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Response of different doses of Vanadium on morphological, biochemical attributing characters of sweet corn (*Zea mays* L.)

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Abstract
A pot experiment was conducted during *Rabi* session to study the effect of different concentration of Vanadium (0, 20, 40, 60, 80, 100 ppm) on morphological and biochemical character of two varieties of sweet corn (*Zea mays* L.) Madhuri & Phule Madhu. Vanadium was applied at 30 DAS & at flowering time. Results showed that the maximum improvement in morphological and biochemical characters was observed in variety Madhuri at 20 ppm Vanadium as compared to control and the Minimum effect was observed in variety Phule Madhu at 100 ppm. Vanadium applied to plant in low concentration (20 ppm) resulted in improvement of morphological, biochemical character of sweet corn.

Keywords: vanadium, sweet corn, growth, biochemical characters

Introduction
Corn (*Zea mays* L.) is a versatile crop, also known as queen of cereals. It has found an important place in the human diet, animal feed as well as fodder including industrial raw material like starch and oil. Being C_4 plant maize has high yielding potential because this crop has greater ability to convert solar energy into food. Its grain contains about 10 % protein, 4 % oil, 70 % carbohydrate, 2.3 % crude fibre, 10.4 % albuminoids, and 1-4 % ash. It also contains vitamin A, nicotine acid and riboflavin, vitamin E. Maize is important crop in the world grown in more than 150 countries having 600 million ha area with 600 million ton of production. Special corn viz., sweet corn (*Zea mays var. saccarata*), popcorn (*Zea mays var. everta*), baby corn (*Zea mays* L.), high-oil corn etc. These corns especially sweet corn with their high market value are perfectly suitable to peri-urban agriculture as they promise higher income to maize growers. Sustainability of sweet corn scientific cultivation practices must be ensured to attain the goal of agricultural sustainability. Sweet corn is picked at milk stage and eaten as a vegetable, rather than a grain. Its consumption at immature stage as roasted and boiled ears is a popular practice as the kernels are sweet. Maize is an exhaustive crop and requires high quantities of nitrogen and phosphorus. Low soil fertility is one of the bottlenecks to sustain agricultural production and productivity in India (Khan and Singh. 2017) [6].

Micronutrients play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity nitrogen fixation and reduction (Adhikary *et al*., 2010) [1]. Vanadium (V) is a transition element widely distributed in nature and biological systems, as well as a part of fossil fuels, and agricultural supplies, such as chemical fertilizers which contain ammonium metavanadate (NH_4VO_3) (Hector *et al*., 2017) [3].

V is the 5th most abundant element among the transitional metals in the earth crust. V is extensively dispersed in the environment by different ways like leaching, combustion, use of fertilizers, and waste material from industries, resultantly, V contaminates the soil, water and atmosphere. The most common form of vanadium is Vanadium pentaoxide (V_2O_5), followed by ammonium metavanadate (NH_4VO_3) and sodium orthovanadate (NaH_2PO_4) (Imtiaz *et al*., 2014). Vanadium is also essential for several species of fungi and nitrogen-fixing microorganisms but there is little evidence whether it is essential for higher plants (Saco *et al*., 2013) [12].

Vanadium is a ubiquitous trace metal in the environment, which is an essential trace element for living organisms. With scientific and technological developments, vanadium is clearly poised to become one of the most important elements for the twenty-first century (Teng *et al*., 2011) [15]. The role of vanadium in plants is very important during proper growth and development of plants on the other hand there are many recent reports,

which demonstrate the essentiality of V for plants growth and metabolism (Vachirapatama *et al*., 2011). However, the adoption of improved agronomic practices, suitable varieties (Madhuri & Phule Madhu) and suitable dose of vanadium can increase crop productivity. Ultimately growing suitable varieties with proper dose of vanadium increase growth and yield of crop. Therefore the objectives of this study the effect of Vanadium (V) on morphological and biochemical characters of sweet corn.

Materials and Methods

The present experiment was undertaken at field of Department of Biological Sciences, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad, Uttar Pradesh, India during *rabi* 2017-18. Sweet corn seeds of hybrid Madhuri and Phule Madhu were used for the pot experiment. Pot experiment was done according to completly randomized design with three replications, and recommended package of practices were followed to raise the crop. Approximately 8 kg of soil was filled in pot and sowing was done using 3-4 seed per pot by dibbling method. The observation were recorded on each plants of each pot and replication for all characters Days to 50 % tasselling, Days to silking, Plant height (cm), Number of leaf, Leaf area, Root length (cm), Chlorophyll content, Carotenoids content, Proline content. Sweet corn (30 DAS and flowering time) were allowed to apply Vanadium solution containing seven different Ammonium metavanadate (NH_4VO_3) concentration: 0, RDF, 20, 40, 60, 80, 100 PPM. The Vanadium solution were maintained a constant volume during the pot experiment. Analysis of variance (ANOVA) as suggested Fisher and Yates (1936) was used to determine the statistical significant of the difference between treatment means in all experiments.

Results

The result presented in the table morphological & biochemical 1 indicated that the effect of different concentration of vanadium on same important parameters viz. days to 50 % tasselling, days to silking, plant height (cm), number of leaf, leaf area, root length (cm), chlorophyll content, carotenoids content. in two varieties of sweet corn Madhuri and Phule Madhu.

Result presented in table 2 showed comparative analysis of growth parameter of sweet corn varieties (Mahuri & Phule Madhu) as infused by different doses of vanadium. (0, 20, 40, 60, 80, 100 ppm).

1) **Plant height at flowering time (cm):-** Result revealed that plant height was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (122.70) and Phule Madhu (60.60). however the minimum plant height was observed in the treatment T_6 (100 ppm) in both varieties Madhuri (109.47) & Phule Madhu (42.70).
2) **Days to Tasseling:-** Result revealed that days to tasseling was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (55.67) and Phule Madhu (63.33) however the minimum days to tasseling was observed in T_6 (100 ppm) in both varieties Madhuri (62) & Phule Madhu (65.33).
3) **Days to Silking:-** Result revealed that days to silkng was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (70) and Phule Madhu (73.67). however the minimum days to silking was observed in the treatment T_6 (100 ppm) in both varieties Madhuri (74) & Phule Madhu (77.33).
4) **Leaf Area (dm^2):-** Result revealed that leaf area was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (2427.96) and Phule Madhu (1006.83). however the minimum leaf area was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (1489.95) & Phule Madhu (686.37).
5) **No. of Leaf:-** Result revealed that no. of leaf was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (13) and Phule Madhu (10.67). however the minimum no. of leaf was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (10) & Phule Madhu (9).
6) **Root Length (cm):-** Result revealed that root length was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (69.50) and Phule Madhu (60.60). however the minimum root length was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (38.7) & Phule Madhu (45.33).

Result presented in table 3 showed comparative analysis of biochemical parameter of sweet corn varieties (Mahuri & Phule Madhu) as infused by different doses of vanadium.(0, 20, 40, 60, 80, 100 ppm).

1) **Chlorophyll a (mg/g/Fr.Wt):-** Result revaluated that chl.a was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (2.71) and Phule Madhu (2.40). however the minimum chl.a was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (2.51) & Phule Madhu (1.27).
2) **Chlorophyll b (mg/g/Fr.Wt):-** Result revaluated that chl.b was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (1.43) and Phule Madhu (2.27). however the minimum chl.b was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (2.06) & Phule Madhu (0.97).
3) **Total Chlorophyll (mg/g/Fr.Wt):-** Result revaluated that total chl. was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (2.39) and Phule Madhu (2.01). however the minimum total chl. was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (1.26) & Phule Madhu (0.98).
4) **Carotenoids (mg/g/Fr.Wt):-** Result revaluated that Carotenoids was the maximum in treatment T_2 (20 ppm) in both varieties Madhuri (1.09) and Phule Madhu (0.82). however the minimum Carotenoids was observed in this treatment T_6 (100 ppm) in both varieties Madhuri (0.95) & Phule Madhu (0.47).
5) **Proline (µg/g.Fr.Wt):-** Result revaluated that proline was the maximum in treatment T_6 (100 ppm) in both varieties Madhuri (0.14) and Phule Madhu (0.19). however the minimum proline was observed in this treatment T_2 (20 ppm) in both varieties Madhuri (0.04) & Phule Madhu (0.04).

Discussion

Plant height, days of floweing & tasseling, no. leaf, root length, leaf area, chlorophyll contentand was increses in treatment having vanadium in low concentration and decreases at concentration.

Similar finding for plant height, no. leaf, root length, leaf area and yield was observed by Vachirapatama *et al.,* (2011) where it was reported that low concentration of vanadium increases the plant growth parameters of chines cabbage and tomato. This effect may be due to the fact that V at this concentration can help increase nitrogen in the form of

ammonium compound activating the rice growth. Vanadium is a crucially important element for photosynthesis and phytoplankton growth Nalewajko *et al.,* (1995). It is also essential for some species of nitrogen fixing bacteria, algae, and fungi. V plays a pivotal role in the formation of the holo-enzyme of peroxidase of bromine, iodine, and chlorine Hector *et al.,* (2017) [3]. Kasai *et al.,* (1999) [5] also reported that V is an essential element for the growth of the green alga (*Scenedesmus obliquus*) in V is required at concentration 0.1 g/ml V in nutrient medium by above 25mg V + RDF This result was due to inhibition of growth & death of cell of plant. Meisch *et al*., (1977) [7]. Signifying amount of V in soil water have shows to have inhibitory effect on plant some enzymes, growth & photosynthesis Kasim *et al*., (1999). The increase of pro-line content was might associated with the development of AMF hypha which assisted the plant to extract water as well as nutrients from the dry soil. Kandowangko *et al*., (2009) [4].

Table 1: Analysis of variance for morphological & biochemical characters of sweet corn.

S. No.	Characters	Mean Sum of Squares			
		Treatments (df=7)		Error (df=21)	
		V1	V2	V1	V2
1	Days of tasseling	31.31**	2976**	2.38	1.33
2	Days of silking	34.44**	5093**	1.28	1.95
3	Plant height at flowering (cm)	560.05**	172.81**	3.50	4.57
4	Leaf per plant	6.31**	4.63**	0.52	0.71
5	Chl. a (mg/g/Fr. Wt.)	10.59**	2.70**	0.01	0.07
6	Chl. b (mg/g/Fr. Wt.)	1.26**	7.02**	0.03	0.03
7	Total Chlrophyll (mg/g/Fr. Wt.)	9.61**	5.36**	0.03	0.04
8	Carotenoid (mg/g/Fr. Wt.)	1.31**	0.80**	0.08	0.24
9	Proline content (µg/g.Fr. Wt)	0.02**	0.01**	0.01	0.01
10	Leaf area (dm^2)	124077**	625022**	9086.68	25604
11	Root length(cm)	566.67**	719.20**	2.75	1.09

** Significant at 1% Level

Table 2: Mean table of Morphological character of sweet corn Madhuri (V_1) and Phule Madhu (V_2).

Treatment	Plant Height (cm)		Days of Tasseling		Days of Silking		Leaf Area (dm^2)		No. of Leaf		Root Length (cm)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Control	100.03	22.10	65.67	40.53	82.00	72.67	1051.74	83.33	9.33	431.93	25.60	6.67
RDF	105.57	26.40	61.33	44.53	76.67	68.67	1272.10	80.33	10.00	538.70	38.03	8.00
RDF+V(20 ppm)	122.70	60.60	55.67	80.43	70.00	63.33	2427.96	73.67	13.00	1006.83	69.50	10.67
RDF+V(40ppm)	117.63	50.47	58.00	72.43	71.00	64.00	1991.57	75.00	11.67	928.37	63.03	10.33
RDF+V(60ppm)	114.87	48.93	60.00	70.47	72.00	65.00	1627.52	75.33	10.33	799.23	55.43	10.33
RDF+V(80ppm)	112.60	46.00	60.67	66.33	72.67	66.33	1686.15	76.33	11.00	739.80	45.67	9.33
RDF+V(100ppm)	109.47	42.70	62.00	64.13	74.00	65.33	1489.95	77.33	10.00	686.37	38.60	9.00
Gen. Mean	111.84	42.46	60.48	62.70	74.05	66.48	1649.57	77.33	10.76	733.03	47.98	9.19
MIN.	100.03	22.10	65.67	40.53	82.00	72.67	1051.74	83.33	9.33	431.93	25.60	6.67
MAX.	122.70	60.60	55.67	80.43	70.00	63.33	2427.96	73.67	13.00	1006.83	69.50	10.67
C.V.	1.91	4.41	1.91	4.10	1.89	2.32	9.70	1.47	7.85	13.00	2.18	7.87
S.E.M.	1.23	1.08	0.67	1.48	0.81	0.89	92.38	0.65	0.49	55.04	0.60	0.42
C.D. 5%	3.74	3.28	2.02	4.50	2.45	2.70	280.22	1.99	1.48	166.93	1.83	1.27

Table 3: Mean table of Biochemical character of sweet corn Madhuri (V_1) and Phule Madhu(V_2).

Treatment	Chlorophyll a (mg/g/Fr. Wt.)		Chlorophyll b (Mg/g/Fr. Wt.)		Total Chlorophyll (Mg/g/Fr. Wt.)		Carotenoids (Mg/g/Fr. Wt.)		Proline Content (µg/g/ Fr. Wt.)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Control	1.92	0.55	1.47	0.39	1.30	0.34	0.65	0.14	0.02	0.01
RDF	2.10	0.97	2.17	0.11	1.93	0.86	0.67	0.33	0.03	0.01
RDF+V(20 ppm)	2.71	2.40	1.43	2.27	2.39	2.01	1.09	0.82	0.04	0.04
RDF+V(40ppm)	2.64	1.75	2.41	1.94	2.18	1.69	0.98	0.57	0.05	0.07
RDF+V(60ppm)	2.58	1.67	2.34	1.79	2.08	1.54	0.96	0.56	0.06	0.15
RDF+V(80ppm)	2.55	1.46	2.17	1.58	1.83	1.40	0.91	0.49	0.10	0.19
RDF+V(100ppm)	2.51	1.27	2.06	0.97	1.26	0.98	0.95	0.47	0.14	0.19
Gen. Mean	2.43	1.44	2.09	1.44	1.85	1.26	0.89	0.48	0.06	0.09
MIN.	1.92	0.55	1.47	0.39	1.30	0.34	0.65	0.14	0.02	0.01
MAX.	2.71	2.40	1.43	2.27	2.39	2.01	1.09	0.82	0.04	0.04
C.V.	0.11	0.08	0.08	0.01	0.12	0.13	0.55	0.58	0.43	0.10
S.E.M.	0.15	0.06	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.02
C.D. 5%	0.47	0.21	0.32	0.31	0.04	0.03	0.08	0.04	0.05	0.01

Conclusion

It is the concluded from studies, on vanadium 20 ppm was found as best treatment to increases the yield of sweet corn in pot experiment. The result of current study also indicated that the higher dose of vanadium shows reverse effect on the morphological, biochemical and yield contributing character of the sweet corn.

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