AGRONOMIC INVESTIGATIONS ON 'TARO' (*COLOCASIA ESCULENTA* L.) VARIETY - THAMARAKANNAN

BY

C. R. MOHAN KUMAR

THESIS
SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE
DOCTOR OF PHILOSOPHY
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

1986

DECLARATION

I hereby declare that this thesis entitled "Agronomic investigations on taro (Colocasia esculenta L.) variety Thamarakannan" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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24th December, 1986

CERTIFICATE

Certified that this thesis, entitled "Agronomic investigations on 'taro' (*Colocasia esculenta* L.) variety-Thamarakannan" is a record of research work done independently by Shri.C.R.Mohan Kumar under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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SPPalaniappan
4/4/81
(SP. PALANIAPPAN)
External Examiner

ACKNOWLEDGEMENT

I wish to place on record my deep sense of gratitude and indebtedness to Dr. N.Sadanandan, B.Sc. (Hons.) (Agri.), Ph.D., Assoc. I.A.R.I., Director (P.G.Studies), Kerala Agricultural University, Chairman of the advisory committee for his valuable guidance, ever willing help, constructive criticisms and constant encouragement throughout the course of the present investigations and preparation of the thesis.

I am greatly obliged to Dr.M.M.Koshy, Dean in Charge, College of Agriculture, Vellayani, for his valuable suggestions and critical evaluation of the script.

I am extremely thankful to Dr.V.K.Sasidhar, Professor and Head, Department of Agronomy, College of Agriculture, Vellayani, for his ever willing help and critical scrutiny of the manuscript.

My sincere thanks are due to Dr.C.Sreedharan, Professor and Head, Department of Agronomy, College of Horticulture, Vellanikkara for his inspiring suggestions and for carefully going through the script.

I am greatly obliged to Dr.(Mrs).P.Saraswathy, Associate Professor of Agrl. Statistics, for her valuable advice,

suggestions and help in the design of field experiments and in the statistical analysis of the data.

I am indebted to Dr. N.M.Nair, Director, Central Tuber Crops Research Institute, Trivandrum, for the grant of study leave which enabled me to take up this work.

I am greatful to Dr. S.P.Gosh, Director, Central Tuber Crops Research, Institute, Trivandrum for providing laboratory facilities and constant encouragement throughout the cource of the investigation.

I record my sincere thanks to Dr. N.G.Pillai, Head of the Division of Agronomy and Soils and Dr. B.Mohan Kumar, Scientist S_2 (Soils), of the Central Tuber Crops Research Institute, Trivandrum, for their limitless help in the conduct of chemical analysis.

Thanks are also due to Dr. K.Pushpangadan, Professor of Agronomy, Instructional farm, College of Agriculture, Vellayani, for providing all facilities for the conduct of field experiments in the farm.

I am also thankful to the staff members of the Division of Agronomy, Agricultural College, Vellayani for their help at various stages in the present study.

I am deeply indebted to my wife M.C. Jaya for her constant encouragement and manifold assistance.

I am grateful to the Indian Council of Agricultural Research for the award of Senior Research Fellowship for the course of study.

(C.R.MOHAN KUMAR)

Vellayani
24th December, 1986

CONTENTS

LIST OF TABLES

Table 9A. Experiment A. Interaction effect of plant population, source of planting material and mulching on yield of mother corm and non-marketable cormel in t ha^{-1}

Yield of Mother Corm(Corm)

Population / Mulch	Plant population x Mulch			
	P_1	P_2	P_3	P_4
M_1	2.96	3.04	3.29	3.12
M_2	2.65	2.63	2.77	2.60
M_3	3.49	3.04	2.94	2.75
M_4	3.21	2.79	3.13	2.90
M_5	2.33	2.76	2.61	2.55

C.D. P x M = 0.373

Non Marketable Cormel

Mulch / Population	Mulch x Plant population				
	M_1	M_2	M_3	M_4	M_5
P_1	2.89	2.82	2.87	2.30	2.34
P_2	2.38	2.78	2.49	2.31	2.61
P_3	2.33	1.93	2.40	2.14	2.22
P_4	1.72	1.39	1.41	1.60	1.57

C.D. P x M = 0.296

Yield of Mother Corm

Source / Mulch	Source of plant material x mulch	
	S_1	S_2
M_1	3.30	2.89
M_2	3.46	2.85
M_3	3.27	2.84
M_4	2.79	3.03
M_5	2.36	2.79

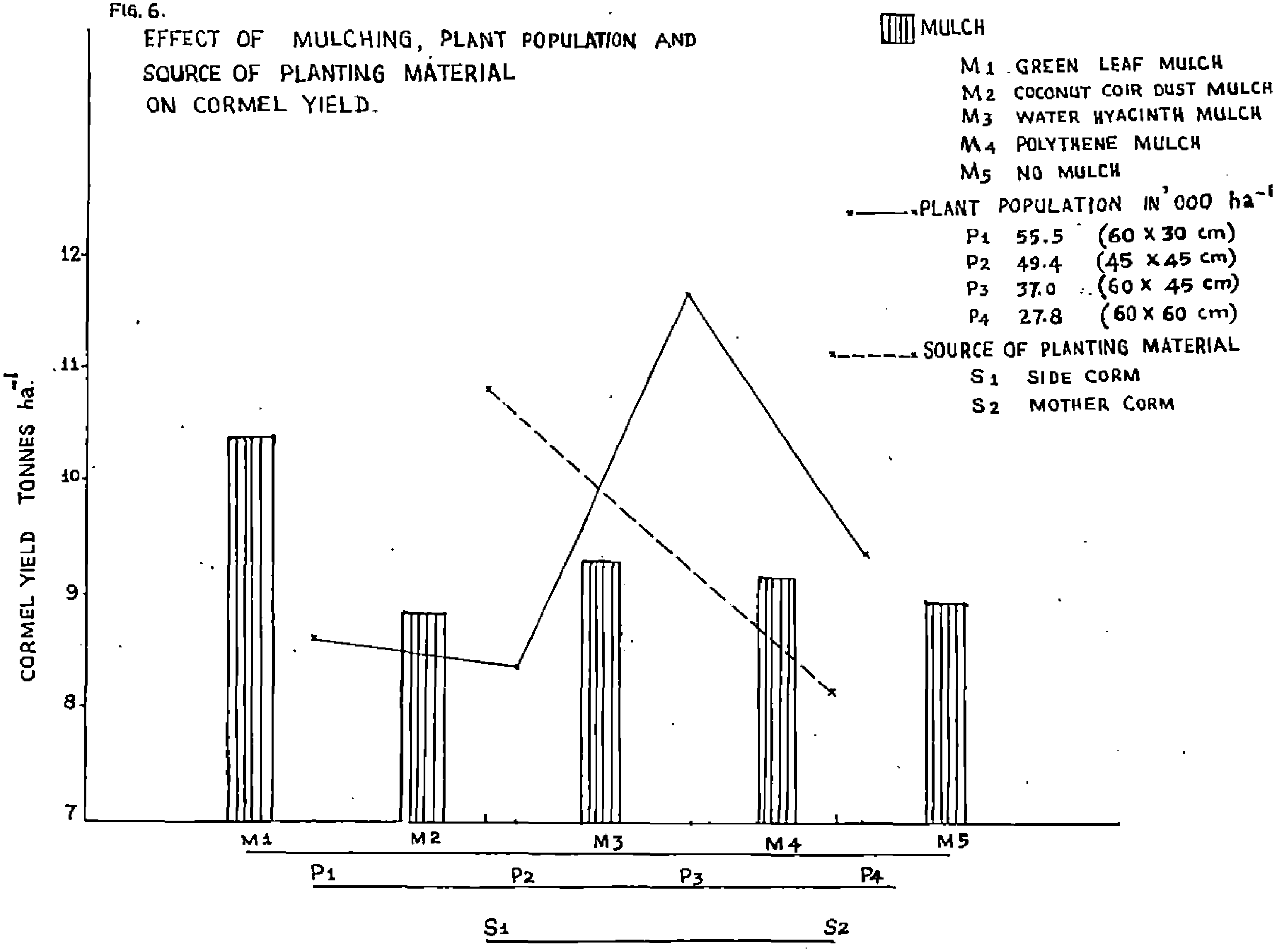
C.D. M x S = 0.263

Table 5. Experiment A. Effect of plant population, source of planting material and mulching on LAI at various stages of growth

Treatments	60th day	90th day	120th day	150th day
Plant population in '000 ha^{-1} (Spacing)				
P_1 55.5 (60 x 30 cm)	0.562	1.113	1.289	0.989
P_2 49.4 (45 x 45 cm)	0.555	1.129	1.230	0.949
P_3 37.0 (60 x 45 cm)	0.440	0.954	1.110	0.770
P_4 27.8 (60 x 60 cm)	0.323	0.805	0.976	0.695
C.D.	0.070	0.151	0.066	0.094
Source of planting material				
S_1 (Side corm/cormel)	0.421	0.907	1.166	0.878
S_2 (Mother corm/cormel)	0.519	1.093	1.136	0.824
C.D.	0.049	0.107	N.S	N.S
Mulch material				
M_1 (Green leaf)	0.447	0.961	1.299	0.933
M_2 (Coconut coir waste)	0.412	0.945	1.096	0.834
M_3 (Water hyacinth)	0.565	1.123	1.162	0.845
M_4 (Black polythene)	0.480	1.054	1.143	0.832
M_5 (No mulch control)	0.446	0.917	1.057	0.811
C.D.	0.055	N.S	0.064	N.S

FIG. 6.

EFFECT OF MULCHING, PLANT POPULATION AND SOURCE OF PLANTING MATERIAL ON CORMEL YIELD.



mother corm. Highest mother corm yield was observed in P_3 but it was on par with other treatments. Source of planting material also did not show any significant effect on corm yield. However, mulching had significant effect on the production of mother corm. Maximum corm yield was recorded for the green leaf mulch which was on par with waterhyacinth (M_3), but significantly superior to other mulches tried.

Of the different plant populations P_1 (60 x 30 cm) recorded the maximum non marketable side tubers which was on par with P_2 (45 x 45 cm). Non-marketable cormel was significantly higher when side corms were used as planting materials. Mulching had no significant effect on the production of non marketable cormels.

Maximum mother corm yield was recorded for the treatment combination P_1 M_3, which was on par with P_3 M_1, P_3 M_4 and P_1 M_4. The interaction effect of source of planting material and mulching on mother corm yield revealed that maximum corm yield was recorded for the treatment combination S_1M_1 which was on par with S_1M_3. Maximum non marketable cormel was produced by the treatment combination P_1M_1 which was on par with P_1M_2 and P_1M_3.

4.1.2.6. Total dry matter yield

Plant population had significant effect on total dry matter production. Maximum dry matter production was observed in P_3 (60 x 45 cm) which was significantly superior to other plant populations tried. Source of plant material also had a significant effect on the total dry matter production. Side corm was significantly superior to mother corm in this respect. Effect of mulching on dry matter production was found to be significant. Leaf mulch has recorded significantly higher dry matter production over other mulch materials tried. The interaction effect was not significant.

As regards harvest index the highest harvest index was recorded for green leaf mulch which was significantly superior to other mulch materials tried.

4.1.3. Quality Attributes

The data on the quality aspects of cormel are presented in Table 10.

4.1.3.1. Dry matter percentage

It is evident from the table (Table 10) that maximum dry matter percentage was observed in P_1 (60 x 30 cm) which

Table 10. Experiment A. Effect of plant population, source of planting material and mulching on contents of dry matter, starch, protein and oxalate in cormel and starch in corm.

Treatments	% Dry matter	% Starch	% protein	Oxalate content (mg/g)	% Starch Corm
Plant population in '000 ha^{-1} (Spacing)					
P_1 55.5 (60 x 30 cm)	24.02	61.40	3.603	0.894	47.34
P_2 49.4 (45 x 45 cm)	23.89	61.35	3.598	0.893	47.46
P_3 37.0 (60 x 45 cm)	23.94	61.33	3.596	0.892	47.48
P_4 27.8 (60 x 60 cm)	23.99	61.50	3.597	0.894	47.57
C.D.	0.064	NS	0.002	NS	NS
Source of planting material					
S_1 (Side corm/cormel)	23.96	61.37	3.600	0.893	47.54
S_2 (Mother corm/cormel)	23.96	61.42	3.597	0.893	47.49
C.D.	NS	NS	0.002	NS	NS
Mulch material					
M_1 (Green leaf)	24.20	62.08	3.619	0.899	47.92
M_2 (Coconut coir waste)	23.87	61.15	3.601	0.892	47.42
M_3 (Water hyacinth)	23.95	61.33	3.593	0.893	47.38
M_4 (Black polythene)	23.88	61.15	3.590	0.897	47.43
M_5 (No mulch control)	23.92	61.28	3.590	0.896	47.41
C.D.	0.093	NS	0.004	NS	0.099

was on par with P_4 (60 x 60 cm). Source of planting material had no effect on the percentage of dry matter production in cormels. Mulching had significant effect on the dry matter percentage of cormels. Maximum dry matter percentage of cormels was recorded for M_1 (leaf mulch) which was significantly superior to all other treatments.

4.1.3.2. Starch percentage

It was observed that different treatments had no significant effect on this character.

4.1.3.3. Protein content

The crude protein content of the cormel was significantly affected by different treatments, P_1 has recorded the highest percentage of protein which was significantly superior to other plant populations tried. Mulching had a significant effect on the crude protein content of the cormels. Leaf mulch recorded the highest protein content in the cormel which was significantly superior to the other mulch materials used.

4.1.3.4. Acridity and Cooking quality

Calcium oxalate content of the cormel was not affected by the different treatments. Cooking quality of the cormel was not markedly affected by the different treatments as judged by organoleptic test.

4.1.4. Available NPK content and physical properties of soil

4.1.4.1. The data on the available NPK content of the soil (after harvest of the crop) as affected by different treatments and physical properties are presented in Table 11 and the interaction in Table 11A.

The results indicated that plant population had no significant effect on the available N and P content of the soil, but had significant effect on the K content in the soil. Maximum K content of the soil was for P_1 which was on par with P_4 but significantly superior to P_2 and P_3.

Source of planting material had no significant effect on the content of available soil nitrogen and potash, but had significant effect on the available P. Side corm had retained significantly more available P than mother corm.

Table 11. Experiment A. Effect of plant population, source of planting material and mulching on the available N, P and K content, bulk density and water stable aggregate at harvest

Treatments	N (Kg ha^{-1})	P (Kg ha^{-1}	K (Kg ha^{-1})	Bulk density (g cc^{-1})	% of water stable aggregate > 0.25 mm
Plant population in '000 ha^{-1} (spacing)					
P_1 55.5 (60 x 30 cm)	313.1	21.03	160.5	1.616	37.12
P_2 49.4 (45 x 45 cm)	319.3	22.70	156.5	1.606	37.11
P_3 37.0 (60 x 45 cm)	325.7	21.40	154.6	1.608	37.20
P_4 27.8 (60 x 60 cm)	334.1	20.90	159.5	1.604	37.19
C.D.	NS	NS	2.74	0.004	NS
Source of planting material					
S_1 (Side corm/cormel)	326.1	22.30	158.4	1.610	37.17
S_2 (Mother corm/corm)	319.9	20.70	157.4	1.607	37.14
C.D.	NS	1.17	NS	NS	NS
Mulch material					
M_1 (Green leaf)	341.9	23.70	162.2	1.600	38.32
M_2 (Coconut coir waste)	316.7	20.50	157.3	1.608	37.34
M_3 (Water hyacinth)	325.7	22.00	156.7	1.611	37.45
M_4 (Black polythene)	317.3	21.60	156.60	1.615	36.36
M_5 (No mulch control)	313.5	19.80	156.0	1.608	36.30
C.D.	6.92	0.598	1.501	0.003	0.141

Table 11A. Experiment A. Interaction effect of plant population, source of planting material and mulching on available soil nitrogen and phosphorus (Kg ha^{-1})

Soil Nitrogen (Available)

Source population	Source planting material x plant population	
	S_1	S_2
P_1	300.2	325.8
P_2	328.9	309.5
P_3	333.6	317.9
P_4	341.9	326.3

C.D. P x S = 19.835

Soil Phosphorus (Available)

Source population	Source of planting material x plant population	
	S_1	S_2
P_1	21.66	21.03
P_2	22.44	22.72
P_3	24.34	21.43
P_4	20.85	20.85

C.D. P x S = 2.346

Mulching had significant effect on the availability of N, P and K content in the soil. Application of leaf mulch had retained higher content of available soil nitrogen which was significantly superior to all other mulch materials used. The trend was the same for available P and K.

The interaction effects were also significant for available nitrogen and phosphorus. The maximum available nitrogen content was observed for the treatment combination S_1P_4 which was significantly superior to P_2S_2 and P_3S_2.

Plant population and source of planting material had significant effect on the available P status in the soil. Maximum content of P was observed for S_1P_3 which was on par with P_2S_1, P_3S_1 and P_2S_2.

4.1.4.2. Bulk density

Plant spacing had a significant effect on the bulk density of the soil (Table 11). The lowest value was observed in P_4 which was significantly superior to other spacings.

Mulching also had significant effect on this character and the lowest value was recorded for green leaf mulch which was significantly superior to the other mulch materials used.

4.1.4.3. Water stable aggregate

Percentage of water stable aggregate of size 0.25mm was maximum in green leaf mulch plot which was significantly superior to the other mulches used. The effect of plant population and source of planting material had no significant effect on this character.

4.2. Experiment D

The results of the experiment on the response of taro to different levels of nitrogen, phosphorus and potassium and its time of application are presented in this chapter.

4.2.1. Growth characters

4.2.1.1. Plant height

The data on the effect of treatments on plant height at various growth stages during 1984 and 1984-'85 are presented in Table 12.

On the 60th day after planting significant increase in plant height was observed only for nitrogen and potassium.

Table 12. Experiment B. Effect of levels of NPK and time of application of N and K on plant height at various stages of growth (cm).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-'85	1984	1984-'85	1984	1984-'85	1984	1984-'85
n_1 (40 kg N ha^{-1})	40.17	29.97	48.28	45.83	53.25	51.61	45.89	39.36
n_2 (80 kg ")	43.06	31.31	50.47	48.44	56.78	58.81	47.06	42.31
n_3 (120kg ")	43.56	31.31	56.39	49.06	64.08	58.92	47.00	42.39
C.D.	1.565	N:S	1.165	1.015	1.822	1.473	N:S	1.913
p_1 (25 kg P_2O_5ha^{-1})	41.22	31.53	51.22	48.61	56.78	57.19	46.97	41.97
p_2 (50 kg ")	42.58	30.86	51.86	46.75	58.83	55.41	46.50	39.89
p_3 (75 kg ")	42.97	30.19	52.06	47.97	58.50	56.72	46.47	42.19
C.D.	N:S	N:S	N:S	1.015	N:S	N:S	N:S	1.913
k_1 (50 kg K_2O ha^{-1})	40.97	31.08	50.81	47.06	56.61	56.05	44.22	39.33
k_2 (100kg ")	42.44	30.61	51.64	47.36	59.00	56.44	46.69	41.89
k_3 (150kg ")	43.36	30.89	52.69	48.92	58.50	56.83	49.03	42.83
C.D.	1.565	N:S	1.165	1.015	1.822	N:S	1.342	1.913
t_1 (N and K in two split applications)	41.80	30.67	51.37	48.25	57.67	57.13	45.09	41.50
t_2 (N and K three split applications)	42.72	31.05	52.05	47.20	58.41	55.76	47.20	41.20
C.D.	N:S	N:S	N:S	1.015	N:S	0.868	1.126	N:S

Increase in the level of nitrogen from n_1 to n_2 had increased the plant height significantly. The difference between n_2 and n_3 was on par. Application of graded doses of phosphorus did not show any significant effect on plant height. Application of K at k_3 level recorded maximum plant height, but was on par with k_2. Time of application was not significant in this trait.

In the second year (1984-'85) none of the treatments had any significant effect on plant height on the 60th day after planting. At 90th and 120th days after planting a marked increase in plant height was observed for the highest dose of nitrogen in 1984 alone. In 1984-'85 significant difference in plant height was observed between n_1 and n_2, but n_2 and n_3 were on par. No significant effect could be seen for P during the second year of observation. In the second year plant height was more or less of similar magnitude at the varying levels of P application.

Although the effect of K was significant in almost all the stages of growth during both the years, the significance was observed only between the lowest (K_1) and the highest levels (K_3).

Significant difference in plant height was observed with the time of application from 90th day, but the results were not consistent during all the growth stages.

4.2.1.2. Number of leaves per plant

The number of leaves per plant at various growth stages are presented in Table 13.

A perusal of the data (Table 13) reveal that at 60th day there was no significant effect for the application of nitrogen and phosphorus on leaf production. However, potassium had a significant effect on leaf production at k_1 level in the first year and k_2 level in the second year.

Time of application did not show any significant effect on this character throughout the growth of the crop during both the years.

At 90th day after planting during 1984, application of nitrogen had a significant effect on the rate of leaf production, and maximum leaf production was observed at n_3 which was significantly superior to n_1 and n_2. P and K were not effective in leaf productions at this stage. During 1984-'85 nitrogen and potassium showed a significant effect on the production of leaves plant^{-1}. Maximum leaf production was observed at n_2 and k_2 levels. At 120th day, application of nitrogen at n_3 level was significant during 1984 whereas during 1984-'85 level of nitrogen was not significant in

Table 13. Experiment B. Effect of levels of NPK and time of application of N and K on the number of leaves plant^{-1} at various stages of growth.

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-'85	1984	1984-'85	1984	1984-'85	1984	1984-'85
n_1 (40 kg N ha^{-1})	4.38	5.05	3.78	4.06	3.23	4.07	2.37	3.02
n_2 (80 kg ")	4.30	5.13	3.74	4.11	3.19	4.08	2.30	3.05
n_3 (120kg ")	4.35	5.08	3.89	4.11	3.33	4.07	2.24	3.04
C.D.	N:S	N:S	0.108	0.039	0.080	N:S	0.026	N:S
p_1 (25 kg P_2O_5 ha^{-1})	4.34	5.08	3.84	4.08	3.32	4.08	2.35	3.02
p_2 (50 kg ")	4.37	5.10	3.74	4.09	3.25	4.07	2.34	3.04
p_3 (75 kg ")	4.33	5.09	3.83	4.10	3.17	4.07	2.31	3.04
C.D.	N:S	N:S	N:S	N:S	0.080	N:S	0.026	N:S
k_1 (50 kg K_2O ha^{-1})	4.38	5.05	3.79	4.07	3.21	4.05	2.31	3.01
k_2 (100kg ")	4.29	5.12	3.80	4.12	3.28	4.09	2.34	3.04
k_3 (150kg ")	4.36	5.11	3.81	4.07	3.25	4.08	2.34	3.05
C.D.	0.066	0.05	N:S	0.039	N:S	0.035	0.026	0.033
t_1 (N and K in two split applications)	4.32	5.08	3.76	4.08	3.24	4.07	2.34	3.03
t_2 (N and K in three split applications)	4.36	5.12	3.85	4.09	3.25	4.07	2.32	3.04
C.D.	N:S	N:S	0.087	N:S	N:S	N:S	N:S	N:S

leaf production. Phosphorus at the lower level (p_1) was effective in leaf production during 1984, while during 1984-'85 it was not effective. Application of potassium had no significant effect during 1984 whereas during 1984-'85 k_2 had recorded the maximum number of leaves plant^{-1} which was significantly superior to k_1, but was on par with k_3.

At 150th day, maximum leaf production was observed at n_2 level which was on par with n_1 during 1984. Phosphorus and potassium had significant effect at p_1 and k_2 levels. During 1984-85 potassium had significant effect and k_3 had recorded the maximum number of leaves plant^{-1} which was significantly superior only to k_1.

From the Table it could be concluded that only potassium and to a certain extent nitrogen showed a significant effect in the production of leaves plant^{-1} whereas phosphorus and time of application had only little effect during most stages of growth of taro.

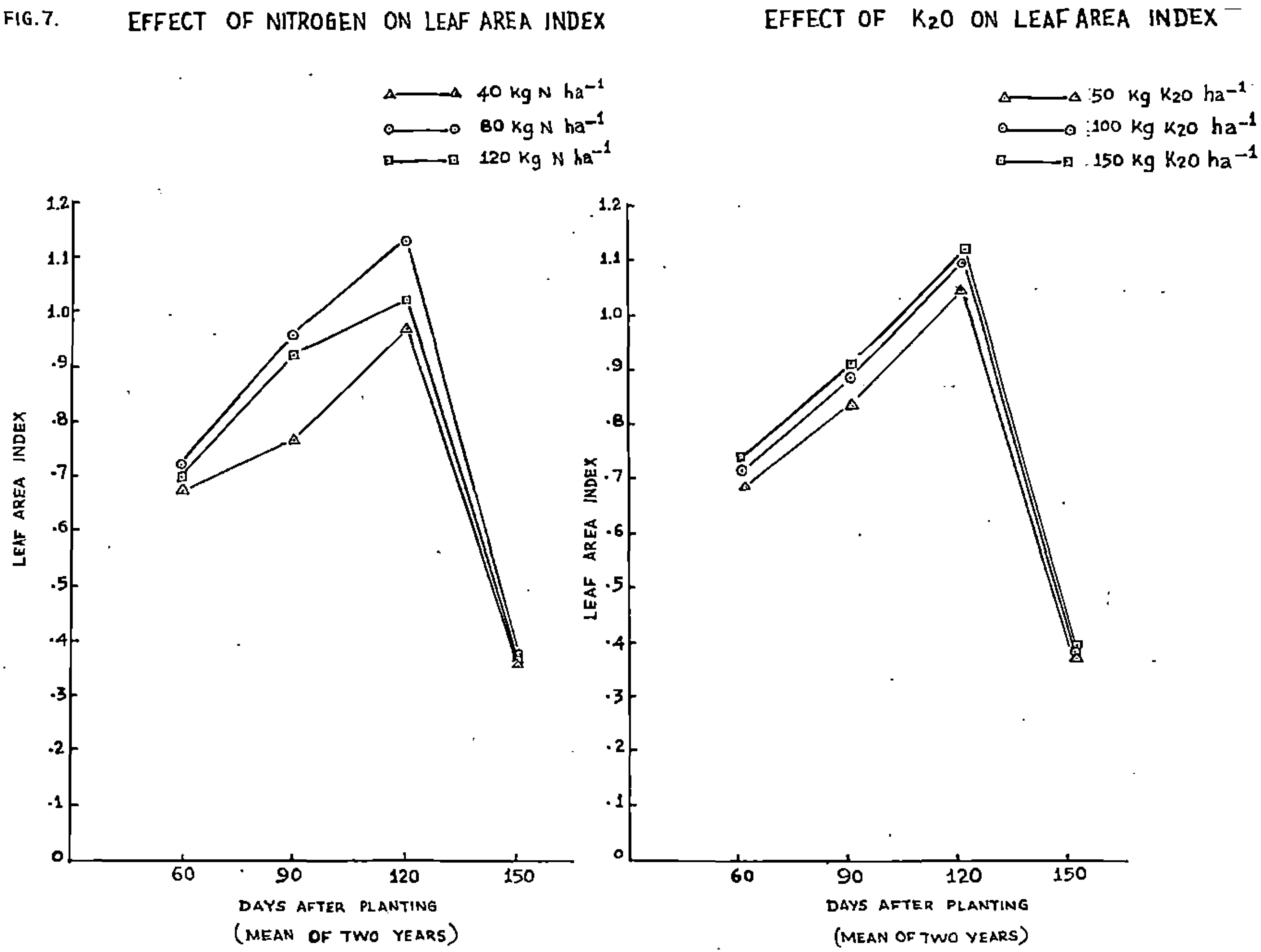
4.2.1.3. Leaf area Index (LAI)

The data on leaf area index (LAI) at various growth stages of taro during 1984 and 1984-'85 are presented in Table 14 (Fig.7).

Table 14. Experiment B. Effect of levels of NPK and time of application of N an K on LAI at various stages of growth.

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-'85	1984	1984-'85	1984	1984-'85	1984	1984-'85
n_1 (40 kg N ha^{-1})	0.81	0.54	0.93	0.60	1.17	0.78	0.43	0.26
n_2 (80 kg ")	0.87	0.59	1.23	0.68	1.40	0.87	0.44	0.29
n_3 (120kg ")	0.82	0.58	1.12	0.72	1.38	0.92	0.40	0.31
C.D.	0.037	0.016	0.072	0.011	0.067	0.025	0.019	0.004
p_1 (25 kg $P_2O_5 ha^{-1}$)	0.82	0.57	1.06	0.67	1.29	0.85	0.41	0.28
p_2 (50 kg ")	0.85	0.57	1.10	0.67	1.34	0.89	0.43	0.29
p_3 (75 kg ")	0.84	0.58	1.12	0.67	1.32	0.85	0.43	0.28
C.D.	N.S	N.S	N.S	N.S	N.S	0.025	0.019	0.004
k_1 (50 kg K_2O ha^{-1})	0.81	0.55	1.04	0.64	1.28	0.84	0.41	0.28
k_2 (100kg ")	0.84	0.58	1.11	0.68	1.33	0.86	0.43	0.29
k_3 (150kg ")	0.86	0.59	1.13	0.69	1.35	0.89	0.44	0.29
C.D.	0.037	0.016	0.072	0.011	0.067	0.025	0.019	0.004
t_1 (N and K in two split application)	0.81	0.56	1.07	0.67	1.28	0.87	0.41	0.29
t_2 (N and K in three split application)	0.85	0.57	1.12	0.67	1.35	0.85	0.43	0.29
C.D.	0.021	0.009	0.030	N.S	0.033	0.019	0.011	N.S

FIG.7.



EFFECT OF NITROGEN ON LEAF AREA INDEX

EFFECT OF K2O ON LEAF AREA INDEX

At 60th day during 1984 nitrogen, potassium and time of application had significant effect on LAI. Maximum LAI, was recorded at n_2 level which was significantly superior to n_1 and n_3. Phosphorus application was not effective on LAI at this stage. Potassium application had a significant effect on LAI and maximum LAI was observed at k_3 level which was significantly superior to k_1, but wason par with k_2. Time of application t_2, was significantly superiot to t_1. The trend was the same for the year 1984'85.

At 90th day during first year (1984) nitrogen and potassium had significant effect on LAI. Maximum LAI was recorded at n_2 level which was significantly superior to n_1 and n_3. The levels of P on LAI were not significant. The levels of K were significant in increasing the LAI. Maximum LAI was observed at k_3 which was significantly superior to k_1 during 1984 but was on par with k_1 and k_2 during 1984-'85.

Time of application was significant during 1984 and t_2 was significantly superior to t_1 for the production of higher LAI.

At 120th day, nitrogen and potassium were found to be significant in the production of LAI during 1984. The level of nitrogen n_2 was on par with n_3. The effect of P on LAI was not significant. Treatment k_3 had a significant effect on LAI which was significantly superior to k_1. As regards time of application, t_2 was significantly superior to t_1. During the second year (1984-'85) p_2 had a significant effect on LAI. Treatment n_3 and k_3 were significantly superior to their lower levels of application for the production of LAI.

4.2.2. Yield components and yield

4.2.2.1. Cormel yield plant^{-1}

The data on cormel yield plant^{-1} are presented in Table 15.

Application of nitrogen had significant effect on cormel yield plant^{-1} during both the years (1984 and 1984-'85). Maximum cormel yield plant^{-1} was obtained for n_2 which was significantly superior to n_1 but was on par with n_3.

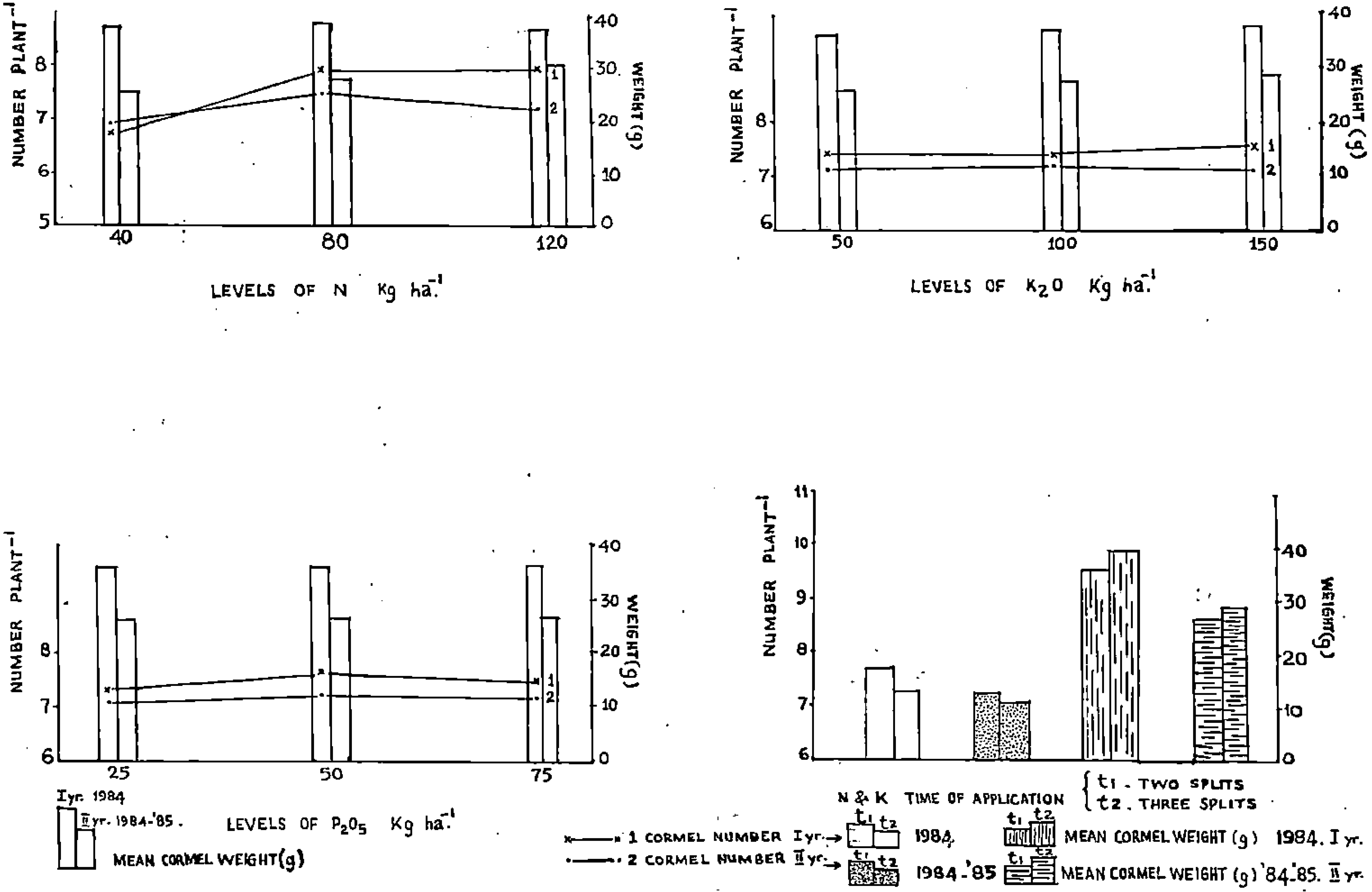
The effect of phosphorus was found to be non significant during both the years.

Levels of potassium were significant on the production of cormels plant^{-1}. Treatment k_3 had a significant influence, which was significantly superior to k_1 but was on par with k_2.

Table 15. Experiment B. Effect of levels of NPK and time of application of N and K on cormel yield, cormel number and weight/size plant^{-1}.

Treatments	cormel yield (g)		No. of cormels		Mean weight of cormel (g)	
	1984	1984-'85	1984	1984-'85	1984	1984-'85
n_1 (40 kg N ha^{-1})	235.7	172.8	6.70	6.91	36.57	25.05
n_2 (80 kg ")	296.4	213.9	7.90	7.50	38.29	28.51
n_3 (120kg ")	292.7	211.0	7.95	7.20	37.71	29.30
C.D.	12.9	8.8	0.433	0.174	N.S	1.223
p_1 (25 kg P_2O_5 ha^{-1})	268.2	195.6	7.40	7.09	37.65	27.57
p_2 (50 kg ")	279.3	201.4	7.63	7.32	37.31	27.47
p_3 (75 kg ")	277.4	200.6	7.50	7.21	37.61	27.81
C.D.	N.S	N.S	N.S	0.174	N.S	N.S
k_1 (50 kg K_2O ha^{-1})	265.4	186.1	7.41	7.19	36.54	25.84
k_2 (100kg ")	276.3	201.6	7.48	7.24	37.65	27.87
k_3 (150kg ")	283.2	209.9	7.63	7.19	38.33	29.14
C.D.	12.9	8.8	N.S	N.S	N.S	1.223
t_1 (N and K in two split application)	267.1	195.4	7.77	7.22	35.31	27.03
t_2 (N and K in three split application)	282.7	203.1	7.25	7.18	39.74	28.21
C.D.	7.2	2.55	N.S	N.S	2.593	0.543

FIG.8. EFFECT OF LEVELS OF N, P_2O_5, K_2O AND TIME OF APPLICATION OF N AND K ON CORMEL NUMBER AND WEIGHT(g)



Time of application was significant during both the years and maximum cormel yield plant^{-1} was observed at t_2.

4.2.2.2. Number of cormels plant^{-1}

The data on the effect of treatments on the number of cormels plant^{-1} are presented in Table 15 (Fig. 8). It could be seen from the data that nitrogen had a significant effect on the number of cormels plant^{-1} during both the years. Treatment n_2 recorded significantly higher number of cormels plant^{-1} during both the years. However, during 1984-'85 there occurred a significant reduction at n_3 level.

The effect of P was significant only in the second year (1984-'85). Maximum number of cormels plant^{-1} was observed at p_2 which was significantly superior to p_1 but was on par with p_3. Potassium was found to have no effect on the production of cormels plant^{-1} during both the years. The time of application was also not significant.

4.2.2.3. Mean weight of cormel (Size)

The data on the effect of treatments on the mean weight of cormels are presented in Table 15 (Fig.8). From the data it is seen that there was significant effect for the application of nitrogen and potassium for increasing the size of cormels during 1984-'85. There was a gradual increase in the size of cormel from n_1 to n_3 levels which was significant upto n_2 level and at n_3 level, though the size was increased, it was on par with n_2. Application of potassium had a significant effect on increasing cormel size from k_1 to k_3. Time of application was significant and t_2 was superior to t_1.

4.2.2.4. Cormel yield

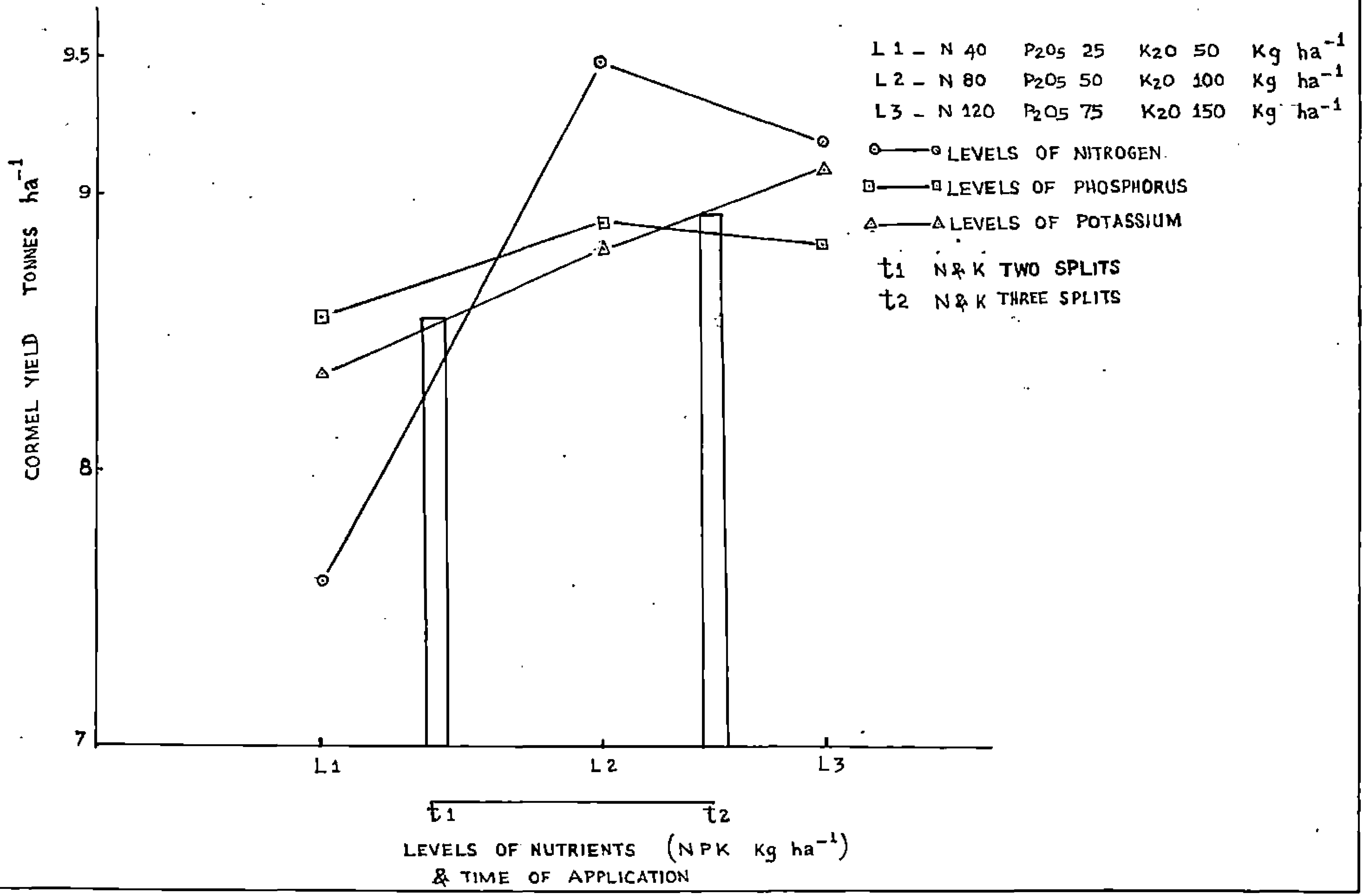
The data on the yield of cormels during both the years are presented in Table 16 (Fig.9). Cormel yield increased with increase in the level of nitrogen upto n_2. Maximum yield was obtained at n_2 which was significantly superior to n_1 and n_3 during 1984. During 1984-'85 also maximum yield was obtained for n_2 which was significantly superior to n_1 but was on par with n_3. During both the years phosphorus application had no significant effect on the yield of cormels in taro. Application of potassium was significant in increasing the yield of cormels during both the years. Highest yield was recorded at k_3 which was on par with k_2.

Pooled analysis showed that the treatments behaved significantly over the periods. Yield was found to increase with an increase in the levels of K. A dose of P higher than p_2 level was not found to be beneficial. A significant reduction in the average yield was observed during the second year. The abstract of pooled analysis is given in Appendix IV. Significantly lower yield during 1984-'85 was due to continuous cropping and lesser number of rainy days during crop growth(Appendix II).

Table 16. Experiment D. Effect of levels of NPK and time of application of N and K on yield (t ha^{-1})

Treatments	Cormel yield		Cormel yield (Average over years)	Corm yield		Total yield		Cormel/corm ratio		Non marketable cormel yield	
	1984	1984-85		1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1(40 kg N ha^{-1})	8.76	6.41	7.59	2.61	1.89	11.37	8.30	3.36	3.39	1.44	1.22
n_2(80 kg ")	11.04	7.94	9.49	3.31	2.29	14.35	10.23	3.33	3.39	1.29	1.22
n_3(120kg ")	10.58	7.82	9.18	3.07	2.35	13.65	10.08	3.43	3.43	1.27	1.14
C.D.	0.411	0.322	0.255	0.101	0.074	0.474	0.385	0.085	N.S	0.052	N.S
p_1(25 kg P_2O_5 ha^{-1})	9.85	7.27	8.56	2.92	2.11	12.77	9.38	3.37	3.40	1.31	1.20
p_2(50 kg ")	10.35	7.47	8.91	3.02	2.17	13.37	9.64	3.41	3.40	1.27	1.12
p_3(75 kg ")	10.20	7.44	8.79	3.04	2.16	13.24	9.60	3.33	3.41	1.41	1.16
C.D.	N.S	N.S	0.255	0.101	N.S	0.474	N.S	N.S	N.S	0.052	N.S
k_1(50 kg K_2O ha^{-1})	9.80	6.91	8.35	2.94	2.05	12.74	8.95	3.35	3.37	1.33	1.20
k_2(100kg ")	10.16	7.48	8.82	3.00	2.15	13.16	9.63	3.37	3.42	1.34	1.13
k_3(150kg ")	10.43	7.78	9.08	3.05	2.25	13.48	10.03	3.39	3.43	1.33	1.23
C.D.	0.411	0.322	0.255	N.S	0.074	0.474	0.386	N.S	N.S	N.S	N.S
t_1(N and K in two split application)	9.87	7.87	10.11	2.97	2.13	12.84	9.33	3.34	3.406	1.34	1.14
t_2(N and K in three split application)	10.33	7.53	7.30	3.02	2.17	13.40	9.70	3.41	3.408	1.46	1.24
C.D.	0.240	0.095	0.125	N.S	0.032	0.288	0.107	0.065	N.S	0.044	0.07

FIG. 9. CORMEL YIELD ($t\ ha^{-1}$) AS AFFECTED BY TREATMENTS
(MEAN OF TWO YEARS)



Time of application was found to be significant in the production of cormels. Three split application (t_2) of nitrogen and potassium have recorded significantly higher cormel yield over two split application (t_1) of nitrogen and potassium.

4.2.2.5. Corm yield

The data on the effect of treatments on corm yield are presented in Table 16.

Maximum corm yield was obtained for the application of nitrogen at n_2 level during both the years, which was significantly superior to n_1 and n_3 during the first year (1984). The effect of P on corm yield was significant in the first year only. Treatment p_3 was significantly superior to p_1 but was on par with p_2. Significant increase in corm yield was obtained for the application of potassium during the second year only (1984-'85). Maximum yield was recorded at k_3 level which was significantly superior to k_1 and k_2.

Though the time of application of N and K at t_2 recorded a higher yield during the first year (1984) it was not significant. But during the second year (1984-'85) the time of application of N and K was significant and t_2 was significantly superiot to t_1 in the production of corm.

4.2.2.6. Total yield (Cormel + Corm)

The data on the effect of treatment on total tuber yield (Cormel + Corm) are presented in Table 16.

Total tuber yield increased significantly with increase in the level of nitrogen during both the years. Maximum tuber yield was obtained during the first year (1984) for n_2 which was significantly superiot to n_1 and n_3. During the second year (1984-'85) the maximum yield was obtained at n_3 which was on par with n_2.

The effect of P was significant only in the first year, and in the second year it was not significant. Application of phosphorus at p_2 level recorded the maximum yield which was on par with p_3, but was significantly superiot to p_1.

Total tuber yield was significantly influenced by the application of potassium during both the years. Maximum yield was obtained at k_3, but it was on par with k_2 and significantly superiot to k_1 during 1984. During 1984-'85 the maximum yield was obtained at k_3 which was significantly superior to k_2 and k_1.

Time of application of nitrogen and potassium had significant effect on the total yield of tubers. Treatment

t_2 was significantly superior to t_1 during both the years (1984 and 1984-'85).

4.2.2.7. Cormel to Corm ratio

The data on the effect of treatments on cormel to corm ratio during both the years are presented in Table 16

The results showed that the cormel to corm ratio was not much affected either by nutrition or by changing the time of application of nutrients. Maximum Cormel to corm ratio of 3.43 was recorded at n_3 level. The effect of P and K were not significant. Time of application was significant only during 1984 and t_2 was significantly superiot to t_1. During 1984-'85 none of the treatments were significant.

4.2.2.8. Non marketable cormel

The data on the effect of treatments on non marketable cormels are presented in Table 16.

In the first year (1984) nitrogen had significant effect on the production of non marketable cormels. By increasing the level of nitrogen there was a decrease in the yield of non marketable cormels. However phosphorus and potassium did not show any effect on the production of non marketable cormels.

Time of application was found to be significant and t_2 was significant in the production of non marketable cormels over t_1.

During the second year (1984-'85) none of the treatments excepting time of application was found to have any significant effect on the production of non marketable cormels.

4.2.3. Quality aspects

4.2.3.1. Dry matter percentage in cormel

The data on the quality aspects of cormel and corm during both the years are given in Table 17.

It is evident from the data that the application of varying levels of nitrogen, phosphorus and potassium had significant effect on the percentage of dry matter in cormel. Maximum dry matter percentage was observed at n_1 level which was significantly superior to n_2 and n_3, which were on par.

Among phosphorus levels, p_1 recorded the highest percentage of dry matter in cormel, which was significantly superior to p_2 and p_3 which were on par.

Increasing the level of potassium from k_1 to k_3 recorded significant increase in the percentage of dry matter.

Table 17. Experiment B. Effect of levels of NPK and time of application of N and K on quality aspects of cormel and corm.

Treatments	Dry matter % (cormel)		Dry matter % (corm)		Starch percentage (Dry matter basis) (cormel)		Starch percentage (Dry matter basis) (corm)		Protein content % cormel (Dry matter basis)		Oxalate content mg g^{-1} (Dry matter basis) cormel	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	23.66	25.33	17.85	19.86	62.54	62.16	48.72	48.48	3.39	3.70	0.936	0.894
n_2 (80 kg ")	23.27	24.84	17.68	19.61	62.27	61.99	48.82	48.64	3.66	3.88	0.934	0.896
n_3 (120kg ")	23.29	24.32	17.59	19.45	62.39	61.85	48.96	49.40	4.14	4.16	0.938	0.894
C.D.	0.069	0.159	0.100	0.079	N.S	N.S	N.S	0.210	0.129	0.106	N.S	N.S
p_1 (25 kg P_2O_5 ha^{-1})	23.47	24.98	17.78	20.32	62.50	61.93	48.68	48.52	3.72	4.00	0.935	0.894
p_2 (50 kg ")	23.38	24.77	17.61	19.40	62.37	62.06	48.90	49.07	3.70	3.84	0.939	0.896
p_3 (75 kg ")	23.38	24.74	17.72	19.19	62.33	62.02	48.91	49.03	3.78	3.90	0.933	0.895
C.D.	0.069	0.159	0.100	0.079	N.S	N.S	N.S	0.214	N.S	0.106	N.S	N.S
k_1 (50 kg K_2O ha^{-1})	22.66	24.16	17.20	19.16	60.95	60.48	47.44	47.52	3.81	3.96	0.945	0.903
k_2 (100kg ")	23.56	24.85	17.78	19.63	62.45	62.00	48.46	48.61	3.67	3.95	0.934	0.891
k_3 (150kg ")	24.00	25.48	18.13	20.12	63.79	63.53	50.60	50.38	3.72	3.82	0.929	0.890
C.D.	0.069	0.159	0.100	0.079	0.286	0.188	0.243	0.214	0.128	0.106	0.006	0.004
t_1 (N and K in two split application)	23.37	24.76	17.68	19.64	62.26	61.95	48.74	48.77	3.77	3.94	0.938	0.895
t_2 (N and K in three split application)	23.44	24.89	17.72	19.64	62.54	62.06	48.93	48.91	3.73	3.89	0.935	0.895
C.D.	0.054	0.062	N.S	N.S	0.158	N.S	0.161	0.121	N.S	N.S	0.003	N.S

Time of application was also found to be significant and t_2 has registered significantly higher percentage of dry matter in cormel. Similar trend was observed in the second year (1984-'85) also.

4.2.3.2. Dry matter percentage in corm

The data on dry matter percentage in corm as affected by treatments are presented in Table 17.

An examination of the data on corm dry matter percentage revealed that by increasing the level of nitrogen from n_1 to n_3, the dry matter percentage in corm was reduced significantly during both the years. Almost the same trend was observed in the case of P also. During 1984, p_1 and p_3 were at par.

Significant increase in the dry matter percentage was observed by increasing the level of potassium from k_1 to k_3 during both the years. The percentage of dry matter in corm was not affected by the time of application of nitrogen and potassium.

4.2.3.3. Starch percentage in cormel

The starch percentage in cormel as affected by N, P, K and time of application of N and K are presented in Table 17.

The data revealed that there was no significant difference in the percentage of starch due to varying levels of nitrogen and phosphorus. However the percentage of starch in cormels increased significantly by increasing the level of potassium from k_1 to k_3 during both the years.

Time of application was significant in the first year (1984) only and t_2 was significantly superiot to t_1 in this respect.

4.2.3.4. Percentage of starch in corm

The data on the effect of treatments on the percentage of starch in corm are given in Table 17.

A perusal of the data reveal that nitrogen and phosphorus had no significant effect on the percentage of starch in corm during the first year (1984), but potassium had registered significant effect on the content of starch in corm. The percentage of starch increased with increase in the level of K from k_1 to k_3.

Time of application was found to be effective during both the years and t_2 was significantly superior to t_1.

4.2.3.5. Percentage of protein in cormel

The data on the effect of treatments on the percentage of protein in cormel are presented in Table 17.

The data reveal that the percentage of protein in cormel increased significantly as the level of nitrogen increased from n_1 to n_3. The trend was the same during both the years. Levels of P had no significant effect on the content of protein in cormel. At higher levels of K there was a reduction in the percentage of protein in cormel and maximum protein percentage was observed at k_1 level.

4.2.3.6. Oxalate content in cormel

The oxalate content in cormel in mg g^{-1} (on dry weight basis) is presented in Table 17. A perusal of the data reveal that application of nitrogen and phosphorus had no significant effect in the content of oxalate in cormel. However potassium had a significant effect in the content of oxalate, but only at the lowest level of application. A significant reduction in the content of oxalate was observed in cormel at higher levels of potassium application.

Time of application had significant effect on the oxalate content only in the first year (1984) and t_1 had recorded significantly higher content of oxalate over t_2.

4.2.4. Growth Analysis

4.2.4.1. Dry matter production and distribution

4.2.4.1.1. Leaf dry matter

The data on leaf dry matter production at various stages of growth in 1984 and 1984-'85 are presented in Table 18.

The data revealed that leaf dry matter production increased significantly from n_1 to n_2. At n_3 a reduction in leaf dry matter production was observed but it was on par with n_2 in most stages of growth during both the years.

Levels of phosphorus application did not show any significant effect on the leaf dry matter production throughout the growth of taro during both the years. Application of potassium was also not significant in most stages of growth during both the years. However time of application was significant during the second year (1984-'85) and t_2 was significantly superiot to t_1.

4.2.4.1.2. Pseudo stem (Leaf petiole) dry matter production

The data on pseudo stem dry matter production at various stages of growth during 1984 and 1984-'85 are provided in Table 19.

Table 18. Experiment B. Effect of levels of NPK and time of application of N and K on leaf dry matter production at various stages of growth (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	235.64	158.75	422.42	201.11	623.83	420.61	184.66	113.17
n_2 (80 kg ")	282.39	188.36	510.97	344.92	724.58	436.01	211.42	137.31
n_3 (120kg ")	282.78	184.00	485.61	340.94	719.16	465.50	204.86	134.06
C.D.	16.91	14.05	22.27	11.53	25.57	19.26	20.87	9.28
p_1 (25 kg P_2O_5 ha^{-1})	267.16	178.44	469.50	317.83	682.47	460.03	205.44	131.33
p_2 (50 kg ")	264.08	176.22	476.44	324.25	695.77	449.11	197.39	126.83
p_3 (75 kg ")	269.55	175.44	473.05	324.89	689.33	462.97	198.11	126.36
C.D.	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
k_1 (50 kg K_2O ha^{-1})	263.50	175.11	467.36	315.92	679.72	443.30	197.42	124.14
k_2 (100kg ")	270.16	178.31	479.27	327.14	690.08	461.53	202.19	130.36
k_3 (150kg ")	267.13	177.69	472.35	322.92	697.77	468.00	201.33	130.03
C.D.	N.S	N.S	N.S	N.S	N.S	19.26	N.S	N.S
t_1 (N and K in two split application)	265.79	176.76	477.14	321.09	686.26	450.96	199.07	125.30
t_2 (N and K in three split application)	268.68	177.31	468.85	323.56	692.13	464.32	201.55	131.06
C.D.	N.S	N.S	N.S	N.S	N.S	7.72	N.S	2.74

Table 19. Experiment B. Effect of levels of NPK and time of application of N and K on pseudostem dry matter production at various stages of growth (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	388.36	261.88	709.72	480.67	1042.92	685.95	370.89	233.50
n_2 (80 kg ")	466.14	308.97	837.44	589.19	1185.92	810.64	433.64	281.17
n_3 (120kg ")	460.97	302.17	827.16	585.75	1205.11	784.83	415.36	272.42
C.D.	28.91	23.42	27.77	19.14	37.08	31.30	36.143	19.51
p_1 (25 kg P_2O_5 ha^{-1})	437.69	294.22	792.72	544.11	1145.28	752.42	411.64	266.11
p_2 (50 kg ")	433.61	287.86	786.61	556.56	1151.64	764.31	409.03	258.97
p_3 (75 kg ")	444.16	290.94	795.00	554.94	1137.02	760.60	404.22	262.00
C.D.	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S
k_1 (50 kg K_2O ha^{-1})	434.86	288.33	769.88	540.78	1123.89	736.30	391.69	253.08
k_2 (100kg ")	442.13	292.30	801.58	560.67	1150.28	770.03	414.97	269.67
k_3 (150kg ")	438.47	292.39	802.66	554.17	1154.77	775.03	418.22	264.33
C.D.	N:S	N:S	27.77	N:S	N:S	31.30	N:S	N:S
t_1 (N and K in two split application)	436.51	290.20	791.02	554.32	1141.93	755.50	406.14	256.98
t_2 (N and K in three split application)	440.46	291.81	791.87	549.43	1147.37	765.44	410.44	267.74
C.D.	N:S	N:S	N:S	N:S	N:S	8.91	N:S	6.30

During both the years, application of nitrogen increased the pseudostem dry matter production at all the stages of growth. The dry matter production increased progressively from 60th day after planting to 120th day and at 150th day there occurred a reduction as a result of senescence. The effect of phosphorus on pseudostem dry matter production was not significant throughout the growth of the plant during both the years. Levels of potassium as well as the time of application were also not significant during most stages.

4.2.4.1.3. Root dry matter production

The data on root dry matter at various stages of growth are presented in Table 20.

The data revealed that there was significant increase in the root dry matter production from n_1 to n_2 during all the stages of growth in both the years and n_3 was on par with n_2. Application of graded levels of phosphorus did not show any significant effect on root dry matter production throughout the growth of the plant during both the years. Application of levels potassium and time of application also did not show any significant effect on the root dry matter production in most stages of growth during both the years.

Table 20. Experiment B. Effect of levels of NPK and time of application of N and K on root dry matter production at various stages of growth (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	22.61	15.25	61.55	40.33	70.42	46.89	17.31	11.39
n_2 (80 kg ")	27.05	18.05	69.90	49.14	79.70	53.47	19.50	12.72
n_3 (120kg ")	27.13	17.89	68.90	49.08	79.08	52.53	19.33	13.14
C.D.	1.63	1.30	3.22	1.76	3.29	2.06	1.93	1.25
p_1 (25 kg P_2O_5 ha^{-1})	25.53	17.17	67.05	45.44	76.69	50.94	19.25	12.61
p_2 (50 kg ")	25.42	16.92	65.94	46.61	76.11	50.86	18.36	12.36
p_3 (75 kg ")	25.87	17.11	67.33	46.50	76.39	51.08	18.52	12.27
C.D.	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
k_1 (50 kg K_2O ha^{-1})	25.22	16.17	63.97	46.14	75.00	49.72	18.47	12.16
k_2 (100kg ")	25.91	17.31	67.58	46.94	76.88	51.39	19.02	12.61
k_3 (150kg ")	25.66	17.11	68.78	46.47	77.31	51.78	18.64	12.47
C.D.	N.S	N.S	3.22	N.S	N.S	N.S	N.S	N.S
t_1 (N and K in two split application)	25.48	16.96	67.18	46.22	76.22	50.85	18.59	12.15
t_2 (N and K in three split application)	25.72	17.16	66.18	46.15	76.57	51.07	18.83	12.69
C.D.	N.S	N.S	N.S	N.S	N.S	N.S	N.S	0.33

4.2.4.1.4. Plant dry matter production

The data on plant dry matter production (leaf + pseudostem + root) at various stages of growth are presented in Table 21.

The data revealed that the plant dry matter production increased significantly with increase in the levels of nitrogen from n_1 to n_2 during all the stages of growth during both the years. The plant dry matter production at n_3 level was on par with n_2. Levels of phosphorus had no significant effect on plant dry matter during both the years. Levels of potassium and time of application also had no significant effect in most stages of growth during both the years.

4.2.4.1.5. Total dry matter production
(Plant + tuber (Cormel + Corm) dry matter)

The data on the effect of treatments on total dry matter production at grand growth and tuber bulking stage (120th day after planting) and at harvest (150th day) are presented in Tables 22 (Fig.10).

The data revealed that total dry matter production increased significantly from n_1 to n_2 at grand growth stage

Table 21. Experiment B. Effect of levels of NPK and time of application of N and K on plant dry matter production (leaf, pseudostem and root) at various stages of growth (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	646.80	436.58	1189.80	800.03	1736.40	1155.00	575.60	357.92
n_2 (80 kg ")	769.90	516.44	1415.40	969.31	1991.10	1354.00	632.70	431.17
n_3 (120kg ")	769.90	503.75	1305.70	972.61	2002.30	1300.00	633.00	417.94
C.D.	46.84	37.03	41.40	27.97	61.48	50.83	53.50	29.39
p_1 (25 kg P_2O_5 ha^{-1})	729.90	488.47	1329.90	904.58	1901.60	1270.00	641.90	408.39
p_2 (50 kg ")	723.40	482.89	1332.80	917.64	1920.90	1264.00	622.20	398.17
p_3 (75 kg ")	733.20	485.42	1338.10	919.72	1907.20	1274.00	627.30	400.47
C.D.	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S
k_1 (50 kg K_2O ha^{-1})	717.20	474.72	1307.80	900.75	1880.20	1229.00	613.30	387.64
k_2 (100kg ")	738.20	492.62	1349.60	920.42	1916.40	1283.00	637.00	412.58
k_3 (150kg ")	731.20	489.39	1343.50	920.78	1933.40	1296.00	641.10	406.81
C.D.	N:S	N:S	N:S	N:S	N:S	50.03	N:S	N:S
t_1 (N and K in two split application)	728.10	482.68	1334.40	914.09	1902.50	1250.00	633.60	394.76
t_2 (N and K in three split application)	729.70	488.50	1332.80	913.87	1917.30	1279.00	627.30	409.93
C.D.	N:S	N:S	N:S	N:S	N:S	16.36	N:S	9.69

Table 22. Experiment B. Effect of levels of NPK and time of application of N and K on total dry matter production (plant and tuber) at grand growth stage and at harvest (t ha^{-1}).

Treatments	At 120th day (Grand growth stage)						At 150th day (harvest)					
	1984			1984-85			1984			1984-85		
	plant	tuber	total	plant	tuber	total	plant	tuber	total	plant	tuber	total
n_1 (40 kg N ha^{-1})	1.730	1.958	3.688	1.155	1.433	2.588	0.575	2.753	3.328	0.358	2.039	2.397
n_2 (80 kg ")	1.991	2.407	4.398	1.354	1.809	3.163	0.682	3.489	4.171	0.431	2.495	2.926
n_3 (120kg ")	2.002	2.368	4.370	1.300	1.783	3.083	0.633	3.459	4.092	0.418	2.477	2.895
C.D.	0.061	0.070	0.095	0.050	0.066	0.061	0.054	0.130	0.135	0.029	0.093	0.085
p_1 (25 kg P_2O_5 ha^{-1})	1.901	2.202	4.103	1.270	1.647	2.917	0.642	3.177	3.819	0.408	2.300	2.708
p_2 (50 kg ")	1.920	2.279	4.199	1.264	1.695	2.959	0.622	3.392	3.914	0.398	2.375	2.773
p_3 (75 kg ")	1.907	2.252	4.159	1.271	1.684	2.958	0.627	3.231	3.858	0.400	2.337	2.737
C.D.	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S	N:S
k_1 (50 kg K_2O ha^{-1})	1.880	2.136	4.016	1.229	1.540	2.769	0.613	3.056	3.669	0.388	2.184	2.572
k_2 (100kg ")	1.916	2.257	4.173	1.283	1.690	2.973	0.637	3.264	3.901	0.413	2.366	2.779
k_3 (150kg ")	1.933	2.340	4.273	1.296	1.795	3.091	0.641	3.381	4.022	0.407	2.455	2.862
C.D.	N:S	0.070	0.095	0.050	0.066	0.061	N:S	0.130	0.135	N:S	0.093	0.085
t_1 (N and K in two split application)	1.902	2.225	4.127	1.230	1.684	2.914	0.629	3.200	3.829	0.395	2.305	2.700
t_2 (N and K in three split application)	1.917	2.264	4.181	1.279	1.696	2.975	0.627	3.268	3.895	0.410	3.370	2.780
C.D.	N:S	0.024	0.04	0.016	0.014	0.022	N:S	0.066	0.065	0.009	0.023	0.026

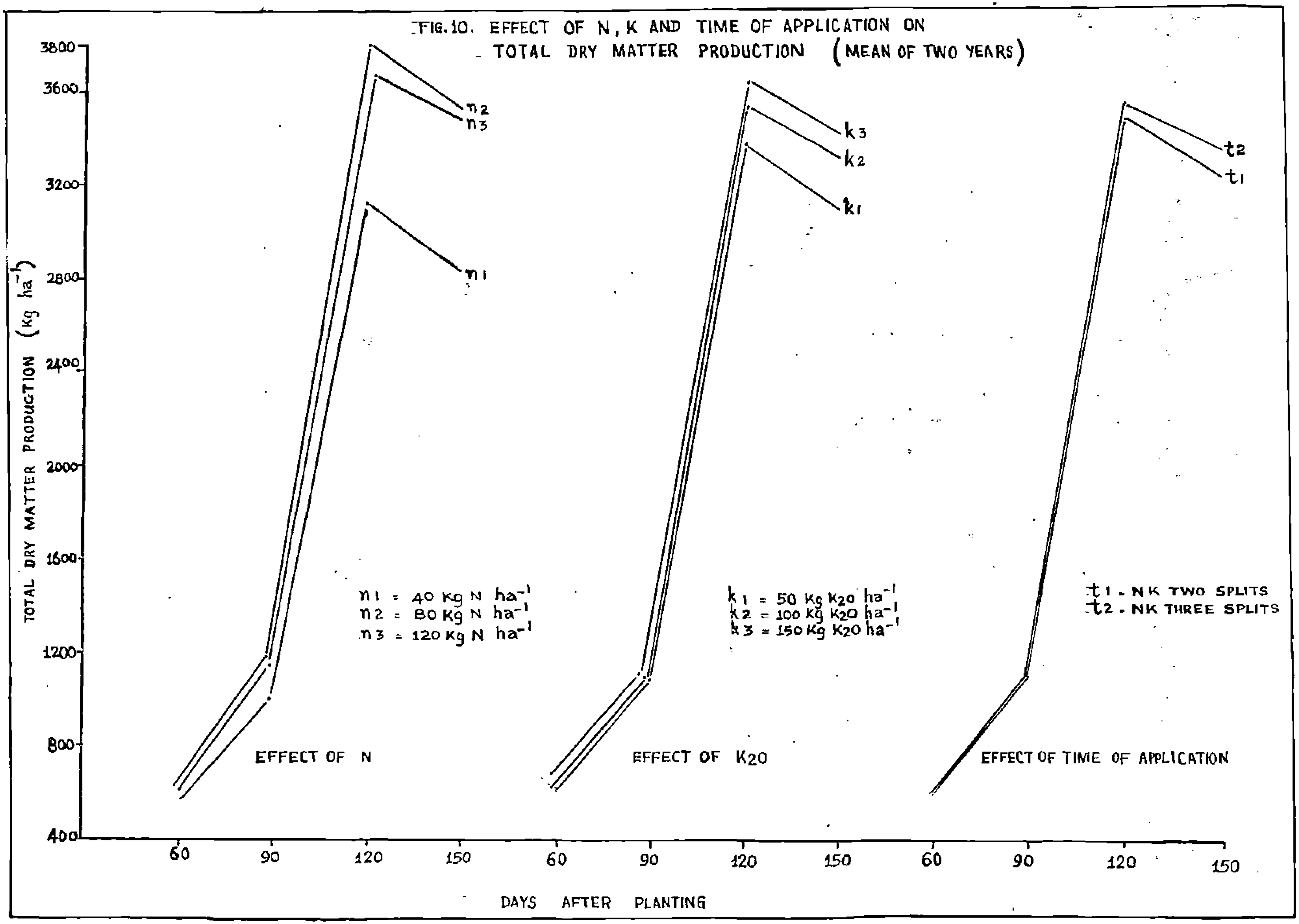


FIG. 10. EFFECT OF N, K AND TIME OF APPLICATION ON TOTAL DRY MATTER PRODUCTION (MEAN OF TWO YEARS)

as well as at harvest during both the years. In most cases there occurred a slight reduction in dry matter yield at n_3.

Application of graded doses of P had no significant effect on the production of total dry matter during both the years. The effect of potassium on total dry matter production was significant in both the years. The rate of dry matter production increased with increase in the level of potassium application from k_1 to k_3, but the increase at k_3 was on par with k_2 in most cases.

Time of application was significant in the production of total dry matter during both the stages of growth during both the years. Application of nitrogen and potassium at t_2 was significantly superior to t_1 in this respect.

4.2.4.1.6. Crop Growth Rate (CGR)

The data on crop growth rate at various growth stages such as tuber initiation stage (0-60 days from planting) tuber differentiation and development stage (60-90 days) and tuber bulking stage (90-120 days) are presented in Table 23.

The data reveal that nitrogen had significant effect on the crop growth rate. The crop growth rate increased significantly from n_1 to n_2 and at n_3, there was a reduction

Table 23. Experiment B. Effect of levels of NPK and time of application of N and K on CGR (gm^{-2} day^{-1}) on dry matter basis and harvest index.

Treatments	0- 60th day		60th-90th day		90th-120th day		Harvest Index (% basis)	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	1.08	0.74	2.51	1.77	7.71	5.24	65.33	63.19
n_2 (80 kg ")	1.30	0.87	3.05	1.24	9.15	6.42	66.85	64.47
n_3 (120kg ")	1.27	0.86	3.01	1.27	8.70	6.31	66.64	64.92
C.D.	0.078	0.053	0.179	0.137	0.321	0.228	0.569	1.471
p_1 (25 kg P_2O_5 ha^{-1})	1.21	0.83	2.85	2.03	8.33	5.98	66.11	63.81
p_2 (50 kg ")	1.20	0.83	2.88	2.13	8.65	5.97	66.56	64.83
p_3 (75 kg ")	1.23	0.82	2.84	2.13	8.53	6.02	66.16	63.94
C.D.	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
k_1 (50 kg K_2O ha^{-1})	1.20	0.81	2.83	2.04	8.33	5.51	66.03	63.42
k_2 (100kg ")	1.23	0.83	2.84	2.11	8.54	6.01	66.18	64.31
k_3 (150kg ")	1.21	0.83	2.90	2.14	8.70	6.46	66.61	64.86
C.D.	N.S	N.S	N.S	N.S	0.321	0.228	N.S	N.S
t_1 (N and K in two split application)	1.21	0.82	2.84	2.09	8.40	5.95	66.06	64.03
t_2 (N and K in three split application)	1.22	0.83	2.88	2.10	8.64	6.03	66.49	64.35
C.D.	N.S	N.S	N.S	N.S	0.183	0.062	N.S	N.S

in CGR in most cases, but was on par with n_2. The trend was the same during both the years. There was a gradual increase in growth rate from cormel initiation to cormel bulking.

Application of graded levels of phosphorus had no significant effect on CGR throughout the growth of the plant during both the years. Levels of potassium had no significant effect on the crop growth rate at cormel initiation and cormel development stages and during the cormel bulking stage potassium application had a significant effect on crop growth rate during both the years. In the first year k_3 was significantly superior to k_1, but k_2 and k_3 were on par. In the second year k_3 was significantly superiot to both k_1 and k_2. In the case of time of application, t_2 was significantly superior to t_1 only at the cormel bulking stage.

4.2.4.1.7. Harvest index

The data on harvest index for 1984 and 1984-'85 are presented in Table 23.

It can be seen that application of nitrogen had a significant effect on the harvest index. In the first year harvest index increased from n_1 to n_2 and at n_3 there was a reduction in harvest index, though it was on par with n_2.

The levels of phosphorus, potassium and time of application had no significant effect in modifying this aspect.

4.2.4.1.8. Cormel bulking rate

The data pertaining to cormel bulking rate from tuber initiation to harvest for the period 1984 and 1984-'85 are given in Table 24.

It is evident from the data that the rate of cormel bulking increased significantly with levels of nitrogen. During both the years, significant increase in the rate of bulking was observed from n_1 to n_2. However at n_3 level there was a reduction in the rate of bulking, but it was on par with n_2 in most cases. Application of graded doses of phosphorus did not show any significant effect in the rate of bulking during both the years.

Levels of potassium application had significant effect in the rate of bulking of the cormels. The rate of bulking increased significantly from k_1 to k_2. At k_3 though there was an increase in the rate of bulking over k_2, it was on par with k_2 in most cases. Time of application of N and K had no significant effect on the bulking rate in most cases during both the years.

Table 24. Experiment B. Effect of levels of NPK and time of application of N and K on cormel bulking rate in g plant^{-1} day^{-1} (dry matter basis).

Treatments		Between 2nd and 3rd month		Between 3rd and 4th month		Between 4th and 5th month	
		1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})		0.192	0.154	1.57	1.14	0.70	0.55
n_2 (80 kg ")		0.247	0.184	1.93	1.44	0.98	0.63
n_3 (120kg ")		0.238	0.181	1.90	1.42	0.92	0.65
	C.D.	0.0055	0.0073	0.067	0.0517	0.0480	0.0344
p_1 (25 kg P_2O_5 ha^{-1})		0.223	0.167	1.77	1.31	0.85	0.59
p_2 (50 kg ")		0.228	0.176	1.83	1.35	0.89	0.63
p_3 (75 kg ")		0.226	0.175	1.80	1.34	0.87	0.61
	C.D.	N.S	0.0073	N.S	N.S	N.S	N.S
k_1 (50 kg K_2O ha^{-1})		0.215	0.159	1.71	1.22	0.80	0.56
k_2 (100kg ")		0.227	0.177	1.82	1.34	0.89	0.62
k_3 (150kg ")		0.235	0.183	1.88	1.43	0.91	0.65
	C.D.	0.0055	0.0073	0.067	0.0517	0.0293	0.0344
t_1 (N and K in two split application)		0.225	0.172	1.79	1.32	0.858	0.614
t_2 (N and K in three split application)		0.227	0.174	1.81	1.34	0.876	0.608
	C.D.	N.S	N.S	N.S	0.0114	N.S	N.S

4.2.5. Nutrient uptake

4.2.5.1. Nitrogen

The data on the uptake of nitrogen by vegetative non economic portion of the plant (leaf, pseudostem and root) at various growth stages of plant during the years 1984 and 1984-'85 are provided in Table 25.

The data revealed that there was significant difference in the uptake of nitrogen by plant from n_1 to n_3. Though there was an increase in the uptake of nitrogen from n_2 to n_3 it was on par with n_2 in most stages. The trend was almost the same during both the years.

The levels of phosphorus and potassium did not exert any significant effect in the uptake of nitrogen during both the years. In most cases, time of application did not show any significant effect on the uptake of nitrogen by plant. In the second year (1984-'85) t_2 had a significant effect on the uptake of nitrogen by plant at 150th day.

4.2.5.2. Uptake of phosphorus by vegetative noneconomic portion of the plant (Leaf, pseudostem and root)

The data on the uptake of phosphorus by plant at various stages of growth are given in Table 26.

Table 25. Experiment B. Effect of levels of NPK and time of application of N and K on the uptake of nitrogen by the vegetative/non economic portion (leaf, pseudostem and root) of the plant (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	10.22	7.31	26.61	15.35	33.78	21.54	9.32	7.20
n_2 (80 kg ")	14.23	9.37	36.83	21.18	46.03	28.28	12.93	9.43
n_3 (120kg ")	15.85	9.65	36.41	32.64	47.91	29.31	13.13	10.49
C.D.	0.923	0.742	1.115	0.788	1.950	1.203	1.356	0.975
p_1 (25 kg P_2O_5 ha^{-1})	13.81	8.89	32.63	19.57	42.56	24.47	12.15	9.10
p_2 (50 kg ")	13.31	8.70	32.91	19.83	42.31	26.93	11.30	9.05
p_3 (75 kg ")	13.81	8.75	32.33	19.77	42.86	26.69	11.86	8.97
C.D.	N:S	N:S	N:S	N:S	N:S	1.203	N:S	N:S
k_1 (50 kg K_2O ha^{-1})	13.26	8.66	32.48	19.45	41.76	25.40	11.78	8.79
k_2 (100kg ")	13.37	8.89	32.78	19.91	43.03	26.62	11.80	9.23
k_3 (150kg ")	13.66	8.78	32.60	19.82	42.94	27.15	11.71	9.11
C.D.	N:S	N:S	N:S	N:S	N:S	1.203	N:S	N:S
t_1 (N and K in two split application)	13.21	8.69	32.70	19.70	42.30	26.15	11.63	8.83
t_2 (N and K in three split application)	13.66	8.87	32.54	19.76	42.86	25.60	11.96	9.26
C.D.	0.373	N:S	N:S	N:S	N:S	N:S	N:S	0.285

Table 26. Experiment B. Effect of levels of NPK and time of application of N and K on the uptake of phosphorus by the vegetative/noneconomic portion (leaf, pseudostem and root) of the plant (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	1.77	1.34	2.79	2.18	4.73	3.37	1.67	1.00
n_2 (80 kg ")	2.17	1.56	3.36	2.66	5.26	3.87	1.99	1.14
n_3 (120kg ")	2.13	1.52	3.35	2.65	5.53	3.83	1.96	1.20
C.D.	0.167	0.123	0.121	0.082	0.182	0.169	0.168	0.133
p_1 (25 kg P_2O_5 ha^{-1})	1.83	1.35	2.51	2.26	4.64	3.53	1.63	1.03
p_2 (50 kg ")	2.04	1.47	3.26	2.56	5.31	3.65	1.90	1.12
p_3 (75 kg ")	2.21	1.58	3.73	2.67	5.57	3.88	2.09	1.19
C.D.	0.167	0.123	0.121	0.082	0.182	0.169	0.168	N.S
k_1 (50 kg K_2O ha^{-1})	1.98	1.44	3.13	2.43	5.11	3.66	1.84	1.09
k_2 (100kg ")	2.03	1.40	3.16	2.53	5.23	3.70	1.90	1.13
k_3 (150kg ")	2.06	1.49	3.20	2.53	5.19	3.71	1.88	1.11
C.D.	N.S	N.S	N.S	0.082	N.S	N.S	N.S	N.S
t_1 (N and K in two split application)	2.02	1.47	3.14	2.48	5.13	3.63	1.87	1.10
t_2 (N and K in three split application)	2.03	1.47	3.20	2.51	5.22	3.69	1.88	1.12
C.D.	N.S	N.S	N.S	N.S	0.080	N.S	N.S	N.S

Application of graded levels of nitrogen from n_1 to n_3 revealed a significant effect on the uptake of phosphorus by taro. At n_3 although a slight reduction in the uptake of phosphorus by plant was observed it was on par with n_2. Increasing the levels of P from p_1 to p_3 showed an increase in the uptake of P by plant at all the stages of growth during both the years. In most cases the uptake was significantly increased from p_1 to p_3.

Varying levels of potassium did not show any significant effect on the uptake of phosphorus by plant. Similar results were observed in the case of time of application and in most cases, the time of application of nitrogen and potassium did not show any significant effect on the uptake of phosphorus by plant.

4.2.5.3. Uptake of potassium by vegetative/non economic portion of the plant

The data on the uptake of potassium by plant (leaf, pseudostem and root) are presented in Table 27.

A perusal of the data revealed that application of nitrogen had significant effect on the uptake of potassium by plant. By increasing the level of nitrogen from n_1 to n_2 there was significant increase in the uptake of potassium by

Table 27. Experiment B. Effect of levels of NPK and time of application of N and K on the uptake of potassium by the vegetative/non-economic portion (leaf, pseudostem and root) of the plant (kg ha^{-1}).

Treatments	60th day		90th day		120th day		150th day	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	25.72	16.05	33.26	22.36	43.13	35.52	22.63	12.64
n_2 (80 kg ")	23.91	18.81	41.26	27.02	52.39	41.86	25.63	14.52
n_3 (120kg ")	28.97	18.31	42.58	27.37	51.36	41.37	25.89	14.63
C.D.	2.371	1.321	1.761	0.857	2.371	1.356	2.620	1.405
p_1 (25 kg P_2O_5 ha^{-1})	27.68	17.63	33.42	24.66	47.19	39.05	25.10	14.21
p_2 (50 kg ")	28.28	17.63	39.31	25.01	50.85	39.25	24.33	13.80
p_3 (75 kg ")	27.65	17.91	39.37	25.08	48.83	40.45	24.72	13.79
C.D.	NS	NS	NS	0.857	2.371	NS	NS	NS
k_1 (50 kg K_2O ha^{-1})	20.70	15.15	30.16	22.41	34.26	35.36	20.30	12.14
k_2 (100kg ")	27.81	18.43	39.22	25.77	49.29	39.99	25.76	14.16
k_3 (150kg ")	35.09	19.57	47.71	28.58	63.33	43.39	28.05	15.50
C.D.	2.371	1.321	1.761	0.857	2.371	1.356	2.620	1.405
t_1 (N and K in two split application)	27.74	17.49	38.33	25.54	48.19	39.14	24.29	13.53
t_2 (N and K in three split application)	28.00	17.95	39.73	25.63	49.73	40.03	25.14	14.34
C.D.	NS	NS	0.732	NS	0.708	0.728	0.672	0.366

plant at all the stages of growth during both the years. However, uptake of potassium at n_3 was on par with n_2. There was significant increase in the uptake of potassium by taro upto p_2 level of phosphorus at 90th day in 1984-'85 and at 120th day in 1984. At other growth stages the application of phosphorus had no significant effect on the uptake of potassium.

Application of potassium had a significant effect on the uptake of potassium by taro. There was significant increase in the uptake of potassium from k_1 to k_2 at all the stages of plant growth during both the years. Similarly there was significant increase on the uptake of potassium from k_2 to k_3 in most cases. At 120th and 150th days after planting (corresponding to cormel development, cormel bulking and maturity stages) there was significant increase on the uptake of potassium from k_1 to k_3. Time of application was also significant at these stages and t_2 recorded significant increase in the uptake of potassium by plant over t_1.

4.2.5.4. (a) Uptake of nitrogen by tuber

The data on the uptake of nitrogen by tuber (cormel + corm) at 120th and 150th days after planting for the years 1984 and 1984-'85 are presented in Table 28.

Table 28. Experiment B. Effect of levels of NPK and time of application of N and K on the total uptake of nitrogen by plant. (Tuber and the vegetative/non-economic portion of the plant) kg ha^{-1}.

Treatments	120th day (Tuber alone)		150th day (Tuber alone)		120th day (Tuber + plant) total uptake		150th day (Tuber + plant) total uptake	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	15.86	15.97	21.71	20.11	49.68	37.51	30.93	27.31
n_2 (80 kg ")	22.68	21.35	29.57	28.34	68.40	49.76	42.20	37.77
n_3 (120kg ")	25.10	21.79	32.58	30.34	72.98	50.98	45.69	40.83
C.D.	1.117	0.741	1.329	1.198	1.760	1.321	1.666	1.462
p_1 (25 kg P_2O_5 ha^{-1})	21.07	19.14	26.84	27.82	63.58	44.70	39.07	36.92
p_2 (50 kg ")	21.23	20.26	29.15	27.45	63.48	47.22	39.44	36.51
p_3 (75 kg ")	21.34	19.70	28.80	27.52	63.99	46.32	40.61	36.49
C.D.	NS	0.741	1.329	NS	NS	1.321	NS	NS
k_1 (50 kg K_2O ha^{-1})	20.36	18.39	27.23	24.21	62.01	43.72	39.01	33.00
k_2 (100kg ")	21.62	19.73	27.53	26.16	64.48	46.40	39.36	35.39
k_3 (150kg ")	21.76	20.93	29.12	26.42	64.57	48.13	40.55	35.53
C.D.	1.117	0.741	1.329	1.198	1.760	1.321	NS	1.462
t_1 (N and K in two split application)	20.54	19.36	27.43	27.26	62.78	45.45	38.97	36.10
t_2 (N and K in three split application)	21.89	20.04	29.48	28.05	64.59	46.70	40.31	37.31
C.D.	0.617	0.403	0.690	NS	1.084	0.641	0.932	1.188

It is evident from the data that by increasing the level of nitrogen there was significant increase in the uptake of nitrogen by tuber from n_1 to n_3 at 120th day during 1984. From n_2 to n_3 the uptake was not significant for tuber at 120th day during 1984-'85. By increasing the level of phosphorus the uptake of nitrogen by tuber was not significant at 120th day in 1984 and in 150th day in 1984-'85. At 120th day in 1984-85 there was significant increase in the uptake of nitrogen by tuber by increasing the level of phosphorus from p_1 to p_2. At p_3 though there was a reduction in the uptake of nitrogen, it was on par with p_2. The effect of level of phosphorus on the uptake of nitrogen by tuber in most cases was not significant.

Application of potassium had a significant effect on the uptake of nitrogen by tuber. At 120th day in 1984 the response of potassium on the uptake of nitrogen was significant from k_1 to k_2, but k_3 was on par with k_2. In 1984-'85 at 120th day an increase in the levels of potassium from k_1 to k_3 had significant effect on the uptake of nitrogen by tuber. At 150th day in 1984 lower levels of potassium had no significant effect, but at k_3 there was significant effect on the uptake of nitrogen by tuber. Time of application was found to be significant, and in most cases t_2 had a significant effect on the uptake of nitrogen by tuber. The mean uptake of nitrogen by a crop yielding 12.3 tonnes of tuber ha^{-1} was found to be 20.0 kg ha^{-1}.

4.2.5.5. (a) Uptake of phosphorus by tuber

The data on the uptake of phosphorus by tuber (cormel + corm) at 120th and 150th day are presented in Table 29.

The data revealed that nitrogen had a significant effect on the uptake of phosphorus by tuber during both the years. In most cases significant increase in the uptake of P was observed from n_1 to n_2 but n_3 was on par with n_2.

The level of phosphorus had a significant effect on the uptake of P by tuber. In most cases by increasing the level of P from p_1 to p_3 there was a significant increase in the uptake of P. Application of potassium during 1984-'85 had a significant effect on the uptake of phosphorus by tuber. During 1984 at 120th day, application of graded doses of potassium had no significant effect on the uptake of P by tuber.

A crop which has recorded an yield of 11.5 tonnes of tuber per hectare removed 4.5 kg P from the soil.

Table 29. Experiment B. Effect of levels of NPK and time of application of N and K on the total uptake of phosphorus by plant. (Tuber and the vegetative/non economic portion of the plant) kg ha^{-1}.

Treatments	120th day (Tuber alone)		150th day (Tuber alone)		120th day (Tuber + plant)		150th day (Tuber + plant)	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	3.13	2.38	3.59	3.99	7.86	5.79	5.26	4.99
n_2 (80 kg ")	3.90	3.13	4.46	4.83	9.19	7.06	6.44	5.95
n_3 (120kg ")	3.97	2.95	4.34	4.80	9.61	6.82	6.27	5.99
C.D.	0.184	0.123	0.212	0.200	0.270	0.240	0.205	0.202
p_1 (25 kg P_2O_5 ha^{-1})	3.16	2.49	3.54	3.95	7.80	6.02	5.15	4.97
p_2 (50 kg ")	3.74	2.86	4.23	4.74	9.16	6.63	6.11	5.06
p_3 (75 kg ")	4.10	3.11	4.61	4.92	9.70	7.00	6.71	6.10
C.D.	0.184	0.123	0.212	0.200	0.270	0.240	0.205	0.202
k_1 (50 kg K_2O ha^{-1})	3.60	2.72	4.00	4.31	8.78	6.44	5.92	5.39
k_2 (100kg ")	3.65	2.80	4.12	4.57	8.89	6.53	6.02	5.70
k_3 (150kg ")	3.75	2.95	4.27	4.73	8.98	6.69	6.13	5.84
C.D.	N.S	0.123	0.212	0.200	N.S	N.S	0.205	0.202
t_1 (N and K in two split application)	3.53	2.81	4.04	4.50	8.71	6.50	5.89	5.59
t_2 (N and K in three split application)	3.80	2.84	4.22	4.58	9.06	6.61	6.09	5.70
C.D.	0.116	N.S	0.103	N.S	0.142	N.S	0.116	0.106

4.2.5.6. (a) Uptake of potassium by tuber.

The uptake of potassium by tuber (cormel + corm) at 120th and 150th day are presented in Table 30.

It is evident from the data that by increasing the level of nitrogen from n_1 to n_2 there was significant increase in the uptake of potassium by tuber. Increasing the level of nitrogen from n_2 to n_3 the uptake was not altered and was on par with n_2 during both the years.

By increasing the level of P the uptake of potassium was not much affected. Application of potassium had a significant effect on the uptake of potassium by tuber. The uptake was significant from k_1 to k_3 during all the stages tried in both the years. Time of application also had a significant effect on the uptake of potassium by tuber. Treatment t_2 was significantly superior to t_1 during both the years. A crop which recorded an yield of 11.4 tonnes of tuber has removed 31 kg potassium from one hectare of land.

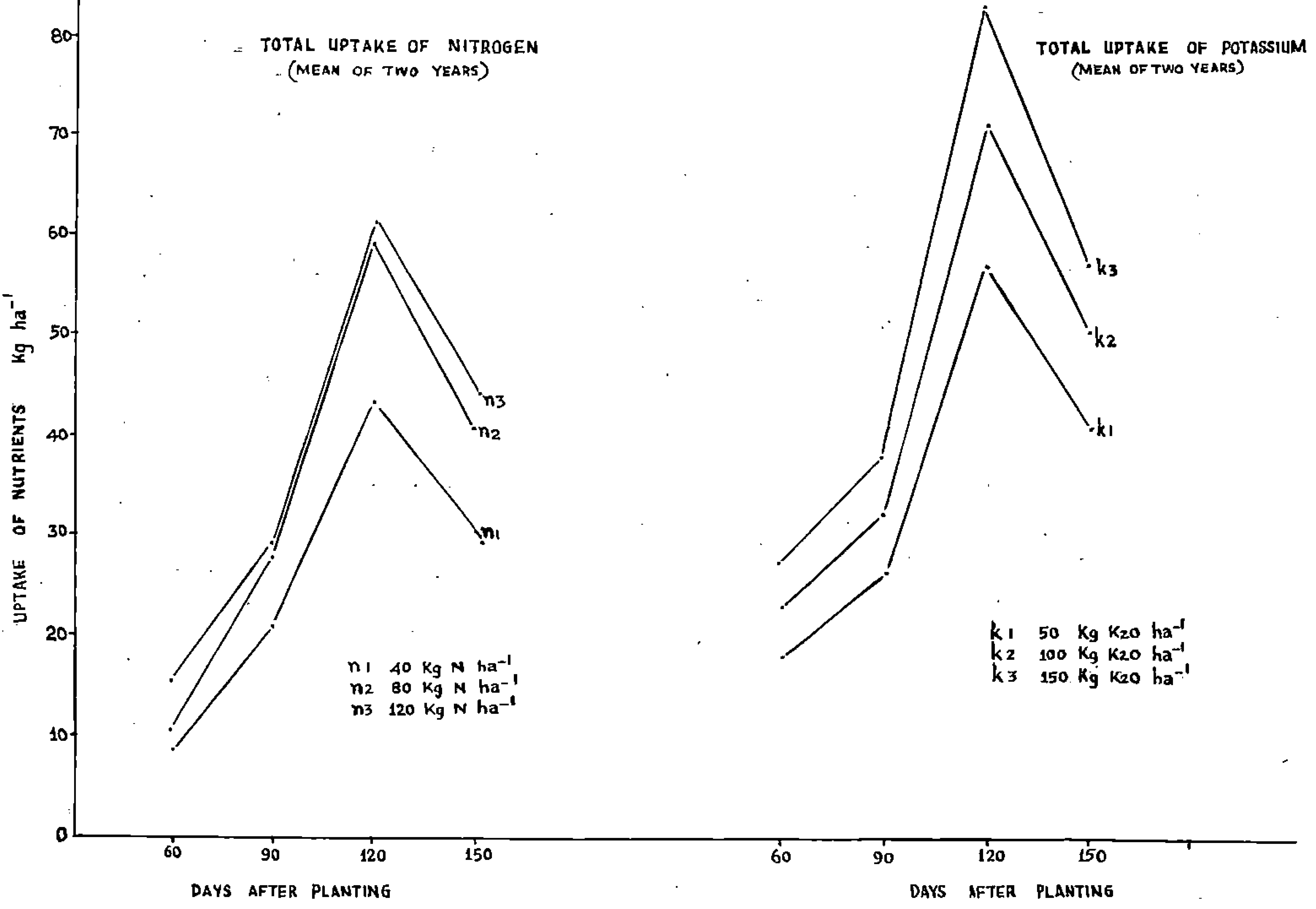
4.2.5.4. (b) Total uptake of nitrogen by plant (Vegetative/non economic portion of the plant and tuber)

The data on the total uptake of nitrogen by plant are presented in Table 28 (Fig.11). Increasing the level of nitrogen there was significant increase in the total uptake

Table 30. Experiment B. Effect of levels of NPK and time of application of N and K on the total uptake of potassium by plant. (Tuber and the vegetative/non economic portion of the plant) kg ha^{-1}).

Treatments	120th day (Tuber only)		150th day (Tuber only)		120th day (Tuber + plant)		150th day (Tuber + plant)	
	1984	1984-85	1984	1984-85	1984	1984-85	1984	1984-85
n_1 (40 kg N ha^{-1})	29.67	17.83	28.80	24.27	72.85	53.38	50.95	33.91
n_2 (80 kg ")	36.87	21.84	35.61	30.04	89.26	63.70	61.16	44.20
n_3 (120kg ")	35.46	21.92	34.15	31.67	86.62	63.30	60.22	46.31
C.D.	1.643	0.847	1.296	1.434	3.042	1.510	3.258	1.898
p_1 (25 kg P_2O_5 ha^{-1})	31.72	20.21	31.84	27.95	78.85	59.30	56.65	42.05
p_2 (50 kg ")	35.36	20.69	33.42	29.09	86.13	59.94	57.03	42.75
p_3 (75 kg ")	34.92	20.69	33.09	28.94	83.75	61.14	58.04	42.61
C.D.	1.648	NS	1.296	NS	3.042	NS	NS	NS
k_1 (50 kg K_2O ha^{-1})	23.45	16.76	26.66	23.68	62.68	52.13	47.32	35.92
k_2 (100 kg ")	33.80	20.83	32.02	29.28	83.08	60.83	57.37	43.44
k_3 (150 kg ")	39.74	24.00	39.67	32.86	102.97	67.43	67.14	48.06
C.D.	1.648	0.847	1.296	1.434	3.042	1.510	3.258	1.898
t_1 (N and K in two split application)	32.71	20.00	31.53	27.92	80.85	59.14	55.33	41.81
t_2 (N and K in three split application)	35.30	21.06	34.04	29.40	84.98	61.11	59.05	43.64
C.D.	0.784	0.376	1.089	0.634	1.225	0.885	0.979	0.793

FIG.11. TOTAL UPTAKE OF N AND K AT VARIOUS STAGES OF GROWTH.



of nitrogen by plant. By increasing the level of phosphorus the total uptake of nitrogen by plant was not affected significantly. Application of potassium had significant effect on the uptake of total nitrogen by plant. Time of application was found to be significant and in most cases t_2 has registered a significant increase on the total uptake of nitrogen by plant. A crop of 1.67 tonnes of plant dry matter and 12.3 tonnes of fresh tuber have removed 59.1 kg nitrogen per hectare.

4.2.5.5. (b) Total uptake of phosphorus by plant (Vegetative/non economic portion of the plant and tuber)

The data on the total uptake of phosphorus by plant are presented in Table 29 (Fig. 12).

The data revealed that levels of nitrogen and phosphorus had significant effect on the total uptake of phosphorus by plant. In most cases graded levels of potassium from k_1 to k_3 had a significant effect on the total uptake of P by plant.

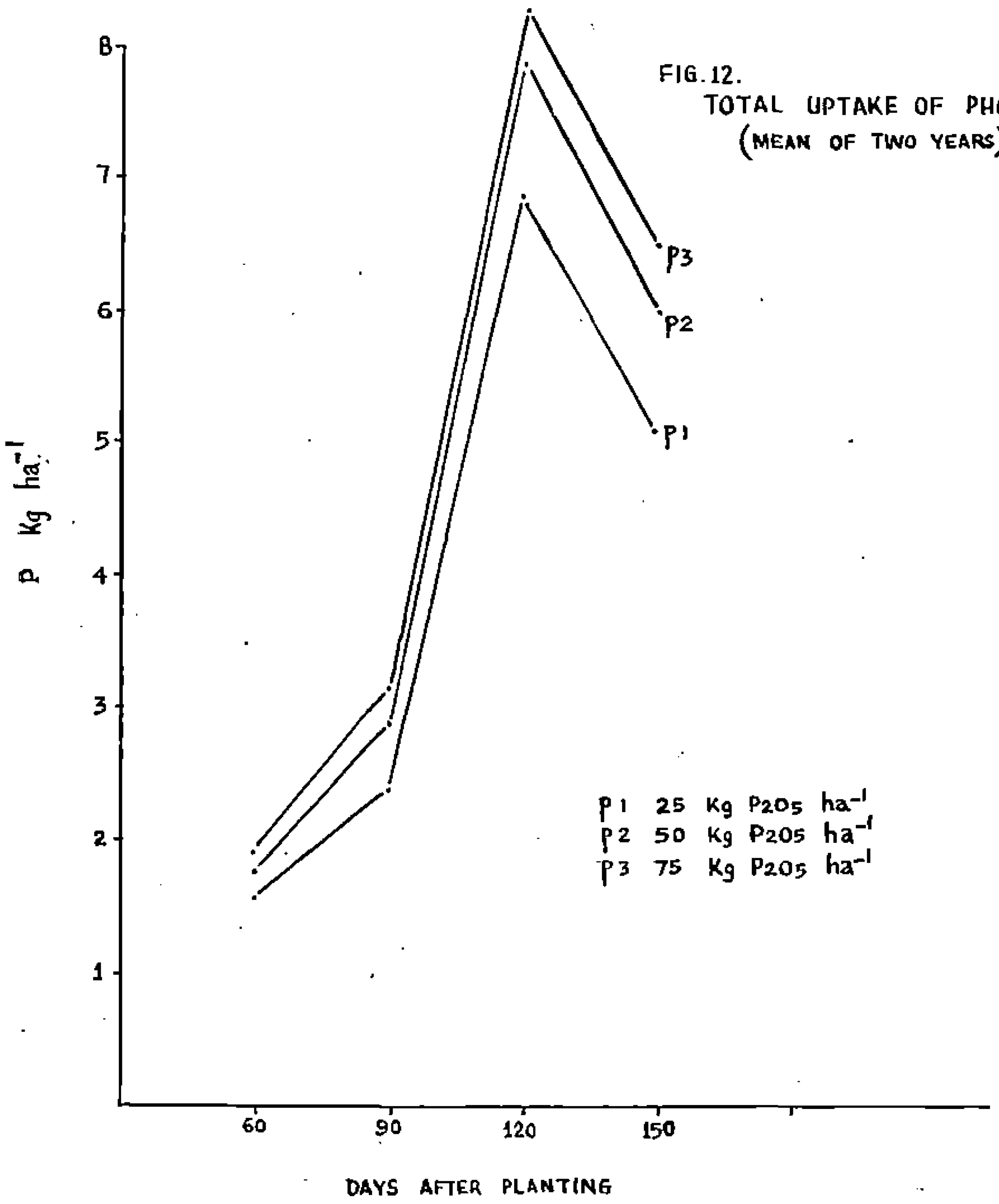
A crop of 1.6 tonnes of plant dry matter and 11.5 tonnes of fresh tuber removed 7.9 kg phosphorus ha^{-1}.

4.2.5.6. (k) Total uptake of potassium by plant (Vegetative/non economic portion of the plant and tuber)

The data on the total uptake of potassium by plant are presented in Table 30 (Fig. 11). It is evident from the Table

FIG. 12.

TOTAL UPTAKE OF PHOSPHORUS AT VARIOUS STAGES OF GROWTH (MEAN OF TWO YEARS)



that by increasing the level of nitrogen from n_1 to n_2 there was significant increase on the total uptake of potassium by plant. However, increasing the level of phosphorus did not show any significant effect on the total uptake of potassium by plant in most cases. But application of potassium had significant effect on the total uptake of potassium by plant. The uptake was significant from k_1 to k_3 in all the stages during both the years. Time of application also had significant effect on the total uptake of potassium by plant, and t_2 was significantly superior to t_1 in this respect during both the years.

A crop of 1.5 tonnes of plant dry matter (non economic portion of the plant) and 11.5 tonnes of fresh tuber removed 72 kg potassium from one hectare of land.

4.2.6. Critical levels of nutrients

The data on the relationship between yield and nutrient concentration in leaf are presented in Table 31.

In general the peak concentration of nutrients (NPK) in leaf was found to be at fourth month of the crop and hence these values were used for finding out the optimum concentration or critical level for optimum yield. A relationship between nutrient concentration in leaf with the final

Table 31. Experiment B. Relationship between kernel yield and foliar nutrient concentration (%) at the fourth month stage of the crop and the critical concentration/optimum concentration of NPK for optimum yield.

Year	Nutrient	Function	Optimum concentration (%)
1984	Nitrogen	$Y = 10.6563 - 3.0781N + 0.7451N^2$	2.0656
	Phosphorus	$Y = 42.3125 - 201.25P + 311.00P^2$	0.3236
	Potassium	$Y = 4.1311 + 7.0569K - 1.9224K^2$	1.0354
1984-'85	Nitrogen	$Y = 13.5 + 11.0625N - 1.4063N^2$	3.9332
	Phosphorus	$Y = 838 - 5308P + 710P^2$	0.3575
	Potassium	$Y = 10.0234 - 3.0313K + 0.7109K^2$	2.1320

tuber yield was established by following the function $y = b_0 + b_1 x + b_2 x^2$ and is presented in Table 31. For nitrogen the function was $y = 10.6563 - 3.0781 N + 0.7451 N^2$ for 1984 and $y = 13.5 + 11.0625 N - 1.4063 N^2$ for 1984-'85. The critical nutrient concentration of nitrogen or optimum concentration was 2.0656 and 3.9332 for 1984 and 1984-'85 respectively. The functions for phosphorus were $y = 42.3125 - 201.25 P + 311 P^2$ and $y = 838 - 5008 P + 7104 P^2$ for 1984 and 1984-'85 respectively. The respective figures for optimum concentration for P were 0.3236 and 0.3525. For potassium the function for 1984 was $y = 4.1311 + 7.0569 K - 1.4062 K^2$ and for 1984-'85 it was $y = 10.0234 - 3.0313 K + 0.7109 K^3$. The critical concentrations or optimum concentrations of K for the respective years was 1.8334 and 2.1320.

4.2.7. Available nutrient status in the soil

4.2.7.1. Available Nitrogen

The data on the effect of treatments on available nutrient status of the soil after each crop are presented in Table 32, and nutrient balance sheet in Appendix V.

The available nitrogen in the soil increased significantly with increase in the application of nitrogen from n_1 to n_2. However application of phosphorus and potassium. did not

Table 32. Experiment B. Effect of levels of NPK and time of application of N and K on the changes in available soil NPK and pH at harvest.

Treatments	Nitrogen kg ha^{-1}		Phosphorus kg ha^{-1}		Potassium kg ha^{-1}		pH	
	1984	1984-'85	1984	1984-'85	1984	1984-'85	1984	1984-'85
n_1 (40 kg N ha^{-1})	315.75	299.55	29.56	34.30	161.86	142.94	4.91	4.85
n_2 (80 kg ")	355.00	301.05	29.31	35.87	166.93	139.86	4.91	4.77
n_3 (120kg ")	350.50	289.00	29.10	35.57	164.24	137.69	4.91	4.78
C.D.	9.11	8.33	N.S	0.774	N.S	3.79	N.S	0.033
p_1 (25 kg P_2O_5 ha^{-1})	339.58	290.52	27.87	33.19	170.37	140.31	4.88	4.77
p_2 (50 kg ")	342.58	300.50	29.64	35.65	158.98	136.73	4.93	4.79
p_3 (75 kg ")	339.08	299.33	30.46	36.89	162.97	142.95	4.93	4.84
C.D.	N.S	N.S	0.494	0.774	5.95	3.79	0.038	0.033
k_1 (50 kg K_2O ha^{-1})	339.22	297.11	29.12	34.84	152.28	134.39	4.89	4.78
k_2 (100kg ")	338.22	301.81	29.34	35.60	164.99	138.81	4.94	4.79
k_3 (150kg ")	343.81	291.50	29.52	35.28	175.04	147.28	4.91	4.83
C.D.	N.S	N.S	N.S	0.774	5.96	3.794	0.038	0.033
t_1 (N and K in two split application)	340.81	295.85	29.45	35.25	165.86	141.93	4.89	4.83
t_2 (N and K in three split application)	340.01	297.75	29.19	35.23	162.35	138.33	4.93	4.77
C.D.	N.S	N.S	0.231	N.S	N.S	2.915	0.029	0.028

show any significant effect on the available soil nitrogen during both the years. Time of application was also significant in the case of available nitrogen in the soil.

4.2.7.2. Available phosphorus

The data on the available P content in the soil as affected by different treatments are presented in Table 32.

In the first year (1984), application of nitrogen and potassium had no significant effect on the availability of soil phosphorus. However levels of phosphorus application from p_1 to p_3 had a significant positive effect on the availability of P in soil.

During the second year (1984-'85) increasing the rate of application of nitrogen from n_1 to n_2 had significant effect on the available soil P. At n_3 level of nitrogen application, though there was a reduction in the available soil phosphorus, it was on par with n_2. Increasing the level of P from P_1 to p_3 also had a significant effect on the available soil P. Levels of potassium application were also significant in this respect.

4.2.7.3. Available potassium

The data on available soil potassium are given in Table 32. During 1984 levels of nitrogen and phosphorus had no significant effect on the available soil potassium. Levels of potassium had significant effect on the availability of potassium in soil. The available content of soil potassium increase with increase in the levels of potassium application from k_1 to k_3. But time of application was not significant.

4.2.7.4. Soil pH

The data on soil pH as affected by continuous cropping of taro are presented in Table 32. Application of nitrogen did not show any significant effect on soil pH in the first year (1984) and during the second year (1984-'85) significantly higher pH was recorded at n_1 level. When the level of phosphorus was increased from p_1 to p_3 the pH increased from 4.88 to 4.93 during the first year and from 4.77 to 4.84 during the second year. A similar trend of increase in pH with increase in the level of potassium was also observed during both years.

4.2.8. Correlation studies

4.2.8.1. Correlation between yield components and yield

Simple correlations were worked out between yield and yield components like number of cormels plant^{-1}, mean weight of cormel, harvest index and leaf area index at 120th day after planting, during 1984 and 1984-'85. The correlation matrices are presented in Table 33.

It could be seen from the data that characters such as number of cormels plant^{-1}, mean weight of cormels (size of cormel), LAI and harvest index were positively correlated with yield during both the years.

4.2.8.2. Correlation between uptake of NPK and yield (Cormel yield)

Simple correlations were worked out between uptake of nitrogen, phosphorus and potassium (at 120th day after seeding) with cormel yield and the results are presented in Table 34.

It could be seen from the table that there was significant positive correlation between uptake of major nutrients and cormel yield.

4.2.8.3. Path analysis of yield components and yield

The results on the path analysis of yield components and yield are presented in Table 35 (Fig. 13).

The correlation between tuber yield and the number of tubers was 0.236 while the direct effect of tuber yield was 0.610. The small correlation is mainly due to the negative

Table 33. Experiment B. Correlation matrix - simple correlation among cormel yield, yield components, harvest index and LAI.

	1984						1984-'85				
	Cormel yield	Number of cormels plant^{-1}	Mean cormel weight (size)	LAI (120th day)	Harvest index		Cormel yield	Number of corm-	Mean weight of cormel	Harvest index	LAI
Cormel yield	1.0	0.2358	0.40696	0.5923	0.9511	Cormel yield	1.0	0.2860	0.0822	0.5968	0.6935
Number of cormels		1.0	-0.7291	0.3293	0.2298	Number of cormels		1.0	-0.1906	0.2580	0.3126
Mean cormel weight			1.0	0.0900	0.4330	Mean weight of cormel			1.0	0.5007	0.5527
LAI				1.0	0.5641	Harvest index				1.0	0.3332
Harvest index					1.0	LAI (120th day)					1.0

C.D. 0.1946

C.D. 0.1946

Table 34. Experiment D. Correlation matrix - simple correlation among uptake of NPK at 120th day and yield.

	1984					1984-'85			
	Cormel yield	Uptake of Nitrogen	Uptake of Phosphorus	Uptake of Potassium		Cormel yield	Uptake of Nitrogen	Uptake of Phosphorus	Uptake of Potassium
Cormel yield	1.0	0.80977	0.70011	0.58560	Cormel yield	1.0	0.87380	0.68474	0.81365
Uptake of nitrogen		1.0	0.67393	0.49655	Uptake of nitrogen		1.0	0.74549	0.78362
Uptake of Phosphorus			1.0	0.43146	Uptake of Phosphorus			1.0	0.60263
Uptake of potassium				1.0	Uptake of potassium				1.0
	C.D.	0.1946				C.D.	0.1946		

Table 35. Experiment B. Path analysis of yield and yield components.

	1984					1984-'85			
	Number of tubers (X_1)	Mean weight of tuber (size) (X_2)	LAI X_3	Correlation with yield (Y)		Number of tubers X_1	Mean weight of tuber X_2	LAI X_3	Correlation with yield (Y)
X_1	0.61015	-0.44904	0.12469	0.26580	X_1	0.46234	-0.18324	0.00542	0.28502
X_2	-0.44486	0.61583	0.22694	0.40696	X_2	-0.08844	0.96107	0.00959	0.88223
X_3	0.13962	0.35668	0.54492	0.95119	X_3	0.14488	0.53126	0.01736	0.69349

Residue (R) = 0.29 Residue (R) = 0.090

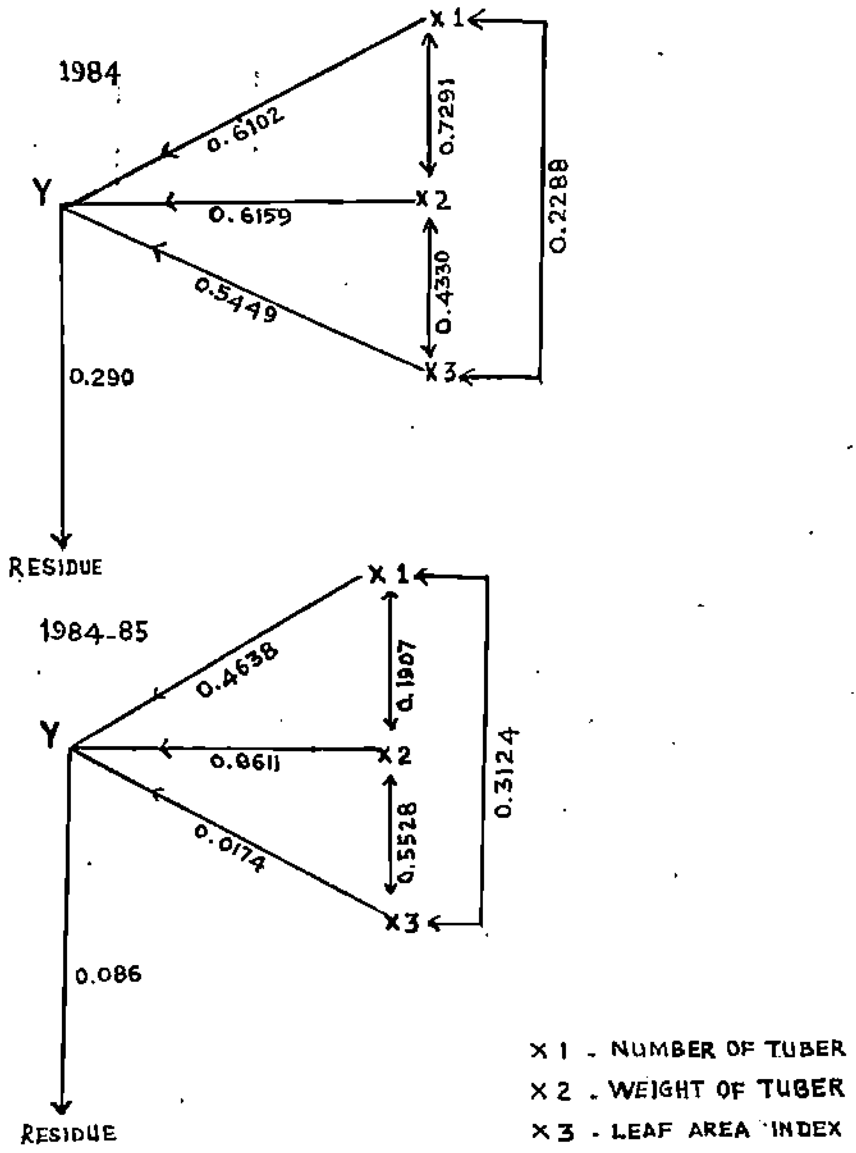
C.D. of correlation co-efficient at 5% = 0.1946

Note:- The diagonal values show the direct effect and the off diagonal values indicate the indirect effect.

indirect effect of the number of cormels via the size of cormel (-0.449). Its indirect effect via LAI was 0.125. Also the correlation between the number of cormels and the size of cormel was significant and negative (-0.729). The direct effect of the size of cormel on yield was 0.616 and its indirect effect via the number of cormels was -0.445 and via LAI was 0.236. These effects contributed to a correlation of 0.407 with yield. The correlation between the LAI and yield was 0.952 which was the resultant of its direct effect of 0.545 and indirect effects via the number of cormels (0.140) and size of cormel (0.267). These three factors contributed directly and indirectly towards yield by 71 per cent in 1984.

In 1984-'85 the correlation between the number of cormels plant^{-1} and cormel yield was 0.236 though its direct effect was 0.464. Its negative indirect effect via the size of cormel (-0.183) was mainly responsible for this small correlation. The direct effect of the size of cormel on yield was high (0.961) and its correlation with yield was 0.892. It contributed indirectly via the number of cormels by -0.083 and LAI by 0.010. Though the correlation between LAI and yield was significant and high (0.693) its direct effect was only 0.017. Its indirect effect via the size

FIG.13. PATH COEFFICIENT ANALYSIS OF YIELD COMPONENTS AND YIELD



of cormels (0.531) mainly contributed to this correlation. The indirect effect via the number of cormels was 0.145. All these factors contributed directly towards yield by 91 per cent.

4.2.8.4. Path analysis of nutrient uptake and yield.

The results of path analysis of yield with nutrient uptake are presented in Table 36 (Fig. 14).

The correlation between total uptake of N and cormel yield was 0.818 of which 0.540 was its direct effect and 0.165 and 0.105 were its indirect effects via uptake of P and K. The correlation between uptake of P and cormel yield was 0.700 which was the sum total effect of the direct effect of uptake of P (0.245) and indirect effects via N (0.364) and K (0.091). Uptake of K has its direct effect 0.212 and indirect effects via N (0.268) and P (0.106) contributing to a correlation of 0.586 with yield. All these factors contributed directly and indirectly towards yield by 63 per cent in the year 1984.

Significant correlation was observed between uptake of N, P and K with yield in 1984-'85 also. The correlation between uptake of N and yield was 0.874 which was its sum

Table 36. Experiment D. Path analysis of yield and nutrient uptake (N, P and K).

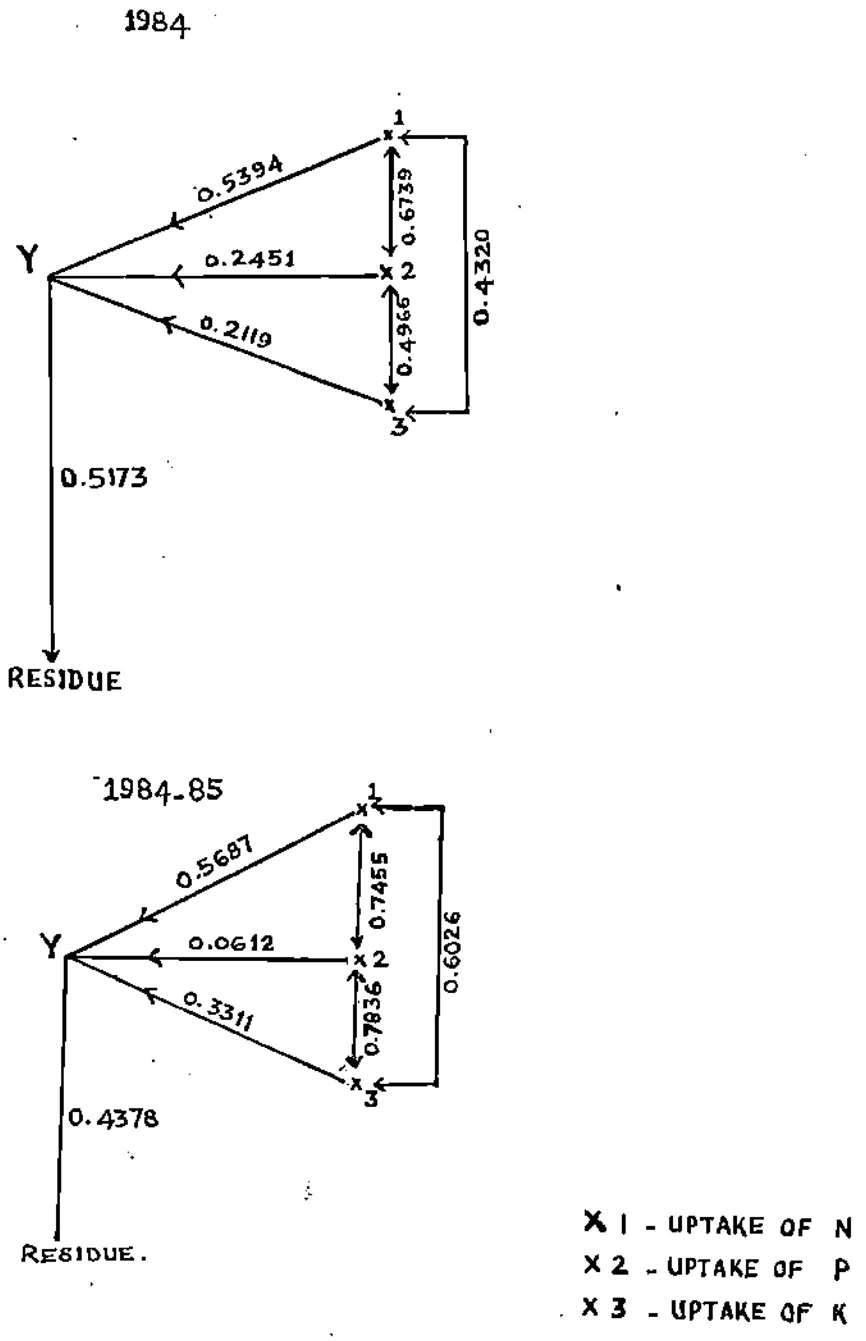
	1984					1984-'85			
	Total uptake of nutrient nitrogen X_1	Total uptake of Nutrient phosphorus X_2	Total uptake of nutrient potassium X_3	Correlation with yield (Y)		Total uptake of nutrient nitrogen X_1	Total uptake of nutrient phosphorus X_2	Total uptake of nutrient potassium X_3	Correlation with yield (Y)
X_1	<u>0.53939</u>	0.16515	0.10522	0.80976	X_1	<u>0.56876</u>	0.04565	0.25963	0.87384
X_2	0.36351	<u>0.24506</u>	0.09154	0.70011	X_2	0.42400	<u>0.06123</u>	0.19951	0.68474
X_3	0.26784	0.10585	<u>0.21192</u>	0.58561	X_3	0.44569	0.03690	<u>0.33106</u>	0.81365

Residue (R) = 0.5173 Residue (R) = 0.4378

C.D. of correlation co-efficient at 5% = 0.1946

Note- The diagonal values show the direct effect and the off diagonal values indicate the indirect effect.

FIG. 14. PATH COEFFICIENT ANALYSIS OF NUTRIENT UPTAKE AND YIELD



total effect directly (0.569) and indirectly via uptake of P (0.046) and K (0.259). The correlation between uptake of P and yield was 0.685 while its direct effect was only 0.061. This significant correlation was mainly due to its indirect effect via uptake of N (0.424) and K (0.200). The direct effect of uptake of K was 0.331 and indirect effect via uptake of N and P was respectively 0.446 and 0.037. These direct and indirect effects of uptake of K contributed to its significant correlation with yield (0.814). All these factors contributed directly and indirectly towards yield by 56 per cent.

4.2.9. Physical and Economic optimum levels of nitrogen, phosphorus and potassium

The data on the physical and economic optimum dose of N, P and K are presented in Table 37.

The relationship between yield and applied nutrients was studied by fitting a quadratic response surface. The physical optimum dose of N, P and K was worked out from the response surface during 1984 and 1984-'85 and are provided in the Table.

Table 37. Experiment 8. Quadratic response surface of yield and applied nutrients (NPK) for physical and economic optimum doses of NPK.

Year	Nutrient	Function		Physical optimum	Economic optimum
1984		$Y = 11.4805 + 8.9673^{*} x_1 + 6.1041^{*} x_2 + 5.8043^{*} x_3 - 2.2887^{*} x_1^2 - 1.2129^{*} x_2^2 - .9325\, x_3^2 - 1.2650^{*} x_1x_2 - 1.3831^{*} x_1x_3 - 1.3502^{*} x_2x_3$			
	Nitrogen	= 40 x 1.290276 + 40	=	91.6	33.0
	Phosphorus	= 25 x 0.969929 + 25	=	49.2	18.0
	Potassium	= 50 x 1.531097 + 50	=	126.5	151.0
1984-'85		$Y = 8.3063 + 6.1924^{*} x_1 + 4.0956^{*} x_2 + 4.4935\, x_3 - 1.4549^{*} x_1^2 - 0.7528^{*} x_2^2 - 0.7636^{*} x_3^2 - 0.9596^{*} x_1x_2 - 0.9388^{*} x_1x_3 - .9125^{*} x_2x_3$			
	Nitrogen	= 40 x 1.253459 + 40	=	90.1	30.0
	Phosphorus	= 25 x 1.08504 + 25	=	52.1	0.0
	Potassium	= 50 x 1.397115 + 50	=	119.8	166.0

The data presented in table showed that the physical optimum for N, P and K were found to be 91.6, 49.2 and 126.5 respectively during 1984 and 90.1, 52.1 and 119.8 respectively during 1984-'85.

The economic doses of fertilisers during the years 1984 and 1984-'85 were found to be N 33, P_2O_5 18 and K_2O 151 Kg ha^{-1} and N 30, P_2O_5 nil and K_2O 166 Kg ha^{-1} respectively.

4.2.10. Economics of fertilizer application

The economics of fertilizer application computed based on the prevailing market price of nitrogen, phosphorus, potassium and the sale price of Colocasia are presented in Table 38.

The data revealed that the maximum benefit cost ratio and net income were obtained for the level of nutrient application at the rate of 80 Kg nitrogen, 50 Kg P_2O_5 and 150 Kg K_2O ha^{-1}, which was closely followed by 80 Kg N, 50 Kg P_2O_5 and 100 Kg K_2O ha^{-1}.

Table 38. Experiment D. Economics of levels of NPK and time of application of N and K on taro (Mean of two years).

Treatments	Time of application of fertilizers (t_1)					Time of application of fertilizers (t_2)				
	Mean yield t ha^{-1}	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit cost ratio	Mean yield t ha^{-1}	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit cost ratio
$n_{40}\ P_{25}\ k_{50}$	6.51	8495	13020	4525	1.53	6.90	8545	13800	5255	1.61
$n_{40}\ P_{25}\ k_{100}$	7.31	8620	14620	6000	1.70	7.43	8670	14860	6190	1.71
$n_{40}\ P_{25}\ k_{150}$	8.12	8745	16240	7495	1.86	7.88	8795	15760	6965	1.79
$n_{40}\ P_{50}\ k_{50}$	7.42	8645	14840	6195	1.72	7.61	8695	15220	6525	1.75
$n_{40}\ P_{50}\ k_{100}$	7.68	8745	15335	6591	1.75	8.17	8795	16340	7545	1.86
$n_{40}\ P_{50}\ k_{150}$	8.08	8895	16160	7265	1.82	8.29	8945	16580	7635	1.85
$n_{40}\ P_{75}\ k_{50}$	7.14	8795	14280	5485	1.62	7.38	8845	14760	5915	1.66
$n_{40}\ P_{75}\ k_{100}$	7.24	8920	14480	5560	1.62	7.94	8970	14580	5610	1.62
$n_{40}\ P_{75}\ k_{150}$	7.59	9045	15180	6135	1.69	7.93	9095	15860	6765	1.74
$n_{80}\ P_{25}\ k_{50}$	8.70	8715	17400	8685	1.99	9.35	8765	18720	9955	2.14
$n_{80}\ P_{25}\ k_{100}$	8.98	8840	17960	9120	2.03	9.31	8890	18620	9730	2.09
$n_{80}\ P_{25}\ k_{150}$	9.52	8965	19040	10075	2.12	9.81	9015	19620	10605	2.18
$n_{80}\ P_{50}\ k_{50}$	8.75	8865	17500	8635	1.97	9.07	8915	18140	9225	2.03
$n_{80}\ P_{50}\ k_{100}$	9.99	8990	19980	10990	2.22	10.09	9040	20180	11140	2.23
$n_{80}\ P_{50}\ k_{150}$	9.55	9115	19100	9935	2.10	10.22	9165	20440	11275	2.23
$n_{80}\ P_{75}\ k_{50}$	8.81	9015	17620	8605	1.95	9.35	9065	18700	9635	2.06
$n_{80}\ P_{75}\ k_{100}$	9.50	9140	19000	9860	2.08	10.16	9190	20320	11130	2.21
$n_{80}\ P_{75}\ k_{150}$	9.54	9265	19080	9815	2.06	10.16	9315	20320	11005	2.18

(Contd...)

Table 38 (Contd.). Experiment B. Economics of levels of NPK and time of application of N and K on taro.

Treatments	Time of application of fertilizers (T_1)					Time of application of fertilizers (T_2)				
	Mean yield t ha^{-1}	Cost of culti-vation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit cost ratio	Mean yield t ha^{-1}	Cost of culti-vation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit cost ratio
N_{120} P_{25} K_{50}	8.72	8935	17440	8505	1.95	9.21	8985	18420	9435	2.05
N_{120} P_{25} K_{100}	8.85	9060	17700	8640	1.95	9.28	9110	18560	9450	2.04
N_{120} P_{25} K_{150}	8.70	9185	17400	8215	1.89	9.44	9235	18880	9645	2.04
N_{120} P_{50} K_{50}	8.70	9085	17400	8315	1.91	8.77	9135	17540	8405	1.92
N_{120} P_{50} K_{100}	8.97	9210	17940	8730	1.95	9.65	9260	19300	10040	2.08
N_{120} P_{50} K_{150}	9.51	9335	19020	9685	2.04	9.89	9385	19780	10395	2.11
N_{120} P_{75} K_{50}	8.65	9235	17300	8065	1.87	9.37	9285	18740	9455	2.02
N_{120} P_{75} K_{100}	8.97	9360	17940	8580	1.92	9.26	9410	18520	9110	1.97
N_{120} P_{75} K_{150}	9.80	9485	19600	10125	1.96	9.96	9585	19920	10335	2.09

Levels of NPK (kg ha^{-1})

N_{40}, N_{80}, N_{120} = 40, 80, 120 kg N ha^{-1}

P_{25}, P_{50}, P_{75} = 25, 50, 75 kg P_2O_5 ha^{-1}

K_{50}, K_{100}, K_{150} = 50, 100, 150, kg K_2O ha^{-1}

Cost of cultivation (Rs ha^{-1}) = 8000 + cost of fertilizer

Price of colocasia cormel = Rs.2 kg^{-1}

Fertilizer price (Rs kg^{-1}) N = 5.50, P_2O_5 = 6.00,

K K_2O = 2.25

Table 38(a). Experiment B. Economics of levels of NPK application on taro

Treatments	Cormel yield t ha^{-1} 1984	Cormel yield t ha^{-1} 1984-'85	Net income Rs ha^{-1} 1984	Net income Rs ha^{-1} 1984-'85
N_{40} P_{25} K_{50}	7.89	5.52	7250	2515
N_{40} P_{25} K_{100}	8.50	6.23	7830	3990
N_{40} P_{25} K_{150}	9.19	6.81	9605	4855
N_{40} P_{50} K_{50}	8.81	6.21	8960	3750
N_{40} P_{50} K_{100}	9.11	6.74	9455	4705
N_{40} P_{50} K_{150}	9.32	7.04	9720	5170
N_{40} P_{75} K_{50}	8.56	5.95	8315	3073
N_{40} P_{75} K_{100}	8.80	6.37	8665	3795
N_{40} P_{75} K_{150}	8.65	6.85	8245	4640
N_{80} P_{25} K_{50}	10.49	7.26	12255	6390
N_{80} P_{25} K_{100}	10.43	7.86	12005	6870
N_{80} P_{25} K_{150}	11.17	8.16	13360	7345
N_{80} P_{50} K_{50}	10.35	7.45	11825	6025
N_{80} P_{50} K_{100}	11.88	8.19	14760	7360
N_{80} P_{50} K_{150}	11.56	8.20	13990	7275
N_{80} P_{75} K_{50}	10.66	7.49	12290	5955
N_{80} P_{75} K_{100}	11.54	8.11	13920	7090
N_{80} P_{75} K_{150}	11.27	8.42	13140	7545

Contd...

Treatments	Cormel yield t ha^{-1}		Net income Rs ha^{-1}	
	1984	1984-'85	1984	1984-'85
N_{120} P_{25} K_{50}	10.50	7.43	12035	5905
N_{120} P_{25} K_{100}	10.22	7.89	11370	6710
N_{120} P_{25} K_{150}	10.21	7.92	11220	5205
N_{120} P_{50} K_{50}	10.30	7.15	11495	6780
N_{120} P_{50} K_{100}	10.60	8.00	11975	6750
N_{120} P_{50} K_{150}	11.15	8.25	12945	7155
N_{120} P_{75} K_{50}	10.58	7.42	11910	5590
N_{120} P_{75} K_{100}	10.30	7.92	11215	6455
N_{120} P_{75} K_{150}	11.35	8.40	13200	7300
CD	-		2530	1971

<u>Levels of NPK (kg ha^{-1})</u>

N_{40} N_{80} N_{120} = 40, 80, 120 kg N ha^{-1}

P_{25} P_{50} P_{75} = 25, 50, 75 kg P_2O_5 ha^{-1}

K_{50} K_{100} K_{150} = 50, 100, 150 kg K_2O ha^{-1}

Cost of cultivation (Rs ha^{-1}) = 8000 + cost of fertilizer

Price of colocasia cormel = Rs. 2 kg^{-1}

Fertilizer price (Rs kg^{-1}) N = 5.50, P_2O_5 = 6.00, K_2O = 2.25

DISCUSSION

5. DISCUSSION

5.1. Experiment 'A'

The results of the experiment 'A', ie. Effect of plant population, source of planting material and mulching on the yield and quality of Colocasia are discussed below.

5.1.1. Growth characters

It is seen that (Table 1) plant population had no significant effect on germination. This might be due to the fact that germination is a quality related to the seed which is independent of population density. Similar results were reported by Mohan Kumar et al. (1973), in Amorphophallus. The source of planting material viz., side vs mother corm also could not make significant effect on this character. In both the cases same germination percentage was achieved at 45th day after planting. The comparatively long period taken for full germination may be due to the fact that some amount of seed dormancy is prevalent in the tubers.

Though mulching had effect on germination, it was on par with no mulch control. Effect of mulching on seedling emergence has been reported by several workers (Caruso, 1968, Miller 1969, Yanateva and Lozovaya 1976), but mostly on temperate region crops like potato, where mulching may provide higher temperature for seedling emergence. But in taro which is mostly grown in the tropics, the effect of mulching on seedling emergence had only little importance. Similar results have been reported by Lyonga (1979) in cocoyam and Kamalam Joseph and Kunju (1981) in Colocasia.

5.1.1.2. Number of leaves per plant

Plant population and source of planting material had no significant effect on the number of leaf production plant^{-1} (Table 2). Similar results have already been reported by Mathur et al. (1966a) Kamalam Joseph and Kunju (1981) in taro.

Mulching also had no significant effect on the number of leaf production during the early stages of plant growth. This is in conformity with the findings of Karikari (1979) in taro. But on 90th, 120th and 150th day mulching exerted significant influence on this character, and it was seen that green leaf mulch had recorded the maximum number of leaves plant^{-1}. This might be due to the higher supply of plant nutrients by green leaf mulch as compared to other mulches. The effect of nutrients on leaf production has been reported by Pillai (1967) in taro and by Paterson et al. (1970) in sweet potato.

5.1.1.3. Height of plants

The effect of treatments on height of plants (Table 3) showed that, upto 90th day plant population had no significant effect on plant height but thereafter lower plant population unit^{-1} land area recorded significantly higher plant height. This might be due to the fact that at grand growth stage lesser number of plants unit^{-1} land area had comparatively lesser competition for light, nutrients and space which contributed to better growth of the individual plants. Similar results were reported by Sivan (1973) in taro.

Between source of planting material, mother corm had recorded higher plant height only in the first observation and in subsequent observations source of planting material had no significant effect on height. The initial higher plant height recorded for mother corm might probably be due to the higher content of stored nutrients in the mother corm, which might have prompted better initial growth of the plant.

Mulching had significant effect on plant height. Leaf mulch and waterhyacinth have recorded higher plant height over polythene, coir waste and no mulch control. This is in conformity with the findings of Jordan and Opoku (1966) in cocoa wherein they observed that mulch treatment gave outstanding results in terms of general growth, stem diameter, height and early bearing of cocoa. Similar results were also reported by Enyi (1967) in Cocoyam and Mohan Kumar *et al.* (1973) in *Amorphophallus*.

5.1.1.4. Number of suckers plant^{-1}

It is seen that plant population had no significant effect on the production of suckers plant^{-1} except on the first observation. Source of planting material ie. mother corm had significant effect on the production of suckers plant^{-1} over side corm (Fig. 4). This may probably be due to the fact that mother corm contains more number of live axillary buds than side corm which contributed to more number of suckers plant^{-1}. Similar results were reported by Ahamed and Quasem (1968) in potato.

Mulching had no significant effect on the production of suckers. This might be due to the fact that sucker production is mostly a character modified only by the source of planting material used and environmental factors do not have any control over this character.

5.1.1.5. LAI

Plant population had significant effect on LAI (Table 5 Fig. 4). An increase in the plant population resulted in an increase in the LAI. This is in agreement with the findings of Enyi (1967) in cocoyam that LAI normally increases with increasing plant density. Similar results were also reported by Sivan (1973) in taro and Asanuma *et al.* (1984) in potato that leaf and stem dry matter m^{-2} were higher with increasing plant density.

Source of planting material was found to have only little effect on LAI. During early stages of growth mother corm had recorded significantly higher LAI, but at 120th and 150th day there was no significant difference for this character. The initial higher LAI recorded for mother corm might probably be due to the higher number of suckers $plant^{-1}$. But during later stages the leaf lamina produced from the sid corms was bigger in size than the plants raised from mother corm, which might have compensated for the leaf area produced from significantly higher number of suckers $plant^{-1}$ emerged from mother corm. Similar results were also reported by Kamalam Joseph and Kunju (1981) in taro.

The effect of mulching on LAI was found to be inconsistent. During earlier stages of growth mulching had no effect on LAI but on 120th and 150th day leaf mulch had positive and significant effect on LAI. The effect of mulching on increased leaf area has been reported by Azariah (1954) in potato, Enyi (1973) in Cocoyam and by Aina (1981) in Maize.

The maximum LAI was observed for the treatment combination M_1S_2. This might be due to the fact that among the mulch material leaf mulch has recorded the maximum LAI which was significantly superior to all other treatments.

5.1.1.6. Weed Growth

The effect of treatment on weed growth (Table 6) showed that mulching had significant effect on weed growth. There was practically no weed growth in black polythene mulch plot. This might be due to the total elimination of sun light under such situation. Though it was effective in the control of weeds it was not an economic proposition for a crop like taro. The next best treatment in controlling weed growth was leaf mulch.

Between sources of planting material maximum weed growth was observed when side corms were used as planting material. This might be due to the significantly lesser number of suckers produced from side corms (Table 4) resulting in more interspace left out for the weeds to grow.

Plant population had no significant effect on the weed population.

The interactions (Table 6A) S_1M_4 and S_2M_4 were significant in the control of weeds. This might be due to the fact that black polythene mulch had completely checked the weed population. Among other interactions M_1S_2 and M_1S_1 were also found to be effective in the control of weeds. The effect of leaf mulch on weed control has been reported by Villanueva and Tupas (1979) in taro.

5.1.2. Yield components and yield

5.1.2.1. Mean cormel weight plant^{-1}

Maximum cormel yield per plant was obtained for the plant spacing of 60 x 60 cm which was significantly superior to all the other spacings. Higher yield plant^{-1} at wider spacing might be as a result of lesser competition between plants for light, nutrients and space, which might have resulted in the better utilisation of growth inputs for productive purposes. Similar results of higher yield plant^{-1} at wider spacing have been reported by several workers viz., Mohankumar _et al_. (1973) in _Amorphophallus_, Gurnah (1974) in yams, Pardales and Villanueva (1984) in taro.

Between sources of planting material significantly higher cormel yield plant^{-1} was obtained for side corms. This might be due to the fact that the mean weight of cormel plant^{-1} was highest when side corms were used as planting material (Table 7, Fig. 5). Similar results were reported by Kamalam Joseph and Kunju (1981) wherein they found that medium sized cormels as planting material had contributed to the maximum weight of cormels as compared to the planting of mother corm.

Green leaf mulch had a significant effect on the cormel yield plant^{-1}. This might be due to the effect of green leaf for providing a better soil physical condition for the better development of cormels as well as the increased supply of plant nutrients as evidenced in Table 11. Moisture may not be a factor, as the crop was raised under irrigated condition.

Maximum number of cormels plant^{-1} was obtained for the treatment 60 x 60 cm and 60 x 45 cm. This might be due to the fact that wider spacing may facilitate less competition between plants for nutrients, light and space, resulting in more number of cormels per plant. Similar results were reported by Enyi (1973), Ezumah and Plucknett (1973), and by Pardales and Villanueva (1984) in taro. Source of planting material had no significant effect on this character (Table 7).

Similarly higher number of cormels produced under leaf mulch (Table 7) might be as a result of better availability of nutrients and favourable physical conditions of the soil for better growth and development of the cormel (Table 11). This is in conformity with the findings of Kamalam Joseph and Kunju (1981).

The interaction effect of plant population and mulching (Table 7A) was significant. Maximum number of cormels plant^{-1} was obtained for the treatment combination M_1P_4 which was significantly superior to all other combinations. It is evident from the above discussion that the plant spacing 60 x 60 cm recorded the maximum number of cormels plant^{-1} which was significantly superior to the plant spacings 60 x 30 and 45 x 45 cm. Likewise mulching with green leaf was superior to all the other materials used. Therefore it is quite natural that their combination also gave significant effect.

5.1.2.3. Mean weight/size of cormel (g)

It is evident from the data (Table 7) that plant population had significant effect on the mean weight of cormel. The cormel weight ranged from 28 to 42 g $cormel^{-1}$. Maximum sized cormels were produced at wider spacings of 60 x 60 cm. This is in agreement with the findings of Ezumah and Plucknett (1973), Mohankumar et al. (1976b), Sivan (1973) and by Pardales and Villenueva (1984) in taro.

Between source of planting material side corms recorded significantly bigger sized cormels than mother corm. It may be remembered in this connection that there was significant reduction in the number of suckers $plant^{-1}$ (Table 4) in the case of side corms as compared to mother corms which contributed to lesser competition for nutrient, light and space, resulting in significantly bigger sized cormels in the case of side corms.

Mulching had significant effect on the production of bigger sized cormels and leaf mulch had been the best in this respect. The increased size of tubers by leaf mulching has been reported by Lal and Hahn (1973) in yam and by Mohankumar et al. (1973) in Amorphophallus.

5.1.2.4. Cormel to Corm ratio

It is evident from Table. 8 that significantly higher cormel to corm ratio was obtained for the plant spacing of 60 x 45 cm, which was on par with the plant spacing of 60 x 60 cm. The higher ratio obtained for 60 x 45 cm was the result of significantly higher cormel yield produced for 60 x 45 cm spacing and at the same time there was no significant difference for the production of mother corm at varying plant spacings (Table 9).

Between source of planting material side corm recorded significantly higher cormel/corm ratio over mother corm. This has occurred as a result of significantly higher yield of cormels recorded for side corm over mother corm (Table 9).

Mulching had no significant effect on this character. The interaction of source of planting material and mulching showed that significantly higher cormel/corm ratio was obtained for the treatment combination S_1M_5. This was as a result of lower yield of mother corm in the treatment combination S_1M_5.

5.1.2.5. Cormel yield

It is evident from the data (Table 9, Fig.6) that the plant spacing 60 x 45 cm had recorded significantly higher yield of cormels over other plant populations tried. This is as a result of optimum number of plants unit area^{-1}, and an increase in the number and size of cormels plant^{-1} (Table 7). This is in agreement with the findings of Gurnah (1974) that by increasing the plant population from 9000 to 36000 plants hectare^{-1} there was an increase in yield in yam. Mohankumar _et al._ (1976b) obtained significantly higher yield in taro at an inter row and intra row spacing of 60 x 45 cm beyond which there occurred an yield reduction. Chandra (1979) also recorded the maximum yield in _Colocasia_ at a spacing of 60 x 45 cm in Fiji. Similar results were also reported by several workers like Ezumah and Plucknott (1981) and Sivan (1984) in taro.

Between source of planting material maximum cormel yield was obtained when side corms were used as planting material. The significantly higher yield recorded for side corm might be due to the significantly higher cormel yield plant^{-1} and mean weight of cormels recorded from side corms (Table 7). Similar results were obtained by Kamalam Joseph and Kunju (1981), wherein they got highest cormel yield when side corms of medium size were used as planting material over mother corm.

Among the mulch material used, significant yield increase was obtained for green leaf mulch. This might be due to the increased supply of nutrients and better soil physical condition provided by the green leaf mulch for better development of cormels (Table 11). Similar results of yield increase for green leaf mulch have been reported by Balakrishna Rao (1957) in ginger, Enyi (1967) in Cocoyam, Lal and Hahn (1973) in yam, Mohankumar et al. (1973) in Amorphophallus and by Karikari (1979) in Cocoyam.

Effect of treatments on mother corm yield and non marketable cormel yield (Table 9) revealed that there was no significant effect for plant population and source of planting material on these characters. Leaf mulch had increased the corm yield. This increased production might be due to increased supply of plant nutrients through leaf mulch.

Regarding non marketable cormel yield (Table 9) plant spacings of 60 x 30 and 45 x 45 cm have recorded the maximum quantity of non marketable cormels, which was significantly superior to other plant populations. The higher rate of production of small cormels in high density planting might be due to the competition between plants for various production inputs resulting in smaller sized cormels. Similar results of undersized cobs and cormels under high density planting have been reported by Willey and Heath (1969) in maize & by Sivan (1973) in taro.

5.1.2.6. Total dry matter yield.

Total dry matter production showed that (Table 9) the plant spacing 60 x 45 cm recorded the maximum dry matter production which was significantly superior to all other spacings tried. This is as a result of optimum number of plants unit area^{-1} and significantly higher cormel yield hectare^{-1} (Table 9).

Side corm was significantly superior to mother corm for total dry matter production. Leaf mulch had a significant effect on the total dry matter production over other mulches tried. This might be as a result of better nutrient supply and better improvement in the physical condition of the soil by leaf mulch (Table 11).

5.1.2.7. Harvest Index

Plant population and source of planting material had no effect on harvest index, whereas mulching had a significant effect on harvest index. Maximum harvest index was observed in leaf mulch which was significantly superior to the other mulch materials used. This was as a result of higher proportion of economic yield in the total bio-mass production.

5.1.3. Quality attributes

5.1.3.1. Dry matter percentage

The dry matter percentage of the cormel was significantly higher for 60 x 30 cm and 60 x 60 cm spacings. This might be due to the higher content of available soil potassium as evidenced in Table 11. The effect of potassium on dry matter production in tuber crops has been reported by several workers like Fujise and Tsuno (1967) in sweet potato and by Kumar <u>et al</u>. (1971) in cassava.

Source of planting material had no effect on the dry matter content of cormels. This may probably be due to the fact that the quality aspects are influenced mostly by the varieties and the environmental conditions rather than the source of planting materials. Mulching had significant effect on this aspect. This may probably be as a result of increased supply of nutrients by the leaf mulch (Table 11). Similar results have been reported by Lal and Hahn (1973) in yam and by Enyi (1973) in cocoyam.

5.1.3.2. Starch percentage

Regarding the percentage of starch in cormels the different treatments had no significant effect, although an increased percentage of starch was observed in lower plant population ie. 60 x 60 cm and in the leaf mulch treatment. The starch percentage in cormel is mostly a character of the variety and nutrition of the crop, and cultural management has little effect on it.

5.1.3.3. Protein content

Plant population had a significant effect on the content of protein in cormels. Maximum protein content was observed in the highest plant population unit area^{-1} (60 x 30 cm) which was significantly superior to other plant spacings. This may be as a result of lower cormel yield under such spacings which might have resulted in a higher percentage of protein in cormels (Table 10).

Leaf mulch had significant effect on the content of protein in cormels. This might be as a result of higher content of nitrogen supplied to the crop through green leaf mulch (Table 11). Increase in the content of protein in cormel by increased nitrogen content in the soil has been reported by several workers like Nadpuri and Singh (1966) and Gupta and Saxena (1976) in potato.

5.1.3.4. Acridity and cooking quality

The oxalate content of the cormel in mg g^{-1} showed that (Table 10) there was no significant effect for the treatments. This may be due to the fact that acridity is a varietal character and may not be affected by cultural practices.

Organoleptic test showed that there was no marked difference for the cooking quality of the cormel.

5.1.4. Available NPK content and physical properties of the soil

5.1.4.1. Available NPK content of soil

It is seen from the data (Table 11) that plant population had significant effect on the available potassium content of the soil. This might be due to the fact that the plant spacings 60 x 30 cm and 60 x 60 cm had registered significantly lower cormel yield over 60 x 45 cm spacing and thereby the quantity of potash removed from the soil might be less which resulted in a higher percentage of available potassium in the soil, whereas source of planting material had no significant effect on this character. Mulching had significant effect on the availability of NPK content in the soil. The increased availability of NPK content for leaf mulch over other mulch materials might be due to the nutrient addition on decomposition of the leaf mulch. The effect of green leaf mulch in increasing the content of soil nutrients has been reported by Mohan Kumar _et al._ (1973) in _Amorphophallus._

The interaction effect of source of planting material and spacing was also significant. The maximum available nitrogen content was observed in the treatment combination S_1P_4 (Table 11a). The higher content of nitrogen in the treatment combination might be due to the significantly lower rate of sucker production unit area^{-1} for 60 x 60 cm spacing, which might have facilitated lesser uptake of nitrogen and retention of comparatively higher levels of N in the soil.

5.1.4.2. Bulk density

Plant spacing had a significant effect on the bulk density of the soil (Table 11). The lowest value of 1.604 g cc^{-1} was observed in 60 x 60 cm spacing. This may probably be due to the higher organic matter content in the soil in that treatment which in turn might have contributed for higher nitrogen content in the soil (Table 11).

Mulching had significant effect on bulk density and the lowest value of 1.600 g cc^{-1} was recorded for green leaf mulch. Effect of organic matter in low bulk density values has been reported by Buckman and Brady (1967) Lal (1978) and by Sasidhar (1978).

5.1.4.3. Water stable aggregate

Leaf mulch had a significant effect on the production of water stable aggregate in the soil. The higher percentage of water stable aggregates in leaf mulch plot might be as a result of addition of organic matter through leaf mulch. Higher soil aggregation as a result of addition of organic matter has been reported by Harris et al. (1966) and by Kumar and Ghildyal (1969).

5.2. Experiment B

The results of the investigation on the effect of graded levels of nitrogen, phosphorus, potassium and time of application of nitrogen and potassium on the growth characters, yield components, cormel yield and quality aspects, dry matter production and nutrient uptake of taro are discussed below.

5.2.1. Growth characters

5.2.1.1. Plant height

The results revealed that an increase in levels of nitrogen significantly increased the height of the plant upto 120th day after planting and then tended to decrease

(Table 12). This type of growth pattern in taro suggests that for early vegetative growth higher levels of nitrogen are required. The increased growth of plant at higher levels of nitrogen would have contributed to higher tuber production by way of enhanced photosynthetic functions resulting in higher carbohydrate production. The influence of nitrogen on the vegetative growth of any plant is a well established phenomenon which needs no detailed discussion. Similar increase in plant height due to higher levels of nitrogen application has been reported in taro by Pureval and Dargan (1957b) and by Hussain and Rashid (1982).

The decrease in plant height observed at 120th day after planting may be due to the fact that at this stage, the plants are going through the active stage of tuber bulking and as such the photosynthate may be utilized for sink activity. Similar results were reported by Sivan (1979) wherein the leaf dry matter increased very rapidly during the early part of the growth of taro and reached a peak at about 20th week and thereafter the plant dry matter declined.

Application of graded doses of phosphorus (Table 12) did not show any significant effect on plant height at most stages of observation. The probable reason for the lack of response may be the higher level of available phosphorus in the soil (Table 32), the non significant effect of total dry matter production, CGR . (Table 22 and 23), and the low requirement of phosphorus by plant (Table 26). Similar results were reported by Purewal and Dargan (1957b), Pillai (1967) in taro, Purewal and Dargan (1959) in Sweet potato and by Mohan Kumar *et al.* (1976a) in cassava.

The data revealed that potassium application increased plant height significantly at various growth stages (Table 12). However, significant effect of potassium was observed only for 100 Kg K_2O ha^{-1}. This shows that 100 Kg K_2O ha^{-1} is sufficient for optimum vegetative growth. This has been further explained with the plant dry matter production (Table 21) wherein significant increase in plant dry matter production was observed upto 100 Kg K_2O ha^{-1}. Similar results were observed by Purewal and Dargan (1957b), Abit and Alferez (1979) in taro, wherein plants supplied with 50 Kg each of N, P_2O_5 and K_2O were significantly taller than unfertilized plants.

5.2.1.2. Number of leaves $plant^{-1}$

The data presented in Table 13 revealed that only potassium had significant effect on the production of leaves $plant^{-1}$ in most of the growth stages of taro, while P had no effect on this trait and effect of nitrogen was observed only at 90th day after planting. The leaf production started slowly and maximum leaf area was attained by about the 16th week after planting. According to Sivan (1984) leaf number and leaf area can be increased by adequate supply of moisture and nutrients. Similar results of increased leaf production by increased level of nitrogen application have been reported by Premraj et al. (1980) and de la Pena and Melchor (1984) in taro.

The lack of response for the application of phosphorus on leaf production may probably be due to the fact that this nutrient is mostly utilized for the production of nucleic acids, nucleo-protein, co-enzymes like NAD, NADP etc. and may have little effect on the vegetative growth of taro. Similar lack of response to P in leaf production of taro has been reported by Purewal and Dargan (1957b). This can be further explained from the data in Table 14, that the application of phosphorus on LAI was not significant in most of the growth stages. The leaf dry matter production (Table 18) also revealed that there was no significant difference between the levels of phosphorus during any of the growth stages.

Application of potassium at 100 Kg K_2O ha^{-1} was found to be effective in the production of number of leaves during most of the stages. This is in agreement with the findings of Purewal and Dargan (1957b) and Pillai (1967).

Time of application of N and K was not significant in increasing leaf production. In two split applications half dose of N and K and the remaining half dose of N and K were received at the end of the first and second month after germination, whereas in three splits only two thirds of the nitrogen and potassium were received during this time. The lack of response for the time of application might probably be due to the fact that two third of the dose of N and K received by the end of second month might be sufficient to produce enough number of leaves and the one third dose of N and K received by the end of the third month may not have much influence on leaf production as the crop has started the productive phase and as such the dose of nitrogen and potassium received during this time might have been utilized for cormel production as evidenced in Table 16, wherein three split application of N and K has recorded significantly higher cormel yield over two split application of N and K.

5.2.1.3. Leaf Area Index (LAI)

Levels of nitrogen revealed significant difference in LAI at various growth stages during both years (Table 14, Fig. 7). In most of the stages maximum LAI was recorded at 80 Kg nitrogen ha^{-1}. The important of nitrogen as a factor in influencing LAI has been reported in many crops. According to Russell (1973), as nitrogen supply increases, the extra protein produced allows the plant leaves to grow larger and hence to have larger surface area available for photosynthesis. Increase in LAI was also due to an increase in leaf number at higher levels of nitrogen as evidenced from the data in Table 13. Increase in leaf area due to incremental doses of nitrogen was reported by Purewal and Dargan (1957b), de la Pena and Plucknett (1972), Premraj *et al.* (1980) and Hussain and Rashid (1982) in taro.

Application of varying levels of phosphorus was not significant in increasing leaf area index in most stages of growth. It can be seen in this connection that the effect of P was not significant in the production of leaves also, as shown in Table 13. Similar results were reported by Purewal and Dargan (1957b) and Pillai (1967) in taro.

Leaf area index was increased significantly by increasing the level of potassium. Maximum leaf area was observed at 150 Kg K_2O ha^{-1}, but was on par with 100 Kg K_2O ha^{-1}. The increased leaf area for higher levels of potassium may be due to the significantly higher rate of leaf production at higher levels of potassium as seen in Table 13. This is in conformity with the findings of Purewal and Dargan (1957b) and Abit and Alferez (1979). This can be further explained by the increased uptake of N with K application (Table 27).

Time of application was also found to be effective in increasing the leaf area index. Application of nitrogen and potassium in three splits was significantly superior to two splits. The higher leaf area index observed for three split applications may probably be due to better utilisation of nitrogen and potassium for leaf area development. Taro is usually grown under moist conditions and the crop has a shallow root system (Onwueme, 1984). As such there is possibility of a part of the applied N and K being leached beyond the root zone when applied in lesser number of splits whereas three split applications of N and K may facilitate better availability of these nutrients for growth and development of taro.

5.2.2. Yield components and Yield

5.2.2.1. Cormel yield plant^{-1}

The data presented in Table 15 reveal the influence of nitrogen, potassium and time of application on the cormel yield plant^{-1}.

Cormel yield plant^{-1} increased significantly upto 80 Kg nitrogen and 100 kg K_2O ha^{-1}. Three split applications of nitrogen and potassium were significantly superior to two split applications. Levels of phosphorus were not significant.

Pooled analysis showed the consistency of treatments over periods (Appendix IV). No interaction was observed between major treatments and year.

Increased cormel yield plant^{-1} for nitrogen, potassium and time of application can be substantiated by the increased LAI for these treatments as shown in Table 14. Moreover a highly significant correlation was also recorded between LAI and yield (Table 32). This is in agreement with the findings of Reddy et al. (1968) that a high correlation was found between leaf area and cormel yield in taro.

5.2.2.2. Number of cormels plant^{-1}

Nitrogen had significant effect on the number of cormels plant^{-1} (Table 15, Fig. 8). Significantly higher number was produced for the application of nitrogen at 80 Kg ha^{-1}. The trend remained the same for both years. The highest level of nitrogen i.e. 120 Kg ha^{-1} was on par with 80 Kg N ha^{-1}. Crops such as tubers which are grown for carbohydrates show a higher rate of photosynthesis consequent on increased leaf area obtained by nitrogen application (Russell, 1973). Such increase in leaf area has been observed in the present study also for the application of nitrogen and maximum leaf area was recorded for the application of nitrogen at 80 Kg ha^{-1} over 120 Kg ha^{-1} in most stages of growth (Table 14). This has been further explained by the leaf dry matter (Table 18) wherein higher leaf dry matter production was observed for the application of nitrogen at 80 Kg ha^{-1} over 120 Kg ha^{-1} though they were on par in all the stages of growth during both years. Similar results were reported by Enyi (1973) in Colocasia, Tobata and Takase (1968) in potato, and by Shanmughavelu et al. (1973) in sweet potato.

The effect of phosphorus application on cormel number plant^{-1} was inconsistent (Table 15). In the first year the effect was not significant. The lack of response for the applied phosphorus during the first year may probably be due to the higher initial status of this element in the soil (Table 32), and also for the low phosphorus requirement of the crop (Table 29). Similar result of lack of response for phosphorus application has been reported by Sivan (1984) in Fiji.

Application of graded levels of potassium had no significant effect on the number of cormels plant^{-1} during both years. This may probably be due to the fact that potassium is not a constituent in the cell and its main physiological role is to help in the translocation of carbohydrates from the leaves and as such it may not have much effect on the number of cormels plant^{-1}. Similar results were obtained by Pillai (1967) in *Colocasia* and Asokan and Sreedharan (1977) in cassava. Number of cormels plant^{-1} was not affected by the time of application of N and K also. Since the cormels are developed from lateral buds present on the corm, their development is presumably influenced by apical dominance exercised by the apical bud of the corm and as such time of application of nitrogen and potassium may not have much influence on the production of cormels plant^{-1}.

5.2.2.3. Mean weight of cormel (g)/Size

The data on mean cormel size (Table 15, Fig. 8) revealed that nitrogen influenced the mean cormel size significantly during 1984-'85. By increasing the level of nitrogen from 40 Kg ha^{-1} to 120 Kg ha^{-1}, there was increase in the size of cormel. Application of 80 Kg nitrogen ha^{-1} gave significantly higher size of cormel over 40 Kg N ha^{-1}, but was on par with 120 Kg N ha^{-1}. Mean cormel size is considered as one of the important yield determinants in taro. As already discussed nitrogen exerts beneficial influence on the photosynthetic activity of leaves. This increased photosynthetic activity influenced by nitrogen might have resulted in the synthesis of more assimilates which in turn would have deposited in the cormels thereby resulting in an increase in the size of cormels. The difference in cormel size occurs mainly due to the dif. difference in cormel bulking rate. An examination of the data in Table 24 reveals the influence of nitrogen nutrition on cormel bulking. It is evident from the data that bulking rates were highest at 80 Kg N ha^{-1} and tended to decrease at 120 Kg N ha^{-1}. The lack of response on the size of cormel at 120 Kg N ha^{-1} has been further explained with the response of nitrogen on leaf area index at 120 Kg N ha^{-1} (Table 14). It has also been reported that when nitrogen supplies are more and conditions are favourable for growth, proteins are formed from manufactured carbohydrates and less carbohydrates are stored in the storage organs (Tisdale and Nelson 1975). This may probably be one of the reasons for lack of response at 120 Kg nitrogen ha^{-1} for the size of cormel. Significantly higher content of protein in cormels at 120 Kg nitrogen ha^{-1} has been reported in this study also (Table 17). It has been reported by de la Pena and Plucknett (1972) that nitrogen fertilisation increased corm weight of both upland and lowland taro. Similar results were also obtained by Sivan *et al.* (1972) in Fiji, wherein the ill effects of closer spacing on reduced cormel size was nullified by the application of nitrogen. Chandra (1979) in Fiji reported that in the absence of nitrogen most of the cormels were smaller in size and of low economic value. However, with nitrogen, most of the cormels were in the preferred market range and only 10% of the cormels were less than the preferred market range in taro.

Levels of phosphorus did not show any significant effect on the size of cormel. This can be explained from the data on number of leaves plant^{-1} and LAI (Table 13 and 14 respectively) which showed that none of these characters was influenced by the level of phosphorus application.

The maximum cormel size was observed at the highest level of potassium application. Cormel bulking is essential for the increase in mean cormel weight. It may be noted that cormel bulking occurs as a result of the accumulation of assimilates synthesised in the leaves of the plants. Potassium has been identified as being necessary for rapid translocation of nutrients especially at the later stages of tuberisation and cormel bulking. Cormel bulking rate showed that the rate of bulking increased as the level of potassium increased from 50 Kg K_2O ha^{-1} to 150 Kg K_2O ha^{-1} (Table 24). Several earlier workers have reported increase in size of tuber to potassium nutrition in tuber crops. [Plucknett et al. (1970) and Asokan and Nair (1984) in taro, Enyi (1973) in lesser yam, Nair (1982) in cassava and Grewal and Trehan (1984) in potato].

Time of application of nitrogen and potassium exerted significant influence on size of cormels. Cormel size was maximum in treatment with three split applications. The beneficial influence of three split applications could very well be seen on the total uptake of nutrients by tuber and plant (Table 29) wherein the highest uptake of nitrogen and potassium was observed in three split applications of N and K. Therefore it is quite natural that growth was better and the mean cormel weight higher in this treatment.

5.2.2.4. Cormel yield

The data on cormel yield presented in Table 16 (Fig.9 & Appendix IV) reveal the significant influence of all the treatments excepting phosphorus on the cormel yield during both the years.

It is seen that cormel yield increased significantly by nitrogen application. The highest cormel yield was observed by the application of 80 Kg N ha^{-1} which was on par with 120 Kg N ha^{-1}.

Nitrogen is a constituent of chlorophyll and plays a vital role in the photosynthesis of plants. The yield of taro depends more upon the extent of assimilation and assimilate accumulation in the cormels. Assimilation in turn depends upon the extent of the assimilating surface. The influence of nitrogen in increasing the assimilating surface of the plant is well known. Increase in leaf area upto 80 Kg N ha^{-1} was observed in this study also (Table 14). This aspect is further substantiated by the favourable influence of nitrogen on crop growth rate, cormel bulking rate, etc. These physiological attributes registered an increase due to nitrogen nutrition upto 80 Kg N ha^{-1} (Table 23 and 24).

The two important yield components of taro viz., cormel number and cormel size were seen increased by nitrogen application (Table 15). This result is in agreement with the findings of several other workers like Enyi (1973), de la Pena and Plucknett (1972) and Sivan *et al.* (1972) in *Colocasia.*

The uptake studies conducted further substantiate the role of nitrogen in tuber production (Cormel + Corm). It is seen that nitrogen uptake was more or less in proportion to tuber production. This was further explained by the correlation studies (Table 34) which revealed a significant positive association between cormel production and uptake of nitrogen.

All these factors either individually or in combination might have contributed substantially to the higher cormel yield observed at 80 Kg level of nitrogen ha^{-1}. Many workers have reported yield increase in taro by nitrogen application.

[Purewal and Dargan (1957b) Mathur et al. (1966b) de la Pena and Pluckrett (1967), Hussain and Rashid (1982) and Moles et al. (1984)].

A decrease in cormel yield was observed by the application of N beyond 80 kg N ha^{-1}. It may be noted that the vegetative characters like plant height was increased at the highest level of nitrogen. The excessive vegetative growth produced by nitrogen dressings beyond a certain level might have caused a reduction in cormel yield. As nitrogen supply increases and conditions are favourable for growth, proteins are formed from the manufactured carbohydrates (Tisdale and Nelson, 1975). As a result of the diminished rate of translocation of carbohydrates to roots the growth and development of the underground parts are badly affected. Samuels (1967) and Black (1973) have reported that high rates of nitrogen application result in luxuriant vegetative growth at the expense of root and tuber growth.

Graded levels of phosphorus did not show any significant effect on the yield of cormels. The lack of response for the applied phosphorus may probably be due to the fact that most of the growth attributes like plant height (Table 12) number of leaves $plant^{-1}$ (Table 13), LAI (Table 14) as well as the yield components like cormel yield plant^{-1} were not affected by the application of phosphorus. It can further be explained by the fact that crop growth rate, harvest index (Table 23) rate of tuber bulking (Table 24), uptake of nitrogen by plant (Table 25) etc. were also not modified by the application of varying levels of phosphorus. The growth attributes, uptake of nutrients and other physiological traits like crop growth rate, rate of cormel bulking, harvest index etc. are responsible for higher yield in crop plants. As all these factors did not get altered significantly by the application of graded doses of phosphorus, significant yield differences could not be achieved. Further, the lack of response for the applied phosphorus may be due to the application of farm yard manure @ 12 tonnes ha^{-1} as basal. It was also reported that the requirement of phosphorus for most crop plants is very low and only about 15-20% of the applied phosphorus will be utilized by the crop and the rest will remain in the soil, and will be slowly made available to the subsequent crops. The P status of the soil in the present study was medium in nature. It is also reported that many crop plants attain maximum growth even at very low concentration of less than 0.1 ppm of phosphate (Arnon 1953). Lack of response to the application of phosphorus by tuber crops has been reported by several workers like

Ferguson and Haynes (1970) in yams, Berwick *et al* (1972), Lucas *et al.* (1973) Chandra (1979) and Moles *et al.* (1984) in taro.

By the application of incremental doses of potassium cormel yield increased upto 150 Kg K_2O ha^{-1}, but was significant only upto the level of 100 Kg K_2O ha^{-1}. Potassium has been identified as being essential for the photosynthetic activity of plants. The increase in leaf area index (Table 14) observed in the present study by potassium is worth mentioning in this context. This might have led to a more efficient photosynthetic activity of plants resulting in the production of more assimilates. The data on crop growth rate at tuber bulking stage (Table 23) and rate of cormel bulking (Table 24) also revealed the beneficial influence of potassium nutrition on these physiological attributes. The data given in Table 22 revealed progressive increase in tuber dry matter by incremental doses of potassium which was maximum at 150 Kg K_2O ha^{-1}. Potassium is known to be essential for the synthesis and translocation of carbohydrates which is considered as one of the most important physiological activities of root crops. This is further confirmed by the high values of cormel bulking rates attained at 150 Kg K_2O ha^{-1} (Table 24).

Potassium application enhanced the plant uptake of potassium (Table 27) and total uptake of potassium by plant vegetative parts and tuber (Table 30). It can be seen that there was a progressive increase in the uptake of potassium upto 150 Kg K_2O ha^{-1} which might have favourably influenced the growth and development of taro. The influence of potassium uptake on cormel yield can be further explained by the positive correlation obtained between these two characters (Table 34).

Thus it is seen that the combined effects of all the above factors discussed might have favourably influenced the increased cormel production at higher levels of potassium nutrition. The beneficial effects of potassium nutrition in enhancing the cormel yield in taro was reported by several workers like Purewal and Dargan (1957b), de la Pena and Plucknett (1967) and Asokan and Nair (1984).

Three split application of nitrogen and potassium has recorded significantly higher cormel yield over two split application during both the years. Significant influence of three split application of nitrogen and potassium to taro yield may be due to the fact that the crop is shallow rooted such that the applied fertilisers can easily be leached beyond the rooting zone, especially when they are grown in situations of high moisture supply. It is expedient therefore that fertilisers should be applied in split doses. The high crop growth rate at the cormel bulking stage for three split application

(Table 23) shows the enhanced rate of physiological activity of the plants by the application of nutrients in three splits (Table 15). Total uptake of nitrogen and potassium by plant and tuber (Table 28) and total dry matter production by plant and tuber (Table 22) were improved substantially by the application of nitrogen and potassium in three splits. All these might have contributed to the higher yields in this treatments. Similar results of three split application of potassium have been reported by Rao (1972) in sweet potato and Nair (1982) in cassava.

From the above discussion it could be suggested that under the agroclimatic conditions prevailing in Vellayani, a fertilizer dose of 80 Kg nitrogen and 100 Kg K_2O with a minimum dose of P_2O_5 viz., 25 Kg P_2O_5 ha^{-1} would be a suitable fertilizer dose for taro.

5.2.2.5. Corm yield

The data on the effect of treatment on corm yield are presented in Table 16. It could be seen from the Table that nitrogen exerted a beneficial effect on corm yield during both the years upto 80 Kg N ha^{-1}. Levels of P had significant effect on corm yield during 1984 and in the second year (1984-85) levels of P had no significant effect on corm yield.

Application of K was not significant in the first year (1984) and during second year (1984-'85) levels of K had significant effect on corm yield. Time of application of N and K was significant only during the second year and three splits was superior to two split application.

The increased trend in corm yield for the increased doses of nitrogen at 80 Kg ha^{-1} and K at 100 Kg K_2O ha^{-1} could be explained by the significant increase in LAI (Table 14). Very strong positive correlation between LAI and yield in taro has been reported by Ezumah and Plucknett (1973) and Abit and Alferez (1979). The uptake of P by tuber (Table 29) revealed that the requirement of P for tuber production is very low as compared to N and K (Table 28 and 30). The lack of response to P on corm yield has been reported by Chandra (1979) and Moles *et al.* (1984) in taro.

Time of application was significant only during the second year and three split application was significantly superior to two splits. This may probably be due to the better availability of N and K to the crop which is grown in situations of high moisture supply such that part of the applied nitrogen and potassium might have easily been leached beyond the rooting zone when applied in less number of splits.

5.2.2.6. Total yield

The data on total yield (Corm + Cormel) revealed that nitrogen and potassium had exerted a beneficial effect on this trait (Table 16). Application of 80 Kg N ha^{-1} and 100 Kg K_2O ha^{-1} was significantly superior to 40 Kg N ha^{-1} and 50 Kg K_2O ha^{-1} but was on par with 120 Kg N and 150 Kg K_2O ha^{-1}. Effect of phosphorus was significant only during the first year i.e. upto 50 Kg P_2O_5 ha^{-1}. During second year P did not show any significant effect. Time of application was significant and three split application of N and K was significantly superior to two splits.

The increased yield of nitrogen and potassium at 80 Kg N ha^{-1} and 100 Kg K_2O ha^{-1} could be explained by the significant increase in leaf area index at these levels of N and K application (Table 14). Very strong positive correlation between leaf area index and yield in taro obtained in the present investigation (Table 33), is in conformity with the findings of Purewal and Dargan (1957b) Ezumah and Plucknett (1973) and by Abit and Alferez (1979) in <u>Colocasia</u>. Uptake studies conducted further substantiate the role of nitrogen and potassium for tuber yield. The data presented in Table 28 and 30 revealed that the uptake of nitrogen and potassium was more or less in proportion to the tuber production. This was further confirmed by correlation studies (Table 34), which showed a significant positive correlation between tuber yield and uptake of nitrogen and potassium. Similar results of increased tuber yield for the application of N and K in taro have been reported by Plucknett *et al.* (1970), Premraj *et al.* (1980) and by Moles *et al.* (1984).

The response of taro to levels of phosphorus application was significant during the first year. The response of taro to phosphorus application has been reported by Pillai (1967) and Mohandas and Sethumadavan (1980). During the second year there was no response for the levels of P application. This could be further explained by the lack of response for the application of P on the size of cormel (Table 15), crop growth rate (Table 23) and rate of bulking (Table 24). Similar results of lack of response for P have been reported by Vanderzaag *et al.* (1980) in yams and Moles *et al.* (1984) in taro.

Total tuber yield increased with increase in the level of potassium from 50 Kg K_2O ha^{-1} to 150 Kg K_2O ha^{-1}. During 1984 though the tuber yield increased with increase in levels of potassium, the highest level of 150 Kg K_2O ha^{-1} was on par with 100 Kg K_2O ha^{-1}. During 1984-'85 the tuber yield increased significantly with increase in the level of potassium from 50 to 150 Kg K_2O ha^{-1}. The higher tuber yield for the higher level of potassium application may probably be due to the production of higher LAI (Table 14). Significant positive correlation with LAI and tuber yield was also observed. Similar results of higher tuber yield for increased levels of potassium application in taro have been reported by Purewal and Dargan (1957b) Pillai (1967) and by Plucknett et al. (1970).

Application of N and K in three split recorded significantly higher tuber yield over two split application (Table 16). The higher yield for three split application may probably be due to the higher LAI recorded during most stages of growth in both the years (Table 14) and significantly higher size of cormel production (Table 16) occurred as a result of better utilisation of N and K for tuber production at three splits. Similar results of higher yield in three split application have been reported by Kuo (1972) in sweet potato and Nair (1982) in cassava.

5.2.2.7. Cormel to corm ratio

The cormel to corm ratio was not significantly influenced by NPK nutrition. Maximum cormel to corm ratio of 3.43 was obtained at 120 Kg nitrogen ha^{-1}. The effect of phosphorus and potassium was not significant. This may probably be due to the fact that when cormel yield was increased there was a corresponding increase in the corm yield, thus maintaining a constant cormel to corm ratio. Similar results were reported by Mohandas and Sethumadhavan (1980) in <u>Colocasia</u>.

5.2.3. Quality Aspects

5.2.3.1. } Dry matter percentage in cormel and corm
5.2.3.2. }

The results (Table 17) revealed that higher percentage of dry matter was observed at lower levels of nitrogen and phosphorus. But the reverse holds good in the case of potassium, wherein increase in the level of potassium showed significant increase in the percentage of dry matter. Three split application of N and K was significantly superior to two split application.

The probable explanation for low percentage of dry matter under higher levels of nitrogen application may be that in plants where the nitrogen supply and other factors are favourable for growth, the tendency is for the utilisation of carbohydrates to form more protoplasm and more cells, rather than for deposition of carbohydrates to thicken the cell wall. Cells produced under such conditions tend to be large and have thin walls. Because protoplasm is mostly water, high nitrogen promotes growth resulting in a relatively high proportion of water and lower proportion of dry matter. [Black (1973)]. Similar results were also obtained by Enyi (1973) in lesser yam, wherein nitrogen application encouraged greater total dry matter production, but reduced the content in tuber. Mandal *et al.* (1982) observed the highest dry matter production in taro at the lowest level of nitrogen viz., 40 Kg ha^{-1}.

The lack of response for the higher levels of phosphorus in dry matter production may probably be due to the fact that the phosphorus requirement of the crop may be low. This can be explained from the data which show that there was no significant difference for the application of graded levels of phosphorus for LAI, yield attributes and yield in most stages of growth during both the years. (Tables 14, 15, [illegible], and 16). This clearly shows that the lowest level of phosphorus applied is sufficient for growth and yield and as such the higher doses do not show any significant effect over the lower doses in the content of dry matter in tuber. Further, the lack of response for the applied fertiliser may be due to the application of farm yard manure @ 12 tonnes ha^{-1} as basal dressing. Several workers have reported lack of response of tuber crops to fertilizer phosphate. [Samuels (1967) in sweet potato, Lyonga *et al.* (1973) in yams, Villanueva and Abenoja (1984), Pardales and Villanueva (1984) in taro]. This can be further substantiated by the low level of uptake by plant and tuber as shown in Table 29 (Fig.12).

The significantly higher dry matter content of tubers for graded doses of potassium (Table 17) may probably be due to the fact that potassium is essential for the action of enzymes that catalyse certain reactions in both carbohydrate and nitrogen metabolism. Potassium acts as a corrective to the harmful effects of nitrogen (Russell, 1973). Tuber crops are relatively sensitive to potassium deficiency. Yield and dry matter content of tubers continue to increase with potassium assimilates (Black, 1973). Similar results were reported by Fujise and Tsuno (1967) in sweet potato, Enyi (1973) in yam and by Premraj *et al.* (1980) in taro. Three split application of nitrogen and potassium was significantly superior to two split application. The probable reason for the high content of dry matter for three split application of N and K was the significantly higher uptake of nitrogen and potassium for this treatment (Table 28 and 30), which in turn might have contributed for higher content of dry matter in cormels and corm. Higher dry matter content for higher uptake of potassium has been reported by Fujise and Tsuno (1967) in sweet potato.

5.2.3.3. } Starch percentage in cormel and corm
5.2.3.4. }

Application of nitrogen and phosphorus did not show any significant effect on the percentage of starch in tuber

(Cormel + Corm). Though there was significant increase in yield for the application of graded doses of nitrogen (Table 16), it had no role in increasing the percentage of starch in tuber. On the other hand, the rate of nitrogen reduced the starch content of tubers and maximum percentage of starch was obtained in plants supplied with lowest dose of nitrogen (Table 17). Similar results were reported by Anderson (1936) and Morgan (1939) who observed that starch content did not show any significant difference due to nitrogen or phosphorus in sweet potato. Reduction in starch content at higher levels of nitrogen application was reported by workers like Singh _et al._ (1973) in yams, Reddy and Rao (1968) in potato and Mohandas and Sethumadhavan (1980) in _Colocasia_.

The lack of response for fertilizer phosphorus on starch percentage in tuber may probably be due to the fact that the lowest level applied was quite sufficient to carry out the vital functions of phosphorus in taro. Lack of response to phosphorus by root crops has been reported by several workers like Samuels (1967) in sweet potato, Sivan (1984) in taro and Lyonga (1979) in cocoyam. The lack of response for the levels of applied phosphorus to the content of starch in tuber samples obtained in this study is in tune with the findings of Anderson (1936) and Morgan (1939), Samuels (1967) in sweet potato and by Pillai (1967) in _Colocasia_.

The starch content of tuber increased significantly due to potassium nutrition and the maximum values were obtained at 150 Kg K_2O ha^{-1}. The beneficial effect of potassium on this quality trait can be attributed to the well known role of K in carbohydrate synthesis and translocation. CIAT (1979) reported linear increase in starch yield with increasing amounts of applied potassium upto 200 Kg K_2O ha^{-1}. The observation in the present investigation is in conformity with the findings of Pillai (1967), Mohandas and Sethumadhavan (1980), Premraj *et al.* (1980) in taro, that application of potassium had significant influence on the starch content of tubers in *Colocasia*.

Time of application had a significant influence on the content of starch in tubers and three split application recorded the maximum content of starch in cormels and corm. In this treatment the top dressing given in the third month after planting might have been utilised mainly for the synthesis and translocation of starch. The beneficial effect of late application of nitrogen has been reported by Champbell and Gooding (1962) and Chapman (1965) who observed that nitrogen applied three months after planting gave a greater increase in dry matter production and yield than that applied at planting in *D. alata*.

5.2.3.5. Crude protein

The results reveal significant influence of nitrogen on this quality attribute. Protein content increased significantly by nitrogen nutrition upto the highest level of 120 Kg N ha^{-1}. The favourable effects of nitrogen nutrition on protein synthesis in relation to carbohydrate accumulation has already been discussed. The possibility of enhanced conversion of carbohydrates to protein in the presence of adequate nitrogen is explained by Russell (1973). Increase in crude protein content of tubers of several tuber crops by the application of nitrogen was reported by Nadpuri and Singh (1966) in potato, Collins and Walter (1982) in sweet potato, Pluckrett et al. (1970) in taro, Singh et al. (1973) in yams, and by Mohandas and Sethumadhavan (1980) Premraj et al. (1980) and Mandal et al. (1982) in taro.

The influence of potassium on this quality trait was just the reverse of that of nitrogen. Application of higher levels of potassium in increasing the dry matter content and at the same time reducing the content of protein in potato was reported by Herlihy and Carroll (1969).

5.2.3.6. Oxalate content in cormel

Oxalate content in cormel (Table 17) revealed that the application of nitrogen and phosphorus did not make any significant effect on the oxalate content in cormel. Coursey (1960) reported that the irritant taste of Colocasia is due to the present of calcium oxalate crystals (raphides). Osisigu *et al.* (1974) have found that the irritation was mainly due to some volatile, water soluble principles, because when the cocoyam was cooked or volatalised, the capacity to irritate was lost.

In the present study significant reduction in the content of oxalate was observed for the levels of potassium application. Similar trend was observed by Asokan and Nair (1984).

5.2.4. Growth Analysis

5.2.4.1. Dry matter production and distribution

5.2.4.1.1. to 5.2.4.1.6. Leaf, pseudostem, Root and plant dry matter production

Leaf, pseudostem (leaf petiole) and root dry matter contents increased significantly with incremental doses of nitrogen (Table 18,19,20). In this respect application of 80 Kg N ha^{-1} was on par with 120 Kg N ha^{-1} at 120th day. In taro this stage coincides with the stage of maximum vegetative growth. Leaves, pseudostem and root dry matter production and total activity of the plant were maximum at this stage. Leaves are the important organs of photosynthesis and as such the high rate of leaf dry matter observed at 80 Kg N ha^{-1} might have produced more assimilates which in turn might have led to maximum tuber yield (Table 16). The higher rate of nitrogen uptake observed during this period at 80 Kg N ha^{-1} was on par with 120 Kg N ha^{-1} (Table 25), which might have created congenial conditions for higher tuber dry matter production (Table 22) as evidenced from the high rates of cormel bulking observed in this treatment (Table 24). The result is in agreement with the findings of Enyi (1973) and Chandra (1979) that the application of nitrogen increased the cormel number and mean bulking rate in taro.

The decrease in tuber dry matter observed at 120 Kg N ha^{-1} can be attributed to the high rates of protein synthesis occurring at the highest level as already discussed. Such reduction in tuber dry matter at the highest level of nitrogen is in agreement with the findings of Obigbesan and Agboola (1978) and Black (1973).

Levels of phosphorus did not show any significant effect on the leaf, pseudostem and root dry matter production in taro.

It is evident from growth observations (Table 12, 13 and 14) that none of the growth characters like plant height, number of leaves produced and LAI was affected by levels of P application in most stages of growth during both the years. This has been further explained by the lack of response of phosphorus to yield components and yield (Table 15 and 16). The lack of response to phosphorus in taro in the present study is in line with the findings of Lucas *et al.* (1973) Chandra (1979) and Moles *et al.* (1984).

Potassium increased the leaf, stem and root dry matter only upto 100 Kg K_2O ha^{-1} but was not significant. Though the leaf dry matter production was not significant statistically, significant increase in LAI was observed for the levels of potassium application (Table 14). Reddy and Rao (1968) obtained a strong correlation between LAI and yield in potato. Karikari (1979) observed a very high linear correlation between leaf area and cormel production in *Xanthosoma*. In the present study also there was a strong significant positive correlation between LAI and cormel yield (Table 33), cormel yield and potassium uptake (Table 34).

Though the leaf dry matter yield was not statistically significant (Table 18) in most stages, the yield components and yield of cormels were significant for the levels of potassium application (Table 15 and 16). This suggests that potassium contributes to the higher photosynthetic activity of leaves. Similar results were also reported by Fujise and Tsuno (1967) in sweet potato, were they observed that LAI was somewhat low as compared to control plot in high potassium plot, the net assimilation rate in the high potassium plot was about 20-30% higher than that of the control plot.

The effect of time of application was not significant in the dry matter production of leaf, pseudostem and root. The corm development in taro commences early and the leaf and corm development synchronises upto maximum canopy development (120th day). So the latter application of nitrogen and potassium will be utilised mostly for productive purpose rather than for vegetative growth. This might be the probable reason for the non significant effect for the application of nitrogen and potassium for leaf, stem and root dry matter production. The third month application of N and K might be utilised mostly for tuber development and yield (Table 15 and 17). Similar results of beneficial effects for the split application of nitrogen and potassium for yield have been reported by Rao (1972) in sweet potato and Nair (1982) in cassava.

5.2.4.1.5. Total dry matter production by plant and tuber (Cormel and Corm)

Levels of nitrogen, potassium and time of application were significant in the total production of plant dry matter (Table 22, Fig 10). This can be explained by the significant responce of taro to levels of nitrogen, potassium and time of application on growth components like plant height, number of leaves, and LAI (Table 12, 13, 14) and significant positive response to yield components and yield (Table 15 and 16). Similar results of significant response to nitrogen, potassium and time of application on total dry matter production including tuber have been reported by Purewal and Dargan (1957b), Enyi (1973), de la Pena and Plucknett (1972) in *Colocasia*.

The lack of response for phosphorus in total dry matter production can be explained by the non significant effect of levels of phosphorus to growth characters, yield components and yield (Table 12, 13, 14, 15 & 16 and Fig. 7, 8 and 9). The lack of response for the application of phosphorus has been reported by Lucas *et al*. (1973), Chandra (1979) in taro and Vanderzaag *et al*. (1980) in yams.

5.2.4.1.6. Crop growth rate (CGR)

It is seen that levels of nitrogen exerted significant influence on crop growth rate. The highest values were observed at 80 Kg N ha^{-1} but at 120 Kg N ha^{-1} there was a slight reduction in CGR though they were on par.(Table 23). The favourable influence of nitrogen application upto a certain level might be due to an increase in the net photosynthetic rate which leads to an increase in all the physiological parameters studied.

Levels of phosphorus did not show any significant effect on this trait. This might be due to the fact that the lower levels of phosphorus applied would be sufficient to carry out the physiological functions of plant.

In the case of potassium, the highest level gave the maximum values of CGR especially in the later stages of Cormel development. Time of application had a significant effect on this character during both the years at the cormel development and bulking stages. Potassium also exercised a favourable effect in increasing the photosynthetic activity of plants as explained earlier. Moreover, it exerted an indirect effect on these characters by increasing the nitrogen availability of plants as is seen in the data on uptake of nutrients (Table 28 and 30, Fig. 11).

5.2.4.1.7. Harvest index

The effect of nitrogen on the harvest index was significant (Table 23). An application of 80 Kg N ha^{-1} produced the highest harvest index in the first year and 120 Kg N ha^{-1} in the second year. Yield increases were observed for nitrogen nutrition upto 80 Kg N ha^{-1} during both the years (Table 16). The low values of harvest index observed at 40 Kg N ha^{-1} were due to the low cormel yield obtained at this level.

Application of potassium enhanced the harvest index from 50 Kg K_2O ha^{-1} to 150 Kg K_2O ha^{-1}, but this was not significant. The lack of response may be due to the fact that the increase in cormel yield by the application of potassium was accompanied by a corresponding increase in the total biological yield. Three split application of N and K showed the highest harvest index which was on par with two splits. The data on cormel yield for three split application showed the highest value which was significantly superior to two splits during both the years (Table 16). At the same time, the influence of time of application on plant dry matter production (vegetative parts only) was not significant (Table 21) and the maximum values were secured at three splits. It is evident that application of nutrients N and K in three splits has benefitted the crop in increasing the cormel yield rather than the vegetative growth.

5.2.4.1.8. Cormel bulking rate

The results in Table 24 reveal the significant influence of nitrogen nutrition on cormel bulking rate upto 120 Kg N ha^{-1} during the various growth stages. The leaf area was the highest in most of the growth stages at this level, which might have resulted in the production of more assimilates as discussed earlier. The highest values of the physiological parameters such as harvest index and CGR observed conclusively prove the high rate of photosynthetic activity occurring at this level. The assimilates produced at higher rates at 80 Kg N ha^{-1} might have resulted in the high rate of cormel bulking observed in the present study.

The fact that phosphorus could not make any significant effect on cormel bulking rate clearly indicate that the lowest level of phosphorus is sufficient for taro. Unlike phosphorus, levels of potassium had significant effect on the rate of bulking of cormel. The beneficial effects of potassium in the synthesis and translocation of starch could be attributed to as explained earlier. It was already seen that potassium at higher rates was mostly used for cormel growth and development.

Cormel bulking rates were the highest at three split application of nitrogen and potassium. The better absorption and utilisation of nutrients in this treatment may be the reason for this high value. The cormel bulking rates were highest in the third and fourth months of observation. In taro this phase denotes the period of active tuber development and hence the peak values.

5.2.5. Nutrient uptake

5.2.5.1. Uptake of nitrogen by vegetative/noneconomic portion of the plant (leaf, pseudostem and root)

It is seen from Table 25 that there was significant increase in the uptake of nitrogen from 40 Kg N ha^{-1} to 80 Kg N ha^{-1}. At 120 Kg N ha^{-1} though there was an increase in the uptake of nitrogen it was on par with 80 Kg N ha^{-1}. The increased uptake of N from 40 Kg to 120 Kg N ha^{-1} may probably be due to the fact that the plant dry matter production (Table 21) also followed a similar trend and during most stages the dry matter production at 120 Kg N ha^{-1} was slightly less than that observed at 80 Kg N ha^{-1}. It was further observed that the concentration of nutrients at the maximum growth stage (120th day after planting) showed an increasing trend in the concentration of nutrients in the leaf as the level of nitrogen increased from 40 to 120 Kg ha^{-1} (Appendix III). Both these factors jointly might have contributed for the significant increase in the uptake of nitrogen from 40 to 80 Kg N ha^{-1}.

5.2.5.2. Uptake of phosphorus by vegetative/non economic portion of the plant

The plant uptake of phosphorus increased significantly for the level of phosphorus application from 25 to 75 Kg ha^{-1} (Table 26) but the plant dry matter production was not increased significantly for the level of phosphorus application (Table 21). This may probably be due to the fact that the requirement of P for taro is less and the lowest dose of phosphorus was sufficient to produce enough dry matter and as such the higher levels of P failed to produced any significant effect on plant dry matter production. The significant increase in the plant uptake of P for the increased levels may probably be due to the higher leaf concentration for the higher levels of phosphorus application (Appendix III).

5.2.5.3. Uptake of potassium by vegetative/non economic portion of the plant

The uptake of potassium increased significantly from 50 to 150 Kg K_2O ha^{-1} at most stages of growth (Table 27) but the plant dry matter production was not increased significantly for the application of potassium from 50 Kg K_2O ha^{-1} to 150 Kg

K_2O ha^{-1}. The increased uptake of potassium in the present study for the higher levels of K may probably be due to the higher leaf concentration of this element in the leaf (Appendix XII). This is in agreement with the findings of Obigbesan and Agboola (1978) that the uptake of mineral from farm land through crop harvest depends on yield of dry matter and concentration of the element in that dry matter.

5.2.5.4.(a) Uptake of nitrogen by tuber (Cormel and Corm)

The uptake of nitrogen by tuber increased significantly from 40 to 120 Kg N ha^{-1} (Table 28). From 80 to 120 Kg N ha^{-1} the uptake was not significant at 120th day during 1984-'85. The data on cormel yield during both the years revealed that the yield was highest at 80 Kg N ha^{-1} thereby showing the efficient utilization of the absorbed nitrogen for cormel production at this level. Eventhough the uptake increased at 120 Kg N ha^{-1} the cormel yield decreased at this level clearly showing that an application of this nutrient in excess of 80 Kg N ha^{-1} leads to lack of response to additional dose. Nair (1982) recorded similar observation in cassava. Levels of P and K in the uptake of nitrogen by tuber were inconsistent. Time of application of N and K had significant effect on the uptake of nitrogen by tuber. This may probably be due to the fact that taro has a shallow root system and the crop is raised mostly in a moist situation such that part of the applied N and K may be leached beyond the root zone. Therefore the application of these nutrients in more splits may facilitate their better utilization for productive purposes (Table 16).

5.2.5.5. (a) Uptake of phosphorus by tuber (Cormel + Corm)

Levels of nitrogen from 40 to 90 Kg N ha^{-1} had significant influence on the uptake of phosphorus by tuber (Table 29). This phenomenon has been explained by the fact that when Ammonium sulphate is mixed with a water soluble phosphatic fertilizer there is great proliferation of roots and great increase in the uptake of phosphorus by plant (Tisdale and Nelson, 1975).

Increasing levels of phosphorus had a significant effect on the uptake of phosphorus by tuber (Table 29). This is in agreement with the findings of de la Pena and Plucknett (1967). Application of potassium at levels varying from 50 to 150 Kg K_2O ha^{-1} had a significant effect on the uptake of phosphorus by tuber. The probable reason for significant uptake of P by tuber on potassium application may be due to the fact that phosphorus is a component of protein and is absorbed rapidly during vegetative growth and translocated from the vegetative organs to the tubers.

5.2.5.6. (a) Uptake of potassium by tuber

The uptake of potassium by tuber at 120th and 150th day (at harvest) is presented in Table 30. Nitrogen had a significant effect on the uptake of potassium from 40 Kg to 120 Kg. N ha^{-1} during both the years. By increasing the level of phosphorus from 25 to 75 Kg ha^{-1} and potassium from 50 to 150 Kg K$_2$O ha^{-1} there was significant increase in the uptake of potassium by tuber. The uptake of potassium by tuber has resulted in an increase in the percentage of dry matter and starch in cormels and corm, and reduction in the content of oxalate in cormels (Table 17). Three split application of nitrogen and potassium had a significant effect on the uptake of potassium over two split application. This fractional application might have resulted in the better availability of nutrients thereby leading to efficient absorption by plant. Similar results of beneficial effects for three split applications have been reported by Kuo (1972) in sweet potato and by Nair (1982) in cassava.

5.2.5.4. (b) Total uptake of nitrogen by plant (vegetative/ non economic portion of the plant and tuber)

The total uptake of nitrogen by plant increased significantly from 40 Kg N to 120 Kg N ha^{-1} in most stages during both the years (Table 27, Fig. 11). The dry matter production increased significantly upto 80 Kg N ha^{-1} and at 120 Kg N ha^{-1} there was a slight reduction in dry matter though it was on par with 80 Kg N ha^{-1} (Table 22). The higher uptake of nitrogen for increasing the level of nitrogen may probably be due to the increased level of nitrogen content in plant parts especially in leaf for the increased level of N application (Appendix III).

Increasing the level of P from 25 to 75 Kg P_2O_5 ha^{-1} had no significant effect on the uptake of nitrogen by plant. This may be due to the low requirement of P for taro. The levels of potassium showed significant effect on the total uptake of nitrogen by plant during most cases. This can be explained by the higher requirement of K by taro. Three split application of nitrogen and potassium had a significant effect over two split in the total uptake of N by plant. This may be due to the better absorption of nitrogen by plant especially at the later stages of tuber development (Table 28).

5.2.5.5. (b) Total uptake of phosphorus by plant

Levels of nitrogen from 40 to 80 Kg N ha^{-1}, had significantly increased the total uptake of phosphorus by plant in most cases (Table 29. Fig. 12). This phenomena has been explained by the fact that when Ammonium sulphate is mixed with a water soluble phosphatic fertilizer there is great proliferation of roots and great increase in the uptake of phosphorus by plant (Tisdale and Nelson, 1975). Increasing the level of phosphorus from 25 to 75 Kg P_2O_5 ha^{-1} showed an increase in the total P uptake by plant. This is in agreement with the findings of de la Pena and Plucknett (1967) wherein the composition of P in the leaf, petiole and tuber in taro was directly related to the increasing rate of phosphorus fertilization.

Application of varying levels of potassium had significant effect on the total uptake of P by plant (Table 29). The probable reason for significant uptake of P on potassium application may be due to the fact that phosphorus is a component of protein and is absorbed rapidly during the growth period of the plant.

Time of application of nitrogen and potassium showed significant effects for the total uptake of phosphorus by plant (Table 29). In the total uptake larger portions of the nutrient P is absorbed during tuber development and tuber bulking stage. During this period the photosynthetic activity is more and the nitrogen and potassium applied might have contributed favourably for photosynthesis and translocation of assimilates to tuber.

The increased metabolic activities as a result of photosynthesis and translocation for which phosphorus also plays an important role in energy transformation, might have resulted in an increased uptake of phosphorus for three split application of N and K.

5.2.5.6. (b) Total uptake of potassium by plant

Nitrogen had a significant effect on the uptake of potassium at the levels of 40 and 80 Kg N ha^{-1} for both the years. By increasing the level of phosphorus from 25 to 75 Kg P_2O_5 ha^{-1} and potassium from 50 to 150 Kg K_2O ha^{-1}, there was significant increase in the uptake of potassium by plant and total uptake by tuber and plant (Table 30, Fig. 11). Increase in the percentage of N, P and K in plant parts of upland taro for increased levels of potassium fertilization have been reported by de La Pena and Plucknett (1967). This enhanced rate of uptake at higher levels of application was effectively utilised by the plant for tuber production as evidenced from the data on tuber yield (Table 16). Similar observations were made by Premraj et al. (1980) in taro, and by Nair (1982) in cassava.

The data on the uptake of nitrogen and potassium at tuber development and tuber bulking stage had significant effect for three split application over two split application.

This fractional application might have resulted in the better availability of nutrients, thereby leading to efficient absorption by plant. This can be further explained by the fact that taro has a shallow root system and the crop is grown under moist situations so that the applied fertilizers can easily be leached beyond the rooting zone for basal application and this can be avoided by splitting the dose of N and K three times. Similar results of beneficial effects for three split application have been reported by Nair (1982) in cassava and by Kuo (1972) in sweet potato. The present study is in conformity with the above findings wherein three split application of N and K is significantly superior to two split application as evidenced by the significantly higher cormel yield for three split application (Table 16).

5.2.6. Available nutrients in the soil as effected by treatments

5.2.6.1. Available soil nitrogen

It is evident from the initial and final soil analysis (Table 32) that available nitrogen was considerably less at the time of harvest during both years. This may probably be due to the depletion caused by crop removal and other types of losses of nitrogen. However, it significantly increased with increase in the levels of nitrogen. The available nitrogen content was generally lower in the second year than in the first year. This lower level of N at harvest time indicated that there was considerable loss of mineralised nitrogen from the plots where alternate wetting and drying existed. Further there were more spells of rains in the second year which might have favoured more losses of nitrogen from the soil in different forms. Similar results in an upland rice soil were reported by Soundararajan and Mahapatra (1980).

The available phosphorus and potassium status of the soil were not found to be affected by different levels of nitrogen application.

5.2.6.2. Available phosphorus

With increasing levels of phosphorus application, the available P in the soil also increased (Table 32). A build up of phosphorus in the soil was observed at the end of the second year which may be due to the high phosphorus fixation taking place in this type of soil and also due to the low P utilization by this crop. The residual effect of applied P persisted even after the harvest of two crops. Similar results were reported by Prasad *et al.* (1985).

Increasing doses of P application did not much influences the available nitrogen and available potassium contents of the soil.

5.2.6.3. Available potassium

It was observed from the present study that higher application of potassium caused significantly higher availability of potassium in the soil in both years (Table 32). This might be due to increase in solution K and exchangeable K in the soil. Moreover, higher levels of K might have left behind larger amounts of potassium after satisfying the crop removal over and above those fixed in the soil. A similar trend in the availability of potassium was reported by Loganathan and Raj (1973).

The available nitrogen and phosphorus status of the soil were found to be not affected by different levels of potassium application.

5.2.6.4. Soil pH

In general the pH of soil tended to decline in the second year as compared to the first year (Table 32). Both phosphorus and potassium application slightly improved the pH whereas it showed a declining trend in the second year with increasing levels of nitrogen application. This may probably be due to the acid producing nature of nitrogenous fertilizers (Buckman and Brady, 1967).

5.2.7. Critical level of nutrients

The fitted functions for nitrogen, phosphorus and potassium between their concentration in leaf and cormel yield and the worked out critical levels for optimum yield (Table 31) showed that in the case of nitrogen and phosphorus, the critical limits were in between the concentration ranges observed in the various treatments. Eventhough the concentration of nitrogen and phosphorus in the leaf linearly increased with increasing levels of their application (Appendix. XXI) the critical levels for optimum yield were much below the peak concentration observed in the leaf. Hence inorder to realise optimum yield the range of critical values for nitrogen was 2.07 to 3.93 and that for phosphorus was 0.32 to 0.35. However in the case of potassium the critical values did not reach the observed concentrations.

Thus for obtaining optimum yields of Colocasia under the tested conditions the critical level of nutrients in the leaf at 4th month stage is found to be N optimum 2.07 to 3.93%. P optimum 0.32 to 0.35 % and K optimum 1.84 to 2.13%.

5.2.8. Correlation studies

5.2.8.1. Relationship between yield components and yield

The results showed that the characters such as mean weight of cormels, number of cormels, LAI and harvest index were positively and significantly correlated with yield (Table 33). This clearly indicated the importance of these characters on the cormel yield of taro. Similar results were also reported by Chapman (1965) in white yam wherein he found a strong correlation between leaf area and yield. Karikari (1974) has observed a very high linear correlation between LAI and cormel yield in cocoyam.

5.2.8.2. Relationship between uptake of NPK and yield

The results in Table 34 showed that the uptake of nitrogen, phosphorus and potassium at the fourth month stage was highly correlated with yield. Such positive correlation of uptake of nutrients in cassava was reported by Rajendran et al. (1976).

5.2.8.3. Path coefficient analysis

Path analysis of number of cormels, cormel size, LAI and yield.

The results of yield components and yield are presented in Table 35, Fig 13. Path analysis was performed to know the direct and indirect effect of number of cormels, cormel size, LAI on cormel yield. The maximum direct effect was observed for cormel size during both the periods. These three factors contributed by 71% towards yield both directly and indirectly in 1984, while the yield was influenced by 91% during 1984-85.

5.2.8.4. Path coefficient analysis on yield and nutrient uptake

The results of path coefficient analysis on yield and nutrient uptake are presented in Table 36. Path analysis of N, P, K uptake and yield was also done. The N uptake was found to have maximum direct effect in both years. These 3 factors contributed directly and indirectly towards yield by 48% during the Ist year and 56% during the second year.

5.2.9. Response surface

The relationship between yield and applied nutrients were worked out by fitting a quadratic response surface for physical and economic optimum and are presented in Table 37.

The data on cormel yield during the year 1984 showed that maximum yield was obtained at 80 Kg N ha^{-1} which was significantly superiot to 40 and 120 Kg N ha^{-1}. The physical and economic optimum of this nutrient were 91.6 Kg and 30 Kg respectively. Comparatively lower level for economic dose may probably be due to the high price per unit of nitrogen.

For P the physical and economic doses obtained were 49.2 and 10 Kg P_2O_5 ha^{-1} for the first year, 52.1 and 0 Kg P_2O_5 ha^{-1} for the second year respectively. This may probably be due to the fact that the price per unit of phosphatic fertilizer was the maximum (Rs.6 Kg^{-1}) among major nutrients. It was also observed that there was no significant difference in the yield of cormel for the various levels of P (Table 16). The initial P status of the experimental site was towards the medium range and more over there was a build up of available soil P in the second year (Table 32), which might have satisfied the P requirement to a larger extent and for economic optimum, additional dose of P may not be required. The lack of response for added phosphorus on taro has been reported by Chandra (1979) and Vanderzaag *et al.* (1980) on yams.

The higher economic dose of potassium (K_2O) obtained in this experiment may be due to its low price per Kg of nutrient (Rs. 2.50) compared to that of nitrogen (Rs.5.50) and phosphorus (P_2O_5) (Rs. 6.00). It was also observed that at highest dose of nitrogen and phosphorus there was a decline in yield during both the years. Whereas for K there was an increase in yield with increasing the level of potassium from 50 to 150 Kg K_2O ha^{-1}. It was further observed that the requirement of K for taro was more when compared to nitrogen and phosphorus (Tables 27 and 30). High requirement of potassium for taro production has been reported by Pillai (1967), de la Pena and Plucknett (1967), Chandra (1979).

5.2.10. Economics of fertilizer application

The economics of fertilizer application (Table 38 and 38(a) showed a higher benefit cost ratio for increased levels of potassium application in most cases.

Statistical analysis of the data (Table 38a) showed that maximum profit was obtained from 80 Kg nitrogen, 50 Kg P_2O_5 and 100 Kg K_2O ha^{-1} during both the years.

Conclusions

From the present investigation it can be concluded that the best source of planting material for maximum yield in taro (<u>Colocasia esculenta</u>) was the side corm. The optimum spacing for significantly higher yield was 60 x 45 cm. Among sources of mulch materials tried, mulching with greenleaf was found to be the best.

A fertilizer dose of 80 Kg N, 50 Kg P_2O_5 and 100 Kg K_2O recorded the highest yield and profit.

Time of application of N and K in three split doses of 1/3 N and 1/3 K_2O when 50% of the plants have established, and the remaining dose of N and K_2O in two equal splits at monthly intervals thereafter was found to be the best for maximum yield.

SUMMARY

SUMMARY.

SUMMARY OF THE RESULTS OF THE EXPERIMENT ON TARO (COLOCASIA ESCULENTA L.)

In order to standardise the cultural and manurial requirement of taro, two separate experiments were conducted at the College of Agriculture, Vellayani, during the period 1983-84 and 1984-85. The salient research findings are summarised below.

Experiment A

"Standardisation of cultural techniques such as plant population, source of planting material and mulching" on taro.

1. There was no significant difference on the sprouting percentage for variation in spacing, source of planting material and mulching.

2. There was no significant difference on plant height during any of the growth stages of crop due to the difference in planting material. Mulching had a significant effect on plant height. Leaf mulch recorded the maximum plant height over the other mulch materials used.

3. Mother corm as planting material produced more number of suckers per plant. Mulching had little effect on the production of suckers per plant.

4. Maximum leaf area index was observed with 60 x 30 cm spacing, which was gradually decreased as the plant population decreased. Source of planting material had no effect on this aspect. The effect of mulching on LAI was found to be inconsistant.

5. Mulching had significant effect on weed growth. The weed growth in the black polythene mulch plot was practically nil. The next best mulch material to control weed growth was green leaf mulch. Though black polythene mulch was effective in controlling the weeds, it was not economical.

6. Plant population had significant effect on the number of cormels per plant. Maximum number of cormels plant^{-1} was produced with the spacing treatment 60 x 60 cm. Source of planting material was found to be non-significant on this character. Green leaf mulch recorded the maximum number of cormels per plant.

7. Spacing treatment 60 x 60 cm recorded the maximum cormel yield plant^{-1}, which was significantly superior to all other spacings tried. Green leaf mulch was significantly superior to other mulch materials for increasing the mean cormel weight plant^{-1}.

8. Maximum sized cormels were produced at 60 x 60 cm. Between source of planting material side corm has recorded the biggest sized cormels over mother corm.

9. The highest cormel/corm ratio was observed with the spacing of 60 x 45 cm; which was significantly superior to 60 x 30 cm and 45 x 45 cm spacings. Side corm recorded significantly higher cormel/corm ratio over mother corm. Mulching had no significant effect on this character.

10. Maximum marketable cormel yield was obtained in the present study at 60 x 45 cm, spacing which was significantly superior to all other treatments. Between source of planting material significant yield increase was obtained with side corm over mother corm. Among the mulch materials tried, green leaf mulch recorded the maximum cormel yield which was significantly superior to other treatments.

11. Source of planting material had no effect on the percentage of dry matter in cormels. Starch content in the cormel was also not affected by the different treatments. Leaf mulch recorded the highest protein content in cormel which was significantly superior to other mulch materials tried. Oxalate content of the cormel was not affected by the different treatments.

<u>Experiment B</u>

1. Nutritional requirement and time of application of NPK on the yield and quality of taro (<u>Colocasia esculenta</u>).

12. Application of nitrogen and potassium had a significant effect on increasing the plant height but phosphorus had no effect on this character. Time of application was also found to be unaffected.

13. Application of nitrogen had a significant effect on increasing the LAI. Nitrogen @ 80 Kg ha^{-1} was significantly superior to 40 Kg N ha^{-1}, but was on par with 120 Kg N ha^{-1}. Levels of phosphorus had no significant effect on leaf area index. Application of potassium had a linear effect on LAI. Time of application of N and K had a significant effect on LAI. Three split application of N and K was found to have a significant effect on LAI.

14. Plant dry matter production at various stages of growth has shown that the dry matter production increased with increasing age of the plant upto 120 days and thereafter there was a sudden reduction on plant dry matter yield at 150th day. Maximum plant dry matter was observed at 120th day. Application of nitrogen had a significant

effect on the dry matter yield. Application of nitrogen at 80 Kg ha^{-1} was on par with 120th Kg N ha^{-1} in this aspect.

Application of P had no significant effect on increasing the plant dry matter. Potassium had a significant effect on plant dry matter production. Application of potassium at 100 Kg K_2O ha^{-1} had significant effect on plant dry matter yield, beyond which it was not significant.

Time of application had no significant effect on increasing plant dry matter yield in taro. The trend remains the same for both the years.

15. Increase on the uptake of nitrogen was observed with increasing levels of nitrogen upto 120 Kg ha^{-1}. Though higher levels of nitrogen had increased the uptake, it was on par with 80 Kg N ha^{-1} in most stages of crop growth. Phosphorus had no significant effect on the uptake of nitrogen. The total uptake of nitrogen by plant at 120th day was 43.6, 59.1 and 62.0 Kg N ha^{-1} for the application of 40, 80 and 120 Kg N ha^{-1} respectively.

Levels of nitrogen had significant effect on the total uptake of phosphorus by taro. Uptake of P increased with increase in the level of application. Total uptake of Phosphorus by plant at 120th day was 6.9, 7.9 and 8.4 Kg ha^{-1} with the application of 25, 50 and 75 Kg P_2O_5 ha^{-1} respectively.

Nitrogen and potassium had a significant effect on the uptake of potassium by taro. At higher levels of nitrogen (n_3) there was a reduction in the uptake of potassium. Increasing levels of potassium from k_1 to k_3 (50 to 150 Kg K_2O ha^{-1}) had a significant effect on the uptake of potassium by plant. The total uptake of potassium by plant at k_1, k_2 and k_3 (50, 100 and 150 Kg K_2O ha^{-1}) at 120th day was 57.8, 72.0 and 85.2 Kg ha^{-1} respectively.

Time of application had a significant effect on the uptake of potassium by plant.

16. Application of NPK had significant effect on the uptake of nitrogen by tuber. With increase in nitrogen from 40 to 120 Kg ha^{-1}, the uptake increased from 21.0 to 31.4 Kg ha^{-1}.

Application of N, P and K had a significant effect on the uptake of P by tuber. Levels of phosphorus application had significant effect on the uptake of phosphorus. Maximum uptake of P by tuber, ie. 4.8 Kg ha^{-1} was observed at p_3 level (75 Kg P_2O_5 ha^{-1}). Application of potassium also had significant effect on the uptake of P by tuber.

Application of N, P and K had significant effect on the uptake of K by tuber. Maximum uptake of potassium ie. 36.3 Kg ha^{-1} was noticed at k_3 level. Uptake of potassium was found to be linear with increasing dose of K.

17. The critical level of N, P and K was found by using the fitted function $y = b_0 + b_1x + b_2x^2$ between yield (y) and nutrient concentration in the leaf lamina (x) during the fourth month stage. From the fitted function the critical level of nutrients are 2.07 to 3.93%, 0.32 to 0.35% and 1.84 to 2.13% respectively for nitrogen, phosphorus and potassium.

18. Application of nitrogen and potassium had significant effect on the cormel bulking rate. Maximum cormel bulking was observed at n_2 level (80 Kg N ha^{-1}) and at n_3 level (120 Kg N ha^{-1}) there was a reduction in the bulking rate. In potassium the cormel bulking increased by increasing the rate of potassium application.

19. Nitrogen had significant effect on the crop growth rate. Maximum crop growth rate was observed at 80 Kg N ha^{-1} which was significantly superior to 40 and 120 Kg N ha^{-1}. The effect of P and K was found to be

nonsignificant. Time of application had significant effect on crop growth rate. Three split application of N and K recorded significantly higher CGR of 8.6 g m^{-2} day^{-1} (on dry matter basis).

20. Nitrogen, phosphorus and potassium had significant effect on dry matter percentage in tuber. Dry matter percentage decreased with increasing the level of nitrogen but increased with increasing the level of potassium.

Only potassium had a significant effect on increasing the starch content of tuber. Split application of N and K was found to be effective in increasing the starch content in tuber (cormel).

21. There was significant effect for the application of nitrogen and potassium for increasing the cormel yield during both the years. Level of P had no significant effect on cormel yield on taro. In both N and K yield increase was observed at 80 and 100 Kg N and K_2O ha^{-1} respectively, which recorded an yield of 12.3 & 11.4 t ha^{-1} None of the interactions was found to be significant.

The results suggest that taro responds to 80 Kg N and 100 Kg K_2O ha^{-1}, and P had no significant effect on yield. Time of application was found to be significant in increasing the yield in taro. Three split applications of N and K was found to be superior to two split applications of N and K.

22. Path analysis was performed to know the direct and indirect effect of number of cormels $plant^{-1}$, size of cormels and LAI on cormel yield. The maximum direct effect was observed for cormel size during both the years. These three factors contributed by 71% towards yield both directly and indirectly in 1984, while it was 91% during 1984-'85.

23. Path analysis of NPK uptake and yield was also done. The N uptake was found to have maximum direct effect in both years. These three factors contributed directly and indirectly towards yield by 48% during the first year and 56% during the second year.

24. The responce surface of yield on NPK was fitted and the mathematical optimum for NPK for 1984 and 1984-'85 was found to be 91.61 Kg N, 49.24 Kg P_2O_5 and 126.50 Kg K_2O based on the first year's trial and 90.12 Kg N, 52.12 Kg P_2O_5 and 119.8 Kg K_2O based on the second year's trial.

25. From the fitted responce surface the economic optimum dose of nitrogen, phosphorus and potassium was found to be 33:18:151 Kg N, P_2O_5 and K_2O ha^{-1} during the year 1984 and 30:0:166 Kg N, P_2O_5 and K_2O ha^{-1} during 1984-'85.

26. The economics of fertilizer application worked out revealed that a fertilizer dose of 80 Kg N, 50 Kg P_2O_5 and 100 Kg K_2O has recorded the highest net income of Rs. 11,060/- ha^{-1} at the prevailing market rate of <u>Colocasia</u> @ Rs.2/- Kg^{-1} and N, P_2O_5 and K_2O @ Rs.5.50, 6.00 and 2.50 Kg^{-1} respectively.

Future line of work

1. Effect of various mulch materials on the physiochemical properties of the soil, with special reference to the retention of soil moisture for scheduling irrigation has to be investigated.

2. Sucker production is a phenomenon in taro and no detailed study has been conducted on the influence of suckering and desuckering under varying plant population on the yield and market quality of cormels. So it is worthwhile to conduct a detailed study on this aspect.

3. The fertilizer study revealed that there was no response to the application of phosphorus for cormel yield. Hence it is felt necessary to evaluate the phosphorus nutrition on taro at lower levels of phosphorus with and without FYM.

4. Heavy dose of organic matter application has been recommended as basal and as mulch. In view of the high cost of organic manures, soil fertility monitoring with and without organic matter has to be carried out.

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* Originals not seen

APPENDICES

APPENDIX - I

Soil Characteristics of experimental field

Sl. No.	Constituent	Unit
A	Mechanical composition	%
	1. Coarse sand	34.69
	2. Fine sand	15.56
	3. Silt	10.20
	4. Clay	39.80
B	Physical properties	
	1. Bulk density	1.609 g c.c^{-1}
	2. Water stable aggrotate >0.25 mm	36.31%
C	Chemical properties	
	1. Organic carbon (per cent	1.04
	2. Available nitrogen (Kg ha^{-1})	373.10
	3. Available P. (Kg ha^{-1})	21.50
	4. Available K. (Kg ha^{-1})	187.70
	5. pH (1:2.5 water suspension)	4.9-5.1

APPENDIX - II

Weather data during the crop periods at the Instructional farm, Vellayani

Sl. No.	Month	Maximum tempera-ture (0 c)	Minimum temper-ature (0'c)	Relative humidity (%)	Rainfall (m.m)	Number of rainy days
1.	August 1983	28.0	22.8	83	217.2	14
2.	September	29.9	21.2	83	133.4	14
3.	October	26.7	22.0	79	50.6	9
4.	November	30.9	21.1	80	152.3	10
5.	December	31.2	23.5	76	108.2	8
6.	January 1984	31.0	23.5	74	35.6	3
7.	February	32.5	25.3	77	65.0	4
8.	March	32.0	23.5	78	46.4	5
9.	April	32.9	19.2	77	191.0	8
10.	May	32.5	20.4	69	100.0	6
11.	June	30.4	22.8	73	215.0	12
12.	July	28.9	23.8	80	131.0	10
13.	August	29.8	23.8	70	22.0	2
14.	September	30.4	23.8	76	83.0	3
15.	October	29.7	22.2	72	201.0	9
16.	November	30.7	23.8	80	120.0	5
17.	December	30.6	21.6	78	5.4	2
18.	January 1985	30.8	21.9	80	62.0	2
19.	February	31.8	23.8	82	26.0	1
20.	March	32.5	25.6	82	8.0	1

APPENDIX - III

Effect of levels of N, P and K on the concentration of nitrogen, Phosphorus and Potassium in the leaf lamina at 4th month stage of taro (mean of two years)

Treatment Combination	n_1	Treatment Combination	n_2	Treatment Combination	n_3
$n_{40}\ P_{25}\ k_{50}$	2.99	$n_{80}\ P_{25}\ k_{50}$	3.46	$n_{120}\ P_{25}\ k_{50}$	3.64
$n_{40}\ P_{25}\ k_{100}$	3.30	$n_{80}\ P_{25}\ k_{100}$	3.44	$n_{120}\ P_{25}\ k_{100}$	3.68
$n_{40}\ P_{25}\ k_{150}$	3.37	$n_{80}\ P_{25}\ k_{150}$	3.56	$n_{120}\ P_{25}\ k_{150}$	3.63
$n_{40}\ P_{50}\ k_{50}$	3.39	$n_{80}\ P_{50}\ k_{50}$	3.65	$n_{120}\ P_{50}\ k_{50}$	3.69
$n_{40}\ P_{50}\ k_{100}$	3.42	$n_{80}\ P_{50}\ k_{100}$	3.60	$n_{120}\ P_{50}\ k_{100}$	3.71
$n_{40}\ P_{50}\ k_{150}$	3.31	$n_{80}\ P_{50}\ k_{150}$	3.63	$n_{120}\ P_{50}\ k_{150}$	3.67
$n_{40}\ P_{75}\ k_{50}$	3.38	$n_{80}\ P_{75}\ k_{50}$	3.67	$n_{120}\ P_{75}\ k_{50}$	3.64
$n_{40}\ P_{75}\ k_{100}$	3.24	$n_{80}\ P_{75}\ k_{100}$	3.54	$n_{120}\ P_{75}\ k_{100}$	3.74
$n_{40}\ P_{75}\ k_{150}$	3.04	$n_{80}\ P_{75}\ k_{150}$	3.58	$n_{120}\ P_{75}\ k_{150}$	3.73

Treatment Combination	P_1	Treatment Combination	P_2	Treatment Combination	P_3
$n_{40}\ P_{25}\ k_{50}$	0.33	$n_{40}\ P_{50}\ k_{50}$	0.36	$n_{40}\ P_{75}\ k_{50}$	0.37
$n_{40}\ P_{25}\ k_{100}$	0.33	$n_{40}\ P_{50}\ k_{100}$	0.35	$n_{40}\ P_{75}\ k_{100}$	0.37
$n_{40}\ P_{25}\ k_{150}$	0.34	$n_{40}\ P_{50}\ k_{150}$	0.35	$n_{40}\ P_{75}\ k_{150}$	0.37
$n_{80}\ P_{25}\ k_{50}$	0.35	$n_{80}\ P_{50}\ k_{50}$	0.36	$n_{80}\ P_{75}\ k_{50}$	0.36
$n_{80}\ P_{25}\ k_{100}$	0.34	$n_{80}\ P_{50}\ k_{100}$	0.36	$n_{80}\ P_{75}\ k_{100}$	0.36
$n_{80}\ P_{25}\ k_{150}$	0.33	$n_{80}\ P_{50}\ k_{150}$	0.35	$n_{80}\ P_{75}\ k_{150}$	0.36
$n_{120}P_{25}\ k_{50}$	0.33	$n_{120}P_{50}\ k_{50}$	0.37	$n_{120}\ P_{75}\ k_{50}$	0.38
$n_{120}P_{25}\ k_{100}$	0.33	$n_{120}P_{50}\ k_{100}$	0.36	$n_{120}\ P_{75}\ k_{100}$	0.37
$n_{120}P_{25}\ k_{150}$	0.34	$n_{120}P_{50}\ k_{150}$	0.37	$n_{120}\ P_{75}\ k_{150}$	0.37

contd.

Appendix - III Continued

Treatment Combination	k_1	Treatment Combination	k_2	Treatment Combination	k_3
$n_{40}\ p_{25}\ k_{50}$	1.94	$n_{40}\ p_{25}\ k_{100}$	2.29	$n_{40}\ p_{25}\ k_{150}$	2.82
$n_{40}\ p_{50}\ k_{50}$	1.87	$n_{40}\ p_{50}\ k_{100}$	2.43	$n_{40}\ p_{50}\ k_{150}$	2.73
$n_{40}\ p_{75}\ k_{50}$	1.89	$n_{40}\ p_{75}\ k_{100}$	2.39	$n_{40}\ p_{75}\ k_{150}$	2.73
$n_{80}\ p_{25}\ k_{50}$	1.83	$n_{80}\ p_{25}\ k_{100}$	2.11	$n_{80}\ p_{25}\ k_{150}$	2.85
$n_{80}\ p_{50}\ k_{50}$	2.17	$n_{80}\ p_{50}\ k_{100}$	2.43	$n_{80}\ p_{50}\ k_{150}$	2.59
$n_{80}\ p_{75}\ k_{50}$	1.98	$n_{80}\ p_{75}\ k_{100}$	2.34	$n_{80}\ p_{75}\ k_{150}$	2.74
$n_{120}p_{25}\ k_{50}$	1.75	$n_{120}p_{25}\ k_{100}$	2.35	$n_{120}p_{25}\ k_{150}$	2.84
$n_{120}p_{50}\ k_{50}$	1.88	$n_{120}p_{50}\ k_{100}$	2.39	$n_{120}p_{50}\ k_{150}$	2.71
$n_{120}p_{75}\ k_{50}$	1.79	$n_{120}p_{75}\ k_{100}$	2.30	$n_{120}p_{75}\ k_{150}$	2.82

$n_{40}\ n_{80}\ n_{120}$ = 40, 80, 120 Kg N ha^{-1} (n_1, n_2, n_3)

$p_{25}\ p_{50}\ p_{75}$ = 25, 50, 75 Kg P_2O_5 ha^{-1} (p_1, p_2, p_3)

$k_{50}\ k_{100}k_{150}$ = 50, 100, 150 Kg K_2O ha^{-1} (k_1, k_2, k_3)

APPENDIX IV

Abstract of Pooled ANOVA

Source	df	MS	F
Year (Y)	1	398.730	S
Major Treats (T)	26	0.995	S
Y x T	26	0.387	NS
E_1 (Pooled)	44	0.572	
Minor Treat (t)	1	9.240	S
T x t	26	0.121	NS
Y x t	1	0.920	S
Y x T x t	26	0.045	NS
E_2 (Pooled)	56	0.234	

S - Significant

NS - Not significant

APPENDIX V Soil nutrient balance sheet
(Nitrogen) Kg ha^{-1}

Treatments	1984						1984-'85					
	Initial status	Added N (a)(b)	Crop Removal	Theoretical Balance	Actual balance	Loss or Gain	Initial status	Added N (a)(b)	Crop removal	Theoretical balance	Actual balance	Loss or Gain
n_1(40 Kg N ha^{-1})	373.1	+40+30	-49.7	393.4	315.8	- 77.6	315.8	40+30	-37.5	365.8	299.6	- 66.2
n_2(80 Kg ")	373.1	+80+30	-68.4	414.7	355.0	- 59.7	355.0	80+30	-69.7	415.3	301.1	-114.2
n_3(120Kg ")	373.1	+120+30	-73.0	400.1	350.5	- 49.6	350.5	120+30	-61.0	449.5	289.8	-159.7
p_1(25 Kg P_2O_5 ha^{-1})	373.1	+40+30	-63.6	379.5	339.6	- 39.9	339.6	40+30	-44.7	364.9	290.5	- 74.4
p_2(50 Kg ")	373.1	+80+30	-63.5	419.6	342.6	- 77.0	342.6	80+30	-47.2	405.4	300.5	-104.5
p_3(75 Kg ")	373.1	+120+30	-64.0	459.1	339.1	-120.0	339.1	120+30	-46.3	442.8	299.4	-143.4
k_1(50 Kg K_2O ha^{-1})	373.1	+40+30	-62.0	381.1	339.2	- 41.9	339.2	40+30	-43.7	365.5	297.1	- 68.4
k_2(100Kg ")	373.1	+80+30	-64.5	418.6	338.2	- 80.4	338.2	80+30	-46.4	401.8	301.8	-100.0
k_3(150Kg ")	373.1	+120+30	-64.6	458.5	343.8	-114.7	343.8	120+30	-48.1	445.7	291.5	-154.2
PHOSPHORUS												
n_1(40 Kg N ha^{-1})	21.50	11+14	-7.86	38.6	29.6	- 9.0	29.6	11+14	-5.8	48.8	34.3	-14.5
n_2(80 Kg ")	21.50	22+14	-9.19	48.3	29.3	-19.0	29.3	22+14	-7.1	58.2	35.9	-22.3
n_3(120Kg ")	21.50	33+14	-9.61	58.9	29.1	-29.8	29.1	33+14	-6.8	69.3	35.6	-33.7
p_1(25 Kg P_2O_5 ha^{-1})	21.50	11+14	-7.80	38.7	27.9	-10.8	27.9	11+14	-6.0	46.9	33.2	-13.7
p_2(50 Kg ")	21.50	22+14	-9.16	48.3	29.6	-18.7	29.6	22+14	-6.6	59.0	35.7	-23.3
p_3(75 Kg ")	21.50	33+14	-9.70	58.8	30.5	-28.3	30.5	33+14	-7.0	70.5	36.9	-33.6
k_1(50 Kg K_2O ha^{-1})	21.50	11+14	-8.79	37.8	29.1	- 8.7	29.1	11+14	-6.1	48.0	34.8	-13.2
k_2(100Kg ")	21.50	22+14	-8.89	48.6	29.3	-19.3	29.3	22+14	-6.5	58.8	35.6	-23.2
k_3(150Kg ")	21.50	33+14	-8.98	59.5	29.5	-30.0	29.5	33+14	-6.7	69.8	35.3	-34.5

Contd...

APPENDIX V Contd.

POTASSIUM

Treatments	1984						1984-'85					
	Initial soil status	Added K (a) (b)	Crop removal	Theoretical balance	Actual balance	Loss or Gain	Initial soil status	Added K (a) (b)	Crop removal	Theoretical balance	Actual balance	Loss or Gain
n_1(40 Kg N ha^{-1})	187.7	41+30	-72.9	185.8	161.9	-23.9	161.9	41+30	-53.4	179.5	143.0	- 36.5
n_2(80 Kg ")	187.7	82+30	-89.3	210.4	166.9	-43.5	166.9	82+30	-63.7	215.2	140.0	- 75.2
n_3(120Kg ")	187.7	123+30	-86.7	254.0	164.2	-89.8	164.2	123+30	-63.3	253.9	137.7	-116.2
p_1(25 Kg P_2O_5 ha^{-1})	187.7	41+30	-78.9	179.8	170.4	- 9.4	170.4	41+30	-59.3	182.1	140.8	- 21.3
p_2(50 Kg ")	187.7	82+30	-86.1	213.6	159.0	-54.6	159.0	82+30	-59.9	211.0	136.7	- 74.4
p_3(75 Kg ")	187.7	123+30	-83.8	256.9	162.9	-94.0	162.9	123+30	-61.1	254.8	143.0	-111.8
k_1(50 Kg K_2O ha^{-1})	187.7	41+30	-62.7	196.0	152.3	-43.7	152.3	41+30	-52.1	171.3	134.4	- 36.9
k_2(100Kg ")	187.7	82+30	-83.1	216.6	165.0	-51.6	165.0	82+30	-60.8	216.2	139.0	- 77.2
k_3(150Kg ")	187.7	123+30	-102.9	237.8	175.0	-62.8	175.0	123+30	-67.4	260.6	147.3	-113.3

(a) - Nutrients added by way of fertilizer source.

(b) - Nutrients added by way of organic source.

AGRONOMIC INVESTIGATIONS ON 'TARO' (*COLOCASIA ESCULENTA* L.) VARIETY - THAMARAKANNAN

BY

C. R. MOHAN KUMAR

ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE
DOCTOR OF PHILOSOPHY
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

1986

ABSTRACT

In order to standardise the cultural and fertilizer requirement of taro (*Colocasia esculenta*) two separate field experiments were conducted during 1983-'84 and 1984-'85 at the College of Agriculture, Vellayani.

The first experiment (Experiment A) with treatments consisting of two sources of planting material (side and mother corm) four spacing (60 x 30, 45 x 45, 60 x 45, 60 x 60 cm) and five sources of mulching (Green leaf, Coconut coir/husk Waste, Water hyacinth, black polythene and no mulch) was conducted in a split plot design. The second experiment (Experiment B) was a 3^3 x 2 partially confounded factorial design with three levels each of nitrogen (40, 80, 120 Kg ha^{-1}), P_2O_5 (25, 50, 75 Kg ha^{-1}), K_2O (50, 100, 150 Kg ha^{-1}) and two times of application (two split application of N and K and three split application of N and K) with two replication.

The salient findings of the experiments are as follows.

The percentage of germination was not affected by mulching, source of planting material and spacing. Mulching had significant effect on increasing the plant height, in the control of weed growth, on yield components like number of cormels $plant^{-1}$, size of cormel and the yield of cormel ha^{-1}.

The available NPK content and some of the physical properties of the soil like bulk density and water stable aggregate were improved by leaf mulching. Between sources of planting material, bigger sized cormels were produced when side corm was used as planting material. Significant yield increase was also observed for side corm. The spacing 60 x 45 cm recorded the maximum marketable cormel yield which was significantly superior to all other spacings tried.

Nutritional requirement of taro revealed that application of nitrogen at levels of 40 and 80 Kg ha^{-1} had significant effect on plant height, LAI, number and weight of cormel plant^{-1} and cormel yield ha^{-1}. The level of nitrogen at 120 Kg ha^{-1} was on par with 80 Kg N ha^{-1}. Quality aspects like percentage of dry matter were reduced and the content of protein in cormel increased significantly with levels of nitrogen from 40 to 120 Kg ha^{-1}. The growth characters like crop growth rate, cormel bulking rate, total dry matter production and uptake of nitrogen, phosphorus and potassium were increased significantly with levels of nitrogen at 40 and 80 Kg ha^{-1}. The effect of N at 120 Kg ha^{-1} was on par with 80 Kg N ha^{-1}.

The levels of phosphorus had no significant effect on LAI, yield components like number and weight of cormels plant^{-1} yield of cormels ha^{-1}, quality aspects like percentage of dry matter, starch, protein and oxalate content in cormels and growth characters like CGR, cormel bulking rate etc.

Application of graded doses of potassium at 50 and 100 Kg K_2O ha^{-1} had significant effect on leaf production, LAI, yield components like cormel number $plant^{-1}$, mean weight of cormel and yield of cormel ha^{-1}. The level of potassium at 150 Kg K_2O ha^{-1} was on par with 100 Kg K_2O ha^{-1} in most of these characters. Quality aspects like dry matter content and starch percentage in cormels were increased and oxalate content reduced significantly by potassium application ranging from 50 to 150 Kg K_2O ha^{-1}. Total dry matter production and cormel bulking rate increased with increasing levels of potassium applications ranging from 50 to 150 Kg K_2O ha^{-1}.

Time of application of N and K in three split doses had significant effect on the mean weight of cormel, cormel yield ha^{-1}, quality aspects like dry matter and starch percentage in cormel. Plant dry matter production was not affected by time of application but tuber dry matter production was increased by three splits of N and K. Critical levels of nutrients in the leaf lamina for optimum yield at the 4th month stage of the crop was found to be in the range of 2.065 to 3.933 for N, 0.323 to 0.352 for P and 1.835 to 2.132 for K.

Physical optimum doses of nitrogen, phosphorus and potassium were found to be 91.6, 49.2 and 126.5 Kg ha^{-1} of N, P_2O_5 and K_2O during 1984 and 90.1, 52.1 and 119.8 during 1984-'85.

The economic doses for the same was found to be 33.0, 18.0 and 151.0 Kg ha^{-1} N, P_2O_5 and K_2O respectively for 1984 and 30.0, 0 and 166.0 Kg, N, P_2O_5 and K_2O ha^{-1} for 1984-85.

The economics of fertilizer application worked out revealed that a fertilizer dose of 80 Kg N, 50 Kg P_2O_5 and 100 Kg K_2O has recorded the highest net income of Rs. 11,060/- ha^{-1} at the prevailing market rate of *Colocasia* @ Rs.2/- Kg^{-1} and N, P_2O_5 and K_2O @ Rs.5.50, 6.00 and 2.50 Kg^{-1} respectively.