# THE INFLUENCE OF NPK LEVELS ON THE GROWTH AND TUBER DEVELOPMENT OF CASSAVA IN TANKS[1]

— *by* —

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## INTRODUCTION

Methods used in growing cassava (*Manihot esculenta Crantz*) are undergoing changes as the crop shifts from a backyard garden culture to a large scale managed crop. Varying amounts of mechanization (Krochmal 1966) 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.* (1955) carried out a study in sand culture to find the effects of NPK on the yields and composition of the roots. Krochmal *et. al.* (1955) also worked in sand culture to describe the visible symptoms of major, secondary, and minor elements deficiencies in cassava leaves and to correlate these with chemical analyses of the leaves, petioles, and stems of plants under complete and deficient treatments.

This report concerns nutrient solution tank studies to determine the effects of varying levels of NPK on production of tubers and tops. It was conducted under the Virgin Islands Agriculture Program, of the U.S. Department of Agriculture in Co-operation with Harvey Aluminum, Torrance, California.

## PROCEDURE

Three 6 inch cuttings of 'Fowl Fat', a yellow fleshed cassava, were planted in large concrete conduits each 4 feet deep and 18 inches in diameter.

Each conduit was painted on the inside with a mixture of aluminum paint and asphalt, and each had a 1" drain pipe 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 grown in full sunlight. After 6 weeks the most vigorous plant was kept in each conduit and the 2 others were eliminated. Rainwater was used in preparing Hoagland's Modified nutrient solutions (Table 1) because sufficient distilled water was not available.

Each container received 2½ liters of nutrient solution twice a week; as plants grew additional water was added as needed.

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

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Measurements of tuber number, tuber weight, top hieght and top weight were made in May, 1966, at harvest 11months after start.

## RESULTS

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

*Table I. Nutrient levels used in the cassava experiment*

| Nutrient level | | | Treatment identification | | | Nutrient level in parts per million | | |
|---|---|---|---|---|---|---|---|---|
| N | P | K | | | | 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 |

*Tops*

The highest weight yield of tops in grams per plant was obtained with the HLH[3] 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 (Malavolta et al 1955), sweet potatoes (Landrau & Samuels 1951 and Stino 1953), and sugar beets (Mullen et al 1963). However, the trend was not too strong for all high N vs. low N treatments since the average increase was only 11% (Table III).

*Tubers*

Phosphorus was necessary for good tuber production. Averaging the various P treatments, we find that high P over low P gave a 93% increase in yield (Table III). In only one treatment, HHH, did the cassava fail to respond. The response of cassava to P has been reported by Malvolta *et al.* (1955) in sand culture and Normanha and Soares Pereira (1949) in soils in Brazil. P is essential for the phosphorylation process in the enzymatic synthesis of starchy reserves in cassava tubers (Malavolta et al 1955).

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

[3] For ease in presentation the abbreviations used in Tables I and 2 will be used in the text of this article.

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

| Treatments[a] N P K | Height per plant, cm | Total weight per pot Tops % | Total weight per pot Tubers % | Average weight per tuber % | Top: tuber weight ratio[b] |
|---|---|---|---|---|---|
| H H H | 140.1 | 468 | 30 | 30 | 15.6 |
| H H L | 129.5 | 695 | 559 | 241 | 1.2 |
| H L H | 127.0 | 1000 | 574 | 395 | 1.8 |
| H L L | 96.5 | 423 | 0 | 0 | 0 |
| L H H | 114.3 | 544 | 574 | 191 | 1.0 |
| L H L | 144.8 | 830 | 908 | 305 | 0.9 |
| L L H | 96.5 | 302 | 136 | 136 | 2.2 |
| L L L | 109.2 | 650 | 155 | 155 | 1.8 |
| Least significant differences | | | | | |
| 5-percent | | 293 | 541 | 371 | |
| 1-percent | | 449 | 848 | 547 | |

[a] L low H high

[b] Tubers 1 for total weight per pot

*Table III. Percent change in yield due to treatment levels of nutrient (NPK) on cassava*

| Treatment high vs low | Total weight per pot % | | Average weight per plant % | |
|---|---|---|---|---|
| | Tops | Tubers | Tops | Tubers |
| Nitrogen | +11[a] | −70 | +9 | −18 |
| Phosphorus | +7 | +93 | +20 | +12 |
| Potassium | −12 | −39 | −11 | +7 |

[a] Minus sign indicates low outyielded high treatment level; plus sign indicates high outyielded low treatment.

Aside from a definite and significant influence of P, the major effects on tuber yields were brought about by combinations and inter-actions of NP, PK, and NPK. For example, in the presence of high N and low P, high K level gave a significant yield increase of weight of tubers over the low K level (Table II). 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 70% yield reduction was noted with high N compared to low.

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 and tuber weight per pot and a 7% increase in the average weight per plant (Table III). This is contradictory to the finding of many workers who report significant root and tuber yield responses to potash fertilizer application (Ignatieff & Page 1962). Malavolta *et. al.* (1965) also using sand culture techniques obtained much less marked response to K than to P and N. Normanha and Soares Pereira (1949) working in soils in the state of San Paulo in Brazil failed to obtain any significant tuber yield response to potash fertilizers for harvests of 9 month old cassava and a negative response for 19 month old tubers. Although we are aware of the essential need for K in the translocation of carbohydrates, the low K levels in this experiment were apparently sufficient for good tuber production as measured by weight of tuber produced per plant.

The average weight per tuber followed the same trends in response to treatments as total weight of tubers per pot (Table II). The N effect showed an average decrease of 30 grams per tuber with increasing N levels. The P and K effects gave increases of 20 and 13 grams respectively, for increasing P and K levels from low to high.

*Ratio*

The relationship between plants top and tuber weight 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.

The production of tubers was inversely related to the top: tuber weight ratio (fig 1). A decrease in top: tuber ratio to 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 high N and low PK levels.
4. Increasing N levels reduced tuber growth by 70%.
5. The major effect on tuber yields was due to increasing P levels that raised production 93%.
6. High K levels did not favor tuber production.
7. Greatest tuber production was associated with 1:1 top to tuber ratio and a high P level.

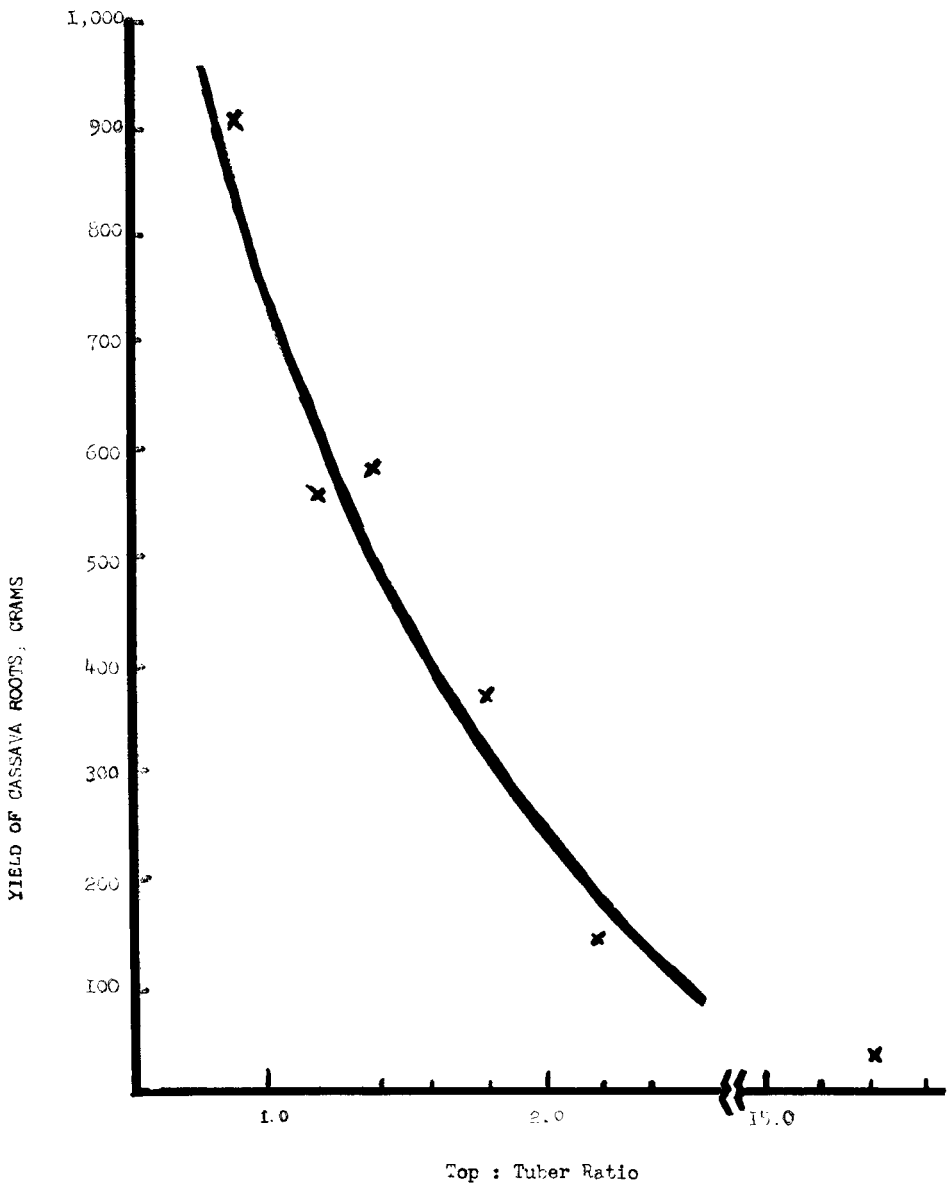


Figure 1. - The relationship of top : tuber ratio to yields of cassava roots.

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