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Third Agricultural Science Congress
PAU, Ludhiana, March 12-15, 1997

SEARCHING ALTERNATIVES TO BURNING RICE STRAW

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In a recent survey in Punjab, India, jointly arranged by the authors, it was recorded that almost all Punjab farmers using combine for harvesting rice, burnt the rice–straw. The extent of burning of straw in the fields varied from 50 to 90%. Quantities of rice–straw burnt in Punjab was assessed to be about 12 million tons annually and through this significant quantities of nutrients are lost. Calculated in economic terms, through N alone the Punjab farmers are loosing Rs. 684 million (US$ 19.5 m) annually. Cost of environmental damage through global addition of carbon dioxide, a green house gas, and through the reported increase in number of cases of respiratory problems to local population associated with the period of burning rice–straw can be enormous. This paper describes converting rice–straw into a value added organic product which can potentially save significant quantities of chemical fertilizers while sustaining productivity of rice–wheat cropping system.

Composting rice–straw: The procedure followed was essentially same (with minor modifications) as published by Banger et al. (1989). Composting was done in covered cement tanks/digestors (75 cm deep, 75 cm diameter, with lined surface) buried in soil. In each digestor, 10.0 kg air dried rice–straw (without chopping), moistened in 15L suspension of *Aspergillus awamori, Bacillus polymixa* (strain 411), and 0.38% N as urea (on straw dry weight basis) in water, was placed as 10 cm thick layers. Mats of *Bacillomyces fusisporus* grown on potato dextrose agar plates, cut into 1 cm square pieces was also placed randomly at various depths in the digestor. Powdered Mussoori rock phosphate (2.5 kg) was sprinkled between the layers. Surface was kept moist by sprinkling about 200 ml water at every 2–3 days interval. The contents in a digestor were mixed 15 to 20 days after starting the process when 500 ml broth of *Pseudomonas striata* (Strain, 303) was sprinkled. Eighty two g of urea granules per digestor were also added. A second mixing was done between 25 to 30 days when 500 ml of *Azotobacter chroococum* (Strain, MAC 27) was added.

Field evaluation: The Value Added Rice–straw Manure (VARM) prepared at the ICRISAT Asia Centre (IAC) was transported to the Punjab Agricultural University (PAU) for characterization and use in a long–term field experiment. The long–term experiment has following ten treatments of a continuous Rice–Wheat cropping system:

1 Control (no amendment) = C
2 Fertilizer (120 kg N/ha to rice, 120 kg N and 60 kg P_2O_5 to wheat) = F
3 F + Incorporation of rice–straw (4 t/ha) to wheat = FI
4 F + Burnt rice–straw (equivalent to 4 t/ha) to wheat = FB
5 F + VARM(2 t/ha, dry weight basis) to wheat = F2V
6 F + VARM (2 t/ha) both to rice and wheat = F2VV
7 1/2 F and 4 t/ha VARM both of rice and wheat = 1/2 F4VV
8 Eight t/ha VARM both to rice and wheat = 8VV
9. F + 4t/ha VARM to rice; 4 t/ha VARM, full N, nil P, to wheat = 4VVOPN
10 F + 4t/ha VARM to rice; 4t/ha VARM, full N, 1/2 P to wheat = 4 VV1/2PN

Table 1. Grain and straw yields (t/ha) and NPK uptake (kg/ha) by rice as affected by application of Value Added Rice–Straw Manure (VARM) and urea

Treatment	*Grain**	*Straw*	*Total NPK uptake*		
			N	*P*	*K*
Control	2.58	2.71	48.2	7.3	53.4
VARM (V, 6 t/ha)	4.23	4.37	78.7	15.7	93.7
Fertilizer (F, 120 kg N/ha)	5.69	6.17	107.8	19.3	124.2
F + V (1.5 t/ha)	5.62	5.90	104.8	18.6	118.1
1/2 F + V (3 t/ha)	5.43	4.98	97.0	17.3	103.1
F + V (3 t/ha)	5.83	6.60	112.1	21.2	138.4
CD (5%)	0.481	0.717	7.25	3.44	17.9
CV(%)	5.4	7.53	4.31	11.28	8.78

* Rice with husk

Sidhu, B. S., Rupela, O. P., Gopalakrushnan, S., and Beri, V. 1997. Searching alternative to burning rice straw. Pages 29-30, proceedings (volume 2) of the 3rd Agrucultural Science Congress, 12 –15 Mar 1997, Punjab, India (V. Beri, V. K. Dilawari and M. S. Bajwa eds.). Ludhiana 141 004, India: Punjab Agricultural University and National Academy of Agrucutural Sciences.

There were three replications for each of the ten treatments with plot size 8.5 x 4 = 34 m². Rice in the rainy season was transplented on 20 Jun 1996. Its harvesting was done on 24 Oct. 1996 from a net plot harvest area of 23 m². Some of the treatments will start in the post–rainy season 1996-97. Thus, until the first rice crop of year 1, the treatments F, FI, FB were same; treatments F2V, F2VV were same, and treatment 4VVOPN and 4VV1/2PN were same. Data from these groups was therefore averaged for presentation here.

The enriched compost named Value Added Rice–straw Manure (VARM) was ready in about 35 days when prepared during February to June when the ambient maximum temperature was generally >30°C. On chemical analysis, this batch of VARM was found to have 0.07% mineral N, 1.72% total N, 2.13% total P, 0.032% water soluble P, 1.09 % available K, 1.60% total K and 25.4% total organic C. Its C:N ratio was 14.76. In addition, it may contain a high population of beneficial microorganisms which were not assessed. Although the application of VARM was planned at rates of 2,4 and 8 t/ha in the designated treatments but its short supply in first year dictated us to apply, respectively 1.5,3.0 and 6.0 t/ha. Even at these rates some of the treatment effects were highly encouraging.

Application of 6 t/ha resulted in 64% increase in rice yield over the unamended control (Table 1) that yielded lowest (2.58 t/ha). Rice yield was maximum (5.83 t/ha) with full fertilizer plus VARM (3 t/ha) but it was not significantly superior to the yield with full fertilizer (5.69 t/ha) and full fertilizer + 1.5 t/ha VARM. Yield with 1/2 fertilizer and 3 t/ha VARM was statistically similar (5.43 t/ha) to that due to full fertilizer (5.69 t/ha). Thus 3 t/ha VARM application was equivalent to that of 60 kg N/ha (Table 1).

Addition of 6 t/ha VARM resulted in higher uptake of 63% N, 115% P, and 75% K by rice than by rice in the control treatment. But this may be due to the overall better growth and yield than due to the nutrients in the VARM; because the additon of 120 kg N/ha also resulted in greater uptake of 171% P and 133% K over that by rice in the control plots (Table 1).

Composting is thus a highly promising alternative to the burning of rice-straw and may at least sustain present productivity of rice-wheat cropping system while solving the problem of environmental pollution.

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