# THE INFLUENCE OF NPK LEVELS ON THE GROWTH AND TUBER DEVELOPMENT OF CASSAVA IN TANKS1/

By

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## INTRODUCTION

Methods used in growing cassava (*Manihot utilissima* Pohl) are undergoing changes as the crop shifts from a backyard garden culture to a large scale managed crop. Varying amounts of mechanization (3) are being adopted and in Brazil and Mexico fertilizers are in use.

To date, little information is available as to the mineral nutrition requirements of this plant. Malavolta et al. (5) carried out a study in sand culture to find the effects of NPK on the yields and composition of the roots. Krochmal and Samuels (2) also worked in sand culture to develop the visible symptoms of major, secondary, and minor element deficiencies in cassava leaves and completed chemical analyses of the leaves, petioles, and stems of plants under complete and deficient treatments.

This report concerns the effects of varying levels of NPK on production of tubers and tops in tank studies in the U.S. Virgin Islands.

## PROCEDURE

Three 6-inch cuttings of "Fowl Fat," a yelow fleshed cassava, were planted in large concrete conduits (Fig. 1) each 4 feet deep and 18 inches wide.

Each conduit was painted on the inside with a mixture of aluminum paint and asphalt, and each had a 1" drain pipe (Fig. 2) in the bottom. Three cubic yards of No. 3 perlite was used per container.

Experimental design was a random block of 8 treatments and 3 replicates per treatment in full sun. Rainorwater was used in preparing nutrient solution (Table 1) because sufficient distilled water was not available.

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1/ This work was carried on under terms of a cooperative Agreement between Harvey Aluminum, Torrance, California and A.R.S. U.S.D.A.

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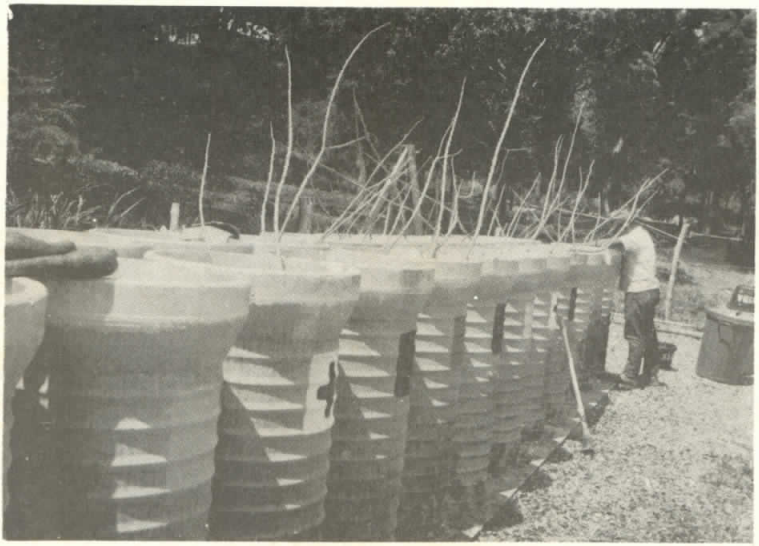

Figure 1.–Upper: View of conduits; Lower: tuber development was normal.

Figure 2.–Conduits were drained by a 1" pipe leading into a layer of gravel as shown above.

*Table 1.*– Nutrient levels used in the cassava experiment.

| N | P | K | Treatment identification | Nutrient level in parts per million N | P | K |
|---|---|---|---|---|---|---|
| high | high | high | H H H | 240 | 240 | 240 |
| high | high | low | H H L | 240 | 240 | 40 |
| high | low | high | H L H | 240 | 40 | 240 |
| high | low | low | H L L | 240 | 40 | 40 |
| low | high | high | L H H | 40 | 240 | 240 |
| low | high | low | L H L | 40 | 240 | 40 |
| low | low | high | L L H | 40 | 40 | 240 |
| low | low | low | L L L | 40 | 40 | 40 |

Each container received 2 1/2 liters of nutrient solution twice a week; as plants grew, additional water was added as needed. After 6 weeks, the most vigorous plant was kept in each conduit and the 2 others were eliminated.

Measurements of tuber number, tuber weight, and top weight were made at harvest 11 months after start in May 1965.

## RESULTS

### *Height*

High P plants averaged 9 inches taller than low P plants. Other elements used failed to show any consistent affect on height (Table 2).

Plants grown under high phosphate solution averaged 9 inches taller than low P plants. Other elements failed to show any consistent effect on height (Table 2).

### *Tops*

The highest weight yield of tops in grams per plant was obtained with the HLH[4] treatment and the lowest was found with the LLH treatment, suggesting that greater top growth was associated with high N levels. This has been reported for cassava (5), sweet potatoes (4,8), and sugar beets (6). However, the trend was not too strong for all high N vs low N treatments since the average increase was only 11% (Table 3).

Production of tubers was severely curtailed with several treatments (Table 2). No tubers were formed with HLL treatment and few with HHH.

Aside from a definite and significant influence of P, the major effects on tuber yields were brought about by combination and interactions of NP, PK and NPK. For example, in the presence of high N and low P, high K level gave significant yield increase of weight of tubers over the low K level (Table 2). However, high K did not affect tuber weight if N levels were lowered or P levels raised.

The N effect was the reverse of the P. A 41% yield reduction per pot was noted with high N compared to low.

4/ For ease of presentation the abbreviations used in Tables 1 and 2 will be used in the text of this article.

*Table 2.* —Influence of (varying) N-P-K levels on the weight of cassava tops and tubers, fresh weight basis.

| Treatments[a/] | | | Height per plant | Total Weight per pot | | Average weight per tuber | Top: tuber weight ratio[b/] |
|---|---|---|---|---|---|---|---|
| N | P | K | cm | Tops | Tubers | g | |
| H | H | H | 140 | 468 | 30 | 30 | 15.6 |
| H | H | L | 130 | 695 | 559 | 241 | 1.2 |
| H | L | H | 127 | 1000 | 574 | 395 | 1.8 |
| H | L | L | 97 | 423 | 0 | 0 | 0 |
| L | H | H | 144 | 544 | 574 | 191 | 1.0 |
| L | H | L | 145 | 830 | 908 | 305 | 0.9 |
| L | L | H | 97 | 302 | 136 | 2.2 | 2.2 |
| L | L | L | 109 | 650 | 155 | 155 | 1.8 |
| Least significant differences | | | | | | | |
| 5—percent | | | | 293 | 541 | 371 | |
| 1—percent | | | | 449 | 848 | 547 | |

a/ L-Low

b/ Tubers-1 for total weight per pot.

*Table 3.* –Percent change in yields[a/] due to tratment levels of nutrient (NPK) on cassava

| Treatment – high vs low | Average weight per pot % | |
|---|---|---|
| | Tops | Tubers |
| Nitrogen | +11 | - 41 |
| Phosphorus | + 7 | + 93 |
| Potassium | -11 | - 28 |

a/Calculations based on the percentage obtained when comparing the difference between the totals of all high treatments and low treatment of a given element (Table 2) with the low treatment totals. Minus sign indicated low outyielded high treatment level; plus sign indicated high outyielded low treatments.

Many researchers have reported heavy top growth and lowered root and tuber crop yields in pounds per acre associated with high N. Increased N levels result in carbohydrates combining to form proteinaceous materials (tops) rather than polymerizing to form starch (tubers and roots).

The raising of K from low to high levels produced an average decrease in top: tuber weight per pot of 28% average per plant (Table 3). This differs from the finding of many workers who report significant root and tuber yield increases to potash fertilizer application (1). However, Malavolta et al. (5) also using sand culture techniques obtained much less marked response to K then to P. and N. Also Normanha and Soares Pereira (7) working in soils in the state of San Paulo in Brazil failed to obtain any significant tuber yield response to potash fertilizer for harvest of 9 month old cassava and a negative response for 19 month old tubers. Although K is essential for the translocation of carbohydrates, the low K levels in this experiment were apparently sufficient for good tuber production.

*Ratio*

The relationship between plant top and tuber weight (Fig. 3) is always of interest to cassava producers when relating response to fertilizers. A low top: tuber weight ratio is desired for production of tubers, a high ratio would indicate poor tuber production despite an abundant growth of leaves and stems.

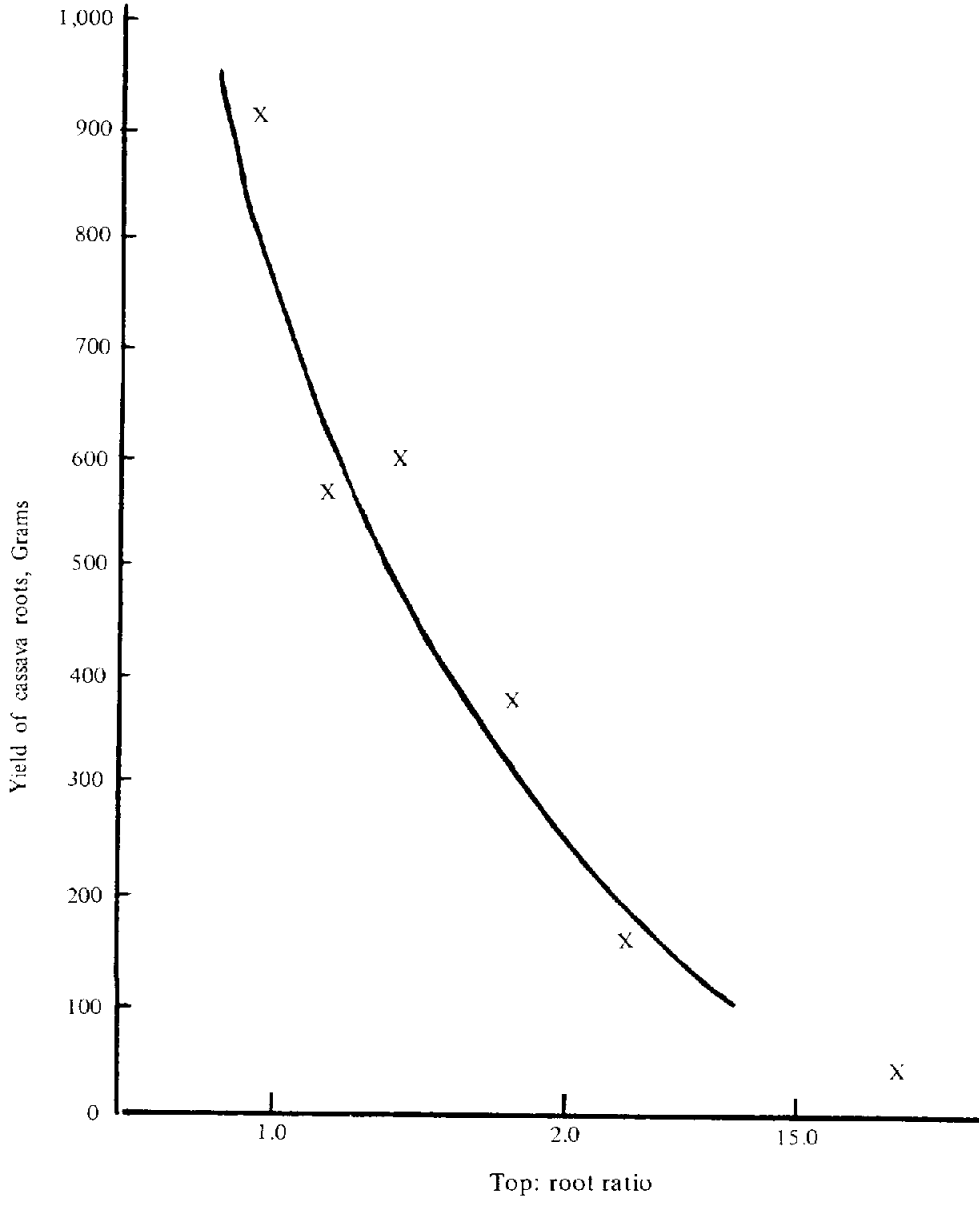


**Figure 3.—The relationship of top: root ratio to yield of cassava roots**

The production of a top: root ratio of approximately 1:1 appears to be related to high tuber weight production in this experiment.

SUMMARY

Cassava grown in nutrient solution tank studies with various combinations of NPK at low and high levels indicated the following:

1. Only high P increased plant height.

2. Production of tops as g/ plant was favored by high N levels and reduced with high K levels.

3. No tubers were formed with N and low Pk levels.

4. High N levels reduced tuber growth per pot by 41%.

5. The major effect on tuber yields was due to higher P levels that raised production 93%.

6. High K levels did not favor tuber production.

7. Greatest tuber production was associated with a 1:1 top to tuber ratio and a high P level.

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