Chapter - IV
Summary & Conclusions

The study of halophytes has received a great impetus in last two decades after realization of the ever-increasing problem of soil salinization. In developing and highly populated country like India, the problem of soil salinity has become further acute due to lack of expertize and technologists. In this situation the biological approach appears more rewarding in this contexts. Halophytes have great potential either for direct agricultural use in saline areas or for the incorporation of their characteristics into existing crop species, by whatever means possible. With this view, several marine algae, mangroves and sea-grasses have been studied in our laboratory for last several years. The review of literature on halophytes clearly indicates that considerable research work has been done on various aspects in chenopod and monocotyledonous halophytes. However, the same can not be said about leguminous halophytes, inspite of the fact that family leguminosae is a host of several important food grain crops. The extensive survey of coastal vegetation of India by Rao and Sastry (1974) has indicated that legume climber *D. trifoliata* Lour. is an important component of coastal vegetation.

There are 120 species of *Derris*, of these 23 species are found in India and nine species are endemic. The *Derris* species are highly reputed for their use as fish poison and their insecticidal activities. Several other Derris species have served as green manures, shadetrees, wood sources and source of fodder. The review of literature indicates that very little physiological work has been done on leguminous halophytes in general and Derris species in particular. Hence an attempt has been made to investigate some physiological aspects of D. trifoliata in the present investigation. Alongwith this halophytic Derris species the other Derris species D. scandens growing in the border line vegetation was also included in the present study. The significant findings of the present investigation can be briefly summarized as follows:

1) Habitat analysis :

The plants of D. trifoliata were found to grow around different mangrove species, right in the core of estuarine vegetation. The plants of D. scandens were seen associated with the tree species like Pongamia glabra which occupied the border of the estuarine vegetation. The soil supporting the growth of D. trifoliata were slightly acidic and richer in sodium and chloride while that supporting the growth of D. scandens was slightly alkaline and richer in magnesium and manganese. A luxuriant growth of both the species was evident during rainy season and flowering and pod developments occur in the month of April-May. A marked leaf yellowing (senescence) and leaf shedding was noticeable in the month of February-

March. Similar to other mangrove species the vivipary or Cryptovivipary was not seen in D. trifoliata. Similarly the development of the pneumatophores as observed in other mangroves was not noticed in case of this mangrove associate.

2) Plant analysis :

a) Leaf anatomy :

The leaf anatomy of both species were typically dorsiventral with well developed palisade and spongy parenchyma. The leaflets of D. trifoliata were characterized by thick cuticle on both surfaces, double layer of palisade and less compact spongy parenchyma. In the leaflet of D.scandens the abaxial epidermal cells were papillose and the mesophyll was compact with multilayered palisade cells. The leaves of both Derris species showed the absence of "Kranz" anatomy, a characteristic feature associated with C_4 pathway of photosynthesis.

The stomatal studies revealed that the stomata were restricted to the lower leaf surface and they were of paracytic type. The stomatal Index In D. trifoliata was quite high indicating higher potential of gas exchange.

b) Nodulation studies :

Occurrence of profuse nodulation both below the soil and at ground level on the roots of the Derris trifoliata was noticed mainly during rainy season. The nodules of both the species were spherical, short lived and of determinate nature. The anatomical studies revealed that the nodules possess cortex with patches of vascular tissue and irregular layer of sclerides, central infected tissue and prominent lenticels. The presence of lenticels on nodules can be regarded as an adaptive feature for aeration in coastal swampy habitat and this is in tune with the occurrence of pneumatophores in some other mangrove species. The nodulation ability of D.trifoliata can be considered as an important feature for fixation of nitrogen in the salt dominated coastal ecosystem and this in turn can benefit the accompanying mangrove plants.

c) Inorganic constituents :

The analysis of inorganic constituents revealed that the sodium and chloride levels in different parts of D. trifoliata were quite high as compared to those of D.scandens. It was noticed that both Derris species are able to regulate the sodium accumulation in leaf tissue as sodium levels in the leaf tissue were quite low as compared to other plant parts. However similar trend was not noticed in case of chlorides. Efficient potassium uptake mechanism was clearly noticeable in case of D. trifoliata plants as all the plant parts had considerably higher levels of potassium than those of D. scandens. The efficient potassium uptake mechanism has been regarded as one of the physiological adaptation in plants growing under saline conditions and this feature is clearly seen in D. trifoliata. The calcium levels in different parts of D. trifoliata were lower than those of D.scandens indicating that the calcium uptake in this halophytic legume was rather sensitive to salinity. The young leaves of both the species showed quite high levels of phosphorus which clearly suggest the greater involvement of this element in the metabolic process in the active growing tissue. The leaf tissue of D. trifoliata had higher magnesium content as compared to those of D. scandens. On the other hand, the manganese levels in different plant parts of D. scandens were quite higher. The zinc levels in the foliar tissues of D. trifoliata were quite low indicating a disturbance in zinc translocation under saline conditions. Accumulation of iron in the root and stem tissue was very clearly noticeable in both the species. The cobalt contents in different plant parts did not show much variations. These observations indicate that D. trifoliata is able to maintain a fairly optimum nutrient balance in its major metabolic centres "leaves" eventhough growing under saline conditions. The analysis of inorganic constituents of nodules revealed that as compared to other plant parts they are quite rich in various mineral elements such as sodium, magnesium, iron, zinc and cobalt. It is quite probable that above elements may be playing some role in nitrogen fixation process under saline conditions.

d) Organic constituents :

Although the moisture content in different plant parts of *D. trifoliata* was found to be higher than those of *D. scandens*, development of leaf succulence typical of some halophytes was not noticeable. The analysis of carbohydrate fractions in different plant parts revealed that the starch was a major carbohydrate showing very little variation in different plant parts. The nonreducing sugarswere more prominent than reducing sugars in both the species and considerably high levels of sugars were recorded in the mature leaves indicating probable involvement of these compounds in osmoregulation. The mature leaves of *D.trifoliata* had more total nitrogen content than the root or stem tissue. On the other hand, in *D. scandens* higher levels of total nitrogen were recorded in the root tissue. The analysis of free proline content revealed that the free proline levels in different plant parts (especially leaves) of *D. trifoliata* were quite higher than those of *D.scandens.* Proline, a cyclic amino acid of glutamate family is known to play a key role in stress resistance process in higher plants. Hence the capacity of *D. trifoliata* to accumulate free proline can be regarded as an important metabolic adaptation. The preliminary paper chromatographic analysis revealed that besides proline, the other amino acids like isoleucine, glutamate, cystine, lysine and α-amino butyrate are also prominent in the leaf free amino acid pool. The analysis of organic acid level (as indicated by TAN values) showed that in D. trifoliata the leaves had higher amount of organic acids than other plant parts. On the other hand, the root tissue of D. scandens showed the highest TAN values among different plant parts. The leaf TAN values in case of D. trifoliata were considerably higher than those of D. scandens which indicate possible involvement of organic acids in osmoregulation in D. trifoliata. The chlorophyll contents of both Derris species were found to be relatively higher than those recorded for other mangrove species. The chlorophyll a/b ratio of young leaves in both the species was higher than that of the mature leaves indicating higher photosynthetic efficiency of the young leaves. The total polyphenol content in the stem and leaves of D. scandens was quite high as compared to that of D. trifoliata. Polyphenols are products of secondary metabolism. The low levels of phenolic compounds in D. trifoliata indicate that unlike other mangrove species, the secondary metabolism is not stimulated to a great extent due to soil salinity in this legume.

c) Pod and seed analysis and germination studies :

It was noticed that the winged nature of pods of Derris trifoliata can help in floating on the estuarine water especially during high tide and thus in seed dispersal. The seeds of D. trifoliata were larger in size and with higher seed weight. Potassium was a major cation in seeds and podwall of both _Derris_ species while magnesium and calcium were also present in considerable amounts. Seeds of both _Derris_ species had higher phosphorus level as compared to the pod tissue. The micronutrient status of _D. scandens_ seeds was found to be superior to that of _D. trifoliata_ except iron. It was noticed that the seeds and podwall contained very low levels of sodium, eventhough the plants are exposed to saline conditions.

There was also a difference in the levels of organic constituents in the seeds of two species. The seeds of _D. trifoliata_ were richer in carbohydrates while those of _D. scandens_ were found to be richer in lipids, crude proteins and polyphenols. Thus it is apparent that the seeds of _D. trifoliata_ can be used as source of carbohydrates and crude proteins.

The preliminary germination studies revealed that there are basic difference in the germination behaviour of the two species. A seed dormancy due to hard seed coat was noticed in seeds of _D. scandens_ which was found to be broken by pretreatment of concentrated sulphuric acid for 10 minutes. Such dormancy was not noticeable in _D. trifoliata_ seed and they were found to germinate even when enclosed in pod. It was noticed that under field conditions the multiplication of _D. trifoliata_ was further facilitated by vegetative propagation by formation of adventitious roots along the stem region lying in close vicinity of the soil.

It is evident from the foregoing account that the leguminous halophyte D. trifoliata possess several eco-physiological adaptive features. A more detailed study of these adaptive features will clearly unravel the mechanism of salt tolerance in leguminous species. Such studies will be undertaken in future.