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Effects of Nutrient Culture Solutions on Growth and Yield of Tomato

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Tomato plants grown on sand culture with analytical reagent culture solution had higher nutrient content of N, P, K, Ca and Mg in their vegetative growth as compared with plants of commercial fertiliser culture solution. A significantly higher response was obtained in nutrient content of P and Ca. Plants grown with commercial fertiliser solution had significantly higher chloride content. A similar increase in nutrient contents occurred on tomato roots and contents of N, P, K, Ca, Mg and ascorbic acid in tomato juice. The increase of plant dry weight, root dry weight and yield of tomato grown with analytical reagent culture solution was 58 per cent, 97 per cent and 200 per cent higher respectively over plants grown on fertiliser solution.

The methods of sand and water culture of plants were originated in pure scientific enquiry more than a century ago and they have shown to be of value to plant physiologists in their studies on nutritional requirements of plants (Salisbury, 1966; Malvick & Percich, 1993). The plants grown in hydroponic culture are often used as experimental models for soil grown plants (Asher & Edwards, 1983; Miyasaka, Checkai, Grunes & Norvel, 1988). Hydroponic culture has also proven to be more valuable because less pesticides are required for plants grown in controlled environmental conditions. Little or no research work has been done on hydroponic in Sabah, Malaysia. Research in this area is needed to create awareness of the method.

MATERIALS AND METHODS

The experiment was conducted in the greenhouse at the Institute of Agriculture, Timbang Menggaris, Sabah. Each clay pot of 8 in. x 12 in. in size filled with 10 kg of washed sea sand was planted with one tomato plant. The pots were irrigated with two sources of culture nutrient solutions *viz.* analytical reagent grade salts (*Table 1*) and commercial fertilisers (*Table 2*). The continuous irrigation system with constant rate was used as shown in *Figure 1*. Thirty-two- month-old plants from each source of nutrient solution were sampled and analysed for N, P, K, Ca, Mg and Cl. Ripe tomato fruits were also analysed for nutrient content including ascorbic acid. Plant dry weight and root dry weight were recorded after all the fruits have been harvested. Plant roots were analysed for nutrient contents.

RESULTS

Mean nutrient contents between tomato plants grown in analytical reagent culture solution and commercial fertiliser culture solution for N, K and Mg were not significantly different. However, phosphorus and Ca contents were significantly higher in analytical reagent culture solution. Whereas Cl content was significantly increased with commercial fertiliser culture

TABLE 1
CONSTITUENTS OF ANALYTICAL REAGENT CULTURE SOLUTION

Element	*Salts used*	*Concentration*
N	$KNO_3.Ca(NO_3)2.4H_2O$	128.6 mg^{L-1}
P	KH_2PO_4	114.0 mg^{L-1}
K	KH_2PO_4	336.0 mg^{L-1}
Ca	$Ca(NO_3)_2 4H_2O$	84.8 mg^{L-1}
Mg	$MgSO_4.7H_2O$	48.5 mg^{L-1}
Fe	$FeSO_4.7H_2O$	0.2 mg^{L-1}
Zn	$ZnSO_4.7H_2O$	0.25 mg^{L-1}
Mn	$MnCl_2.4H_2O$	0.28 mg^{L-1}
Cu	$CuSO_4.5H_2O$	0.25 mg^{L-1}
B	H_3BO_3	0.18 mg^{L-1}
Mo	$H_2MoO_4.H_2O$	0.53 mg^{L-1}
Cl	From above salts	0.36 mg^{L-1}
S	From above salts	72.3 mg^{L-1}

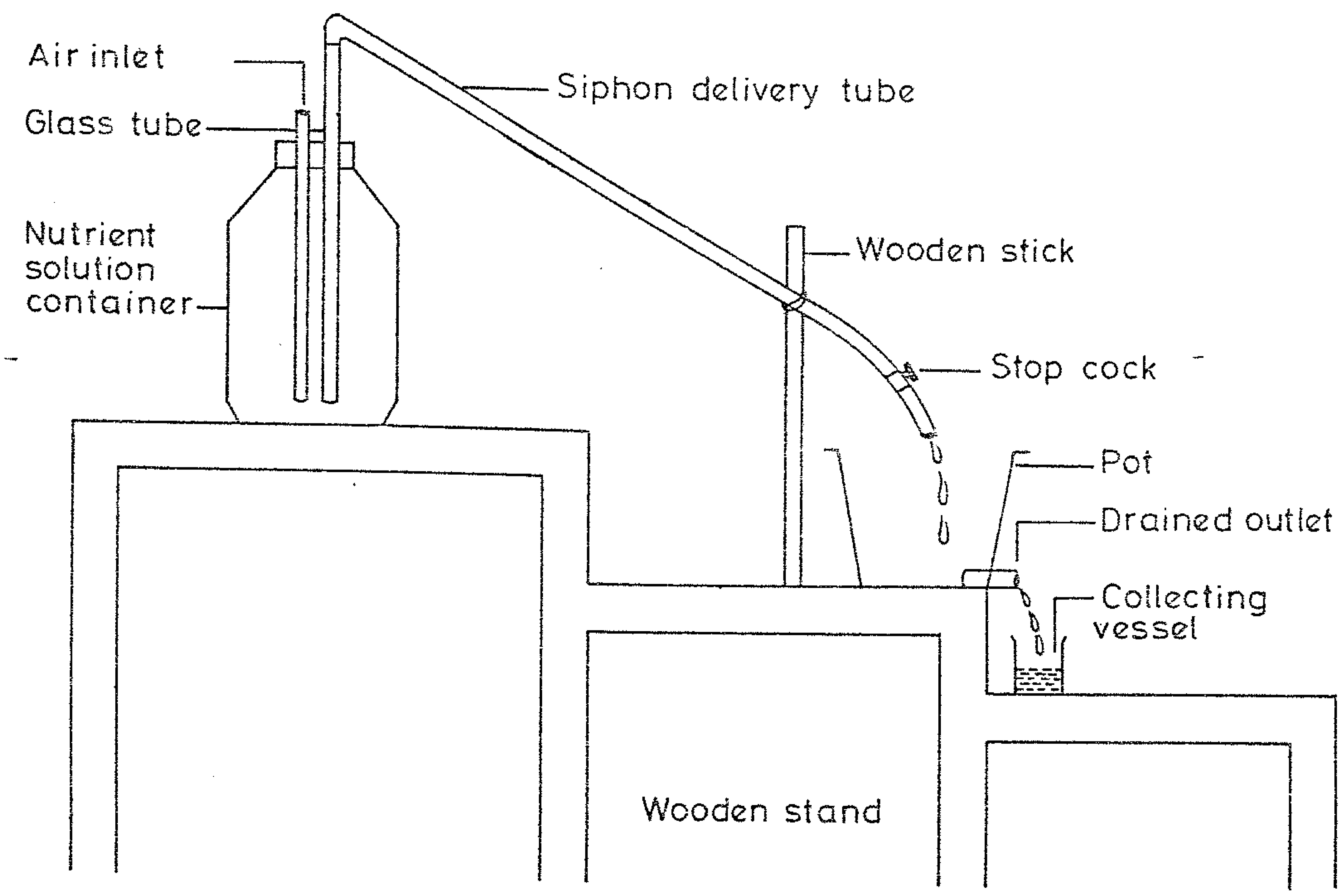

Figure 1. Continuous flow system with constant rate of nutrient solution supply

solution (*Figure 2a*), but their variances for sample unit population were not of statistical significance.

The plants grown with analytical reagent culture solution had a significantly higher P content in tomato juice (*Figure 2b*). The means and variance for sample unit population for N, K, Ca, Mg and ascorbic acid were not statistically different.

Analytical reagent culture solution substantially increased the nutrient contents of tomato roots (*Figure 2c*). The means and variance of unit population for N, K, and Mg contents were not significantly different. However, phosphorus and Ca contents were significantly higher with analytical reagent culture solution. Cl content was significantly higher in root of plants grown with commercial fertiliser culture solution.

The mean values for plant dry weight, root dry weight and yield of tomato significantly increased with analytical reagent culture solution as compared to commercial fertiliser culture solution (*Table 3*). The increases were 58 per cent in plant dry weight, 97 per cent in root dry weight and 200 per

TABLE 2
CONSTITUENTS OF COMMERCIAL FERTILISER CULTURE SOLUTION

Element	*Fertilisers used*	*Concentration*
N	NH_2CoNH_2 (Urea)	128.6 mgL^{-1}
P	$Ca(H_2PO_4)_2$ (TSP)	114.0 mgL^{-1}
K	KCl (Muriate of potash)	336.0 mgL^{-1}
Ca	From TSP	
Mg	$MgSO_4.7H_2O$ (Magnesium sulphate)	48.5 mgL^{-1}
	Micronutrients same as *Table 1*	

TABLE 3
PLANT DRY WEIGHT, ROOT DRY WEIGHT AND YIELD OF TOMATO PER PLANT AS AFFECTED BY NUTRIENT CULTURE SOLUTION

Source of culture solution	*Plant dry* weight (g)*	*Root dry weight (g)*	*Yield** (kg)*
Analytical reagent culture solution	238.8a	14.5a	1.5a
Commercial fertiliser culture solution	150.57b	7.27b	0.5b

* Means of 30 tomato plants
** Means not followed by same alphabet are significantly different at the 0.05 level of probability based on LSD

cent in yield of tomato, respectively.

DISCUSSION

The mean values of N, P, K, Ca and Mg contents of tomato plant, tomato juice and tomato root were increased with analytical reagent culture solution as compared with commercial fertiliser culture solution. The increases were only significant for P and Ca. The higher response in nutrient contents of plant, juice and root with laboratory nutrients showed that the nutrient source was purer, higher in solubility and thus more

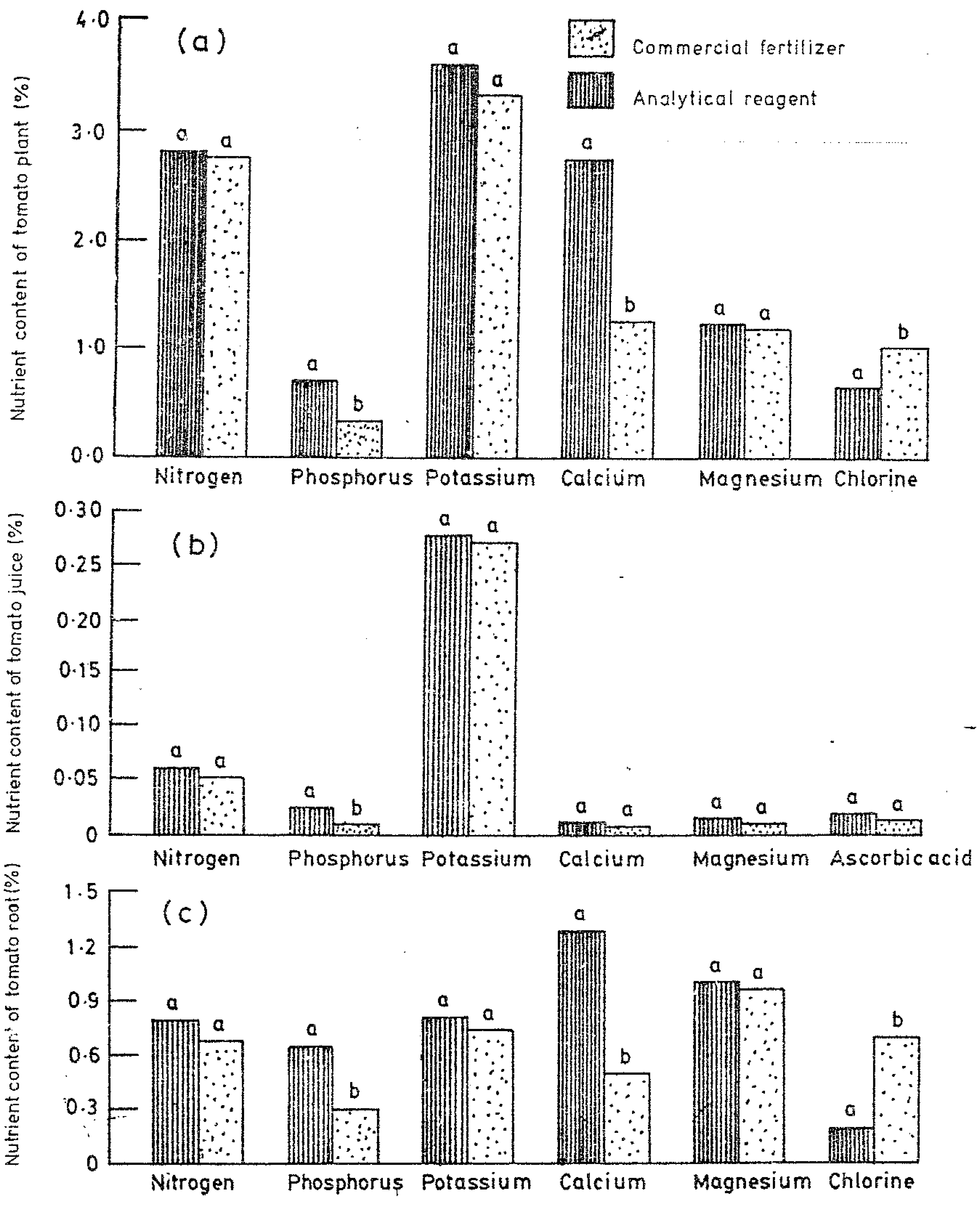

Figure 2. Effects of nutrient culture solution on nutrient content of (a) tomato plant, (b) tomato juice and (c) tomato root. Bars not followed by the same letter are significantly different at the 0.05 level of probability based on L S D

available to plants.

The chloride content of plant and root was significantly higher in commercial fertiliser culture solution than analytical reagent culture solution. This may suggest more Cl was available to plant roots from muriate of potash.

Plant dry weight, root dry weight and yield of tomato were significantly higher with analytical culture solution as compared to commercial fertiliser culture solution suggesting efficient utilisation of nutrients from analytical reagent culture solution by plants.

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