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THE EFFECT OF CHEMICALS ON GROWTH
AND SEED PRODUCTION IN THE ONION

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THESIS

Onions



THE EFFECT OF CHEMICALS ON GROWTH AND
SEED PRODUCTION IN THE ONION

THESIS

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INTRODUCTION

The commercial onion is a true biennial and under ordinary conditions requires two years from the time of planting for the production of seed. This condition greatly handicaps experimental breeding work since two years are required before a selection can be tested. The purpose of this piece of work was to determine if it were possible to break the rest period of mature bulbs and produce a crop of seed under glass in time for the regular spring planting.

REVIEW OF LITERATURE

Several workers have used chemicals for breaking the rest period of woody plants and starchy bulbs but very little work has been done on the onion. Boswell (1) noted that the rest period in both early and late maturing bulbs of the yellow Danvers onion was approximately eight weeks. He also found that chilling at a temperature of 31° to 32° Fahrenheit for several days tended to shorten the rest period and that freezing seriously injured the bulbs. He found that greening by exposure to sunlight retarded rather than stimulated growth, however wounding and treatment with ether gave variable results with considerable injury.

Loomis and Evans (6) found that ethylene chlorhydrin gas was not effective in breaking the rest period of onion sets, whereas wounding along with forced injection of water

gave immediate results, but 75 per cent of the bulbs rotted after starting growth. Cuts made nearer the growing point produced a greater response. Longitudinal cuts through the stem plate greatly stimulated root growth, but had no effect on top growth. Wilson (7) on the other hand found that wounded bulbs averaged a larger number of seed stalks.

Jones (4), working with the Ebenezer onion in California, found that lots stored at 7.5° and 11° to 12° centigrade during the winter storage season were the earliest to produce seed stems. These also were the first to blossom. The yield of seed in pounds per acre of these bulbs was 51 and 60 per cent respectively greater than bulbs placed in common storage. Bulbs stored at higher or lower temperatures produced many vegetative bulbs. Boswell (1) found that exposure of mature onion bulbs to a temperature of 32° Fahrenheit for longer than six months increased the inhibition of floral development.

Garned and Allard (3) found that breaking the continuity of the daily illumination periods of plants by darkening them in the middle of the day for periods of 1, 2, and 5 hours duration may materially affect the general nutrition and amount of growth. As a rule it fails to influence reproduction activities to a degree at all comparable with that produced by excluding the early morning or late afternoon light of the long summer days. He also found this to be true with long day plants.

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METHOD

The material consisted of bulbs and sets of Southport Yellow Globe, Sweet Spanish and sets only of Giant Gibraltar. Each treated lot and check contained ten bulbs or ten sets. Each treatment was placed in a milk can and the varieties were separated by a saxoline bag, so that the concentrations of the gas would be the same for each variety. The chemicals were placed in a shallow container on top of the bulbs. The cans were kept at room temperature of approximately 70 degrees Fahrenheit.

The treatments and concentrations were as follows:

1. Ethylene chlorhydrin ($\text{ClCH}_2\text{CH}_2\text{OH}$). 1 cc. per liter of air space and treated for 48 hours.
2. Sodium thiocyanate (NaCNS). The bulbs were dipped in a 2 per cent solution and then placed in a sealed can for 24 hours.
3. Ether at a concentration of 1 cc. per liter of air space, and treated for 24 hours.
4. Ethylene dichloride (Cl_2CH_2). Concentrations of 0.03 and 0.06 cc. per liter of air space were used and treated for 24 hours.
5. Check. No treatment.

The bulbs were planted in muck soil in the greenhouse November 15th. The rows were ten inches apart and mature bulbs were spaced eight inches and sets four inches apart in

the rows. The muck had a range of pH 6.6 to 6.8. Three 500 watt lights were spaced equidistant apart over the bench. They were turned on before dark and left on until ten o'clock at night during the period from December 1st to March 31st. Unfortunately the temperature of the house varied from 65 to 70 degrees Fahrenheit during the day. This was too high, but could not be changed on account of other experimental work in the house.

The blossoms were self pollinated by covering the heads with glazine bags at the time the spathe broke and before any of the blossoms opened. This was also taken as the blossoming date because it is more uniform than trying to decide when the majority of the blossoms of a head were open. Pollination was aided by tapping the bags at least once a day.

PRESENTATION OF DATA

The data presented in Table 1 show that there were no significant differences between the check and any of the treatments on the rate of growth of sets. There were slight differences in shoot growth, which may easily be within the range of experimental error. The bulbs, when harvested, ranged from 1/2 to 3/4 inches in diameter which was about the size of the sets at planting.

In Table 2 the data show that mature Valencia and Sweet Spanish onion bulbs treated with chlorhydrin made the longest shoot growth, but the bulbs treated with 0.03 cc. per liter ethylene dichloride started growth eight days

Table 1. The Average Length of Shoot Growth for Three Varieties of Sets Measured in Inches

VALENCIA SETS							
Treatment	November 26	29	6	December 13	20	27	January 3
*Ethylene Dichloride .03cc. per liter of air	5.4	9.3	13.3	16.6	20.6	22.8	23.5
Check	3.9	10.0	14.3	17.9	21.7	24.0	25.6
Sodium Thiocyanate	4.3	9.4	12.8	16.5	19.5	21.7	22.4
Ethylene Chlorhydrin	4.8	11.4	16.4	21.4	25.5	28.5	30.2
*Ethylene Dichloride .06cc. per liter of air	4.1	7.1	11.9	15.9	20.1	22.7	23.1
SOUTHPORT SETS							
Ethylene Dichloride .03cc. per liter of air	3.4	8.1	11.7	15.2	17.9	21.3	22.7
Check	3.9	10.3	14.6	18.6	22.5	23.4	26.7
Sodium Thiocyanate	3.5	9.7	16.4	21.3	25.1	27.6	28.7
Ethylene Chlorhydrin	4.4	11.8	17.2	21.8	25.8	27.8	30.1
Ethylene Dichloride .06cc. per liter of air	2.4	4.4	7.7	11.0	14.3	17.0	19.0
GIBRALTAR SETS							
Ethylene Dichloride .03cc. per liter of air	5.6	9.2	13.2	16.6	20.1	21.7	23.0
Check	5.6	11.4	16.3	20.6	24.9	27.3	28.9
Sodium Thiocyanate	5.2	10.7	14.6	17.9	22.9	24.5	25.8
Ethylene Chlorhydrin	6.0	12.4	17.1	21.3	25.5	27.8	29.2
Ethylene Dichloride .06cc. per liter of air	4.0	7.0	11.6	15.7	19.5	21.7	24.3

*These treatments in the remainder of the paper will be designated as .03 and .06 Ethylene Dichloride



Table 2. Effects of Various Treatments on Growth and Seed Production of the Onion

Treatment	Total Av- erage Growth inches	Per cent increase or decrease of shoot Growth Over Check	Number of Seed stalks	Average Number of Seed per Plot	Average Number of Seed per Bulb	Per cent increase or decrease of crease of Seed over Check	Number of Barren Bulbs
VALENCIA							
Ethylene Dichloride .05cc. per liter of air	22.8	24	15	99	9.9	- 45	23
Check	18.4	0	11	181	18.1	0	25
Sodium Thiocyanate	21.1	15	8	318	31.8	71	21
Ethylene Chlorhydrin	29.4	60	23	309	30.9	71	18
Ethylene Dichloride .06cc. per liter of air	16.4	- 19	12	109	10.9	-39	24
SOUTHWEST							
Ethylene Dichloride .03cc. per liter of air	12.6	2	9	139	13.9	0	14
Check	12.3	0	14	141	14.1	0	17
Sodium Thiocyanate	29.0	13.6	22	237	28.7	104	9
Ethylene Chlorhydrin	30.6	14.9	18	327	32.7	132	6
Ethylene Dichloride .06cc. per liter of air	23.9	9 6	17	192	19.2	36	7

earlier than the check. Three bulbs in the plot treated with 0.06 ethylene dichloride and two bulbs in the plot treated with chlorhydrin died. During the entire growing period the Valencia onions never appeared as vigorous as the Southport onions and growth in all treatments started eight to twelve days later. A few bulbs in the check plot apparently had no rest period and started growth as soon as any of the treated lots.

The plot of Southport onions treated with ethylene dichloride showed considerable injury and three bulbs showed no root or shoot growth. Two bulbs in the chlorhydrin treatment started shoot growth and floral development, but never sent out roots. The lots treated with sodium thiocyanate and ethylene chlorhydrin showed on the average, (Table 2), 40 to 50 per cent longer shoot growth and gave an increase of 104 to 132 per cent increase respectively in set of seeds over the check. The corresponding treatment of Valencia onions showed an increase in seed production of 71 per cent over the check. From observation the check and ethylene dichloride treated bulbs formed very weak seed stalks during the latter part of June and died before producing seed. The plots treated with ethylene chlorhydrin more consistently produced fewer bulbs than the check or any treatment.

The peak for floral development as shown in table 3 for plots treated with 0.06 ethylene dichloride was reached

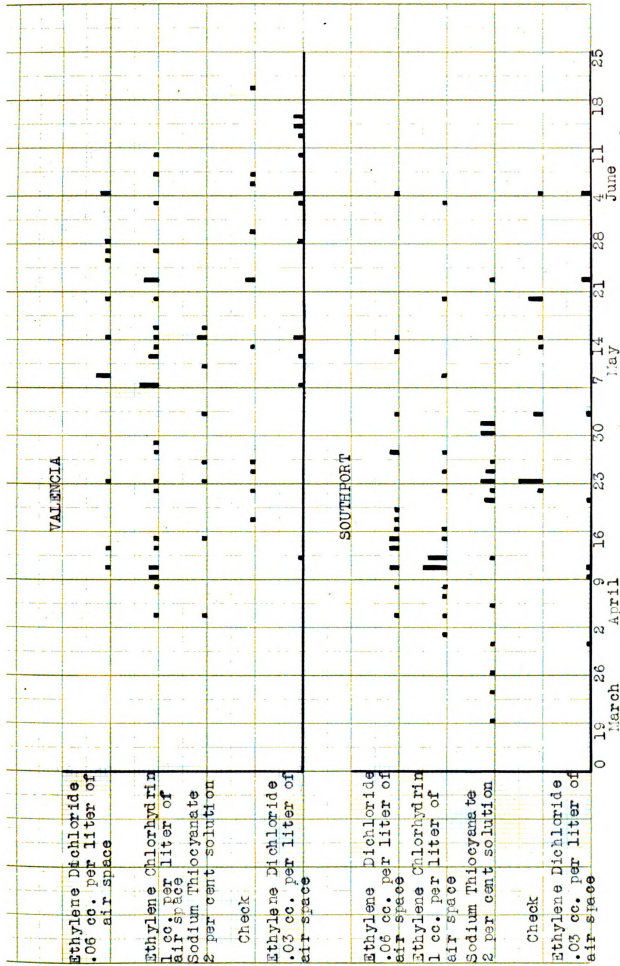


Table 3. The Blossoming Date of the Onions Under the Various Treatments

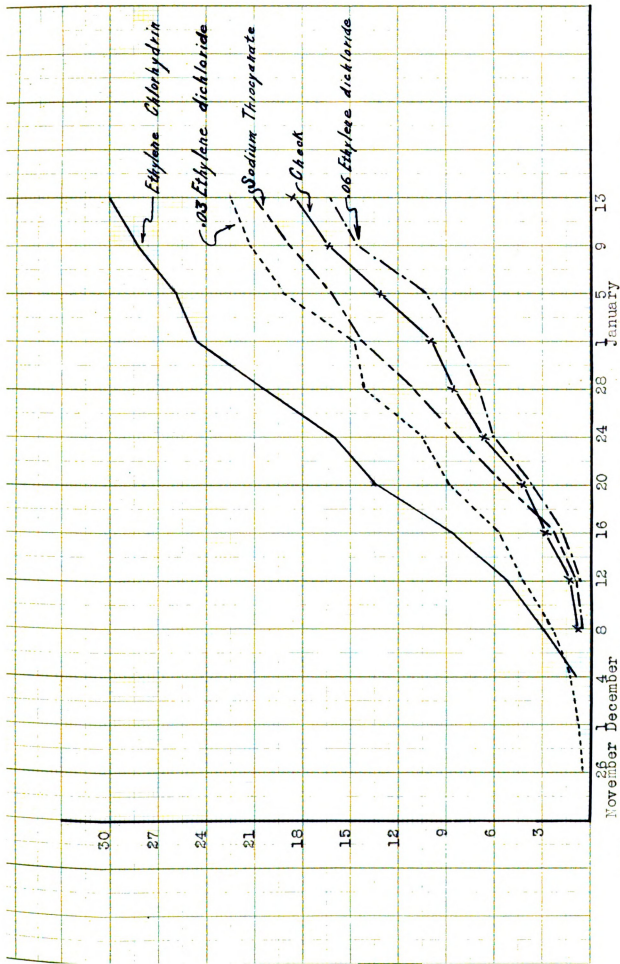


Figure 1. The average shoot growth of Valencia Onions measured in inches and recorded every 4th day.

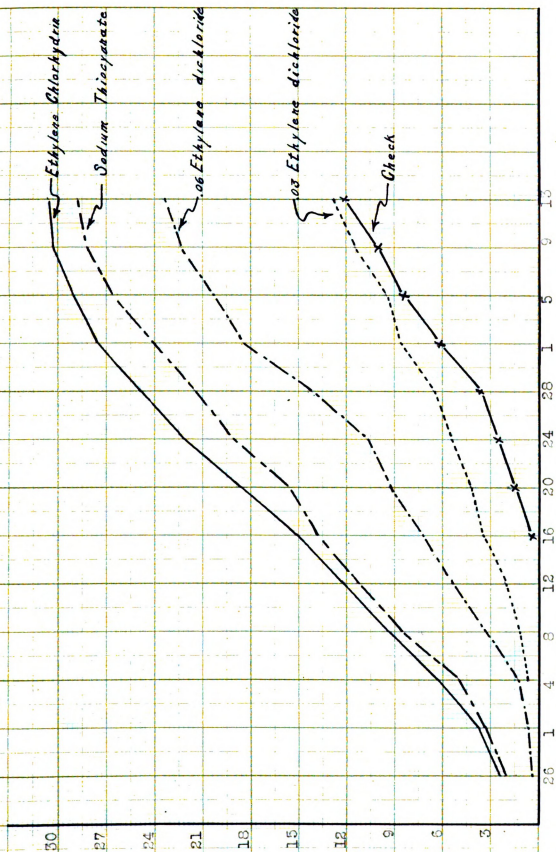


Figure 2. The average shoot growth of Southport Onions measured in inches and recorded every 4th day

approximately fourteen days earlier than the check, while the peak for sodium thiocyanate was at the same time as the check. In each of the above treatments there were more seed stalks than in the check. The Valencia plots did not reach any definite peak, but produced more seed stalks than the check except the plot treated with sodium thiocyanate.

Ether killed all of the sets and mature bulbs.

DISCUSSION

As stated in the introduction the primary purpose of this work was to ascertain if the rest period of mature onion bulbs and sets could be broken, so that for experimental breeding work one generation of seed could be grown annually. Treatment with ethylene chlorhydrin, sodium thiocyanate and 0.06 ethylene dichloride on mature bulbs of Southport onions caused the shoots to start growth 18 to 20 days sooner than the check. The mature Valencia onions showed no significant difference between the treatments and the check in the time growth started, but the bulbs treated with ethylene dichloride showed an increase of approximately 60 per cent over the check. The probable reason that there was no greater difference in the time growth started is that the strains used were not pure lines as the rest period of a few bulbs in the check and treated lots was apparently over when they were planted. Bulbs treated with the chemicals mentioned above were more uniform in the time of starting growth. This indicates that the rest period of some bulbs in all lots was

broken.

Mature Southport onion bulbs treated with chlorhydrin and 0.06 ethylene dichloride reached the peak of flower production 12 to 14 days before the other treatments and check. In the same treatment on Valencia onions, several flowers appeared in the lot treated with ethylene chlorhydrin approximately one week earlier than the check. In the latter treatments flower production was scattered over a longer period of time and no definite peak was reached as in the Southport variety. Had it been possible to have used larger numbers and to have kept the growing conditions more nearly ideal, it is probable that the flowering peak would have been more pronounced between the check and the treated lots. In all plots growth was slow and the growing season more prolonged than it might have been under a more ideal environment.

Treatment with chlorhydrin on Valencia onions caused nearly twice the number of seed stalks to be formed as any other treatment. On Southports sodium thiocyanate and ethylene chlorhydrin gave practically the same results. Sodium thiocyanate produced more seed stalks in this instance because two bulbs in the ethylene chlorhydrin plot died. This fact further shows the need for using larger numbers in the treatments.

The total number of seeds for both varieties was greatest in lots treated with ethylene chlorhydrin and sodium thiocyanate. The average number of seed per seed stalk was

not consistent possibly due to the method of pollination. As stated previously, the first formed seed stalks did not set seed well and in some cases did not produce seed.

Ethylene chlorhydrin is most consistent of the treatments used except in the number of seed stalks in the Southport treatments. It is obvious that further experiments with ethylene chlorhydrin in various concentrations and with larger numbers of bulbs should be tried.

There was considerable variation in maturity and length of the rest period of apparently similar bulbs in all the plots. Boswell (1) found that mature healthy bulbs differed as much as three weeks in length of the rest period. This may be expected for Jones and Rosa (5) stated that the onion is naturally cross pollinated and there is a loss of vigor due to inbreeding which causes a low yield of seed. The results would have been of more value if pure strains had been used, but these were not available. Cloudy weather at the time of seed formation on the early flowering stalks probably is the reason for the poor set of seed. Light is very often the limiting factor for fruit or seed production in winter vegetables grown under glass.

Boswell (1) believes that oxygen is the activating material for enzymatic action on the hydrolysis of higher starches and sugars. He wounded bulbs and coated them over with a low melting paraffin to exclude air, and one month later there was no growth except where the paraffin had

cracked. Bulbs started growth immediately if the paraffin cracked. He also states that exclusion of oxygen and the retention of oxygen and the retention of carbon dioxide, or some other gases, or a combination of both factors, prevented growth in bulbs during the rest period; and that an increase in permeability of cells which will permit a ready exchange of gases is one of the changes that is responsible for termination of the rest period.

Loomis and Evans (6) suggested that the effect of ethylene chlorhydrin in breaking the rest period may be connected with the hydrolysis of starch reserves and similar compounds in plant organs, but was not effective on bulbs such as the onion which contain little or no starch. They used onion sets only.

The data for mature onion bulbs presented in this paper do not agree with the work of Loomis and Evans. In every measurement used, ethylene chlorhydrin showed an increase in growth and seed production over the check.

Denny (2) found that potato tubers treated with ethylene chlorhydrin showed an increase in sucrose of 100 per cent over the check, and a decrease in starch content. The sucrose was localized near the growing point thus showing more enzymatic action near this growing point. In wounded onions the nearer cuts were made to the growing point the greater was the response.

Sets in this experiment did not produce bulbs because the house was warm. This shows that low temperature is necessary for bulb formation.

It is obvious from the review of literature and the data presented in this paper, that the bulbs should be treated not later than two weeks after harvesting because the rest period of many individual bulbs is very short and may be broken before the bulbs are treated. The bulbs for experimental purposes should be stored in a room with temperatures of 45 to 55 degrees Fahrenheit and never subjected to high or low temperatures.

SUMMARY

1. There is much variation in the length of the rest period of apparently similar individuals of commercial varieties of mature onions.

2. Ethylene chlorhydrin produced the longest shoot growth and on mature Southport there was an increase of 132 per cent in the set of seed. Valencia onions showed a 71 per cent increase.

3. Sodium thiocyanate showed slightly shorter shoot growth and fewer seed stalks, but a very good increase over the check.

4. The sets in any treatment did not show promising results.

5. Treatment with ether killed all of the sets and bulbs.

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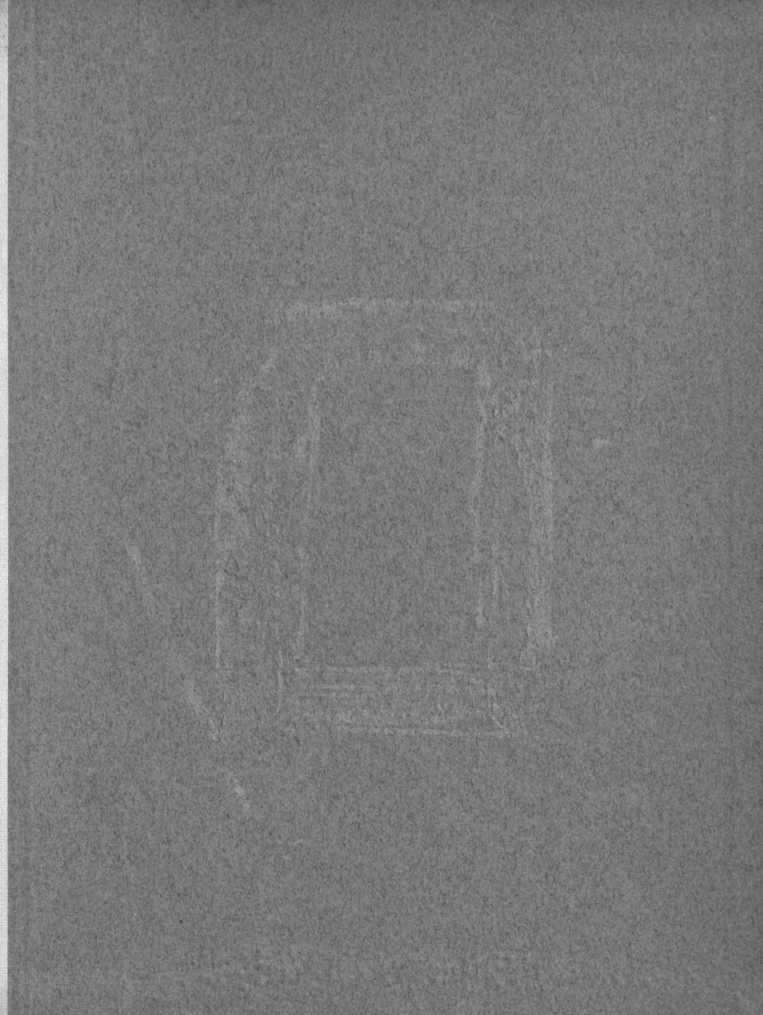
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