CHAPTER IV

SUMMARY AND CONCLUSIONS

Crop production in modern agriculture is threatened by some of the extreme environmental conditions such as high temperature, freezing temperature and drought. Drought condition specifically referred as "physical drought" is developed due to scarcity of water in the environment. Water stress creates number of problems for plants growth and development. It leads to a reduction in hydrostatic pressure, increase in concentration of micromolecules and solutes of low molecular weight and reduction in the chemical potential of plant water. Number of metabolic processes are also influenced. Cell expansion, cell division, cell wall and protein synthesis, activity of several enzymes, stomatal opening and photosynthesis are affected by water stress.

Response of the plants to drought however, varies from plant to plant and species to species. Some of the plants have well developed mechanism to resist water stress and make use of available water efficiently.

Drought resistance covers a range of mechanisms whereby plants withstand soil water deficit. Three primary types of drought resistance have been identified. i) Drought escape, ii) Drought tolerance at high tissue water potential and iii) Drought tolerance at low tissue water potential.

Pulses form an essential part of the Indian diet, and are grown commonly as pure crops, in rotation or mixed with cereals, oilseeds and fibre crops. Pulses are rich in proteins, minerals and Vitamin B. Because they have high energy content, they are particularly well adapted for use in cold weather and also where physical exertion is involved.

Phaseolus aconitifolius is one of the important minor grain legume crops of semi-arid regions. In India it is grown as a hot season crop. It is the most drought resistant of the Kharif pulses and is largely grown on dry, light, sandy soils in the arid and semi-arid regions of the country. It is certain, therefore, that this will be an ideal material for the study to understand the mechanism(s) of drought resistance in plants. We thought worthwhile to investigate the effect of water stress on the physiology of this very important but rather neglected pulse crop.

In the present investigation an attempt has been made to study the effect of water stress on biomass production, some organic constituents and inorganic constituents, some enzyme systems and rate of transpiration and diffusive resistance have been investigated.

The significant findings of the present investigation can be summarised as follows -

1. Water stress has immediate effect on the biomass production by moth bean plants. There is a slight decrease in both fresh as

well as dry weights of almost each plant part upto 7 days water stress. However, fresh as well as dry matter production in all plant parts is severely affected by 15 days water stress. The ratio of biomass produced by shoot to that produced by roots is almost constant in plants water stressed upto 3 days. However, it dramatically increases in plants stressed for 7 days. Therefore, it appears that this plant is able to tolerate drought conditions quite successfully without affecting its biomass production and normal growth upto 7 days in water depleted conditions.

2. The effect of water stress on the osmotic potential of root, stem and leaf of P. aconitifolius indicated that the root tissue has on an average lower values for osmotic potential as compared to those of either stem or leaves. The plant has the ability to maintain the osmotic potential of the tissue in favour of normal absorption of soil nutrient solution upto 7 days water stress. However, the tissue appears to loose its ability to maintain osmotic potential when severely stressed i.e. for 15 days.

3. Reducing sugar content of the root, stem and leaves of moth bean increases during 3 days water stress and then thereafter declines and again increases during 15 days water stress. Total sugar content of the root, stem and leaves increases during two days water stress and then decreases towards 15 days water stress. Starch content of the root and leaves increases

throughout the period of water stress. However, that of the stem decreases linearly with the advancement of the duration of water stress.

From the above findings it appears that moth bean also possesses a moderate drought resistance potential as the sugar contents registered increase when plants are subjected to water stress. Therefore, moth bean utilizes carbohydrates for the osmotic adjustment under adverse conditions of drought.

4. Total nitrogen content increases remarkably in root and leaves but there is a considerable decrease in it in the stem. Probably nitrogen from the stem of water stressed plants is translocated to the other parts of the plant where it may be involved in the synthesis of aminoacids like proline and synthesis of proteins involved in drought resistance mechanism.

5. Proline content of root, stem and leaves is increased linearly with increase in water stress intensity. It appears that P.aconitifolius has remarkable ability to synthesize and accumulate proline after exposure to water stress which can be considered as one of the important adaptive features of the plant to withstand or endure drought conditions.

6. The activity of peroxidase in the root when expressed on both fresh weight as well as protein basis increases remarkably due to water stress. However, in case of leaves it decreases slightly when expressed on the basis of fresh weight

but recorded considerable increase upto 7 days water stress. The activity however, is decreased in the leaves after 15 days water stress. From these findings, it appears that metabolic activities in the plants stressed for more than 7 days are elevated over those in control or well irrigated plants which may be taken as a sign of an adaptation to drought. The root system of the plant seems to play a vital role in this respect.

7. The activity of acid phosphatase in the root and leaves of moth bean is adversely affected towards 15 days water stress. Leaf acid phosphatase, however, seems to be rather sensitive to water deficit. It is found that the activity of this enzyme is maintained in the roots even upto 7 days water stress. This is suggestive of stability of phosphate turnover in the roots exposed to water stress, helping the phosphorus metabolism and hence the other metabolic activities of roots and other plant parts under drought.

8. Total chlorophyll content of the leaves increases linearly with increasing the period of drought. However, it is increased dramatically in the leaves stressed for 15 days. This sudden rise may be due to tremendous and very rapid loss of moisture from the leaves of these plants. It appears that this species has a well developed capacity of retention of chlorophylls or have a very good chlorophyll stability under stress conditions.

9. The polyphenol content of the leaves increases linearly

and remarkably with increasing the duration of drought. This may be due to the enhanced secondary metabolism during drought conditions.

10. The relative humidity at the upper leaf surface is relatively more than that at the lower surface in the plants daily irrigated as well as water stressed for different durations. It can be seen that with the increase in duration of water stress, there is linear increase in the diffusive resistance in the leaves. It appears that the plant has well developed mechanism to check the loss of water when exposed to drought conditions. The increase in diffusive resistance due to drought may affect the process of gaseous exchange and hence the rate of photosynthetic CO_2 assimilation.

11. The sodium and chloride contents in the water stressed moth bean stem and leaves are increased. This may be considered as an adaptive feature during drought.

12. The moth bean plant exposed to water stress shows increased potassium content in stem but in case of leaves it increases upto 3 to 7 days water stress. After 7 days water stress however, it decreases slightly. Potassium is more in vegetative stage, thereafter it slowly decreases with the age of the plant. This indicates that probably stem acts as a buffer for potassium accumulation and its translocation. Water deficit causes the accumulation of potassium in this plant which may be accounted for osmotic adjustment.

13. The calcium content of the stem of moth bean increases during 3 days water stress and then dedlines linearly towards 15 days water stress. However, this divalent cation is accumulated considerably in the leaves of this plant exposed to water stress even upto 7 days. Therefore, it can be said that the calcium uptake by this plant is definitely increased due to water stress. Like potassium, calcium may be involved in drought resistance mechanism in this plant.

14. Phosphorus content of the stem and leaves of moth bean increases during 7 days and then slightly declines towards 15 days stress. Increase in phosphorus content in moth bean indicates stimulation of the metabolic activities of this plant where phosphorus is involved during water stress. This might be an adaptive feature to overcome drought.

15. The magnesium content of stem and leaves increases during three days water stress and thereafter decreases slightly during 7 days stress and again increases towards 15 days stress. Probably magnesium accumulated in the leaves helps in maintaining chlorophylls in the leaves even under drought.

16. The iron content in the stem is increased after 3 days water stress and thereafter there is a linear decrease whereas in the leaves it is increased after 7 days as well as 15 days water stress. The increase in the level of iron, particularly in the leaves seems to be beneficial.

17. The manganese content of the stem and leaves of moth bean increases upto 3 days water stress and then declines towards 15 days water stress.

In conclusion it can be said that there are considerable changes in the pattern of inorganic and organic constituents in different parts of the moth bean plant due to water stress. The metabolism of this plant is also influenced by this environmental factor. The accumulation of proline, soluble sugars and some minerals under water stress are suggestive of adaptive features of P.*aconitifolius*.