CHAPTER - IV

SUMMARY AND CONCLUSIONS

Although every inorganic element is found to play a role in plant metabolism some elements have been found to be of paramount significance importance for plant metabolism. Potassium is among these elements and it is regarded as one of the most indispensable element for plant growth. Deficiency of potassium, affects various physiological processes in plants which ultimately leads to retardation of plant growth and loss of overall productivity. There is evidence that potassium is rather specifically involved in osmoregulation and opening of stomata. Potassium also implicated in transport of photosynthates, nitrogen metabolism and regulation of water economy. Potassium helps in strengthening plant tissues, preventing lodging, increasing resistance to pests and promoting root growth. It is also well known that univalent cation potassium is a necessary cofactor for many of the enzyme-catalyzed steps in metabolic pathways. Thus potassium ion has a fundamental influence on a whole series of metabolic processes in plants. Review of literature indicates that crop responses to potassium have been extensively studied and K fertilizer prictises are accordingly arranged but for this purpose it is essential to see the responses of each crop to soil K deficit.

Amaranthus is some times referred to as pseudocereal and it is one of the ancient plant in India. It is a double-duty plant with edible stem and leaves and highly nutritious grains. In *Amaranthus* leaves and seeds are rich in proteins as well as vitamins and minerals. This plant possess efficient C_4 mode of photosynthesis and can grow in variety of adverse environmental conditions. However physiological studies on this crop are quite limited and this perticularly notable for mineral nutrition. In the present investigation an attempt has been made to study physiological responses of three *Amaranthus* species which include two grain type species *A. hypochondriacus* AG-114, NBRI evolved and (*A. paniculatus* L.) and one vegetable type species (*A. caudatus* L.) Some of the significant findings of the present investigation can be summarised as follows :

A. **Deficiency Symptoms**

Visible symptoms of potassium deficiency were observed from early stage of growth in all three *Amaranthus* species. Deficiency symptoms were observed on older leaves. Yellowing, curling or rolling of leaf lamina from margins and tips was evident. The flowering was delayed and panicle size was very much reduced. The root growth was reduced in all the three *Amaranthus* species due to potassium deficiency.

B. **Growth**

The growth analysis revealed that the potassium deficiency caused considerable reduction in various growth parameters in all three *Amaranthus* species. Potassium deficiency resulted in marked reduction in total height, number of leaves per plant, leaf area, fresh weight and dry weight and length of internodes.

C. Leaf Water Relations

Potassium shows an influence on leaf succulence, water content and relative water content. Leaf succulence and water content were lowered in all three *Amaranthus* species. This decreased leaf succulence and lowered water content can be attributed to increase in transpiration.

D. Transpiration

Diffusive conductance to water and transpiration rate were increased in the leaves of three *Amaranthus* species due to K deficiency. From this it is clear that potassium is highly essential for regulation of transpiration.

E. Mineral Nutrition

Potassium deficiency caused drastic reduction in K content in all plant parts this decline is quite significant in aerial parts. Sodium level was increased in roots and old leaves but decreased in stem and young leaves of *Amaranthus* species due to K deficiency. But an increase in sodium content is not very significant so as to account for replacement of K by sodium. From this it is clear that *Amaranthus* is sodium excluding plant and sodium level remains at micronutrient level. Calcium level was found to be increased in roots and old leaves whereas decreased in stem and young leaves in *Amaranthus* species due to K deficiency. Thus it is clear that *Amaranthus* shows tendency to accumulate Ca^{2+} mainly in the root tissues and exclude Ca^{2+} in stem and young leaves due to K deficiency. This increase in Ca^{2+} content can helps in minimizing the membrane damage in root tissue of K deficient plants. The Mg content was increased in roots and leaves of *A. paniculatus* and *A. hypochondriacus* whereas it was decreased in stem and young leaves of *A. caudatus* and *A. hypochondriacus* due to K deficiency. From this it is clear that Mg can at least partially replace K in cation balance in some parts of the three species. But functional replacement with respect to other roles of K appears quite impossible. Potassium deficiency had influence on the phosphorus level. Phosphorus level was increased in roots and young leaves whereas it was decreased in stem and old leaves of *A. hypochondriacus* and *A. paniculatus*. Phosphorus is accumulated in the metabolically active organs i.e. leaves which may helps to overcome the situation of K deficiency at the metabolic level. Iron level was increased in root, stem and young leaves of three *Amaranthus* species where as it decreased in old leaves. But this increase is not significant so as to account for any iron toxicity. Manganese content was also increased in roots and leaves but it was decreased in stem tissue of K deficient *Amaranthus* plants. Thus overall Mn uptake and its distribution is not significantly affected by K deficiency. *Amaranthus caudatus* and *Amaranthus hypochondriacus* showed accumulation of Zn in root and stem where as it was decreased in leaf tissues under K deficient conditions. From this it is clear that distribution of Zn within the plant is disturbed due to K-deficiency.

F. **Photosynthetic Pigments**

Potassium deficiency caused decrease in chlorophyll and carotenoids content in all three *Amaranthus* species at latter growth stages. This would undoubtedly affect the photosynthetic efficiency of K deficient plants. There was increase in betacyanin content in leaves of *A. caudatus* and *A. hypochondriacus* due to K deficiency. This may be probably a protective response.

G. **Titratable Acid Number (TAN)**

All three species of *Amaranthus* showed decreased in leaf TAN value due to omission of K from nutrient medium. This decreased TAN value would suggest an impaired respiration and decreasing energy supply in *Amaranthus* plants due to potassium deficit.

H. **Photosynthetic Products - Carbohydrates**

Potassium deficiency was found to exert an influence on carbohydrate contents of three *Amaranthus* species. The carbohydrate fractions such as reducing sugars, nonreducing sugars and starch were increased in leaf tissues of all three *Amaranthus* species. Among the three fractions the accumulation of starch in K deficient leaves is particularly significant. In *Amaranthus* species K deficiency caused delay in flowering and also reduced the inflorescence (Sink) size. Thus decline in translocation capacity may results in increase in level of various carbohydrate fractions in K deficient leaves.

I. **Polyphenols**

The content of polyphenols in the leaves of three *Amaranthus* species was increased due to K deficiency. This increase was more significant in *A. caudatus*. Increased polyphenol content in K deficient *Amaranthus* might be due to stimulation of secondary metabolic activities.

J. **Free Proline**

Potassium deficiency exerted positive influence on proline content of leaf tissues of *Amaranthus* species. The proline content was increased in leaves of K deficient *Amaranthus* plants. Among three species *A. paniculatus* showed greater accumulation of proline. In this plant proline might be playing protective role under K deficient conditions.

K. **Glycinebetaine**

Among the three species studied *A. caudatus* and *A. hypochondriacus* have the potential to accumulate glycinebetaine under K deficient conditions. It might be playing a protective role for overall metabolic machinery in these plants.

L. Total Nitrogen and Soluble Proteins

Amaranthus species showed accumulation of nitrogen in root tissues whereas in leaf tissues nitrogen level was decreased due to potassium deficiency. It clearly indicates that the transport of nitrogen from root to shoot is affected. The soluble protein level was also decreased in all three *Amaranthus* species due to omission of K from nutrient medium which suggest arrested protein synthesis in these plants.

M. Enzymes

Potassium deficiency was found to exert a profound influence on enzyme activities. Due to K deficiency activity of nitrate reductase, acid phosphatase, catalase and peroxidase were increased in all three *Amaranthus* species. From stimulated NR activity it is clear that the K deficient *Amaranthus* plants try to assimilate more nitrate at levels comparable to that of healthy plants. Increased acid phosphatase activity due to potassium deficiency indicates definite trend towards promotion of hydrolytic and catabolic processes in *Amaranthus*. Increased peroxidase in K deficient plants indicates stimulated secondary metabolism in these plants. Whereas stimulated catalase activity controls further toxic consequences in plants and it can be regarded as an adaptive feature in *Amaranthus*.