Chapter-6

SUMMARY AND CONCLUSIONS

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Oil seeds are oldest product of the earth & they play an important role in human welfare.

The yield of important oil crops like peanut (**Arachis hypogea**) is gradually deteriorating in recent years to cope up the demands, it is essential to promote the production of oil seeds like safflower (**Carthamus tinctorius** Linn.), as additional oil yielding plant in the areas where rainfall is comparatively low.

Saflower has been grown in India since time immemorial. In past it was grown for a source of dye for clothing and food. The leaves of young plants are also being used as a vegetable. In recent years, Safflower is now grown mainly for edible oil. It has attracted the attention of many agricultural scientists and considerable data have been accumulated in recent years. However, comparatively little work has been done in India on physiology of this plant. In present investigatigation an attempt has been made to study the physiology of **Carthamus tinctorius.**, with reference to germination under saline condition, salt stress and water stress. In this study a promising safflower variety **Bhima** has been selected.

Some of the significant findings of the investigation can be listed as follows:-

(A) Germination under saline condition :-

Seed germination is an important phase in lifecycle of plants. In crop production the germination and seedling establishment are important factors. In present investigation an attempt has been made to study effect of NaCl salinity on Carthamus tinctorius variety Bhima, at germination level, with reference to germination percentage, height of shoot & root length, organic and inorganic constituents.

The results of germination percentage and seedling growth has been statistically analysed. From the statistical analysis of germination percentage it is evident that variety Bhima is sensitive at higher NaCl concentration (0.1 M, 0.15 M & 0.2 M NaCl treatments). Germination percentage is not al all affected by NaCl salinity upto 0.05 M NaCl treatment. At 0.10 M, 0.15 M & 0.2 M NaCl treatment drastically reduced the germination percentage.

Height of shoot and length of root in seedlings of Carthamus tinctorius variety Bhima decreases with in NaCl concentration from 0.01 M to 0.05 M, 0.1 M, 0.15 M & 0.2 M NaCl. At 0.01 M & 0.05 M Nacl treatment height of shoot & root length slightly decreases but at higher salinity level it is highly reduced.

Moisture percentage, and TAN decreases with increasing NaCl salinity. Salinity found to be exert a profound influence

of on carbohydrate metabolism during seed germination. At 0.01 M NaCl treatment starch & total carbohydrates decreases. Similarly reducing and total sugars also decline with under NaCl treatments. Total nitrogen and crude protein content in seedling increases at lower concentration of NaCl. At higher salinity level it decreases with increasing NaCl treatments.

Lipids form the major fraction of organic constituents in oil yielding seeds. From our values of lipids in NaCl treated seedlings it can be said that, total lipids are not degradated during germination under saline condition. At higher concentration of NaCl there is a inhibition in degradation of lipids. This may be due to inhibitory effect of Na^+ or Cl^- ions on enzyme system like lipases which are responsible for utilisation of lipids and lipid derivatives in the process of germination. Therefore lipids are not hydrolysed into glycerol and fatty acids & ultimatly carbohydrate leve may be decline in seedlings during germination.

Phenolic compounds are increases with increasing NaCl salinity level. It may inhibit the enzyme activity in other physiological reactions which involved during germination and seedling growth. Proline accumulation takes place in seedling under saline condition upto 0.15 M NaCl treatment. While at 0.2 M NaCl treatment proline level slightly decline.

The results of inorganic constituents of seedlings reveal that Sodium contents increased with increasing NaCl treatment, which may be inhibit the metabolic activities of cell resulting in retardation of process of germination and early seedling developmental stages. Potassium, calcium & magnessium contents increases with increasing salinity level. Mg^{2+} level at 0.2 M NaCl treatment slightly decreases. NaCl salinity causes the uptake of Phosphorus content. Phosphorus level during salt stress more or less decreases as compared to control seedlings.

Iron contents in seedling decreases with increasing NaCl treatment. However, chloride uptake is more under saline condition. The chloride concentration in seedling is more or less proportional to that of environment.

Thus our studies clearly indicate that **Carthamus tinctorius** variety **Bhima** is a sensitive at germination level under NaCl salinity.

(B) **Salt Stress** :-

Salinity affects many aspects of the plant metabolism and induces the changes in their anatomy as well as morphology. These changes are often considered to be adaptations which increase the changes of the plant to endure the stress imposed on them by salinity. Salinity influences several metabolic activities like mineral nutrition, nitrogen metabolism, photosynthesis etc.

Salinity problem arises mainly due to excessive presence of chloride, sulphate and carbonate salts of sodium and magnesium In India, about 12 million hectares of land has been affected by salinity & alkalinity. (Sharma and Gupta, 1986). Soil salinity must be minimized by engineering techniques or through biological approach, in which the salt tolerant crop cultivars are identified or breed. For the salt tolerance. Such species can be successfully grown in problem soils. The biological approach seems to be practicable in Indian conditions.

Keeping this view in mind, in the present investigation an attempt was made to study the influence of NaCl salinity on **Carthamus tinctorius** variety **Bhima**. The effect of various concentrations of Nacl on growth, organic constituent and inorganic constituents have been investigated, and their results are sumerised as follows:-

1) The height of shoot and root length of **Carthamus tinctorius** decreases with increasing NaCl treatments. Average number of leaves/plant, Average leaf area decreases with increasing concentration of NaCl. However as the NaCl salinity in the environment increases the leaf thickness, and moisture percentage in leaves, stem also increases with increasing NaCl treatment. This increase of leaf, leaf thickness can be attributed to the succulence of leaves in NaCl treated plant.

(2) The values of TAN in leaves of C. tinctorius variety Bhima more in NaCl treated plant. TAN values in leaves & stem increases with increasing NaCl salinity. While TAN values in root of 0.01 M, 0.05 M & 0.1 M NaCl treated plant decreases. At 0.15 M NaCl treatment TAN values slightly increases and again decreases at 0.2 M NaCl treatment as compared to control roots.

(3) Total chlorophyll contents of leaves decreases with increasing NaCl treatment. Chlorophyll 'a' also decreases with increasing NaCl salinity. At 0.15 M NaCl treatment chlorophyll 'b' contents slightly increases but less than control leaves. Chlorophyll a:b ratio increases at 0.05 M & 0.1 M NaCl treatment. At 0.15 M NaCl treatment again Chloro a:b ratio decreases. While at 0.2 M NaCl treatment this ratio is hightly increases as compared to 0.15 M NaCl treated leaves. But this ratio is less than that of control leaves.

(4) As far as carbohydrate contents are concerned, the salinity in the environment. The carbohydrate metabolism gets much disturbed in Carthamus tinctorius variety Bhima, It is observed that as NaCl concentration increases their is decreases in the starch & total carbohydrate contents in leaves, stem & root of NaCl treated plants. At lower NaCl treatment carbohydrate metabolism is not much affected but at higher NaCl treatment starch as well as carbohydrates much affected due to salinity.

(5) An increase in nitrogen & crude protein contents in leaves upto 0.1 M NaCl treatment with increasing salinity level is observed. While at 0.15 M & 0.2 M NaCl treatment total nitrogen & crude protein contents inleaves slightly decreases but these value an more than that of control leaves. Similar situation is observed in lcase of stem & root of treated plants.

(6) Polyphenols & proline content in leaves stem & root increases with increasing NaCl salinity. this proline & polyphenolic compounds are more accumulated in leaves of treated plants.

Accumulation of polyphenols in the various part of **Carthamus tinctorius** variety **Bhima**, indicate that NaCl salinity induces the secondary metabolic conent. Which may be related to salt tolerant capacity. Due to NaCl treatment proline is accumulated and it is adaptive feature of this plant to adverse effect of salinity.

(7) The response of plant to various levels of salinity is ultimately due to uptake and accumulation of various inorganic salts which influence the metabolism to a great extent. Hence NaCl treated plants of **Carthamus tinctorius** variety **Bhima** were analysed for some inorganic salts.

Na^{+} seems to remain accumulated in stem & root under higher salinity level. The plant is probably unable to regulate it's uptake and translocation causing disturbance in metabolic activities of the plant. this may be altimatly leads to reduced growth of plant. When these plants are exposed to NaCl salinity K^{+} level increases in leaves & stem. Similarly C^{++} contents are also increases with increasing NaCl treatments. At 0.1 M NaCltreatment Mg^{2+} content increases while at 0.2 M NaCl treatment Mg^{2+} level in leaves decreases. Under saline condition phosphorus is more accumulated in leaves & stem. Accumulation of Fe^{3+}, partcularly at higher NaCl salinity levels, may be toxic, causing impairment of metabolic activities culmining in retardation of growth. Chloride accumulation take place more in leaves than stem & root of NaCl treated plants. This indicate that possibly chlorides may play some role in osmoregulation.

(8) Effect of various concentration of NaCl salinity on Carthamus tinctorius variety Bhima, studied & it is observed that due to NaCl salinity, there is delay in flowering. No. of inflorescence, total no. of seeds & seed weight decreases with increasing NaCl treatment. This indicate that NaCl salinity causes reduction in yield of Carthamus tinctorius, variety Bhima.

(C) **Water stress** :-

Crop production in modern agriculture threatened by some of the extreme environmental conditions such as high tempt, freezing tempt. & drought. Drought condition specifically referred as 'Physical drought; is developed due to scarcity of water in environment. Water stress affects on plant growth & development. Response of the plants to drought however, varies from plant to plant & species to species. Some of the plants have well developed mechanism to resist water stress make use of available water efficiently.

In the present investigation an attampt has been made to study the effect of water stress on plant growth, organic & inorganic constituents of **Carthamus tinctorius**, variety **Bhima**. The significant findings of this water stress treatment can be summerised as follows :-

(1) The shoot height & root length decreases with increasing water stress treatment. The No. of leaves per plant, average leaf area also decreases with increasing water deficit condition. Leaf thickness often increases with increasing water stress treatment. Moisture content in leaves stem & root of **Carthamus tinctorius** variety **Bhima** decreases due to water stress treatment.

(2) Total chlorophyll contents, chlorophyll a:b ratio decreases with increasing water stresstreatment. Thus on the basis of chlorophyll synthesis under water stress tratment

Carthamus tinctorius variety Bhima, may be drought sensitive in nature. TAN values are decreases in leaves & stem, while TAN increases in root with increasing water stress treatment.

(3) The carbohydrate metabolism is disterbed during water stress condition. Starch & totalcarbohydrate contents during water stress treatment decreases. However in 6-days water stress treatment carbohydrate contents are slightly increases in stem, but it more than control stem. When plants are exposed to water stress nitrogen level in leaves decrease. It appears that probably nitrogen from leaves translocated to the other part of plant where, it may be involved in the synthesis of amino acids like proline, During water stress treatment protein contents are more accumulated in stem of water stressed plants. While protein level decline in root due to water stress treatment.

(4) Polyphenol contents are increase during water deficit condition. Increase in phenolic content is more pronounced in leaf tissues & stem than root. This may be due to the enhanced secondary metabolism during drought condition.

(5) Carthamus Tinctorius variety Bhima has remarkable ability to synthesize & accumulate proline during water stress treatment, which can be considered as one of the important adaptive features of plant to withstand or endure drought conditions.

The sodium and chloride contents in the water stressed safflower stem & leaves are increased. This may be an adaptive feature during drought.

Potassium level decreases due to water stress treatment. In 8-days water stressed plant K^+ level slightly increases. This indicate that K^+ translocation is affected due to drought condition.

Calcium content in leaves increases in 2 & 4 day water stress treatment. When plants are exposed to higher water stress Ca^{2+} level in leaves decline. Ca^{2+} is more accumulated in stem of 2-days water stressed stem of plant. When plants are subjected to 6-days water stress treatment Ca^{2+} is more accumulated in root. This situation indicate that Ca^{2+} uptake is mostly disturbed due to water deficit condition. Mg^{++} level decreased in leaves while increased in stem with increasing water stress treatment. Increase in phosphorus content during water stress treatment indicates less disturbances in metabolic activities of this plant where phosphorus is involved during water stress. This might be an adaptive feature to overcome drought. Fe^{3+} contents increases during water stress treatment.

In conclusion it can be said that NaCl seems to be more toxic to plant growth. Salinity affects the seedling growth & thereare considerable changes in organic as well as inorganic constituents during germination under saline condition.

Salinity also affects on pattern of inorganic and organic & constituents & yield of Carthamus tinctorius variety **Bhima** under NaCl treatment. Similarly under water stress condition growth of this variety is also affected. Change in organic & inorganic constituents takes place under water deficit condition.

Accumulation of proline under salt stress & water stress condition is suggestive feature of Carthamus tinctorius variety **Bhima**.

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