obtained. High fertilizer rates did not increase marketable yield but did reduce the proportion of culls. There was no apparent advantage to transplanting unless early prices were at a premium and 'TAM-Dew Improved' was utilized. However, in light of the reduction in total marketable yield and weight per fruit by transplanting, it would be preferable to achieve earliness by direct seeding 'Earli-Dew'. Growers should consider devoting part of their acreage to each variety since this would achieve a desirable combination of both high early and total marketable yields.

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YIELD AND QUALITY RESPONSE OF CRISPHEAD LETTUCE CULTIVARS TO SEEDING DATES AND FARMS IN SOUTH FLORIDA ORGANIC SOILS

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Abstract. **Twelve cultivars and breeding lines were seeded in early, mid, and late winter on 2 farms. The growing seasons were designed to be winter, early spring, and spring in consideration of the sub-tropical south Florida weather. Farm 1 had a history of very low incidence and farm 2 of very high incidence of corky root rot. Yields were significantly affected by seasons, farms, varieties, and their interaction. Farm 1 was significantly more productive than farm 2, but this was dependent on seasons. In early spring head weight was *high* for all entries regardless of farms, whereas in winter and spring, head weight was lower particularly on farm 2. Corky root rot tolerant entries were significantly more productive than susceptible entries on farm 2. All entries tended to produce less head weight under cloudy cold winter or hot spring conditions. Florida 1265 and 1366 were equal or better in yield and quality than 'Ithaca' and 'Shawnee'. Florida 44063, 49019, 49017, and 49018 showed the same degree of corky root resistance as 'Montello' and 'Green Lake' but produced slightly smaller heads *in* winter. Florida 49014 and 49015 produced heaviest heads. These lines were susceptible to corky root rot but tolerant to lettuce mosaic virus. In addition, Fl. 49015 was resistant in these tests to the race of downy mildew that caused extensive damage to all other entries in winter and early spring. Florida 49014 and 49015 had significantly more brown rib and tipburn than other entries. These disorders were not present in the winter plantings. 'Montello' had significantly more cracked ribs than Fl. 44063. The main component affecting yield and quality was weather during the growing season. Mean temperatures 50°F or below with low light intensity and short days, or mean temperatures above 70°F with longer days resulted in lower yields and quality. Presence of corky root rot was the second most important factor restricting yield.**

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Crisphead lettuce production in Florida increased in the last 10 years to approximately 10,000 acres with an estimated value of $23 million (2). Most crisphead production is centered in the Everglades. New York cultivars developed by Dr. J. G. Raleigh from Cornell University (5) were the foundation cultivars for the industry until recently, when corky root rot became the limiting production factor. The cultivars 'Montello' and 'Green Lake', developed by Dr. L. Sequiera (6) from the University of Wisconsin and released in 1978, are corky root rot (CRR) tolerant and are now the predominant cultivars. However, tests conducted with these cultivars before their release showed them to be susceptible to rib cracking under Florida conditions. A breeding program was begun at Belle Glade in 1976 to incorporate CRR and rib cracking tolerance into Florida's breeding lines. Several Florida breeding lines appear to have the desired CRR and rib cracking tolerance. The objective of this study was to determine the effect of 3 seeding dates (called seasons here) on 2 farms, one with low incidence and the other with high incidence of CRR on the performance of 12 cultivars, 6 susceptible and 6 tolerant to CRR.

Materials and Methods

The trials were seeded in organic soils, 30 December, 1980, 27 January and 20 February 1981, in farms 1 and 2 on the same day. Seeding was done on raised beds in land that had been flooded during the summer and fertilized following standard practices. All cultural practices were applied similarly by the grower-cooperators to the experimental plots. Split-split-plots with units in randomized complete block design with four replications were used. Seeding dates were considered main plots, farms the subplots and cultivars and lines the sub-sub-plots or units (Table 1). Randomization was different for each farm and seeding date. Plots were 40′ x 3′ on 8-inch raised beds with 2 rows per bed. Yields were secured from 20′ mid sections of each plot. Harvest was done by professional cutters at approximately mean maturity for most of the early lines; late lines were harvested ca. 5 days later. Data were recorded on yield and quality attributes such as cracked rib, brown rib, tipburn and CRR lesions for 10 plants at random. Brown rib refers to dark discoloration of the midrib or adjacent tissue, generally of the middle size leaves. This may be similar to what is called rib discoloration (4). Tipburn is darkening of the margins of leaves inside the head. Cracked rib is usually a transversal break of the mid rib tissue which in time turns reddish-brown. Corky root rot is a malady that appears as yellow necrotic lesions, becoming dark brown and longitudinally fissuring the tap root with cork-like tissue which eventually causes death of lateral and top roots (1). Corky root rot damage was rated outside and inside the main root, and outside the root hairs. These data are presented as means for the whole root. The rating of 1 indicated none or very small lesions which were difficult to differentiate from other root discolorations, to 5, where the root was practically destroyed. Seeding dates were spread ca. 25 days apart, but all were in winter. Growing periods however extended into spring, and for all practical purposes for south Florida it is assumed that the first planting was grown in winter, the second in early spring, and the third in spring (Table 2).

Table 1. Tolerance of crisphead lettuce cultivars and breeding lines to corky root rot, lettuce mosaic virus and downy mildew.

		Tolerance		
Cultivars	Origin	Corky root rot	Lettuce mosaic virus	Downy mildew
Ithaca	Cornell	no	no	no
Shawnee	Florida-Cornell	no	no	no
Montello	Wisconsin	yes	no	no
Green Lake	Wisconsin	yes	no	no
Breeding lines				
Fl. 1265	Florida	no	no	no
Fl. 1366	Florida	no	no	no
Fl. 49017	Florida	yes	no	no
Fl. 49018	Florida	yes	no	no
Fl. 49019	Florida	yes	no	no
Fl. 44063	Florida	yes	no	no
Fl. 49014	Florida	no	yes	no
Fl. 49015	Florida	no	yes	yes

Table 2. Seeding and harvesting dates of 3 crisphead lettuce variety trials conducted in organic soils of south Florida.

Seeding	Growing season[z]	Harvesting	Days to maturity
December 30, 1980	Winter	March 18, 1981	78
January 27, 1981	Early spring	April 4, 1981	67
February 20, 1981	Spring	April 22, 1981	61

[z]Assumed season for south Florida.

Results and Discussion

Yield parameters are difficult to discuss under one criteria classification. The trade requires a 24 head carton with 45 lb minimum. Weight per unit area may not be sufficient for variety selection, since weight is not the only factor involved. Mean head weight is not sufficient if the number of heads per unit area is low. Number of marketable heads harvested per unit area will be used here as the most appropriate parameter for yield comparison as long as the mean head weight is 1.7 lb or more.

Main Effects

Planting dates or seasons.—The number of heads harvested was significantly higher in winter, but head weight was marginal (Table 3). Weight per plot and mean head weight were significantly better in early spring. Thus, more cartons of marginal weight would have been harvested in winter as compared with slightly fewer cartons of greater weight per carton harvested in early spring. Cracked rib, brown rib and tipburn were not present in winter but increased significantly in spring. Lesions of CRR did not differ among seasons.

Farms.—Significantly greater number and weight of heads were harvested on the farm without CRR infestation vs. the farm with a history of the malady. Mean head weight was not affected by farms. Number of heads with brown rib and tipburn was significantly greater in farm 1, and number of heads with cracked rib and intensity of CRR lesions was greater in farm 2 (Table 3). Weather could have been an important factor in manifestation of the first 3 disorders.

Varieties.—Greatest number of marketable heads per plot were harvested from 'Montello', Fl. 44063, 49014 and 1366, 'Shawnee', 49017, and 49018 (Table 3). Yields of other entries were good but slightly inferior to those mentioned above. Significant differences in internal quality were found due to varieties. Fl. 49014 and 44015 had the worst internal quality. 'Montello' had more heads with cracked ribs than Fl. 44063. In general, entries tolerant to CRR (Table 1 and 3) had fewer root lesions than susceptible ones.

Interactions

Seasons x farms.—Significantly more heads were harvested from farm 1 than from farm 2 in winter and early spring. In spring this trend was reversed. The possible reason for this reversal was that a damaging rain fell on farm 1 which reduced growth and delayed maturity. Number of heads with cracked ribs, brown ribs and tipburn were significantly affected by seasons, farms, varieties and their interactions (Table 4). These disorders were not present in winter; they appeared in early spring and spring (8), but the number of heads affected was low.

Seasons x varieties.—Significant differences existed for number of heads harvested, marketable weight per plot, and mean head weight (Table 4). 'Ithaca' and 'Shawnee', for instance, produced excellent yields in early spring, but 'Shawnee' was better in winter and inferior in spring to 'Ithaca'. This is contrary to previous observations, where

Table 3. Mean of marketable yields and quality attributes expressed as main effects of 12 crisphead lettuce cultivars and breeding lines grown in winter, early spring, and spring on 2 farms, farm 1 with low incidence of corky root rot and farm 2 with heavy incidence of corky root rot.

		Yields/plot[z]				Quality[z]		
Treatment	Stand	No.	lb	Head lb	Cracked rib[y]	Brown rib[y]	Tip-burn[y]	Root rot
Season								
Winter	39	35	62.6	1.7	0.0	0.0	0.0	2.4
E. Spring	37	33	74.9	2.2	1.5	2.1	2.1	2.3
Spring	36	31	55.2	1.8	1.9	1.1	3.4	2.3
	**	**	**	**	**	**	**	NS
Farm								
1	39	34	66.4	1.9	1.0	1.5	2.5	1.7
2	35	32	62.1	1.9	1.2	0.5	1.2	2.6
	**	**	*	NS	*	**	**	*
Varieties								
Ithaca	36	32cd	60.0c	1.87df	0.9bc	1.1c	1.0c	2.4ab
Shawnee	37	33abc	63.3bc	1.89df	0.9bc	0.9c	0.5c	2.6a
Montello[x]	39	35a	67.0ab	1.92cdf	1.3b	0.7c	0.2c	2.2bc
Greenlake[x]	37	32cd	64.1bc	1.98abcd	0.7bc	0.7c	0.6c	2.2bc
Fl. 1265	35	31cd	64.0bc	2.03ab	0.8bc	0.7c	0.8c	2.5a
Fl. 1366	37	33abc	67.2ab	2.01abc	0.8bc	0.6c	1.0c	2.6a
Fl. 49017[x]	37	33abc	60.2c	1.83f	0.7bc	0.3c	0.3c	2.1c
Fl. 49018[x]	37	33abc	64.3bc	1.94abcd	1.0bc	0.8c	0.7c	2.1c
Fl. 49019[x]	36	32cd	61.8bc	1.93abcdf	1.0bc	0.9c	0.6c	2.2c
Fl. 44063[x]	39	35a	67.3ab	1.93abcdf	0.5c	0.3c	0.5c	2.1c
Fl. 49014	38	34abc	70.4a	2.04a	2.6a	3.4a	8.4a	2.4ab
Fl. 49015	37	30d	61.2c	2.01abc	2.1a	2.0b	6.8b	2.6a
	**	**	**	**	**	**	**	**

[z]*Significant at 5% and ** at 1% level. Columns means not followed by the same letter differ at 5% level.
[y]Cracked stem, brown rib and tipburn are expressed as means of plants affected in 10 plants per plot. Corky root rot data are the mean of disease intensity rating on a scale of 1 = no disease to 5 = severely damaged roots.
[x]Corky root rot tolerant.

'Ithaca' was superior to 'Shawnee' for winter production due to its large head. This contradiction may be due to seasons x variety interaction which was dependent on farms. 'Ithaca' yields in most cases decreased more on the farm with CRR than yields of 'Shawnee'. This does not fully explain, however, the superiority of 'Shawnee' over 'Ithaca' in these tests. 'Montello' produced better yields than 'Green Lake' in winter and spring, whereas in early spring 'Green Lake' was superior to 'Montello'. All entries produced excellent yields and quality in early spring.

Farms x varieties.—Only mean head weight was significantly affected. Head weight of CRR susceptible ('Ithaca' and 'Shawnee') as well as tolerant cultivars (Montello' and 'Green Lake') were the same on farm 1, whereas on farm 2 infested with CRR, head weight was reduced for susceptible cultivars vs. tolerant ones. A similar trend was obtained for marketable weight and for number of marketable heads harvested.

Interaction of farms and varieties for tipburn and CRR was highly significant. Farm 1 had more heads with tipburn than farm 2, but it was dependent on varieties. Florida 49014 and 49015 had more heads affected than 'Montello', Fl. 44063, and 'Green Lake'. In general, varieties performed similarly on the farm without CRR, but on the infested farm susceptible varieties produced lower head weight.

Lettuce requires long sunny days and moderately cool temperatures with minimum fluctuation for optimum growth. A mean of 70°F appears to be maximum and 40°F the minimum (3, 7). Higher temperatures promote seed stalk elongation, puffy heads, bitter flavor, and an increased tendency toward internal disorders (8). Low temperatures decrease or halt growth. With sufficient solar radiation and a mean close to 70°F, the growing period is shortened. In early fall and spring crisphead cultivars mature in ca. 65 days, whereas sometimes 110 days is necessary in winter; however, growth is not always directly related to temperature. Head weight was greater with 15

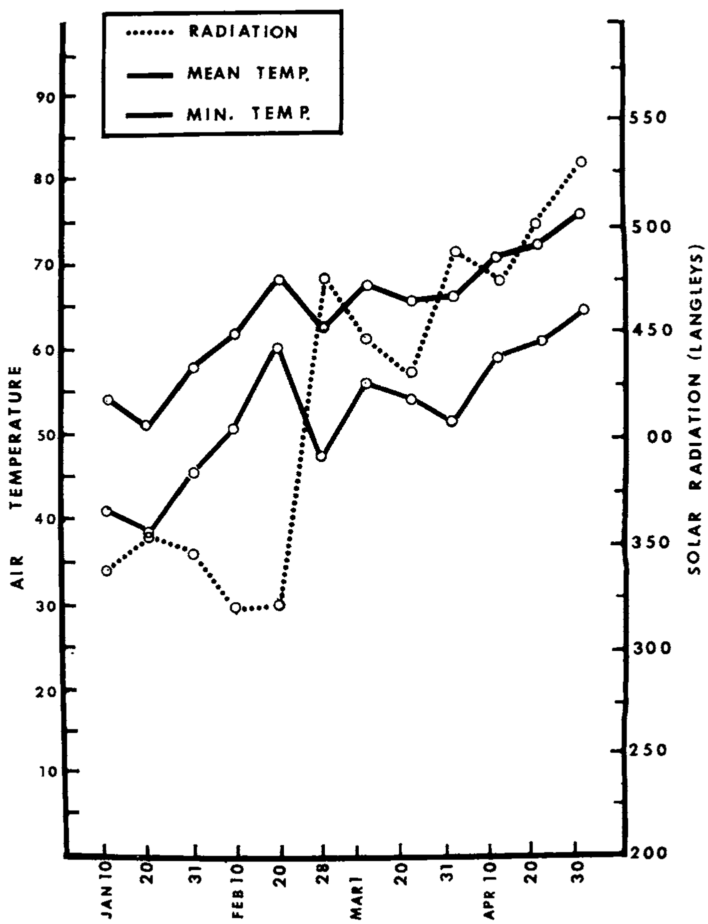

Fig. 1. Mean and minimum temperatures and solar radiation during the experimental growing period. Each point is the mean of previous 10 days. Rainfall was nil, except for a heavy rain on farm 1 on March 23.

Table 4. Interaction effect of 3 seasons x 2 farms and 3 seasons x 12 varieties on stand, marketable yields, number of plants with cracked ribs, brown ribs, tipburn and intensity of corky root rot lesions.

Interactions		Stand	Yields/plot[z] No.	Yields/plot[z] lb	Head lb	Quality[z] Cracked rib[y]	Quality[z] Brown rib[y]	Quality[z] Tipburn[y]	Quality[z] Corky Root-rot[y]
Season x Farm		**	**	**	*	NS	**	**	NS
Winter	1	42	38	71.0	1.8	0	0	0	1.7
"	2	36	32	55.0	1.7	0	0	0	3.1
E. Spring	1	39	35	75.2	2.1	1.5	2.7	2.6	1.6
"	2	34	31	75.0	2.3	1.5	1.3	1.5	2.3
Spring	1	37	29	53.3	1.8	1.6	1.9	4.9	1.6
"	2	35	32	57.2	1.7	2.2	0.4	2.0	2.3
Season x Varieties		**	**	**	**	**	**	**	**
Winter	Ithaca	36	32	55.0	1.7	0	0	0	2.6
	Shawnee	38	34	60.7	1.7	0	0	0	2.9
	Montello	39	37	69.0	1.8	0	0	0	2.2
	Greenlake	39	36	66.4	1.8	0	0	0	2.2
	Fl. 1265	38	35	62.8	1.7	0	0	0	2.7
	Fl 1366	40	37	63.6	1.7	0	0	0	2.7
	Fl. 49017	39	35	58.3	1.6	0	0	0	2.1
	Fl. 49018	40	36	64.8	1.7	0	0	0	2.0
	Fl. 49019	37	31	57.0	1.8	0	0	0	2.2
	Fl. 44063	40	37	65.7	1.7	0	0	0	2.1
	Fl. 49014	40	35	62.8	1.8	0	0	0	2.4
	Fl. 49015	41	34	65.0	1.8	0	0	0	2.7
E. Spring	Ithaca	37	33	72.9	2.2	0.5	1.3	0.6	2.4
	Shawnee	35	33	77.6	2.3	0.6	0.7	1.1	2.4
	Montello	39	35	73.1	2.1	1.8	0.8	0.3	2.2
	Greenlake	36	33	75.3	2.3	1.0	0.5	0.3	2.4
	Fl. 1265	36	33	78.0	2.3	1.0	1.2	1.3	2.4
	Fl. 1366	36	34	81.7	2.4	0.8	0.3	1.7	2.5
	Fl. 49017	38	34	72.7	2.1	0.7	0.3	0.5	2.1
	Fl. 49018	37	35	76.6	2.2	1.6	1.6	1.0	2.3
	Fl. 49019	36	33	71.9	2.1	1.5	0.7	0.6	2.2
	Fl. 44063	37	33	76.0	2.3	0.8	0.3	0.6	2.3
	Fl. 49014	37	33	76.1	2.2	4.6	10.2	9.8	2.3
	Fl. 49015	37	30	66.5	2.1	2.8	6.1	6.7	2.3
Spring	Ithaca	36	31	52.1	1.7	2.3	2.1	2.6	2.3
	Shawnee	37	32	51.7	1.6	2.2	2.1	0.6	2.3
	Montello	39	33	58.9	1.7	2.1	1.5	0.5	2.2
	Greenlake	34	28	50.6	1.7	1.3	1.6	1.5	2.3
	Fl. 1265	32	26	51.2	1.9	1.5	0.8	1.2	2.4
	Fl. 1366	35	30	56.3	1.8	1.6	1.5	1.5	2.4
	Fl. 49017	35	29	49.4	1.6	1.5	0.6	0.5	2.1
	Fl. 49018	34	28	51.6	1.8	1.3	0.8	1.1	1.5
	Fl. 49019	35	32	56.4	1.7	1.7	2.1	1.2	2.3
	Fl. 44063	40	35	60.2	1.7	0.7	0.7	1.1	2.1
	Fl. 49014	38	35	72.3	2.0	3.3	0	15.5	2.7
	Fl. 49015	33	26	52.1	1.9	3.5	0	13.8	2.8

[z]*Significant at 5% and ** at 1% level.
[y]Cracked stem ,brown rib and tipburn are expressed as mean of plants affected in 10 plants per plot. Corky root rot data are the mean of disease intensity rating on a scale of 1 = no disease to 5 = severely damaged roots.

hr day than with 10-12 hr day at 50-60°F, but not 60-70°F or 70-80°F (7). During the first 20 days of the winter planting (Fig. 1), minimum temperatures were near or below 40°F with 50 days of low solar radiation (ca. 350 Ly), which resulted in smaller heads. It is estimated that in 45 days a head weight reduction of 13% occurred with 25% shade vs. plants growing in the open (Dr. R. J. Allen's personal communication), which is roughly a drop from 450 to 350 Ly (Fig. 1). For the early spring planting, temperatures and light limited growth for a short period, but soon the daily mean temperatures increased to ca. 65°F, and solar radiation to 450 Ly, resulting in excellent growth and head weight. The spring planting grew largely under good weather conditions, except for the last 3 weeks when the mean was above 70°F, resulting in marginal head weight and accelerated maturity. It follows that the overriding influence on lettuce yield and quality is the weather. Stresses from abnormal weather are reflected in head weight and quality.

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