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Effect of replacing a part of nitrogenous fertilizer by brown manuring in direct seeded rice: a field study

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ABSTRACT

A field experiment was conducted, during wet season 2012, to study effects of replacing 25% of nitrogenous fertilizer by brown manuring in direct seeded rice on plant height, effective tiller number, vermcast per square meter, grain yield, organic carbon content and benefit to cost ratio. The plant height (1.57%), effective tiller number (9.09%), organic carbon content (13.04%) and grain yield (7.91%) were increased in the brown manuring plots as compared to farmers practice. The biomass incorporated in the field (133%) and vermcast/m ^{2} (63.26%) was significantly improved in the brown manuring fields indicating better soil health. The benefit to cost ratio was 7.79% more in the brown manuring plots than that of farmers practice. The findings from the present study indicated that use of nitrogenous fertilizer can be reduced up to 25% in the farmers' field without affecting the economical attributes and saving the precious soil health in the farmer's fields.

Key words: *Brown manure, nitrogen, rice, Sesbania, soil health*

Increase in population every year is increasing the demand for more and more food. Thus, there is need to raise grain production. Rice is the staple diet of majority of Indian people and most of the farmers depend on rice cultivation. As in India area expansion under rice crop is not feasible; green revolution had called for inclusion of better agronomic practices, application of fertilizers, herbicides and pesticides for fulfilling the increased demand for ever rising human population. In India, there is stiff rise in agricultural inputs and labour, particularly in the peak time of operation. Aberrant climate in many pockets/ areas usually result in sharp fall of nutrient use. The modern agricultural practices emphasized higher use of fertilizers as a source of plant nutrients. This approach resulted in decline in the use of organic manures. The continuous and imbalanced use of chemical fertilizer leads to soil health degradation and agro ecosystem pollution (Kibblewhite *et al*. 2008; Powlson *et al*. 2011).

Integration of organic manures in agriculture production can supply nutrients and organic carbon that can support crop production and can maintain or improve soil health (Barrios 2007). The cost of production can also be reduced by the use of organic source of nutrients. Green manuring with *Sesbania* spp. is adopted in many regions with varying degree of success **(**Sharma and Mitra 1988; Sharma and Ghosh 2000**)**. Due to the erratic monsoon farmers are unwilling to take the risk of green manuring before rice cultivation. Considering all the above aspects we tested the brown manuring technology in direct seeded rice as a resource conservation technology in farmers' fields in Tangi block of Cuttack district and compared the performance with existing farmers practice.

A participatory rural appraisal followed by a focus group discussion involving the farmers of Tangi block was conducted during pre-monsoon time for making the experiment under participatory approach. The farming situation was analyzed and farmers were trained in the new technology. The field trial was conducted in the village Jagannathpur in Tangi Block of Cuttack district in Odisha. The variety performance under the evaluation was Pooja. Rice cultivated with the existing agronomical practices was taken as control

(T1) and that with inclusion of brown manure was treated as treatment group (T2). The experiment was conducted with seven farmers with total land holding of one hectare for both the control and treatment groups. In the control group, fertilizer dose of 60:30:30 was used by the farmers, whereas in the treatment group plots the nitrogen (N) dose was reduced up to 25%, i.e., 45 kg N/ha, for balancing the N requirement and supplemented from *Sesbania*.

Brown manuring of direct seeded rice is the co-culture of Dhaincha (*Sesbania acculeata)* with rice. In practice, rice and *Sesbania* (seed rate, 15 kg/ha) were sown simultaneously. In practice, after 20-25 days of sowing Sesbania overtook rice in height. At this time 2, 4-D (1.0 kg/ha) was sprayed in the field. Sesbania plants appeared brown after 4-5 days and then died. In broadcasted rice at the time of "Beusani" the brown manure was incorporated in the soil.

The sampling and data recording were done at 5 different locations selected at random from each farmer's field. The initial soil samples were collected from the farmer's field to know the physiochemical properties of the experimental plots. The bio-mass generated for incorporation in the soil was recorded before application of 2, 4-D. Sesbania in one square meter area was uprooted at five different parts of the field selected at random and washed thoroughly in water. The weight was noted. Similarly, the weed populations in the farmer's fields were noted as they do manual weeding and bury these weeds in the field. Plant height and number of effective tiller per hill were recorded after panicle initiation. At the time of harvest the grain yield was recorded in 5 m^2 area. After the harvest the soil samples were taken for analyzing organic carbon build up. The organic carbon (OC) content in both the plots was done by Walkley and Black method (1934) after the harvest of the crop. Vermicasting per square meters was counted just after harvesting was done. The data generated were statistically analyzed by Student's t-test as per Snedecor and Cochran (1994).

Rice and *Sesbania* grew simultaneously and by 25 days of sowing they started to overtake rice. By selective herbicidal effect 2, 4-D killed *Sesbania* plants in 4-5 days of application, whereas the rice crop was not affected. A major problem faced by the farmers in direct seeded rice was weed infestation in early stage in the control plots, whereas the weed population was lowered by the co-culture of *Sesbania* as it is fast growing. Low weed population in the brown manuring plots were also noted in a study by Maity and Mukherjee (2011). Biomass in the farmers plot (T1) was 150 g per square meter, whereas in brown manuring plots (T2) the biomass addition was 350 g per square meter. There was a significant increase of biomass (133%) in the brown manuring plots when compared with the plots following farmers practice.

The data on plant height, tiller number and vermcast per square meter is mentioned in Table 1. The plant height and effective tiller number were similar in both the groups indicating brown manuring could replace 25% of N fertilizer without any adverse effect on plant height and tiller number. However, the vermcast was significantly higher in T_2 plots over the plots with existing farmers practice (T_1). The increased vermcast number in the T_2 plots suggest better soil health in these fields due to brown manuring and less inorganic fertilizer application. As better soil health facilitates better soil environment for availability of essential nutrients and yield attributes T_2 plots can foster better crops in the next cropping season (Barrios, 2007).

The data on grain yield, organic carbon content and benefit to cost ratio is presented in Table 2. Statistical analysis revealed no significant increase in grain yield (7.91%) by replacement of 25% of nitrogen from inorganic nitrogen fertilizer by brown manuring as compared to the existing farmers practice. However,

Table 1. Effect of replacing 25% nitrogenous fertilizer by brown manuring on soil health and other parameters

Parameters	Farmer's practice	Brown manuring	Percent increase
Biomass incorporated (g/m^2)	150^a±9.74	350^b±15.58	133
Plant height (cm)	95.5±3.65	97.0±3.22	1.57
No. of effective tiller	11±1.64	12±1.59	9.09
Vermcast/sq.mt.	48^a±2.57	79^b±3.42	63.26

^{a,b}Values bearing different superscripts in a row differ significantly ($P<0.01$)

Table 2. Effect of replacing 25% nitrogenous fertilizer by brown manuring on economic indicators

Parameters	Farmer's practice	Brown manuring	Percent increase
Grain yield (q/ha)	45.5±2.98	49.1±2.21	7.91
Organic carbon (%)	0.46±0.04	0.52±0.04	13.04
Benefit to cost ratio	1.54±0.26	1.66±0.19	7.79

the cost saving due to reduction of N fertilizer and 7.91% increase in yield gives appreciable benefit for the farmers. In a study with different treatments, Maity and Mukherjee (2011) observed the highest nutrient use efficiency (N, P and K) in the treatment associated with brown manuring.

An appreciable result was obtained in the organic carbon builds up as the OC content was higher in the tested technology (T_2) and 13.04% more carbon build up was recorded after the harvest of the crop. The increased OC content might be attributed to the addition of organic materials from brown manuring and better root growth of the crops grown. Lastly, the economic parameter was also superior in T_2 plots over the existing farmers practice (T_1). The benefit to cost ratio was higher (7.79%) in the brown manuring plots than that of farmer's practice. In a study, green manuring of direct-seeded rice with dhaincha was beneficial for substituting urea fertilizer up to 40 kg N ha^{-1} (Sharma and Ghosh 2000).

As there is a rising trend in the chemical fertilizer cost, brown manuring would form an alternative approach for higher production and net benefit. By the practice of 25% replacement of nitrogenous fertilizer with brown manuring the overall soil health of the rice growing area can be sustained in a better condition as observed in the present study.

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