Table 4. Main effects of soil and foliar fertilizer rates on foliar N and K.

Fertilizer treatment	Dover Mar. 1981	Dover Dec. 1982	Dover Feb. 1983	Tufts Dec. 1981	Tufts Mar. 1982	Tufts Dec. 1982	Tufts Feb. 1983
Soil				N (%)			
None	2.5	2.0	1.9	2.5	2.7	2.3	2.1
Low	3.0	3.1	2.8	2.7	3.1	3.0	2.6
High	3.2	3.3	3.1	2.7	3.2	3.1	2.7
Sign.[z]	L*	L**Q**	L**Q**	L**Q**	L*	L**Q**	L**Q**
Foliar							
None	2.8	2.8	2.5	2.6	2.9	2.9	2.4
Low	2.9	2.8	2.5	2.6	3.0	2.8	2.4
High	2.9	3.0	2.8	2.7	3.0	2.8	2.5
Sign.[z]	NS	L**	L**	L*	NS	NS	NS
Soil				K (%)			
None	1.3	2.0	1.5	1.7	1.3	2.4	1.6
Low	1.6	2.0	1.7	1.8	1.6	2.4	1.8
High	1.7	2.1	1.7	1.8	1.8	2.7	1.9
Sign.[z]	L*	NS	L**Q**	NS	L**	L**Q**	L**
Foliar							
None	1.5	2.0	1.5	1.7	1.5	2.5	1.7
Low	1.5	2.0	1.6	1.8	1.6	2.5	1.8
High	1.5	2.1	1.7	1.8	1.7	2.5	1.8
Sign.[z]	NS	NS	L**	L*	L**	NS	NS

[z]NS, *, ** Non-significant and significant at 5 and 1%, respectively, for linear (L) and quadratic (Q) responses.

but treatments receiving no fertilizer were below 1.2% K. However, K deficiency symptoms were not evident on plants in any plots.

Foliar-applied fertilizer damaged leaves each season. Damage was confined mostly to browning of leaf margin after 4 or more foliar applications. Often, browning of the calyx of the exposed fruit was noticed in the low and high foliar fertilizer plots. Foliage damage was greatest in plots receiving the highest rates of foliar or soil fertilizer. Damage was not evident in plots receiving no foliar fertilizer.

In summary, the application of foliar fertilizer on a weekly basis did not increase fruit yields when soil fertilization was adequate (high rate). With marginal rates of soil fertilizer (low rate), fruit yields generally increased with foliar fertilization, but results varied with the year. If no soil fertilizer was applied, foliar fertilization always increased yields, but increases were not necessarily significant.

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BANDING FERTILIZERS FOR IMPROVED FERTILIZER USE EFFICIENCY FOR LETTUCE ON EVERGLADES HISTOSOLS

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Abstract. **Studies were conducted to evaluate the response of crisphead lettuce (*Lactuca sativa* L.) to banding P and mixed fertilizers in combination with various rates of broadcast fertilization. All banded fertilizers were applied 5 cm below the seeds in bands 10 cm wide. Overall, treatments which included banded P fertilizer improved the yield of lettuce over treatments where comparable P rates were applied only broadcast. Banding N and P together appeared to even further improve lettuce yields. The results of experiments conducted in 1986 and 1987 suggest that banding part of the fertilizer will reduce the rate required for optimal yields thereby improving the efficiency of fertilization.**

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Organic soils in the Everglades often contain appreciable amounts of Fe and Al hydrous oxides and calcium carbonate (10). Mixing P with these soils tends to tie up the phosphate in forms unavailable or very slowly available to plants. Theoretically, soluble phosphate is more efficiently utilized by plants when placed in localized bands and not mixed with the soil (1, 4). Because lettuce does not have an extensive root system, it might also benefit from band placement of other nutrients in addition to P.

The benefits of banding fertilizer for various agronomic crops (5, 14) and horticultural crops (6, 9) has long been recognized. However, because of concern that lettuce might be adversely affected by a high salt concentration near the root zone, banding fertilizers is not widely practiced for lettuce production in the Everglades. Because of increasing costs of production relative to crop value and increasing concerns about water pollution, we must begin to rigorously evaluate strategies which improve the efficiency of fertilization. The objective of this study was to evaluate the response of lettuce to banding P and mixed fertilizers at several broadcast rates of fertilization.

Materials and Methods

Experiments to evaluate band placement of fertilizers were conducted on Everglades Histosols in 1979, 1980, 1986, and 1987. The preliminary soil test and planting and harvest dates for individual experiments are shown in Table 1. These experiments are henceforth referred to as experiments 1, 2, 3a, and 3b. In all experiments, lettuce was direct-seeded in double-row beds with 0.9-m centers and thinned to a population of approximately 54,000 plants ha^{-1} when the lettuce was at the four-leaf stage. Plots of 3 by 12 m in size in a randomized complete-block design were used. Experiments 1 and 2 had three replications while experiment 3a and 3b had four replications. Potassium and micronutrients were applied preplant according to soil test recommendations (16). Lettuce was harvested from the center bed in the middle 6-m portion of each of two rows 12 m in length. The total stand, percent harvested, total mass of marketable heads, as well as quality parameters were measured. Data were subjected to analysis of variance and regression analysis by SAS (15) techniques, where appropriate.

Experiment 1. This study was conducted in the fall of 1979 at the Everglades Research and Education Center, Belle Glade. The site was planted to sugar cane in 1976 and 1977, and was fallow in 1978 and the first half of 1979. The soil was a Pahokee muck (Euic hyperthermic Lithic Medisaprist), a Histosol 9-130 cm in depth over limestone. Phosphorus fertilizer was broadcast at 0, 49, 98, 148, 197, and 296 kg P · ha^{-1} with and without an additional 42 kg P · ha^{-1} applied in a band 5 cm below the seed. The P source was concentrated superphosphate.

Experiment 2. This study was conducted in the winter of 1980 on an area adjacent to experiment 1. Fertilizer was broadcast at 0, 49, 98, 197, and 296 kg P · ha^{-1} without banded fertilizer, with an additional 49 kg P · ha^{-1} banded 5 cm below the seed, and with an additional 34 kg N · ha^{-1} and 49 kg P · ha^{-1} banded 5 cm below the seed. The P source was concentrated superphosphate and the N source was urea.

Experiment 3. This study was conducted in the fall of 1986 and in the spring of 1987 at farms of South Bay Growers Inc., near Belle Glade. The site used in the fall experiment had been cropped to vegetables for more than a decade. The site used in the spring experiment had been cropped to sugar cane from 1961 (the time it was taken out of its virgin state) until 1986. The soil in both experiments were Terra Ceia Muck (Euic hyperthermic Typic Medisaprist), a Histosol > 130 cm in depth over limestone. Broadcast fertilizer treatments of N, P, and K were appied based on soil test recommendations (16). These broadcast treatments were 0, 50, and 100% of the N, P, and K fertilizer called for by soil test. The full recommendation of broadcast fertilizer in the fall was 154 kg P · ha^{-1} and 84 kg K · ha^{-1}. The full recommendation of broadcast fertilizer in the spring was 276 kg P · ha^{-1}, and 429 kg K · ha^{-1}. Banded fertilizer treatments were put in plots receiving 50% of the broadcast fertilizer. The banded treatments were no banded fertilizers, banded P (60 kg P · ha^{-1} banded 5 cm below the seed), and 50-60-120 kg ha^{-1}N-P-K banded 5 cm below the seed.

Results and Discussion

The yield response of lettuce to P fertilizer in experiment 1 was highly significant ($P<0.01$). The greatest increase in yield came from the first increment of P fertilizer. The response of 'Montello' to broadcast P and broadcast plus banded P is shown in Fig. 1. Banding part of the P fertilizer 5 cm below the seed resulted in improved yields ($P<0.05$) over applying all of the fertilizer broadcast. Yields of lettuce were maximized by 148 kg P · ha^{-1} broadcast plus 42 kg P · ha^{-1} banded.

In experiment 2, a 10-cm rainfall caused much damage to the crop. Later, there was extensive infection by lettuce mosaic virus. Because it would not be appropriate to present marketable lettuce yields under these conditions, fertilizer treatments were evaluated by considering average lettuce head weights. Lettuce head weights significantly ($P<0.01$) increased with increasing P rates. Banding part of the P fertilizer generally resulted in improved lettuce head weights over applying all of the P fertilizer broadcast, however, the effects were not as striking as in experiment 1. The most significant effect of banding in this experiment was the benefit obtained when N was included with the P fertilizer band. The addition of the N fertilizer resulted in significantly ($P<0.01$) larger lettuce head weights than either the broadcast or broadcast and banded P fertilizer treatments (Table 2).

Table 1. Preliminary soil test results (16), planting and harvesting dates and cultivars used in four fertility experiments.

Experiment	Preliminary soil test P	Preliminary soil test K	Cultivars	Planting date	Harvest date
	----- kg ha^{-1} -----				
1	6	29	Montello	10 Oct 79	21 Dec 79
2	6	29	Montello	10 Jan 80	28 Mar 80
3a	16	222	Raleigh, South Bay	6 Nov 86	19 Jan 87
3b	4	153	Raleigh, South Bay	20 Feb 87	27 Mar 87

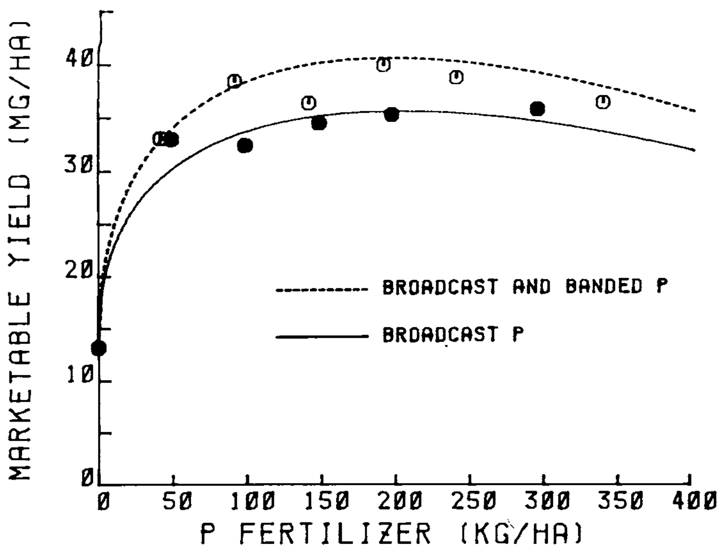

Fig. 1. Yield of lettuce as affected by broadcast P and broadcast and banded P fertilizer.

The benefits of including N with P fertilizer bands has been recognized by numerous investigators (8, 13, 14). Generally, the response is over and above that which can be attributed to a simple N fertilizer response. The effect may be due to increased root growth resulting in a more efficient utilization of P fertilizer (7, 12), it may be due to cation-anion effects at the root surface resulting in increased P uptake (2, 3), or it may be a pH effect resulting in improved P availability (1). Regardless of the mechanism, these results show the benefits of banding P and N together for lettuce grown on Everglade Histosols.

The yield response of lettuce to the various treatment combinations in experiment 3 is shown in Table 3. Generally both 'South Bay' and 'Raleigh responded' similarly. In 1986 the application of only 50% of the soil test fertilizer recommendation resulted in significantly ($P<0.01$) higher lettuce yields than the control but significantly ($P<0.05$) lower yields than the treatment receiving 100% of the soil test fertilizer recommendation. However, when either 60 kg P · ha^{-1} or 50-60-100 kg N-P-K ha^{-1} were banded 5 cm below the seeds in plots receiving only 50% of broadcast soil test fertilizer recommendations, yields were equal to or greater than the treatments receiving 100% of the recommendation. Results in 1987 were similar to 1986 except that plots receiving 50% of the soil test fertilizer recommendation were not significantly different at the 5% level from those receiving 100% of the recommendation. This comparison, however, was significant at the 10% significance level. The loss in sensitivity was probably the result of the large difference in yield between the control and the rest of the treatments. The field plots used in 1987 tested very low in P and the controls (no fertilizer applied) produced essentially no marketable lettuce.

Table 2. Mean lettuce head weights as influenced by broadcast P fertilizer rates and banded N and P fertilizer in experiment 2.

Fertilizer treatment			
Broadcast P (kg · ha^{-1})	Banded P (kg · ha^{-1})	Banded N (kg · ha^{-1})	Lettuce weight (g · head^{-1})
0	0	0	658
0	49	0	658
0	49	34	781
49	0	0	731
49	49	0	790
49	49	34	840
99	0	0	735
99	49	0	785
99	49	34	813
197	0	0	785
197	49	0	767
197	49	34	790
296	0	0	767
296	49	0	817
296	49	34	863
P Rate LSD (P = 0.05)			99
Band LSD (P = 0.05)			72

Table 3. Marketable yields as affected by broadcast and broadcast and banded fertilization in experiment 3.

Fertilizer treatment		Lettuce yield (Mg · ha^{-1})			
		South Bay		Raleigh	
Broadcast (% recommended)[z]	Banded	Fall	Spring	Fall	Spring
0	0	22.2	0	21.4	1.3
50	0	26.6	46.1	24.1	50.5
100	0	32.6	53.3	27.8	54.8
50	P[y]	35.3	52.3	31.6	52.3
50	N, P, K[x]	34.7	50.0	34.7	56.6
LSD (P=0.05)		6.2	16.2	7.3	23.7

[z]Percentages as recommended by soil test. The 100% recommended was fall, 154-84 Kg P-K · ha^{-1}; spring 276-429 Kg P-K ha^{-1}.
[y]Applied to give 60 kg P ha^{-1}.
[x]Applied to give 50-60-100 kg N-P-K ha^{-1}.

The results of experiment 3 indicate that banding part of the fertilizer will reduce the total rate required for optimal yields. This results are not only of economic importance to the growers but also provides us an approach for minimizing adverse environmental effects associated with fertilization.

Additional work is currently under way to identify the right combination of banded and broadcast fertilization as related to soil test fertility levels. Work is also needed to explore the possibility of banding all the P fertilizer. The results of these studies, however, indicate that lettuce is not adversely affected by banded fertilizer applications and the efficiency of fertilization can be improved substantially by banding at least part of the fertilizer.

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EFFECT OF RATES, FORM, AND APPLICATION DATE OF NITROGEN ON GROWTH OF POTATOES

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Absract. **Fertilizer N was applied to potatoes (*Solanum tuberosum,* L.) in a 3 x 3 factorial experiment at Hastings, Florida. Nitrogen was applied at 100, 200, and 300 lb./acre. The portion of the NO_3-N in the fertilizer was 5, 25, and 45% of the total. The portion of N applied at planting was 0, 33, and 67% with the remainder sidedressed 35 days later. Significant positive linear and quadratic yield responses were observed for all main effects. A three way interaction between three main effects was attributed to the large yield depression which occurred when a high rate of N was applied at planting with a low level of NO_3-N.**

Fertilization of potatoes has been investigated under many different environmental conditions (2, 5). The growing conditions of north Florida can produce different responses to N application (1, 3). Volk and Gammon (7) established the importance for maintaining NO_3-N in fertilizer to prevent nutritional leafroll. Researchers in other areas have found N-source was not an important limiting factor for potatoes (4, 6).

The objective of this research was to determine the proper balance between nitrate and ammonical sources of nitrogen, rate of nitrogen application, and the proper time of application for maximum efficiency.

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Materials and Methods

The experiment was conducted on the Yelvington Research Farm, AREC Hastings on an Ellzey fine sandy soil (sandy, siliceous, hyperthermic, Typic Humaquept). The preplant soil test values reported by IFAS Soil Test Laboratory were 200, 38, 50, and 736 ppm for P, K, Mg and Ca respectively. Nitrogen was applied at three rates 100, 200, and 300 lb./acre. The percent of the total N applied at planting was 0, 33, and 67 with the remainder applied at 33 days after planting. The percent of NO_3-N was 5, 25, and 45. Treatments were arranged in a 3x3x3 factorial design with 4 replicates. The N was supplied from ammonium nitrate and urea sources. A basic mix was applied at planting which contained 11, 125, 30, and 25 lb./acre of P, K, Mg and micronutrients supplied from concentrated superphosphate, muriate of potash, magnesium sulfate, and FN 503 micronutrient mix, respectively. The basic mix plus the appropriate N treatment was placed in bands approximately 4 inches to each side of the seed piece. Plots were 4 rows wide (40 inches between rows) and 25 feet long. Recommended pest control practices were followed. Irrigation was supplied by seepage/water furrow method on 60 foot spacing. Sidedressing N treatments were placed by hand and the fertilizer was covered by discs 33 days after planting. Potatoes were harvested and sized mechanically. Potatoes less than 1 1/2 inches in diameter were discarded. Potatoes between 1 1/2 and 1 7/8 inches were classified as Size B, and those over 1 7/8 inches were Size A. The Size A tubers were visually graded for defects, and the culls were weighed separately. The marketable (No. 1) size A tubers were sorted into four additional sizes: 1 ranged from 1 7/8 to 2 1/2 inches, 2 from 2 1/2 to 3 inches, 3 from 3 to 3 3/4 inches, and 4 those over 3 3/4 inches. Data was recorded electronically and analyzed by analysis of variance.

Results and Discussion

The main treatment effects on potato yields for all size factions and total yields are presented in Table 1. Signifi-