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Levels and methods of potassium fertilization on tomato cv Duke yield[1]

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ABSTRACT

Two field experiments in 1988 and 1989 were conducted at the Fortuna Substation to evaluate levels and methods of potassium fertilization on tomato cv Duke. Applications of K_2O ranging from 0 to 336 kg/ha, either banded (by hand) or through drip irrigation system (fertigation) showed no significant ($P=0.5$) mean difference between treatments in tomato yield. The average tomato yield for the 1988 experiment varied from 46,689 kg/ha for the O-K_2O/ha treatment to 45,605 kg/ha for 336 kg of K_2O/ha banded, and 48,617 kg/ha for 336 kg of K_2O/ha in combined fertigation and banded application. In the 1989 experiment, the corresponding figures were 46,779, 47,962 and 44,060 kg/ha, respectively. The highest average tomato production in the combined 1988 and 1989 experiments was obtained with 196 kg of K_2O/ha in combined fertigation and banded application, and with 252 kg of K_2O/ha banded, yielding 48,095 and 48,018 kg/ha, respectively, whereas the O-K_2O treatment produced 46,707 kg/ha. The lack of significant response to K_2O application seems to be the result of a high inherent available K content of the San Antón soil prevailing on the experimental site, a finding confirmed by laboratory analysis as 367 p/m.

RESUMEN

Efecto de cantidades y métodos de la aplicación de potasa en el rendimiento de tomate, variedad Duke

En 1988 y 89 se establecieron dos experimentos de campo en la subestación de Fortuna para evaluar cantidades y métodos de la aplicación de potasa en el rendimiento de tomate de la variedad Duke. Las aplicaciones de K_2O entre 0 y 336 kg./ha. en banda (a mano) o por el sistema de riego por goteo no afectaron significativamente ($P>0.05$) el rendimiento medio de tomates entre tratamientos. El rendimiento medio de tomates en el experimento de 1988 fluctuó entre 46,689 kg./ha. para el tratamiento O K_2O, 45,605 kg./ha. para 336 kg. de K_2O/ha. aplicados en banda y 48,617

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kg./ha. en aplicación combinada por goteo y banda. Los números correspondientes para el experimento de 1989 fueron 46,752, 47,962 y 44,060 kg./ha., respectivamente. Las producciones más altas como promedio para los experimentos de 1988 y 1989, se obtuvieron con 196 kg. de K_2O/ha. en aplicación combinada de goteo y banda y 252 kg. de K_2O/ha. en banda, con 48,095 y 48,010 kg./ha., respectivamente, mientras que el tratamiento con O K_2O produjo 46,707 kg./ha. La ausencia de respuesta significativa a la aplicación de K_2O parece ser el resultado de un alto contenido inherente de K disponible en el suelo San Antón (367 p/m) que prevalece en el lugar del estudio, el cual se comprobó mediante análisis de laboratorio.

INTRODUCTION

Total gross income generated from local production of horticultural crops for fiscal year 1987-88 was $27.5 million. Tomato production amounted to 14,090 t with a farm value of $8.3 million or 30% of total. However, 12,772 t of tomatoes was imported to compensate for exports (7185 t) and to meet local consumption of 19,719 t. (2)

Tomato production in Puerto Rico is limited to the south coast. This project was established 12 years ago in soil traditionally planted to sugarcane for many years. Flat lands with deep fertile soil, low rainfall and available irrigation water are prime characteristics of the area.

High soil fertility (5) together with high application of N, P and K when sugarcane was under cultivation, makes the San Antón soil ideal for vegetable production with very little or no additional fertilization, except for nitrogen.

Research in Puerto Rico with hand-applied fertilizers on tomato has been conducted by Abrams (1), Landrau (7) and Rico-Ballester (9); and research with nitrogen applied through drip irrigation, by Goyal, Rivera and Santiago (6). Potassium has been successfully applied to fertigated sweet pepper experiments (7,9). However, no previous investigation has been conducted in which levels of potassium were injected through the drip irrigation (fertigation) system for tomato in the Mollisols of the southern region. If this method of K application proves to be feasible it will be of great benefit to the vegetable project of the southern region of the island. There is also a need to determine whether the soils of this area, traditionally planted to sugarcane with heavy applications of K_2O, really need potassium applications for high tomato yields.

MATERIALS AND METHODS

A field experiment was established at the Fortuna substation in December 1987 in which tomato var. Duke was fertilized with potassium (K_2O) levels through the drip irrigation system (fertigation) and hand banded (table 1).

Fertigation treatments were applied every other week during the first 16 weeks of tomato growth. The hand-banded potassium treatments

TABLE 1.—*Fertigation and potassium levels*

Main plots		Subplots	
Treatment	K_2O-kg/ha	Treatment	K_2O-kg/ha
T_1 fertigation	168	S1 banded	168
T_2 fertigation	112	S2 banded	84
T_3 fertigation	56	S3	0
T_4 banded	112		
T_5	0		

Treatment combination	K_2 Applied		
	Fertigation	Banded	Total
		kg/ha	
T1S1	168	168	336
T1S2	168	84	252
T1S3	168	0	168
T2S1	112	168	280
T2S2	112	84	196
T2S3	112	0	112
T3S1	56	168	224
T3S2	56	84	140
T3S3	0	0	56
T4S1	0	168[1]+168	336
T4S2	0	168[1]+84	252
T4S3	0	168[1]+0	168
T5S1	0	168	168
T5S2	0	84	84
T5S3	0	0	0

[1]Banded at every fertigation round.

were divided into three equal portions and applied at planting, at flowering and at first tomato fruit picking. All plots received 112 kg of P_2O_5 and 224 kg N/ha divided in equal amounts at every fertigation round.

A factorial arrangement in split plots with two factors was used. There were 15 treatment combinations and 4 replications. Main plots consisted of 4 tomato rows 1.8 m apart and 13.26 m long; subplots were 4.42 m long. Tomato yield was collected from the two inner rows. Soil samples were taken for analyses before treatment application.

Another field trial was initiated December 1988 to corroborate results from the previous experiment, which had shown no significant mean differences ($P=0.05$) between treatments, neither for levels nor for methods of potassium application. In order to reduce possible bias and experimental error, we conducted the second trial on the same site, with plots as in the first experiment. Disease, pest and weed control practices followed those recommended by the "Conjunto tecnológico para la producción de hortalizas, EEA" (4).

TABLE 2. — *Analyses of soil samples collected from the experimental site*

Treatment	pH	P[1]	K	Ca	Mg	% SB	CEC
			p/m				*Meq/100 g*
1–T1S1	7.71	38	353	2751	675	92.2	22
2–T1S2	7.44	44	376	2650	643	93.2	21
3–T1S3	7.26	40	380	2685	654	90.2	22
4–T2S1	7.58	35	357	2685	663	90.3	22
5–T2S2	7.50	38	348	2685	675	95.0	21
6–T2S3	7.51	38	358	2609	644	87.9	22
7–T3S1	7.69	38	370	2650	643	85.0	23
8–T3S2	7.46	38	366	2650	654	85.4	23
9–T3S3	7.46	34	352	2685	663	94.5	21
10–T4S1	7.39	45	369	2650	663	85.7	23
11–T4S2	7.40	45	376	2685	654	90.2	22
12–T4S3	7.34	41	376	2720	675	87.8	23
13–T5S1	7.55	38	375	2688	669	90.8	22
14–T5S2	7.36	43	381	2612	654	88.6	22
15–T5S3	7.36	38	370	2650	654	85.4	23
Average	7.47	40	367	2620	659	89.5	22

[1]Olsen Method.

RESULTS AND DISCUSSION

Soil samples collected before applying the treatments showed the following analyses as an average of all plots (table 2): pH=7.47, P (Olsen)=40 p/m, K=367 p/m, Ca=2670 p/m, Mg=659 p/m, % SB=89.5, and CEC=22 meq./100 g.

Tables 3 and 4 present tomato fruit yield data for the 1988 experiment. The yield of banded potassium application as an average of all fertigation treatments ranged from 42,822 kg/ha to 44,002 kg/ha, whereas the fertigated plots as an average of all banded treatment yielded from 41,767 kg/ha to 45,284 kg/ha, with no significant differences (P=0.05) between treatments. The tomato production for all treatment combinations (table 4) ranged from a low 38,677 kg/ha to a high 48,617 kg/ha, with no significant difference between treatment means.

TABLE 3.—*Average yield of tomatoes for methods and levels of K_2O fertilization, 1988*

Sub-plots	T1	T2	T3	T4	T5	Average
S1	48,617	41,629	41,267	45,605	40,303	43,484
S2	43,617	47,713	40,725	43,376	38,677	42,822
S3	43,617	43,436	43,315	42,954	46,689	44,002
Average	45,284	44,259	41,767	43,978	41,890	43,436

TABLE 4.—*Total production of tomatoes – 1988*

	Treatment		Tomato yield
	Fertigation	Banded	
		kg/ha	
T1S1	168	168	48,617
T1S2	168	84	43,617
T1S3	168	0	43,617
T2S1	112	168	41,629
T2S2	112	84	47,713
T2S3	112	0	43,436
T3S1	56	168	41,267
T3S2	56	84	40,725
T3S3	56	0	43,315
T4S1	0	168[1]+168	45,605
T4S2	0	168[1]+84	43,376
T4S3	0	168[1]+0	42,954
T5S1	0	168	40,303
T5S2	0	84	38,677
T5S3	0	0	46,689
Average			43,436

[1]Banded at every fertigation round.

Tables 5 and 6 show yield data for the 1989 experiment. As for the 1988 experiment, significant treatment means were observed. The average tomato yield (46,520 kg/ha) was somewhat higher (3,084 kg/ha) than the yield of the 1988 experiment (43,436 kg/ha).

Table 7 presents the combined tomato yield for the 1988 and 1989 experiments. Again, there was no significant difference among treatment means.

The yield data presented for both experiments indicate a lack of significant response to potassium application, regardless of the method used. No trend was observed, since plots receiving 336 kg of K_2O/ha

TABLE 5.—*Average yield of tomatoes for method and levels of K_2O fertilization*

	Fertigation K_2O levels					
Sub-plots	T1	T2	T3	T4	T5	Average
			kg/ha			
S1	40,061	44,355	46,177	47,962	45,886	45,688
S2	46,795	48,473	43,358	52,661	45,205	47,299
S3	49,642	49,830	43,019	43,598	46,779	46,573
Average	46,833	47,553	44,183	48,074	45,939	46,520

TABLE 6.—*Total production of tomatoes, 1989*

	Treatment		Tomato yield
	Fertigation	Banded	
	----------*kg/ha*----------		
T1S1	168	168	44,060
T1S2	168	84	46,795
T1S3	168	0	49,642
T2S1	112	168	44,355
T2S2	112	84	48,473
T2S3	112	0	49,830
T3S1	56	168	46,177
T3S2	56	84	43,358
T3S3	56	0	43,019
T4S1	0	168[1]+168	47,962
T4S2	0	168[1]+84	52,661
T4S3	0	168[1]+0	43,598
T5S1	0	168	45,886
T5S5	0	84	45,205
T5S3	0	0	46,779
Average			46,520

[1]Banded at every fertigation round.

averaged 46,562 kg/ha, whereas these plots not fertilized with K produced 46,734 kg/ha and an overall average of 44,928 kg/ha.

The soil fertility components were from adequate to high as indicated by soil analyses. The soil available potassium content was high at 367 p/m, as compared to the generally considered adequate level of 200 p/m. The high potassium content of the San Antón soil prevailing in the experimental site seems to be the main reason for the lack of response to K application observed in this study.

On the basis of results obtained in the present study, it is concluded that under conditions similar to those prevailing for this research, potassium fertilization is not needed for commercial tomato production.

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TABLE 7.—*Combined yield of tomatoes, 1988-89*

Treatment combination	Tomato yield		
	1988	1989	Average
	kg/ha		
T1S1	48,617	44,060	46,339
T1S2	43,617	46,795	45,206
T1S3	43,617	49,642	46,630
T2S1	41,629	44,355	42,992
T2S2	47,713	48,473	48,093
T2S3	43,436	49,830	46,633
T3S1	41,267	46,177	43,722
T3S2	40,725	43,358	42,041
T3S3	43,315	43,019	43,167
T4S1	45,605	47,962	46,784
T4S2	43,376	52,661	48,018
T4S3	42,954	43,598	43,276
T5S1	40,303	45,886	43,094
T5S2	38,677	45,205	41,941
T5S3	46,689	46,779	46,734
Average	43,436	46,520	44,978

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