contributed to higher plant yield but only at the 76 cm (30 inches) in-row plant spacing. Yield per ha was significantly higher in the 4-bed arrangement with closer in-row spacing, that is, increasing plant population.

In the experiments, the application of high amounts of fertilizers for tomatoes did not increase yield, number of fruit harvested, or fruit size. With higher fertilizer rates, higher amounts of residual salts remained in the soil. Residual soil salt content also increased with increasing in-row plant spacing (Table 3). Higher number of plants/ha, regardless of the type of plant bed arrangements, would increase yield and reduce residual soil salt content.

Table 3. Total soluble salts in soil solution as measured by the saturated paste extract method, spring and fall 1978.

Sampling date	Soil depth (cm)	Within row plant spacing (cm)	Fertilizer treatment: Low[z] — Plant bed arrangement between lateral irrigation furrows: Two	Low[z] — Four	High[z] — Two	High[z] — Four
Spring			ppm			
Mar. 15, 1978	0-15		126,580	126,580	174,590	174,590
June 10, 1978		46	48,760	55,560	105,740	125,950
		61	58,550	65,260	114,880	124,220
		76	65,860	73,010	125,710	145,980
Fall						
Sept. 21, 1978	0-15		153,390	153,390	234,410	234,410
Dec. 12, 1978		46	37,460	37,540	30,710	73,560
		61	40,580	44,810	45,590	75,060
		76	56,200	47,610	76,420	80,420

[z]Low fertilizer rate: 29.7 kg, high fertilizer rate: 44.6 kg of 18-0-25 + 2 per 100 linear m of plant bed.

The 4-bed arrangement between two lateral irrigation furrows, however, has several disadvantages compared to the 2 or single bed production systems. The disadvantages of the 4-bed system are: it requires more input of materials and labor, it is more difficult to collect the harvested fruit, and the drainage of water from the land after a heavy rainfall is slower.

These adverse factors of the 4-bed arrangement have to be taken into consideration against the higher marketable yield potential of this system when selecting plant bed spacing between lateral irrigation furrows for fresh market tomato production.

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INFLUENCE OF FERTILIZER RATES AND PLASTIC MULCH ON THE PRODUCTION OF TWO CULTIVARS OF CRISPHEAD LETTUCE[1]

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Abstract. **Three rates, 420, 700 or 920 lb./acre (470, 784 or 1030 kg/ha), of an 18-0-25 fertilizer, with and without mulch, were evaluated for their effect on yield and head weight of 2 crisphead lettuce cultivars grown on a sandy soil in southwest Florida. In addition to the 18-0-25 fertilizer, all plots received a 5-8-8 fertilizer at a rate of 500 lb./acre (560 kg/ha). All fertilizer for the mulched plots was applied pre-plant. In the non-mulched plots, all of the 5-8-8 and one-half of the 18-0-25 fertilizers were applied pre-plant. The remainder of the 18-0-25 fertilizer was applied to the non-mulched plots 3 weeks after transplanting. Lettuce cultivars used were 'Shawnee' and 'Ithaca.'**

The use of plastic mulch resulted in a highly significant increase in weight of lettuce per acre, average weight per head, and the number of heads weighing 1.7 lb. (0.77 kg) or more. Plastic mulch did not increase the total number of heads per acre. The effect of fertilizer rates and cultivars on yield and average head weight was not significant.

The season had higher than normal rainfall. Without plastic mulch, severe leaching of plant nutrients occurred, even at the highest rate of fertilizer. With plastic mulch, plant nutrient level in the soil was adequate even at the low rate of fertilizer. Consequently, the primary effect of mulch on improved lettuce production was in reducing the leaching of plant nutrients.

Between 14 and 15 thousand acres of lettuce are grown in Florida annually. Most of this acreage is on the organic soils centered around Lake Okeechobee, Zellwood, Lake Placid, and Sarasota. Very little lettuce has been grown commercially on the mineral soils of the state. It appeared feasible to expand lettuce, particularly head type, production in Florida (9). This opportunity has become even greater during the past 5 years, due mainly to the rapid increase in transportation costs from California to eastern

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markets. With the favorable economic and marketing situation, more interest is being generated for commercial lettuce production on Florida's mineral soils.

In the early 1940's, there was some interest in lettuce production in Florida (1, 2, 6, 7). Most early reports were concerned with varieties, plant populations, planting dates, and weather conditions. Beckenbach (2) reported that, on sandy soils in Manatee and Hillsborough Counties, iceberg lettuce should be fertilized with at least 60 and not more than 100 lb. of N per acre. Since these early reports, there has been little, if any, published research concerning lettuce production on the mineral soils of Florida. The more recent research (3, 4, 5) has been done on the organic soils.

This paper furnishes some preliminary information on the effect of fertilizer rates and plastic mulch on yield and quality of 2 crisphead lettuce cultivars grown on mineral soils with seep irrigation.

Materials and Methods

A 3 x 2 x 2 factorial experiment was conducted during January and February, 1980, to evaluate the effect of 3 rates of an 18-0-25 fertilizer, with and without full-bed plastic mulch, on the yield and head weight of 2 cultivars of crisphead lettuce. The experimental design was randomized blocks with 4 replications of each treatment. Fertilizer rates were 420, 700 or 920 lb./acre (470, 784 or 1030 kg/ha) of an 18-0-25 fertilizer. Soil test values indicated a high level of phosphorous, therefore, this plant nutrient was applied uniformly to all plots at 18 lb. P/acre (20 kg/ha). The plastic mulch was 1.25 mil black polyethylene film, and the lettuce cultivars were 'Shawnee' and 'Ithaca.'

All plastic mulch plots received 500 lb. 5-8-8/acre (560 kg/ha) applied in a 30 inch (76 cm) wide band on a pre-bed and then bedded-over to a 4 inch (10 cm) depth. The 18-0-25 fertilizer was then applied in narrow bands on the bed surface 7 inches (18 cm) to each side of the bed center. Plots without plastic mulch were fertilized in a similar manner except the 18-0-25 was applied one-half pre-plant in narrow bands on the pre-bed and the other half applied as a sidedress 3 weeks after transplanting. All plots were fumigated with a broad spectrum soil fumigant 3 weeks prior to transplanting.

On Dec. 31, 1979, 4-week-old container grown lettuce seedlings were transplanted into the raised plant beds which were 6 inches (15 cm) high and 38 inches (96 cm) wide at the top with 6 ft (1.83 m) between bed centers. Each plot consisted of three 10 ft (9.1 m) rows of lettuce. The rows were spaced 14 inches (36 cm) apart across the bed with a down-row spacing of 10 inches (25 cm). This arrangement resulted in 36 plants/plot which is equivalent to 26,136 plants/acre (64,582 plants/ha). Irrigation was supplied with an open-ditch seepage system.

Soil samples from the high and low rates of fertilizer, with and without mulch, were taken 3 times during the experiment. The first sampling was made Dec. 5, 1979, the day after the initial fertilizer application, the second sampling was made on the day prior to the second fertilizer application of the non-mulched plots, and the third sampling was made on the day of harvest. Six soil cores (1 inch diameter x 6 inches deep) were taken through the fertilizer bands in each plot. These cores were then combined to form 1 sample. Total soluble salts were determined on these samples using the saturated paste extract procedure.

Lettuce was harvested on Mar. 4, 1980, at 64 and 92 days after transplanting and seeding, respectively.

Results and Discussion

Table 1 shows the effects of plastic mulch, fertilizer rates and cultivar on the total yield of lettuce. Total yield refers to all heads regardless of head-weight. Plastic mulch significantly increased total yield (cwt/acre) and the average head-weight by 53% and 60%, respectively, over that from the non-mulched plots. Although the total number of heads harvested from the non-mulched plots was slightly higher than from the mulched plots, this difference in number of heads was not significant. Since the total number of heads harvested with and without mulch was approximately the same, the higher yield (cwt/acre) with mulch was attributed to larger heads produced with this treatment. Neither fertilizer rate nor cultivar had any significant effect on total yield, number of heads harvested or average weight/head.

Table 1. Main effects of plastic mulch, fertilizer rate and cultivar on the total yield of crisphead lettuce.

Variable	Total yield cwt/acre[z]	Total yield no. heads/acre[y]	Avg wt lb./head[x]
Plastic mulch			
Mulch	590	25,123	2.4
No mulch	386	26,086	1.5
F value[w]	**	N.S.	**
18-0-25 fert. (lb./acre)			
420	471	25,905	1.8
700	498	25,542	2.0
920	496	25,361	2.0
F value	N.S.	N.S.	N.S.
Cultivar			
Shawnee	474	25,724	1.8
Ithaca	502	25,482	2.0
F value	N.S.	N.S.	N.S.

[z]cwt/acre x 1.12 = quintal/hectare.
[y]no. heads/acre x 2.471 = no. heads/hectare.
[x]lb./head x 0.454 = kg/head.
[w]F values are significant at 1% (**) level or not significant (N.S.). Interaction effects were not significant.

Many of the heads grown without mulch were small. Lettuce weighing less than 1.7 lb./head is often discounted by the trade. Table 2 shows data for lettuce weighing at least 1.7 lb./head. When only these larger heads were considered, the number of marketable heads/acre produced

Table 2. Main effects of plastic mulch, fertilizer rate and cultivar on the yield of crisphead lettuce weighing at least 1.7 lb. per head.

Variable	Total yield cwt/acre[z]	Total yield no. heads/acre[y]	Avg wt lb./head[x]
Plastic mulch			
Mulch	546	21,980	2.5
No mulch	210	9,540	2.2
F value[w]	**	**	*
18-0-25 fert. (lb./acre)			
420	352	15,036	2.3
700	392	16,303	2.4
920	391	15,941	2.4
F value	N.S.	N.S.	N.S.
Cultivar			
Shawnee	366	15,820	2.3
Ithaca	390	15,700	2.4
F value	N.S.	N.S.	N.S.

[z]cwt/acre x 1.12 = quintal/hectare.
[y]no. heads/acre x 2.471 = no. heads/hectare.
[x]lb./head x 0.454 = kg/head.
[w]F values were signficant at 5% (*) and 1% (**) levels or not significant (N.S.). Interaction effects were not significant.

with plastic mulch was more than double the number produced without mulch. As with total yield, neither fertilizer rate nor cultivar had any significant effect on the yield of larger heads.

Table 3 shows the main effects of plastic mulch, fertilizer rate, and cultivar on the percentage of heads in 4 size ranges based on head-weight. With plastic mulch, most (89%) of the heads were in the 1.5 to 3.5 lb. range. Without plastic, only 48% were in this range, while the remainder of the heads weighed less than 1.5 lb.

Table 3. Main effects of plastic mulch, fertilizer rate and cultivar on the head-weight distribution of crisphead lettuce.

Variable	Head-weight ranges in pounds[z]			
	<1.5	1.6-2.5	2.6-3.5	>3.5
	%			
Plastic mulch				
Mulch	8	48	41	3
No mulch	52	40	8	0
F value[y]	**	N.S.	**	N.S.
18-0-25 fert. (lb./acre)				
420	33	47	19	1
700	29	42	28	1
920	28	42	26	4
F value	N.S.	N.S.	N.S.	N.S.
Cultivar				
Shawnee	31	47	22	0
Ithaca	29	41	26	4
F value	N.S.	N.S.	N.S.	N.S.

[z]Pounds x 0.454 = kilograms.
[y]F values were significant at 1% (**) level or not significant (N.S.). Interaction effects were not significant.

This experiment was conducted during a winter with higher rainfall than normal. The 20 year average rainfall for Dec., Jan. and Feb. is 5.2 inches (13.2 cm), while the rainfall during the winter of 1979-80 was 10.7 inches (27.2 cm). The primary reason for improved production of head lettuce with plastic was its effect on reducing the leaching of plant nutrients (Table 4). Even though several intense rains occurred during the growing season, plastic mulch maintained a high level of plant nutrients in the soil at all rates of fertilizer, whereas severe leaching occurred without mulch, even at the high rate of fertilizer. It should be pointed out that the soluble salt concentrations shown in Table 4 are from soil samples taken in the fertilizer bands (high salt zones) and do not represent the concentration throughout the plant bed. For example, salt concentrations in the plant row, 7 inches (18 cm) from the fertilizer bands, ranged between 1,800 and 2,200 ppm in the mulch plots.

Although there was no statistical significance between the

Table 4. Effect of plastic mulch on total soluble salts in soil at three sampling dates for low[z] and high[y] rates of fertilizer.

Plastic mulch	Sampling date					
	12/5/79		1/21/80		3/4/80	
	Low	High	Low	High	Low	High
	ppm[x]					
Mulch	5,100	7,420	4,870	5,250	4,960	5,480
No mulch	4,640	5,950	580	675	520	460
Rainfall (inches) between dates		5.07		8.78		

[z]420 lb./acre 18-0-25 fertilizer.
[y]920 lb./acre 18-0-25 fertilizer.
[x]Average of 4 replications.

3 rates of 18-0-25 fertilizer with respect to either total yield, average weight per head or head-weight distribution, there was a trend in favor of the medium rate. Therefore, until additional data can be secured, the equivalent of 700 lb./acre of an 18-0-25 fertilizer plus 500 lb./acre of a 5-8-8 fertilizer is suggested for lettuce production on sandy soils in south Florida. If the above rates are used without plastic mulch, supplemental applications of fertilizer may be needed if leaching rains occur.

It should be emphasized that proper fertilizer placement and water control are essential when using full-bed mulch culture, because both are directly related to soluble salt concentration in the soil. This can be especially critical when using the mulch system for lettuce, which is more sensitive to high salt concentration than either tomato or pepper (8).

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