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RESEARCH ARTICLE

EVALUATION OF RICE ESTABLISHMENT METHODS AND NUTRIENT MANAGEMENT PRACTICES ON THE PRODUCTIVITY, YIELD PARAMETERS, NUTRIENTS UPTAKES, QUALITY CHARACTERISTICS, PROFITABILITY AND FERTILITY OF SOIL

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ABSTRACT

To asses variability in rice productivity and nutrients concentrations along with their uptake in relation to soil supply capacity of plant nutrients and their management for developing fertilizers prescription alone and in conjunction with optimum dose of farm yard manure (FYM) under various emerging rice production systems to achieve maximum rice production with good quality and improving different physico-chemical characteristics of experimental soils Taking this fact in view present investigation was planned and conducted during five consecutive kharif seasons 2014 to 2018 to evaluate the impact of various treatments on the rice 'NDR-359' Results obtained from the experiment revealed that average maximum grain (61.18 q ha^{-1}) and straw yield (71.30 q ha^{-1}) panicles m^{-2} (378), Filled grains (195), Plants height (116.5 cm) panicle length (29.10 cm) along with net return (Rs 33343.10 ha^{-1}) and BCR (2.15 Rs^{-1}) were recoreded in transplanted rice fallowed by DSR crop establishment method. The aforesaid yield and yield components of rice 'NDR-359' were obtained lowest in aerobic rice establishment method. Grain yield of rice under transplanted establishment method (TPR) showed 15.65 % and 22.71% more than D.S.R and A.R. establishment methods, respectively. However, direct sown rice method recorded its superiority (5.59%) over aerobic rice. Amongst nutrient management addition of 100% RDF. + 50% N through FYM noticed significantly highest grain and straw yield along with various yield components, net returns (Rs 32482) with 2.18 BCR value (T_4) followed by T_1, T_2 and T_5. Lowest yield and yield attributing characteristics with net profit were observed in that plot which received 100% RDF through FYM alone. Maximum average nitrogen, phosphorus and potassium uptake by grain was 83.74, 21.75, and 28.31 kg ha^{-1} and by rice straw was 61.3, 10.85 and 99.29 kg ha^{-1}, respectively in that plot which treated with 100 % RDF along with 50 % N through FYM and lowest N (64.47 $kgha^{-1}$), P (16.54 $Kgha^{-1}$) and K (21.98 $kgha^{-1}$) uptake rice grain in that condition where 100 % RDF was added through FYM alone. Integrated use of fertilizer nutrients on the basis of recommendation along with optimum level of FYM or V.C. significantly enhanced N, P and K use efficiency percentage over 100 % NPK through FYM alone. The different quality characteristics of rice grain and availability of NPK and organic carbon content after termination of experiment markedly improved under all crop establishment methods and nutrient management practices. Maximum organic carbon content in experimental soil was determined in TPR (46%) followed by DSR (33%) and A.R. (29%) under crop established matters and 27% (100% NPK through FYM) and 15% more than that of initial soil under nutrient management practices.

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INTRODUCTION

Rice is one of the major staple food crop, more than 60% population with cultivated area of 163 million ha and a production of 700 million tonnes. India has the world's largest area under rice with 44 million ha and second largest producers (103.41 million tonne) next to china. Within the country, rice occupies one quarter of total cropped area contributing 58% of total food grain production and continues to play a key role in national food and livelihood security system. The current growth rate of population is more than 2% by which the population of our country is expected to touch 1.63 billion by 2050 and per capita demand of 250 g per day for rice. Thus country would require 150 million tonnes of rice. Therefore, the rice productivity needs to be enhanced from the present 2.05 tha^{-1} to 3.3-4.05 t ha^{-1} in the next years.

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Uttar Pradesh is the largest rice growing state only after West Bengal in the country. In this state rice is grown an area of about 60 lakh hectare with annual production of 131 lakh tonnes. The productivity being low (21.70 q ha^{-1}) ranks seventh position in our country (Tripathi *et al.* 2018). Depleted soil productivity and reduced ground water level are main challenges in present day agriculture. Availability of water for rice as well as agriculture, in particular will be less in future and therefore, it is necessary to explore a new technology for water saving to maximize rice production. However, same situation is almost labourers availability also as a result of migration of agriculture labourers to other activities in various sectors. Some newly emerging rice production systems like direct seeded rice (DSR) and aerobic rice (A.R.) have potential to perform better under such type situation. But for, these systems often results in lower yield potential of rice which are caused by nutritional disorders. Irrigated and rain fed low land rice systems account for 92% of total rice production and nutrients added as various fertilizers account for 20 to 25% of total production costs in aforesaid rice systems. Fertilizer use is one of the major factor for continuous increase in rice production 20% nitrogenous fertilizers use in rice production. Optimum dose and schedule of fertilizer nutrients addition is necessary to achieve higher yield along with sustaining of crop productivity and soil health. Keeping this fact in view the present investigation was planned and conducted from 2014-2018 to assess sustainability of evolving rice production system *viz.,* DSR, , A.R. vis-à-vis conventional transplanted system in terms of productivity of the cropping system, soil quality and carbon sequestration potential and utilization efficiency of resources along with other inputs.

MATERIALS AND METHODS

The present investigation entitled "Evaluation of crop establishment methods and nutrients management practices on the rice productivity yield attributes, nutrients uptake, quality characteristics, profitability and fertility of soil was planned and conducted during five consecutive kharif season 2014 to 2018 at New Dairy Farm Kalyanpur, C.S. Azad University of Agriculture and Technology, Kanpur (U.P) situated in sub tropical and semi arid zone The mechanical characteristics of experimental soil was sand 56.70%, silt 22.7% and clay 20.6% and chemical characteristics *viz.,* pH 7.83, electrical conductivity 0.42 dsm^{-1}, organic carbon 4.08 g kg^{-1}, CEC – 14.20 cmol (p^{+}) kg^{-1}, available N-238.57 $kgha^{-1}$, available – P_2O_5 – 18.95 $kgha^{-1}$ available K_2O- 172.36 $kgha^{-1}$ and available – Zn-0.42 $mgkg^{-1}$ of soil were determined by standard methods subbiah and Asija (1956), Jackson *et al.* (1973), Flame photo meter and DTP method Lindsay and Norvell (1978), respectively. The soil was sandy loam in texture and taxonomical class was inceptisol. The treatments of crop establishment *viz.,* Transplanted rice (TPR), Direct sown rice (DSR) and Aerobic rice (A.R) and under nutrients management were: T_1 = 100 % RDF + Zn, T_2 = 75% RDF + 25% N though FYM, T_3 = 100 % NPK through FYM, T_4 = 100% RDF + 50% N through FYM and T_5 = 50% RDF + 2t vermi compost ha^{-1}. All doses of fertilizer nutrients except nitrogen, FYM and vermi compost were applied at the time of 21 days old seedling of NDR – 359 rice transplanting at 20 × 10 cm spacing. Nitrogen was applied in 03 equal doses at the time of transplanting, maximum tillering and panicle initiation stages of rice crop. Nitrogen phosphorus, potassium and zinc were applied through urea. SSP, MOP and $ZnSO_4$, respectively.

Experiment was conducted in split plot design with 03 replication. Agronomical cultural practices such as irrigation, weeding and plant protection measures have been performed as per requisited. Yield and yield attributes i.e., grain and straw yield, panicles m^{-2}, panicle weight, test weight , tillers m^{-2}, filled grain $panicle^{-1}$, plant height, panicle length and Net profit along with B:C ratio were recorded during each years. Nitrogen, phosphorus and potassium uptake along with their percentage of use efficiency were recorded / determined. The physical and chemical characteristics of rice grains were determined by standard procedures. The crude protein content was determined by multiplying N concentration in rice grain with factor 5.95. The yield and yield components and quality characteristics of rice grains were recorded on the basis of 14% moisture content.

RESULTS AND DISCUSSION

Response on yield, yield attributes and net profit of rice crop: It is obvious from the Table–1 that average grain, straw yield, panicles m^{-2}, panicle weight, test weight of 1000 grains, tillers m^{-2}, filled grains $panicle^{-1}$, plant height, panicle length, net returns and BC ratio per rupees varied from 50.10 to 61.18 q ha^{-1}, 59.40 to 71.30 qha^{-1}, 372 to 476,2.28 to 3.52 g, 25.18 to 28.78 g, 378 to 424, 152.8 to 195.5, 98.6 to 116.5 cm, 26.15 to 29.10 cm, Rupee 27304.50 to 33343.10 ha^{-1} and 1.69 to 2.15 with general mean value 54.72 qha^{-1}, 63.93 qha^{-1}, 416, 2.88g, 26.74 g, 404.6, 175.0, 107.9 cm, 27.51 cm, Rs 29826.03 ha^{-1} and 1.93, respectively under the influence of various establishment methods. Maximum yield, yield attributing characteristics except total number of tillers m^{-2}, net returns with BC ratio were recorded in transplanted rice condition (TPR) followed by direct sown rice (DSR). Lowest impact on aforesaid parameters were noticed in aerobic rice (A.R.) condition. It might be due heavy weed competition for water and nutrients applied.

These findings have dose conformity with those reported by Kumar *et al.* (2011), Tripathi *et al.* (2016) and Tomar *et al* (2018). Addition of 100% RDF + 50% through FYM showed average maximum grain (59.60 qha^{-1}) straw (70.32 qha^{-1}), test weight of 1000 grain (29.15 g), panicles weight (3.62g), filled grains $panicles^{-1}$ (210), plant height (116.3 cm), panicle length (29.25 cm) net return Rs 32482.00 ha^{-1} and B:C ratio (2.18), respectively (T_4) followed T_1, T_2 and T_5. How ever, lowest grain (48.00 qha^{-1}), straw (55.60 qha^{-1}), test weight (23.70 g), panicles weight (2.47 g), filled grains (130.9), plant height (100.8 cm), panicle length (26.72 cm), net profit (Rs 2616.00) and B:C. ratio (1.69) respectively in that plot which was treated 100 % NPK through FYM alone (T_3). Application of 50% RDF with 2 t vermin compost ha^{-1} (T_5) markedly enhanced yield and yield component than that of 100% NPK through FYM. Integrated use of organic manure (FYM and V.C.) with 75% or 100% RDF through chemical fertilizer significantly increased the yield and yield component, net profit over 100 % NPK through FYM alone. In general, the response of 100 % RDF + 50 % through FYM on the yield and yield components was more pronounced (T_4) but could not significantly differ with that obtained under 100 % RDF + Zn (T_1). On other hand, the average number of tiller m^{-2} (424) and number of panicles m^{-2} (406) were recorded maximum under aerobic rice establishment method, respectively showing reverse trend than other yield components. The impact of 100 % NPK through FYM during five kharif season recorded maximum tillers m^{-2} (432) and panicles m^{-2} (418) than other

Table 1. Response of establishment methods and nutrient managements on the yield, yield attributes, and net returns of rice 'NDR-359' (Mean values of 5 years)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Panicles m^{-2}	Test weight of 1000 grain	Panicle weight (g)	Tillers m^{-2}	Filled grain $panicles^{-1}$	Plant height (cm)	Panicles length (cm)	Net return (Rs ha^{-1})	BCR (Rs^{-1})
Establishment methods											
1. TPR	61.18	71.30	372	28.78	3.52	378	195	116.5	29.1	33343.10	2.15
2. DSR	52.90	61.10	400	26.25	2.85	412	176	108.7	27.2	28830.50	1.95
3. A.R.	50.10	59.40	406	25.18	2.28	424	152	98.6	26.1	27304.50	1.69
Mean	54.72	63.93	303.70	26.74	2.88	404.6	175	107.9	27.5	29826.03	1.93
CD 5%	1.523	1.782	10.206	0.815	0.719	9.373	4.102	3.352	0.890	-	-
Nutrients management											
1. 100 % RDF + Zn	59.00	69.55	396	28.95	3.25	406	195.2	112.0	28.8	32155.00	2.07
2. 75 % RDF + 25 % N through FYM	56.50	66.10	416	26.56	2.92	429	174.8	106.4	27.6	30792.50	1.98
3. 100% NPK through FYM	48.00-	55.60 –	418	23.70	2.47	432	130	100.8	26.7	26160.00	1.69
4. 100 % NPK + 50% N through FYM	59.60	70.32	352	29.15	3.62	359	210	116.3	29.2	32482.00	2.18
5. 50% RDF + 2 t V.C. ha^{-1}	51.60	6030.	393	24.65	2.80	409	152	104.7	27.5	28122.00	1.82
Mean	54.94	63.92	395	26.65	3.01	407	172.7	108.0	28.0	29942.20	-
CD5%	1.813	2.110	12.982	0.809	0.091	13.302	5.700	3.579	0.928	-	-

Table 2. Response of establishment methods and nutrient managements on the nutrients uptake and their use efficiency percentage in rice (Mean values of 5 years)

Treatments	Nitrogen uptake (Kgha-^{1})			Phosphorus uptake (kgha^{-1})			Potassium uptake (Kgha^{-1})			Nitrogen use efficiency (NUE) %	Phosphorus use efficiency (PUE) %	Potassium use efficiency (KUE) %
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total			
Establishment method												
1. TPR	85.96	60.53	146.49	23.80	11.20\	35.00	29.37	102.1	131.38	46.39	118.30	51.34
2. DSR	73.42	53.16	126.58	19.60	9.76	29.36	24.76	87.82	112.58	43.58	110.22	48.67
3. A.R.	69.54	51.41	120.95	15.12	8.20	23.32	23.10	82.66	105.76	40.46	108.18	4310
Mean	76.31	55.03	131.34	19.51	9.72	23.23	25.74	90.83	116.57	43.47	112.23	47.70
CD 5%	2.49	1.78	4.15	0.63	0.32	0.75	0.83	2.94	3.81	-	-	-
Nutrients managements												
1. 100 % RDF + Zn	80.53	56.71	137.24	20.89	8.87	29.76	27.73	97.25	124.98	45.12	114.75	48.20
2. 75 % RDF + 25 % N through FYM	78.25	54.98	133.23	19.66	8.10	27.76	26.10	93.28	119.38	43.38	112.27	46.10
3. 100% NPK through FYM	64.47	44.46	108.93	16.54	7.68	24.22	21.98	78.48	100.46	39.76	107.32	44.52
4. 100 % NPK + 50% N through FYM	83.74	61.05	144.77	21.75	10.85	32.60	28.31	99.29	127.60	47.94	117.94	50.45
5. 50% RDF + 2 t V.C. ha^{-1}	76.60	53.19	129.79	17.64	7.80	24.84	23.63	91.95	115.58	41.87	109.51	45.30
Mean	76.76	54.07	130.79	19.30	8.54	27.84	25.55	92.05	117.60	43.61	112.36	47.11
CD5%	2.48	1.75	4.19	0.62	0.28	0.90	0.82	2.98	3.80	-	-	-

Table 3. Response of establishment methods and nutrient managements on the Quality characteristics of rice 'NDR -359'(Mean values of 5 years)

Treads	Physical characteristics				Chemical characteristics				
	Milling %	Hulling %	Length of grain (mm)	Length/breadth ratio	Crude protein %	True protein %	Starch %	Amylose %	Mineral matter %
Establishment methods									
1. TPR	60.22	75.48	3.59	4.09	8.40	8.17	78.92	18.82	1.87
2. DSR	51.56	69.83	3.48	4.16	8.22	7.97	78.60	18.60	1.68
3. A.R.	45.88	65.72	3.25	4.26	8.08	7.82	78.53	18.52	1.43
Mean	52.55	70.34	3.44	4.17	8.23	7.99	78.68	18.65	1.66
CD 5%	1.71	2.25	0.11	0.13	0.27	0.26	2.52	0.61	0.04
Nutrients managements									
1. 100 % RDF + Zn	57.18	75.26	3.56	4.12	8.23	7.99	78.90	18.56	1.74
2. 75 % RDF + 25 % N through FYM	53.47	73.12	3.42	4.19	8.18	7.90	78.73	18.37	1.62
3. 100% NPK through FYM	51.85	69.87	3.27	4.30	8.12	7.82	78.55	18.12	1.59
4. 100 % NPK + 50% N through FYM	62.32	78.15	3.62	4.06	8.38	8.16	79.15	18.84	1.90
5. 50% RDF + 2 t V.C. ha^{-1}	52.69	72.57	3.35	4.28	8.16	7.87	78.72	18.25	1.57
Mean	55.50	73.79	3.45	4.19	8.21	7.75	78.81	18.43	1.67
CD5%	1.80	2.38	0.11	0.14	0.27	0.25	2.50	0.60	0.05

Table : - 4 Response of establishment methods and nutrients management on the soil properties after harvest of the experimental rice crops (Mean values of 5 years)

Treatments	Organic carbon (gkg^{-1})	Available nitrogen ($Kgha^{-1}$)	Available P_2O_5 ($Kgha^{-1}$)	Available K_2O ($Kgha^{-1}$)
Establishment method				
1. TPR	5.96	206.9	30.8	199.7
2. DSR	5.45	203.8	28.7	196.9
3. A.R.	5.28	200.3	27.5	194.3
Mean	5.56	203.67	29.0	196.90
CD 5%	0.18	2.67	0.90	2.56
Nutrients managements				
1. 100 % RDF + Zn	3.88	190.8	28.5	194.3
2. 75 % RDF + 25 % N through FYM	4.37	194.3	30.8	196.8
3. 100% NPK through FYM	5.18	203.8	33.6	209.7
4. 100 % NPK + 50% N through FYM	4.69	186.7	27.2	186.8
5. 50% RDF + 2 t V.C. ha^{-1}	4.43	197.9	32.4	206.2
Mean	4.51	194.7	360.5	198.76
CD5%	0.15	2.55	0.88	2.59

treatments under nutrients managements practices. The findings of the experiments of Das and Patra (2014), Tripathi *et al.* (2018) and Tripathi *et al.* (2019) have showed similarity of these results.

Response on nutrients uptake by rice crop: Data presented in Table–2 revealed that the mean values of nitrogen, phosphorus and potassium uptake by rice grain varied from 69.54 to 85.96 $kgha^{-1}$, 15.12 to 23.80 $kgha^{-1}$ and 23.10 to 29.37 $kgha^{-1}$ with mean value of 76.31, 19.51 and 25.74 $kgha^{-1}$ respectively under the impact of different crop establishment methods. Maximum N (85.96 $kgha^{-1}$) , P (23.80 $kgha^{-1}$) and K (29.37 $kgha^{-1}$) uptake by rice grain were recorded under transplanted rice (TPR) condition followed by direct sown rice establishment method. Lowest uptake of N (69.54 $kgha^{-1}$), P (15.12 $kgha^{-1}$) and K (23.10 $kgha^{-1}$ by rice grain were determined under the influence of aerobic rice condition. The uptake of N and P by rice straw under the influence of various crop establishment methods recorded lower quantity than that of by grain. Potassium uptake by rice straw showed reverse trend. The nitrogen, phosphorus and potassium use efficiency percentage were ranged from 40.46 to 46.39, 108.18 to 118.30 and 43.10 to 51.34 with mean value of 43.47%, 112.27 % and 47.70%, respectively under the impact of various crop establishment methods. Thus, crop establishment strategies for augmenting rice production and nutrients uptake as well as their use efficiency were received and showed similar trends of responses by Mondal *et al*. (2016), Kumar *et al*. (2017) and Tripathi *et al*. (2019).

The average Nitrogen, phosphorus and potassium uptake by grain during experimental years differed from 64.47 to 83.74 $kgha^{-1}$, 16.54 to 21.75 $kgha^{-1}$ and 21.98 to 28.31 $kgha^{-1}$ with general mean value 76.76, 19.30 and 25.55 $kgha^{-1}$, respectively, under the influence of various nutrients management treatments. The average N,P and K uptake by straw ranged from 44.46 to 61.03 $kgha^{-1}$, 7.68 to 10.85 $kgha^{-1}$ and 78.48 to 99.29 $kgha^{-1}$ with average mean value of 54.07, 8.54 and 92.05 $kgha^{-1}$, respectively. Application 100 % RDF along with 50 % N through F.Y.M in rice crop recorded maximum N (83.74 $kgha^{-1}$), P (21.75 $kgha^{-1}$) and K (28.31 $kgha^{-1}$) uptake by rice grain and N (61.03 $kgha^{-1}$), P (10.85 $kgha^{-1}$) and K (99.29 $kgha^{-1}$) uptake by rice straw (T_4) during all the experimental years, followed by 100% RDF + Zn (T_1), 75 % RDF + 25% N through FYM (T_2) and 50% RDF + 2t V.C. ha^{-1} (T_5). The minimum uptake of these nutrients by rice grain (N-64.47, P-16.54, and K . 21.98 $kgha^{-1}$) and by straw (N – 44.46, P- 7.68 and K 78.48 $kgha^{-1}$), respectively noticed in that condition in which 100 % NPK was added through F.Y.M. alone during all experimental kharif season. Integrated use of various levels of RDF along with FYM or vermi compost beneficially improved the availability of NP and K resulting more uptake of NPK by both grain and straw (T_2 and T_5). Nitrogen, Phosphorus and potassium use efficiency varied from 39.76 to 47.94 % , 107.32 to 117.94 % and 44.52 to 51.45 % respectively. These findings have close conformity with those reported by Kumar *et al*. (2017), Tripathi *et al*. (2018) and Tripathi *et al*. (2019).

Response on Quality characteristics of rice grain: It is palpable from the data presented in Table-3 that various physical quality parameters Viz. length of grains, length : breadth ratio , hulling and milling percentage differed from 3.25 to 3.59 mm, 4.09 to 4.26, 65.72 to 75.48% and 45.88 to 60.22 % with general mean values of 3.44 mm, 4.17, 70.34% and 52.55% respectively under the influence of different crop establishment methods. Maximum aforesaid physcial characteristics were determined under transplanting method followed by D.S.R. Lowest values of these physical characteristics were noticed aerobic condition of crop establishment. However, length : breadth ratio of rice grain showed reverse trends under the impact of aerobic condition. The mean value of five year experiment results related to percentage of crude protein, true protein, starch, amylose and mineral matter under the impact of crop establishment methods ranged from 8.08 to 8.40 %, 7.82 to 8.17 % , 78.53 to 78.92%, 18.52 to 18.82% and 1.43 to 1.87 % with general mean values of 8.23%, 7.99%, 78.68 %, 18.65 % and 1.66 % , respectively. Highest values of crude protein (8.40%), true protein (8.17%), starch (78.92%), amylose (18.82%) and mineral matter (1.87 % were recorded in transplanting condition of rice followed by D.S.R and A.R. condition. It might be due to more favourable physic- chemical changes occurred in transplanting condition of rice than that of others establishment methods. Similar results were also reported by Kumar *et al*. (2017) and Tomar *et al*. (2018).

The percentage of hulling, milling, crude protein, true protein, amylaoe and mineral matter content in rice grain under the influence of various nutrients management practices ranged from 69.87 to 78.15, 51.85 to 62.32, 8.12 to 8.38, 7.82 to 8.16, 78.55 to 79.15, 18.12 to 18.84 and 1.52 to 1.90 with mean values of 73.79%, 55.50%, 8.21%,7.75%,78.81%, 18.43% and 1.67%, respectively. Integrated use of 100% NPK along with 50% N through FYM at various growth stages markedly enhanced maximum hulling (78.15%), milling (62.32%), crude protein (8.38%), true protein (8.16%), starch (79.15%), amylose (18.84%) and mineral matter (1.90%) (T_4). Addition of 100% NPK through FYM alone showed lowest values of hulling (69.87%), milling (51.85%) crude protein (8.12%), true protein (7.82%), starch (78.55%), anmlose (18.12%) and mineral matter (1.52%), respectively (T_3). Incorporation of 75% RDF + 25 % N through FYM (T_2) and 50% RDF + 2t vermi compost ha^{-1} (T_5) beneficially improved aforesaid physical and chemical quality characteristics of rice grain but could not recorded their superiority over that of 100% RDF + Zn (T_1). Lengths of grain was highest (3.62 mm) in T_4 treatment and lowest (3.27 mm) was noticed in T_3 Thus, it is clear from the result that integrated use of organic fertilizer viz : FYM or V.C. along with recommended dose of NPK significantly improved all physical and chemical characterizes of rice grains. However, length/breadth ratio showed reverse trend during all years, The findings of experiments of Shubhalaxmi *et al*. (2014), Tripathi *et al*. (2018) and Kumar *et al*. (2017) noticed similarity of these results

Response on nutritional status of soil: On the perusal of the data illustrated in Table-4 it is evident that average values of organic carbon, available nitrogen, phosphorus and potassium after termination of experiment after five kharif season ranged from 5.28 to 5.96 gkg^{-1} of soil, 202.3 to 206.9 $kgha^{-1}$, 27.5 to 30.8 $kgha^{-1}$ and 194.3 to 199.7 $kgha^{-1}$ with mean values of 5.56 gkg^{-1} soil, 203.67 $kgha^{-1}$ 29.00 $kgha^{-1}$ and 196.90 $kgha^{-1}$, respectively under various establishment methods of rice crop. Maximum availability of NPK and organic carbon were determined in transplanting condition followed by DSR establishment method. Lowest value were recorded in aerobic condition. Although, yield and nutrients uptake under TPR condition was maximum but availability these nutrients were lowest in aerobic condition followed by direct sown method.

It might be due to more uptake to nutrients through weeds and nutrients disorder along with less water availability to rice crop under such type of sandy loam soils (Tomar *et al*. 2018) and Mondal *et al*. (2016). Available N,P K and organic carbon content varied from 186.7 to 203.8 $kgha^{-1}$, 27.2 to 33.6 $kgha^{-1}$, 186.8 to 209.7 $kgha^{-1}$ and 4.15 to 5.18 gkg^{-1} soil with mean values of 194.70, 30.50 198.76 $kgha^{-1}$ and 4.51 gkg^{-1} soil, respectively under the impact of various nutrient management practices during all kharif season. Organic carbon content was maximum (5.185 gkg^{-1}) in that plot which received 100 % NPK through FYM alone and lowest (4.15 gkg^{-1}) in that condition where 100 % RDF + Zn (T_1) was added in rice crops. Integrated use of FYM or V.C. along with 75% RDF + 25 % N through FYM (T_2) or 50% RDF + 2 t V.C. ha^{-1} (T_5) significantly improved organic carbon content in soil than that of 100 % RDF t Zn (T_1) Although, addition of 100 % RDF + 50% N through FYM (T_4) significantly improved organic carbon status in experimental soil but availability nitrogen (186.7 $kgha^{-1}$), phosphorus (27.2 $kgha^{-1}$) and potassium (186.8 $kgha^{-1}$) were lowest. It may be due to maximum uptake of these nutrients by rice grain and straw. These findings have close conformity with those reported by Kumar *et al*. (2017) and Tripathi *et al*. (2019).

Conclusion

It can concluded from the results that under the impact of various crop establishment methods the average maximum grain yield of rice NDR-359 was recorded under transplanting condition (TDR) fallowed by direct sown rice (DSR). The lowest was noticed in aerobic rice (AR). Grain yield under TPR treatment was higher 22.1% and 15.6% than that of A.R. and D.S.R , respectively in such type of sandy loam soil. The yield attributing characteristics and net profit along with B;C ratio showed similar trends of response. Application of 100 % RDF + 50 % N through FYM obtained maximum grain yield and yield component along with net profit Rs 32482 ha^{-1} with 2.18 B:C ratio. Incorporation of 100 % NPK through F.Y.M alone showed lowest yield and yield attributes, net profit Rs 26160 ha^{-1} with B : C ratio (1.69). Integrated use of fertilizer nutrients and farm yard manure or vermi compost such as 75 % RDF + 25% N through FYM or 50 % RDF + 2t V.C ha^{-1} significantly enhanced the productivity and profitability than that of 100% NPK added through FYM alone The quality characteristic of rice grains *viz.,* crude protein true protein, starch, amylose and mineral matter, content , hulling, milling percentage along with NP and K uptake by both grain and straw showed similar trends of responses under crop establishment methods and nutrient management practices. Soil fertility status of soil after termination of experiment after five year markedly improved by 100 % NPK through FYM and integrated use of organic manures and chemical fertilizers. Therefore, it is suggested that maximization of rice production and improving soil health, integrated use of various plant nutrients through FYM or vermi compost and chemical fertilizers in optimum levels under trans planting condition is more pronounced in such type of sandy loam soils.

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