ALL INDIA COORDINATED AGRONOMIC EXPERIMENTS SCHEME

Annual Report
1971-72

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Introduction:

Simple fertilizer trials in cultivator's fields and fertiliser trials in the Model Agronomic Centre, Karamana have been in existence in Kerala from 1953 and 1955 respectively under the Fertiliser Use and Soil Fertility Project and are being continued under the All India Coordinated Agronomic Experiments Scheme(AICAES). With the introduction of high yielding varieties and the changed outlook on agricultural strategey, the scope and content of the AICAES have widened and the scheme with the new set up started functioning in this State from the rabi season of 1968. The IADP Districts, Palghat and Alleppey were selected for conducting the simple fertiliser trials and after completion of 3 year's trial, these were shifted to Trichur and Quilon districts from rabi 1971.

M.A.Centre/SFT	Year of starting of work
1) Model Agronomic Centre, Karamana	1955
2) Simple Fertiliser trial districts:	
Palghat	1968
Alleppey	1968
Trichur	1971
Quilon	1971

The main objectives of the experiments conducted at the Model Agronomic Centre, Karamana were:

1) to study the production potential of one year high intensity crop rotation,

2) to study the direct, residual and cumulative effect of farmyard manure, phosphorus and potassium fertilisation in fixed single year two crop rice rotation;

3) to study the direct and residual effect of liming in acid soils in relation to yield of rice and soil properties;

4) to study the response of high yielding varieties of rice to P and K in relation to time of application;

5) to study the response of high yielding varieties of rice to N, P and K and their interaction;

6) to evaluate the complex fertilisers as sources of N and P for rice;

7) to study the effect of slow release nitrogenous fertilizers;

8) and to find out the safe limit of biuret content in urea for foliar spray.

The main objectives of the simple fertilizer trials SFT(HYVP) were:-

1) to study the response of high yielding varieties of rice to N, P, K and zinc with a view to formulating fertiliser recommendations for different agroclimatic zones in the State;

2) and to study the relationship between soil test values and crop responses to fertilisers.

This report presents the results obtained from these experiments conducted under the AICAES in Kerala during 1971-72.

EXPERIMENTAL:-

The soil characteristics of the Model Agronomic Centre, Karamana are given in Table I.

Table I

Soil characteristics of the M.A.Centre, Karamana

Major soil group	Mechanical composition			Texture	Chemical properties					
	Sand	Silt	Clay		pH	Organic carbon %	Available P kg/ha	Available K kg/ha	CEC (me %)	E.C. m.mhos / cm
Laterite	70.10	5.15	20.20	Sandy clay loam	5.3	0.45	24	.100	3.0	0.25

Details of fertility status of fields where simple fertilizer trials were conducted are furnished along with the yield data in relevant summary tables. A brief summary of soil fertility status of the different zones of the SFT districts are however presented in Table II.

Table II

Summary of soil fertility status of the different zones of SFT districts.

District	Zone	Blocks	Available N	Available P	Available K	pH
Palghat	I	Thrithala Pattambi	Low	Medium	Medium	Acidic
	II	Coyalmannam Alathur	Low	Medium	Medium	Acidic
	III	Ottappalam Palghat	Medium	Medium	Medium	Acidic
	IV	Mannarghat Sreekrishna-puram.	High	Medium	High	Acidic
Alleppey	I	Koippuram Mallappally	Medium	Low	Low	Acidic
	II	Kulanada Pandalam	Medium	Low	Low	Acidic
	III	Muthukulam Bharanikkavu	Low	High or Medium	Medium or low	Acidic
	IV	Mavelikkara	Low	Medium	Low	Acidic
Trichur	I	Chowghat Chowannur	Medium	Medium	Medium	Acidic
	II	Pazhayannur Wadakkancherry	Low	Low	Medium	Acidic
	III	Irinjalakuda Chalakudi	Medium	Medium	Medium	Acidic
	IV	Ollukkara	High	Medium	Low	Acidic
Quilon	I	Elanthoor Konni	High	Low	Medium	Acidic
	II	Sasthamcotta Vettikkavala	High	Medium	Low	Acidic
	III	Kottarakkara	Medium	Low	Medium	Acidic
	IV	Karunagappally Oachira	Low	Low	Low	Acidic

A total rainfall of 1213.80 mm was received during the year at Karamana. During

the kharif season (May to September) the mean monthly rainfall was 198.4 mm and during rabi season (October to March) this was 36.9 mm. The mean maximum and minimum temperatures during kharif season were 31.1°C and 22.6°C respectively, while during rabi season these were 33.79°C and 21.14°C respectively. The annual rainfall and number of rainy days in Alleppey district (recorded at Kayamkulam) were 3288.4 mm and 140 days respectively, while the corresponding figures for Palghat district (recorded at Pattambi) were 2792.2 mm and 122 days respectively. The weather in general was quite satisfactory.

RESULTS AND DISCUSSION:-

I. Model Agronomic Experiments

Production potential experiment (Experiment No.1).

The object of the experiment was to find out the production potential and economics of high intensity crop rotation with high yielding varieties. Six rotations involving four crops were grown in a single year. Individual crops were raised according to local practices. The results are presented in Table 1.1.1

Table 1.1.1

Yields and total production of different crop rotation sequences during 1971-72

Crop sequence			Yield in kg/ha			Total yield in kg/ha			Total No. of non-cropped days	Grain yield/day cropped (kg/ha)	Grain yield/day over one calender year (kg/ha)
Kharif	Rabi	Summer	Kharif	Rabi	Summer	Grain	Fodder	Others			
Paddy (Jaya)	Paddy (Jaya)	Paddy (Jaya)	4588	4591	2763	11942	-	--	13	34	33
" "	" "	Fallow	4556	4355	--	8911	-	--	138	39	24
" "	" "	Cowpea (New era)	4757	4845	1571	11173	-	-	37	34	31
" "	" "	Bhindi (local)	4824	4945	11954	9769	-	11954	41	43	27
" "	" "	Sweetpotato	4856	4390	6325	9246	-	6325	50	41	25
" "	" "	Groundnut	4690	4824	1979	9514	-	1979	50	42	26

Maximum output and income per hectare were obtained in the rotation paddy-paddy-bhindi followed by paddy-paddy-sweet potato. The total production of rice in the kharif and rabi seasons in the rotation in which the land was kept fallow during summer was less than that obtained in other rotations involving a crop other than rice during summer. From the data it appears that cultivation of a non-cereal crop during summer is definitely advantageous from the point of view of total production and income.

Manurial requirements of a fixed crop rotation:
(Experiment No.2)

The object of the experiment was to study the direct, residual and cumulative effect of phosphorus, potassium and farmyard manure on a fixed one year crop rotation with a high yielding variety of rice. Treatments included all combinations of three levels of phosphorus (0, 30, 60 kg P_2O_5/ha), two levels of potassium(0, 30 kg K_2O/ha) and two levels of farmyard manure (0, 15000 kg/ha) in three phases applied over a basal dressing of 120 kg N/ha to each crop.

This experiment was started on a fresh site in kharif 1971-72 season and therefore data on cumulative effect was not available for the year.

Kharif:

The maximum grain yield of 5539 kg/ha was recorded in plots receiving no phosphorus and at higher doses of P a progressively significant depression in yield was registered (Table 2.1.1;Fig.I). There was no direct response to application of potassium or farmyard manure.

Table 2.1.1

Direct response of rice (IR.8) to phosphorus.

Variety	Average yield without phosphorus	Direct response (kg/ha) to 30 kg P_2O_5/ha	Direct response (kg/ha) to 60 kg P_2O_5/ha	CD at 5%	GM	CV
IR.8	5539	-433	-688	322	5165	0.9

Rabi

In the rabi season there was no response either direct or residual to application of potassium, phosphorus and farmyard manure.

Response of high yielding variety of rice (IR.8) to levels and times of application of phosphorus and potassium

(Experiment No.3)

The experiment was conducted to determine the response of high yielding varieties of rice to phosphorus and potassium in relation to their time of application. The treatments consisted of all combinations of 4 levels of phosphorus viz., 0, 60, 120 and 180 kg P_2O_5/ha; 3 levels of potassium viz., 0, 60 and 120 kg K_2O/ha and two times of application, full dose applied at planting and in the other, half at planting and the remaining half as top dressing. Nitrogen at the rate of 120 kg/ha was applied to all treatments; half as basal and the remaining half in two equal split doses as top dressings.

Kharif:

There was no response to phosphorus, and the yields due to different times of application did not differ significantly. There was response to potassium applied at 120 kg/ha, being of the order of 680 kg/ha and this was however not significantly higher than the response obtained with 60 kg/ha (Table 3.1.1 and Fig.II)

Table 3.1.1

Response of high yielding variety(IR.8) to potassium(kg/ha)

Soil group	Centre	Variety	Average yield of plots without potash	Response to potassium at 60 kg K_2O/ha	Response to potassium at 120 kg K_2O/ha	CD 5%
Laterite	Karamana	IR8	4344	357	680	493

Rabi:

Response to phosphorus was not indicated in the rabi season and at 120 kg/ha (a depression in yield of 267 kg/ha) was registered. Response to potassium applied at 60 and 120 kg/ha was found to be substantial, the additional yields obtained being 619 kg and 640 kg respectivdly (Table 3.1.2). There was not much difference between the two methods of applying P and K.

Table 3.1.2

Response of high yielding variety of rice(IR.8) to potassium

Average yield without potassium.	Response to potassium at 60 kg/ha	Response to potassium at 120 kg/ha	CD at 5%
5033	619	640	NR

Nitrogen, Phosphorus and Potassium requirements of high yielding variety of rice:

(Experiment No.4)

The objective of this experiment was to study the response of a high yielding variety of rice(IR.8) to nitrogen, phosphorus and potassium and their interactions. The treatments consisted of all combinations of four levels of nitrogen (0, 60, 120 and 180 kg N/ha), 3 levels of phosphorus (0, 60, 120 kg P_2O_5/ha) and 3 levels of potassium(0, 60,120 kg K_2O/ha).

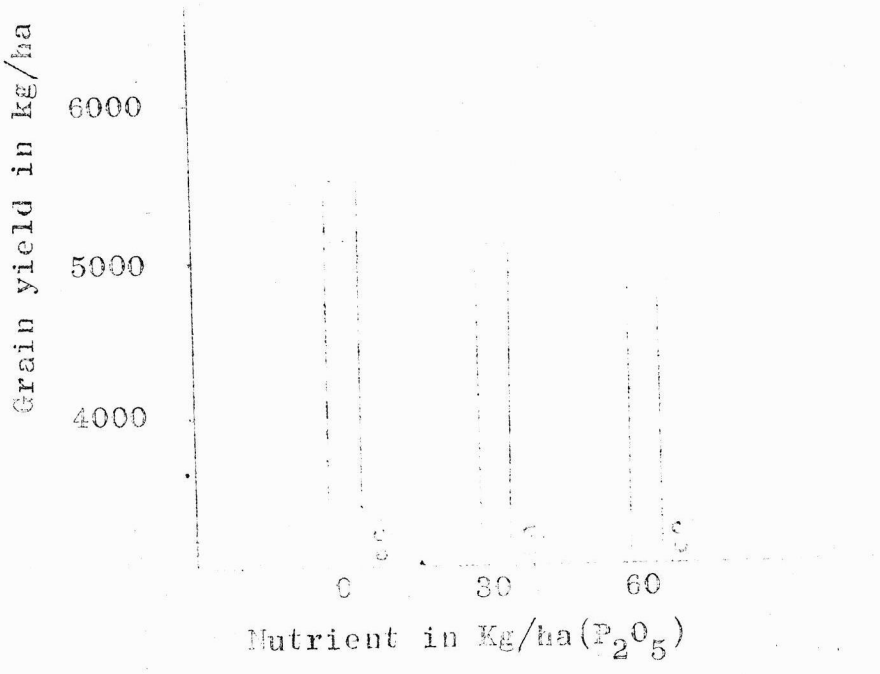


FIG.I. DIRECT RESPONSE OF RICE (IR.8) TO PHOSPHORUS

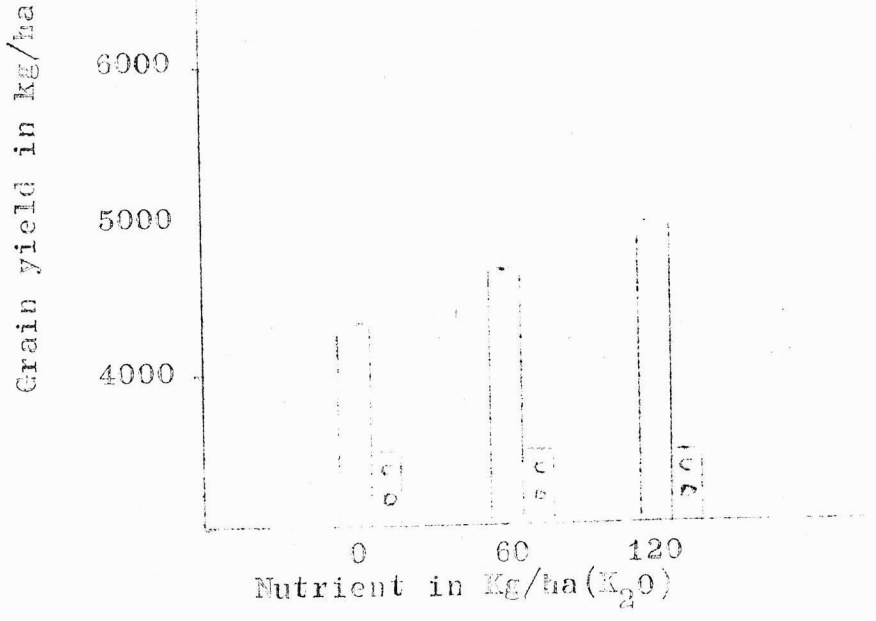


FIG.II RESPONSE OF HIGH YIELDING VARIETY (IR.8) TO POTASH

Kharif:

Responses to nitrogen were highly significant and these were influenced by the application of potassium, there being no interaction with phosphorus. There was no response to either phosphorus or to potassium. The response to nitrogen applied at 60 and 120 kg/ha were of the order of 1255 and 2466 kg/ha respectively (Table 4.1.1:Fig III) and the response at 120 kg/ha was significantly higher. When the dose was increased from 120 to 180 kg/ha the highest response of 2496 kg/ha was registered(over a basal grain yield of 3056 kg/ha recorded in the absence of nitrogen), but there was no further significant additional response gained.

Table 4.1.1

Response of high yielding variety of rice to nitrogen (kg/ha) Kharif 71-72

Soil group	Variety.	Average yield of plots without nitrogen	Response to nitrogen at			CD at 5%	GM	CV
			60 kg N/ha	120 kg N/ha	180 kg N/ha			
Laterite	IR8	3056	1255	2466	2496	296	4610	10

The nitrogen-potassium interaction was positive(Table 4.1.2;Fig IV) and the response registered for the combined application of 120 kg/ha of nitrogen and 60 kg/ha of potassium being 2723 kg/ha. At further high levels of N and K additional response was non-significant.

Table 4.1.2

Response of high yielding variety of rice(IR 8) to nitrogen(kg/ha)at different levels of potassium.

Variety.	Levels of K_2O(kg/ha)	Average yield of plots without nitrogen	Response to nitrogen(kg/ha)at			CD at 5%
			60 kg N/ha	120 kg N/ha	180 kg N/ha	
IR.8	0	3222	1452	1706	2133	513
	60	3041	998	2723	2723	
	120	2904	1317	2769	2633	

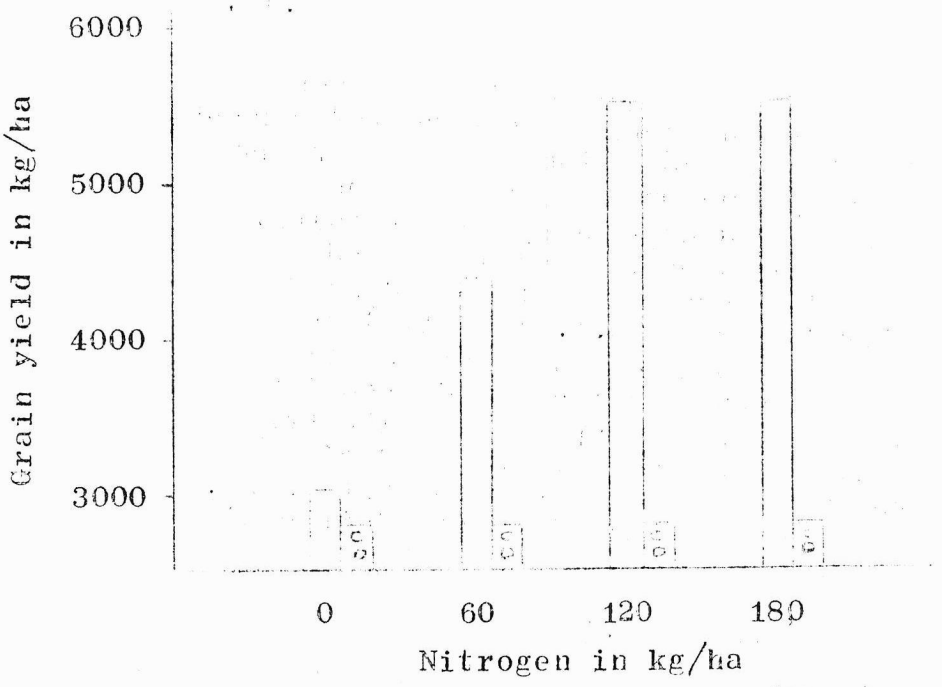


FIG.III RESPONSE OF RICE (IR.8) TO DIFFERENT LEVELS OF NITROGEN

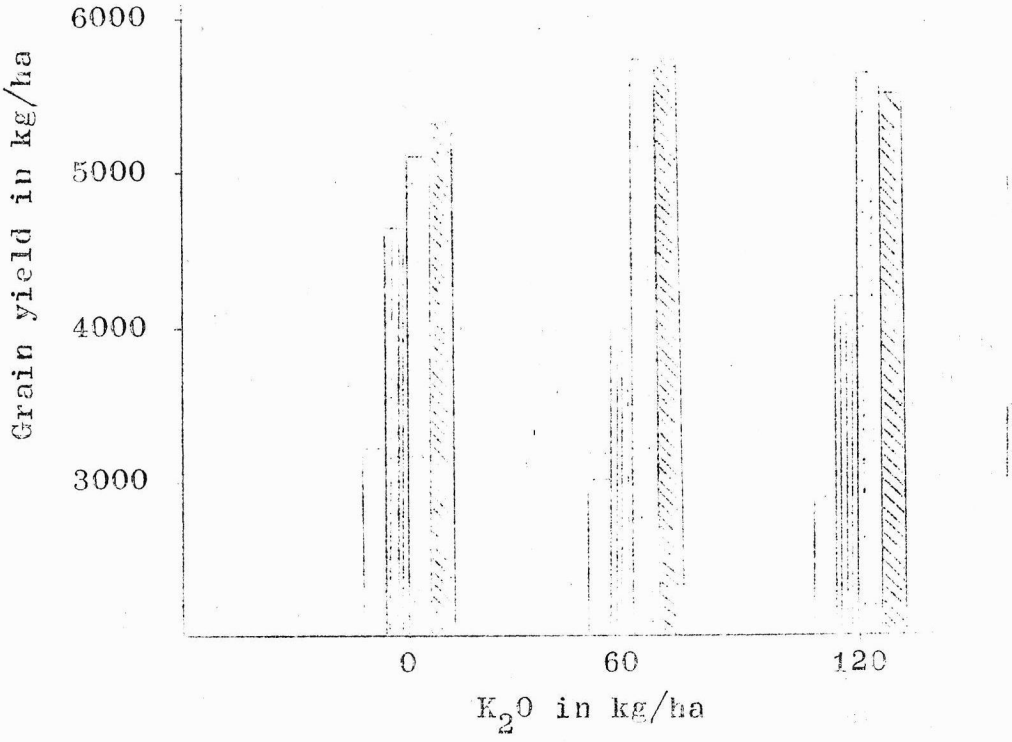


FIG.IV RESPONSE OF RICE (IR.8) TO NITROGEN IN THE PRESENCE OF DIFFERENT LEVELS OF POTASH

Rabi:

In the rabi season highly significant responses were obtained to different doses of nitrogen (Table 4.1.3). The average yield without nitrogen was 3812 kg/ha and the response to nitrogen applied at 60, 120 and 180 kg/ha were respectively, 1248, 2086 and 1710 kg/ha, the maximum recorded response being at 120 kg/N/ha. There was no significant increase in response when the level of nitrogen applied was increased from 120 to 180 kg/ha. This finding is in conformity with the results obtained in the kharif season.

Table 4.1.3

Response of high yielding variety of rice(IR.8)to nitrogen(kg/ha) rabi 71-72.

Variety	Average yield without nitrogen (kg/ha)	Response to nitrogen (kg/ha) at 60 kg/ha	120 kg/ha	180 kg/ha	CD at 5%	GM	CV
IR.8	3812	1248	2086	1710	783	5075	13.64

Application of different doses of phosphorus did not result in significant variation in grain yields, while the response to potassium was significant(Table 4.1.4) and positive. The average grain yield obtained with potassium applied at 120 kg/ha was 5293 kg/ha, as compared with 4748 kg/ha recorded in control, the difference (545 kg/ha) being significant. At 180 kg/ha the yield was 5185 kg/ha and this was not significantly different from the yield attained at 120 kg/ha.

Table 4.1.4

Response of high yielding variety of rice (IR.8) to potassium(kg/ha)

Variety.	Average yield without potassium kg/ha	Response to potassium(kg/ha)at 60 kg/ha	120 kg/ha	CD at 5%
IR.8	4748	545	437	391

None of the NP, NK, PK and NPK interactions were significant in the rabi season.

Safe limit of biuret content in urea for foliar spray.

(Experiment No.5)

This experiment was conducted only in the rabi season. The objective was to determine the safe limit of biuret in urea when applied as foliar spray on rice, with regard to phytotoxicity and consequent depression in grain yield. Urea of different biuret contents over a range from 0.3 to 0.9% at intervals of 0.1% was sprayed to provide 20 kg N/ha over a basal dressing of 60 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha. Two additional plots, one with 20 kg N/ha applied to soil over the same basal dressing as above and the other as absolute control were also included in the experiment.

There was a progressive increase in physical damage to plants at doses above 0.3% but significant depression in grain yield was not registered.

Effect of liming the acid soils.

(Experiment No.7)

The object of the experiment was to study the direct and residual effect of liming of acid soils on crop yields. The treatments were a) liming treatment: no lime(L_0), lime application on the basis of Mehlich's method (L_1) and lime application to raise the pH of the soil to 6.5(L_2) and(b) fertilizer treatments: no fertilizer-control, nitrogen + phosphorus, nitrogen + Phosphorus + potassium. The doses of nitrogen, phosphorus and potassium were 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha respectively. The experiment with the above modified set of treatments was started in the kharif season. The overall effect of liming was not indicated, the variation in yield being attributable to the effect of fertilizer treatments.

Slow-release nitrogenous fertilizers:

(Experiment No.9)

This experiment was conducted only in the kharif season and the objective

was to study the relative efficiency of different slow release nitrogenous fertilizers for rice. The treatments consisted of T_1 - urea at 50 kg N/ha, T_2 - urea at 100 kg N/ha, T_3 - urea at 150 kg N/ha, T_4 - urea at 200 kg N/ha, T_5 - S.coated urea(S_1) at 100 kg N/ha, T_6 - S.coated urea (S_2) at 100 kg N/ha, T_7 - Mahua cake at 100 kg N/ha(IBDU), T_8 - Karanj cake at 100 kg/ha, T_9 - Lac coated urea at 100 kg N/ha, T_{10} - AM fertilizer at 100 kg N/ha, T_{11} - Neem cake coated urea at 100 kg N/ha and T_{12} - control receiving no nitrogen at all. The two grades of sulphur coated urea differed in the amount of sulphur coatings and consequent differences in nitrogen release rate, S_1 being a fast release type as compared to S_2. The maximum grain yield of 4811 kg/ha was obtained with the AM fertilizer (Table 9.1.1;Fig.V) applied at 100 kg N/ha and this was significantly higher than yields obtained from sulphur coated(S_2) urea at 100 kg/ha and Karanj cake at 100 kg N/ha the yields registered being 3903 and 3812 kg/ha respectively. Sulphur coated urea of the two grades S_1 and S_2 did not show any significant differences. There were no differences between treatments receiving 100 kg N/ha from different sources viz., neem cake, Mahua cake, sulphur coated urea (S_2) and urea.

Table 9.1.1

Response of rice(IR.8) to slow release nitrogenous fertilizers(kg/ha)

Average yield of untreated plot(kg/ha)	Urea at 50 kg N/ha	Urea at 100 kg N/ha	Urea at 150 kg N/ha	Urea at 200 kg N/ha	S.coated urea(S_1) at 100 kg/ha
1	2	3	4	5	6
3086	545	908	1633	635	1089

S.coated urea(S_2) at 100 kg N/ha	Mahua cake at 100 kg N/ha	Karanj cake at 100 kg N/ha	Lac coated urea at 100 kg N/ha	AM fertilizer at 100 kg N/ha	Neem cake at 100 kg N/ha	CD at 5%	CV
7	8	9	10	11	12	13	14
817	908	726	1180	1725	998	854	12.55

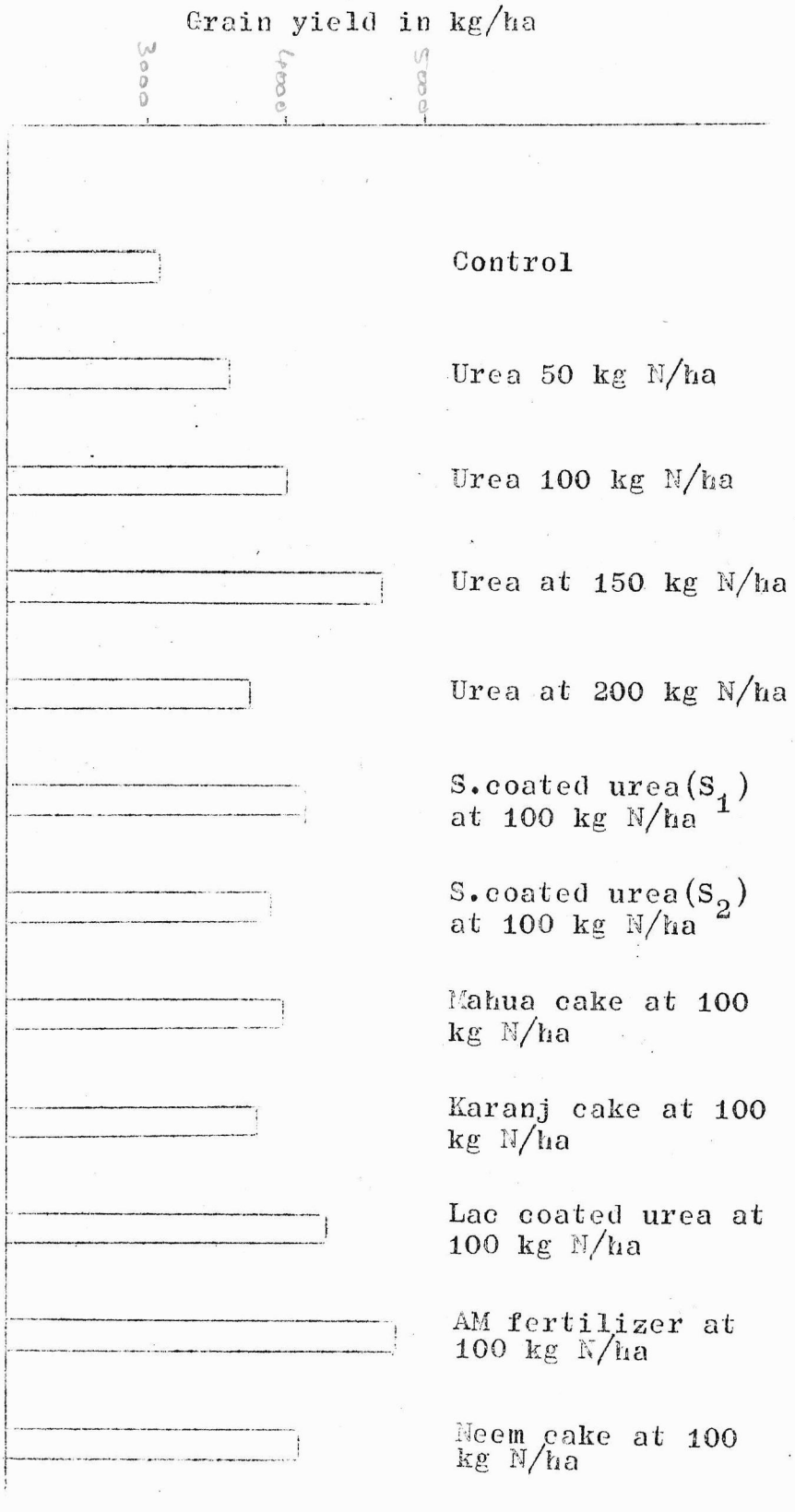


Fig. V. RESPONSE OF RICE (IR.8) TO DIFFERENT SLOW RELEASE NITROGENOUS FERTILISERS

Comparative study of complex fertilizers:

(Experiment 10a)

The objective of the experiment was to evaluate complex fertilizers as sources of nitrogen and phosphorus when applied at sowing, for rice. The treatment consisted of T_1 - urea + super to provide 60 N, 30 P, T_2 - urea + super to provide 60 N, 60 P, T_3 - am.sulphate + super to provide 60 N, 30 P, T_4 - am.sulphate + super to get 60 N, 60 P, T_5 - nitro phosphate(30% WSP) to supply 60 N 60 P, T_6 - urea am.phosphate to supply 60 N 60 P, T_7 - am.phosphate sulphate(20:20:0) to provide 60 N 60 P, T_8 - di amm.phosphate(18:46:0) to supply 60 N 60 P, and absolute control. Complex N-P fertilizer sources were not found to differ among themselves both in the kharif and in the rabi seasons.

II. SIMPLE FERTILISER TRIALS
(High yielding variety programme)

The SFT districts were divided into agriculturaly homogenous zones on the basis of soil type and cropping pattern etc., and the trials were conducted in the fields of cultivators selected at random. Details about the manurial and cultural practices in brief are as follows:-

The crop was grown under rainfed conditions in all the districts during both kharif and the rabi seasons. The source of nitrogen was ammonium sulphate in Alleppey and Quilon districts while this was urea in Palghat and Trichur districts. Super phosphate and muriate of potash were the sources of P and K respectively in all the districts. In Alleppey and Quilon districts ammonium sulphate was applied in 3 equal doses, the first as basal and the remaining as top dressing at active tillering phase and the second at the panicle initiation stage, whereas in Palghat and Trichur districts urea was applied in two doses, two third as basal and

one third as top dressing at maximum tillering phase. Super phosphate, muriate of potash and zinc were applied as basal in all the districts. All other cultural and management practices were as adopted by the cultivators of the locality.

kharif.

The data on the response of rice to N and zinc are summarised in Table A.K.1 and graphical depiction of these are presented in Fig. VI(a) and (b).

During the kharif season T(N)1 in Alleppey District has positively and significantly responded to nitrogen upto 120 kg/ha in the presence of 60 kg P_2O_5 and 60 kg K_2O/ha, in all the three zones of Alleppey district. In zone III(Muthukulam and Bharanikkavu blocks) the response was significant even beyond 120 kg level. At the highest level of application of 160 kg N/ha the increase in response was 9 and 16 per cent in zone II (Pandalam and Kulanada blocks) and zone III respectively over the response obtained to 120 kg N/ha while in zone I(Koipuram and Mallappally) it was showing a negative trend. The additional response to 160 kg N/ha was 172, 202 and 152 per cent of that obtained at the lowest level of 40 kg N/ha in zone I, II and III respectively. The maximum response of 1711 kg/ha over a basal yield of 3280 kg/ha was obtained in zone III where the soil nitrogen level was low. Lack of significant response beyond 120 kg N/ha in the other two zones, might be due to the medium status of available nitrogen in the soil in these zones. The response due to 60 kg P_2O_5 and 60 kg K_2O/ha was positive and significant in all the three zones in the absence of nitrogen. With 160 kg N/ha the effects due to P_{90} and K_{90} was significantly superior to P_{60} and K_{60}, only in zone II which suggests that at the highest level of nitrogen the dose of P and K has to be increased to obtain significant response in this zone.

Fig. VI(a) Response of rice (TN 1) to Nitrogen in the presence of Phosphorus (60 kg/ha) and Potassium (60 kg/ha)in Alleppey Dt during kharif 1971-72.

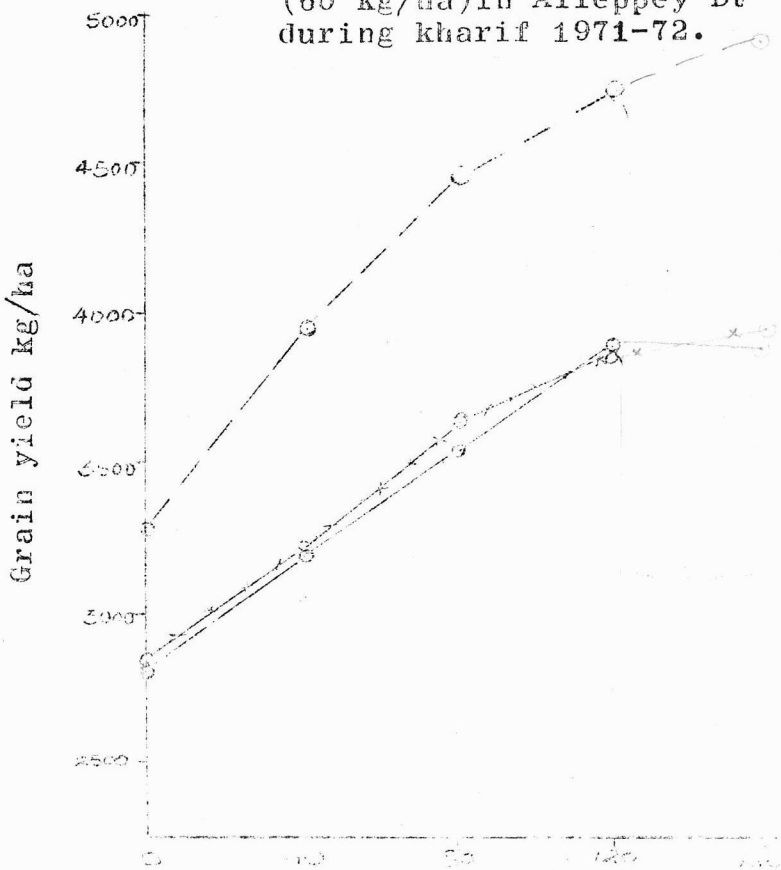


Fig. VI(b) Response of rice (IR.8) to Nitrogen in the presence of Phosphorus (60 kg/ha) and Potassium (60 kg/ha)in Palghat District during kharif 71-72.

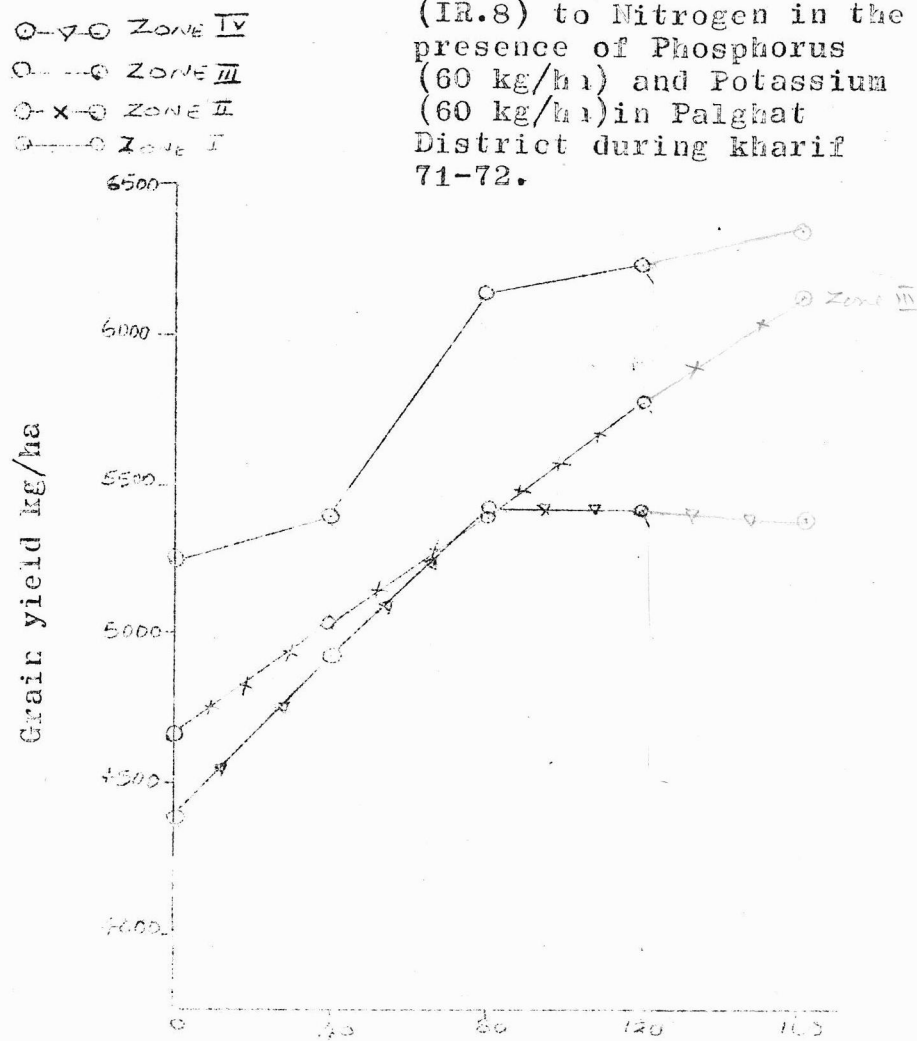


Table A.K.1 Response to Nitrogen(kg/ha) in the presence of phosphorus and potassium

strict	Variety	Zone (b)	No.of trials	Mean yield T_1 (a)	Mean yield T_2	Response to nitrogen N_{40} (T_3-T_2)	N_{80} (T_4-T_2)	N_{120} (T_5-T_2)	N_{160} (T_6-T_5)	Zinc (T_7-T_5)	T_8 (T_8-T_1)	Nutrient index O.C	P	K	S.E of response	CD (.05)
leppey	T(N)1	I	15	2593	2787	400	746	1113	-23	-10	1373	1.95	1.10	1.08	68	133
		II	17	2575	2817	390	813	1076	102	320	1624	1.80	1.66	1.20	101	197
		III	13	2885	3280	680	1198	1479	232	60	2175	1.18	2.40	1.18	43	84
lghat	IR.8	I	16	5019	5258	639	875	980	221	87	1548	1.41	2.00	1.96	180	352
		III	12	4347	4667	369	721	1110	727	363	2046	1.80	1.69	2.04	132	258
		IV	13	4239	4378	551	1011	1042	-45	-74	1194	2.34	1.82	2.50	209	409

(a)

T_1	-	N_0	P_0	K_0	T_5	-	N_{120}	P_{60} K_{60}
T_2	-	0	60	60	T_6	-	160	60 60
T_3	-	40	60	60	T_7	-	120	60 60 + Zn
T_4	-	80	60	60	T_8	-	160	90 90

(b) Alleppey district

I. Koipuram, Mallappalli
II Kulanada, Pandalam
III Muthukulam, Bharanic[illegible]uvu

Palghat district

I Trithala, Pattambi
III [illegible]
IV Mannarghat, Sreekrishra[illegible]a, Ottappalam, Palghat

In Palghat district, IR.8 has responded to nitrogen upto the highest level of nitrogen in Zone I (Trithala and Pattambi blocks) and Zone III(Ottappalam and Palghat blocks) and upto 120 kg N/ha in Zone IV(Sreekrishnapuram and Mannarghat blocks) of Palghat district during the kharif season(Table A.K.1). The additional responses obtained at 160 kg N/ha were 83, 397 and 81 per cent in zones I, III and IV respectively over that obtained at 40 kg N/ha. The maximum response of 1837 kg/ha over a basal yield of 4667 kg/ha was obtained in zone III where responses to successive doses of nitrogen was significant upto the highest level of nitrogen. Although an increase in yield was observed with increase in the level of nitrogen in the other two zones, the difference in yield due to successive doses of nitrogen was not significant beyond 40 kg N/ha in zone I and beyond 80 kg N/ha in zone IV. The influence of P and K each at 60 kg/ha as P_2O_5 and K_2O on grain yield in the absence of nitrogen was significant only in zone III. The response was least in zone IV. With 160 kg N per ha the response to P_{90} and K_{90} was significantly superior to P_{60} and K_{60} in zone III only, where a significant response to P and K was registered in the absence of nitrogen.

In Alleppey district the response due to the application of 25 kg zinc sulphate/ha over the basal dose $N_{120}P_{60}K_{60}$ was significant only in zone II comprising Kulanada and Pandalam blocks. An additional yield of 320 kg/ha was obtained in this zone. In zone I there was a slight reduction in yield, while in zone III there was positive increase in yield but this was not significant.

The effect due to the application of zinc was also significant in zone III of Palghat district, the additional response being 363 kg/ha. In the other two zones the responses were not significant.

In both the districts response to zinc was observed in those zones where significant responses were also obtained to P_{60} and K_{60} applied in the absence of nitrogen and also to P_{90} and K_{90} in the presence of 160 kg N/ha.

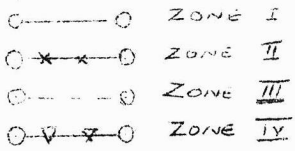
The data on responses to P and K are given in Table 3(X)1 and the trend is presented in Figure VII(a), (b), (c) and (d). In all the zones of Alleppey district the grain yield increased with increasing level of P (Table B.K.1) but at a reduced rate beyond 120 kg P_2O_5/ha. The response to successive doses viz., 60 kg P_2O_5, 120 kg P_2O_5 and 180 kg P_2O_5/ha was significant upto the highest level in zone I. In zone II the response was not significant at the lowest level, whereas at 120 kg P_2O_5 level the increase over the lowest dose was significant. The maximum response of 1477 kg/ha over the basal yield of 3603 kg/ha was obtained in zone III where the nutrient status of the soil with regard to available P was high. But the consistent and significant response upto the highest level of P_2O_5 was observed in the zone where the available P in the soil was very low. Thus irrespective of the quantity of available P in the soil, significant response to P_2O_5 was observed in all the zones in the district. A comparison of the response to N 120/haTable A.K.1) and the response to 120 kg P_2O_5/ha (Table B.K.1) shows that response to P at 120 kg level was almost equal to that for N applied at 120 kg level in zones I and III of Alleppey district.

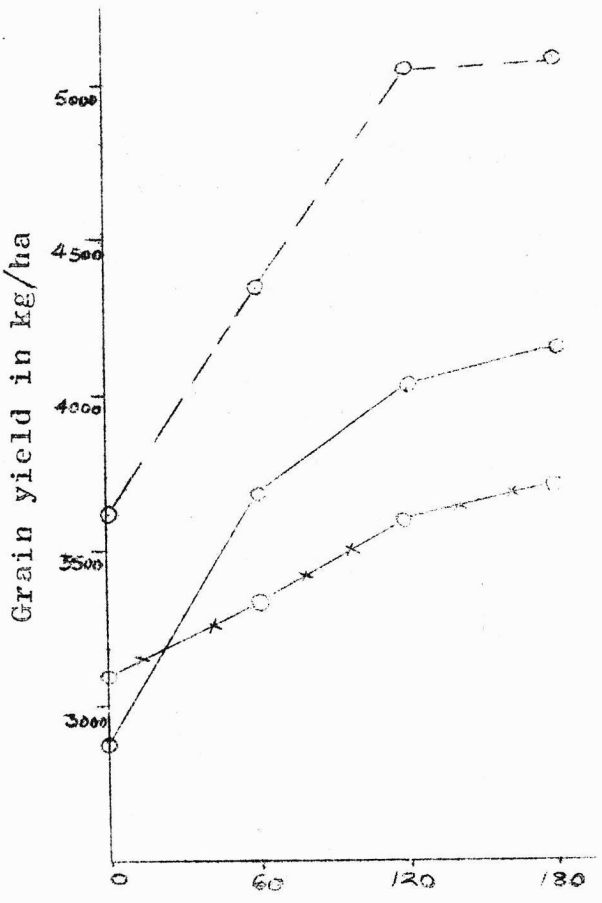
The response due to phosphorus was not significant at any of the levels tried in zones I and IV of Palghat district (Table B.K.1). In zone III the response was significant at 120 kg level but there was a depression in yield at the higher dose. The absence of good response to P in all the zones might be due to the medium status of available P in the soils of these zones.

Fig.VII. Response of rice to phosphorus(kg/ha) in the presence of nitrogen(120 kg/ha) and potash(60 kg/ha)

(a) TN(1) in Alleppey District Kharif 1971-72.

(b) IR.8 in Palghat District Kharif 1971-72.





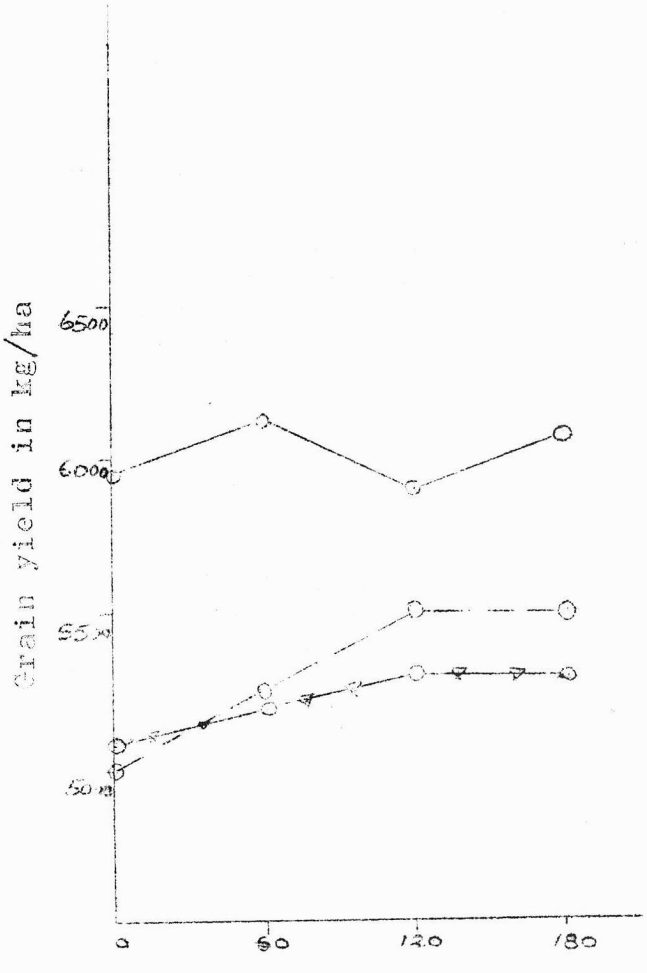


Fig. VII Response of rice to potash in the presence of nitrogen (120 kg/ha) and phosphorus (120 kg/ha)

(c) TN(1) in Alleppey District - Kharif 1971-72

(d) I.R.8 in Palghat District - Kharif 1971-72

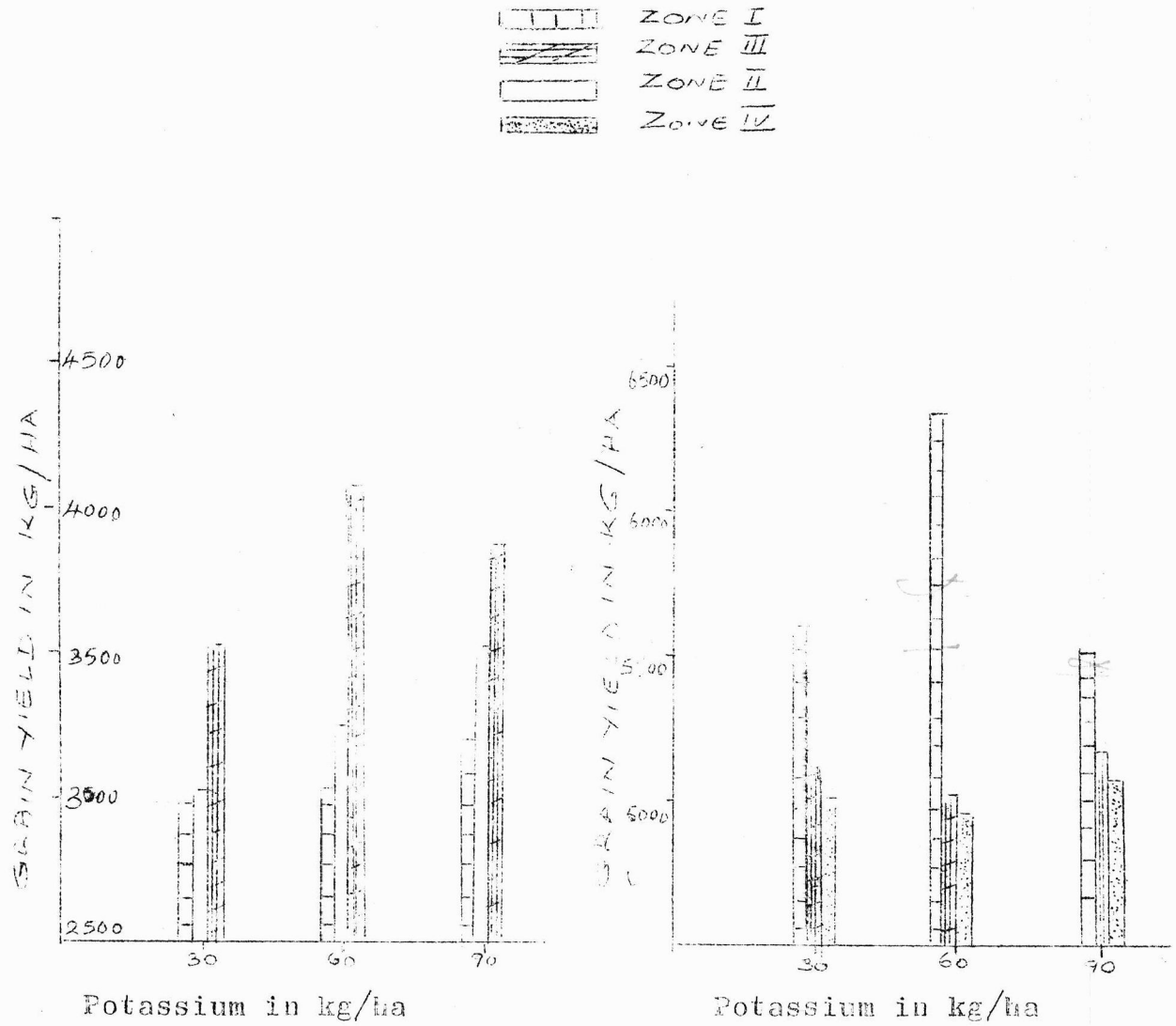


Table B.K.1 Response(kg/ha) of rice to phosphorus in the presence of nitrogen and potassium and to potash in the presence of nitrogen and phosphorus.

District	Variety	Zone	No.of trials	Mean yield in kg/hectare			Response in kg/hect						T_2	T_{10}	Nutrient index			SE of response	CD (0.05)
				T_1 (a)	T_2	T_3	Phosphorous $P\frac{1}{2}b$ T_4-T_3	Pb T_5-T_3	$P1\frac{1}{2}b$ T_6-T_3	Potash $K\frac{1}{2}b$ T_8-T_7	Kb T_5-T_7	$K1\frac{1}{2}b$ T_9-T_7	T_2-T_1	$T_{10}-T_1$	O.C	P	K		
Alleppey	TN(1)	I	15	2567	2803	2882	811	1161	1282	99	161	330	236	1778	1.95	1.19	1.58	69	137
		II	16	2606	2934	3233	87	486	597	88	17	295	378	1575	1.80	1.66	1.80	138	199
		III	18	2857	3212	3603	742	1456	1477	168	491	271	355	2027	1.18	2.40	1.43	74	145
Palghat	IR 8	I	15	5196	5762	5940	173	-88	139	-345	-612	-448	566	1227	1.41	2.0	1.86	1.93	378
		III	16	4324	4950	5000	244	501	486	116	14	173	626	1661	1.80	1.39	2.04	129	252
		IV	15	4482	5120	5201	-13	100	90	-193	-251	-139	638	929	2.34	1.82	2.50	166	325

(a) T_1 - N_0 P_0 K_0

T_2 - 120 0 0

T_3 - 120 0 60

T_4 - 120 60 60

T_5 - 120 120 60

T_6 - N_{120} P_{180} K_{60}

T_7 - 120 120 0

T_8 - 120 120 30

T_9 - 120 120 90

T_{10} 120 180 90

The nature of response to potash was not uniform in zones I and II of Alleppey district (Table B.K.1) where the soils are low in available K. In zone I the response was linear and positive upto 90 kg K_2O/ha and significant at 60 and 90 kg levels. In zone II the response was significant only at the highest levels. In zone II the response was significant only at the highest level (90 kg K_2O/ha) while in zone III the response was significant upto 120 kg level but beyond this a reduction in yield was observed. Such a behaviour in the latter zone might be due to the medium status of available K in the soil.

The response due to phosphorus on grain yield was not significant at any of the levels in zone I and IV of Palghat district (Table BK.1). In zone III the response was significant at 120 and 180 kg level but the maximum response was obtained at 120 kg level. Soils in all the zones are medium as regards available phosphorus and probably this might be the reason for not obtaining good responses to added phosphorus in the different zones in the district.

The influence of different levels of potash on grain yield was negative in zone I and IV of Palghat district and a significant reduction in grain yield was recorded at K_{60} and K_{90} levels in zone I. The maximum reduction in grain yield was recorded at 60 kg P_2O_5/ha in this zone. Though positive, the response to different levels of K in zone III were not significant.

rabi:

The data on the response to nitrogen and zinc and phosphorus and potash obtained from the trials conducted during the rabi season in Quilon and Trichur districts are given in Tables A.R.1 and B.R.1 respectively.

Table A.R.1 Responses to nitrogen (kg/ha) in the presence of phosphorous and potash. Rabi 1971-72

stri-	Vari- ety.	Zone (b)	No.of trials	Average yield (kg/ha) T_1 (a)	Average yield (kg/ha) T_2	Response to nitrogen N_{40} T_3-T_2	Response to nitrogen N_{80} T_4-T_2	Response to nitrogen N_{120} T_5-T_2	Response to nitrogen N_{160} T_6-T_5	Zinc T_7-T_5	T_8 T_8-T_1	Nutrient index O.C	Nutrient index P	Nutrient index K	SE	C.D (5%)
ilon	Jaya	I	16	3417	4104	327	746	961	85	305	1986	2.75	1.26	2.00	120	233
		II	17	3180	3491	339	771	1204	177	85	1700	2.38	2.00	1.25	134	266
		IV	10	2226	2285	183	373	573	125	44	848	1.20	1.75	1.60	96	189
ichur	IR.8	I	12	4319	4822	228	830	760	476	282	1630	1.85	1.68	2.06	174	344
		II	13	3537	3894	284	744	934	70	203	1726	1.37	1.51	1.99	115	227
		III	12	2874	3656	74	488	335	-101	-18	1099	2.03	2.21	1.94	146	290

(a) T_1 - N_0 P_0 K_0

T_2 - N_0 P_{60} K_{60}

T_3 - N_{40} P_{60} K_{60}

T_4 - N_{80} P_{60} K_{60}

T_5 - N_{120} P_{60} K_{60}

T_6 - N_{160} P_{60} K_{60}

T_7 - N_{120} P_{60} K_{60} + 25 kg zinc sulphate

T_8 - N_{160} P_{90} K_{90}

(b) For details of zones refer Table III (page 3)

Fig.VIII(a) Response of rice(Jaya) to nitrogen in the presence of phosphorus(60 kg) and potassium (60 kg/ha)in Quilon district during rabi 1971-72.

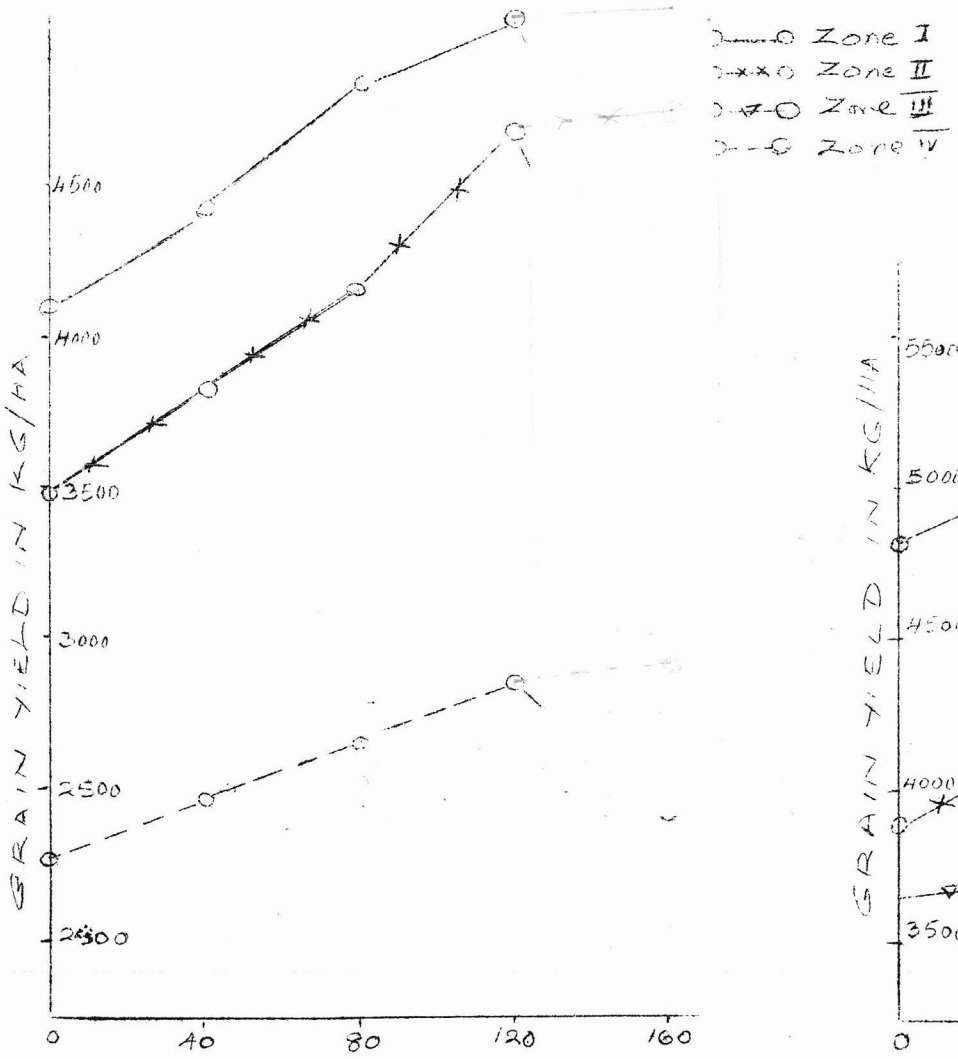
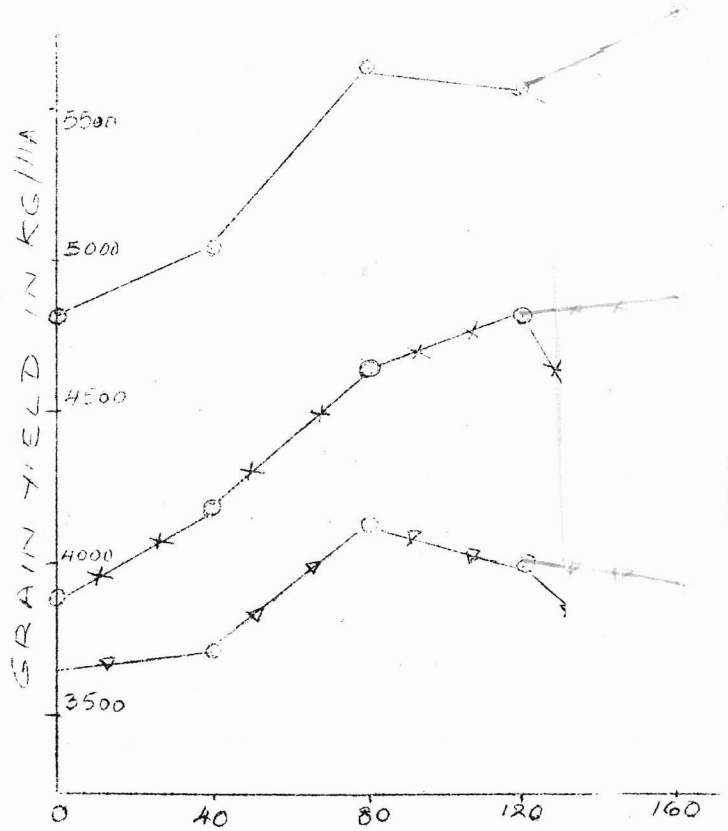


Fig.VIII(b) Response of rice(IR.8) to nitrogen in the presence of phosphorus(60 kg) and potassium (60 kg/ha) in Trichur district during rabi 1971-72.



Responses to nitrogen have been depicted in Fig.VIII(a) and (b) while the responses to phosphorus and potash are presented in Fig;IX(a) to (d).

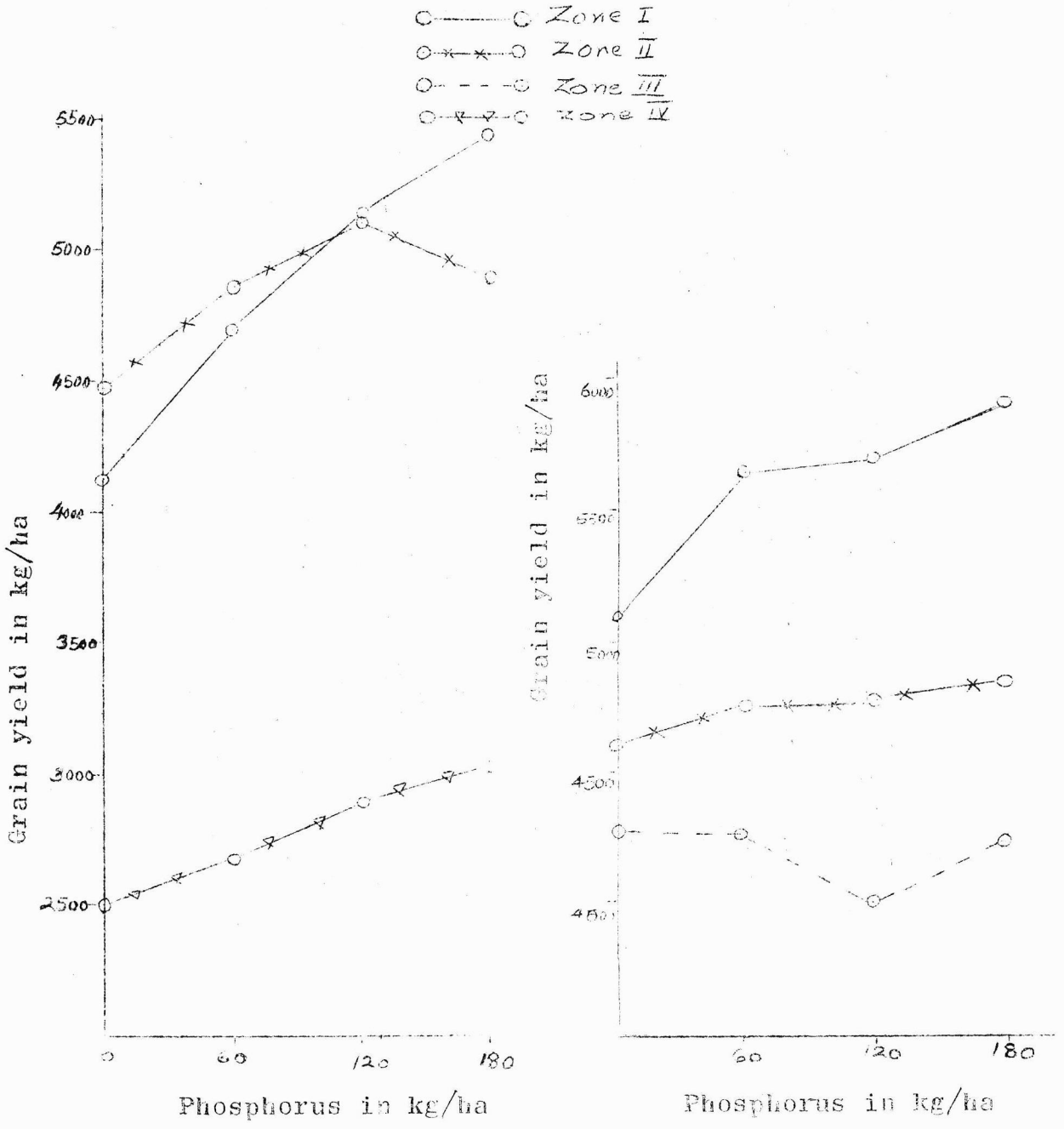
In Quilon district the variety Jaya responded to nitrogen in the presence of phosphorus and potassium each at 60 kg/ha upto 160 kg level in all the zones during rabi season but the response over 120 kg level was not spectacular (Table A.R.1). The response over successive doses of nitrogen was significant only upto 120 kg level in zone I and II while this was registered upto 160 kg level in zone IV. The maximum response was obtained in zone II, the response to 160 kg N/ha over that of 40 kg N/ha being 300 per cent. In zone I when the dose of P and K was increased to 90 kg without any change in the level of nitrogen, the increase in yield over N_{160} P_{60} K_{60} was significant. This indicates that at higher level of nitrogen the dose of P and K has also to be increased to get the maximum response to nitrogen in this zone.

In Trichur District the yield of IR.8 increased with an increase in the dose of nitrogen upto the highest level of nitrogen(160 kg N/ha) over the basal dose of 60 kg of P_2O_5 and K_2O/ha in zone I and II (Table A.R.1); but in zone III the maximum increase was at 80 kg level. Beyond this level, the response had decreased with increase in the level of nitrogen. The response due to nitrogen at the lowest level was not significant in any of the zones except zone II, while this was significant beyond 40 kg level in all the zones except zone III. However the difference in response due to successive doses were not significant beyond 80 kg level in all the zones. When the P and K doses were raised to 90 kg level keeping the level of nitrogen at 160 kg N/ha, significant increase in yield over that of treatment No.6 ($N_{160}P_{60}K_{60}$) was obtained.

Fig.IX Response of rice to phosphorus (kg/ha) in the presence of nitrogen (120 kg/ha) and potash (60 kg/ha)

(a) Jaya in Quilon District Rabi 1971-72

(b) IR.8 in Trichur District Rabi 1971-72



Significant positive response to zinc (25 kg zinc sulphate over a fertilizer level of N_{120} P_{60} K_{60}/ha) was observed in zone I of Quilon district. A maximum response of 305 kg/ha was obtained in this zone. In all the other zones of this district the responses were either negative or positive and was of a relatively low order and were nonsignificant. Here also, as was observed in Alleppey and Palghat districts, the response to zinc was obtained in the zone where significant response was registered to the highest level of N (160 kg N/ha) in combination with a higher dose of P and K(P_{90} and K_{90}/ha) over that of the same level of N in conjunction with a lower dose of P and K (60 and 60 kg/ha).

Jaya responded to P positively and significantly upto the highest level of P (180 kg P_2O_5/ha) in all the zones in Quilon district (Table B.R.1). The response was linear in zone I and IV while in zone II the maximum response was observed at 120 kg level but beyond that level the response decreased. In zone I where the status of P was medium the response was of a high order and at 120 kg level it was almost double of the response obtained at 60 kg level. The differences in responses over the successive doses of P_2O_5 was significant in all the zones. The low response obtained in zone IV might be due to the low status of available P.

Fig.IX Response of rice to potash in the presence of nitrogen(120 kg/ha)and phosphorus (120 kg/ha)

(c)Jaya in Quilon District rabi 1971-72

(d) IR.8 in Trichur District rabi 1971-72

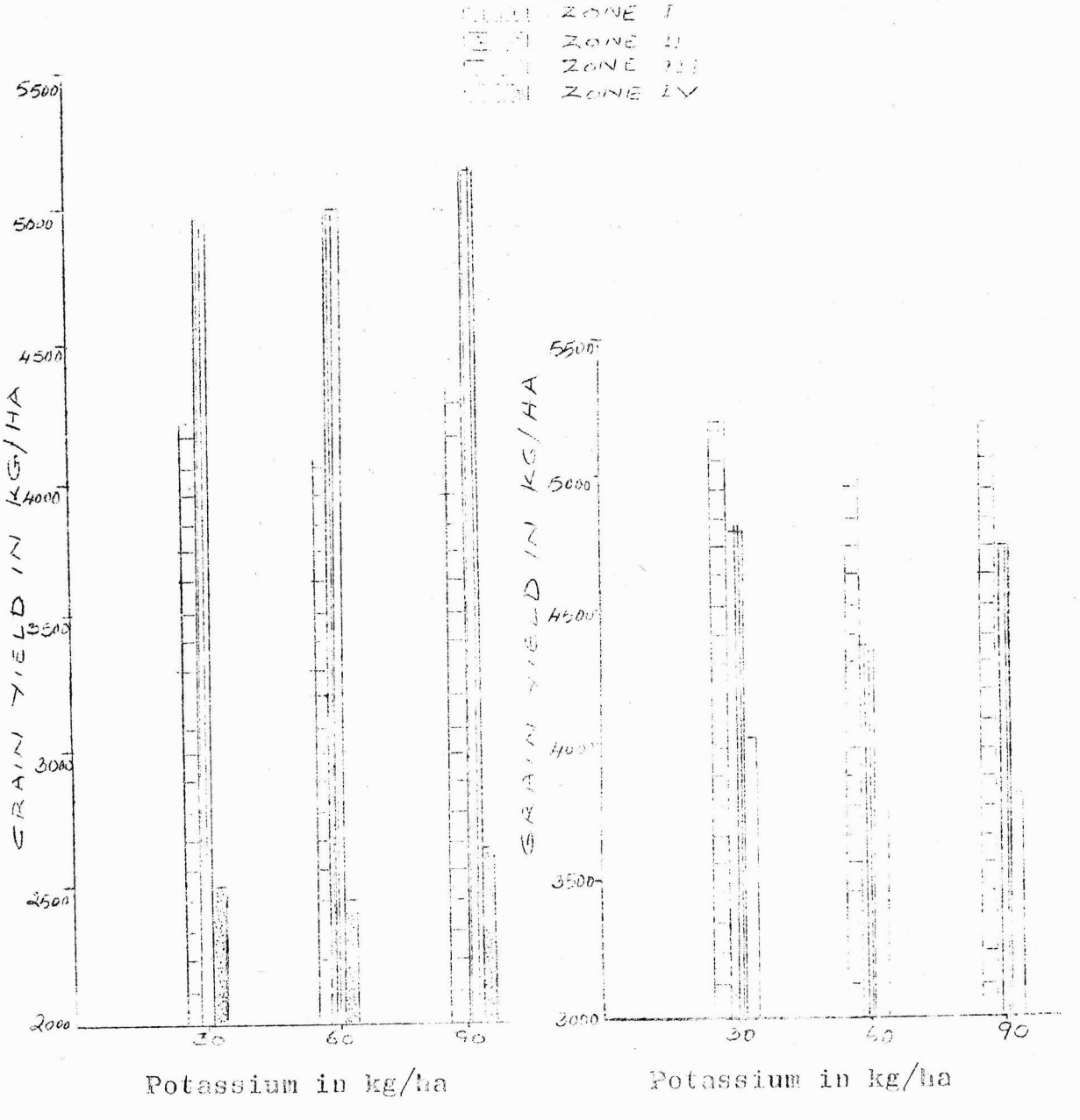


Table B.R.1 Response(kg/ha) to phosphorous in the presence of nitrogen and potassium and to potash in the presence of nitrogen and phosphorus.

District.	Variety.	Zone	No.of trials	Mean yield T_1 (a)	T_2	T_3	Response (kg/ha) to Phosphorous $P\frac{1}{2}b$ T_4-T_3	Pb T_5-T_3	$P1\frac{1}{2}b$ T_6-T_3	Potash $K\frac{1}{2}b$ T_8-T_7	Kb T_5-T_7	$K1\frac{1}{2}b$ T_9-T_7	T_2-T_1	$T_{10}-T_1$	Nutrient index O.C	P	K	SE	CD (0.05
Quilon	Jaya	I	16	3518	3897	4119	698	1142	1382	90	-20	228	379	2214	2.75	1.26	2.00	109	218
		II	18	3759	4284	4462	392	638	485	510	551	697	525	1725	2.38	2.00	1.25	97	194
		IV	16	2300	2409	2487	191	403	541	12	-49	211	109	917	1.20	1.75	1.60	31	62
Trichur	IR8	I	15	4588	5104	5217	428	483	693	-11	-235	-25	516	1378	1.85	1.68	2.06	186	364
		II	16	3703	4494	4600	160	173	247	205	-239	134	791	1625	1.37	1.51	1.99	132	258
		III	11	3127	3856	4271	-11	-363	-22	-230	-504	-448	729	2113	2.03	2.21	1.94	646	126

(a) T_1 N_0 P_0 K_0

T_2 N_{120} P_0 K_0

T_3 N_{120} P_0 K_{60}

T_4 N_{120} P_{60} K_{60}

T_5 N_{120} P_{120} K_{60}

T_6 N_{120} P_{180} K_{60}

T_7 N_{120} P_{120} K_0

T_8 N_{120} P_{120} K_{30}

T_9 N_{120} P_{120} K_{90}

T_{10} N_{120} P_{180} K_{90}

Significant positive response to phosphorus was obtained at all the 3 levels (60, 120 and 180 kg P_2O_5/ha) in zone I only of Trichur district (Table B.R.1), where the P status was medium. Although the response was positive at all levels in zone II, it was significant only at the highest level. The magnitude of response to different levels of P in this zone when the P status was low was lower than that obtained in zone I where the P status was medium. In the zone III, the response was negative and non-significant at all levels of P.

Positive and significant response to potassium was observed upto the highest level in zone II only of Quilon district but the difference over successive doses was not significant. In zone I and IV the significant response was obtained only at the highest level.

Response to potassium was positive in zone II of Trichur district at 30 and 120 kg K_2O/ha only. In the other zones the response was negative and not significant.

It will be interesting to note that when the responses to different levels of potassium namely 30, 60 and 90 kg K_2O/ha in the presence of nitrogen and phosphorus each at 120 kg/ha are compared, the minimum response is observed at the intermediate level (60 kg/ha), irrespective of the fertility status of the soil in all the zones of Quilon and Trichur district. The same trend could also be seen in all the zones of Palghat and in one zone of Alleppey districts. A deeper study is required for a satisfactory and convincing explanation for this behaviour.

C.TYPE TRIALS

Kharif:

The response of rice to phosphorus and potassium observed during the kharif season in the different fertility classes are given in Table C.K.1.

Positive response to nitrogen in the absence of P and K was observed in Alleppey district in the LL, ML and HL fertility classes, but it was significant only in the ML class. The maximum response was also observed in this fertility class whereas the minimum response was in the LL class. Response to phosphorous was negative in all the fertility classes and levels of P_2O_5 except in LL class at 50 kg level and in ML class at 100 kg level. But the response was non-significant in all cases. Positive response to K was observed in all the fertility classes and at all levels, but the response was significant only at the highest level (150 kg K_2O/ha) in LL and HL classes. In the ML class response to successive doses of K was significant. The maximum response (23 kg grain/per kg of K_2O) was obtained at 90 kg, but in the LL class while it was almost equal(16 kg grain/kg of K_2O) in the other two fertility class.

IR.8 responded to nitrogen at 120 kg level positively and significantly in the absence of P and K in Palghat district in the LL and LM fertility (Table C.K1). The maximum response was in the LL class. The response to P was positive but it reached the significant level only from 60 kg in both the fertility classes. The maximum response to the different levels were observed in the LL class. The response to K was positive at all levels in both the fertility classes except at K_{60} level, in the LL class, where this response was negative. The responses were non-significant in both classes at different levels. The maximum response was observed in the LL class and this may probably due to the low potash status of the soil.

Response (kg/ha) to phosphorous in the presence of nitrogen and ~~potashium~~ potash and to potassium in the presence of nitrogen and phosphorus in different PK fertility classes.

d	Response in kg/ha						T_2	T_{10}	SE	CD
	Phosphorous			Potassium						
T_3	$P\frac{1}{2}b$	Pb	$P1\frac{1}{2}b$	$K\frac{1}{2}b$	Kb	$K1\frac{1}{2}b$	(T_2-T_1)	$(T_{10}-T_1)$		(0.05)
4571	50	-451	-417	664	370	2032	286	3066	527	1032
4238	-16	350	-336	478	886	1444	495	2477	208	407
5373	-139	-779	-762	257	163	1454	439	2350	499	978
5818	212	505	452	246	139	225	1128	1598	196	384
5567	130	300	347	214	-5	128	845	1531	135	264

P_0	K_0	T_6	$N_{120}P_{150}K_{60}$
P_0	K_0	T_7	120 [illegible] 0
0	60	T_8	120 [illegible] 30
[illegible]	60	T_9	120 [illegible] 90
[illegible]	60	T_{10}	120 [illegible] 90

As in Table B.K.I (P.1a)

binations for Palghat district on basis
P_2O_5/ha

Rabi

Irrespective of the P and K fertility status of the soil there was positive response to nitrogen without P and K in all the fertility classes in Quilon District(Table C.R.1) The response to P was positive and significant and showing a linear trend in soils with low P, while a negative trend was observed in soils testing medium in P. In Trichur district on the other hand, a negative trend in response to P was observed at the lowest level, while at the successive higher levels the response was positive in soils testing low in P. The maximum response, however, was obtained at the intermediate level. The response to potash was erratic in both the districts. Even in soils testing low in K and P negative trend in response was observed at almost all levels of K.

Table C.D.1 Response (kg/ha) to phosphorus in the presence of nitrogen and potash and to potash in the presence of nitrogen and phosphorus in different fertility classes during the rabi season.

District	Variety.	Fertility class	No.of trials	Mean yield in kg/ha			Response in kg/ha						T_2	T_{10}	
							Phosphorous			Potassium					
				T_1 (*)	T_2	T_3	$P\frac{1}{2}b$	Pb	$P1\frac{1}{2}b$	$K\frac{1}{2}b$	Kb	$K1\frac{1}{2}b$	(T_2-T_1)	$(T_{10}-T_1)$	SE
Quilon	Jaya	LL	5	3267	3711	3651	359	702	989	-405	-91	-380	444	1553	91
		ML	5	3287	3588	3899	276	165	335	36	-37	127	301	1172	352
		MM	8	3485	3686	3568	252	491	749	199	-371	385	401	1851	217
		HM	1	2750	2750	3000	-500	-	-125	250	250	125	-	250	-
		HH	2	3000	3875	3750	-125	-125	-125	-187	-312	313	875	1375	192
Trichur×	IR8	LL	6	3360	4097	4661	-108	105	96	-153	-28	52	737	1188	171
		LM	4	2906	3396	3885	-43	436	369	-61	151	-127	490	1475	234
		ML	4	3656	4170	4472	30	18	-151	66	-236	-133	514	877	256
		MM	4	4073	4762	5028	-6	-36	283	139	-30	532	689	1032	171
		HL	1	4037	4230	4932	-340	-605	-242	-145	97	630	207	73	

	N	P	K
T_1	N_0	P_0	K_0
T_2	120	0	0
T_3	120	0	60
T_4	120	30	60
T_5	120	60	60
T_6	120	90	60
T_7	120	60	0
T_8	120	60	30
T_9	120	60	90
T_{10}	120	90	90

* Pb for Trichur district = 60 kg/ha

Economic Analysis

The most economic dose of nitrogen in combination with 60 kgs each of P_2O_5 and K_2O/ha for T(N)1 during Kharif season for maximising the return per rupee invested in fertilisers was found to be 120 kg N/ha in zones I and II and to be 80 kg N/ha in zone III of the Alleppey district.

Table E.A.1(a) Economics of fertilizer application in A type experiments conducted in 1971-72.

Season	District	Variety	Zone	Return per rupee invested, from treatments			
				$N_{40}P_{60}K_{60}$	$N_{80}P_{60}K_{60}$	$N_{120}P_{60}K_{60}$	$N_{160}P_{60}K_{60}$
Kharif	Alleppey	TN1	1	1.16	1.41	1.59	1.32
			2	1.23	1.58	1.60	1.46
			3	2.09	2.38	2.28	2.16
	Palghat	IR8	1	1.80	1.80	1.59	1.61
			3	1.41	1.68	1.91	1.95
			4	1.41	1.86	1.58	1.29
Rabi	Quilon	Jaya	1	1.97	2.14	2.00	1.77
			2	1.26	1.62	1.84	1.73
			4	.47	.65	.77	.78
	Trichur	IR8	1	1.49	2.15	1.68	1.98
			2	1.30	1.77	1.72	1.55
			3	1.75	1.90	1.49	1.16
		Triveni	1	-	1.00	.83	.57
			3	1.43	1.80	1.18	1.20

Price of N/kg 2.10 as urea(Palghat & Trichur dist)
2.50 as amm.sulphate(Alleppey & Quilon districts)
P/kg 2.80 as super phosphate
K/kg 1.10 as muriate of potash
Price of rice 65/- rupees per quintal.

A return of 1.59 Rs, 1.60 Rs, and 2.28 Rs. per rupee invested in fertilisers has been obtained in zone I, II and III respectively.

In Palghat district for the variety IR.8, the maximum return of Rs.1.80 was been obtained from 40 kg N/ha in zone I, Rs.1.95 under 160 kg N/ha and Rs.1.86 under 80 kg N/ha in conjunction with 60 kg P_2O_5 and K_2O/ha in zones III and IV respectively. During rabi season Jaya yielded the maximum return of 2.14 Rs. per invested rupee as fertilizers, when 80 kg N/ha was applied along with 60 kg of P_2O_5 and K_2O/ha in zone I of Quilon district while the maximum return(1.84 Rs./rupee) was under 120 kg N/ha in zone II. In zone IV, application of fertilisers has resulted in loss, although there was significant response to nitrogen under all the levels tried. The loss was due to the relatively low order of response. There was however, a progressive decrease in the loss with increase in the level of nitrogen.

In zone II of Alleppey and Palghat districts and zone I of Quilon and Trichur districts the maximum return per rupee was obtained when 25 kg of zinc sulphate was applied along with $N_{120}P_{60}K_{60}$ (Table E.A.1(b)).7 In some other zones of these districts, though the income per hectare obtained when zinc was applied was relatively more this was not of such a magnitude as to be more economical than the latter treatment.

Table E.A.1(b) Economics of fertilizer application in conjunction with zinc in A type experiments conducted in 1971-72.

Season	District	Variety	Zone	Additional income over control in Rs/ha*		Return per rupee invested, from treatments (*)	
				N_{120} P_{60} K_{60}	$N_{120}P_{60}K_{60}$ + 25 kg zinc	N_{120} P_{60} K_{60}	$N_{120}P_{60}K_{60}$+ 25 kg zinc sulphate
Kharif	Alleppey	TN1	1	850	843	1.59	1.36
			2	857	1065	1.60	1.72
			3	1218	1257	2.28	2.03
	Palghat	IR8	1	773	829	1.59	1.45
			2	929	1165	1.91	2.04
			3	768	720	1.58	1.26
Rabi	Quilon	Jaya	1	1071	1269	2.00	2.05
			2	984	1040	1.84	1.68
			4	410	439	0.77	0.71
	Trichur	IR.8	1	820	1004	1.68	1.76
			2	839	971	1.72	1.70
			3	726	714	1.49	1.25
		Triveni	1	403	482	0.83	0.85
			2	577	568	1.18	0.92

* based on costs indicated in Table E.A1(a)

In Alleppey district for TN(1) the maximum return per rupee invested on fertilisers was obtained from the treatment N_{120} P_{120} K_{90} (Table E.B.1) in zones I and II and for N_{120} P_{120} K_{60} in zone III.

Table E.I.1 Economics of fertilizer application in B type experiments conducted in 1971-72.

Season	District	Variety	Zone	Return per rupee invested, from treatment *								
				$N_{120}P_0K_0$	$N_{120}P_0K_{60}$	$N_{120}P_{60}K_{60}$	$N_{120}P_{120}K_{60}$	$N_{120}P_{180}K_{60}$	$N_{120}P_{120}K_0$	$N_{120}P_{120}K_{30}$	$N_{120}P_{120}K_{90}$	$N_{120}P_{180}K_{90}$
Kharif	Alleppey	TN1	I	.51	.56	1.37	1.37	1.19	1.34	1.37	1.45	1.28
			II	.82	1.11	.87	1.03	.91	1.13	1.15	1.23	1.13
			III	.77	1.33	1.81	2.04	1.66	1.75	1.83	1.75	1.46
	Palghat	IR8	I	1.46	1.52	1.23	.85	.70	1.20	.97	.88	.93
			III	1.62	1.38	1.23	1.17	.90	1.29	1.34	1.26	1.36
			IV	1.65	1.47	.95	.81	.64	1.18	.92	.88	.71
Rabi	Quilon	Jaya	I	.69	.96	1.50	1.55	1.42	1.73	1.74	1.70	1.55
			II	1.13	1.24	1.33	1.24	.85	.80	1.26	1.31	1.24
			IV	.23	.33	.45	.54	.54	.65	.63	.75	.66
	Trichur	IR.8	I	1.33	1.28	1.41	1.10	1.04	1.48	1.39	1.25	1.04
			II	2.04	1.83	1.41	1.06	1.03	1.21	1.58	1.36	1.23
			III	1.87	2.33	1.51	.85	.88	1.70	1.20	.88	1.60
	Triveni		I	1.24	1.48	1.93	1.68	1.43	-	2.29	1.37	1.74
			III	1.47	1.28	1.09	.60	.58	1.03	.93	1.00	.80

* based on cost indicated in Table E.A.1(a).

In Palghat district (variety IR.8), the treatment $N_{120}P_{0}K_{60}$ gave the maximum return per rupee in zone I, while in zones III and IV the most economic treatment was $N_{120}P_{0}K_{0}$.

In Quilon district the maximum net return per rupee in zones I, II and IV were found from treatments $N_{120}P_{120}K_{30}$, $N_{120}P_{60}K_{60}$ and $N_{120}P_{120}K_{90}$ respectively, the variety being Jaya.

In Trichur district for IR.8, the treatments $N_{120}P_{120}K_{0}$, $N_{120}P_{0}K_{0}$ and $N_{120}P_{0}K_{60}$ gave the maximum net return per rupee in zones I, II and III respectively. For the variety Triveni in zones I and III the treatments $N_{120}P_{120}K_{30}$ and $N_{120}P_{0}K_{0}$ were most economic.

SUMMARY AND CONCLUSIONS:-

I Model Agronomic Experiments

These were conducted in the Karamana Centre (Trivandrum district).

1. Among the six crop rotation sequences tried (Experiment 1) to ascertain the production potential and economics of high intensity crop rotation with high yielding varieties, the sequential cultivation of Paddy--Paddy-Bhindi yielded the maximum output and income. The cultivation of a non-cereal crop during summer was found to be advantageous from the point of view of total production and income.

2. In the experiment (No.2) to study the direct, residual and cumulative effect of P, K and farmyard manure started on a fresh site in kharif 1971-72 season, direct response to P was negative in the kharif season but this trend was not revealed in the rabi season.

3. Experiment conducted to determine the response of high yielding varieties of rice to P and K in relation to their time of application (Experiment No.3), significant and positive response to potassium applied at 60 and 120 kg/ha was detected in the kharif season. Substantial response to potassium were also indicated in the rabi season. There was no response to P and the two methods of applying P and K did not show any differences.

4. Responses to nitrogen applied at 60 and 120 kg/ha were highly significant and positive both in the kharif and the rabi seasons. These were influenced by the application of potassium, the maximum grain yield being obtained for a combined application of 120 kg N/ha and 60 kg K_2O/ha. This N-K interaction was however not manifested in the rabi season. Response to potassium at 60 kg/ha was detected only in the rabi season.

5. The physical damage sustained by rice as a result of foliar application of urea (Experiment No.5) was progressively higher when the biuret contents in urea was 0.3% and above but a significant depression in grain yield was not registered on this account.

6. A study of the relative merits of different slow-release nitrogenous fertilizers (Experiment No.9) has revealed that AU-fertilizer to supply 100 kg N/ha was found to be better than sulphur coated urea and karanj cake.

II SIMPLE FERTILISER TRIALS.

Simple fertilizer trials in cultivators fields were conducted in Alleppey and Palghat districts in the kharif season and in Quilon and Trichur districts in the rabi season, to study the response of high yielding varieties of rice to N, P, K and zinc.

a) Responses to nitrogen.

Positive and significant responses to nitrogen upto 120 kg/ha over 60 kgs each of phosphorus and potassium/ha, were obtained in Koipuram, Mallappalli, Kulanada and Pandalam blocks of Alleppey district and in Sreekrishnapuram and Mannarghat blocks in Palghat district. In Muthukulam and Bharanickavu blocks of Alleppey district and in Trithala, Pattambi, Ottappalam and Palghat blocks of Palghat district, there was good response to nitrogen even at the highest level of 160 kg/ha. In Quilon district, response to nitrogen was recorded in all the zones upto 120 kg/ha, and there was additional response to 160 kg/ha of nitrogen in Karunagappalli and Cachira blocks. The response to nitrogen at 40 kg/ha was not significant in Trichur district except in Pazhayannur and Vadakkancherry blocks. The difference in response to N due to successive doses were not significant beyond 80 kg level in all zones of Trichur district.

b) Response to zinc:

Response to zinc at 25 kg/ha over a level of $N_{120} P_{60} K_{60}$ was significant in the following blocks.

Zone	Blocks	District
II	Pandalam, Kulanada	Alleppey
III	Ottappalam, Palghat	Palghat
I	Elanthoor, Konni	Quilon
I	Chowghat, Chowannur	Trichur

In all these blocks where responses to zinc was registered, responses were also detected to the highest level ofnitrogen(160 kg/ha) applied in conjunction with higher doses of P_{90}, K_{90} as compared to the lower doses of $N P_{60}, K_{60}$.

c) Response to phosphorus.

In Koipuram and Mallappalli blocks(Alleppey district) responses to successive doses of phosphorus at 60, 120, 180 kg was significant upto the highest level.

In the other zones these were significant only upto 120 kg/ha, irrespective of the level of available P. The extent of these responses was almost equal to that registered for nitrogen.

In Palghat district significant response upto 120 kg/ha was recorded only in Ottappalam and Palghat blocks.

In Quilon district, Jaya responded to P positively and significantly upto the highest level (180 kg/ha) in all the zones, the response being highest in Sasthamcotta and Vettikkavala blocks.

In Trichur district significant positive response was obtained to phosphorus at 60, 120 and 180 kg/ha in Pazhayannur and Vadakkancherry blocks. In Irinjalakuda and Chalakudy blocks, the response was negative.

d) Response to potash:

The nature of response to potash was not uniform in Alleppey district. In Koipuram and Mallappalli Blocks the responses were linear and positive upto 90 kg/ha while in Kulanada and Pandalam blocks, the significance was attained only at the highest level of 90 kg/ha. On the other hand the maximum response of 491 kg/ha was obtained at 60 kg level in Muthukulam and Bharanikavu blocks in Alleppey district and there was significant reduction at 90 kg level. The influence of different levels of potash on grain yield was negative in Trithala, Pattambi, Mannarghat and Sreekrishnapuram blocks of Palghat district, the maximum depression being registered at the intermediate level i.e. 60 kg K_2O/ha. In Quilon district positive response to Potash was indicated only in Sasthamcottah and Vettikkavala blocks and in Trichur district the response was significant only in Pazhayannur and Vadakkancherry blocks.

C type experiments:

Positive response to nitrogen in the absence of P and K was significant in Mavelikara block(Alleppey district) only in the ML fertility class. In Coyalmannam and Alathur blocks(Palghat district), this was significant both in LL and LM classes, the maximum being in the former. Irrespective of the fertility status of soils there was positive response to nitrogen in Kottarakara block(Quilon district). There was no response to P in Mavelikkara block(Alleppey district) while this was significantly positive at 60 kg/ha level in the LL, LM classes of Coyalmannam and Alathur blocks(Palghat district). In Kottarakkara block(Quilon district) the response to P was linearly positive and significant in soils testing low P while this trend was negative in soils with high P.

Positive response to potash was observed in LL, ML fertility classes in Mavelikkara block(Alleppey district) at the highest level of 180 kg/ha while in the ML class there was response to successive doses of K. In Coyalmannam and Alathur blocks(Palghat district) response was not evident to K while in Mavelikkara block(Quilon district) and Ollukara block(Trichur district) the response to potash was erratic.

Economic analysis:

The economic doses of nitrogen applied in conjunction with 60 kg P_2O_5 and 30 kg K_2O were as follows:

Economic dose	Blocks	District
40 kg/ha	Trithala, Pattambi	Palghat
80 kg/ha	Muthukulam, Bharanickavu	Alleppey
	Mannarghat, Sreekrishnapuram	Palghat
	Elanthoor, Konni and all blocks	Quilon Trichur
120 kg/ha	Koipuram, Mallappalli	Alleppey
	Sasthancotta, Vettikkavala	Quilon
160 kg/ha	Ottappalam, Palghat	Palghat

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APPENDIX I

LIST OF WORKERS

Sl.No.	Designation	Names	Date from	Date to
Staff at Headquarters				
1	Officer in charge	Dr.P.K.Vijayan	1--4-71	9--1-72
		Sri.N.Rajappan Nair	10-1-72	31-3-72
2	Assistant Chemist	Sri.N.N.Ramankutty	1--4-71	31-3-72
3	Statistical Officer	Sri.K.M.George	1--4-71	11-8-71
		Dr.C.C.Abraham	12-8-71	31-3-72
4.	Chemical Assistant	Sri.K.Chandrasekharan Nair.	1-4--71	10-5-71
		Vacant	11-5-71	4--6-71
		Smt.T.M.Mary	5--6-71	31-1-72
		Vacant	1--2-72	31-3-72
Model Agronomic Centre, Karamana				
1.	Assistant Agronomist	Sri.H.L.Rose	1--4-71	3--7-71
		Sri.J.Velayudhan Nair	4--7-71	22-12-71
		Dr.V.T.Alexander	22-12-71	31-3-72
SFT (HYVP)				
Palghat and Trichur Districts:				
	Research Officer	Sri.A.I.Thomas	1--4-71	31-3-72
Alleppey and Quilon Districts:				
	Research Officer	Sri.P.K.Chellappan Nair.	1--4-71	31-3-72

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