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EFFECT OF DIFFERENT ESTABLISHMENT METHODS AND NITROGEN LEVELS ON NUTRIENTS AVAILABILITY IN SOIL AFTER HARVEST OF BASMATI RICE

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ABSTRACT

A field experiment was conducted during *kharif* season 2010 and 2011 with 6 establishment methods in horizontal plots and 4 nitrogen levels in vertical plots in strip plot design. The soil was sandy loam with normal soil reaction and electrical conductivity, low in organic carbon and available N, medium in available P and K. The results revealed that effect of different establishment methods on NO_3-N, NH_4-N, OC, N, P, K, Zn, Mn and Fe status of soil after harvest of basmati rice was non-significant. NO_3-N, NH_4-N, OC, P, K, Zn, Mn and Fe status of soil after harvest of basmati rice vary non-significantly amongst different nitrogen levels. However, available nitrogen status of the soil was significantly higher with N_4 as compared to N_1 and was statistically at par with N_3 and N_2 levels during both the years of study.

Key words : *Establishment methods, nitrogen levels, macronutrients, micronutrients.*

Transplanting is the dominant method of rice establishment in rice growing areas of the IGP and in all Asia (1). Rice transplanting requires a large amount of labor, usually at a critical time for labor availability, which often results in shortages and increasing labor costs. In addition, under the changing socioeconomic environment, workers (especially younger male workers) are not available or are reluctant to undertake tedious agricultural operations such as transplanting. These situations also produce labor shortages and further escalate labor costs. Alternate methods of establishing crops, especially rice, that require less labor and water without sacrificing productivity are needed. Under such condition Direct seeding of rice mechanized transplanting can be considered as the most promising options as it saves labour, ensures timely planting and attain optimum plant density and to reduce water use. This paper has the objective to reported the effect of different establishment methods and nitrogen levels on nutrients availability after harvest of basmati rice.

MATERIALS AND METHODS

The field experiment was conducted at Student's Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *kharif* season 2010 and 2011. The composite soil samples from 0-15 cm profile layers were collected before sowing from randomly selected sites and analyzed for chemical analysis. The soil was sandy loam with normal soil reaction (8.10 and 8.00) and electrical conductivity (0.36 and 0.32 dS/m), low in organic carbon (0.28 and 0.26 %) and available N (255.02 and 238.20 kg/ha), medium in available P (19.10 and 17.20 kg/ha) and K (155.00 and 140.00 kg/ha) at both the locations. Basmati rice variety Punjab Mehak 1 was used as test variety. The experiment was conducted in strip plot design with six establishment methods viz; direct seeded basmati rice, direct seeded basmati rice with brown manuring, machine transplanting in zero-tillage (ZT) with brown manuring, machine transplanting in zero-tillage (ZT) without brown manuring and conventional practice and four nitrogen levels viz; 0% (N_1), 75% (N_2), 100% (N_3) and 125% (N_4) of recommended dose (90 kg urea/ha). Establishment methods were kept in horizontal plots, while nitrogen levels were placed in vertical plots. Nitrogen fertilizer was applied in two equal splits to transplanted basmati rice at about 3 weeks and 6 weeks after transplanting and two equal splits of nitrogen fertilizer were applied to DSR as half dose after two weeks and rest half of nitrogen fertilizer was applied five weeks after sowing. For brown manuring, seeding of *Sesbania aculeata* was done 30 days before the sowing of direct seeded rice and machine transplanting of rice in zero tilled plots. 2, 4-D @ 1 kg/ha was sprayed on *Sesbania* three days before direct sowing of rice and transplanting of rice with machine in zero tilled plots. The sowing of direct seeded rice (DSR) was done on 24 June during first year and 27 June during second year with rice drill in dry moist soil. Nursery for machine transplanting was raised in plastic trays. Sowing of nursery was done on 24 June during first year and 27 June during second year using seed @ 30 kg/ha for raising nursery in trays. Twenty five days old nursery was used in mechanized transplantation. In case of conventional transplanting, nursery was raised by broadcasting seed on 24 June during first year and 27 June during second year with seed rate of @ 20 kg for transplanting a hectare. Transplanting was done using 25 days old seedlings. Machine transplanting was done by paddy transplanter. In zero tilled plots it was done in standing water. In conventional transplanting nursery was irrigated before uprooting. Seedlings were uprooted and transplanted two seedlings per hill about 2-3 cm deep in puddled field in lines at 20cm x15 cm spacing manually. In direct seeded rice and transplanted rice weeds were controlled by applying pendimethalin @ 2.5 litre/ha within two days of sowing and transplanting of basmati rice and bispyribac @ 250 ml/ha at 30 days after sowing and 25 days after transplanting of basmati rice, respectively. The left over weeds were removed by two hand weedings in DSBR after 51 and 66 days after sowing and one hand weeding in transplanted rice after 56 days of transplanting during *kharif* 2010. In *kharif* 2011 left over weeds were removed by two hand weedings in DSBR after 50 and 72 days after sowing and one hand weeding in transplanted rice after 49 days of transplanting. Irrigation was applied as per requirement to direct seeded basmati rice. In transplanted rice water was kept standing continuously for first fifteen days after transplanting. After that irrigations were applied two days after the ponded water had infiltrated into soil. No irrigation was applied on rainy days. Irrigation application was withheld 15 days before harvesting of crop. Fungicide Tilt 25 EC @ 500ml/ha and insecticide monocrotophos @ 1400 ml/ha during *kharif* 2010 and 2011 was applied to basmati rice. Direct seeded basmati rice was harvested on 18 and 19 October during first and second year and harvesting of transplanted basmati rice was done on 29 October and 3 November during first and second year of the study. For determining NO_3-N and NH_4-N, soil samples were taken at 30 days interval starting from 60 DAS from 0-15 cm soil layers. A 10 g portion of the soil was extracted with 100 ml of 2N-KCl solution after shaking for 1 hour. Suspension was filtered and filtrate was analysed for NO_3-N and NH_4-N by steam distillation using Devarda's alloy and MgO respectively (2). Organic carbon was determined by Walkly and Black's rapid titration method (3). Available nitrogen was determined by modified alkaline permanganate method as described by (4). Available phosphorus was determined with the method described by (5). The intensity of colour in the extract was developed-by ascorbic acid and measured at 760nm on spectrophotometer. Available potassium was extracted with neutral normal ammonium acetate solution as described by (6) and it was determined by flame photometer. The micronutrients were determined from 1:2; soil-extractant ratio using (Diethylene Triamine Penta Acetic acid) DTPA-TEA buffer (0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M TEA, pH 7.3) as per method proposed by (7) and concentration of these micronutrients was measured on an atomic absorption spectrophotometer (AAS). Standard statistical techniques as described by (8) adopted for statistical analysis of data recorded on all aspect of the crop and the comparisons were made at 5 % level of significance.

RESULTS AND DISCUSSION

Nitrate-N : The NO_3-N accumulated in the soil profile at various growth stages of basmati rice is presented in table 1 revealed that the concentration of NO_3-N in the soil profile decreased with increasing stages of crop growth in each of the treatment during both the years of study. Averaged over the treatments NO_3-N content in soil at basmati rice harvest decreased at a rate of 27.95 and 30.77 per cent during 2010 and 2011, respectively from the values recorded at 60 days after sowing. Maximum NO_3-N accumulation occurred in direct seeded basmati rice with brown manuring which is closely followed by direct seeded basmati rice without brown manuring. (9) also observed that highest NO_3-N content in the soil was found under minimum water regimes in the unpuddled soil in the rice-wheat system. Although, non-significant difference in NO_3-N content was observed with different establishment methods during both the years of study. Among nitrogen levels, maximum NO_3-N accumulation was observed with N_4 treatment. NO_3-N content in soil profile was increased with increase in nitrogen levels upto N_4 during both the years of study (Table-1).

Table-1: Effect of different crop establishment methods and nitrogen levels on nitrate-N (µg/g) in soil after harvest of basmati rice.

Treatments	2010			2011		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Establishment methods						
DSBR	5.94	5.11	4.66	7.20	5.96	5.43
DSBR with brown manuring *Sesbania*	5.96	5.11	4.67	7.21	5.97	5.51
Machine transplanting in ZT with brown manuring	5.86	5.06	4.64	6.99	5.87	5.39
Machine transplanting in ZT without brown manuring	5.83	5.03	4.62	6.93	5.85	5.27
Machine transplanting after puddling	5.79	5.01	4.59	6.81	5.81	5.26
Conventional practice	5.74	4.99	4.29	6.66	5.77	5.13
CD at 5%	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg/ha)						
N_1 (0% of Rec)	4.27	3.43	2.99	5.34	4.29	3.74
N_2 (75% of Rec)	5.77	4.95	4.48	6.86	5.79	5.23
N_3 (100% of Rec)	6.17	5.37	4.86	7.28	6.19	5.62
N_4 (125% of Rec)	6.22	5.46	4.98	7.37	6.24	5.73
CD at 5%	NS	NS	NS	NS	NS	NS

Ammonical-N : The NH_4-N accumulated in the soil profile at various stages of basmati rice growth is presented in table 2 showed that concentration of NH_4-N in the soil profile decreased with the advancement of stages of crop towards maturity during both the years of study. Averaged over all treatments the decrease in NH_4-N content in soil profile at harvest was 67.68 and 70.67 per cent from the initial value recorded at 60 days after sowing during 2010 and 2011, respectively. Machine transplanting of rice after puddling recorded maximum NH_4-N accumulation which is closely followed by conventional transplanted rice. However, establish- ment methods failed to have any significant effect on NH_4-N content in the soil profile during both the years of study. Amongst nitrogen levels maximum NH_4-N accumulation was recorded in N_4 treatment. NH_4-N content in soil profile increased with increase in nitrogen levels during both the years of study. However, the differences for NH_4-N among nitrogen levels were found to be non-significant.

Organic carbon : Organic carbon content in plough layer of the soil after harvest is given in table-3. The organic carbon status improved significantly in treatments where basmati rice was grown with *Sesbania* brown manuring during both the years of study. However, the organic carbon status of soil was improved in all the treatments over its initial values. The maximum organic carbon build up was accrued where basmati rice was grown with *Sesbania* as a brown manuring in machine transplanted rice in zero tilled plots with brown manuring and direct seeded basmati rice with brown manuring. The differences in organic carbon content among different establishment methods were found to be non-significant. The organic carbon content of the soil did not vary significantly with varying nitrogen levels during both the years of study

Table-2: Effect of different crop establishment methods and nitrogen levels on ammonical-N (µg/g) in soil after harvest of basmati rice.

Treatments	2010			2011		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Establishment methods						
DSBR	27.68	20.91	16.61	30.03	21.81	17.61
DSBR with brown manuring Sesbania	27.76	21.21	16.63	30.26	22.21	17.93
Machine transplanting in ZT with brown manuring	28.06	21.61	16.83	30.86	23.11	18.13
Machine transplanting in ZT without brown manuring	27.98	21.51	16.73	30.68	22.92	18.03
Machine transplanting after puddling	28.63	22.01	16.93	31.63	23.81	18.36
Conventional practice	28.58	22.00	16.86	31.58	23.80	18.33
CD at 5%	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg/ha)						
N_1 (0% of Rec)	21.51	14.74	11.04	24.22	16.14	12.34
N_2 (75% of Rec)	27.66	20.94	16.54	30.73	22.34	17.84
N_3 (100% of Rec)	28.96	22.34	17.14	31.69	23.74	18.44
N_4 (125% of Rec)	29.34	23.14	17.34	32.07	24.54	18.64

Table-3: Effect of different crop establishment methods and nitrogen levels on organic carbon (OC), available N, P and K status of soil after harvest of basmati rice.

Treatments	2010				2011			
	OC (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	OC (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Establishment methods								
DSBR	0.32	183.86	20.10	148.05	0.31	186.26	20.92	147.26
DSBR with brown manuring Sesbania	0.35	204.02	21.97	149.45	0.35	206.56	22.82	149.44
Machine transplanting in ZT with brown manuring	0.36	200.11	21.88	149.36	0.36	208.93	22.57	148.09
Machine transplanting in ZT without brown manuring	0.33	196.87	19.95	147.73	0.32	199.69	20.73	146.41
Machine transplanting after puddling	0.34	183.20	20.35	149.18	0.34	192.42	21.30	147.95
Conventional practice	0.33	189.79	20.29	148.30	0.32	192.95	21.42	147.92
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg/ha)								
N_1 (0% of Rec)	0.32	181.09	19.91	146.55	0.32	188.85	20.64	145.71
N_2 (75% of Rec)	0.33	192.36	20.44	148.19	0.33	196.54	21.41	147.25
N_3 (100% of Rec)	0.35	196.60	21.20	149.75	0.34	200.41	22.04	148.92
N_4 (125% of Rec)	0.35	201.84	22.05	150.49	0.34	205.40	22.76	149.50
CD at 5%	NS	10.03	NS	NS	NS	9.76	NS	NS
Initial values	0.28	255.02	19.10	155.00	0.26	238.20	17.20	140.00

levels. The maximum organic carbon content was obtained with N_3 and N_4 closely followed by other nitrogen levels.

Available nitrogen : Available nitrogen in soil in all the treatments decreased from initial value (Table-3). Although, non-significant difference in available N status of the soil was observed with different establishment methods. Maximum value of available nitrogen in the soil after harvest of basmati rice obtained with brown manuring treatments viz. machine transplanted basmati rice in zero tilled plots with brown manuring and direct seeded basmati rice with brown manuring alternatively during both the years of study. The available nitrogen status of the soil after harvest of crop, however, varied significantly with varying nitrogen levels. Available nitrogen status of the soil was significantly higher with N_4 as compared to N_1 and was statistically at par with N_3 and N_2 levels during both the years of study.

Available phosphorus : Available phosphorus status of the soil was improved in all the treatments over its initial values 19.1 and 17.2 kg/ha during first and second year of study (Table 3). There was no significant difference in the available P content of soil due to different establishment methods and nitrogen levels during both the years of study.

Available Potassium : Table-3 showed an increment in potassium status from its initial value during both the years of study. Further, in treatments where brown

Table-4: Effect of different crop establishment methods and nitrogen levels on Zn, Mn and Fe status of soil after harvest of basmati rice.

Treatments	2010			2011		
	Zn (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)
Establishment methods						
DSBR	3.80	11.20	21.06	3.53	10.42	19.89
DSBR with brown manuring Sesbania	3.93	11.73	22.35	3.70	11.38	20.33
Machine transplanting in ZT with brown manuring	3.88	11.62	22.80	3.65	11.12	20.77
Machine transplanting in ZT without brown manuring	3.79	11.50	21.20	3.47	10.76	20.04
Machine transplanting after puddling	3.85	11.60	21.32	3.64	10.82	20.10
Conventional practice	3.84	11.35	21.16	3.58	10.47	20.28
CD at 5%	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg/ha)						
N_1 (0% of Rec)	3.81	11.02	21.59	3.57	10.41	19.59
N_2 (75% of Rec)	3.84	11.47	21.63	3.59	10.75	19.51
N_3 (100% of Rec)	3.87	11.60	21.66	3.61	11.06	19.74
N_4 (125% of Rec)	3.87	11.92	21.71	3.63	11.08	19.89
CD at 5%	NS	NS	NS	NS	NS	NS
Initial values	3.5	10.10	21.50	3.1	8.6	19.2

manuring was included, generally high content of potassium was observed but there was no significant difference in available potassium content of soil after the harvest of crop due to different establishment methods. With respect to nitrogen levels, available potassium status did not differed significantly.

Zinc (Zn) : There was no significant difference in the zinc (Zn) content in soil due to different establishment methods and nitrogen levels (Table-4). However, the maximum value of zinc (Zn) was obtained in brown manuring treatments and higher nitrogen level during both the years of study.

Manganese (Mn) : It was indicated in table 4 that DTPA-extractable Mn in different treatments increased over its initial value. Further there was no significant difference in the Mn content of soil due to different establishment methods and nitrogen levels.

Iron (Fe) : Fe content of soil increased appreciably over its initial value in all the treatments as in table-4. The DTPA- extractable Fe status of the soil in different establishment methods varied from 22.80-21.06 mg/ kg during 2010 and 20.77-19.89 mg/kg during 2011, respectively. Amongst different establishment methods and nitrogen levels DTPA-extractable Fe status of the soil did not differ significantly and found equivalent Fe status.

The NO_3-N in soil profile decreased with advancement of crop growth stages. This decrease in NO_3-N in the soil profile with increasing period of rice growth can be ascribed to higher N requirement of crop with increasing time period. The organic carbon status of soil was improved in all the treatments over its initial values may be due to increase in organic matter added by root biomass (10). Brown manuring in conjunction with chemical fertilizers increased the available nitrogen in soil, which may be attributed to mineralization of organic sources or through solubilization of nutrient from native sources during decomposition (11). The slight increase in available potassium content of soil from its initial value may be ascribed to mineralization of organic sources and solubilization from the native sources during decomposition. An increase in DTPA-extractable Mn over its initial value may be attributed to the reduction of Mn^{4+} to Mn^{2+} accompanied by increase in its solubility under submerged conditions. The increase in Fe content of the soil over its initial value may be due to the induced submerged conditions and lowering of pH of the soil during basmati rice growing season, thereby resulting in an increase in the soluble Fe^{2+} ion in the soil (12). Thus it may be concluded that effects of different establishment methods and nitrogen levels on availability of nutrients in soil after harvesting of basmati rice were non-significant. However, availability of nutrients and organic carbon status in soil was slightly higher with brown manuring treatments. The organic carbon status of soil was improved in all the treatments over its initial value.

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