

**STUDIES ON THE RESPONSE OF N, P AND K IN CONJUNCTION
WITH Ca ON THE GROWTH AND YIELD OF TAPIOCA
(MAN/HOT UTILISSIMAPOHL) VAR. "MALAYAN-4" ***

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The importance of tapioca, as a subsidiary food crop and its use as a raw material for the manufacture of starch is being increasingly realised and appreciated in several countries and there has been, of late, perceptible signs of significant increase in the demand for 'Tapioca' for the above purposes.

Tapioca is a tropical crop which thrives well under a warm humid climate with a moderate rainfall of about 120-150 cm per annum. The laterite and the red loam soils of Kerala are ideally suited for this crop. These soils are, however, generally deficient in nitrogen, available phosphoric acid and potash, although the nutrient requirements of the crop are very high. Earlier work on the manuria! requirement of the crop has shown that 112 kg of nitrogen and 135 kg of potash per hectare, over a basal dose of 5-8 tons of farm yard manure is quite adequate. The response to phosphorus being erratic in nature, it was recommended only for soils poor in available phosphorus (Anon. 1963).

Laterite soils, in general and Kerala soils in particular are deficient in lime status. The beneficial effects of liming by way of increased utilization of N and P fertilizers have been reported in other tuber crops like potato (Mariakulandai, 1955). However, the response to graded levels of N P K in conjunction with calcium on the growth and tuber yield of tapioca has not been investigated in the red loam and acid lateritic soils of Kerala and hence the present investigation was undertaken to study the response of these major elements on the growth and yield of tapioca, when used in conjunction with calcium.

Materials and Methods

Field experiments were conducted in the red loam soils of the Agricultural College farm, Vellayani during the year 1966—67 to study the response to graded levels of nitrogen (50, 100 and 150 kg N per hectare), phosphorus (0, 50 and 100 kg P_2O_5 per hectare, potash (100, 150 and 200 kg K_2O per hectare) and calcium (0, 600 and 1200 kg CaO per hectare) in factorial combinations, on the growth and yield of an improved variety of tapioca "M4". A 3^4 confounded

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Table 1

Growth characters, yield components and yield of tapioca as influenced by graded levels of N, P, K and Ca in factorial combinations (Mean effects averaged over other treatments)

Treatments	Plant height (cm)	% of plants branched	No. of leaves per plant (no.)	Weight of vegetative growth/plant (kg)	No. of tubers per plant (no.)	No. of non-productive roots per plant (no.)	Mean length of tubers (cm)	Mean girth of tubers (cm)	Yield of tubers (t/ha)
50 kg N/ha	474	63	315	1.71	8.9	8.7	54.3	19.3	30.99
100 kg N/ha	502	64	321	2.09	11.1	8.4	54.0	20.1	34.32
150 kg N/ha	483	63	324	2.19	11.8	8.2	54.4	20.8	35.50
'F' test	NS	NS	NS			NS	NS		**
0 kg P ₂ O ₅ /ha	472	62	321	1.91	10.1	8.5	53.7	19.9	31.83
50 kg P ₂ O ₅ /ha	500	61	311	2.07	10.7	8.4	53.6	20.9	33.93
100 kg P ₂ O ₅ /ha	487	71	328	2.01	11.1	8.0	55.4	20.4	35.05
'F' test	NS	NS	NS	NS	NS	NS	NS	NS	**
100 kg K ₂ O/ha	468	68	MS	1.83	9.8	8.4	53.5	19.4	32.63
150 kg K ₂ O/ha	467	67	318	1.99	11.1	8.0	54.3	20.8	35.72
200 kg K ₂ O/ha	523	61	314	2.17	10.9	9.0	54.9	21.0	34.46
'F' test	*	NS	NS	*	*	NS	NS	**	*
0 kg CaO/ha	503	59	315	1.95	9.8	8.4	54.4	19.3	31.43
600 kg CaO/ha	494	66	327	2.00	11.1	8.5	53.8	21.1	34.32
1200 kg CaO/ha	461	70	319	2.04	11.0	8.5	54.5	20.7	35.06
'F' test	NS	#	NS	NS	*	NS	NS	**	**
C. D. (0.05)	46	9		0.23	1.1	—	—	0.9	1.35

factorial experiment was laid out, with 81 treatment combinations. The soils were generally low in fertility analysing for 0.056 per cent N, 0.002 per cent available phosphoric acid, 0.0007 per cent available potash and with a pH of 5.1.

A uniform dose of farm yard manure at the rate of 6 t/ha was applied as basal dose. The entire dose of calcium as per treatments was applied 10 days prior to the application of farm yard manure. Phosphorus was applied all as basal dose at planting. Nitrogen and potash were applied in two split doses; the first dose being applied immediately after the first inter-cultivation, two months after planting and the second dose after the second inter-cultivation, three months after planting. The fertilizers were applied in basins formed around

The overall effect of these mineral elements on the yield components studied in the present investigation was in agreement with the findings of Dhesi *et al.* (1964) on carrots, and of Malavolta *et al.* (1965) on tapioca. Higher doses of these elements in adequate proportions might have naturally helped in the production of more of carbohydrates for storage in tubers, leading to more number of tubers and in increased girth of these tubers, so formed. The significant increase in number of tuber per plant as well as the mean girth of individual tubers, as influenced by these major elements ultimately reflected in a very significant improvement in tuber yield of tapioca at graded levels of N, P, K and Ca nutrition. A very significant positive correlation between the number of tubers and tuber yield was observed in the present investigation.

4. *Correlation studies*:- Correlations worked out between the yield of tubers in tapioca and other biometric and yield determining characters of the plants have indicated positive correlations between tuber yield and number of tubers per plant ($r = 0.71$), weight of above ground parts ($r = 0.50$) and with branching ($r = 0.27$). Higher levels of Ca and the combined effect of N and Ca contributed towards increased branching in tapioca, in the present study. Application of N and K increased the vegetative growth and the weight of above ground parts. Branching might have been helpful in better interception of solar energy and in synthesising more of photosynthates, leading to more number of productive roots and ultimately in increased yield of tubers.

Summary

A field experiment to study the response of three graded levels each of nitrogen (50, 100 and 150 kg N/ha), phosphorus (0, 50 and 100 kg P_2O_5 /ha), potash (100, 150 and 200 kg K_2O /ha) in conjunction with calcium (0, 600 and 1200 kg CaO/ha) on the growth and yield of tapioca var. "Malayan-4" grown in the acid red loam soils of the Agricultural College farm at Vellayani, Trivandrum has shown that the plant height of vegetative parts were generally increased by N and K; while branching of stems and number of tubers were increased by N and Ca application. Higher levels of N, K and Ca were instrumental for increased girth of tubers, while the tuber yield was increased by all the four elements. Application of 100 kg N, 50 kg P_2O_5 and 150 kg K_2O in conjunction with 600 kg CaO per hectare seems to be most promising for realising the maximum tuber yield of this variety of tapioca under the conditions of this experiment.

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Application of 100 kg N/ha recorded a mean yield of 34.32 t/ha, as against 30.99 t/ha at 50 kg N/ha. N application beyond 100 kg/ha had no effect in increasing the yield at significant levels. P application at 50 and 100 kg/ha recorded 33.32 and 35.05 t/ha, respectively, as against a lower yield of 31.33 t/ha recorded in control plots receiving no phosphorus. The tuber yield at 200 kg K_2O /ha was significantly higher than at 100 kg K_2O /ha, while the application of Ca at 600 kg/ha recorded a very significant increase in tuber yield (34.32 t/ha) over control plots (31.43 t/ha) receiving no calcium.

The influence of N and K in increasing the tuber yield of tapioca has been conclusively proved on the basis of a large number of trials in Kerala (Anon. 1955, 1960 and 1963) and elsewhere (Malavolta *et al.* 1955 and Cours *et al.* 1961). The major objective of N fertilization for root crops according to these findings is to obtain a rapid elaboration of leaves in the early part of the growth cycle, in order that the photosynthetic capability of the plants are increased. The growth of leaves must be checked by a decrease in N content at appropriate time, in order to give time for the storage organs to develop properly. The potash content of plants was positively correlated with the rate of metabolism and potash is found to be essential in the carbohydrate metabolism.

In potatoes Gruner (1963), found that phosphorus play an essential part in the transformation of substances and energy and regulate the carbohydrate metabolism through high energy phosphates. Application of phosphorus in conjunction with calcium might have increased the availability of P in the present investigation and hence the observed trend in yield. The beneficial effect of Ca as a plant nutrient as well as a corrective of soil acidity and its indirect role on the increased utilisation of N and P have been reported earlier by many workers in the case of potatoes, which is also in agreement with the present findings on the yield of tapioca in acid red loam soils.

3. *Yield components:* The number of tubers per plant increased significantly with increase in the levels of N, K and Ca application; the effect of N being most pronounced than that of all the other elements studied. Application of P had very little effect on the number of tubers per plant. The number of unproductive roots per plant was not significantly influenced by any of these nutrients, although higher levels of N and P had a depressing effect on this character, though not at significant levels.

The length of tubers also was not influenced much by mineral nutrition; while the mean girth was significantly increased by N, K and Ca nutrition. Although the direct effect of P was not statistically significant, application of 50 kg P_2O_5 per hectare resulted in a significant increase in the girth of tubers over those receiving no P application.

individual plants and were covered properly. Tapioca stem cuttings of the variety "Malayan-4" of 20-22 cm length were planted upright on the centre of the mounds raised at 90 cm apart, after land preparation and basal application of manures. Uniform cultural practices such as inter-cultivation, weeding and earthing up were followed for all the treatments. The crop was harvested on maturity at 280 days after planting.

The data relating to various biometric characters viz., height of plants, branching, number of leaves and weight of above ground growth at harvest were collected from a sample of four plants from the net plot standing in a diagonal line in the same direction. Yield components such as number of tubers per plant and the number of unproductive roots per plant based on these four plants, the mean length and girth of tubers selected at random, as well as the final yield of tubers from the net plot as influenced by the various treatment combinations were studied.

Results and Discussion

1. *Growth characters:* The direct effect of all the nutrients expecting potash had little effect on the final height of plants at harvest (Table 1). The maximum mean height of 523 cm was recorded at 200 kg K_2O per hectare.

Graded levels of N showed a trend in increasing the percentage of plants branched in a graded manner, though the rate of increase was not statistically significant, while in the case of K the function was of a depressing nature. The positive effect of N and Ca in contributing to increased branching might have resulted in a general reduction of plant height under such treatments.

The total number of leaves per plant, was not influenced significantly by any of these elements, although there was an increasing trend at incremental doses of N. Purewal and Dargon (1957) and Dhesi *et al.* (1964) have recorded similar influences of N and K on the growth characters of other tuber crops like colocasia and carrot.

The weight of vegetative parts above ground level was influenced significantly by incremental doses of N and K fertilization. Malavolta *et al.* (1955) recorded similar findings on tapioca as influenced by N and K fertilization. The lack of response to P and Ca application on vegetative growth as observed in the present study is also in agreement with the earlier observations of Purewal and Dargon (1959) on the weight of vines in sweet potato.

2. *Yield of tubers:* The yield of tubers was significantly increased by all the four nutrient elements under study and also by the combined effect of N and K application.

സംഗ്രഹം

നൈട്രജൻ, ഫോസ്ഫറസ്, പൊട്ടാഷ്, ക്ഷായം എന്നിവ വ്യത്യസ്ത അളവുകളിൽ നൽകിയാൽ അവ മരച്ചീനിയുടെ വിളവിലെയും ചെടിയുടെ വളർച്ചയെയും എങ്ങനെ ബാധിക്കുന്നു എന്ന് പരീക്ഷിച്ചുനോക്കിയതിൽ നൈട്രജൻ പൊട്ടാഷും ഉയരം വർദ്ധിപ്പിക്കുന്നതിനും, നൈട്രജൻ ക്ഷായവും ശിഖരങ്ങളുടെയും കീഴ്ബാക്കളുടെയും എണ്ണം കൂട്ടുന്നതിനും പൊതുവെ വിളവ് വർദ്ധിപ്പിക്കുന്നതിന് എല്ലാ പോഷകമൂലകങ്ങളും സഹായകമായതായും രേഖപ്പെടുത്തപ്പെട്ടു. ഏറ്റവും കൂടുതൽ വിളവ് ലഭിക്കുന്നതിന് 100 കിലോ നൈട്രജൻ, 50 കിലോ ഫോസ്ഫറസ്, 150 കിലോ പൊട്ടാഷ് എന്ന കണക്കിന് ആവശ്യമാണെന്നും രേഖപ്പെടുത്തിയിട്ടുണ്ട്.

REFERENCES

- Anonymous 1955. *Report on the combined scheme of Research on Tapioca and sweet potato, Govt. of Travancore-Cochin 1954-'55.*
- Anonymous 1960. *Report on the combined scheme of research on tapioca and other tuber crops Govt. of Kerala. 1958-'59.*
- Anonymous 1963. *Ibid.*, 1961-'62.
- Cours, G., Fritz J. and Ramahadimby 1961. Phellodermic diagnosis of the nutritional status of manioc. *Fertilite*, 12, 3—20.
- Dhesi, N. S., Padda, D. S. and Malik B. S. 1964. Effect of different doses of nitrogen at two levels of potash on the development and yield of carrot. *Jour. Res. Ludhiana I*, 50—55.
- Grunner, G. 1963. The manuring of potatoes. *Potatoes Green Bill*. 17.
- Malavolta, E. W., Graner, T., Coury, M. O. C., Sobr. Brasil and Pacheco, J. A. C. 1955. Studies on mineral nutrition of cassava. *Plant. Physiol.* 30, 81—82.
- Purewal, S. S. and Karam Singh Dargon 1957. 'The effect of various fertilizers in relation to spacing on development and yield of colocasia' *Indian J. Agron.* \ 4.
- Purewal, S. S. and Karam Singh Dargon 1959. Effect of sowing dates, fertilizers and spacing on development and yield of sweet potatoes. *Indian J. Agron.* 3, 2.

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