Table 1 *Effect of heavy metals on SOD activity and chlorophyll content in bajra seedlings*

Metal ion treatment		48 h		96 h	
		SOD*	Chlorophyll+	SOD*	Chlorophyll+
Control		5.1 ± 0.05	63 ± 0.15	6.6 ± 0.1	240 ± 0.25
Copper	50 μM	5.0 ± 0.1 (2.0)	58 ± 0.2 (8.0)	6.5 ± 0.05 (1.5)	225 ± 0.15 (6.3)
	100 μM	4.6 ± 0.02 (9.8)	50 ± 0.12 (20.6)	5.7 ± 0.1 (13.6)	210 ± 0.1 (12.5)
Lead	50 μM	5.0 ± 0.05 (2.0)	60 ± 0.1 (4.8)	6.4 ± 0.25 (3.0)	230 ± 0.15 (4.2)
	100 μM	4.8 ± 0.2 (5.8)	57 ± 0.2 (9.5)	6.2 ± 0.1 (6.0)	222 ± 0.18 (7.5)
Manganese	50 μM	4.9 ± 0.01 (4.0)	50 ± 0.1 (20.6)	6.1 ± 0.01 (7.6)	220 ± 0.1 (8.3)
	100 μM	4.5 ± 0.02 (11.8)	40 ± 0.15 (36.5)	5.4 ± 0.01 (18.2)	185 ± 0.15 (23.0)
Mercury	50 μM	4.5 ± 0.15 (11.8)	40 ± 0.2 (36.6)	5.7 ± 0.2 (13.6)	200 ± 0.25 (16.7)
	100 μM	4.0 ± 0.05 (21.6)	28 ± 0.14 (55.6)	4.8 ± 0.15 (27.3)	100 ± 0.07 (58.3)

Values are mean of 4 replications; ± S D; *Units/mg protein; +μg/g wt of the seedling; Values in parentheses indicate per cent decrease over the control.

moderate nutrient levels of zinc or manganese in the growing medium. Mercury markedly decreased the chlorophyll content of the seedlings as compared to the other metal ions examined. The decrease in the chlorophyll content and SOD activity suggests that some heavy metals especially mercury and to a slight extent copper and manganese (not lead) may have inhibitory effect at the level of chloroplast biogenesis where superoxide radicals will be generated due to photochemical reactions.

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OPTIMUM FREQUENCY OF ADDITION OF NUTRIENT SOLUTION FOR MASS PRODUCTION OF *GLOMUS FASCICULATUM* INOCULUM

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VESICULAR-ARBUSCULAR mycorrhizal (VAM) fungi are associated with increased growth of many plant species. The obligate symbiotic nature of VAM fungi presently dictates that all VAM inoculum must be grown on roots of an appropriate host plant in pot culture[1]. It is advantageous to produce VAM in a partially, if not completely, artificial substrate. In such conditions, addition of a nutrient solution for VAM multiplication becomes necessary. Of the various nutrient solutions, Ruakura nutrient solution has proved to be the best for plant growth[2]. The present study was undertaken to determine the optimum frequency of addition of Ruakura nutrient

Table 1 *Frequency of addition of Ruakura nutrient solution on per cent root colonization, spore number and inoculum potential of G. fasciculatum inoculum and the shoot and root dry biomass of Rhodes grass*

Frequency of addition of nutrient solution (days)	Per cent root colonization	Spore number per 50 ml substrate	Number of infective propagules/g inoculum ($\times 10^7$)	Shoot dry biomass (g/plant)	Root dry biomass (g/plant)
Control	62(52)	283	0.14	3.2	2.2
2	61(51)	287	0.17	3.6	2.2
4	67(55)	341	0.21	4.4	2.5
6	76(60)	393	0.43	5.5	2.7
8	96(78)	560	1.23	10.1	5.0
10	89(70)	496	0.95	10.7	5.0
F test significant at $P = 0.05$	*	*		*	*
LSD at $P = 0.05$	3.94	44.55		0.34	0.18

Per cent root colonization values after arcsin transformation are given in parantheses.

solution for mass production of the VAM fungus *Glomus fasciculatum* (Thaxt.) Gerd and Trappe.

Perlite-soilrite mix (1:1 by volume) was filled to 16 cm earthen pots of 3 kg capacity. Pots were inoculated with *G. fasciculatum* inoculum (30 g/pot having 2100 infective propagules/g) 2 cm below the surface of the substrate as a thin layer. Rhodes grass (*Chloris gayana* Kunth) seeds were sown and covered with a thin layer of the substrate mix. Pots were maintained in a glass house with a mean temperature range of 28–32°C and watered whenever necessary. Plant population was maintained uniformly in all the 4 replications in each treatment. Ruakura plant nutrient solution[2] was added (50 ml/pot with 2.5 l substrate mix) to the pots once in 2, 4, 6, 8 or 10 days. Control pots were maintained with the addition of 50 ml water. Plants were harvested on the 60th day, and shoot and root dry biomass were recorded. Per cent mycorrhizal root colonization was estimated by staining the roots with trypan blue[3] and spore count by wet sieving and decanting techniques[4]. The number of infective propagules in the pot ball (total pot content), after chopping the roots to 1 cm bits, was determined by MPN technique[5], using onion as the test plant.

The percentage of root colonization, the number of extramatrical chlamydospore and infective propagules per unit weight of the inoculum were highest when the nutrient solution was added once in 8 days. The parameters decreased significantly when the nutrient solution was added either once in 10 days or more frequently i.e. less than 8 days. Increasing the frequency of addition of nutrient solution less than 8 days proportionally decreased the quality of inoculum. The control with no addition of the nutrient solution as well as the treatment in which the nutrient solution was added once in 2 days had similar effect on the number of infective propagules (table 1). There was also a marked increase in the shoot and root dry weight of plants given nutrient solution once in 8 days compared to plants more frequently fed with the nutrient solution (table 1). The decrease in the infective propagules when the nutrient solution was added once in 2 days is perhaps caused by the toxicity of nutrients accumulated due to the frequent addition of nutrient solution[6–8]. The decrease in the propagule number when the nutrient solution was added once in 10 days may be attributed to insufficient nutrient supply to VAM fungi for its proliferation. The present study clearly brings out that addition of Ruakura nutrient solution (50 ml/2.5 l substrate mix) once in 8 days is optimum for the mass production of the VAM fungus, *G. fasciculatum*.

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RESPONSE OF *WESTIELLOPSIS PROLIFICA* TO SALT-STRESS II. UPTAKE OF Na^+ IN THE PRESENCE OF K^+ AS CHLORIDE, NITRATE AND PHOSPHATE

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Most of the higher plants react to salt-stress either through osmotic adjustments[1] by sequestering the inorganic ions[2], or secretion of excess polysaccharides[3]. Indications of increased nitrogen demand and accumulation of K^+ by certain algae under salt-stress are also available. Cyanobacterial response to salt-stress, is, however, little understood. We have therefore studied the physiological aspects of cyano-bacterial adaptation to salts[4]. In this report we examine the influence of K^+ as KCl, KNO_3 and KH_2PO_4 on the uptake of Na^+ and K^+ by cyanobacteria.

Westiellopsis prolifica ARM 366 was grown in BG-11 medium[5] devoid of combined nitrogen at 30 ± 1°C under continuous illumination (2400 lux). Na^+ uptake was examined at a fixed concentration of Na^+ as 400 mM NaCl which is equivalent to 23.4 mg NaCl/ml. K^+ at graded concentrations of 20, 50, 100, 150 and 200 μg/ml was added as KCl, KNO_3 and KH_2PO_4 and their influence was examined on growth, pigments (chlorophyll)[6], nitrogen fixation[7] and uptake of Na^+ and K^+. To estimate Na^+ and K^+, the pellet was dried, ashed in a muffle furnace for 15 min at 500°C and dissolved in 0.1 M HNO_3 and estimated in flame photometer[8], using a digital flamephotometer (Elico).

Supplementation of growth medium with KCl or KH_2PO_4 was not effective to overcome the salt-stress and the lowered chlorophyll level remained unaffected. A marginal improvement in chlorophyll content was, however, observed due to NO_3^-, suggesting that NO_3^- although partially effective, was not sufficient to overcome the salinity stress. The biomass turnover was slightly higher (up to 12%) in the presence of KCl and KNO_3 but not in KH_2PO_4.

Table 1 *Influence of K^+ as Cl^-, NO_3^- and PO_4^- on the growth and acetylene reduction activity of Westiellopsis prolifica in presence of 23.4 mg NaCl/ml*

Treatment	Chlorophyll μg/ml	Dry weight mg/ml	μmol C_2H_4 mg/chl/h
BG-11	5.43	5.93	1.91
NaCl	0.58	0.51	2.85
+ KCl μg/ml			
20	0.55	0.52	2.06
50	0.55	0.49	2.18
100	0.53	0.55	2.89
150	0.55	0.50	2.78
200	0.56	0.56	2.73
+ KNO_3 μg/ml			
20	0.66	0.56	3.4
50	0.61	0.51	3.7
100	0.59	0.54	2.9
150	0.68	0.57	3.3
200	0.63	0.53	3.6
+ KH_2PO_4 μg/ml			
20	0.56	0.44	3.09
50	0 60	0.48	3.70
100	0.54	0.45	3.20
150	0.60	0.50	3.70
200	0 58	0.48	3.90