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Changes in physiological and biochemical parameters and fruit yield of banana cv. NEY POOVAN as influenced by plant growth regulators

C. Tamilselvi*, S. Sasikala and M. Kavitha
Department of Crop Physiology, Tamil Nadu Agricultural University, COIMABTORE (T.N.) INDIA

ABSTRACT
Studies were carried out to understand the effects of certain plant growth regulators on physiological and biochemical parameters in relation to yield improvement of banana cv. Ney Poovan. Foliar spray of different plant growth regulators at 3rd , 5th and 7th month after planting were given. Among the different growth regulator treatments, salicylic acid 100 ppm significantly increased the physiological parameters, such as, relative water content, stomatal resistance and significantly decreases the leaf temperature and transpiration rate.

Key words : Growth regulators, Soluble protein, Chlorophyll content, Stomatal resistance, Fruit yield, Banana.

INTRODUCTION

In India, banana is cultivated in 3, 92,000 ha with a total production of 10.4 million tonnes, contributing 34 per cent of the world production. In Tamil Nadu, it is grown in an area of 83,308 ha with a total production of 29,190 metric tonnes (Anon, 2001). Ney Poovan' (Musa 'AB' Syn : Kadali, Flakki bale, Njali Poovan etc.,) is a popular emerging variety due to the premium price fetches in the market, especially if its production is so adjusted to coincide with major festivals. It is a medium stature variety and is conventionally fertilized with 110:35:330 g of NPK (Crop Production Guide, 1998). In the present investigation by using various nitrogen levels and plant growth regulating chemicals the vegetative growth, source size and yield could be increased by improving the assimilate translocation to developing sink.

MATERIALS AND METHODS

Field experiment in banana cv. Ney Poovan was conducted with various plant growth regulators at Orchard, Tamil Nadu Agricultural University, Coimbatore to study the influences and interrelationships of various plant growth regulators in altering source – sink relationship of banana. Foliar spray of salicylic acid 100 ppm, mepiquat chloride 500 ppm, chlormequat chloride 1000 ppm, nitrobenzene 50 ppm, benzyl adenine 20 ppm and 25 ppm of 2, 4-D at 3rd , 5th and 7th month after planting were given and compared with untreated control. Relative water content of leaf samples was determined as per the method of Barrs and Weatherly (1962). Turgid weight was determined by taking the leaf samples of 1.5 cm diameter in Petri dishes containing water for four hours (Bennett *et al*., 1981). Dry weight was arrived by keeping the samples in hot air oven at 60^0C. From these data, the RWC was worked out and expressed as per cent. Transpiration rate was measured by using Steady State Porometer (LICOR-1600, Licor Inc, Nebraska, USA) at 3rd ,5th ,7th month after planting and at harvest and expressed as µg H_2O cm^{-2} s^{-1}. Stomatal resistance was measured at 3,5th and 7th month after planting and at harvest by using Steady State Porometer between 10.00 am to 12.00 noon (LICOR 1600, Licor Inc, Nebraska, USA) and expressed as s cm^{-1}. Leaf temperature was recorded between 10.00 A.M to 12.00 noon at 3rd , 5th and 7th month after planting and at harvest stage using Steady State Porometer (LICOR 1600, Licor Inc, Nebraska, USA) and expressed as °C.

The content of total chlorophyll were estimated by adopting the procedure of Yoshida et al. (1972) and the contents were expressed as mg g^{-1} of fresh weight. Soluble protein content of leaf was estimated by following the procedure of Lowry *et al*. (1951), by using folin ciocalteau reagent and expressed in mg g^{-1} of fresh weight. Nitrate reductase activity was estimated using naphthalene ethylene diamine dihydrochloride by following the method described by Nicholas *et al*. (1976) and expressed as mg NO_2 $g^{-1}h^{-1}$ (fresh weight). The IAA oxidase activity was quantified by estimating residual IAA, as suggested by Parthasarathy *et al*. (1970) and expressed as mg of unoxidised IAA g^{-1} h^{-1}.

RESULTS AND DISCUSSION

Salicylic acid 100 ppm had more relative water content at shooting stage (83.63), which was 4.18 per cent increase over control. This was followed by (benzyl adenine 20 ppm) with a per cent increase of 3.82. Salicylic acid and benzyl adenine appeared to have good effect in maintaining higher moisture status (Table 1). Salicylic acid is known to change the membrane organization, thereby increasing the mobility of nutrients (Jain and Srivastava, 1981). Many phenolics also act as chelating agents and help in restricting the movement of nutrients (Marschner, 1995). By retaining nutrients within the cell the osmotic effect will have been created for retaining more cellular water.

High transpiration rate was observed in control plants in all the chosen stages except at 3 MAP, when 2, 4-D and benzyl adenine treatments registered enhanced rates over control. Almost all the growth regulator treatments distinctly recorded lower transpiration rate than control. Among them salicylic acid spray at 100 ppm recorded lowest rate at 3 and 7 MAP (21.8 and 21.4 per cent lower than control respectively), mepiquat chloride and CCC registered lower

* Author for corrospondence.

Table 1 : Effect of plant growth regulators on relative water content (%), transpiration (µg H_2O $cm^{-2}s^{-1}$) and stomatal resistance (s cm^{-1}) at different growth stages of banana cv. Ney Poovan

Treatment	Relative water content (%)			Transpiration (µg H_2O $cm^{-2}s^{-1}$)			Stomatal resistance (s cm^{-1})		
	3 MAP	5 MAP	7 MAP	3 MAP	5 MAP	7 MAP	3 MAP	5 MAP	7 MAP
Control	65.41	71.99	80.32	7.35	8.87	8.31	1.22	4.61	5.73
Mepiquat chloride 500 ppm	67.07	74.88	82.1	6.00	7.17	7.02	1.46	4.96	6.22
Chlormequat chloride 100 ppm	67.13	74.55	82.07	6.32	7.31	6.91	1.41	4.90	6.48
Ethrel 500 ppm	65.99	71.96	81.23	6.08	7.43	7.37	1.33	4.76	6.72
Salicylic acid 100 ppm	68.24	77.84	83.63	5.75	7.50	6.53	1.46	5.18	6.55
Nitrobenzene 100 ppm	66.48	73.44	81.67	7.08	8.54	7.71	1.29	4.44	5.86
Benzyladenine 20 ppm	68.05	76.96	83.39	7.63	8.86	8.22	1.33	4.46	5.71
2, 4-D 25 ppm	66.49	73.6	81.95	7.66	8.78	8.09	1.27	4.54	5.37
Mean	66.86	74.40	82.05	6.73	8.06	7.52	1.34	4.73	6.08
CD (p=0.05)	0.596	0.665	0.731	0.004	0.002	0.003	0.004	0.020	0.020

transpiration rate at 5 MAP and at harvest by 19.5 and 27.2 per cent respectively below the values of control. The effect of salicylic acid in reducing the rate of transpiration was confirmed in previous works (Saavedra, 1978).

Salicylic acid spray recorded values of 1.46, 5.18, 6.55 and 1.24 at 3, 5, 7 MAP and at harvest which were 19.7, 12.4, 14.3 and 49.4 per cent increase over control respectively. Benzyl adenine and 2, 4-D performed poorly with low values in most of the stages. The results indicated that salicylic acid and growth retardant chemicals tended to increase stomatal diffusive resistance, while nitrobenzene, benzyl adenine and 2,4-D appeared to reduce the resistance. As stomatal resistance is an useful parameter in identifying drought resistant character, salicylic acid appears to be an useful tool for inducting resistance to drought. Eris (1983) observed significant increase in stomatal resistance in pepper with salicylic acid treatment. Anitha (2003) reported promotary effect of cycocel treatment on stomatal resistance in banana leaves, which is in conformity with the present findings as all growth retarding chemicals including CCC (cycocel) maintained positive influence on stomatal resistance.

All the growth regulator treatments recorded the leaf temperature below that of control treatment and salicylic acid appeared to lower the leaf temperature consistently in all the stages. Mepiquat chloride and cycocel also reduced the temperature considerably. On the other hand, nitrobenzene, benzyl adenine and 2, 4-D effected high leaf temperature among the chemicals tried. The reduced leaf temperature values in certain growth regulator treatments might be attributed to the maintenance of better water status in leaf tissues (Table 2).

Table 2 : Effect of plant growth regulators on leaf temperature (^oC), bunch weight (kg) at different growth stages of banana v. Ney Poovan

Treatment	Leaf temperature (^oC)			Bunch weight (kg)
	3 MAP	5 MAP	7 MAP	
Control	30.7	30.7	29.4	11.0
Mepiquat chloride 500 ppm	29.0	29.2	27.2	11.56
Chlormequat chloride 100 ppm	29.5	28.5	27.2	11.54
Ethrel 500 ppm	29.6	29.3	27.4	10.93
Salicylic acid 100 ppm	29.1	28.4	26.9	12.58
Nitrobenzene 100 ppm	30.6	30.3	28.7	11.51
Benzyladenine 20 ppm	30.4	29.3	28.1	12.52
2, 4-D 25 ppm	30.6	30.4	29.0	11.97
Mean	30.0	29.5	28.0	11.69
CD (p=0.05)	0.080	0.089	0.087	0.09

Among the treatments (salicylic acid 100 ppm) recorded highest total chlorophyll content followed by benzyl adenine 20 ppm at all growth stages. The maximum pigmentation was observed at shooting stage (1.48 and 1.47, for salicylic acid and benzyl adenine respectively), which recorded increases of 5.0 and 4.3 per cent over control respectively. Increase in chlorophyll content by salicylic acid spray was reported by many early workers in different crops (Setia *et al.,* 1995; Kalpana, 1997; Sivakumar, 2000). The reason adduced for enhanced chlorophyll biosynthesis by phenolic substances was that the phenolics inhibited chlorophyllase enzyme which led to higher accumulation of chlorophyll (Paricha *et al.,* 1977).

Table 3 : Effect of plant growth regulators on total chlorophyll content, soluble protein content, IAA oxidase activity at different growth stages of banana cv. Ney Poovan

Treatment	Total chlorophyll content (mg/g)			Soluble protein content (mg/g)			IAA oxidase activity (unoxidised auxin/ g/h)		
	3 MAP	5 MAP	7 MAP	3 MAP	5 MAP	7 MAP	3 MAP	5 MAP	7 MAP
Control	0.98	1.25	1.41	8.74	15.42	20.56	287.5	457.4	636.9
Mepiquat chloride 500 ppm	1.10	1.31	1.37	9.66	16.70	23.92	303.7	522.7	717.7
Chlormequat chloride 100 ppm	1.08	1.32	1.37	9.59	16.57	24.64	297.8	508.7	703.7
Ethrel 500 ppm	1.05	1.35	1.37	8.55	16.79	23.49	314.0	467.7	650.1
Salicylic acid 100 ppm	1.18	1.45	1.48	10.84	18.88	26.85	320.4	545.7	782.2
Nitrobenzene 100 ppm	1.04	1.32	1.38	8.69	16.69	24.97	293.1	482.2	658.9
Benzyladenine 20 ppm	1.17	1.43	1.44	10.66	18.47	26.18	309.9	534.0	766.9
2, 4-D 25 ppm	1.07	1.33	1.14	9.73	16.90	24.37	294.9	490.5	672.5
Mean	1.08	1.34	1.38	9.46	17.01	24.37	302.7	501.1	698.6
CD (p=0.05)	0.009	0.011	0.012	0.081	0.140	0.622	2.582	4.527	6.293

Soluble protein is one of the important parameter reflecting the photosynthetic ability. Among the chemicals and plant growth regulators, salicylic acid 100 ppm recorded significantly the maximum (26.85) soluble protein followed by (26.18) at shooting stage. The best treatment salicylic acid 100 ppm recorded an increase of 30.6 per cent over control at shooting stage. The treatments differed significantly among themselves at all the growth stages. The content was maximum, when salicylic acid was sprayed at 100 ppm and increase in content was above 22 per cent at 5 MAP and above 30 per cent both at 7 MAP and harvest over that of untreated plants. The content was also high in benzyl adenine treatment with more than 27 per cent increase after 7 MAP. It is pertinent to note that all the growth regulators studied were found effective in enhancing soluble protein content over that of control (Table 3). Anitha (2003) recorded more soluble protein content in CCC sprayed plants.

Salicylic acid 100 ppm clearly established the lead by recording significantly higher nitrate reductase enzyme activity at all the stages. Benzyl adenine 20 ppm was found to be the next best treatment. At shooting stage, the value of nitrate reductase in treatment was 268.40. The effective increase in nitrate reductase activity by salicylic acid was confirmed by many workers (Leslie and Romani, 1988; Jagadish Rane *et al.,* 1995; Kalpana, 1997). Salicylic acid was assumed to increase nitrate reductase activity by protecting the enzyme from inactivation (Gehlot *et al.,* 1998). Lu *et al,* (1992) stated that the well known increase in nitrate reductase activity by cytokinin was expressed at the level of nitrate reductase – mRNA, which was increased by cytokinin. This might be the reason for the good performance of benzyl adenine, a synthetic cytokinin, in the present study.

Among the treatments (salicylic acid 100 ppm) recorded highest IAA oxidase activity ppm at all growth stages. Significant differences were observed among various chemicals and plant growth regulator treatments at all stages of crop growth. (Salicylic acid 100 ppm) portrayed a value of 728.18 during shooting stage and it maintained the superiority over the other treatments in every growth stage by recording higher unoxidised auxin contents. Closely followed in all the growth phenophases. Sivakumar (2000) revealed that salicylic acid was capable of inhibiting IAA oxidase activity, and thereby increased the auxin content which was in agreement with the present finding. Jose *et al.* (1991) had confirmed that phenolics had the property to suppress IAA destruction. Salicylic acid, being a phenol, might have reduced the IAA oxidase activity and enhanced unoxidised auxin content.

The maximum bunch weight of 12.58 kg was recorded by giving foliar spray of salicylic acid at 100 ppm level, which resulted in 13.9 per cent increase over untreated control. Benzyl adenine treatment also performed better with 12.52 kg bunch weight and 13.4 per cent increase over control. As a culmination of favorable effects of major yield components, namely number of hands, number of fingers and finger weight, obtained by salicylic acid treatment, the maximum bunch weight of 12.58 kg was recorded in this treatment.

REFERENCES

Anitha, R. (2003). Physiological investigations in banana cv. Grand Nain as influenced by certain plant growth regulators and chemicals. M.Sc.(Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Anonymous (2001). Production statistics. Association for the Improvement in Production and Utilization of Banana (AIPUB), Trichy.

Barrs, H.D., and Weatherley, P.E. (1962). A re-examination of the relative targidity technique for estimating water deficit in leaves. *Aust. J. Biol. Sci.,* **15**:413-428.

Bennett, J.M., Boote, K.J. and Hammond, L.C. (1981). Alterations in the components of peanut leaf water potential during desiccation. *J. Exptl. Bot.,* **32**:1035-1043.

Eris, A. (1983). Effect of salicylic acid and some growth regulators on stomatal resistance of pepper seedling leaves. *Acta Hort.*, **137**:189-192.

Gehlot, H.S., Purohit, Sanjay, Bora, K.K. and Bohra, S.P. (1998). Salicylic acid : A new PGP in signal transduction. In: "Advances in Plant Physiology". Eds. A. Hemantarajan Scientific Publishres, Jodhpur. Pp. 273-289.

Jain, A. and Srivastava, H.S. (1981). Effect of salicylic acid on nitrate reductase activity in maize seedlings, *Physiol. Plant.,* **51**: 339-342.

Jose, O., Siqueira, G., Muraleedharan, Nair, Raymaond Hammer Schmidt and Gene R. Safir (1991). Significance of phenolic compounds in plant – soil – microbial systems. *Critical Rev. Plant Sci.,* **10** : 63-121.

Kalpana, S. (1997). Studies on the effect of botanicals, chemicals and plant growth regulators on growth and productivity in rice (*Oryza sativa* L.) var. ADT 36. M.Sc. (Ag.) Thesis, submitted to TamilNadu Agricultural University, Coimbatore.

Leslie, C.A. and Romani, R.J. (1988). Inhibition of ethylene biosynthesis by salicylic acid *Plant Physiol.*, **88**: 833-837.

Lu, J.L., Ertl, J.R. and Chen, C.M. (1992). Transcriptional regulation of reductase mRNA levels by cytokinin-abscissic acid interactions in etiolated barley leaves. *Plant Physiol.,* **98**: 1255-1260.

Marschner,H. (1995). Mineral Nutrition of Higher Plants.Second Ed: Harcourt Brace and Company, Publishers, London.

Paricha, P.C., Ghosh, B.K. and Saboo, N.C. (1977). Further studies on the significance of cycocel in enhancing drought resistance in rice. *Science Culture,* **43**: 230-231.

Rane Jadagish, Karuna, C., Lakkineni, P., Kumar , Anand and Abrol, Y.P. (1995). Salicylic acid protects nitrate reductase activity of wheat leaves. *Plant Physiol. Biochem.*, **22**: 119-121.

Saavedra, A.L. (1978). The antitranspirant effect of acetylsalicylic acid on *Phaseolus vulgaris*. *Physiol. Plant.,* **43**:126-128.

Setia, R.C., Bathal, Gurmeet and Setia, Neelam (1995). Influence of paclobutrazol on growth and yield of *Brassica carinata*. *Plant Growth Regulation,* **16**: 121-127.

Sivakumar, R. (2000). Physiological studies on increasing yield potential in pearlmillet (*Pennisetum glaucum* L.R. Br.) with plant growth regulators and chemicals. *MSc. (Ag.) Thesis*, submitted to Tamil Nadu Agricultural University, Coimbatore .

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