FERTILIZER TRIALS WITH TURMERIC (*CURCUMA DOMESTICA VAL.*) AT SANTA CRUZ, SOLOMON ISLANDS

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ABSTRACT

In four experiments with turmeric (Curcuma domestica Val.) at Santa Cruz, Solomon Islands (S.I.), potassium applications significantly increased the yield of rhizomes in all trials. There was some indication that sulphate of ammonia, phosphorus and a proprietary mixture of trace elements may increase yields in the presence of potassium. Urea applied alone depressed yields.

Key words : Turmeric, fertilizers, potassium, Hydrandepts

INTRODUCTION

Santa Cruz is an Island situated at 10° 45'S and 116°E in the Solomon Islands. As part of the agricultural programme of diversification and development it was decided to introduce turmeric, *Curcuma domestica* Val., to Santa Cruz for trial and evaluation. The crop was chosen because the climatic conditions are favorable for growing turmeric (Purseglove 1973) and since the island is remote from a major port, a product with a relatively low bulk and high price is desirable. The boiled rhizomes are used in Santa Cruz as a cosmetic for adorning the body during traditional ceremonies. No local markets as such exist, and attempts are being made to establish export markets of the commodity. The boiled dried rhizomes of turmeric are a major constituent of curry powder.

The soils of Western Santa Cruz are ash-soils formed over limestone terraces and are classified as Hydrandepts (Wall and Hansell 1976). The addition of volcanic ash from Tinakula crater has resulted in a soil with chemical and physical properties deprived from the presence of allophane. The soils show no signs of impeded drainage, have a very high moisture content and low bulk density. If exposed to strong sun or if compacted they may dry out irreversibly resulting in destruction of the natural soil structure. The greater part of the profile is top soil which rests directly on weathered limestone.

The soils are influenced by the underlying limestone, and the exchangeable bases are dominated by calcium. Levels of total phosphorus are high in the topsoil (0.38%) but available levels are moderate to low (9 ppm Olsen) and (25 ppm Bray). Total potassium is low in the upper topsoil (0.094%) and available levels extremely low (0.2 meq %). In the lower topsoil there was only a trace of available potassium. Nitrogen levels in the topsoil were high (0.89%) and organic matter content was unusually high (up to 16%) (Wall & Hansell 1976).

MATERIALS AND METHODS

A 5.7 ha pilot project of turmeric was planted at Santa Cruz on farmers land during May 1972 using selected rhizomes of variety "Tuu vetolio" from Dala Research Station, Malaita, S. I., which had previously been commercially evaluated by the Tropical Products Institute, London (Gollifer 1973). Four fertilizer trials were superimposed on the block

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planting and the result are described in this paper.

Turmeric rhizomes approximately 25 g in weight of variety were planted during April and May 1972 at a spacing 0.6 x 0.6 m and at the depth of approximately 5 cm. In all experiments the plot size including guard rows were 0.0036 ha and the harvestable plots size was fifty plants (0.0018 ha). Fertilizers were applied 6 months after planting, and the crop was lifted with hand forks at 15 months, when senescence of the leaves was complete. All bulbous material was rejected and only the 'fingers' weighed.

Experiments 1 & 2

The design used was a 2^4 factorial with factors N, P, K and T arranged in blocks of eight plots each, with the NPKT interaction being completely confounded (Table 1) and randomized within the blocks. There were three replicates (Cochran & Cox 1966, plan 6.2).

Treatment :	N	Control (C)
	P	NP
	K	NK
	T	PK
	PK	NT
	NPT	PT
	NKT	KT
	PKT	NPTK

In Experiment 1 the nitrogen (N) was applied as sulphate of ammonia, N(a), and in Experiment 2 as urea, N(u).

Experiment 3

The design was a 3 x 2^2 factorial, with two forms of N, sulphate of ammonia (Na) and urea (Nu) in combination with P (triple super phosphate) and K (muriate of potash). The NPK interaction was confounded and the PK interaction partially confounded. There were three replicated with treatments randomized within the blocks. (Cochran & Cox 1966, plan 6.9).

Treatments :	K	C
	P	PK
	N(a)	N(a) K
	N(a) PK	N(a) K
	N(u)	N(u) K
	N(u) PK	N(u) P

Experiment 4

The design was a balanced incomplete block design with six replicates, type III (Cochran & Cox 1966, plan 11.16).

Treatments :	C	N(u)
	K1	N(u) K1
	K2	N(u) K2
	K3	N(u) K3
	K4	N(u) K4

Table 1. **Fertilizer treatment structure for Experiments 1 - 4.**

Symbol	Description	Experiment
C	Absence of fertilizer	1, 2, 3, 4
N(a)	56 kg of elemental N per ha as sulphate of ammonia	1, 3
N(u)	56 kg of elemental N per ha as urea	2, 3, 4
P	56 kg of elemental P per ha as triple superphosphate	1, 2, 3
K	56 kg of elemental K per ha as muriate of potash	1, 2, 3, 4
K2	112 kg of elemental K per ha as muriate of potash	4

(Contd....)

K3	168 kg of elemental K per ha as muriate of potash	4
K4	224 kg of elemental K per ha as muriate of potash	4
T	251 kg of "Ess-min-el" (*) per ha	1, 2

(*) A propriety compound manufactured by Amalgamated Chemical (NSW) Pty Ltd. containing Mg, Mn, Fe, Cu, B, Mo, Co, and S.

RESULTS AND DISCUSSION

The results for the four experiments are presented in Tables 2 - 5. Tables 2 and 3 provide a concise presentation of the main effects and two-factor interactions, the response to each factor being shown seperately for each level of every other factor. For instance the row labelled K contains mean response and the differential responses to potassium. The figure +22.36 for instance (response to potassium with trace elements absent) in Table 2, is the average response to potassium over all plots that did not receive trace elements. The Table enables a rapid appraisal to be made of the nature of the main effects and two-factor interactions.

In Experiment 1 (Table 2) there was a large, significant response in the yield of turmeric rhizomes resulting from applications of potassium. The interaction effects of NK, PK and PKT also produced significant increases in yield (Table 2). Similarly there was a significant response due to potassium in Experiment 2 (Table 3), and the interaction effect of KT also produced a significant increase in yield. Nitrogen in the form of sulphate of ammonia and in the presence of potassium resulted in an increase in yield (Table 2), but in the form of urea produced no yield increase when applied with potassium (Table 3).

Table 2. **Yield differences of fresh turmeric rhizomes (t/ha) - Experiment 1.**

Factor mean response		Response with							
		-T	+T	-N	+N	-P	+P	-K	+K
T	+0.48	-	-	-1.38	+2.36	-1.00	+1.98	+0.88	+0.10
N(a)	-3.92	-5.75	-2.06	-	-	-6.63	-1.21	-13.33	+5.47
P	-2.56	-4.07	-1.08	-6.30	+0.15	-	-	-10.14	+5.47
K	+21.96	+22.36	+22.19	+12.60	+32.23	+14.43	+4.39	-	-

Significant effects : K +21. 96 *; NaK***; PK**; PKT****

Significance levels : *(P=0.05); **(P=0.01); *(P=0.001)**

Control Yields 32.05t/ha

S.E. +/-2.75 for differental response; +/-1.96 for mean response.

Table 3. **Yield differences of fresh turmeric rhizomes (t/ha) - Experiment 2.**

Factor mean response		Response with							
		-T	+T	-N	+N	-P	+P	-K	+K
T	-1.23	-	-	-0.98	-1.51	-4.42	+1.93	+5.52	+3.04
N(a)	-0.25	-0.03	-0.55	-	-	-2.81	+2.23	-0.13	-0.45
P	-0.73	-3.89	+2.46	-3.24	+1.81	-	-	-1.83	+0.40
K	+21.31	+17.07	+25.60	+21.49	+21.16	+20.21	+22.40	-	-

Significant effects: K +21.31*; KT***

Significance levels: *(P=0.05); *(P=0.001)**

Control yields 21.13 t/ha

S.E. +/-2.31 for differential response; +/-1.63 for mean response

Table 4. **Yields of fresh turmeric rhizomes (t/ha) - Experiment 3.**

	C	Na	Nu	Mean	C	P
	19.88	22.49	12.85	18.41	18.45	18.35
K	31.75	25.71	33.01	30.49	28.92	32.08
Mean	25.82	24.60	22.93		23.69	25.22
C	24.92	20.98	25.18	23.69		
P	26.71	28.21	20.71	25.22		

Significant effects K** (P=0.001)

As none of the interactions between the two factors were significantly different at P=0.05, a table exhibiting the three-way factor interactions has not been presented. Control yields = 20.58t/ha

Table 5. **Yield of fresh turmeric rhizomes (t/ha) - Experiment 4.**

	C	N(u)	Mean
C	28.41	16.06	22.24
K	27.84	22.57	25.21
K2	29.19	33.51	31.35
K3	28.69	30.67	29.68
K4	32.68	36.57	34.63
Mean	29.36	27.88	28.62

S.E. of means +/- 2.89
S.E. of difference between two adjacent means = +/- 4.09
L.S.D (P=0.05)=2.83
The treatment means were significantly different at P=0.001
Control yields = 28.41 t/ha

In Experiment 3 (Table 4) the yield response due to potassium was highly significant but applications of nitrogen (as sulphate of ammonia/urea) and phosphorus had no effect (Table 4). In Experiment 4 (Table 5) the response to potassium was again significant. Nitrogen as urea when applied with high levels of potassium (224 kg/ha) produced a significantly larger yield than did low levels of potassium (56 kg/ha) with and without nitrogen, or the high level of potassium applied in the absence of nitrogen. Nitrogen applied alone as urea significantly depressed yields. The nitrogen/potassium interaction is however by no means clear, as there were positive NK interactions in Experiments 1 & 4 but not in Experiment 2 & 3.

Wall & Hansell (1976) have stated that phosphate may be immobilised by the volcanic ash soils at Santa Cruz, and as available soil levels are consequently low, this would explain the significant response to phosphate in the presence of potassium (Experiment 1) but not the non significant PK interactions (Experiments 2 & 3). They also suggested that part of the response of turmeric to applications of sulphate of ammonia (Table 2) could be due to the sulphur component of the fertilizer, as absorbed sulphate in weathered ash soils has low solubility. Wall & Hansell (1976) noted that the soils were low in iron and boron and that manganese applications may be beneficial to plant growth. Limiting levels of these elements may explain the response of turmeric to applications of trace elements in the presence of potassium (Tables 2 & 3).

Soils in the Solomon Islands formed over clacareous material are low in available potassium (Ballantyne 1961; Wall & Hansell 1973) and Gollifer (1972) has reported yield responses due to applications of potassium in annual crops grown on these soils. Further investigations are required to define the optimal dose of potassium for the soils of the area. However applications of fertilizer are unlikely to be used on cash crops unless an active outlet can be developed for the produce.

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REFERENCES

BALLANTYNE, A.O. (1961). A report on the soil survey of the Guadalcanal Plain and other areas of the British Solomon Islands Protectorate; April 1959 - April 1961. p. 52-57. Departmental Report, Department of Agriculture, British Solomon Island Protectorate. 55 pp.

COCHRAN, W.G. and COX, G.M. (1966). *Experimental designs. Second edition*, John Wiley & Sons, New York. 811 pp.

GOLLIFER, D.E. (1972). Effect of applications of potassium on annual crops grown on soils of the Dala Series in Malaita, British solomon Islands. *Tropical Agriculture (Trinidad)*, 49: 261-288.

GOLLIFER, D.E. (1973). The introduction of spice crops into the British Solomon Islands. Proceedings of Conference on Spices, Tropical Products Institute, London. 151 pp.

PURSEGLOVE, J.W. (1972). *Tropical crops*: Monocotyledons, 2. Longman, London. 524 pp.

WALL, J.R.D. and HANSELL, J.R.F. (1973). Soils of some quaternary marine terraces in the British Solomon Islands Protectorate and some problems in their agricultural use. *New Zealand Journal of Agricultural Research*, 16: 271-286.

WALL, J.R.D. and HANSELL, J.R.F. (1976). *Land Resources of the Solomon Islands & Outer Islands,* Land Resources Study, 18, Overseas Development Ministry, Tolworth, Surrey, UK. 151 pp.

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