Table 6. Marketable yields by harvest date for spring 1984 pepper trial.

Cultivar	Marketable yields by harvest date (cartons/acre)[z]			
	May 10	May 17	May 24	June 4
Gator Belle	868.2 a[y]	537.7 a	300.1 b	456.9 a
Crispy	819.3 ab	468.1 ab	382.9 a	365.0 ab
Pro Bell	946.2 a	380.2 b-d	258.1 b	341.5 ab
Bell Boy	866.8 a	440.3 ab	273.8 b	327.0 bc
Lady Bell	775.0 ab	504.2 ab	237.1 b	305.0 b-d
Better Belle	765.2 ab	416.9 a-c	223.6 b	292.9 b-d
Hybelle	715.9 ab	426.5 a-c	280.3 b	253.5 b-d
Annabelle	777.3 ab	286.8 cd	253.7 b	176.5 d
Early Calwonder	710.7 ab	272.6 d	259.2 b	203.4 cd
Big Bertha	568.1 b	271.5 d	148.2 c	174.6 d

[z]Carton = 25 lb. fruit.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Spring 1983 vs. 1984. Of the 8 cultivars ('Bell Boy', 'Better Belle', 'Big Bertha', 'Crispy', 'Early Calwonder', 'Hybelle', 'Lady Bell' and 'Pro Bell') tested in both years the yield was generally lower in 1984. However, 2 cultivars, 'Crispy', and 'Bell Boy', showed little difference in yield between 1983 and 1984. Half of the cultivars showed an increase in the number of marketable fruit produced per plant in 1984, and half showed a decrease. Since the average fruit weight was lower for all cultivars in 1984, any increased fruit production was obscured by packing out more fruit per 25 lb. carton. Cull production for all cultivars was greater in 1984, but was dramatically higher for 'Big Bertha' and only slightly higher for 'Bell Boy'.

Overall, the most consistent performance for both seasons came from the cultivars 'Crispy', 'Pro Bell', and 'Lady Bell', all of which ranked in the top 5 cultivars in marketable yield in both 1983 and 1984. The yields from these cultivars were influenced by a tendency for greater fruit production per plant and lower cull production. The performance of 'Gator Belle' in the spring 1984 season (not examined in 1983) warrants further study.

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Proc. Fla. State Hort. Soc. 97: 148-150. 1984.

NITROGEN SOURCES AND COMBINATIONS FOR POLYETHYLENE MULCHED TOMATOES[1]

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Additional index words. Sulfur coated urea, isobutylidene diurea, $Ca(NO_3)_2$, KNO_3, NH_4NO_3, *Lycopersicon esculentum.*

Abstract. **Tomatoes (Lycopersicon esculentum Mill) were grown with paired combinations of 4 N sources or each alone applied at 200 lb. N/acre to evaluate their effect on fruit yield and tissue elemental concentration. The N sources were NH_4NO_3 (AN), KNO_3 — $Ca(NO_3)_2$ [KN-CaN], sulfur-coated urea (SCU), and isobutylidene diurea (IBDU). Yields of extra large, large, and total marketable fruits were highest with combination of IBDU or SCU with KN-CaN or AN, lowest with all of the N from AN or KN-CaN, and intermediate with all of the N from IBDU or SCU. Leaf N and K concentrations and available soil N concentrations were not consistently influenced by N source treatment.**

Most of the N required for tomatoes produced on sandy soils is supplied from soluble N sources. Due to nutrient leaching, the efficiency of applied N may be low; therefore, high rates of N are generally applied. Polyethylene mulch reduces leaching but its use requires that most of the fertilizer be applied before mulch application. If the threshold for soluble salt injury is exceeded, reduced yields can result from this over fertilization. Little difference in soluble N source for tomatoes has been found (1), although part of the N applied as NO_3-N is desirable under conditions of low nitrification. In the early stages of tomato plant growth, N need is low compared to that during fruit set and fruit development. In a study by Shelton (6) with SCU, a slow release N source, tomato production was found to be superior to that with soluble N sources. Similar enhancements in production with SCU have been reported for watermelon (3) and with SCU and IBDU for pepper (4).

The purpose of this study was to evaluate the influence of paired combinations of soluble and slow release N sources for polyethylene mulched tomatoes.

Experimental Procedures

'Tempo' tomatoes were grown during the spring of 1980 on a Sparr fine sand. The soil contained 1.7% organic matter in the upper 6 inches and had been limed to a pH of 6.5 at the time of transplanting. Rate of N applied was 200 lb./acre derived from SCU, KN-CaN, IBDU, and AN. These were applied alone or in combinations of 2 N sources for a total of 16 treatments (Table 1). Treatments were arranged in a randomized complete block design with 4 replications of single row plots 4 ft by 36 ft. Fertilizer was applied at 200-100-180-20 lb./acre N-P-K-micronutrient formulated from the appropriate N sources, concentrated superphosphate, potassium chloride, and FTE 503 (Frit Industries, Ozark, AL), respectively. The soil was fumigated with 22 gal/acre of dichloropropane-dichloropropene mixture. Two weeks later, on March 17, 1980, beds 4 ft apart were prepared, fertilizer was applied broadcast on the bed

[1]Florida Agricultural Experiment Stations Journal Series No. 5975.

tops and was incorporated by a rototiller to 6 to 8 inches into the beds. Black polyethylene mulch was applied and containerized tomatoes were transplanted on March 20 and staked approximately 4 weeks later. Overhead irrigation was applied as needed. Insecticide and fungicide were applied twice weekly for pest control. Recently-matured tomato leaves were taken for N, P, K, Ca and Mg analyses in mid-May and June. Total N was determined by the micro-Kjeldahl method, P colorimetrically, K by flame emission spectrocopy, and Ca and Mg by atomic absorption (2). Soil samples were taken monthly from the bed center between 2 plants to a depth of 6 inches. Soil samples were stirred in a 1:1 soil to distilled water solution and pH determined with a glass electrode. The filtrate was analyzed for NO_3-N with a nitrate electrode and an aliquot taken for NH_4-N analysis by the phenol method (2). Electric conductance (soluble salts) was measured over a 0.4-inch distance with a meter (Barnstead) on the filtrate and data were calculated to mmhos in the soil solution at field moisture. The sum of NH_4-N and NO_3-N was considered the soil available N. Mature green fruit were harvested weekly for 5 harvests and were graded into marketable size categories extra large (5x6), large (6x6), medium (6x7) and small (7x7) fruit. Harvests 1 and 2 were considered early harvests.

Results and Discussion

Tomato plant growth was excellent with no apparent difference due to treatment. Rainfall was very low during April and May. June also was dry except for a 4.0-inch rainfall that occurred on June 17. Overall fruit production was excellent. Early marketable yields ranged from 855 to 1356 cartons (25 lb.)/acre. Most of the fruits harvested were in the extra large and large categories (Table 1). Highest yields of the extra large fruit were obtained with combinations of 2 N sources. These treatments include N supplied from 1/3 IBDU + 2/3 KN-CaN, 2/3 KN-CaN + 1/3 AN, 2/3 IBDU + 1/3 KN-CaN, and 1/3 IBDU + 2/3 AN. Lowest yields of extra large fruit were produced when each of the 4 N sources were applied as 100% of the N source and 2/3 with SCU and 1/3 IBDU. Yields with the remaining treatments were intermediate. Early marketable yield of large fruit was lowest with KN-CaN and highest with SCU. Yields varied with the other treatments, but these differences generally were not significant. Early yields (data not shown) of medium and small fruit were also highest with SCU. Yields of medium fruit were lowest with 100% KN-CaN and with 2/3 KN-CaN + 1/3 AN. Early yields of small fruit were low and not influenced greatly by N source. Total early marketable yields were highest with 100% SCU, 2/3 SCU + 1/3 KN-CaN, 2/3 IBDU + 1/3 KN-CaN and 1/3 IBDU + 2/3 AN. Yields were lowest with 100% KN-CaN and 100% AN.

Total yields of extra large fruit (Table 1) were highest with combinations of N sources including 2/3 IBDU + 1/3 KN-CaN, 1/3 IBDU + 2/3 KN-CaN, 1/3 IBDU + 2/3 AN, and 2/3 KN-CaN + 1/3 AN. Yields were lowest when each N source was applied alone and with 1/3 KN-CaN + 2/3 AN and generally intermediate with the other N source combinations. The effects of N sources on total yields of large fruit were different from that obtained for extra large fruit. Large fruit yields were highest with all combinations of KN-CaN with SCU, IBDU and AN. Yields of medium size fruit (data not shown) were highest with 2/3 SCU + 1/3 KN-CaN 2/3 SCU + 1/3 AN, 1/3 SCU + 2/3 IBDU, + 2/3 or 1/3 IBDU and 1/3 or 2/3 KN-CaN, respectively. Yields of small fruit (data not shown) were highest with SCU, IBDU, and 1/3 IBDU + 2/3 AN. Total marketable fruit yields were highest with 2/3 SCU + 1/3 KN-CaN, 2/3 or 1/3 IBDU + 1/3 or 2/3 KN-CaN, respectively, and 1/3 IBDU + 2/3 AN. The lowest total yields were obtained with KN-CaN, AN, 2/3 SCU + 1/3 IBDU, 2/3 IBDU + 1/3 AN, 1/3 KN-CaN + 2/3 AN. Yields were intermediate with the other N source treatments.

Leaf N concentrations were not influenced by N source at the first sampling taken at the time of early fruit development (Table 2). One month later, leaf N concentrations were significantly influenced by N source. However, N concentrations were above the critical level with all N sources (5). Leaf K concentrations were influenced by N source at both samplings. At the second samplings, K concentrations were highest with 3 of the 4 treatments that provided the highest total marketable yield of extra large fruit. The N sources had no effect on Ca, Mg or P leaf concentrations.

Conductance as a measure of soluble salt concentrations in the soil solution were influenced at all samplings by N sources except at the May samplings (Table 3). Treat-

Table 1. Early and total marketable tomato yield as influenced by N source. 1980.

N sources[z]	Marketable yield (26-lb. cartons/acre) Early Ex. lg.[y]	Early Large[y]	Early Total	Total Ex. lg.	Total Large	Total Total
SCU	387	532	1356	564	987	2633
KN-CaN	320	307	855	651	925	2467
IBDU	309	407	1060	557	975	2672
AN	351	353	965	604	938	2492
2/3 SCU + 1/3 KN-CaN	469	444	1282	711	1122	2908
2/3 SCU + 1/3 IBDU	379	362	1020	652	911	2493
1/3 SCU + 1/3 AN	433	430	1164	682	989	2797
1/3 SCU + 2/3 KN-CaN	390	418	1046	693	1185	2863
1/3 SCU + 2/3 IBDU	466	384	1195	711	922	2677
1/3 SCU + 2/3 AN	453	350	1052	693	963	2637
2/3 IBDU + 1/3 KN-CaN	529	444	1255	861	1162	3055
2/3 IBDU + 1/3 AN	481	346	1073	770	876	2486
1/3 IBDU + 2/3 KN-CaN	505	353	1102	912	1014	2970
1/3 IBDU + 2/3 AN	517	409	1217	835	953	2842
2/3 KN-CaN + 1/3 AN	570	354	1105	889	1064	2760
1/3 KN-CaN + 2/3 AN	405	448	1117	619	1025	2591
LSD 5%	141	147	353	204	191	396

[z]KN-CaN is KNO_3-$Ca(NO_3)_2$ and AN is NH_4NO_3.

[y]Ex. lg is extra large and mean fruit weights for extra large and large fruit were 7.25 oz. and 5.30 oz, respectively.

Table 2. Tomato leaf N and K concentrations as influenced by N source. 1980.

N source[z]	Leaf concentration (%) N May 14	N June 12	K May 14	K June 12
SCU	4.73	3.79	2.09	0.99
KN-CaN	4.79	3.81	2.35	1.34
IBDU	5.05	3.76	2.14	0.95
AN	5.08	4.06	1.88	0.89
2/3 SCU + 1/3 KN-CaN	4.80	3.56	2.59	1.39
2/3 SCU + 1/3 IBDU	5.03	3.54	1.85	1.03
2/3 SCU + 1/3 AN	4.81	3.99	1.84	0.80
1/3 SCU + 2/3 KN-CaN	4.61	3.80	2.25	1.25
1/3 SCU + 2/3 IBDU	5.16	4.10	1.81	0.88
1/3 SCU + 2/3 AN	5.16	4.00	2.06	1.06
2/3 IBDU + 1/3 KN-CaN	4.78	4.00	2.36	1.50
2/3 IBDU + 1/3 AN	5.01	3.86	1.98	0.93
1/3 IBDU + 2/3 KN-CaN	5.03	3.76	2.08	1.46
1/3 IBDU + 2/3 AN	5.15	3.84	2.30	0.75
2/3 KN-CaN + 1/3 AN	5.11	4.26	2.24	1.49
1/3 KN-CaN + 2/3 AN	5.05	3.91	2.06	0.95
LSD 5%	N.S.	0.59	0.41	0.41

[z]KN-CaN is KNO_3-$Ca(NO_3)_2$ and AN is NH_4NO_3.

Table 3. Soil soluble salt and total available N concentrations as influenced by N source. 1980.

	Soil concentration							
	Soluble salts (mmhos/cm[y])				Available N (ppm)			
N source[z]	April	May	June	July	April	May	June	July
SCU	5.31	3.02	2.10	3.45	50	36	5	33
KN-CaN	6.97	3.85	1.78	1.38	38	34	11	34
IBDU	5.06	3.30	1.91	3.27	66	55	14	44
AN	6.68	3.69	1.78	1.97	63	49	9	25
2/3 SCU + 1/3 KN-CaN	4.88	3.66	1.81	2.23	40	24	9	22
2/3 SCU + 1/3 IBDU	5.46	4.09	1.28	2.22	45	31	8	22
2/3 SCU + 1/3 AN	4.57	3.29	2.30	2.37	39	27	9	21
1/3 SCU + 2/3 KN-CaN	6.64	3.85	2.36	2.18	70	40	18	30
1/3 SCU + 2/3 IBDU	7.40	4.22	3.13	2.47	52	37	11	35
1/3 SCU + 2/3 AN	5.03	3.04	3.90	1.98	43	31	19	21
2/3 IBDU + 1/3 KN-CaN	5.04	3.85	2.43	2.28	43	39	14	23
2/3 IBDU + 1/3 AN	7.61	4.38	1.74	3.59	60	46	10	32
1/3 IBDU + 2/3 KN-CaN	5.47	2.79	2.70	1.86	59	28	19	26
1/3 IBDU + 2/3 AN	8.84	4.04	2.74	2.16	83	49	14	22
2/3 KN-CaN + 1/3 AN	5.47	4.33	2.98	1.37	62	58	22	19
1/3 KN-CaN + 2/3 AN	8.51	4.46	1.84	1.33	84	54	10	13
LSD 5%	3.00	N.S.	1.57	1.59	32	29	13	24

[z]KN-CaN is KNO_3-$Ca(NO_3)_2$ and AN is NH_4NO_3.
[y]Approximately 820 ppm soluble salts in soil solution per mmhos/cm.

ment effects were not consistent for soluble salts throughout the season. At the first sampling, total soluble salt concentrations measured as mmhos/cm ranged from 4.88 to 8.84 and from 1.33 to 3.59 at the last sampling.

Soil available N concentrations were very high to moderate with all N sources throughout the season (Table 3). Most of the N was in the NO_3-N form with all samples, and concentrations were highest with the AN, KN-CaN and many of the combinations that contained these sources. The N sources had very little effect on concentration of soil available K, Ca, Mg and P or soil pH. However, tomato leaf K uptake was slightly higher with KN-CaN than with other N sources and KCl.

In nutrient culture studies, the use of NH_4-N sources for tomatoes has resulted in poorer fruit production than with NO_3-N source. In typical soil culture situations for tomatoes in Florida, NH_4-N is rapidly nitrified to NO_3-N and the source of soluble N has less effect on growth than in nutrient culture. Since nitrification occurs in a matter of 2 to 3 weeks, the effects of N source includes the initial possible toxic effects of NH_4-N, and might occur as NH_4-N is released from the slowly soluble sources. In this study, tomato production was moderate with a 100% of the N from the slow release N sources, namely SCU and IBDU. Yields were low yith 100% of the N from the soluble sources AN or KN-CaN.

The highest total marketable yields were obtained with treatments that contained a combination of slow release N and soluble N. The reason for this response was not evident from tissue and soil analysis data. Apparently, application of 100% N in the soluble form at planting has a high potential for masked plant injury, possible soluble salt effects. This injury may result in slightly reduced plant growth and reduced production, particularly of extra large fruit. With the slow release N sources, N stress may have occurred during early plant growth which later resulted in reduced yield of extra large fruit. Three of the 4 treatments that produced highest yields of extra large fruit and total marketable yield received a combination of soluble and slowly available N sources. Yields were slightly higher with IBDU than SCU as part of the N source and this difference probably relates to differences in the N release from the 2 sources. With drip irrigation, N source influenced fruit size (5). Data from this preliminary study indicate that considerable yield increases of extra large fruit and total marketable fruit can be obtained with a combination of slow release and soluble N sources.

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