RESEARCH REPORT
SUWANNEE VALLEY REC 95-8

EFFECTS OF K RATE AND PROPORTION OF K SUPPLIED FROM CONTROLLED-RELEASE K ON PEPPER

George Hochmuth[1]
Robert Hochmuth

ABSTRACT

Pepper response to K fertilization and to proportion of K from controlled-release K (coated KNO_3) was evaluated at Live Oak, FL in the spring of 1994. Pepper yield was maximized with 100 lb K_2O per acre when 130 lb were recommended. Pepper yields were 33% of maximum with zero K. Potassium fertilization increased yields of fancy fruits and decreased the production of US No. 2 fruits, the fruits of lesser value. Proportion of K from controlled-release K had negligible effects on early pepper production. With 150 lb K, yields of early and total fancy fruits were increased with 50% K from controlled-release K compared to 0% from controlled-release K. Yields with 25 and 50% of K from controlled-release K were similar. Proportion of K from controlled-release K had little effect on total marketable fruit yield. K fertilization and controlled-release K resulted in increases in pepper leaf K concentrations.

INTRODUCTION

Bell pepper was produced on 21,600 acres in the 1993-94 season (Freie and Pugh, 1995) with average yields of 1000 28-lb cartons per acre. Northern Florida growers grew 500 acres with an average yield of 600 cartons per acre. Pepper is produced in most areas in the state with polyethylene mulch on raised beds (Hochmuth, 1988) and fertilizer is a significant cost input (Smith and Taylor, 1995). Fertilizer accounts for about 5% of the preharvest costs.

Current fertilization recommendations for pepper are based on field research conducted over the previous 40 years (Hochmuth and Hanlon, 1989). Fertilizer K recommendations are based on a Mehlich-1 soil test (Hochmuth and Hanlon, 1995a) and are maximized with 160 lb K_2O per acre (Hochmuth and Hanlon, 1995 b).

Considerable research has been conducted with nitrogen fertilization of pepper (Hochmuth and Hanlon, 1989) but lesser amounts of work with K fertilization. Most research with N fertilization supports a recommendation of 175 lb N per acre (Hochmuth et al., 1992; Locascio and Fiskell, 1977; 1979; Stanley and Clark, 1993). Controlled-release N provided favorable yield increases for pepper in some studies (Locascio and Fiskell, 1977; 1979; Locascio et al., 1981), but

---

[1]George Hochmuth, Professor Horticultural Sciences, University of Florida, Gainesville, FL 32611-0690 and Robert Hochmuth, Multi County Extension Agent, Suwannee Valley Research and Education Center, University of Florida, Live Oak, FL 32060-3696.

not in all cases (Locascio and Alligood, 1992). Pepper N results in Florida are supported by work elsewhere (Batal and Smittle, 1981; Hartz et al., 1993; Miller et al., 1979; Olsen et al., 1993; Russo, 1991). Controlled-release N sources have been studied in Texas with negligible benefit (Wiedenfeld, 1986).

Potassium fertilization has only been recently studied in Florida. Field testing of K fertilization recommendations failed to support the very high rates of K fertilization practiced by commercial pepper growers in Florida (Hochmuth et al., 1988).

Our studies were conducted to field test current recommendations for K and to investigate the effects of supplying a portion of the K from controlled-release K.

MATERIALS AND METHODS

Potassium fertilization studies were conducted during the spring of 1994 on a Lakeland fine sandy soil at the Suwannee Valley Research and Education Center near Live Oak, FL. Soil was disked and unfertilized soil was sampled to 6-inch depth, extracted with Mehlich-1 solution, and analyzed for P, K, Ca, Mg, Cu, Mn, and Zn.

Potassium fertilization treatments (Table 1) included rates of K (0, 100, and 150 lb K_2O/acre) and proportion of K (0,25, and 50%) supplied from controlled-release (coated) potassium nitrate (Vicksburg Chem. Co., Vicksburg, Mississippi). Fertilizer mixtures were formulated from ammonium nitrate, magnesium sulfate, a micronutrient mix, soluble potassium nitrate, polymer coated potassium nitrate, and polymer coated urea.

Nitrogen was supplied at 175 lb N/acre and formulated from a mixture of soluble and coated N so all K treatments had equal proportions of the N supplied from coated, slow-release N. Coated urea was used to equilibrate the controlled-release N for all treatments since controlled-release potassium nitrate supplied both controlled-release N and K. The soil tested high in P, therefore no P fertilizer was applied. Magnesium was supplied at 20 lb Mg/acre.

Fertilizer was blended, applied in a 30-inch swath in the future bed area, and rototilled to incorporate fertilizer into soil uniformly. Plots consisted of a single bed 25 ft in length with 5 ft between bed centers. Fertilizer rates were calculated on the basis of 6-ft centers to conform to standardized fertilization practices (Hanlon and Hochmuth, 1989. The 7 fertilization treatments were arranged in four randomized complete-blocks.

On 16 Mar., fertilized soil was bedded, fumigated with a mixture of methyl bromide and chloropicrin (98:2) (400 lb/acre broadcast rate), pressed, and covered with black polyethylene mulch (Sonoco Film Products, Hartsville, South Carolina). Drip irrigation tubing (Roberts Ro Drip) was placed in the center of the bed in a 1 inch groove 1 inch in the soil. Beds were 24 inches wide and 6 inches tall. The tubing had 8-mil. thick walls with emitters on 12-inch spacing with a flow rate of 0.4 gal. per minute per 100 ft at 8 PSI pressure.

On 25 Mar, 'Camelot' pepper transplants were placed in two rows on each bed at a 12-inch plant spacing. Drip irrigation was operated as needed to maintain a tensiometer gauge at -8 to -12 centibars at the 12-inch depth between two plants in a row, three inches from the drip tubing. Diseases and insect pests were controlled by timely applications of labeled pesticides based on pest scouting of the crop.

On two occasions (29 Apr, plants with first flowers open and 7 June, at second harvest), whole leaves were collected for N and K analyses. Leaves were dried, ground, and wet-ashed in sulfuric acid and hydrogen peroxide. Leaf-N was determined by rapid-flow colorimetry and leaf-K was determined by plasma emission spectroscopy (Hanlon et al., 1994). Pepper fruits were harvested three times on 1, 7, and 16 June. Fruits were graded into fancy, No. 1, No. 2, and cull categories according to U.S.D.A. standards, counted, and weighed. All data were analyzed by analysis of variance and regression techniques.

RESULTS

Soil used for this study contained (ppm) (Mehlich-1 extractant): 100 P (VH), 20 K (L), 32 Mg (H), and 492 Ca (adequate). Micronutrient concentrations were (ppm) 1.8 Zn, 0.60 Cu, and 9.0 Mn. Recommendations were for 130 lb K_2O per acre.

Yields of early fancy fruits and average fruit size were affected by K fertilization treatment (Table 2). Other early yield characters were not affected by K fertilization treatment. Yields of fancy fruits were negligible with no K but were best with 100 or 150 lb K_2O per acre and 25 or 50% K from controlled-release K (CRK) in most cases. Effects of CRK were especially pronounced at the highest K rate. Most K treatments resulted in maximum fruit size compared to the zero-K treatment.

Main effects for K rate, 100 or 150 lb K_2O per acre for all early fruit chacters were not significant (Table 3). Proportion of K from CRK increased the numbers of fancy fruits but had little effect on other fruit grade measurements or fruit size.

K fertilization treatment had significant effect on total-season yields of pepper fruit (Table 2). Most variables measured were maximized with any K treatment compared to the control treatment (zero K). Yields of fancy fruit were apparently favorably enhanced when some K was supplied from CRK, especially at the 150 lb K rate. This might indicate that the use of CRK was reducing possible negative effects of the higher soluble salt effects with high rates of fertilization. Total marketable fruit yield was not affected by K treatment.

Main effects of K rate were significant for yields of fancy and US No. 2 fruits, and for average fruit weight (Table 3). Yield of fancy fruit was better with 150 lb K_2O compared to 100 lb while yield of US No. 2 fruit (lesser value fruits) was reduced with higher K. Average fruit weight was better with 150 compared to 100 lb K_2O per acre.

The main effects of increasing proportion of K from CRK were significant for cull yield and fruit size at the 1% probability level and at the 8% level for yields of fancy fruits (Table 3). Yields of total marketable fruits were slightly increased ($P = 0.06$) with 25% K from CRK. Large proportions of K from CRK also increased cull fruit yields, a surprising result given the slight yield and quality benefits of a small amount of K from CRK. Since cull fruits were mostly due to small fruit size, an explanation might be that CRK resulted in a slight increase in fruit set on the plants.

Leaf K concentrations were adequate with all K treatments compared to the zero-K treatment (Table 4). Leaf K concentration was always deficient for plants with zero K (Hochmuth et al., 1991). Leaf K concentration was enhanced with 150 compared to 100 lb K_2O per acre and with increasing CRK.

Results in this study showed that current K recommendations are adequate for pepper in north Florida. For situations (low soil K) that require large amounts of K fertilization, it might be beneficial to supply a portion of the K from a CRK source.

LITERATURE CITED

Batal, K. M., and D. A. Smittle. 1981. Response of bell pepper to irrigation, nitrogen, and plant population. J. Amer. Soc. Hort. Sci. 106:259-262.

Freie, R. L., and N. L. Pugh. 1995. Florida Agricultural Statistics - Vegetable Summary. Fla. Dept. Agr. Consumer Serv. Orlando, FL.

Hanlon, E. A., J. G. Gonzales, and J. M. Bartos. 1994. IFAS extension soil testing laboratory chemical procedures and training manual. Fla. Coop. Ext. Serv. Circ. 812.

Hanlon, E. A., and G. J. Hochmuth. 1989. Calculating fertilizer rates for vegetable crops grown in raised-bed cultural systems in Florida. Fla. Coop. Ext. Serv. Special Series SS-SOS-901.

Hartz, T. K., M. LeStrange, and D. M. May. 1993. Nitrogen requirements of drip-irrigated peppers. HortScience 28:1097-1099.

Hochmuth, G. (ed.). 1988. Pepper production guide for Florida. Fla. Coop. Ext. Serv. Circ. 102E.

Hochmuth, G. J., and E. A. Hanlon. 1989. Fertilizer management for bell pepper production in Florida. Fla. Agr. Exp. Sta. Circ. S-357.

Hochmuth, G. J., and E. A. Hanlon. 1995a. IFAS standardized fertilization recommendations for vegetable crops. Fla. Coop. Ext. Serv. Circ. 1152.

Hochmuth, G. J., and E. A. Hanlon. 1995b. Commercial vegetable crop nutrient requirements in Florida. Fla. Coop. Ext. Serv. Circ. SP 177.

Hochmuth, G., E. Hanlon, and R. Hochmuth. 1992. Response of pepper to N fertilization in a polyethylene mulch and drip irrigation production system at Live Oak, FL, Spring 1988. Suwannee Valley AREC Research report 92-29.

Hochmuth, G., D. Maynard, C. Vavrina, and E. Hanlon. 1991. Plant tissue analysis and interpretation for vegetable crops in Florida. Fla. Coop. Ext. Serv. Special Series SS-VEC-42.

Hochmuth, G. J., K. D. Shuler, P. R. Gilreath, and R. L. Mitchell. 1988. Field-testing of revised Mehlich-1 predicted potassium fertilizer recommendations for mulched pepper. Soil Crop Sci. Soc. Fla. Proc. 47:30-35.

Locascio, S. J., and M. R. Alligood. 1992. Nitrogen and potassium source and N rate for drip-irrigated pepper. Proc. Fla. State Hort. Soc. 105:323-325.

Locascio, S. J., and J. G. A. Fiskell. 1977. Pepper production as influenced by mulch, fertilizer placement, and nitrogen rate. Soil Crop Sci. Soc. Fla. Proc. 37:113-117.

Locascio, S. J., and J. G. A. Fiskell. 1979. Pepper response to sulfur-coated urea, mulch, and nitrogen rate. Proc. Fla. State Hort. Soc. 92:112-115.

Locascio, S. J., J. G. A. Fiskell, and F. G. Martin. 1981. Responses of bell pepper to nitrogen sources. J. Amer. Soc. Hort. Sci. 106:628-632.

Miller, C. H., R. E. McCollum, and S. Claimon. 1979. Relationships between growth of bell peppers (*Capsicum annuum L.*) and nutrient accumulation during ontogeny in field environments. J. Amer. Soc. Hort. Sci. 104:852-857.

Olson, J. K., D. J. Lyons, and M. M. Kelly. 1993. Nitrogen uptake and utilization by bell pepper in subtropical Australia. J. Plant Nutr. 16:2055-2071.

Russo, V. M. 1991. Effects of fertilizer rate, application timing and plant spacing on yield and nutrient content of bell pepper. J. Plant Nutr. 14:1047-1056.

Smith, S. A., and T. G. Taylor. 1995. Production cost for selected vegetables in Florida, 1994-95. Fla. Coop. Ext. Serv. Econ. Information Report EI 95-1.

Stanley, C. D., and G. A. Clark. 1993. Water use and nitrogen balance for subirrigated fresh-market bell pepper production. Proc. Fla. State Hort. Soc. 106:202-204.

Widenfeld. R. P. 1986. Rate, timing, and slow-release nitrogen fertilizers on bell peppers and muskmelons. HortScience 21:233-235.

Table 1. Treatments used in potassium fertilization research with pepper at Live Oak, FL, 1994.

	K_2O rate	Soluble (%)[z]		Controlled release (%)[z]	
Treatment	(lb/acre)	N	K	N	K
1	0	100	100	0	0
2	100	50	100	50	0
3	100	50	75	50	25
4	100	50	50	50	50
5	150	50	100	50	0
6	150	50	75	50	25
7	150	50	50	50	50

[z]Soluble potassium nitrate and controlled-release potassium nitrate (Multicoat, Vicksburg Chem. Co., Vicksburg, MS).

Table 2. Effects of K fertilization programs on yield and fruit quality of pepper, Live Oak, FL, Spring, 1994.

K fertilization		Yield (per acre)										
		Fancy		U.S. No. 1		U.S. No. 2		Total mkt.		Cull		Avg. fruit
lb K_2O/acre	% K from CRK[z]	No.	Ctn.[y]	No.	Ctn.	No.	Ctn.	No.	Ctn.	No.	Ctn.	wt. (lb)
		Early yield (first harvest)										
0	0	780c[x]	10c	4620	45	780	6	6190	61	260	2	0.24c
100	0	3140ab	48ab	7405	81	170	2	10720	132	1570	10	0.31ab
100	25	3050ab	47ab	6710	75	610	5	10370	127	1040	17	0.30ab
100	50	2960ab	47ab	8100	94	610	5	11670	147	1040	12	0.32ab
150	0	1570bc	24bc	6530	72	260	2	8360	98	700	7	0.29bc
150	25	4360a	70a	5400	63	260	2	10020	136	700	7	0.35a
150	50	4620a	73a	5840	72	85	1	10540	146	1570	21	0.35a
Signif.[w]		**	**	NS	NS	NS	NS	NS	NS	NS	NS	**
		Total season (3 harvests)										
0	0	1310c	18c	12200b	115b	7230b	50c	20740b	182b	5580bc	36cd	0.20d
100	0	8890b	133b	29710a	309a	7840b	55bc	46440a	498a	4790c	48cd	0.26c
100	25	10800ab	167ab	29880a	333a	11760a	90a	52450a	590a	8540abc	76bc	0.27bc
100	50	8280b	127b	29450a	334a	10110ab	85ab	47830a	546a	9845ab	94ab	0.29abc

K fertilization		Yield (per acre)										
		Fancy		U.S. No. 1		U.S. No. 2		Total mkt.		Cull		Avg. fruit
lb K_2O/acre	% K from CRK[z]	No.	Ctn.[y]	No.	Ctn.	No.	Ctn.	No.	Ctn.	No.	Ctn.	wt. (lb)
150	0	7930b	118b	27180a	301a	7840b	59abc	42950a	479a	3830c	30d	0.26c
150	25	13070ab	212ab	27880a	314a	7230b	55bc	48180a	581a	6190bc	61bcd	0.30a
150	50	15070a	235a	26660a	315a	6710b	51c	48440a	601a	11935a	123a	0.31a
Signif.[w]		**	**	**	**	*	*	**	**	*	**	**

[z]CRK = controlled-release potassium fertilizer (Multicoat KNO_3).
[y]Carton (ctn) = 25 lb.
[x]Mean separation by Duncans multiple range test (P = 0.05).
[w]Significant at 5% (*) or 1% (**) probability level or not significant (NS).

Table 3. Main effects of K rate and proportion of K from controlled-release K on pepper fruit yield and quality, Live Oak, FL, Spring, 1994.

K fertilization		Yield (per acre)										
		Fancy		U.S. No. 1		U.S. No. 2		Total mkt.		Cull		Avg. wt.
lb K_2O/acre	% K from CRK[z]	No.	Ctn[y]	No.	Ctn	No.	Ctn.	No.	Ctn.	No.	Ctn.	
Early yield (first harvest)												
100		3050	48	7405	83	465	4	10920	135	1220	13	0.
150		3515	56	5925	69	205	2	9640	127	990	11	0.
Signif.[x]		NS	NS	N S	NS	NS	NS	NS	NS	NS	NS	N
	0	2350	36	6970	77	218	2	9540	115	870	9	0.
	25	3700	59	6055	69	435	4	10190	131	1130	12	0.
	50	3790	60	6970	83	349	3	11110	147	1306	16	0.
	Signif.[x]	L*	NS 0.07	NS	NS	NS	NS	NS	NS	NS	NS	N
Total season (3 harvests)												
100		9320	143	29680	326	9900	76	48900	545	7725	73	0.
150		12020	189	27240	310	7260	55	46520	554	7320	72	0.
Signif.[x]		*	*	NS	NS	**	*	NS	NS	NS	NS	,
	0	8410	126	28445	305	7840	57	44690	489	4310	39	0
	25	11940	190	28880	325	9495	72	50310	589	7360	69	0
	50	11675	181	28050	325	8410	68	48130	575	10890	109	0
	Signif.[x]	NS	NS 0.08	NS	NS	NS	NS	NS	NS 0.06	L**	L**	L

[z]CRK = controlled-release potassium fertilizer (Multicoat KNO_3).
[y]Carton (ctn) = 25 lb.
[x]Significant at 5% (*) or 1% (**) probability level or not significant (NS). Regression models contained significant linear (L) terms.

Table 4. Effects of K fertilization programs on N and K concentrations of most-recently-matured leaves of pepper at two sampling periods in a controlled-release K study at Live Oak, FL, Spring, 1994.

		Sampling date[z]			
K fertilization		29 April		7 June	
lb K_2O/acre	% K from CRK[y]	N	K	N	K
		% dry matter			
0	0	6.2a[x]	2.0d	5.4a	1.8d
100	0	5.7bc	5.2c	4.6abc	2.1cd
100	25	5.5c	5.6c	4.4bc	3.4bc
100	50	5.4c	6.0b	4.0c	3.4bc
150	0	5.4c	5.5c	4.6abc	3.0c
150	25	5.6bc	6.0b	4.8ab	3.8b
150	50	5.7b	6.5a	4.5bc	4.4a
Signif.[w]		**	**	*	**
Main effects:					
100		5.5	5.6	4.4	3.0
150		5.6	6.0	4.6	3.7
Signif.[w]		NS	**	NS	**
	0	5.5	5.4	4.6	2.6
	25	5.5	5.8	4.6	3.6
	50	5.6	6.2	4.3	3.9
	Signif.[w]	NS	L**	NS	L**

[z]Growth stages at sampling were early blossoming (29 April) and at second harvest (7 June).
[y]CRK = controlled-release potassium fertilizer (Multicoat KNO_3).
[x]Mean separation by Duncans multiple range test (P = 0.05).
[w]Significant at 5% (*) or 1% (**) probability level or not significant (NS). Regression models contained significant linear (L) terms.