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EFFECT OF PRODUCTION MEDIA, CULTIVAR, AND FERTILIZER ON YIELD OF GREENHOUSE TOMATOES[1]

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Abstract. **Studies were conducted during 1974, 1975, and 1976 to evaluate cultivars and effects of media and source of N and K on production of greenhouse tomatoes** (Lycopersicon esculentum **Mill.). Highest fruit production was obtained with 'Tropic' as compared with 'Floradel' and 'Walter'. Fruit yield during 1974 was not influenced by media or fertilizer source. In 1975 and 1976, these two factors interacted in their effects on yield. In both seasons, no difference in yield was found for the standard and the low rate of slow release fertilizer (180-248-240 lb/acre N, P_2O_5, K_2O) with soil, peat-soil, and peat-vermiculite media. Fruit yields in both seasons were significantly higher with the 1960-2080-1200 lb/acre N, P_2O_5, K_2O rate of slow release fertilizer as compared with the 180-248-240 rate of standard fertilizer with the peat-vermiculite media.**

Greenhouse tomato *(Lycopersicon esculentum)* operations have increased in numbers in Central, North, and West Florida during the past 3 to 5 years. Many were built as a result of exaggerated claims of profit, high production and ease of production. Production systems have ranged from peat-vermiculite media with slow release fertilizers (6) to the use of native soil with standard outdoor production recommendations (4). Recently, Sheldrake (5) reported on the use of peat-vermiculite media with fertilizer injected into drip irrigation systems for greenhouse tomato production. Most of the peat-vermiculite systems are more expensive than native soil production and the advantages and disadvantages must be evaluated in terms of production costs per unit of tomatoes. Studies reported here were undertaken to determine the effects of production media, cultivar, and fertilizer source, on the production of greenhouse tomato.

Materials and Methods

Studies were conducted in a fiberglass greenhouse in Gainesville during 1974, 1975, and 1976. Treatments were 2 cultivars, 3 media, and 2 fertilizer sources. The experimental design was a split plot arrangement with cultivars as main plots. Sub-plots were combinations of media and fertilizer. Cultivars were 'Floradel' and 'Walter' in 1974, and 'Tropic' and 'Floradel' in 1975 and 1976. Media were as follows: (1) soil (St. Johns fine sand), (2) 1:1 by volume peat and soil mix, and (3) 1:1 peat and vermiculite mix. In 1974, fertilizer treatments consisted of standard and slow release fertilizers (Table 1). They were (1) standard fertilizer, 180-248-240 lbs/acre of N, P_2O_5, and K_2O, respectively, applied in 3 equal applications from ammonium nitrate, superphosphate, and potassium sulfate, and (2) slow release fertilizer, 1960-2080-1200 lbs/acre N, P_2O_5, and K_2O with peat-vermiculite and 180-248-240 with the peat-soil and soil media as a single application from Osmocote (18-6-12) and MagAmp (7-40-6-12) applied broadcast preplant. The high rates of slow release materials, lime and micronutrients were used for the peat-vermiculite media only and these rates correspond to that recommended by Sheldrake *et al.* (6). The lower rate of slow release materials was used for the soil and peat-soil media to avoid soluble salt injury. In 1975, the fertilizer treatments were as above but drip irrigation was used. For the 1976 standard fertilizer treatment, 100% of the P_2O_5 and 20% of the N and K_2O were applied preplant. The remainder of the N and K_2O was applied through the drip irrigation system twice a week at a rate of 5-0-6 per application.

Main plot size was 3 x 6 feet with an average depth of 8 inches. Each was framed with wood and lined with plastic to maintain plot integrity. Holes were punched in the plastic to provide adequate drainage. One row of each cultivar was set in the plots with 12 inch spacing between plants and 24 inches between cultivar rows. Plants were

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Table 1. Rates of nutrients applied with the three media for standard and *slow release fertilizers*.

Media	Nutrient rates, lb/acre					
	N	P_2O_5	K_2O	FTE	$CaCO_3$	Fe chelate
			Standard			
Soil	180	248	240	60	3000	
Peat-Soil	180	248	240	60	3000	
Peat-Verm	180	248	240	120	9700	10
			Slow release			
Soil	180	248	240	60	3000	
Peat-Soil	180	248	240	60	3000	
Peat-Verm	1960	2080	1200	600	9700	50

pruned to a single leader and supported by strings attached to an overhead wire system. Laterals were removed and leaders were tied twice weekly. Pollination was accomplished with an electric vibrator beginning with first bloom. Plants were pollinated daily until the plants were topped out late in the season. During the 1974 season, water was applied with a hose. In 1975 and 1976, drip irrigation was used. Prior to first fruit set, plants were irrigated once a day. After a fruit load was established, irrigations were twice a day. Fruit were harvested twice weekly as they reached the 'pink' stage of maturity. Pesticides were applied weekly or twice weekly with a hand sprayer to control insects and diseases (4).

The house had a wet-pad cooling system and had overhead heaters. Growing temperatures were maintained at 58-62°F at night and 75-85°F during the day. Growing media was replaced for each crop.

Results and Discussion

The main effects of cultivar on marketable yield of tomatoes are given in Table 2. In all 3 seasons, the effect of cultivar was significant. 'Floradel' produced more than 'Walter' in 1974 and 'Tropic' produced more marketable fruit than 'Floradel' in 1975 and 1976. 'Walter' was grown in 1974 because of its desirable external fruit qualities and general acceptance in commercial channels. Since 'Walter' is a semi-determinate plant type it was expected to produce a greater early yield with a shorter overall harvest period than the indeterminate 'Floradel'. However, 'Walter' did not perform as well as 'Floradel' in any portion of the harvest season. The indeterminate large fruited cultivars 'Floradel' and 'Tropic' were used in 1975 and 1976. Except for the early harvest period of 1975, 'Tropic' consistently yielded more marketable tomatoes than 'Floradel'.

Growing media had no significant effect on fruit yield in 1974 and 1975 but did significantly influence mid season, late, and total marketable yield of tomatoes in 1976 (Table 3). The 1976 yields were significantly higher with peat and vermiculite media than with soil and peat-soil media. The difference in response to media during the 3 seasons may be related to the different irrigation methods used in each season. Early in the 1974 fruiting season it was noted that irrigation was adequate for the soil and peat-soil media but was not adequate for the peat-vermiculite media. Water stress was noted in the latter plots and additional water was then added to these in later irrigations. Yields later in the season with peat-vermiculite were similar to those with soil and peat-soil media. In 1975, a drip irrigation system (Anjac Bi-wall) was used and water was applied twice a day automatically. Generally, the plots received a greater total amount of water than in 1974. Differences in 1975 between media at all harvest periods were small and not significant

Table 2. Main effects of cultivar on early, mid season, late, and total marketable yield of tomatoes for 1974, 1975, and 1976.

Cultivar	Marketable fruit, lb/plot			
	Early	Mid	Late	Total
		1974		
Walter	5.4	4.6	2.8	12.8
Floradel	8.6	18.0	5.8	32.4
F value[z]	N.S.	**	*	**
		1975		
Floradel	2.7	4.6	1.2	8.5
Tropic	2.2	8.1	1.7	12.0
F value	N.S.	**	N.S.	**
		1976		
Floradel	0.8	16.7	7.3	24.8
Tropic	2.7	21.0	10.4	34.0
F value	*	N.S.	**	*

[z]F values were not significant (N.S.) or significant at the 5% (*) and 1% (**) levels.

(Table 3). Mean yields, however, were less than 50% of those in the 1974 season. The 1975 harvest season was shorter than 1974 with 8 weeks and 12 weeks during the respective years. The lower yields are in part due to this reduced harvest period and to apparently poor plant growth due to N and K deficiencies. During the 1975 season, the twice daily drip irrigation constantly moved the soluble N and K downward and out of the effective root zone. It has been shown that where drip irrigation is used, N and K must be applied with the water to replace leached nutrients to obtain maximum yields (1, 2, 3). In 1976, where 80% of the N and K was applied wth drip irrigation, fruit production was higher than in the previous 2 years and was significantly influenced by media. Fruit production in 1976 was significantly greater with the peat-vermiculite media than with soil or peat-soil. Fruit production with the latter two media was statistically similar (Table 3). The water rates in the 1976 study were set to maintain adequate moisture in the media that required the most water, peat-vermiculite; thus, overwatering resulted with the soil and peat-soil media. This overwatering problem was serious during mid and late season and probably contributed to the reduced yields with these media. In future work with media, water rates must be adjusted to accommodate each media.

Table 3. Main effects of media on early, mid season, late, and total marketable yield of tomatoes for 1974, 1975, and 1976.

Media	Marketable fruit, lb/plot			
	Early	Mid	Late	Total
		1974		
Soil	6.2	10.1	4.1	20.5
Peat-Soil	7.1	12.4	4.0	23.4
Peat-Verm	2.8	11.8	4.7	22.9
F value[z]	N.S.	N.S.	N.S.	N.S.
		1975		
Soil	2.3	6.4	1.2	9.9
Peat-Soil	2.7	6.0	1.3	10.0
Peat-Verm	2.3	6.6	1.8	10.7
F value	N.S.	N.S.	N.S.	N.S.
		1976		
Soil	1.8	15.9b	6.9b	24.4b
Peat-Soil	1.8	14.9b	6.9b	23.6b
Peat-Verm	1.6	25.8a	12.8a	40.2a
F value	N.S.	**	**	**

[z]F values were not significant (N.S.) or significant at the 5% (*) and 1% (**) levels. Mean separation within columns by Duncan's multiple range test, 5% level.

Fruit yield was not differentially influenced by the source of fertilizer during 1974 (Table 4). During 1975, mid season, late, and total marketable yields were significantly greater with the slow release source than the standard fertilizer. Since the slow release fertilizer was more resistant to leaching, tomato production was significantly greater than in plots where standard fertilizer was used. In contrast, during the 1974 season when nutrient leaching was not a factor, no difference in fertilizer source on yield was observed. In the 1976 season, where 80% of the N and K for the standard fertilizer treatment was added through the drip system, no difference in early, late, or total yield due to fertilizer source was recorded. Yields during mid season were significantly greater with the slow release as compared with the standard fertilizer. During 1975 and 1976, fertilizer source significantly interacted with media in their effects on fruit yield (Table 5). The major source of the interaction was that with soil and peat-soil media, fertilizer source had no effect on yield. With the peat-vermiculite media, the effects of source were significant for early, mid, and total fruit yield. With this media, the slow release fertilizer delayed early yield but significantly increased the mid season and total fruit yield as compared with the standard fertilizer.

Table 4. Main effects of fertilizer on early, mid season, late, and total marketable yield of tomatoes for 1974, 1975, and 1976.

Fertilizer	Marketable fruit, lb/plot			
	Early	Mid	Late	Total
		1974		
Standard	6.8	11.8	4.4	23.0
Slow release	6.4	11.0	4.1	21.5
F value[z]	N.S.	N.S.	N.S.	N.S.
		1975		
Standard	2.3	5.1	1.0	8.5
Slow release	2.5	7.6	1.8	11.9
F value	N.S.	**	*	*
		1976		
Standard	2.1	16.5	9.2	27.8
Slow release	1.4	21.2	8.5	31.1
F value	N.S.	*	N.S.	N.S.

[z]F values were not significant (N.S.) or significant at the 5% (*) and 1% (**) levels.

Although 'Tropic' produced higher yields than 'Walter' and 'Floradel', yields in this study were generally lower than desirable for the intensity of production. Media appears to have less overall effect on yield than fruit set, water, light, and fertilizer control. In this greenhouse study, it was difficult to maintain optimum temperature control particularly with regard to cooling during periods when outdoor temperatures were above 90°F. Light transmission through the fiberglass was a definite problem during 1974 and 1975. The roof was recovered prior to the 1976 season and the improved light conditions contributed to the generally higher yields for 1976. Yields of 'Tropic' were highest in the 1975-76 seasons with the peat-vermiculite media with the 1960-2080-1200 lb/acre N, P_2O_5, and K_2O rate of slow release fertilizer. These yields were about 47% higher than that with the standard fertilizer with the same media. For the other 2 media there was no significant difference between slow release and standard fertilizer sources. These studies indicate that water and nutrient management are critical and must vary with media.

Table 5. The interactions of fertilizer and media on marketable yield of tomatoes for 1975 and 1976. Fruit/plot, lb.

Fertilizer[z]	Media		
	Soil	Peat Soil	Peat Verm
		1975	
		Mid yield	
Standard	5.6	5.9	4.1
Slow release	7.3ab	6.2b	9.3a[y]
		Total yield	
Standard	8.3	9.9	7.5
Slow release	11.7b	10.1b	13.9a
	*		*
		1976	
		Early yield	
Standard	1.6	1.5	3.2
Slow release	2.0a	2.1a	0.1b
			*
		Mid yield	
Standard	14.4	16.3	18.7
Slow release	17.2b	13.5b	32.9a
			*
		Total yield	
Standard	23.3b	26.2ab	33.8a
Slow release	25.6b	21.0b	46.6a
			*

[z]Difference between fertilizer for a media significant at the 5% level (*).
[y]Mean separation between media by the Duncan's multiple range test, 5% level.

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