

EFFECTS OF DIFFERENT METHODS OF FERTILIZER APPLICATION ON THE YIELD AND QUALITY OF PINEAPPLE

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RINGKASAN

Kajian telah dijalankan untuk mengetahui kesan-kesan formula-formula baja yang berlainan yang sedang dijalankan oleh pihak pekebun kecil dan ladang (estate) ke atas hasil, kos/pulangan (returns), dan mutu tanaman nenas. Lima formula baja telah diuji di kawasan tanah gambut di negeri Johor. Pertumbuhan pokok telah direkodkan hingga 12 bulan selepas ditanam dan hasil telah dipungut selepas 18 bulan. Bentuk pertumbuhan adalah bergantung pada kadar pemakanan (nutrients) yang digunakan. Formula baja yang disyorkan oleh MARDI, menghasilkan buah yang lebih besar, hasil yang paling tinggi serta kos/pulangan per hektar yang tertinggi.

Perubahan hasil adalah selaras dengan kadar N yang digunakan. Kandungan gula ($^{\circ}$ Brix) dan asid (% citric acid) adalah tidak dipengaruhi oleh perlakuan (treatment) yang dijalankan.

Kepentingan unsur Zn dan kekerapan pembajaan perlu dikaji dengan lebih lanjut dan mendalam lagi.

INTRODUCTION

Various fertilizer formulations are being used for pineapple growth on peat soils in the estate and smallholders' fields of Johore. The smallholders are applying foliar spray with urea, copper sulphate and lime in the first fertilizer application three months after planting. Broadcasting of fertilizer by hand is practised only at six and nine months after planting with either three or four bags of the fertilizer mixture (30:1:32) per acre (ABDULLAH, *pers. comm.*, 1976). The estate has their own formulation and mode of application. These are modified wherever necessary depending on the costs of fertilizer (LEE, *pers. comm.*, 1976).

The variation from MARDI's recommended fertilizer schedule had prompted MARDI to investigate into the effects of the different fertilizer formulations on the yield, fruit quality and cost/returns in the pineapple production on peat.

MATERIALS AND METHODS

Initially a survey was carried out among the smallholders in the Pontian District, Johore, to determine the exact amount of fertilizer used (*Appendix 1*). The two levels *viz.*: T_3 and T_4 , commonly employed by the smallholders, were then incorporated into the study.

The investigation was carried out on 9.10.76 and ended on 9.4.78. The pH of the peat was 3.4. The average maximum and minimum temperature recorded were 32°C and 22°C , respectively. The experimental area received a total rainfall of 364 cm during the duration of the experiment.

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TABLE 1: THE FIVE TREATMENTS AND THE TOTAL AMOUNT OF APPLIED NUTRIENT IN EACH TREATMENT

TREATMENTS*	N (kg N/ha)	2 (kg P ₂ O ₅ /ha)	K (kg K ₂ O/ha)	Lime (kg/ha)	CuSO ₄ (kg/ha)	ZnSO ₄ (kg/ha)
TREATMENT 1 (T1) – MARDI's fertilizer recommendation**	224.0	5.6	239.7	33.6	2.2	2.2
TREATMENT 2 (T2) – Fertilizer formulations used by Simpang Rengam Estate	175.8	14.6	221.8	20.2	7.3	–
TREATMENT 3 (T3) – Smallholder's fertilizer formulation Urea spray + 2 hand broadcast (H/B) using three 50–kg bags of 30:1:32 mixture per H/B	140.0	3.4	121.0	49.3	3.4	–
TREATMENT 4 (T4) – Smallholder's fertilizer formulation Urea spray + 2 H/B using four 50–kg bags of 30:1:32 mixture per H/B	187.0	4.5	161.3	49.3	3.4	–
TREATMENT 5 (T5) – Suggested formulations. Five H/B using two 50–kg bags of 30:1:32 mixture per H/B	187.0	5.6	201.6	33.6	2.2	2.2

* For details refer Appendix 2.

** Interim recommendation agreed upon between MARDI and MPIB (Malaysia Pineapple Industrial Board).

Five treatments (*Table 1*) were used in the investigation. Treatments 3 and 4 were fertilizer levels commonly used by the smallholders. The mode and details of the manuring schedule for the various treatments are shown in *Appendix 2*.

The design used for the experiment was a Randomized Complete Block (RCB) with four replications. The plot size was 11 x 3 m. The planting distance employed was 1.2 x 0.6 x 0.3 m giving a population of 358000 plants per hectare. Uniform size of Masmerah slips were used as planting materials and the planting procedure was in accordance to TAY *et al.*, (1968).

Plant height, total number of leaves were recorded monthly until hormonizing (flowering induction) was carried out at 12th month after planting. The fruit weight, size, sugar (°Brix) and % citric acid contents were also determined at the end of the experiment.

RESULTS AND DISCUSSION

Plant Height and Number of Leaves

Figures 1 and *2* show the distributions of plant heights and number of leaves with time, respectively, for the various treatments. From *Figures 1* and *2* it is observed that T_2 , T_3 and T_4 resulted in taller plants with more number of leaves in the first six months of growth.

Subsequently, however, this growth pattern changed following the order of $T_1 > T_5 > T_4 > T_2 > T_3$. This illustrated that foliar application of fertilizer could have probably benefited the pineapple plant by encouraging vegetative growth. However, the benefits of a taller plant with more leaves were not carried into later growth of the pineapple plants. Seven months after planting the trend was noted to follow the level of nutrients applied. Thus, at the end of the fertilizer application schedule, T_1 recorded the biggest plant while T_3 with the lowest level of applied N recorded the smallest plant with the least number of leaves. This was also reflected in the yield figures.

Effects on Yield

The effect of different treatments on yield is illustrated in *Table 2*. Fertilizer applications as recommended by MARDI gave the highest yield per hectare, followed by T_5 while the lowest yield was obtained from T_3 . No significant difference in yield was observed between T_4 and T_2 which received almost similar amount of N. The yield pattern therefore corresponded with the amount of applied fertilizer notably with the N levels in the various treatments.

Repeated foliar sprays of fertilizer did not increase the efficiency of nutrients uptake by the pineapple plant. This was inferred from the low yields obtained from such treatments. This observation was contradictory to the findings of OLIVER & WEBSTER (1969) who found that there was no significant yield differences in the method of fertilizer application either by spraying or soil application though the trend was in favour of the latter. Thus one can say that under the present experiment hand broadcast as in T_1 and T_5 were superior to foliar spray though the main yield determining factor is still the N levels.

Besides the effects of different N levels on the yield differences between T_1 and T_5 , the differences could also be due to the ineffectiveness of the two later fertilizer applications (10th and 12th months) in T_5 . It was also noted that T_1 and T_5 which received $ZnSO_4$ gave higher yields than T_2 , T_3 and T_4 . Perhaps Zn is an important element for pineapple which may be deficient in peat soil. TAY (1972) reported some Zn deficiency symptoms in pineapple. These two aspects can be investigated further.

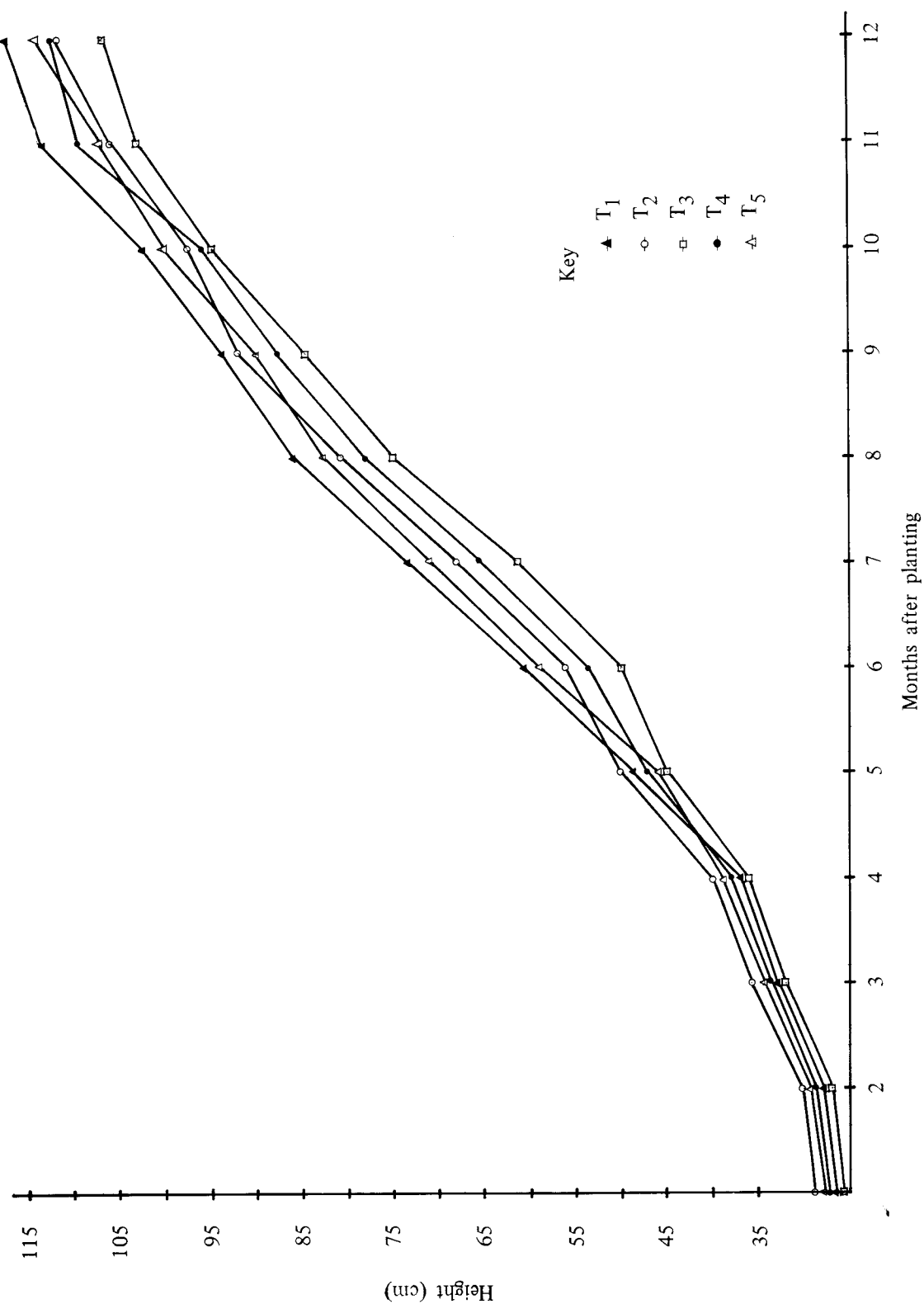


Figure 1. The effects of different methods of fertilizer application on plant height.

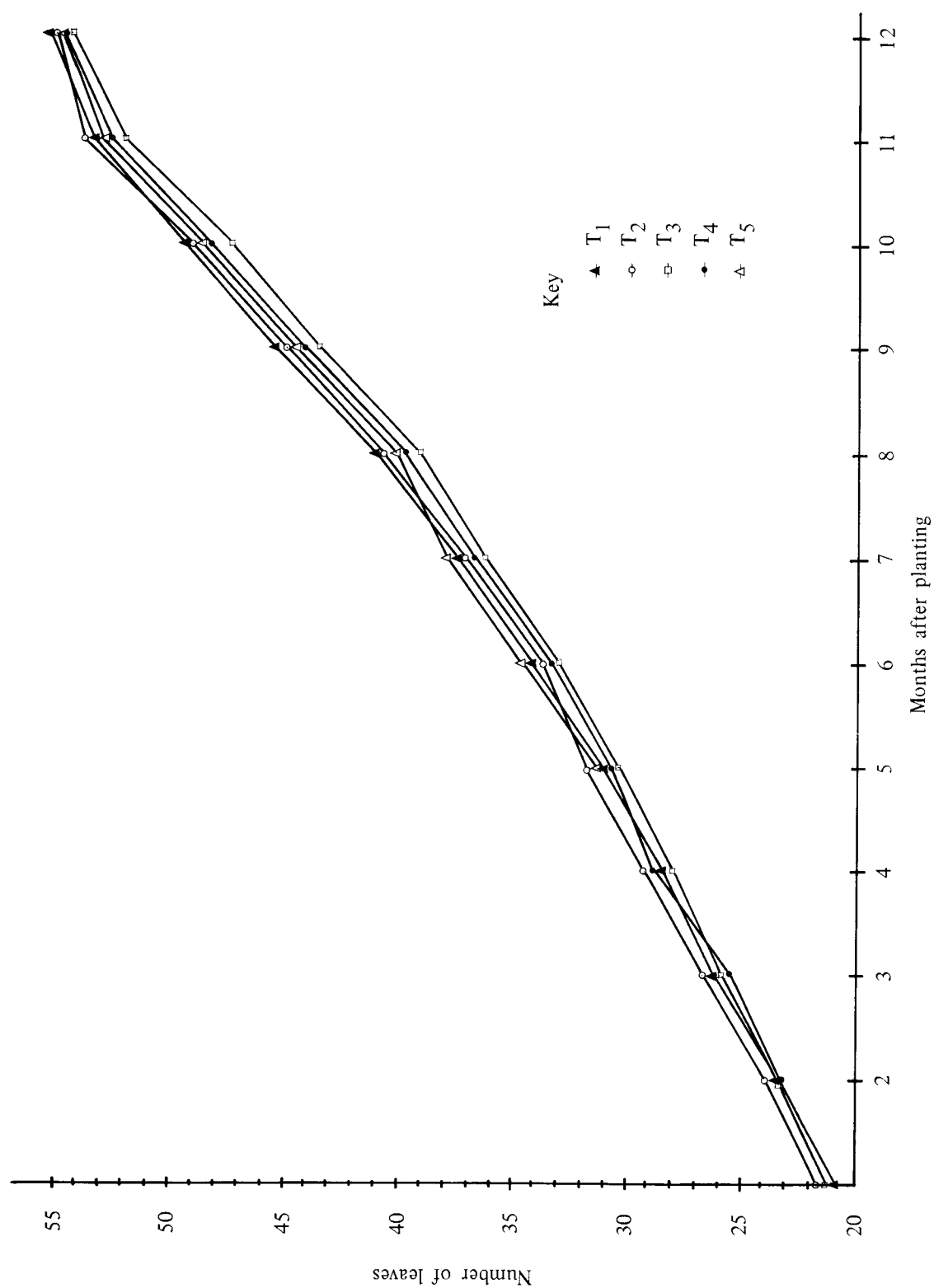


Figure 2. The effects of different methods of fertilizer application on total number of leaves.

TABLE 2: EFFECTS OF DIFFERENT FERTILIZER APPLICATION ON THE YIELD OF PINEAPPLE IN M TONS PER HECTARE (DMR TEST AT P = 0.05)

Treatments	Ranked Means
T1	45.37
T5	42.39
T4	41.82
T2	41.74
T3	41.05
\bar{x}	42.46
s.e \bar{x}	0.35
c.v %	2.03

Treatments covered by the bar indicated non-significance at the 5 % level of probability.

Thus one can conclude under the present experiment that the main attribute to the yield differences between treatments is the levels of N applied.

Fruit Size (Length and Diameter)

As shown in Table 3, T₁ gave a significantly bigger fruit size. The ranked position of the fruit size corresponded approximately with the levels of N applied per hectare.

Foliar spray did not increase fruit size suggested that the amount of nutrients applied is more critical in determining the fruit size. Foliar spray probably encouraged vegetative growth at the expense of yield.

Sugar Content (°Brix and % Citric Acid)

No significant differences were determined between the various treatments in the sugar content and % citric acid in the fruit (Table 3). This showed that fruit quality in terms of sugar content was not affected by the nutrients applied either in the form of spray or hand broadcast.

Cost/Returns

Assuming all the cost factors were constant except for fertilizer, MARDI's recommendation gave the highest returns/ha (column 11 in Table 4). This value exceeded values obtained from other treatments by M\$157–190 per hectare (column 12 in Table 4). The extra yield compensated for the higher expenditure on fertilizer in MARDI's recommendation. The profit margin per hectare from T₁ could have been greater if the costs of fertilizer application were considered, as hand broadcast would require less man hours compared to foliar spray.

CONCLUSION

Vegetative growth in terms of plant height and number of leaves and the yield figures were primarily dependent on the levels of N applied.

MARDI's recommendation is superior to other treatments in the pineapple fruit size, yield and cost/returns per hectare.

Further investigation could be carried out in the study of the requirement of trace elements especially Zn and the time of application of fertilizer.

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TABLE 3: EFFECTS OF DIFFERENT FERTILIZER APPLICATION ON THE LENGTH, DIAMETER, SUGAR CONTENT ($^{\circ}$ BRIX) AND % CITRIC ACID OF THE PINEAPPLE FRUIT (DMR TEST AT P = 0.05)

Treatments	Length Ranked Means (cm)	Treatments	Diameter Ranked Means (cm)	Treatments	Sugar Content ($^{\circ}$ Brix) Ranked Means	Treatments	% Citric Acid Ranked Means
T1	17.3	T1	12.4	T1	11.4	T2	0.67
T5	16.3	T5	12.2	T4	11.4	T5	0.65
T2	15.8	T3	11.9	T2	11.3	T4	0.65
T4	15.5	T2	11.8	T3	11.3	T1	0.63
T3	15.4	T4	11.8	T5	11.1	T3	0.62
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\bar{x} = 16.1		\bar{x} = 12.0		\bar{x} = 11.3		\bar{x} = 0.64	
se \bar{x} = 0.260		se \bar{x} = 0.1083		cv % = 3.2		cv % = 5.4	
cv % = 3.2		cv % = 1.8					

Treatments covered by the bar indicated non-significance at the 5 % level of probability.

TABLE 4: EFFECTS OF DIFFERENT METHODS OF FERTILIZER APPLICATION ON THE COST/RETURN
(BASED ON MARCH 1978 PRICES)

Treatment	1	2	3	4	5	6	7	8	9	10	11	12
	Pineapple mixture 30:1:32 @ \$18.54 per 50 kg bag M\$	Urea @ \$650 per metric ton M\$	TSP \$510/ metric ton M\$	KCL \$254/m. ton M\$	CuSO ₄ @ \$3600 /m ton M\$	ZnSO ₄ @ \$1050 /m ton M\$	Lime @ \$200/m ton M\$	Total ferti- lizer cost/ ha M\$	Yield in metric tons per/ha M\$	Av. Gross returns per ha @ 4.2 cts /kg M\$	Returns after deduction of ferti- lizer (10-8) M\$	Defference in returns (Treat- ment 1 vs. the rest) M\$
1	222.48	-	-	-	3.27	0.95	2.72	566.67	45.37	4192.19	3625.52	0
2	-	100.45	6.26	38.10	10.64	-	1.64	388.01	41.74	3856.78	3468.77	156.75
3	111.24	16.25	-	-	4.90	-	4.00	336.88	41.05	3793.02	3456.14	169.38
4	148.32	16.25	-	-	4.90	-	4.00	428.47	41.82	3864.17	3435.70	189.82
5	185.40	-	-	-	3.27	0.95	2.72	475.08	42.39	3916.84	3441.76	183.76

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SUMMARY

The present study was carried out to investigate the effects of different fertilizer formulations as practised by smallholders and estate on the yield, cost/returns and fruit quality of pineapple. Five fertilizer formulations were tested on cultivated peat in Johore. Plant growth was recorded up to the 12th month and the yield and fruit quality were determined at 18 months after planting. The pattern of vegetative growth followed the levels of nutrients applied. MARDI's recommendation yielded bigger fruits, the highest yield and cost/return per hectare. The yield trend corresponded with the level of N applied. The Brix and % citric acid were not affected by the various treatments. The importance of Zn and time of application are areas that need further investigation.

REFERENCES

- OLIVER, M.C. and WEBSTER, G.S. (1969). Nitrogen for pineapple which method of application? *Fmg. S. Afr.* 44: 37-38.
- TAY, T.H., WEE, Y.C. and CHONG, W.S. (1969). The nutritional requirements of pineapple *Ananas comosus* (L) Merr. var. Singapore Spanish on peat soil in Malaya. I. Effect of nitrogen, phosphorus and potassium on yield, sugar and acid content of the fruit. *Malays. Agric. J.* 46: 458-68.
- TAY, T.H. (1972). Crop production on West Malaysian Peat. 4th. Int. Peat Cong. Vol. 3, 75-88.

APPENDIX 1: SUMMARY OF A SURVEY ON FERTILIZER APPLICATIONS IN THE FIRST FOLIAR SPRAY FROM 22 PINEAPPLE SMALLHOLDERS IN PONTIAN DISTRICT, JOHORE

Urea Kg/ha Applied	Nos. of smallholders	CuSO ₄ kg/ha applied	Nos. of smallholders	Lime kg/ha applied	Nos. of small- holders
45	4	1.12	4	45	3
46-56	4	2.24	4	46-56*	8
57-67*	8	3.36**	11	57-67	5
68-78	1	4.48	3	68-78	2
79	5			79	4

* The average value of these figures were taken as the standard foliar application of the smallholders.

** This value taken as the average.

APPENDIX 2: MANURING SCHEDULE OF THE VARIOUS TREATMENTS

Treatments	Time and mode of application	kg/ha
1. MARDI'S recommendation	3rd month hand broadcast (H/B) at 4 bags of 30:1:32 pineapple mixture	355 S/A 5.3 CIRP 133 KCL 2.2 CuSO ₄ 2.2 ZnSO ₄ 33.6 Limestone
	6th month H/B	— as above — (without trace elements)
	9th month H/B	— as in 6th month H/B
2. Estate's practice	1st month spray	45 Urea 3.4 TSP 1.7 CuSO ₄ 4.5 Limestone
	3rd month spray	50.4 Urea 3.4 TSP 33.6 KCL 1.7 CuSO ₄ 4.5 Limestone
	5th month spray	— as in 3rd month spray —
	6th month H/B	157 Urea 16.8 TSP 258 KCL
	9th month spray	56 Urea 3.4 TSP 45 KCL 2.2 CuSO ₄ 6.7 Limestone
	12th month spray (together with flower induction hormoning)	22.4 Urea
3. Smallholders — 2½ months Urea spray +2 Hand Broadcast @ 3 bags of (30:1:32) mixture per hand <u>broadcast</u>	At 2½ month spray	62 Urea 3.4 CuSO ₄ 49 Limestone
	6th month H/B	267 S/A 3.9 CIRP 101 KCL
	9th month H/B	— as in 6th month H/B

Treatments	Times and mode of application	kg/ha
4. Smallholders @ 2½ months Urea spray + 2 hand broadcast @ 4 bags of (30:1:32) mixture per hand broadcast	At 2½ month spray	62 Urea 3.4 CuSO ₄ 49 Limestone
	6th month H/B	355 S/A 5.3 CIRP 133 KCL
	9th month H/B	— as in 6th month H/B —
5. Suggested application @ 2 bags of 30:1:32 per handbroadcast	4th month H/B	178 S/A 2.6 CIRP 67 KCL 2.2 CuSO ₄ 2.2 ZnSO ₄ 33.6 Limestone
	6th month H/B	— as in 4 months H/B without trace elements and Limestone
	8th month H/B	”
	10th month H/B	”
	12th month H/B	”

* S/A = Ammonium sulphate
 CIRP = Christmas Island Rock Phosphate
 KCL = Muriate of Potash