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EFFECT OF NITROGEN AND PHOSPHORUS ON THE YIELD AND QUALITY OF CASSAVA*

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With about 2.3 lakh hectares under cassava (*Manihot esculenta* Crantz.) Kerala produces Rs. 45 crores worth of tubsrs annually. This crop enjoys a unique importance in the State as a subsidiary food crop.

Chadha (1958) showed that the mean response to nitrogen of the crop varied from 20 to 50 per cent for 40 lb nitrogen per acre and from 23 to 79 per cent for 80 lb nitrogen per acre; the mean response to phosphorus varied from 4 to 12 per cent for 80 lb phosphoric acid per acre. According to Malavoita *et al* (1955) nitrogen and phosphorus were the most important nutrients for cassava in increasing both yield of tubers and shoot growth. Pillai (1967) showed that the response of cassava (variety M 4) to phosphorus and nitrogen was highly significant and that they individually increased the percentage of dry matter, starch and crude protein contents of cassava tubers. The percentage of edible portion of the tubers decreas?d with increasing doses of nitrogen while phosphorus could not produce a significant effect on this quality.

Precise information is lacking on the response of cassava to nitrogen and phosphorus and on the optimum ratio in which the two nutrients are to be applied to the soil for obtaining the maximum yield and other quality attributes for the tubers. The present work was undertaken to fill this gap in our knowledge on the nutritional needs of cassava.

Material and Methods

The experiment was laid out in a split plot Randomised Block Design with three replications, in the Agricultural College Farm, Vellayani, Kerala, during 1967-'68, The major treatments were nine combinations of nitrogen and phosphorus each at three levels, viz., zero (n_0), 75 (n_1) and 150 kg (n_2) nitrogen per hectare; and zero (p_0), 50 (p_1) and 100 kg (p_2) phosphoric acid per hectare. Nitrogen and phosphoric acid were applied in the form of ammonium sulphate and superphosphate respectively. A uniform dose of 250 kg of K_2O per hectare as potassium sulphate and 1200 kg of CaO per hectare as fully burnt lime were applied to ah the treatments. The minor treatments were two varieties of cassava M 4 and H 105. The entire doses of lime and superphosphate were applied as basal dressing. Ammonium sulphite and potassium sulphate were applied in two equal split doses 3 months and 4½ months after planting. Cuttings of the two varieties, about 15 to 20 cm long, were planted on mounds of about 45 cm in height taken in lines 99 cm apart each way. Each net

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plot (3.6 x 3.6 m) contained 25 plants. Two weedings and two earthing-ups were given at an interval of two months after planting. The planting was dons on 28-6-1967 and the harvesting on 17-3-1968.

Three plants standing diagonally in every net plot formed the sample for the biometric observations including the number of leaves per plant and total length of the stem. The number and weight of tubers per plant and weight of the shoot at the time of harvest were also recorded.

Dry matter contents of the tubers were determined by chipping them into small pieces and drying them to constant weight in an air oven at 105°C. The percentage of the edible portion of the tubers was determined from samples of 1000 g of fresh tubers. The starch content of the oven dried samples of the tubers was estimated by the A. 0. A. C. method (1956.) Crude protein content of the oven dried samples was determined by the Kjeldhal method as given in Piper (1950). The hydrocyanic acid content of the tubers was estimated by the method of Sinha and Nair (1968).

Results and Discussion

Results are presented in Tables 1 to 4.

Table 1

Mean number of leaves per plant and mean height of plants of 2 varieties of cassava at three different stages of growth

Plant character	62 days		136 days		203 days	
	M 4	H 105	M 4	H 105	M 4	H 105
Number of leaves	27.8	45.7	56.0	63.9	64.8	63.5
Height of plants	30.5	35.4	109.1	115.4	164.4	178.5
CD (5%) between :						
Varieties for number of leaves	4.11		7.41			
Varieties for height of plants	2.28				7.62	

Table 1 shows that the variety H 105 had a significantly greater number of leaves per plant when 62 and 136 days old; the two varieties did not differ much in this character when 203 days old. Further, H 105 showed a clear superiority over M 4 in the character of plant height also.

From Table 2 it may be observed that the combined effect of nitrogen and phosphorus was significant. The maximum tuber yield of 28.6 tons per hectare for M 4 and 30.9 tons per hectare for H 105 were given by the treatment combinations consisting of 150 kg nitrogen and 100 kg P_2O_5 per hectare (n_2p_2); this was nearly 3 times the yield in the control. The treatment giving the second highest yield was the one with 75 kg nitrogen and 50 kg P_2O_5 per hectare (n_1p_1). Preference of the rop for a certain ratio between nitrogen and phosphoric acid was indicated as was

shown by the inferior yield with 150 kg nitrogen and 50 kg P_2O_5 per hectare as against that with 75 kg nitrogen and 50 kg P_2O_5. Nitrogen and phosphorus in the ratio 3 : 2 recorded the maximum yield.

Table 2

Mean yield and number of tubers and yield of shoots of cassava under different manurial treatments

Treatments	Yield of tubers (tonnes/ha)		No. of tubers per plant		Yield of shoots (tonnes/ha)	
	M 4	H 105	M 4	H 105	M 4	H 105
n_0p_0	7.8	8.7	3.70	6.30	6.5	7.2
n_0p_1	10.0	9.5	4.70	6.40	6.5	10.4
n_0p_2	16.9	17.8	6.10	6.70	11.7	18.9
n_0	11.6	12.0	4.83	6.47	8.2	12.2
n_1p_0	10.8	11.1	6.80	8.40	10.4	14.3
n_1p_1	24.0	26.0	6.70	8.90	24.7	33.8
n_1p_2	20,5	22.1	5.60	8.20	18.9	23.4
n_1	18.4	19.7	6.37	8.50	18.0	23.8
n_2p_0	17.3	19.5	6.00	6.30	13.0	26.0
n_2p_1	21.5	21.7	6.30	9.20	18.9	25.4
n_2p_2	28.6	30.9	5.90	9.80	26.7	37.7
n_2	22.5	24.1	6.07	8.43	19.5	29.7
Varietal mean	17.5	18.6	5.75	7.80	15.2	21.9
Po	12.0	13.1	5.50	7.00	9.9	15.8
p_1	18.5	19.1	5.90	8.17	16.7	23.2
Pa	22.0	23.6	5.87	8.23	19.1	26.7
CD (5%) between :						
Varieties	0.65		0.44		2.51	
Varieties under same major	1.96		1.34		7.53	
Varieties under different major	5.74		1.93		8.48	
Levels of N or P	3.19		0.97		3.77	

An increase of nitrogen from zero to 75 kg per hectare enhanced the number of tubers significantly, but a further increase of nitrogen to the highest level (150 kg per hectare) showed a slight depressing effect. The variety H 105 was significantly superior to M 4 in the number of tubers per plant.

The effects of nitrogen and phosphorus singly and in their combination in increasing the weight of shoots were similar to those observed for the tubers. A highly significant correlation existed between the weight of the shoots and that of the tubers ($r = + 0.93$). This also indicates that similar factors were operative in increasing the yield of both shoots and tubers.

Table 3

Mean percentage of dry matter and edible portion of cassava tubers under different manurial treatments

Treatments	Dry matter		Edible portion	
	M 4	H 105	M 4	H 105
n_0p_0	36.2	35.2	85.5	84.4
n_0p_1	36.9	36.0	84.4	83.8
n_0p_2	37.1	36.8	84.9	83.7
n_0	36.7	36.0	84.9	83.9
n_1p_0	36.7	35.8	82.0	82.3
n_1p_1	39.1	37.3	83.3	83.0
n_1Pa	39.3	37.5	83.1	83.3
n_1	38.4	36.8	82.8	82.8
n_2p_0	37.3	36.6	81.8	80.7
$n2p_1$	38.3	37.1	83.9	81.2
n_2p_2	39.9	37.9	83.0	81.1
n_2	38.5	37.2	82.9	81.0
Varietal mean	37.9	36.7	83.5	82.6
Po	36.7	35.8	83.1	82.4
p_1	38.1	36.8	83.8	82.6
p_2	38.8	37.4	83.7	82.7
CD (5%) between !				
Varieties	0.16		0.66	
Varieties under same major	0.49		1.99	
Varieties under different major	0.65		0.29	
Levels of nitrogen or phosphorus	0.33		0.79	

Table 3 presents the data on the mean percentages of dry matter and edible portion of the tubers. Phosphorus influenced the dry matter content of the tubers while the effect of nitrogen was significant only up to the middle level of 75 kg nitrogen per hectare. A combination of the higher doses of the two nutrients gave the maximum percentage of dry matter in both the varieties. But the highest level of nitrogen in the absence of phosphorus recorded a significantly low percentage of dry matter in both the varieties. Further, increases of nitrogen from the n_1 level had a significant depressive effect on the percentage of edible portion of the tubers. Increase of nitrogen to the highest level had no effect on M 4, but it decreased the edible protion in H 105. Phosphorus though individually had no effect increased the edible portion when combined with nitrogen. The variety M 4 was superior to H 105 in this character.

Table 4 shows that the starch content increased significantly with increase in the levels of nitrogen. The influence of phosphorus on the starch content was

considerably more than that of nitrogen. The combinations of the higher levels of nitrogen and phosphorus showed a significantly higher starch content that than shown by the higher doses of the two nutrieats individually. In view of the physiological significance of nitrogen and phosphorus in the synthesis of starch it is only natural to expect that a crop like cassava rich in starch requires large quantities of these two nutrients. The reduction in starch content observed with the highest dose of nitrogen may be due to the enhanced conversion of carbohydrates into proteins in the presence of adequate nitrogen, That this could be so was borne out by the observation that the crude protein content was the highest in the higher levels of nitrogen.

Table 4

Mean starch, crude protein and hydrocyanic acid contents of tubers of cassava under different manurial treatments

Treatments	Starch		Crude protein %		HCN mg/kg	
	M 4	H 105	M 4	H 105	M 4	H 105
n_0p_0	69.4	71.7	1.49	1.46	41.7	38.2
n_0p_1	72.6	72.6	1.48	1.49	39.6	38.2
n_0p_2	76.2	77.5	1.69	1.70	37.4	38.2
n_0	72.9	73.9	1.55	1.55	39.6	38.2
n_1p_0	74.9	76.7	1.95	1.98	48.2	47.5
n_1p_1	81.4	81.4	1.74	1.94	38.9	40.3
n_1p_2	82.5	82.8	1.91	1.76	39.6	41.0
n_1	79.6	80.8	1.87	1.89	42.2	42.9
n_2p_0	73.3	72.4	1.89	1.89	48.9	54.0
n_0p_1	79.3	79.1	2.35	2.15	47.5	48.9
n_2p_3	80.0	82.3	2.19	2.18	40.3	41.8
n_2	77.5	77.9	2.14	2.07	45.6	48.2
Varietal mean	76.7	77.4	1.85	1.84	42.4	43.1
p_0	72.5	73.6	1.77	1.77	46.3	46.5
p_1	77.7	77.7	1.86	1.86	42.0	42.5
p_2	79.8	80.8	1.93	1.88	39.1	40.3

CD (5%) between :			
Varieties	0.68		
Varieties under same major	2.01	0.22	5.30
Varieties under different major	3.07	0.19	5.15
Levels of N or P	1.56	0.06	2.02

The incremental doses of nitrogen significantly increased the hydrocyanic acid content of the tubers and phosphorus showed just the reverse effect. Thus phosphorus appeared to suppress the effect of nitrogen in this regard. It appears that the low phosphorus supply inhibited protein synthesis in the phosphorus deficient plants resulting in the accumulation of hydrocyanic acid.

The above findings, in general, highlight the importance of a balanced application of nitrogen and phosphorus to ensure a high yield and high quality of tubers. Imbalance of the two nutrients is more detrimental than even their lower yet balanced doses. A ratio of 3: 2 between nitrogen and phosphorus is found to be the best to ensure both quality and quantity.

Summary

Response of the two varieties of cassava, M 4 and H 105, to graded doses of nitrogen (0, 75, and 150 kg N/ha) and phosphorus (0, 75 and 100 kg P_2O_5/ha) in respect of yield and quality of tubers was ascertained in a field experiment.

Application of nitrogen (as ammonium sulphate) and P_2O_5 (as superphosphate) at 150 and 100 kg/ha gave the highest yield of 28.6 and 30.9 tonnes of tubers and 26.7 and 37.7 tonnes of shoots per hectare for the varieties M 4 and H 105 respectively. Doses of 75 kg of N and 50 kg of P_2O_5 per hectare ranked second in yield. A ratio of 3: 2 between N and P_2O_5 appeared to be the optimum combination for these nutrients. Increase of nitrogen from 0 to 75 kg/ha increased the number of tubers but further increases in N decreased it.

The variety H 105 was significantly superior to M 4 both in yield and in number of tubers produced. The former produced more number of leaves and grew to a greater height than the latter.

Nitrogen and P_2O_5 at 150 kg/ha respectively gave the highest dry matter content of the tubers; an increase in the nutrients individually did not give any significant increase.

None of the nutrient treatments had a significant effect in improving the percentage of edible portion of the tubers.

Starch contents of the tubers increased with increase of introgen upto 75 kg/ha and decreased with further increase of nitrogen. A combination of N and P_2O_5 at 150 and 100 kg/ha gave the maximum starch contents. Crude protein contents increased with increase in N and was maximum when N and P_2O_5 were combined at 150 and 100 kg/ha. HCN contents increased with increases in N and decreased (or had no effect) with P_2O_5.

A balanced application of N and P_2O_5 at a ratio of 3: 2 was indicated as the most advantageous for cassava.

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