A STUDY OF THE INFLUENCE OF SUMMER DEFOLIATION OF RED RASPBERRY CANES ON THEIR SUBSEQUENT BEHAVIOUR

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Reception

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A THESIS

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THESIS

A Study of the Influence of Summer Defoliation of Red Raspberry Canes on Their Subsequent Productivity.

By A. Harold Uphall

INTRODUCTION

The fact that red raspberries are grown commercially over a wide range of soil and climatic conditions that they will flourish under many conditions of soil and climate. For this reason one would expect to find a great diversity in cultural practices and this proves to be the situation. For instance, dormant pruning and the removal of old fruiting canes is sometimes done in the fall, sometimes in the spring; summer pruning and thinning of shoots may or may not be practiced; if fertilizers are used, applications may be made in the spring, summer or fall. Furthermore the results of experimental work that has been done with this fruit are so conflicting that few definite conclusions may be drawn. In some trials fertilizers have produced much larger crops of fruit, in others the reverse has been true. Pinching the young shoots at certain heights has in some experiments increased the yield; in others it has been of questionable value. These variable results, together with the diversity of practices employed by growers, emphasize the need for further and more detailed investigations.

It is generally accepted that a full fruit bears a premature full of leaves is a disadvantage. Roberts (6, points out that an artificial defoliation up to August 24 has an

inhibiting growth of the canes and leaves in the fall. Hampson (5) notes a similar effect in the case of the apple as a result of early autumn defoliation. The writer has been unable to find any record of investigations of a premature defoliation of raspberry canes, but this early defoliation is of common occurrence and, probably, is of considerable importance.

OUTLINE OF THE EXPERIMENT

This investigation was begun in an endeavor to learn the effects of (1) early autumn defoliation of red raspberry canes on (1) vegetative growth and dormancy (2) winter hardiness and winter injury (3) subsequent fruiting (4) fruiting by lateral production the following spring (5) number of blossoms produced (6) date of blossoming and setting fruit and (7) quantity and quality of the fruit.

MATERIALS AND METHODS

The field work on this problem was done at the Horticultural Experiment Station, Vineland, Ontario, during the summers of 1924 and 1925, and the laboratory work in the Department of Horticulture, Michigan State College. The block of Viking raspberries used in this experiment was planted in 1919 and was in a fairly vigorous condition. Prior to beginning the treatments the plantation had been carefully rogued for disease plants. There were 7 rows, 8 feet apart and 77 yards long. The plants had not been kept

separate in the rows. The soil is a well-drained sandy loam, [illegible] of acres, [illegible] very uniform.

On May 17, 1921, all the trees were cut back to about 3' from the ground and a few weak or crooked sprouts removed. All the trees were sprayed with Bordeaux mixture (3 lbs. copper sulphate, 3 lbs. hydrated lime, 1 lb. fish [illegible] to 50 gals. of water). By June 30 most canes had lost their leaves from the lower nodes; by July 30 these were often 3 or 4 leaves missing from the basal portion and some of the basal buds were beginning to break out to form laterals. On July 17 the first sign [illegible] was noted and the first [illegible] was made on July 21. By this time [illegible] spider injury was [illegible] that it was necessary to [illegible] about half the spray [illegible], to prune out the old canes in order to allow for thorough spraying of the shoots. The next day these shoots were sprayed with [illegible] sulphur, 12½ lbs. to 40 gals. of water. This treatment gave satisfactory control. A few days afterwards the field [illegible], outlined below, were [illegible].

In the spring of 1923 two canes of various lengths were tied back to their original [illegible] at the time of pruning in 1922 and three canes of [illegible] were left unpruned. As in 1,24 the ground was cultivated frequently until the 15th of July. No spraying was done in this season, and no fertilizer was applied at any time [illegible] the experiments.

Outline of Experimental Treatments

Series 1 - Treatments given Aug. 12. Canes divided into 3 sections.

Treatment Number	Treatment	No. of Canes
1A	Basal third of cane defoliated	45
1Aa	" " " " " & clipped above	15
1Ab	" " " " " " below	15
1Ac	" " " " " " above & below	15
2A	Middle " " " "	45
2Aa	" " " " " & clipped above	15
2Ab	" " " " " " below	15
2Ac	" " " " " " above & below	15
3A	Top " " " "	45
3Aa	" " " " " & clipped above	15
4	Alternate 3 node sections defoliated	45
5	Basal and middle thirds defoliated	45
6	Basal and top thirds defoliated	45
7	Middle and top thirds defoliated	45
8	Check - no defoliation or clipping	45

Series 2 - Duplicate of above treatments given August 30.

Series 3 - 1. 6 hills - 1/3 of shoots completely defoliated Aug. 30.
2. 6 hills - No treatment.

[illegible]

On August 7 and 8 the canes for the artificial treatment were selected. They ranged in weight from 3 lb. 6 oz. to 5 lb. and from 1 to 1.5 centimetres in diameter just above the 6th bud. Though this may seem like a wide range, actually, very few of the canes approached the extremes. Because of previous natural defoliation it was considered advisable to disregard the basal six buds. On August 11 the necessary canes for Series 1 were divided into 3 equal lengths, measuring from the 6th basal bud to the pruning point. Narrow bands of adhesive tape were used for marking the same divisions. Not until August 20 were the canes for Series 2 divided in this manner and the growth recorded during the intervening period is the reason for a slightly greater height of cane in Series 2. Bud counts were given in the order appearing in the Collins, going up one row, to the next one and so on. The one lot of 5 buds came practically in the center of the plantation.

On August 14 Series 1 was defoliated and ringed according to the Collins. Defoliation was done with a sharp knife, the leaves being cut off near the base of the petiole but not near enough to disturb the bud in its axil. In ringing, a band of bark ¼ inch wide was removed, care being taken to avoid injury to the woody portions. Two safety razor blades set ¼ inch apart in a small wooden block were used for cutting out the ring of bark. Immediately 2 thicknesses of adhesive tape 1½ inches wide were wrapped around the

wounded portion and the whole surface sterilized with [illegible] solution, consisting of 70% alcohol and 30% turpentine. The [illegible] is applied with a [illegible] brush.

[illegible] the [illegible] are [illegible] the [illegible] the [illegible] are [illegible] in the spring. [illegible] the [illegible] are [illegible] in April and in the following [illegible] [illegible] [illegible]. [illegible] setting and [illegible]. [illegible] of the intervals of 1/25 [illegible] [illegible] [illegible] after the removal of the [illegible].

PREPARATION OF MATERIAL FOR ANALYSIS

On November 11 five average canes from each plot were cut off just below the usual band, carefully packed in damp excelsior and oiled paper, and shipped to the laboratory at East Lansing. Shipment arrived on the 14th and that day and the next each of the portions were cut up and put in [illegible] bottles. Intervals from all treated canes were discarded and intervals from check canes were kept by themselves for analyses. The samples were killed to stop starch [illegible] at 95° C and then [illegible]. The selected ones were tested for carbohydrates by the Allihn method (4,, specially modified for horticultural material. Takadiastase was used for starch digestion. Carbohydrates figures used in this report are expressed in grams per 100 cc of oven-dry weight.

[illegible]

In order to determine, if possible, the effect of defoliation on fruit [illegible] and buds were taken from the various plots [illegible] treatment and split open lengthwise for microscopic examination. In order to be better able to interpret [illegible] to be seen in these full-grown buds a series was also taken in the spring from untreated trees. All these were killed either in Bisel's fluid or in formal-acetic alcohol, the air being exhausted in order to secure good penetration of the killing solution. From [illegible] alcohol and xylol into paraffin, in which they were sectioned by means of a rotary microtome. The sections, 7 microns in thickness, were stained with Delafield's hematoxylin and Eosin.

[illegible]

The following tables are given to show the results of the various defoliation and pinching treatments on some of the factors involved in fruit production. The application of the treatments is given in the outline of experimental treatments.

Table 1 - [illegible]

[illegible]

Series 1. Aug. 12-Apr. 20.

Treatment	1.	1a	1b	1c	2.	2a.	2b	2c	3.	3a	4	5	6	7	8
Av. length of same	39.0	36.6	41.6	37.6	37.0	41.6	37.7	41.1	37.3	41.2	40.4	36.1	37.4	41.6	37.
Av. dia. of same	1.09	1.10	1.13	1.12	1.09	1.09	1.09	1.14	1.06	1.13	1.07	1.11	1.10	1.07	1.1
Wt. in gm. of after treatment	9.7	10.1	9.7	11.3	9.1	broken	9.2	broken	9.1	8.2	7.3	9.1	7.5	8.6	9.
Wt. in gm. after treatment	.062	.060	.056	.056	.064	"	.056	"	.056	0	.076	.091	.063	.023	.05
Total Milligrams per same	12.1	8.3	8.5	7.1	12.1	"	7.8	"	12.9	0.3	13.1	8.2	11.1	21.9	10.
Wt. of fruit in same	0.9	0.6	0.9	7.7	0.9	7.1	9.0	4.4	4.2	0.0	4.4	3.1	0.7	4.2	7.

Series 2. Aug. 7-Apr. 20

Av. length of same	47.1	4.1	44.7	[illegible]	44.7	41.9	47.1	47.4	4.7	46.7	4.7	46.2	47.9	45.9	
Av. dia. of same	1.20	1.11	1.09	1.10	1.11	1.11	1.13	1.06	1.01	1.07	1.13	1.11	1.10	1.1	
Wt. in gm. after treatment	3.1	3.4	3.7	4.3	2.9	4.3	3.5	2.7	3.3	3.5	3.3	3.2	3.1	3.9	
Wt. in gm. after treatment	.046	.030	.044	.029	.074		.029		.070	.050	.064	.032	.053	.029	

The Effects of Defoliation and Blighting on Increase in Length and Diameter of Canes--The average increase in length and diameter of canes after treatment is given in Table 1. That little difference appears can be explained by the fact that, with one exception (Treatment 3), defoliation and blighting did not check the growth of those canes for the remainder of the season, nor has it favored growth. Canes in Plot 3 were the only section that showed a marked check in growth, in fact only a few buds were produced. This is in accord with the results obtained by Curtis (1) in various study plots. The error in taking diameter measurements with steel calipers is liable to be rather large, especially in the measurement of very small increases, so figures on diameter increase are not very reliable. Each bud has several nodes and several buds after the first one. It is an easy matter to take the reading at a different place or at a different angle. In this experiment diameter measurements were taken from immediately above the bud mark. Different days of the growth between treatments is the reason for the canes of Series 2 being taller than those of Series 1.

The Effects of Defoliation and Blighting on Lateral Formation--There is at present no reason to suspect that defoliation would induce buds to open and form laterals. The figures for average total lateral growth per cane for each treatment of Series 1 are given in Table 1. There is some indication

that defoliation causes increased length of lateral growth but the figures are for one season only. However, it is reasonably certain that pruning has resulted in greater use of lateral growth. Unfortunately no data on lateral growth were obtained for Series 2.

Table 2 - Effect of various treatments on length of lateral growth. Treatments given August 17, 1929. Measurements taken October 21, 1929.

10 canes under each treatment

Treatment	av. no. of laterals per cane	av. length of laterals per cane	av. length of each lateral
Pruned off at 7 ft.	3.5	76.7	13.9
Check	3.3	52.7	16.0
Defoliated from 7 ft. up	3.4	66.3	20.1
Defol'd from 7 ft. up & broken over	3.5	71.4	16.8
Broken off at 7 ft. only	3.4	63.7	19.3
Defol'd below 7 ft. only	4.9	70.5	12.6
Check	3.5	65.4	18.7
Defol'd below 7 ft. & broken over	3.8	52.6	7.1
Defol'd below 7 ft. & pruned off	7.4	57.1	7.9

In an endeavor to secure more information on this question 9 lots of 10 selected canes each were given special defoliation and pruning treatments in the summer of 1929. These canes were all about 5 ft. high and selected for uniformity, yet between 2 check lots of 10 there is quite a variation. Practically all laterals grew below the 7 ft. mark on a cane so defoliation of this portion did not induce long lateral growths, not even when the cane was pruned off or broken over above the defoliated area. Breaking over and pruning by themselves seem to have practically encouraged

lateral formation and pre th. Thern. evolution fro. 3 ft. up shows a slight increase in lateral re th over a con it is not cnen l to conclude that this is the result of ins lapse.

The conclusion is, therefore, to draw that there is no evidence to prove that defoliating and raspberry canes about the middle of August will induce lateral formation. Note that this is the first serious l ss to be met in the year of 1924.

Table 7 - Sugar and starch content of bush beans and their by-products.

Sample	Treatment	Micrograms per milligram of dry weight.						
		% water loss in green wt.	Reducing sugars	Sucrose	Total Sugars	Starch	Total Poly-sacc.	Total Carbohy-drates
Tip	Bush	55.90	3.07	.62	4.72	3.54	25.41	22.72
Middle	"	56.11	3.00	.54	4.45	3.61	23.09	20.74
Base	"	51.00	3.84	.33	7.17	3.62	24.72	20.47
	By-products of Bush	55.61	1.57	.76	3.37	4.06	27.00	21.23

Curve fitting and determination of the base-line for the carbon dioxide peak were carried out in the manner described in connection with the calculated curve as is shown in Table 3. However, even the best possible graphical method for determining the amount of carbohydrates, as well as total gas evolved, is a little bit uncertain, a little bit arbitrary. In other words there is some difference, not essential as it will be seen later, between the graphical method, which we have described, and other possible graphical methods.

Table 4 - Comparison of results of three determinations by graphical methods.

Station	Area under curve (cm²)	Area under peak	Area under peak (cm²)
Top	4.4	3.3	.23
Middle	7.3	6.9	.50
Base	12.7	9.3	1.21

Table 4 shows that (1) a large percentage of the total gas evolved is produced in the basal portion of the cane (2) the bulk of bacteria were present in this section. Since light of these cells was rather strong, the presence of the maximum concentration of gas, but the fact that much higher proportion of the gas is produced in the middle and top sections will have been caused by the diffusion of the gas from the basal section. However, a careful look in this figure will show that the basal section alone produces less gas

fruit and the most fruit. It was noted in both seasons that the largest and earliest fruit was produced on laterals or shoots arising from the crown at or near the soil level.

Dates selected for the final study were 1 and 15 Nov. 11, 1944, at which time they had lost nearly all their leaves and were in a dormant state. It was assumed that the transfer from this time until the beginning of growth in the spring, and it is probably true, the earlier the period after the setting of the fruit in the early spring as does not include the time of the fruit production, even though some is made for the extra fruit and flowers. Furthermore, there is a considerable period of fruiting laterals in this section. Data on this point was developed as to the time of use in 1943 it was found that the supply of stored carbohydrates in the roots, crown or cane itself. The fact remains that yield in the first season, when they cannot be attributed to local storage of foods, must be due to a transfer of foods from other parts of the vine, probably the roots of roots. Therefore, the importance should be attached to the stored foods in the whole plant and in individual parts or portions of the vine.

Table 3 - Effect of Defoliation of Base and Top Sections (Avr. 12) on Carbohydrate Content.

Sample	Treatment	Water Extract.	Reducing Sugars	Sucrose	Total Sugars	Starch	Total Poly-Osc.	Total Carbohy-drates
	Axis Top							
1-Top	Not defol.	66.60	3.44	1.32	4.97	2.21	22.20	27.03
1-Middle	" " "	67.35	3.25	.89	3.68	2.10	19.60	23.68
1-Base	" " "	71.05	2.04	.67	2.75	3.06	23.21	26.12
2-Top	Defol.	65.15	3.91	.62	4.32	3.24	23.41	27.73
2-Middle	"	66.11	3.98	.54	4.45	2.91	23.89	28.34
2-Base	"	71.61	3.24	.50	3.77	3.02	24.72	28.49

Effect of Defoliation of Tube and Top Portions (Fig. 12) on Carbohydrate Content--In Table 3 values which received severe defoliation treatments (Fig. 12) are compared with the untreated values of the check plot. It is quite apparent that defoliation has caused a marked increase in sugar content, averaging over 3 percent in all portions of the canes. The defoliated canes are still low in carbohydrate content, especially the tube section which initially was the one on which the leaves were left. In these one would expect a greatly reduced carbohydrate condition in canes of treatment No. 6 and because it is not the defoliated sections which are lowest in carbohydrates there is reason to believe that carbohydrates are freely translocated from one part of the cane to another and possibly from one part of the plant to another in the fall of the year. Between check canes and canes defoliated in one section only, there is very little difference in carbohydrate content. Although the canes of Plot 6 had a reduced carbohydrate content they gave a yield of 42 1/2 per cane 20% greater than did the check canes. This result indicates that a deficiency of carbohydrates in individual canes in the tube section is not the reason for a small fruit crop or an early "falling off" in fruit crop.

Table 6 - Influence of Time of Defoliation on Carbohydrate Content.

Sample	Treatment	Water in green wt.	Reducing sugars	Sucrose	Total Sugars	Starch	Total polysaccharides	Total Carbohydrates	Percent in length after treatment
2A-top	Mid. Sept. Defoliated	58.33	2.57	1.27	3.91	3.44	24.73	28.64	11.6
2A-middle	" "	56.42	1.13	1.06	2.97	2.07	23.05	26.02	
2A-base	" "	53.22	2.17	.79	3.06	4.04	25.27	28.27	
2-2A-top	Mid.Sept.Defol.Aug.30	59.67	3.00	.83	4.32	4.11	25.52	29.84	2.8
2-2A-middle	" "	58.62	3.21	.54	4.30	3.93	24.13	28.51	
2-2A-base	" "	56.09	3.30	.28	3.66	3.17	23.94	27.54	

Influence of time of defoliation on carbohydrate content--In Table 6 similar treatments given at different times, viz., Aug. 12 and 30, are compared with respect to their effect on the carbohydrate content. The differences occurring are all within the range of experimental error, especially when percentages of total carbohydrates are considered. The question arises as to how it is that the defoliation of these canes Aug. 12 when they are still growing vigorously is not more effective in producing a reduction in carbohydrates than a similar treatment given Aug. 30 when growth has nearly ceased. The transfer of carbohydrates during the latter half of August from other parts of the plant to the area of reduced manufacture caused by defoliation is a possible explanation.

Table 7 - The effects of girdling on water and carbohydrate content.

Sample series 2.	Treatment	% water green wt.	Reducing sugars	Sucrose	Total sugars	Starch	Total polysacc.	Total carbohydrates	Growth in lgth. after treatment.
2A-Top	Mid.west. def. leaf. Top	57.07	3.60	.68	4.32	4.11	25.52	29.84	2.7
2Ax "	Same + ring-ing above	x56.78	4.49	.72	5.25	3.42	22.71	27.96	4.7
2Bx "	Same + ring-ing below	x53.62	5.36	.75	5.73	3.14	24.31	30.04	7.3
2A-Middle	Mid.west.def. leaf. Top	51.62	3.91	.54	4.30	3.93	24.13	28.51	2.1
2Bx "	Same + ring-ing above	50.47	2.52	.27	2.76	1.39	20.33	23.09	4.3
2Bx "	Same + ring-ing below	x54.70	3.33	.55	3.11	2.17	22.20	25.31	3.6
2A-Base	Mid.west.def. leaf. Top	56.59	3.30	.20	3.66	3.17	23.94	27.54	2.8
2Ax "	Same + ring-ing above	57.59	2.57	.67	3.23	.96	23.26	26.49	4.8
2Bx "	Same + ring-ing below	54.96	1.32	.72	2.16	1.98	23.11	25.27	3.9

x denotes a section above a ring.

The Effects of Girdling on Water and Carbohydrate Content--In Table 7 values receiving defoliation and girdling treatments are compared with values receiving similar defoliation treatments but no girdling. In the first place girdling does not inhibit growth, in fact there was a tendency to favor growth. It has been previously noted that all cane sections above the rings in girdled vines died over winter. Examination of Table 7 shows that above the rings there is marked reduction in water content in the autumn and therefore the death of the tissue may have been due to a lack of water to carry on the vital processes. In regard to chemical analyses, starches, total polysaccharides and total carbohydrates are slightly lower above the rings but sugars are even more abundant. Below the rings there is an increased water content in the canes and a decrease in the other; but all sections below rings show a considerable decrease in all carbohydrates and especially in starches. This condition is coincident with a decrease in yield of fruit per cane but after allowance has been made for the dead sections above rings no very striking difference in yields can be claimed.

Table 8 - Observations on the Effects of Various Defoliation Treatments on the Extent of Winter Killing.

10 dead; 1 very slight injury

Treatment No.	Treatment Given	Series 1	Series 2	Series 3 rips
1A	Basal section defoliated	5	5	
2A	Middle section defoliated	4	7	
3A	Top section defoliated	7	7	
4	Alternate 3 pole stretches defol.	6	5	
5	Basal & middle sections "	5	5	
6	Basal & top sections "	6	8	
7	Middle & top thirds "	9	8	
8	Check	5	5	
	Completely defoliated Aug. 30			9+

Effects of Various Defoliation and Ringing Treatments on the Extent of Winter Killing--The figures in Table 8 show great variation in the degree of winter killing. Those of the canes in Plots 6 and 7 of Series 1 were more severely winter killed than Check canes (8) that produced more fruit. Canes of Series 3 which were completely defoliated Aug. 30 bore some ripe fruit on their basal sections even though they were winter killed almost to the base of the cane. In contrast with Series 1 canes in Plots 6 and 7 of Series 2 that were almost as severely winter killed as the corresponding canes of Series 1 produced considerably less fruit than Check canes. But, on the whole these figures indicate that a moderate pilling back of the canes is not serious with respect to decreasing the yield. In cases of severe injury lines 3 and 4 on the basal section produce proportionately more vigorous and more fruitful shoots which make up for the loss of fruit from the tips of canes that have been pruned from the killing back on the cane.

In Plots 3A, 6 and 7, both series. Where the top section was defoliated, winter injury seemed to be the most severe.

An important and interesting result of pinching these red raspberry canes was the death of practically all of the buds above the pinch before the spring of 1925. Up until the time of leaf fall they appeared to be perfectly healthy and most of the canes taken for chemical analyses Nov. 11 were alive. By this time the pithy portion of canes in Series 1 was almost completely brown except in Series 2 where there was little callus formation. In only a few canes had the pithy tissues connected again with callus tissue.

It would be interesting and valuable to know just how winter injury takes place in raspberry canes and just how to treat the canes to prevent it. Certainly in a study like this one winter injury, not well understood, is a factor which may confuse other results. Had the canes in this experiment been unaffected the effects of treatments on yield might have shown up more clearly. Chandler (1) points out that red raspberry canes will stand very low temperatures, for even in the severe winter of 1917-18 there was little injury. He gives evidence which suggests that most of the injury is due to desiccation, resulting either from a lack of water in the soil or the inability of the cane to secure and to hold the necessary water. In the Niagara District (Ontario) the fall of 1924 was exceptionally dry and it is possible that there was an actual deficiency of water or at least that the soil water was not easily absorbed. Even if the canes may have absorbed plenty of water it may have left it too rapidly in respiration or by evaporation; in short, could the water-

Table 3 - Partial list of Black A soils.

Analyses of 3 cores selected from each treatment of series 1.

Depth in Ft.	1a	1b	1c	1d	2a	2b	2c	2d	3a	3b	4	5	6	7	8
Total solids-															
Wt. of soil	25.1	17.0	17.2		13.2	13.2	13.0	10.4	12.0	13.0		26.4	18.0	27.2	18.0
Vol. of soil															
N. of cores	22.0	17.0	11.1		17.0	9.0	12.1	11.0	13.0	14.0		21.0	17.0	14.0	11.0
Depth	"														
Wt. of soil	7.1	7.0	6.0		6.7	6.7	6.6	7.0	7.7	7.0		7.1	7.4	7.3	7.0
Vol. of soil															
N. of cores	14	17	17		17	9	17	14	16	17	9	21	19	21	11
Depth															
Wt. of soil	6.7	6.0	6.9	7.7	6.6	7.1	7.0	6.4	6.2	6.6	6.4	5.1	6.7	6.2	7.

Effect of blossom on the formation of fruit buds and blossoms--Each fruit bud's axis [illegible] ends usually [illegible] a terminal cluster of from 4 to 7 flowers; sometimes a smaller [illegible] cluster in the first leaf will have from two to [illegible] one flower in each of several leaf axils back from the terminal cluster. These fruiting shoots [illegible] the first flow of sap with the [illegible] end of the fruit proved the [illegible] fruit. [illegible] a positive correlation between [illegible] of fruit buds [illegible] and [illegible] blossoms produced. [illegible] the [illegible] per cent of each fruit bud is included in this [illegible]. The number of blossoms per [illegible] various fruit buds also [illegible] same general relationship to one another that [illegible] do. The error in the selection of [illegible] from which to take these records is likely to be small [illegible] usually [illegible] very close correlation. However, even [illegible] this point in mind it is evident that the majority of these clusters never [illegible] fruit. Some did not set, some were frozen in cultivation and others failed to ripen fruit.

Table 10 - [illegible] of Various Pollination and Fruit Treatments, Given at Two Different Times, on the Yield of Fruit.

Series 1. Treatments given Jan. 11.

Treatment	11	11a	11b	11c	21	21a	21b	21c	31	31a	4	5	6	7	8
No. trees yielding	31	7	2	4	35	11	0	2	30	7	30	31	33	31	34
Av. lbs. fruit per tree (lbs)	38.9	37.0	29.9	33.7	38.7	30.1	0.0	41.4	42.2	39.8	44.4	30.1	39.7	34.2	34.7
Av. No. berries per tree	51.7	51.0	33.0	30.5	34.9	30.2	0.1	44.1	30.9	36.7	41.9	33.2	37.1	31.1	33.3
Av. wt. each berry	1.02	1.16	.77	1.10	1.06	1.00	1.05	1.16	1.14	1.25	1.06	.94	1.15	1.12	1.07

Series 2. Treatments given Jan. 30.

No. of trees yielding	36	9	2	2	39	2	2	2	38	8	34	31	31	28	34
Av. wt. fruit per tree (lbs)	32.8	33.3	0	0	42.7	29.3	25.2	30.4	45.6	41.0	32.4	43.8	28.8	35.8	34.7
Av. No. berries per tree	31.5	24.3	0	0	41.7	27.7	21.0	28.1	42.9	41.8	32.0	41.5	19.2	33.1	33.3
Av. wt. each berry	1.03	1.37	0	0	1.00	1.06	1.19	1.16	1.06	1.20	.98	1.13	1.13	1.08	1.03

must be looked for elsewhere.

The Effect of Blossom Thinning on the Amount of Defoliation--The number of defoliated cases in each lot of thinned cases is so small that definite conclusions on this point cannot be drawn. In Lot 1 the number of defoliated cases is the same in the thinned and unthinned plots. Lots 2a and 3a were thinned at the same time and should differ only in the degree of defoliation and the former gives a much smaller yield in both cases. Lots 2b and 3b were thinned very little in proportion to the unthinned lots and it is conceivable that this fact might explain the increased yield over the cases of 2a and 3a which were thinned more severely.

Results of End Section Studies

This work was taken for sections left from previous and check cases Sept. 17 and Nov. 11, 1924. Plates 1 and 2 show that there is no evidence of fruit bud formation in buds taken from check cases in the fall of the year, and the same could be said for the treated cases.

In order properly to interpret sections of buds taken in the fall of the year it is necessary to section buds taken in the spring of the year. Plates 3 to 12 illustrate the progressive steps in blossom bud formation at this time. The first bud collected in the spring, Apr. 6, (Plate 3)

do not clearly show the beginnings of blossom bud formation but by Apr. 9 and 17 (Plates 4 and 5, there are small swellings in the axils of the leaves which may be young blossoms. By Apr. 16 (Plate 6, the fruiting laterals were elongating rapidly ; the terminal blossom is quite distinct and two additional blossoms can be seen in the axils of the leaves immediately back from the growing point. Plates 7, 8 and 9 show the rapid development of blossoms from Apr. 16 to May 5. In plate 9 the terminal blossom is not shown in the photograph but it is still in advance of the two axillary blossoms which are to be seen. By May 9 the flower parts may all be distinguished (Plate 10), the floral envelope, the stamens at each side of the torus, situated on the sutural and the pistils standing as knobs on the surface of the torus. At this time the flower buds are beginning to separate at the end of the shoot and are becoming visible to the naked eye. It seems that under the conditions prevailing during the time of this experiment the flower parts are actually being formed over a month's time only, Apr. 9 to May 7, but this is not saying that nutritive conditions within the cane have not previously determined the number and size of the blossoms.

DISCUSSION

If one is justified in regarding that these artificial defoliation treatments were in effect similar to a natural defoliation, such as frequently occurs in raspberry plantations, the statement may be made that the effect on the yield of

from the fall layer is not very serious. Data are
[illegible] to the fact that in the use of 2,4-D [illegible]
[illegible]. In fall [illegible] and that the size of the [illegible] and size of
laterals [illegible] to [illegible] before [illegible].
The results of [illegible] (F) [illegible] show a positive correlation [illegible].
This is this correlation [illegible] appear that [illegible] should be given [illegible].
[illegible] from this [illegible] that the [illegible] of the [illegible] in the [illegible].

Observation [illegible] laterals [illegible] laterals [illegible] of the [illegible] from this [illegible] that the bulk of the [illegible] crop is produced on the basal portion of the cane. [illegible] is [illegible] to consider early [illegible] will [illegible] the [illegible] of [illegible] from [illegible].

SUMMARY

1. In [illegible] Series, [illegible], the [illegible]

of simple external fruit growth and diameter of the canes. Only in the first year, with Cory 3, were the defoliation treatments applied when fruit was present on canes.

2. Canes pinched at 12 nodes produced an increased lateral growth but established canes do not appear to grow in lateral growth after pinching.

3. Defoliation of red raspberry canes in August has not materially reduced the yield of these canes or at least it has not been sufficiently severe to become a limiting factor in fruit production.

4. In this experiment a large percentage of the red raspberry crop was produced on the basal third of the canes and mostly on laterals arising therefrom. This may not be true under other conditions.

5. Early fruiting canes bear more fleshy fruit than later ones.

6. Defoliation treatments in Exp. 12 have not decreased yields of fruit the following year as have similar treatments given Exp. 7 have apparently adversely affected the yield.

7. Under the conditions of this experiment the flower parts in buds taken from defoliated canes were not visibly microscopically until June 1 i.e. 7.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation of the helpful suggestions given by Dr. V. R. Boswell in the plan-

ning and collection of the material and in the preparation of the manuscript. Thanks are due to Mr. L. J. Fuller for his cooperation in regard to the field account taking and to the latter to other with Mr. J. L. Mallon for revising the manuscript.

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Plate 1. Buds taken at Vineland, Ontario, Sept. 13, 1924.

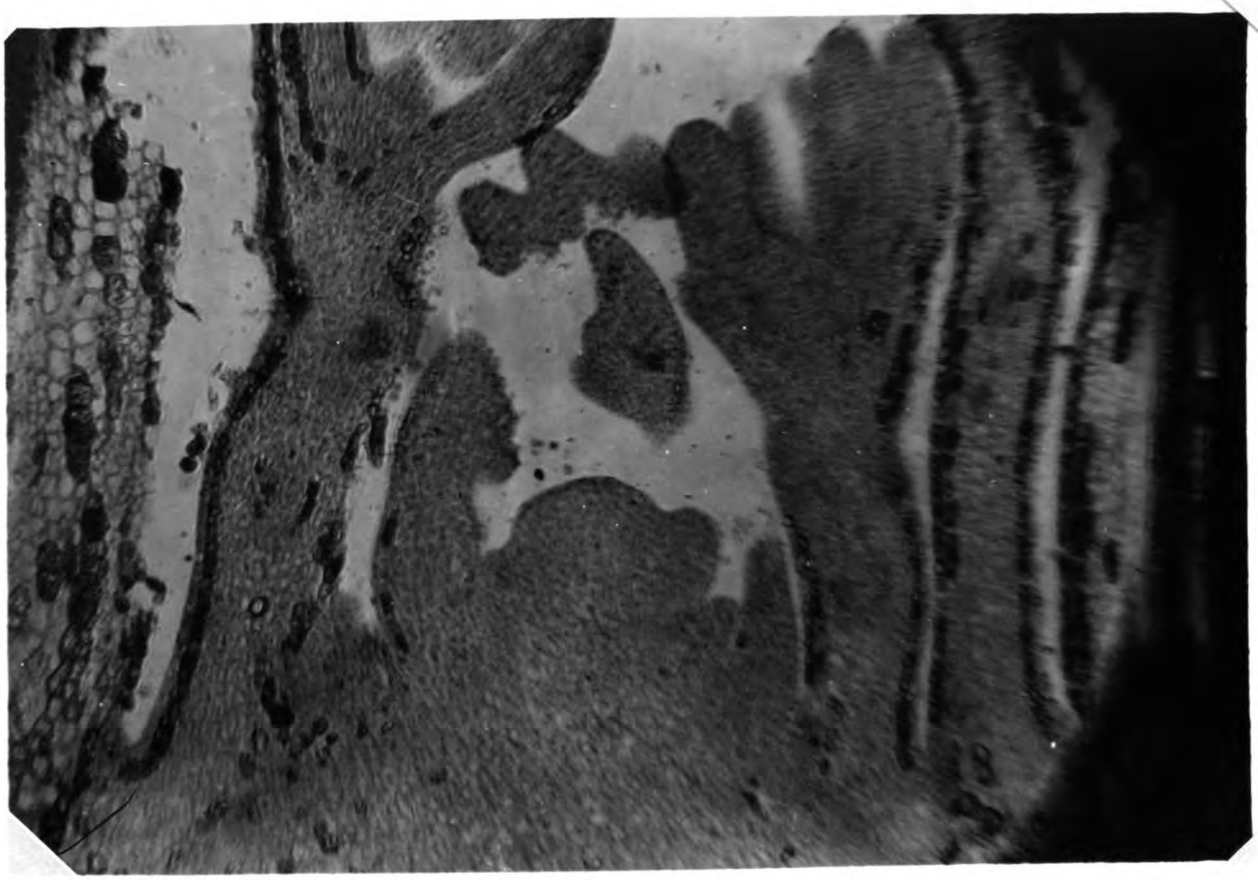

Plate 2. Buds taken at Vineland, Ontario, Nov. 11, 1924.

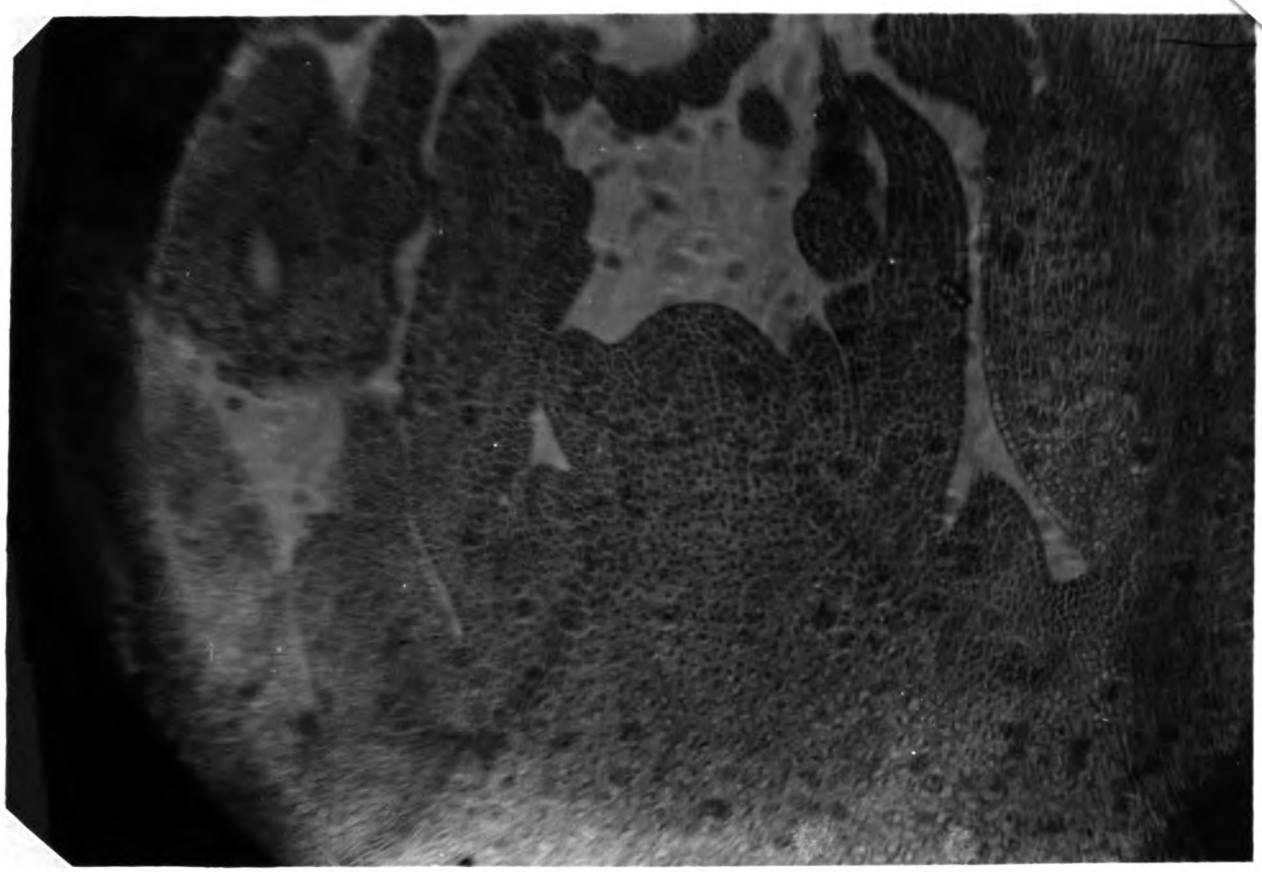

Plate 3. Buds taken at East Lansing, Michigan, April 6, 1925.

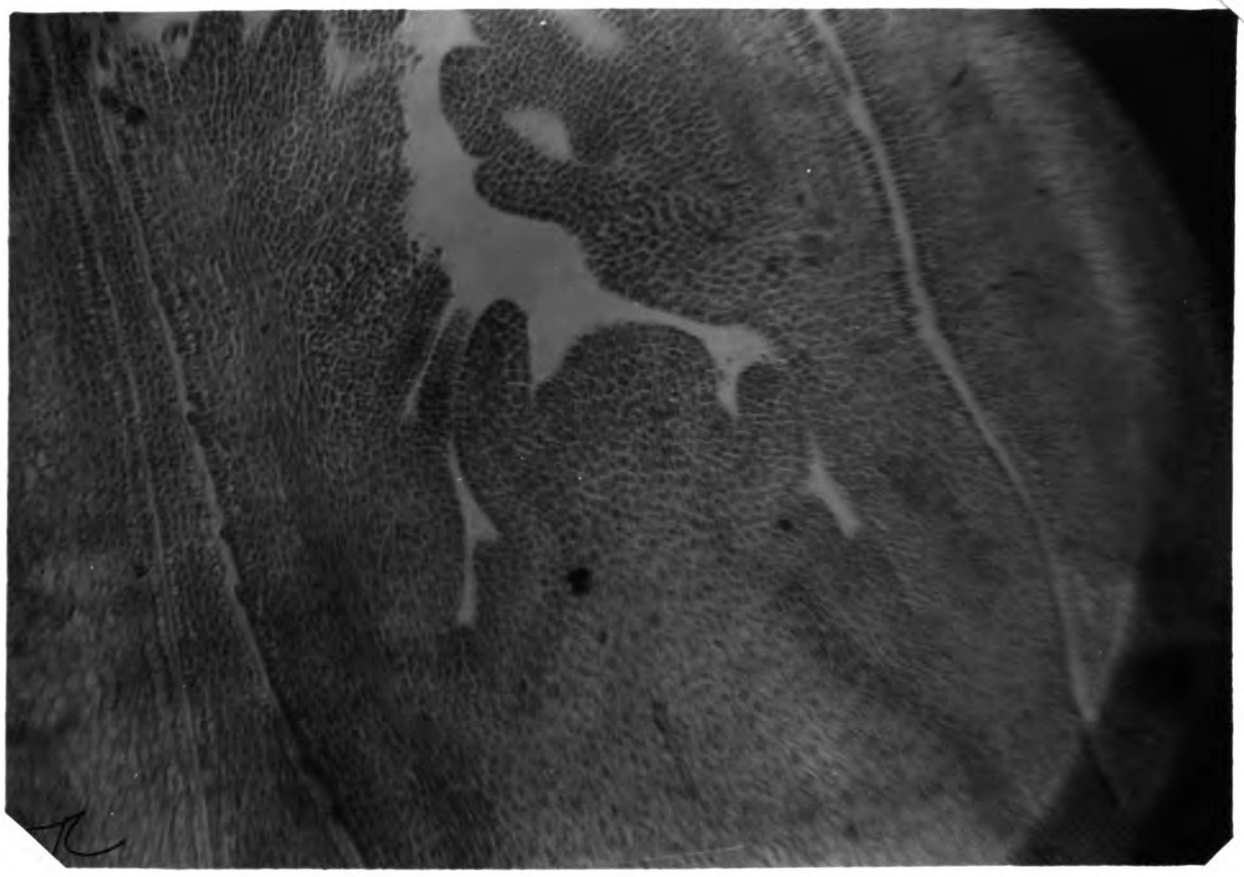

Plate 4. Buds taken at East Lansing, Michigan, April 9, 1925.

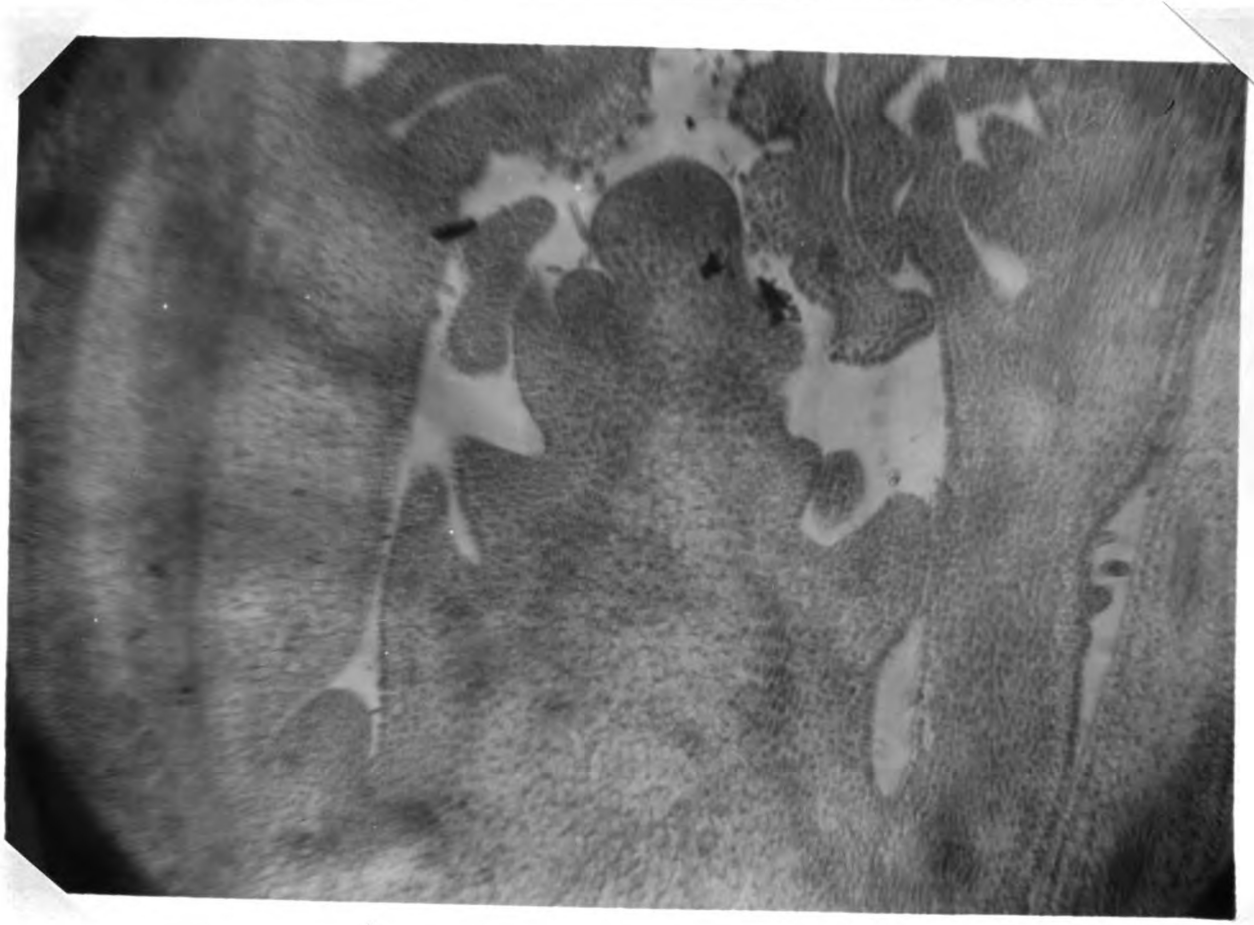

Plate 5. Buds taken at East Lansing, Michigan, April 13, 1925.

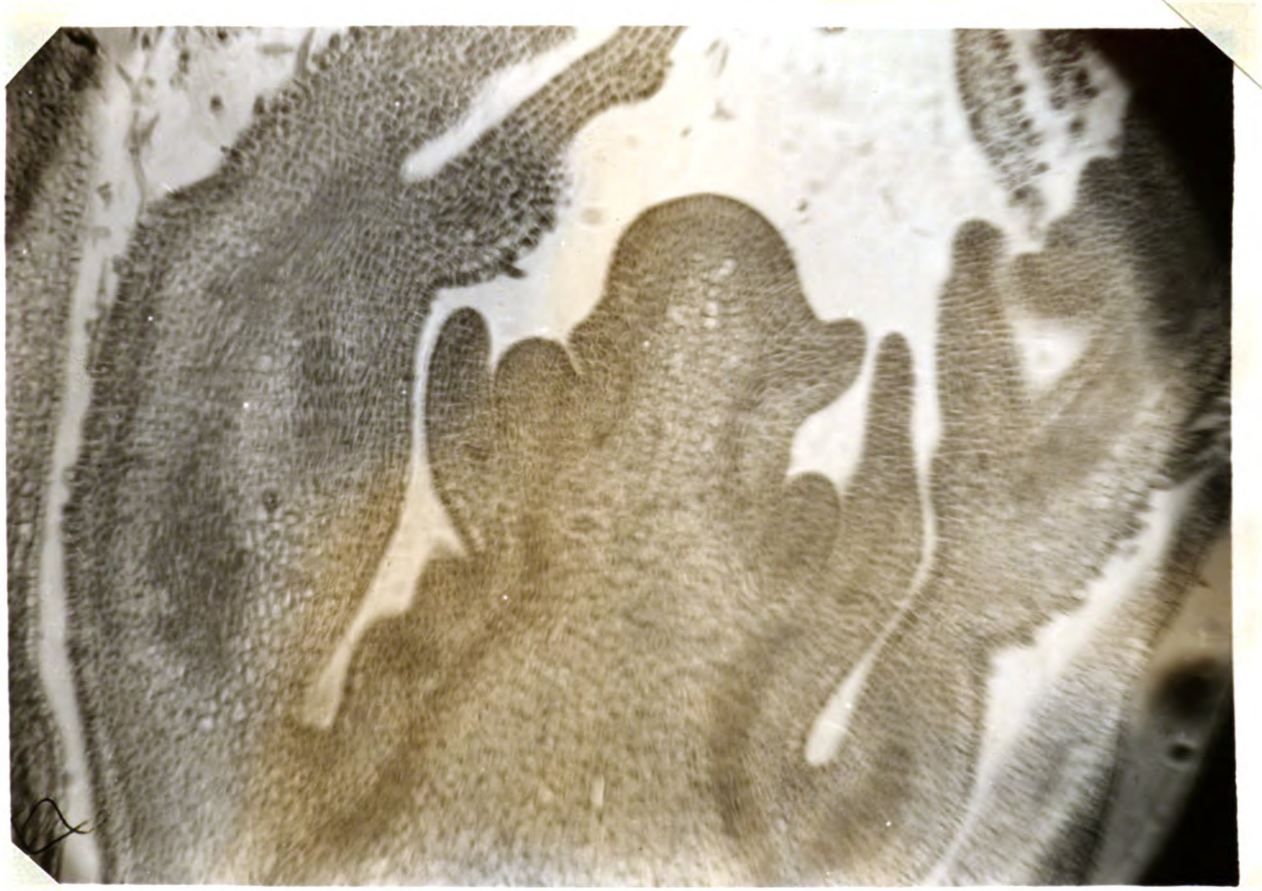

Plate 6. Buds taken at Vineland, Ontario, April 16, 1925.

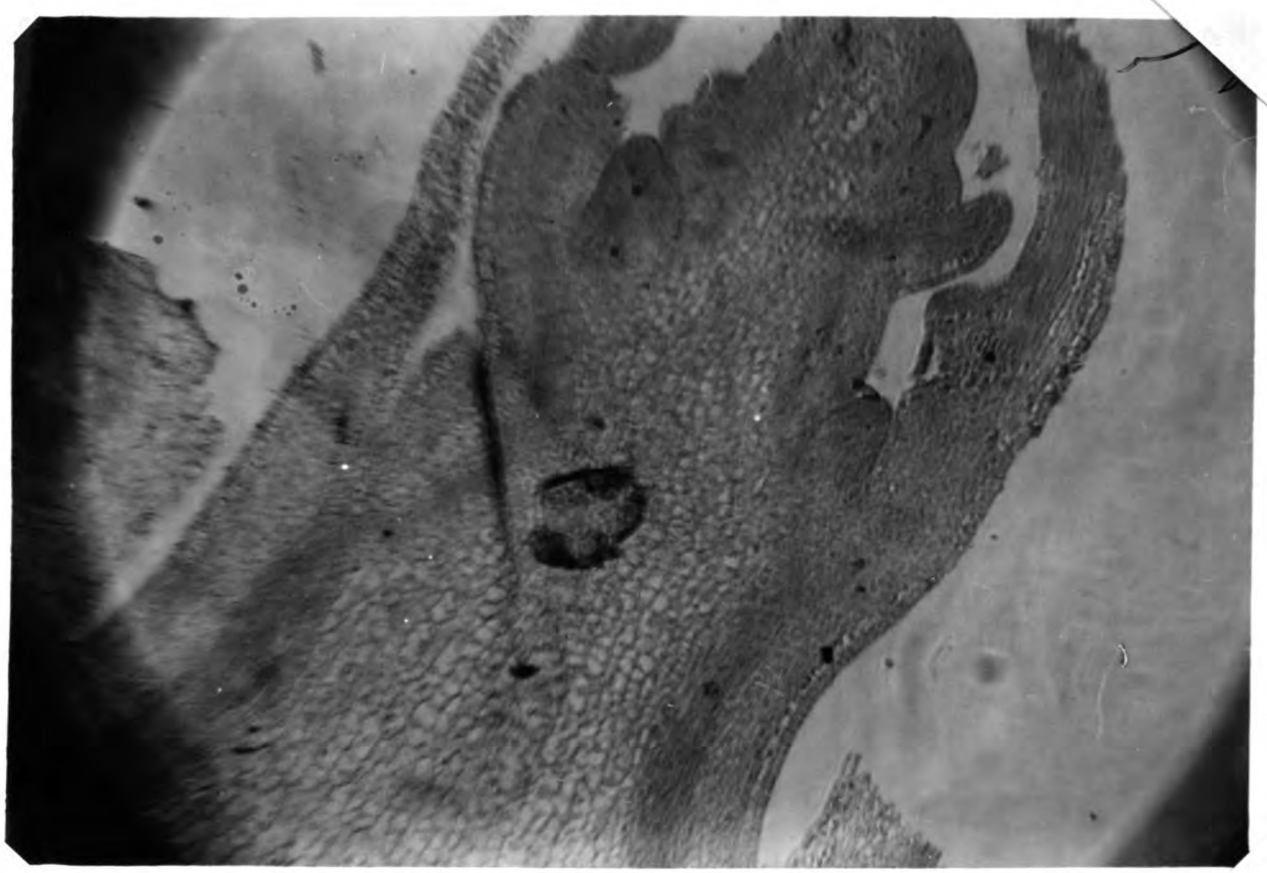

Plate 7. Buds taken at Vineland, Ontario, April 23, 1925.

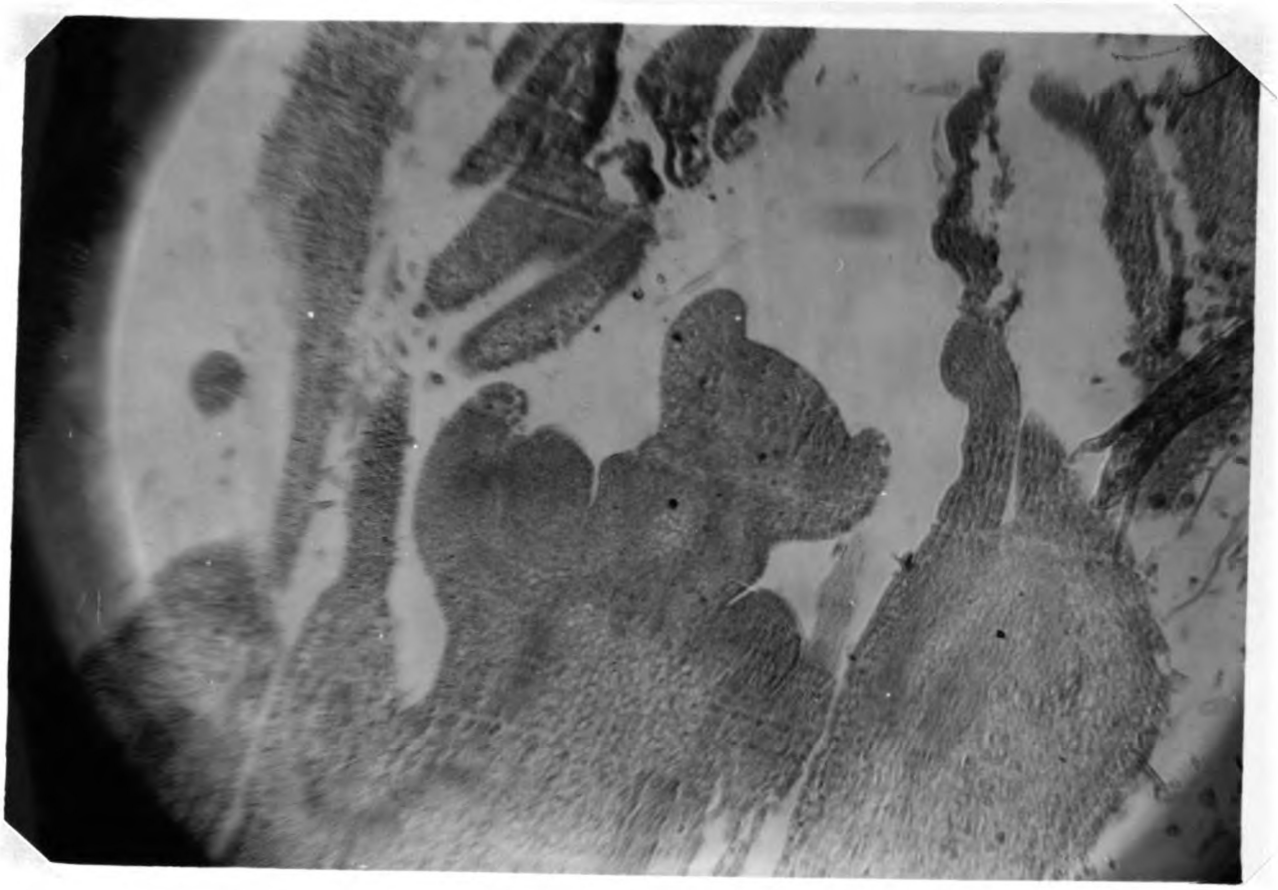

Plate 8. Buds taken at Vineland, Ontario, April 28, 1925.

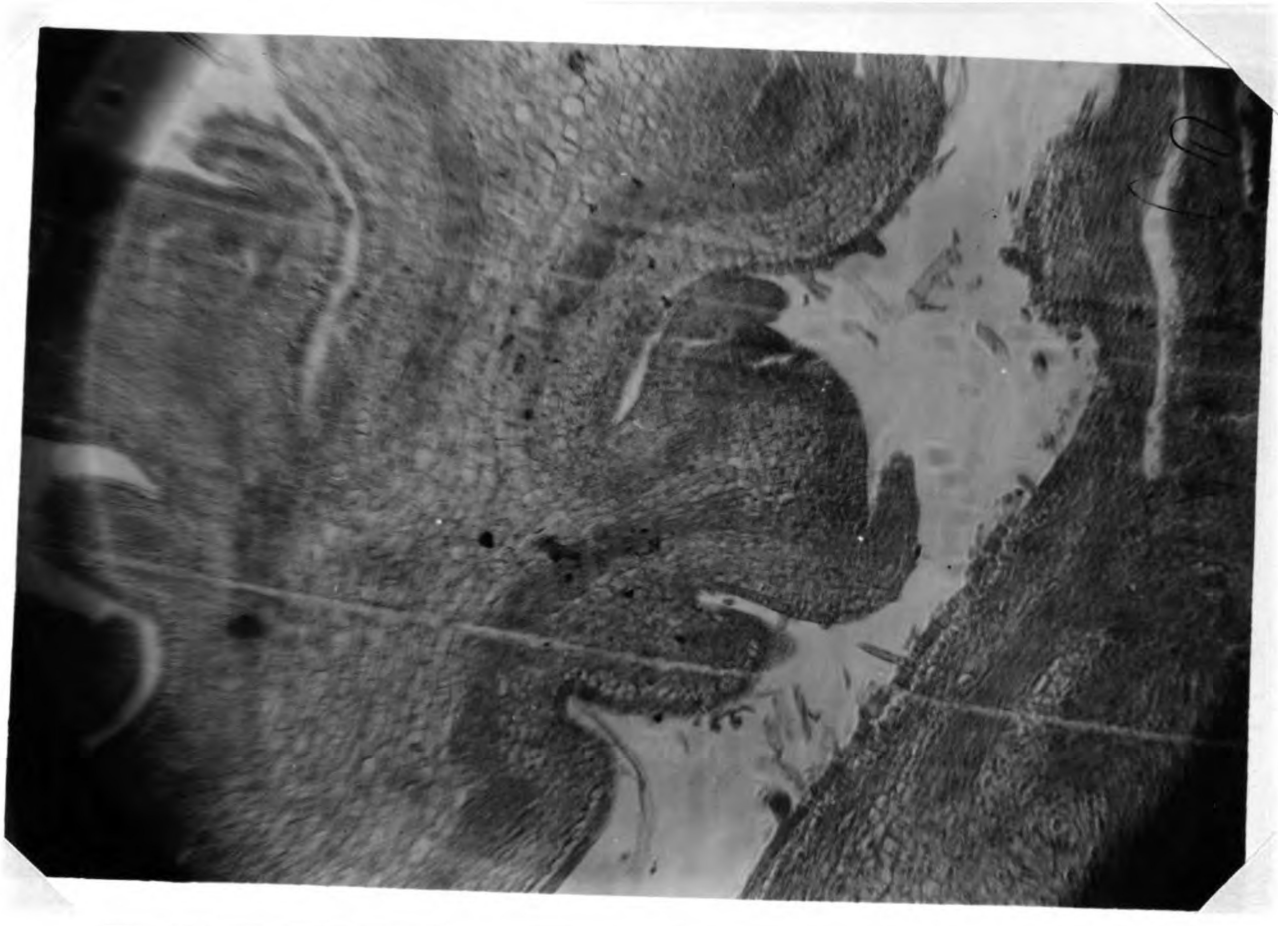

Plate 9. Buds taken at Vineland, Ontario, May 5, 1925.

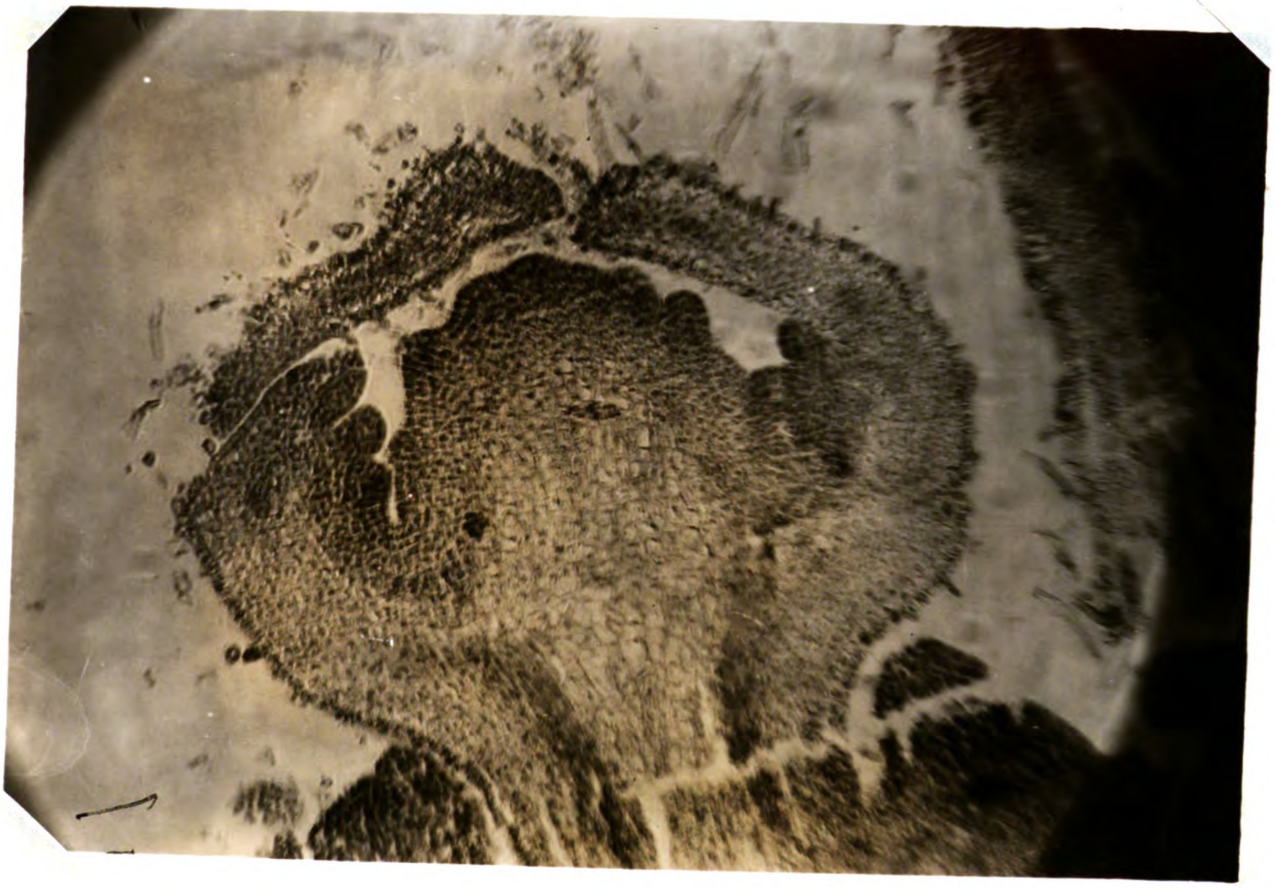

Plate 10. Buds taken at Vineland, Ontario, May 9, 1925.

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