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EFFECT OF SOME REGULANTS ON SPROUTING AND EARLY SEEDLING GROWTH IN TURMERIC (*Curcuma longa* Linn.) UNDER SALINE CONDITIONS

P.K. SINGH and M.H. KHAN
Department of Life Sciences, Manipur University, Canchipur, Imphal - 795 003, India.

Attempts were made to see the response of Indole Acetic Acid (IAA) and Phenol (P) on sprouting and early seedling growth in turmeric (*Curcuma longa* Linn.) under salinity stress conditions by using sodium chloride (NaCl) and sodium sulphate (Na_2SO_4) in an artificial pot sand-culture method. The rate of sprouting was found to be optimum in the rhizomes treated with 100 ppm concentrations of IAA and P under NaCl salinity 8 mmhos/cm-2.047 g/1 and Na_2SO_4 salinity (8mmhos/cm-1.313 g/1). The minimum rate of sprouting was recorded under 16 mmhos/cm-4.325g/1 of NaCl salinity and 16 mmhos/cm-2.840g/1 of Na_2SO_4 salinity. Early seedling growth was favourable in 8 mmhos/cm salinity stress conditions of both NaCl and Na_2SO_4. The length of shoot was found to be decreased as the level of salt stress increased. However, the root length showed an increasing trend upto 12 mmhos/cm level of both NaCl and Na_2SO_4 and declined thereafter. Number of root was found to be decreased as the level of salt stress increases.

Keywords: Turmeric, Salinity, Growth, *Curcuma longa*.

Introduction

Turmeric (*Curcuma longa* Linn.) is a perennial herb that belongs to the family zingiberaceae, a native plant of South East Asia. Since time immemorial, the rhizome is used as a condiment, dyestuff, medicine, etc. India is by far the large producer of turmeric in the world. About one-third of the total production of turmeric in India comes from Andhra Pradesh alone. The plant is also commonly cultivated in the hilly and plain areas of Manipur state with progressive increase in terms of area and yield (Table-1). Turmeric is also grown under irrigated conditions. It can be propagated from seeds, but the common method of propagation is through rhizomes. Turmeric can be grown on varieties of soils. However, the crop is highly sensitive to ill drained and alkaline conditions.

Soil salinity is an ever alarming problem in Indian agriculture. Saline habitats are characterised by an excess of inorganic salts and their accumulation in the upper layer of the soil. Such soil influences negatively, germination, 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 different crops[3,4]. Application of sulphate salts of magnesium and sodium affect germination of some crops under salt stress conditions[5]. However, the

Table 1: Turmeric production of Manipur State, during the period from 1992 to 1996.*

SI	Spice	1992		1993		1994		1995		1996	
No.	Name	A	P	A	P	A	P	A	P	A	P
1.	Turmeric	183	2.20	200	2.40	208	2.50	233	2.30	250	3.00

A = Area in hectare P = Production in Metric Tonne
*Data collected from the Directorate of Agriculture, Government of Manipur, Imphal.

use of carbonates and bicarbonate salts of sodium also have an adverse effect on the length and weight of shoot and root[6].

The response of growth hormones in various physiological processes of different crop plants have been reported under salt stress conditions[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 lignification of cells[10].

From the above facts, it is worth to be mentioned that, with the increase of salinity level, there is a progressive reduction in the growth and yield of crops. The present investigation, is planned to get basic information concerning with physiology of bud sprouting, number of roots, root length and early shoot growth of turmeric in relation to growth regulants under different salinity 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 of uniform size with two fingers (buds) were selected and soaked with 100 ppm concentration of growth regulants viz., IAA and P separately, for 24 hours. The two salts viz, NaCl and Na_2SO_4 were used to prepare different salinity levels[11]. These salts were dissolved separarely in 1000 ml of rain water as per their electric conductance (EC) - 0, 4, 8, 12 and 16 mmhos/cm for the present study.

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 up with 2.5 kg of dry Sandy soil. 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 7.0. Prior to transplantation of the seedlings, the soils were uniformly fertilised with murate of potash and urea (1:1). The average amount of fertiliser in each pot was 19.60 gm[12].

For all the experiments, rhizomes which were treated with only rain water were considered as control. The rhizomes which were treated with 100 ppm concentration of IAA and P separately were considered as treatments. The rhizomes for control and treatments were planted in the polythene bags and arranged in a randomised block design method[13,14]. 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. 250 cc of rain water was added to the control and the treatment blocks at an interval of 15 days from the date of plantation. However, the doses of NaCl and Na_2SO_4 salinity levels were re-added to the plants after 60 days and 90 days from the date of plantation.

After completion of 45 days, only one seedling was maintained for every polythene bag, to study the parameters like, rate of sprouting, number of roots, root length and early shoot growth. Statistical analysis and representation of experimental data were also worked out[13,14].

Results and Discussion

Sprouting Rate: Table 2, shows that, 100% rhizomal buds sprouted in the control block (T_1) under 0 salinity level of NaCl and Na_2SO_4 after 45 days of plantation. 100 ppm concentrations of IAA and P (Treatment block-T_2) have variable influence on sprouting rate of turmeric rhizomes at 0 mmhos/cm salinity stress of both NaCl and Na_2SO_4. The rate of sprouting was found to be higher in IAA treated rhizomes than that of P.

Table 2: Sprouting rate of rhizomal buds in Turmeric (*Curcuma longa* L.) under different saline conditions.

Treatment		No. of sprouted rhizomal buds					
Growth Regulators	Salinity Levels	After 20 Days			After 45 Days		
100 ppm	mmohs / cm. EC	Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4
T_1 - Control	0	4			10		
T_2 - IAA	0		3	3		9	8
Phenol			1	2		7	7
T_3 - IAA	4		3	4		7	6
Phenol			2	3		6	6
T_4 - IAA	8		4	5		8	9
Phenol			3	4		8	8
T_5 - IAA	12		3	3		5	6
Phenol			2	2		6	5
T_6 - IAA	16		1	2		2	3
Phenol			1	1		2	2
Mean of salinity levels:	0		2.66	3.00		8.66	8.33
	4		3.00	3.66		7.66	7.33
	8		3.66	4.33		8.66	9.00
	12		3.00	3.00		7.00	7.00
	16		2.00	2.33		4.66	5.00
Mean of growth Regulators: IAA			2.8	3.4		6.2	6.4
Phenol			1.8	2.4		5.8	9.3
C.D. at 5% -			8.190			1.021	
C.D. at 1% -			8.85			1.103	
S.E. at 5% -			± 0.3			± 0.374	

Sprouting rate was noticed optimum in the rhizomes of treatment block-T_4 with 100 ppm concentration of both IAA and P under NaCl salinity (8 mmhos/cm-2.047 g/1). The minimum sprouting rate was recorded in the treatment block-T_6, under 16 mmhos/cm-4.325 g/1 of NaCl and 16 mmhos/cm-2.840 g/1 of Na_2SO_4 at 100 ppm concentration of IAA and P. In general, turmeric proved to be quite sensitive to salt stress.

There was progressive decrease in the rate of sprouting in higher salinity stress induced by NaCl and Na_2SO_4 (100 ppm concentration of IAA and P.) It was also observed that high doses of NaCl caused more reduction in sprouting rate, than that of Na_2SO_4 salinity. The same was reported in Mung.[15] Effective increase in salinity level, generally retarded the germination[16]. Saline soils have concentration of soluble salts which interfere in germination/bud emergence and disturb many metabolic processes in plants.

It may be mentioned that, sprouting was delayed, as the salinity increased beyond 8 mmhos/cm. Reduction in sprouting rate at higher salinity levels might be due to the

Table 3. Effect of IAA and Phenol on number abd root length (cm) under different salinity levels in Turmeric (*Curcuma longa* L.)

Treatment		No. of Root mean						Root length (cm) Mean					
		60 Days						60 Days					
Growth Regulators 100 ppm	Salinity mmohs / cm. EC	Thin Adv. root			Soft. Adv. root			Thin Adv. root			Soft & Thick Adv. root		
		Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4
T_1 - Control	0	5			3			3.2			2.5		
T_2 - IAA			6	6		4	4		4.4	4.4		3.2	3.2
Phenol	0		4	4		3	3		3.5	3.5		2.7	2.7
T_3 - IAA			5	5		3	3		3.0	3.3		2.2	2.4
Phenol	4		2	3		2	2		2.8	3.1		1.9	2.3
T_4 - IAA			5	6		2	3		3.5	3.7		2.8	2.9
Phenol	8		3	4		2	3		3.2	3.4		2.4	2.7
T_5 - IAA			6	6		4	5		4.4	4.6		3.4	3.6
Phenol	12		4	4		3	4		3.8	4.1		2.9	3.1
T_6 - IAA			3	4		2	3		2.9	3.1		2.1	2.2
Phenol	16		2	3		1	2		2.5	2.6		1.8	1.9
Mean of salinity levels:	0		5.00	5.00		3.33	3.33		3.70	3.70		2.80	2.80
	4		4.00	4.33		2.66	2.66		3.00	3.20		2.20	2.40
	8		4.33	5.00		2.33	3.00		3.30	2.43		2.56	2.70
	12		5.00	5.00		3.33	4.00		3.80	3.43		2.93	3.06
	16		3.33	4.00		2.00	2.66		2.86	2.96		2.13	2.20
Mean of growth Regulators:	IAA		5.00	5.40		3.00	3.60		3.64	3.82		2.74	2.86
	Phenol		3.00	3.60		2.20	2.80		3.16	3.34		2.34	2.54
C.D. at 5%	-		1.173			0.818			0.333			0.191	
C.D. at 1%	-		1.268			0.885			0.359			0.206	
SE at 5%	-		± 0.43			± 0.30			± 0.122			± 0.07	

decrease in the imbibition rate and also due to the accumulation of ions to a toxic level in sprouting buds, thereby, adversely affecting the enzymatic activity. It was observed that, phenol can improve sprouting rate upto 8 mmhos/cm salinity levels of both NaCl and Na_2SO_4.

Number of Roots: Table 3, shows that, 100 ppm concentrations of IAA and P have variable influence on the roots treated with 0 mmhos/cm salinity (Treatment block-T_2). The optimum number of roots was observed in IAA treated rhizomes. Root numbers were not found at uniform rate with 0, 4, 8, 12 and 16 mmhos/cm salinity levels of both NaCl and Na_2SO_4. It was found favourable in 12 mmhos/cm salinity of NaCl and Na_2SO_4 at 100 ppm concentration of IAA and P for thin as well as in soft and thick adventitious roots (Treatment block-T_5), and declined thereafter

Table 4. Early seedling growth in Turmeric (*Curcuma Longa* L.)

Treatment		Concentration of Salt grm/L			No. of rhizomes planted		Shoot length (Cm) Mean					
Growth Regulators 100 ppm	Salinity mmohs / cm. EC						45 Days			60 Days		
		Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4	Control	NaCl	Na_2SO_4
T_1 - Control	0	0	0		10		5.60			7.32		
T_2 - IAA	0	0	0		10			9.20	9.90		14.30	14.95
Phenol								4.90	5.10		7.82	8.55
T_3 - IAA	4	0.994	0.639		10			4.85	4.75		5.90	5.80
Phenol								4.70	6.35		5.70	7.40
T_4 - IAA	8	2.047	1.313		10			5.90	6.85		6.25	7.45
Phenol								5.40	7.30		6.12	8.50
T_5 - IAA	12	3.159	1.987		10			3.50	3.35		4.45	4.40
Phenol								3.95	5.30		4.62	5.90
T_6 - IAA	16	4.325	2.840		10			3.10	3.25		3.95	4.10
Phenol								3.45	5.10		4.12	5.13
CD at 1% -								2.723			4.230	
CD at 5 % -								1.970			3.054	
S E -								± 1.71			± 2.868	

(Treatment block-T_6). The soluble salts at higher salinity levels have become sufficient to surpass the growth of root[17].

Root and Shoot Length: It was found that, saline soil adversely affect the growth of shoot and root in turmeric (Table 3 and 4). Due to salinity stress, the shoot growth of turmeric was severely affected than that of root. 100 ppm concentrations of both IAA and P have variable effect on root and shoot growth under 0 mmhos/cm salinity (Treatment block-T_2). The rate of root and shoot elongation was found higher in IAA treated rhizomes than that of P treated rhizomes.

Early root and shoot growth was not uniform at 0, 4, 8, 12 and 16 mmhos/cm salinity levels of both NaCl and Na_2SO_4. The shoot growth was favourable in 8 mmhos/cm of both NaCl an Na_2SO_4 salinity stress (Treatment block-T_4). However, the root elongation was optimum at 12 mmhos/cm salinity levels of both NaCl and Na_2SO_4. Thereafter, root elongation was found to be decreased at 16 mmhos/cm salinity levels. It was also observed that, 16 mmhos/cm NaCl salinity was most deleterious than 16 mmhos/cm salinity level of Na_2SO_4 for root and shoot elongation. The reduction in the root and shoot length was because of delayed sprouting which is invariably observed under saline stress.[15]

It was noted that, root elongation consistently increased but shoot length decreased with the increase of salinity. The fresh weights of root and shoot were considerably reduced under high salinity[18]

Similarly, shoot and root growth decreased with the increase in salinity[19]. Effect of salinity on reduced growth of root and shoot might be due to the reduction in the absorption of moisture in the rhizomal buds and delayed translocation of reserve foods[20]. Root and shoot growth of plants also depended on IAA concentration and IAA destroying system. Phenol, the secondary plant metabolite helps in growth of root and shoot in Na_2SO_4 salinity rather than NaCl. The shoot growth is significantly controlled by the signals perceived from roots[21], or transmission of signals from shoot to root or vice versa[22].

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