

# Direct and Cumulative Effects of Nitrogen, Phosphorus and Potassium on Rice

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It has been reported by several workers that the optimum fertiliser requirements for paddy vary from place to place.

Earlier work carried out by Anandan *et al.* (1943) at Aduthurai showed significant response to application of nitrogen at two levels viz., 20 and 30 lb per acre for the first and second crop paddy. However, Samad and Sahadevan (1952) got consistent response to nitrogen up to 60 lb per acre in North Kerala. Srinivasan and Rajagopalan (1956) obtained increasing economical yields with increasing doses of nitrogen upto 80 lb per acre with stiff strawed and non-lodging varieties like Basmathi 370. Similar results were also obtained by Negi and Singh (1956). The maximum potential experiments reviewed by Mariakulandai (1957) revealed that 60 lb nitrogen per acre was the maximum dose that could be profitably adopted. In the agronomic experiments carried out at Aduthurai during 1955-57 very high response of 35.5 lb and 28.25 lb grain per pound of nitrogen was recorded for 30 and 60 lb nitrogen levels respectively. Pawar (1959) also observed a mean response of 8.1 and 6.1 lb of grain per pound of nitrogen at 30 and 60 lb nitrogen levels. Singh and Singh (1962) obtained increasing yields upto

80 lb nitrogen per acre. Tomy (1963) also reported a linear response upto 60 lb nitrogen per acre for the variety PTB. 9. Potti (1964) found that the optimum dose of nitrogen for rice was 85.5 lb per acre.

Varying results have been reported by several workers on the effect of phosphorus on the yield of paddy. According to Sethi *et al.* (1952) there was little or no response to phosphorus in most of the rice stations in India. Mariakulandai (1957) also reported that the response to phosphatic manures was absent at Samalkot, Aduthurai, Pattambi, Thirukkuppam and Ambasamudram. However, increasing yields of paddy due to application of phosphorus have been reported by Verma (1960) Mukherjee (1957) and Ghose *et al.* (1960). Motiramani (1961) reported an average increase in yield of 360 and 425 lb of grain per acre when 30 and 60 lb of phosphorus were added.

Trials conducted in various places by several authors have revealed that potassic fertilisers have no response or only a negative response. Sethi *et al.* (1952) recorded lack of response to application of potash. Similar results were also observed by Mariakulandai (1957) in Madras, Abichandani (1959) in Cuttack and Pawar *et al.* (1960) in Hyderabad.

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Exhaustive trials carried out in the Agricultural Research stations at Pattambi, Mannuthy, Mankompu and Kayamkulam in Kerala State have revealed significant differences in the response due to different levels of nitrogen. Increasing doses of nitrogen upto 45 lb per acre increased the yield of paddy at Pattambi and Mannuthy. The differences in the response due to applications of 30 and 60 lb nitrogen per acre were also significant at Mankompu and Kayamkulam. Hence the present trial was undertaken with a view to studying the direct and cumulative response of paddy to applications of nitrogen, phosphorus and potassium at different levels.

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#### Experimental

A 3<sup>5</sup> confounded, factorial experiment was laid out. Pattambi strains viz., PTB 9 and PTB. 4, were used in this experiment during the first crop and the second crop seasons, respectively. A spacing of 9" x 9" with 2 seedlings per hill was adopted.

#### Treatments

Nitrogen	n <sub>0</sub> : 0 lb per acre
	n <sub>1</sub> : 30 lb per acre
	n <sub>2</sub> : 60 lb per acre
P <sub>2</sub> 0 <sub>5</sub>	p <sub>0</sub> : 0 lb per acre
	p <sub>1</sub> : 30 lb per acre
	p <sub>2</sub> : 60 lb per acre
K <sub>2</sub> 0	k <sub>0</sub> : 0 lb per acre
	k <sub>1</sub> : 30 lb per acre
	k <sub>2</sub> : 60 lb per acre
Farm yard manure	m <sub>0</sub> : 0 lb per acre
	m <sub>1</sub> : 5,000 lb per acre
	m <sub>2</sub> : 10,000 lb per acre

Phases of application of fertilisers and manures :

p<sub>1</sub> : Manuring every season

p<sub>2</sub> : Manuring in Rabi only

p<sub>3</sub> : Manuring in Kharif only

Plots of size 30' x 15'(gross) were laid out. Raised consolidated bunds were provided in between the plots. Irrigation and drainage channels were also laid out to irrigate and drain each plot separately.

#### Time and method of application of fertilisers and manures

Superphosphate and Muriate of potash were the sources of phosphorus and potash. The entire quantity of phosphorus and potash was applied as basal dressing just before the last puddling. Nitrogen in the form of Ammonium sulphate was applied broadcast as top dressing one month after planting. Farm yard manure was applied immediately after the first puddling.

#### Distribution of different treatments

The experiment comprised of only one replication of 243 plots in 9 blocks of 27 plots each. Out of the 243 plots, a set of 81 plots received manures and fertilisers during only one of the two crop seasons in a year. Another set of 81 plots received similar manurial treatments during the other season. Thus in Kharif, the 81 plots which received "Kharif season manuring" were not manured during the Rabi season. (During the Rabi season a bulk crop without the application of any fertiliser was grown in these 81 plots). Hence the residual effect of fertilisers was completely avoided. Similar rotational treatments were given in the other set of 81 plots of the Rabi season as well. These two sets of plots in their respective seasons of fertiliser application were named as "Direct phase" in this experiment. Thus in every season a set of 81 plots was not receiving any kind of manu-

rial application. Such a set of plots, after a direct phase in the previous season was known as the "Residual phase". The third set of 81 plots received manures and fertilisers during both the seasons. From the second season of the experiment these 81 plots were in the "cumulative phase" which indicated the cumulative effects of the nutrients applied.

## Results and Discussion

### 1. Direct phase

The effect of direct application of fertilisers could be studied since the manurial applications were made in the concerned plots only (81 numbers each) in that particular season. Effect of direct application of fertilisers on the yield of paddy is presented in Table I.

TABLE I  
Effect of Direct Application of Fertilizers\* on the Yield of Paddy  
(Yield in maunds per acre)

Season of the expt.	Yield with-out N	Response to N at 30lb/A. 60lb/A.		Yield with-out P <sub>2</sub> O <sub>5</sub>	Response to P <sub>2</sub> O <sub>5</sub> at 30lb/A. 60lb/A.		Yield with-out K <sub>2</sub> O	Response to K <sub>2</sub> O at 30lb/A. 60lb/A.	
First (Second crop)	17.7	1.6	4.0	17.3	4.0	2.8	18.6	1.0	1.9
Second (First crop)	21.8	1.9	6.8	22.3	4.7	5.6	26.0	-0.6	-0.2
Third (Second crop)	12.8	2.6	3.9	13.8	1.5	2.8	15.1	0.7	-1.0
Fourth (First crop)	17.8	4.1	5.0	20.9	4.4	5.5	22.8	2.2	1.8
Fifth (Second crop)	14.1	7.2	22.1	20.8	4.3	5.0	22.4	1.0	3.1
Sixth (First crop)	13.4	7.9	13.8	18.7	2.2	3.6	20.3	0.8	0.2
Seventh (Second crop)	12.7	8.0	17.2	19.9	1.8	1.8	21.6	-0.9	-0.6
Average for seven Seasons	15.8 (1301 lb)	5.2 (428 lb)	10.4 (865 lb)	19.1 (1571 lb)	3.3 (271 lb)	3.8 (313 lb)	21.0 (1728 lb)	0.6 (48 lb)	0.7 (57 lb)

An increase of 428 lb of grain per acre has been observed due to an application of 30 lb nitrogen per acre, whereas an application of 60 lb nitrogen per acre has given an increase of 856 lb of grain over an yield of 1301 lb per acre of grain obtained without the application of nitrogen. The agronomic experiments carried out at

Aduthurai during 1955-57 also revealed very high response of 1065 lb and 1696 lb of grain per acre for 30 and 60 lb nitrogen levels respectively. The differences in the response to nitrogen could be attributed either to the differences in the strains used or to the available nitrogen content of the soil.

In the present study the average additional response due to 30 lb and 60 lb levels of phosphorus is in the order of 271 lb and 313 lb per acre over the no phosphorus yield of 1571 lb per acre. As reported by several workers, the magnitude of response due to a difference of 30 lb phosphorus is much lower when compared to that of nitrogen at Karamana also. This might probably be due to a high status of available phosphorus in Karamana soils.

In the present investigation, it has been observed that the response to potash at either levels, viz., 30 lb and 60 lb per acre, is very poor. The additional yields over the control yield of 1728 lb of grain

obtained are only 48 lb and 57 lb per acre for 30 and 60 lb  $K_2O$  respectively. Lack of response to potash was also reported by several authors like Mariakulandai (1957), Abichandani (1959) and Pawar (1960). The low response due to application of potash could probably be attributed to a high status of potassium in the Karamana soils.

## 2. Cumulative phase

In this case, fertiliser applications were made in the same set of plots (SI numbers) in all the seasons continuously. The cumulative effect due to continuous application of fertilisers is presented in Table II.

TABLE II  
Cumulative Effect due to Continuous Application of Fertilizers to Paddy  
(Yield in maunds per acre)

Season of the expt.	Yield without N	Response to N at		Yield without $P_2O_5$	Response to $P_2O_5$ at		Yield without $K_2O$	Response to $K_2O$ at	
		30lb/A.	60lb/A.		30lb/A.	60lb/A.		30lb/A.	60lb/A.
First (Second crop)	17.7	1.6	4.0	17.3	4.0	2.8	18.6	1.0	1.9
Second (First crop)	24.4	3.0	4.3	24.1	4.6	3.6	26.2	1.9	0.0
Third (Second crop)	12.8	2.6	3.9	13.8	1.5	2.0	15.1	0.7	-1.0
Fourth (First crop)	17.2	4.6	16.3	20.4	5.0	6.4	23.2	1.2	1.7
Fifth (Second crop)	14.2	7.3	22.3	21.0	4.1	5.0	22.4	1.9	-6.8
Sixth (First crop)	13.5	8.1	14.0	19.1	2.1	3.3	20.5	0.7	0.4
Seventh (Second crop)	13.6	7.7	7.0	20.2	2.2	2.8	22.1	-0.4	-0.3
Average for seven Seasons	16.2 (1332 lb)	5.0 (401 lb)	10.3 (847 lb)	19.4 (1595 lb)	3.3 (272 lb)	3.7 (304 lb)	21.2 (1744 lb)	1.0 (82 lb)	-0.6 (-49 lb)

The data indicate that the difference in the cumulative effect of nutrients (the combined effect of direct application of fertilisers and the residual effect of fertilisers applied in the previous seasons) and the effect due to direct application of fertilisers avoiding the residual effect is not significant. Thus the present study also indicated that the average response on the yield of grain due to direct application of fertilisers in a single season and the cumulative effect due to continuous application of fertilisers in all the seasons are almost the same.

#### Economics

A steady increase in the net profit due to application of nitrogen was observed. Application of nitrogen alone at a level of 30 lb per acre gave a net income of Rs. 64 per acre whereas at 60 lb level the net income obtained was Rs. 125/- per acre. A reduction in the net profit was observed due to the increasing doses of phosphorus and potash.

#### Summary and Conclusions

A 3<sup>5</sup> factorial experiment was conducted at Karamana to study the direct and cumulative effects of nitrogen, phosphorus and potassium on paddy. Three levels each of the major nutrients were tried in the experiment. The experiment was repeated for seven seasons. Important conclusions drawn are summarised below:

Increase in the dose of nitrogen significantly increased the grain yield upto the maximum level of nitrogen, viz., 60 lb per acre tried in the experiment. The magnitude of increase in yield due to application of phosphorus was much lower than that of nitrogen. The response of potash on the yield of grain at either levels viz., 30 and 60 lb per acre was not significant. No significant difference in response on the

yield of grain due to direct application of fertilizers in a single season and the cumulative effect due to continuous application of fertilizers in all the seasons was observed. This indicated that there was no residual effect due to application of fertilizers in a continuously cropped land.

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