MP-245

Harvest Period Trends in the Composition of Turnip Greens Grown in Texas

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TEXAS AGRICULTURAL EXPERIMENT STATION

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SUMMARY AND CONCLUSIONS

Seven Top turnip greens were grown as spring and fall crops at one site within the 1948-51 period and at a second site the last 3 years. Data on the contents of dry matter, ascorbic acid, thiamine, riboflavin, carotene, calcium, iron and fiber have been examined with respect to individual crops considered by years, seasons, sites and plantings, on the basis of 100 grams of fresh leaf-blade tissue and on the total weight of constituents per plant. The contents of nutrients in these raw greens have been compared with the National Research Council (NRC) recommended allowances.

For each of the eight constituents per 100 grams, similarity among the means for the different years is much more conspicuous than are differences. Statistically significant differences were found most often, but not always, between years within season. Significant differences between seasons within years were fewer, were not consistently in favor of either season, and the differences for the most part were too small to be of practical importance. Not one significant difference between seasons was found for all years together in spring and fall. Considering all years together, there were no significant differences between means for any constituent in greens from the two sites.

Trends through the individual harvest periods, in most cases, showed little variation in content per 100 grams of fresh greens. For only one of the eight constituents, fiber, was the whole harvest period trend consistently in the same direction. These trends are in contrast to the within-season rise and fall of some crops which may suggest short-time effects.

As between additional plantings made at successive 2-week intervals, among samples harvested on the same days, there were very few significant differences in the two-planting or the three-planting comparisons. Absolute differences are of unimportant magnitude.

Weight of each of the eight constituents per plant is highly correlated with time, all the correlation coefficients being significant beyond the 1 percent level in both spring and fall in greens from site 1, plantings 1 and 2. A high correlation between content of dry matter and each of the other seven constituents of the plant is indicated, regardless of the actual accumulation of dry matter over the harvest period. That is, if conditions promote growth, the several constituents of dry matter are built up in characteristic proportions.

Comparison of mean content of each of six nutrients in the raw fresh greens with NRC recommended allowance shows that these greens were an excellent source. In 100 grams of greens the nutrients were present in the following proportions of the allowances: ascorbic acid nearly 2 times; carotene, 1¾ times; calcium, nearly ½; riboflavin and iron, each ¼; thiamine above 1/10. Even the low content over all years showed these greens to be a valuable source of at least five nutrients. Turnip greens are well worth eating any time in the harvest period, in any season of any year. From a practical standpoint, the variations in the nutritional value of turnip greens are unimportant. However, in controlled dietary studies, each lot of the greens used should be analyzed.

Harvest Period Trends in the Composition of Turnip Greens Grown in Texas

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THE TEXAS AGRICULTURAL EXPERIMENT STATION was a participant in a southern regional study on the influence of environment on the chemical composition of plants. Seven Top turnip greens were used as the test plant. The crops each year were grown in spring and fall with seed from a common source and under standard procedures adopted by the stations cooperating in the study. The greens from each crop were analyzed for 14 constituents. Some of the findings in the regional study dealing with variations in the composition of turnip greens with location, season and concomitant environment have been reported in Southern Cooperative Series Bulletin No. 42 (12).

The Texas data for eight constituents of dietary interest are reported in this bulletin. Emphasis has been placed upon individual crops considered by years, seasons, sites and plantings and as a source of nutrients in terms both of 100 grams of fresh leaves and total weight of constituents per plant.

PROCEDURE

Growing and Harvesting

The Texas greens were grown in 1948-51, Table 1. Site 1 of the two locations was on the Upland Farms area at College Station, and site 2 about 10 miles away on the A&M plantation in the Brazos River bottom. The soil at site 1 was Lufkin fine sandy loam; that at site 2 was Miller clay. The seed were planted in rows 3 feet apart and the plants thinned to a 3-inch spacing. Second and third plantings were made at successive 2-week intervals after the first planting at site 1. A complete fertilizer of 5-10-5 analysis was applied at the rate of 1,000 pounds per acre, in bands 3 to 4 inches from the row and about 2 inches below the level of the planted seed. The station's customary methods for preparing the soil, cultivation and weeding were followed.

Field samples, consisting of horticultural duplicates, were taken for chemical analyses twice each week (Tuesdays and Thursdays) over harvest periods of 36 to 40 days at site 1, planting 1, and weekly at site 2 from 22 to 29 days. The plants were taken from the plot at 8:00 a.m. by cutting enough of the crown to hold the leaves together, and the plants in each duplicate were wrapped in moisture-vapor proof cellophane for transporting to the laboratory. Site 1 was approximately 2 miles, and site 2 about 5 miles from the laboratory.

Preparation in the Laboratory

In the laboratory, the leaves were cut off about 2 inches above the crown. Washing was done by holding three to five leaves loosely in each hand and moving them up and down several times in an aluminum or granite pan with tapwater running continuously into the container. The leaves were then rinsed in a similar manner in a second container filled with tapwater, and

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Contents

afterward, similarly rinsed twice in distilled water. Fresh water was used for each horticultural duplicate. Visible surface water was removed either by wiping each leaf with cheesecloth or by draining the leaves laid singly on a shelf of cheesecloth under a gentle breeze from an electric fan. Each leaf was then deribbed by use of a sharp safety razor blade. Three or four leaves were then stacked together and diced with a very sharp knife into pieces approximately one-half inch square. The entire lot of diced material was thoroughly mixed and duplicate subsamples were drawn from the diced sample for chemical analysis.

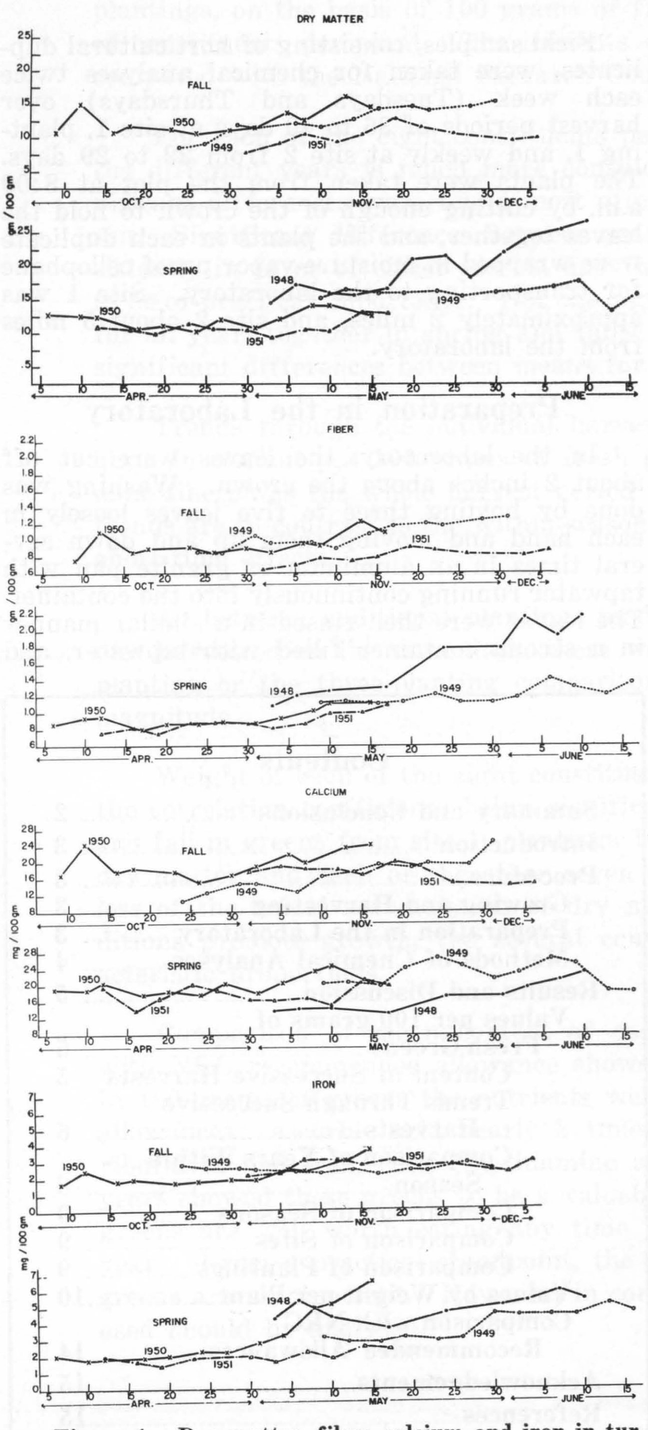

Figure 1. Dry matter, fiber, calcium and iron in turnip greens at successive harvests in spring and fall for different years.

TABLE 1. SOURCE OF SAMPLES FOR CHEMICAL ANALYSIS

Year	Planting	Number of harvests per planting			
		Site 1		Site 2	
		Spring crop	Fall crop	Spring crop	Fall crop
		For content of constituents in fresh leaf blades			
1948	1	12	12		
	2	4	6		
1949	1	12	12	6	5
	2	9	14		
	3	5			
1950	1	12	12	4	4
	2	10	10		
	3	8	5		
1951	1	11	10	5	5
	2	8			
	3	4			
		For average weight of constituents per plant			
1950	1	9	10	4	4
	2	8	8		
	3	7	5		
1951	1	10	9	5	5
	2	8			
	3	4			

Methods of Chemical Analyses

All chemical analyses were made in duplicate by accepted methods agreed upon by the workers in the regional study. The Texas Station determined dry matter, ascorbic acid, thiamine, riboflavin and carotene in the fresh samples and crude fiber in dried material. Dried samples were sent to other cooperating stations for determination of calcium and iron. The results of these analyses constitute the data on the 100-gram basis.

The weight of each constituent per plant was determined as follows. After separating the leaf blades from the midribs, the total dry matter in the leaf blades was calculated from the percent of moisture and the weight of the leaf blades. The dry weight of the plant was equal to the dry weight of the midribs plus the calculated dry weight of the leaf blades. Constituents in the leaf blades were calculated from the weight of the constituent per 100 grams of dry matter and the total dry weight of the leaf blades.

In order to calculate the weight of a constituent per plant, it was assumed that the amount of the constituent in the midribs was the same as that in the leaf blades. Although it was realized that this procedure did not give the absolute amount of the constituent per plant, the percentage error would be essentially the same for each increment increase in weight of the plant. In fact, a previous side study (13) had shown that midribs, including petiole, constituted a remarkably constant proportion of the fresh weight of whole leaves of turnip greens within a given planting and variety over an entire harvest period. Therefore, for comparative purposes the values per plant should be valid.

Dry matter was determined on 10 grams of fresh material by drying to constant weight in a forced draft electric oven at 65° C, or in a vacuum oven. Analysis for fiber was made on 1-gram dried samples. In these determinations, A.O.A.C. methods (1) were employed.

The Morell method (5), as modified by Heinze, Kanapaux, Wade, Grimball and Foster (3) was used to determine ascorbic acid in 10-gram subsamples,

For determination of carotene, a 5-gram sample was analyzed by the method of Moore and Ely (4).

The procedure followed in the extraction of thiamine and riboflavin and the determination of thiamine was an adaptation of the method of Conner and Straub (2). Riboflavin was determined by a modification (8) of the method of Peterson, *et al.* (7). A sample of 10 or 15 grams was used.

Calcium was determined by adaptations of blood microprocedures, which were developed (8) for analysis of small samples of plant material. A 200-milligram sample was used.

Iron was determined by the ortho-phenanthroline method of Saywell and Cunningham (10) as modified by Sheets and Ward (11). Duplicate samples of 150 milligrams were analyzed, and a check sample was analyzed on each day of analysis.

Statistical treatment of the data includes calculation of mean values with standard errors, standard deviation and coefficients of variability, and, where appropriate, analysis of variance and calculation of coefficients of correlation and of regression.

RESULTS AND DISCUSSION

The unit of measure of content of each constituent is that adopted by the workers in the regional study. Likewise, the number of decimal places, one for ascorbic acid, thiamine, riboflavin and calcium; two for dry matter, carotene, iron and fiber are the ones adopted as standard.

Values per 100 Grams of Fresh Greens

Content at Successive Harvests

The amount of each constituent at successive harvests in each season for seven of the eight crops of greens at site 1, planting 1, is shown by the graphs in Figure 1 and Figure 2. The fall crop in 1948 was omitted from these graphs because the seed were planted later than usual and the harvest period extended from February 2 through March 30, whereas the other three fall crops were harvested between October 9 and December 6. The values for the 1948 fall crop are included in the tabulated data.

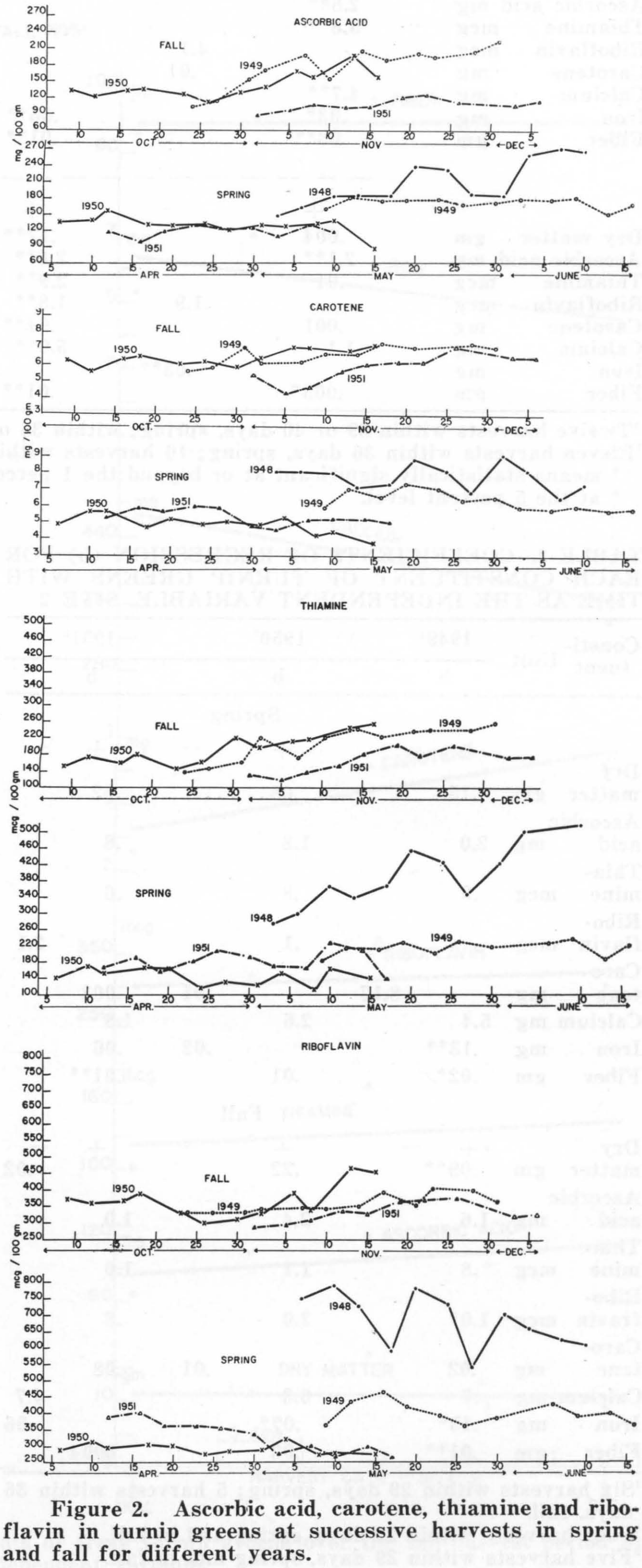

Figure 2. Ascorbic acid, carotene, thiamine and riboflavin in turnip greens at successive harvests in spring and fall for different years.

TABLE 2. COEFFICIENTS OF REGRESSION (b) FOR EACH CONSTITUENT OF TURNIP GREENS WITH TIME AS THE INDEPENDENT VARIABLE, SITE 1, PLANTING 1

Constituent	Unit	1948[1] b (+)	1948[1] b (−)	1949[1] b (+)	1949[1] b (−)	1950[1] b (+)	1950[1] b (−)	1951[2] b (+)	1951[2] b (−)
Spring									
Dry matter	gm	.31*** [3]			.002	.04		.05	
Ascorbic acid	mg	2.8**			.1		.8	.3	
Thiamine	mcg	5.6**		.4			.5	.2	
Riboflavin	mcg		4.1		.7		.6		.2**
Carotene	mg		.01		.02*		.03**		.37
Calcium	mg	4.7**			.4	2.0		.9	
Iron	mg	.03*		.06**		.11**		.02**	
Fiber	gm	.03**		.01**		.004		.01*	
Fall									
Dry matter	gm	.004		.17**		.08		.04	
Ascorbic acid	mg	2.1**		2.6**		1.4**		.6	
Thiamine	mcg	.01		2.9**		2.6**		1.8*	
Riboflavin	mcg		1.9	1.8**		1.8		1.4	
Carotene	mg	.001		.04**		.03**		.06**	
Calcium	mg	1.1		5.9**		2.1			2.5*
Iron	mg		.03**		.002	.04**		.01	
Fiber	gm	.005*		.01**		.005		.005*	

[1]Twelve harvests within 39 or 40 days, spring; within 38 or 39 days, fall.
[2]Eleven harvests within 36 days, spring; 10 harvests within 36 days, fall.
[3]** means statistically significant at or beyond the 1 percent level;
 * at the 5 percent level.

TABLE 3. COEFFICIENTS OF REGRESSION (b) FOR EACH CONSTITUENT OF TURNIP GREENS WITH TIME AS THE INDEPENDENT VARIABLE, SITE 2

Constituent	Unit	1949[1] b (+)	1949[1] b (−)	1950[2] b (+)	1950[2] b (−)	1951[3] b (+)	1951[3] b (−)
Spring							
Dry matter	gm	.15		.08		.02	
Ascorbic acid	mg	2.0		1.8		.8	
Thiamine	mcg	.9		.8		.6	
Riboflavin	mcg		.5	.1			2.1
Carotene	mg		8.17		.01	.003	
Calcium	mg	5.4		2.6		1.8	
Iron	mg	.13**			.02	.06	
Fiber	gm	.02*		.01		.01**	
Fall							
Dry matter	gm	.09**		.22			.02
Ascorbic acid	mg	1.6		2.4		1.0	
Thiamine	mcg	.8		1.1		1.0	
Ribofravin	mcg	1.0*		3.0		.8	
Carotene	mg	.02			.01	.08	
Calcium	mg	.7		6.3			4.7
Iron	mg	.15*		.07*			.06
Fiber	gm	.01**		.02		.0004	

[1]Six harvests within 29 days, spring; 5 harvests within 36 days, fall.
[2]Four harvests within 22 days, spring and in fall.
[3]Five harvests within 29 days, spring and in fall.

In these graphs the unit on the vertical axis is the standard deviation of the constituent shown. Thus, it can be seen that the variability over the harvest periods, for the most part, was small. The consistency in nutrient content among the years was much more pronounced than the differences. This consistency was more evident in the fall crops than in the spring crops. The 1948 crop was the most variable and amounts of some of the constituents appeared to have definite trends with age. Dry matter, ascorbic acid, thiamine, calcium, iron and fiber increased and riboflavin decreased but carotene did not change throughout the harvest period.

The graphs show that in each year, the content at several harvests was practically the same for every constituent. Increases or decreases in content did not occur consistently at any particular date for the different years. These short-term variations may suggest the effect of some short time environmental influence, but no attempt was made to identify this factor.

Trends Through Successive Harvests

To determine as precisely as possible the total harvest period trends, the coefficients of correlation and of regression were calculated for each of the eight constituents in the greens for each year, from site 1, planting 1 and from site 2, with time as the independent variable. Of the 56 correlation coefficients for the two sites together each season, only 17 for the spring crops are significant, and 24 for fall crops. In fall crops, 11 of the 24 significant values are in the greens grown in 1949. The predominance of very small coefficients of regression is shown in Tables 2 and 3. Even for the significant cases, the total accumulations per 100 grams of fresh greens (regression coefficient times number of days in harvest period) are, except for some of the calcium and iron values, less than the respective corresponding means for all springs and all falls. Moreover, fiber is the only one of the eight constituents with the same sign (+) for the correlation coefficient in all seven crops, and regression coefficients for fiber are exceedingly small.

The graphs in Figure 3 illustrate the overall harvest period trend. Of the 16 regression lines, 10 approach being horizontal. The divergence of short-time and long-time effects presents a challenge for explanation.

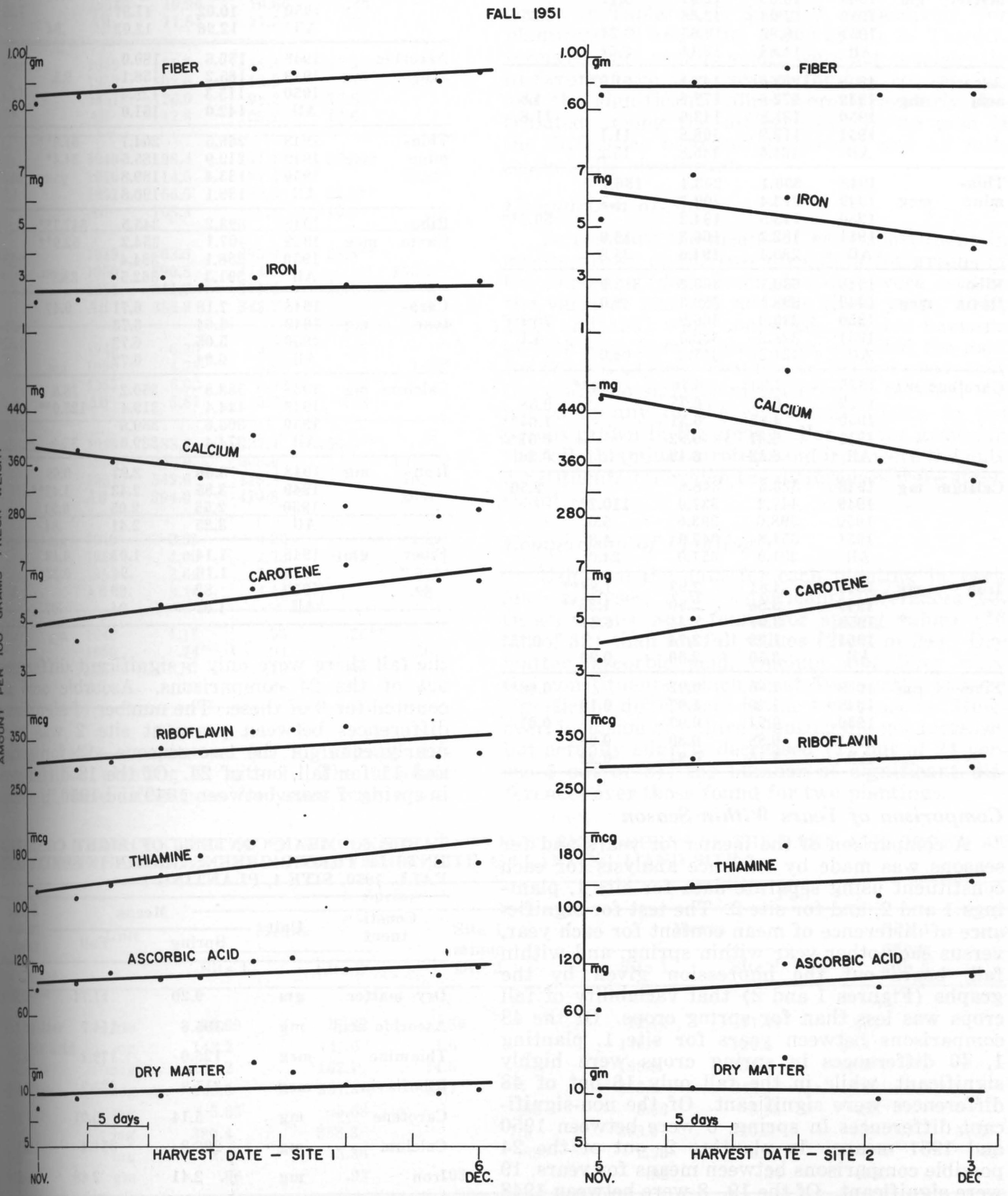

Figure 3. Trend in the content of each of eight constituents of fresh turnip greens over the fall-harvest period at two sites, as indicated by regression lines with time as the independent variable.

TABLE 4. MEAN CONTENT OF EACH OF EIGHT CONSTITUENTS IN TURNIP GREENS GROWN IN SPRING AND FALL IN 4 YEARS, SITE 1, PLANTING 1

Constituent	Unit	Year	Means: Spring	Means: Fall	Spring minus fall: +	Spring minus fall: −
Dry matter	gm	1948	20.03	12.08	7.95**	
		1949	16.03	12.91	3.12**	
		1950	12.03	12.68		0.65
		1951	10.89	10.65	0.24	
		All	14.83	12.14	2.69	
Ascorbic acid	mg	1948	209.0	147.1	61.9*	
		1949	172.8	177.6		4.8
		1950	131.8	143.6		11.8
		1951	119.9	108.8	11.1	
		All	161.0	145.8	15.2	
Thiamine	mcg	1948	390.1	203.4	186.7**	
		1949	213.4	209.7	3.7	
		1950	143.5	194.2		50.7**
		1951	182.3	166.3	16.0	
		All	230.4	194.6	35.8	
Riboflavin	mcg	1948	680.1	366.2	313.9**	
		1949	398.1	359.3	39.0	
		1950	290.0	366.9		76.9**
		1951	328.2	332.3		4.1
		All	421.2	357.2	64.0	
Carotene	mg	1948	7.90	6.70	1.20**	
		1949	6.37	6.75		0.38
		1950	4.87	6.51		1.64**
		1951	5.31	5.92		0.61*
		All	6.13	6.49		0.36
Calcium	mg	1948	323.6	348.6		2.50
		1949	447.2	337.0	110.2**	
		1950	398.6	393.6	5.0	
		1951	351.8	347.0	4.8	
		All	381.0	357.0	24.0	
Iron	mg	1948	4.81	2.93	1.88**	
		1949	3.86	2.50	1.36**	
		1950	3.07	2.23	0.84*	
		1951	1.99	2.74		0.75*
		All	3.50	2.60	0.90	
Fiber	gm	1948	1.60	0.92		0.68**
		1949	1.20	1.07	0.13	
		1950	0.94	0.95		0.01
		1951	0.88	0.80	0.08	
		All	1.16	0.94	0.22	

Comparison of Years Within Season

A comparison of the means for years and for seasons was made by variance analysis for each constituent using separate data for site 1, plantings 1 and 2, and for site 2. The test for significance of difference of mean content for each year, versus each other year within spring, and within fall, bears out the impression given by the graphs (Figures 1 and 2) that variability of fall crops was less than for spring crops. Of the 48 comparisons between years for site 1, planting 1, 40 differences in spring crops were highly significant, while in the fall only 16 out of 48 differences were significant. Of the non-significant differences in spring, 6 were between 1950 and 1951 means. In planting 2, out of the 24 possible comparisons between means for years, 19 were significant. Of the 19, 8 were between 1948 and 1950, and 8 between 1949 and 1950; while in

TABLE 5. MEAN CONTENT OF EIGHT CONSTITUENTS IN TURNIP GREENS GROWN IN SPRING AND FALL IN 3 YEARS, SITE 1, PLANTING 2.

Constituent	Unit	Year	Means: Spring	Means: Fall	Spring minus fall: +	Spring minus fall: −
Dry matter	gm	1948	14.84	12.71	2.13*	
		1949	15.38	11.75	3.63**	
		1950	10.02	11.97		1.95*
		All	12.96	12.02	.94	
Ascorbic acid	mg	1948	156.6	180.0		23.4
		1949	165.2	156.1	9.1	
		1950	115.3	126.4		11.1
		All	142.0	151.0		9.0
Thiamine	mcg	1948	266.5	204.7	61.8**	
		1949	219.9	185.5	34.4*	
		1950	133.4	189.8		56.4**
		All	189.1	190.8		1.7
Riboflavin	mcg	1948	693.2	345.5	347.7**	
		1949	407.1	354.2	52.9**	
		1950	288.1	384.4		96.3**
		All	391.3	362.5	28.8	
Carotene	mg	1948	7.18	6.71	0.47	
		1949	6.64	6.73		.09
		1950	5.05	6.72		1.67**
		All	6.04	6.72		.68
Calcium	mg	1948	388.8	350.2	38.6	
		1949	444.4	319.4	125.0**	
		1950	305.6	359.6		54.0**
		All	374.4	339.0	35.4	
Iron	mg	1948	3.66	2.97	0.69	
		1949	3.85	2.43	1.42**	
		1950	2.55	2.05	0.50	
		All	3.25	2.41	.84	
Fiber	gm	1948	1.14	1.01	0.13	
		1949	1.16	.94	0.22**	
		1950	.82	.89		.07
		All	1.01	.94	.07	

the fall there were only 5 significant differences out of the 24 comparisons. Ascorbic acid accounted for 3 of these. The number of significant differences between years at site 2 was more nearly equal in the two seasons—13 for spring and 11 for fall, out of 24. Of the 13 differences in spring, 7 were between 1949 and 1950, the same

TABLE 6. MEAN CONTENT OF EIGHT CONSTITUENTS IN TURNIP GREENS GROWN IN SPRING AND FALL, 1950, SITE 1, PLANTING 3

Constituent	Unit	Means: Spring	Means: Fall	Spring minus fall: +	Spring minus fall: −
Dry matter	gm	9.20	11.74		2.54**
Ascorbic acid	mg	105.6	114.7		9.1
Thiamine	mcg	126.0	179.2		53.2**
Riboflavin	mcg	315.9	423.9		108.0**
Carotene	mg	5.14	6.01		.87*
Calcium	mg	236.2	351.4		115.2
Iron	mg	2.41	2.48		.07
Fiber	gm	.74	.84		.10

TABLE 7. MEAN CONTENT OF EIGHT CONSTITUENTS IN TURNIP GREENS GROWN IN SPRING AND FALL IN 3 YEARS, SITE 2

Constituent	Unit	Year	Means: Spring	Means: Fall	Spring minus fall: +	Spring minus fall: −
Dry matter	gm	1949	14.38	10.49	3.89**	
		1950	9.12	14.07		4.95**
		1951	10.96	10.60	.36	
		All	11.84	11.55	.29	
Ascorbic acid	mg	1949	181.0	138.5	42.5**	
		1950	102.6	142.2		39.6*
		1951	126.0	98.2	27.8	
		All	142.8	125.2	17.6	
Thiamine	mcg	1949	198.4	141.1	57.3**	
		1950	114.5	187.3		72.8**
		1951	166.5	143.3	23.2**	
		All	165.4	155.1	10.3	
Riboflavin	mcg	1949	363.5	295.0	68.5**	
		1950	290.8	444.5		153.7**
		1951	341.7	311.6	30.1	
		All	336.9	343.7		6.8
Carotene	mg	1949	6.35	5.73	.62	
		1950	4.73	5.93		1.20*
		1951	6.02	5.43	.59	
		All	5.81	5.68	.13	
Calcium	mg	1949	488.2	337.4	150.8**	
		1950	308.0	505.0		197.0**
		1951	349.6	419.8		70.2
		All	394.0	414.8		20.8
Iron	mg	1949	2.95	4.22		1.27
		1950	4.00	2.33	1.67	
		1951	2.62	5.49		2.87**
		All	3.16	4.14		.98
Fiber	gm	1949	1.11	.85	.26**	
		1950	.74	.94		.20
		1951	.87	.79	.08	
		All	.93	.86	.07	

pair of years conspicuous for significant differences for planting 2, site 1. The absolute values of these differences for years within seasons are small for the greater number of them in comparison with the mean of the respective constituents.

Comparison of Seasons

Comparisons between the means of spring and of fall of each year with each other year, and of all springs with all falls, were made by variance analyses for each constituent. The results are shown in Tables 4, 5, 6 and 7, respectively, for plantings 1, 2 and 3 site 1, and at site 2. The differences were usually small, were not consistently in favor of the same season for any constituent, and the significant values were irregularly distributed among the differences. In no case is the difference between *all springs* and *all falls* statistically significant.

Comparison of Sites

To compare the means of each constituent in greens grown at the two sites, data for greens of the same age (days from planting) were used in the variance analyses and the three years, 1949, 1950 and 1951 were combined. Twelve harvests at each site, four in each year, supplied the data for these analyses. The data in Table 8 show that there are no significant differences between the means of any of the eight constituents in the greens grown in the spring. For greens grown in the fall, thiamine, carotene and iron were the only constituents for which the differences were significant.

Comparison of Plantings

Using all the data for each planting in variance analyses, more significant differences between means were found for spring values (16 out of 32) than for fall values (2 out of 24). Dry matter, ascorbic acid, calcium and fiber were the constituents which most frequently showed significant differences in the two seasons. However, inclusion of a third planting did not increase, but actually slightly decreased (11 out of 24 versus 5 out of 8), the number of significant differences over those found for two plantings.

TABLE 8. MEAN CONTENT OF EIGHT CONSTITUENTS IN TURNIP GREENS OF THE SAME AGE, GROWN AT TWO SITES IN SPRING AND FALL, IN 3 YEARS,[1] SITE 1, PLANTING 1 AND SITE 2

Constituent	Unit	Spring: Means: Site 1	Spring: Means: Site 2	Spring: Site 1 minus site 2: +	Spring: Site 1 minus site 2: −	Fall: Means: Site 1	Fall: Means: Site 2	Fall: Site 1 minus site 2: +	Fall: Site 1 minus site 2: −
Dry matter	gm	12.69	11.83	.86		12.12	11.48	.64	
Ascorbic acid	mg	143.2	141.6	1.6		140.9	120.8	20.1	
Thiamine	mcg	177.2	162.7	14.5		199.9	153.6	46.3**	
Riboflavin	mcg	348.0	331.3	16.7		353.9	346.1	7.8	
Carotene	mg	5.65	5.68		.03	6.53	5.65	.88**	
Calcium	mg	380.4	388.3		7.9	363.0	420.5		57.5
Iron	mg	2.48	3.36		.88	2.53	3.95		1.42*
Fiber	gm	.96	.93	.03		.92	.84	.08	

[1]The data for 1949-51 at each site, each season, were combined for statistical analysis.

Indication of short-time variations having been found, a comparison of plantings using only harvests of the same date seemed the best procedure for further variance analyses of plantings. Differences of means for each constituent in each crop are shown in Table 9 for two plantings and in Table 10 for three plantings. With two plantings having a total of 10 significant differences out of 32 comparisons, the means of 1949 are significantly different for each constituent except riboflavin.

With three plantings, 9 of the 15 significant differences of means (out of 24) in the spring crops are for dry matter, calcium and fiber. In the fall, only ascorbic acid differed significantly for different plantings. Ten differences out of 24 were significant. Whether for two plantings or three, differences of means are, for the most part, too small to be of practical importance.

To illustrate the close agreement among plantings, the harvests on the same days in 1950 are presented graphically in Figures 4 and 5. This year was the only one in which there were three plantings in both seasons.

Values by Weight per Plant

In sharp contrast to the small effects of time on the content of the constituent per 100 grams of fresh greens is the relationship between accumulation of the constituent and plant growth. This is shown by the coefficients of correlation

TABLE 9. MEAN CONTENT OF EIGHT CONSTITUENTS IN TURNIP GREENS HARVESTED ON THE SAME DAYS FROM EACH OF TWO PLANTINGS

Year	Spring: Means/100 gm, Planting 1	Spring: Means/100 gm, Planting 2	Spring: Planting 1 minus planting 2, +	Spring: Planting 1 minus planting 2, −	Fall: Means/100 gm, Planting 1	Fall: Means/100 gm, Planting 2	Fall: Planting 1 minus planting 2, +	Fall: Planting 1 minus planting 2, −
				Dry matter, gm				
1948	24.78	14.82	9.96**		11.97	12.72		.75
1949	16.08	15.38	.70*		14.41	11.56	2.85**	
1950	11.94	10.03	1.91*		12.82	11.44	1.38	
1951	10.71	9.62	1.09					
				Ascorbic acid, mg				
1948	245.7	156.6	89.1*		171.1	180.0		8.9
1949	173.0	165.2	7.8		198.0	152.4	45.6**	
1950	130.2	115.3	14.9		148.4	120.7	27.7*	
1951	122.7	114.2	8.5					
				Thiamine, mcg				
1948	477.3	241.5	235.8*		205.6	204.7	.9	
1949	217.5	219.9		2.4	238.5	188.4	50.1**	
1950	141.4	132.9	8.5		240.6	181.8	22.8	
1951	188.7	174.6	14.1					
				Riboflavin, mcg				
1948	628.3	693.2		64.9	345.3	345.5		.2
1949	390.7	407.1		16.4	375.0	366.5	8.5	
1950	288.0	288.1		.1	367.7	376.4		8.7
1951	319.1	344.6		25.5				
				Carotene, mg				
1948	7.80	7.18	.62		6.76	6.71	.05	
1949	6.32	6.64		.32	7.14	6.71	.43*	
1950	4.79	5.05		.26	6.65	6.45	.20	
1951	5.29	5.63		.34				
				Calcium, mg				
1948	405.8	388.8	17.0		350.1	350.1	0.0	
1949	461.2	444.5	16.7		389.8	315.7	74.1*	
1950	403.1	305.6	97.5**		392.7	354.4	38.3	
1951	351.2	287.6	63.6*					
				Iron, mg				
1948	5.49	3.66	1.83**		2.51	2.97		.46*
1949	4.15	3.85	.30		2.46	1.97	.49**	
1950	3.30	2.55	.75		2.32	1.94	.38	
1951	1.96	1.63	.30					
				Fiber, gm				
1948	2.02	1.14	.88**		.96	1.01		.05
1949	1.23	1.16	.07		1.16	.88	.28**	
1950	.94	.82	.12*		.95	.85	.10	
1951	.88	.77	.11**					

TABLE 10. MEAN CONTENT OF EACH OF EIGHT CONSTITUENTS IN TURNIP GREENS HARVESTED ON THE SAME DAYS FROM EACH OF THREE PLANTINGS

Constituent	Unit	Mean of planting 1	2	3	Difference 1 minus 2 +	1 minus 2 −	1 minus 3 +	1 minus 3 −	2 minus 3 +	2 minus 3 −
Spring, 1949-51, combined										
Dry matter	gm	12.89	11.47	10.37	1.42*		2.52**		1.10*	
Ascorbic acid	mg	137.2	130.0	118.4	7.2		1.88*		11.6	
Thiamine	mcg	171.7	170.4	160.5	1.3		11.2		9.9	
Riboflavin	mcg	313.1	324.2	344.3		11.1		31.2**		20.1*
Carotene	mg	5.08	5.47	5.57		.39*		.49**		.10
Calcium	mg	400.8	343.2	286.4	57.6**		114.4**		56.8**	
Iron	mg	3.64	3.02	2.51	.62		1.13**		.51	
Fiber	gm	1.05	.94	.82	.11**		.23**		.12**	
Fall, 1950										
Dry matter	gm	14.55	13.60	11.62	.95		2.93*		1.98	
Ascorbic acid	mg	171.8	141.8	113.5	30.0*		58.3**		28.3*	
Thiamine	mcg	233.5	220.2	176.8	13.3		56.7*		43.4*	
Riboflavin	mcg	412.6	419.0	424.9		6.4		12.3		5.9
Carotene	mg	7.11	7.00	5.75	.11		1.36**		1.25**	
Calcium	mg	447.0	404.8	352.6	42.2		94.4*		52.2	
Iron	mg	2.90	2.42	2.46	.48*		.44			.04
Fiber	gm	1.06	1.04	.82	.02		.24		.22	

and of regression recorded in Tables 11 and 12 for 1950, 1951, respectively. These are the only years for which such data are available.

In all analyses of weight per plant with time as the independent variable, correlations are positive. Correlation coefficients for spring crops site 1, plantings 1 and 2, for both years, are significant beyond the 1 percent level of probability. Correlation coefficients for spring values for site 1 planting 3 and site 2 are of comparable magnitude with those for plantings 1 and 2. Of the 32 coefficients, 14 are significant beyond the 1 percent level, 11 at 5 percent and the remaining ones have too few harvests to be rated for significance. The correlation coefficients for fall

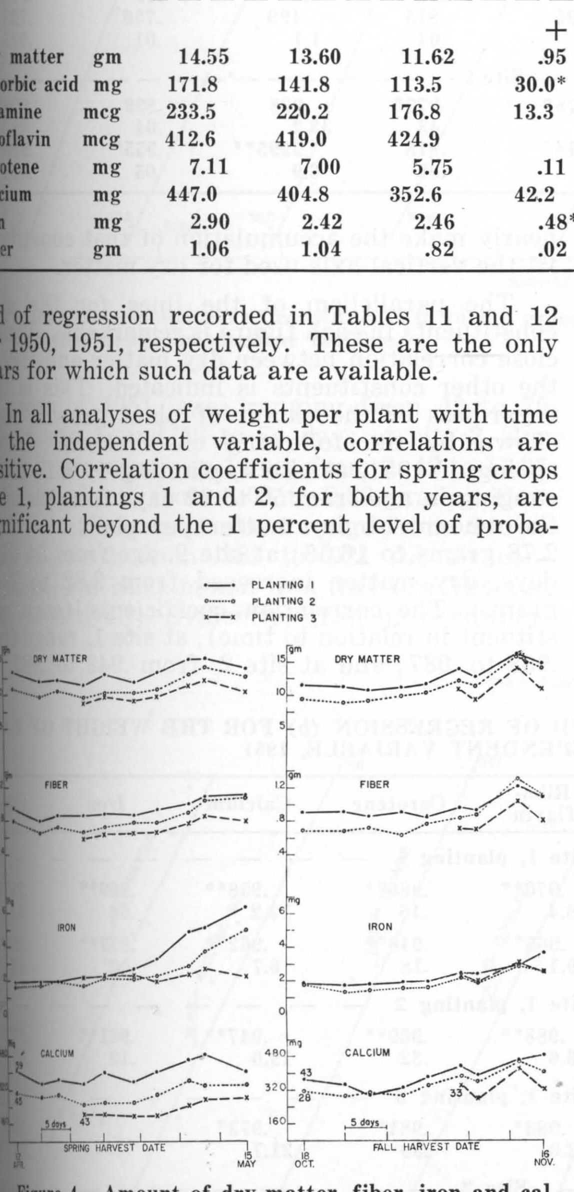

Figure 4. Amount of dry matter, fiber, iron and calcium in turnip greens from plantings made at successive 2-week intervals in the spring and fall crops of 1950.

The number on the curves for calcium represents the age of the plants when that sample was taken for analyses. Samples of the same material were analyzed for the other constituents.

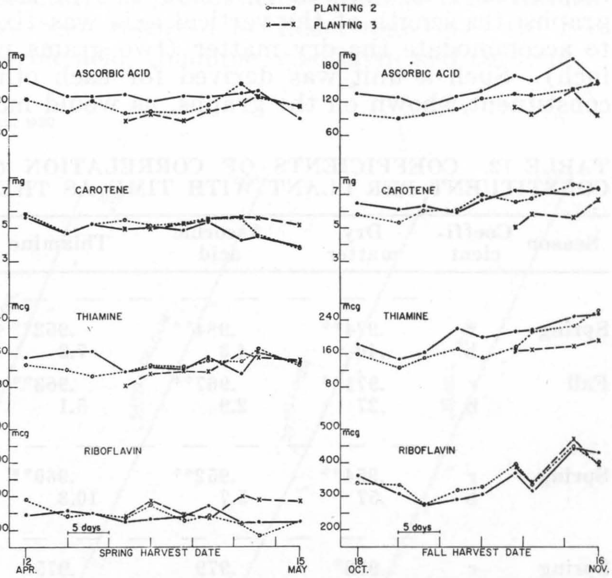

Figure 5. Amount of ascorbic acid, carotene, thiamine and riboflavin in turnip greens from plantings made at successive 2-week intervals in the spring and fall crops of 1950.

The number on the curves for riboflavin represents the age of the plants when that sample was taken for analyses. Samples of this same material were analyzed for the other constituents.

TABLE 11. COEFFICIENTS OF CORRELATION (r) AND OF REGRESSION (b) FOR THE WEIGHT OF EACH CONSTITUENT PER PLANT WITH TIME AS THE INDEPENDENT VARIABLE, 1950

Season	Coefficient	Dry matter	Ascorbic acid	Thiamine	Riboflavin	Carotene	Calcium	Iron	Fiber
					Site 1, planting 1				
Spring	r	.929**	.928**	.937**	.944**	.940**	.938**	.911**	.939**
	b	.43	4.7	5.0	11.6	.19	15.1	.13	.04
Fall	r	.969**	.958**	.970**	.968**	.970**	.961**	.948**	.981**
	b	.57	7.1	9.9	14.8	.31	17.5	.10	.04
					Site 1, planting 2				
Spring	r	.981**	.965**	.969**	.965**	.976**	.974**	.977**	.983**
	b	.70	8.4	9.2	15.6	.35	21.2	.18	.06
Fall	r	.987**	.980**	.971**	.981**	.981**	.992**	.972**	.975**
	b	.60	6.0	9.0	17.3	.29	17.4	.11	.05
					Site 1, planting 3				
Spring	r	.940**	.942**	.931**	.890**	.921**	.887**	.917**	.911**
	b	.45	5.4	7.4	15.3	.23	13.7	.10	.04
Fall	r	.679	.459	.788	.695	.815	.499	.756	.728
	b	.05	.4	.8	1.5	.04	1.1	.01	.005
					Site 2				
Spring	r	.946	.948	.985*	.978*	.973*	.938	.899	.959*
	b	.99	12.2	11.2	24.9	.43	33.2	.04	.08
Fall	r	.986*	.943	.930	.914	.918	.9995**	.955*	.990**
	b	.21	2.3	2.4	5.0	.06	6.9	.05	.02

crops, plantings 1 and 2, are all significant beyond the 1 percent level. Fall crops in planting 3, and at site 2, also show high correlation coefficients (with four exceptions: .679, .695, .499, .459). Significance in a number of instances cannot be demonstrated on account of too few harvests in the analyses.

To illustrate the close relationship between accumulation of each of the eight constituents and time, regression lines for planting 2, site 1, spring and fall, and site 2 for spring 1950, are shown, respectively, in Figures 6, 7 and 8. In these graphs, the length of the vertical axis was fixed to accommodate the dry matter (two grams per inch). Such a unit was derived for each other constituent, shown on the graphs, as would most nearly make the accumulation of that constituent fit the vertical axis used for dry matter.

The parallelism of the lines for the eight constituents in each figure is remarkable. Thus, a close correlation between dry matter and each of the other constituents is indicated. This is true regardless of the extent of plant growth, as is shown by the following observations. In the spring of 1951, at site 1, planting 1, with plants ranging in age from 50 to 82 days from planting, the amount of dry matter per plant rose from 2.78 grams to 16.56; at site 2, age from 54 to 82 days, dry matter increased from 2.82 to 21.32 grams. The correlation coefficients (each constituent in relation to time), at site 1, range from .958 to .987; and at site 2, from .948 to .982. In

TABLE 12. COEFFICIENTS OF CORRELATION (r) AND OF REGRESSION (b) FOR THE WEIGHT OF EACH CONSTITUENT PER PLANT WITH TIME AS THE INDEPENDENT VARIABLE, 1951

Season	Coefficient	Dry matter	Ascorbic acid	Thiamine	Riboflavin	Carotene	Calcium	Iron	Fiber
					Site 1, planting 1				
Spring	r	.974**	.984**	.962**	.970**	.986**	.958**	.969**	.987**
	b	.40	4.3	7.2	8.4	.16	12.2	.08	.03
Fall	r	.971**	.967**	.963**	.965**	.940**	.962**	.977**	.955**
	b	.27	2.9	5.1	9.1	.18	6.7	.06	.02
					Site 1, planting 2				
Spring	r	.954**	.952**	.960**	.988**	.969**	.947**	.961**	.972**
	b	.57	5.7	10.3	16.6	.32	19.0	.10	.05
					Site 1, planting 3				
Spring	r	.988*	.979	.975*	.983*	.981*	.973*	[1]	.984*
	b	.67	6.2	12.8	22.0	.39	21.7	[1]	.06
					Site 2				
Spring	r	.968**	.948	.987**	.963**	.960**	.972**	.982*	.974**
	b	.62	6.6	9.4	17.0	.32	20.4	.23	.05
Fall	r	.840	.870	.833	.896*	.921*	.794	.606	.848
	b	.17	2.2	3.0	5.9	.14	4.9	.03	.01

[1]Data not available.

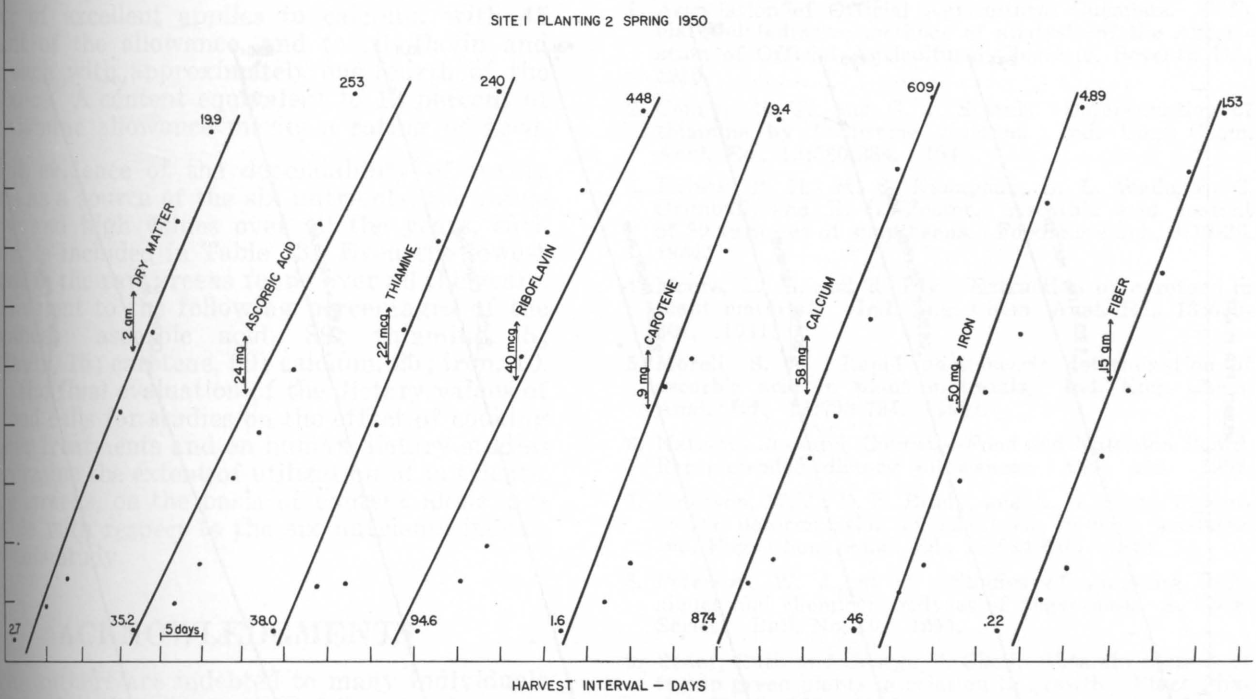

Figure 6. **Accumulation of constituents in turnip greens over a 27-day spring harvest period indicated by regression lines with time as the independent variable.**

fall crops of 1951, ages ranging from 43 to 75 days at site 1, and 46 to 74 days at site 2, dry matter in greens at site 1 rose from 2. 42 to 11.31 grams; at site 2, from 3.02 to 8.83 grams. Correlation coefficients at site 1 range from .940 to .977; at site 2, from .833 to .921 for six constituents. For calcium and iron they are .794 and .606, respectively. Evidently, growing conditions in the fall of 1951 were not as favorable as in spring, yet the correlations of constituents with time are of similar magnitude as in other crops. That is, if conditions promote growth, the several constituents of dry matter are built up in characteristic proportions. Similar observations have been reported by Reder and Odell (9) for ascorbic acid, thiamine, riboflavin and carotene.

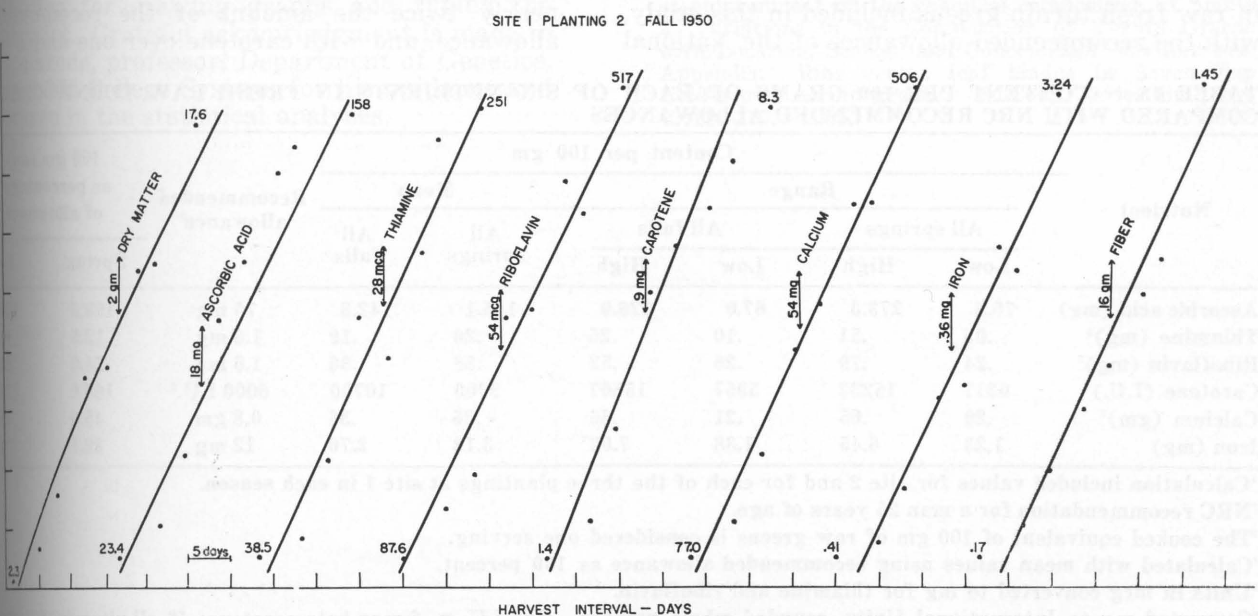

Figure 7. **Accumulation of constituents in turnip greens over a 27-day fall harvest period indicated by regression lines with time as the independent variable.**

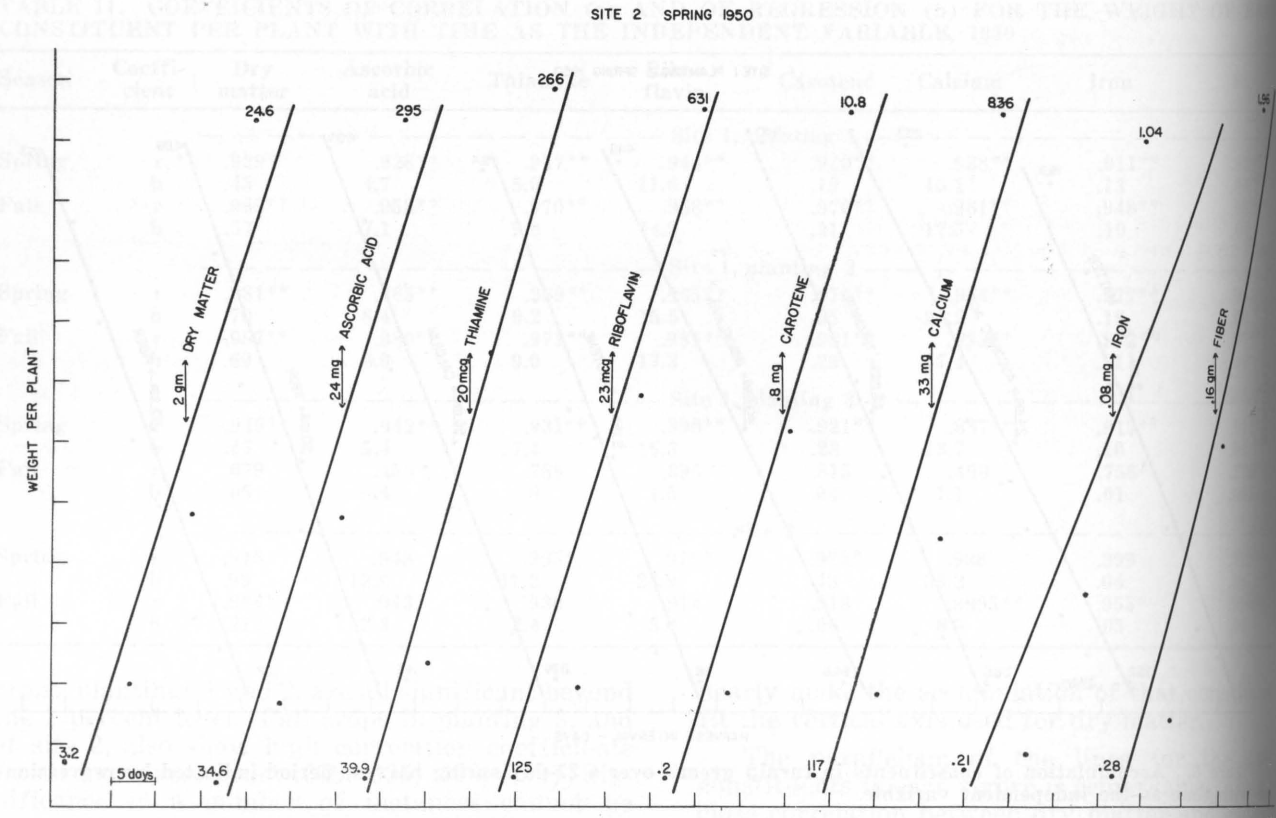

Figure 8. Accumulation of constituents in turnip greens over a 22-day spring harvest period indicated by regression lines with time as the independent variable.

Comparison with NRC Recommended Allowances

The dietary contribution of nutrients from any food material is dependent first on its content of the nutrient under consideration. Therefore, it is of interest to compare the content of nutrients in raw fresh turnip greens included in this study, with the recommended allowances of the National Research Council (6). The results of such comparison are given in Table 13. For emphasis on the likeness of mean content in the two seasons for all years together, calculations have been made of percentage contribution for both all spring and all fall crops using the recommended allowance as 100 percent. With the content of ascorbic acid nearly twice the amount of the recommended allowance, and with carotene over one and a half

TABLE 13. CONTENT PER 100 GRAMS OF EACH OF SIX NUTRIENTS IN FRESH RAW TURNIP GREENS COMPARED WITH NRC RECOMMENDED ALLOWANCES

Nutrient	Content per 100 gm						Recommended allowance[2]	100 gm raw[3] as percentage[4] of allowance	
	Range				Mean[1]				
	All springs		All falls		All springs	All falls			
	Low	High	Low	High				Spring	Fall
Ascorbic acid (mg)	76.8	273.3	67.0	226.0	145.1	142.8	75 mg	193.5	190.4
Thiamine (mg)[5]	.08	.51	.10	.26	.20	.19	1.6 mg	12.5	11.9
Riboflavin (mg)[5]	.24	.79	.26	.52	.38	.36	1.6 mg	24.0	22.5
Carotene (I.U.)[6]	6217	15233	5967	15367	9900	10700	6000 I.U.[6]	165.0	178.3
Calcium (gm)[7]	.20	.65	.21	.66	.36	.36	0.8 gm	45.0	45.0
Iron (mg)	1.23	6.45	1.38	7.02	3.13	2.76	12 mg	26.1	23.0

[1]Calculation included values for site 2 and for each of the three plantings at site 1 in each season.
[2]NRC recommendation for a man 25 years of age.
[3]The cooked equivalent of 100 gm of raw greens is considered one serving.
[4]Calculated with mean values using recommended allowance as 100 percent.
[5]Units in mcg converted to mg for thiamine and riboflavin.
[6]Converted mg to International Units, rounded whole number. One I.U. = .6 mcg beta-carotene. If all vitamin A activity supplied by beta-carotene, the allowance is 6,000 I.U.
[7]Units in mg converted to gm.

times the allowance, turnip greens are to be considered a superior source of these vitamins. A rating of excellent applies to calcium, with 45 percent of the allowance, and to riboflavin and iron, each with approximately one-fourth of the allowance. A content equivalent to 12 percent of the thiamine allowance merits a rating of good.

For evidence of the dependability of turnip greens as a source of the six nutrients, the range of low and high values over all the years, each season, is included in Table 13. Even the lowest content in the raw greens found over all the years, is equivalent to the following percentages of the allowances: ascorbic acid, 89; thiamine, 5; riboflavin, 15; carotene, 99; calcium, 25; iron, 10. While the final evaluation of the dietary values of any food calls for studies on the effect of cooking or other treatments and on human dietary studies to determine the extent of utilization of nutrients, turnip greens, on the basis of content alone, are valuable with respect to the six nutrients included in this study.

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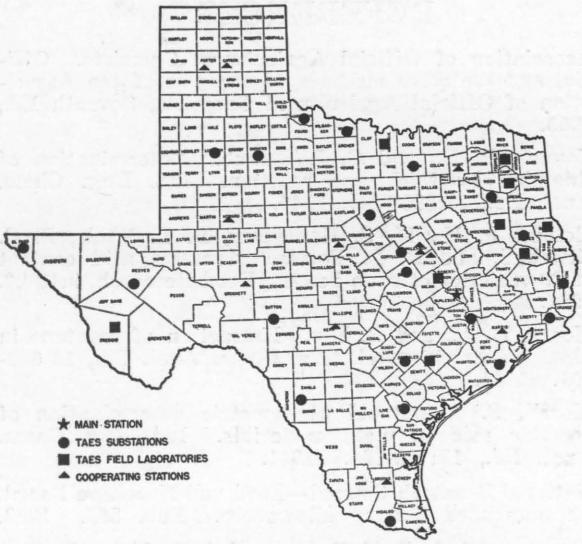

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System

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IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

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Conservation and use of water	Dairy cattle
Grasses and legumes	Sheep and goats
Grain crops	Swine
Cotton and other fiber crops	Chickens and turkeys
Vegetable crops	Animal diseases and parasites
Citrus and other subtropical fruits	Fish and game
Fruits and nuts	Farm and ranch engineering
Oil seed crops	Farm and ranch business
Ornamental plants	Marketing agricultural products
Brush and weeds	Rural home economics
Insects	Rural agricultural economics

Plant diseases

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