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EFFECT OF SALINE WATER ON GROWTH, YIELD, QUALITY AND NUTRITION OF BANANA (*MUSA* [AB] NEYPOOVAN)

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Abstract : The field experiment with Neypoovan by using irrigation water having three levels of salinity **viz..** 0.3, 2.5 and 5.0 dS m^{-1} in Udic Haplustalfs showed that the girth, physiologically active leaves, biomass and bunch yield decreased significantly with higher levels of saline water irrigation. The magnitude of yield reduction at 2.5 and 5.0 dS m^{-1} was 16 and 36 per cent over non-saline water. The finger weight reduced from 76.7 g at 0.3 dS m^{-1} to 47.7 g at 5.0 dS m^{-1} salinity and likewise pulp and peel weight, pulp / peel ratio and total soluble solids of fruits. Nutrient concentrations of N, K, Mg, Na, Cl and Mn in the index leaves varied due to saline water irrigation. Root was found to be the best sampling organ for sodium as accumulation was more in the roots than in the index leaves. Salinity threshold values worked out based on regression equation for 25 and 50 per cent yield decrease were found to be 3.90 and 6.94 dS m ' respectively for this variety of banana.

Key words : Banana nutrition, Haplustalfs, saline water irrigation.

INTRODUCTION

In India, banana is grown in an area of 3.68 lakh ha with an annual production of 10.45 million tonnes. Neypoovan banana is mainly grown in South India for its good quality and taste. The Karnataka, Tamil Nadu and Andhra Pradesh have got extensive saline soils and poor quality of ground water. However, in Kerala, it is acid sulphate soils that cause sulphate salinity which affects the production of banana and other crops. Most of the area under Neypoovan in southern states is affected by salinity due to salts in soils or by use of saline water for irrigation. Increased salinity in water led to marked decrease in the growth and productivity of banana (Israeli *et al.* 1986, Hernandez *et al.* 1986). In view of this background, a study was conducted to determine the effects of saline water irrigation on the growth, yield, quality and nutrition of Neypoovan banana.

MATERIALS AND METHODS

Neypoovan (*Musa*, AB group) banana was planted at 1.8 m x 1.8 m in Udic Haplustalfs of Hessaraghatta soils at Bangalore during 1992-93. Initial characteristics of soil were : pH 6.8, EC 0.3 dS m^{-1}, OC 0.32%, clay 18%, silt 20%, sand 58%, CEC 10 cmol (p^+) kg^{-1}, available NPK 135, 9.0 and 140 kg ha^{-1} in that order. There were three treatments viz., T1 - Fresh water having 0.3 dS m^{-1} salinity, T2 - 2.5 dS m^{-1} salinity in water and T3 - 5.0 dS m^{-1} salinity in the water. Plots of 26 m^2 were used for each treatment to accommodate eight plants and each treatment was replicated four times. Irrigation water was prepared by dissolving NaCl and $CaCl_2$ in the ratio of 1:2 to have salinity levels of 2.5 and 5.0 dS m '. Fertilisers at the rate of 200, 100 and 200 g of NPK per plant were applied.

Growth parameters and nutrient concentrations in the index tissues were recorded at vegetative, shooting and harvest stages. Biomass, bunch weight, finger weight, pulp and peel weight and pulp / peel ratio were also recorded at the time of harvest. T.S.S. in the ripe fruit was also estimated. For total elemental analysis (N, P, K, Ca, Mg, S, Mn, Fe, Cu, Zn, Na and Cl) in banana leaves and Na and Cl in the roots standard procedures have been used (Page *et al*, 1982). Middle part of leaf lamina measuring 20 cm on either side of the third leaf from the top was selected for nutrient analysis as suggested by Lahav and Turner (1989).

RESULTS AND DISCUSSION

Growth parameters and yield

Height of the plant was significantly affected at vegetative and shooting stage and girth of the plant at harvest stage by irrigation with saline water. These parameters decreased with

Table 1. Effect of saline water irrigation on growth parameters of Neypoovan banana

Salinity level, dS m^{-1}	Vegetative stage			Shooting stage			Harvest stage				
	Height, cm	Girth, cm	No. of leaves	Height, cm	Girth, cm	No. of leaves	Height, cm	Girth, cm	No. of leaves	DFFP	DMFF
0.3	108.8	38.25	5.00	217.0	54.7	20.5	315.5	63.2	13.2	347	107
2.5	75.8	31.50	5.00	178.5	47.0	18.5	308.0	57.3	9,7	397	133
5.0	73,5	33.00	5.75	182.7	44.7	19.0	290.7	54.0	8.7	408	115
CD(0.05)	10.1	NS	NS	31.5	NS	NS	NS	5.6	3.2	15	8

DFFP - Days to flowering from planting DMFF - Days to maturity from flowering

Table 2. Effect of saline water irrigation on biomass, bunch yield and fruit characteristics of Neypoovan banana

Salinity level, dS m^{-1}	Biomass	Bunch yield	Finger wt.	Pulp wt.	Peel wt.	Pulp/peel ratio	T.S.S. Brix
	kg per plant		g				
0.3	39.42	8.23	76.7	61.9	13.6	4.54	30.85
2.5	36.95	6.95	62.3	53.5	8.7	6.18	29.47
5.0	33.10	5.30	47.7	40.5	6.9	5.94	27.67
CD (0.05)	2.52	0.79	14.7	13.0	2.9	0.87	1.22

the increase in the level of salinity in irrigation water (Table 1). Saline water irrigation had no effect on the number of leaves at growth and shooting stage, however, there was significant reduction in the number due to salinity at the time of harvest. Irrigation with saline water has not affected the number of days taken for flowering and maturity of Neypoovan banana (Table 1).

Total biomass and bunch yield was reduced significantly due to saline water irrigation. There was 16 per cent decrease in biomass at 5.0 dS m^{-1} over non saline water. At 2.5 dS m^{-1}, decrease in biomass was 7 per cent. The magnitude of decrease in bunch weight at the 2.5 dS m^{-1} was only 16 per cent and it was 36 per cent at 5.0 dS m^{-1} level of salinity in the irrigation water (Table 2). Yield reduction at higher level of saline water irrigation was mainly attributed for the reduced height at vegetative and shooting stage, decreased girth, reduced number of leaves at physiologically active stage and imbalance in the nutrition of the crop. Threshold values worked out based on regression equation for Neypoovan banana were found to be 3.90 and 6.94 dS m^{-1} salinity in irrigation water for 25 and 50 per cent yield reductions, respectively.

Fruit characteristics and quality of fruits

Salinity of water had significant effect on finger, pulp and peel weight and pulp / peel ratio and total soluble solids. All these parameters recorded significant reduction due to increased salinity in the irrigation water (Table 2). Reduction in the finger weight was 18 per cent at 2.5 dS m^{-1} and 38 per cent at 5.0 dS m^{-1} salinity over non saline irrigation water. Total soluble solids in the Neypoovan banana decreased by three units at higher level of saline water irrigation over non saline water. Decreased bunch weight was mainly due to reduced weight of fingers and not due to number of fingers.

Table 3. Effect of saline water irrigation on the nutrient status of Neypoovan banana leaves

Salinity level, dS m^{-1}	N	P	K	Ca	Mg	S	Cl	Na	Mn	Fe	Zn	Cu
	%							mg kg^{-1}				
Vegetative stage												
0.3	2.65	ND	2.92	1.12	0.72	ND	1.04	205.0	1241	107.0	38.5	24.0
2.5	2.22	ND	2.79	1.14	0.60	ND	1.21	194.2	1165	116.2	35.0	18.7
5.0	2.23	ND	2.47	1.18	0.56	ND	1.22	194.0	1032	97.0	33.0	20.2
CD (0.05)	NS	-	0.34	NS	0.10	-	NS	NS	NS	NS	NS	NS
Shooting stage												
0.3	2.57	0.23	2.71	1.35	0.35	0.23	1.66	211.2	2797	230.5	21.0	24.0
2.5	2.46	0.23	2.42	1.28	0.32	0.22	1,88	224.7	2373	297.7	21.5	22.0
5.0	2.26	0.23	2.28	1.27	0.27	0.24	1.84	262.5	2357	275.5	24.2	21.2
CD (0.05)	0.17	NS	0.24	NS	NS	NS	NS	40.2	351	NS	NS	NS
Harvest stage												
0.3	1.97	0.17	1.46	1.27	0.29	0.25	0.73 (0.99)	107.5 (1500)	1073	180.2	19.2	9.0
2.5	1.97	0.16	1.43	1.19	0.24	0.23	0.92 (1.35)	100.2 (4200)	1016	223.2	17.2	8.5
5.0	2.05	0.15	1.38	1.19	0.21	0.24	1.06 (1.25)	100.0 (6600)	829	201.7	19.2	8.7
CD (0.05)	NS	NS	NS	NS	0.06	NS	0.23	NS	158	NS	NS	NS

ND - Not determined
Figures in the parenthesis for Cl and Na values are for the root samples

Table 4. Effect of saline water irrigation on the uptake of nutrients by Neypoovan banana, kg ha^{-1}

Salinity level, dS m^{-1}	N	P	K	Ca	Mg	S	Cl	Mn	Na	Fe	Zn	Cu
0.3	240.3	21.2	177.8	154.9	36.1	30.6	89.5	13.0	1.31	2.08	0.23	0.11
2.5	224.6	18.5	163.3	134.3	27.5	26.8	104.9	11.4	1.14	2.54	0.19	0.10
5.0	209.2	15.4	141.0	121.6	21.9	24.3	108.6	8.4	1.02	2.06	0.19	6.09
CD (0.05)	NS	NS	NS	13.2	8.3	NS	NS	1.4	0.20	NS	NS	NS

Nutrient composition

Concentration of nutrients in leaves at growth, shooting and harvest stages are presented in Table 3.

Vegetative stage: In this stage, only potassium and magnesium in index leaves decreased significantly due to saline water irrigation. The changes in other nutrients were nonsignificant due to use of saline water. Magnitude of decrease in K concentration at 2.5 dS m^{-1} salinity of water was five per cent and 16 per cent at 5.0 dS m^{-1} salinity over nonsaline water. Magnesium decreased by 17 per cent at 2.5 dS m^{-1} and 23 per cent at 5.0 dS m^{-1} level of saline water irrigation over nonsaline water.

Shooting stage : At this stage, N, K and Mn concentration in index leaves found to be significantly low due to use of saline water

for irrigation. Shooting stage constitutes the important stage and any imbalance in the nutrition of nitrogen and potassium will have adverse impact on the productivity of banana crop. Significant reduction in K concentration in the index leaves at 5.0 dS m^{-1} suggested that nutrition of K is a problem in these soils above 2.5 dS m^{-1} salinity level. Added to this, sodium concentration increased by 20 per cent in index leaves at 5,0 dS m^{-1} level of saline water irrigation over nonsaline water. Manganese concentration significantly decreased at higher level of salinity in irrigation water over fresh water irrigation. Accumulation of Na in the roots (Table 3) which competes for cationic absorption sites of the root surface of NH_4 and K^+ ions by the plant results in reduced uptake of N and K. However, variations in other nutrient concentrations are found to be non significant due to salinity.

Harvest stage: At this stage, only magnesium and manganese concentration decreased significantly due to saline water irrigation effect. Hernandez *et al.* (1986) are of the opinion that, sodium and chloride accumulate in the root zone and suggested root to be the best sampling organ for these elements. However, chloride concentration was found to be significant in the leaf due to effect of saline water irrigation and non significant in the root in the present investigation. Whereas, sodium concentration was significant in root and not in the leaves due to saline water irrigation (Table 3). It was found that concentration of sodium varied to a large extent in the roots and leaves. Magnitude of increase in the sodium concentration in root at 5.0 dS m^{-1} level of saline water irrigation was 78 per cent over nonsaline water.

It may be noted that in banana, growth and dry matter production is closely associated with nitrogen and potassium nutrition. The data clearly indicate set back in nitrogen at shooting stage and potassium at both vegetative and shooting stage (Table 3). Symptoms of marginal drying of leaves associated with chloride injury was also noticed at the time of harvest. Nitrogen concentration was highest at vegetative stage and decreased at later two stages. Similar kind of observation was made by Sheela and Aravindakshan (1990) in Palayankodan banana. Potassium concentration was highest at growth and shooting stage and reduced at the time of harvest. Generally, content of K was less in the treatment where saline water was used for irrigation. Concentration of N, P, K, Mg, Mn, Fe, Zn, Cu and Cl decreased at harvest compared to shooting stage. Diversion of major nutrients to reproductive organs and fingers may be the reason for reduction in the concentration of nutrients from shooting to harvest stage (Palaniappan and Yerriswamy, 1996).

Nutrient uptake:

Uptake of Ca, Mg, Na and Mn were found to be significantly less due to saline water irrigation. Uptake of nitrogen was highest among all the nutrients in Neypoovan banana. It corroborates the findings of Sheela and Aravindakshan (1990) in Palayankodan banana and Palaniappan and Yerriswamy (1996) in Robusta banana where K uptake was highest. In the present experiment, uptake of K was less than the nitrogen (Table 4). Calcium uptake was 154.9 kg ha^{-1} at 0.3 dS m^{-1} and was 121.6 kg ha^{-1} at 5.0 dS m^{-1} level of saline water irrigation. Rengel (1992) was of the opinion that salt toxicity would reduce the amount of Ca^{2} being transferred to leaf cells. Uptakes of Mg, Na and Mn have been reduced significantly at higher level of saline water irrigation.

From the results of the study, it is seen that Neypoovan banana can be grown successfully at moderate level of saline water irrigation (2.5 dS m^{-1}) as the decrease in bunch yield is only 16 per cent. At higher level of salinity (5.0 dS m^{-1}), yield reduced to the extent of 36 per cent. Yield reduction under higher level of saline water irrigation was attributed to the toxic effect of sodium and chloride on the growth parameters and nutrition of essential elements.

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