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SHORT COMMUNICATION

Effect of vanadium on the growth, yield and chemical composition of maize (*Zea Mays* L.)

Summary

The effects of application of vanadium on the growth, yield, and chemical composition of maize were compared in a series of pot experiments during several years.

It was concluded that above a threshold value (0.05 ppm) vanadium was injurious to maize crop, but at milder dose it increased the yield of maize crop significantly. Quality of produce was also affected markedly by vanadium application.

Introduction

Several reports indicated that vanadium is essential for certain plants and micro-organisms [3], especially of marine habitats [4], while Gericke [5] obtained negative response with wheat and clover plants. Arnon and Wessel [3] forwarded a sound evidence supporting vanadium as an essential element.

Methods and Materials

Hybrid maize (*Zea mays* L. var. G_3) plants were raised in sand culture at 5 levels of vanadium (0, 0.05, 0.25, 1.25, and 6.25 ppm). The complete and deficient solutions were prepared as described by Hoagland and modified by Arnon [6]. Other details have been reported elsewhere [11].

Growth observations were recorded at 67 days after showing. Chlorophyll, nitrogen, phosphorus, potash, calcium and magnesium were estimated in leaves at two successive stages of plant growth, *viz* 37 and 67 days after sowing. Methods for the extraction and estimation of chlorophyll pigment were adopted after Schertz [10]. Total nitrogen estimation was made using A.O.A.C.[1] method. Phosphorus was determined by the method described in A.O.A.C.[2] Potassium was estimated using the Cobalti-nitrate method as modified by Johnson and Ulrich [7]. Calcium was also determined by Johnson and Ulrich [7] method. Magnesium was estimated after Loomis and Shull [9]. The method described by Lane and Eynon [8] was followed for the determination of carbohydrates in grain.

TABLE 1

Effect of vanadium supply on growth and maturity of maize

Treatment	Plant height (cm)	Number of leaves	Area of leaves	Days to maturity
V_0	203.0	13	8096.2	105
V_1	215.6	14	9575.6	109
V_2	216.0	14	9577.0	111
V_3	200.0	13	8070.5	115
V_4	159.0	11	5000.0	107
C.D. at 5% P	18.90	2.70	186.60	—

TABLE 2

Effect of different concentrations of vanadium supply on chlorophyll, carotine and xanthophyll content (mg/100 gm fresh weight) of maize leaves at knee high stage

Treatment	Chlorophyll content			
	Chlorophyll			
	(a)	(b)	Carotine	Xanthophyll
V_0	470.0	350.0	20.5	36.2
V_1	473.5	352.6	21.2	36.5
V_2	475.8	354.8	22.0	36.8
V_3	477.6	358.6	22.2	37.0
V_4	478.9	358.8	22.3	37.0

TABLE 3

Effect of different concentrations of vanadium supply on chlorophyll, carotine and xanthophyll content (mg/100 g fresh weight) of maize leaves at grain formation stage

Treatment	Chlorophyll content			
	'a'	'b'	Carotins	Xanthophyll
V_0	465.6	346.2	20.8	36.8
V_1	475.5	355.0	21.5	36.5
V_2	478.2	356.8	22.2	36.9
V_3	479.6	359.2	22.5	37.2
V_4	480.2	360.6	22.8	37.3

Results and discussion

Effects on plant growth. Visual differences in plants growth due to differential vanadium supply were well marked. Since from the very beginning of the treatment application, vanadium at 0.05 and 0.25 ppm concentrations increased plant height and foliage growth significantly (Table 1). At 1.25 and 6.25 ppm, plant height, number of green leaves, and the area of green leaves were severely restricted with increasing doses of vanadium supply the maturity of plants delayed.

Effects on chlorophyll pigments. Vanadium supply markedly affected chlorophyll content of maize leaves (Tables 2 and 3). Increasing doses of vanadium supply positively increased chlorophyll content. Chlorophyll 'a' and 'b' were greatly increased by increasing doses, but the difference was not well marked.

Effects on grain yield. Effect of vanadium supply on grain yield was recorded for consecutive three years period (1966–68) and data obtained have been presented in table 4. The yield of grain increased only at 0.05 and 0.25 ppm concentrations, afterwards it decreased with increasing doses of vanadium supply. In the entire range of vanadium supply higher doses depressed the yield of grains. The depression was marked and statistically significant within the range 0.05 to 6.25 vanadium supply.

TABLE 4

Effect of vanadium supply on grain yield of maize (g)

Treatment	Year		
	1966	1967	1968
V_0	210.00	225.60	215.80
V_1	240.25	251.90	243.20
V_2	241.00	252.60	244.50
V_3	195.60	200.20	198.80
V_4	140.20	135.60	127.70
C.D. at 5% P	22.50	24.00	20.25

Effects on chemical composition of leaves. Vanadium supply markedly affected mineral content of maize leaves (Tables 5 and 6). Only 0.05 ppm concentration of vanadium increased N, P, K, Ca and Mg content of maize leaves afterwards mineral content decreased with corresponding increase in vanadium concentrations.

Effects on carbohydrate content of grains. Percentage protein, starch and total carbohydrates were determined in maize grains after harvesting (Table 7). It has been observed that 0.05 and 0.25 ppm concentrations of vanadium increased protein, starch and carbohydrate contents than con-

TABLE 5

Effect of vanadium supply on mineral content of maize leaves at knee-high stage

Treatment	N (%)	P (%)	K (%)	Ca (mg/g)	Mg (mg/g)
V_0	1.60	0.25	1.20	0.45	0.70
V_1	1.90	0.28	1.22	0.46	0.76
V_2	1.70	0.26	1.20	0.45	0.75
V_3	1.50	0.21	1.15	0.42	0.70
V_4	1.30	0.30	1.20	0.46	0.65

TABLE 6

Effect of vanadium supply on mineral content of maize leaves at grain-formation stage

Treatment	N (%)	P (%)	K (%)	Ca (mg/g)	Mg (mg/g)
V_0	1.70	0.23	1.25	0.46	0.72
V_1	2.00	0.25	1.24	0.48	0.78
V_2	2.00	0.24	1.22	0.45	0.76
V_3	1.50	0.20	1.20	0.44	0.72
V_4	1.45	0.20	1.20	0.47	0.70

TABLE 7

Effect of vanadium supply on protein, starch and total carbohydrate of maize grains after harvesting

Treatment	Protein (%)	Starch (%)	Total carbohydrate (%)
V_0	9.60	61.00	12.2
V_1	9.72	61.25	12.5
V_2	9.70	61.20	12.3
V_3	9.55	61.00	12.0
V_4	9.00	58.65	12.5

trol. The higher doses of 1.25 and 6.25 ppm drastically reduced carbohydrate content in grains.

Effects on mineral content of grains. N, P, K, Ca, and Mg were determined in harvested grains (Table 8). It is interesting to note that vanadium supply seemingly affected the N, P and K content of maize grains

TABLE 8

Effect of vanadium supply on mineral content of maize grains after harvesting

Treatment	N (%)	P (%)	K (%)	Ca (mg/g)	Mg (mg/g)
V_0	1.42	0.25	0.42	0.06	0.72
V_1	1.50	0.27	0.42	0.05	0.73
V_2	1.45	0.26	0.40	0.07	0.72
V_3	1.35	0.20	0.43	0.06	0.75
V_4	1.30	0.19	0.42	0.05	0.72

as affected leaf composition. But contrariwise, Ca and Mg contents were unaffected by vanadium nutrition, and sometimes higher doses of the same increased content of these elements.

The growth and yield of plants showed significant difference with vanadium supply. Yield of maize cobs increased significantly upto 0.25 ppm concentrations, although the difference between 0.05 and 0.25 ppm concentrations was not significant. It appears probable that the higher yield of maize grains by judicious supply of vanadium was mainly due to the higher photosynthetic area of the leaves. Vanadium may be evolved in biological oxidation-reduction reactions in view of its different oxidation states as well as its similarity to molybdenum.

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