Madras Agric. J., 99 (10-12): 704-706, December 2012
https://doi.org/10.29321/MAJ.10.100174

Influence of Soil Test Based Fertilization on Soil Fertility and Productivity of Rice

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On farm testing and frontline demonstrations were conducted during the years 2010 and 2011 under mandatory work of Krishi Vigyan Kendra, Seoni district of Madhya Pradesh. The status of soil nutrients, their depletion and build-up and crop productivity after two years under various combinations of fertilizer dose and manures on sandy clay was studied. The differences in the values of organic carbon available N, P and K in soil at 20 cm depth and crop productivity were found to be very marked. The data on yield show that the application of balanced fertilizer dose of N P and K as per STCR treatment with or without farm yard manure @ 2.5t/ha helped in sustaining the yield of rice at higher level over the years. The inclusion of FYM in the treatment schedule maintaining the organic carbon status and available N, P and K in soil thereby, sustaining the soil health. The under dosing of plant nutrients (Farmers practice) has caused a depletion in the available nutrients status of soil. The status of available K in soil was found to decrease in all the treatments but the decrease was of lower magnitude indicating the need to raise the level of K fertilizer application to meet the demand of the crops.

Key words: Sandy clay, Fertilization, Crop productivity, Targeted yield, rice

Paddy (*Oryza sativa L*.) is one of the low cost sources of the dietary energy and protein for a vast majority of rural and urban poor of Asian countries including India. The agricultural scenario of India has completely changed due to modern intensive agriculture with high doses of fertilizers, biocides and high yielding fertilizer responsive varieties of crops. To get more and more yields farmers use chemical fertilizers indiscriminately. However the decision of exact and balanced fertilizer use requires knowledge of the expected crop yield response to nutrient application (Dobermann et al, 2003). Use of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by crop causes adverse effects on soil and crop regarding both nutrient toxicity and deficiency either by excess quantity or under dosing (Ray et al 2000). The experiments are considered as tools for providing valuable information on impact of continuous application of fertilizers with varying combination of plant nutrients on soil fertility and crop productivity. Soil test based application of plant nutrient helps to realize higher response and benefit: cost ratio as the nutrients are used in proportion to the magnitude of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization (Rao and Srivastava, 2000). Field specific balanced amounts of primary nutrients (N, P and K) were prescribed based on crop based estimates of the supply of N,P, and K and by modeling the expected yield response as a function of nutrient interaction was done by many workers. Therefore, the present study was undertaken to study the influence of balanced fertilization on soil fertility and productivity of high yielding rice variety (MTU-1081) under system of rice intensification method in comparison to conventional practice.

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Materials and methods

Under mandatory work of Krishi Vigyan Kendras, on farm testing and field demonstrations were conducted in five locations of Seoni district of Madhya Pradesh during the year 2010 and 2011. The soil was sandy clay having slightly acidic in reaction with pH 5.8%. The organic carbon content was 0.66%. The available soil nitrogen, phosphors and potassium were 215, 9.85 and 304 kg/ha, respectively. The front line demonstrations were conducted on the same site in next year 2011. The experiment consists of 5 treatments namely T_1-CP (conventional practice), T_2-100% NPK, T_3 - STCR based NPK, T_4 - T_3+Zn@5kg/ha, T_5- T_4+FYM @ 2.5 t/ ha, each replicated in five locations in a randomized block design. Recommended dose of fertilizer for paddy was 100:60:40 kg of N, P_2O_5 and K $_2$O per hectare respectively supplied through urea, single superphosphate and muriate of potash. Zinc was applied @20kg $ZnSO_4$ per ha. Nitrogen, phosphorus and potassium were calculated with the help of following fertilizer adjustment equations for 70 quintals targeted yield of rice.

FN=4.25T- 0.45 SN, FP_2O_5=3.55T- 4.89 SP, FK_2O = 2.1T- 0.18SK

Were – T is Targeted yield (q/ha)

FN = Fertilizer nitrogen (kg/ha.)

FP_2O_5 = Fertilizer phosphorus (kg/ha.)

Fk_2O = Fertilizer Potassium (kg/ha.)

SN = Soil available nitrogen (kg/ha.)

SP = Soil available phosphorus (kg/ha.)

SK = Soil available Potassium (kg/ha.)

The crop received one third nitrogen and full dose of P_2O_5 and K_2O as basal application at the time of transplanting and remaining N were at 25 days after transplanting and panicle initiation stage topdressed equally.

Initially and at harvest of crop soil samples (0-15cm depth) were collected and analyzed for different parameters by following standard procedures for organic carbon (wet digestion method), available N (alkaline permanganate method), available P (Black1965) and available K (ammonium acetate extract).

Results and Discussion

Yield data have been pooled and presented in Table 1. It indicated that highest pooled average yield of rice was (75q/ha) obtained with STCR based NPK applied in conjunction with FYM (T_5) and the lowest yield of rice (50.75q/ha) was recorded in conventional practice (T_1). Use of 100% NPK (Recommended by state Agriculture Department) had increased the yield by 17.93% for rice over conventional practice. When the plant nutrients applied according to soil test crop response based (T_3) yields was found to be increased by 29.37% . However, use of FYM@2.5t/ha in conjunction with T_4 further increased the yield by 47.78%. These findings clearly indicate that highest crop response can be assigned to RDF followed by STCR and STCR with FYM.

Table 1. Response of nutrients in rice crop

Treatment	Pooled average grain yield (kg/ha)	% response over conventional practice
T_1 Conventional practice (Control)	50.75	-
T_2 100% NPK	59.85	17.37
T_3 STCR based NPK	65.66	29.37
T_4 T_3+Zn@20kg $ZnSO_4$/ha	71.20	39.90
T_5 T_4+FYM@2.5t/ha	75.00	47.78
CD (P=0.05)	4.28	-

STCR, Soil test-crop response; FYM, farm yard manure

Organic Carbon

Organic carbon content of the soil which was 0.66 per cent in the initial sample had maintained in all the treatments. This shows that use of fertilizers with or without FYM also helps in maintained the organic carbon content of the soil. The findings are in conformity with Tiwari et al (2002). These increase/ maintained in organic carbon content due to use of fertilizers can be attributed to contribution of biomass to the soil in the form of crop stubbles and residues. However, the differences in the organic carbon content due to application of fertilizers might be the result of differential rate of oxidation of organic matter by microbes. Organic carbon plays an important role in maintaining soil health and its increase during the period shows that use of fertilizers has contributed in improving the soil health. This also indicates that if fertilizer use is integrated with manure substantial improvement in soil health can be expected.

Available Nitrogen

Use of nitrogenous fertilizers over two years tended to meager decrease in the available nitrogen status of soil and the decrease was 1.86% in conventional practice treatment (T_1). However, when the dose was increased to 100% NPK, and STCR treatments, the increase range from 216 to 223 kg/ ha in treatments T_2,T_3,T_4 and T_5 as compared to the initial value 215 kg/ha and 211 kg/ha in conventional practice (T_1). Highest value of 223 kg/ha of available nitrogen was recorded by integrating the use of balanced dose of fertilizer (STCR) with FYM (T_5). This showed an increase of 5.68% over value of conventional practice (T_1) clearly indicating the benefits accruing from integrated use of fertilizers organic manure and improved cultural practice which is also evident from the yield data presented in Table 2. These findings are in line with findings of Meena et al (2010) who observed that available nitrogen content in soil increased significantly with the use of recommended/balanced dose of fertilizers and manure.

Table 2. Changes in available nutrient and organic carbon status of soil

Treatment	Soil organic carbon	Soil available nutrient status		
	(%)	N	P	K
T_1 Conventional practice (Control)	0.66	211	9.50	290
T_2 100% NPK	0.69	216	10.91	295
T_3 STCR based NPK	0.69	221	11.55	298
T_4 T_3+Zn@20kg $ZnSO_4$/ha	0.68	221	11.83	298
T_5 T_4+FYM@2.5t/ha	0.69	223	11.99	295
CD (P=0.05)	NS	4	0.44	2
Initial	0.66	215	9.85	304

Available phosphorus

It is an accepted fact that 25 to 30 % of applied phosphorus is used by the crops and the rest remains in the soil in different forms. The data of available phosphorus also supported this contention as use of fertilizers had resulted in an increase in the available phosphorus status of soil. It was found that increasing the dose to 100% NPK (T_2) over T_1 had resulted in 14.84% increase.

However, when plant nutrients were applied as per soil test crop response technology and integration with FYM had increased the soil available phosphorus to 26.2 per cent. The values are comparable with T_4. These findings indicated that integrating the use of fertilizers with manure could enhance the available phosphorus content of soil as build-up of available phosphorus. These results are in conformity with the findings of Yaduvanshi (2001) who attributed the appreciable increase in available P content of soil to the influence of organic manure which could have enhanced the labile phosphorus in soil by complexing the cation like ca, mg and A1 responsible for the fixation of phosphorus. Further, yield date also show that yields obtained in this treatment was also maximum.

Available Potassium

It appears from the changes in available potassium content of the soil that intensive cropping over the years has resulted in decline in the status as compared to the initial value. The decline was found in all the treatments. This indicates that the recommended fertilizer schedule failed to meet the requirement of the high yielding crop varieties. Maximum decline was observed in conventional practice (T_1). The magnitude of decline decreased with increasing level of NPK application (Balance fertilization). This is in consonance with the findings of Bharadwaj et al (1982) who has also observed similar effects on available potassium status of soil.

The above results indicate the significant influence of continuous cropping with fertilizers and manure application as per soil test value (STCR Technology) on soil fertility and productivity of rice. Although there has been a build-up in the content of organic carbon and in the available of N and P status due to continuous application of plant nutrients in précised manner. The highest yields and sustainability in yield could be achieved only by the balanced use of organic and in organic fertilizers as per soil test value (STCR Technology) for rice crop. These findings indicate that application of integrated use of précised fertilizer dose with manure was successful in maintaining high level of rice productivity and in the maintenance and improvement of soil fertility. Further the importance of inclusion of zinc in fertilizer schedule is also highlighted by these results as treatment effect on the crop productivity.

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Received: February 29, 2012; Accepted: August 21, 2012