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COMPARISON OF FOUR FERTILIZER SCHEDULES FOR PINEAPPLES IN CENTRAL QUEENSLAND

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SUMMARY

Four fertilizer schedules for pineapples were compared in the Yeppoon district of Queensland. The soil was very stony, sandy clay loam with a high available potassium content. The highest yields were obtained from a schedule which applied side-dressings of a mixed NPK fertilizer five times a year throughout the trial.

Intermediate yields were obtained from schedules which (a) applied potassium in a preplant dressing and in side-dressings in the second summer of growth, nitrogen in side-dressings in the summers, and urea sprays in the winters; and (b) applied potassium in a preplant dressing and nitrogen in urea sprays throughout the trial. The lowest yields were from a schedule which provided for preplant potassium and no nitrogen.

I. INTRODUCTION

Prior to 1960, the fertilizer schedule recommended for pineapples in Queensland consisted of regular side-dressings with a mixed NPK fertilizer (Mitchell and Cannon 1953). In 1960, a schedule was suggested which involved a preplant dressing of potash and phosphate followed by 10% urea sprays every 8 weeks (Cannon 1960). More recently, a new "balanced schedule" has been recommended which is based on detailed nutrient uptake data obtained by Departmental officers at the Pineapple Research Laboratory at Nambour (Black 1965; Anon. 1967).

The Yeppoon district, some 350 miles north of Nambour, differs from the Nambour district in both climate and soil type. Before recommending the new "balanced schedule" to growers in that district it was considered necessary to conduct trials comparing the new schedule with the two established schedules. A treatment involving preplant dressings of potash and phosphate but no nitrogen was included in the trials to evaluate the nitrogen-supplying ability of the soil. Trials were conducted on both virgin and replant soil.

II. MATERIALS AND METHODS

(a) Treatments and Design

The treatments were as follows (all mixed fertilizers expressed as N: P: K percentages):—

(1) No applied nitrogen—

Preplant: 0:2:31 at 70 lb/1,000 plants.

(2) Urea spray schedule—

Preplant: 0:2:31 at 70 lb/1,000 plants.

Urea sprays: 10% urea sprays applied every 6 weeks at a rate just sufficient to wet the leaves (46 lb N/1,000 plants actually applied throughout the trials).

(3) Side-dressings schedule—

Side-dressings: 11:2·5:9 fertilizer applied at 50 lb/1,000 plants at planting and in December, February, March, April and September each year thereafter.

(4) Balanced schedule—

Preplant: 0:2:31 at 70 lb/1,000 plants.

At planting: One 10% urea spray at a rate just sufficient to wet the leaves.

First summer: Two ammonium sulphate side-dressings at 25 lb/1,000 plants applied in December and February.

First winter: Four 10% urea sprays applied at intervals of 6 weeks commencing mid April at a rate just sufficient to wet the leaves (8 lb N/1,000 plants actually applied).

Second summer: Three side-dressings each containing 6·3 lb N, 1 lb P and 8 lb K per 1,000 plants applied in October, December and February.

Second winter: Four 10% sprays applied at intervals of 6 weeks commencing mid April (10 lb N/1,000 plants actually applied).

All treatments received a preplant dressing of 0·3 lb Cu and 0·3 lb Zn, and iron sprays as required.

Two trials were conducted, No. 1 on a virgin site and No. 2 on an adjacent replant site. Each trial contained the four treatments replicated five times in a randomized block design. Plots contained 60 plants, 12 of which were internal guard plants.

(b) Soil and Cultural Data

Both trials were on the same soil type, a very stony, sandy clay loam with the following analysis:

Site	pH	Total N (%)	Avail. P_2O_5 (p.p.m.)	Repl. K + (m-equiv. %)
Virgin	6·2	0·30	42	0·77
Replant ..	6·0	0·25	129	0·65

Both sites were on steeply sloping hillsides, and the virgin site was often exposed to strong winds.

Graded slips of the Smooth Cayenne variety were planted in October 1963. The plants were laid out in double rows spaced 6 ft apart (centre to centre) with 2 ft between each of the two paired rows and 1 ft between plants in the row.

Flowering for the plant crop was forced in May 1964 with two applications of saturated acetylene solution and the crop was harvested in January 1965. Flowering for the ratoon crop was forced in May 1965 with two applications of 10 p.p.m. alpha naphthalene acetic acid and the crop was harvested in January and February 1966.

III. RESULTS

(a) Yield

Yield data covering the number of fruit harvested, the average fruit weight and the total weight of fruit harvested are presented for the plant crop in Table 1, for the ratoon crop in Table 2 and for the whole period of the trials in Table 3. These data have been converted to a per 1,000 plants basis.

TABLE 1

PLANT CROP YIELDS

Treatment	No. of Fruit per 1,000 Plants	Mean Fruit Weight (tops off) (lb)	Yield of Fruit (tons/1,000 plants)
Trial 1: Virgin Soil			
1. Preplant K and P, no N	987	2·92	1·29
2. Preplant K and P, urea sprays ..	979	3·23	1·41
3. 11 : 2·5 : 9 side-dressings	996	3·44	1·53
4. P.R.L. balanced schedule	992	3·24	1·44
Necessary differences for significance 5%	28	0·21	0·11
Necessary differences for significance 1%	39	0·30	0·15
	N.S.	2,3,4≫1	3≫1 2,4>1 3>2
Trial 2: Replant Soil			
1. Preplant K and P, no N	975	2·61	1·13
2. Preplant K and P, urea sprays ..	967	2·96	1·27
3. 11 : 2·5 : 9 side-dressings	992	3·24	1·44
4. P.R.L. balanced schedule	987	3·06	1·34
Necessary differences for significance 5%	33	0·16	0·07
Necessary differences for significance 1%	46	0·23	0·09
	N.S.	2,3,4≫1 3≫2 3>4	2,3,4≫1 3≫2 4>2 3>4

TABLE 2

RATOON CROP YIELDS

Treatment	No. of Fruit per 1,000 Plants	Mean Fruit Weight (tops off) (lb)	Yield of Fruit (tons/1,000 plants)
Trial 1: Virgin Soil			
1. Preplant K and P, no N	1,087	3·20	1·53
2. Preplant K and P, urea sprays ..	733	2·86	0·93
3. 11 : 2·5 : 9 side-dressings	942	3·23	1·35
4. P.R.L. balanced schedule	783	3·01	1·06
Necessary differences for significance 5%	206	0·32	0·21
Necessary differences for significance 1%	289	0·45	0·30
	1≫2,4 3>2	N.S.	1,3≫2 1≫4 3>4
Trial 2: Replant Soil			
1. Preplant K and P, no N	733	3·35	1·12
2. Preplant K and P, urea sprays ..	871	4·10	1·61
3. 11 : 2·5 : 9 side-dressings	1,096	3·90	1·91
4. P.R.L. balanced schedule	950	4·03	1·70
Necessary differences for significance 5%	216	0·29	0·39
Necessary differences for significance 1%	303	0·40	0·55
	3≫1 3>2 4>1	2,3,4≫1	3,4≫1 2>1

TABLE 3

TOTAL CROP RESULTS

Treatment	No. of Fruit per 1,000 Plants	Yield of Fruit (tons/1,000 plants)
Trial 1: Virgin Soil		
1. Preplant K and P, no N ..	2,075	2·82
2. Preplant K and P, urea sprays	1,712	2·34
3. 11 : 2·5 : 9 side-dressings ..	1,937	2·88
4. P.R.L. balanced schedule ..	1,775	2·49
Necessary differences for significance 5%	216	0·25
Necessary differences for significance 1%	302	0·35
	1>2,4 3>2	1,3≫2 3≫4 1>4
Trial 2: Replant Soil		
1. Preplant K and P, no N ..	1,708	2·26
2. Preplant K and P, urea sprays	1,837	2·88
3. 11 : 2·5 : 9 side-dressings ..	2,087	3·34
4. P.R.L. balanced schedule ..	1,937	3·05
Necessary differences for significance 5%	223	0·39
Necessary differences for significance 1%	313	0·54
	3≫1 3>2 4>1	2,3,4≫1 3>2

(b) Slip and Sucker Counts

Slips were removed from the plant crop fruit stalks on February 15, 1965, and weighed fresh. On June 9, 1965, a count was made of the number of suckers large enough to flower for the ratoon crop. These results are presented in Table 4.

TABLE 4

SLIP AND SUCKER PRODUCTION

Treatment	Weight of Slips per 1,000 Plants* (lb)	No. of Suckers per 1,000 Plants†
Trial 1: Virgin Soil		
1. Preplant K and P, no N ..	310	1,296
2. Preplant K and P, urea sprays	344	1,394
3. 11 : 2·5 : 9 side-dressings ..	678	1,410
4. P.R.L. balanced schedule ..	354	1,408
Necessary differences for significance 5%	17·4	147
Necessary differences for significance 1%	24·5	206
	3⩾1,2,4	N.S.
Trial 2: Replant Soil		
1. Preplant K and P, no N ..	562	936
2. Preplant K and P, urea sprays	1,198	1,112
3. 11 : 2·5 : 9 side-dressings ..	1,502	1,322
4. P.R.L. balanced schedule ..	1,332	1,228
Necessary differences for significance 5%	358	189
Necessary differences for significance 1%	502	265
	2,3,4⩾1	3,4⩾1 3>2

* Feb. 15, 1965. † Apr. 9, 1965.

(c) Fruit Measurements

A sample of four fruit was taken from each plot during each crop. The sample was taken from a plot when one-third of its fruit had been harvested. Measurements were made of the number of eyes per fruit and the weight of fruit per eye. The juice was then extracted from a representative longitudinal quarter of each fruit and its total soluble solids content was determined with a refractometer. Acid concentration in the juice was determined by titrating with $^1/_{10}$N NaOH and converting the results to percentage citric acid equivalent. These results are presented in Tables 5 and 6.

TABLE 5

FRUIT MEASUREMENTS, PLANT CROP

Treatment	No. of Eyes	Weight/Eye (g)	Sugar in Juice (%)	Acid in Juice (%)
Trial 1: Virgin Soil				
1. Preplant K and P, no N	99·8	12·62	13·34	0·902
2. Preplant K and P, urea sprays ..	106·4	13·53	12·64	0·862
3. 11 : 2·5 : 9 side-dressings	105·2	14·61	12·86	0·758
4. P.R.L. balanced schedule	107·0	13·76	12·26	0·814
Necessary differences for significance 5%	9·5	1·40	0·46	0·126
Necessary differences for significance 1%	13·3	1·96	0·64	0·177
	N.S.	3≫1	1≫2,4 1>3>4	1>3
Trial 2: Replant Soil				
1. Preplant K and P, no N	94·6	12·22	13·44	0·696
2. Preplant K and P, urea sprays ..	93·8	13·69	13·10	0·584
3. 11 : 2·5 : 9 side-dressings	102·4	14·41	13·02	0·594
4. P.R.L. balanced schedule	98·2	13·75	13·42	0·586
Necessary differences for significance 5%	7·0	1·49	0·84	0·066
Necessary differences for significance 1%	9·9	2·09	1·17	0·092
	3>1,2	3≫1 4>1	N.S.	1≫2,3,4

TABLE 6

FRUIT MEASUREMENTS, RATOON CROP

Treatment	No. of Eyes	Weight/Eye (g)	Sugar in Juice (%)	Acid in Juice (%)
Trial 1: Virgin Soil				
1. Preplant K and P, no N	105·2	13·66	13·34	0·690
2. Preplant K and P, urea sprays ..	108·0	12·62	12·70	0·756
3. 11 : 2·5 : 9 side-dressings	117·2	13·09	13·04	0·716
4. P.R.L. balanced schedule	110·4	13·83	13·72	0·618
Necessary differences for significance 5%	7·0	1·25	1·02	0·144
Necessary differences for significance 1%	9·8	1·76	1·43	0·201
	3≫1 3>2	N.S.	N.S.	N.S.
Trial 2: Replant Soil				
1. Preplant K and P, no N	110·0	14·33	13·12	0·658
2. Preplant K and P, urea sprays ..	124·4	14·86	12·10	0·450
3. 11 : 2·5 : 9 side-dressings	117·6	14·56	12·82	0·528
4. P.R.L. balanced schedule	123·2	14·83	13·12	0·472
Necessary differences for significance 5%	8·1	1·15	0·61	0·117
Necessary differences for significance 1%	11·3	1·61	0·86	0·165
	2,4≫1	N.S.	1,4≫2 3>2	1≫2,4 1>3

(d) Leaf Analysis

Leaf samples for analysis were taken on three occasions by removing the longest leaf from six plants per plot. The sampling dates were Feb. 18, 1964, May 26, 1964 (at the time of plant crop flower initiation), and Apr. 21, 1965 (at the time of ratoon crop flower initiation). Leaf samples on the last date were taken from the suckers on six plants per plot.

These whole-leaf samples were dried, ground and analysed. Nitrogen was determined by a modified semimicro Kjeldahl method, phosphorus by a molybdo-vanadate method and potassium by flame photometry following water extraction (Mathis 1955).

The results of these analyses are listed in Tables 7–9.

TABLE 7

LEAF NITROGEN CONTENT
% N, oven-dry basis

Treatment	Sample Dates		
	18.ii.64	26.v.64	21.iv.65
Trial 1: Virgin Soil			
1. Preplant K and P, no N	1·37	1·23	1·15
2. Preplant K and P, urea sprays ..	1·78	1·51	1·83
3. 11 : 2·5 : 9 side-dressings	1·78	1·69	1·93
4. P.R.L. balanced schedule	1·88	1·62	2·45
Necessary differences for significance 5%	0·20	0·17	0·12
Necessary differences for significance 1%	0·28	0·23	0·17
	2,3,4≫1	2,3,4≫1 3>2	4≫1,2,3 2,3≫1
Trial 2: Replant Soil			
1. Preplant K and P, no N	1·31	0·96	1·04
2. Preplant K and P, urea sprays ..	1·64	1·28	1·50
3. 11 : 2·5 : 9 side-dressings	1·71	1·36	1·68
4. P.R.L. balanced schedule	1·68	1·51	1·92
Necessary differences for significance 5%	0·32	0·15	0·11
Necessary differences for significance 1%	0·45	0·21	0·15
	2,3,4>1	2,3,4≫1 4≫2	4≫1,2,3 3≫2≫1

TABLE 8

LEAF PHOSPHORUS CONTENT
% P, oven-dry basis

Treatment	Sample Dates		
	18.ii.64	26.v.64	21.iv.65
Trial 1: Virgin Soil			
1. Preplant K and P, no N	0·133	0·125	0·110
2. Preplant K and P, urea sprays ..	0·120	0·108	0·098
3. 11 : 2·5 : 9 side-dressings	0·104	0·129	0·139
4. P.R.L. balanced schedule	0·109	0·112	0·127
Necessary differences for significance 5%	0·014	0·009	0·010
Necessary differences for significance 1%	0·019	0·013	0·013
	1≫3,4 2>3	3≫2,4 1≫2 1>4	3,4≫1,2 3>4 1>2
Trial 2: Replant Soil			
1. Preplant K and P, no N	0·156	0·162	0·192
2. Preplant K and P, urea sprays ..	0·139	0·130	0·124
3. 11 : 2·5 : 9 side-dressings	0·140	0·128	0·139
4. P.R.L. balanced schedule	0·133	0·123	0·129
Necessary differences for significance 5%	0·029	0·019	0·020
Necessary differences for significance 1%	0·040	0·026	0·028
	N.S.	1≫2,3,4	1≫2,3,4

TABLE 9

LEAF POTASSIUM CONTENT
% K, oven-dry basis

Treatment	Sample Dates		
	18.ii.64	26.v.64	21.iv.65
Trial 1: Virgin Soil			
1. Preplant K and P, no N	4·99	3·50	2·34
2. Preplant K and P, urea sprays ..	4·57	3·21	2·14
3. 11 : 2·5 : 9 side-dressings	3·63	3·13	2·20
4. P.R.L. balanced schedule	4·58	3·05	3·13
Necessary differences for significance 5%	0·37	0·28	0·21
Necessary differences for significance 1%	0·52	0·39	0·29
	1,2,4≫3 1>2,4	1≫4 1>2,3	4≫1,2,3
Trial 2: Replant Soil			
1. Preplant K and P, no N	4·57	3·10	2·52
2. Preplant K and P, urea sprays ..	4·88	2·96	1·81
3. 11 : 2·5 : 9 side-dressings	3·88	2·87	1·99
4. P.R.L. balanced schedule	4·95	3·10	2·73
Necessary differences for significance 5%	0·95	0·56	0·26
Necessary differences for significance 1%	1·33	0·79	0·37
	2,4>3	N.S.	1,4≫2,3

IV. DISCUSSION

(a) Fruit Yield

In general, treatment 3, the side-dressing schedule, outyielded all other treatments. In the plant crop from both trials, it was significantly better than all treatments except treatment 4 in the virgin soil trial. In the ratoon crop, it was significantly better than treatments 2 and 4 in the virgin soil trial and treatment 1 in the replant soil trial.

The next highest yields came from treatment 4 (the P.R.L. balanced schedule) and treatment 2 (the urea spray schedule) in that order. These two treatments were, however, significantly different from each other only in the plant crop of the replant soil trial.

Treatment 1, the no-nitrogen treatment, had a significantly lower yield than all other treatments in all crops except the ratoon crop from the virgin soil trial. In this crop it gave, rather surprisingly, the highest yield of all.

The numbers of fruit produced in the plant crop by all treatments were high and approximately equal. All differences in yield were thus due to differences in fruit weight. In the ratoon crop, yield was influenced by both fruit number and fruit weight. In the virgin soil trial, the orders of treatments for decreasing fruit weight and fruit numbers were the same but in the replant soil trial this was not so. In this case, the number of fruit had a greater influence on fruit yield than had mean fruit weight.

(b) Fruit Measurements

Measurements of the number of eyes per fruit and the weight of fruit per eye both show the same trends, as does average fruit weight.

Differences between treatments in fruit sugar and acid levels are quite variable. The only pattern obvious is that treatment 1, with no nitrogen, is high in both sugar and acid, particularly in the plant crop.

(c) Slip and Sucker Production

The order of treatments for slip and sucker production is the same as that for fruit yield, viz. treatment 3 highest and treatments 4, 2 and 1 next in decreasing order of magnitude.

(d) Causes of the Yield Differences between the Treatments

The aim of this trial was to compare the new P.R.L. balanced schedule with two established fertilizer schedules and a no-nitrogen schedule. Because the schedules differ in several important respects—viz. timing, rate of application and method of application of both nitrogen and potassium—it is not possible to identify with certainty the factor that has most influenced the yield differences obtained.

Leaf analysis results, however, show some trends which tie in with the yield results obtained.

The no-nitrogen schedule (treatment 1), which had the lowest yields of fruit, slips and suckers of all treatments, also had the lowest leaf nitrogen levels. No doubt this treatment was nitrogen deficient. Leaf analysis does not indicate any reason for the anomalous high yield obtained from this treatment in the ratoon crop on the virgin soil.

The urea spray (treatment 2) and balanced schedule (treatment 4), which produced somewhat similar yields, also had similar leaf nutrient levels. In the plant crop from the replant soil, the balanced schedule out-yielded the urea spray schedule and at the time of forcing it also had a higher leaf nitrogen content. This fact suggests that the urea spray schedule supplied insufficient nitrogen, at least on replant soil.

At the time of forcing for the ratoon crop in both trials the balanced schedule had higher leaf potassium and nitrogen but did not produce a greater yield. The extra potassium may have been unnecessary on the high potash soil or it may have been supplied too late to benefit the ratoon crop. In this trial, the ratoon crop was harvested only 12 months after the plant crop.

Treatment 3, the side-dressing schedule, which produced the highest yields of all (except for the anomalous high yield of treatment 1, on one occasion), differed from the other treatments mainly in leaf potassium levels in February 1964. This was 4 months after planting. The lower leaf level of potassium from this treatment reflected the fact that it supplied potassium in small side-dressings throughout the trial whereas the other treatments supplied potassium in a heavy preplant dressing.

The side-dressing schedule also supplied nitrogen at a slightly higher rate than the other schedules during the first summer and autumn of growth. This effect does not, however, show up in the leaf nitrogen levels.

Because both trials were on steeply sloping sites of extremely stony soil, it was not possible to bed the soil or mechanically incorporate the preplant dressings. These were spread over the ground in the row position and the only incorporation was where the surface of the soil was disturbed in planting the slips. This is the general practice on these soils in the Yeppoon district. It means, however, that the preplant dressing is incorporated in the surface of the soil only, where it is available to the plants as soon as growth commences. Because of this method of incorporation and/or the fact that the soil was already naturally high in potassium, the preplant dressings may well have produced excessive concentrations of potassium and consequently lower yields than the side-dressing treatment.

(e) Virgin Soil versus Replant Soil

Soil analysis showed little difference in nitrogen and potassium content between the soils. This was reflected in leaf analysis and yield results, which were similar from both trials. The virgin soil site was, however, the more exposed

of the two. A period of cold wind in the second autumn of the trials caused obvious leaf damage on this site and no doubt contributed to the lower ratoon yields from this trial.

Available soil phosphorus was higher in the replant soil trial and so were leaf levels of phosphorus in this trial.

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