

# Physiological studies of some nutrient elements on some aquatic plants

Hosny Mohammed Mohamed Abd El-Dayem

The present investigation was carried out in an attempt to add some information about the response of *Azolla pinnata* and *Spirodela polyrhiza* to variable concentrations of some essential nutrient elements such as phosphorus, calcium and cobalt added to the nutrient media. Also, the effect of some different levels of cadmium and lead as a toxic heavy metals which may contaminate the natural aqueous media of these two genera was studied under laboratory conditions. To approach this aim, two laboratory experiments were carried out under semi-controlled conditions which include:

A. Comparative studies on the effects of some concentrations of phosphorus, calcium and cobalt on the growth behaviour and mineral accumulation in both studied genera as well as the contents of sugars, chloroplast pigments and amino acid fractions.

B. Comparative studies on the toxic effects of some concentrations of Cadmium and lead on growth behaviour, mineral contents and the changes in chloroplast pigments, sugars and amino acid fractions of the two studied genera.

The results obtained could be summarized as follows:

- 1- Application of different P, Ca and Co levels seemed to regulate the growth of *Azolla* and *Spirodela* plants. Such regulation varied greatly within the tested plant genera and according to the examined element and its level.
- 2- The application of different P, Ca and Co levels affected greatly the concentrations and the uptake of N, P, K, Ca, Hg, Na, Fe, Mn, Cu and Zn by *Azolla* and *Spirodela* plants. This effects differed greatly within the tested plant genera and varied according to the examined element and its level. This may indicate that the response of the used genera to the application of different levels of P, Ca and Co was greatly differed and that may be related to the variable inheritance tendency.
- 3- The proportion and the distribution of different elements in *Azolla* and *Spirodela* tissues was greatly influenced by variation of P, Ca and Co application levels.
- 4- Photosynthetic pigment concentrations changed greatly with the variable change in the levels of P, Ca and Co in *Azolla* and *Spirodela* plant tissues. Such changes seemed to affect the accumulation of sugars and amino acid accumulations in plant tissues. The degree of such change was greatly differed between the studied genera.
- 5- Sugars and total free amino acids contents in *Azolla* and *Spirodela* plant tissues were the variable concentrations of P, greatly affected by Ca and Co levels affected the plant metabolism which varied according to the inheritance tendency and the variable response of the used plant species.
- 6- The proportion of reducing - to non-reducing sugars was changed greatly by the variable applications of P, Ca and Co in *Azolla* and *Spirodela*.
- 7- The application of P, Ca and Co seemed to regulate the accumulation of different amino acid fractions in *Azolla* and *Spirodela* plant tissues.
- 8- The variable changes in the accumulation of different nutrient elements, and different tested organic matters in *Azolla* and *Spirodela* plant tissues as related the variations in P, Ca and Co levels take a role in plant growth responses. The dominant amino acids in *Azolla* are: Glutamic + Alanine followed by aspartic acid, leucine, arginine, lysine, Phenylalanine, isoleucine, glycine, serine, proline, threonine, valine, cystine, methionine and finally histidine in descending order. The inhibiting effect of lack of (P) or (Ca) on total amino acids resulted mainly from the concentration of glutamic + alanine. Also (P) deficiency minimized most of the various amino acids, but (Ca) deficiency minimized only glycine, isoleucine, threonine, serine, cystine and phenylalanine. The absence of (Co) slightly altered the amino acids picture. With regard to *Spirodela* plants, the absence or the excess of (P), (Ca), or (Co) decreased the concentrations of the total amino acids, but shortage of (P) was superior in this

respect followed by (Co) and (Ca). The most abundant amino acids in Spirodela are glutamic + alanine followed by: aspartic or leucine, arginine, cystine, threonine, valine, phenylalanine, isoleucine, proline, glycine, histidine, serine and cystine in descending order. The negative effect of (P) deficiency occurred on the concentrations of glutamic + alanine, leucine, threonine, serine, methionine, cystine, lysine, arginine, phenylalanine and histidine. Lack of (Co) minimized the concentrations of glutamic + alanine besides threonine, methionine, cystine, lysine, arginine and histidine. The other amino acids slightly increased or unchanged.

**B- Experiment II: 1- Observation during growth, different concentrations of (Cd) or (Pb) changed the normal light green appearance into yellowish one. The proportional chlorosis appearance increased progressively in the frond with increasing plant age and also with increasing (Cd) or (Pb) levels. Also (Cd) treatments seemed to enhance the abscission of lateral branches from the main axis of the mother fronds more than did (Pb) treatment. So both Azolla and Spirodela could be used as an excellent biological indicators or monitors for (Cd) or (Pb) water pollution, however, Spirodela plants are more sensitive than Azolla in this respect.**

**2- Growth, the different levels of (Cd) or (Pb) decreased significantly Azolla or Spirodela fresh weight and daily percentage was also decreased. However number of plants per one gram fresh weight was increased and the reduction increased with increasing (Cd) or (Pb) concentrations. Also lead had less toxicity on Azolla growth comparing to (Cd) effect. Azolla plant could absorb (Cd) from the natural media easily than that absorbed by Spirodela. Also under the natural conditions in which Azolla survives such plant may be considered as (Cd) sink and could be used for removing such element from the very low contaminated pollutant media.**

**3- Different levels of (Cd) or (Pb) decreased mostly the concentrations of H, P, K, Ca, Hg, Na, Mn and Cu in both Azolla and Spirodela, but (Fe) increased with increasing of (Cd) concentration. Also in case of Spirodela, (Mn) and (Zn) concentrations increased with increasing (Pb) concentration.**

**4. Total accumulation of some nutrient elements: 1- In Azolla plants: a. The different levels of (Cd) were very harmful to the process of N-fixation and the reduction observed in N-accumulation increased with concentration. b. The different levels of (Pb) were less harmful to N-increasing (Cd) fixation than those of (Cd). Thus, the lower (Pb) concentrations (10, 15 and 25 PPM.) increased of the total N-accumulated in plant tissues, while the high (Pb) concentration (40 PPM.) decreased this accumulation and this decrease was less than that caused by (Cd). c. Different levels of (Cd) or (Pb) decreased the accumulations and/or the uptake of the different essential elements, but (Pb) was less harmful in this respect than (Cd). The only exception in this respect was (Fe) which showed continuous increase especially under (Cd) treatments. d. The different levels of both (Cd) or (Pb) did not effect the proportion but affected the balance of the essential elements in Azolla tissues.**

**2) In Spirodela plants: -a) The effect of (Cd) or (Pb) levels on the amounts of the essential elements was less in case of Spirodela than in Azolla and also the effect of (Pb) was less than that of (Cd) in this respect. b) The applied rates of (Cd) or (Pb) caused troubles in mineral accumulation and their uptake. c) Cadmium and lead reduced (Ca) accumulation in both Spirodela and Azolla and such reduction was proportional to the increase in (Cd) or (Pb) levels. Also (Cd) was more effective than (Pb) in this respect.**

**5- The different levels of (Cd) or (Pb) decreased the concentrations of the photosynthetic pigments in both Azolla and Spirodela. Such reduction was great with increasing concentrations of (Cd) or (Pb). Also, (Cd) was more effective than (Pb) in this respect.**

**6- Sugars, the different levels of (Cd) or (Pb) reduced greatly the sugar accumulation in both Azolla and Spirodela, and (Cd) was more effective than (Pb). All the tested rates of (Cd) or (Pb) disturbed the proportion of reducing- or non-reducing sugars as related to the total sugar amounts.**

**7- Host of the different (Cd) or (Pb) levels increased the concentrations of free amino acids in both Azolla and Spirodela and (Cd) seemed to be more effective than (Pb). The different levels of (Cd) lowered the accumulation of free amino acids in Azolla, while (Pb) enhanced such accumulation. On the other hand, the different levels of (Cd) or (Pb) enhanced such accumulation in Spirodela.**

**8- In both Azolla and Spirodela the total amino acids concentrations (mg/g dry matter) decreased continuously with increasing the rates of (Cd) or (Pb). This reduction was observed with every amino acid tested. In case of Azolla the different (Cd) or (Pb) levels changed the concentrations of most amino acids and the most pronounced reduction was obtained with glutamic + alanine, leucine, lysine and Phenylalanine, amino acids were unaffected or may increased slightly. In case of Spirodela, nearly all the tested amino acids**

decreased with increasing the concentration of (Cd) or (Pb).