Table 3. Residues (ppm) NAA in Bearss lemons, Group II.[z,y,x]

Sample	1% spray	2% spray
Chopped peel	0.012	0.12
Dried peel	0.010	0.07
Peel oil	0.28	3.0
Press liquor	0.008	0.027
Fruit juice	<0.004	0.005
Emulsion water	0.009	0.047
Peel frit	0.028	0.29
Finisher pulp	<0.004	0.009
Molasses (ester)	0.005	0.013
Molasses (free acid)	0.028	0.158

[z]No residues were found at the limit of detection (0.004 ppm) in any other fraction.
[y]Average of two separate field replications.
[x]Harvested September 14, 1973.

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RESPONSE OF PINEAPPLE (ANANAS COMOSUS MERR.) GROWING IN SAVANNA SOIL OF BRASILIA TO LEVELS OF N, P AND K

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Abstract. **'Pernambuco' pineapple was grown under 3 levels of NPK on a tropical savanna soil of Brazil. The fertilizers used were ammonium sulphate, superphosphate regular, and potassium sulphate with the following levels of g/plant, N: 3.0, 6.0, and 9.0; P_2O5: 0.9, 1.8, and 2.7; and K_2O: 5.0, 10.0, and 15.0.**

Observations were made on weight and number of fruits, slips and suckers produced, plant height, and production of precocious fruits called "Maritacas". In general, fruit weight and number, plant height, and number of slips and suckers produced were increased with increased levels of N and K, but there was no effect of the 3 levels of P. Increased soil levels of N, P, and K produced correspondingly increased leaf levels. Production of "Maritacas" was not affected by NPK levels.

Research in Brazil recommends the pineapple as a crop for cultivation on the Brazilian Savanna, called "Cerrado" (14). This crop has an adequate foliar structure to tolerate dry seasons (11), does not demand high soil levels of P (8), and the soil pH for best fruit quality is around 4.5-6.0 (11, 13). Thus the characteristics of this crop and region are well matched (14).

It has been suggested that N is the main nutrient that controls the rate of growth (5, 6, 7, 8), thereby improving the yield and the fruit quality, particularly if the plant has an adequate level by bloom time (12). Responses to P are not reported to be significant (8), but this element is needed most during the flowering stage (13). K has been suggested as the second most important nutrient (6, 7, 8), and reportedly needs to be available immediately after planting, and during fruit ripening (13).

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Materials and Methods

This work was established on a dark-red latosol of the savanna region of Brasilia. The soil analysis was N: 0.13%; P: 2ppm; K: 52ppm; Al+++: 0.3 eq. mg/100cc soil; and pH: 5.24. The experimental design was a fractorial 3^3 with 3 replications in a randomized block design. All the treatments were established on the double-row planting system, with a density of 35,000 plants/ha (1). There were 40 plants per plot, from which 16 plants were measured. The cultivar was 'Pernambuco'. The slips selected were 35-45 cm long (2).

The nutrient levels were, N: 3.0, 6.0, and 9.0; P_2O5: 0.9, 1.8, and 2.7; and K_2O: 5.0, 10.0, and 15.0 g/plant. As sources of N, P, and K, ammonium sulphate, superphosphate regular, and potassium sulphate were used (12, 13). All the P was applied at planting time, but N and K were applied 3 times: 2, 9, and 12 months after planting.

Before being set the planting material was "cured", in order to avoid the disease caused by *Fusarium moniliforme* Sheld. var. *subglutinans* Wr. & Rg. and treated with insecticides to control pests such as *Dysmicoccus brevipes* Geyer (3). Fruit weight and number, slips and suckers produced, plant height, and production of the undesirable precocious fruits called "Maritacas", were observed.

Results and Discussion

Higher levels of N, applied along with K or P, resulted in higher yields, as indicated by an increase in fruit number and weight as well as an increase in height of the plants and number of slips and suckers produced (Table 1). However, the foliar levels of this nutrient observable by harvest time showed that it was much depleted. Also, mean fruit weight was below the standard weight for the cultivar. The positive and highly significant linear response (Nl) to the N levels may lead one to conclude either that all N levels selected were below the optimum, that there was a deficient

Table 1. Analysis of variance, mean squares, of fruit weight and number, plant height, maritaca fruits, slips and suckers produced, as affected by 3 levels of N, P, and K.

Source	d.f.	Fruit weight	Fruit number	Plant height	Maritaca fruits	Slips and suckers
N	2	75.53 **	41.21 **	151 **	.35 n.s.	1283 **
Nl	1	75.28 **	40.91 **	138 **	—	1213 **
Nq	1	3.25 n.s.	0.30 n.s.	13 n.s.	—	70 n.s.
P	2	6.33 n.s.	2.01 n.s.	2 n.s.	4.23 *	42 n.s.
K	2	52.74 **	36.25 **	281 **	3.02 n.s.	697 **
Kl	1	51.09 **	34.24 **	280 **	—	675 **
Kq	1	1.65 n.s.	2.01 n.s.	1 n.s.	—	22 n.s.
NxP	4	5.56 n.s.	11.59 *	25 n.s.	3.0 n.s.	64 n.s.
NxK	4	9.52 *	9.75 n.s.	49 n.s.	6.0 n.s.	58 n.s.
PxK	4	12.41 *	11.44 *	22 n.s.	1.1 n.s.	156 n.s.
Replications	2	3.83 n.s.	4.60 n.s.	48 n.s.	12.70 *	235 n.s.
Error	60	3.67	4.25	25	2.87	154
Total	80					
C.V.		23%	19%	8%	45%	20%

*—Significant at 5% of probability.
**—Significant at 1% of probability.
n.s.—No significant.

absorption of N, or that better yields could be obtained with higher levels of N and changes in the timing of the fertilization program.

Considering that these pineapples were planted at the end of the rainy season, it is probable that absorption of nutrients during the first 3-4 months was delayed or deficient, because the formation of a large root system takes around 4 months when the crop is planted at the beginning of the dry season (4).

The formation of maritaca fruits was not affected by N and K levels (Table 1), although it was significantly influenced by the levels of P (Table 2). Maritacas occurred in up to 44% of some plots, thus indicating that there was an unbalanced relation in the absorption of N, P, and K. The absorption of high levels of soil P that occurs when the levels of plant carbohydrates are low tends to induce precocious bloom (12).

There was no significant effect of P on the yield, height of the plants, and number of slips and suckers produced, although the interactions NP and PK, were significant for fruit number (Table 1). The average response of the levels of P when interacting with the levels of N showed a positive linear tendency in increase the fruit number. Also, the average levels of N increased the yield up to level 2 of P, but when N interacted with level 3 of P a yield decrease resulted (Table 3). However, the N and P levels showed an absence of relationship, that probably was due to low absorption of N in the presence of high levels of P (10, 12).

The interaction of P and K was significant for both fruit weight and fruit number, but increase in yield occurred only when the average levels of K interacted with levels 1 and 2 of P. The average response of the levels of P when interacting with the levels of K suggests a linear relationship (Table 4). The ratio of P:K in the leaves was 1:10, thus it is possible to suppose that this high concentration of P has affected the yield negatively, as has been reported by others (11, 13).

Levels of K directly and positively influenced fruit weight and number, plant height, and number of slips and

Table 2. Average maritaca fruit number/plot, as affected by 3 levels of N and P.

Levels of P	Levels of N 1	2	3	Mean
1	3.7	4.5	3.2	3.8
2	3.8	4.1	3.8	3.9
3	4.5	3.4	3.0	3.6
Mean	4.0	4.0	3.3	3.8

Table 3. Average fruit number (1000/ha) as affected by 3 levels of N and P.

Levels of P	Levels of N 1	2	3	Mean
1	22.4	21.8	27.1	23.7
2	23.3	27.5	23.8	24.0
3	20.9	23.6	27.0	23.8
Mean	22.2	24.3	25.9	24.1

Table 4. Average fruit number (1000/ha), and fruit weight (mT/ha) as affected by 3 levels of K and P.

NUMBER					WEIGHT				
Levels of P	Leavels of K 1	2	3	Mean	Levels of P	Levels of K 1	2	3	Mean
1	21.8	25.3	24.3	23.8	1	15.83	19.28	18.59	17.90
2	23.1	21.9	29.7	24.9	2	16.30	16.25	24.64	19.06
3	22.4	24.8	24.0	23.7	3	16.05	17.04	17.75	16.94
Mean	22.4	24.0	26.0	24.1	Mean	16.06	17.52	20.32	17.96

suckers (Table 1). However, the below-standard yield of fruits at the highest level of application, and the highly significant response to K, lead one to conclude that it is possible to obtain higher yields by the use of higher dosages of this nutrient.

The interaction of N and K (Table 5), permits the desirable effects obtained by the high-level use of both nutrients to be observed. Therefore, this situation leads one to consider valid the increase in yield obtained by applying N and K in combination at high levels, inasmuch as both of them gave linear and positive responses when applied to pineapple by other workers (6, 7, 8, 13).

Table 5. Average fruit weight (mT/ha) as affected by 3 levels of K and N.

Levels of K	Levels of N			Mean
	1	2	3	
1	11.93	19.25	17.00	16.06
2	13.49	18.22	19.66	17.12
3	18.56	18.32	24.09	20.32
Mean	14.66	18.59	20.25	17.83

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EFFECTS OF GROWTH REGULATORS ON HEALING AVOCADO PRUNING WOUNDS[1]

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Abstract. **Several growth regulators applied to terminal pruning wounds of small, container-grown avocado seedlings stimulated callus formation. The best treatments often caused almost complete coverage of the wound with callus before untreated controls had produced any. Some growth regulators inhibited bud growth near the wounds and some were phytotoxic at high concn. Gibberellic acid (GA), 2,2-4 dichlorophenoxyacetic acid (2,4-D) and benzyladenine (BA) at certain concn were the best treatments on the basis of callus formation, lack of phytotoxicity and bud growth near the wound area. Improvement of healing of large wounds on mature trees in the field was not attained.**

Callus formation is the first step in healing. After a time a cambium or meristematic layer forms in the callus. From this time on progress in covering wounds extending into the woody cylinder is by formation of new phloem, xylem and cork along the sides (4). The importance of selecting wound dressings which encourage callus development has been recognized by a number of authors (10, 11, 13). Rapid formation of callus at the edges of the wound protects cambium cells from death due to desiccation and thereby prevents enlargement of the wound. Temp (1) and moisture (1, 2) influence callus formation.

Wound dressings have traditionally been applied to pruning cuts to prevent drying of tissue around the edges and surface of the wound, to sterilize the wound, to prevent the entrance of decay organisms, and to hasten wound healing. No commercial wound dressing accomplishes all of these objectives. Black asphalt wound dressings aid healing by preventing desiccation but dieback has occurred when used on wounds subjected to intense sunlight. White latex paint was superior to black asphalt compounds under such conditions (12). There are no reports of commercial wound dressings stimulating callus formation.

Haberlandt (7) postulated the production of a wound hormone in damaged tissue that aids in healing. Growth of new shoots in the vicinity of the wound is recognized as enhancing healing, possibly through growth regulators produced in the expanding leaves. Several growth regulators have increased callus in tissue cultures but attempts to increase callus and thereby aid healing of woody plant wounds have been largely unsuccessful. The work has, however, been sparse. The purpose of this work, therefore, was to evaluate a wider range of kinds and concentrations of growth regulators than have been previously investigated for their influence on callus formation and wound healing.

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