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Relationship between Some Macronutrients of Paddy Growing Soils of Kashmir and their Contents in Rice Plants

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Abstract

Available nitrogen, phosphorus, potassium, calcium, magnesium and sulfur contents of paddy growing soils of district Srinagar, Kashmir showed that these soils were adequately supplied with all the nutrients except sulfur and nitrogen which were low to medium in status. There was a negative and significant relationship of available N, P, Ca and S with pH and a positive correlation of pH with available Mg. The available N, P and S showed significant positive correlation with organic carbon. The clay content in the soil had a significant and positive effect on available N, P, Ca and S while negative effect on K and Mg. The available Ca and S showed significant and positive correlationship with their respective contents in plants.
Key words : Macronutrients, Correlation, Paddy, Soils of Kashmir.

The introduction of high yielding varieties, increased use of chemical fertilizers and improved irrigation techniques have resulted in increase in the yield of crops. The widespread of high yielding fertilizer responsive crop varieties have decreased the status of soil nutrient reserves and their replenishment has become essential. Nutrient survey of a region is potential to know the general fertility status of soils and is pre-requisite for any crop research and development program. Rice is the principal cereal crop of Jammu and Kashmir grown on an area of 2.49 lakh ha. The information about their fertility status is quite meager, therefore the present investigation was undertaken to assess the available nutrients in the soil and their contents in paddy plants.

Methods

Thirty representative surface (0—15 cm) composite soil samples of paddy fields were collected from different locations of Srinagar district. The samples were processed and analyzed for various physico-chemical properties using standard methods of chemical analysis. The calcium carbonate was determined by rapid titration method and clay by international pipette method. The available nitrogen was determined by alkaline permanganate method, given, available phosphorus by Olsen's method and sulfur by turbidity method. Plant samples were collected by taking ten paddy plants from the same location from where soil samples were obtained at tillering stage. The samples were dried after washing and then crushed. The plant samples were digested in di-acid (nitric and perchloric acid muxture) and analyzed for P, S and N.

Results and Discussion

The pH of soils varied from 6.1 to 8.2 (Table 1), which can be attributed to variations in amount of organic matter and calcium carbonate. The calcium carbonate content of the soils ranged from 0.04 to 0.47%. Similar results were reported by Kher and Singh (1) and Jalai et al. (2). The organic carbon content ranged from 0.50 to 1017% i.e. these soils were medium to high in organic carbon content, which might be due to judicious use of FYM together with the incorporation of paddy roots. Clay content varied from 27.0 to 32.1% in these soils. Similar results were reported by Wani (3) in soils of Kashmir. Available nitrogen was medium and varied from 107 to 297 mg/kg (Table 1). The content being relatively higher in high altitude and lower in karewas and these wide variations might be due to climatic and altitudinal differences, which help in accumulation of organic matter. The available phosphorus was high and varied

Table 1. Physico-chemical and available macronutrient elements of soil. * Significant at 5% level, ** Significant at 1% level.

Attributes (mg/kg)	Range	Mean	Percent sample deficient
pH	6.1—8.2	7.33	–
$CaCO_3$ (%)	0.04—0.47	0.25	–
OC (%)	0.50—1.17	0.96	–
Clay (%)	27.0—32.10	28.91	–
N	107—297	188.26	6.6
P	10.2—21.2	16.26	–
K	170—230	192.5	–
Ca	1680—3720	2497.3	–
Mg	300—1224	591.2	–
S	8.8—10.8	9.63	73.3

between 10.2 to 21.2 mg/kg, which could be due to favorable pH, formation of organo-phosphate complexes and coating of iron and aluminium particles by humus. The potassium status of soils was high in range of 170 to 230 mg/kg, which could be attributed to illicit nature of these soils. The available calcium varied from 1680 to 3720 mg/kg with the status being high in these soils due to the presence of thick limestone within substantial quantity of dolomite and shale in these soils of Triassic age, which encircle whole valley of Kashmir. The magnesium content varied in the range of 300 to 1224 mg/kg. The status being sulfur was in the range of 8.8 to 10.8 mg/kg, the soil status being low.

The coefficient of correlation (*r*-value) obtained between physico-chemical properties and available macronutrients revealed that pH had significant negative correlation with N, P, Ca and S; while Mg was positively correlated with soil pH (Table 2). A significant negative correlation of pH with nitrogen can be due to loss of nitrogen as a result of volatilization with increase in pH. Significant negative correlation of pH with phosphorus is due to conversion of soluble phosphates into insoluble phosphates. Calcium exhibits dissolution as $CaCO_3$ with decrease in pH in calcareous soils thus decreasing the availability of calcium with increasing pH. The sulfur content decreases with increase in pH due to co-precipitation of sulfur with $CaCO_3$ at high pH. The significant positive correlation between pH and magnesium is due to the basic nature of this element (4).

Table 2. Relationship of physico-chemical properties with available macronutrients.

Nutrients	pH	$CaCO_3$	OC	Clay
N	-0.60**	-0.22	0.74**	0.48**
P	-0.83**	-0.68**	0.70**	0.51**
K	0.02	-0.21	-0.23	-0.91
Ca	-0.40*	-0.28	0.34	0.45*
Mg	0.52**	0.49**	-0.35	-0.50**
S	-0.90**	-0.75**	0.79**	0.56**

Table 3. Macronutrient content of paddy plants at tillering.

Attributes	Range	Mean
N	2.7—3.2	2.92
P	0.08—0.18	0.11
K	2.1—3.2	2.42
Ca	0.30—0.54	0.36
Mg	0.2—0.3	0.25
S	0.13—0.28	0.18

The calcium carbonate showed significant negative correlation with available P and S, and a positive correlation with available Mg (Table 2). The availability of phosphorus decreases with increase in $CaCO_3$ content due to its precipitation into tricalcium and hydroxyl phosphate. The available sulfur decreases with $CaCO_3$ due to co-precipitation of sulfur as also shown by the work of Jalali et al. (2). The significant positive correlation of magnesium with $CaCO_3$ is supported by findings of Antoo (4).

There was significant positive correlation of organic carbon with N, P and S (Table 2). The significant positive correlation of organic carbon with nitrogen may be attributed to the association of nitrogen with organic carbon and adsorption of NH_4-N by humus complexes of soil. Similar results were reported by Kanthaliya and Bhatt (5) and Bhan and Shanker (6). The significant and positive correlation of organic

Table 4. Correlation coefficient (*r*-value) between available macro nutrient content and plant nutrient. *Significant at 5% level, **Significant at 1% level.

Available nutrient	Plant nutrient content	Correlation coefficient
N	N	0.11
P	P	0.23
K	K	-0.27
Ca	Ca	0.87**
Mg	Mg	-0.12
S	S	0.98*

carbon and sulfur is attributed to the reason that organic carbon is a rich source of sulfur. The available N, P, Ca and S showed significant positive correlation with clay while magnesium was negatively correlated with clay. The positive significant correlation of clay with nitrogen is due to the formation of clay humus complex. A significant and positive correlation of clay with phosphorus is in agreement with Bhan and Shanke (6) and that of clay with calcium is consistent with works of Mahapatra and Sahu (7). A significant positive correlation between clay and sulfur is in accordance with the findings of Karwarsa et al. (8).

Table 3 indicates that the concentration of nitrogen was adequate and varied from 2.7 to 3.2%, which could be due to annual application of manures and fertilizers and decomposition of natural and added organic matter together with biological nitrogen fixation. The phosphorus and potassium content of the paddy plants were significant which could be due to high phosphorus and potassium status of the soils besides favorable pH. The calcium and magnesium contents of plants were adequate which could be due to high calcium and magnesium status in soils. The results are in agreement with Chabbra and Thakur (9). The sulfur content of plants ranged from 0.13 to 0.28%, the plant sulfur content being adequate. The increase in sulfur availability could be due to flooding of the soils (10).

The correlation coefficients (*r*-value) of available macronutrients and its concentration in paddy plants revealed that Ca and S had significant correlation with respective plant contents (Table 4). The results are in agreement with those of Antoo (4).

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