

A STUDY OF THE TABLE BEET
IN AN ATTEMPT TO DISCOVER
THE CONDITIONS, CLIMATIC
AND CULTURAL,
WHICH CAUSE ITS DISCOLORATION
Thesis for the Degree of M. S.
Austin L. Pino
1928

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A Study Of The Table Beet In An Attempt To Discover The Conditions, Climatic And Cultural, Which Cause Its Discoloration.

Thesis

Submitted to the Faculty of the Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of Master of Science.

by

Austin L. Pino June 1928

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M. Bardiner

THESIS

Introduction

It is a matter of common knowledge that the roots of table beets present a great amount of variation in the prominence of their alternating zones of light and dark color. This applies not only to varieties but to strains as well. Some varieties, as Bassano and Lentz's Extra Early, have comparatively wide bands of white separated by narrow bands of dark tissue. Other varieties, such as Crosby's Egyptian (Special) and Detroit Dark Red, have wide bands of dark tissue separated by white bands so narrow as to be scarcely noticeable. The latter type is preferred because it presents a better appearance and is thought to be indicative of greater tenderness.

Successful attempts have been made in securing highly colored types by careful selection and isolation. The results have not been entirely satisfactory, however, for, under certain conditions of growth, beets highly bred for color have tended to deteriorate in a single season. Naturally this makes it appear that environmental factors, which have heretofore been more or less overlooked may be of considerable importance and should be studied along with the genetic.

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Literature Review

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There is little or no literature pertaining directly to the problem. However, work with sugar beets indicates that environment plays an important part in their morphological and physiological development. Shaw (1) found that plants possess an inherent sensitiveness and responsiveness to environment and his general observations indicated a correlation between climatic conditions and "the manifold morphological phenomena exhibited in the (sugar) beet."

Jones and Rosa (2) state that "the peculiar zonation noticed in a cross-section of beet root is produced by concentric rings of vascular tissue enclosing broad bands of parenchyma." These rings become noticeable through the color present, so a study of the zonation of the table beet should take into consideration the red anthroyan pigment. The gradation from pure white to solid red roots is represented by varying widths of white and red rings.

Wheldale (3) is of the opinion that anthocyan is an oxidation product of a colorless chromogen present in tissues in combination with sugars as glucosides; that the formation of glucosides from chromogen and sugar is in the nature of a reversible enzyme action; that the process of oxidation is carried out by one or more oxidizing enzymes and that oxidation is only after the liberation of the chromogen from the glucoside. The quantity of pigment

formed is inversely proportional to the concentration of sugar and directly proportional to the concentration of glucosides in the tissue.

The general observation is that pigment formation increases with a lowering of temperature. Autumnal coloration is usually cited as an example of this effect. Klebs (4) is of the opinion that color changes induced by changes of temperature are indirect effects of temperature on metabolism. Overton (5) examined the sugar content of autumnal leaves and found considerably more present than in the same species in midsummer. Thus the effect of low temperature may be indirect in that it affects the sugar content of the tissues.

as to how pigment formation is affected by light, observations disagree, and here, as with temperature, the main question is whether the effect is direct or indirect. The absence of light does not bar the formation of pigment in the root of the beet. That there is a direct action of light in the production of anthocyan is evidenced by the coloring of exposed portions of normally uncolored roots. Pigment development in roots of Salix (6) and Zea (7) has been observed when they were exposed to light. Linsbauer (8) concludes from experiments on seedlings of Fagopyrum esculentum "that the photo-chemical process of anthocyanin production in light is a typical stimulus reaction, and is dependent upon both the intensity and duration of light."

Drought increases anthocyan formation. Warming (9) found that certain plants which are green when grown in

water are strongly red when grown on land. Molisch (10) found that leaves of certain plants redden strongly if only watered a little, and Wheldale (3) observed the same thing for pot plants of Pelargonium. Whether this effect is direct or indirect is not known.

Materials and Methods

Garden trials, for the purpose of testing the effects of light intensity, cultivation, and irrigation on the sonation of garden beets, were made during the growing season of 1927. Crosby's Egyptian (light strain) beet was used in the experiments. This beet has a greater amount of white tissue than Detroit Dark Red and a less amount of white tissue than such varieties as Lentz's Extra Early, which made it desirable for trial in these experiments. Ten plots were laid out and the following treatments used.

Plots 1 and 2.- A wooden frame work 2½ feet high was built around each of two plots (designated hereafter as plots 1 and 2). In Plot 1, the framework was covered (top and sides) with two thicknesses of heavy cheesecloth. The top cover was removed each day at 10 A.M. and replaced at 5 P.M., thus giving the plants a seven hour period of full day light. A single thickness of heavy cheesecloth was placed over Plot 2 and left on continuously, thereby giving the plants partial shade throughout the season. Six rows of beets, 12 feet long and 18 inches apart, were grown in each of these two plots and the beets thinned to 3 inches in the row. The soil in these plots is a sandy loam, which

is slightly acid in Plot 1 and has a lime requirement of about 2000 pounds per acre in Plot 2. (Soiltex Method).

Plot 3.- Plot 3 served as a check plot. It was of the same size as Plots 1 and 2. The soil is a sandy loam which has a lime requirement of about 3000 pounds.

Plots 4 and 5.- Different types of cultivation were tried in plots 4 and 5. In addition to ordinary cultivation, the beets in Plot 4 were entirely covered with soil, as shown in Figure 1, while in Plot 5, the dirt was kept pulled away from the roots, as shown in Figure 2. The soil in these plots is a sandy loam, neutral in Plot 4 and with a lime requirement of about 3000 pounds in Plot 5. These were of the same size as plots 1, 2 and 3.

Plot 6.- The major check plot (No.6) consisted of 16 rows, 18 inches apart and 40 feet long. The soil is a sandy loam with the same lime requirement as Plot 5. These beets received ordinary hand cultivation and were thinned to 3 or 4 inches apart in the row.

Plots 7-10.- Tests for the effect of irrigation on zonation were made in plots 7, 8, 9 and 10. Each plot was 33 feet long with 10 rows of beets 18 inches apart. These received hand cultivation and the plants were thinned to 3 or 4 inches in the row. The plots were along one side of an overhead irrigation line (Figure 3) and, by means of plugs inserted in the nozzles, the irrigation was shifted from one plot to another. Plot 7 received irrigation as needed throughout the season; Plot 8 was irrigated during the first third of the season, Plot 9 during the second

third and Plot 10 during the last third. The soil in Plots 7, 8 and 9 is a sandy loam with a lime requirement of 4000 pounds. Plot 10 is a heavier loam with a lime requirement of 3000 pounds.

Soil samples at depths of 1" to 6", and 6" to 12" were taken weekly and oven dried to determine the soil moisture content. These data will be presented as averages for four week periods.

Soil temperature records (continuous) were obtained for Plot 2 by means of a Freas Soil Thermograph with the tube buried at a depth of 6 inches. Air temperature and humidity records (continuous) were taken with a Freas hygrothermograph kept in the ordinary type of outdoor shelter.

The first planting of seed, which was made June 1, was unsuccessful except in Plot 6. Plots 1 and 2 were replanted June 20. Plots 4 and 5 had a little better stand so they were interplanted June 25. Plots 7, 8, 9 and 10 were replanted entirely on July 2. The second planting did well in all plots, considering the dry weather which prevailed throughout most of the growing season.

Greenhouse Trials

Greenhouse trials, for the purpose of studying the effects of commercial fertilizer, soil acidity, soil moisture, and soil temperature, on the zonation of table beets, were made in the fall and early winter of 1927.

The soil for the fertilized lots (designated as A, B and C) was a wornout silt loam with a lime requirement of 5000 pounds. The lots were separated in the bench by boards, each lot consisting of 6 rows cross-wise of the bench,

4 inches apart. Each lot was limed to meet the requirement and, a few days later, Lot A was given an application of 4-8-10 fertilizer at the rate of 300 pounds, and Lot C at the rate of 600 pounds per acre. Lot B was left as a check.

Soil Acidity Tests. - Acidity tests were made in Lots la, lb and lc, each consisting of 25 six inch pots of a sandy loam soil requiring 6000 pounds of lime per acre.

Lot la received the full lime requirement; Lot lb was not limed, and lc was limed at the rate of 3000 pounds. Distilled water was used on these lots throughout the experiment.

Soil Temperature Trials. Lots 2a, 2b and 2c, each consisting of 30 pots of ordinary greenhouse soil, comprised the soil temperature trials. Lot 2a, which received no bottom heat, had an average weekly temperature range of 56.8° to 63.9°F. with the average for most weeks falling below 60°. Lot 2b, with bottom heat, had average weekly temperatures of 64.0° to 75.4°F. Lot 2c, which was carried in a cool house, had weekly soil temperatures averaging from 48.3° to 56.1°F. The average temperature for the 9 weeks period was 59.9° in Lot 2a, 71.2° in Lot 2b and 51.5° in Lot 2c.

Soil Moisture Tests. Soil moisture experiments were run in pots over bench heat in Lots 3a, 3b and 3c. Each lot consisted of 27 pots of greenhouse soil. Lot 3a was carried

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with a normal amount of water for greenhouse production while 3b received an excessive amount, and 3c was allowed only enough water to prevent severe wilting.

Crosby's Egyptian (light strain) seed was planted September 10 in Lots A, B and C, and on September 27 in the other lots.

Roots from the garden and greenhouse trials were classified according to a chart shown in Figure 4. This chart was made up from a preliminary planting of different varieties of table beets, and shows the gradations in zonation from practically solid red to white. The darkest colored specimen is classed as No.1 and the numbering is consecutive with the lessened amount of dark color, the whitest one being No.6.



Figure 1. Showing roots covered in Plot 4.



Figure 2.- Showing uncovered roots in Plot 5.





Presentation of Data

Table 1.-Record of soil moisture content in top six inches of soil in the garden plots. Four week averages

		2003 340		PLOT NUMBER	BER				
	-	87	4	ນ	9	7	ω	თ	10
	7-hour day	7-hour day Continuous Roots partial covereshade	ad.	Soil Checoultivated plot	Check plot	Irrigated Irr.1st. through third	irr.lst. third	Irr. 2nd third	Irr. 2nd Irr. last third third of
Date				roots					
July 2	11.7	12.16	12.67	11.37	11.38	12.26	15.41	11.77	12.10
July 30	10.72	11.75	10.57	10.57	10.73	12.47	13,88	10.77	10.83
August 26	36 3.49	5.69	4.01	4.67	5.41*	13.63	8.77	11.24	10.95
Average	8.64	9.87	80.6	8.87	9.17	12.79	12.02	11.26	11.29

* Average for week ending August 6. Beets harvested August 10.

••• • • • The data in Table 1 show that the soil moisture content became very low in the non-irrigated plots during the last third of the growing period. Plot 2, which received continuous partial shade shows the highest average moisture content of all non-irrigated plots. It is of interest that, during the 12-week growing period, there were but 3.7 inches of rainfall at this station and that the heaviest precipitation any one week was but .81 inches.

Table 2.-Soil temperatures for Plot. 2, which received continuous partial shade

verage fo	r 2 week	period end	ling	
11y 15 J	uly 31	ugust 15	August 31	Average
58.9	65.3	61.0	58.5	60.9
6 0 .0	66.0	66.1	64.7	64.2
	11y 15 J	11y 15 July 31 2 58.9 65.3	11y 15 July 31 August 15 58.9 65.3 61.0	

It is evident from Tables 3 and 4 that temperature and humidity differences between the covered and open plots were practically insignificant. Variation in humidity as between day and night was considerably greater, however, in the open than in the covered plots. (See page 14).

Beets in Plot 1, which were given a 7 hour light day, and in Plot 2, which had continual partial shade, were harvested August 27. A median cross-section was made through each root, and the zonation of each beet was classified according to the chart. See Table 5, page 15.

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5,	did moin	es de la	Average for two week period ending	or two we	ek peri	od end	ling			
218	July	15	July 31	31	Augus	12	August 15 August 27	27	Average	o
72.10	Temp.	Hum.	Temp.	Hum.	1	Hum.	Temp. Hum. Temp. Hum. Temp. Hum.	Hum.	Temp.	Hum.
Day	75.0	61.1	6.97	6.09	76.4	50.5	50.5 70.5	51.7 75.4	75.4	56.0
Night	6.69	69.3	64.2	79.4	59.5	77.8	77.8 57.5	76.4	76.4 62.5	75.6

able	41	rante 4 remperaren	TLE STIN	מוות וותווים בפסדתם דסד דרים כ (פוופסי הדים	TOOPT	101	0	dono.	10012	-	-
1	est	5 10	cus	Average for two week period ending	for two	week	period	ending			
1	5 1	July	15	July 31	31	Augu	August 15	Augn	August 27	Ave	Average
1	0	Temp.	Hum.	Temp. Hum.	Ham.	Temp.	Temp. Hum.	Temp.	Temp. Hum.	Temp. Hum.	Hum
Day		0.97	52.8	52.8 81.0 62.1	62.1	76.0	9.94	69.5	46.1	9.94	51.9
Nigh	140	67.4	70.1	66.1	84.5	61.3	80.4	58.4	74.2	63.3	77.3

Table 5.-Classification of beets, Plot 1, which was given a 7-hour day, Plot 2, which had continuous partial

	snade			
Class	Plo Number of bee	t 1 ts Percent	Plot 2 Number of bee	
1	3	1.3	0	0.0
2	67	29.0	43	23.0
3	108	46.75	107	57.22
4	53	22.95	3 7	19.78
5	0	0.0	0	0.0
			•	

On the basis of percentages, these two plots do not show material differences. There was, however, a difference in the outward appearance of the roots and in the depth of redness of the flesh. Beets in Plot 1 were more irregular in shape, had shorter and more fibrous roots. Beets in Plot 2 had more of an orange colored tinge in the flesh and to some extent in the skin, and several roots were distinctly orange colored.

During the very dry period of the summer, the plants in Plot 1 wilted badly, as compared with the plants in Plot 2. Figures 7 and 6 show the plants during this period. At no time did the plants in Plot 2 show signs of wilting, and the soil moisture content was from 1.25% to 4.5% higher in this plot than in Plot 1.

Cultivation Plots. - Three harvests were made of Plots
4 and 5, in which the effect of cultivation was tested. Beets
from the first planting were ready to harvest August 9.

Some of the beets of the second planting were ready August 29. There were many beets, however, which were too small at this time and they were left unpulled. Rains later in the season brought these on and they were harvested October 21. The classification for the harvests is given separately and collectively in Tables 6 and 7, page 17.

Besides showing a significant difference in zonation. the beets in these plots showed distinctly different outward appearances. Almost without exception, the roots in Plot 4, which had been kept covered with soil, were broader across the top and shorter in length than were those in Plot 5. from which the soil had been kept pulled away. This is well illustrated in Figure 5, the roots for which were taken from the average, rather than from the extreme, shape. These were taken from the first harvest. Beets from the second harvest of Plot 5 showed a greater tendency to elongate at the neck and become undesirable in shape. This possibly happened because the soil was pulled away from the roots as soon as the young plants were through the ground. In the first planting, the plants were starting to send out their second set of true leaves before the soil was pulled away from the roots.

The harvest of Plots 3 and 6, which were check plots, was made august 10. The roots were combined for classification as the number of beets in Plot 3 was very small.

16	lst.	harvest	03	2nd harvest	Vest	3rd harvest	Vest	Combined	ā
Class	No.beets	Percent	11	No. beets	Percent	No beets	Percent	No.beets	Percen
н	1	2.94		0	0.0	0	0.0	1	0.62
03	63	8.82		6	16.07	15	21.13	27	16.77
63	15	44.12	13	35	62.5	32	45.07	82	50.93
4	13	38.24	1	123	21.43	24	33.8	49	30.44
D.	03	5.88		0	0.0	0	0.0	લ્ય	.24

Table	7Class	Table 7Classification from the roots		of beets of Plot 5 in which soil was kept cultivated away	ot 5 in w	hich soil	was kept	cultivated	амау
		lst. harves	arvest	2nd harvest	Vest	3rd. harvest	vest	Combined	đ
Class	No.	No. beets	Percent	No.beets Percent No.beets Percent No.beets	Percent	No.beets	Percent	No.beets	Percent
Н		0	0.0	ю	5.36	18	16.36	. 22	11.05
03		9	25.0	14	25.0	43	39.1	63	33.16
83		13	54.17	36	64.28	68	26.36	78	41.05
4		മ	20.83	ю	5.36	20	18.18	88	14.74
D.		0	0.0	0	0.0	0	0.0	0	0.0

Table 8Cl	assificat	ion of	beetsPlots	3 and	6 combi	ned
Class	1	2	3	4	5	Total
Number of beets	3	123	386	107	1	620
Percent	0.48	19.84	62.26	17.26	0.16	

A comparison of the classification of beets in the check plots with those of Plots 4 and 5, shows that there was a considerably higher percentage of poorly colored roots in Plot 4, and about twice as many highly colored roots in Plot 5 as in the checks.

The irrigation plots (7, 8, 9 and 10) were harvested august 31. The data are shown in Table 9, page 19.

The variation in zonation of beets in these plots is hardly sufficient to indicate any effect resulting from irrigating at different periods in the growth of the plants. On the basis of soil moisture content, however, there is slight evidence to indicate that the higher the average moisture content, the higher the percentage of poorly colored beets.

There was a variation in the shade of the color of the roots in these plots. Those in Plots 7 and 10 were of about the usual shade for this strain, while those in Plot 9 had a distinctly brighter shade of red, and those in Plot 8 had a lighter shade.

The zonation records for all plots are brought together in Table 10. page 20.

		ا دي				-		
ason)	10	Percen	0.0	6.92	83.04	10.04	0.0	
ghout ses	Plot 10	No.beets Percent	0	31	372	45	0	
ered throuthird of	6	Percent	0.0	12.39	79.55	8.06	0.0	
irrigation Plots 7. (watered throughout season season), 9 (watered 2nd third of season), and season)	Plot 9	No.beets	0	100	642	65	0	
irrigation I season), 9 season)	: - tº	Percent	0.0	12.46	74.27	13.27	0.0	
n of beets, ir t. third of se rd third of se	Plot 8	ent Mo.beets	0	93	554	66	0	
cation of ed lst. t red 3rd t	4	Percent	0.0	11,86	71.24	16.90	0.0	
Table 9Classification 8 (watered ls: 10 (watered 3:	Plot	No.beets	0	134	805	191	0	
Table :		Class	ч	03	63	4	Ю	

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e				

	Plo	tl	Plot	2	Plo	ot 4	Plo	t 5	Plot		Plot		Plot		Plo		Plot	
lass	7-h:	r.day	Partis			ots vered	Roo	ts	Chec	k	Irrig throuseasc		1st.	gated th ird eason	2nd	igated third season	last	igated t third season
		per	No.	Per	No.	Per	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per	No.	Per	No.	Per cent
1	3	1.3	0	0.0	1	0.62	21	11.05	3	0.48	0	0.0	0	0.0	0	0.0	0	0.0
2	67	29.0	43	23.0	27	16.77	63	33.16	123	19.84	134	11.86	93	12.46	100	12.39	31	6.92
3	108	46.75	107	57.22	82	50.93	78	41.05	386	62.26	805	71.24	554	74.27	642	79.55	372	83.04
4	53	22.95	37	19.78	49	30.44	28	14.74	107	17.26	191	16.90	99	13.27	65	8.06	45	10.04
5	0	0.0	0	0.0	2	1.24	0	0.0	1	0.16	0	0.0	0	0.0	0	0.0	0	0.0
Total			187		161	gan agan iga water enter with refer refer	190		620	1 -	1230	2.7	746		807		448	
Total No.	231	64	187	97	161	9.08	190	837	620	19	1230	7 a	746	· ·	807	2 6	448	-

The data in Table 10 bring out clearly the variation in zonation for beets under the different treatments. It is evident that the outstanding difference is between Plots 4 and 5 which received different cultivation treatments. It is also clear that the cultivation plots vary considerably Irom the check plots 3 and 6. In Plot 5, in which the roots were kept covered, there is a much higher percentage of well colored beets than in the check plots. And in Plot 4, in which the soil was kept away from the roots, the percentage of poorly colored beets is nearly double that of the check plots. Plots 1 and 2, which received light treatments, had both a higher percentage of well colored and a higher percentage of poorly colored beets than the check plots. The irrigation plots (7, 8, 9 and 10) showed a consistently lower percentage of well colored beets than did the check plots.

An outline drawing of an average best from each plot, based on the width to length ratio, is shown in Figure 9. The ideal for canning purposes is a ratio of 1.0. The drawings for Plots 4 and 5 show clearly the flat shape of beets in Plot 4 as compared with those of Plot 5.

Greenhouse Trials

Beets in Lots A, B, C, which were the fertilizer lots, la, lb and lo in which soil acidity treatments were run, failed to develop sufficiently to be of any value so far as sonation records were concerned. Harvest was made December 20.

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which allowed 90 days for root development. In the fertilizer lots all of the beets were through the ground at about the same time and for 3 to 4 weeks Lot C showed a decided response to the heavy application of fertilizer. Lot A showed a slight response to the 3000 pound application for about 2 weeks. Gradually the plants in all lots came to have about the same height. The foliage in Lot B had more of a red appearance that that in Lots A and C. Green weights were taken separately for all roots and tops and the number of true leaves of each plant recorded. See Table 11.

Table 11.-Root and top weights and number of true leaves,
Lots A, B and C fertilizer treatments, la, lb
and lo soil acidity treatments

	Weights are a decimals of l		each lot recorde	d in
Lot	Root Weight	Top weight	Average number true leaves	
À	.81	3.46	8.3	
В	•71	3.31	8.15	
C	•84	3.74	8.14	
la	1.25	9.46	10.1	
1 b	1.25	12.36	9.77	
10	1.56	9.6	10.2	

Lots 2a, 2b and 2c, the temperature trials, were harvested December 22. The roots in Lot 2c, which was carried in the cool house, did not develop sufficiently to be of any value in the records. Figure 10 shows the relative size of average plants in these lots. All plants having roots

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weighing more than 1/16 ounce were weighed (top and root separately) and count made of the number of true leaves.

The same data were taken for Lots 3a, 3b and 3c which were harvested the same day. As previously noted, the soil moisture trials were carried in these lots.

Table 12.-Classification of roots; average root and top weights recorded in decimals of 1/16 ounce, and average number of true leaves in Lots 2a, 2b, 3a, 3b and 3c

	Cla	ssific a	tion	_ Root	Top	No. of			
Lot	1	2	3	4	5	weigh	t weigh	true leaves	
2a	0.00	48.28	44.83	6.89	0.00	2.73	34.08	13.5	
2 b	0.00	60.00	40.00	0.00	0.00	2.26	14.55	12.47	
3a	5.00	45.00	50.00	0.00	0.00	2.19	18.21	13.1	
3b	0.00	8.33	62.50	25.00	4.17	4.56	26.35	13.2	
3 0	7.15	78.57	14.28	0.00	0.00	1.28	8.64	11.4	

It is very evident from the data shown in Table 12 that the high soil moisture carried in Lot 3b may have been the cause of the poor color for other conditions were identical with those in Lots 3a and 3c. Likewise, in Lot 3c, in which the soil was kept very dry, there was a large percentage of highly colored roots. These results are in accord with the findings of Warming (9) Molisch (10) and Wheldale(3) previously mentioned.

The temperature Lots 2a and 2b, however, do not conform to previous observations relative to temperature and anthogyan

production. In this case the lot having the highest temperatures has a greater percentage of highly colored roots. The mean daily temperatures taken in these lots are given as weekly averages in Table 13.

Table 13.-Average weekly soil temperature records
Lots 2a. 2b and 2c

					Ending				
Lot	0ct. 20	0ot. 27			Nov.	Nov.	Dec.	Dec.	Dec. 15
2a	60.3	63.9	63.5	57.1	61.0	58.7	58.7	56.8	59.8
Sp	68.8	72.3	70.9	68.9	75.4	75.9	64.0	69.9	75.1
20	49.9	54.4	56.1	48.5	54.8	53.8	48.4	48.3	49.2

From the standpoint of growth, it appears that the soil temperatures were above the optimum in Lot 2b, and below the optimum in Lot 2c for the best development of the best. With reference to the soil temperatures in the garden Plot 2, the temperatures in Lot 2a were almost the same.

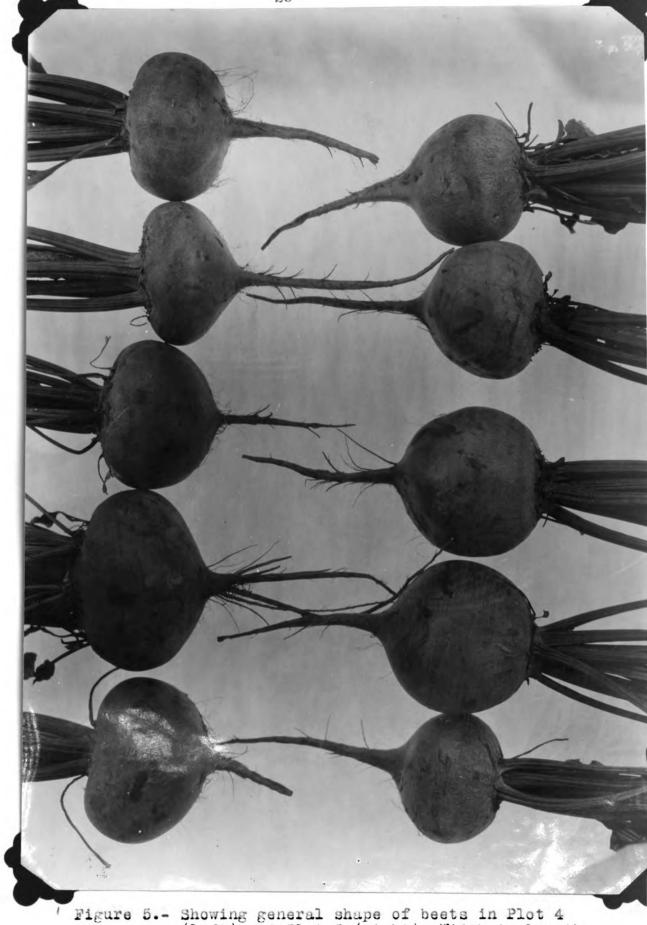


Figure 5.- Showing general shape of beets in Plot 4 (left) and Plot 5 (right). Width to length ratio Plot 4, 0.884, Plot 5, 1.05.

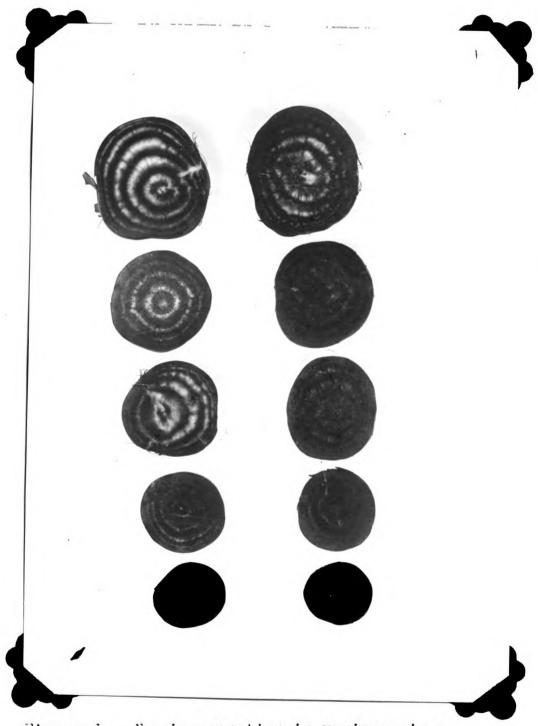


Figure 6.- Showing zonation in various sizes of beets. Plot 4 (left), Plot 5 (right).





Fig.-9- Orawing of average beet for various plots based on the wilth to length ratio.

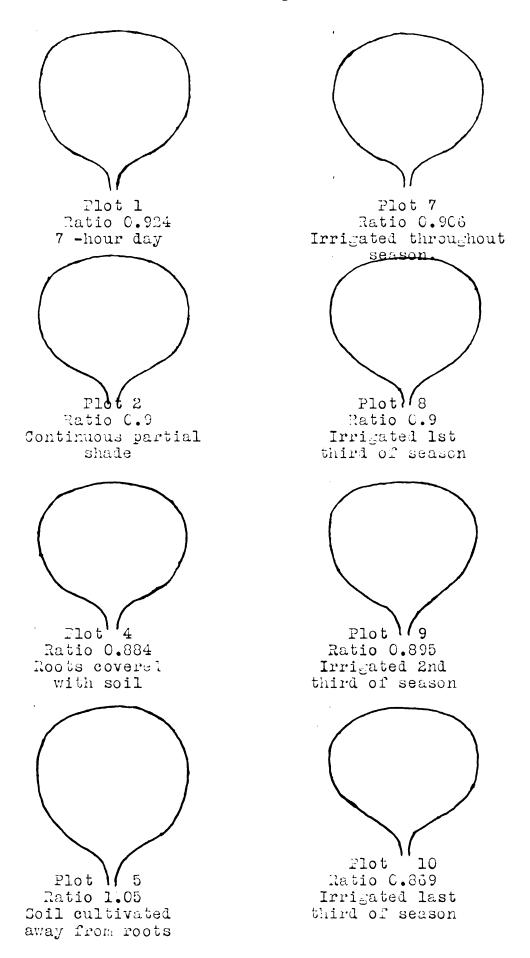




Figure 10.- Average plants in greenhouse Lot 2a (right), 2b (center), 2c (left). Temperature Trials.



Figure 11.- Average plants in greenhouse Lot 3a (center), 3b (right), 3c (left). Soil Moisture Trials.

Discussion

It has been demonstrated in these experiments, that by artificially producing the condition of being uncovered or covered with soil, color and growth characters of roots were produced somewhat comparable to the differences between red and white varieties under usual cultivation. From the data at hand, it seems possible that red table beets grown in a naturally loose soil might easily become fully covered by cultivation and thus flattened in shape and become lighter in color than is common for the variety.

The data seem to indicate the necessity of growing beets in well drained soil and, in this locality, during the warmest period of the season to secure the most highly colored roots. It is realized, however, that tonnage is sacrifised under these conditions if the season is lacking in rainfall. It is apparent that if beets are grown under irrigation the soil should not be kept in a wet condition.

Nothing in the data shows the desirability of growing beets in shaded places, but rather that warm, sunny locations should be chosen.

It is not safe to predict, however, that all varieties could be changed as this one has by cultivation, or that this variety could be altered in zonation and shape in a season of normal precipitation. It is likewise possible that this particular strain is not as well fixed in these characters as some other strains may be. It is improbable that a white beet, such as Lentz's Extra Early, could be

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made to develop color of much importance in a single season by simply cultivating the soil away from the roots or by withholding water from the soil. Nor is it likely that the best strains of the reddest type of table beet could be materially whitened by keeping the roots well covered with soil. These characters have supposedly become well fixed through careful selection.

Loss of color has been known to occur, however, in the best red varieties through the influence of unknown factors. Previous explanations have been on the basis of poor seed selection or seed mixture. Two varieties (Detroit Dark Red and Lentz's Extra Early) were grown along with the major part of this experiment just to observe the general tendency of root development. It was apparent that the red variety tended to develop its roots somewhat above the surface of the ground while the root development for the white variety was mostly below the surface of the ground. Likewise. it was observed that, in the red variety, those beets that did not develop above the surface showed a strong tendency toward a flatter shape and lighter color than beets which did develop above ground. And in the white variety, those beets that did develop mostly above ground were rounder in shape and showed more color than the others. This same difference was also noted in the main variety in the check and irrigation plots.

In view of this apparent general tendency of highly colored varieties to develop roots somewhat above the ground surface, it is possible that this character should be considered in selecting beets for seed purposes.

SUMMARY

amount of red zone area in Crosby's Egyptian (light strain) beets and produced roots which were practically round. Cultivating soil over beets of the same variety produced roots with a much larger proportion of white area and flatter in shape.

Zonation of roots produced in continuous partial shade was not materially different from that of roots grown in the check plots or with a seven-hour day, but the shade of red was lighter.

Zonation of beets grown outdoors was not affected by irrigating at different periods in their growth.

A high soil moisture content was effective in increasing the white zone area of beets grown in the greenhouse. A very low soil moisture content produced roots with a comparatively much larger red area.

Bench heat was effective in producing a large_red zone area as compared with no bench heat.

Bibliography

- 1. Shaw, Harry B.-Climatic Control of the Morphology and Physiology of Beets.-Sugar, 1917-1918.
- 2. Jones and Rosa.-Truck Crop Plants, p. 103, 1928.
- 3. Wheldale, M .- The Anthocyanin Pigments of Plants, 1916.
- 4. Klebs, Y,-Ueber Variationen der Bluten.

 Jahrb. wiss. Bot., Leipzig, 1906, XLII p. 155-320
- 5. Overton, E,-Beobachtungen und Versuche über das Auftreten von rothem Zellsaft bei Pflanzen; Jahrb. wiss. Bot. Leipzig. 1899. XXXIII. pp 171-231.
- 6. Schell, J.- Weber die Pigmentbildung in den Wurzeln einiger Salix- Arten. Justs Bot. Jahresber, Berlin, 1877, V. p. 562.
- 7. Devaux, De l'action de la lumière sur les racines croissant dans l'eau.
 Bul. Soc.Bot. Paris, 1888, XXXV, pp. 305-308
- 8. Linsbouer, L,-Ueber photochemische Induktion bei der anthokyanbildung.

 Niesner-Festschrift, wien, 1908, pp.421-436.
- 9. Warming, E.-Exkursionen til Fano og Blaavand i Juli 1899; Bot. Tids., Kjobenhavn, 1902, XXV, p. 53.
- 10. Molisch, H., Blattgrun und Blumenblau.- Vortrage des Vereines Zur Verbreitung naturwissenschaftlicher Kenntnisse in wien, wien, 1890, XXX.

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