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SHORT COMMUNICATION

REVERSAL OF SALINITY STRESS EFFECTS ON MORPHO-PHYSIOLOGICAL PARAMETERS OF MOTHBEAN SEEDLINGS BY GROWTH REGULATORS

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Two genotypes of mothbean IPCMO-912 and FMM-96 were germinated in petriplates. The treatment included 0.5% NaCl with and without 100 ppm GA_3/IAA in Hoagland solution. Hoagland solution alone acted as control. Morphological parameters and water relation parameters were recorded on 7 and 12 days old seedlings. Salinity decreased the root length, shoot length, seedling fresh weight and dry weight but increased the root-shoot ratio. Hormonal treatment alleviated the adverse effect of salinity on seedling growth (length and weight) to some extent in both the genotypes. Salinity also decreased leaf water potential, osmotic potential and turgor potential and the decrease was greater in FMM-96 than in IPCMO-912. Application of the hormones reversed the salinity induced fall in water potential, osmotic potential and turgor potential in the two genotypes. However, genotype FMM-96 responded more to these hormones compared to IPCMO-912.

***Key words*: Gibberellic acid, indole acetic acid, moth bean, salinity stress.**

Soil salinity is a major limitation to crop production throughout the world. Salinity leads to metabolic alterations and reduction in plant growth. This reduction in growth is a cumulative effect of salinity on dry matter production through various physiological processes. However, plants try to adapt themselves to salinity stress by accumulating several metabolites that serve as osmoticum. Accumulation of free amino acids and soluble sugars has been reported in relatively salt tolerant legume species as adaptation toward salinity stress (Varshney *et al* 1998). Changes in the level of hormones also appear to be involved in response to salinity. Pre-soaking treatment of seeds with 100 or 200 ppm of gibberellic acid or indole acetic acid has shown to alleviate the detrimental effect of NaCl-salinity in soybean (Zaidi and Singh 1995). Foliar spray of gibberellic acid or indole acetic acid ameliorated harmful effect of NaCl salinity on metabolic activity of mungbean (Chakrabarty and Mukherji 2000). Restoration of hormonal equilibrium under the new environment therefore plays a central role in the survival of the plants (Amzallag and Lerner 1995).

Mothbean (*Vigna aconitifolia*) is an important legume grown in semi arid and arid areas of India particularly Rajasthan state. It is one of the cheapest and the excellent source of protein (23.6%). Cultivation of pulses especially mothbean has been restricted to marginal lands including those prone to salinity. Since mothbean is highly sensitive to salt stress, improvement of its salinity tolerance is of immense importance. Salinity has been shown to influence metabolism of mothbean by decreasing levels of chlorophyll, soluble proteins and starch and increasing those of free proline and amino acids (Garg and Gupta 1997). However, there is hardly

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any report relating to enhancement of salt tolerance or to devise management practice using growth regulators for mothbean under saline conditions. Present study therefore was undertaken to study the effect of plant hormones gibberellic acid (GA_3) and indole acetic acid (IAA) on morpho-physiological parameters of mothbean under salinity stress. Treatment of the plant hormones was given through hoagland solution to the growing seedlings to maintain the hormonal equilibrium throughout the experiment.

Seeds of two genotypes of mothbean (*Vigna aconitifolia*), viz. IPCMO-912 and FMM-96 (both developed and released by Rajasthan Agricultural University, Bikaner) were surface sterilized with 0.2% $HgCl_2$ and were placed on sterilized germination paper in petriplates for germination. In each petriplate, 10 seeds were allowed to germinate and grown at 32°C in BOD incubator. GA_3 and IAA, each at 100 ppm concentration were applied to germinating seeds through hoagland solution containing 0.5% NaCl at 0, 3, 6 and 9 days stage uniformly. At each time 5 ml hoagland solution was given to each petriplate. The hoagland solution having 0.5% NaCl acted as salinity treatment while Hoagland solution alone acted as control. The experiment had three replications in completely randomized design. The use of 100 ppm IAA/GA_3 is based on earlier studies (Zaidi and Singh 1995) that showed almost the same effect of 100 or 200 ppm IAA or GA_3 in alleviating salinity stress in soybean through seed treatment. Morphological parameters including seedling height, root length, fresh weight and dry weight of seedlings were recorded at 7 and 12 days stage. Water potential was measured by pressure chamber (PMS instrument Co., USA) as described by Scholander *et al.* (1965) and osmotic potential by vapour pressure osmometer (WESCOR 500 USA). Turgor potential was calculated by subtracting osmotic potential from water potential (Lange *et al.* 1976) and transpiration rate was estimated by quick weighing method (Srivastava and Kumar 1993).

The effects of salinity and the two hormones on root and shoot length and fresh and dry weight of IPCMO-912 and FMM-96 are shown in Table 1. Salinity caused significant reduction in root and shoot length in both the genotypes. The reduction in root length due to salinity was more in FMM-96 (up to 75%) than IPCMO-912 (up to 45%), while decrease in shoot length was almost the same in both the genotypes (72-74%). The data thus showed that reduction in shoot length was more than the decrease in root length due to salinity. Both IAA and GA_3 were able to reverse the effect of salinity to some extent on root and shoot length. The maximum increase in root length due to IAA over salinity control was 16 per cent in IPCMO-912 and 31 per cent in FMM-96, while due to GA_3; it was 36 per cent and 59 per cent, respectively in the two genotypes. The maximum increase in shoot length due to IAA was 73 per cent and 94 per cent, respectively in IPCMO-912 and FMM-96. Gibberellic acid was much more effective, causing increase in shoot length by 371 percent in IPCMO-912 and 390 percent in FMM-96. In an earlier study, Zaidi and Singh (1996) have also shown increase in root growth with GA_3 and IAA in soybean.

Fresh and dry weight of seedlings also decreased due to salinity in genotype IPCMO-912 as well as FMM-96. The maximum decrease in fresh weight (68%) and dry weight (44%) were observed in genotype IPCMO-912. Application of the hormones was able to alleviate the adverse effect of salinity on fresh and dry weight to some extent. Out of the two hormones, GA_3 was more effective than IAA in both the genotypes particularly in IPCMO-912. In clusterbean, dry matter has been shown most adversely affected by NaCl salinity at the seedling stage and the least at the flowering stage (Garg *et al.* 1997). Cowpea seedlings have also shown significant reduction in seedling length and their dry weight due to NaCl salinity (Rema Devi and Gopalkrishna 1997). Salinity stress induced inhibition of germination and seedling growth in rice was reversed by brassinolide (Anuradha and Rao 2002).

Salinity lowered the leaf water potential (LWP) and osmotic potential (LOP) as shown in Table 2. The maximum reduction in leaf water potential (92%) and in osmotic potential (68%) was observed in FMM-96. Treatment of IAA and GA_3 under salinity restored the LWP and LOP partially in both the genotypes. The highest increase in LWP (31% of salinity control) and in LOP (17% of salinity control) was noticed with GA_3 in FMM-96. The leaf turgor potential (LTP) also decreased

Table 1. Effect of indole acetic acid and gibberellic acid on growth parameters of mothbean seedlings under salinity

Cultivar	Treatment	Root length (cm)		Shoot length (cm)		Fresh weight g seedling^{-1}		Dry weight g seedling^{-1}	
		7 DAS	12 DAS	7 DAS	12 DAS	7 DAS	12 DAS	7 DAS	12 DAS
IPCMO-912	Non-saline	6.36	9.70	9.23	12.50	2.90	3.15	0.12	0.18
	Saline	3.76	4.53	2.60	3.20	1.58	1.00	0.07	0.11
	Saline+IAA	4.30	5.17	4.50	4.63	1.70	1.03	0.08	0.13
	Saline+ GA_3	5.13	6.07	10.36	15.07	2.88	1.84	0.10	0.16
FMM-96	Non-saline	8.36	14.33	9.50	11.80	2.78	3.01	0.14	0.20
	Saline	2.46	3.53	2.63	3.30	1.82	1.05	0.10	0.13
	Saline+IAA	3.23	3.97	5.10	4.53	2.01	1.18	0.11	0.15
	Saline+ GA_3	3.86	5.63	10.80	16.17	3.04	1.70	0.13	0.17
	S.Em ±	0.22	0.39	0.39	0.18	0.01	0.02	0.01	0.01
	CD (P=0.05)	0.70	1.22	1.24	0.56	0.03	0.06	0.03	0.02

DAS = Days after sowing, IAA = Indole acetic acid, GA_3 = Gibberellic acid

Table 2. Effect of indole acetic acid and gibberellic acid on water relation parameters of mothbean seedlings under salinity

Cultivar	Treatment	LWP (MPa)		LOP (Mpa)		LTP (Mpa)		LTR (mg/g/ fw/min)	
		7 DAS	12 DAS	7 DAS	12 DAS	7 DAS	12 DAS	7 DAS	12 DAS
IPCMO-912	Non-saline	-0.62	-0.83	-0.92	-1.08	0.31	0.25	16.26	18.27
	Saline	-1.02	-1.53	-1.21	-1.71	0.19	0.18	8.15	8.40
	Saline+IAA	-0.91	-1.42	-1.13	-1.63	0.22	0.20	13.61	14.43
	Saline+GA_3	-0.74	-1.25	-1.02	-1.50	0.28	0.25	15.35	16.69
FMM-96	Non-saline	-0.52	-0.75	-0.82	-0.97	0.30	0.22	15.12	15.63
	Saline	-0.96	-1.45	-1.12	-1.62	0.17	0.17	5.35	5.61
	Saline+IAA	-0.83	-1.33	-1.08	-1.52	0.24	0.20	11.96	11.54
	Saline+GA_3	-0.66	-1.13	-0.94	-1.35	0.28	0.22	14.25	15.00
	S.Em ±	0.01	0.02	0.01	0.02	0.01	0.01	0.61	0.31
	CD (P=0.05)	0.04	0.05	0.02	0.05	0.03	0.02	1.93	0.98

LWP = Leaf water potential, LOP = Leaf osmotic potential, LTP = Leaf turgor pressure, LTR = Leaf transpiration rate.

due to salinity and the maximum reduction was 38 and 40 per cent of control in IPCMO-912 and FMM-96, respectively (Table 2). Both IAA and GA_3 increased the leaf turgor potential under salinity. The increase in LTP due to IAA and GA_3 was, respectively 16 and 46 per cent in IPCMO-912 and 41 and 68 per cent of salinity control in FMM-96. Predominance of positive turgor in both the genotypes under salinity with or without hormone points towards more decline in leaf osmotic potential than water potential. Further, it suggests for osmotic adjustment in the two-mothbean genotypes due to accumulation of solutes. Leaf transpiration decreased due to salinity in both the mothbean genotypes. The maximum decrease was 54 and 65 per cent of the control in IPCMO-912 and FMM-96, respectively. Treatment of IAA and GA_3 mitigated significantly the reduction in leaf transpiration due to salinity in both the genotypes. The maximum increase due to IAA and GA_3 were respectively 68 and 99 per cent in IPCMO-912 and 167 per cent of salinity control in FMM-96.

The study thus shows that fall in leaf water potential, osmotic potential, turgor potential and leaf transpiration due to salinity was greater in FMM-96 than in IPCMO-912. The decrease in transpiration caused by salinity is probably due to osmotic effect. However, decrease in transpiration, partly due to increased resistance to the transpirational flow of water cannot be ruled out. Higher reduction in the water potential of FMM-96 as compared to IPCMO-912 seems to be due to greater reduction in root length of this genotype leading to decreased water uptake. This finds explanation from greater response of GA_3 on root length under salinity in FMM-96 leading to increased water absorption and hence mitigating adverse effect of salinity more effectively than IAA. Secondly, FMM-96 responded more to these hormones compared to IPCMO-912. More adverse effect of salinity in genotype FMM-96 and better response of the hormones in alleviating salinity stress in this genotype as compared to IPCMO-912 show that salinity does cause hormonal imbalance. The study also shows that gibberellic acid seems more effective than IAA in alleviating inhibitory effect of salinity on water relation parameters in mothbean.

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