Maximising Yield of a Rice-Wheat Sequence in Recently Reclaimed Saline-Sodic Soils

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In India, saline-sodic soils account for approximately 7 million ha. Of this area, about 3.25 million ha are presently reclaimable due to the availability of good irrigation water and soil amendments. About 2 million ha of these soils occur on the Indo-Gangetic Plain, with a large area in Uttar Pradesh. Successful crop production on these soils will impact agricultural production in India and will contribute to meeting its growing demand for food.

Rice-wheat cropping sequences can be successfully adapted to recently reclaimed saline-sodic soils. However, there is an urgent need to increase the productivity of this crop rotation by adopting best management practices (BMPs) that correctly combine inorganic nitrogen (N), phosphorus (P), and potassium (K) fertilisers with organic manures, including green manure (GM), while maintaining proper plant populations and planting methods. Current recommendations for rice growing conditions are to apply fertiliser at 120-60-60 kg/ha of N-P_2O_5-K_2O using a plant population of 444 x 10^3 hills/ha. Wheat is commonly sown on flat land with fertiliser applied at 120-60-40 kg/ha of N-P_2O_5-K_2O. This study evaluated different practices for maximising yields in a rice-wheat sequence.

Field experiments were conducted for 3 years on a recently reclaimed saline-sodic soil at C.S. Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh. In rice, the treatments consisted of combining factors of (1) farm yard manure (FYM) applied at 12.5 t/ha and in-situ green manuring with *Sesbania aculeata*; (2) N levels of 120, 150 and 180 kg N/ha; and (3) plant populations of 444 x 10^3 (15 x 15 cm spacing), 667 x 10^3 (15 x 10 cm spacing), and 1,000 x 10^3 hills/ha (10 x 10 cm spacing). In wheat, the treatment factors were (1) the residual effect of the previous FYM/GM in rice; (2) N applied at 120, 150 and 180 kg N/ha; and (3) planting on flat land, east-west facing ridges, or north-south facing ridges. Soil properties for

Table 1. Selected soil properties of the reclaimed saline-sodic soil, Uttar Pradesh.

Soil classification	Texture	pH	Electrical conductivity (EC) mmhos/cm	Exchangeable sodium percentage (ESP)	Sodium adsorption ratio (SAR)
Typic Halaquept	Silty clay loam	9.8	4.9	70.6	101.2

Table 2. Rice yields (t/ha) due to different treatments, Kanpur, Uttar Pradesh.

Treatment	Year 1	Year 2	Year 3	Mean
Organic manuring				
Control	3.155	3.865	2.570	3.197
FYM	3.467	4.302	2.860	3.543
GM	3.639	4.456	3.030	3.708
C.D. (5%)	0.110	0.148	0.099	
$N-P_2O_5-K_2O$, kg/ha				
120-75-75	3.056	3.832	2.540	3.143
150-75-75	3.536	4.334	2.910	3.593
180-75-75	3.669	4.444	3.030	3.714
C.D. (5%0	0.108	0.085	0.130	
Population (x 10^3 hills/ha)				
444	3.253	3.929	2.600	3.261
667	3.470	4.319	2.880	3.556
1,000	3.538	4.374	3.001	3.641
C.D. (5%)	0.108	0.085	0.099	

Table 3. Wheat yields (t/ha) due to different treatments, Kanpur, Uttar Pradesh.

Treatment	Year 1	Year 2	Year 3	Mean
Residue of organic manuring				
Control	2.685	2.930	1.740	2.452
FYM	3.061	3.149	2.190	2.800
GM	3.181	3.270	2.120	2.857
C.D. (5%)	0.059	0.150	0.105	
$N-P_2O_5-K_2O$, kg/ha				
120-75-75	2.661	2.832	1.710	2.401
150-75-75	3.093	3.189	1.950	2.744
180-75-75	3.177	3.322	2.030	2.843
C.D. (5%0	0.045	0.088	0.118	
Sowing method				
Flat land	2.728	2.885	1.750	2.454
East-west ridges	3.161	3.261	1.960	2.794
North-south ridges	3.042	3.163	2.200	2.802
C.D. (5%)	0.086	0.088	0.105	

the experimental site are outlined in **Table 1**.

Rice and wheat yield responses to the different factors over 3 years are outlined in **Figure 1**.

Rice yields increased significantly with either FYM or *Sesbania* GM applied before rice transplanting (**Table 2**). However, GM was more efficient as it increased rice yield by 16 percent over the control, while the increase from FYM was 11 percent. Application of 150 kg/ha N increased rice yield by 14 percent over yields obtained with 120 kg N/ha.

The successive yield increase obtained by applying 180 kg N/ha was an additional 4 percent. The study determined 1,000 x 10^3 hills/ha to be the most productive plant population, increasing yield by 12 percent over the conventional practice (444 x 10^3 hills/ha). Rice planted at 667 x 10^3 hills/ha yielded 9 percent more than conventional practice.

Wheat yields were improved as a consequence of residual nutrients supplied from either FYM or GM applied for the previous rice crop (**Table 3**). Similar to rice, the residual effect of GM was greater than that resulting from FYM application. Wheat yields were increased by 17 percent with green manure residue and by 14 percent with FYM. Successive levels of N significantly increased wheat yield, the effect being higher from 120 to 150 kg N/ha (14 percent increase) than from 150 to 180 kg N/ha (4 percent increase).

With respect to the method of planting, sowing wheat on ridges was more effective than on flat land. Flat land wheat yields were 14 percent lower than yields obtained on soil that was ridged in a north-south direction and 14 lower than soil ridged in an east-west direction. Over the 3 years studied, a consistent difference could not be found between wheat planted on ridges facing north-south or east-west bearings.

The BMPs for maximising yield in a rice-wheat sequence on reclaimed saline-sodic soils are to apply either 12.5 t FYM/ha or use in-situ *Sesbania aculeata* as a GM source in rice. These organic amendments should be combined with fertiliser applied at 150-75-75

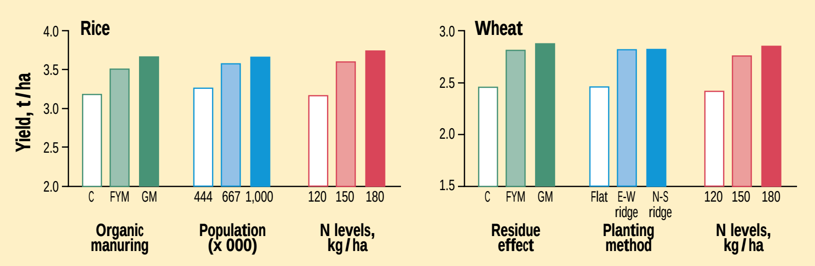

Figure 1. Yield of rice and wheat due to different treatments (mean of 3 years), Kanpur, Uttar Prodesh.

kg/ha N-P_2O_5-K_2O. A plant population of 667 x 10^3 hills/ha should also be adopted. In wheat, fertiliser applied at 150-75-75 kg/ha N-P_2O_5-K_2O combines well with any residual nutrients from the previous rice crop. It appears that planting wheat on ridged land is preferred over flat land. **BCI**

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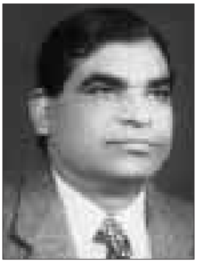
Dr. K.N. Tiwari Joins Staff of PPIC-India Programme



Dr. Kashi Nath Tiwari has joined the staff of the PPIC-India Programme. He will be located in Kanpur, Uttar Pradesh, as Deputy Director for East India. PPIC-India Programme headquarters are in Gurgaon, and another Deputy Director for South India is located at Hyderabad (Andhra Pradesh).

Dr. Tiwari received his Ph.D. in Agricultural Chemistry from Kanpur University in 1974. He has served as principal investigator of 15 research projects related to soil fertility and fertilizer sponsored by councils and institutes in India and internationally. In addition to numerous honors, Dr. Tiwari has received academic recognition as a Fellow of the Indian Society of Soil Science, Fellow of the Indian Society of Agricultural Chemists, and awards by other highly respected groups. He is the author of six books, as well as numerous bulletins, project reports, research papers, and technical articles.

During his association with extension programmes in Uttar Pradesh, Dr. Tiwari has been closely involved with transfer of technology related to balanced use of fertilizers, integrated nutrient management, reclamation and management of salt-affected soils, efficient use of saline/alkaline waters, and diagnosis of nutritional disorders in crops. **BCI**