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STUDIES ON THE RESPONSE N, P AND K IN CONJUNCTION: WITH Ca ON THE GROWTH AND YIELD OF TAPIOCA (MANIHOT UT1LISSIMA POHL) VAR. "MALAYAN–4" *

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The importance of tapioca, as a subsidiary food ciop 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 manurial 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 avaiiable 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 reeported in other tuber crops iike potato (Mariakulandai, 1S55). However, the rsponse 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 g rowth 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 to study the response to graded levels of nitrogen (50, 100 and 150 kg N per ha), phosphorus (0, 50 and 100 kg P_2O_5 per ha). potash (100, 150 and 200 kg K_2O per ha) and calcium (0, 600 and 1200 kg CaO per ha) in factorial combinations, on the growth and yield of an improved variety of tapioca "M4". A 3^4 confounded factorial experiment was laid out with

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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	Weight of vegetative growth/plant (Kg)	No. of tubers per plant	No. of non-productive roots per plant	Mean length of tubers (cm)	Mean girth of tubers (cm)	Yield of tubers (t/ha)
50 kg N/ha	474	63	316	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	68	324	2.19	11.8	8.2	54.4	20.8	35.50
'F' test	N.S.	N.S.	N.S.	**	**	N.S.	N.S.	**	**
0 kg P_2O_5/ha	472	62	321	1.91	10.1	8.5	53.7	19.9	31.83
55 kg P_2O_5/ha	500	61	311	2.07	10.7	8.4	53.6	20.9	33.93
100 kg P_2O_5/ha	487	71	328	2.01	11.1	8.0	55.4	20.4	35.05
'F' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**
100 kg K_2O/ha	468	68	328	1.83	9.8	8.4	53.5	19.4	32.63
150 kg K_2O/ha	467	67	318	1.99	13.1	8.0	54.3	20.8	33.72
200 kg K_2O/ha	523	61	314	2.17	10.9	9.0	54.9	21.0	34.46
'F' test	*	N.S.	N.S.	*	*	N.S.	N.S.	**	*
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	34.06
'F' test	N.S.	*	N.S.	N.S.	*	N.S.	N.S.	**	**
C.D. (0.05)	46	9	—	0.23	1.1	—	—	0.9	1.35

** Significant at 0.01 per cent level * Significant at 0.05 per cent level

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 second after inter-cultivation three months after planting. The fertilizers were applied in basins formed around individual plants and were covered properly. Tapioca stem cuttings of 20—22 cm length were planted upright at the centre of the monts raised 90 cm apart, after land preparation and basal application of manures. Uniform cultural practices were followed for all the treatments. The crop was harvested 280 days after planting. The data on biometric characters and yield components were collected at harvest from a sample of four plants from the net plot standing in a diagonal line in the same direction. The final yield of tubers from the net plot as influenced by the various treatment combinations was also recorded.

Results and Discussion

The direct effect of all the nutrients except 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 ha. 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 plants, 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 incrementa doses of N and K fertilization. Malavolta *et al.* (1955) recorded similar findings on tapioca. The lack of response to P and Ca application on vegetative growth as observed in the present study is in agreement with the earlier observations of Purewal and Dargon (1959).

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. 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 icreasing 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 31.83 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 (34.32t/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 already reported in Kerala (Anon. 1S55, 1960 and 1963) and elsewhere (Malavolta *et al*. 1955 and Cours *et al.* 1961) The major objective of N fertilization for root crops 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 a give time for the storage organs to develop properly. The potash content of plants was possitively correlated with the rate of metabolism and potash is found to be essential in the carbohydrate metabolism. In potatoes Grunner (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 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 case of potatoes, which is also in agreement with the present findings.

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 un-productive 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 ha. resulted in a significant increase in the grith of tubers, over those receiving no P application. 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.

There were 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. 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, as well as weight 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 ha seems to be most promising for realising the maximum tuber yield of this variety of tapioca under the conditions of this experiment.

സംഗ്രഹം

വെള്ളായണി കാർഷിക കോളേജിലെ ചുവന്ന ലോം മണ്ണിൽ, "മലയൻ-4" എന്ന ഇനം മരച്ചീനിയ്ക്ക്, പാക്യജനകവും, ഭാവഹവും, ക്ഷാരാംശവും, കുമ്മായവും അടങ്ങിയ fug ങ്ങും വിവിധ അളവിൽ ചേർത്ത് വളർത്തിയപ്പോൾ ആയത് മരച്ചീനിച്ചെടികളുടെ വളർച്ചയേയും വിളവിനേയും ഏതെല്ലാം തരത്തിൽ ബാധിയ്ക്കുകയുണ്ടായി എന്നതിനെപ്പറ്റി CDS ത്തിയ പഠനങ്ങളിൽ നിന്നും താഴെപ്പറയുന്ന വിവരങ്ങൾ ലഭ്യമായിരിയ്ക്കുന്നു.

ചെടികളുടെ പൊക്കത്തിലുള്ള വളർച്ചയേയും മൺനിരപ്പിനു മുകളിലുള്ള ഭാഗങ്ങളുടെ തൂക്കത്തേയും പാക്യജനകവും ക്ഷാരപ്രധാനവുമായ വളങ്ങൾ സഹായിച്ചപ്പോൾ ചെടികൾക്കുണ്ടാകുന്ന ശരാശരി ശാഖകളുടേയും, കിഴങ്ങുകളുടേയും എണ്ണം പാക്യജനകവും കുമ്മായവും അടങ്ങിയ വളങ്ങൾ വർദ്ധിപ്പിയ്ക്കുന്നതായിക്കണ്ടു. കിഴങ്ങുകൾ കൂടുതൽ വണ്ണിച്ചും പുഷ്ടിച്ചും കാണുന്നതിനു പാക്യജനകവും, ക്ഷാരവും, കുമ്മായവും അടങ്ങിയ വളങ്ങൾ സഹായകമായി. ഏറ്റവും നല്ല വിളയ്ക്ക് ഉദ്ദേശം 100 കിലോഗ്രാം പാക്യജനകവും, 50 കിലോഗ്രാം ഭാവഹവും 150 കിലോഗ്രാം ക്ഷാരാംശവും, 600 കിലോഗ്രാം കുമ്മായവും അടങ്ങിയ വളങ്ങൾ നൽകുന്നത് ഉത്തമമെന്നു ഈ പരീക്ഷണങ്ങളിൽ നിന്നും അനുമാനിക്കാവുന്നതാണു.

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