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Nutrient Uptake as Influenced by Post Panicle Initiation Nutrient Management in Rice Plant Organs

P. Murali Arthanari, S. Ramasamy and M. Mohamed Amanullah

Department of Agronomy, Tamil Nadu Agricultural University,
Coimbatore – 641 003, Tamil Nadu, India.

Abstract: Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India during *rabi* (November 2000 – March 2001) and k*harif* (July 2001 – November 2001) seasons to identify nutrient translocation at different rice plant organs as influenced by post panicle initiation nutrient management in rice (Var. ADT 36). Furnace slag was applied as a silicon source at 2 t ha^{-1} at the panicle initiation stage along with other nutrients, *viz.,* nitrogen, phosphorus and potassium which were applied in splits at different crop stages. Among the nutrients, nitrogen was applied at two levels (150 Kg N ha^{-1} and 120 kg N ha^{-1}) in four treatments. From the results of the two season experiments it is concluded that application of furnace slag at Panicle Initiation (PI) stage with N and K at flowering stage enhanced the leaf nutrient uptake. The uptake of nutrients by roots and culm enhanced up to one week after flowering and maturity stage. For maintaining the root NPK fairly at a higher level, slag application with flowering nutrients was useful. The residual NPK uptake, which is described as unutilized at the time of maturity, was higher in culm than in leaves. The panicle NPK uptake was influenced by slag application at PI stage with nutrients at flowering stage.

Key words: Rice, post panicle initiation, nutrient management, nutrient uptake

INTRODUCTION

The uptake of nutrients by crops is largely governed by the nutrient supply system of the soil through native and applied sources and their losses through leaching, weeds etc., [5]. Fertilizer application plays an important role in the uptake of nutrients and yield of rice plant. With the introduction of many high yielding varieties requiring high nutrient supply, there is an imperative need for effecting economy in fertilizer application. Addition of silicate materials to the soil not only increases the available Si, but also enhances the solubility of soil phosphorus and decreases the fixation of the added phosphorus in soil[4].

The response of rice to nutrient is almost universal. In spite of considerable increase in fertilizer use, multiple nutrient deficiencies particularly that of NPK and Si is on the increase in Indian Agriculture and is posing problem to maintain the soil fertility and to sustain rice productivity. Moreover, the nutrient use efficiency from fertilizer application is very low particularly after panicle initiation stage. The study of nutrient flow in the plant organ will give some idea about uptake pattern of plants at different crop stages. Hence, to know the nutrient translocation of different plant organs of rice at maturity stage, a research work was carried out to find out nutrient uptake of rice plant organs.

MATERIAL AND METHODS

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India during *rabi* 2000-01 (November 2000 – March 2001) and *Kharif* 2001 (July 2001 – November 2001). The soil of the experimental site was clay loam, medium in organic carbon (0.63), medium in available N (254, 267 kg ha^{-1}), medium in available P (15.8, 14.9 kg ha^{-1}) and high in available K (511, 503 kg ha^{-1}) with pH 7.72 and 7.65. The electrical conductivity was 0.40 dS m^{-1}.

The experiments were laid out in a randomized block design with three replications during both the seasons in a puddled lowland rice ecosystem. There were eight treatments in total. Nitrogen was applied at two levels (150 kg N ha^{-1} and 120 kg N ha^{-1}) in four treatments each and P and K were applied at 50 kg ha^{-1} each but at different stages in split doses (Table 1). The furnace slag obtained as waste from iron industry was applied as silicon source @ 2 t ha^{-1}. In all the treatments the nutrients were applied in splits at different crop stages [Basal, Active Tillering (AT),

Corresponding Author: P. Murali Arthanari, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India.

Table 1: Treatment Details

Treatment	Basal	AT	PI	FL
T_1	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}K_{25}$	-
T_2	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}K_{25}$	N_{40}
T_3	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}$	K_{25}
T_4	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}K_{25}$ Si $_{2\ t}$	-
T_5	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}K_{25}$	P_{25}
T_6	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}$	$N_{40}K_{25}$
T_7	$N_{60}P_{25}K_{25}$	N_{20}	$N_{40}P_{25}$ Si $_{2\ t}$	$N_{40}K_{25}$
T_8	$N_{60}P_{25}K_{25}$	N_{20}	N_{40} Si $_{2\ t}$	$N_{40}P_{25}K_{25}$

Si = 2 t ha^{-1} furnace slag, AT = Active Tillering stage, PI = Panicle Initiation Stage, FL = Flowering stage

Table 2: Nutrient uptake (kg ha^{-1}) in rice plant organs as influenced by post panicle nutrient management during *rabi* 2000-01.

Treatments	Green leaves			Senescent leaves (at OWAF stage)			Culm			Root(at OWAF stage)			Panicle		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1	20.7	0.9	36.0	50.6	4.4	16.3	62.9	1.8	48.9	27.3	0.99	8.6	51.4	10.7	44.3
T_2	29.1	0.8	55.3	41.8	2.9	15.6	74.8	3.7	57.1	27.2	0.78	6.8	73.1	13.2	48.8
T_3	23.7	1.1	46.3	35.0	3.4	14.8	63.9	3.7	50.5	34.5	1.0	7.2	52.7	17.0	43.1
T_4	34.4	0.9	28.7	24.7	1.3	8.9	79.8	3.5	37.2	54.5	1.2	7.0	102.9	18.6	59.1
T_5	24.8	1.7	51.0	31.4	2.9	12.9	65.6	3.5	56.0	30.9	0.9	8.4	41.6	16.1	41.3
T_6	26.0	0.8	58.9	39.8	1.7	14.6	72.1	3.6	73.0	26.2	0.8	6.3	66.3	10.5	34.6
T_7	37.9	1.2	17.8	24.5	1.4	7.9	82.9	3.6	23.8	53.7	1.2	5.5	127.6	20.7	63.9
T_8	33.7	1.8	30.3	28.6	1.3	9.1	78.6	5.9	45.3	50.7	1.9	5.1	89.2	24.6	58.4
SEm ±	3.25	0.24	6.47	3.39	0.85	2.37	5.37	0.79	9.08	10.34	0.27	1.19	6.88	2.34	6.31
CD (P-0.05)	6.97	0.52	13.89	7.28	1.85	5.08	11.5	1.69	19.48	22.19	0.58	2.55	14.75	5.02	13.54

OWAF – One week after flowering

Table 3: Nutrient uptake (kg ha^{-1}) in rice plant organs as influenced by post panicle nutrient management during *kharif* 2001

Treatments	Green leaves			Senescent leaves (at OWAF stage)			Culm			Root (at OWAF stage)			Panicle		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1	23.4	1.9	38.0	52.6	4.7	48.3	64.9	2.8	50.9	29.3	1.5	9.6	54.4	10.7	46.3
T_2	31.8	1.8	57.3	43.5	3.2	17.6	76.8	4.7	65.8	29.2	1.4	7.8	76.1	13.2	50.8
T_3	26.1	2.1	48.3	37.0	3.6	16.8	65.9	5.0	52.5	35.5	1.4	8.2	55.6	16.4	45.1
T_4	38.8	1.9	30.7	27.4	1.7	10.9	81.8	4.5	39.2	55.2	1.5	9.0	106.2	19.3	61.1
T_5	29.1	2.7	53.0	33.4	2.9	14.9	67.6	4.5	58.0	32.9	1.7	9.4	44.6	16.7	43.3
T_6	30.0	1.8	60.9	42.1	1.8	16.6	74.1	6.3	85.0	28.2	1.7	8.3	69.3	11.5	36.6
T_7	41.3	2.9	19.8	25.8	1.5	9.8	85.6	4.6	25.8	55.1	2.2	8.5	131.0	26.3	67.3
T_8	37.7	2.8	32.3	30.6	1.4	11.1	80.6	6.6	47.3	52.7	2.3	7.1	82.6	20.7	60.4
SEm ±	3.60	0.35	6.47	3.19	0.94	2.37	5.33	1.12	9.73	9.95	0.25	1.23	6.97	2.24	6.65
CD (P-0.05)	7.72	0.76	13.4	6.84	2.0	5.08	11.44	NS	20.9	21.33	0.53	2.63	15.0	4.8	14.27

OWAF - One week after flowering

Panicle Initiation (PI) and Flowering stages]. The recommended dose with split application of fertilizer was taken as the control plot (T_1). The cultivar Aduthurai 36 (ADT-36) was used in these experiments. The recommended seed rate (60 kg) and spacing (15 X 10 cm) of the study area were used for this rice crop. Plant samples collected to assess the dry weight of plant organs *viz.,* green leaf, culm, root and panicles were dried to moisture free condition and then ground into fine powder in a willey mill and used for chemical analysis. The root and senescent leaf samples were collected at one week after flowering stage only (OWAF). The standard procedures for nutrient analysis were followed[2,3].

RESULTS AND DISCUSSIONS

Nitrogen Uptake: In general the uptake of N in the green leaves was increasing with age and decreasing at maturity. During both the seasons, the highest green leaf nitrogen, culm N was observed in slag at PI with application of N and K at flowering stage. The N uptake in dead leaves was higher at one week after flowering (OWAF). The senescent leaf N uptake that is believed as unutilized and left out ranged from 10 - 50 kg ha^{-1} in various treatments. During both the seasons, the highest senescent leaf N uptake of 50.63 kg ha^{-1} and 52.63 kg ha^{-1} was recorded in control plot at OWAF stage, which was higher than other treatments.

The N uptake in the roots increased progressively with the crop maturity. The N uptake was more in the treatment with the silica source at PI and N and K applied at flowering stage (T_7). Panicle N uptake increased steadily and steeply after panicle exertion and reached a maximum at maturity stage in both the seasons. The N uptake was greatly influenced by silica application at PI along with NPK at flowering during *rabi* and *kharif* seasons.

The nitrogen uptake is the product of nitrogen concentration and dry matter production and hence, it follows the pattern of dry mater production. Besides, nitrogen the nutrient uptake increased with slag application. This is in conformity with the results obtained from the earlier workers[7]. The functional leaf N concentration was declined towards maturity. But additional amount of 30 kg N ha^{-1} application influenced the leaf N uptake till the maturity stage. The leaf N concentration observed varied due to the seasons, a lower concentration was recorded in *rabi* season than *kharif* season. The N uptake in the culm declined at maturity stage. This might be due to the transport of a part of nitrogen to other parts after a week of flowering stage, possibly to panicle and the sharp decline in the contents per unit area is probably by degenerating tillers.

The residual N content in the senescent leaves was found increasing towards maturity. This is probably due to the inability of the ageing roots towards maturity to accept the translocates from the lower senescent leaves as normally the food materials required for roots are being nourished by these lower section of the leaves [8]. Slag application has reduced the senescent leaf N content. This might be due to better translocation in good soil environment.

The slag application with nutrients at flowering stage had a firm role in the root production and N uptake. Due to reduced soil condition around PI stage, the slag application at this stage enhances the soil condition for better crop growth[1]. The production of panicles, obviously the final process of an annual crop growth process was seen with increasing N contents. Higher N applications with or without slag application were also seen in higher N uptakes in the panicles. This might be due to better translocation of nutrients under healthy soil environment.

P and K Uptake: In general P and K uptake was more during *kharif* crop than the *rabi* crop. The treatments T_8 and T_6 recorded the maximum P and K uptake in green leaves during both the seasons, where as in culm, the T_8 treatment was comparable with other treatments. In case of senescent leaves, the highest uptake was recorded with application of K at flowering stage (T_3) and there was no much difference in K uptake among treatments.

During both the seasons, the highest uptake of P and K was observed in NPK application at flowering with slag at PI stage (T_8). Panicle P and K uptake increased with the age of crop. The nutrient uptake was greatly influenced by slag application at PI stage. Perceptible higher panicle P and K uptake was recorded in slag at PI with N and K at flowering stage.

Higher level of N with furnace slag application had marked influence on P and K uptake in leaf, culm and root. The slag applied plots had declined P uptake towards maturity. This might be attributed to better availability of soil P and K and/or enhanced mobility of P and K from these parts to panicle[6].

The furnace slag application with higher dose of N decreased the P uptake of the senescent leaves. This might be due to better translocation of assimilates towards economic part. The panicle P uptake was drastically increased by slag application with or without higher dose of N. Absorption of additional quantities of P and K from slag with higher N application would have resulted in higher dry matter production. This also improved the uptake of P and K in *kharif* seasons than *rabi*.

Conclusion: From these experiments, it can be concluded that application of slag at PI stage with N and K at flowering stage enhancing nutrient translocation in different parts of plants particularly towards the panicles. It shows that, all organs except senescent leaves had good amount of nutrients to strengthen the panicle yield.

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