# EFFECT OF GROWTH REGULATORS ON SPROUTING OF BERMUDAGRASS SPRIGS

By

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EFFECT OF GROWTH REGULATORS ON

SPROUTING OF BERMUDAGRASS

SPRIGS

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# CHAPTER I

## INTRODUCTION

Bermudagrass (Cynodon dactylon (L.) Pers.) is commonly used for turf purposes and erosion control. Most varieties used for turf are vegetatively propagated. Because of the risk of winter kill the year following seeding, vegetative parts are commonly planted (Ahring et al. 1975).

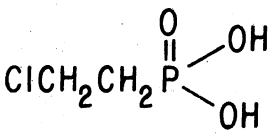
When bermudagrass is vegetatively propagated, it is not uncommon to find no more than one shoot or root per sprig. Commonly, three or four nodes containing buds are present on a sprig and potentially there should be as many as three or four shoots and roots per sprig. If sprouting potential could be realized, it is conceivable that the sprigging rates could be reduced, or a more rapid stand established, or both.

The purpose of this research was to evaluate growth regulators as a means of increasing the number and length of shoots and roots on bermudagrass sprigs. This objective will be achieved through the use of five growth regulators, each at four concentrations, plus water as the control, and exposure of the bermudagrass sprigs to these materials for four periods of time.

# CHAPTER II

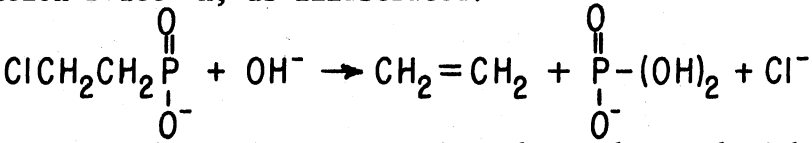
## LITERATURE REVIEW

Ethrel is a tradename for 2-chloroethyl phosphonic acid. The structure of ethrel is:



2-chloroethyl phosphonic acid

Ethrel releases ethylene directly to plant tissues, producing numerous physiological effects for regulating plant development. The mode of action of ethrel appears to be related to its ability to releases ethylene to plant tissues (Yang 1969). The acid undergoes a chemical decomposition which can be best described as a base catalyzed elimination reaction, as illustrated:



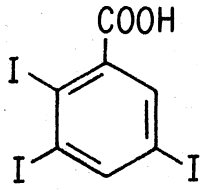
Many physiological responses have been observed with chemical applications of formulations containing ethrel. Ethrel has been shown by Amchem Products Inc. (1969) to remove apical dominance; induce root formation; induce fruit, leaves, and flower abscission; accelerate fruit ripening; and influence auxin transport. Weaver (1972) reports ethrel also promotes loosening and separation of fruit and abscission sites in apples, cherries, citrus, olives, pecans, plums, and walnuts. This has aided in reducing the required fruit removal force of these trees.

Levy and Kedar (1970) found that ethrel induces swelling of leaf bases and initiates bulbing in onion during noninductive day lengths. In field tests Cooke and Randall (1968) sprayed ethrel on smooth Cayene pineapple plants and produced 100 percent flower induction. The control plants remained vegetative. Spraying 'Redskin' peach trees with ethrel at 100 ppm resulted in a larger diameter fruit and hastened fruit ripening (Byers et al. 1969). Ethrel also increased the cartenoid content of the harvested fruits. Higher concentrations caused severe abscission of both fruit and leaves. Hale et al. (1970) reported that an application of ethrel at stage two (slow growth) in the berry development of grapes hastens ripening. Whereas, application of ethrel in stage one (fast growth) of berry development inhibited ripening. The early black variety of cranberry sprayed at the preharvest stage with ethrel, at a concentration of 600 ppm, was found by Eck (1969) to significantly increase anthocyanin pigmentation as compared to untreated plants. Immersing green bananas for one hour in a solution of ethrel at room temperature gave the same results as those obtained from subjecting the fruit to ethylene gas for twenty-four hours according to Russo et al. (1968). Both ethylene and ethrel ripened the bananas. They also conducted research using tomatoes and found that ethrel hastens the ripening of tomato.

There has been limited research reported using ethrel to stimulate growth of turfgrasses. In an unpublished report, Ahring (1974) found that ethrel stimulated growth of 'Oklawn' centipedegrass (Eremochloa ophiuroides (Munro) Hack.)

## TIBA

2,3,5-Triiodobenzoic (TIBA) is one of the synthetic growth regulators that has been used in soybean production (Anderson et al. 1965). TIBA is considered as an auxin synergist; that is, it may enhance or inhibit auxin, depending on the concentration, but does not have a hormone effect of its own. The structure of TIBA as reported by Greer (1969) is:

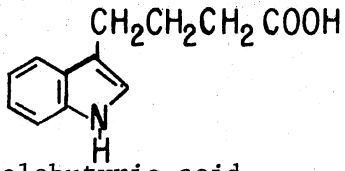



2,3,5-triiodobenzoic acid

Most of the work using TIBA in agriculture has been concerned mainly in the area of soybean production. It was reported by Galston (1947), that TIBA caused reduced auxin transport in soybean plants. The use of TIBA in greenhouse experiments by Greer (1964), was found to have stimulated pod formation tenfold in soybeans, but very few seeds were formed. In further research, working with soybeans, Anderson et al. (1965) reported that TIBA applied as a spray to soybeans inhibited apical dominance; increased branching; enhanced flower formation; modified leaf structure (interveinal puckering), leaf color (deeper green), and leaf orientation (more upright); caused an overall change in leaf canopy shape; increased the percentage of dry matter going into the seed and pod; and reduced lodging. The lodging reduction was the result of reduced plant height. No literature concerning the use of TIBA on turfgrasses to promote growth has been reviewed.

IBA

3-indolebutyric acid (IBA) is one of the best and most commonly used synthetic auxin for stimulating root growth according to Weaver (1972). IBA has weak auxin activity and is destroyed relatively slowly by auxin-destroying enzyme systems, Weaver (1972) reported. This type of chemical, that is persistent, is very effective as a root promoter. The structure of IBA as given by Salisbury and Ross (1969) is:




3-Indolebutyric acid

Because IBA translocates poorly, it is retained near the site of application (Weaver 1972).

Most of the research reported using IBA has been concerned with root stimulation of horticultural plants. Limited research has been reported using IBA for shoot and root development in grasses. Hoveland (1963) reported using IBA to stimulate shoot development and rooting of several bermudagrasses. He concluded that shoot and root development of 'Coastal' bermudagrass (Cynodon dactylon (L.) Pers.) rhizomes was superior to that of 'Suwanee' (Cynodon dactylon (L.) Pers.). IBA improved shoot development and rooting of Suwanee, increased rooting of Coastal, but had no effect on shoot development of Coastal or 'Midland' bermudagrass (Cynodon dactylon (L.) Pers.).

IBA has aided in the transplanting of pecan trees as reported by Romberg and Smith (1938). They demonstrated that when toothpicks containing four milligrams of IBA were inserted into the roots of five-to-seven-year-old pecan trees, there was an increase in root development compared with that of the controls. They also reported

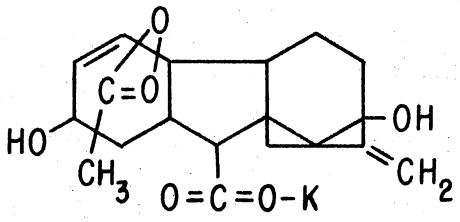
that ten-year-old nursery pecan trees could be transplanted successfully when the roots were first treated with IBA-impregnated toothpicks. IBA has been shown to increase root production in pears according to Looney and McIntosh (1968), when they treated roots of one-year-old 'Bartlett' pear trees that had been grafted to Bartlett seedling roots with IBA before planting. They found that the treatment stimulated the production of new roots. McGuire et al. (1968) reported that foliar or terminal applications of one percent IBA on fourteen species of woody ornamental plants stimulated root initiation. IBA has also been reported by Verner (1939) to affect the crotch angles in young apple trees. He applied IBA in a lanolin paste in a variety of ways to the young developing side branches of young apple trees. The most effective method found was to be to cut the tree back to about two and one-half feet and apply the auxin paste to the cut apex. This was found to induce the developing lateral branches to grow at a much wider angle to the main stem (average of $65^{o}$) as compared with untreated trees (average of $48^{o}$).

IBA applications to fig fruits has resulted in seedless fruits according to Crane (1949).

## Gibberellic Acid

Gibberellic acid ($GA_3$) is one of the gibberellins, a group of plant growth regulators discovered by the Japanese. Kurosawa (1926), a Japanese plant pathologist, is given credit for the discovery of gibberellins. Gibberellic acid is derived from cultured filtrates of the fungus Gibberella fujikuroi according to Mitchell (1970). In 1935, Yabuta obtained an active preparation and named it gibberellin after

the fungus from which it was isolated. The Japanese scientists studied the gibberellins intensively in the 1930's but Western workers did not become actively engaged in gibberellic acid research until the 1950's. The following decade saw a flurry of research activity on these growth regulators, and gibberellins were shown to be widely distributed in higher plants. The structure of gibberellic acid according to Salisbury and Ross (1969) is:




Potassium salt of gibberellic acid ($GA_3$)

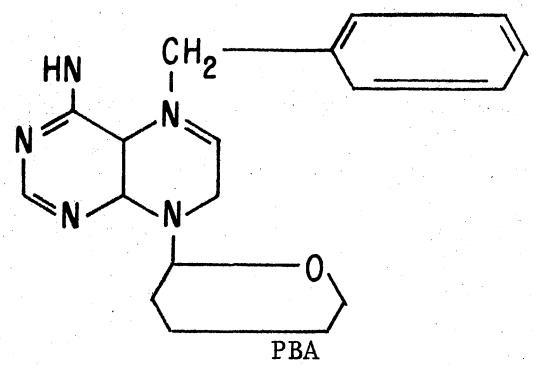
The most pronounced effect of gibberellic acid is on stem internode elongation, Mitchell (1970) reported. Further studies have shown that gibberellic acid may cause a deminution of leaf area; stimulate flowering in long-day plants; prevent the formation of root initials, but not inhibit root elongation; break seed and bud dormancy; and interact with IBA in apical dominance. Gibberellic acid has been used quite extensively in researching the growth and production of turfgrasses. Juska (1959) reported that repeated applications of gibberellic acid reduced the quantity of roots produced by 'Kentucky' bluegrass (Poa pratensis L.). Further research by Leben and Barton (1957) and Leben et al. (1959) working with Kentucky bluegrass found gibberellic acid stimulated initial growth, however, regrowth after clipping was chlorotic and spindly. A reduction in ground cover was the result of previous fall or summer application of gibberellic acid.

Juska (1958) reported that bermudagrass and Kentucky bluegrass were most responsive to gibberellic acid treatments in terms of shoot stimulation as compared to several other species of turfgrasses. A dwarf variant of bermudagrass, called 'No Mow', responded to gibberellic acid treatments according to Kriedeman (1963). The gibberellic acid treatments increased internode length which increased the rate of ground cover by the dwarf variant. Gibberellic acid applied as a foliar spray on Zoysia japonica Steud, during late spring and summer, was reported by McVey and Wittwer (1959) to have responded to these treatments. However, Youngner (1958) and 1959) reported that treating Zoysia Willd., planting material with gibberellic acid did not improve the rate of establishment. Whereas, treatments with gibberellic acid on established plots of Zoysia, while being weak in growth, were somewhat superior to the untreated plots in color throughout the winter.

These studies show that the value of gibberellic acid treatments to improve winter growth and color of subtropical turfgrasses is extremely doubtful. Even if satisfactory color can be produced by these applications, it may be undesirable because of the pronounced weakening of the turfgrasses.

## SD 8339

SD 8339 is Shell Development Company's name for PBA-6-benzylamino-9 (tetrahydropyran-2-yl)-9H-purine (PBA). PBA according to Moon (1974), is a synthetic cytokinin with the following structure:




PBA

Cytokinins were first discovered by Skoog and Tsui (1948) as a direct outcome of tissue culture studies using tobacco stem segments. Cytokinins have been shown to affect plant growth by increasing mitosis and cell division, breaking dormancy, stimulating cell enlargement, retarding apical dominance, and delaying senescence Moon (1974) reported.

Interaction between cytokinins, auxins, and gibberellins regulate cell division, cell enlargement, and cell differentiation, according to Moon (1974). Apical dominance is thought to depend upon an antagonism between the inhibiting influence of auxin and the promoting influence of the cytokinins. When the growing apex of a shoot is intact, the auxin inhibits lateral shoots because there is more auxin present than cytokinin. Sachs and Thimann (1967) reported when synthetic cytokinins are applied or the apex removed, the cytokinins become greater than the auxins and lateral branching occurs.

In a report by Weaver et al. (1966), they reported that an application of PBA was effective in increasing fruit set in open-pollinated clusters of two seedless varieties and three seeded varieties of grape (Vitis vinifera L.). PBA has been shown by Crane (1965) to induce parthenocarpy in fruits. He treated 'Calimyrna' figs with PBA at a concentration of 500 ppm and obtained parthenocarpic figs similar to

those obtained by application of an auxin or a gibberellin. PBA has also been reported by Negi and Olmo (1966) to change the sex expression in grapes. They found that the synthetic cytokinin, PBA, changed the sex of a cluster from male to hermaphrodite. The ability to convert a male vine to a hermaphroditic one should be of great value in plant breeding because it means that the male vine can be utilized as a female parent. No literature has been reviewed on the use of PBA to stimulate root and/or shoot development of turfgrasses.

# CHAPTER III

## METHODS AND MATERIALS

Sprigs of common bermudagrass were harvested using a sprig-harvesting machine in August 1974, at the Oklahoma State University Agronomy Research Station, Stillwater, Oklahoma. The sprigs were washed free of soil and roots were removed with scissors. Sprigs were then cut into sections and examined carefully to insure that each sprig (section) had exactly four nodes with one or more buds per node. The sprigs were stored in a refrigerator set for $5^{o}$ C prior to treatment. The time lapse between digging and treating the sprigs with the growth regulators was approximately 24 hours. The sprigs were then treated with one of the six growth regulators, at each of four different concentrations, with the exception of water, as shown in Table 1. Soaking times varied as to growth regulators used. Quantities of each growth regulator were individually measured for the desired ppm concentration. For example, the active ingredient for ethrel is 21.3 percent. To calculate a concentration of 400 ppm in one liter of water, the following procedure was used:

Given: Ethrel 21.3% active ingredient

0.1 cc of active ingredient per liter = 1000 ppm

Needed: 400 ppm concentration of ethrel

Procedure: $\frac{400 \text{ ppm X } 0.1 \text{ cc}}{21.3} = \frac{40}{21.3} = 1.88 \text{ cc}$

1.88 cc of ethrel brought to one liter volume =

400 ppm ethrel

After soaking the sprigs for a specified length of time in the desired concentration of growth regulator, the sprigs were labeled as to treatment and placed in germination boxes filled with moist vermiculite. The sprigs were then placed in a Stults germinator set for alternating light at 30° C for eight hours, and 20° C for sixteen hours of darkness per day. Counts were made on each treated sprig for shoot and root numbers and their lengths after a fourteen day incubation period. Each treatment consisted of eight replications, with one sprig per replication. The experimental design was a randomized block with a factorial arrangement of 84 treatment combinations.

Four individuals assisted in the counting and measuring of shoots and roots. Each individual collected data from two replications. This was necessary to complete the process of data collection in a reasonable length of time.

The research procedure of preparation of growth regulators and data collection was utilized in order to have a measure of experimental error that would better relate to a field situation.

TABLE I

GROWTH REGULATORS, CONCENTRATIONS, AND SOAKING TIMES OF BERMUDAGRASS SPRIGS USED IN THIS EXPERIMENT

| | Chemical | Concentration (ppm) | | | | Soaking Time (minutes) (1)* | (2)* | (3)* | (4)* |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Ethrel | 50 | 100 | 200 | 400 | 60 | 120 | 240 | 360 |
| 2. | Shell SD8339 | 50 | 100 | 200 | 400 | 60 | 120 | 240 | 360 |
| 3. | IBA | 100 | 200 | 400 | 800 | 5 | 10 | 20 | 40 |
| 4. | TIBA | 5 | 10 | 20 | 40 | 5 | 10 | 20 | 40 |
| 5. | $GA_3$ | 37.5 | 75 | 150 | 300 | 5 | 10 | 20 | 40 |
| 6. | Water | - | - | - | - | 60 | 120 | 240 | 360 |

*These numbers refer to the soaking times shown in Figures 1, 2, 3, and 4.

# CHAPTER IV

## RESULTS AND DISCUSSION

A Duncan's Multiple Range Test was used to compare the treatment means of each of the four variables investigated as shown in Appendix Tables II, III, IV, and V. These variables were root and shoot length and number as affected by soaking times and concentrations of growth regulators. These data indicated significant differences existed among and within the growth regulators as shown in Appendix Tables VI, VII, VIII, IX, X, and XI. Water, the control, was equally effective in promoting root and shoot development and subsequent elongation as the best growth regulator treatments used in this experiment. The effects on bermudagrass sprigs of these growth regulators at various concentrations and different soaking periods as measured by shoot and root numbers, and length, are graphically illustrated in Figures 1, 2, 3, and 4. For convenience and clarity of presentation, the effects of each growth regulator on bermudagrass sprigs as determined by shoot and root numbers and length, are discussed individually in alphabetical order.

### Effect of Ethrel on Shoot Number

There were no significant differences in shoot numbers among replications, rates, and rate X time interaction when the sprigs were soaked in different concentrations of ethrel. The large error term

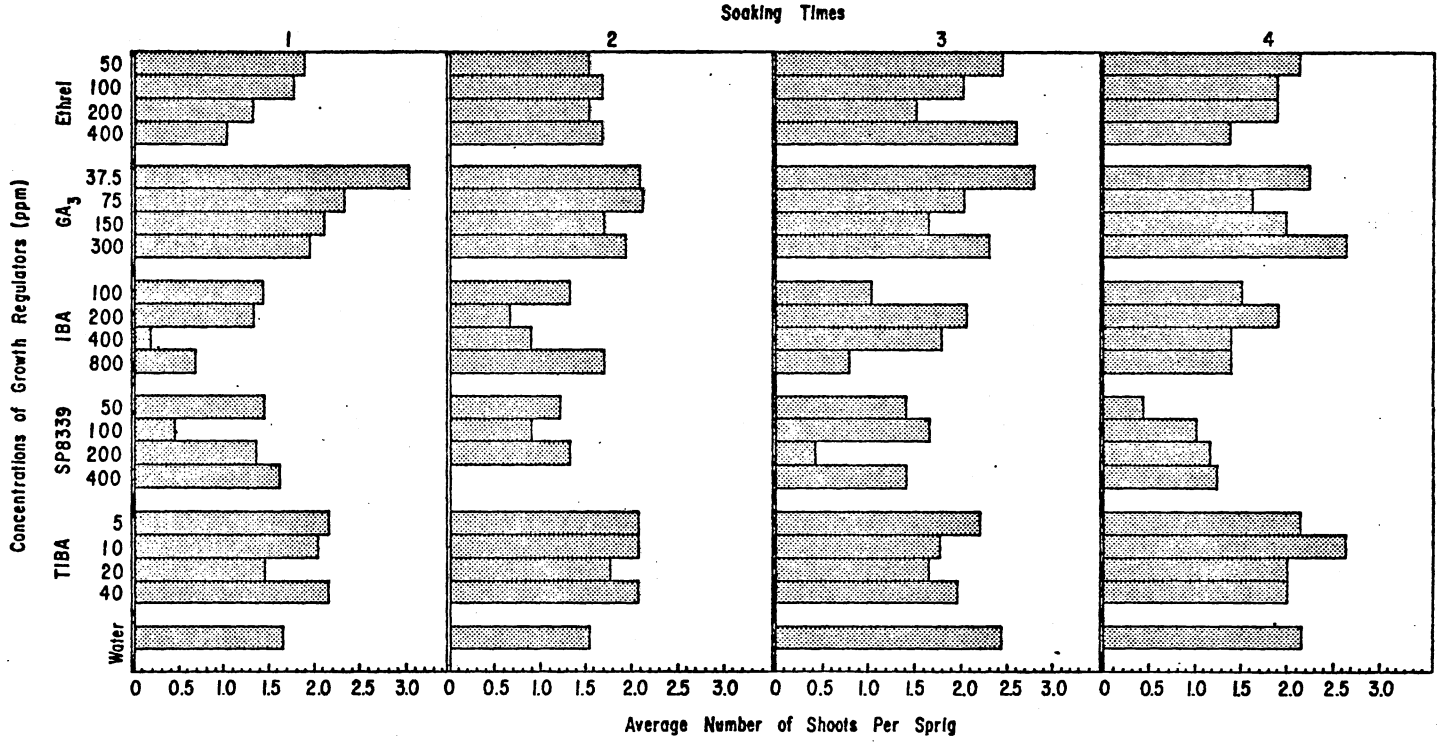



Figure 1. Effect of Growth Regulators at Various Concentrations on Shoot Numbers of Bermudagrass Sprigs Soaked for Different Periods of Time

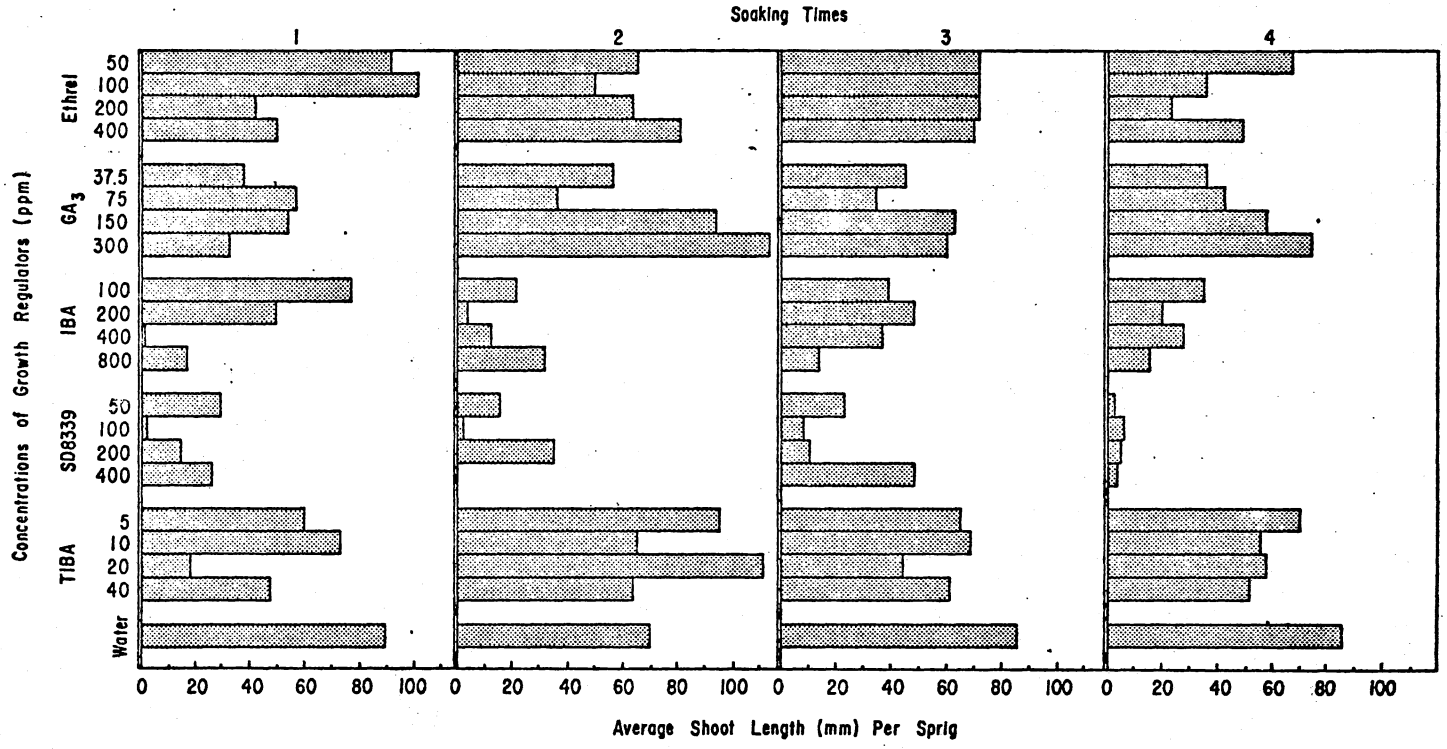



Figure 2. Effect of Growth Regulators at Various Concentrations on Shoot Elongation of Bermudagrass Sprigs Soaked for Different Periods of Time

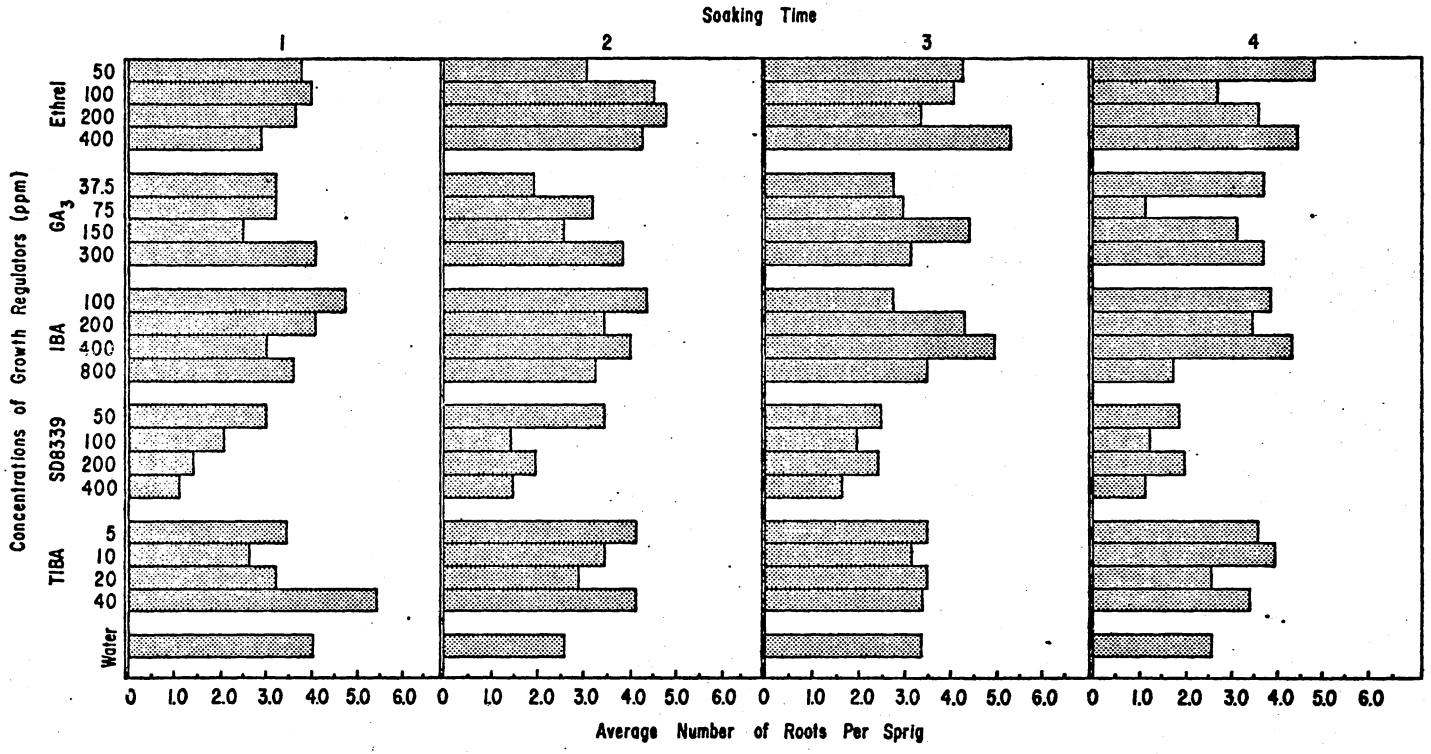



Figure 3. Effect of Growth Regulators at Various Concentrations on Root Numbers of Bermudagrass Sprigs Soaked for Different Periods of Time.

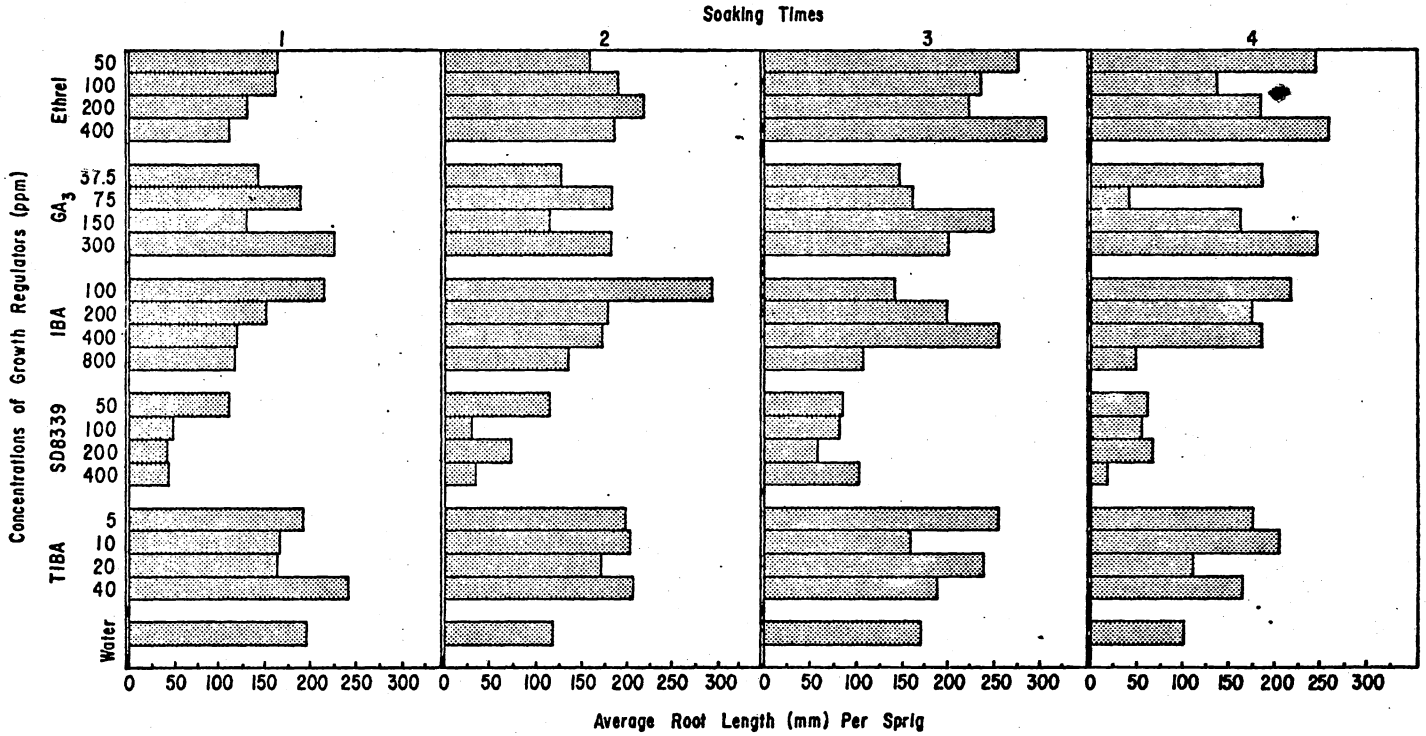



Figure 4. Effect of Growth Regulators at Various Concentrations on Root Elongation of Bermudagrass Sprigs Soaked for Different Periods of Time

perhaps masked any significant treatment differences in shoot numbers. A significant difference in shoot numbers among the different soaking times is shown in Figure 5. When the sprigs were soaked for 360 minutes, there was a decrease in the number of shoots. To attain maximum shoot numbers, it would appear an optimum soaking time for all concentrations of ethrel is in the vicinity of 240 minutes.

## Ethrel Effects on Shoot Length

There were no significant differences in shoot length among replications, rates, and rate X time interaction when sprigs were soaked in different cincentrations of ethrel. The inability to detect significant differences in shoot length can in part be attributed to the large experimental error that may have masked these differences. However, differences in shoot length as a result of soaking times were significant as shown in Figure 6. With the exception of the soaking sprigs for 240 minutes, there was a decrease in shoot length as the soaking time increased. Ethrel seems to have an inhibitory effect on shoot length when the sprigs are soaked in an ethrel solution longer than 240 minutes.

## Ethrel Effects on Root Numbers

Significant differences in numbers of roots were not evident among replications, rates, and soaking times when sprigs were soaked in different concentrations of ethrel. The inability to detect significant differences in root numbers is attributed in part to experimental error. The rate X time interaction was highly significant. The reason for this interaction is unknown.

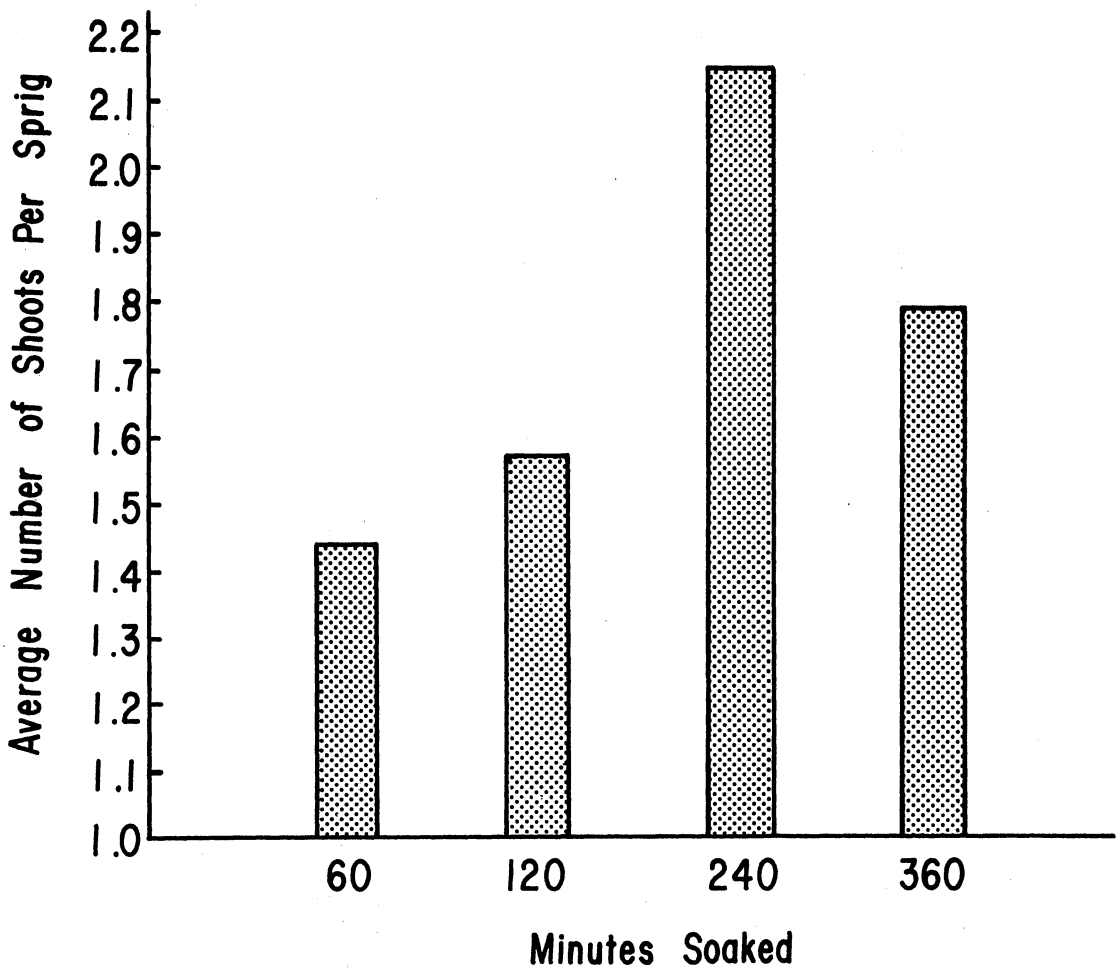



Figure 5. The Effect of All Concentrations of Ethrel on Bermudagrass Sprigs Soaked for Various Periods of Time as Determined by the Average Number of Shoots

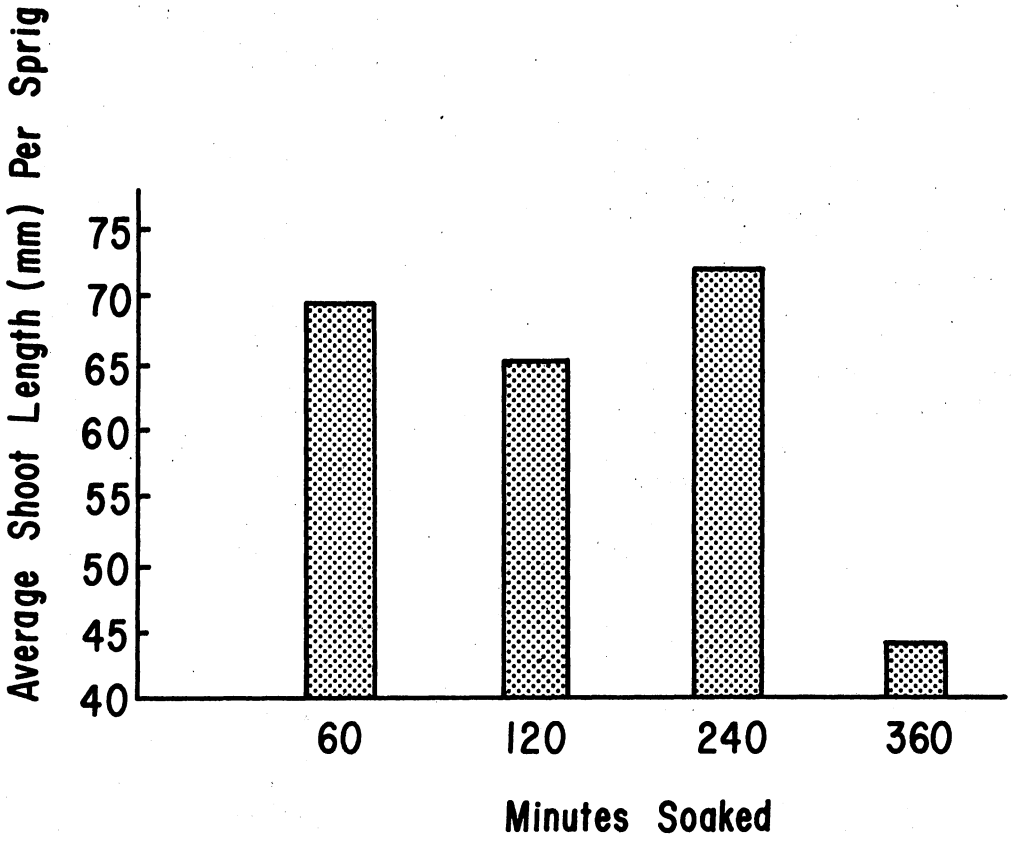



Figure 6. The Effect on Shoot Elongation of Bermudagrass Sprigs Soaked for Various Periods of Time in All Concentrations of Ethrel

## Ethrel Effects on Root Length

Differences were not significant for root length among replications, rates, and rate X time interaction when sprigs were soaked in varying concentrations of ethrel. The large error term was a factor and perhaps masked any significant differences in root length. A significant difference in root length was obtained among the different soaking times as shown in Figure 7. As the soaking time was increased to 240 minutes, there was a resulting increase in the root length. However, when the sprigs were soaked for 360 minutes there was a decrease in root length. It appears that for maximum root length, as well as shoot numbers, the optimum soaking time, regardless of ethrel concentrations used, is in the vicinity of 240 minutes.

## $GA_3$ Effects on Number of Shoots and Roots and Root Length

No significant differences in the number of shoot and roots or root length, were found among replications, rates, soaking times, and rate X time interaction when the bermudagrass sprigs were soaked in the different concentrations of $GA_3$. Evidently $GA_3$ has no apparent influence or role in promoting sprig germination.

## $GA_3$ Effects on Shoot Length

Significant differences were not evident for shoot length among replications, soaking times, and rate X time interaction when bermudagrass sprigs were soaked in various concentrations of $GA_3$. However, there were highly significant differences in shoot length as effected by rates of $GA_3$ used, as shown in Figure 8. As the concentration of

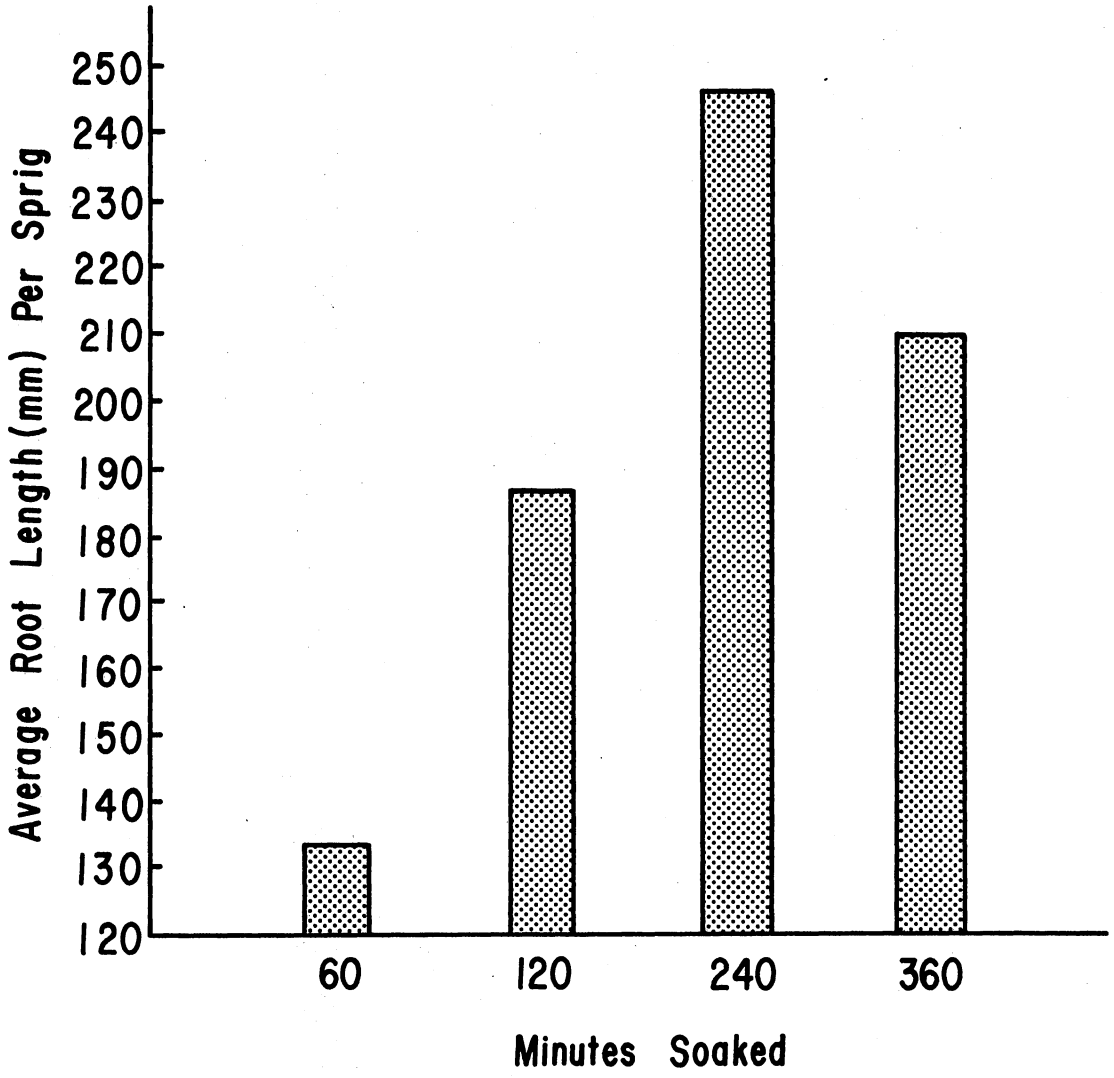



Figure 7. The Effect on Root Elongation of Bermudagrass Sprigs Soaked for Various Periods of Time in All Concentrations of Ethrel

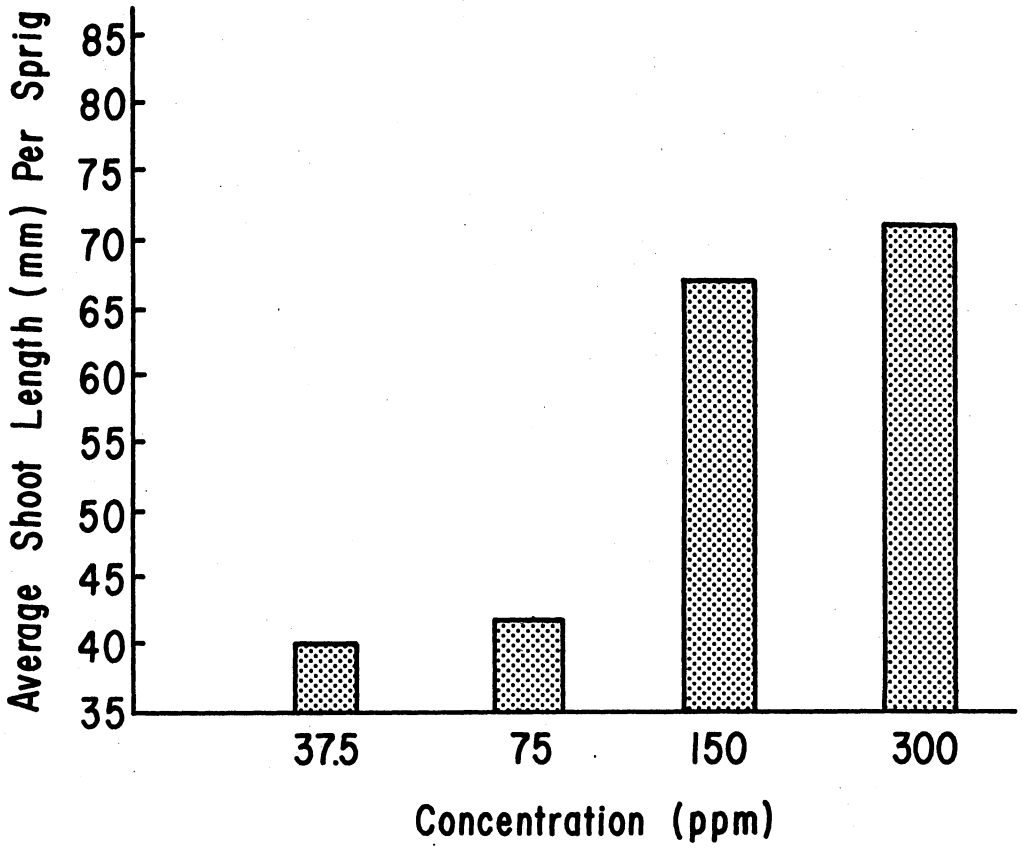



Figure 8. The Effect of Different Concentrations of Gibberellic Acid on Shoot Elongation of Bermudagrass Sprigs Soaked for All Periods of Times

$GA_3$ increased, there was a resulting increase in shoot length. It would appear that for maximum shoot length, an optimum concentration for soaking sprigs in $GA_3$ is in the vicinity of 300 ppm. The response to $GA_3$ appeared curvilinear, and possibly higher concentrations may have given even greater responses.

## IBA Effects on Shoot Numbers

Significant differences in numbers of shoots were not found among replications, rates, soaking times, and rate X time interaction when sprigs were soaked in different concentrations of IBA. The inability to detect significant differences in the number of shoots can possibly be attributed to the large error term that masked these differences.

## IBA Effects on Shoot Length

Significant differences in shoot length were not significant among replications, rates, and soaking times when IBA was used on the sprigs. However, a significant rate X time interaction was found in the length of shoots. The reason for this interaction is unknown.

## IBA Effects on Root Numbers

Significant differences in numbers of roots were observed among replications, rates, and rate X time interaction when the sprigs were treated with IBA. Soaking time in different concentrations of IBA seemed to have no significant effects on the number of roots on bermudagrass sprigs. However, significant differences were evident for concentrations as shown in Figure 9. As the concentration of IBA increased, regardless of soaking duration, the number of roots

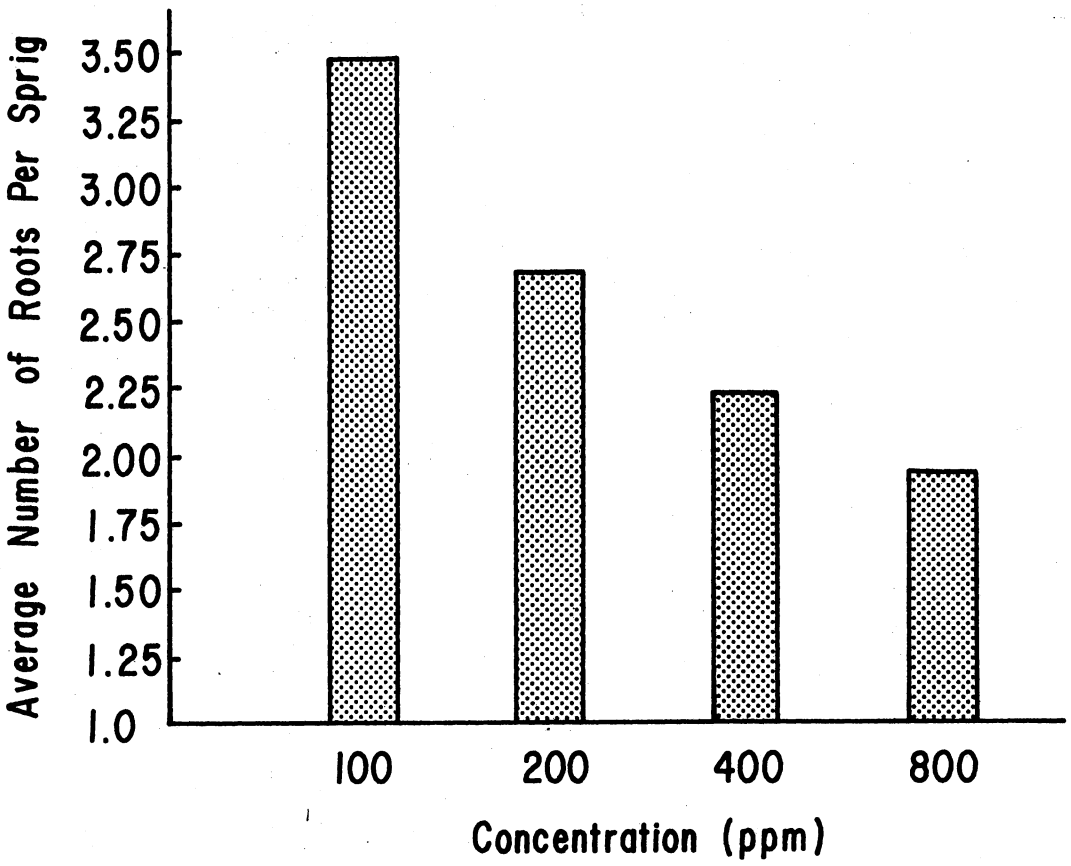



Figure 9. The Effect of Different Concentrations of IBA on Bermudagrass Sprigs Soaked for all Periods of Time As Determined By the Average Number of Roots

significantly decreased. It would appear that for maximum number of roots, an optimum concentration for all soaking times of IBA is in the vicinity of 100 ppm or less. Reasons for the significant differences in the replications and rate X time interaction are unknown.

## IBA Effects on Root Length

Significant differences for root length were not evident among replications, soaking times, and rate X time interaction when bermudagrass sprigs were soaked in different concentrations of IBA. However, highly significant differences were found for root length as affected by rates used as shown in Figure 10. As the concentration of IBA increased, a significant decrease in root length occurred. It would appear that in order to obtain maximum root length, an optimum concentration for all soaking times of IBA is in the vicinity of 100 ppm or less.

## SD8339 Effects on Shoot Number and Shoot and Root Lengths

No significant differences in shoot number, nor shoot and root lengths could be detected among replications, rates, soaking times, and rate X time interaction when sprigs were soaked in different concentrations of SD8339.

## SD8339 Effects on Root Numbers

Significant differences in number of roots were not found among replications, soaking times, and rate X time interaction when sprigs were soaked in different concentrations of SD8339. However, there was

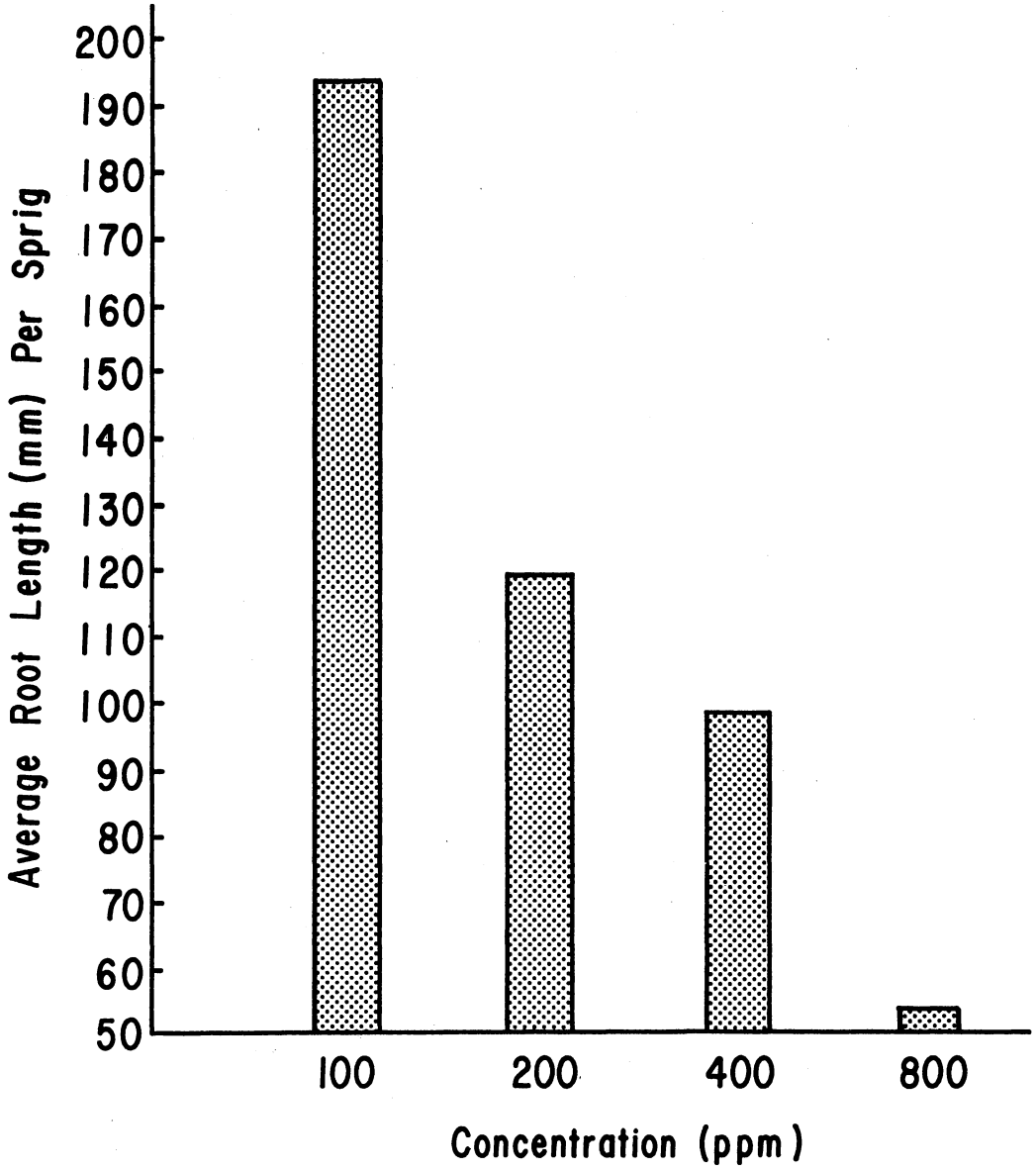



Figure 10. The Effect of Different Concentrations of IBA on Bermudagrass Sprigs Soaked for A11 Periods of Time as Determined by the Average Number of Roots

a significant difference in the number of roots as affected by concentrations of SD8339 as shown in Figure 11. As the concentration increased, there was a resulting decrease in the number of roots, with the exception at 200 ppm where there was a slight increase in the number of roots. The reason for this increase is unknown.

## TIBA Effects on Shoot Number and Length

Significant differences in shoot numbers or length were not found among replications, rates, soaking times, and rate X time interaction when the sprigs were soaked in different concentrations of TIBA. The inability to detect significant differences in shoot numbers and length can possibly be attributed to the large error term that masked this response.

## TIBA Effects on Root Numbers and Length

Significant differences in root numbers or length could not be found among replications, soaking times, and rate X time interaction or rates on root length when sprigs were soaked in different concentrations of TIBA. However, rates of TIBA were significant for root numbers when the bermudagrass sprigs were soaked in TIBA, as shown in Figure 12. Root numbers decreased as the concentration increased, with the exception being at 40 ppm where there was an increase. The reason for this increase is unknown.

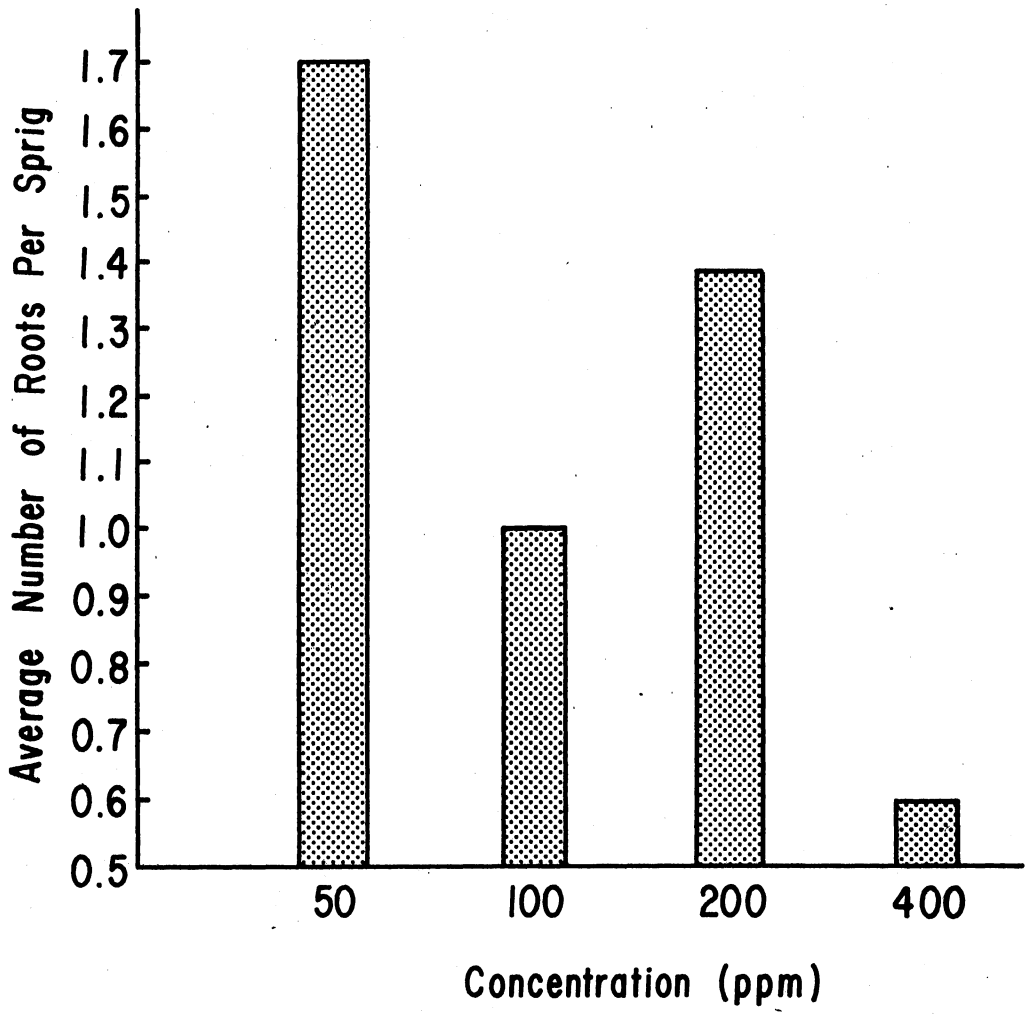



Figure 11. The Effect of Different Concentrations of SD8339 on Bermudagrass Sprigs Soaked for All Periods of Time as Determined by the Average Number of Roots

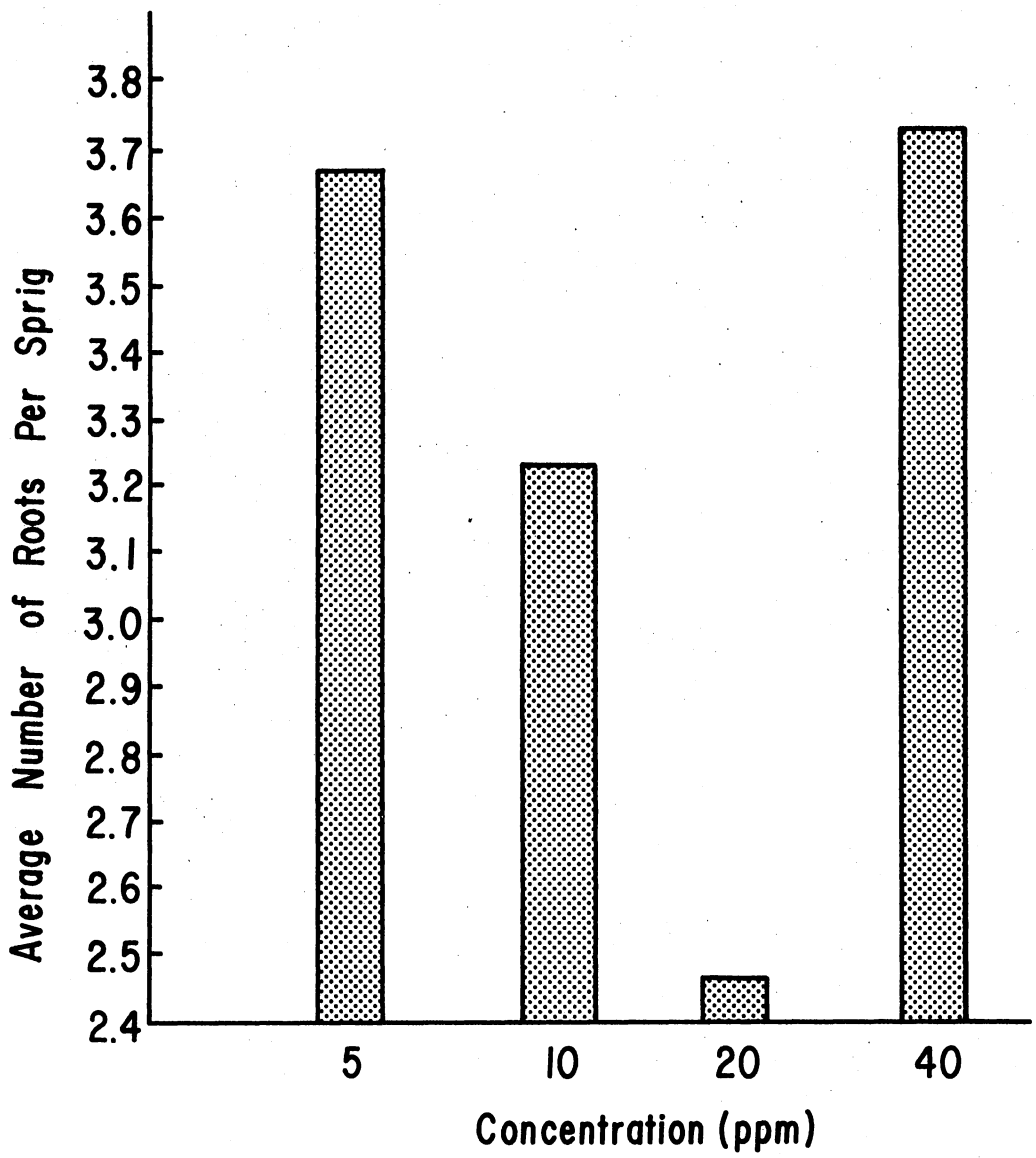



Figure 12. The Effect of Different Concentrations of TIBA on Bermudagrass Sprigs Soaked for All Periods of Time as Determined by the Average Number of Roots

## Water Effects on Shoot and Root Numbers and Shoot and Root Lengths

Significant differences at the 5% level of confidence could not be detected in shoot and root numbers, nor shoot and root lengths, as a result of different soaking times. The inability to detect significant differences in shoot and root numbers and shoot and root lengths may have been because of a large experimental error which would tend to mask these differences. Although not statistically different, the average number of shoots per sprig increased with an increase in soaking time up to 240 minutes. Soaking beyond 240 minutes decreased the average number of shoots per sprig.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

The Duncan's multiple range test of the 84 treatment means revealed that water, the control in the experiment, was equally as effective in promoting shoot and root development as the best treatments from the five growth regulators used in this investigation.

The length of time bermudagrass sprigs were soaked in all concentrations of ethrel resulted in significant differences in shoot number, shoot length, and root length. It appears that for maximum number of shoots, an optimum soaking time for any of the concentrations of ethrel used in this study is in the vicinity of 240 minutes. Beyond a soaking period of 240 minutes resulted in a decrease in shoot length. Ethrel seems to have an inhibitory effect on shoot length when sprigs are soaked longer than 240 minutes. Ethrel seemed to have no significant effect on the number of roots, however, there was a significant effect on root length. It appears that for maximum root length, an optimum soaking time for any of the concentrations of ethrel used in this study is in the vicinity of 240 minutes.

Gibberellic acid ($GA_3$) had a significant effect on shoot length of bermudagrass sprigs. As the concentration of $GA_3$ increased, there was a corresponding increase in shoot length with an optimum concentration being in the vicinity of 300 ppm. $GA_3$ had no significant effects on shoot or root number or root length.

The concentrations (rates) of IBA had a significant effect on root numbers and length. As the concentration of IBA increased, there was a corresponding decrease in root numbers and length with an optimum concentration being in the vicinity of 100 ppm or less. IBA had no significant effects on shoot numbers or length.

SD8339 had only one significant effect on bermudagrass sprigs and that being a decrease in the number of roots as the concentration increased with the exception at 200 ppm where there was a slight increase in the number of roots. The reason for this increase is unknown. SD8339 as a growth regulator had no significant effects on shoot numbers or length or root length.

TIBA had a significant effect on the number of roots. As the concentration increased, the number of roots decreased. However, at 40 ppm, there was an increase in root number for some unknown reason. TIBA had no significant effects on shoot number, shoot length, or root length.

Sprigs soaked in water for 240 minutes seemed to have a higher average number of shoots per sprig than those soaked for a lesser or a longer period of time.

Although not statistically different, when all plant responses were placed on a comparable basis, the TIBA treatments occurred more frequently in all variable measurements than other materials investigated. The least responsive, as indicated by frequency of occurrence in all response measurements, was SD8339. Ethrel and water were tied for second in frequency of occurrence followed by $GA_3$ and IBA in that order. $GA_3$ and TIBA were essentially equal in having the highest frequency of occurrence of treatments affecting shoot number. SD8339

had the lowest frequency of occurrence of treatments affecting shoot number. Water had the highest frequency of occurrence of treatments affecting shoot length. Ethrel and TIBA were tied for second in frequency of occurrence. SD8339 had the lowest frequency of occurrence of treatments affecting shoot lengths. Ethrel, IBA, and TIBA were essentially equal in having the highest frequency of occurrence of the treatments affecting root number followed by $GA_3$, and water.

SD8339 had the lowest frequency of occurrence of treatments affecting root number. Ethrel, $GA_3$, IBA, TIBA, and water were essentially equal in having the highest frequency of occurrence of treatments affecting root length.

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# APPENDIX

# TABLE II

## THE EFFECT OF VARIOUS GROWTH REGULATORS ON BERMUDAGRASS SPRIGS AS DETERMINED BY MEAN SHOOT NUMBERS AS ANALYZED BY DUNCAN'S NEW MULTIPLE RANGE TEST

| Chemical | Rate (ppm) | Time (minutes) | Means* |
|---|---|---|---|
| $GA_3$ | 37.5 | 5 | 3.00 a |
| $GA_3$ | 37.5 | 20 | 2.75 ab |
| TIBA | 10 | 40 | 2.63 abc |
| $GA_3$ | 300 | 40 | 2.63 abc |
| Ethrel | 400 | 240 | 2.57 a-d** |
| Ethrel | 50 | 240 | 2.43 a-e |
| Water | - | 240 | 2.38 a-e |
| $GA_3$ | 300 | 20 | 2.25 a-f |
| $GA_3$ | 75 | 5 | 2.25 a-f |
| $GA_3$ | 37.5 | 40 | 2.24 a-g |
| $GA_3$ | 75 | 10 | 2.14 a-g |
| $GA_3$ | 37.5 | 10 | 2.13 a-g |
| TIBA | 5 | 20 | 2.13 a-g |
| TIBA | 5 | 40 | 2.13 a-g |
| Ethrel | 50 | 360 | 2.13 a-g |
| TIBA | 40 | 5 | 2.13 a-g |
| $GA_3$ | 150 | 5 | 2.13 a-g |
| Water | - | 360 | 2.13 a-g |
| TIBA | 5 | 5 | 2.13 a-g |
| TIBA | 10 | 10 | 2.00 a-h |
| TIBA | 5 | 10 | 2.00 a-h |
| TIBA | 20 | 40 | 2.00 a-h |
| Ethrel | 100 | 240 | 2.00 a-h |
| TIBA | 40 | 10 | 2.00 a-h |
| $GA_3$ | 75 | 20 | 2.00 a-h |
| TIBA | 40 | 40 | 2.00 a-h |
| $GA_3$ | 150 | 40 | 2.00 a-h |
| IBA | 200 | 20 | 2.00 a-h |
| TIBA | 10 | 5 | 2.00 a-h |
| Ethrel | 100 | 360 | 1.88 a-h |
| TIBA | 40 | 20 | 1.88 a-h |
| IBA | 200 | 40 | 1.88 a-h |
| $GA_3$ | 300 | 5 | 1.88 a-h |
| $GA_3$ | 300 | 10 | 1.88 a-h |
| Ethrel | 200 | 360 | 1.88 a-h |
| Ethrel | 50 | 60 | 1.88 a-h |
| IBA | 400 | 20 | 1.75 a-i |
| TIBA | 10 | 20 | 1.75 a-i |
| TIBA | 20 | 10 | 1.71 a-i |
| Ethrel | 100 | 60 | 1.71 a-i |
| $GA_3$ | 75 | 40 | 1.63 a-i |
| Ethrel | 400 | 120 | 1.63 a-i |
| $GA_3$ | 150 | 10 | 1.63 a-i |
| $GA_3$ | 150 | 20 | 1.63 a-i |
| Ethrel | 100 | 120 | 1.63 a-i |
| Water | - | 60 | 1.63 a-i |
| IBA | 800 | 10 | 1.63 a-i |
| TIBA | 20 | 20 | 1.63 a-i |
| SD8339 | 100 | 240 | 1.63 a-i |
| SD8339 | 400 | 60 | 1.57 a-j |
| Ethrel | 200 | 240 | 1.50 b-j |
| Water | - | 120 | 1.50 b-j |
| IBA | 100 | 40 | 1.50 b-j |
| Ethrel | 50 | 120 | 1.50 b-j |
| Ethrel | 200 | 120 | 1.50 b-j |
| SD8339 | 400 | 240 | 1.38 b-k |
| SD8339 | 50 | 240 | 1.38 b-k |
| IBA | 400 | 40 | 1.38 b-k |
| IBA | 100 | 5 | 1.38 b-k |
| IBA | 800 | 40 | 1.38 b-k |
| Ethrel | 400 | 360 | 1.38 b-k |
| SD8339 | 50 | 60 | 1.38 b-k |
| TIBA | 20 | 5 | 1.38 b-k |
| SD8339 | 200 | 60 | 1.25 c-k |
| IBA | 200 | 5 | 1.25 c-k |
| SD8339 | 400 | 360 | 1.25 c-k |
| SD8339 | 200 | 120 | 1.25 c-k |
| Ethrel | 200 | 60 | 1.25 c-k |
| IBA | 100 | 10 | 1.25 c-k |
| SD8339 | 200 | 360 | 1.14 c-k |
| SD8339 | 50 | 120 | 1.13 d-k |
| SD8339 | 100 | 360 | 1.00 e-k |
| Ethrel | 400 | 60 | 1.00 e-k |
| IBA | 100 | 20 | 1.00 e-k |
| SD8339 | 100 | 120 | 0.88 f-k |
| IBA | 400 | 10 | 0.88 f-k |
| IBA | 800 | 20 | 0.75 g-k |
| IBA | 800 | 5 | 0.63 h-k |
| IBA | 200 | 10 | 0.63 h-k |
| SD8339 | 100 | 60 | 0.38 ijk |
| SD8339 | 50 | 360 | 0.38 jk |
| SD8339 | 200 | 240 | 0.38 jk |
| IBA | 400 | 5 | 0.13 jk |
| SD8339 | 400 | 120 | 0.00 k |

*Means bounded by the same letter are not significantly different.

**Dash (-) indicates "through" as in a-g.

# TABLE III

## THE EFFECT OF VARIOUS GROWTH REGULATORS ON BERMUDAGRASS SPRIGS AS DETERMINED BY MEAN SHOOT LENGTH AS ANALYZED BY DUNCAN'S NEW MULTIPLE RANGE TEST

| Chemical | Rate (ppm) | Time (minutes) | Means* |
|---|---|---|---|
| $GA_3$ | 300 | 10 | 114.25 a |
| TIBA | 20 | 10 | 111.86 ab |
| Ethrel | 100 | 60 | 102.29 a-c** |
| $GA_3$ | 150 | 10 | 95.38 a-d |
| TIBA | 5 | 10 | 94.13 a-e |
| Ethrel | 50 | 60 | 91.50 a-f |
| Water | - | 60 | 88.50 a-g |
| Water | - | 240 | 86.25 a-h |
| Water | - | 360 | 85.25 a-h |
| Ethrel | 400 | 120 | 81.75 a-i |
| IBA | 100 | 5 | 77.13 a-j |
| $GA_3$ | 300 | 40 | 75.50 a-k |
| Ethrel | 50 | 240 | 72.29 a-l |
| TIBA | 10 | 5 | 71.88 a-l |
| Ethrel | 100 | 240 | 71.88 a-l |
| Ethrel | 200 | 240 | 71.63 a-l |
| Ethrel | 400 | 240 | 70.29 a-m |
| TIBA | 5 | 40 | 69.50 a-m |
| Water | - | 120 | 69.25 a-m |
| TIBA | 10 | 20 | 68.38 a-m |
| Ethrel | 50 | 360 | 68.25 a-m |
| Ethrel | 50 | 120 | 64.63 a-n |
| TIBA | 5 | 20 | 64.38 a-o |
| TIBA | 10 | 10 | 63.88 a-o |
| Ethrel | 200 | 120 | 63.13 a-o |
| $GA_3$ | 150 | 20 | 62.25 a-o |
| TIBA | 40 | 10 | 61.75 a-p |
| TIBA | 40 | 20 | 60.63 a-p |
| $GA_3$ | 300 | 20 | 60.38 a-p |
| TIBA | 5 | 5 | 58.75 a-p |
| $GA_3$ | 150 | 40 | 58.63 a-p |
| TIBA | 20 | 40 | 57.25 b-q |
| $GA_3$ | 37.5 | 10 | 57.00 b-q |
| $GA_3$ | 75 | 5 | 56.63 b-q |
| TIBA | 10 | 40 | 55.13 b-q |
| $GA_3$ | 150 | 5 | 53.63 c-q |
| TIBA | 40 | 40 | 51.63 c-q |
| Ethrel | 100 | 120 | 51.13 c-q |
| Ethrel | 400 | 360 | 49.63 c-q |
| IBA | 200 | 5 | 48.75 c-q |
| Ethrel | 400 | 60 | 48.50 c-q |
| SD8339 | 400 | 240 | 48.38 c-q |
| IBA | 200 | 20 | 48.38 c-q |
| TIBA | 40 | 5 | 47.38 c-q |
| Ethrel | 200 | 60 | 44.25 d-q |
| $GA_3$ | 37.5 | 20 | 44.13 d-q |
| TIBA | 20 | 20 | 44.00 d-q |
| $GA_3$ | 75 | 40 | 43.13 d-q |
| IBA | 100 | 20 | 38.50 e-q |
| $GA_3$ | 37.5 | 5 | 37.50 f-q |
| IBA | 400 | 20 | 37.00 f-q |
| $GA_3$ | 75 | 10 | 35.43 f-q |
| $GA_3$ | 37.5 | 40 | 34.86 f-q |
| Ethrel | 100 | 360 | 34.50 g-q |
| Ethrel | 200 | 120 | 34.00 g-q |
| IBA | 100 | 40 | 33.75 g-q |
| $GA_3$ | 75 | 20 | 33.50 g-q |
| $GA_3$ | 300 | 5 | 32.25 g-q |
| IBA | 800 | 10 | 30.50 h-q |
| SD8339 | 50 | 60 | 28.63 i-q |
| IBA | 400 | 40 | 27.63 i-q |
| SD8339 | 400 | 60 | 25.86 i-q |
| Ethrel | 200 | 360 | 24.25 j-q |
| SD8339 | 50 | 240 | 23.13 j-q |
| IBA | 100 | 10 | 20.63 j-q |
| IBA | 200 | 40 | 20.38 k-q |
| TIBA | 20 | 5 | 16.63 l-q |
| IBA | 800 | 40 | 16.00 l-q |
| IBA | 800 | 5 | 14.75 l-q |
| SD8339 | 50 | 120 | 14.25 l-q |
| IBA | 400 | 10 | 13.38 m-q |
| IBA | 800 | 20 | 13.00 m-q |
| SD8339 | 200 | 60 | 12.88 m-q |
| SD8339 | 200 | 240 | 10.13 n-q |
| SD8339 | 100 | 360 | 6.63 opq |
| SD8339 | 100 | 240 | 6.50 opq |
| SD8339 | 200 | 360 | 5.43 opq |
| IBA | 200 | 10 | 4.13 pq |
| SD8339 | 400 | 360 | 3.88 pq |
| SD8339 | 50 | 360 | 3.25 pq |
| SD8339 | 100 | 120 | 2.25 pq |
| SD8339 | 100 | 60 | 1.25 pq |
| IBA | 400 | 5 | 0.38 q |
| SD8339 | 400 | 120 | 0.00 q |

*Means bounded by a common letter are not significantly different.

**Dash (-) indicates "through" as in a-g.

# TABLE IV

## THE EFFECT OF VARIOUS GROWTH REGULATORS ON BERMUDAGRASS SPRIGS AS DETERMINED BY MEAN ROOT NUMBERS AS ANALYZED BY DUNCAN'S NEW MULTIPLE RANGE TEST

| Chemical | Rate (ppm) | Time (minutes) | Means* |
|---|---|---|---|
| TIBA | 40 | 5 | 5.38 a |
| Ethrel | 400 | 240 | 5.29 ab |
| Ethrel | 50 | 360 | 4.88 abc |
| IBA | 400 | 20 | 4.88 abc |
| Ethrel | 200 | 120 | 4.88 abc |
| IBA | 100 | 5 | 4.75 a-d** |
| Ethrel | 400 | 360 | 4.63 a-e |
| Ethrel | 100 | 120 | 4.63 a-e |
| IBA | 400 | 40 | 4.50 a-e |
| $GA_3$ | 150 | 20 | 4.50 a-e |
| IBA | 100 | 10 | 4.38 a-f |
| IBA | 200 | 20 | 4.38 a-f |
| Ethrel | 400 | 120 | 4.38 a-f |
| Ethrel | 50 | 240 | 4.29 a-g |
| TIBA | 5 | 10 | 4.13 a-g |
| IBA | 200 | 5 | 4.13 a-g |
| TIBA | 40 | 10 | 4.13 a-g |
| Ethrel | 100 | 240 | 4.13 a-g |
| $GA_3$ | 300 | 5 | 4.13 a-g |
| Ethrel | 100 | 60 | 4.00 a-h |
| Water | - | 60 | 4.00 a-h |
| IBA | 400 | 10 | 4.00 a-h |
| TIBA | 10 | 40 | 4.00 a-h |
| IBA | 100 | 40 | 3.88 a-h |
| $GA_3$ | 300 | 10 | 3.88 a-h |
| $GA_3$ | 37.5 | 40 | 3.76 a-i |
| Ethrel | 50 | 60 | 3.75 a-i |
| Ethrel | 200 | 360 | 3.75 a-i |
| $GA_3$ | 300 | 40 | 3.75 a-i |
| TIBA | 5 | 40 | 3.63 d-i |
| IBA | 800 | 5 | 3.63 a-i |
| Ethrel | 200 | 60 | 3.63 a-i |
| TIBA | 20 | 20 | 3.50 a-j |
| IBA | 800 | 20 | 3.50 a-j |
| TIBA | 5 | 5 | 3.50 a-j |
| SD8339 | 50 | 120 | 3.50 a-j |
| TIBA | 5 | 20 | 3.50 a-j |
| IBA | 200 | 40 | 3.50 a-j |
| TIBA | 10 | 10 | 3.50 a-j |
| IBA | 200 | 10 | 3.50 a-j |
| Ethrel | 200 | 240 | 3.38 a-k |
| TIBA | 40 | 20 | 3.38 a-k |
| TIBA | 40 | 40 | 3.38 a-k |
| Water | - | 240 | 3.38 a-k |
| $GA_3$ | 75 | 10 | 3.29 a-k |
| $GA_3$ | 37.5 | 5 | 3.25 a-k |
| $GA_3$ | 150 | 40 | 3.25 a-k |
| TIBA | 20 | 5 | 3.25 a-k |
| $GA_3$ | 75 | 5 | 3.25 a-k |
| IBA | 800 | 10 | 3.25 a-k |
| Ethrel | 50 | 120 | 3.13 a-k |
| $GA_3$ | 300 | 20 | 3.13 a-k |
| TIBA | 10 | 20 | 3.13 a-k |
| SD8339 | 50 | 60 | 3.00 b-k |
| IBA | 400 | 5 | 3.00 b-k |
| $GA_3$ | 75 | 20 | 3.00 b-k |
| Ethrel | 400 | 60 | 2.88 b-k |
| TIBA | 20 | 10 | 2.86 b-k |
| IBA | 100 | 20 | 2.75 c-k |
| $GA_3$ | 37.5 | 20 | 2.75 c-k |
| Ethrel | 100 | 360 | 2.75 c-k |
| Water | - | 360 | 2.63 c-k |
| TIBA | 10 | 5 | 2.63 c-k |
| TIBA | 20 | 40 | 2.63 c-k |
| $GA_3$ | 150 | 10 | 2.63 c-k |
| Water | - | 120 | 2.63 c-k |
| $GA_3$ | 150 | 5 | 2.50 d-k |
| SD8339 | 50 | 240 | 2.38 e-k |
| SD8339 | 200 | 240 | 2.38 e-k |
| SD8339 | 200 | 120 | 2.00 f-k |
| SD8339 | 100 | 60 | 2.00 f-k |
| SD8339 | 200 | 360 | 2.00 f-k |
| SD8339 | 100 | 240 | 1.88 g-k |
| $GA_3$ | 37.5 | 10 | 1.88 g-k |
| SD8339 | 50 | 360 | 1.88 g-k |
| IBA | 800 | 40 | 1.75 h-k |
| SD8339 | 400 | 240 | 1.63 h-k |
| SD8339 | 400 | 120 | 1.50 ijk |
| SD8339 | 200 | 60 | 1.38 ijk |
| SD8339 | 100 | 120 | 1.38 ijk |
| SD8339 | 100 | 360 | 1.25 jk |
| $GA_3$ | 75 | 40 | 1.25 jk |
| SD8339 | 400 | 60 | 1.14 jk |
| SD8339 | 400 | 360 | 1.13 k |

*Means bounded by a common letter are not significantly different.

**Dash (-) indicates "through" as in a-g.

# TABLE V

## THE EFFECT OF VARIOUS GROWTH REGULATORS ON BERMUDAGRASS SPRIGS AS DETERMINED BY MEAN ROOT LENGTH AS ANALYZED BY DUNCAN'S NEW MULTIPLE RANGE TEST

| Chemical | Rate (ppm) | Time (minutes) | Means* |
|---|---|---|---|
| Ethrel | 400 | 240 | 306.14 a |
| IBA | 100 | 10 | 293.38 ab |
| Ethrel | 50 | 240 | 274.57 abc |
| Ethrel | 400 | 360 | 258.75 a-d** |
| TIBA | 5 | 20 | 256.38 a-d |
| IBA | 400 | 20 | 253.13 a-e |
| $GA_3$ | 300 | 40 | 250.50 a-e |
| Ethrel | 50 | 360 | 250.38 a-e |
| $GA_3$ | 150 | 20 | 250.25 a-e |
| TIBA | 40 | 5 | 236.88 a-f |
| Ethrel | 100 | 240 | 234.63 a-f |
| TIBA | 20 | 20 | 234.00 a-g |
| $GA_3$ | 300 | 5 | 230.25 a-h |
| Ethrel | 200 | 120 | 223.50 a-i |
| IBA | 100 | 40 | 216.75 a-i |
| IBA | 100 | 5 | 215.88 a-i |
| TIBA | 10 | 40 | 207.25 a-j |
| TIBA | 40 | 10 | 206.25 a-j |
| TIBA | 10 | 10 | 203.88 a-k |
| $GA_3$ | 300 | 20 | 203.13 a-k |
| IBA | 200 | 20 | 199.00 a-l |
| Ethrel | 400 | 120 | 198.75 a-l |
| TIBA | 5 | 10 | 195.00 a-l |
| Water | - | 60 | 192.88 a-l |
| TIBA | 5 | 5 | 190.50 a-l |
| Ethrel | 100 | 120 | 190.13 a-l |
| $GA_3$ | 75 | 5 | 189.38 a-l |
| $GA_3$ | 37.5 | 40 | 188.86 a-m |
| Ethrel | 200 | 360 | 188.25 a-m |
| IBA | 400 | 40 | 187.75 a-m |
| $GA_3$ | 75 | 10 | 181.57 a-n |
| $GA_3$ | 300 | 10 | 181.00 a-n |
| TIBA | 40 | 20 | 179.63 a-n |
| IBA | 200 | 10 | 177.38 a-n |
| Ethrel | 200 | 240 | 177.25 a-n |
| IBA | 200 | 40 | 175.00 a-n |
| TIBA | 5 | 40 | 174.88 a-n |
| IBA | 400 | 10 | 173.50 a-n |
| Water | - | 240 | 170.38 a-o |
| TIBA | 20 | 10 | 169.86 a-o |
| Ethrel | 50 | 60 | 166.00 b-o |
| Ethrel | 100 | 60 | 165.14 b-p |
| $GA_3$ | 150 | 40 | 164.00 c-p |
| TIBA | 10 | 5 | 163.88 c-p |
| TIBA | 20 | 5 | 162.88 c-p |
| TIBA | 40 | 40 | 162.38 c-p |
| $GA_3$ | 150 | 20 | 158.38 c-p |
| Ethrel | 50 | 120 | 157.38 c-p |
| TIBA | 10 | 20 | 156.75 c-q |
| IBA | 200 | 5 | 154.25 c-q |
| $GA_3$ | 37.5 | 20 | 148.75 c-r |
| $GA_3$ | 37.5 | 5 | 141.63 c-r |
| Ethrel | 100 | 360 | 140.50 d-r |
| IBA | 100 | 20 | 139.50 d-r |
| IBA | 800 | 10 | 134.13 d-r |
| Ethrel | 200 | 60 | 131.75 d-r |
| $GA_3$ | 150 | 5 | 131.25 d-r |
| $GA_3$ | 37.5 | 10 | 126.63 e-r |
| IBA | 400 | 5 | 119.50 f-r |
| IBA | 800 | 5 | 119.38 f-r |
| Water | - | 120 | 117.63 f-r |
| $GA_3$ | 150 | 10 | 115.88 f-r |
| Ethrel | 400 | 60 | 113.63 f-r |
| SD8339 | 50 | 120 | 113.50 f-r |
| SD8339 | 50 | 60 | 110.88 f-r |
| TIBA | 20 | 40 | 108.88 f-r |
| IBA | 800 | 20 | 104.38 g-r |
| SD8339 | 400 | 240 | 100.75 h-r |
| Water | - | 360 | 100.38 i-r |
| SD8339 | 50 | 240 | 82.88 j-r |
| SD8339 | 100 | 240 | 81.00 j-r |
| SD8339 | 200 | 120 | 74.38 k-r |
| SD8339 | 200 | 360 | 68.71 l-r |
| SD8339 | 50 | 360 | 58.88 m-r |
| SD8339 | 200 | 240 | 56.63 m-r |
| SD8339 | 100 | 360 | 55.00 m-r |
| SD8339 | 100 | 60 | 50.00 n-r |
| IBA | 800 | 40 | 47.13 n-r |
| $GA_3$ | 75 | 40 | 45.50 n-r |
| SD8339 | 400 | 60 | 44.57 n-r |
| SD8339 | 200 | 60 | 44.00 o-r |
| SD8339 | 400 | 120 | 34.00 pqr |
| SD8339 | 100 | 120 | 28.75 qr |
| SD8339 | 400 | 360 | 19.00 r |

*Means bounded by the same letter are not significantly different.

**Dash (-) indicates "through" as in a-g.

TABLE VI

ANALYSES OF VARIANCE FOR THE EFFECT OF DIFFERENT CONCENTRATIONS OF ETHREL ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total (corrected) | 127 | 1.09 | 2076.39 | 4.09 | 15539.43 |
| Rep | 7 | 2.40 | 3797.15 | 4.37 | 15027.57 |
| Rate | 3 | 1.04 | 2480.41 | 0.30 | 9117.89 |
| Time | 3 | 2.96 | 5087.86 | 6.11 | 69962.28 |
| Rate x Time | 9 | 0.90 | 2656.27 | 9.75 | 23920.12 |
| Error | 105 | 0.97 | 1814.38 | 3.63 | 13483.75 |
| CV | | 57% | 68% | 49% | 60% |

TABLE VII

ANALYSES OF VARIANCE FOR THE EFFECT OF DIFFERENT CONCENTRATIONS OF GIBBERELLIC ACID ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total (corrected) | 127 | 1.48 | 2510.32 | 3.51 | 12912.80 |
| Rep | 7 | 0.63 | 2311.12 | 3.21 | 17991.41 |
| Rate | 3 | 1.98 | 8494.87 | 6.04 | 27765.90 |
| Time | 3 | 1.33 | 4550.34 | 1.42 | 7665.76 |
| Rate x Time | 9 | 1.31 | 2926.82 | 5.86 | 22265.60 |
| Error | 105 | 1.54 | 2258.62 | 3.32 | 11498.10 |
| CV | | 59% | 86% | 61% | 67% |

TABLE VIII

ANALYSES OF VARIANCE FOR THE EFFECT OF DIFFERENT CONCENTRATIONS OF IBA ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total (corrected) | 127 | 1.54 | 1679.51 | 6.08 | 16014.35 |
| Rep | 7 | 1.99 | 2180.95 | 13.02 | 8554.00 |
| Rate | 3 | 1.03 | 3118.27 | 14.51 | 106446.14 |
| Time | 3 | 2.78 | 2013.90 | 3.84 | 10952.72 |
| Rate x Time | 9 | 2.37 | 3240.94 | 11.29 | 20700.35 |
| Error | 105 | 1.42 | 1461.59 | 4.99 | 13670.90 |
| CV | | 99% | 142% | 88% | 101% |

TABLE IX

ANALYSES OF VARIANCE FOR THE EFFECT OF DIFFERENT CONCENTRATIONS OF SHELL SD8339 ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total (corrected) | 127 | 1.50 | 939.28 | 2.91 | 5791.41 |
| Rep | 7 | 3.94 | 642.75 | 4.06 | 12350.48 |
| Rate | 3 | 0.41 | 1204.63 | 7.09 | 5620.83 |
| Time | 3 | 1.67 | 1922.11 | 3.43 | 7047.15 |
| Rate x Time | 9 | 2.40 | 1190.00 | 3.42 | 8043.83 |
| Error | 105 | 1.28 | 901.90 | 2.66 | 5130.07 |
| CV | | 125% | 243% | 139% | 160% |

TABLE X

ANALYSES OF VARIANCE FOR THE EFFECT OF DIFFERENT CONCENTRATIONS OF TIBA ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total (corrected) | 127 | 1.46 | 3365.48 | 4.29 | 14342.02 |
| Rep | 7 | 4.05 | 2926.66 | 6.97 | 31435.42 |
| Rate | 3 | 1.24 | 1776.20 | 10.70 | 27322.36 |
| Time | 3 | 0.74 | 6770.21 | 1.03 | 11018.01 |
| Rate x Time | 9 | 0.34 | 2934.52 | 5.49 | 12247.95 |
| Error | 105 | 1.42 | 3379.81 | 3.92 | 13106.06 |
| CV | | 60% | 93% | 61% | 66% |

TABLE XI

ANALYSES OF VARIANCE FOR THE EFFECT OF WATER ON GROWTH RESPONSES OF BERMUDAGRASS SPRIGS SOAKED FOR ALL PERIODS OF TIME

| | | Mean Squares | | | |
|---|---|---|---|---|---|
| | | Shoot | | Root | |
| Source | df | Number | Length | Number | Length |
| Total | 31 | 1.17 | 124.88 | 3.17 | 493.41 |
| Rep | 7 | 1.64 | 45.58 | 3.07 | 358.86 |
| Trt. | 3 | 1.87 | 38.84 | 3.53 | 946.05 |
| Error | 21 | 0.91 | 163.60 | 3.15 | 473.60 |
| CV | | 52% | 62% | 56% | 60% |

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# VITA

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