Growth and productivity of rice-wheat cropping system as influenced by green manuring

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ABSTRACT

An investigation on the effect of green manuring in rice – wheat cropping system was undertaken at the experimental farm in Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, in consecutive three seasons during May 2001 to March 2002. Four green manure crops viz Sesbania rostrata, Sesbania aculeata, Vigna sisensis and Crotalaria juncea were grown during summer (Kharif) followed by rice (variety Annada) under direct seeded rainfed condition in Kharif and wheat (variety UP 262) in irrigated condition during dry season. Results revealed that green manuring and its residual effect increased all the growth attributes like plant height at harvest, dry matter accumulation, leaf area index, crop growth rate, yield components like number of panicles m^{-2}, number of filled grains $panicle^{-1}$, grain and straw yield of rice and succeeding wheat compared with control. However, both the Sesbania sp. was found the best among the different green-manuring crops. The highest rice grain yield (3 t ha^{-1}) and wheat grain yield (3.4 t ha^{-1}) were obtained when grown in sequence with Sesbania rostrata.

Key words: *Green manuring growth, productivity, rice, wheat, cropping system.*

Use of green manures and FYM in conjunction with chemical fertilizers is essential to maintain soil quality for sustainable crop yield (Hegde, 1998). More over green manuring can save 50 – 100 kg N ha^{-1} (Singh and Singh, 2000). So it can be a boon to poor and marginal farmers who can't afford fertilizers always due to escalating prices. Keeping all the above views into account, the present investigation was undertaken to find out the effect of different green manuring crops with and without *Rhizobium (Azorhizobium* sp., *Bradyhizobium* sp. and *Rhizobium* sp.) inoculation on grown and yield of rice growth under recommended fertilizer dose as well as their residual effects on succeeding wheat.

The field experiment was conducted in three consecutive seasons during May 2001 to March 2002 at research farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. The experiment was laid out in a Randomized Block Design with ten treatment combinations under three replications. Seeds of the green manure crops were inoculated with Rhizobium culture (*Azorhizobium* sp. in *Sesbania*, *Bradyrhizobium* sp. in cowpea and *Rhizobium* sp. in *Crotalaria*) @ 50 g kg^{-1} of seed before sowing as per the treatment. All the green manuring crops were sown on 15.05.2001 and were incorporated at 42 DAS. The treatment details are given below:

Treatments	Green manure crops	Rice (N.P.K)	Wheat (N.P.K)
T_1	*Sesbania rostrata* with inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	50:21.8:41.7 kg ha^{-1}
T_2	*Sesbania rostrata* without inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	75:21.8:41.7 kg ha^{-1}
T_3	*Sesbania aculeata* with inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	50:21.8:41.7 kg ha^{-1}
T_4	*Sesbania aculeata* without inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	75:21.8:41.7 kg ha^{-1}
T_5	*Vigna sinensis* with inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	50:21.8:41.7 kg ha^{-1}
T_6	*Vigna sinensis* without inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	75:21.8:41.7 kg ha^{-1}
T_7	*Crotalaria juncea* with inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	50:21.8:41.7 kg ha^{-1}
T_8	*Crotalaria juncea* without inoculation +13.1 kg P ha^{-1}	60:0:25 kg ha^{-1}	75:21.8:41.7 kg ha^{-1}
T_9	Without green manure crop	0:13.1:25 kg ha^{-1}	0:21.8:41.7 kg ha^{-1}
T_{10}	Without green manure crop	60:13.1:25 kg ha^{-1}	100:21.8:41.7 kg ha^{-1}

In wet season, rice (variety Annada) was sown on 20.07.2001 at a spacing of 15 cm (row-row) using a seed rate of 80 kg ha^{-1} and was harvested on 05.11.2001. Wheat (Variety UP262) was sown on 4.12.2001 after the harvest of rice, in rows 15 cm apart using a seed rate of 120 kg ha^{-1} and was harvested on 20.3.2002. In rice 60 kg N ha^{-1} was applied as the initial fertility status of soil was low and N was top dressed in three equal splits at 3, 5 and 7 weeks after sowing by broadcasting. As the objective of study was to find out weather there is any additive response of green manure crop along with the recommended dose of fertilizer in rice and residual effect on succeeding wheat so the fertilizer dose was same in rice. Full dose of K was applied as basal. Phosphatic fertilizer @ 13.1 kg ha^{-1} was applied basally to rice grown after non-inoculated green manure crops only, while inoculated green manure crops received similar P dose basally. While in wheat, full dose of P and K and ½ N were applied as basal and rest ½ N was top dressed before giving first irrigation at 20 DAS. Two more irrigations were given to wheat at 55 and at 80 DAS.

Significantly higher number of panicles m^{-2}, number of filled grains panicle^{-1}, grain yield, leaf area index (at 75 and 95 DAS) and dry matter accumulation (at 95 DAS) of rice were obtained in the treatment receiving green manures compared with control (Table 1). However, straw yield of rice treated with *Sesbania rostrata* with inoculation and without inoculation (T_1 T_2) and *Sesbania aculeata* with inoculation (T_3); *Vigna sinensis* with and without inoculation (T_5 T_6), *Crotalaria juncea* with inoculation (T_7) and rice receiving full dose of fertilizer (T_{10}) were at par; grain yield of rice treated with *Sesbania rostrata* without inoulation (T_2) and *Vigna sinensis* with inoculation (T_7), *Sesbania aculeata* with and without inoculation (T_{3-} and T_4) were at par; number of filled grains panicle^{-1} in rice under *Sesbania rostrata* with inoculation (T_1) and *Vigna sinensis* with inoculation (T_7) were at par; and plant height and number of panicles in T_1, T_2, T_3, T_7 and T_8 were at par; dry matter accumulation in T_2 and T_3; T_4, T_5 and T_6, T_7 and T_8 were at par; LAI both at 75 and 95 DAS in T_1, T_2, T_3, T_4 and T_5, T_6, T_7 were at par. But the highest

Table 1. Effect of green manuring on plant height, dry matter, leaf area index (LAI), yield components, grain and straw yield of rice

Treatment	Plant height (cm)	Dry matter at 95 DAS (gm^{-2})	LAI at 75 DAS	LAI at 95 DAS	No. of panicles (m^{-2})	No of grains (panicle^{-1})	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Sesbania rostrata with inoculation + NPK at 60:13.1:25 kg ha^{-1}	89.6	472.6	6.07	2.10	286.4	69.9	22.8	3.0	4.6
Sesbania rostrata without inoculation +NPK at 60:13.1:25 kg ha^{-1}	88.1	466.7	5.67	2.17	283.4	66.1	22.8	2.9	4.7
Sesbania aculeata with inoculation + NPK at 60:13.1:25 kg ha^{-1}	87.1	457.44	5.63	1.93	280.3	63.9	22.6	2.8	4.6
Sesbania aculeata without inoculation +NPK at 60:13.1:25 kg ha^{-1}	86.5	449.6	5.53	1.92	274.2	61.5	22.5	2.8	4.5
Vigna sinensis with inoculation + NPK at 60:13.1:25 kg ha^{-1}	85.8	425.4	5.20	2.07	252.2	59.4	22.4	2.6	4.2
Vigna sinensis without inoculation + NPK at 60:13.1:25 kg ha^{-1}	85.5	420.5	5.10	2.23	248.1	57.3	22.2	2.5	4.2
Crotalaria juncea with inoculation + NPK at 60:13.1:25 kg ha^{-1}	87.8	452.7	5.97	2.07	284.3	67.1	22.8	2.9	4.1
Crotalaria juncea without inoculation + NPK at 60:13.1:25 kg ha^{-1}	87.3	415.4	5.43	1.93	272.3	62.6	22.6	2.7	4.3
Without greed manure crop + NPK at 0:13.1:25 kg ha^{-1}	71.0	260.9	3.33	1.63	187.8	41.7	21.8	2.0	3.4
Without green manure crop + NPK at 60:13.1:25 kg ha^{-1}	81.8	395.7	4.80	2.13	228.7	53.0	21.9	2.4	4.1
SEm (±)	0.91	22.59	0.16	0.15	2.99	1.07	0.46	0.03	0.06
CD (P=0.05)	2.70	67.09	0.51	0.47	8.88	3.18	NS	0.09	0.17

Table 2. Effect of green manuring on plant height, dry matter, leaf area index (LAI), yield components, grain and straw yield of wheat

Treatment	Plant height (cm)	Dry matter at 95 DAS (gm^{-2})	LAI at 75 DAS	LAI at 95 DAS	No. of ear bearing tillers (m^{-2})	No of grains (ear^{-1})	Test weight (g)	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)
N:P:K at 50:21.8:41.7 kg ha^{-1}	101.3	1032.9	5.69	2.05	283.0	39.5	42.0	3.3	5.1
N:P:K at 75:21.8:41.7 kg ha^{-1}	102.7	1072.1	5.91	2.35	284.3	39.8	42.3	3.4	5.2
N:P:K at 50:21.8:41.7 kg ha^{-1}	99.5	1029.8	5.28	2.03	279.3	38.6	42.2	3.3	4.5
N:P:K at 75:21.8:41.7 kg ha^{-1}	100.4	1037.6	5.51	2.04	283.0	39.0	42.4	3.4	4.9
N:P:K at 50:21.8:41.7 kg ha^{-1}	93.3	1016.3	4.58	1.79	273.6	37.3	42.2	3.2	4.8
N:P:K at 75:21.8:41.7 kg ha^{-1}	97.1	1023.2	4.77	1.99	275.3	37.5	42.3	3.3	4.9
N:P:K at 50:21.8:41.7 kg ha^{-1}	99.7	1027.5	5.63	1.94	275.3	38.5	42.2	3.3	5.1
N:P:K at 75:21.8:41.7 kg ha^{-1}	100.3	1051.0	5.68	2.06	280.0	39.1	42.1	3.3	5.2
N:P:K at 0:21.8:41.7 kg ha^{-1}	78.0	755.0	2.71	1.70	186.6	22.0	40.8	2.2	4.4
N:P:K at 100:21.8:41.7 kg ha^{-1}	96.1	1019.3	5.38	2.28	273.6	37.2	42.1	3.1	5.0
SEm (±)	1.25	5.02	0.10	0.06	3.83	0.25	059	0.03	0.05
CD (P=0.05)	3.71	14.91	0.32	0.20	11.38	0.74	NS	0.08	0.15

grain yield was recorded when rice was grown after the incorporation of *Sesbania rostrata* with inoculation (T_1) (Panda *et al.,* 2005). In case of wheat, plant height was at par when wheat was sown after the harvesting of rice grown with *Sesbania rostrata* both with and without inoculation (T_1, T_2), *Sesbania aculeata* with and without inoculation (T_3, T_4), *Vigna sinensis* with and without inoculation (T_7, T_8). But number of ear bearing tillers in wheat grown in rice plots under *Sesbania rostrata* with and without inoculation (T_1, T_2), *Sesbania aculeate* with and without inoculation (T_3, T_4) and *Vigna sinensis* without inoculation (T_8) were at par; number of grains ear^{-1} in T_1, T_2, T_4, T_8 and T_3, T_7 were at par, grain yield in T_2, T_4 and T_1, T_3, T_6, T_7 and T_8 were at par (Mandal et al., 1992), while straw yield in crops grown in plots under *Sesbania rostrata* with and without inoculation (T_1, T_2) and *Vigna sinensis* with and without inoculation (T_7, T_8) were at par (Table 2); dry matter accumulation in T_1, T_3, T_4, T_7 and T_5, T_6 were at par, LAI in T_1, T_2, T_4, T_7, T_8 and T_2, T_{10} at 75 DAS and LAI in T_3, T_4, T_8 and T_6, T_7 at 90 DAS were at par (Table 2).

Therefore among the leguminous green manuring crops both the specieses of *Sesbania* could be used to increase yield of rice and its residual effect on succeeding wheat crop would also be beneficial.

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