System productivity and nitrogen use efficiency in rice-wheat cropping system as influenced by integrated nutrient management

Sheela Barla*[1] and R.R. Upasani

Department of Agronomy, Birsa Agricultural University, Ranchi - 834006, Jharkhand, India

ABSTRACT

The efficacy of organic sources, viz. farmyard manure (FYM) and green Karanj leaf (Derris indica) manure (KL), in combination with inorganic sources of nutrients in rice wheat cropping system was evaluated and the results revealed that substitution of 25 % N through Karanj leaf in rice followed by 100% recommended dose of fertilizer in wheat produced significantly maximum rice equivalent yield (94.72 q ha^{-1}), production efficiency (39.32 kg grain ha^{-1} day^{-1}), apparent N recovery (59.90%) and benefit cost ratio (2.85:1) and was at par with 25 % N substitution by Karanj leaf in rice followed by 75% recommended dose of fertilizer in wheat and 25% N substitution by farmyard manure in rice followed by 100 % recommended dose of fertilizer in wheat, while, maximum land use efficiency (65.94%) was under 50 % N substitution by Karanj leaf in rice followed by 100% recommended dose of fertilizer in wheat and maximum N-use efficiency was recorded under 25 % N substitution by Karanj leaf in rice followed by 75% recommended dose of fertilizer in wheat.

Key words: *Nitrogen use efficiency, rice-wheat cropping system, INM*

Rice - wheat cropping system, plays a pivotal role in Indian economy as it accounts for nearly seventy seven percent of the total food grain production and occupies nearly 12.3 million hectare (Kumar *et al*., 1998). Rapid spread of rice-wheat system in India caused a reduction on sustainability of soil productivity (Ratan and Singh, 1997) due to declining soil fertility, especially soil organic matter (Olk *et al.,* 1996). There are indications of stagnation or even decline in productivity of this cropping system due to over mining and losses of nutrients from soil varying from 600 to 700 kg ha^{-1} every year against application of 400 kg NPK ha^{-1}, (Singh *et al*., 2006). So, to get sustainable production from this system integrated plant nutrient supply system (INMS) has been advocated. Therefore, an experiment was conducted to evaluate the performance of organic sources of nutrients viz., farmyard manure and *Karanj* leaf manure, a native forest tree plant of Jharkhand on productivity of rice - wheat cropping sequence under integrated nutrient supply system.

MATERIALS AND METHODS

Field experiments were conducted at the University Farm, Ranchi, during both wet and dry seasons of 2001-02 and 2002-03. The soil was loam in texture (47.4% sand, 38.6% silt, and 14% clay) having 241.92, 15.94, and 130.19 kg ha^{-1} available N, P and K, respectively with pH 6.3. The experiments were laid out in randomized block design consisting of eleven treatment combinations of inorganic fertilizer alone and also in combinations with organic sources of nutrient for rice-wheat system with three replications, keeping the layout undisturbed throughout the course of experimentation The treatmetns were, application of no NPK (both inorganic and organic) in rice and wheat, 100% recommended dose (RD) of inorganic NPK in rice wheat, 100% NPK in rice and 75% of NPK in wheat, (inorganic) and 100% PK and 25% N (as FYM) in rice and 100% NPK in wheat. In integrated nutrient supply system, 25 and 50% nitrogen only to rice was substituted either through farm yard manure (FYM) or

Present address: *[1]Zonal Rrsearch Station (BAU), Darisai, E. Singhbhum, Jharkhand*

green *Karanj* leaves (KL) on the basis of their N content (0.94 & 2.63% during 2001 and 0.95 & 2.65% during 2002, respectively) and accordingly the requisite amount of organic sources were incorporated two weeks ahead of rice transplanting as per treatment. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash, respectively. Full dose of phosphorus & potash and half dose of nitrogen were given as basal, while remaining half of nitrogen in three equal splits at 10 days after transplanting, at tillering and at panicle initiation stages in rice and at maximum tillering and boot stages in wheat. The 100% recommended dose of nitrogen, phosphorus and potash both in rice and wheat was 100 kg N, 21.50 kg P and 20.75 kg K ha^{-1}. Rice var IR 36 and wheat var K 9107 were used for the experiment.

RESULTS AND DISCUSSION

Maximum rice equivalent yield and production efficiency during both the years (Table 1) was found when 25% nitrogen was substituted through *Karanj* leaf in rice followed by 100% recommended fertilizer NPK in wheat. Maximum pooled rice equivalent yield (94.72 q ha^{-2}) and production efficiency (39.32 kg grain ha^{-1} day^{-1}) was also recorded in this treatment and was similar to that, when 75% recommended fertilizer NPK was applied in wheat at the same level of substitution by *Karanj* leaf. It can be inferred that by substituting 25% nitrogen through *Karanj* leaf in rice, the recommended dose of fertilizer in wheat can be reduced to 75% for having high rice equivalent yield. The results corroborate the findings of Kundu and Samui (2000) and Yadav *et al*., (2005).

Maximum land use efficiency (65.94%) was under 50 % nitrogen substitution by *Karanj* leaf in rice followed by 100% recommended dose of fertilizer in wheat and all the treatments were significantly superior to control.

Maximum nitrogen uptake was recorded under integration of 75% recommended nitrogen through fertilizer and 25% nitrogen through *Karanj* leaf in rice followed by 100% recommended fertilizer NPK in wheat during both the years of study. During first year this treatment proved significantly superior, however, during second year it was at par with 25 or 50% nitrogen substitution through farmyard manure in rice followed by 100% recommended fertilizer NPK in wheat and 25% nitrogen substitution through *Karanj* leaf in rice followed by 75% recommended fertilizer NPK in wheat. This may be due to build up of soil fertility during the succeeding year.

Integration of 75% recommended nitrogen through fertilizer with 25% nitrogen through *Karanj* leaf in rice and 100% recommended fertilizer NPK in wheat recorded maximum N-use efficiency (21.09 kg grain $kg^{-1}N$) followed by 25% nitrogen substitution through *Karanj* leaf in rice and 75% recommended fertilizer NPK in wheat during 2001-02. Whereas, 25% nitrogen substitution through *Karanj* leaf in rice and 75% recommended fertilizer NPK in wheat recorded maximum N-use efficiency (35.41 kg grain $kg^{-1}N$) followed by 25% nitrogen substitution through *Karanj* leaf in rice and 100% recommended fertilizer NPK in wheat during 2002-03. Pooled data revealed that 25% nitrogen substitution through *Karanj* leaf in rice and 75% recommended fertilizer NPK in wheat recorded maximum N-use efficiency (27.88 kg grain kg^{-1} N) followed by 25% nitrogen substitution through *Karanj* leaf in rice and 100% recommended fertilizer NPK in wheat (27.30 kg grain $kg^{-1}N$).

Integration of 75% recommended nitrogen through fertilizer with 25% nitrogen through *Karanj* leaf in rice followed by 100% and 75% recommended fertilizer NPK in wheat recorded maximum apparent N recovery i.e., 53.20% and 68.88% during 2001-02 and 2002-03, respectively. Whereas, pooled data revealed that maximum apparent N recovery was under 25% nitrogen substitution through *Karanj* leaf in rice and 100% recommended fertilizer NPK in wheat (59.9%) followed by 25% nitrogen substitution through *Karanj* leaf in rice and 75% recommended fertilizer NPK in wheat (58.77%). Substitution of 25% nitrogen through *Karanj* leaf in rice followed by 100% and 75% recommended fertilizer NPK in wheat improved apparent N recovery by 27.99% over 100% recommended fertilizer NPK in rice followed by 100% and 75% recommended fertilizer NPK in wheat (Table 1). Yadav *et al*., (2005) also reported higher N-uptake and N-recovery with integration of inorganic nitrogen and green manuring in rice crop.

Integrated application of 75% recommended nitrogen through fertilizer with 25% nitrogen through *Karanj* leaf in rice followed by 100 or 75%

Table 1. Rice equivalent yield (q ha^{-1}), Production efficiency (kg grain ha^{-1} day^{-1}), Land use efficiency (%), Nitrogen uptake (kg ha^{-1}), Nitrogen-use efficiency* (kg rice equivalent yield kg^{-1} N applied), Apparent-N recovery (%), Cost of cultivation (Rs. ha^{-1}) and Benefit: Cost ratio under rice – wheat ropping sequence as influenced by integrated nutrient management

Treatments			Rice equivalent yield			Production efficiency	LUE	N uptake		NUE	Apparent N recovery	Cost of cultivation	B:C ratio
Rice		Wheat	2001-02	2002-03	Pooled	Pooled	Pooled	2001-02	2002-03	Pooled	Pooled	Pooled	Pooled
Inorganic	Organic	Inorganic											
$N_0P_0K_0$	$N_0P_0K_0$	$N_0P_0K_0$	44.51	35.74	40.13	17.93	61.60	73.75	60.31	-	-	13184.13	1.75
100% NPK	0	100%	79.93	94.26	87.10	36.16	65.89	151.51	177.65	23.48	48.78	18458.91	2.62
100% NPK	0	75%	74.60	83.51	79.05	32.97	65.66	136.65	151.20	22.24	43.94	17835.73	2.44
75%N 100%PK	25% N (FYM)	100%	82.89	95.73	89.31	37.12	65.84	159.20	178.51	24.59	50.91	18930.34	2.61
75%N 100%PK	25% N(FYM)	75%	78.00	89.81	83.91	34.98	65.66	149.91	160.76	25.02	50.46	18307.16	2.54
50%N 100%PK	50% N (FYM)	100%	75.46	96.62	86.04	35.67	65.84	132.27	187.53	22.96	46.43	19474.10	2.45
50%N 100%PK	50% N (FYM)	75%	70.85	90.60	80.73	33.65	65.48	117.59	160.91	23.20	41.27	18850.92	2.36
75%N 100%PK	25% N (KL)	100%	86.69	102.76	94.72	39.32	65.89	180.15	193.50	27.30	59.90	18484.02	2.85
75%N 100%PK	25% N (KL)	75%	80.10	97.71	88.91	36.95	65.75	158.90	180.85	27.88	58.77	17860.84	2.76
50%N 100%PK	50% N (KL)	100%	77.33	93.26	85.30	35.37	65.94	143.87	176.07	22.59	46.47	18580.34	2.55
50%N 100%PK	50% N (KL)	75%	70.89	90.93	80.91	33.59	65.75	126.48	160.14	23.30	43.59	17957.16	2.49
CD (P=0.05)			7.40	7.19	7.3	3.06	0.66	14.52	15.18				0.22

* kg rice equivalent yield kg^{-1} N applied

LUE - Land use efficiency; NUE- Nitrogen use efficiency; FYM- Farm yard manure; KL- Karnaj leaves

recommended fertilizer NPK in wheat (2.63 and 2.49 respectively) and 25% nitrogen substitution by farm yard manure in rice followed by 100% recommended fertilizer NPK in wheat (2.43) recorded almost equal benefit: cost during 2001-02 (Table 1). While during 2002-03, integrated application of 75% recommended nitrogen through fertilizer with 25% nitrogen through *Karanj* leaf in rice followed by 100 or 75% recommended fertilizer NPK in wheat recorded significantly higher benefit: cost i.e., 3.08 and 3.04, respectively over rest of the nutrient management practices.

Analysis of pooled data revealed that integration of 75% recommended nitrogen through fertilizer with 25% nitrogen through *Karanj* leaf in rice followed by 100 or 75% recommended fertilizer NPK in wheat produced maximum benefit: cost i.e., 2.85 and 2..76 respectively and was significantly higher than rest of the nutrient management practices.

REFERANCES

Kumar P, Joshi PK, Johansen C and Asokan M 1998. Sustainability of rice-wheat based cropping system in India. Econ. Polit. Weekly 33, A182-188

Kundu AL and Samui RC 2000. Long- term soil fertility experiment in rice- wheat cropping system in West Bengal. Page 63-67 *In* Long- term soil fertility experiments in rice- wheat cropping system (Abrol, I.P., Bronson, KF., Duxbury, JM and Gupta, RK eds.). Rice- wheat Consortium Paper Series 6. New Delhi, India; Rice-wheat Consortium for the Indo- Gangetic Plains.

Olk, DG, Cassman KG, Randall EW, Kindhesh P, Sanger LJ and Anderson JM 1996. Changes in the chemical properties of soil organic matter in tropical lowland soils. Environmental J of Soil Sci 47: 293-303

Singh YV, Singh BV, Pabbi S, Dhar DW and Singh PK . 2006. Influence of integrated plant nutrient supply system on grain yield,quality and fertility in rice (*Oryza sativa*)- wheat (Triticum aestivum) cropping system. National Symposium on conservation Agriculture and Environment,October 26-28, 2006, BHU, Varanasi, pp: 157-158

Rattan RK and Singh AK 1997. Role of balanced fertilization in rice-wheat cropping system. Fertilizer News 42(4): 592-600

Yadav MP, Aslam Mohd and Kushwaha SP 2005. Effect of integrated nutrient management on rice (*Oryza sativa*) – wheat (*Triticum aestivum*) cropping system in central plains zone of Uttar Pradesh. Indian J of Agron 50(2): 89-93