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RESEARCH ARTICLE

EFFECTS OF ZINC AND ARSENIC ON GERMINATION, SEEDLING GROWTH AND BIOCHEMICAL CONTENT OF *PHYSALIS MINIMA* L

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ABSTRACT

Effects of different concentrations of zinc and arsenic on germination, root and shoot growth, dry weight of root and shoot and changes in content of total chlorophyll, carotenoids, total sugar and protein of *Physalis minima* L. was studied. The lower concentration of zinc has beneficial effect but application of higher level of zinc has an adverse effect. Arsenic reduced the percentage of germination, root and shoot length and dry weight of root and shoot. Total chlorophyll, carotenoids, sugar and protein were also affected by arsenic and their contents were decreased.

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INTRODUCTION

Rapid growth of industrialization leads to pollution due to waste water. Many countries have experienced pollution hazards due to toxic metals. Industrial waste containing toxic metals are creating water pollution problems. *Physalis minima* is a small herbaceous medicinal plants used for the various diseases. Juice of stem is used in treatment of diarrhoea (Sharma *et al*., 2001). Leaves mixed with water and mustard oil and is used in earache and deafness (Chopra *et al*., 1956; Satyavati *et al*., 1987). Fruits are reported to be useful in snake bite and scorpion sting. It is also useful in splenic disorders and in gonorrhoea (Chopra *et al*., 1956; Satyavati *et al*., 1987). The present work is an attempt to study the effect of zinc and arsenic on the growth of *Physalis minima*. The effect on various aspects viz., seed germination and growth of seedling and biochemical contents was investigated.

MATERIALS AND METHODS

The seeds of *Physalis minima* were collected from the plants cultivated in the AspeeDhanvantriUdyan, Bapalal Vaidya Botanical Research Center, Department of Biosciences, VNSG University, Surat and surface sterilized with 0.2% mercuric chloride and then washed with distilled water.

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Ten seeds were eventually placed in each petri dishes lined with filter paper. Various salt concentration of zinc sulphate and sodium arsenate salt (as a source of arsenic) (10, 25, 50, 100, 125 and 150 mgl^{-1}) were prepared and used for germination studies. The germination carried out by using distilled water was control. Each treatment and control was replicated three times. Various parameters were studied 10 days after germination. The biochemical estimations were carried out as per the methods, of Arnon (1949) for chlorophyll; of Krik and Allen (1965) for carotenoid; of Nelson (1944) for total sugar and of Lowry *et al*. (1951) for protein.

RESULTS AND DISCUSSION

The treatment of lower concentration of zinc resulted increase in seed germination, growth of root and shoot and their dry weight (Table. 1, 2, 3). At higher concentration, the process of germination, growth of root and shoot and dry weight were affected (Table. 1, 2, 3). These results indicated that zinc at lower level has a beneficial effect and at higher concentration has an adverse effect on the germination and growth of seeding. The treatment of arsenic has adverse effect. When the concentration of arsenic was increased in the treatment, the inhibition of seed germintion and decrease in the length of root, shoot and dry weight was observed. Similar reduction in growth parameters was also reported in pea (Chugh and Sawhney, 1996), cowpea (Lalitha *et al*., 1999) and cotton (Srivastava *et al*., 1997).

Table 1. Effect of zinc and arsenic on germination (Percentage, Root length)

Concentration mg/l	Zinc Germination Percentage	Arsenic Germination Percentage	Zinc Root Length (cm)	Arsenic Root Length (cm)
Cont.	95	95	5.80	5.80
10	97	93	6.28	5.10
25	98	92	6.10	4.92
50	92	86	5.48	4.28
75	85	80	4.72	3.74
100	78	72	3.92	3.18
125	75	70	3.50	3.02
150	70	68	3.08	2.92

Table 2. Effect of zinc and arsenic on germination (Shoot length, Root Dry Weight)

Concentration mg/l	Zinc shoot Length (cm)	Arsenic shoot Length (cm)	Zinc Root Dry Weight (mg/g)	Arsenic Root Dry Weight (mg/g)
Cont.	12.10	12.10	0.118	0.118
10	14.24	11.88	0.142	0.108
25	14.62	11.42	0.128	0.092
50	13.58	11.08	0.101	0.085
75	11.46	10.42	0.090	0.072
100	10.94	10.12	0.082	0.066
125	10.42	9.72	0.074	0.062
150	9.25	8.5	0.068	0.060

Table 3. Effect of zinc and arsenic on germination (Shoot Dry Weight, Total chlorophyll)

Concentration mg/l	Zinc Shoot Dry Weight (mg/gm)	Arsenic Shoot Dry Weight (mg/gm)	Zinc Total chlorophyll (mg/gm)	Arsenic Total chlorophyll (mg/gm)
Cont.	0.404	0.404	0.496	0.496
10	0.460	0.390	0.568	0.544
25	0.422	0.376	0.532	0.510
50	0.386	0.332	0.450	0.438
75	0.310	0.279	0.384	0.316
100	0.272	0.264	0.342	0.268
125	0.232	0.212	0.302	0.228
150	0.218	0.198	0.280	0.205

Table. 4: Effect of zinc and arsenic on (Carotenoid, Total Sugar)

Concentration mg/l	Zinc Carotenoid (mg/gm)	Arsenic Carotenoid (mg/gm)	Zinc Total sugar (mg/gm)	Arsenic Total sugar (mg/gm)
Cont.	0.282	0.282	4.165	4.165
10	0.324	0.266	4.673	3.908
25	0.298	0.240	4.485	3.784
50	0.261	0.218	3.968	3.658
75	0.247	0.198	3.662	3.538
100	0.210	0.186	2.342	2.836
125	0.202	0.178	2.282	2.454
150	0.196	0.172	2.245	2.164

The inhibition in seed germination in *Physalis minima* at higher concentration was possibly due to the interference of heavy metal ions during the process of seed germination (Sankar Ganesh *et al.*, 2008). The reduction in root and shoot growth may be attributed to the accumulation of heavy metals in the plant tissues and their interaction with the minerals (Banu *et al.*, 1997). Total chlorophyll and carotenoid content showed a decreasing trend with progressive increase in zinc and arsenic in the treatment, however low level of zinc (10 and 25 mg^{-1}) produced positive effect on chlorophyll and carotenoid content (Table. 3, 4). The increase in these pigment contents was due to zinc at low level act as a structural and catalytic components of proteins, enzymes and as cofactors for the biosynthesis of pigments (Balashouri and Prameeladevi, 1995). The higher level of zinc and arsenic reduced the chlorophyll and carotenoid contents. This can be due to excess supply of heavy metals resulting into interference with the synthesis of pigments (Manivasagaperumal *et al*., 2011).

Table 5. Effect of zinc and arsenic on (Protein)

Concentration mg/l	Zinc Protein (mg/gm)	Arsenic Protein (mg/gm)
Cont.	20.132	20.132
10	23.440	18.800
25	21.812	16.248
50	18.120	14.644
75	16.346	13.868
100	15.832	13.225
125	14.332	13.102
150	13.220	12.880

Total sugar content was higher at low concentration of zinc further the proportion decreased with an increase in zinc level (50 - 200 mg^{-1}). There was decrease in total sugar by progressive increase in the content of arsenic (Table 4). Similar reduction was also observed in wheat leaves (Lanaras *et al*., 1993). The decreased total sugar content was due to the effect of heavy metals on enzymatic reactions of carbohydrate catabolism (Rabie *et al*., 1992). Protein content was higher than control at lower level of zinc. It was decreased when concentration of zinc was increased in the treatment. Arsenic has adverse effect on protein content. It reduced the proportion of protein (Table 5). Zengin and Kirbag (2007) and Jayakumar *et al*. (2010) also obtained similar results about protein content. The inhibition of higher concentration of zinc in protein content may be due to binding of metals with sulfhydryl group of protein and bringing changes in the normal protein farm (Manivasagaperumal *et al*., 2011).

Conclusion

From these results it can be considered that arsenic has adverse effect on seed germination and growth of seedlings of *Physalis minima.* Lower level of zinc (10 - 25 mg^{-1}) had beneficial effect on germination, root and stem growth and biochemical content of *Physalis minima* seedlings. Application of higher levels adversely affected the same parameters.

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