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Remediation of eutrophied water using *Spirodela polyrrhiza* L. Shleid in controlled environment

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Abstract. The range of pH from 6.5 to 6 and temperature of 25 to 30°C were the most suitable environmental condition for remediation of eutrophic water using giant duckweed. When harvested regularly duckweed plants may be of use in counteracting eutrophication in affected water bodies.

Key words: controlled environment, eutrophied water, growth, remediation, *Spirodela polyrrhiza*

Resumo: Tratamento de água eutrofizada usando *Spirodela polyrrhiza* L. Shleid em ambientes controlados. A faixa de pH entre 6,5 e 6 e temperatura entre 25ºC e 30ºC foram as condições ambientais mais adequadas para a remediação da eutrofização da água usando *Spirodela polyrrhiza.* Quando colhetadas regularmente, as "lentilhas d'água" podem ser usadas no controle da eutrofização em corpos de água afetados.

Palavras chave: ambiente controlado, agua eutrofizada, crescimento, remediação, *Spirodela polyrrhiza*

The physiochemical processes within a water source have major implications for controlling eutrophication in aquatic bodies (Khan & Ansari 2005). The free-floating members of family Lemnaceae may be of use in phytoremediation of eutrophic waters (Ansari & Khan 2008). In the present study growth response of *Spirodela polyrrhiza* at various temperature and pH levels was investigated for its possible use and application for remediation of eutrophic waters.

The experiments were conducted in small polyvinyl pots (maintained in triplicate) containing 500 ml of fresh water with nutrient solution (1ml l^{-1}) (Mahadevan & Sridhar 1986) inoculated with 1g of *S. polyrrhiza.* Growth of duckweed plants were tested at various temperatures (15° 20°, 25° 30°, 35° and 40° C) and pH levels (6, 6.5, 7, 7.5, 8 and 8.5) by placing pots for 20 days in a growth chamber in a light of 36 µ mol m^{-2} s^{-1}. For all temperature treatments the sets were maintained at pH 7.0 measured with a pH meter (Elico Limited, Hyderabad). NaOH or HCl were added to growth medium to maintain the specific pH. For all sets with various pH levels was maintained at 30°C temperature. Standard deviation and least significant difference at 5% level of significance were calculated using three replicates for each treatment following Dospekhov (1984).

The chlorophyll-*a* content in plants was estimated following the method of Zhao (2000a). The nitrogen and phosphorus contents were determined using the method of Lindner (1944) and Fiske & Subba Row (1925) respectively. Potassium was determined with a Flame photometer (AIMIL). Soluble protein was extracted following the method of Lazan *et al.* (1983) and Lowery *et al.* (1951). For peroxidase (POD) assay used the technique of Kar & Mishra (1976) and the activity was determined as described by Putter (1974). Catalase (CAT) activity was estimated following Lu (2002). Melanodialdehyde (MDA) contents were estimated according to the .

Table I. Growth response of giant duckweed at various temperatures. (FW = Fresh weight, U = Unit, LSD = Least significant difference, % = level of significance)

	Temperature						
	15oC	20ºC	25ºC	30ºC	35ºC	40ºC	LSD at 5 %
Dry weight mg g-1 FW	125.4±3.3	130.7±2.8	134.6±3.4	141.2±4.6	132.3±2.1	118..4±2.5	2.5
Chlorophyll mg g-1 FW	1.182±0.015	1.218±0.021	1.242±0.019	1.259±0.013	1.238±0.017	1.203±0.021	0.017
Nitrogen mg 100mg-1	3.10±0.18	3.47±0.13	3.69±0.15	3.87±0.16	3.61±0.12	2.96±0.10	0.19
Phosphorus mg 100mg-1	0.268±0.022	0.285±0.020	0.312±0.027	0.343±0.031	0.327±0.032	0.287±0.021	0.021
Potassium mg 100mg-1	1.65±0.26	1.89±0.22	2.10±0.27	2.29±0.31	2.15±0.11	1.91±0.13	0.17
Soluble protein mg g-1 FW	1.21±0.09	1.32±0.12	1.55±0.14	1.67±0.16	1.49±0.14	1.36±0.15	0.13
POD U mg1protein min-1	431±7	414±5	395±4	371±5	406±5	427±6	8
CATU mg-1protein min-1	117±3	103±4	85±2	74±2	88±4	105±5	12
MDA µmol g-1 FW	2.89±0.17	2.75±0.14	2.59±0.12	2.40±0.11	2.55±0.16	2.68±0.13	0.15

Table II. Growth response of giant duckweed at various pH levels. (NS = Not Significant, FW = Fresh weight, U = Unit, LSD = Least significant diference, % = level of significance)

	pH levels						
	6	6.5	7	7.5	8	8.5	LSD at 5 %
Dry weight mg g-1 FW	138.9±3.4	135.8±3.1	131.6±2.8	128.2±2.2	123.3±2.3	119.6±2.1	2.8
Chlorophyll mg g-1 FW	1.246±0.013	1.231±0.011	1.214±0.014	1.195±0.012	1.69±0.016	1.136±0.06	0.015
Nitrogen mg 100mg-1	3.87±0.22	3.65±0.31	3.40±0.34	3.22±0.24	2.91±0.32	2.79±0.26	0.16
Phosphorus mg 100mg-1	0.381±0.013	0.364±0.012	0.339±0.011	0.309±0.017	0.272±0.021	0.285±0.022	0.019
Potassium mg 100mg-1	2.35±0.10	2.29±0.09	2.22±0.05	2.17±0.09	2.12±0.08	2.06±0.11	NS
Soluble protein mg g-1 FW	1.39±0.06	1.32±0.10	1.27±0.13	1.20±0.09	1.15±0.08	1.07±0.07	0.05
POD U mg-1protein min-1	347±7	352±8	349±6	356±9	361±7	365±5	NS
CAT U mg-1protein min-1	82±5	80±4	86±3	88±3	93±6	95±5	NS
MDA µmol g-1 FW	2.35±0.20	2. 38±0.17	2.42±0.22	2.48±0.31	2.52±0.30	2.55±0.22	NS

method of Zhao (2000b).

Dry matter and chlorophyll-*a* accumulation were significantly higher at 25°C to 30°C (Table I). The optimum uptake of nitrogen, phosphorus and potassium was noted at 30°C. The temperatures of 15° and 40°C significantly reduced the nutrient uptake, dry matter and chlorophyll-*a* concentration. POD, CAT and MDA were higher at 15°C but maximum was at 40°C. The temperature regulates cell division, enzyme activity, translocation of food and photosynthesis in plants. 30° C is the optimum temperature for most of the biochemical processes (Devlin and Witham 1986). Lower temperature (10°C) retarded cell growth, synthesis and the absorption of nutrients from the water by duckweed (Ansari & Khan 2006).

The variation in pH (Table II) did not affect potassium, POD, CAT and MDA in plants. The plants grow well at all the tested pH levels. However, with the dry matter determination it was found that the nitrogen, phosphorus and protein contents of plants were significantly higher at acidic pH. It is known that the pH regulates origin, mobility and availability of ions and their different forms (Devlin & Witham 1986).

This study indicated that, under controlled conditions (at acidic pH and temperature between 25° and 30°C) of water and by harvesting regularly, giant duckweed may be used for removing high nutrient levels in eutrophic water.

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