THE EFFECTS OF CHEMICAL GROWTH RETARDANTS ON LEAF LETTUCE GROWTH UNDER HIGH TEMPERATURES

By

SAMPAN ASAKIT

Bachelor of Science

Central Luzon State University

Nueva Ecija, Philippines

1966

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 1972

THE EFFECTS OF CHEMICAL GROWTH RETARDANTS

ON LEAF LETTUCE GROWN UNDER

HIGH TEMPERATURES

Thesis Approved:

F. A. Romshe
Thesis Adviser

W R Kays

R. N. Payne

Robert D Morrison

N Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

During the course of this study the author has had much help and advice from several members of the Oklahoma State University Department of Horticulture.

Sincere thanks is due Professor F. A. Romshe, my major professor, whose initial guidance and continued cooperation made possible the completion of this thesis.

Grateful appreciation is also due to Professor W. R. Kays, department head, for his initial guidance and cooperation.

Acknowledgement is made to Dr. R. N. Payne and Mr. Bobby Burk for providing some of the chemicals used and for technical assistance provided. Further acknowledgement is made to Dr. R. D. Morrison, Professor, Statistics Department, for his help in analysis of the data.

Finally, thanks is due to my wife and daughter for their inspiration to make my study fulfilled.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure | Page

Figure | Page

Figure		Page

CHAPTER I

INTRODUCTION

When the number of hours of light per day are twelve or more and average daily temperatures are high (70^{o}-80^{o}F) the production of leaf lettuce is curtailed because the plants will form seed stalks at an early stage of development (2, 7, 14, 15). Since these conditions are usually prevalent from May to September in Oklahoma, this is a major problem of year-round leaf lettuce production.

The objective of this study was to determine if seed stalk initiation can be inhibited or materially delayed by nullifying plant responses to the environmental condition with selected growth retardants. This study was conducted during the period April 13 to September 6, 1971.

In a previous study by Willis Johnson in 1967 on the growth response of leaf lettuce plants to the foliar application of growth retardants he obtained information on the height, number of leaves and weight of plants. He suggested that leaf lettuce production in Oklahoma can best be done during the cool months of the year due to the initiation and rapid development of seed stalks during the summer months (May - September).

CHAPTER II

LITERATURE REVIEW

Prior to the time this research problem was planned a thesis (7) study conducted by Johnson in 1967, concerned the effect of growth retardants on the inhibition of seed stalk initiation in leaf lettuce under greenhouse condition. These growth retardants have been reported effective in retarding plant growth in a wide range of genera and species.

Gibberellin Like Responses

Plant symptoms of bolting as generally known in leaf lettuce are characterized by the elongation of the internodes. The leaves are more narrow, slightly longer, and paler green in color. These symptoms are typical of various genera and species of plants when treated with gibberellic acid (1, 10).

The study reported by Bukovac and Wittwer (2) revealed that when the reproductive responses of plants of Great Lakes cultivar head lettuce which had been vernalized were compared to lettuce plants which had been treated with gibberellic acid, the vernalized plants were similar to the gibberellin treated plants in internodal elongation, leaf size and in color. Harrington (6) found that spraying lettuce plants with gibberellic acid at the concentration of 3 to 10 ppm during the 4 to 8 leaf stages caused them to bolt and produce seed stalks two weeks earlier than non-treated plants. This investigation suggests that the natural occurring process of bolting in leaf lettuce is similar to bolting induced by treating the lettuce plant with gibberellic acid. This experiment had led some researchers to conclude that seed stalk development in leaf lettuce is a gibberellin-like response that may actually be caused by an assimilation of gibberellic acid in the plant.

Causes of Bolting

The cause of bolting has been studied by many investigators. Thompson and Knott (19) found that temperature was the most important factor that influenced bolting of lettuce and that long days did cause more rapid elongation of seed stalks. It has been suggested by Raleigh (11) that day temperature could be in the high ranges (70°-80°F) without excessive seed stalk development if the night temperature was low (50°F). Rappaport and Wittwer (12) found that non-vernalized lettuce plants flowered only when the night temperature was about 65°F, independent of day length and they

(13) also observed that the number of days preceding the appearance of flower parts in Grand Rapids cultivar of leaf lettuce varied only slightly with day length but showed a marked response to night temperatures about 65^{o}F.

Growth Retardants

During the summers in Oklahoma both day and night temperatures are relatively high and the day length is long. The production of marketable leaf lettuce at this time of the year is seldom successful. The controlling of bolting would be a great help. A possible method has been suggested by Johnson's work (7) with greenhouse grown leaf lettuce sprayed with various concentrations of growth retardants. Growth retardants actually cause a reduction of internodal length by inhibiting cell division and/or cell elongation in the sub-apical meristem (3). As a result, the development of seed stalks in leaf lettuce may be delayed by the use of growth retardants (to inhibit cell division and cell elongation).

Mode of Action of Growth Retardants

There have been at least four possible modes of action proposed for the short internodes resulting from the use of growth retardant chemicals.

One theory is that growth retardants caused inhibitions which are not directly related to either gibberellin or auxin metabolism. To support this particular position, Kuraishi and Muir (9) found that the effect of CCC on growth of Raphanus leaf disks was not reversed either by gibberellic acid or auxin. Cleland (4) also gave this support in his work with the oat plant. He found that growth retardants seemed to act by interfering with auxin metabolism in the tissue and by exerting an inhibiting effect on growth of a non-hormonal aspect. In addition, he found that auxin could not completely reverse the dwarfing effect of growth retardants. The non-hormonal action remains unknown. Reed et al. (14) found that B-9 (Alar) caused inhibition of shoot elongation by inhibiting tryptamine through diamine oxidase. This could not be reversed by addition of either auxin or gibberellin. Cathey (3) suggested that growth retardants caused an inhibition that could not be reversed by gibberellin or auxin when he found that growth retardants were not analogs of any known growth substance.

Secondly, growth retardants block the synthesis of gibberellic acid. Kende et al. (8) found that CCC and AMO-1618 prevented the synthesis of gibberellic acid in Fusarium moniliforme. The results of this mode of action would be that the growth retardants become competitive inhibitors of endogenous growth, but would be reversible if more gibberellic acid was added. Sach et al. (16) and Tolbert (20) also suggested that such inhibition of gibberellin synthesis may occur.

Thirdly, growth retardants affect auxin metabolism in plant tissue. Halevy (5) suggested that gibberellic acid inhibited and growth retardants (Alar, CCC and AMO-1618) stimulated the activity of peroxidase and indoleacetic acid oxidase in cucumber seedlings.

Lastly, growth retardants may compete with gibberellin at the site of gibberellic acid action. The observation made by Cleland (4) revealed that AMO-1618 possessed the ability of inhibiting gibberellin-induced elongation, it did not act at the site of gibberellin action. For these reasons, AMO-1618 is not an anti-gibberellin compound. Cathey (3) concluded that growth retardants were not anti-gibberellins when he found that they were not the same as any known growth promoting substances.

Methods of Application

Cathey (3) reported that spray applications of growth retardants were sufficiently active to provide a satisfactory method of treating most plants. Foliar application of growth retardants to the plants controlled internode elongation in varied day length treatments. It has been found that one application (or at most two) made within the first weeks of growth was usually enough to suppress stem elongation.

Wirwille and Mitchell (21) found that the concentration of growth retardants should be carefully regulated and uniformly applied.

Effects of Growth Retardants

Wirwille and Mitchell (21) found that when the plants were sprayed with AMO-1618, a deep green color developed and the leaves were thicker than those of non-treated plants. However, the total solids in the treated plants were 11% less than control plants. Cathey (3) found that reduced weight was primarily due to the reduction in stem length because the number of nodes and weight of leaves of the treated plants were not affected. This suggested that growth retardants are active in the sub-apical meristem where cell division and cell elongation occur and not in the apical meristem where the leaves and nodes are initiated. A similar result was also obtained by Riddell et al. (15) which indicated that although B-9 reduced plant height, the rate of leaf development was not affected.

Wirwille and Mitchell (21) found that AMO-1618 delayed flowering of some plants by as much as ten days. Stuart (17) suggested that the application of CCC on tomato plants caused earlier flowering.

Characteristics of Growth Retardants

According to Cathey (3) AMO-1618 could persist in the soil for as much as ten years whereas CCC and B-9 would break down within three to four weeks. Alar was degradated however the process was much slower than with B-9. It requires more than three months before much breakdown occurs.

CHAPTER III

METHODS AND MATERIALS

The objective of these experiments was to obtain information on growth response of leaf lettuce plants to foliar sprays of four growth retardants under long day, high temperature conditions. Determinations were made on the height, number of leaves, stem length and total weight of ten plants in each treatment.

Chemicals used were Alar, B-9, EL-531 and BAS 0660W. Concentrations of each growth retardant used in the study were: (1) Alar at 5,000 ppm; (2) B-9 at 5,000 ppm; (3) EL-531 at 20 and 50 ppm; (4) BAS 0660W at 1,000, 2,500 and 5,000 ppm. The materials were applied to plants of three cultivars of leaf lettuce: (1) Grand Rapids, (2) Waldmann's Green and (3) Big Green.[1]

The materials used for treatment were dissolved in water at their specific concentrations without the addition of a surfactant. It has been shown in previous work that

---

[1]Big Green is an unofficial name of a dark green selection of U. S. #1 strain of Grand Rapids lettuce made by Bobby Burk, Dept. of Horticulture, Okla. State University.

growth retardants were sufficiently mobile and that a foliar spray application was an effective method of application. The materials were applied by means of a "Beauty Mist" hand atomizer with the leaves being thoroughly wetted.

Lettuce seeds were planted in a soil mix of one part sandy soil, one part peat and one part perlite. Plant bands (Bird's Vita-bands, 2"x2"x2½") were placed in flats and filled with the soil mix. Seed was dropped on the surface of the mix in each band and the flats were placed under intermittent mist. The seedlings had well developed cotyledon leaves in about three days and were removed from the mist and placed in a pad-and-fan cooled greenhouse (House 6). When the seedlings were 5 - 6 weeks of age, they were transplanted to outside beds. Three plantings were made at two-week intervals. Each group of seedlings produced was transplanted as a replication. Each crop was grown under the same procedure and each of the three plantings was considered as trials 1, 2 and 3.

The experimental layout for this study was a common design of seventy plants each spaced 8"x8". Each variety was grown in two rows of about seventy plants per row. Plots were established by dividing the rows of plants into five sections with two plants left as a buffer between sections. Measurements were taken from ten plants selected at random from each treatment.

Data on plant height, number of leaves per plant, and weight of ten plants taken from each variety and each treatment were collected and analyzed.

Trial 1

Seeds were planted May 25 and the plants transplanted June 29. Treatments were applied July 11. The treatments consisted of: (1) check (no chemical treatment); (2) Alar at 5,000 ppm; (3) B-9 at 5,000 ppm; (4) EL-531 at 20 ppm; (5) EL-531 at 50 ppm. The plants were harvested and data collected July 27.

Trial 2

Seeds for the second trial were started June 15. Plants were transplanted to beds July 13. The same growth retardants used in trial 1 were applied July 20 and the crop harvested August 10.

Trial 3

This trial was identical with trials 1 and 2, except for the dates and age of plants at the time of applying the growth retardants. Seeds were planted July 7 and seedlings transplanted to beds August 11. Treatments were applied August 17 and the plants harvested September 6.

In addition to the above trials, a study was conducted using BAS 0660W. Since this chemical is rather new to this field of study the work was done in the greenhouse and the same cultivars of leaf lettuce were grown in 6" plastic pots. Seeds were planted May 3. The seedlings were transplanted into pots June 12 and treated June 15 with BAS 0660W at 200 ppm and 500 ppm. Plants were harvested and data collected July 11.

The study of BAS 0660W was continued with the same cultivars of leaf lettuce and the same procedure except the concentration of the chemical in the treatment was increased. Seeds were planted June 15 and seedlings potted July 11. The plants were treated July 15 with (1) 1,000 ppm; (2) 2,500 ppm; and (3) 5,000 ppm of BAS 0660W. The crop was harvested and data collected August 12.

Another study of Alar on Grand Rapids cultivar has been included in this study, since it seems to be the most effective chemical for growth control on leaf lettuce. Seeds were planted in vermiculite in a 5"x10" seedflat which was placed in a 40°F cooler for four days. Each day the seedflat was removed from the cooler and placed in sunlight for 30 minutes. During the time of germination the outdoor temperature was extremely high (above 90°F). The seeds germinated quickly and uniformly. The seedlings were transplanted to the soil mix in flats containing 48 plant bands.

One flat was treated with Alar at 2,500 ppm when the plants were 1, 2 or 3 weeks of age. Plants from flat No. 4 were treated with Alar at 5,000 ppm one week after they were transplanted to the beds. Plants from flats Nos. 1, 2 and 3 were treated with a second application of Alar at 2,500 ppm one week after they were transplanted to the beds.

CHAPTER IV

RESULTS

Plant growth response to varying growth retardants is variable. Significant differences were found among the varieties studied. Results of this study suggest that growth retardant treatments may have a desirable effect on leaf lettuce production by making it possible to continue to produce during the summer months.

Figure 1 shows that spray applications of Alar, B-9 and EL-531 reduced plant height of Grand Rapids as compared to the check plants. However, all treatments produced marketable leaf lettuce. All of the retardant treatments reduced the number of leaves per plant (Figure 2). As shown in Table 1, the plants treated with growth retardants were reduced in average weight.

Figure 3 shows the effect of spray applications of growth retardants on plant height of the cultivar Waldmann's Green. With the exception of EL-531 at 20 ppm, all treatments caused the plants to be shorter. Treated plants produced almost the same number of leaves as did the check plants, although Alar treated plants had the least number

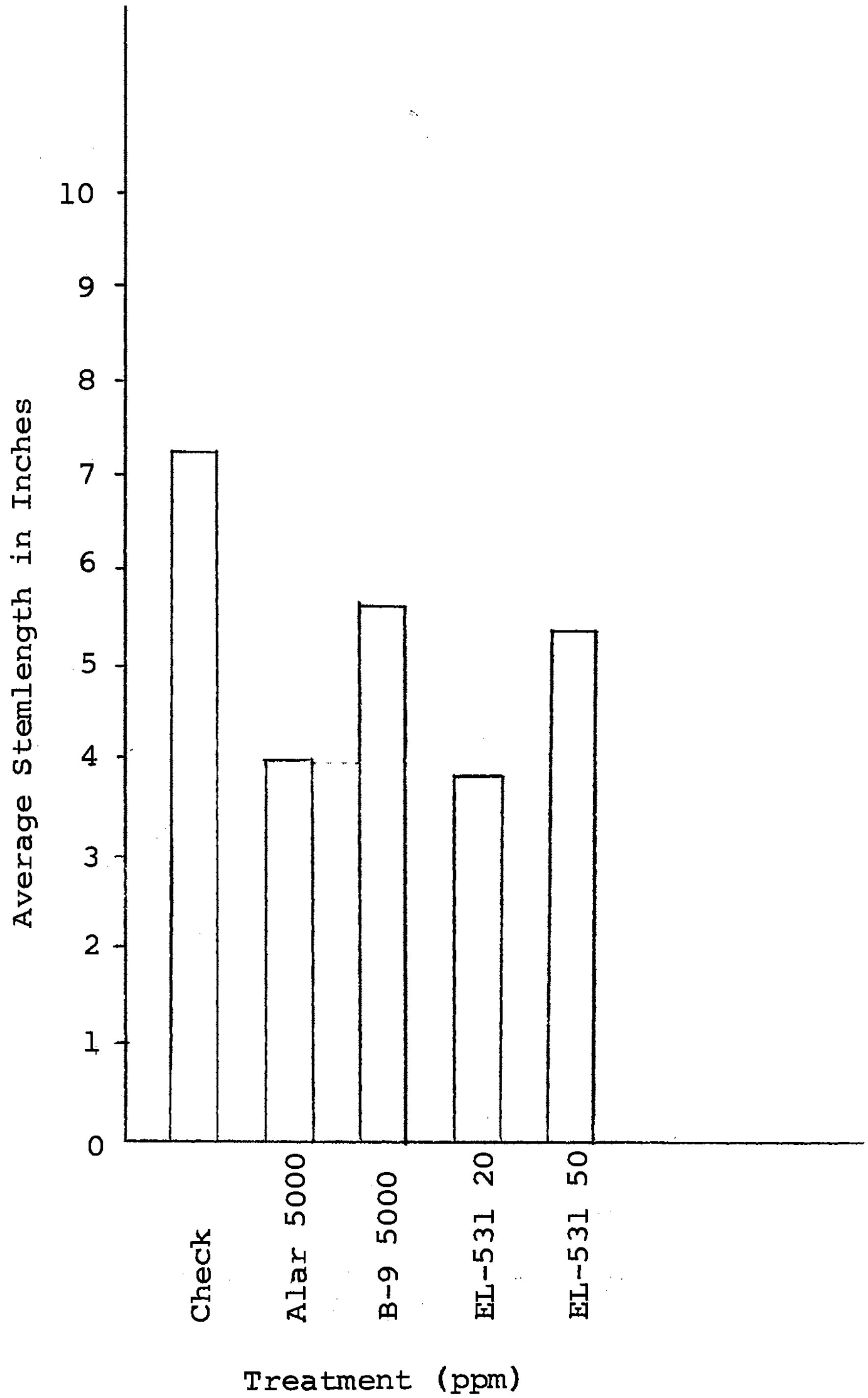


Figure 1. Effect of Spray Applications of Alar, B-9 and EL-531 at Various Concentrations on the Stemlength of Grand Rapids Leaf Lettuce Plants

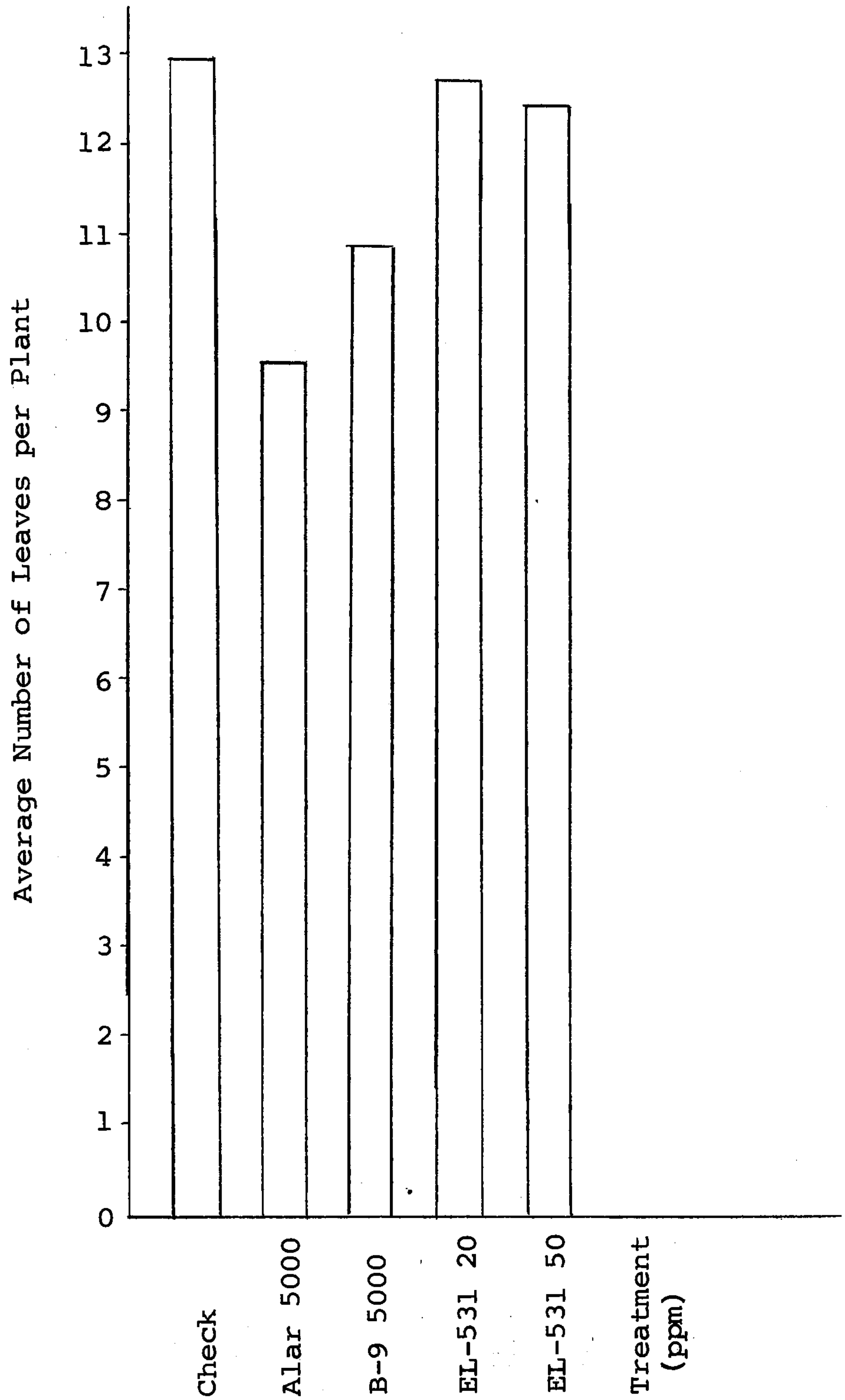


Figure 2. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on the Number of Leaves per Plant of Grand Rapids Leaf Lettuce

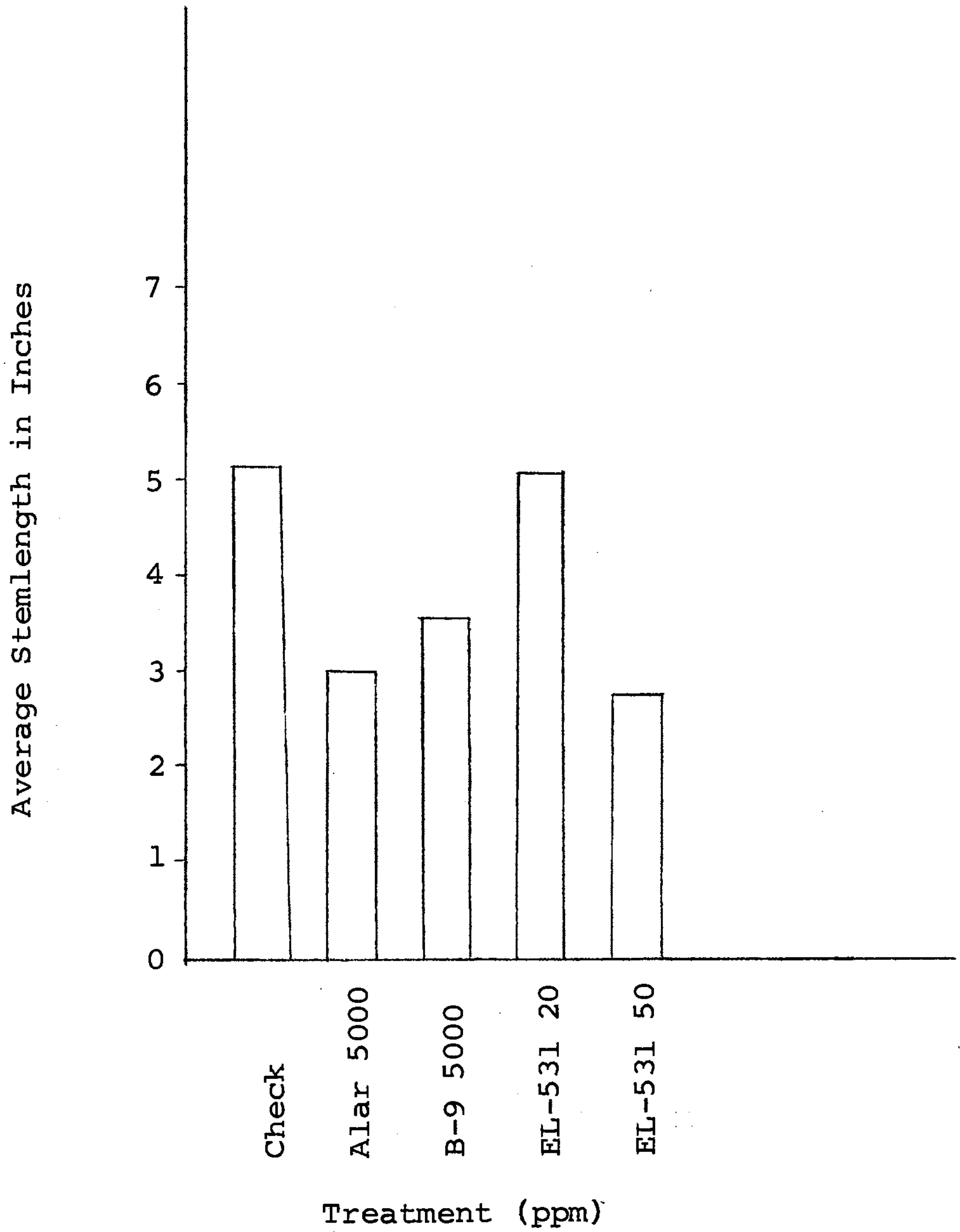


Figure 3. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on Stemlength of Waldmann's Green Leaf Lettuce Plants

of leaves (Figure 4). Plants treated with EL-531 at 20 ppm had the greater weight and plants treated with other growth retardants had lower weights, when compared to the weight of check plants. These results are reported in Table II.

TABLE I

THE EFFECT OF SPRAY APPLICATIONS OF GROWTH RETARDANTS ON THE WEIGHT OF GRAND RAPIDS LEAF LETTUCE

Treatment	Weight of Ten Plants* (Pounds)
Check	3.1
Alar at 5000 ppm	2.1
B-9 at 5000 ppm	2.3
EL-531 at 20 ppm	2.7
EL-531 at 50 ppm	2.6

* Average from 3 trials, applies to Tables I, II, and III.

TABLE II

THE EFFECT OF SPRAY APPLICATIONS OF GROWTH RETARDANTS ON THE WEIGHT OF WALDMANN'S GREEN LEAF LETTUCE

Treatment	Weight of Ten Plants* (Pounds)
Check	1.8
Alar at 5000 ppm	1.4
B-9 at 5000 ppm	1.5
EL-531 at 20 ppm	1.9
EL-531 at 50 ppm	1.6

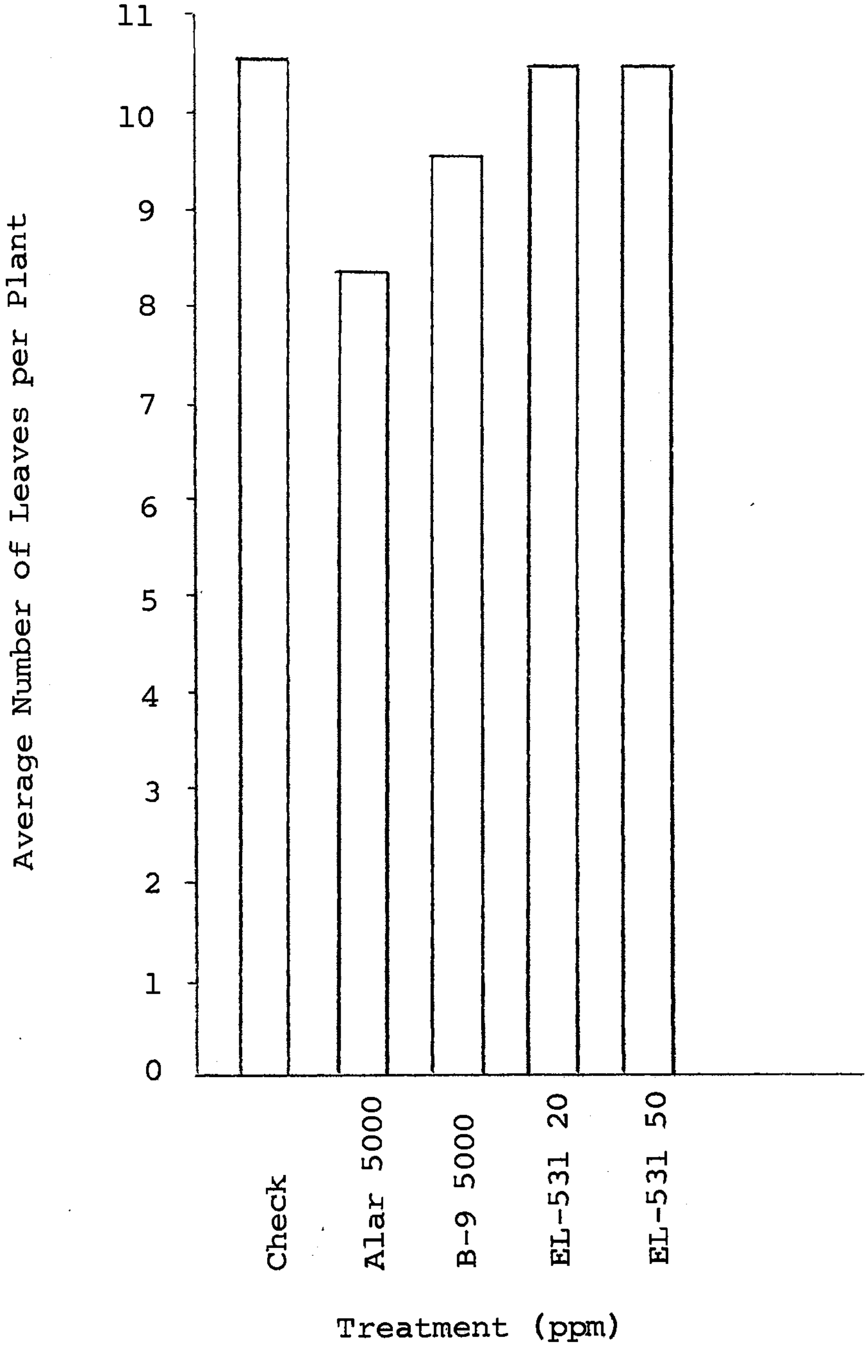


Figure 4. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on the Number of leaves per Plant of Waldmann's Green Leaf Lettuce

Figure 5 shows the effect of applications of growth retardants on plant height of the cultivar Big Green. With the exception of Alar at 5,000 ppm, the treatments did not cause the plants to be shortened. Treated plants produced no significant difference in number of leaves per plant, as shown in Figure 6. The total weight of plants treated with these growth retardants was increased, when compared to the check plants. These results are presented in Table III.

The responses of the different cultivars of leaf lettuce studied to the growth retardants in regard to stem length was variable. Figure 7 shows that the cultivar Waldmann's Green was most responsive to the growth retardants while Big Green was the least responsive. Grand Rapids, as shown in Figure 8, produced the most number of leaves per plant.

Spray applications at different times resulted in different effects of growth retardants on the stem length and the number of leaves per plant. Figure 9 and Figure 10 show that the relationship of stem length was proportional to that of the number of leaves per plant. Also Figure 10 and Figure 11 show the same results with the exception that those plants planted later (Transplanted August 11, treated August 17, harvested September 6) produced longer stem length and fewer leaves per plant. This result is attributed to the time of the year (September) when the temperature was quite high.

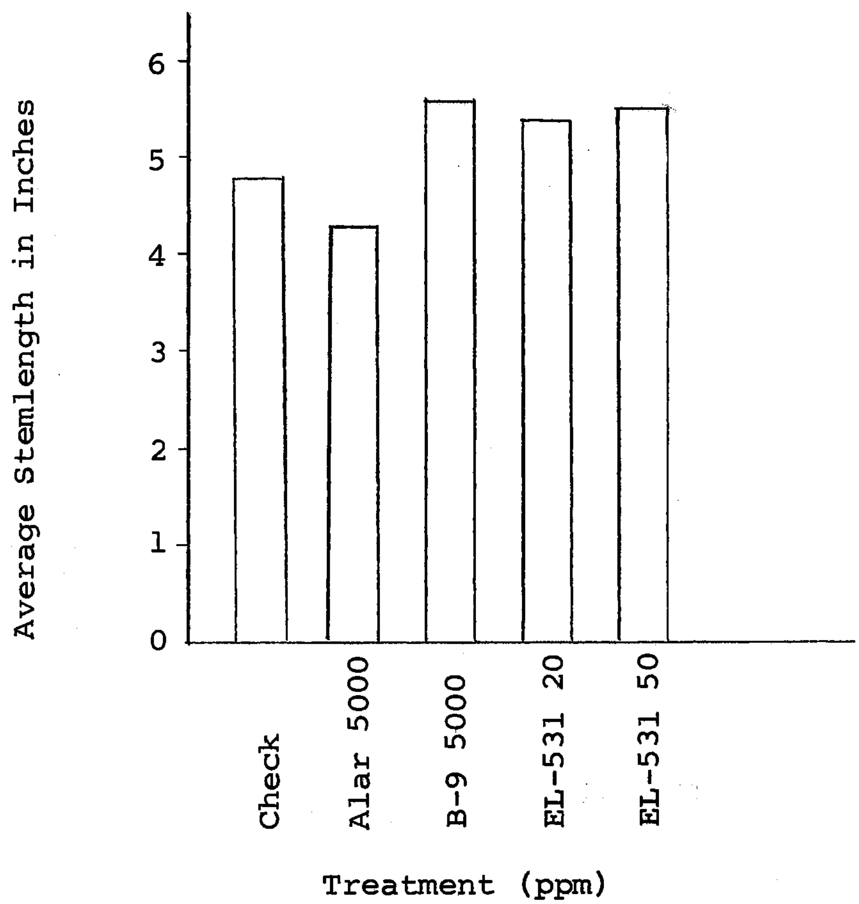


Figure 5. Effect of Spray Applications of Alar, B-9, EL-531 at Various Concentrations on Stemlength of Big Green Leaf Lettuce Plants

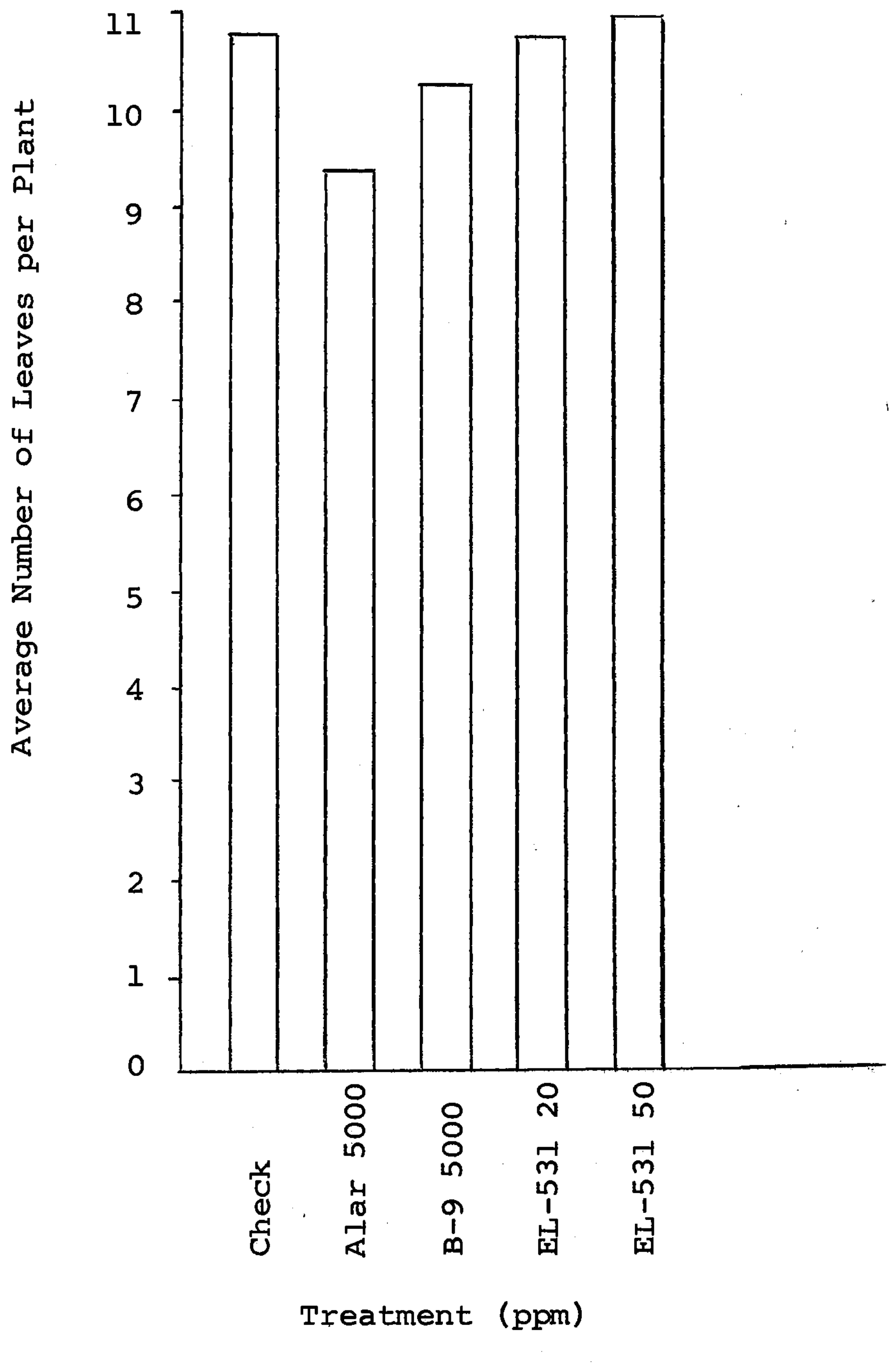


Figure 6. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on the Number of Leaves per Plant of Big Green Leaf Lettuce

TABLE III

THE EFFECT OF SPRAY APPLICATION OF GROWTH RETARDANTS ON THE WEIGHT OF BIG GREEN LEAF LETTUCE

Treatment	Weight of Ten Plants* (Pounds)
Check	1.6
Alar at 5000 ppm	1.7
B-9 at 5000 ppm	2.0
EL-531 at 20 ppm	2.1
EL-531 at 50 ppm	2.1

Figure 12 shows that the number of leaves produced per plant was also more than from the previous planting (transplanted July 13, treated July 20, harvested August 10).

The effect of the growth retardants studied herein were not found significantly different among the cultivars. Figure 13 shows that the treated plants were shortened when compared with the checks. Plants treated with EL-531 produced more leaves per plant than did those treated with Alar and B-9 as shown in Figure 14.

The influence of the growth retardants on stem length varied appreciably with the dates of growing. Plants that were set July 13 and harvested August 10 produced the shortest stem length, whereas plants set August 11 and harvested

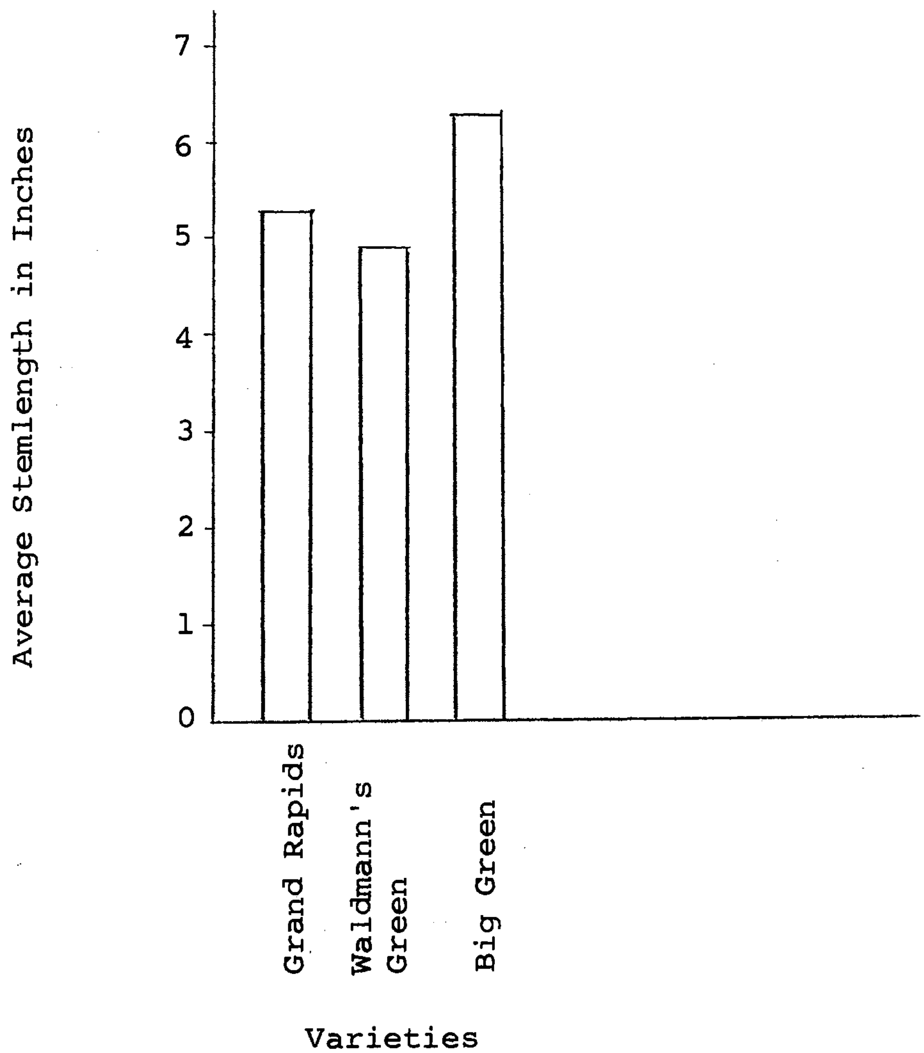


Figure 7. Effect of Spray Applications of Growth Retardants on the Average Stemlength of Different Varieties of Leaf Lettuce. (Transplanted June 29, treated July 11, harvested July 27, 1971)

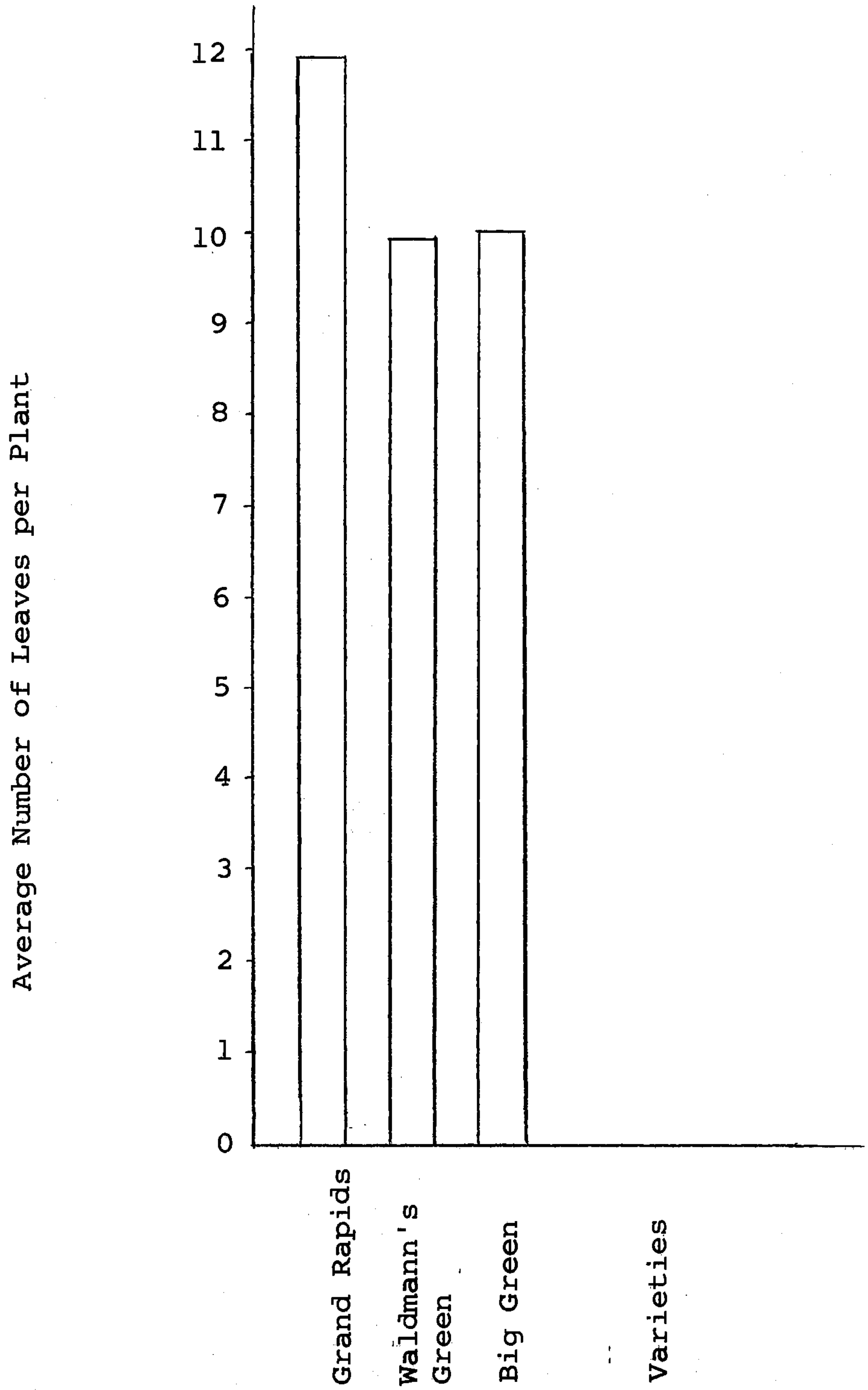


Figure 8. Effect of Spray Applications of Growth Retardants on the Number of Leaves per Plant of Different Varieties of Leaf Lettuce (Transplanted June 29, treated July 11, harvested July 27, 1971)

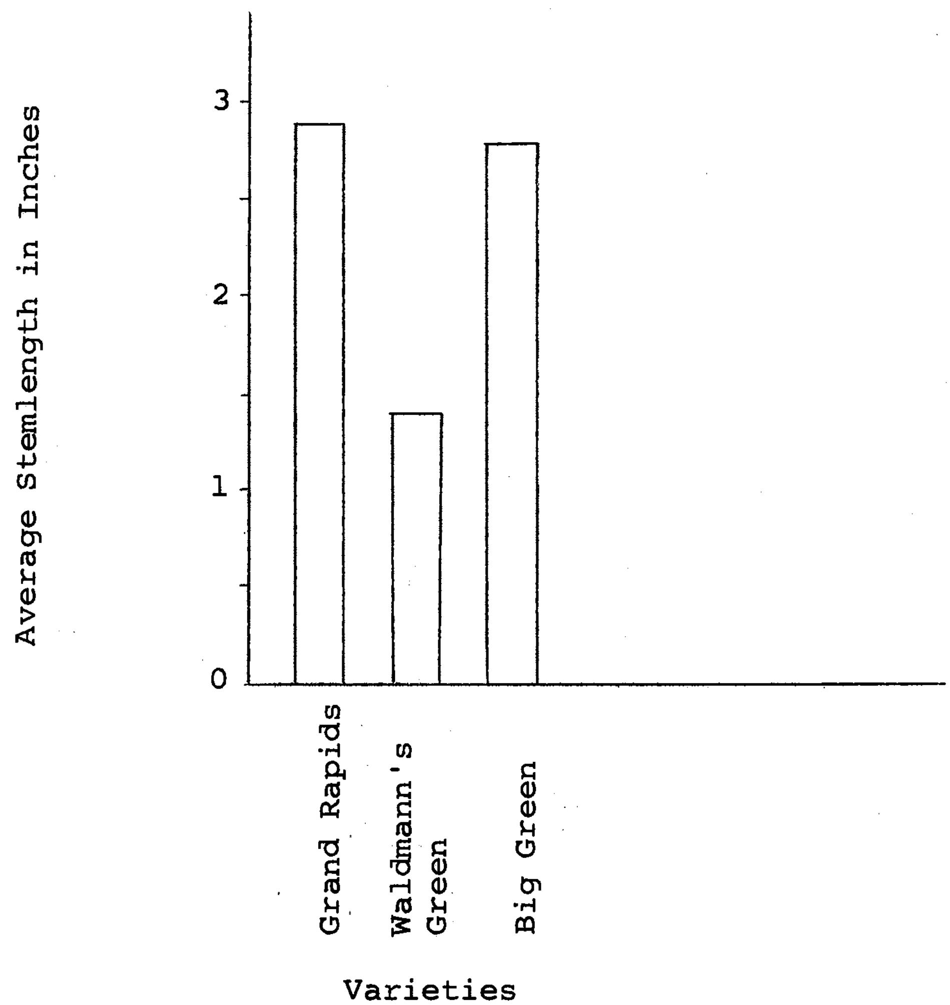


Figure 9. Effect of Spray Applications of Growth Retardants on the Average Stemlength of Different Varieties of Leaf Lettuce (Transplanted July 13, treated July 20, harvested August 10, 1971)

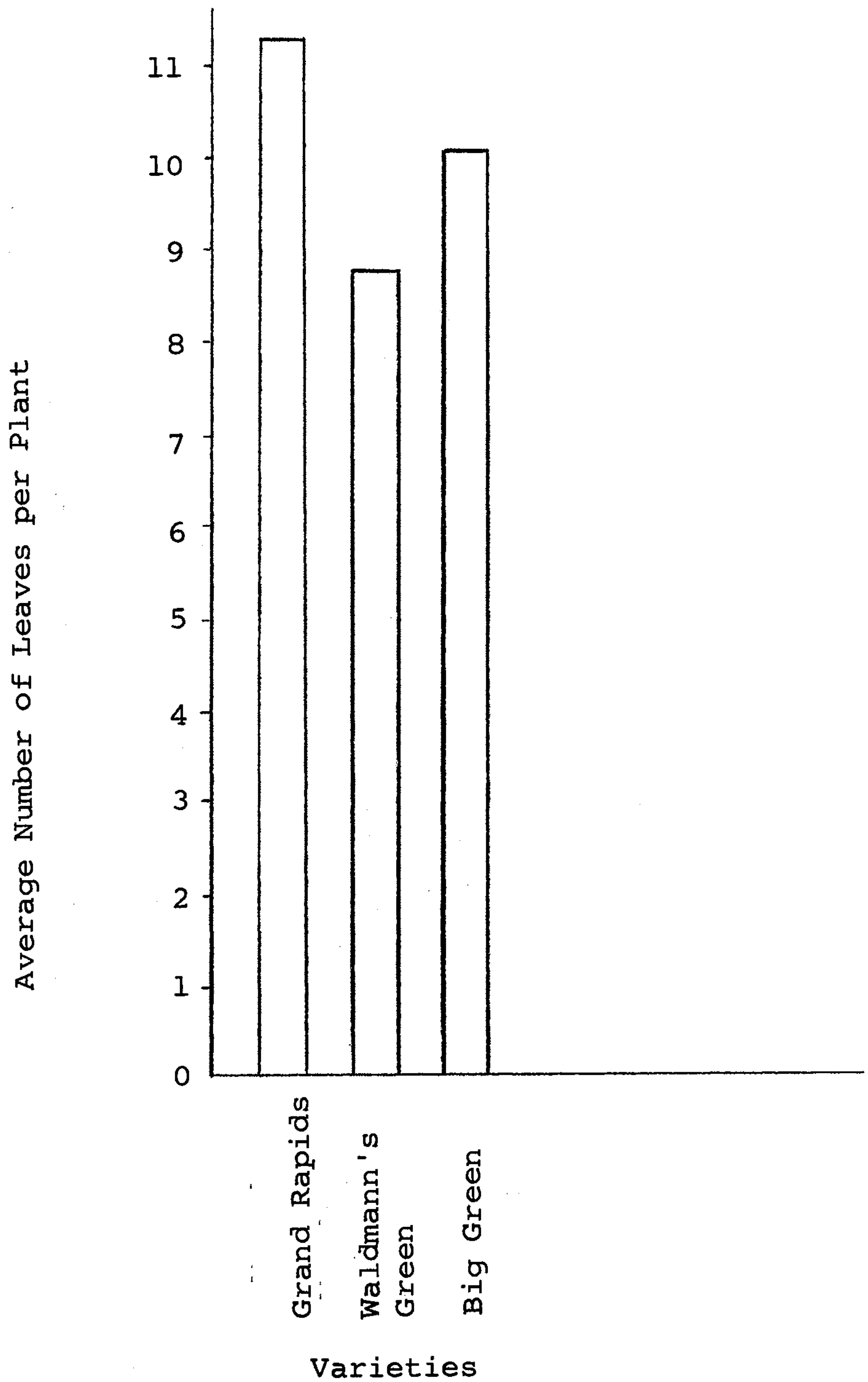


Figure 10. Effect of Spray Applications of Growth Retardants on the Number of Leaves per Plant of Different Varieties of Leaf Lettuce (Transplanted July 13, treated July 20, harvested August 10, 1971)

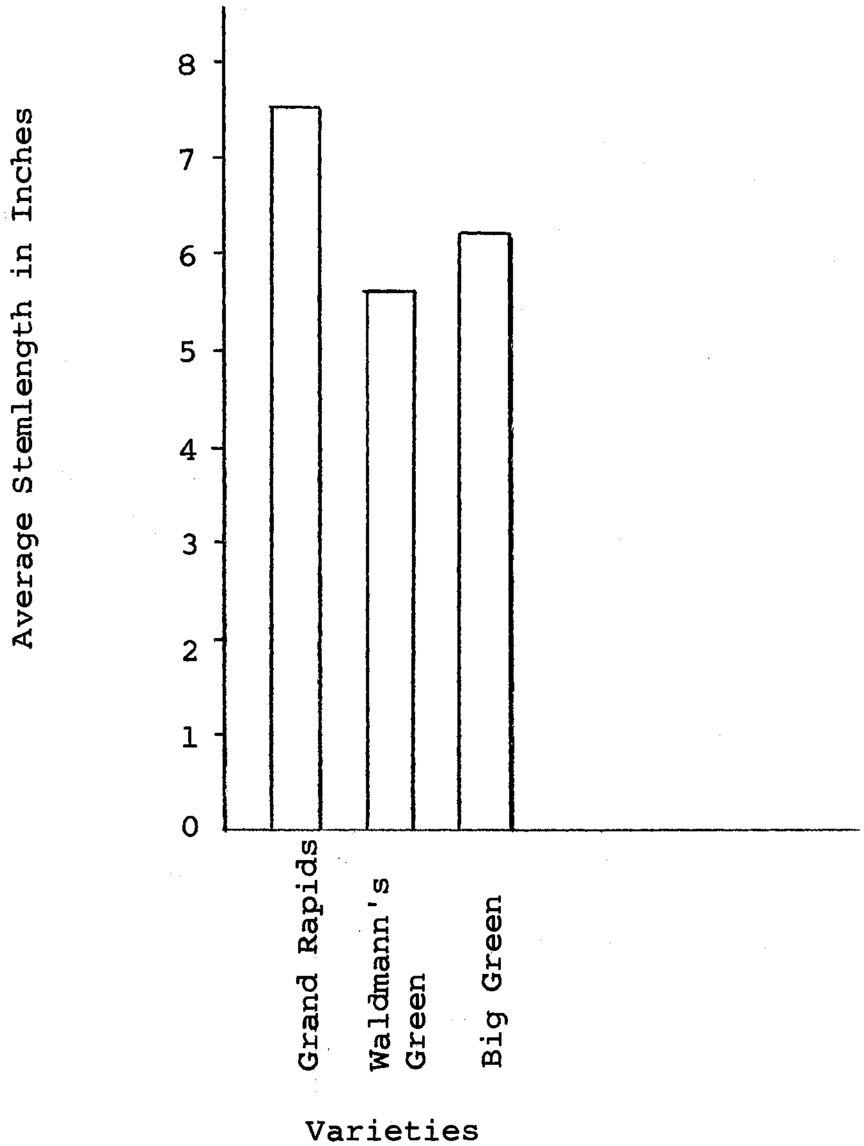


Figure 11. Effect of Spray Applications of Growth Retardants on the Average Stemlength of Different Varieties of Leaf Lettuce (Transplanted August 11, treated August 17, harvested September 6, 1971)

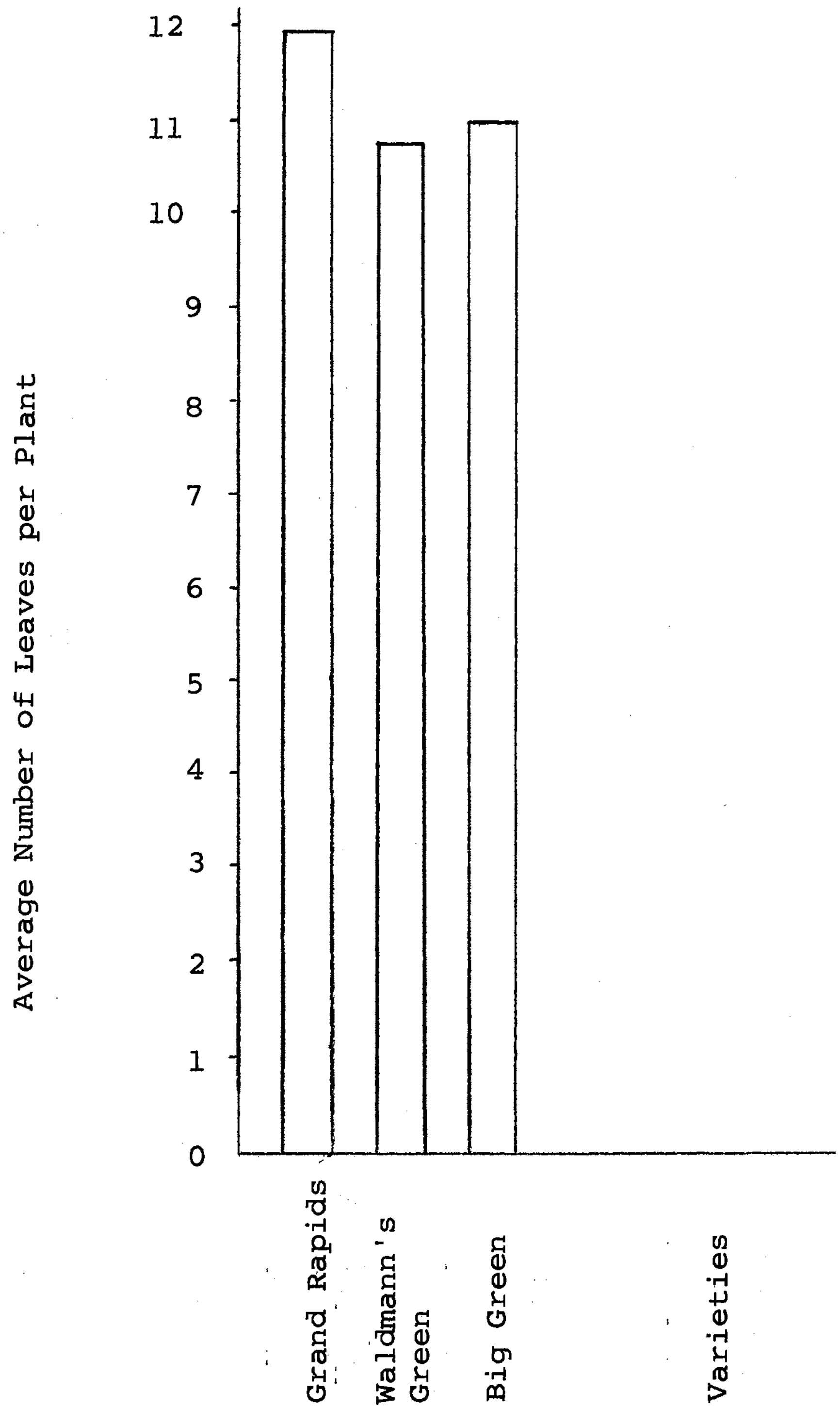


Figure 12. Effect of Spray Applications of Growth Retardants on the Number of Leaves per Plant of Different Varieties of Leaf Lettuce (Transplanted August 11, treated August 17, harvested September 6, 1971)

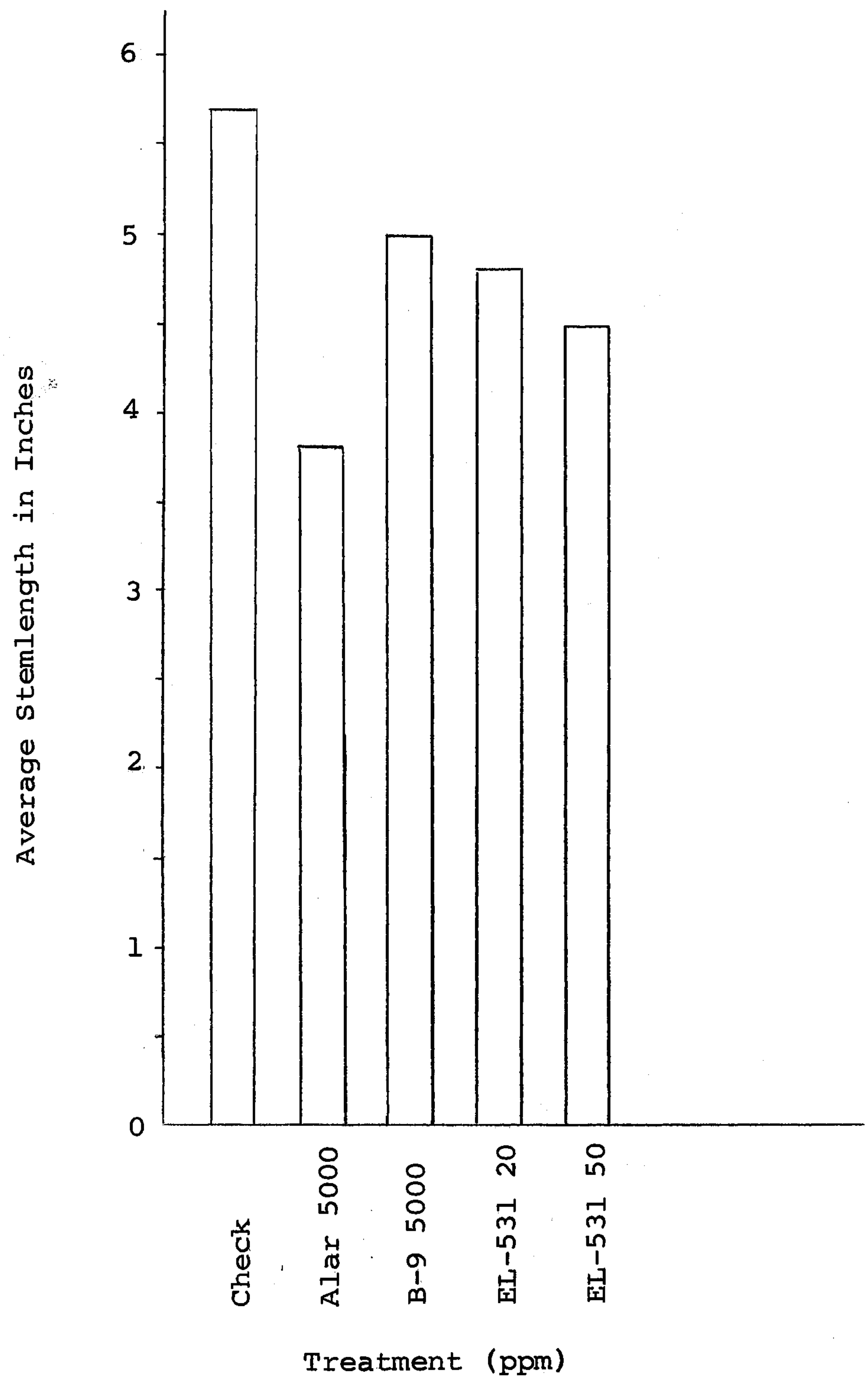


Figure 13. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on Stemlength of Leaf Lettuce Plants

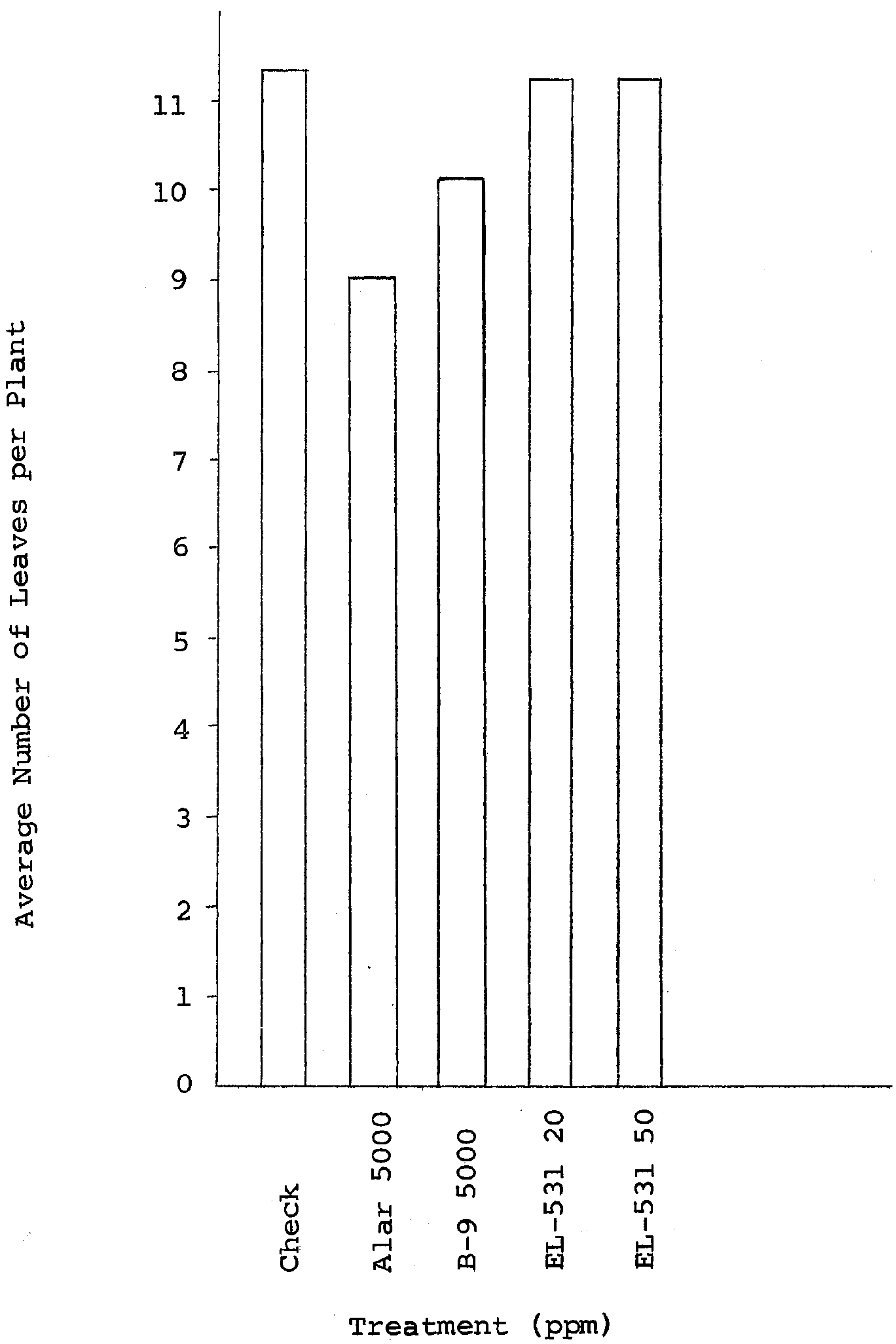


Figure 14. Effect of Spray Applications of Alar, B-9, and EL-531 at Various Concentrations on the Number of Leaves per Plant of Leaf Lettuce

September 6 produced the longest stems. These differences are shown in Figure 15. The time period of production also affected the average number of leaves per plant. Figure 16 shows that those plants produced during the period August 11 to September 6 developed the most leaves per plant, while the plants grown June 13 to August 10 produced the lowest number of leaves per plant. This is proportionally related to the stem length of the plants. This variation might be associated with age of the plants. The plants that were harvested July 27 were transplanted June 29, five weeks after sowing. They were treated two weeks after transplanting and harvested only two weeks after treating. The plants harvested August 10 were transplanted one week earlier than those harvested July 27 and September 6, and were harvested one week earlier than those of the two other dates of harvesting. The schedules for three trials are presented in Table IV.

The results of the study of the effects of Alar at different concentrations and the time of applications on Grand Rapids cultivar were variable. Figure 17 shows the application of Alar at 5,000 ppm one week after they were transplanted in the field caused the plants to be shortened. Whereas the treatment with Alar at 2,500 ppm when the plants were one, two or three weeks of age in the flats and again one week after they were transplanted in the field caused

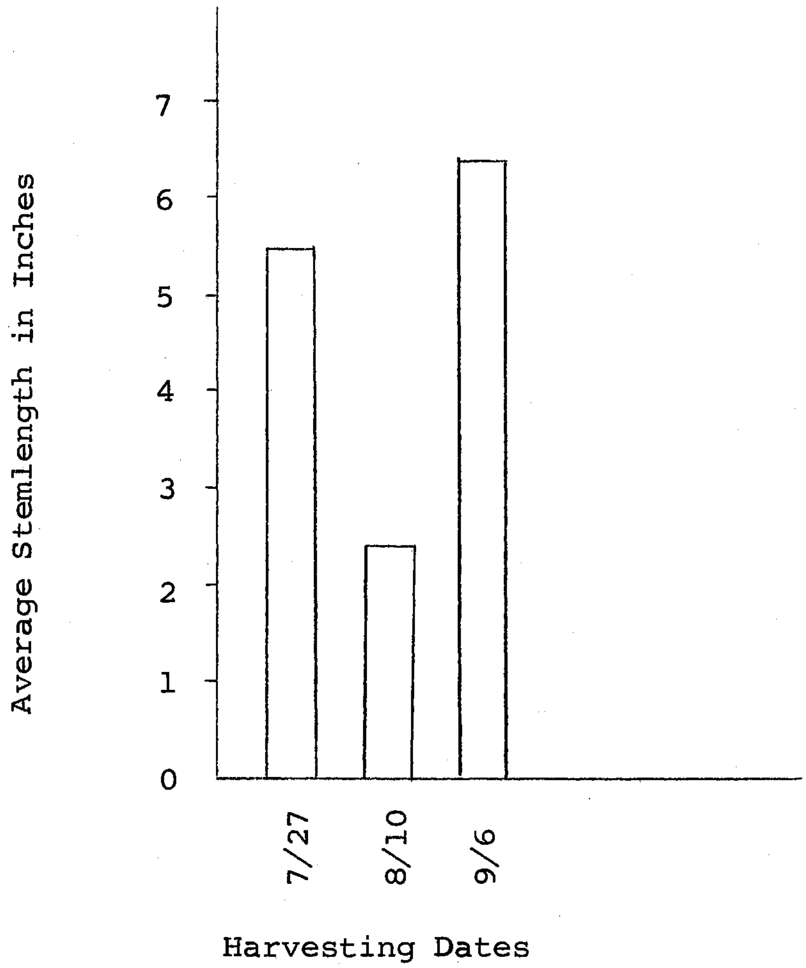


Figure 15. Effect of Spray Applications of Growth Retardants on Leaf Lettuce Plants as Affected by the Dates of Applications on the Stemlength

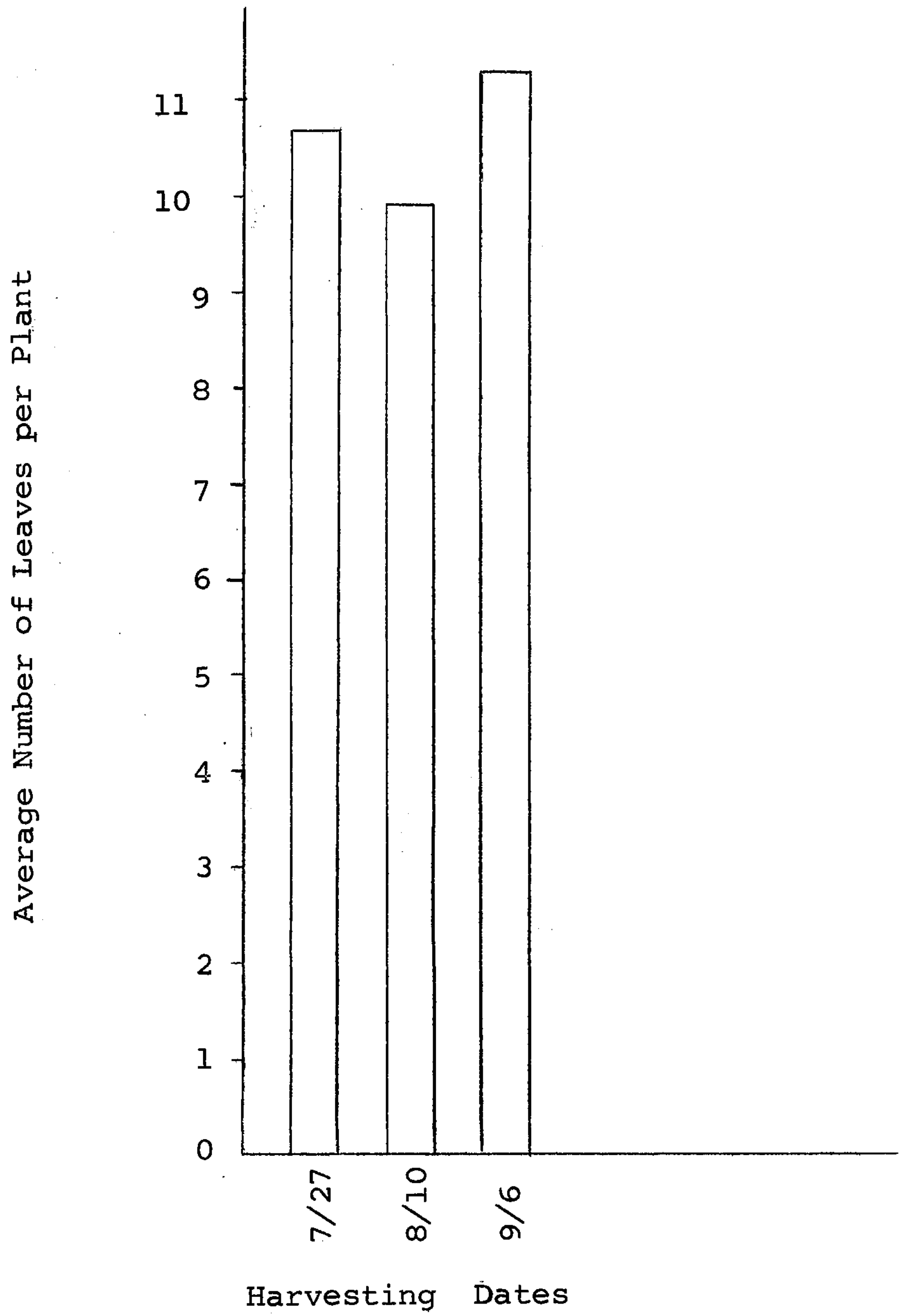


Figure 16. Effect of Spray Applications of Growth Retardants on Leaf Lettuce Plants as Affected by the Dates of Applications on the Average Number of Leaves per Plant

TABLE IV

THE SCHEDULE OF THE STUDY

Sowing	Weeks	Transplanting	Weeks	Treating	Weeks	Harvesting
May 25	5	June 29	2	July 11	2 + 2 days	July 27, 71
June 15	4	July 13	1	July 20	3	Aug. 10, 71
July 15	5	Aug. 11	1	Aug. 17	3	Sept. 6, 71

the plants to be shortened. This was in order of age when first treatment was applied, but they were taller than plants of the check treatment. In Figure 18 the effect of spray application of Alar on the number of leaves per plant is shown. Application of Alar at 2,500 ppm to plants when they were in flats at one, two or three weeks of age and another 2,500 ppm application one week after they were transplanted in the field caused the plants to produce more leaves than those of the check treatment. Treatment with Alar at 5,000 ppm on Grand Rapids leaf lettuce one week after they were set in the field resulted in less leaves per plant than did the check. It was also found that plants treated with Alar at 2,500 ppm when the seedlings were one, two or three weeks in the flats and retreated with 2,500 ppm one

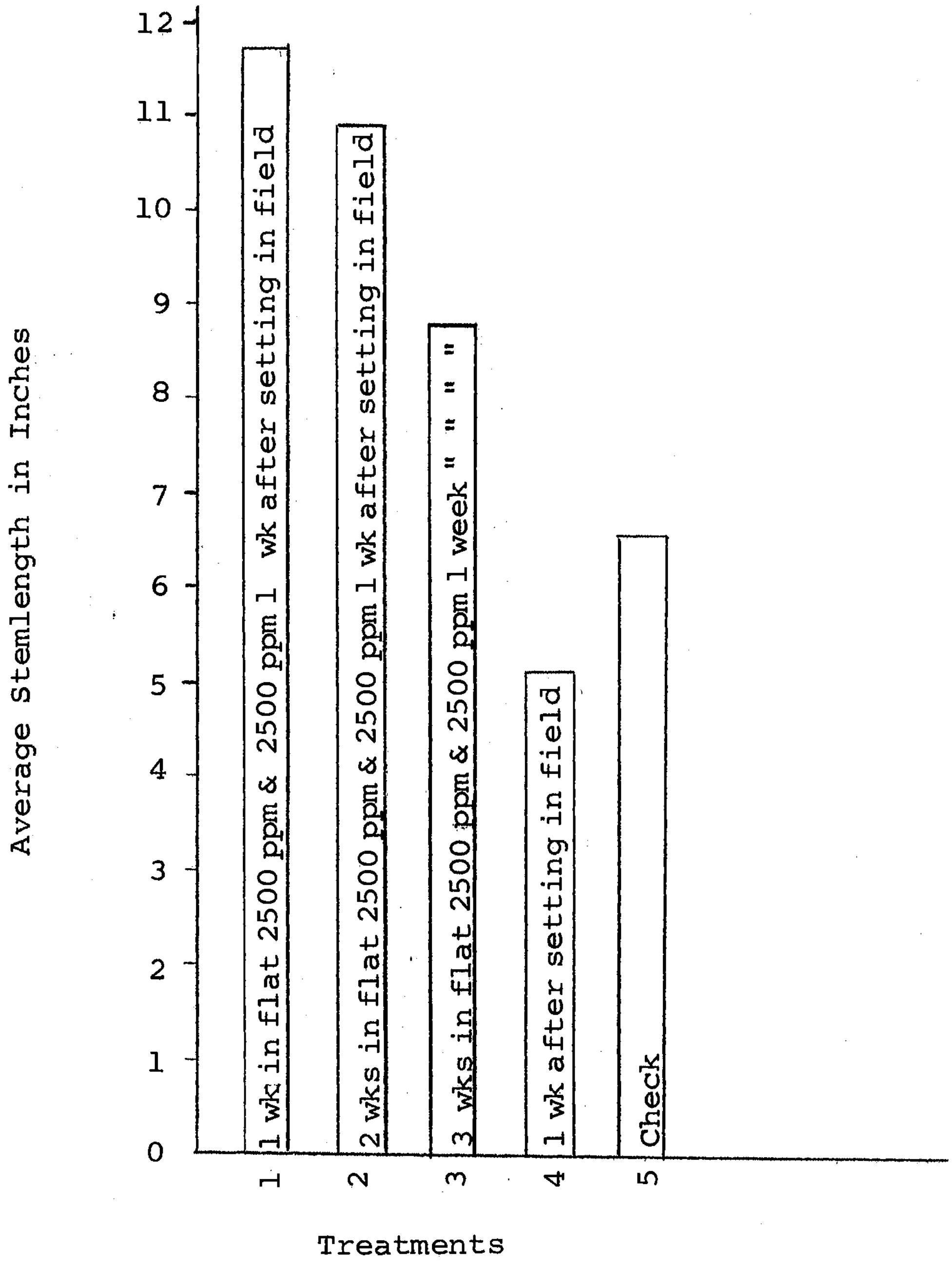


Figure 17. Effect of Spray Applications of Alar on the Average Stemlength of Grand Rapids Leaf Lettuce Plants

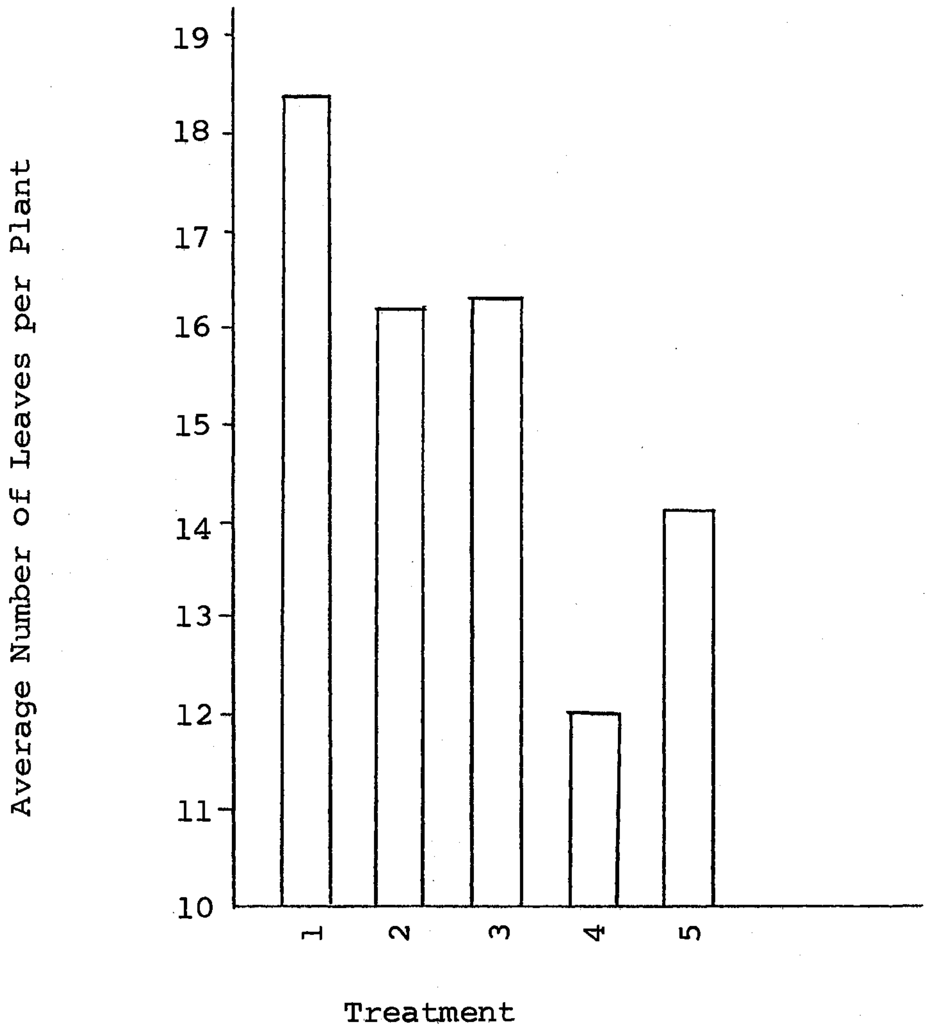


Figure 18. Effect of Spray Applications of Alar on the Average Number of Leaves per Plant of Grand Rapids Leaf Lettuce

week after they were set in the field was higher in weight than both check and those treated with Alar at 5,000 ppm one week after they were set in the field, as shown in Figure 19.

The results of the study of spray applications of various concentrations of BAS 0660W on the stem length and number of leaves per plant of leaf lettuce are shown in Figure 20. In general, increasing concentrations of the growth retardant reduced plant height of Grand Rapids as compared to that attained by the checks. All treatments caused the number of leaves per plant to be decreased (Figure 21).

The effect of spray treatment of Waldmann's Green and Big Green on plant height is shown in Figure 22 and Figure 23. In general, high concentrations of the retardant caused a reduction in plant height. Difference in height of plant between the check and treated plants did not appear to be due to a shortening of internodes since the number of leaves per plant was reduced. The same result was obtained on Big Green cultivar as shown in Figure 24 and Figure 25. The treated plants were normal in size and shape. After the treatments, all concentrations caused the leaves to develop marginal burn. The most serious marginal burn resulted from spraying with BAS 0660W at 5,000 ppm. Grand Rapids showed the most serious damage of this type. The bolting period was delayed. Waldmann's Green cultivar showed more delay in bolting and more uniform growth than the other two cultivars.

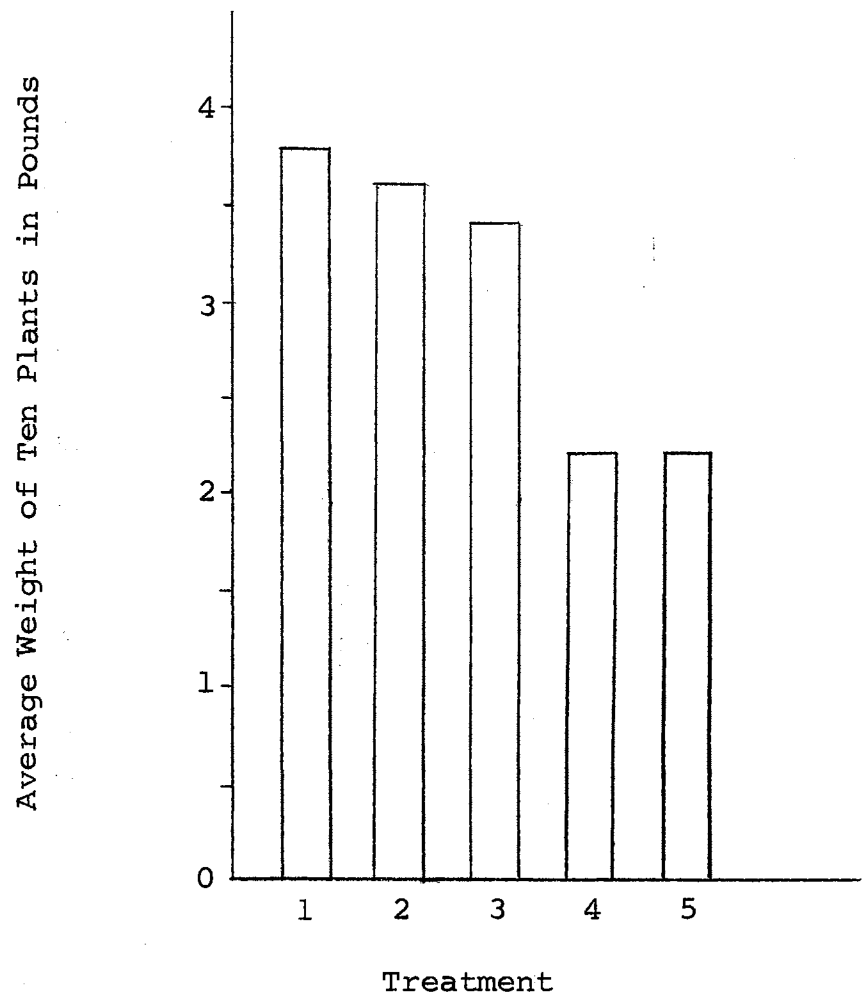


Figure 19. Effect of Spray Applications of Alar on the Average Weight in Pounds of Grand Rapids Leaf Lettuce Plants

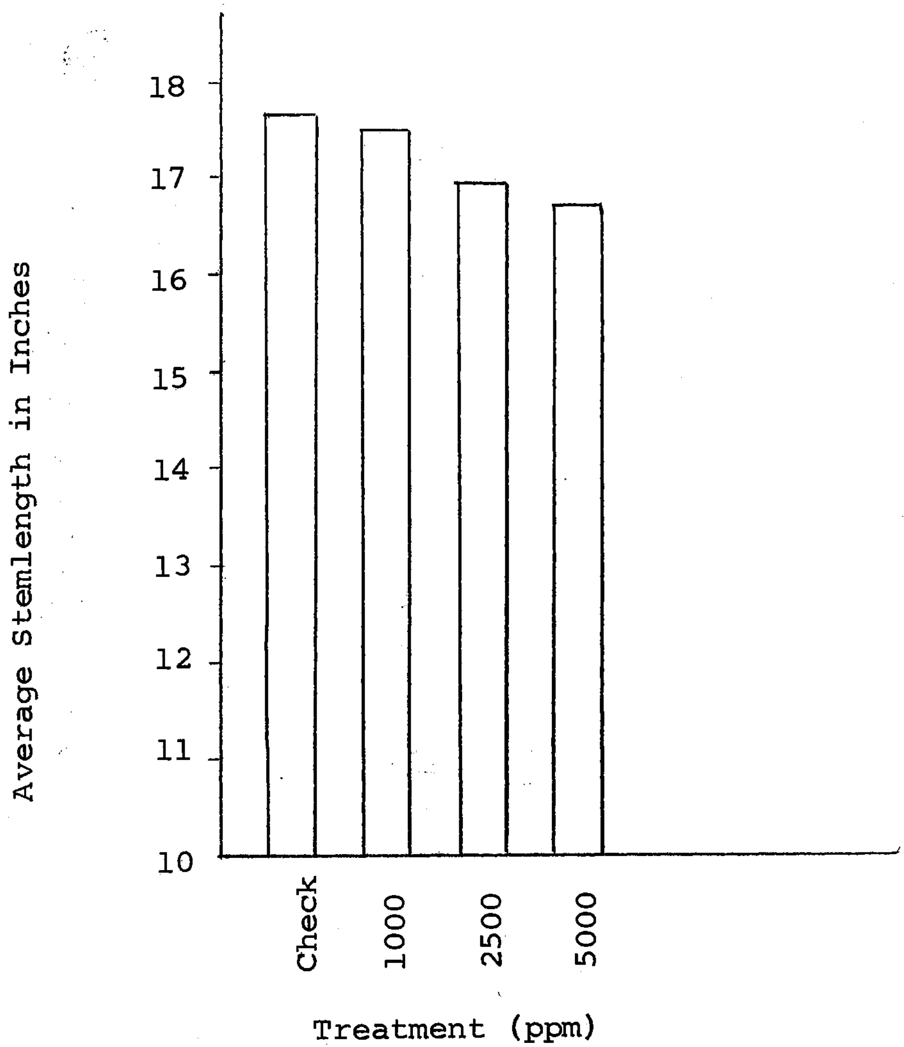


Figure 20. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Stemlength of Grand Rapids Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

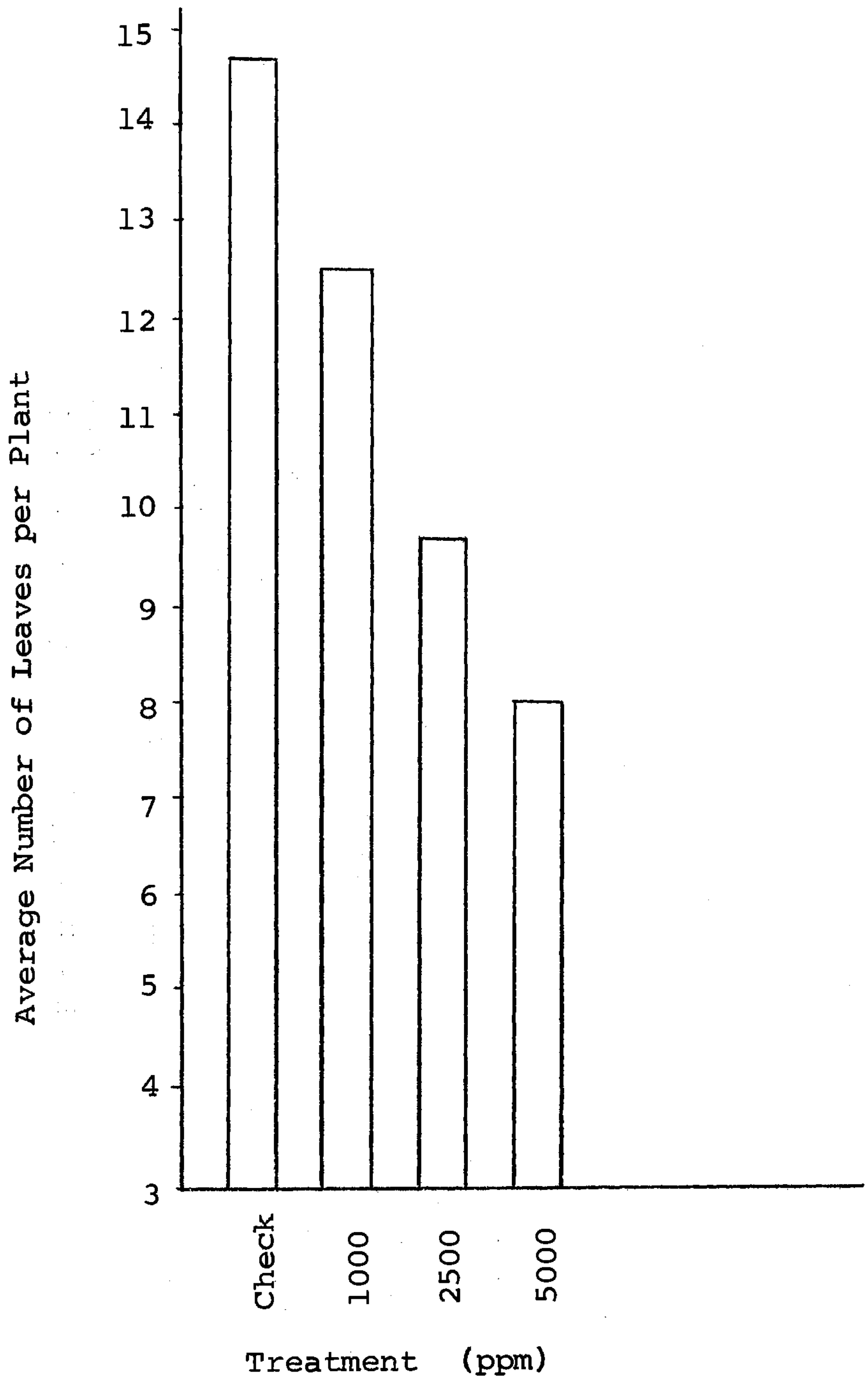


Figure 21. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Number of Leaves per plant of Grand Rapids Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

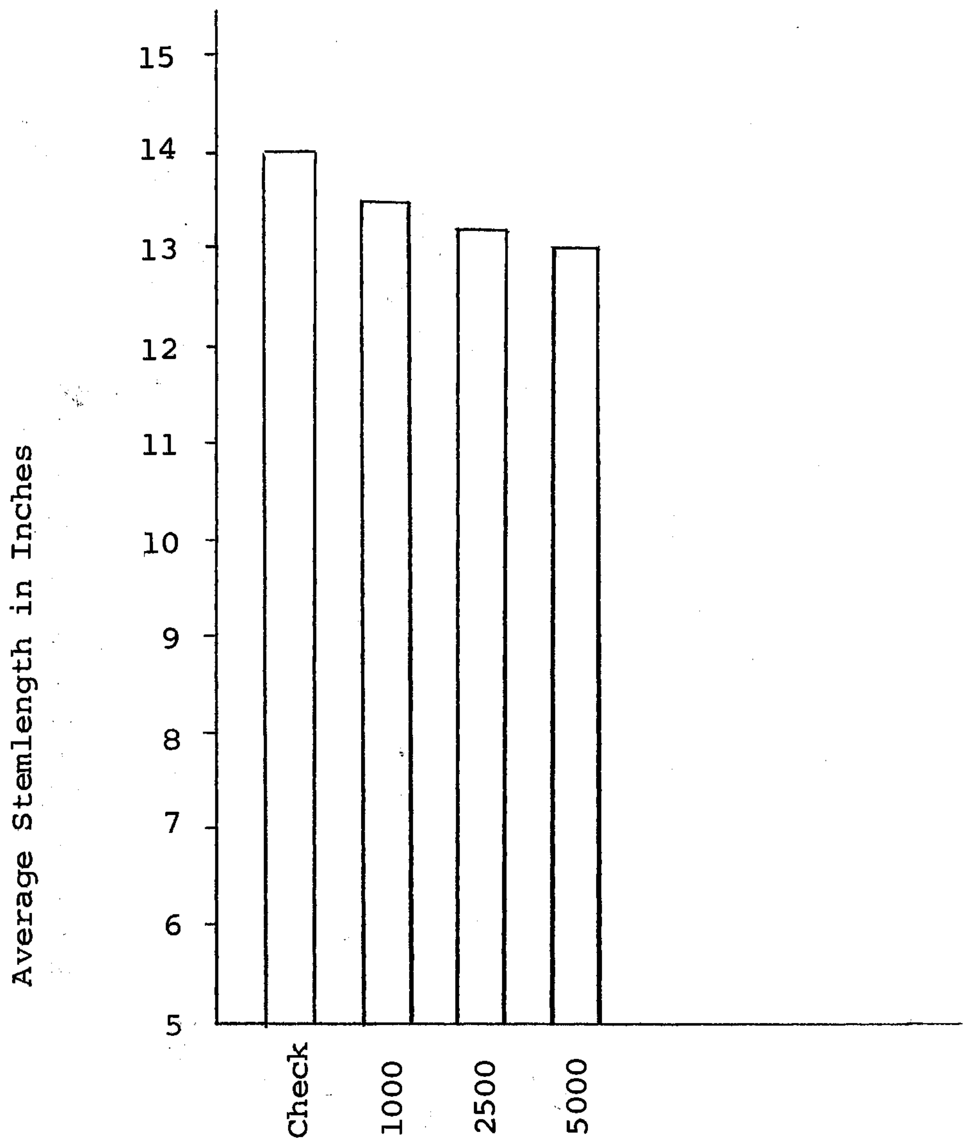


Figure 22. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Stemlength of Waldmann's Green Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

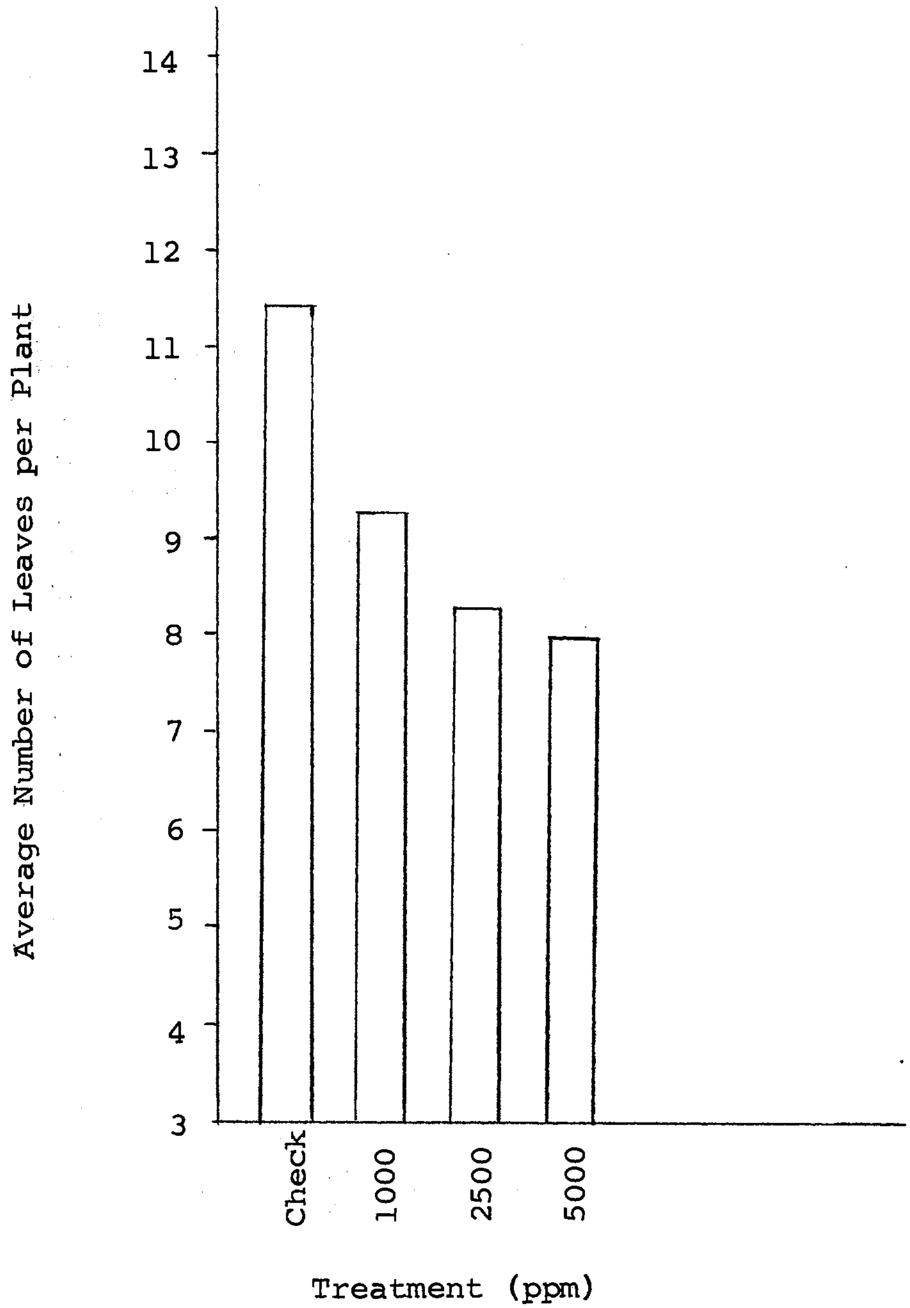


Figure 23. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Number of Leaves per Plant of Waldmann's Green Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

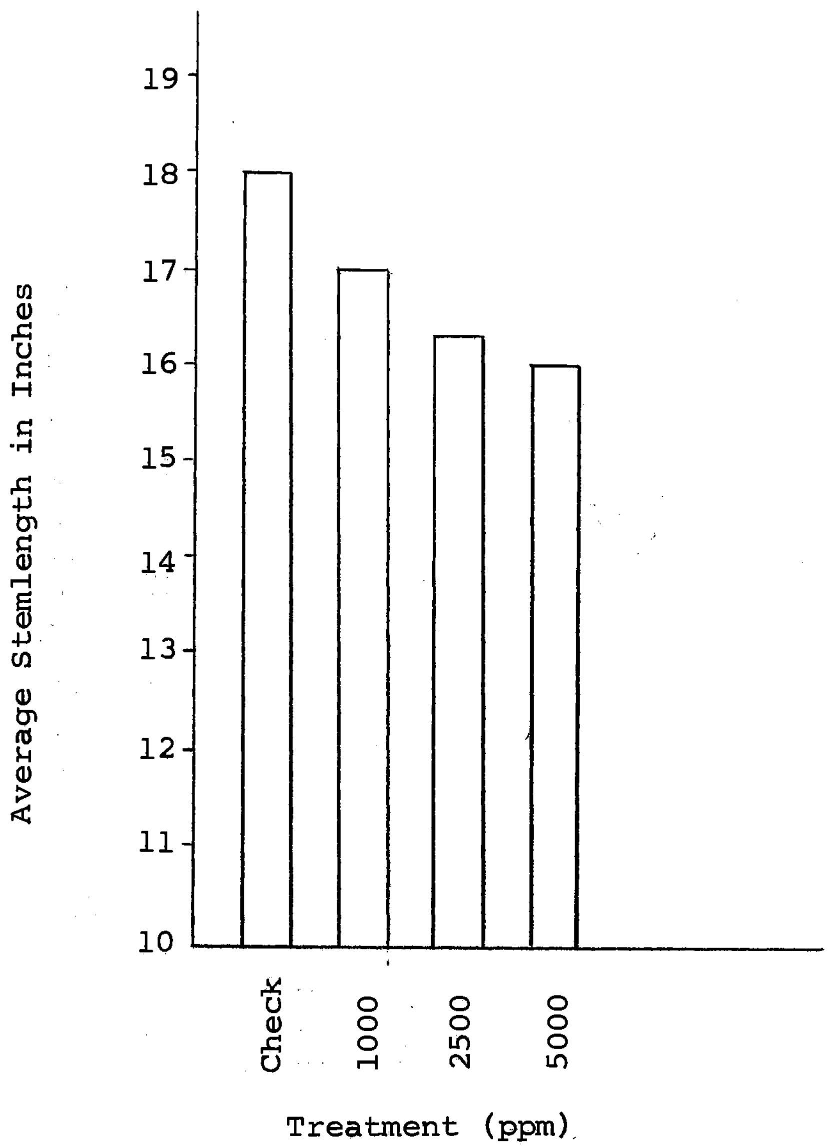


Figure 24. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Stem-length of Big Green Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

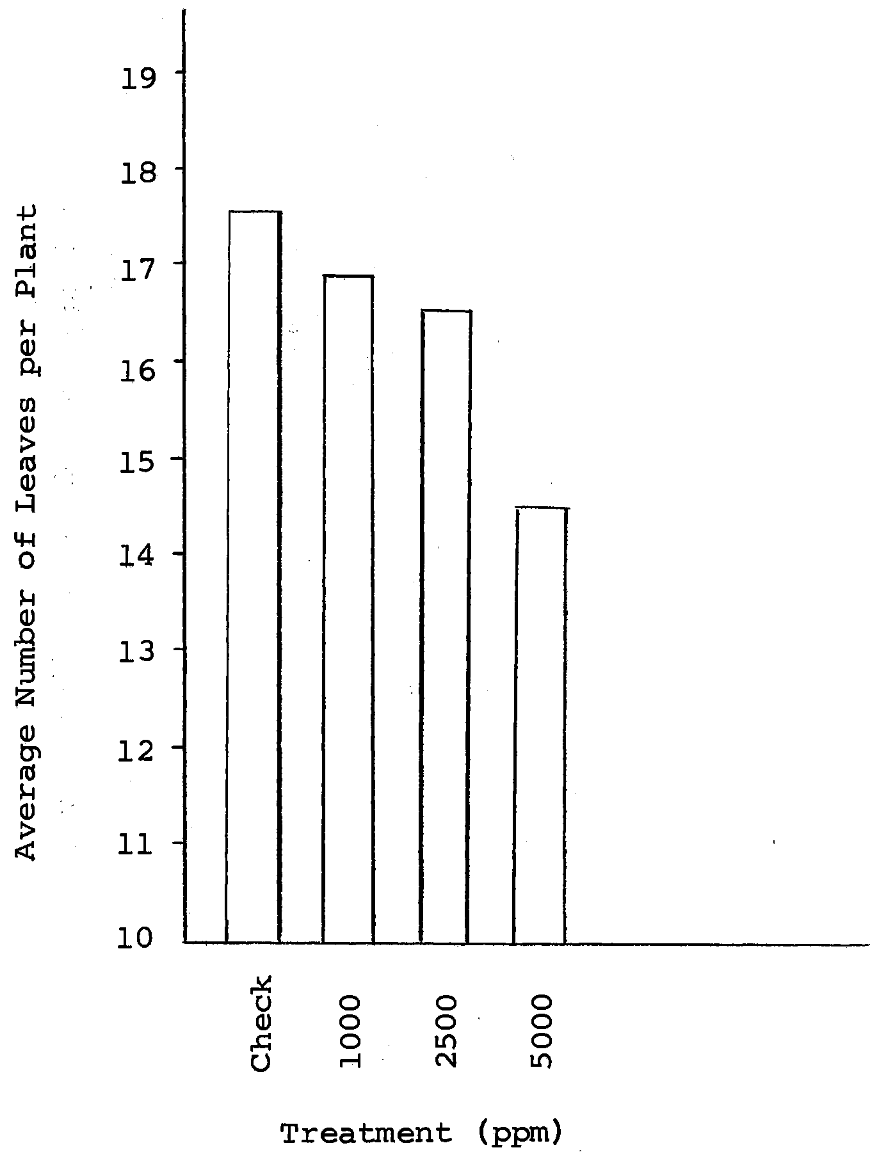


Figure 25. Effect of Spray Applications of Various Concentrations of BAS 0660W on the Average Number of Leaves per Plant of Big Green Leaf Lettuce Plants (potted July 11, treated July 15, harvested August 12, 1971)

CHAPTER V

DISCUSSION AND CONCLUSION

The production of leaf lettuce in Oklahoma can best be done during the cool months of the year due to the initiation and rapid development of seed stalks during the summer months (May through September). Treatment of leaf lettuce with spray applications of Alar, B-9 and EL-531 apparently activates some chemical change or changes within the plants which delays seed stalk initiation even when the temperatures are relatively high (70^{o} to 80^{o} F).

In the study reported herein, the treatment of leaf lettuce with spray applications of certain growth retardants satisfactorily suppressed the initiation of seed stalks. The increase in the number of leaves per plant was not expected, but this would be another advantage for the use of retardants on leaf lettuce. In general, the average weight of the treated plants was reduced due to the reduction of stem length. On the basis of this study, it is believed that growth retardants can be used to circumvent the effects of high temperatures in seed stalk development.

The treated plants were judged, by qualified dietitions, to be of better quality than the check plants. These decisions were based on the size, shape and color of the leaves. The leaves were more uniform in size. There were no extremely large or small leaves. The shape of the leaves was more compact due to the reduction in petiole length. This helped to reduce waste when lettuce plants were used. Thus, it can be concluded that all the growth retardant treatments tested produced plants that were more salable than check plants.

CHAPTER VI

SUMMARY

The studies reported herein related to the effect of spray applications of 5000 ppm of Alar, B-9 and various concentrations of EL-531 on certain phases of growth and development of leaf lettuce.

Four crops of outdoor grown leaf lettuce were sprayed with growth retardants the first week after transplanting in the field. The treated plants had shorter stems and the number of leaves were somewhat increased. The chemical treatments delayed bolting for several days, as compared to the check plants. All growth retardant treatments produced salable quality plants, although the Alar treatments produced the more desirable plants.

LITERATURE CITED

(1) Bukovac, M. J. and S. H. Wittwer. 1956. Gibberellic Acid and Higher Plants. General Growth Responses. Mich. Agr. Exp. Stat. Quart. Bul., 39:307-320.

(2) _____ and _____. 1958. Reproductive Responses of Lettuce (*Lactuca sativa*, variety Great Lakes) to Gebberellin as Influenced by Seed Vernalization, Photoperiod and Temperature. Proc. Amer. Soc. Hort. Sci., 71:407-411.

(3) Cathey, H. M. 1964. Physiology of Growth Retarding Chemicals. Ann. Rev. Plant Physiol., 15:271-302.

(4) Cleland, R. 1965. Evidence on the Site of Action of Growth Retardants. Plant and Cell Physiol., 6:7-15.

(5) Halevy, A. H. 1963. Interaction of Growth-retarding Compounds and Gibberellin on Indoleacetic Acid Oxidase and Peroxidase of Cucumber Seedling. Plant Physiol., 38:731-737.

(6) Harrington, J. F., L. Rappaport, and K. J. Hood. 1957. Influence of Gibberellins on Stem Elongation and Flowering of Endive. Science, 127:601-2.

(7) Johnson, Willis O. 1967. "The Effect of Certain Growth Retardants on Plant Growth and Seed Stalk Retardation of Leaf Lettuce" (Unpublished M.S. Thesis, Oklahoma State University) p. 82.

(8) Kende, H., H. Ninnemann and A. Lang. 1963. Inhibition of Gibberellic Acid Biosynthesis in Fusarium Moniliforme by AMO-1618 and CCC. Naturwiss, 50: 599-600.

(9) Kuraishi, S. and Robert Muir. 1963. Mode of Action of Growth Retarding Chemicals. Plant Physiol., 38: 19-24.

(10) Marth, P. C., W. V. Audie and J. W. Mitchell. 1956. Effect of Gibberellic Acid on the Growth and Development of Plants of Various Genera and Species. Bot. Gaz., 118:106-111.

(11) Raleigh, G. J. 1959. Effects of Varying Day and Night Temperatures on Seedstalk Elongation in 456 Lettuce. Proc. Amer. Soc. Hort. Sci., 73: 374-376.

(12) Rappaport, Lawrence and S. H. Wittwer. 1956. Flowering in Head Lettuce as Influenced by Seed Vernalization, Temperature and Photoperiod. Proc. Amer. Soc. Hort. Sci., 67:429-437.

(13) _____ and _____. 1956 Night Temperature and Photoperiod Effects on Flowering of Leaf Lettuce, Proc. Amer. Soc. Hort. Sci., 68:279-282.

(14) Reed, D. J., T. C. Moore and J. D. Anderson. 1965. Plant Growth Retardant B-995; A Possible Mode of Action. Science, 148:1469-1471.

(15) Riddell, J. A., H. A. Hageman, C. M. Anthony, and W. L. Hubbard. 1962. Retardation of Plant Growth by a New Group of Chemicals. Science, 136:391.

(16) Sachs, R. M., A. Lang, C. F. Bretz and J. Roach. 1960. Shoot Histogenesis, Subapical Meristematic Activity in Caulescent Plant and Action Gibberellic Acid and AMO-1618. Amer. Jour. Bot., 47:260-266.

(17) Stuart, N. W. 1961. Initiation of Flower Buds in Rhododendron After Application of Growth Retardants. Science, 134:50-51.

(18) Thomas, T. H. 1968. Effect of Growth Retardant CCC on Flowering, Seed Production and Performance of the Progency of Two Lettuce Species. Jour. Hort. Science, 43:400.

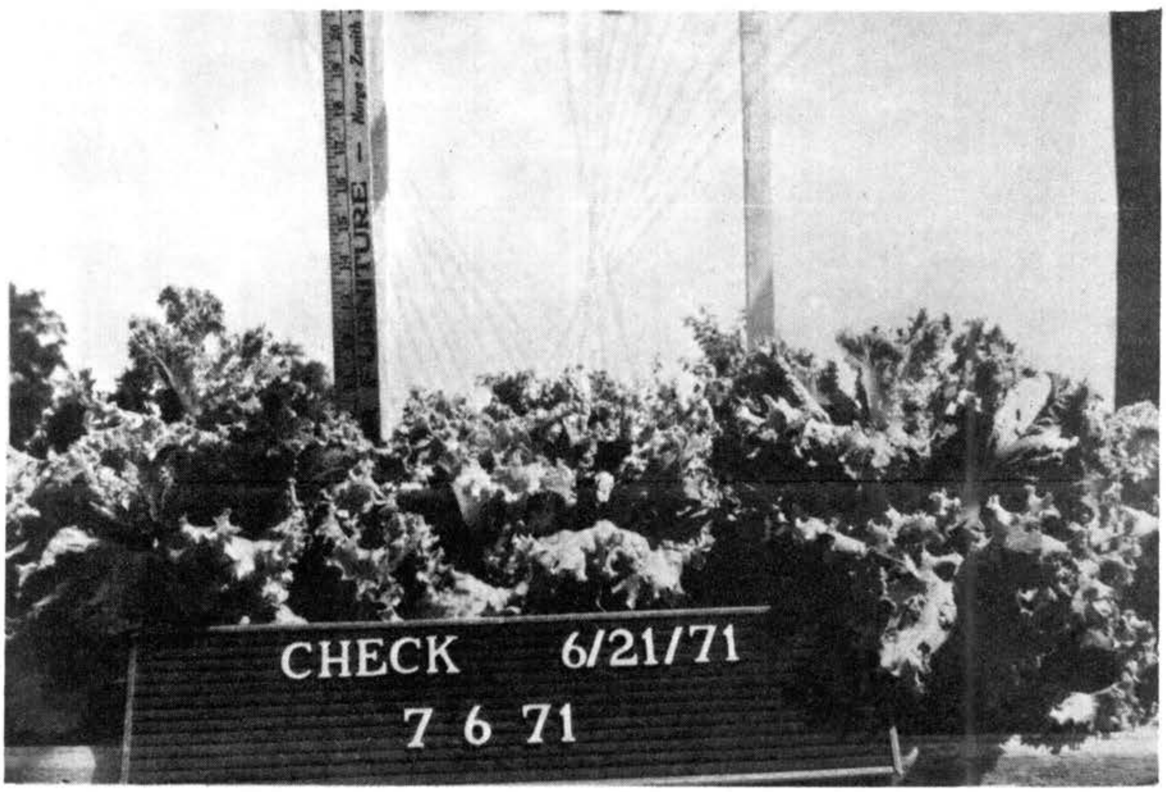
(19) Thompson, H. C. and J. E. Knott. 1930. The Effect of Temperature and Photoperiod on the Growth of Lettuce. Proc. Amer. Soc. Hort. Sci., 30:507-509.

(20) Tobbert, N. E. 1960. 2-Chloroethyltrimethyl ammonium chloride and Related Compounds as Plant Growth Substances. II. Effects on Growth of Wheat. Plant Physiol., 35:380-385.

(21) Wirwille, J. W. and J. W. Mitchell. 1950. Six New Plant Growth Inhibiting Compounds. Bot. Gaz., 111:491-494.

APPENDIX A

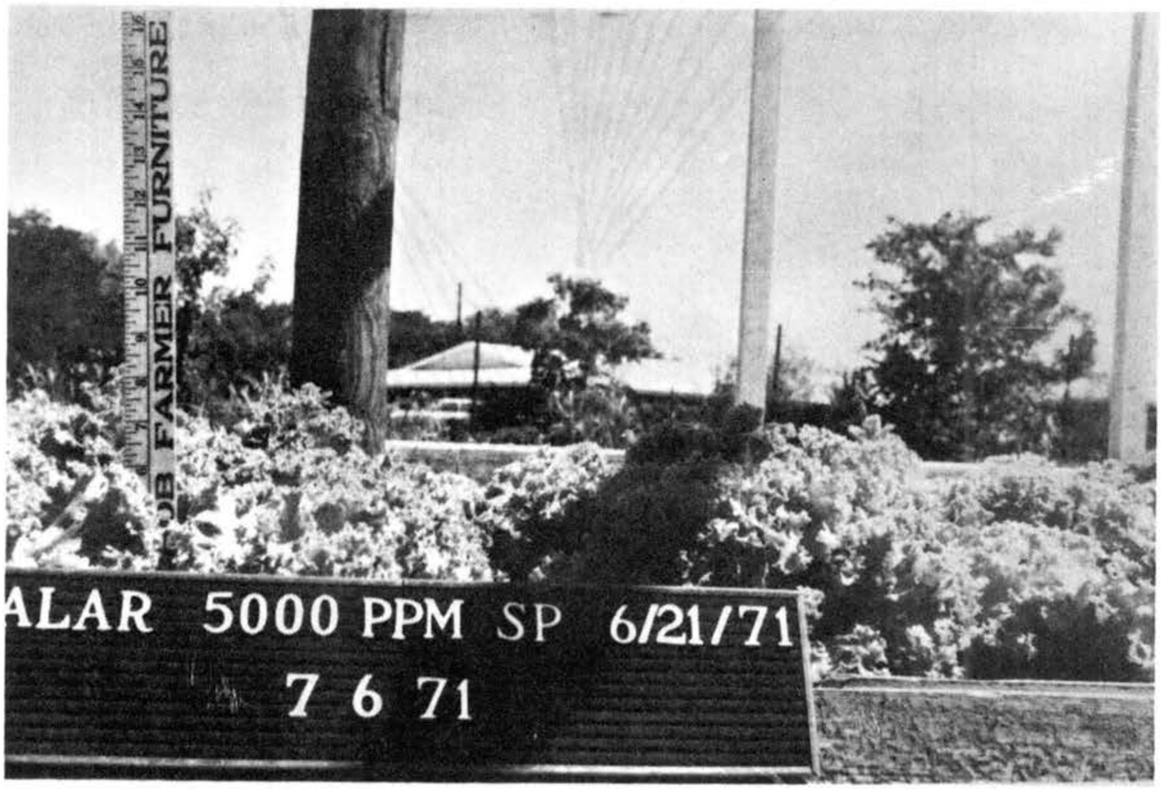
UNTREATED PLANT HEIGHT



Plant height and bolting characteristics of Grand Rapids leaf lettuce plants not treated with retardants.

APPENDIX B

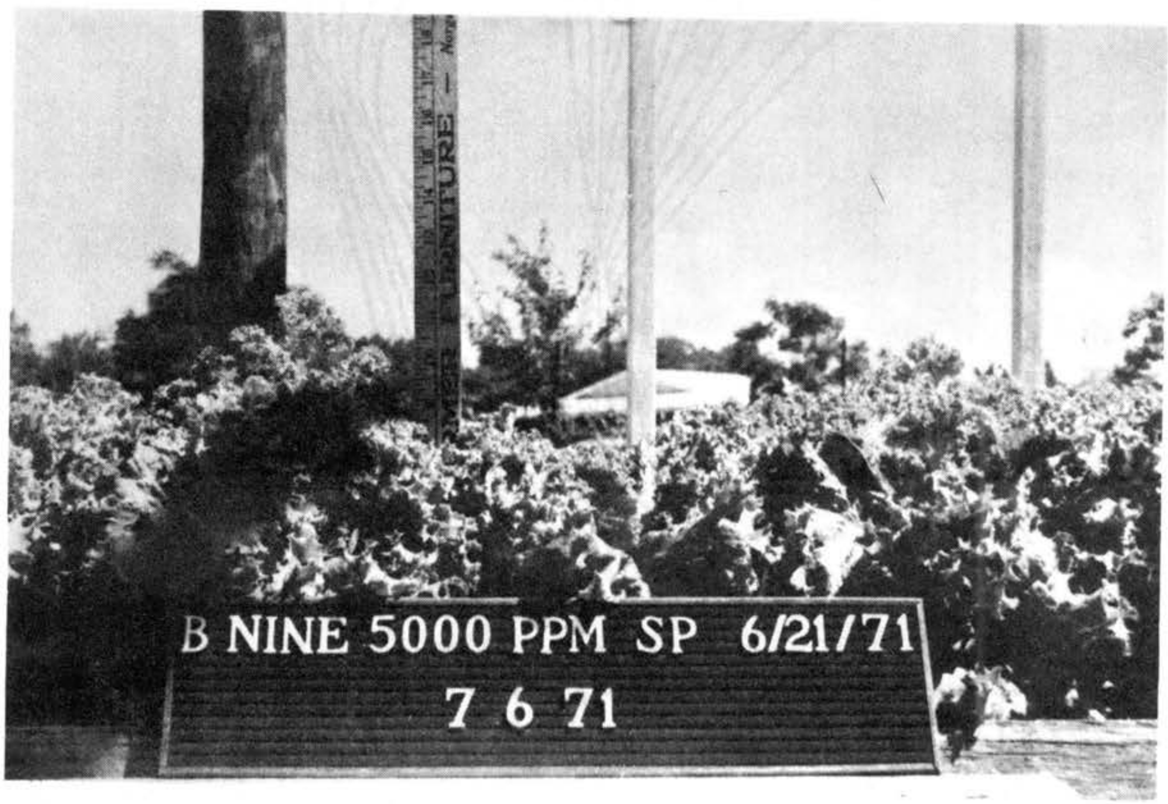
THE EFFECT OF ALAR ON PLANT HEIGHT OF LEAF LETTUCE



The treatment of Alar 5000 ppm on the plant height of Grand Rapids leaf lettuce.

APPENDIX C

THE EFFECT OF B-9 ON PLANT HEIGHT OF LEAF LETTUCE



The treatment of B-9 at 5000 ppm on plant height of Grand Rapids leaf lettuce.

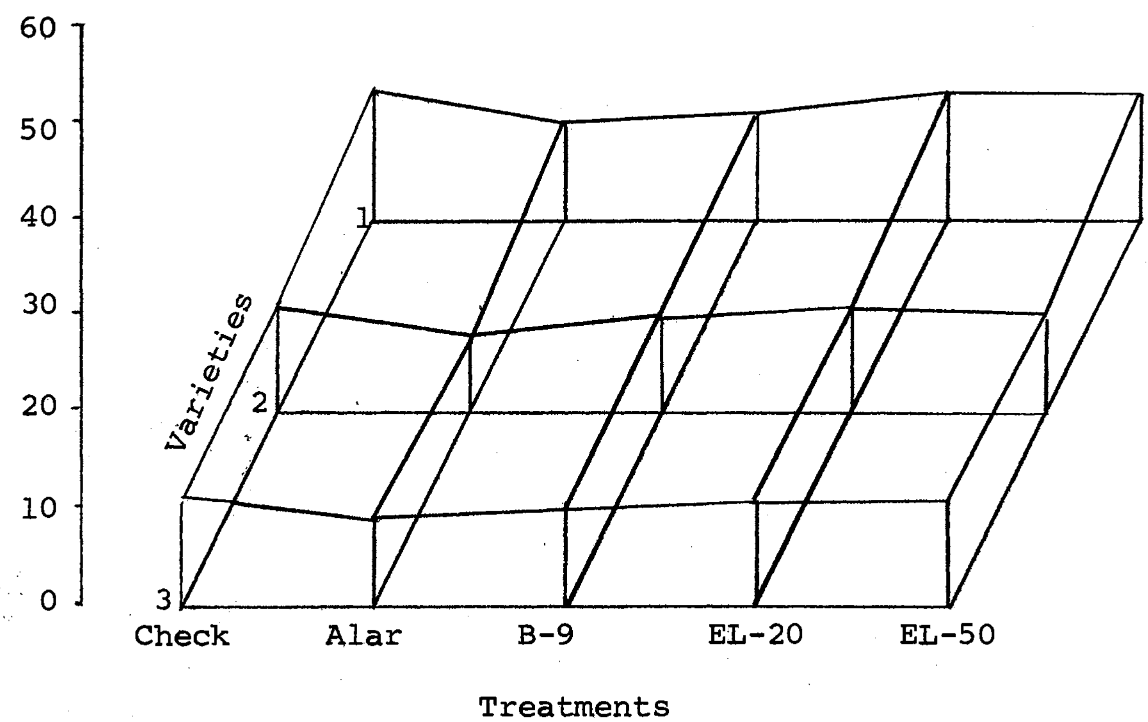
APPENDIX D

THE EFFECT OF B-9 ON PLANT HEIGHT OF LEAF LETTUCE

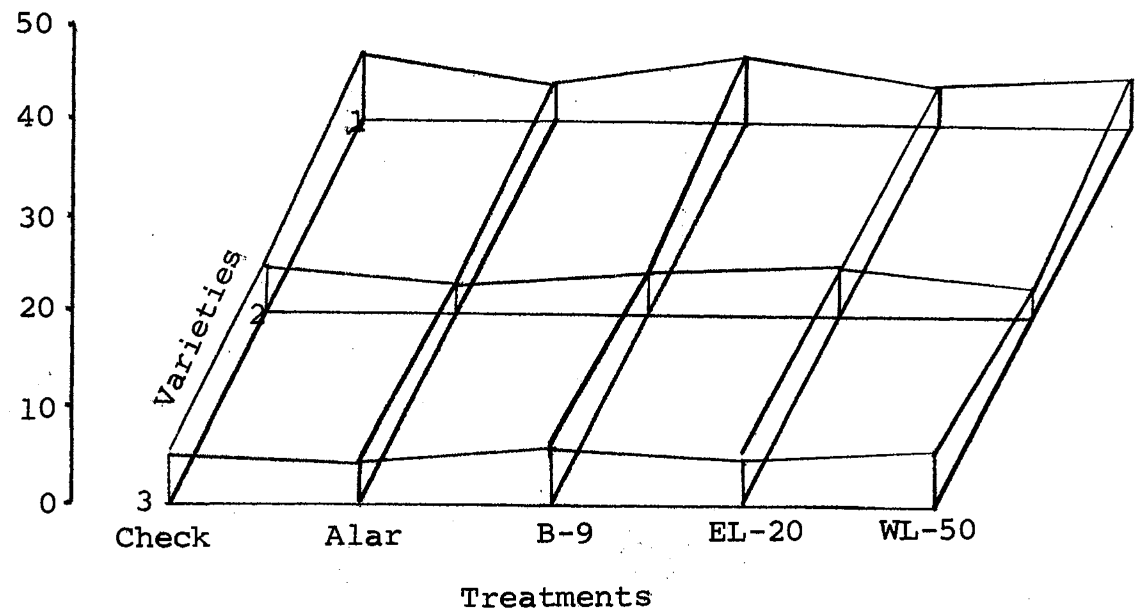
The treatment of B-9 at 5000 ppm on plant height of Grand Rapids leaf lettuce.

APPENDIX E

THE EFFECT OF VARIOUS GROWTH RETARDANTS ON THE NUMBER OF LEAVES PER PLANT OF LEAF LETTUCE PLANTS



THE EFFECT OF VARIOUS GROWTH RETARDANTS ON STEMLENGTH OF LEAF LETTUCE PLANTS



VITA

Sampan Asakit

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF CHEMICAL GROWTH RETARDANTS ON LEAF LETTUCE GROWN UNDER HIGH TEMPERATURES

Major Field: Horticulture

Biographical:

Personal Data: Born in Chiengmai, Thailand, July 4, 1934, the son of Mr. Duang and Mrs. Sun Asakit.

Education: Graduated from Chiengmai Agricultural College, Chiengmai, Thailand in 1958; received Bachelor of Science in Agricultural Education from Central Luzon State University, Nueva Ecija, Philippines in May 1966; completed requirements for the Master of Science degree in July 1972.

Professional Experience: Teacher of Buriram Agricultural School, Buriram, Thailand, from 1959 to 1972.

Professional Organizations: Horticulture Club, Oklahome State University.