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Effect of green biomass application of different trees on the yield of rice

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Abstract: Soil organic matter status in Bangladesh is very low. To restore the organic matter, it is needed to explore the best organic amendment for better crop production. Therefore, a field experiment was conducted in the Agroforestry Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2011 to find out the response of different leaf biomass application on yield contributing characters and yield of rice cv. BR11(Mukta). Eight experimental treatments such as T_1= Ipil-ipil (*Leucaena leucocephala)* leaf biomass, T_2= Bakphul (*Sesbania grandiflora)* leaf biomass, T_3= Minjiri (*Cassia siamea)* leaf biomass, T_4= Ipil-ipil leaf biomass + ½ RFD (recommended fertilizer dose), T_5= Bakphul leaf biomass + ½ RFD, T_6= Minjiri leaf biomass + ½ RFD, T_7= RFD, and T_8= Control were imposed in this study. The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. Soil fertility status was determined before and after the study. Growth, yield and yield contributing characters were recorded as well. Soil fertility status in different treatments changed after rice cultivation. Soil pH did not change after rice cultivation but organic matter (%) was improved where green leaf biomass was incorporated to the soil and Nitrogen (%), phosphorus (ppm), potassium (me/100g soil), sulphur (ppm), zinc (ppm) were decreased where RFD applied. Results showed that the treatment T_4, T_7 gave the highest grain yield where Treatment T_8 (control) gave the lowest yield. Most of the yield contributing characters also significantly influenced or increased to the treatment T_4 (Ipil-ipil + ½ RFD) and T_7 (RFD) and in the control all the parameters mentioned above were significantly decreased. Among the green leaf biomass treatment, ipil-ipil and bokphul gave better results. Therefore, this study suggests that the combined application of tree litter of ipil-ipil and recommended fertilizer dose may produce good rice yield.

Key words: Tree green leaf biomass, *Leucaena leucocephala, Cassia siamea, Sesbania grandiflora,* rice.

Introduction

Organic farming is the form of agriculture that relies on techniques such as crop rotation, green manuring, composting and control of pest biologically. Organic farming uses fertilizers and pesticides but excludes or strictly limits the use of manufactured (synthetic) fertilizers, pesticides (which include herbicides, insecticides and fungicides), plant growth regulators such as hormones, livestock antibiotics, food additives, genetically modified organisms, human sewage sludge etc. Organic matter is called the life of the soil and plays an important role for sustainable soil fertility and crop productivity. It plays vital role to improve physical, chemical and biological properties of the soils and ultimately enhance the crop production. Organic matter acts as a reservoir of plant nutrients especially N, P, K and S and prevents leaching of the nutrients (Konboon *et al.* 1993). Organic matter of Bangladesh soils is decreasing day by day and presently organic matter in the soil of Bangaldesh is around 0.5-1.15%. Different tree leaf biomasses such as Mahogoni, Ipil-ipil, Bokful, Minjiri, Akashmoni and Eucalyptus etc. are good sources of organic matter and can play a vital role in soil fertility improvement as well as supplying nutrients specially N, P, K and S.

Sustainable crop production gets more attention in Bangladesh through introduction of agroforestry system, whereby tree litter is used as a supplement and to enhance crop production. Bangladesh has a homestead area of 13,018,415 thousand acres (BBS, 2004) where retention of trees is being encouraged. Thus, there is ample opportunity for green manure sources. Leaf biomass is a very important organic source of soil fertility improvement. The decomposition of leaf litters influence the amount of N availability for plant uptake (Samsuzzaman and Karim 2002). Leaf litter supplies the carbon, nitrogen, phosphorus, potassium and other nutrients in soil that are further considered as important indicators of soil productivity and the ecosystem health. Moreover, this leaf lifter has been waste by several ways. So, if we can utilize these materials as a source of organic matter for rice cultivation, then we can reduce the considerable amount of chemical fertilizer like urea. For biochemical nutrient cycling and food webs of floodplain in agroforestry system, decomposition of tree leaf litter is an integral and significant part. Through decomposition, the nutrients within leaf litter are converted into available form for uptake by vegetation and thereby exercising a critical control on vegetation productivity (Mitch and Gosselink, 1993). Rice production system in Bangladesh has undergone immense change during the past three decades. The green revolution in rice ushered in a period of substantial growth which resulted near doubling of rice production between 1995-96. But per capita rice production has increased only marginally because of continuous population growth at a relatively high rate. Furthermore, agricultural land is increasingly being diverted to other uses such as housing, roads and industrial development (FAO, 1999).

To meet up the demand of our increasing population, farmers are now encouraged in practicing agroforestry system, which is environmentally sound and ecologically balanced. Most of the fuel wood, timber and vegetables requirement of rural people are met by the homestead production. Recently few non-government organizations (NGOs) and government organizations (GOs) have implemented social forestry programs to increase tree coverage and socio-economic condition of the beneficiaries under different categories, such as woodlot agroforestry as well as roads, railway and embankment plantations. The area under social forestry was 9922 thousand acres in 2002 (BBS, 2003) and the area has expanded hopefully by the last four years. Thus, there are ample scopes for utilization of tree litter as green manure in the farmers' crop field. The farmer of our country is indifferent about providing additional time for growing green manuring crops to be used as green manure viz. *Sesbania rostrata, S. aculeata*, *Crotalaria juncia, Vigna* *unguiculata* etc. Therefore, use of tree leaf biomass as green manure may be an alternative for green manuring crops for maintaining the fertility status of soil.

Materials and Methods

The experiment was conducted at the Agroforestry Field Laboratory, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during July-December, 2011. The experimental soil belongs to AEZ- Old Brahmaputra Floodplain (No. 9). Rice cv BR11 (Mukta), a modern rice cultivar, was used as the test crop in this experiment. The experiment was conducted in a Randomized Complete Block Design (RCBD) with three replications. The total numbers of plots were 24 with a unit plot size was 3.7 m x 2.2 m. In this study three tree leaf biomass viz. Ipil-ipil (*Leucaena leucocephala*), Minjiri (*Cassia siamea*), Bakphul (*Sesbania grandiflora*) were used (Fig. 1). These leaf biomasses were chopped by hand and mixed uniformly with soil during final land preparation and then left to decompose for 30 days. Leaf biomasses were collected from the Ipil-ipil, Minjiri, Bakphul tress of Bangladesh Agricultural University Campus,Mymensingh. For this experiment, eight treatments were used. These are: T_1- Bokful, T_2=Minjiri, T_3= Ipil ipil, T_4= Bokful + ½ RFD, T_5= Minjiri + ½ RFD, T_6= Ipil ipil + ½ RFD, T_7= RFD, T_8= Control. The main land was first opened with spade. Thereafter, the land was ploughed and cross-ploughed as many as four times followed by laddering at suitable intervals. Before and after rice cultivation soil sampling was done. Soil was collected from each plot and it was analyzed. Details of soil analysis of the soil collected before rice cultivation is given in Table 1.

Fig. 1. Experimental view: (A) Green biomass of Ipil-ipil, (B) Green biomass of Bakphul (C) Green biomass of Minjiri, (D) Overall view of experiment.

The whole amount of various tree leaf biomasses such Ipil-ipil, Minjiri, Bakphul leaves were incorporated in experimental plots before final land preparation. Recommended dose of all fertilizers were Urea 180 kg ha^{-1}, TSP 90 kg ha^{-1}, Gypsum 60 kg ha^{-1} and MOP 40 kg ha^{-1}. Urea was top dressed in three equal splits i.e.15, 30 and 55 days after planting (DAP). Thirty five (35) day old seedlings of cv. BR11 were collected from the Agronomy Field Laboratory of BAU. The seedlings were transplanted on 18 July 2011 with a hill to hill and line to line distance of 15 cm x 20cm with 3 seedlings per hill. Weeds were controlled by uprooting and removing from the field. Crop was grown under rain fed condition. Prior to each top dressing of urea fertilizers, plots were weeding manually. When rice was harvested, again soil sampling was done and analyzed. Soil sampling was done to know the soil fertility status.

The recorded data were compiled and analysed by RCBD design to find out the statistical significance of the experimental results. The means for all recorded data were calculated and the analyses of variance for all the characters were performed. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significant Difference (LSD) test.

Results and Discussion

Soil fertility status before and after the rice cultivation

Average soil pH, organic matter (%), nitrogen (%), phosphorus (ppm), potassium (me/100g soil), Sulphur (ppm), zinc (ppm) recorded from soil before the rice cultivation were 5.00, 0.46, 0.058, 11.795, 13.50, 7.21 and 2.61, respectively (Table 1). This indicates that the initial fertility status was very low, close to each other and statistically non-significant. After rice cultivation soil pH did not change significantly, in the treatment T_7 pH had slightly increased (0.60) due the application of fertilizer. Treatment T_4, T_5 where half of the RFD was applied pH has slightly increased because fertilizer helps to increase the pH level (Table 2). Organic matter (%) of soil significantly changed due to various treatments after rice cultivation. In the treatment T_1 (0.51%) and T_2 (0.48%) where leaf biomass of ipilipil and bakphul were applied respectively, here organic matter (%) has been increased because no fertilizer was applied. Nitrogen (%) content of soil in the treatment T_1 was increased (0.071) because more nitrogen was released from ipilipil leaf biomass and green biomass was added to the soil. In the treatment T_5, T_6, T_7 and control, nitrogen content (%) was decreased. Because the application of RFD and plant uptake available N from soil. These results are agree with the report of Halepyhati (1988). Phosphorus (ppm), Potassium (me/100g), Sulphur (ppm) and Zinc (ppm) of soil did not changed in the treatment Ipilipil, Bokphul and Minjiri. But in the treatment T_4, T_5, T_6, T_7 and $T_{8,}$ phosphorus (%) and Potassium (me/100g) was decreased for applying fertilizer and plant uptake the available P & K (Table 2).

Growth and yield of rice as affected by green leaf biomass of different trees

Growth: Plant height of rice seedlings were observed at 30, 60 DAP and after harvesting. It was found that during initial stage of establishment plant height of seedlings in all treatments were almost similar (Table 3). At 60 DAP, tallest plant (95.60 cm) was found in the treatment T_7 because of supplying recommended fertilizer and shortest (41.30 cm) in the control (Table 3). After harvesting, Tallest plant

(98.70 cm) was found in the treatment T_7 due to uptake of sufficient nutrient and shortest (74.60 cm) in the treatment T_8 (control) where nutrients were not supplied. All the treatments gave significantly taller plant over control. These results are in agreement with that of Sharma and Mitra (1990) who reported that addition of organic manure increased plant height significantly. Table 3 showed that no. of leaves hill^{-1} was affected by the treatment at 30 DAP. In the treatment T_4 (36) and T_7 (36) gave highest no. of leaves observed for applying leaf biomass and fertilizer. And the lowest one (16) was found in control treatment. Table 3 showed that at 60 DAP, in the treatment T_7 (55) highest no. of leaves observed for applying fertilizer and lowest in control (18). Except control all the treatment was very close to each other. Table 3 showed that in the treatment T_4, T_5 and T_7 leaf size were 21.96, 21.83 and 22.80 cm^2 respectively at 30 DAP. They have no significant difference. At 60 DAP, Table 2 showed highest leaf size was found in T_4 (28.11 cm^2) because for applying RFD plus leaf biomass and T_7 (28.70 cm^2) for applying fertilizer only. These results are supported by Mohapatra and Jee 1993. The number of tillers hill^{-1} initially more or less similar of all treatments. Highest no. of tillers hill^{-1} was found in T_4 (12) because for applying fertilizer plus leaf biomass and T_7 (10) for applying fertilizer only. And lowest in the T_8 (4) where fertilizer or biomass were not applied (Table 3). T_1, T_2, T_3 and T_4, T_7 have no significant difference. At 60 DAP no. of tillers hill^{-1}of rice has increased. Highest no. of tillers hill^{-1} was found in T_7 (14) for applying fertilizer and lowest in the control (5) treatment (Table 3). After harvesting, the number of tillers hill^{-1} of different treatments ranged from 7 to 16. The highest number of tillers hill^{-1} (16) was produced by treatment T_7. Among the leaf biomass the highest number of tillers hill^{-1} (14) was produced by treatment T_4 (Table 4) than the controlled plot. Treatment T_4 produces more than the other leaf biomass because more nutrients were released from ipilipil leaf biomass. No. of panicle hill^{-1} of rice was significantly influenced by the incorporation of tree leaf biomass. The no. of panicle hill^{-1} varied from 4 to 12 due to different treatment. Highest no. of panicles hill^{-1} was found in RFD (T_7) treatment which was significantly similar value to leaf biomass of Ipilipil+ 1/2RFD. These result supported by the findings of Kulkarni (1988). Non-effective tiller means the tiller which does not bear any panicle. Non-effective tiller was higher in the treatment T_6 (4) and T_7 (4). Lowest no. of non-effective tiller was 1 in the leaf biomass ipilipil. The treatment T_2, T_3, T_4, T_5, T_8 and T_6, T_7 have no significant differences (Table 4). Data presented in Table 4 revealed that all the treatments produced higher panicle length over control. The panicle length varied from 12.50 to 24.00 cm. The treatment of RFD (T_7) produced the panicle length of 24.00cm and the control treatment produced 12.50 cm. Second highest panicle length 22.5 cm which was found in the treatment T_4 because more nutrient was released from ipilipil leaf

Table 1. Existing soil fertility status before rice cultivation

Treatment	pH	Organic matter (%)	N(%)	P(ppm)	K (me/100g)	S (ppm)	Zn (ppm)
T_1	4.95	0.46	0.055	11.81	13.50	7.23	2.62
T_2	5.00	0.45	0.058	11.75	13.48	7.22	2.63
T_3	5.05	0.45	0.054	11.78	13.51	7.20	2.59
T_4	4.95	0.47	0.059	11.77	13.54	7.19	2.61
T_5	5.05	0.46	0.061	11.82	13.48	7.21	2.60
T_6	4.95	0.46	0.058	11.8	13.5	7.20	2.59
T_7	5.00	0.45	0.062	11.79	13.51	7.20	2.62
T_8	5.05	0.47	0.058	11.84	13.49	7.23	2.58
Mean	5.00	0.46	0.058	11.795	13.50	7.21	2.61
Level of sig.	NS	NS	NS	NS	NS	NS	NS

T_1 = Ipil-ipil, T_2 = Bakphul, T_3 = Minjiri, T_4 = Ipil-ipil+1/2RFD, T_5 = Bakphul + 1/2RFD, T_6 = Minjiri + 1/2 RFD, T_7 = RFD, and T_8 = Control

Table 2. Soil fertility status in different treatment after rice cultivation season

Treatment	pH	Organic matter (%)	N(%)	P(ppm)	K (me/100g)	S (ppm)	Zn (ppm)
T_1	4.95c	0.51a	0.071a	11.81a	13.12a	7.05a	2.60a
T_2	5.00c	0.48ab	0.065b	11.75a	12.98a	6.98a	2.57a
T_3	5.05c	0.46b	0.061bc	11.78a	13.11a	7.05a	2.55a
T_4	5.25b	0.39c	0.058c	10.55b	11.45b	6.66b	2.30b
T_5	5.20b	0.37cd	0.057c	10.15b	11.15b	6.44b	2.22bc
T_6	5.22b	0.35d	0.053d	9.35bc	10.55b	6.16c	2.11c
T_7	5.60a	0.25e	0.042f	7.38c	8.33c	6.01c	1.42e
T_8	5.25b	0.35d	0.048e	6.84c	8.45c	5.31d	1.58d

Means in column followed by the different letter are significantly different by DMRT at $P \le 0.05$; T_1 = Ipil-ipil, T_2 = Bakphul, T_3 = Minjiri, T_4 = Ipil-ipil + 1/2RFD, T_5 = Bakphul + 1/2RFD, T_6 = Minjiri + 1/2 RFD, T_7 = RFD, and T_8 = Control biomass, which was more than the controlled plot and statistically similar with the treatment RFD (T_7). The lowest panicle length (12.50 cm.) was recorded in the control, which was less than all other treatments (Table 4). These results are agree with the report of Chaphale and Badole (1999) that organic manure increased panicle length significantly. Table 4, showed that no. of total spikelets panicle^{-1} was varied from 97 to 210. The highest no. of total spikelet penicle^{-1} was found in the treatment T_7 was 210 for applying fertilizer and the lowest one in the control treatment. The highest weight (26.80g) of 1000-grains was obtained in treatment T_7 and the second highest was obtained from the treatment of T_4 (26.58g). The lowest weight (15.00 g) of 1000-grains was observed in control plot. Treatment T_1, T_4, T_5 and T_7 were statistically non significant. These results are in agreement with that of Bhuiya, M.R, M.S. Akhand (1982).

Table 3. Growth performance of rice in different treatments at 30 DAP & 60 DAP

Treatment	Plant height (cm)		No. of tillers hill-1		No. of leaves hill-1		Leaf size (cm^2)	
	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP
T_1	46.24a	92.80b	8c	10cd	34b	45c	21.84a	27.84a
T_2	45.00a	89.70c	9b	9d	32bc	39d	20.11b	27.06b
T_3	48.21a	85.50d	8c	9d	30d	38d	19.43c	24.90c
T_4	48.39a	94.10a	10a	12b	36a	49b	21.96a	28.11a
T_5	47.00a	92.40b	9b	11bc	33b	46c	21.83a	27.88a
T_6	46.77a	89.00c	9b	11bc	31cd	45c	20.77b	26.57b
T_7	48.78a	95.60a	10a	14a	36a	55a	22.80a	28.70a
T_8	35.32b	41.3e	4d	5c	16e	18e	12.22d	14.66d

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$; T1 = Ipil-ipil, T2 = Bakphul, T3 = Minjiri, T4 = Ipil-ipil+1/2RFD, T5 = Bakphul + 1/2RFD, T6 = Minjiri + 1/2 RFD, T7 = RFD, and T8 = Control

Table 4. Yield contributing characteristics of rice in different treatments after harvest

Treatments	Plant height (cm)	No. of tillers hill^{-1}	No. of panicles hill^{-}	Non-effective tillers hill^{-1}	Panicle length (cm)	No. spikelets panicle^{-1}			1000 grain weight (g)
						Total	Filled	unfilled	
T_1	95.50b	12cd	11bc	1d	21.0b	185b	140bc	45bc	26.16a
T_2	94.40c	11de	9cd	2c	17.5cd	177bc	129c	48b	23.20c
T_3	91.30d	10e	8d	2c	16.4d	163cd	112d	51b	20.00d
T_4	97.20a	14b	11ab	3b	22.5ab	190b	148b	42c	26.58a
T_5	96.80ab	13c	10bc	3b	19.9b	187b	144b	43c	25.94a
T_6	95.90	13c	9cd	4a	18.5bc	172c	130c	42c	24.20b
T_7	98.70a	16a	12a	4a	24.0a	210a	175a	35d	26.80a
T_8	74.60e	7f	4e	3b	12.5e	97e	30e	67a	15.00e

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$; T1 = Ipil-ipil, T2 = Bakphul, T3 = Minjiri, T4 = Ipil-ipil +1/2RFD, T5 = Bakphul + 1/2RFD, T6 = Minjiri + 1/2 RFD, T7 = RFD, and T8 = Control

Yield: The highest grain yield with the application RFD (T_7) of rice (cv. BR 11) was found in the treatment T_7 (6.12 t ha^{-1}). And lowest yield (0.75 t ha$^{-1)}$ was found in control. Second highest yield was obtained from treatment treatment T_4 (6.05 t ha^{-1}) where leaf biomass of Ipil-ipil + ½ RFD applied. In the Treatment T_4 ipilipil leaf biomass released nutrients and ½ RFD applied for that plant got considerable amount of nutrient which was beneficial for plant growth, development and physiological process. And this yield was comparatively better than the Treatment T_7 (Fig. 2). These results are similar with the BRRI (1984) and Budelman (1988).

Soil fertility status is improved in the treatment where only green leaf biomass was applied. The treatment containing green leaf biomass and recommended fertilizer dose slightly deteriorate the soil fertility status because of residual effect of fertilizer. All the yield and yield contributing characters such as plant height, panicle length, no. of tillers hill^{-1}, no.

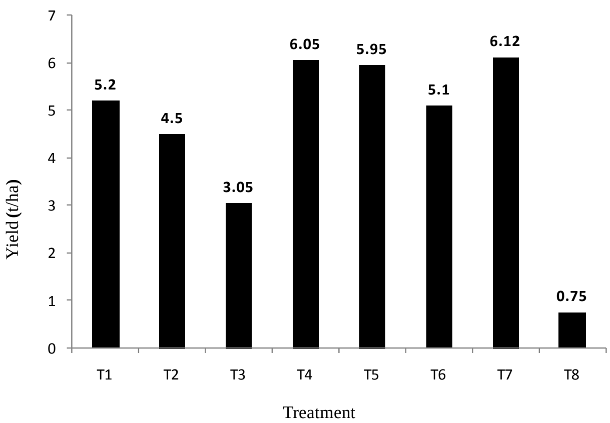

Fig. 2. Yield of rice in different treatments

of leaves $hill^{-1}$, leaf size, no. of panicles $hill^{-1}$, no. of non-effective tillers $hill^{-1}$, no. spikelets $panicle^{-1}$, 1000-grain weight, and grain yield was found best results in the treatment where green leaf biomass and recommended fertilizer dose were applied over control treatment.

References

BBS (Bangladesh Bureau of Statistics). 2004. Monthly Statistical Bulletin, June. 2004. Stat. Div. Ministry of Planning, Govt. Peoples Republic of Bangladesh. p.11

BBS (Bangladesh Bureau of Statistics). 2003. Statistical Pocketbook of Bangladesh. Bureau Stat. Div. Ministry of Plan. Govt. People's Rep. Bangladesh.

Bhuiya, M.R. and Akhand, M.S. 1982. Effect of different sources of organic materials along and combination with two fertilizer levels on growth parameters and composition of rice. Bangladesh J. Agric., 7(3&4): 32-39.

BRRI. 1984. Annual Report for 1984. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh.

Budelman, A. 1988. The decomposition of the leaf mulches of *Leucaena leucocephala, Gliricidia sepium* and *Flemingia macrophylla* under humid topical conditions. Agroforestry Systems, 7.(33): 47-62.

Chaphale, S.D and Badole, W.P. 1999. Effect of green manuring and NPK combination on soil. health and yield of rice (*Oryza sativa*). Indian J. Agron., 44: 448-481.

FAO (Food and Agricultural Organization). 1999. Yearbook Production. FAO Statistics Division. 53: 72- 73.

Gomez, A.K. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research John Willey and Sons. New York, pp. 130-215.

Halepyhati, A.S. and Sheelavantar, M.N. 1988. Nitrogen substitution with *Sesbania rostrata* in rice productivity. IRRN., 15(6): 17.

Konboon, Y.K., Naklang, D., Suriya-arunroj, G., Blair, A., Whitebread, A.and Lefroy, R.B.B. 1993. Managing the decomposition rate of crop residues and leaf litter to match-nutrient demand and enhance the sustainability of lowland rice-cropping systems. International Rice Research Institute. pp. 169-183.

Kulkarni, K.R. and Pandey. 1988. *Sesbania rostrata* as green manure in nice based cropping systems, In green manure in rice farming. Manila, Philippines, IRRI, pp 89-299.

Mitch and Gosselink, 1993. Influence of mirasoil organic and X-rice liquid fertilizer in combination with inorganic fertilizer on IR66 and IR12 rice varieties. Malabon, Metro Manila (Philippines). 3(1):24-26.

Mohapatra, A.K. and Jee, R. 1993. Integrated. nutrient management in rice (*Oryza sativa*), tori (*Brassica campestris* sub sp. *Oleifiera* var. *toria*) rice cropping sequence for coastal Orrissa. Indian J. Agron., 38(3): 462-462.

Samsuzzaman and Karim 2002 . Effect of organic nitrogen sources on growth and yield of rice (*Oryza sativa*). Agron. Sci., Digest (Kerala) 15(2): 104. [Cited from Soils and Fert., 1994, 57(8): 865].

Sharma, A,R. and Mitra, B.N. 1990. Effect of nitrogen and phosphorus on rice and their residual effect on succeeding wheat/grain crop. Indian J Agron., 34 (I): 51-52.