Table 5. Main effects of nitrogen form and gel and nitrogen rate on soil test values in potato.

Urea-NH_4NO_3 treatment	Soil test values[z] 9 April 1990 (ppm) NH_4-N	NO_3-N	K	Soluble salts ($dS \cdot m^{-1}$)	21 May 1990 (ppm) NH_4-N	NO_3-N	K	Soluble salts ($dS \cdot m^{-1}$)
Liquid	7.1 c[y]	24.1	249 b	1.5	22.0	50.0	256	2.7
Liquid + Gel								
Nonionic polymer(1.1%)	9.2 abc	25.6	312 ab	1.2	48.3	54.0	398	2.6
Anionic polymer(0.8%)	11.4 ab	18.5	362 a	1.2	19.2	50.4	263	3.1
Cationic polymer(1.1%)	7.8 bc	41.9	241 b	1.5	27.7	63.2	291	2.9
Dry	13.5 a	34.1	277 b	1.4	32.0	52.5	334	2.7
N (lb/acre)								
125	9.2	19.2	284	1.3	32.7	30.5	327	2.7
225	10.7	39.8	291	1.4	27.0	77.4	291	2.9
Significance[x]	NS	**	NS	NS	NS	**	NS	NS

[z]Soil test values from water extracts calculated at 14% soil water.
[y]Mean separation of N-gel treatment by Duncan's Multiple Range Test, 5% level.
[x]N rate effects were not significant (NS) or significant at the 1% level (**) by F test.

4. Biddington, N. L., T. H. Thomas, and A. J. Whitlock. 1975. Celery yield increased by sowing germinated seeds. HortScience 10(6):620-621.
5. Yeager, T. H. and J. E. Barrett. 1986. Influence of an anion exchange resin on phosphorus and sulfur leaching from a soilless container medium. HortScience 21(1):152.

Proc. Fla. State Hort. Soc. 103:110-113. 1990.

EVALUATION OF SIDEDRESS FERTILIZATION FOR CORRECTING NUTRITIONAL DEFICITS IN CRISPHEAD LETTUCE PRODUCED ON HISTOSOLS

C. A. Sanchez, V. L. Guzman, and R. T. Nagata
University of Florida, IFAS
Everglades Research and Education Centr
P. O. Box 8003, Belle Glade, FL 33430

Additional index words: Nitrogen, phosphorus, potassium, *Lactuca sativa* L.

Abstract. **Studies were conducted on 4 site-seasons during 1986 to 1988 to evaluate sidedress fertilization as a means of correcting fertilizer deficits in crisphead lettuce (*Lactuca sativa* L.). Treatments were 0, 25, 50, and 100% of the N, P, and K fertilizer recommended on the basis of preplant soil tests with no sidedress fertilizer application, or sidedress fertilizer application 1, 2, 3 and 4 weeks after the thinning of lettuce seedlings. Soil test P and K prior to sidedress fertilization reflected the preplant fertilizer treatments. Lettuce yields significantly ($P<0.01$) increased with the percentage of recommended N-P-K fertilizer applied preplant in all experiments. The highest marketable yields were generally obtained with 100% of the soil test fertilizer recommendation rate applied preplant. Sidedress N-P-K fertilization did not significantly increase lettuce yields in any experiment, even under conditions where P and K fertilizer deficits existed. Leaf analysis indicate that P was the most limiting nutrient. Sidedress fertilization did not increase the P concentration in lettuce leaf tissue in any experiment.**

Florida Agricultural Experiment Station Journal Series No. N-00380.

The production of high quality crisphead lettuce is dependent to a great extent upon soil fertility. Preplant soil-test provides the basis for P and K fertilization rates of lettuce produced on Histosols in Florida (5,6). Phosphorus fertilizer recommendation are based on a water-soluble P test and K recommendations are based on an acetic acid extractable K test (7). Soil testing or tissue testing for N does not correlate to crop response on these organic soils. Hence, N fertilizer recommendations for lettuce are based on apparent crop requirement and the probability of response, which is related to weather conditions.

Crisphead lettuce produced in south Florida is planted almost daily between 15 Sept. and 15 Mar. to provide a continuous supply for winter markets. In an attempt to adhere to this planting schedule, fertilizer needs are often guessed, and subsequently nutrient deficiencies are identified by soil test, plant analysis, and poor crop performance. The objective of these studies were to evaluate sidedress fertilization as a means for correcting nutritional deficits in crisphead lettuce.

Materials and Methods

Studies were conducted over 4 site-seasons during 1986 to 1988 to evaluate sidedress fertilization as a means of correcting fertilizer deficits in crisphead lettuce (Table 1). Studies were conducted on a Terra Ceia Muck (eucic hyperthermic Typic Medisaprist). The site used in experiment 1 had been cropped alternately to lettuce and celery since 1970. The sites used in experiments 2, 3, and 4 had

Table 1. Planting dates, harvest dates, weather data, and preliminary soil-test data for four lettuce experiments conducted from 1986 to 1988.

			Weather data				Soil test data		
Experiment	Planting date	Harvest date	Mean temperature (F)	Mean solar radiation (ly)	Rainfall (inches)	Pan evaporation (inches)	pH[z]	(lb/Acre) P[y]	K[x]
1	6 Nov. 86	19 Jan. 87	61	224	6.4	5.8	6.9	25	170
2	20 Feb. 87	27 Apr. 87	61	358	6.7	12.6	6.7	3	137
3	23 Oct. 87	5 Jan. 88	62	246	9.0	9.3	6.8	6	51
4	30 Nov. 87	15 Feb. 88	61	263	4.6	9.0	7.0	5	79

[z]1:2 soil:water (v:v) with glass electrode while stirring.
[y]1:12.5 soil:water (v:v) extraction.
[x]1:2.5 soil:solution (v:v) extraction with 0.5 *N* acetic acid.

been cropped to sugarcane since 1964. The experimental design of all experiments was a split-plot. Main-plot treatments were 0, 50, and 100% of the N, P, and K recommended on the basis of preplant soil-test in experiment 1, 25%, 50% and 100% of the N, P, and K recommended in experiment 2, and 0, 25, 50, and 100% of the N, P, and K recommended on the basis of soil test in experiments 3 and 4. The amount of fertilizer applied for the 100% recommendation in experiment 1 was 75-198-187 lb N-P-K/acre. The amounts applied for the 100% recommendation in all remaining experiments was 160-282-398 lb N-P-K/acre. All main-plot fertilizer treatments were applied as a suspension derived from ammonium polyphosphate, phosphoric acid, and potassium sulfate. The suspension was sprayed uniformly on the soil surface and disked into the soil about a week prior to seeding.

Sub-plot treatments were time of sidedress fertilizer application. The treatments consisted of no sidedress N-P-K application, and sidedress fertilizer application 1, 2, 3 and 4 weeks after the thinning of seedlings (at the four-leaf stage). All sidedress fertilizer was applied at 360 lb/acre of a 11-15-3 to provide 40-54-11 lb/acre N-P-K. This ratio of N-P-K was selected based on past experience which indicated that high rates of K applied sidedress may cause damage to lettuce. In experiments 1 and 2 sidedress fertilizers were applied with a conventional knife applicator. Because of a concern that this type of application may have caused damage to the lettuce root system a point injection system was used in experiments 3 and 4. Sub-plots were 3 ft by 50 ft and were randomized within the main-plots.

'South Bay' crisphead lettuce was seeded in elevated double-row beds on 3 ft centers and thinned at the four-leaf stage to a 12 inch in row spacing to give an approximate population of 29,040 plants/acre. Water was supplied using subsurface irrigation from field ditches by maintaining a water table approximately 3 ft below the soil surface (9).

Lettuce heads were harvested from 20-ft of each 2 rows per bed and marketable yields were determined after grading according to standard marketing criteria (10). The oldest sound leaf from each of 15 plants was collected in each plot for mineral analysis in experiments 1, 2, and 3. Plant material was dried at 60C for 48 hours. After wet ashing (11), N and P was determined colorimetrically, and K, Ca, Mg, Zn, Fe, Mn, and Cu by atomic absorption spectrophotometer. Soil samples were taken before planting and again before sidedress fertilizer application. The samples collected prior to sidedress fertilization were taken at random from within the lettuce bed to a depth of 6 inches. These samples were analyzed for water-soluble P and acetic acid extractable K by methods previously described (7). Data were subjected to analysis of variance using SAS-GLM (8).

Results and Discussion

Soil test P and K values prior to sidedress fertilization clearly reflect the preplant fertilizer treatments (Fig. 1). Generally, only the application of 100% of the recommended N-P-K raised both the soil test P and K levels above the critical index values for lettuce of 30 lb/acre for P and 200 lb/acre for K (7). Histosols used for crop production in south Florida are naturally low in both P and K, and residual P and K fertility is largely a reflection of cropping history (7). For example, soils testing less than 10 lb P/acre and 100 lbs K/acre would largely represent the residual fertility of land previously cropped to sugarcane which receives little P and only modest amounts of K. Soils testing 10 to 15 lb P/acre and 100 to 150 lb K/acre would generally reflect the residual fertility of land previously cropped to sweet corn and radish which receive only modest amounts of P and K. And finally, soil test values more than 15 lb P/acre and 150 lb K/acre would represent the residual fertility of land cropped to lettuce and celery which receive appreciable amounts of both P and K fertilizer. Hence, although the fertility of both P and K varied simultaneously in these experiments this situation reflects the nature of residual fertility encountered by lettuce producers in south Florida.

Marketable lettuce yields ranged from 23,000 to 55,000 lb/acre in experiments 1 through 4 (Fig. 2). The lower yields in experiment 1 occurred because of unseasonably warm temperatures early in the growing season followed by cool temperatures later in the season. This caused marked seed stalk formation (bolting) and reduced the number of heads achieving marketable grade.

Yields significantly ($P<0.01$) increased with percentage of fertilizer applied preplant in relation to the amount recommended by soil test (Fig. 2). As expected, the highest marketable yields were generally obtained with 100% the preplant soil test fertilizer recommendation. Sidedress fertilization did not significantly increase yield in any experiment, even under conditions where P and K deficits existed.

Results of leaf analysis with no sidedress N-P-K applied, indicate that P was the most limiting nutrient. As shown by the data collected in experiment 4, sidedress fertilization had little effect, on tissue nutrient P concentrations (Table

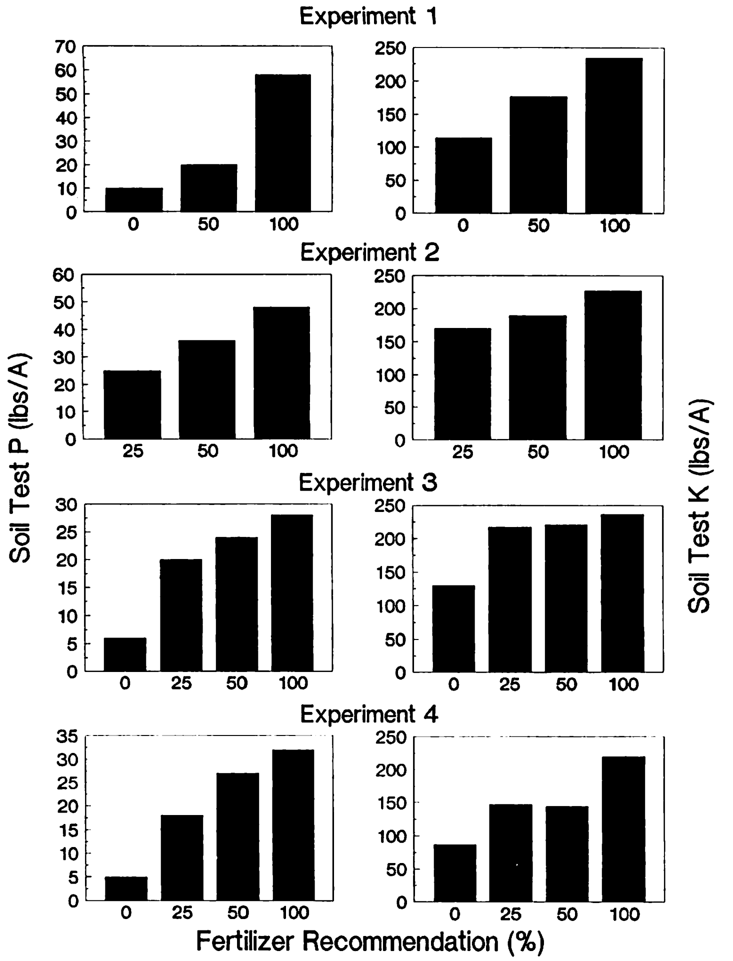

Fig. 1. Soil test P and K levels as affected by percentage fertilizer applied preplant broadcast on the basis of fertilizer recommendations.

Table 2. Nutrient concentration in lettuce leaves as affected by preplant broadcast and sidedress fertilization in Experiment 4.

Recommended fertilizer	Time of sidedress (DAT)	Leaf concentration (%) N	P	K
(%)	DAT[z]			
25	0	3.73	0.25	10.3
25	7	3.57	0.24	10.5
25	14	3.58	0.23	10.2
25	21	3.77	0.23	10.5
25	28	3.84	0.25	9.7
50	0	3.50	0.29	9.5
50	7	3.46	0.30	10.1
50	14	3.34	0.29	10.5
50	21	3.73	0.34	10.0
50	28	3.55	0.30	10.2
100	0	3.60	0.36	10.8
100	7	3.62	0.34	10.7
100	14	3.50	0.30	10.2
100	21	3.70	0.33	10.9
100	28	3.71	0.34	11.3
Stat.				
Broadcast		NS[y]	L**Q**	NS
Sidedress		NS	NS	NS
Broadcast x sidedress		NS	NS	NS

[y]Significant linear (L) and quadratic (Q) response at the 1% (**) level, NS indicates no significance.
[z]Days after thinning.

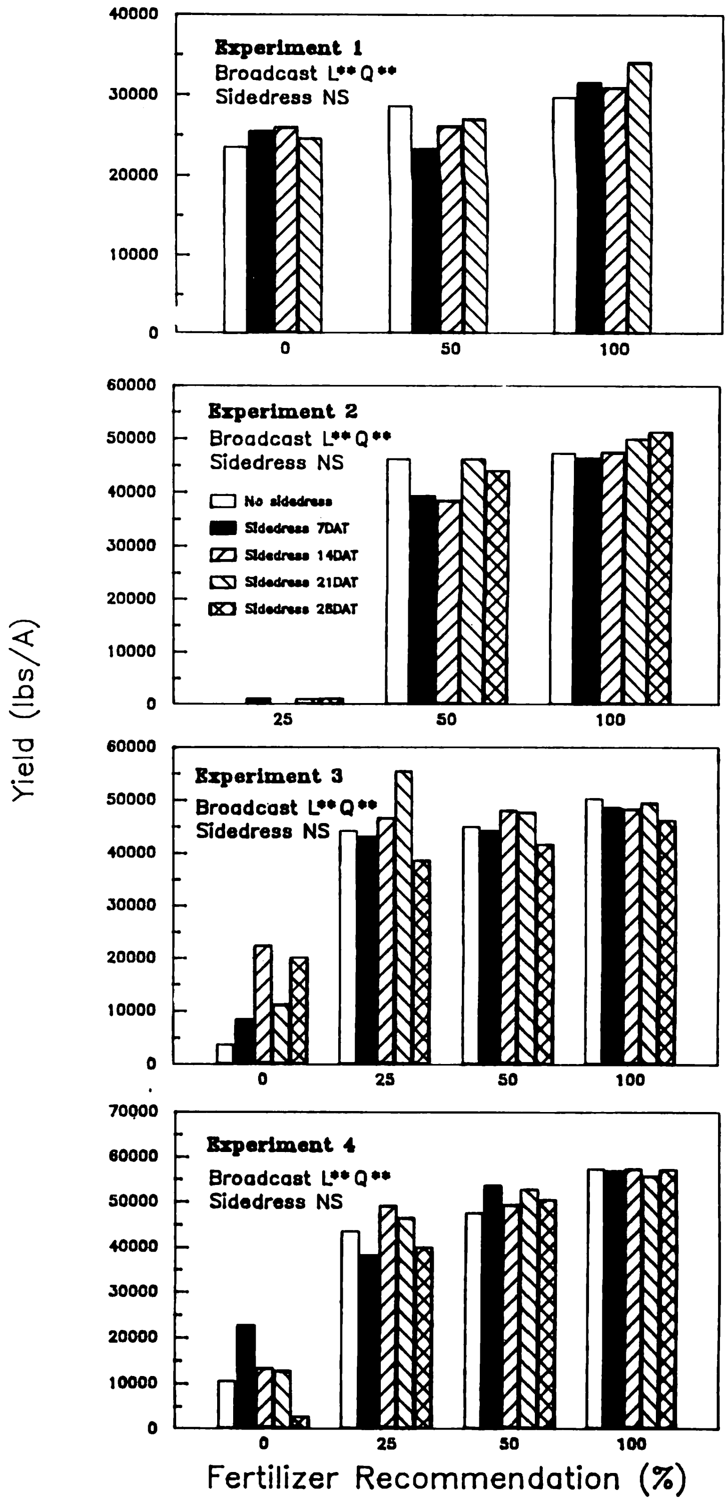

Fig. 2. Marketable yields of lettuce as affected by preplant broadcast and sidedress fertilization.

2). Results from experiments 1 and 2 were similar (data not shown), in nearly every case where fertilizer deficits existed the leaf tissue P concentration was below the critical level of 0.43% (6). Although past soil-test calibration research indicates that K deficits existed, the concentrations of K were almost always above the critical concentration of 5.5% (6). Although responses to N were variable, and seem to depend on weather conditions, work has also shown that lettuce will sometimes respond to N rates greater than

100 lb/acre (6). Various studies conducted throughout the United States and Europe have shown that lettuce always shows a larger response to P than to N and K when all 3 nutrients were limiting (1,2,3,4). Perhaps, in accordance with Liebig's "Law of minimum" response to N and K would only have been expressed if the P requirement of lettuce was satisfied.

Results clearly indicate that sidedress fertilization is not a viable strategy for meeting the P nutritional requirements of lettuce. However, because the limitation of P was severe relative to N and K the possibility of using sidedress fertilization to correct N and K deficits cannot be ruled out. Past research has shown that sidedress N is effective for lettuce (7). Also, since sidedress K has been effective for celery, it is commonly practiced for lettuce following large amounts of rainfall. Additional work is needed to evaluate the effectiveness of sidedress fertilization for meeting the N and K requirements of lettuce.

Acknowledgement

Special thanks is extended to South Bay Growers, Inc. for providing the sites used in these studies and part of the crop care. Thanks is also extended to Douglas Fertilizer for mixing the fertilizer suspensions used in these studies.

Literature Cited

1. Alt, D. 1987. Influence of P and K fertilization on the yield of different vegetable species. J. Plant Nutrition 10:1429-1435.
2. Greenwood, D. J., T. J. Cleaver, M. K. Turner, J. Hunt, K. B. Niedorf, and S. M. Loquens. 1980. Comparison of the effects of potassium fertilizer on the yield, potassium content, and quality of 22 different vegetable and agricultural crops. J. Agric. Sci. Camb. 95:441-446.
3. Greenwood, D. J., T. J. Cleaver, M. J. Turner, J. Hunt, K. B. Niedorf, and S. M. Loquens. 1980. Comparison of the effects of phosphate fertilizer on the yield, phosphate content, and quality of 22 different vegetable and agricultural crops. J. Agric. Sci. Camb. 95:457-469.
4. Greenwood, D. J., T. J. Cleaver, M. K. Turner, J. Hunt, K. B. Niedorf, and S. M. Loquens. 1980. Comparison of the effects of nitrogen fertilizer on the yield, nitrogen content, and quality, of 22 vegetable and agricultural crops. J. Agric. Sci. Camb. 95:457-469.
5. Sanchez, C. A., and H. W. Burdine. 1988. Response of crisphead lettuce to soil test P and K. Soil Crop Sci. Soc. Fla. Proc. 47:52-56.
6. Sanchez, C. A., H. W. Burdine, V. L. Guzman, and C. B. Hall. 1988. Yield quality and lead nutrient composition of crisphead lettuce as affected by N, P, and K on Histosols. Proc. Fla. State Hort. Soc. 101:346-350.
7. Sanchez, C. A. 1990. Soil testing and fertilizer recommendations for crop production on organic soils in Florida. Univ. Fla. Exp. Stn. Bull. 876.
8. SAS Institute, Inc. 1982. SAS User's guide: Statistics. 1982 ed SAS Institute, Cary, NC. 21.
9. Snyder, G. H., H. W. Burdine, J. R. Crockett, G. J. Gascho, D. S. Harrison, G. Kidder, J. W. Milshoe, D. L. Myhre, F. M. Pate, and S. F. Shih. 1978. Water table management for organic soil conservation and crop production in the Florida Everglades. Univ. Fla. Bull. 801.
10. USDA. 1973. USDA standards for grades of lettuce. Agriculture marketing service. Washington, D.C.
11. Wolf, B. 1982. A comprehensive system of leaf analyses and its use for diagnosing crop nutrient status. Commun. Soil Sci. Plant Anal. 13:1035-1059.

Proc. Fla. State Hort. Soc. 103:113-117. 1990.

FOLIAR AND SOIL-APPLIED BIOSTIMULANT STUDIES WITH MICROIRRIGATED PEPPER AND TOMATO

A. A. Csizinszky, C. D. Stanley,
and G. A. Clark
Gulf Coast Research and Education Center
University of Florida, IFAS
Bradenton, FL 34203

Additional index words. Capsicum annuum, Lycopersicon esculentum, trickle irrigation, cytokinin, foliar sprays, full-bed mulch.

Abstract. **Bell pepper, (*Capsicum annuum* L. cv. Bell Captain), and tomato (*Lycopersicon esculentum* Mill., cv. Summer Flavor 5000) were treated with foliar, soil, and the combination of soil and foliar applied product containing cytokinin as kinetin (Triggrr) and macro and micronutrients. Bell peppers and tomatoes were grown in the summer-fall (Aug.-Dec.) in microirrigated full-bed polyethylene mulch culture. The combination of 2 soil-applied kinetin treatments and 9 applications of foliar applied kinetin, amended with macronutrients (designated as 'Crop Product Guide'), increased the total marketable fruit yield of bell pepper compared to the water-treated control. The biostimulant treatments did not increase early yields or fruit size of bell peppers compared with water control. In tomatoes, the 'Crop Product Guide' treatment increased the early yield of medium size (6x6) fruit. Early and seasonal total yields of large and marketable grade fruits of tomatoes were similar or lower with biostimulants than with the water control treatment. Tomato yields were adversely affected by the infection of the whitefly, *Bemesia tabaci* (Glenn), transmitted geminivirus. Biostimulant treatments had little or no effect on plant height and on macro and micronutrient concentrations in bell pepper leaves and fruits.**

Several commercially available biostimulant products have been evaluated in Florida for their effect on tomatoes (2,3,6,7), bell peppers (4,8,9,12), and on strawberries (1). Biostimulants that were evaluated contained phytohormones, humates, or amino acids. Many also contained essential macro and micronutrients in various quantities and proportions. Other products contained only macro and micronutrients from inorganic sources. The main interest in the studies was whether biostimulants had a beneficial effect on early and total yields and on fruit size of vegtables.

In south Florida, Bryan (2) reported increased growth and yield of tomatoes from α-keto acid and humate treatments. In west central Florida, seaweed based foliar sprays

Florida Agricultural Experimental Station Journal Series No. N-00315.