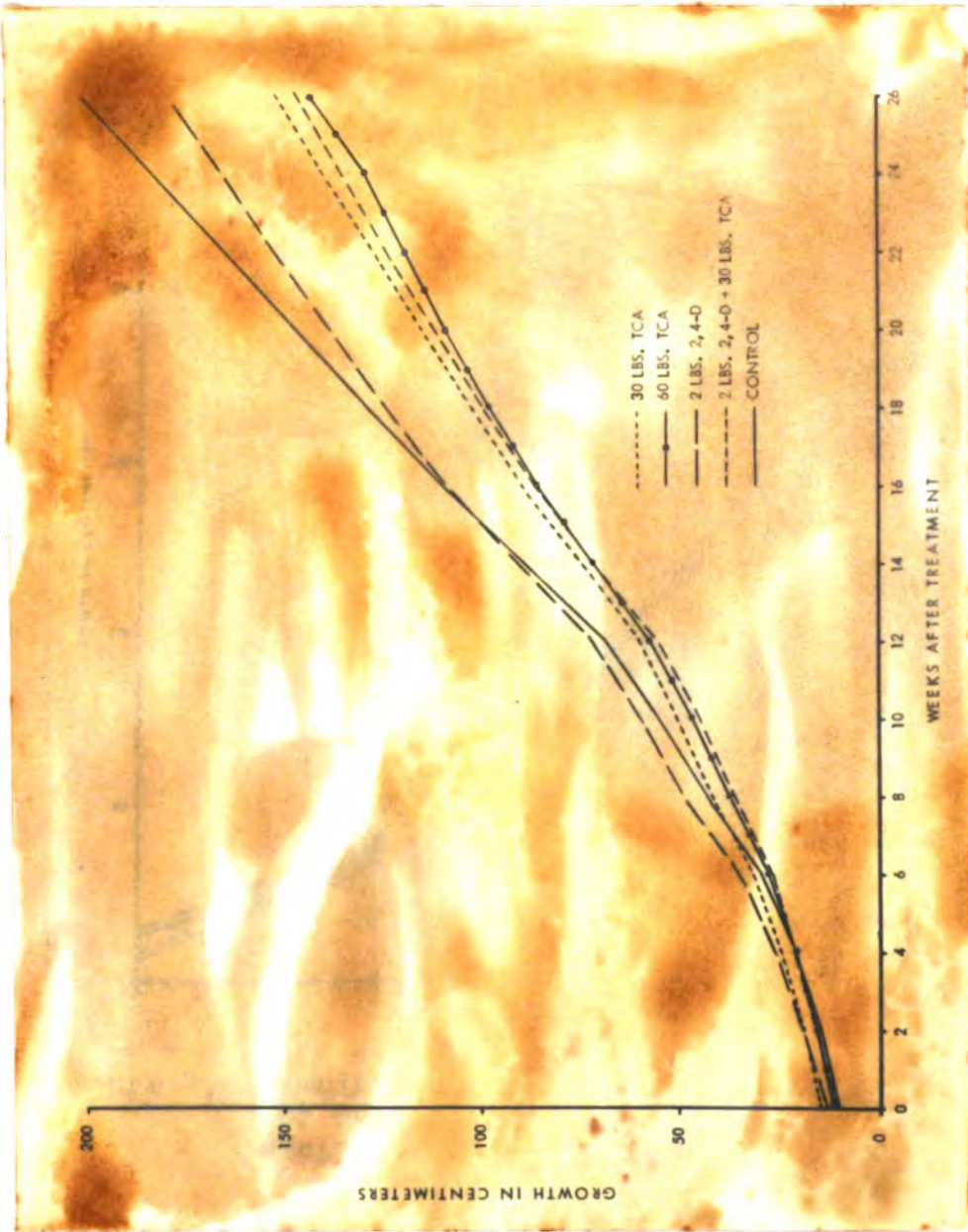


Figure 1. Cumulative growth at bi-weekly intervals for herbicidal treatments. All plants included.

Figure 1. Composite Group of P-2000. Infrared for
P-2000. P-2000. P-2000. P-2000. P-2000. P-2000. P-2000. P-2000.



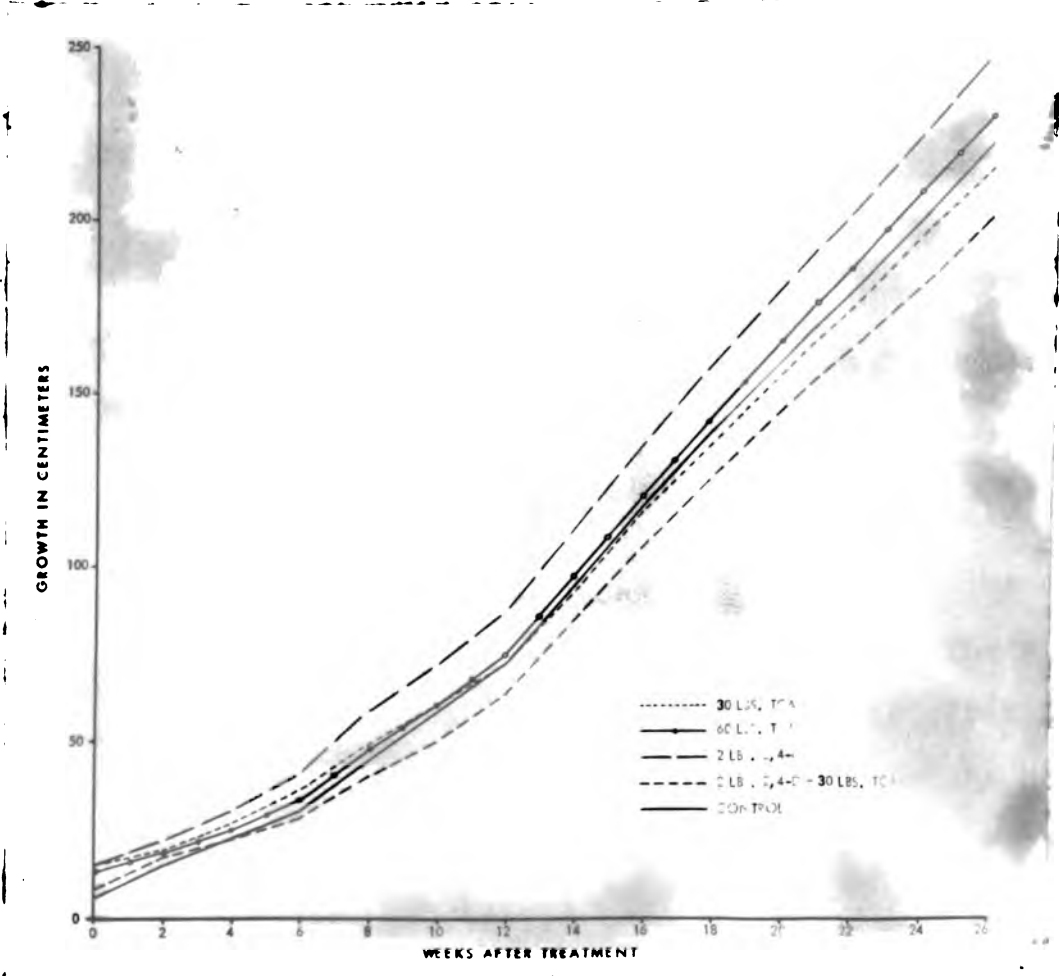


Figure 2. Cumulative growth at bi-weekly intervals for herbicidal treatments. All dead plants excluded.



Original copy of the above mentioned documents for personal reference. All other copies excluded.

cidal treatments at bi-weekly intervals, but all dead plants have been excluded. When calculated on this basis the average height per plant for all treatments was greater, and the final arrangement of the growth curves is quite different. However, the variation in plant height between treatments at the end of the experiment was not significant.

Figure 3 shows the same data expressed as the bi-weekly growth increment in per cent of ultimate height. All of the plants initially selected for measurement were included. These curves show two peaks, one at 8 weeks and another at 14 weeks after treatment. These peaks are correlated with the amount of rainfall registered during this period. No great differences in growth could be observed during the early part of the experiment. The control plants registered higher growth increments after 14 weeks with an increase in elongation at 24 weeks which resulted in flowering. Flowering for the chemical treatments was retarded, especially for TCA applied at 30 and 60 lbs. to the acre. The same results were observed when the growth increment was calculated on the basis of actively growing plants at the end of the experiment.

Figure 4 shows cumulative growth for the hormonal treatments at bi-weekly intervals. All of the plants initially selected for measurement were included. Again,

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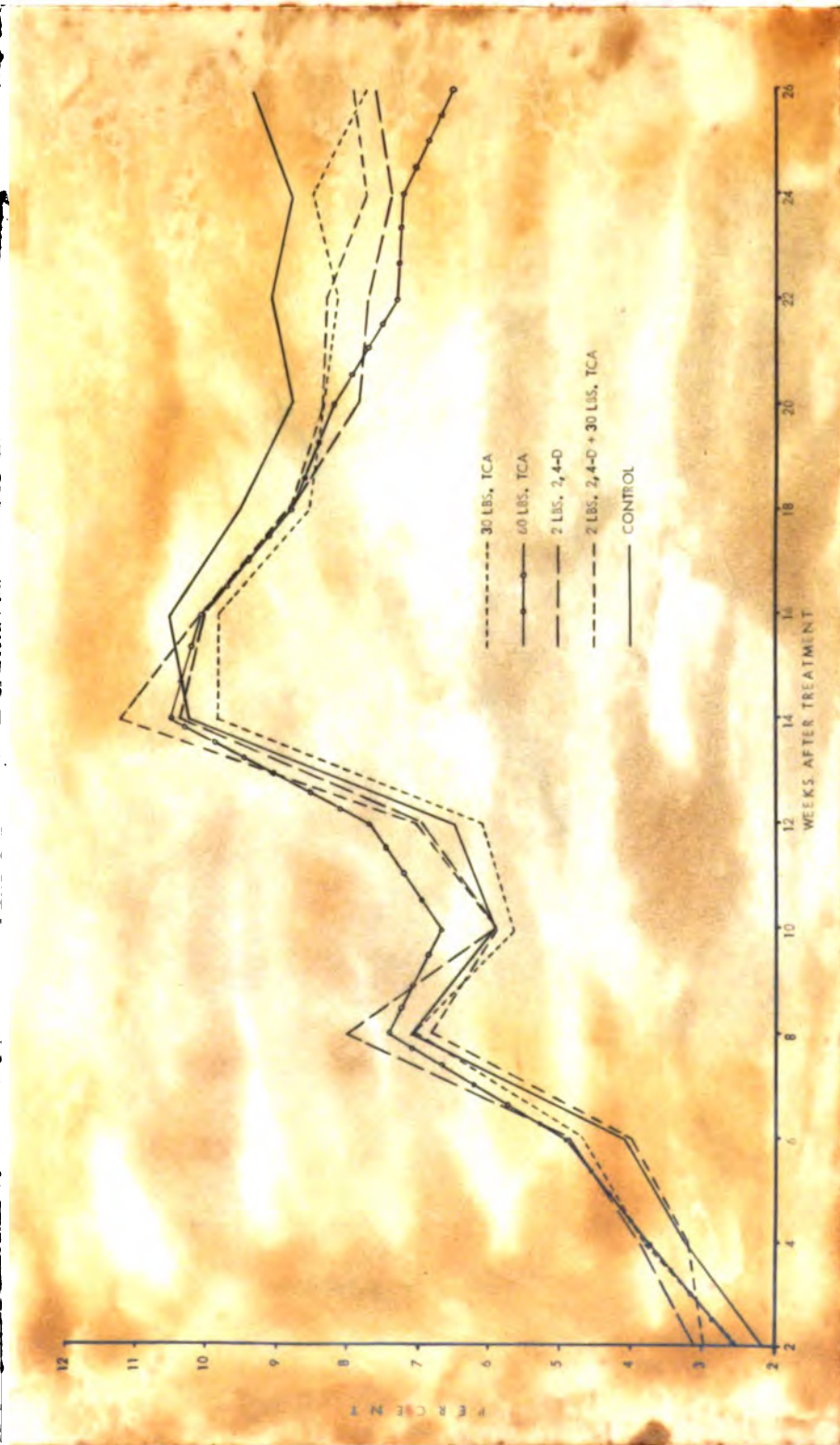


Figure 3. Bi-weekly growth increment for herbicidal treatments expressed as per cent of ultimate length. All plants included.

VII. 1944-1945. 1946-1947.
VIII. 1948-1949. 1950-1951.
IX. 1952-1953. 1954-1955.
X. 1956-1957. 1958-1959.
XI. 1960-1961. 1962-1963.
XII. 1964-1965. 1966-1967.
XIII. 1968-1969. 1970-1971.
XIV. 1972-1973. 1974-1975.
XV. 1976-1977. 1978-1979.
XVI. 1980-1981. 1982-1983.
XVII. 1984-1985. 1986-1987.
XVIII. 1988-1989. 1990-1991.
XIX. 1992-1993. 1994-1995.
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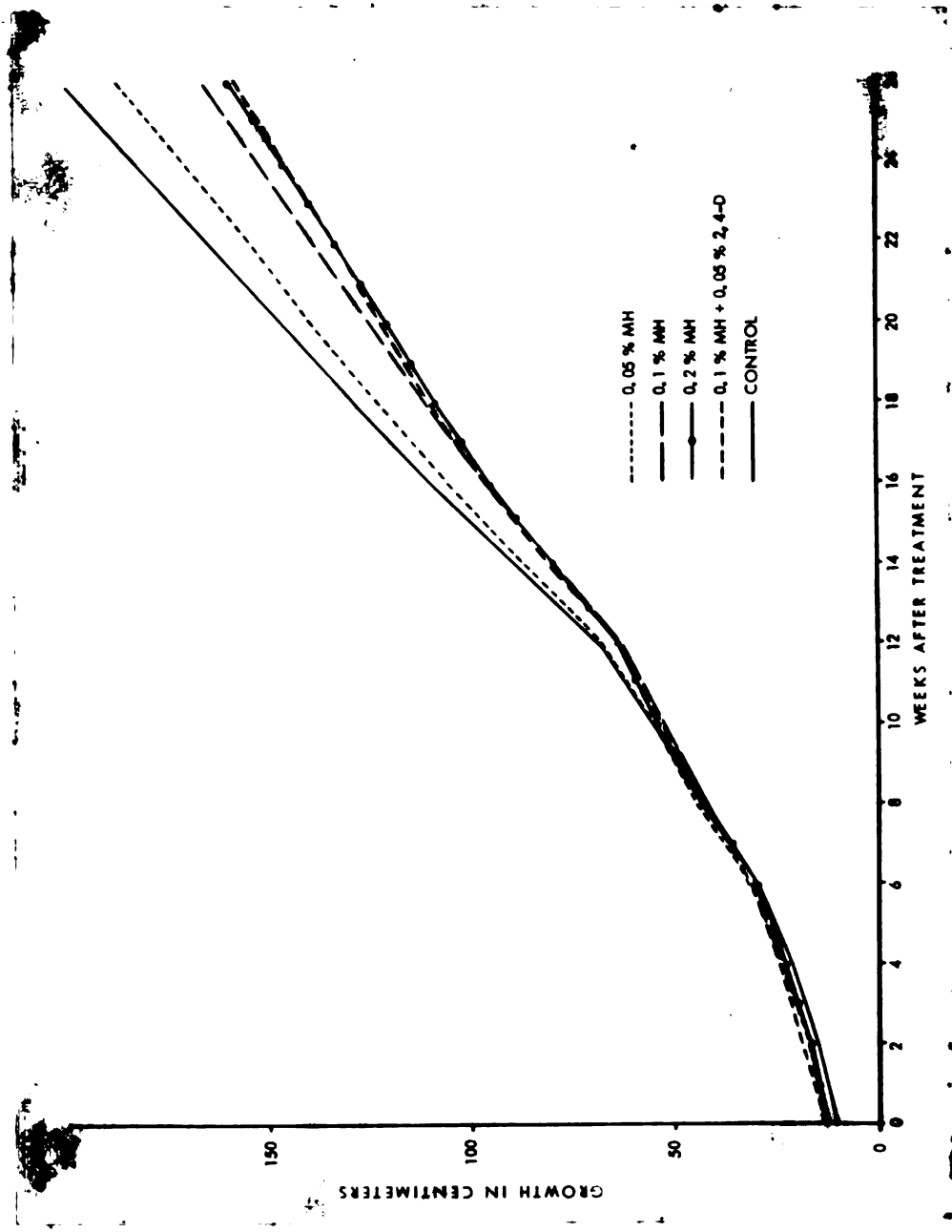


Figure 4. Cumulative growth at bi-weekly intervals for hormonal treatments. All plants included.

although the average height of the plants in the control plots was lower at the beginning of the experiment, control plants were superior in height to all treatments 10 weeks after application. When average plant height was calculated, excluding all dead plants, there was practically no variation between treatments.

Figure 5 shows the same data for the hormone treatments expressed as the bi-weekly growth increment in percent of ultimate height. All of the plants initially selected for measurement were included. The same general pattern of growth obtained for the herbicidal treatments can be observed and again is correlated with the amount of rainfall registered during this period. The growth increment for the control is superior to all treatments after 14 weeks. Contrary to the results obtained for the herbicidal treatments, none of the hormone-type applications seemed to delay flowering.

Summary and Discussion

For both herbicidal and hormonal treatments the degree of plant mortality is in line with the concentrations used. However, since other factors such as competition and/or disease undoubtedly affected the growth of some plants directly or indirectly, we cannot assume that all deaths were due entirely to the effect of the

although the average height of the plants in the control plots was lower at the beginning of the experiment, control plants were superior in height to all treatments 10 weeks after application. When average plant height was calculated, excluding all dead plants, there was practically no variation between treatments.

Figure 5 shows the same data for the hormone treatments expressed as the bi-weekly growth increment in per cent of ultimate height. All of the plants initially selected for measurement were included. The same general pattern of growth obtained for the herbicidal treatments can be observed and this is correlated with the amount of rainfall registered during this period. The growth increment for the control is superior to all treatments after 12 weeks. Contrary to the results obtained for the herbicidal treatments, none of the hormone-type applications seemed to delay flowering.

Summary and Discussion

For both herbicidal and hormone treatments the degree of plant mortality is in line with the concentrations used. However, since other factors such as competition and/or disease undoubtedly affected the growth of some plants directly or indirectly, we cannot assume that all deaths were due entirely to the effect of the

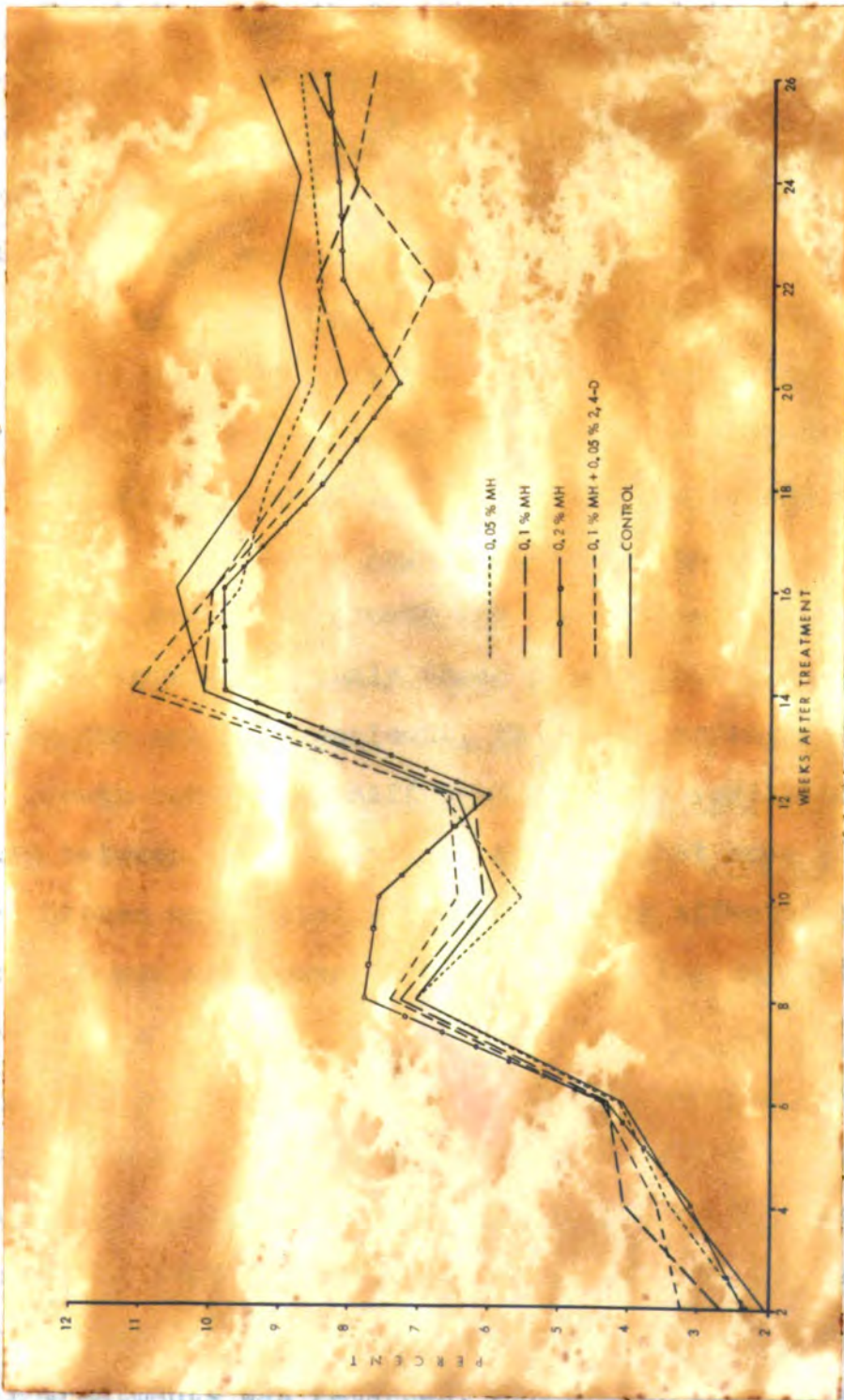


Figure 5. Bi-weekly growth increment for hormonal treatments expressed as per cent of-ultimate length. All plants included.

Figure 2. Aerial view of the study area. The study area is located in the northern part of the study area.



treatments.

Cumulative growth for the herbicidal treatments based on all of the plants initially selected for measurement shows that all of the chemical treatments affected growth to some extent, although not significantly so. Similar results were obtained by Nolla (59) who found that when cane two months old was treated with 0.1% 2,4-D and measured for a period of 11 months the growth was retarded even when no symptoms of injury were apparent. Stamper and Chilton (71) working with TCA obtained lower yields due possibly to injurious effect on the cane.

When cumulative growth for the herbicidal treatments was calculated using only those plants that grew actively during the entire experiment, the final arrangement of the growth curves was different and less variation was found between treatments. It appears that some plants were either unaffected or only slightly affected and that their growth was comparable to that of the untreated plants.

When this data was expressed in bi-weekly growth increment in per cent of ultimate height using all plants initially selected for measurement, no great differences could be observed in the growth rate during the early part of the experiment. However, flowering for the chemical treatments was retarded, especially for TCA at 30 and

treatments.

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60 lbs. per acre. Similar results were obtained by Hagood (30), who interpreted lowered sugar yields from the application of TCA as a delay in maturity due to retarded growth. When growth increment was calculated on the basis of actively growing plants only, the same results were observed.

Cumulative growth for the hormonal treatments based on all the plants initially selected for measurement shows that all chemical treatments affected the growth of the cane to some extent and that the effects were dependent on concentration. When cumulative growth for these treatments was calculated using only those plants that grew actively during the entire experiment there was practically no variation between treatments. As in the case of the herbicidal treatments, it appears that some plants were not affected or only slightly affected and that their growth was comparable to that of the untreated plants.

When growth increment based on all plants initially selected for measurement was calculated for the hormonal treatments, the growth rate for the control plants was superior to all treatments after 14 weeks, although not significantly so. Contrary to the results obtained for the herbicidal treatments, none of the hormone-type applications seemed to delay flowering.

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When growth increment based on all plants initially selected for measurement was calculated for the hormonal treatments, the growth rate for the control plants was superior to all treatments after 14 weeks, although not significantly so. Contrary to the results obtained for the herbicidal treatments, none of the hormone-type applications seemed to delay flowering.

From the results obtained in this experiment, it appears that the application of selective herbicides, especially at higher concentrations, may affect plant population and yields due to delayed maturity of the cane as a result of retarded growth. This would be particularly true in weed control programs where application of one or more materials are made at different stages during the growth of the cane.

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EFFECT OF PRE-HARVEST FOLIAGE SPRAYS WITH MALEIC HYDRA-
ZIDE ON THE SUCROSE CONTENT OF SUGARCANE AND INVERSION OF
SUCROSE IN HARVESTED CANE

Review of Literature

It has been found that some growth-regulators influence carbohydrate metabolism. Sell, et al. (65) reported that the application of 2,4-D to red kidney beans reduced the content of reducing and non-reducing sugars in the stems, while Weller, et al. (88) observed a reduced percentage of non-reducing sugars in the leaves and roots of treated kidney bean plants, but no change in reducing sugars.

Increase in the sucrose content of plants as a result of application of 2,4-D has been reported in buckwheat (92, 93), in tomato (94), and in cotton (25).

In 1949 (77) it was reported that apart from weed elimination, treatment with 2,4-D might increase the sucrose content of sugarcane. Beauchamp (7) reported an average increase in sucrose of 1.38% from the application of 2,4-D prior to harvest in tests carried out during 1947-1949. However, Loustalot, et al. (47) did not obtain significant increases in sucrose content in a similar experiment. Cerighelli (17) reviewing the work of these investigators, pointed out the need for further work along

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It has been found that some growth-regulators influence carbohydrate metabolism. Bell, et al. (6) reported that the application of 2,4-D to red kidney beans reduced the content of reducing and non-reducing sugars in the stems, while Weller, et al. (8) observed a reduced percentage of non-reducing sugars in the leaves and roots of treated kidney bean plants, but no change in reducing sugars.

Increase in the sucrose content of plants as a result of application of 2,4-D has been reported in buckwheat (9), in tomato (10), and in cotton (11). In 1942 (12) it was reported that apart from weed elimination, treatment with 2,4-D might increase the sucrose content of sugarcane. Beauchamp (13) reported an average increase in sucrose of 1.5% from the application of 2,4-D prior to harvest in tests carried out during 1947-1948. However, Houstaford, et al. (14) did not obtain significant increases in sucrose content in a similar experiment. Ceryghelli (15) reviewing the work of those investigators, pointed out the need for further work along

this line. Lugo and Grant (48) failed to obtain any increase in sucrose content from heavy applications of 2,4-D to sugarcane prior to harvesting. Beauchamp (8) demonstrated his technique in Brazil with promising results. More recently Lugo, Samuels and Grant (49) failed to obtain an increase in the sucrose content of sugarcane from the pre-harvest application of 2,4-D.

The possibility that maleic hydrazide may influence carbohydrate metabolism has been suggested by Naylor and Davis (56). Currier, et al. (22) found that MH-treated barley had a lower fresh weight but higher dry weight due to accumulation of fructosan. Analysis of exudate from the leaves showed a predominance of sucrose. McIlrath (50) reports that the chemical analysis of the leaves of cotton treated with MH showed an increase in sucrose and a marked increase in starch over the checks. He suggests that the accumulation of carbohydrates might be due to damage to phloem sieve tubes. In vitro experiments with carrots by Phouphas (61) showed that MH produced a rapid increase in sucrose content, with a subsequent rapid decline. MH also inhibited the transformation of glucose to fructose.

Corn sprayed with MH at 0.1% showed exudate rich in sugar on the underside of the leaves (56). Naylor (55) obtained similar results from application to corn at 0.05

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The possibility that cyclic hydrazide may influence carbohydrate metabolism has been suggested by Taylor and Davis (21). Taylor, et al. (22) found that P-treated plants had a lower fresh weight but higher dry weight due to accumulation of fructose. Analysis of extracts from the leaves showed a predominance of sucrose. Clifton (23) reports that the chemical analysis of the leaves of cotton treated with P showed an increase in sucrose and a marked increase in starch over the checks. He suggests that the accumulation of carbohydrates might be due to change in phloem sieve tubes. In vitro experiments with carrots by Robinson (24) showed that P produced a rapid increase in sucrose content, with a subsequent rapid decline. He also inhibited the transformation of glucose to fructose.

Corn sprayed with P (25) showed considerable increase in sugar on the underside of the leaves (26). Taylor (27) obtained similar results from application to corn at 1.05

and 0.4%. Tatum and Curme (75) sprayed MH at 0.1 to 0.8% into the leaf whorl of corn 25 days old. Plants developed red pigmentation in the leaves which the author suggests was due to accumulation of sugars in the leaves.

Ririe and Mikkelsen (62) found that foliage sprays of sugar beets with maleic hydrazide at 0.025 and 0.3% prior to harvest produced significantly higher sucrose content, with the maximum increase registered during the first 21 days following treatment. Similar results were obtained by Wittwer and Hansen (90), who found that the application of sodium and diethanolamine salts of MH significantly increased the sucrose content of sugar beets at the time of harvest. Mikkelsen, et al. (54) harvested beets 30 and 44 days subsequent to treatment at rates of 0.75, 1.5 and 3 lbs. MH to the acre. Per cent sucrose increased with the higher rates of application. They suggest that increase in sucrose may be due to interference with mitotic development of tops and partial inhibition of root growth resulting in higher sucrose content of roots with little increase in root size.

Lugo, Samuels and Grant (49) applied maleic hydrazide to sugarcane at concentrations ranging from 0.025 to 2.0%. Daily samples showed no significant differences in Brix, polarization or purity.

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Sucrose losses from delayed milling of sugarcane have

been studied by Lauritzen and Balch (41), Balch, Broeg and Lauritzen (5), Lauritzen, Balch and Fort (42), Varas (87), and Hes (36).

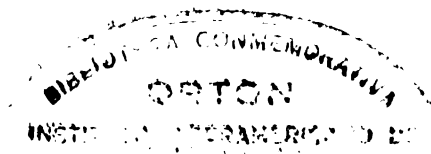
Balch, et al. calculated that there is a loss in weight of 1% per day for cane stored in the field under Louisiana conditions, a daily loss of about 45,000 tons of cane over the State (5).

Sucrose losses are due primarily to the inversion of sucrose to reducing sugars and secondarily to a consumption of sugars through respiration. The most important factor controlling the inversion of sucrose in cane during storage under Louisiana conditions is moisture balance, while temperature is of secondary importance (5).

Lauritzen and Balch (41) found that in entire stalks there tended to be a gradient in the loss of moisture, increase in Brix, drop in purity and loss of sucrose, and that these changes were greatest in the top, next greatest in the middle and least in the basal sections of the stalk.

Lauritzen, Balch and Fort (42) found no relation between the invertase content of the stalk and its resistance to inversion of sucrose. Varietal differences in loss of weight by evaporation are related to the thickness of the waxy covering of the stalk which differs among varieties.

The use of maleic hydrazide to prevent storage losses in sugar beets has been investigated. Peto, et al. (60)



been studied by Lauritzen and Balch (41), Balch, Broeg and Lauritzen (5), Lauritzen, Balch and Fort (42), Vavas (37), and Nes (38).

Balch, et al. calculated that there is a loss in weight of 1.5 per day for cane stored in the field under Louisiana conditions, a daily loss of about 1,000 tons of cane over the State (3).

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found that treated beets harvested and stored for 34 days were 0.25% higher in sucrose at the beginning of storage and 0.38% higher at removal. Wittwer and Hansen (91) found that although there was no change in the sugar composition of beets treated before storage, per cent sugar in control beets was reduced by more than 4% at the end of storage. Weight losses also were high in control as compared to treated beets, giving a total loss of 13.06% of the total original sugar content as compared to 0.72% in the treated beets. The average temperature of the bins where the treated beets were stored ran several degrees cooler during the experiment. They suggest that MH might inhibit respiratory losses through the partial inactivation of one or more of the dehydrogenases, as reported by Isenberg, et al. (39).

An experiment was undertaken to study the effect of maleic hydrazide on the sucrose content of sugarcane and the inversion of sucrose in harvested sugarcane.

Materials and Methods

Sample size study.

A sample size study was undertaken to determine the number of stalks that would constitute a representative sample. The method employed by the Division of Sugar Plant Investigations, United States Department of Agriculture,

found that treated beets harvested and stored for 34 days were 0.2% higher in sucrose at the beginning of storage and 0.38% higher at removal. Witter and Hansen (21) found that although there was no change in the sugar composition of beets treated before storage, per cent sugar in control beets was reduced by more than 1% at the end of storage. Weight losses also were high in control as compared to treated beets, giving a total loss of 13.6% of the total original sugar content as compared to 1.7% in the treated beets. The average temperature of the bins where the treated beets were stored ran several degrees cooler during the experiment. They suggest that it might inhibit respiratory losses through the partial inactivation of one or more of the dehydrogenases, as reported by Isenberg, et al. (32).

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for conducting variety tests in Louisiana (34) furnished part of the needed information. In sampling studies they have found that although individual stalks in a stool vary considerably, individual stools taken as a unit show little variation over a 1/40 acre plot (33).

The following test was conducted in the same field selected for the maleic hydrazide treatments. This was 14-month-old P.O.J. 2878 plant cane. From rows selected at random 40 stalks were cut in the same order in which they stood in the field and segregated into two 5-stalk and three 10-stalk units in the order cut. These units were milled separately in that order so as to obtain aliquots from 5, 10, 20, 30, and 40-stalk bundles. Four replications were used.

Milling was done in a 3" x 4-3/4" 3-roller laboratory mill giving 66% extraction with the variety used in this trial. Brix was determined by hydrometer, and initial reducing value and sucrose following invertase hydrolysis by a modification of the Shaffer-Somogyi semi-micro method (35). The resulting glucose equivalent was then read from a table prepared from the analysis of standard glucose solutions. Conversion to sucrose was made using the factor 0.95 (45).

Results of the analyses are shown in table 13.

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The following test was conducted in the same field selected for the maleic hydrazide treatment. This was 14-month-old P.O.S. 2000 plant cane. From rows selected at random 40 stalks were cut in the same order in which they stood in the field and segregated into two 2-stalk and three 10-stalk units in the order cut. These units were milled separately in that order so as to obtain aliquots from 2, 10, 20, 30, and 40-stalk bundles. Four replications were used.

Milling was done in a 3" x 1/4" 3-roller laboratory mill giving 60% extraction with the variety used in this trial. Brix was determined by hydrometer, and initial reducing value and sucrose following invertase hydrolysis by a modification of the Shaffer-Somogyi semi-micro method (35). The resulting glucose equivalent was then read from a table prepared from the analysis of standard glucose solutions. Conversion to sucrose was made using the factor 0.95 (45).

Results of the analyses are shown in table 13.

Table 13. Analyses of various size samples for determining the variation in sucrose content.

Number of stalks	% Sucrose by Weight					Max. var. between %	
	1	2	3	4	Ave.	Replic.	var.
5	16.5	18.4	20.8	19.9	18.9	4.3	22.6
10	18.1	18.6	20.3	19.1	19.1	2.3	11.9
20	18.6	19.1	19.8	19.7	19.3	1.3	6.8
30	18.9	19.3	19.4	19.4	19.2	0.5	2.7
40	19.0	19.1	19.7	19.4	19.3	0.8	4.1

These figures show that the per cent variation decreased as the number of stalks in a sample increased up to 30 stalks. From these results it was decided that 20 stalks would constitute a representative sample for a 1/40 acre plot when collected from the same length of row under local conditions. Increased accuracy obtained by the collection of a larger sample would be offset by the increased time and labor necessary to grind samples of this size.

Experiment 1: Effect of pre-harvest foliage sprays with maleic hydrazide on the inversion of sucrose in harvested cane.

This experiment was undertaken to determine the effect of maleic hydrazide on the inversion of sucrose in cut cane

Table 13. Analyses of various size samples for determining the variation in sucrose content.

Number of stalks	Average for weight					Max. var. between 2 consecutive var.
	1	2	3	4	Ave.	
5	16.5	17.4	20.8	19.9	18.9	4.3
10	14.1	16.6	20.3	19.1	19.1	3.3
20	13.6	19.1	19.5	19.7	19.3	1.3
30	13.9	19.3	19.4	19.4	19.3	0.9
40	19.0	19.1	19.7	19.4	19.3	0.6

These figures show that the per cent variation decreased as the number of stalks in a sample increased up to 30 stalks. From these results it was decided that 20 stalks would constitute a representative sample for a 1/4 acre plot when collected from the same length of row under local conditions. Increased accuracy obtained by the collection of a larger sample would be offset by the increased time and labor necessary to grind samples of this size.

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This experiment was undertaken to determine the effect of malic hydrazide on the inversion of sucrose in cut cane.

subjected to field conditions for different periods of time.

Materials and Methods

Twenty plots 40' x 27' (approximately 1/40 acre each) were set out in a 4 x 5 randomized block design. Each plot included four rows of cane 40' long. Alleys were cleared around the plots to facilitate spraying. Two rows of standing cane were left as buffers between plots.

Five treatments were included:

1. Maleic hydrazide at 750 ppm. (0.8 lbs. per acre)
2. " " " 1500 " (1.6 " " ")
3. " " " 3000 " (3.2 " " ")
4. " " " 6000 " (6.4 " " ")
5. Control - no treatment.

ESSO experimental sticker RDA-156 was added to the sprays at the rate of 0.125%. The materials were applied to the cane foliage by means of knapsack sprayers equipped with a 9-foot hose at a pressure of 55 lbs. By having one man carry the tank and another operating the boom, the applications were made with little difficulty.

All treatments were applied in the morning. Light rain amounting to 0.36 inch was recorded that afternoon, followed by 0.16 inch the next day.

Five days after treatment three 20-stalk samples were

collected from each plot using the technique described in the sample-size study. These were tied into separate bundles and marked 0, 3, and 9. All 0 samples were milled and analyzed that same day, while samples 3 and 9 were left in the field and milled three and nine days after harvesting.

The weight of each sample, the weight of the juice extracted, the Brix, and the initial reducing value as well as total reducing value after hydrolysis with invertase were determined for each sample.

Results

Results for this experiment are presented in table 14. The analysis for 0-day samples (milled same day harvested) shows an increase in Brix for MH applied at the rates of 3,000 and 6,000 ppm. However, the differences are not significant. Difficulties were experienced in determining initial reducing values for this series, and these are omitted from the table. Other data presented have been calculated on the basis of total reducing value, giving slightly higher values for per cent sucrose. Total reducing value expressed as per cent sucrose was superior for MH applied at the rate of 1,500, 3,000 and 6,000 ppm. However, none of these differences are significant.

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Results

Results for this experiment are presented in table I. The analysis for 0-day samples (milled same day harvested) shows a decrease inrix for all plots at the rates of 1,000 and 2,000 ppm. However, the differences are not significant. Differences were experienced in determining initial reducing values for this series, and these are omitted from the table. Other data presented have been calculated on the basis of total reducing value, giving slightly higher values for per cent sucrose. Total reducing value expressed as per cent sucrose was superior for all plots at the rate of 1,000, 2,000 and 4,000 ppm. However, none of these differences are significant.

Table 14. Analysis of samples collected five days after treatment and milled at 0, 3, and 9 days subsequent to harvest.

Treatments	0-Day Samples			3-Day Samples			9-Day Samples				
	Brix	% Sucrose Juice Cane	% Red. Sug. in Sample	Brix	% Sucrose Juice Cane	% Red. Sug. in Sample	Brix	% Sucrose Juice Cane	% Red. Sug. in Sample		
750 ppm. MH (0.8 lb./acre)	20.4	18.9	12.7	21.1	1.6	20.8	13.3	20.8	5.7	19.0	12.7
1500 ppm. MH (1.6 lb./acre)	20.7	20.0	13.8	20.6	1.9	19.3	12.9	20.2	5.9	18.4	12.1
3000 ppm. MH (3.2 lb./acre)	21.6	21.1	14.3	20.9	1.8	19.8	13.6	21.7	5.8	19.8	13.3
6000 ppm. MH (6.4 lb./acre)	21.3	20.6	13.8	20.9	1.9	19.9	12.7	21.0	5.0	19.7	13.1
Control - no treatment	20.2	19.3	13.1	21.0	1.6	19.8	13.3	21.0	3.2	20.0	13.3

x Calculated on the basis of total reducing value, since initial reducing value was not obtained for 0-Day samples.

Analysis of 3-day samples showed no differences in Brix between treatments. Although no changes in Brix were observed for treatments consisting of 1,500, 3,000 and 6,000 ppm. MH as compared to the 0-day samples, the lowest concentration of MH and the control had the lowest per cent reducing value and showed apparent increases in Brix and per cent sucrose.

At 9 days no changes in Brix were observed. The control was slightly superior in per cent sucrose over all treatments. Inversion of sucrose in all samples had increased. The control had the lowest per cent reducing value, although these differences were not significant.

Experiment 2: Effects of pre-harvest foliage sprays with maleic hydrazide on the sucrose content of sugar cane.

This experiment was run in conjunction with the experiment on the inversion of sucrose in harvested cane.

Materials and Methods

The materials employed in this study were the same. The original plan called for sampling and analysis at one, two, and four weeks subsequent to application of the materials. Due to difficulties with the mill, however, results for only two dates - 5 days and 30 days after treatment - were obtained.

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At 9 days no changes in invert were observed. The con-
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Experiment 2: Effects of pre-harvest foliar sprays with

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This experiment was run in conjunction with the ex-
 periment on the inversion of sucrose in harvested cane.

Materials and Methods

The materials employed in this study were the same.
 The original plan called for sampling and analysis at one,
 two, and four weeks subsequent to application of the water-
 salts. Due to difficulties with the mill, however, results
 for only two dates - 5 days and 30 days after treatment -
 were obtained.

Results

Data for this experiment are presented in table 15. Two treatments, maleic hydrazide at 3,000 and 6,000 ppm., were superior in Brix and total reducing value expressed in as per cent sucrose 5 days after treatment. Maleic hydrazide applied at 1,500, 3,000 and 6,000 ppm. gave higher per cent sucrose in the cane than the control.

Data for the series analyzed 30 days subsequent to treatment shows an overall reduction in Brix. MH applied at 3,000 and 6,000 ppm. was superior in Brix and per cent sucrose in the juice to the control. When compared on the basis of per cent sucrose in cane, all treatments were superior to the control.

Summary and Discussion

It was found that under local conditions 20 stalks constitute a representative sample for 1/40 acre plots when collected from the same length of row. This is in agreement with results obtained by the Division of Sugar Plant Investigations in Louisiana (33, 34).

Contrary to results obtained with sugar beets (60, 91) the application of maleic hydrazide to sugarcane prior to harvesting for preventing sucrose losses due to delayed milling does not seem to be effective. When milling was delayed for three days after harvesting, maleic hydrazide

Results

Data for the experiment are presented in Table I. Two treatments, maleic hydrazide at 3,000 and 6,000 ppm, were superior to both control and reducing water. In a separate experiment, maleic hydrazide applied at 1,500, 3,000 and 6,000 ppm gave higher per cent sucrose in the cane than the control.

Data for the series employed in cane subsequent to treatment are given in Table II. All applications at 3,000 and 6,000 ppm. were superior to both control and per cent sucrose in the juice to the control. When compared on the basis of per cent sucrose in cane, all treatments were superior to the control.

Summary and Discussion

It was found that under local conditions the maleic hydrazide treatments were superior to the control. This is in agreement with results obtained by the Division of Sugar Plant Investigations in Louisiana (33, 34). Contrary to results obtained with sugar beets (30, 31) the application of maleic hydrazide to sugarcane prior to harvesting for preventing storage losses due to delayed ripening does not seem to be effective. When ripening was delayed for three days after harvesting, maleic hydrazide

Table 15. Analysis of samples milled 5 and 30 days subsequent to applications.

Treatments	5 Days		30 Days	
	Brix	% Sucrose Juice Cane	Brix	% Sucrose Juice Cane
750 ppm. MH (0.8 lbs. per acre)	20.4	18.9	19.6	19.4
1500 ppm. MH (1.6 lbs. per acre)	20.7	20.0	19.5	19.7
3000 ppm. MH (3.2 lbs. per acre)	21.6	21.1	20.1	20.0
6000 ppm. MH (6.4 lbs. per acre)	21.3	20.6	20.1	19.9
Control - no treatment	20.2	19.3	19.5	19.5

x Calculated on the basis of total reducing value, since initial reducing value was not obtained for 5-Day samples.

for 2-day samples.
 since initial readings were 1.2 and 0.8 respectively
 x calculated on the basis of 100% for 100% active.

Treatment	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Control - no treatment	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(1.0 lbs. per acre)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(2.0 lbs. per acre)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(3.0 lbs. per acre)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(4.0 lbs. per acre)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
(5.0 lbs. per acre)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

NOTE: Analysis of variance with 2 and 30 days adjustment for significance.

treatments in general showed lower Brix and higher per cent reducing value. At nine days no changes in Brix had taken place, but the per cent reducing value of all maleic hydrazide treatments was consistently higher than for the control. Control plots were superior in per cent sucrose to all treatments.

Results obtained from the application of maleic hydrazide to sugarcane prior to harvesting show an increase in Brix and total reducing value for the three higher concentrations of maleic hydrazide five days after application. Analysis of samples collected 30 days after treatment show a general reduction in Brix and per cent sucrose due probably to rather heavy rains recorded during this period, but the aforementioned treatments still exhibit superiority over the control. Samples obtained from sugarcane treated with maleic hydrazide at the rate of 3,000 ppm. gave higher analyses throughout the experiment. However, these differences were not significant. Further work should be undertaken to determine the interaction between concentration and time of application prior to harvest.

treatments in general showed lower brick and higher per cent reducing value. At nine days no changes in brick had taken place, but the per cent reducing value of all maleic hydrazide treatments was consistently higher than for the control. Control plots were superior in per cent sucrose to all treatments.

Results obtained from the application of maleic hydrazide to sugarcane prior to harvesting show an increase in brick and total reducing value for the three higher concentrations of maleic hydrazide five days after application. Analysis of samples collected 30 days after treatment show a general reduction in brick and per cent sucrose due probably to rather heavy rains received during this period, but the aforementioned treatments still exhibit superiority over the control. Samples obtained from sugarcane treated with maleic hydrazide at the rate of 3,000 ppm. gave higher analyses throughout the experiment. However, these differences were not significant. Further work should be undertaken to determine the interaction between concentration and time of application prior to harvest.

RESUMEN

La aplicación de 2,4-D, ácido indolbutírico, y ácido naftalenoacético en pulverización a trozos de semilla en el surco no dió resultados positivos.

No se encontraron diferencias entre el talco, lanolina y solución acuosa como vehículos para la aplicación de sustancias reguladoras del crecimiento al corte superior de trozos de una yema. La aplicación de maleic hydrazide y naftalenoacetamida en la forma indicada aumentó la rapidez de germinación, aunque no significativamente. El ácido indolbutírico mostró un efecto inhibitorio sobre el porcentaje y rapidez de germinación. Cuando los datos fueron agrupados de acuerdo al origen de los trozos en el tallo, los trozos provenientes de la parte terminal del tallo exhibieron mayor porcentaje y rapidez de germinación mientras que aquellos de la parte central y basal mostraron porcentaje y rapidez de germinación reducidos. Con la excepción del maleic hydrazide y del naftalenoacetamida, todos los tratamientos inhibieron el desarrollo de tallos secundarios. El ácido indoleacético redujo el número de tallos secundarios por 80% en comparación al testigo. Este material estimuló la producción de raíces primarias. Cualesquiera que fuese el

RESUMEN

La aplicación de S,4-D, ácido indolacético, y ácido naphthalenoacético en pulverización a trozos de semillas en el surco no dio resultados positivos.

No se encontraron diferencias entre el tallo, base y la solución de semillas como vehículos para la aplicación de sustancias reguladoras del crecimiento. El ácido salicílico y naphthalenoacético en la forma indicada aumentó la raíz de germinación, aunque no significativamente. El ácido indolacético mostró un efecto inhibidor sobre el porcentaje y raíces de germinación.

Cuando los datos fueron agrupados de acuerdo al origen de los trozos en el tallo, los trozos provenientes de la parte terminal del tallo exhibieron mayor porcentaje y raíces de germinación mientras que aquellos de la parte central y basal mostraron porcentaje y raíces de germinación reducidos. Con la excepción del ácido glicoxílico del naphthalenoacético, todos los tratamientos inhibieron el desarrollo de tallos secundarios. El ácido indolacético redujo el número de tallos secundarios por 60% en comparación al control. Este material estimuló la producción de raíces primarias. Cualquiera que fuese el

tratamiento, los trozos provenientes de la parte basal del tallo produjeron la mayor cantidad de raíces primarias, seguidos por aquellos provenientes del centro, con la menor cantidad producida por los trozos provenientes de la parte terminal del tallo.

La aplicación de maleic hydrazide y naftalenoacetamida a la yema de trozos de semilla de una yema aumentó la germinación, aunque las diferencias no fueron significativas. / No se logró determinar la concentración óptima para el maleic hydrazide aplicado en esta forma. La concentración óptima para el naftalenoacetamida parece estar entre las 750 y 2,000 ppm.

Cuando se aplicó 2,4-D, TCA, y maleic hydrazide en concentraciones tipo herbicida y tipo hormona a caña de retoño (soca) de dos meses de edad el número de plantas muertas fué mayor para todos los tratamientos químicos que para el testigo. Sin embargo, no se puede asumir que todas las plantas muertas fueron debidas al efecto de los tratamientos. Datos de crecimiento para los tratamientos en concentraciones tipo herbicida y tipo hormona demuestran que todos los materiales afectaron el crecimiento hasta cierto punto. Los tratamientos en concentraciones tipo herbicida, particularmente el TCA a razón de 30 y de 60 libras por acre, retardaron la floración de la caña, mientras que ninguna de las concentraciones tipo hormona

tratamiento, los trozos provenientes de la parte basal del tallo produjeron la mayor cantidad de raíces adventivas, seguidas por aquellos provenientes del centro, con la menor cantidad producida por los trozos provenientes de la parte terminal del tallo.

La aplicación de maleato hidrático y nitalenacetato a la zona de trozos de semillas de una vena aumentó la germinación, aunque las diferencias no fueron significativas. No se logró determinar la concentración óptima para el maleato hidrático aplicado en esta forma. La concentración óptima para el nitalenacetato parece estar entre las 750 y 2,000 ppm.

Cuando se aplicó 2,4-D, IAA, y maleato hidrático en concentraciones tipo herbicida y tipo hormona a café de tefío (saca) de los meses de edad el número de plantas muertas fue mayor para todos los tratamientos químicos que para el testigo. Sin embargo, no se puede afirmar que todas las plantas muertas fueron debido al efecto de los tratamientos. Datos de crecimiento para los tratamientos

en concentraciones tipo herbicida y tipo hormona demuestran que todos los materiales afectaron el crecimiento hasta cierto punto. Los tratamientos en concentraciones tipo herbicida, particularmente el IAA a razón de 30 y de 60 libras por acre, retardaron la floración de las café, mientras que ninguna de las concentraciones tipo hormona

parecieron tener este efecto.

Se encontró que bajo condiciones locales 20 tallos constituyen una muestra representativa para parcelas de 1/40 de acre cuando son tomadas del mismo surco. La aplicación del maleic hydrazide previo a la cosecha para evitar pérdidas de sacarosa ocasionadas por estacionamiento antes de la molienda no parece ser efectiva. La aplicación de maleic hydrazide^A a la caña de azúcar previa a la cosecha resultó en aumentos en Brix y sacarosa cinco días después de la aplicación, y algunas diferencias eran evidentes a los 30 días después del tratamiento. Aunque estas diferencias no fueron significativas, parece prometedora la aplicación de maleic hydrazide previa a la cosecha para aumentar el contenido de sacarosa.

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Se encontró que bajo condiciones locales de tallos
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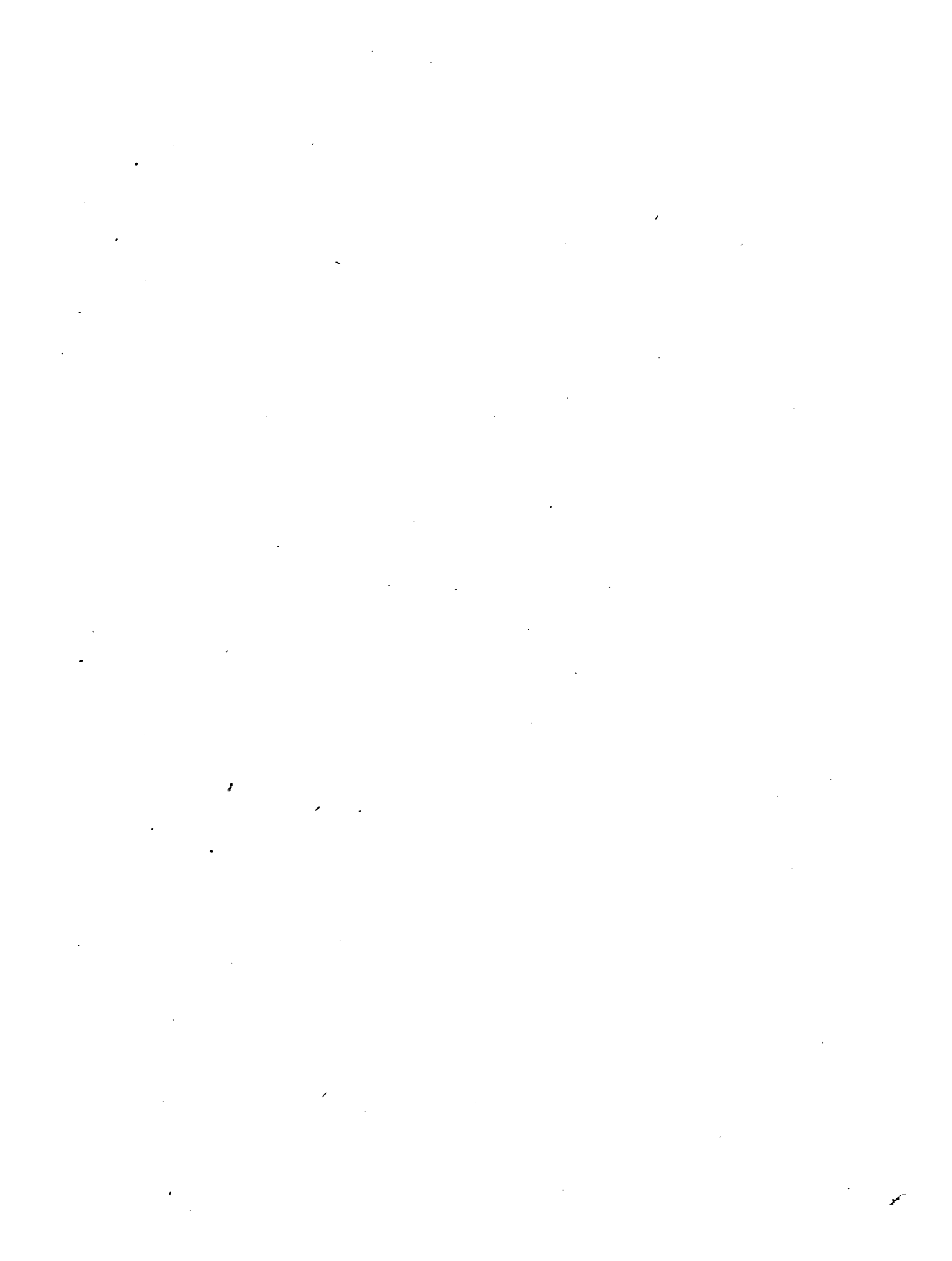
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Esteves, Guillermo
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substances on the germination,
growth and sucrose content of sugar
cane

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