SUMMARY
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Soil salinity is an ever alarming world-wide problem in general and for Indian agriculture in particular. Saline habitats are characterised by an excess of inorganic salts and their accumulation in the upper layer of the soil, which have disadvantageous consequences on plant life. The most common adverse responses under saline stress are the various depleted physio-biochemical aspects of plants including the numerous changes induced by salinity in the plant morphology. These changes may help the plants to check the stress imposed by salinity and disrupt the normal equilibrium of the life processes. Salinity is probably the major factor determining the characteristics of the habitat.

The magnitude of salinity effect varies with the plant species and types. The plant species growing in an area may provide useful information regarding the degree of salinisation and soil deterioration. Such information may help in the effective planning of practical uses of waste lands.

Salinity plays an important role in maintaining the vegetation cover and distribution of plants on the soil. The reponse of salt stress in plants may be divided into three categories: (i) a reduction in the osmotic potential of the soil solution that reduces the availability of water to root system; (ii) a deterioration in the physical structure of the soil that decreases the permeability of plants cells to water and gases; (iii) specific ion toxicity which would be responsible for hindering the normal development of plants.

The various climatic factors like rainfall, temperature, wind direction and velocity etc., play a key role in the formation of saline soils. Rainfall has more
effect than temperature in determining the soil salinity because high evaporation rate of water from the soil surface leaves more accumulation of salts in the soils.

On saline soil, plants can survive by adapting increased drought tolerance and water use efficiency. Such plants may have a number of modifications in their structures and functions like osmotic adjustment, smaller cell volume, thick cuticle or waxy layers on epidermis, reduced leaf area, increase in leaf thickness, hairy leaves, salt glands on the leaf, increase root-shoot ratio, stomatal responses and changes in the enzymes and hormone production and their activity.

The genus *Curcuma* belongs to the family Zingiberaceae, is a native of South East Asia, containing about 50 species. India is by far the largest producer of turmeric in the world, about one-third of the total production of turmeric in India comes from Andhra Pradesh alone.

Turmeric (*Curcuma longa* L.) is a herbaceous perennial plant with a thick underground rhizome giving rise to short blunt daughter rhizomes called fingers, the leaves are broadly lanceolate with long leaf stalk and are borne in a tuff. The flowers are borne on a separate peduncle arising directly from the rhizome.

The rhizome is used as a condiment, dyestuff, in cosmetic preparation and also in medicines since time immemorial. Turmeric contains essential oil whose main content is curcumin. Besides oil, turmeric also has protein, fat, mineral matter, fibre, carbohydrate and carotene as a vitamin A.
Curcuma longa L. is not found in wild condition. The plant is also commonly cultivated in the hills and plain areas of Manipur with progressive increase in terms of area and yield. The turmeric crop needs a hot moist climate, a good supply of water and a well drained soil. It thrives on only loamy or alluvial soil; the soil must be loose and friable. Heavy clay or clay or stony soils are unsuitable for the development of the turmeric rhizomes. Red loamy soils which are rich in organic matter, having natural drainage are ideal for the cultivation of turmeric. Normal water is essential for the growth of the crop. In tracts with heavy rainfall, it is grown as a rainfed crop. Turmeric is also grown under irrigated conditions. However, the crop is highly sensitive to ill-drained and alkaline conditions. The turmeric can be propogated from seeds, but the common method of propagation is through rhizomes.

The plant thrives well with a light partial shade; however, much shade adversely affects the yield. When the plants mature, the lower leaves start to turn yellow and droop down. The crop generally mature within nine to ten months after planting.

The application of IAA (Indole Acetic Acid) under different salt stress favours rhizome initiation and ultimately increases crop yield. Phenol, one of the secondary plant metabolites has a significant effect on plant growth when applied at physiological conditions by acting as an alogue of growth hormone. Phenols are known to facilitate oxidation of IAA and lignification of cells.

The objective of the present work is to investigate the effect of growth regulators like IAA and P on sprouting, early seedling growth and yield in turmeric (Curcuma longa L.) under saline conditions. Experimental attempts have also
been made to evaluate the effects of IAA and P on sprouting rate of rhizome, plant
dependence, number of roots and their length, biomass, leaf area, leaf area index, leaf
area duration photosynthetic pigments, metabolites like carbohydrates, protein and
amino acids including curcumin and yield under saline stress conditions. The
experiments are conducted on turmeric at normal temperature in close room
getting diffuse sunlight by using artificial pot sand culture method at 100 ppm
concentration of IAA and Phenol under EC-0, 4, 8, 12 and 16 mmhos/cm salinity
of two sodium salts, viz., NaCl and Na₂SO₄. The control and treated rhizomes are
subjected separately to polythene bags of uniform size (30 x 20 cm²) at the rate of
three rhizomes per bag. Each bag is filled with 2.5 kg of dry sandy soil collected
from river bank. A pH of 7.0 is maintained for the experimental soil. Prior to
plantation of seedlings the soils are uniformly fertilized with murate of potash and
urea (1:1). The average amount of fertilizer in each pot is 19.60 g. The control and
the treatment plants are arranged in a randomized block design method. After
plantation, the control block of the experiment is sprayed with rain water whereas
treatment blocks are subjected to various concentrations of salinity levels of NaCl
and Na₂SO₄. Two hundred fifty (250) cc of rain water is added to the control and
treatment blocks at the gap of 15 days from the date of showing. However, the first
dose of NaCl and Na₂SO₄ salinity are added at the time of showing and the
subsequent does are re-added at 90 and 180 days from the date of showing.

After completion of 45 days only one seedling is maintained for every
polythene bag to study the parameters of present investigations. Statistical analysis
and representation of experimental data are also discussed.

The rate of sprouting is noticed optimum in the rhizomes treated with
100 ppm concentration of IAA and Phenol under 8 mmhos/cm salinity of NaCl and
The minimum rate of sprouting is recorded under 16 EC of sodium salts at equal concentrations of IAA and Phenol.

Salinity causes a considerable decrease in the growth of turmeric in terms of Plant Height (PH), Root Length (RL), Number of Leaves (NL), Number of Roots (NR), Biomass (B), Leaf Area (LA), Leaf Area Index (LAI), Photosynthetic pigments (PP), Metabolites like Proteins (PR), Amino Acids (AA), Total Available Carbohydrates (TAC), Total Soluble Sugars (TSS) and Total non-soluble sugars (TNSS) in the leaves, curcumin in the rhizomes and total Fresh Yield (FY).

Plant Height (PH) is favourable in 8 mmhos/cm salinity stress conditions of NaCl and Na₂SO₄ but the root length shows an increasing trend upto 12 mmhos/cm level of both NaCl and Na₂SO₄ and declined thereafter. The rate of root and shoot elongation is noticed higher in IAA treated rhizomes than that of rhizomes treated with Phenol.

One hundred ppm concentration of IAA and Phenol has variable influence on the NR under 0 mmhos/cm salinity of NaCl and Na₂SO₄. The optimum NR is observed in IAA treated rhizomes against that of the rhizomes treated with Phenol. It is found favourable in 12 mmhos/cm salinity of NaCl and Na₂SO₄ at 100 ppm concentration of IAA and Phenol for thin as well as for tuberous adventitious roots and decline thereafter because the soluble salts at higher salinity levels have become sufficient to suppress the growth of root.

Biomass (B) and moisture contents are decreased by increasing the salinity levels of NaCl and Na₂SO₄. The turmeric plants which are treated with 100 ppm of IAA have more moisture content that than of the plants treated with the
same concentration of Phenol. The higher dry weight is noticed under 4 mmhos/cm salinity of NaCl and Na₂SO₄ in 100 ppm of IAA, however, at the same concentration of P the dry weight is recorded higher at 8 mmhos/cm of NaCl and Na₂SO₄ thereafter it decreases.

The Number of Leaves (NL) is noticed more or less constant in all the treatments including control. However, in the present investigation, the values of LA and LAI are found optimum at 100 ppm concentration of IAA and Phenol under EC-12 mmhos/cm of NaCl and Na₂SO₄. The least values of LA and LAI are recorded at 16 mmhos/cm salinity level of NaCl and Na₂SO₄ under the interaction of IAA and Phenol. The growth regulators viz., IAA and Phenol at EC 0 mmhos/cm of NaCl and Na₂SO₄ have differential effect on LA and LAI. The effect of Phenol is noticed more significant than IAA for LA and LAI under salinity stress of Na₂SO₄ at different levels of its EC. The reduction of LA and LAI under different levels of NaCl and Na₂SO₄ salinity with the interaction of IAA and Phenol are found statistically insignificant. The increase in salinity level progressively causes reduction in the production of leaves. NL, LA and LAI. However, gradual reduction with the increase in salinity clearly shows that the plant growth rather than the production of new leaves is found to be affected by salinity. The decrease in LA and LAI thus reduces the production of photosynthates and thereby total plant dry matter.

Photosynthetic Pigments (PP) parameters like total chlorophyll (TC), Chlorophyll-a (Chl-a), Chlorophyll-b (Chl-b), Chl-a/Chl-b ratio and carotenoides (C) are found to be decreased with the increase of NaCl and Na₂SO₄ salinity levels. The TC, Chl-a and Chl-b are optimum under EC-4 mmhos/cm of NaCl and Na₂SO₄ at 100 ppm concentration of IAA and Phenol. However, these three
parameters are depleted subsequently. The Chl-a/Chl-b ratio is found maximum in EC-4 mmhos/cm of NaCl and in 8 mmhos/cm of Na₂SO₄ salinity stress respectively. Carotenoides shows an increasing trend up to EC-8 mmhos/cm at NaCl and 12 mmhos/cm salinity of Na₂SO₄. IAA and Phenol have differential effect on PP under 0 mmhos/cm salinity of NaCl and Na₂SO₄. Turmeric leaf has sufficient Chl-a and Chl-b contents. Both Chl-a and Chl-b and their ratio decrease with the increase of salinity levels. The accumulation of salts in leaves causes a decrease in photosynthetic pigments specially when the chloride ions predominant in the soil. The Chlorophyllase activity may also increase under stress conditions. The effect of salinity is visualised during experimentation through yellowing of leaves and stunted growth of seedlings in the early stages of development. A negative correlation between TC and Chl-a/Chl-b ratio is observed which indicates that as TC decreases under high stress of NaCl and Na₂SO₄ salinity, the Chl-a/Chl-b ratio also decreases. The TC and Chl-b suffers variably more at different salinity stress of NaCl and Na₂SO₄.

The response of the treatments on turmeric ss also observed by analysing various metabolites viz., PR, AA, TAC, TSS and TNSS of leaf samples at various time intervals after plantation. Whereas, PR, AA, TAC, TSS and TNSS are found optimum under EC-4 mmhos/cm of NaCl and Na₂SO₄. These metabolites, however, are in a decreasing trend thereafter. The minimum content of metabolites is noticed in 16 mmhos/cm salinity of NaCl and Na₂SO₄ respectively. The decrease in the protein synthesis may be due to decrease availability of AA and denaturation of enzymes involved in the synthesis of PR and AA under saline stress conditions. Among the treatments, 100 ppm of IAA under 4 mmhos cm of NaCl is the best favourable combination at salinity stress conditions. Salinity stress has influenced
in the depletion of protein content of the crop. The decrease in the protein synthesis may be due to the decrease availability of AA and denaturation of enzymes involved in the synthesis of AA and PR under saline stress conditions. In the present investigation the decrease in the PR content may be due to its poor synthesis rather than hydrolysis, because, the contents of AA also decreases under saline stress condition. The decline level of AA in turmeric leaves under saline conditions is due to their transport to other organs and to incorporate in protein synthesis.

The decline trend in TAC, TSS and TNSS contents of turmeric leaves with the increase of NaCl and Na₂SO₄ salts at equal concentrations of IAA and Phenol may be because the metabolic activities are high during the development stages and carbohydrates are used as a source of energy. The level of carbohydrates are thereby found to be decreased with the advancement in the age of crop. The translocation of TAC under salt stress conditions from the leaves to sink may be less in comparison with control and other treatments.

The performance of growth hormones under different salinity levels of NaCl and Na₂SO₄ respectively in regard to curcumin content is also discussed and found that curcumin content in the turmeric rhizomes depletes as the salinity stress of sodium salts increase under equal concentrations of IAA and Phenol.

There is an apparent reduction in the total fresh yield (FY) of turmeric at all the salinity levels of NaCl and Na₂SO₄ under 100 ppm of IAA and Phenol. The reduction in the yield is found directly proportional to the increase in salinity levels. The yield is poor under 100 ppm of IAA at 0 mmhos cm salinity of both the salts than that of Phenol under the same concentration. The maximum yield is