CHAPTER - VI

SUMMARY AND CONCLUSIONS

In the present investigation an attempt has been made to study the physiology of Jatropha curcas L. with reference to germination under saline conditions, salt stress and effect of different forms of nitrogen fertilizers. Some of the significant findings of the investigation have been summarised below.

A. Germination under Saline Condition :

Germination of seed is an important phase in the life cycle of a plant. At this stage, the dormancy is terminated and the emergence of radical and later on the plumule is seen. In the present investigation the effect of NaCl salinity on Jatropha curcas L. at germination level with reference to germination percentage moisture percentage, dry matter content, organic and inorganic constituent has been studied.

The results of germination percentage have been statistically analysed. From the statistical analysis of germination percentage it is evident that Jatropha curcas L. is salt sensitive. At lower salinity (0.1 M NaCl) level germination is delayed while at higher salinity it is completely inhibited. The moistsure percentage in seedlings of J.curcas L.after 14 days was recorded. Moisture percentage was inhibited by NaCl salinity.

During the process of germination organic matter is used up in oxidation. This process takes place by series of chemical reaction which are catalysed by enzymes such reactions are influenced by presence of salt in their tissues. Obviously the process of germination also gets inhibited. Our study indicate that whenever the values of dry matter are more in salinity treatments, the germination is reduced. Thus there is a negative correlation between moisture percentage and dry matter content. In J.curcas.L. the inhibition in oxidation of dry matter and germination takes place in all treatments indicating that it is salt sensitive plant.

The study of organic constituent during germination of seeds is very important as they supply energy to the developing embryo. Hence the organic constituent of J.curcas L. seeds as well as their utilisation during germination under normal and salt stsressed conditions have been studied. The results indicate that there is a inhibition in hydrolysis of starch in all NaCl treatments. It reveals that J.curcas L. is sensitive to chloride salinity.

TAN values of seedlings decrease with increasing NaCl concentration. These results indicate that there may be inhibition in the synthesis of organic acids in NaCl salinity. In NaCl treated seedlings there is a inhibition in protein syntheis at all salinity levels. Lipids form the major fraction of organic constituents in oil yielding seeds. From our values of lipids in NaCl seedlings it can be said that the degradation of lipids during germination of seeds is inhibited in NaCl salinity. This may be due to inhibitory effect of Na^+ and Cl^- ions on enzyme systems like lipases which are responsible for utilisation of lipids and lipid derivatives in the process of germination.

An increase in proline content due to salt stress is observed in seedlings of Jatropha curcas L. which can be one of the adaptive feature towards salinity tolerance.

The results of inorganic constients of germinating seeds under NaCl salinity reveal that in Jatropha curcas L. potassium uptake is considerably inhibited in all NaCl treatments. This inhibition of K uptake at all levels of salinity clearly indicates that it is a salt sensitive plant. The sodium contents in J.curcas L. seedlings increases with increasing concentrations of NaCl in the medium. At higher concentrations (0.1 M NaCl) the Na uptake is more which may inhibit the metabolic activities of cell resulting in retardation of the process of germination and seedling development. The calcium uptake is hampered by NaCl. It is interesting to record that in J. curcas L. Mg accumultion is stimulated by increasing NaCl concentration which can be one of the adaptive feature towards salinity tolerance.

The accumulation of chloride in J. curcas L. takes place chloride content increases in seedling by increasing NaCl salinity. This indicate that possibly chloride may play some role in osmoregulation. Phosphorus content decreases by increasing NaCl salinity. Fe content decreases in seedlings treated by NaCl salinity.

Thus, our study indicate that J. curcas L. is a salt sensitive at germination level under NaCl salinity and thus unsuitable for cultivation under saline conditions.

B. Salt Stress :

Salinity is one of the adverse factor limiting crop production in arid and semi-arid regions. To utilise soil salinity affected areas, there are two methods. Either the soil salinity must be reclaimed or minised by engineering techniques or through bioligical approach, in which salt tolerant crop cultivars are identified or breed for the salt tolerance. Such species can be successful grown in problem soil. The biological approach seems to be particable in Indian conditions.

Keeping this view in mind, in the present investigation an attempt is made to study the influence of NaCl salinity on some physiological aspects on J. curcas L. The effect of various concentrations of NaCl salinity on growth, organic and inorganic constituents have been investigated. Some of the significant findings of the present investigation are listed as below.

The height of a plant in *J. curcas* L. decreases as the salinity level in the growth medium increases. Similarly the root length of the plants decreases with increasing NaCl salinity. Average number of leaves per plant decreases with increasing salinity level. As the NaCl concentration in the medium increases the leaf thickness and moisture content in the leaves increases. This increase can be attributed to the succulence of leaves in NaCl treated plants. In stem the moisture content increase with increasing NaCl concentration. In roots moistusre percentage increases at lower NaCl salinity while it decrease at higher NaCl salinity.

The chlorophyll synthesis in the leaves of *J. curcas* L. is stimulated upto 0.01 M NaCl concentration. However in higher concentrations there is retardation in chlorophyll synthesis. These results indicate that the salinity affects the photosynthetic activities. The values of TAN in leaves of *J. curcas* L. decreases at all NaCl salinity levels. In stem TAN values is more in lower NaCl salinity (0.01 M) while it decreases at higher NaCl salinity. In root TAN values are more upto 0.15 M NaCl salinity while it decreases later on. From these observations it is clear that higher NaCl concentrations have inhibitory effect on accumulation of organic acids.

The carbohydrate metabolism in leaves and stem is stimulated at lower salinity, while at higher salinity it is inhibited. In roots carbohydrates metabolism is inhibited in all salinity treatments. Increase in total nitrogen content at lower salinity is seen in leaves, stem and roots of J.curcas L. while at higher NaCl salinity it decreases. The leaves of treated plants are rich in polyphenols as compared to stem and roots. The polyphenol content of leaves, stem and roots increases with increase in NaCl concentration in the growth medium. It suggests that salinity stimulates the synthesis of secondary metabolism in all plant parts.

An increase in proline content due to salt stress is observed in J. curcas L. Accumulation of proline in plant parts (more in stem) is quite significant, appears to be an adaptive feature towards salinity tolerance.

On the basis of potassium values, it is observed that the uptake of potassium in all parts of J. curcas L. is inhibited at all NaCl salinity levels. Na as well as Cl accumulate markedly in all parts of plant when grown in salinised conditions. However, Na and Cl seem to be accumulated more in leaves. This indicates the differential uptake and distribution of these tow ions. The accumulation of Cl possibly may play some important role in osmoregulation. However, the high uptake of chloride influence many physiological reactions in the tissues which may ultimately show inhibitory effects on growth and development. The calium content in all plant parts of J. curcas L.decreases at higher NaCl salinity. In stem and roots accumulation of Ca slightly stimulates at lower salinity (0.01 M NaCl). The low calcium content in the tissues of the plant grown under higher NaCl salinity can be attributed to high Na content of the medium which may depress calcium absorption.

Magnesium uptake is stimulated in leaves at lower NaCl salinity, while in leaves, stem and roots it is inhibited at higher salinity level. Magnesium content decreases appreciably due to chloride salinity. Uptake of iron is stimulated in all plant parts of J. curcas L. under NaCl salinity. It is accumulated more in leaves. It is likely that accumulated iron particularly at the higher salinity levels, may be toxic causing impairment of metabolic activities culminating in retardation of growth. Uptake of phosphorus stimulated in all plant parts of J. curcas L. under NaCl salinity, it accumulates more in leaves.

Thus, our results on the effect of various concentrations of chloride salinity on J. curcas L. indicate that it is most sensitive plant and unsuitable for cultivation under salt stress conditions.

C. Effect of Different Forms of Nitrogen Fertilizers:

Nitrogen occupies an unique position among the nutrient elements essential for plant growth. There are three groups of synthetic nitrogenous fertilizers depending upon the form in which nitrogen occurs, (i) nitrate fertilizers which supply NO_3^- ion, (ii) ammonium fertilizers which supply NH_4^+ ions and (iii) amides (urea) which contain nitrogen in NH_2 form. In the present investigation the effect of three different forms of nitrogen on growth and development of J. curcas L. has been studied. The three forms of nitrogen selected for the study are (i) nitrates, (ii) ammonium and (iii) amide (urea). These were supplied to Jatropha curcas plants through soil in (10 gm nitrogen) two doese and effect on growth, development, organic and inorganic constituents have been studied.

The results indicate that in J.curcas L. the ammonium (ammonium sulphate) form of nitrogen is more favourable for shoot development than nitrate and amide forms. The control plant of this plant show less growth of shoot. The average number of leaves per plant in nitrogen treated plants are more than those in control plants. Average number of leaves per plant is more in ammonium (ammonium sulphate) treated plants.

Nitrogen treatment shows a stimulation in the uptake of water. In stem moisture percentage is more. In leaves and stem uptake and accumulation of water is stimulated in ammonium sulphate treated plants while in roots it is stimulated by urea treatment.

Chorophyll synthesis is stimulated in leaves of the plants which are treated by nitrogen fertilizers. Total chlorophyll content is more in the leaves which are treated by calcium nitrate. It is followed by ammonium sulphate and urea. In control as well as treated plants the leaves show higher TAN values. The values of TAN are more in all nitrogen treated plant parts than that of control parts. Amongst the three different nitrogen forms supplied ammonium sulphate shows maximum stimulation of organic acid metabolism in leaves.

The carbohydrate content in *J. curcas* L. increases in nitrogen fertilizer treated plants. Amongst the different sources of nitrogen fertilizers studied, nitrate (calcium nitrate) form of nitrogen maximum stimulation of carbohydrate syntheis is followed by ammonium sulphate and urea. The study of nitrogen metabolism in plants treated with various forms of nitrogen is important. In *J. curcas* L. the leaves show the maximum values of nitrogen content in both treated and untreated plants. The uptake of nitrogen increases with the application of nitrogen fertilizers. Urea appears to be more efficient source of nitrogen in leaves, roots, it is followed by calcium nitrate and ammonium sulphate.

Proline and polyphenol contents are more in all plant parts in control plants (except proline in root, here it accumulates in root treated urea).

Nitrogen when supplied as a fertilizer not only controls the nitrogen uptake but influences uptake of other mineral elements also. Hence the effect of different forms of nitrogen fertilizers on uptake and accumulation of sodium, potassium, calcium, magnesium, phosphorus, iron and chloride has been studied. Our results reveal that in *J.curcas* L., in stem potassium accumulates in large amount than leaves and roots. On the basis of potassium values in different parts of *Jatropha curcas* L., we can say that due to application of nitrogen fertilizers potassium uptake is stimulated. Amongst the different forms of nitrogen fertilizers the application of urea shows more stimulation of average potassium uptake.

Sodium accumulation in leaves takes place in the plants treated by calcium nitrate. In other plant parts sodium content decreases in nitrogen fertilizer treatment.

In all plant parts the uptake of calcium is stimulated in nitrogen fertilizer treatment. Calcium accumulation is higher in the plants treated by ammonium sulphate. It is followed by urea and calcium nitrate. Amongst the various treatments of nitrogen fertilizers, accumulation of magnesium is stimulated in leaves, stem and roots by urea, calcium nitrate and ammonium sulphate respectively.

In Jatropha curcas L. accumulation of phosphorus is stimulated by nitrogen fertilizers. Phosphorus uptake in leaves and stem is maximum in urea treated plants. Chloride content is less in leaves of Jatropha curcas L. which are treated by nitgrogen fertilizers. Its uptake is stimulated in stem which are treated by ammonium sulphate and urea while in roots it accumulates in urea treated plants.

Iron uptake and accumulation is more in nitrogen fertilizer treated plants. Iron accumulation is maximum in leaves.

Thus our study indicate that source of nitrogen as an appreciable influence on uptake and accumulation of different salts, these in turn modify metabolism in plants on the whole it appears that ammonium sulphate stimulate vegetative growth in Jatropha curcas L.