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Influence of Modes of Fertilizer Application on Nutrient Uptake and Yield of Paddy Grain and Straw

by

M. CHANDRASEKARAN[1] and D. RAJ[2]

Introduction: An attempt was made to study the influence of single, double and triple split applications of N, P and K on the uptake of these nutrients by paddy grain and straw and also its effect on paddy yield, in three representative paddy soils from Tamil Nadu, *viz.*, clay loam and sandy loam, collected from Coimbatore, Sirugamani and Tirurkuppam respectively.

Review of Literature: Udea and Shigematsu (1931) top dressed ammonium sulphate (10 g per 1/2000 acre pot) at 5 day intervals at successive stages during and after transplanting. They found that the highest grain yield was obtained in the case of the application made 10 days after transplantation and and the second highest with the application made 15 days after transplanting. Matsuki *et al.* (1941) reported that when the full dose of N was applied, the most effective stage of such application from the point of view of grain production was 10 days after transplanting. Hayashi *et al.* (1951) found that for grain production P was most efficient when applied on the 16th day after transplanting. Kiuchi (1951) showed that the application of K to rice in water culture (35–45) days before heading increased the number of grains and weight of 1000 grains. Fried and Broeshart (1963) observed that the application of P at later stages of growth after transplanting was almost, as effective as application at transplanting, the final yield not being affected. They concluded that phosphate applications might be made in a single dose at the time of transplanting.

Materials and Methods: A pot culture experiment was conducted using the three above mentioned soils. N, P and K were applied at the rate of 60 lb N, 45 lb P_2O_5 and 30 lb K_2O/acre as ammonium sulphate, single superphosphate and potassium sulphate, respectively. Green leaf manure in the form of *Gliricidia maculata* was applied at the rate of 5000 lb/acre as basal dressing for all the treatments. In the case of the first treatment (T1) all the N, P and K were applied as one single dose at the time of planting the seedlings. Double equal split applications, one at planting and the other 30 days afterwards, were adopted in the second treatment (T2). In the third treatment (T3) triple equal split applications were employed, the first at planting and the second and third, 30 and 45 days after planting, respectively.

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1. Assistant Lecturer in Chemistry and 2. Professor of Soil Science, Agricultural College and Research Institute, Coimbatore-3.

CO 29 paddy seedlings were raised in the nursery and 25 day old seedlings were transplanted at the rate of ten seedlings per pot in 5 holes. In each treatment the grain and straw were analysed for the content of N, P and K. Yield of both grain and straw were recorded separately for each treatment. N was estimated by Kjeldahl digestion and distillation method. P was estimated colorimetrically by Vandadomolybdate method. K was estimated in the triple acid digest using a Perkin-Elmer Flame photometer (Piper, 1950). Analysis of variance was worked out for the yields of grain and straw and also the uptake of N, P and K by grain and straw.

Results and Discussion: The uptake figures of N, P and K by grain and straw are given in Table 1 and 2, respectively. The yields of grain and straw are given in Table 3.

TABLE 1. *Uptake of N, P and K by grain (mgm/plant on moisture free basis)*

Soil	Treatment number	Nitrogen N	Phosphorus P_2O_5	Potassium K_2O
Coimbatore	T1	18.1	12.1	6.4
Coimbatore	T2	14.7	9.4	4.8
Coimbatore	T3	12.0	7.2	4.5
Sirugamani	T1	23.6	16.6	9.1
Sirugamani	T2	17.5	11.3	7.1
Sirugamani	T3	23.2	16.6	7.2
Tirurkuppam	T1	19.6	15.4	7.3
Tirurkuppam	T2	15.9	10.7	6.5
Tirurkuppam	T3	14.5	8.6	5.4

TABLE 2. *Uptake of N, P and K by straw (mgm/plant on moisture free basis)*

Soil	Treatment number	Nitrogen N	Phosphorus P_2O_5	Potassium K_2O
Coimbatore	T1	8.3	6.8	25.1
Coimbatore	T2	6.5	5.4	19.1
Coimbatore	T3	6.0	4.7	16.7
Sirugamani	T1	10.0	9.4	33.1
Sirugamani	T2	7.1	5.7	20.4
Sirugamani	T3	10.7	7.6	28.7
Tirurkuppam	T1	9.6	5.5	26.4
Tirurkuppam	T2	7.2	6.2	21.1
Tirurkuppam	T3	6.7	4.3	16.4

TABLE 3. *Yield of Paddy grain and straw (gm/pot)*

Soil	Treatment number	Grain	Straw
Coimbatore	T1	10.27	15.12
do	T2	8.42	12.73
do	T3	7.46	10.56
Sirugamani	T1	15.64	20.40
do	T2	11.97	13.95
do	T3	15.04	19.36
Tirurkuppam	T1	14.00	16.50
do	T2	10.46	12.89
do	T3	9.39	10.76

Uptake of nutrients by grain: The uptake of N, P and K by grain was maximum in loamy soil, followed by sandy loam, the least being in clayey soil. Krishnamoorthy (1966) found that total N in *ragi* plants at harvest in alluvial soils was significantly higher than that for clayey soil. The clayey and loamy soils taken up in the present study were comparable to the black and alluvial soils studied by him. Single application produced the highest uptake of N by grain in clayey and sandy loam soils, while in loamy soil single and triple split application were both superior to double split application. The same was found to hold good for P uptake by grain. The uptake of P by grain was the least in clayey soil regardless of the mode of application. The coarse rooting in clayey soil might have resulted in the low P content of the grain due to the diminished uptake of P induced by such a type of rooting (Wiersum, 1961).

Uptake of nutrients by straw: Regarding the uptake of nutrients by straw, loamy soil was found to rank higher. This might be attributed to the dense root growth in loamy soil (Wiersum, 1961). Single application was found to be the best in the uptake of N by straw in sandy loam and clayey soils, while triple split application registered the highest N uptake by straw in loamy soil. Single application produced the highest uptake of P by straw in loamy and clayey soils, while double split application recorded the highest P uptake by straw in sandy loam. The potash content of straw was highest in all the three soils when single application was made at planting.

Influence of mode of fertiliser application on the yield: In the present investigation single application of nutrients at planting recorded higher yields of both grain and straw in all the three soils over split applications. This was in agreement with the earlier finding of Ishisuka and Tanka (1954) that a single application as basal dressing produced the best grain yield. Reyes *et al.*

(1962) found that 93% of the total uptake of P occurred from transplanting to booting stage and suggested an adequate supply of P during this period. In the present finding it was possible that single application at planting made higher amounts of P for the uptake of the crop in the initial stages compared to split applications, and hence the yield would be higher in single application than in split applications.

Patnaik *et al.* (1965) found that P absorption during tillering was most efficiently utilised for grain production and P absorbed beyond this period tended to accumulate in the grain, straw and root with no advantage to grain yield. In the present investigation it was seen that the uptake of P by paddy was high, especially during earlier stages of growth, when one single application of nutrients was made at planting. Since the efficiency of P absorbed at tillering was very high according to Patnaik *et al.* (1965) from the point of view of grain production, single application of P at planting would be expected to record higher grain yield over split applications. In the present investigation also, single application of nutrients at planting produced higher grain yield than split applications. Hayashi *et al.* (1951) also found that for maximum grain production P was most efficient when applied on the 16th day after planting.

Davis and Jones (1940) and Mikkelsen *et al.* (1958) found that application of all N at planting produced higher yields than when applied during tillering or heading. Miears and Petersen (1957–62) found that full application of P and K at planting and N applied at about three weeks after seeding recorded the highest grain yield.

Shibuya and Saeki (1939) found that the uptake of ammoniacal N by rice caused greater absorption of phosphoric acid. Since in the present experiment N was applied as ammonium sulphate greater absorption of P would be observed in the case of single application than in split applications, in the earlier stages. As stated by Hayashi *et al.* (1951) the absorbed P was most efficiently used for grain production in the earlier stages and thus the single application at planting would be expected to record higher yield than split applications.

Summary: The influence of single, double and triple split applications of N, P and K on the uptake of these nutrients by paddy grain and straw and also on yield was investigated in three representative paddy soils from Tamil Nadu, *viz.*, clay, loam and sandy loam collected from Coimbatore, Sirugamani and Tirurkuppam, respectively.

Sirugamani loamy soil recorded the maximum value in the uptake of nutrients by grain and straw. Single application at planting recorded the highest uptake of nutrient by grain and straw over double or triple applications.

Single application of nutrients at planting recorded significantly higher grain and straw yields in all the soils over double or triple split applications.

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