International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 2540-2544

Received: 17-09-2018
Accepted: 23-10-2018

Neelam Bisen
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ramesh K Singh
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
Neelam Bisen
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Nutrient dynamics in soil as affected by planting methods, water management and weed management in dry seeded rice

Neelam Bisen and Ramesh K Singh

Abstract
Field experiments were conducted on rice (*Oryza sativa* L.) to evaluation of nutrient balance sheet as influenced by planting methods, water management and weed management in dry seeded rice, at irrigation plot (UGC, SAP project), Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) during *kharif* seasons of 2016 and 2017. The experiment was conducted in split plot design with four replications and 20 treatment combination. Results showed that maximum losses/ gain of nitrogen, phosphorus and potassium was maximum in FIRB planting, (-2.35 and -5.92 kg/ha), (2.02 and -0.91 kg/ha), and (-63.72 and -57.64 kg/ha) during 2016 and 2017. Among water management the net gain /loss was higher in saturation to field capacity (-3.61 and -5.96 kg/ha) N, (2.05 and -1.04 kg /ha) P and (-63.09 and-57.91 kg/ha) K during 2016 and 2017 respectively. Among the weed management treatments the weedy check recorded maximum gain in N (7.10 and 2.68 kg/ha), and P (2.88 and 0.18 kg/ha). The minimum losses of K (-54.06 and -51.88 kg/ha) was also recorded in weedy check during both year. Thus it needs to evolve such practices of planting, water and weed management in DSR, that it maintains the balance in soil with sustainable yield.

Keywords: Balance sheet of N, P and K, dry seeded rice, weeds

Introduction
Rice (*Oryza sativa* L.) is a staple food crop of world. India is the second largest producer of rice only after China. Rice in India, cultivated in the area of 43.39 Mha with a production of 104.32 Mt and average productivity of 2.40 t/ha during 2015-16 (Directorate of Economics & Statistics, 2016) [1]. Uttar Pradesh is the largest rice growing state only after West Bengal in the country, where it is raised over an area of about 5.87 m ha with the production of 12.51 Mt and productivity of 2.13 t/ha, respectively (Directorate of Economics & Statistics, 2016) [1]. It is the primary source of food, income, and employment for more than 100 million households in Asia.

Traditionally rice is grown as transplanting, but due to the declining water table, sacristy of labour at the peak period of transplanting due to migration of rural labor to urban areas, majority of Asian farmers are shifted towards dry seeded rice (Mahajan *et al*. 2013; Pandey and Velasco, 2005) [2, 3]. Dry seeding of rice not only saves the labour cost for nursery raising and transplanting of rice but also harvest the early shower of monsoon. In rice cultivation, soil undergoes drastic changes, *viz.,* aerobic to anaerobic environment, which leads several physical and electrochemical transformations in the soil also cause the nutrient loss in terms of volatilization, leaching, and fixation. The furrow irrigated raised bed system of planting creates aerobic condition in soil which proliferates the root growth of the rice crop, and facilitates the maximum nutrient uptake by crop. Alternate wetting and drying (AWD) is a water management system introduced to reduce water inputs and improve water productivity with non-submerged conditions maintained for several days until cracks appear in plow sole (Cabangon *et al*., 2004) [4]. In dry seeded rice because of the diversity and severity of weed infestation and the absence of standing water layer and less vigour of rice plant unlike nursery transplanted rice cause serious weed infestation, and herbicides are an only cost-effective measure for weed control. Weed also compete with the main crop and it harvests the marked amount of nutrients which applied for the crop. Hence, the present investigation was carried out to work out the balance sheet and net change in soil fertility of rice field as influenced by planting methods, water management, and weed management.

Materials and methods

The experiment was conducted in the Irrigation Plots (UGC, SAP project), Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) during *kharif* seasons of 2016 and 2017 situated at $25^0$18'N latitude, $88^0$03'E latitude and at an altitude of 75.7 meters above the mean sea level. The experiment was laid out in the split plot design replicated four with 20 treatment combination. The main plot comprises (2 planting method) *viz.* Conventional method (flatbed), Farrow irrigated raised bed system (FIRB), (2 water management practices) *viz.* alternate wetting and drying (AWD) and saturation to field capacity and in subplot 5 weed management practices *viz.* weedy check (W_0), two hand weeding at 20 and 40 DAS (W_1), pendimethalin 1 kg/ha (PE) *fb* bispyribac sodium 25 g/ha at 4-6 leaf stage of weeds (W_2), oxadiargyl 90 g/ha (PE) *fb* penoxsulam 22.5 g/ha at 4-6 leaf stage of weeds (W_3), flufenacet 120 g/ha (PE) *fb* pyrazosulfuron 20 g/ha + bispyribac sodium 25 g/ha at 4-6 leaf stage of weeds (W_4) were allocated in sub plots during both the years of examination. The plots size was 4 mx 4 m area with surrounded by cemented waterproof brick walls. The soil of experimental field was sandy clay loam, well drained with moderate fertile being low in organic carbon, low available nitrogen, medium available phosphorus, and available potassium. The variety was sown HUR-105 with uniform recommended fertilizer dose 120:60:40 kg NPK /ha was applied during both years. The irrigation has been given through water meter opened at each plot as per treatment scheduled. To study soil, the composite soil samples were collected with the help of soil auger and core sampler. Soil samples were brought to the laboratory, air dried and crushed to pass through 20 mm mesh sieve, taking all possible precautions prescribed for soil sampling (Black *et al*., 1965). The processed soil samples were subjected to appropriate analysis of mechanical, physical and chemical properties. The results thus obtained are presented in Tables 1.

Table 1: methods used for analysis of NPK in soil of experimental field

S. No.	Particulars	Method employed
1	pH (1:2.5 soil: water suspension) at 25 ^{0}	Buckman pH meter (Jackson, 1958) [5]
2	EC (1:2.5 soil: water suspension dS/m) at 25 ^{0}C	Systronics EC meter Jackson, 1958) [5]
3	Organic carbon (%)	Walkley and Black rapid titration (Jackson,1958) [5]
4	Available Nitrogen (kg/ha)	Alkaline permanganate method (Subbiah and Asija, 1956) [6]
5	Available Phosphorus (kg/ha)	Olsen's method (Olsen *et al*., 1954) [7]
6	Available Potassium (kg/ha)	Flame photometric method (Jackson, 1958) [5]

Results and Discussions

Available NPK in soil after harvest of crop

Among the planting method conventional planted crop recorded higher available N (178.7 and 178.39 kg/ha), available P (24.23 and 22.70 kg/ha) and available K (159.85 and 158.43 kg/ha) as compared to furrow irrigated raised bed system of planting methods during 2016 and 2017 respectively. Similarly alternate wetting and drying recorded higher available N (180.01 and 178.43 kg/ha), available P (23.88 and 22.50 kg/ha) and available K (175.15and 159.22 kg/ha) in soil after harvest than saturation to field capacity treatment. This might be due to less uptake of total NPK by crop and also by reduction of losses through leaching. The FIRB and saturation to field capacity treatment planted crop has higher grain and straw yield causes maximum uptake of NPK. Beek *et.al* (2016) [8] also found that the higher yield results in grater nutrition depletion in the soil nutrient pool. In case of weed management treatment the higher availability of NPK in soil was found under weedy check (187.61 and 184.11 kg/ha N), (25.0 and 23.72kg/ha P) and (164.44 and 163.24 kg/ha K) during 2016 and 2017 respectively.

Gain and loss of nutrient in soil

The net losses of nitrogen, and potassium (Table 2 and 3) was maximum in FIRB planting, (-2.35 and -5.92 kg/ha) and (-63.72 and -57.64 kg/ha) respectively during both years. This may be due to FIRB facilitate unrestricted root growth and be able to uptake nutrients at the rate for maximum growth. In case of water management the negative balance of nitrogen and phosphorus was recorded in saturation to field capacity (-3.61 and -5.96 kg/ha) N and (-63.09 and 57.91 kg/ha) K compare to alternate wetting and drying during both years. This might be due to moisture availability throughout the growth season causes maximum nutrient uptake by crop and also the weed infestation was found more in this plots results in lower soil available N and K. This finding was in confirmation with Singh *et al.* (2017) [9]. In the case of phosphorus (Table 4) the balance was found positive in all treatments during first year of study but goes negative in second year. The net gain and loss of P was higher in conventional planting (2.02 and -0.91 kg/ha), and alternate wetting and drying (2.05 and -1.04 kg /ha).

Among the weed management treatments the weedy check recorded maximum gain in N (7.10 and 2.68 kg/ha), and P (2.88 and 0.18 kg/ha). The minimum losses of K (-54.06 and -51.88 kg/ha) was also recorded in weedy check during both year. The next lowest loss was found in treatment oxadiargyl 90 g a.i./ha (PE) *fb* penoxsulam 22.5g a.i./ha at 4-6 leaf stage of weeds (-2.43 kg/ha) during 2016 and in Pendimethalin 1 kg a.i./ha (PE) *fb* bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds (-3.72 kg/ha) during 2017. In case of P and K the next best treatment was Pendimethalin 1 kg a.i./ha (PE) *fb* bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds (1.99 kg/ha) recorded maximum gain (1.99 kg/ha P) and minimum loss of K (61.87 kg/ha) during 2016 and minimum loss (-0.89 kg/ha P and -57.46 kg/ha K) during 2017. These findings were confirmed those of Bhosale (2010) [10].

Table 2: Effect of planting methods water management and weed management on nitrogen balance sheet after harvest of dry seeded rice

Treatment	Initial soil N status (kg/ha)		Added N through (kg /ha)		N uptake by crop (kg /ha)		Expected balance of N in soil {(A+B)-C}		Actual Soil Nitrogen status (kg /ha)		Apparent gain or loss of N (kg /ha) (E-D)		Net gain or loss of Nitrogen (A-E)	
	A	A	B	B	C	C	D	D	E	E	F	F	G	G
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Planting methods														
Conventional method	180.51	181.43	120	120	80.44	76.57	220.07	224.86	178.75	178.39	41.32	46.47	-1.76	-3.04
Furrow irrigated raised bed (FIRB)	180.51	181.43	120	120	87.26	84.83	213.25	216.6	178.16	175.51	35.09	41.09	-2.35	-5.92
Water management														
Alternate wetting and drying	180.51	181.43	120	120	81.7	77.68	218.81	223.75	180.01	178.43	38.8	45.32	-0.50	-3.00
Saturation to field capacity	180.51	181.43	120	120	86	83.72	214.51	217.71	176.9	175.47	37.61	42.24	-3.61	-5.96
Weed management														
Weedy check	180.51	181.43	120	120	44.12	40.7	256.39	260.73	187.61	184.11	68.78	76.62	7.10	2.68
Two hand weedings at 20 and 40 DAS	180.51	181.43	120	120	100.47	98.01	200.04	203.42	173.98	173.11	26.06	30.31	-6.53	-8.32
Pendimethalin 1 kg a.i./ha (PE) *fb* bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	180.51	181.43	120	120	88.41	85.24	212.1	216.19	177.58	177.7	34.52	38.49	-2.93	-3.73
Oxadiargyl 90 g a.i./ha (PE) *fb* penoxsulam 22.5g a.i./ha at 4-6 leaf stage of weeds	180.51	181.43	120	120	89.5	86	211.01	215.43	178.08	175.91	32.93	39.52	-2.43	-5.52
Flufenacet 120 g a.i./ha (PE) *fb* pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	180.51	181.43	120	120	96.76	93.55	203.75	207.88	175.03	173.92	28.72	33.96	-5.48	-7.51

Table 3: Effect of planting methods water management and weed management on phosphorus balance sheet after harvest of dry seeded rice

Treatment	Initial soil P status (kg/ha)		Added P Through (kg /ha)		P uptake by crop (kg /ha)		Expected balance of P in soil {(A+B)-C}		Actual Soil P status (kg /ha)		Apparent gain or loss of P (kg /ha) (E-D)		Net gain or loss of P (kg /ha) (A-E)	
	A	A	B	B	C	C	D	D	E	E	F	F	G	G
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Planting methods														
Conventional method	22.21	23.54	60	60	24.8	23.40	57.41	60.14	24.23	22.63	33.18	37.44	2.02	-0.91
Furrow irrigated raised bed (FIRB)	22.21	23.54	60	60	27.59	26.34	87.59	86.34	23.91	22.70	63.68	63.71	1.70	-0.84
Water management														
Alternate wetting and drying	22.21	23.54	60	60	25.24	23.88	85.24	83.88	24.26	22.50	60.98	61.05	2.05	-1.04
Saturation to field capacity	22.21	23.54	60	60	27.15	25.86	87.15	85.86	23.88	22.83	63.27	63.36	1.67	-0.71
Weed management														
Weedy check	22.21	23.54	60	60	14.5	13.43	74.5	73.43	25.09	23.72	49.41	49.71	2.88	0.18
Two hand weedings at 20 and 40 DAS	22.21	23.54	60	60	32.64	31.11	92.64	91.11	23.35	22.08	69.29	69.03	1.14	-1.46
Pendimethalin 1 kg a.i./ha (PE) *fb* bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	22.21	23.54	60	60	26.31	25.73	86.31	85.73	24.2	22.65	62.11	63.08	1.99	-0.89
Oxadiargyl 90 g a.i./ha (PE) *fb* penoxsulam 22.5g a.i./ha at 4-6 leaf stage of weeds	22.21	23.54	60	60	26.86	24.82	86.86	84.82	24.12	22.58	62.74	62.24	1.91	-0.96
Flufenacet 120 g a.i./ha (PE) *fb* pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	22.21	23.54	60	60	30.64	29.26	90.64	89.26	23.59	22.27	67.05	66.99	1.38	-1.27

Table 4: Effect of planting methods water management and weed management on potassium balance sheet after harvest of dry seeded rice

Treatment	Initial soil K status (kg/ha)		Added K through (kg /ha)		K uptake by crop (kg /ha)		Expected balance of K in soil {(A+B)-C}		Actual Soil K status (kg /ha)		Apparent gain or loss of K (kg /ha) (E-D)		Net gain or loss of K (kg /ha) (A-E)	
	A	A	B	B	C	C	D	D	E	E	F	F	G	G
	2016	2017	2016	2017	2016	2017	2016	2017	2015	2016	2015	2016	2015	2016
Planting methods														
Conventional method	218.50	215.12	40.00	40.00	82.57	80.15	175.93	174.97	159.85	158.43	16.08	16.54	-58.65	-56.69
Furrow irrigated raised bed (FIRB)	218.50	215.12	40.00	40.00	89.19	85.82	169.31	169.3	154.78	157.48	14.53	11.82	-63.72	-57.64
Water management														
Alternate wetting and drying	218.50	215.12	40.00	40.00	83.53	79.97	174.97	175.15	159.22	158.7	15.75	16.45	-59.28	-56.42
Saturation to field capacity	218.50	215.12	40.00	40.00	88.23	86.00	170.27	169.12	155.41	157.21	14.86	11.91	-63.09	-57.91
Weed management														
Weedy check	218.50	215.12	40.00	40.00	55.13	51.58	203.37	203.54	164.44	163.24	38.93	40.3	-54.06	-51.88
Two hand weedings at 20 and 40 DAS	218.50	215.12	40.00	40.00	98.71	95.52	159.79	159.6	154.03	155.40	5.76	4.20	-64.47	-59.72
Pendimethalin 1 kg a.i./ha (PE) *fb* bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	218.50	215.12	40.00	40.00	86.98	86.46	171.52	168.66	156.63	157.66	14.89	11.00	-61.87	-57.46
Oxadiargyl 90 g a.i./ha (PE) *fb* penoxsulam 22.5g a.i./ha at 4-6 leaf stage of weeds	218.50	215.12	40.00	40.00	91.47	88.16	167.03	166.96	156.48	157.47	10.55	9.49	-62.02	-57.65
Flufenacet 120 g a.i./ha (PE) *fb* pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	218.50	215.12	40.00	40.00	97.1	93.19	161.4	161.93	155	156.01	6.40	5.92	-63.5	-59.11

Conclusion
It may be concluded that to reduce the negative nutrient balance in the soil, it needs to enhance the nutrient application rate along with efficient water and weed management practices for dry seeded rice that not only enhances the crop yield but also conserve nutrient in the soil.

Acknowledgements
The author acknowledges the Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) and UGC for providing financial support to carry out the research work.

Reference
1. Agriculture statistics a glances. Government of India Ministry of Agriculture. Department of Agriculture & Cooperation Directorate of Economics & Statistics. New Delhi, 2016.
2. Mahajan G, Chauhan BS. The role of cultivars in managing weeds in dry-seeded rice production systems, Crop Protection. 2013; 49:52-57,
3. Pandey S, Velasco L. Trends in crop establishment methods in Asia and research issues. In: Toriyama, K., Heong, K. L., Hardy, B. (Eds.), Rice is Life: Scientific Perspectives for the 21st Century. International Rice Research Institute, Los Baños (Philippines) 2005, 178-181,
4. Cabangon RJ, Tuong TP, Castillo EG, Bao LX, Lu GA, Wang GH, *et al*. Effect of irrigation method and N-fertilizer management on rice yield, water productivity and nutrient-use efficiencies in typical lowland rice conditions in China. Paddy Water Environment. 2004; 2(4):195-206.
5. Jackson ML. Soil Chemical Analysis, Prentice Hall Engleword Cliffs, NJ, 1958, 151-157.
6. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soil, Current Science. 1956; 25:259-260,
7. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate, US Department of Agriculture Circular No. 939, Banderis, AD, Barter DH and Anderson, K, Agricultural and Advisor, 1954.
8. Beek CLV, Elias E, Yihenew GS, Heesmans H, Tsegaye A, Feyisa H *et al*. Soil nutrient balances under diverse agro-ecological settings in Ethiopia. Nutrient cycling in Agroecosystem. 2016; 106:257-274.
9. Singh A, Sharma SK, Chopra R, Meena SC, Mali H. Evaluation of nutrient balance sheet as influenced by drip fertigation in cauliflower. International Journal of Current Microbiology and Applied Sciences. 2017; 4:25-29
10. Bhosale SS. Growth, yield and nutrient uptake by crop and weeds as influenced by integrated weed management in groundnut (*Arachis hypogea* L.) M.Sc. (Agri.) Thesis submitted to Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (MP), 2010.