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EFFECT OF GROWTH REGULANTS ON SOME METABOLITES OF TURMERIC (*CURCUMA LONGA* LINN.) LEAVES UNDER SALINE CONDITIONS

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An artificial pot-sand culture experiment of Turmeric (*Curcuma longa* Linn.) was undertaken with the application of Indole Acetic Acid (IAA) and Phenol (P) under varied salinity stress conditions of sodium salts like-Sodium chloride (NaCl) and Sodium sulphate (Na_2SO_4). The response of the treatments on Turmeric was observed by analysing various metabolites of leaf samples at 60, 90 and 120 days after transplantation. Among the control conditions, the total available carbohydrates (TAC) content was optimum at 60 days and depleted thereafter. However, Protein (PR) and Amino Acid (AA) content were found to be in an increasing trend from 60 to 120 days after transplantation. Among the treatments, T_3-IAA/Na_2SO_4 is the best fabourable combinations in salinity stress conditions.

Keywords: Growth hormones; Metabolites; Salinity stress; Turmeric.

Introduction

Turmeric (*Curacma longa* Linn.) a parennial herb belongs to the family Zingiberaceae, a native of South East Asia. The rhizome is used as a condiment, dyestuff and also in medicines since time immemorial. The plant is commonly cultivated in the hills and plain areas of Manipur with progressive increase in terms of area and yield (Table 1). The crop is highly sensitive to ill drained and alkaline conditions. Saline soil influences negatively, sprouting, growth and yield of crop plants[1]. However, the magnitude of salinity effect varies with the plant species and types[2].

The use of different ranges of NaCl only to increase the salinity levels, was done by various scientists in various crops[3,4]. Application of sulphate salts of magnesium and sodium affects the growth of some crops under salt stress conditions[5]. However, the use of carbonate and bicarbonate salts of sodium also have an adverse effect on the length and weight of shoot and root[6]. The application of IAA under different salt stress favoured rhizome initiation and ultimately increased crop yield[7].

Phenols one of the secondary plant metabolites have a significant effect on plant growth when applied at physiological conditions by acting as analogues of growth hormones[8]. Phenols are known to facilitate oxidation of IAA[9] and lingification of cells[10] Growth regulators have been reported to increase the yield by making the plant photosynthetically more effective[11]. From the adove facts, it is worth to be mentioned that, with the increase of salinity, there is a prograssive reduction in the growth and yield of crops. The objective of the present work is to investigate some metabolic parameters like Proteins (PR), Amino Acids (AA) and Total available Carbohydrates (TAC) in leaf samples of turmeric in relation to growth regulants under different saline stress conditions.

Materials and Methods

The experiments were conducted on turmeric (*Curcuma longa* Linn). at normal temperature in close room getting diffuse sunlight. Turmeric rhizomes of the same age group and uniform size with two fingers (buds) were selected and were soaked in 100 ppm

concentration of growth regulants viz., IAA and P for 24 hours separately in glass containers. The two salts viz., NaCl and Na_2SO_4 were used to prepare different salinity levels[12]. These salts were dissolved separately in 1000 ml of rain water as per their electric conductance (EC) - 0, 4, 8, 12 and 16 mmhos/cm for the present study (Table 2).

The control and treated rhizomes were subjected to polythene bags of uniform size (30 x 20 cm) separately at the rate of three rhizomes per bag. Each bag was filled with 2.5 kg of dry sandy soil collected from river banks. The soils were treated with dilute HCl for 12 hours and washed in running water and dried. The pH of the soil was maintained at 7. Prior to transplantation of the seedlings, the soil were uniformly fertilized with murate of potash and urea (1:1). The average amount of fertilizer in each pot was 19.60 gms[13]. For all the experiments, rhizomes which were treated with only rain water were considered as control (T_1). The rhizomes which were treated with 100 ppm concentration of IAA and P separately were considered as treatments (T_2 to T_6).

The rhizomes for control and treatments were planted in polythene bags by using randomized block design method[14,15]. After plantation, the control block of the experiment was sprayed with rain water, whereas treatment blocks were subjected to concentrations of different salinity levels of NaCl and Na_2SO_4. The rain water (250 cc) was added to the control and treatment blocks at the gap of 15 days from the date of sowing. However, the dozes of NaCl and Na_2SO_4 salinity levels were re-added to 60 days, 90 days and 120 from the date of sowing. After completion of 45 days only one seedling was maintained for every polythene bag to study the metabolic parameters like PR, AA and TAC in leaf samples of turmeric. Statistical analysis, representation of experimental data and design were also worked out[15]. Leaf samples were analyzed for determination of PR by Lowry's technique[16], AA estimation with the help of Barnett and Naylor's method[17] and TAC by Loewus's process[18].

Table 1. Estimated Area and Production of Turmeric for the Period from 1992-93 to 1996-97

Sl. No.	Name of Species	1992-93		1993-94		1994-95		1995-96		1996-97	
		A	P	A	P	A	P	A	P	A	P
1.	Turmeric	183	2.2	200	2.4	208	2.5	233	2.3	250	3.0

Note : A = Area in hectare, P = Production in mt.
Source : Data Collected from Directorate of Agriculture, Government of Manipur

Table 2. Different Salinity Levels of NaCl and Na_2SO_4

Salinity Level (mmhos/cm)	QUANTITY OF SALT (G) PER LITER OF SOLUTION	
	NaCl	Na_2SO_4
0	0.000	0.000
4	0.994	0.639
8	2.047	1.313
12	3.159	1.987
16	4.325	2.840

Table 3 (A). Effect of Growth Regulants on Protein (mg/g fresh wt) in Leaf Samples of Turmeric (*Curcuma longa* L.)

Treatments	Salinity Levels (mmhos/cm)	Control			Protein (mg/g fresh wt) mean 60,90,120 DAP Growth Regulators - 100 ppm											
					Indole Acetic Acid						Phenol					
					NaCL			Na_2SO_4			NaCl			Na_2SO_4		
T_1	0	48.2	53.5	56.4												
T_2	0				59.4	71.2	76.2	59.4	71.2	76.2	56.8	65.7	69.8	56.8	65.7	69.8
T_3	4				51.6	55.7	58.6	53.8	57.8	61.7	49.7	54.9	56.2	52.6	56.7	58.4
T_4	8				47.3	53.2	55.7	49.8	55.9	57.2	44.8	50.6	51.6	47.4	54.6	53.9
T_5	12				39.4	42.8	47.3	42.5	44.2	49.5	36.2	40.3	44.5	43.8	42.3	46.7
T_6	16				30.5	32.7	36.2	30.7	33.4	31.8	25.4	27.8	31.2	28.2	30.9	33.2
CD at 1%						60 DAP			90 DAP						120 DAP	
CD at 5%						2.877			2.688						3.277	
S.E.						± 1.054			± 0.984						± 1.200	

Table 3 (B). Effect of Growth Regulants on Amino Acids (mg/g fresh wt) in Leaf Samples of Turmeric (*Curcuma longa* L.) Under Saline Stress Conditions

Treatments	Salinity Levels (mmhos/cm)	Control			Amino Acids (mg/g fresh wt) mean 60,90,120 Days after Pplantation (DAP) Growth Regulators - 100 ppm											
					Indole Acetic Acid						Phenol					
					NaCL			Na_2SO_4			NaCl			Na_2SO_4		
T_1	0	1.75	19.6	22.4												
T_2	0				20.6	23.8	26.2	20.6	23.8	26.2	19.3	21.9	24.7	19.3	21.9	24.7
T_3	4				17.8	19.6	23.5	18.3	19.8	24.7	16.6	18.3	22.9	17.6	20.7	25.2
T_4	8				16.1	18.6	22.8	17.2	19.2	23.2	15.3	17.5	21.2	16.2	18.4	24.1
T_5	12				14.7	15.8	20.4	15.7	17.3	21.3	13.4	14.3	19.7	14.3	16.7	22.1
T_6	16				11.8	13.3	15.9	12.5	14.5	17.5	10.2	12.9	14.3	11.6	13.3	15.7
CD at 1%						60DAP			90DAP						120DAP	
CD at 5%						0.880			12.115						1.539	
S.E.						0.814			11.214						1.417	
						+ 0.298			+ 4.107						+ 0.522	

Table 3 (C). Effect of Growth Regulants on total available Carbohydrates (mg/g fresh wt) in Leaf Samples of Turmeric (*Curcuma longa* L.) Under Saline Stress Conditions

Treatments	Salinity Levels (mmhos/cm)	Control			Total Available Carbohydrates (mg/g fresh wt) mean 60,90,120 Days after Pplantation (DAP) Growth Regulators - 100 ppm											
					Indole Acetic Acid						Phenol					
					NaCL			Na_2SO_4			NaCl			Na_2SO_4		
T_1	0	40.5	38.9	35.5												
T_2	0				37.5	34.6	31.8	37.5	34.6	31.8	35.4	32.8	29.7	35.4	32.8	29.7
T_3	4				36.2	32.9	30.0	37.4	33.2	30.3	34.7	30.1	28.4	35.2	31.9	30.1
T_4	8				35.4	31.2	28.7	36.9	32.4	29.8	31.2	28.6	26.9	32.8	29.9	27.8
T_5	12				34.8	28.4	25.2	35.2	30.6	26.3	30.1	25.2	24.8	30.4	26.8	25.7
T_6	16				28.7	24.7	22.3	29.2	25.7	22.9	22.4	22.3	20.4	24.5	21.5	20.6
CD at 1%						60DAP			90DAP						120DAP	
CD at 5%						2.676			1.917						1.188	
S.E.						2.476			1.774						1.100	
						± 0.907			± 0.650						± 0.403	

Results and Discussion

The response of the treatments on turmeric was observed by analysing various metabolites of leaf samples at 60, 90 and 120 days after transplantation. The results were found to be quite interesting (Table 3-A, B and C). Among the control conditions, TAC content was optimum at 60 days and depleted thereafter. However, PR and AA contents were found in an increasing trend from 60 to 120 days transplantation. The decrease was more deleterious at higher conductivities of both the salt sodium as well as due to advancement in the age of turmeric leaves. The metabolites like PR, AA and TAC were found optimum in T_3 under EC-4 mmhos/cm of NaCl and Na_2SO_4. However, these parameters were in a decreasing trend thereafter(T_4-T_6).

Salinity stress has influenced in the depletion of protein content of the crop. This is in conformity with view of many researchers[19,20]. The decrease in the protein synthesis may be due to decreased availability of AA and denaturation of enzymes involved in the synthesis of PR and AA 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 decreased under saline stress conditions. The enhanced protease activity with increasing concentration of NaCl was supported by some earlier workers[21]. The plants under saline conditions were found to loose their capacity to regulate the ratio between polycations and polyanions. Polyanion with negative charge replace DNA in protein synthesis and thus caused an inhibitory effect on protein synthesis[22].

The decrease of AA in the turmeric leaves under saline conditions may be due to their transport to other organs and to incorporate in protein synthesis. Accumulation of free proline in the leaves of many plants as a result of water stress is known[23], but, only a few reports are available on accumulation of proline under salinity stress conditions[24,25,26]. However, accumulation of free proline was not noticed in the turmeric leaves under NaCl and Na_2SO_4 salinity at 100 ppm of IAA and P. The decline trend in TAC of turmeric leaves with increasing concentration of NaCl and Na_2SO_4 salts at 100 ppm of IAA and P is because, during development the metabolic activities are high and carbohydrates are used as source of energy, therefore, the level of carbohydrate 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. It was reported a delayed translocation of carbohydrates from cotyledons to embryonic axis in pea under salt treatments[27]

The statistical analysis of the experimental data clearly reveals that various salinity levels of NaCl and Na_2SO_4 have variable effect on the various metabolic parameters of turmeric crops under IAA and P at 100 ppm concentrations. Authors have reported in their earlier works regarding the salinity stress on morphological parameters of turmeric[28]. They reported that IAA and P at 100 ppm concentrations have shown variable influence on sprouting rate, root number, root and shoot growth of turmeric at 0 mmhos/cm salinity of NaCl and Na_2SO_4. It was also observed that 16 mmhos/cm NaCl salinity was most deleterious than 16 mmhos/cm salinity of Na_2SO4 for root number, root and shoot elongation. It may be due to delayed sprouting[28]. In the present report also PR, AA and TAC contents declined with the increase concentrations of NaCl and Na_2SO_4. The PR, AA and TAC values were found optimum in T_3 under EC-4 mmhos/cm of both the salts of sodium, and these parameters were depleted thereafter (T_4-T_6). The growth regulants viz.,

IAA and P at EC-0 mmhos/cm of NaCl and Na_2SO_4 have shown differential effect on PR, AA and TAC.

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