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INVESTIGATION OF PINEAPPLE FERTILIZING METHODS AND FLOWER INDUCTION

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SUMMARY

The fertilizing methods used included several forms, rates and times of application of nitrogen and potassium fertilizers.

Greater yields were obtained from nitrogen supplied in urea sprays than in side-dressings. No differences in yield were obtained from the various rates and frequencies of urea spraying used. Solid urea side-dressings gave the same yield as ammonium sulphate side-dressings. Applying some nitrogen in the base-dressing gave no improvement in yield.

A base-dressing of potash gave a higher plant crop yield but a lower ratoon crop yield than side-dressings of potash.

Forcing produced a higher yield from all crops than did natural flowering. There were more fruit with forced flowering but their average weight was less.

The effectiveness of the forcing treatment in inducing flowering was not influenced by the different fertilizer treatments. However, when potash was used as a side-dressing, fewer plants flowered naturally for the plant crop than when it was applied as a basal dressing.

I. INTRODUCTION

Prior to 1957 the recommended fertilizer schedule for pineapples in Queensland involved regular side-dressings of mixed fertilizers and sulphate of ammonia. These were applied at a fixed rate throughout the life of the plants (Mitchell and Cannon 1953).

A modification of this schedule, which involved the application of nitrogen after flowering at twice the rate at which it was applied before flowering, was suggested by Cannon (1957).

In 1960, a new schedule involving two major changes was suggested (Cannon 1960). These changes involved the use of (a) a preplant dressing to supply phosphorus and potassium for the whole plant and ratoon crop cycle, and (b) foliar sprays of 10% urea every 8 weeks to supply nitrogen.

In 1963 a trial was established in the Dundowran district, near Maryborough, to investigate the applicability of the new schedule to that district. The trial also investigated the influence of fertilizer treatments on natural and induced flowering.

II. MATERIALS AND METHODS

(a) Location and Design

The trial was located on the property of M. L. and L. R. Neilsen, Dundowran. The soil was a silty clay loam with the following analysis:

Depth (in.)	pH	Total N (%)	Avail. P_2O_5 (p.p.m.)	Repl. K (m-equiv. %)
0–6	5·1	0·12	55	0·12
6–12	4·9	0·11	40	0·08

A 9 x 4 randomized block design was used, with plots split for forcing treatments. There were 100 plants per plot and 50 plants per sub-plot.

(b) Fertilizer Treatments

All treatments received a base-dressing of 14·3 lb of superphosphate per 1,000 plants and all except treatment 9 received a base-dressing of 53·5 lb of potassium sulphate per 1,000 plants. The fertilizer treatments fall into two groups:

Treatments 1-5.—Urea spray group, receiving 10% urea sprays at the rates and time intervals indicated.

(1) 8-weekly sprays of 3·6 gal per 1,000 plants.

(2) 6-weekly sprays of 3·6 gal per 1,000 plants.

(3) 8-weekly sprays of 3·6 gal per 1,000 plants up to forcing for plant crop; thereafter 5·4 gal per 1,000 plants.

(4) 6-weekly sprays of 3·6 gal per 1,000 plants up to forcing for plant crop; thereafter 5·4 gal per 1,000 plants.

(5) As for 3 but with the first spray after planting deleted and replaced by 11 lb of ammonium sulphate per 1,000 plants in the base-dressing.

Treatments 6-9.—Side-dressing group, receiving the fertilizers indicated at a rate sufficient to supply 7·2 lb of nitrogen per 1,000 plants in the preflowering period and 14·2 lb of nitrogen per 1,000 plants in the period from flowering to harvest (for both plant and winter ratoon crops). Side-dressings were applied every 2-4 months, with the shorter intervals in summer and the longer intervals in winter.

(6) Ammonium sulphate.

(7) Solid urea.

(8) Ammonium sulphate: 11 lb of ammonium sulphate per 1,000 plants of the total allotment for the period from planting to plant crop flowering was applied in the base-dressing.

(9) Potassium sulphate: No potassium sulphate was applied in the base-dressing. Instead it was applied in side-dressings at the rate of 30 lb per 1,000 plants before flowering and 60 lb per 1,000 plants from flowering to harvest for both the plant and winter ratoon crops.

(c) Forcing Treatments

(1) Flowering induced by treating with two applications of saturated acetylene solution at 2 oz per plant, 1 week apart. Forcing treatments for the plant crop were applied in May/June 1963 and for the ratoon crop in October 1965.

(2) Natural flowering.

(d) Cultural

Graded slips of the Smooth Cayenne variety were planted in May 1963. Planting distances were 9 in. between plants in the row, 18 in. between rows within the double row, and 5 ft between double-row beds (centre to centre). These planting distances give a planting rate of 23,200 plants per acre. The beds were 9 in. high.

Slightly below average rainfall was received up to the harvest of the plant crop; thereafter average to above average rainfall was received. The average annual rainfall is approximately 45 in.

III. RESULTS

(a) Yield and Fruit Weight

Yields were recorded from the summer plant crop and winter ratoon crop for which the trial was designed and from a summer ratoon crop intermediate between these for which no forcing treatments were applied. Yields are expressed as number of fruit per sub-plot of 50 plants, average weight of fruit "tops-off" and total weight of fruit "tops-off" per sub-plot. The results for the individual crops are presented in Tables 1-3 and the total yield is in Table 4.

TABLE 1

PLANT CROP RESULTS: SUMMER 1965

Treatment	No. of Fruit per Sub-plot (Natural Flowering Only)	Mean Fruit Weight (lb)	Yield of Fruit (lb per sub-plot)
1	48·2	4·02	194·6
2	48·7	4·09	201·0
3	47·7	4·03	194·5
4	47·7	4·06	199·7
5	49·0	4·01	195·5
6	48·5	3·76	184·2
7	48·5	3·72	181·1
8	46·7	3·69	177·6
9	44·7	3·62	168·4
Necessary differences for significance .. 5%	2·3	0·12	8·0
1%	3·1	0·17	10·6
Significant differences ..	1,2,5,6,7≫9 3,4>9	1,2,3,4,5 ≫6,7,8,9 6>9	2,4,5≫6,7,8≫9 1,3≫7,8,9 1,3>6
Forced	50	3·89	192·5
Natural	47·8	3·89	184·6
Significant differences ..	F≫N	N.S.D.	F≫N

TABLE 2

SUMMER RATOON CROP RESULTS: SUMMER 1966

No forcing treatments applied

Treatment	No. of Fruit per Sub-plot	Mean Fruit Weight (lb)	Yield of Fruit (lb per Sub-plot)
1	30·6	3·59	110·0
2	31·2	3·45	107·7
3	29·9	3·52	105·4
4	28·7	3·66	104·1
5	28·5	3·65	103·4
6	23·4	3·29	77·0
7	26·9	3·28	87·9
8	26·7	3·29	87·7
9	17·9	3·88	69·1
Necessary differences for significance .. 5%	4·2	0·25	14·8
1%	5·6	0·34	20·0
Significant differences ..	1,2,3≫6,9 4,5,7,8≫9 2>7,8 4,5>6>9	9≫2,3,6,7,8 4,5≫6,7,8 9>1>6,7,8	1≫6,7,8,9 2,3,4,5≫6,9 2,3,4,5>7,8>9

TABLE 3

WINTER RATOON CROP RESULTS: WINTER 1966

Treatment	No. of Fruit per Sub-plot	Mean Fruit Weight (lb)	Yield of Fruit (lb per Sub-plot)
1	28·1	3·52	98·1
2	27·5	3·35	91·5
3	32·4	3·32	106·4
4	30·9	3·51	107·9
5	27·0	3·49	93·0
6	38·0	2·97	111·4
7	34·7	3·18	110·2
8	31·7	3·06	96·6
9	40·2	3·76	150·4
Necessary differences for significance .. 5%	6·3	0·22	21·9
Necessary differences for significance .. 1%	8·6	0·29	29·6
Significant differences ..	9≫1,2,4,5 6≫1,2,5 9>3,8 6>4 7>1,2,5	9≫2,3,6,7,8 1,4,5≫6,7,8 2≫6,8 3≫6 9>1,4,5 3>8	9≫1,2,3,4,5,6,7,8
Forced	36·6	3·15	114·6
Natural	28·0	3·55	99·9
Significant differences ..	F≫N	N≫F	F≫N

TABLE 4

TOTAL CROP RESULTS

Treatment	No. of Fruit per Sub-plot	Mean Fruit Weight (lb)	Yield of Fruit (lb per Sub-plot)
1	107·1	3·76	402·7
2	107·9	3·72	400·2
3	110·1	3·69	406·2
4	108·9	3·79	411·7
5	104·2	3·77	391·9
6	110·2	3·39	372·6
7	110·2	3·44	379·2
8	106·6	3·40	362·0
9	104·6	3·71	387·9
Necessary differences for significance .. 5%	7·0	0·13	23·5
Necessary differences for significance .. 1%	9·5	0·17	31·8
Significant differences ..	N.S.D.	1,2,3,4,5,9 ≫6,7,8	4≫6, 7, 8 3≫6,8 1,2≫8 4>9 1,3>6,7 2>6 5,9>8
Forced	113·7	3·55	403·3
Natural	101·8	3·71	377·7
Significant differences ..	F≫N	N≫F	F≫N

TABLE 5

LEAF NITROGEN PERCENTAGE IN RELATION TO NITROGEN APPLICATION
Nitrogen applied per 1,000 plants up to time of sampling

Treatment	Sampling Date											
	November 1963		February 1964		June 1964		March 1965		October 1965		June 1966	
	% N	lb N	% N	lb N	% N	lb N	% N	lb N	% N	lb N	% N	lb N
1	1·39	4·9	1·80	8·2	1·64	11·5	1·20	18·1	1·39	24·6	1·23	31·2
2	1·74	6·6	2·15	9·9	1·64	14·8	1·26	23·0	1·44	31·2	1·21	39·4
3	1·46	4·9	1·84	8·2	1·71	11·5	1·26	21·4	1·59	31·2	1·19	41·1
4	1·62	6·6	2·13	9·9	1·76	14·8	1·27	27·1	1·67	39·4	1·30	51·6
5	1·39	5·5	1·74	8·8	1·66	12·1	1·27	22·0	1·64	31·8	1·22	41·6
6	1·08	1·8	1·58	3·6	1·55	7·2	1·24	21·4	1·13	28·6	1·28	42·8
7	1·00	1·8	1·69	3·6	1·45	7·2	1·24	21·4	1·21	28·6	1·33	42·8
8	1·00	3·5	1·63	4·7	1·44	7·2	1·28	21·4	1·12	28·6	1·35	42·8
9	1·00	1·8	1·63	3·6	1·63	7·2	1·18	21·4	1·21	28·6	1·31	42·8
Necessary differences for significance 5%	0·10		0·09		0·15		0·04		0·11		0·09	
Necessary differences for significance 1%	0·14		0·12		0·21		0·06		0·15		0·12	
Significant differences	2,4≫1,3,5≫ 6,7,8,9 2>4		2,4≫1,3,5,6,7,8,9 3≫6,7,8,9 1≫6,8,9 5≫6 3>5>8,9 1>7>6		4≫6,7,8 3>6 3,5≫7,8 1,2,9>7,8		2,3,4,5,8≫1,9 6,7≫9 7>1		3,4,5≫1,2 1,2≫6,7,8,9		8≫1,2,3,5 7≫3 7>1,2,5 9>2,3 4,6>3	

TABLE 6

LEAF POTASSIUM PERCENTAGE IN RELATION TO POTASSIUM APPLICATION

K_2O applied per 1,000 plants up to time of sampling

Treatment	Sampling Date											
	November 1963		February 1964		June 1964		March 1965		October 1965		June 1966	
	K %	lb K_2O	K %	lb K_2O	K %	lb K_2O	K %	lb K_2O	K %	lb K_2O	K %	lb K_2O
1	2·80	25·7	3·12	25·7	2·36	25·7	1·56	25·7	1·14	25·7	1·28	25·7
2	2·43	25·7	2·94	25·7	2·22	25·7	1·56	25·7	1·17	25·7	1·23	25·7
3	2·78	25·7	2·87	25·7	2·23	25·7	1·53	25·7	1·17	25·7	1·15	25·7
4	2·53	25·7	3·05	25·7	2·22	25·7	1·60	25·7	1·22	25·7	1·23	25·7
5	2·85	25·7	2·94	25·7	2·14	25·7	1·50	25·7	1·07	25·7	1·16	25·7
6	2·98	25·7	3·25	25·7	2·37	25·7	1·54	25·7	1·22	25·7	1·27	25·7
7	2·93	25·7	3·41	25·7	2·37	25·7	1·48	25·7	1·19	25·7	1·18	25·7
8	2·75	25·8	3·16	25·7	2·33	25·7	1·54	25·7	1·20	25·7	1·17	25·7
9	2·30	3·6	2·31	7·1	2·20	14·2	2·15	42·7	2·37	57·0	2·56	85·4
Necessary differences for significance 5%	0·38		0·41		0·33		0·12		0·18		0·23	
1%	0·51		0·56		0·44		0·17		0·24		0·31	
Significant differences	6≫2,9 7,5≫9 7>2,4 5>2 1,3,8>9		1,2,4,5,6,7,8≫9 7>2,3,5 3>9		N.S.D.		9≫1,2,3,4,5,6,7,8		9≫1,2,3,4,5,6,7,8		9≫1,2,3,4,5,6,7,8	

(b) Leaf Analysis

Leaf samples were taken at intervals throughout the life of the trial and analysed for nitrogen, phosphorus and potassium by the methods of Bould, Bradfield, and Clarke (1960). The results, expressed as a percentage of the weight of the whole leaf dried at 65°C, are presented in Tables 5–7 together with the amounts of each nutrient applied up to the date of sampling. The leaves sampled were the youngest mature leaves selected by bunching the leaves together and removing the tallest one. Each sample comprised 10 leaves per plot. The following are the dates of sampling, the stage in the crop cycle at sampling and the part of the plant from which the leaf sample was taken.

Nov. 1963	Preflowering	Parent plant
Feb. 1964	Preflowering	Parent plant
June 1964	Forcing for plant crop	Parent plant
Mar. 1965	End of plant crop harvest	Sucker
Oct. 1965	Forcing for May/June intermediate crop	Sucker
June 1966	End of May/June intermediate crop harvest	Sucker

TABLE 7

LEAF PHOSPHORUS PERCENTAGE

Treatment	Sampling Date		
	March 1965	October 1965	June 1966
1	0·167	0·088	0·094
2	0·175	0·076	0·085
3	0·167	0·080	0·085
4	0·151	0·074	0·078
5	0·165	0·090	0·084
6	0·140	0·076	0·067
7	0·161	0·085	0·079
8	0·147	0·082	0·067
9	0·130	0·077	0·076
Necessary differences for significance 5%	0·019	0·010	0·010
Necessary differences for significance 1%	0·026	0·014	0·014
Significant differences ..	2≫6,8,9 1,3≫6,9 5,7≫9 2>4>9 1,3>8 5,7>6	5≫4 1,5>2,4,6,9 7>4	1≫4,6,7,8,9 2,3,5≫6,8 4,7>6,8

(c) Fruit Analysis

Fruit samples of approximately equal external colour were taken on one date from the winter ratoon crop. The colour of the flesh of these fruit was rated visually, using a scale of 1 for very pale to 5 for golden. The juice percentage, the total soluble solids percentage and the acidity (expressed as anhydrous citric acid percentage) of the juice were also determined. From these last two, the TSS/acid ratio was determined. The results are presented in Table 8.

TABLE 8

FRUIT ANALYSIS: WINTER RATOON CROP

Treatment	Internal Colour Rating	Juice (%)	Total Soluble Solids (%)	Anhydrous Citric Acid (%)	T.S.S./Acid Ratio
1	1·7	56·9	10·9	0·94	11·6
2	1·3	58·6	10·6	0·88	12·4
3	1·7	59·1	10·7	0·87	12·2
4	2·3	61·1	11·3	0·79	14·1
5	1·3	56·1	10·8	0·88	12·3
6	1·7	58·2	11·2	0·84	13·4
7	2·3	57·7	11·4	0·95	12·1
8	2·7	58·3	11·1	0·79	14·1
9	4·3	56·3	11·3	1·07	10·6
Necessary differences for significance 5%	0·7	6·8	1·1	0·15	2·2
Necessary differences for significance 1%	1·0	9·4	1·6	0·21	3·1
Significant differences	9≫1,2,3,4,5,6,7,8 8≫1,2,3,5,6 7≫2,5 4>2,5	N.S.D.	N.S.D.	9≫4,6,8 9>2,3,5 7>4,8	4,8≫9 4,8>1 6>9

IV. DISCUSSION

(a) Nitrogen

Urea spray treatments produced yields which were, in general, significantly better than those from side-dressing treatments. This effect was produced by larger fruit size rather than larger fruit number. The overall yield from both plant and ratoon crops from urea-sprayed plots was approximately 8% better than from side-dressing plots.

When comparing these groups of treatments (urea spray and side-dressing groups) it must be kept in mind that, although similar total amounts of nitrogen were applied in each case, there were differences in the pattern of application. The particular side-dressing schedule used provided for the application of two-thirds of the nitrogen ration for each crop in the period from flowering to harvest, whereas in the urea spray schedule the nitrogen was applied more evenly throughout the period of the trial.

It seems likely that the response to side-dressing treatments was influenced by the fact that the plants were grown in a rather heavy silty soil formed into narrow, steep-sided beds 9 in. high. These high beds, which are used generally with the heavier soils of the Dundowran area to improve drainage, would encourage wash of fertilizer away from the plants.

Several rates of urea spraying were used in the trial but there were no significant differences in yield between any of them at any stage. There were, however, significant differences in leaf nitrogen percentage between the treatments. These differences reflected the differences in the amounts of nitrogen received, as shown in Table 5.

Similarly, there were no significant differences in yield resulting from the use of different side-dressing fertilizers (urea and ammonium sulphate). There were also no significant differences in leaf nitrogen percentage except for the sample in February 1964, in which the urea-dressed plots had a slightly higher leaf nitrogen concentration. No special precautions were taken against side-dressings lying on the ground for some weeks before rain with possible loss of nitrogen. Thus, under the conditions of the trial, urea could be used in side-dressings instead of the more usual ammonium sulphate without reduction in yield. The choice could be made largely on the price per unit of nitrogen.

The effectiveness of nitrogen applied in the base-dressing was investigated by means of treatments 5 and 8. These treatments involved the same total amount of nitrogen applied in the same form as did treatments 3 and 6 respectively, but part of the nitrogen ration for the period from flowering to plant crop harvest was applied in the base-dressing. There was no increase in yield or leaf nitrogen concentration as a result of applying nitrogen in the base-dressing.

There are several significant differences between treatments in leaf phosphorus concentration although no differential phosphorus treatments were applied. In general, the concentration was lowest in plots receiving side-dressings of ammonium sulphate, higher with side-dressings of urea and higher still in urea-sprayed plots.

This order of treatments would probably correspond with the order of decreasing acidifying effect of the treatments on the soil.

(b) Potassium

The treatment involving side-dressings of potash (treatment 9) was significantly inferior to the comparable treatment involving a base-dressing of potash (treatment 6) in the plant crop in both fruit weight and total yield. This position was reversed in the ratoon crops. The leaf analysis results show that the side-dressings were only sufficient to maintain leaf levels at 2·2 to 2·4% K throughout the trial. On the other hand, the base-dressing raised the leaf content to 3·2% K in 10 months but this effect disappeared by June 1964 and leaf levels later fell to 1·2% K.

It is therefore anticipated that on this soil, which was low in replaceable potassium, the best overall yield would have been obtained from a base-dressing of potash followed by side-dressings of potash commencing 12 months after planting.

Fruit quality determinations were made on samples from the winter ratoon crop. These showed that treatment 9, which gave a higher potash supply at this stage, produced fruit with significantly higher internal colour and anhydrous citric acid percentage than did the potash base-dressing treatments. There were no differences in total soluble solids percentage or juice percentage.

(c) Forcing

An interaction between fertilizer and flowering occurred only with the plant crop. With induced flowering, all fertilizer treatments gave 100% flowering. With natural flowering, however, the potash side-dressing treatment (treatment 9) had significantly fewer fruit per plot than the potash base-dressing treatments.

Considering all treatments and all crops, forcing produced overall 12% more fruit than did natural flowering, but the fruit were 4% lighter. The increase in total yield due to forcing was 7%. These differences were all significant at the 1% level. An increase in yield due to forcing was obtained from all crops to which forcing treatments were applied.

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