PHYSIOLOGICAL STUDIES OF THE SWEETPOTATO (IPOMOEA BATATAS)

PHASE I
EFFECTS OF CHEMICAL TREATMENTS ON SPROUT PRODUCTION

PHASE II
CHEMICAL INDUCTION OF FLOWERING

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

Monticello Jefferson Howell

1956

THESIS

This is to certify that the

thesis entitled

Physiological Studies of the Sweetpotato (Ipomoea Batatas). I. Effects of Chemical Treatments on Sprout Production. II. Chemical Induction of Flowering

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Monticello Jefferson Howell

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AN ABSTRACT

Submitted to the School for Advanced Graduate Studies of
Michigan State University of Agriculture and Applied Science
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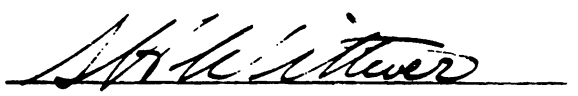
Approved 

THESIS

Two physiological studies of the sweetpotato were conducted during a three-year period from 1953 to 1955, inclusive. The first phase involved the effects of certain chemical treatments applied to the roots on subsequent sprout production for propagation purposes, whereas the second phase dealt with the chemical induction of flowering in sweetpotato plants representing several varieties from foliar applications of 2,4-dichlorophenoxyacetic acid. In 1953, maleic hydrazide (MH-30) and alpha-cyano-beta-(2,4-dichlorophenyl) acrylic acid (B-214) each at concentrations of 10, 100, and 1000 ppm were applied as aqueous solutions to roots of Porto Rico and Goldrush sweetpotatoes by injecting round toothpicks previously impregnated with the solutions containing the chemicals into the roots. Two control comparisons were used. One consisted of roots in which toothpicks previously impregnated with distilled water were injected, while the other involved sweetpotato roots which were not treated. The roots were bedded according to usual practices and the total number and weights of the sprouts as related to treatment and variety were recorded per bushel of bedded roots. Roots of Porto Rico, Goldrush, Yellow and Orange Jersey were similarly treated in 1954 with the sodium salt of maleic hydrazide (MH-40) at concentrations of 100, 250, and 1000 ppm; an emulsifiable concentrate formulation of alpha-cyano-beta-(2,4-dichlorophenyl)

acrylic acid (B-214C) at concentrations of 10, 100, and 1000 ppm; and 2,4-dichlorophenoxyacetic acid (2,4-D) at 10 ppm.

No significant differences in total number of sprouts produced were found in 1953 between treatments. However, B-214 at a concentration of 1000 ppm significantly decreased the weights of sprouts produced by both varieties. Similarly, in 1954 marked differences in sprouting behavior were noted among varieties, but not from treatments. The anticipated improvement in sprout production was not realized in these tests.

Foliar sprays of 2,4-D in concentrations of 100 and 500 ppm, applied to Porto Rico and Goldrush sweetpotato plants in September, 1953, at the time of the initial enlargement of the fleshy roots successfully induced flowering 6 to 8 weeks later. Flowering was general and occurred among plants of both varieties which were treated at two different dates. Similarly, sprays of the sodium salt of 2,4-D from concentrations of 100 to 500 ppm were also effective for inducing flowering in plants of Porto Rico and Yellow Jersey varieties during the fall of 1954. Flowering was general and was associated with a significant depression of storage root growth. The distribution of flowering in the Porto Rico plants was from the 20th to the 64th nodes, whereas in Yellow Jersey it was from the 20th to the 74th nodes. Flowering in Porto Rico was greatest among plants which received 2,4-D at a

concentration of 500 ppm; however, in the Yellow Jersey 100 ppm was best. Concentrations higher than 100 ppm inflicted severe injury on Yellow Jersey.

In 1955, the sodium salt of 2,4-D at concentrations of 100 to 500 ppm again proved effective for the induction of flowering in Porto Rico and Yellow Jersey plants. Of all the plants treated (irrespective of variety), thirty-eight percent flowered, with the greatest number of flowers occurring at 250 ppm. Flowers were more abundant with Yellow Jersey. In all cases, flowering was associated with a significant depression of fleshy root growth, and tumefactions at the nodes of the main stems and laterals were common. Impeded transport was apparent. An attempt was made to show if there was a relationship between flowering response in treated plants and carbohydrate-nitrogen metabolism in the leaves. Chemical analyses of treated and control plants showed no differences in total sugars in leaves collected 4 and 20 days after treatment either between varieties or among treatments. However, treatments with 2,4-D significantly decreased total nitrogen in leaves collected 4 and 20 days after sprays were applied.

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FOREWORD

The investigations are classified under two headings. Phase I deals with the effects of certain chemical treatments on sprout production of different varieties of sweet-potatoes, whereas Phase II involves the chemical induction of flowering in certain varieties.

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PHASE I

EFFECTS OF CHEMICAL TREATMENTS ON SPROUT PRODUCTION

INTRODUCTION

The sweetpotato (Ipomoea Batatas, Lam.) is normally a long-trailing perennial with deep tuberous roots (1). However, there are certain varieties which are characterized by having very short vines. These are often referred to as "bunch" or "bush" type sweetpotatoes. The leaves of the sweetpotato are alternate and usually heart-shaped or some modification of this, a characteristic used to identify varieties as is also the purple pigment in the leaves (43). Sweetpotatoes according to their enlarged roots (30) may be classified as (a) dry and (b) moist in texture after baking. The moist type is frequently, but incorrectly, called yams. True yams are "monocots" of the family Dioscoraceae and are rarely grown outside of the tropics. Some roots of the true yam if allowed to grow for a year or more may weigh as much as 50 to 100 pounds (43). In the southern United States the sweetpotato is one of the principal vegetable foods for human consumption, and it very often replaces the Irish potato in these regions. Moreover, it is utilized to a considerable extent as a feed for livestock.

It has been known for a long time that certain varieties of sweetpotatoes have a characteristically strong proximal

dominance. This is particularly true among bush varieties. The extreme bush habit of a variety is reflected in a tendency to produce exclusively a few terminal sprouts when roots are bedded in the usual manner (68). Therefore, it is necessary to subdivide these terminal sprouts as a means of increasing the number of plants produced per bedded root or per bushel of roots. Consequently, more roots must be bedded than would be necessary with a more vining sweetpotato variety to produce an equivalent number of sprouts.

It appears, therefore, that the development of some effective means for altering the sprouting behavior of certain varieties of sweetpotatoes would be of tremendous economic importance to growers who prefer varieties which have an inherently strong proximal dominance. This altering of the sprouting habit of a variety could possibly result in increasing the number, size, and weight of plants to be used for propagation purposes. Certain chemical methods, such as pre-bedding treatment of the roots with growth regulators might be employed to advantage. It was with these considerations in mind that this phase of the investigation was undertaken.

REVIEW OF LITERATURE

Correlations - Growth correlation, according to Loomis (42), refers to the relation of one plant part or type of development to another part or type of development. The influence one part of a plant (or a portion of a plant organ) has upon another organ or part is in many instances very great. For example, in the propagation of fruit trees, a certain type of stock has a dwarfing effect upon the scion species (28), and cabbage plants may be kept alive for two years or longer by encouraging vegetative growth (49, 73). Growth correlation may exist between vegetative and reproductive growth, also between the processes of growth and differentiation (42).

A more extreme type of correlation in plants is a condition in which certain parts of a plant exert a controlling influence on other parts. This is called dominance. The phenomenon referring to the suppression of lateral bud growth by the terminal bud is designated as apical dominance (4). Likewise, the phenomenon in which the proximal portion of a plant organ has controlling influence over other parts is known as proximal dominance.

Apical dominance has been detected in Irish potato tubers. If a whole tuber is planted, sprouts will arise only from the apical end, whereas the eyes farthest from the apex

appear to remain dormant. However, when the tuber is cut into segments, sprouts arise from each portion in which eyes are left.

Maximov (45) has suggested that correlations may be phenomena of a hormonal character, i.e., that growth is regulated by means of specific chemical agents. This concept implies that near the apical portion of a stem or near the proximal portion of a root there is elaborated some special substance which when translocated inhibits cell division in the meristematic tissues. Thus, the growth of lateral buds is retarded and they are caused to remain dormant. It is further suggested that when the apical or proximal portion is removed, the source of this inhibiting substance is eliminated and the lateral buds begin to develop rapidly. That the substance or substances which inhibit lateral bud growth may be identified with auxin has been postulated (45, 3). Moreover, it has been demonstrated (42) that the balance rather than the presence or absence of certain growth substances controls organ formation in plants.

Usually the enlarged root of the sweetpotato produces the greatest number of sprouts on the proximal end (68). This, however, is not consistent with this species. Exceptions may be observed among roots of different varieties, and even among roots of the same variety.

Effects of Certain Treatments on Sprouting in Crops Other Than the Sweetpotato - In a study to determine the effect of ethylene chlorhydrin gas for breaking the dormancy of seedling potato tubers, Ode (56) reported an effective hastening of sprouting and at no time, from planting to harvest, did the tubers in the check equal the treated tubers in rate of plant emergence or in plant development. Similarly, Denny (17) induced prompt germination of dormant potatoes by exposing cut and whole tubers for varying lengths of time in closed containers to vapors of ethylene chlorhydrin.

Miller (52) found that when potato tubers are treated with vapors of ethylene chlorhydrin, ethylene bromohydrin, hydrogen sulphide, acetaldehyde, hydrocyanic acid, or ethyl mercaptan, increases in respiration of several hundred percent occurred. The respiratory activity of the tubers showed a prompt rise soon after the treatments were initiated with a maximum of 50 to 60 hours, and a gradual decrease until a value approaching that of the control tubers was reached about a week after treatment. A close correlation between the effect of a chemical on the rate of respiration and its efficacy in breaking dormancy was not observed. Potassium thiocyanate, thiourea, and thioacetamide were also found to increase the respiratory activity of cut pieces of potato tubers.

According to Rosa (62), materials which are effective in stimulating sprouting are vigorous oxidizing agents, and

sprouting of dormant potato tubers can be hastened and the percentage germination within a more or less limited period increased by dipping the cut seed pieces in a 0.5 molar solution of sodium nitrate prior to planting.

Thornton (74) suggested that oxygen concentrations of 2 to 10 percent are effective for breaking the dormancy of potato tubers, and the complete elimination of apical dominance in the buds of an eye as well as in all eyes of the tuber is caused by these concentrations of oxygen so that each eye produced three to four sprouts instead of one, as is usually the case with non-dormant tubers. Results of this work indicate that (a) dormant potatoes do not sprout because the bud tissue obtains too much rather than an insufficient supply of oxygen; (b) the skin of a young tuber is more permeable rather than less permeable to oxygen; (c) the skin of the tuber becomes less rather than more permeable as the tuber becomes older; and (d) peeling or otherwise wounding the dormant tuber bring about a condition that retards rather than facilitates the entrance of oxygen.

Steinbauer (67) found that the rest period of Jerusalem artichoke tubers can be effectively shortened by treatment with ethyl alcohol, thiourea, ethylene chlorhydrin and carbon bisulfide.

Denny (18) reported that the effectiveness of ethylene chlorohydrin in breaking the rest period of freshly-harvested

gladiolus corms of several different varieties varied with the variety and with the stage of dormancy at which the treatments were applied. Satisfactory results were not obtained when freshly-harvested corms were exposed to ethylene gas and warm temperatures; however, the rest period of the corms was broken when the treatments were applied at a later stage of the rest period. By using 3 to 5 cubic centimeters (cc) of 40 percent ethylene chlorohydrin per liter of air space in a closed container for a period of 3 to 5 days, Denny and Miller (19) successfully hastened the sprouting of cormels from five different varieties of gladiolus. In another experiment (20) these investigators found that low temperatures (3 and 10° C.) were effective in shortening the rest period of small gladiolus corms (1 to 6 grams per corm).

In an investigation using maleic hydrazide (MH), Paterson et al. (58) found that it completely inhibits the apical dominance of the potato and growth, when it occurs, is initiated at the basal end. Similarly, Rao (60) has shown that following treatment with MH external sprouting in potatoes was characterized by a loss of apical dominance and lack of growth in apical buds because of inhibition of cell division. In these experiments it was found that a greater number of sprouts occurred from the basal half of the Irish Cobbler tubers than from the apical end in sharp contrast to the controls of the same variety in which growth was six times

as great from the apical halves. The potatoes used were harvested from plants previously sprayed with MH at 2500 ppm.

Effects of Certain Chemicals on Sprout Production in the Sweetpotato - Hernandez et al. (31) found that by dipping sweetpotato roots momentarily into a solution of 10 ppm of the amine salt of 2,4-dichlorophenoxyacetic acid (2,4-D), a significantly larger number of sprouts for the first four pullings was produced per root and per 50-pound bushel of roots than in the controls. In the same experiment, treatment with 2,4-D at a concentration of 5.2 ppm (soaking for 30 minutes) gave an increase over controls in the number of plants produced per roots and per bushel, although the differences were not statistically significant. Similarly, interesting results have been reported by Michael and Smith (46). The momentary dipping of roots of All Gold and Cliett Bunch Porto Rico varieties into a solution of the sodium salts of 2,4-D and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) at a concentration of 10 ppm gave significant increases in sprouting. No significant increase in sprout production occurred in the case of Texas Porto Rico. However, by soaking the roots of Texas Porto Rico and All Gold sweetpotatoes for three hours in a three percent solution of thiourea, marked stimulation of sprouting was obtained; however, it was accompanied by considerable injury. Severe injury

was also encountered when the roots were immersed for three hours in an aqueous solution of calcium carbide (8 ounces of calcium carbide per 11 gallons of water). The greatest stimulation of sprouting occurred when the roots were exposed to ethylene chlorohydrin in a sealed container for 72 hours at a dosage of 20 milliliters per hundred pounds of roots. This was the most promising of all the treatments used. The main disadvantage was the toxicity of the treatment. According to Smith (65), stimulation of sprouting from the treatments mentioned above resulted from the partial to complete breaking of proximal dominance, thus permitting sprout formation along the entire length of the root.

Horsfall (32) found that by immersing sweetpotato roots in a four percent solution of thiourea for a period of one hour or longer, a retarding effect on sprouting was produced. In spite of the retardation, the roots which were treated for one hour later "made a fine crop of sprouts well-distributed over the surface". A similar response was observed in roots from which a second crop of plants was pulled. According to Cordner (15), a lower concentration of thiourea (one percent) with a soaking period from one to two hours gives best results as a treatment for the stimulation of sprouting.

Simons and Scott (63) reported that roots of the Porto Rico variety showed a significant reduction of sprouting during storage following pre-harvest foliar applications of

the methyl ester of alpha-naphthalene acetic acid (MENA) and 2,4,5-T. However, roots of the Maryland Golden variety showed a significant reduction in sprouting only following treatment with 2,4,5-T. The effect of maleic hydrazide (MH) as a foliar spray on subsequent sprouting during the storage period was not significant. In this experiment 2,4,5-T caused serious injury to most of the roots and markedly lowered their keeping quality. Concentrations used in the preharvest foliar spray applications were MENA, 500 and 1750 ppm; MH, 500 and 2500 ppm; and 2,4,5-T, 50 and 175 ppm. No inhibition of sprouting occurred when MH in an ethyl alcoholic solution was applied to the tissues of roots by means of toothpicks previously impregnated with the chemical. These investigators also dipped the roots in solutions of MENA at 50 and 250 ppm, MH at 500 and 2500 ppm, and 2,4,5-T at 10 and 50 ppm before storage. No significant effect from these dip treatments on the number of sprouts produced by the roots when bedded in the greenhouse was obtained. No distortion of leaves and stems from the MH immersion treatments was detected as was observed following foliar applications of this chemical.

Results of preliminary experiments by Paterson et al. (57) with pre-harvest foliar applications of the sodium salt of MH over a wide range of concentrations from 0 to 8000 ppm indicated sprout inhibition of the bedded roots of

sweetpotatoes at the highest concentrations; however, the results were inconsistent. When toothpicks were impregnated with MH solutions and inserted into the roots just prior to bedding, there was a striking increase in sprout production among the roots which received a concentration of 4000 ppm. This was attributed to the retarded proximal dominance of some of the roots.

Other Methods Employed to Alter Sprouting in the Sweetpotato - Michael and Smith (46) succeeded in stimulating sprouting in Golden Skin, Ranger, B-5941, and B-5944 varieties of sweetpotatoes by exposing the roots to a temperature of 110° F. for 6, 12, and 18 hours. However, no stimulation occurred in roots of B-5999.

According to Edmond (21), lengthwise cutting of sweetpotato roots increases the number of sprouts per root and per bushel and decreases the weight of roots needed to produce a unit weight of sprout, also it reduces the size of the individual sprout as measured by mean weight. Moreover, when the mother roots of sweetpotatoes are cut, it lowers the yielding capacity of the sprouts produced. Beattie and Thompson (2) have reported that cutting the sweetpotato root increases the number of plants produced, but reduces their size, and that removal of the proximal tip of the root does not appreciably affect the dominance of the proximal end of

the organ nor does it influence the total number of sprouts produced. Miller et al. (51) and Beattie and Thompson (2) agree that it is preferable to plant the whole root when bedding rather than to cut it into pieces.

In an experiment designed to study the use of electrical heat in sweetpotato plant production, Edmond and Dunkleberg (23) found that "crowded" bedding (300 roots per 18 square feet of bedding space) markedly increased the number of plants produced per unit area of bedding space and only slightly increased the amount of electricity necessary to maintain the proper temperature as compared with "regular" bedding in which 150 roots are bedded in 18 square feet of bedding space.

Edmond et al. (24) found by studying the effects of two levels of readily available nitrogen, three times of harvest, and four curing and storage conditions on subsequent plant production of bedded roots that the Porto Rico variety has a higher plant-producing capacity than Triumph and that roots harvested during the early part of the harvest season produced more plants than roots harvested during the middle or end of the season. Moreover, it was further suggested that the storage of sweetpotatoes under favorable conditions of temperature and humidity seems to be more necessary than artificial curing of the roots alone for high plant production. Edmond (22) concluded that exposures to temperatures below the optimum storage range for relatively long periods is likely to lower the plant-producing capacity of the roots.

Cooley and Kushman (13) studied the effect of storage temperatures on the sprouting of four varieties of sweetpotatoes and found that a storage temperature of 50° F. is too low for optimum sprouting of Orange Little Stem, Nancy Hall, and Maryland Golden. Porto Rico stored at this temperature gave good sprouting. At a storage temperature of 55 to 60° F., all four of the varieties sprouted satisfactorily. The results indicate that Porto Rico is more tolerant to low temperature storage than the other varieties. However, the evidence indicates that this is below the optimum temperature for storage of the Porto Rico variety. Nearly all of the rot which developed during the sprouting period occurred among the roots stored at 50° F. Likewise, most of the dormant (non-sprouting) roots were among the ones previously stored at 50° F. That storage temperature has a marked effect upon sprout production of apparently healthy sweetpotatoes and may aid one in explaining certain instances of bedding failures has been suggested (13).

TERMINOLOGY

Sweetpotato - The term "seed stock" refers to enlarged roots used for propagation purposes. The term proximal end refers to that portion of the enlarged storage root nearest the point of attachment to the mother plant, whereas distal end is that portion of the enlarged root farthest from the point of attachment. The term draws or sprouts are used to refer to young plants adventitiously produced from the enlarged storage roots. These are referred to either as sprouts or plants.

Chemical - 2,4-D refers to the acid form of 2,4-dichlorophenoxyacetic acid if not otherwise designated. Sodium salt of 2,4-D refers to the sodium salt of 2,4-dichlorophenoxyacetic acid. B-214 refers to alpha-cyano-beta-(2,4-dichlorophenyl) acrylic acid, whereas B-214C refers to an emulsifiable concentrate formulation of alpha-cyano-beta-(2,4-dichlorophenyl) acrylic acid. MH-30 designates the water soluble diethanolamine salt of 1, 2, dihydro-3, 6-pyridazine-dione containing 30 percent actual maleic hydrazide. MH-40 designates the water soluble sodium salt of 1,2, dihydro-3,6-pyridazine-dione with a wetting agent and sticker containing 40 percent active maleic hydrazide.

EXPERIMENTAL

1- A Preliminary Investigation of the Effects of Certain Chemical Treatments on Sprout Production of Porto Rico and Goldrush Sweetpotatoes (1953)

The problem of proximal dominance among certain varieties of sweetpotatoes has been of primary concern to horticulturists and plant physiologists for some time. Although considerable work pertaining to this problem has been reported (21, 24, 32, 46), no method has been sufficiently successful to gain wide acceptance among commercial plant producers. With the consideration that certain techniques in using growth regulators could be developed as preliminary work on this problem, the following experiment was conducted.

Materials and Methods

Sweetpotato "seed" stocks of Goldrush and Porto Rico varieties were obtained from Hampton Institute and the Texas Agricultural Experiment Station April 23 and May 1, 1953, respectively. After careful examination and sorting, the sweetpotatoes were then placed in a storage unit with the temperature thermostatically controlled at approximately 55° F. Slatted crates were used as storage containers.

Sixty-four roots of each variety were carefully selected for firmness and uniform size and assembled as sixteen lots

of four roots each. Each lot was weighed and then placed in perforated paper bags. Individual lots of four roots comprised a treatment. Ten round toothpicks previously soaked in 10, 100 and 1000 ppm each of MH-30 and B-214 were inserted one-half their length into each root. Two control comparisons were used, one in which the toothpicks previously soaked in distilled water were inserted into the roots, and the other in which no treatment was applied. Chemical treatments were applied May 5 and 6. Two replications of each treatment and variety were randomized, dipped in Semesan Bel solution and bedded in river sand in raised benches of the greenhouse. The temperature of the beading medium was maintained at approximately 80° F. Water was added to the sand and roots as needed. To maintain high relative humidity in the atmosphere, the floors and walls of the propagating room were sprinkled daily.

As a measurement of sprouting response, two pullings were made, beginning June 9 and ending July 2, 1953, and a count of the total number of sprouts per treatment, regardless of their length, was taken and their weights recorded. The data obtained here and all data which follow were subjected to analysis of variance (66) and the least differences for significance determined.

Results

Differences in numbers of plants produced as a results of variety or the various treatments were not significant (Table I). However, differences in mean weights (Table II) were significant at the five percent level. Treatment with B-214 at 1000 ppm significantly reduced the weight of plants produced. On the other hand, MH-30 at 100 ppm was effective in increasing the weight of sprouts over that of the control, but not significantly. The differences between the weights of plants from treatments with MH-30 at 100 ppm and that of B-214 at 1000 ppm were highly significant. Differences in the response of varieties to treatments were not significant. The reduced weight of sprouts from treatment with toothpicks soaked in distilled water may be attributed to the altering of the tissue as caused by the injection of the toothpicks. There were no significant differences in the weight of sprouts produced between treatments within varieties.

TABLE I

Total Sprout Production of Porto Rico and Goldrush Sweetpotatoes as Influenced by Chemical Treatments (1953)

Treatment		Variety		
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Treatment Means
		(Number of sprouts per bushel of bedded roots)		
MH-30	10	2354	1907	2030
	100	1878	3273	2576
	1000	1971	1716	1844
B-214	10	1255	1720	1487
	100	655	2269	1463
	1000	569	871	720
Distilled water		1057	1536	1297
Controls (no treatment)		2504	1587	2046
Variety Means		1530	1860	

TABLE II

The Influence of Chemical Treatments on the Weights of Sprouts Produced by Porto Rico and Goldrush Sweetpotatoes (1953)

Treatment		Variety		
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Treatment Means
		(Pounds per bushel of bedded roots)		
MH-30	10	29	26	28
	100	28	48	38
	1000	18	33	26
B-214	10	17	31	24
	100	14	36	25
	1000	7	13	10
Distilled water		21	21	21
Controls (no treatment)		34	31	33
Variety Means		21	30	
Least differences necessary for significance between treatment means		5%	13	
		1%	19	

2- Further Studies of the Effects of Chemical Treatments on the Sprouting Response of Sweetpotato Varieties (1954)

Materials and Methods

"Seed" stocks of Porto Rico and Goldrush, and Yellow Jersey and Orange Jersey sweetpotatoes were procured from Southern University, Baton Rouge, Louisiana, and from the Menantico Colony, Vineland, New Jersey, respectively. The roots were carefully assorted and eighty of each variety were divided into 20 lots of four roots each and placed in perforated paper bags. The weight in pounds for each lot of four roots was then recorded for future reference. Each root was marked off with India ink as nearly as possible into three equal sections comprising the proximal, middle, and distal portions. The method of applying the chemicals was the same as that mentioned in Experiment 1, consisting of the injection of toothpicks previously soaked in the chemical solutions. The procedure for bedding of the roots was similar to that previously described in Experiment 1.

The plants from roots of each treatment were pulled at two separate times from June 16 through July 19, and sprouting response was recorded as the mean number of sprouts produced over six inches long (Table III); those from one to six inches in length (Table IV); the mean number of sprouts of all lengths (Table V); the percent of sprouts from the proximal end (Table VI); and the weight of sprouts per bushel

(55 pounds) of roots bedded. Concentrations of 100 and 1000 ppm of 2,4-D were used, but these were omitted from the analysis, since these treatments caused considerable injury to the bedded roots.

Results

The mean number of plants over six inches in length, per bushel of bedded roots of the four varieties of sweet-potatoes as influenced by the chemical treatments are shown in Table III. As can be seen, the Yellow Jersey variety produced significantly more sprouts than any of the other three varieties. Similarly, Yellow Jersey was more prolific in the production of sprouts from one to six inches in length (Table IV). Although Orange Jersey produced the least number of sprouts over six inches in length, this variety produced significantly more sprouts from one to six inches long than either Porto Rico or Goldrush. These data agree with general observations made at the time when the plants were pulled from the bedded roots. Table V presents the mean number of sprouts (of all lengths) per bushel of bedded roots as produced by the four varieties. Again, Yellow Jersey significantly excelled all other varieties in sprout production.

Treatments with MH-40 at 250 ppm and with B-214C at 100 ppm were more effective for the production of sprouts

over six inches in length than any of the other treatments employed. Similarly, MH-40 at 1000 ppm and B-214C at 100 ppm appeared to be more effective for the production of sprouts from one to six inches than the other treatments. For total sprout production of all lengths, MH-40 at 250 and 1000 ppm and B-214C at 100 ppm were essentially equal in their effectiveness for sprout production. They were generally more effective than other treatments, and the differences in the number of sprouts produced should have been high enough for statistical significance except for the large variability between treatments.

As shown in Table VI, Porto Rico and Goldrush produced a significantly greater percentage of sprouts from the proximal end than did either Yellow Jersey or the Orange Jersey variety. Moreover, irrespective of chemical treatment, the sprouts produced by Yellow and Orange Jersey were more widely distributed over the roots than were those pulled from roots of Porto Rico and Goldrush varieties. There were no significant differences that could be attributed to chemical treatment nor from the interactions between treatment and variety.

Although the differences in the mean number of sprouts (of all lengths) between varieties were highly significant, the differences between varieties with respect to mean weights of sprouts were not significant (Table VII). It appears that the greater the number of sprouts produced, the smaller they are likely to be.

TABLE III

The Effects of Chemical Treatments on Production of Sprouts Over Six Inches in Length in Sweetpotato Roots (1954)

Treatment		Variety				
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Yellow Jersey	Orange Jersey	Treatment Means
		(Number of sprouts per bushel of bedded roots)				
MH-40	100	1289	1807	2546	856	1624
	250	1521	1557	3453	722	1814
	1000	1260	1494	1873	989	1404
B-214C	10	1319	1521	2825	850	1629
	100	1320	1311	2975	1834	1860
	1000	1978	1925	1698	795	1599
2,4-D	10	1086	588	2125	1104	1225
Distilled water		1298	1600	2950	1200	1761
Controls (no treatment)		926	1630	1405	1412	1356
Variety Means		1333	1492	2433	1085	

Least differences necessary for significance between variety means 5% 805

TABLE IV

The Effects of Chemical Treatments on Production of Sprouts One to Six Inches in Length in Sweetpotato Roots (1954)

Treatment		Variety				
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Yellow Jersey	Orange Jersey	Treatment Means
		(Number of sprouts per bushel of bedded roots)				
MH-40	100	3243	3335	5577	5409	4391
	250	3627	3021	7327	4187	4541
	1000	4378	3479	7253	3803	4728
B-214C	10	3480	2769	4400	3878	3632
	100	3562	3388	6509	5439	4724
	1000	3156	4228	5800	3633	4204
2,4-D	10	3128	3398	6275	4652	4363
Distilled water		2640	3578	5675	5088	4245
Controls (no treatment)		3919	3011	7068	4365	4596
Variety Means		3459	3356	6209	4500	

Least differences necessary for significance

between variety means 5% 999
1% 1834

TABLE V

The Effects of Chemical Treatments on Total Sprout Production in Sweetpotato Roots (1954)

Treatment		Variety				
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Yellow Jersey	Orange Jersey	Treatment Means
		(Number of sprouts per bushel of bedded roots)				
MH-40	100	3778	5148	8122	6265	5828
	250	5151	4584	10280	4909	9356
	1000	6068	4973	9125	4792	6240
B-214C	10	4799	4290	6465	4689	5186
	100	4835	4699	9483	5807	6229
	1000	5133	6153	6748	3308	5336
2,4-D	10	4213	3981	8400	5755	5588
Distilled water		4263	5123	8625	6291	6076
Controls (no treatment)		3502	5827	8598	5455	5821
Variety Means		4638	4975	8772	5318	

Least differences necessary for significance

between variety means	5%	1126
	1%	2066

TABLE VI

The Effects of Chemical Treatments on the Distribution of Sprouts on Sweetpotato Roots (1954)

Treatment		Variety				
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Yellow Jersey	Orange Jersey	Treatment Means
		(Percent of sprouts from proximal end)				
MH-40	100	79	73	54	50	64
	250	68	65	54	49	59
	1000	53	74	50	35	53
B-214C	10	70	78	49	34	58
	100	74	83	49	37	61
	1000	83	72	52	52	65
2,4-D	10	68	79	47	42	59
Distilled water		76	64	60	35	59
Controls (no treatment)		75	58	59	36	57
Variety Means		72	72	53	41	

Least differences necessary for significance

between variety means 5% 10
1% 18

TABLE VII

The Effects of Chemical Treatments on the Weights of Sprouts from Sweetpotato Roots (1954)

Treatment		Variety				
Chemical	Concentration (ppm)	Porto Rico	Goldrush	Yellow Jersey	Orange Jersey	Treatment Means
		(Pounds per bushel of bedded roots)				
MH-40	100	41	52	73	47	53
	250	39	48	85	34	52
	1000	36	48	51	35	43
B-214C	10	38	46	68	41	48
	100	38	38	68	44	47
	1000	49	50	78	62	60
2,4-D	10	29	31	67	39	42
Distilled water		29	50	72	52	51
Controls (No treatment)		39	97	50	41	57
Variety Means		38	47	68	44	

3- Discussion

The effects of treatments with growth regulators on sprout production in the sweetpotato are governed principally by the type of chemical and concentration used, the variety, and the method of application. Among the more recently introduced growth regulators, maleic hydrazide (MH-30) and alpha-cyano-beta-(2,4-dichlorophenyl) acrylic acid (B-214) have been given special consideration. Inasmuch as MH-30 has been reported to destroy apical dominance in potatoes (58, 60) and in celery plants (33), and that work with B-214 has given similar results (41), it was assumed that at certain concentrations these compounds could possibly be used to break the proximal dominance in sweetpotato roots. The technique of applying the chemicals to the roots by use of toothpicks was based upon that described by Marshall and Smith (44). It appeared that certain of the growth regulators could be used more effectively if some means of injecting the chemical beneath the surface of the sweetpotato root rather than resorting to the commonly used momentary dip (46) were employed.

Although data from the preliminary experiment conducted in 1953 are rather inconsistent, they do indicate that different chemicals at various concentrations may influence the

number and weights of sprouts produced in sweetpotato varieties. A satisfactory explanation for the highly significant differences in the weights of sprouts produced by roots subjected to MH-30 at 100 ppm as compared with those treated with B-214 at 1000 ppm is not readily apparent. However, it was observed at the time the pullings were made that sprouts from roots which received the latter treatment were more evenly distributed along the entire root. Moreover, the reduction in weights of sprouts produced following treatment with B-214 at 1000 ppm may be attributable to the injury caused by the chemical. It is suggested that the reduction in weights of sprouts pulled from roots treated with distilled water-soaked toothpicks was influenced by the mechanical altering of the tissue by the injection of the toothpicks.

The differences between varieties in the production of sprouts from one to six inches long, of those six inches in length, and with respect to the percentage of sprouts from the proximal ends of the roots of the 1954 experiment were striking. The Yellow Jersey variety was the highest producer of sprouts from one to six inches and over six inches long, and thus resulted in the greatest total sprout production. However, the Jersey type sweetpotatoes produced a smaller percentage of sprouts from the proximal ends of the roots. It appears that the inherent characters of the moist-fleshed and Jersey type sweetpotatoes influenced to some extent the response of the roots to the diverse chemical treatments.

From the data relative to the distribution of sprouting, it is seen that the extent of sprouting of the moist-fleshed varieties from the proximal end is 72 percent of the total, while that for the Jersey types ranges from 35 to 60 percent. These data suggest that possibly the moist-fleshed varieties are characterized as having an inherently stronger proximal dominance (68). Thus, further investigations might well include other varieties within these two general types.

The weights of sprouts produced by Porto Rico and Goldrush sweetpotatoes were greater as a whole than those from the same varieties in 1953. This difference may be attributable to variations as to source of bedding stock, lack of uniformity in the plant material itself, size of roots used, variation in the formulations applied, or to improvement in plant growing techniques.

4- Summary and Conclusions

Various chemical solutions of maleic hydrazide (MH-30 and MH-40), alpha-cyano-beta-(2,4-dichlorophenyl) acrylic acid (B-214 and B-214C), and 2,4-dichlorophenoxyacetic acid (2,4-D) were applied to roots of several varieties of sweetpotatoes during the years 1953 and 1954 in attempts to find effective means for increasing sprout production for propagation purposes. Applications were made by injecting round toothpicks previously impregnated with the chemicals into the roots. In 1953, MH-30 and B-214 each at concentrations of 10, 100, and 10000 ppm were used. No significant differences between treatments with respect to the number of sprouts produced were found; however, B-214 at a concentration of 1000 ppm significantly decreased the weight of sprouts produced by Porto Rico and Goldrush varieties. There was a marked but non-significant response with respect to varieties.

In 1954, roots of Porto Rico, Goldrush, Yellow Jersey, and Orange Jersey sweetpotatoes were similarly treated with MH-40 at concentrations of 100, 250, and 1000 ppm; B-214C at 10, 100 and 1000 ppm; and 2,4-D at 10 ppm. Results showed marked response with respect to varieties, but there were no significant differences among treatments.

On the basis of these findings, no general recommendations as to the use of the above mentioned chemicals can be

given with respect to promoting sprout production in sweet-potato roots.

PHASE II

CHEMICAL INDUCTION OF FLOWERING

INTRODUCTION

Factors governing the transition from vegetative to reproductive development in higher plants have long intrigued the plant physiologist and horticulturist. However, there is still considerable diversity of opinion as to the underlying principles involved in floral induction. Many different species of plants have been used, among which the sweetpotato has received special attention. In the continental United States, sweetpotatoes of the moist-flesh type are known to flower widely, but rarely have the Jersey type flowered even after being subjected to special treatments or conditions. Consequently, it is difficult to incorporate by hybridization the uniform shape and size of the Jersey type with the disease resistance, high vitamin content, and the vigor of the moist-flesh varieties. As a result of sparse flowering of the Jersey type, the plant breeder encounters a continuing handicap in his attempt to develop improved varieties or strains of sweetpotatoes.

This phase of the investigation deals with the use of 2,4-dichlorophenoxyacetic acid (2,4-D) as a means of inducing flowering in sweetpotatoes.

REVIEW OF LITERATURE

Flower Formation in Higher Plants - The most critical stage involved in flowering of higher plants is that of floral induction. Since this is considered to be the actual transition from vegetative to reproductive development, it must occur before subsequent phases of development, such as differentiation of individual flower parts, flower bud development, and anthesis are evident (38). That each sequence replaces another consecutively and in strict rotation has been established (10).

Considerable and diverse literature on the developmental physiology of plants has accumulated (38), although the means by which flowering is actually brought about in the plant are not fully understood (30, 10, 38, 39). Moskov and Cajlachjan suggested concurrently in 1936 that the "flower-forming substance" manufactured in plants is most probably a hormone (10). According to Cajlachjan (9),

> ...processes leading up to the sexual development of plants are not determined by the processes of their growth and nutrition, but are specific in their nature.

A "hormone of flowering" or "flowering hormone" is believed to fulfill the regulatory function in the process of development, and the maximum production of this hormone is determined by the interaction of day and night conditions

with other factors of the environment to which the plant has become adapted during its evolutionary development. Moreover, as suggested by Cajlachjan, an adequate quantity of the flowering hormone must be formed in the leaves and transferred into the growing points before floral initiation occurs. This postulation is supported by Cholodny (10), who suggested that changes in the growing points just prior to the initiation and development of sexual organs occurs only in the presence and under the influence of certain substances transmitted to the growing point from some other organ, especially from the green leaves. It seems logical to assume that the substances which initiate floral primordia and are manufactured in the leaves are transferred thence to the nearest growing point, regardless of the distance at which the manufacturing leaves are located. Since it is established that flowering may be hastened by introducing into the plant body certain substances having properties of growth hormones, caution must be exercised against hasty conclusions pertaining to "organ-forming substances" (10). In studies of Chrysanthemum, Moskov (10) demonstrated more clearly the significance of leaves of varying ages in conceiving the photoperiodic stimulus. Of the leaves studied, the central four or six were found to be the most active.

Auxin and Antiauxin Relationships in Flower Induction - According to Skoog (64), the first report of chemically induced reversal from reproductive to vegetative growth was in buds of Circaea treated with indoleacetic acid (IAA) by Dostal and coworkers. Lang (38) noted that with short-day plants flowering can be suppressed under short-day conditions by treatment with auxin or synthetic growth regulators and can be induced under non-inductive conditions with auxin antagonists. The crucial factor appears to be the auxin level in the leaves during photo-induction, and the effect of high levels of auxin seems to be mainly that of inhibition of the formation of the floral stimulus. That the auxin level seems to be specifically associated with the functioning of the dark-period process of short-day plants or with the immediate outcome and that the effect of the inductive dark period appears to involve a lowering of the auxin level have been suggested.

By measuring the free auxin in dried Xanthium tissue harvested at different times, Bonner and Thurlow (5) found that no simple relation of leaf auxin content to photoperiodic induction was revealed. Moreover, the complexity of the auxin relation of Xanthium is increased by the presence of an "auxin inhibitor". The main conclusion from these data is that applied auxin is effective in inhibiting photoperiodic induction in Xanthium. It is believed that the effect of applied auxin is to inhibit the production by, or the transport

from, the leaves of the stimulus to floral induction. It has been demonstrated that 2,4-dichloranisole (an analogue of 2,4-D) is an antagonist of auxin. When this substance is applied to Xanthium cuttings during photoperiodic induction, floral development was hastened, since it suppresses the effect of auxin in inhibition of floral initiation (5). Likewise, Bonner and Bandurski (3) believe that flowering is normally influenced by fluctuations in the auxin economy of the plant. Thus, they suggest that flower initiation may be promoted under certain circumstances by the application of auxin antagonists. Moreover, they point out that although information pertaining to flower induction in indeterminate plants is scattered and incomplete, it does show that in this group of plants anxins may also inhibit flowering, and auxin antagonists may promote flowering.

In their work with barley and teosinte, Leopold and Thimann (40) noted that the promotion of floral initiation by auxin was not a simple process, since vegetative buds were not induced in the same way as were the flower buds. Furthermore, the conditions or treatments that would be expected to cause variations in the amount of auxin in barley plants were observed to be correlated with inverse variations in flowering. Inasmuch as there is a strong correlation between number of floral primordia and weight of the plant, it appears that auxin may affect flower initiation in a

manner parallel to its effect on growth (40). That both flowering and growth are promoted by relatively low concentrations of auxin and inhibited by higher concentrations has been established (5, 14, 73). From the evidence reported, it appears that the growth hormone, auxin, is not necessarily opposed to the functioning of the proposed flowering hormone, but rather influences it in a way similar to its effect on growth, and it is suggested that a probable means of explaining the promotive action of auxin on flowering may be through the effect it has on the action of various metabolites present in the plant which are themselves capable of altering flowering (6, 39).

According to Clark and Kerns (11), low concentrations of alpha-naphthaleneacetic acid (NAA) when applied as foliage sprays to pineapple (Ananas comosus) induced flower formation in advance of the normal period. However, with higher concentrations, especially when applied in solution at the apex, this chemical delayed flowering beyond that of the controls. It is suggested that though substances such as alpha-naphthaleneacetic acid, naphthaleneacetamide, naphthalenethioacetamide, and Fruitone initiated floral primordia, this evidence is insufficient to imply that these compounds are "florigens". They have other effects on plant growth as well. Moreover, acetylene and ethylene, compounds chemically unrelated to the phytohormones, also promote premature flowering in Ananas.

Cooper (14) reported that under Florida conditions NAA at 0.01 percent (100 ppm) induced flowering in pineapple only when applied in October, whereas ethylene induced flowering at any time during the summer and fall. In these experiments a high percentage of undeveloped flowers were associated with combined treatments with NAA and ethylene when the former at 100 ppm was sprayed on the leaves in July, either just prior to or within a few days after the ethylene treatment. In some cases, the plant did not flower at all. The probable explanation given is that floral differentiation occurred over a period of weeks or longer and the NAA inhibited development of only those flowers that were being differentiated at the time of application.

One of the most striking effects of auxin in flower induction is with the pineapple (Ananas comosus). Van Overbreek (76) has demonstrated that 2,4-D and NAA were equally effective for floral initiation in pineapple. In these experiments a concentration of 5 ppm (50 cc per plant) applied in the center of the plant, was sufficient to cause a 100 percent response. It is of special interest that 2,4-D, which is being widely used as a selective herbicide, is an effective flower-inducing agent for the pineapple when used at one two-hundredth of the concentration recommended for herbicidal effect.

Galston (27) concluded that 2,3,5-triiodobenzoic acid (TIBA) does not possess florigenic properties, since it will not induce vegetative soybean plants to flower; however, it will greatly augment the flowering response as caused by photoperiodic induction. That TIBA causes auxin aberrations within the plant is supported by certain morphological responses of vegetative soybean plants following treatment with this substance. These are as follows: (a) shortening of the internodes, (b) loss of apical dominance, (c) epinasty of young leaves, and (d) premature abscission of apical leaves and buds. This investigator suggested further that the functional association of hormones, known to exist in animals, may also exist in plants as well. In this type of association, auxin, which favors general vegetative growth, would counteract the effect of florigen, which promotes the differentiation of floral primordia.

In experiments designed to determine the effects of various growth substances on flowering and yield of certain crops, Rice (61) found that sprays of the sodium salts of 2,4-D, 2,4,5-T, and 4-chloro-o-toloxyacetic acid (4-o-T), in concentrations of 0.1, 1.0, and 10 ppm, were successful in inducing flowering in non-vernalized winter wheat or in inducing flowering in biennials during the growing season. There was no difference observed in the time or amount of flowering of oats as the result of any treatments, nor any

effect on time or quantity of flowering in peas. Sprays of the sodium salt of 2,4-D and the sodium salt of 2,4,5-T each in concentrations of 10 ppm resulted in a delay of flowering of bean plants by two and four days, respectively. In no cases was early flowering stimulated as a result of applying the growth substances.

Wittwer et al. (78) reported that for a given plant, the same substance may accelerate or retard flowering, as the case might be, depending on the concentration of the substance used and the stage of plant development when treated. Their data definitely suggest the possibility of controlling seedstalk development in certain vegetable crops by applying growth substances before the time that temperature-induction of flowering normally occurs. Clark and Wittwer (12) noted that the effects of certain growth substances on seedstalk elongation in lettuce plants can be transmitted from the treated plant to its non-treated progeny; however, the investigators were unable to determine how this was actually accomplished. The variability of results obtained in their experiments was striking. (a) In several instances the results indicated that there is an acceleration of the rate of seedstalk elongation in two-month old lettuce plants after treatment with alpha-o-chlorophenoxypropionic acid (CLPP). (b) On the other hand, the rate of seedstalk elongation was retarded in one experiment where CLPP was applied

to one-month old plants, and this retarding effect did not appear to be a function of concentration. Moreover, in later experiments it was found that 100 ppm of CLPP had no effect on seedstalk elongation and 2,4-D at 50 ppm caused a slight retardation of seedstalk elongation. The age of the plant at the time of treatment appeared to be a factor which determined the response to growth substances. There is considerable evidence to support this assumption also in the case of celery. From results of these investigations it was suggested that flowering is not a response to the mere presence of a special flower-forming substance. Instead, it may be influenced by local concentration of phytohormones such as auxins which are capable of causing cell enlargement.

Moore (55) found that seedstalk development of cabbage was inhibited by treatment with CLPP when this substance was applied during the period of cold-induction. However, when this growth regulator was applied before or after the cold-induction especially to medium sized plants, flowering and seedstalk development were enhanced considerably.

Teubner and Wittwer (71) have reported that in addition to promoting fruit set of the tomato plant, N-m-tolylphthalamic acid may influence flower formation in later developing clusters, and if applied to young seedlings, it will increase the flower number in the first cluster.

Flower Induction in the Sweetpotato - Up to 1917 flowers and fruits of sweetpotatoes were rarely seen, and even in 1921 it was reported that sweetpotatoes rarely produce flowers and less frequently mature perfect seed in the commercial sweetpotato producing areas in the United States (70). However, it is further mentioned that mature seed may be produced if the growing period is artificially prolonged. Seedlings and clonal varieties may be completely self-incompatible (69). That information pertaining to the flowering and the production of seeds by sweetpotatoes is of general interest to plant breeders and plant physiologists is supported by the volume of literature on this subject which has accumulated over the last twenty years.

Tioutine (75) was not successful in his attempts to induce flowering in sweetpotato varieties of U.S.S.R. and American origin, which did not flower naturally, by adjustments in the environment. Hartman (29) used as many as eight different methods in attempting to induce flowering in Jersey sweetpotatoes. Mikell (47) reported that water solutions of 2,3,5-triiodobenzoic acid (TIBA), 2,4-D, and NA, each at 10, 25, and 50 ppm were ineffective for the initiation or retardation of floral primordia formation in plants of the Porto Rico and Orlis varieties, and of three seedlings from the Lousiana Agricultural Experimental Station.

By manipulation of certain environmental conditions, Mikell et al. (48) were successful in inducing two plants of

the Maryland Golden variety to flower. Warmke and Cruzado (77) brought three Jersey varieties--Orange Little Stem, Maryland Golden, and Yellow Jersey--into flower in Puerto Rico among field plantings which were trellised and thinned, and received no other special type of treatment. Within recent years it has been reported that varieties of Jersey type sweet potatoes have been induced to flower by grafting scions on stocks of related species which do not have storage roots (34, 37, 79). According to Culbertson (16), the sweetpotato vine is grafted on the stock of moon flower (Ipomoea bona-nox) to induce flowering for cross breeding purposes in Japan. From results of their work with plants of commercial sweetpotato varieties in which scions were grafted on morning glory stocks, Lam and Cordner (37) suggested that the rapid initiation of flowering in the scions of sweetpotatoes, the association of the flowers on the scion with the leaves on the stock, and the influence of growing fruit on the stock, all give support to the conclusion that a flowering hormone ("florigen") originating in the leaves of morning glory stock is translocated to the meristematic region of the sweetpotato scion where it exerts its morphogenetic effect.

According to Kehr et al. (34) and Mikell et al. (48), blooming in the sweetpotato is associated with carbohydrate accumulation in the top growth, which appears to be influenced by grafting on non-storage root species. However, Lam

and Corcner (37) stated that the absence of storage roots in the understock, per se, will not assure blooming in the sweetpotato scion and they also noted that it appears that various stock species irrespective of the presence of storage roots have different abilities to induce flowering. Borthwick and Parker (6) postulated that the accumulation of carbohydrates in plants generally is not necessarily the cause of floral induction, but it may be correlated in some way with the metabolism to promote a reaction or reactions causing induction.

EXPERIMENTAL

1- A Preliminary Study of Flowering in the Sweetpotato as Induced by 2,4-D Treatments (1953)

This experiment was initially designed to study the effects of 2,4-D applied as a pre-harvest foliar spray to Porto Rico and Goldrush sweetpotatoes on subsequent sprout production of the enlarged roots harvested from the treated plants. However, prior to harvesting the roots it was noted that the character of plant response warranted a modification of original objectives to one dealing with floral primordia induction in the sweetpotato.

Materials and Methods

Plants of Porto Rico and Goldrush varieties were set in a ground bed of a greenhouse July 13 and another lot on July 31, 1953, respectively. Twelve plants of each variety were randomized in four blocks of three plants each. The spacing between plants was one foot in rows three feet apart, and the plants were trained with binder twine attached to wires running the length of each row and approximately seven feet above the ground level. To encourage rapid growth of the plants, favorable cultural practices were employed, such as irrigation, cultivation, and control of insects.

Randomized samples of soil from the greenhouse were collected July 17, composited, and the nitrogen, phosphorus, potassium, and pH levels ascertained. On the basis of the results of the soil tests, a fertilizer analysis of 0-15-15 was applied to the area at the rate of 1500 pounds per acre, the first application being made August 17 to 27 and the second on September 9.

At the time that the storage roots had begun to enlarge, single blocks of three plants each were sprayed with water solutions of 2,4-D at concentrations of 100, 500, and 2500 ppm. A hand sprayer was used to treat the plants transplanted July 13 approximately fifty-three days following setting the plants in the bed (September 4). Similar treatments were applied October 4, sixty-four days after the plants of the July 31 planting were set. Three plants of each variety, as controls, remained without treatment in each of the two plantings. A wide strip of Velon[1] was used to protect plants not receiving a specific treatment from the mist in the area of application.

Results

The record of flowering response taken December 5, 1953, with reference to variety, treatment, date of application,

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[1] A commercial thermoplastic prepared from vinylidene chloride.

date of the first flower and number of flowers for each treatment is shown in Table VIII.

That flowering in the Porto Rico variety was successfully induced by 2,4-D treatments is shown in Figure 1. Similarly, flowering occurred among plants of the Goldrush variety (Table VIII), but the response was less striking than that for Porto Rico. The apparent dwarfing effect of 2,4-D treatment at concentration of 500 ppm on the Goldrush plants is shown in Figure 2.

TABLE VIII

The General Effects of 2,4-D on Flowering in Sweetpotatoes (1953)

Treatment		Varieties			
		Porto Rico		Goldrush	
Chemical and Concentration	Date of Application	Date of First Flower	Number of Flowers to Dec. 5	Date of First Flower	Number of Flowers to Dec. 5
2,4-D 100 ppm	October 4	No flowering		November 9	11
2,4-D 500 ppm	September 4	November 7	84	No flowering	
	October 4	November 7	26	No flowering	
2,4-D 2500 ppm		All plants killed		All plants killed	
Control		No flowering		No flowering	

Fig. 1. Flowering of Porto Rico plants as induced by 2,4-D treatments in 1953.

Fig. 2. The dwarfing effect of 2,4-D treatments on Goldrush sweetpotato plants in 1953.

2- The Effects of 2,4-D on Flowering Response of Porto Rico and Yellow Jersey Sweetpotatoes (1954)

Since moist-flesh varieties of sweetpotatoes have been induced to flower in the continental United States with little difficulty (34), this experiment was conducted to study the flowering response of a Jersey type variety following treatment with 2,4-D in a manner similar to that previously described.

Materials and Methods

Roots of Porto Rico and Yellow Jersey sweetpotatoes were bedded May 25, 1954, in an electrically-heated hotbed. Plants were pulled when six to eight inches long and set in the ground bed of a greenhouse July 13. On the basis of results of chemical tests of the soil in the greenhouse bed, triple superphosphate was applied at the rate of 1500 pounds per acre.

Replicated blocks of five plants each for each variety were sprayed with water solutions of the sodium salt of 2, 4-D at concentrations of 100, 250, and 500 ppm. These applications were made September 11 at the time the fleshy roots had begun to enlarge, approximately sixty days after the plants were set in the bed. Plants not treated constituted the controls.

Date of the distribution, with respect to node number, of flowers and flower buds induced by 2,4-D treatments, and those of the weight of roots for each variety were recorded December 20 at the time when maximum flowering had occurred. The position at which a flower or flower bud occurred was determined by the number of nodes beginning from the lowest one on the main stem, the numbers accumulating out onto the primary laterals, the secondary laterals, or even at the terminal portion of the main stem, as the case might be.

Results

Flower buds were observed among plants of the Porto Rico variety by October 13, whereas none were detected in the Yellow Jersey variety until October 26. Thus, flowering occurred in the Porto Rico variety thirty days following treatment, and it occurred among Yellow Jersey plants approximately forty-five days after treatment. In Tables IX and X are shown the number and distribution of flowers and flower buds with respect to node number, and root weights of Porto Rico and Yellow Jersey sweetpotatoes, respectively. Further illustration of flowering response is given in Figures 3 and 4. Table XI shows the effect of the 2,4-D treatments on the mean weights of roots from the two varieties. In the Porto

Rico variety flowering occurred from the 20th through the 64th nodes, inclusive; while flowering in Yellow Jersey occurred from the 20th through the 74th nodes. The greatest number of flowers in the Porto Rico variety resulted from treatment with 2,4-D at a concentration of 500 ppm, whereas flowering was greatest among plants of the Yellow Jersey variety which received 100 ppm of 2,4-D. Concentrations greater than 100 ppm caused severe injury to plants of the Yellow Jersey variety. Control plants (not treated) of both varieties remained completely vegetative throughout the duration of the investigation.

That a significant depression of storage root growth was associated with 2,4-D treatments (regardless of variety) is shown in Table XI. On December 20, the date of harvest, the roots from flowering plants of both varieties were spongy and water soaked, and cankers at the nodes and proliferations of the roots and stems were common. Among all plants which received 2,4-D treatments impeded transport in the stems and roots seemed apparent.

TABLE IX

Number and Distribution of Flowers and Flower Buds With Respect to Node Number, and Root Weights of the Porto Rico Sweetpotato as Induced by 2,4-D Treatments (1954)

Treatment (ppm)	Flowers (numbers/plant)	Flower Buds (numbers/plant)	Nodes at Which Flowers and Flower Buds Occurred	Weight of Roots (pounds/plant)
2,4-D				
100	6	23	20-64	0.92
250	7	13	40-59	0.38
500	47	23	35-54	0.27
Controls (no treatment)	0	0	-	4.73

TABLE X

Number and Distribution of Flowers and Flower Buds with Respect to Node Number, and Root Weights of the Yellow Jersey Sweetpotato as Induced by 2,4-D Treatments (1954)*

Treatment	Flowers (numbers/plant)	Flower Buds (numbers/plant)	Nodes at Which Flowers and Flower Buds Occurred	Weight of Roots (pounds/plant)
2,4-D (ppm)				
100	48	16	20-74	0.58
250	0	0	-	0.54
500	1	3	25-39	0.40
Controls (no treatment)	0	0	-	4.86

*All values are averages from five plants.

TABLE XI

Effect of 2,4-D Treatments on Mean Weight of Roots Produced by Porto Rico and Yellow Jersey Sweetpotatoes (1954)

Treatment		Mean Weight of Roots
2,4-D (ppm)		
100		0.75
250		0.46
500		0.34
Controls (no treatment)		4.80
Least differences necessary for significance		
between treatment means	5%	0.54
	1%	0.99

Fig. 3. The general distribution of flowers on plants of the Porto Rico sweetpotato in 1954.
Treatment: 2,4-D, 500 ppm.

Fig. 4. The general distribution of flowers on plants of the Yellow Jersey sweetpotato in 1954. Treatment: 2,4-D, 100 ppm.

3- Further Studies of the Effects of 2,4-D on Flowering of Porto Rico and Yellow Jersey Sweetpotatoes, with Special Reference to Chemical Composition of the Leaves (1955)

On the basis of results as reported by Kehr et al. (34), Borthwick and Parker (6), and Freiberg and Clark (26), this experiment was conducted primarily to determine if certain changes in chemical composition of the leaves of Porto Rico and Yellow Jersey sweetpotato plants are associated with, or related to, flowering responses as induced by 2,4-D.

Materials and Methods

"Seed" stocks of Porto Rico and Yellow Jersey sweetpotatoes were obtained from Hampton Institute and the Menantico Colony, respectively. The roots were treated with Semesan Bel solution and bedded in an electrically-heated hotbed May 18, 1955. River sand was used as a bedding medium and the hotbed was managed as in earlier experiments.

Plants of both varieties were pulled from the hotbed June 18 and grouped according to clonal (root) source, after which they were "heeled-in" in an outdoor frame. Twenty plants of each variety were set in four blocks of five plants each in the ground bed of a greenhouse July 12. Plants were spaced one foot apart in three-foot rows. Each plant was trained separately on binder twine attached to a

horizontal wire running the length of the bed and at a height approximately seven feet above ground level. The usual cultural practices to encourage rapid growth were followed. Fertilizer with an analysis of 0-20-20 was applied at a rate of 1500 pounds per acre.

The sodium salt of 2,4-D at concentrations of 100, 250, and 500 ppm was applied as a foliar spray September 12, at the time of initial storage root enlargement, approximately sixty days after the plants were set in the bed. Water only as a spray was applied to the control plants.

The extent of growth of the Porto Rico and Yellow Jersey plants on September 9, three days before treatments were applied, is shown in Figure 5. Before treatment, as many as sixty-one nodes were counted on plants of the Porto Rico variety, whereas a total of forty-nine occurred on the Yellow Jersey plants. These estimates were associated with Porto Rico plants approximately nine feet in length and Yellow Jersey plants of eleven feet.

Leaf samples, approximating 300 grams of fresh weight, were collected from two plants of each variety in each block, the plants of which were previously pulled from two different roots of each variety. Leaf samples from the two plants of each replication were composited for collections of September 16, October 2, and October 18, four, twenty, and thirty-six days, respectively, following treatment. These samples were taken between 1:00 and 5:00 P.M.,

Fig. 5. The extent of vegetative growth of Porto Rico and Yellow Jersey plants at the time of treatments with 2,4-D in 1955.

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from the laterals and/or main stem at a distance approximately six inches from the growing points. Care was exercised to select only those leaves intermediate in chronological age, and only the leaf blades were taken for analysis. Fresh weights of the leaves were recorded at the time of collection. The leaves were then dried at 60° to 70° C., ground in a Wiley mill equipped with a 20-mesh sieve, and placed immediately in airtight glass jars.

Duplicate five-gram samples from the first two collections were analyzed for total sugars and total nitrogen according to methods as outlined by the Association of Official Agricultural Chemists.[2] Samples collected October 18 were analyzed only for total sugars. The calculations for all determinations were made on an oven-dry basis.

Results

Growth and Flowering - Three days following treatment of the plants with 2,4-D (September 15) some curling of foliage and twisting of the petioles were observed with both varieties. Epinasty among young leaves of 2,4-D treated plants was especially prominent on those plants with concentrations of 250 and 500 ppm. The gross responses were more pronounced at 500 ppm. From the third day on, the

[2]Association of Official Agricultural Chemists, Official Methods of Analysis, (A.O.A.C., Washington 4, D.C., 1950), pp. 13, 107-108.

effects of the 2,4-D became increasingly noticeable (7). On September 28, sixteen days after treatment, not only were the effects of 2,4-D expressed in considerable epinasty of young leaves and twisting of petioles, but leaf abscission was very pronounced among Porto Rico plants and occasionally observed on Yellow Jersey. Moreover, necrosis, tumefaction and splitting at the nodes were common symptoms of treatment effects.

The first flower buds were observed among plants of the Porto Rico variety October 1, while the first buds among Yellow Jersey plants were first detected October 13. It is believed, however, that flower buds had occurred on plants of the latter variety three to five days earlier, this estimation being based on the size of the buds October 13. Flowers and flower buds with accompanying malformations and 2,4-D effects on the leaves of the Yellow Jersey variety are shown in Figure 6.

Tumefactions at the base of petioles, especially of Porto Rico plants, and formative effects on young leaves of both varieties, photographed October 25, forty-five days after treatment, are shown in Figures 7 and 8. It is suggested that such swellings as seen in Figure 7 may impede transport of foods from the top of the plants to the root systems (34). Although the epinasty of young leaves of both varieties is similar, the condition appeared to be most severe on the Porto Rico at the time the photographs were taken.

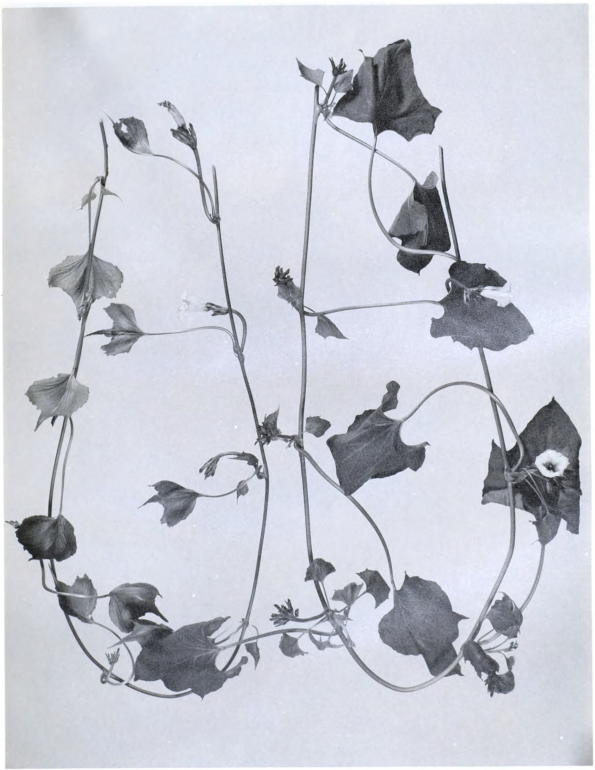

Fig. 6. Flowers and flower buds of Yellow Jersey sweetpotatoes as induced by 2,4-D treatment in 1955.

Treatment: 2,4-D, 250 ppm.

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Fig. 7. Tumefactions at the nodes of the main stem and laterals of Porto Rico plants as caused by 2,4-D treatment in 1955.
Treatment: 2,4-D, 250 ppm.

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Fig. 8. Epinasty of young leaves of Porto Rico and Yellow Jersey sweetpotato plants as caused by 2,4-D treatments in 1955.

Left: Yellow Jersey, 2,4-D, 250 ppm.
Right: Porto Rico, 2,4-D, 250 ppm.

The data on flowering of three plants not defoliated, recorded November 11, are shown in Table XII. Thirty-eight percent of all the plants treated showed some flowering. The greater percentage of flowering occurred among plants of the Yellow Jersey variety, and 2,4-D at a concentration of 250 ppm was the most effective of all the treatments for the induction of flowering in both Porto Rico and Yellow Jersey varieties. Concentrations of 100 and 500 ppm were equally as effective for flower induction in each variety. The controls (plants not treated) remained completely vegetative. The greater amount of young growth seemed to have occurred among Yellow Jersey plants. Since flowering was generally associated with young growth, a plausible explanation for the difference in flowering of the two varieties seems obvious.

The growth of roots from plants which received 2,4-D treatments was again significantly reduced, comparable to that in 1954. These data on root weights were recorded November 12 and the mean values are given in Table XIII. In all cases the weight of roots from the 2,4-D treated plants was considerably less than that of the corresponding controls. Associated with the suppression of root growth also was the water soaked condition as described previously. This condition appeared to be more prominent among roots of the Porto Rico variety than among those of Yellow Jersey. Roots from 2,4-D treated plants were consistently poor in color.

TABLE XII

The Percentage of Flowering Plants of Porto Rico and Yellow Jersey Sweetpotatoes as Induced by 2,4-D Treatments (1955)

Treatment	Variety		
2,4-D (ppm)	Porto Rico	Yellow Jersey	Treatment Means
100	11	56	34
250	67	89	78
500	11	67	39
Controls (no treatment)	No flowering	No flowering	-

TABLE XIII

The Effect of 2,4-D Treatments on Mean Weights of Roots Produced by Porto Rico and Yellow Jersey Sweetpotatoes (1955)

Treatment 2,4-D (ppm)	Variety: Porto Rico	Variety: Yellow Jersey	Treatment Means
	(Values expressed in pounds per plant)		
100	.24	.36	.30
250	.10	.25	.18
500	.14	.26	.20
Controls (no treatment)	1.50	2.47	1.99
Variety Means	.50	.84	

Least differences necessary for significance between treatment means 5% .19
1% .27

Chemical Composition of Leaves - Total Sugars: Results from the analyses for total sugars are given in Tables XIV and XV. These data represent the net sugars in the leaf blades found on the various dates of collection, and were calculated on an oven-dry basis. No significant differences in total sugars were found between varieties nor among treatments in the leaves collected four or twenty days following application of 2,4-D. However, the trend showed a definite increase in total sugars in leaves of the second collection irrespective of treatment. Leaves of Yellow Jersey were generally higher in total sugars than those of Porto Rico. Moreover, the percent of total sugars in Yellow Jersey leaves collected twenty days after treatment was considerably lower from control plants than from those which received 2,4-D treatments. At 250 ppm there was an increase in total sugars in leaves of both varieties at the time of the second collection.

Total Nitrogen: The 2,4-D treatments significantly decreased the percent of total nitrogen in leaves four days following applications (Table XVI). Total nitrogen was greater in leaves from Yellow Jersey plants. Moreover, leaves from control plants contained more total nitrogen than those of treated plants. Generally, with each increase in concentration of 2,4-D there was a decrease in the total nitrogen of the leaves. As shown in Table XVII, there was a definite relation between total nitrogen found in leaves

collected twenty days after treatment and the concentration of 2,4-D applied. Again, the percent of total nitrogen decreased progressively with increase in concentration of 2,4-D. There were no significant differences in nitrogen content between varieties.

Since the leaf samples collected thirty-six days after treatment were inadequate for complete chemical determinations, data with reference to these are herein omitted.

TABLE XIV

Total Sugars in Sweetpotato Leaves Collected Four Days After Treatment with 2,4-D (1955)

Treatment 2,4-D (ppm)	Variety: Porto Rico	Variety: Yellow Jersey	Treatment Means
	(Values expressed in percent on dry weight basis)		
100	.03	.36	.20
250	.28	.23	.26
500	.01	.15	.08
Controls (no treatment)	.02	.46	.24
Variety Means	.09	.30	

TABLE XV

Total Sugars in Sweetpotato Leaves Collected Twenty Days After Treatment with 2,4-D (1955)

Treatment 2,4-D (ppm)	Variety: Porto Rico	Variety: Yellow Jersey	Treatment Means
	(Values expressed in percent on dry weight basis)		
100	.11	1.33	.72
250	.54	1.65	1.10
500	.18	1.43	.81
Controls (No treatment)	.18	1.08	.63
Variety Means	.25	1.37	

TABLE XVI

Total Nitrogen in Sweetpotato Leaves Collected Four Days After Treatment with 2,4-D (1955)

Treatment	Variety		
2,4-D (ppm)	Porto Rico	Yellow Jersey	Treatment Means
	(Values expressed in percent on dry weight basis)		
100	5.63	5.95	5.79
250	5.49	6.00	5.75
500	5.49	5.95	5.72
Controls (no treatment)	5.83	6.33	6.08
Variety Means	5.61	6.06	

Least differences necessary for significance between treatment means 5% .27

TABLE XVII

Total Nitrogen in Sweetpotato Leaves Collected Twenty Days After Treatment with 2,4-D (1955)

Treatment 2,4-D (ppm)	Variety: Porto Rico	Variety: Yellow Jersey	Treatment Means
	(Values expressed in percent on dry weight basis)		
100	5.52	5.56	5.54
250	5.41	5.33	5.37
500	5.32	5.32	5.32
Controls (no treatment)	6.03	6.19	6.11
Variety Means	5.57	5.60	

Least differences necessary for significance between treatment means 5% .14
1% .19

4- Discussion

Considerable interest with respect to the effects of certain treatments on flowering of sweetpotato varieties has developed within recent years. Consequently, various postulations have been presented for evaluation. The concept that florigen or a flowering hormone, as first mentioned by Moskov and Cajlachjan, according to Cholodny (10), functions in the sweetpotato plant to induce floral primordia formation is strongly supported by Lam and Cordner (37). The latter in experiments partly designed to determine the factors that induce flowering in grafted scions of the sweetpotato, found that various stock species appear to have different abilities to induce flowering. With the Orlis variety used as a scion, it was found that flowering following grafting on morning glory stock depended upon the number and continued vigor of the leaves on the stock, and that the number of flowers that appeared on Orlis scions was directly related to the number of active leaves on the stock. From their studies they suggested that a flowering hormone (florigen) originates in the leaves of the morning glory stock, is translocated to the meristematic region of the sweetpotato scion where its flower-inducing effects are exerted.

As shown in Tables IX and X, flowering of Porto Rico and Yellow Jersey sweetpotatoes was associated with definite

depression of root growth. These results were confirmed by data from the experiment conducted in 1955 (Table XIII). Lam and Cordner (37) suggested that the absence of storage roots in the understock *per se* will not assure blooming in the sweetpotato scion. However, it is believed by Zobel and Hanna (79) that flowering in non-flowering types when grafted on easy-flowering stocks is attributable to limited storage of carbohydrates in the roots of the stock. According to them, this might result in a build-up of material in aerial portions of plants and thereby induce flower bud formation. This concept of carbohydrate accumulation in the aerial portions of the plant with respect to flowering response in the sweetpotato has also been suggested by Kehr *et al.* (34) and Mikell *et al.* (48). Since the general flowering in the present investigation was associated with tumefaction at the nodes of the main stem and laterals, and considerable splitting occurred at the points of enlargement (Figure 7), it is highly probable that transport of foods from the top growth to the root system was greatly impeded. This assumption is further supported by the fact that a suppression of root growth was associated with all 2,4-D treatments which induced flowering. That the accumulation of carbohydrates in the top growth may have been associated in some complex manner with flowering response has been suggested (34,48), but not necessarily supported herein by the analyses for total sugars in the leaves of treated plants (Tables XIV and XV). The general increase in total sugars from leaves collected twenty days

after treatment as compared with that of leaves from the first collection may be explained in that greater photosynthetic activity might have occurred at the time and/or the rate of downward transport was impeded (53). The latter is more tenable since the autumn days became increasingly shorter as the plants grew. It appears that a general increase in total sugar content in the leaves accompanied flower development (34), since the first flowers were definitely observed October 1, one day prior to the time of the second collection. Mitchell and Brown (54) have reported that following treatment of annual morning glory plants with toxic amounts of 2,4-D the increase in sugar content as a result of treatment occurred in the leaves.

The effect of defoliation upon photosynthesis perhaps contributed to the initiation and perpetuation of changes in the metabolic activities within the plants from which samples were taken. However, it was assumed that the effect of defoliation alone would be essentially the same in both treated and control plants. Any differences in response among plants from which samples were collected other than those resulting from treatment could possibly be explained on the basis of unequal distribution of sunlight in different areas of the bed in which the plants were grown.

Although in the present investigation no significant differences in total sugars with reference to flowering

response were noted, it was found that there was a definite decrease in total nitrogen in the leaves collected four and twenty days, respectively, after treatment with 2,4-D (Tables XVI and XVII). These results agree with those reported by Freiberg and Clark (26) from their work with soybean plants. They noted a decrease in total nitrogen content in leaves five days after 2,4-D applications. In the present investigation, it is suggested that the 2,4-D treatments resulted in the translocation of nitrogen from the leaves to the stems, and apparently the longer the interval from treatment date to the time of sample collection, the greater the decrease in nitrogen in the leaves is likely to be. This assumption, however, is not supported by findings of Brunstetter et al. (8), who found that the application of 3-indole-acetic acid to stems of bean plants is followed by the movement of sugars and soluble nitrogenous compounds from other parts to the treated region. Mitchell (53) found that in bean plants treated with naphthaleneacetic acid and naphthaleneacetamide the percentage of nitrogen present in the treated portions of the plants was equal to, or greater than, that for control plants. Kraus and Kraybill (36) in their classical report with reference to the carbohydrate-nitrogen ratio from results of their work with the tomato, suggested a suitable relationship between these two major constituents with respect to their effect on flowering and fruiting.

The distribution of flowers on the plants of Porto Rico and Yellow Jersey sweetpotatoes provides further evidence that the amount of vegetative growth preceding the time of flowering is one of the most reliable indices for determining if floral primordia initiation is of a specific nature (38). This was not difficult to establish, herein, since there was a complete absence of flowering on non-treated plants. Differences between varieties with respect to distribution of flowering is influenced by inherent variations within the species. Vines of the Yellow Jersey were more extensive in vegetative growth habit than those of Porto Rico; and since flowering usually occurred on relatively young growth, it is logical to assume that the Jersey variety has a greater capacity for flower formation.

The differences in response of Yellow Jersey plants to the three concentrations used in 1954 and 1955 are very interesting. In 1954 a concentration of 100 ppm showed a greater inductive effect, as expressed by flowering response, than did either of the other concentrations employed. No flowering occurred among plants following treatment with 2,4-D at 250 ppm. The explanation as to the reason or reasons why the plants which received the latter concentration did not flower are not readily apparent, since some flowering occurred following treatment with 500 ppm of the chemical. Moreover, in 1955 the greatest percentage of plants which flowered in both Porto Rico and Yellow Jersey was

associated with 2,4-D at 250 ppm. Certain factors such as lack of uniformity in plant material and in distribution of spray solutions, differences in location of the plants in the bed, and in the dates of recording the data may have been contributing causes.

Attempts to produce viable seed in the greenhouse during the short days of fall and early winter of 1954 were not successful. According to Miller (50), flowering sweetpotato plants set seed best with an increasing day length of from 11 1/2 to 12 1/2 hours and at temperatures considerably higher than those maintained throughout the duration of this experiment. Moreover, Stout (69) has mentioned that as ordinarily grown, the sweetpotato is most decidedly sterile with respect to production of capsules and seeds.

5- Summary and Conclusions

As a foliar spray applied to Porto Rico and Goldrush sweetpotato plants in concentrations of 100 and 500 ppm, 2,4-dichlorophenoxyacetic acid (2,4-D) successfully induced flowering during the fall of 1953. Flowering occurred among plants of both varieties which were treated at two different dates.

Similar results were obtained during the fall of 1954 with Porto Rico and Yellow Jersey varieties. In this investigation spray applications of the sodium salt of 2,4-D at concentrations from 100 to 500 ppm were effective in inducing flowering. As in the previous experiment, flowering was general and associated with a significant depression of storage root growth. Flowering among Porto Rico plants occurred from the 20th to the 64th nodes, whereas in Yellow Jersey it was distributed from the 20th to the 74th nodes. In Porto Rico the greatest number of flowers occurred on plants following treatment with 2,4-D at 500 ppm. However, a concentration of 100 ppm was most effective on Yellow Jersey plants. Higher concentrations caused severe injury to plants of this variety.

During the fall of 1955 the sodium salt of 2,4-D was again found effective for the induction of flowering in

Porto Rico and Yellow Jersey plants at concentrations from 100 to 500 ppm. The greatest percent of flowering in all plants occurred from treatments at concentrations of 250 and 500 ppm, and of all plants treated, thirty-eight percent showed evidence of flowering response. The greater percent of treated plants which flowered occurred with the Yellow Jersey variety. Data from chemical analyses of leaves collected four and twenty days after treatment with respect to percent total sugars were inconclusive, although there was a general increase in total sugar content in leaves collected twenty days following treatment.

Treatments with 2,4-D significantly decreased the total nitrogen content in leaves collected four and twenty days after the sprays were applied. The differences in total nitrogen between treatments twenty days after spray applications were highly significant.

These data herein reported are conclusive with respect to the effectiveness of 2,4-D as a flower-inducing agent for Jersey sweetpotatoes, and the method developed should be a valuable tool for the plant breeder who has encountered considerable difficulty in his many attempts to induce flowering in Jersey sweetpotato varieties. Moreover, it is concluded that the flowering response induced by 2,4-D treatments was associated with a significant depression of storage root growth as well as with a significant decrease in total nitrogen in the leaves.

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