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EFFECT OF VANADIUM AND NITROGEN ON THE CHEMICAL COMPOSITION ON RICE

A.M. Ranjha, Mirza Bargees Baig* and A. Jabbar

Department of Soil Science, University of Agriculture, Faisalabad

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A greenhouse study was conducted to explore the effect of vanadium and nitrogen application on the chemical composition of rice (IRRI-6). Vanadium application at the rates of 0.45, 0.90, 1.80 and 2.70 kg/ha caused a significant increase in the nitrogen percentage of both straw and paddy. The source of nitrogen urea and ammonium nitrate had no significant effect on nitrogen, phosphorus and potash content while vanadium increased their concentration and uptake both in straw and paddy. The vanadium concentrations both in straw and paddy were increased significantly by its application. The highest concentration of vanadium in straw and paddy was observed where it was applied at the rate of 2.70 kg/ha. The source of nitrogen did not show any significant effect upon vanadium concentration in straw and paddy.

INTRODUCTION

A favourable balance of macro-and micronutrients is required for maximum yield and good quality. Micro-elements are essential for the proper functioning of cells and various metabolic activities in plants. Each micronutrient has its specific role to play in plant metabolism, e.g. vanadium increases the rate of CO_2 fixation and decreases respiration level of sugarbeet. It was also essential for plant growth as it promoted tillering, increased yield and nitrogen content of rice seedling [2].

Although earlier studies [8] indicated that vanadium is essential for lower plants and not for higher plants, yet later studies proved that it is equally essential for higher plants as Singh and Bhoosan [11] found that vanadium supplied at milder levels markedly increased the N, P, K, Ca and Mg contents in maize leaves. Similar results were found by Yakushenko *et. al.* [13]. As vanadium is one of the recently established plant micronutrients and a little work on this element has been reported, it was imperative to study the effect of vanadium and nitrogen on the chemical composition of rice which is very important crop for Pakistan from food and foreign exchange supply point of view.

MATERIALS AND METHODS

Surface soil (0-15 cm) was collected from the University of Agriculture Campus, Faisalabad. It was mixed, dried and passed through 2 mm sieve, 10 kg of this soil was filled-in glazed pots lined with polyethylene.

A rice nursery (IRRI-6) was raised in the field on the same soil and three seedlings per pot were transplanted. A basal dose of 9.9 kg P/ha and 18.8 kg K/ha was added in the form of superphosphate and K_2SO_4. Nitrogen from each source of urea and ammonium nitrate was applied at the rate of 45.5 kg/ha in 3 equal doses at transplanting, 30 days after transplanting and 50 days after transplanting. Vanadium as ammonium vanadate was applied at the rates of Vo = O, V1 = 0.45, V2 = 0.90, V3 = 1.80 and V4 = 2.70 kg/ha. The pots were placed in a completely randomised design in three repeats. Canal water was used for irrigation. When the crop was mature, panicles were removed, straw and grains were dried and ground separately for chemical analysis. Nitrogen was determined by the micro-Kjeldahl method [4]. Phosphorus by vanadomolybdo-phosphoric yellow color method (USDA Hand Book 60-1954) and total potassium by digesting with nitric and perchloric acids and then using EEL Flamephotometer [12] were determined. Total vanadium determination was made by phosphotungsto-vanadic acid method [9]. The comparison of treatment means was made by using Ducan's Multiple Range Test [3].

RESULTS AND DISCUSSION

The soil, on which this experiment was conducted, was analysed for various characteristics and the data so obtained

*National Agricultural Research Centre, Islamabad, Pakistan.

are presented in Table 1.

Table 1. Physical and Chemical Characteristics of Soil

(a) Mechanical analysis
1. Sand = 61.0%
2. Salt = 18.0%
3. Clay = 20.4%

(b) Textural class = sandy clay loam
1. Saturation % age = 35.0%
2. pH = 7.9
3. EC_e = 2.4 dsm^{-1}
4. Cation exchange capacity = 6.5 me/100 g of soil.
5. Organic matter = 0.77%
6. Total nitrogen = 0.06%

(c) Available phosphorus = 13.0 ppm.
(d) Available potassium = 0.031 me/100 g of soil.
(e) Extractable vanadium = 1.3 ppm.

Effect of vanadium and nitrogen upon nitrogen content of straw and paddy (Table 2). The application of vanadium increased the nitrogen content of both straw and paddy significantly. This increase was linear, i.e. nitrogen increased with the increasing rates of vanadium application. The source of nitrogen did not show any significant difference in the nitrogen content. Similar conclusion was drawn by Peterburgskij [7]. He found that vanadium application increased the nitrogen availability and its utilization by plant in soil. The increased contents probably were due to the increased activity of plants for protein synthesis as vanadium took active part in this process. Cannon [1] observed that vanadium was required in nitrogen fixtion. As the rice is grown under submerged conditions and the blue green algae is important nitrogen fixer of this habitat, there was increase in the nitrogen supply for the plants.

Potassium content of straw and paddy (Table 2): Potassium content of both straw and paddy increased significantly with the application of vanadium. All rates of vanadium application increased the potassium content significantly over that from control treatment while they

Table 2. Effect of nitrogen and vanadium of the chemical composition of rice.

Treatment	N content of straw (%)	N content of grain (%)	P in straw (%)	P in grain (%)	K in straw (%)	K in grain (%)	V in straw (ppm)	V in grain (ppm)
N0 V0	0.62	1.19 a	0.08	0.64	0.59	0.11	3.4	10 e
N0 V1	0.65	1.20 bc	0.08	0.66	0.59	0.11	5.9	12 d
N0 V2	0.66	1.22 b	0.09	0.67	0.60	0.11	7.1	14 c
N0 V3	0.69	1.23 a	0.09	0.69	0.60	0.12	9.0	15 b
N0 V4	0.69	1.25 a	0.10	0.70	0.61	0.12	10.5	16 a
N1 V0	0.68	1.31 e	0.80	0.64	0.59	0.11	3.4	10 d
N1	0.71	1.36 d	0.08	0.66	0.59	0.11	5.8	12 c
N1 V2	0.71	1.40 c	0.09	6.67	0.59	0.12	7.1	12 c
N1 V3	0.72	1.43 b	0.09	0.69	0.60	0.12	9.0	15 b
N1 V4	0.73	1.44 a	0.10	0.71	0.60	0.12	10.5	16 a
N2 V0	0.68	1.31 d	0.08	0.64	0.59	0.11	3.4	10 d
N2 V1	0.70	1.34 c	0.08	0.66	0.59	0.12	5.9	12 c
N2 V2	0.71	1.38 b	0.09	0.68	0.60	0.12	7.0	13 b
N2 V3	0.72	1.42 a	0.09	0.69	0.60	0.12	9.0	15 a
N2 V4	0.72	1.44 a	0.10	0.71	0.60	0.12	10.5	15 a
Mean values among vanadium levels								
V0	0.66 c	1.27 e	0.07 c	0.64 d	0.59 c	0.11b	3.4e	10e
V1	0.70 b	1.30 d	0.08bc	0.66 c	0.501bc	0.11b	5.9d	12d

(Continued.....)

(Table 2, continued. . . .)

V2	0.70 b	1.33 c	0.08bc	0.67 bc	0.596ab	0.11b	7.1c	13c
V3	0.71 a	1.36 b	0.09ab	0.69 b	0.60 a	0.12a	9.0b	15b
V4	0.71 a	1.37 a	0.10 a	0.71 a	0.60 a	0.12a	10.5a	16a
Mean values among nitrogen levels								
N0	0.66 c	1.22 c	0.09	0.68	0.60	0.11	7.1	13a
N1	0.71 a	1.39 a	0.90	0.67	0.60	0.12	7.1	13a
N2	0.70 b	1.37 b	0.09	0.67	0.60	0.12	7.1	13a

Mean squares for various characteristics

	DF	N in straw	N in paddy	P in straw	P in paddy	K in straw	K in paddy	V in straw	V in paddy
Nitrogon	2	0.0217**	0.1373**	0.00004^{NS}	0.0001^{NS}	0.00002^{NS}	0.00001^{NS}	0.0006^{NS}	0.4592**
Vanadium	4	0.0044**	0.0166**	0.00071**	0.0048**	0.003**	0.0001**	34.39**	38.0808**
N X V	8	0.00014^{NS}	0.00102**	0.00001^{NS}	0.00017^{NS}	0.00001^{NS}	0.000003^{NS}	0.0035^{NS}	0.4641**
Error	30	0.00021	0.0002	0.00007	0.0002	0.00003	0.000004	0.0218	0.0224

V = Vanadium; N = Nitrogen; NS = Statistically non-significant. ** = Statistically highly significant.

were not significant amongst each other. The application of nitrogen as through the nitrogen source tested did not show any significant effect on the potassium content of straw whereas in grains the K contents were higher in case of ammonium nitrate than urea.

Phosphorus content of straw and paddy: The phosphorus contents of straw and paddy were improved as a result of vanadium application to soil. The increase was significant to control except V1 in straw where it was non-significant. The effect of nitrogen application on phosphorus content was non-significant.

Vanadium concentration of straw and paddy: There was a regular and significant increase in the vanadium concentration both in straw and paddy with corresponding increase in vanadium application. Similar results were obtained by Cannon [1] and Kamynina [5]. The application of nitrogen also increased the vanadium content of straw and paddy significantly but the source of nitrogen did not show any significant effect.

Effect of vanadium and nitorgen upon the N, P, K and V contents of soil after harvesting. The soil samples after harvesting the crop were analysed for N, P, K and V. Nitrogen content in the soil increased where nitrogen was applied. The value for N0, N1, and N2 were 0.05, 0.06 and 0.06 ppm respectively. Phosphorus was also increased in the soil from 13.0 (before sowing) to 14 ppm (after harvesting). Increase in K content was only small one, where vanadium concentration of soil was much increased over the initial content of the soil before sowing and that was 1.3 ppm. After harvesting, the contents were 1.23, 1.92, 2.06, 2.06 and 2.86 ppm. with V0, V1, V2, V3 and V4 application respectively.

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