DOI : 10.5958/0974-0112.2022.00026.3

Indian J. Hortic. 79(2), June 2022: 197-201

Application of growth substances through tree injection in banana for increasing yield and fruiting characters

J. J. Patel*, T. R. Ahlawat, S. Kumar, B. M. Tandel and N. B. Patel

Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari- 396 450, Gujarat, India.

ABSTRACT

The present investigation was carried out on banana cv. Grand Naine, treated with nine chemical treatments viz., control (T1), GA3 @ 10 ppm (T2), GA3 @ 20 ppm (T3), GA3 @ 30 ppm (T4), BA @ 2.5 ppm (T5), BA @ 5.0 ppm (T6), NOVEL+ @ 0.5 % (T7), NOVEL+ @ 1.0 % (T8), NOVEL+ @ 1.5 % (T9), applied through injection at the time of bell emergence. The results revealed that the injection of GA3 @ 30 ppm (T4) tended to show the maximum bunch weight (36.38 kg), fruit yield (126.31t/ha), bunch length (101.78 cm), bunch girth (119.17 cm), finger length (22.96 cm), finger girth (13.99 cm) and finger weight (205.78 g), took minimum days from flowering to harvest (89.28). However, the maximum number of fingers per bunch (179.89) and number of hands per bunch (14.06) were observed under the injection of NOVEL+ @ 1.5 % (T9), followed by GA3 @ 30 ppm (T4).

Keywords: *Musa paradisiaca* L, Gibberellic acid, Benzyladenine, Tree injection.

INTRODUCTION

Banana (*Musa paradisiaca* L.) is a large herbaceous perennial monocotyledonous and monocarpic crop , having immense nutritional, medicinal and industrial values. This is interwoven with Indian heritage and culture too. Owing to its greater socio-economic significance and multifaceted uses, it is referred as “Kalpatharu” (Plant of virtues). The ‘Grand Naine’ banana literally translated from French means “Large Dwarf”. It is a cultivar of wellknown Cavendish banana group, which is distinguished from other groups by its AAA genotype. It’s characteristically medium height and large fruit yield make it ideal for commercial cultivation.

Now-a-days, several plant growth regulators and organic amendments are being applied for improving the growth, maturity, yield and quality of banana fruits. Gibberellins are phytohormones, known to contribute in growth by both ways, namely cell division and cell elongation. After anthesis, it is the cell expansion and cell density, which contribute the most for fruit growth and as such, a positive correlation between growth of fruit tissues and gibberellin level is well established (Jackson and Coombe, 6).

BA (6-Benzyladenine), also called asb BAP (6-benzylaminopurine), is a synthetic cytokinins that stimulates protein synthesis and participates in cell cycle control in a cell division. 6-BA has been proved very effective in improving fruiting of various crops through its benefit in enhancing cell enlargement, morphogenesis, development of plastids and stomatal aperture and in delaying the breakdown of chlorophyll, proteins and RNA (Ashour *et al.*, 2).

Novel plus organic liquid nutrients (NOVEL$^+$), internationally patented in year 2012 by Navsari Agricultural University, Navsari is made from the banana pseudostem. It has been prepared using only organic input, and hence suitable for use in organic farming system as liquid formulation. NOVEL$^+$ contains several nutrients including N, P, K, Ca, Mg, S, B, S, Mn, Cu, Zn, Fe *etc.* Besides, it also contains plant growth hormones like gibberellic acid and cytokinins. NOVEL$^+$ has also been found to contain bacteria which can improve soil health and additional insecticidal properties due to incorporation of different botanicals in formulation which collectively improve the production and quality of banana fruit. It can be use in different crops in different stages using various methods like fertigation, drenching, foliar spray, injection, cone feeding *etc.* (Kolambe *et al.*, 7).

Application of growth substances through injection is a new technique in banana. It was therefore felt worthwhile to study the influence of growth substances through injection on yield and fruiting characters of banana cv. ‘Grand Naine’.

MATERIALS AND METHODS

The present investigation was carried out at Instructional Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2018-19. The experimental plot was prepared

*Corresponding author: jollypatel176@gmail.com

by deep ploughing, harrowing and levelling. The pits of 30 cm × 30 cm × 30 cm were dug out at a spacing of 2.4 m × 1.2 m and well decomposed fine textured farm yard manure at the rate of 10 kg per pit was applied at the time of planting. Well hardened, healthy tissue culture plants of banana cv. 'Grand Naine' having 5-6 leaves were used for planting. Each plant was fed up with 300 g N, 90 g P_2O_5 and 200 g K_2O. Nitrogen was applied at 2nd, 3rd, 4th and 5th months after planting in four equal splits doses while, potash was applied at 3rd, 4th and 5th months after planting in three equal splits doses. Further, the entire dose of phosphorus was applied at 2nd month after planting.The experiment was laid out in Completely Randomized Design with three repetitions and nine treatments *viz.,* control (T_1), GA_3 @ 10 ppm (T_2), GA_3 @ 20 ppm (T_3), GA_3 @ 30 ppm (T_4), BA @ 2.5 ppm (T_5), BA @ 5.0 ppm (T_6), NOVEL+ @ 0.5 % (T_7), NOVEL+ @ 1.0 % (T_8), NOVEL+ @ 1.5 % (T_9). The solution (100 ml) was injected at the base of ¼th tip of spathe at the time of bell emergence. Growth substances were injected into the bell, while it was still upright using an injection gun (Fig. 1). The number of days taken from initiation of flowering to harvest was recorded and then averaged was calculated. The observations on yield attributing characters like number of fingers per bunch, number of hands per bunch, bunch weight (kg), fruit yield (t/ha) and fruiting characters like length of bunch (cm), girth of bunch (cm), finger length (cm), finger girth (cm) and finger weight (g) were recorded at commercial maturity of bunch.The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Panse and Sukhatme (11).

Fig. 1. Injecting of different growth substances

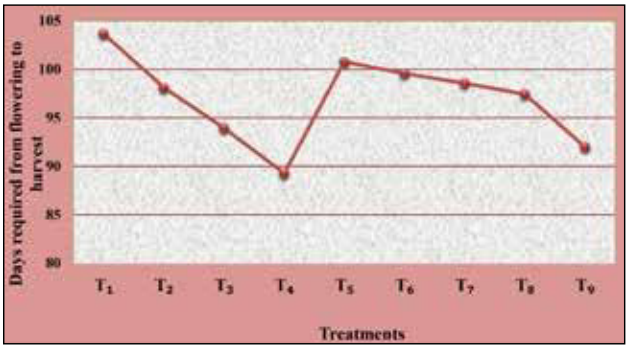

Fig. 2. Effect of growth substances through injection on days required from flowering to harvest in banana cv. 'Grand Naine'

RESULTS AND DISCUSSION

The days required from flowering to harvest was significantly influenced by different treatments (Fig.2). The minimum days required from flowering to harvest was observed in injection of GA_3 @ 30 ppm (T_4), which was statistically at par with NOVEL+ @ 1.5 % (T_9) (92.00 days), GA_3 @ 20 ppm (T_3) (93.94 days) and NOVEL+ @ 1.0 % (T_8) (97.44 days). The maximum duration required from flowering to harvest was noted in control (T_1).This might be due to the involvement of GA_3 stimulus in fruit set wherein pollen substances is a co-enzyme or activator of enzymatic systems present in the ovary, which liberate active hormones from the storage pools (Prasad *et al.,*13). Similar results were also reported by Biswas and Lemtur (3) in banana.

The results of the investigation in Table 1 revealed that the different treatments had a significant effect on number of fingers per bunch and number of hands per bunch, bunch weight and fruit yield. Significantly, the maximum number of fingers per bunch (179.89) was found in injection of NOVEL+ @ 1.5 % (T_9), which was statistically at par with GA_3 @ 30 ppm (T_4) and NOVEL+ @ 1.0 % (T_8). The minimum number of fingers per bunch (140.11) was noted in control (T_1). Similarly, number of hands per bunch was found to be significantly maximum (14.06) under treatment NOVEL+ @ 1.5 % (T_9), which was significantly at par with GA_3 @ 30 ppm (T_4) being 13.22, while it was minimum in control (T_1) treatment *i.e.* 9.05.It might be due to novel plus organic liquid nutrients, which has lavish amount of macro- and micro-nutrients, ameliorating the photosynthetic activity and promoting the production as well as allocation of carbohydrates and photosynthates. The syngergistic effect may have contributed to increased number of fruits. It contains higher amount majority of essential nutrients especially N and K, which ultimately increased the number of fingers per bunch and number of hands per bunch (Gurjar, 5). The similar findings have also been reported in banana (Anon, 1).

Table 1. Effect of growth substances through injection on yield attributing characters of banana cv. 'Grand Naine'.

Treatments	Number of fingers per bunch	Number of hands per bunch	Bunch weight (kg)	Fruit yield (t/ha)
T_1 - Control	140.11	9.05	22.56	78.33
T_2 - GA_3 @ 10 ppm	160.34	11.61	28.00	97.23
T_3 - GA_3 @ 20 ppm	163.67	12.11	31.17	108.23
T_4 - GA_3 @ 30 ppm	178.34	13.22	36.38	126.31
T_5 - BA@ 2.5 ppm	152.33	10.61	25.71	89.27
T_6 - BA@ 5.0 ppm	155.94	11.00	26.74	92.86
T_7 - NOVEL$^+$@ 0.5 %	161.95	12.17	29.13	101.15
T_8 - NOVEL$^+$@ 1.0 %	170.28	12.67	31.13	108.08
T_9 - NOVEL$^+$@ 1.5 %	179.89	14.06	35.53	123.35
S.Em.±	4.89	0.42	1.03	3.56
C.D. @ 5 %	14.52	1.26	3.05	10.59
C.V. %	5.21	6.19	6.01	6.01

Injection of GA_3 @ 30 ppm (T_4) gave the maximum bunch weight (36.38 kg) in banana without any significant difference with NOVEL$^+$ @ 1.5 % (T_9) being 35.53 kg, whereas, it was minimum (22.56 kg) in control (T_1). The maximum fruit yield (126.31 t/ha) was noticed under injection of GA_3 @ 30 ppm (T_4), having similarity statistically with NOVEL$^+$ @ 1.5 % (T_9). The minimum fruit yield (78.33 t/ha) was noted in control (T_1). Gibberellins are phyto-hormones, known to contribute to growth by both ways, namely cell division and cell elongation. After anthesis, it is the cell expansion and cell density, which contribute the most for fruit growth. The positive correlation between growth of fruit tissues and gibberellins level is already well known (Jackson and Coombe, 6). It might be due to rapid cell division, cell elongation by enlargement of vacuoles and loosening of cell wall after increasing cell wall plasticity, translocation of sugars, which contributed towards such an increase in bunch weight and fruit yield (Priya and Pandian, 14). Exogenous application of gibberellin in the present investigation might be the reason behind protein synthesis in active state, and promoted fruit growth. This may also be a result of increased cell division and cell elongation induced by the application of GA_3. Increase in finger size and finger weight, may have contributed to an overall increase in bunch weight and fruit yield. It is already established that GA_3 does bring about certain metabolic changes, which are reflected by more accumulation of food constituents in the fruit and thereby through increased weight of an individual fingers as well as bunch (Digal, 4). Similar results were also reported by Patel *et al.* (12) in banana.

The results obtained under fruiting characters *viz.,* length and girth of of bunch, length and girth of finger and finger weight were significantly influenced by growth substances (Table 2). Significantly the maximum length of bunch (101.78 cm) was observed in injection of GA_3 @ 30 ppm (T_4), which was statistically at par with NOVEL$^+$ @ 1.5 % (T_9) and GA_3 @ 20 ppm (T_3). However, minimum bunch length (77.00 cm) was noted in control (T_1). Significantly the maximum girth of bunch (119.17 cm) was observed under injection of GA_3 @ 30 ppm (T_4), which did not differ significantly with NOVEL$^+$ @ 1.5 % (T_9) and GA_3 @ 20 ppm (T_3). The minimum girth of bunch (98.72 cm) was recorded in control (T_1). In agreement with these findings (Kumar and Sharma, 9), gibberellins may have contributed to fruit growth through induction of rapid cell division and cell elongation. It might be due to increased activity of enzyme, enhanced membrane proliferation and stimulated cell division as well as elongation by altering the auxin status of the tissue (Kumar, 8). .

In the present experiment, injection of different growth substances had a significant effect on finger length, finger girth and finger weight. Significantly, the longest finger length (22.96 cm) was noted in injection of GA_3 @ 30 ppm (T_4), followed by NOVEL$^+$ @ 1.5 % (T_9) and GA_3 @ 20 ppm (T_3)while, the shortest finger length (19.05 cm) was observed in T_1 (control). Significantly the maximum finger girth (13.99 cm) was reported under injection of GA_3 @ 30 ppm (T_4), which was statistically at par with NOVEL$^+$ @ 1.5 % (T_9) and GA_3 @ 20 ppm (T_3). However, it was minimum (12.07 cm) was noted in control (T_1). Gibberellic acid promotes fruit growth by increasing plasticity of the cell wall followed by the hydrolysis of starch into sugars which reduces the cell water potential, resulting in the entry of water into the cell

Table 2. Effect of growth substances through injection on Fruiting characters of banana cv. 'Grand Naine'.

Treatments	Length of bunch (cm)	Girth of bunch (cm)	Finger length (cm)	Finger girth (cm)	Finger weight (g)
T_1 - Control	77.00	98.72	19.05	12.07	160.76
T_2 - GA_3 @ 10 ppm	92.33	105.22	20.50	12.42	174.78
T_3 - GA_3 @ 20 ppm	96.89	114.67	22.07	13.48	190.74
T_4 - GA_3 @ 30 ppm	101.78	119.17	22.96	13.99	205.78
T_5 - BA@ 2.5 ppm	86.78	103.44	19.86	12.16	168.50
T_6 - BA@ 5.0 ppm	89.89	104.72	20.08	12.30	171.47
T_7 - NOVEL$^+$@ 0.5 %	91.22	105.50	20.17	12.50	180.03
T_8 - NOVEL$^+$@ 1.0 %	91.83	107.00	20.66	12.54	183.04
T_9 - NOVEL$^+$@ 1.5 %	98.06	117.67	22.16	13.71	197.16
S.Em.±	3.04	3.29	0.68	0.45	6.40
C.D. @ 5 %	9.04	9.78	2.03	1.34	18.95
C.V. %	5.74	5.26	5.69	6.09	6.09

and causing elongation. Therefore, it is responsible for the increased in finger length and girth may result from cell enlargement (Majumder *et al*., 10). It might also be due to significant increase in finger size and proper nutritional supply to the developing fingers associated with photosynthetic capacity and translocation of photosynthates to the fingers with the application of GA_3 (Kumar and Sharma, 9). The results are in agreement with finding of Digal (4) in banana.

Significantly, the highest finger weight (205.78 g) was noticed in in injection of GA_3 @ 30 ppm (T_4) treated plants closely followed by NOVEL$^+$ @ 1.5 % (T_9) and GA_3 @ 20 ppm (T_3), while it was lowest (160.76 g) in control (T_1). An increase in finger weight might be attributed to the strengthening of the middle lamella and consequently cell wall, which later may have increase solutes in free passage of the fruits. By application of GA_3, certain changes of fruit are improved which reflected in more accumulation of water and enhanced deposition of soluble solids (Priya and Pandian, 14). It might also be due to application of GA_3 may be ascribed to greater photosynthesis and plant metabolism that enable higher cell growth, cell expansion which in turn producing bigger fruit size with respect to maximum fruit length and girth (Majumder *et al*., 10). These results are in conformity with those of Patel *et al.* (12) in banana and Digal (4) in banana.

From the result of the present experiment, it can be concluded that injection of GA_3 @ 30 ppm at the time of bell emergence enhanced the yield and yield contributing traits with minimum duration from flowering to harvest in banana cv. 'Grand Naine'. Further, application of NOVEL$^+$ @ 1.5 % recorded the maximum number of fingers per bunch and number of hands per bunch. It also emerged as the second best treatment for maturity, yield attributing characters and fruiting characters in banana cv. 'Grand Naine'.

AUTHORS' CONTRIBUTION

Conceptualization of research (TRA); Designing of the experiments (JJP, NBP); Contribution of experimental materials and Execution of field experiments, data collection (JJP, SK, BMT); Analysis of data and interpretation (JJP, TRA); Preparation of the manuscript (JJP, TRA).

DECLARATION

The authors declare that they have no conflict of interest.

REFERENCES

1. Anonymous 2014. Effect of enriched banana pseudostem sap (injection) at pre-flowering stage on production and quality of banana var. Grand Naine. *10th AGRESCO Report*, S.W.M.R.U., N.A.U., Navsari, pp. 128.

2. Ashour, N. E., Mostafa, E. A. M., Malaka, A. S. and Omaima, M. H. 2018. Effect of GA_3, 6-benzylaminopurine and boric acid spraying on yield and fruit quality of Barhee date palm. *Middle East J. Agric. Res*. **7**: 278-86.

3. Biswas, P. K. and Lemtur, K. 2014. Effect of growth regulators and certain organic sprays on bunch characters in banana cv. Robusta. *Asian J. Hortic*. **9**: 269-71.

4. Digal, J. R. 2016. Effect of bunch management and chemical treatments on maturity, yield and quality of banana (*Musa paradisiaca* L.) cv. Grand Naine. *M. Sc. Thesis,* Navsari Agricultural University, Navsari, Gujarat, India.

5. Gurjar, T. 2017. Effect of foliar spray of novel organic liquid fertilizer and micronutrients on yield and quality of banana cv. Grand Naine. *Ph. D. Thesis,* Navsari Agricultural University, Navsari, Gujarat, India.

6. Jackson, D. I. and Coombe, B. G. 1966. Gibberellin-like substances in the developing apricot fruit. *Science* **54**: 277-78.

7. Kolambe, B. N., Patel, K. K., Pawar, S. L., Patel, J. M., Prajapati, D. R. and Anand, V. 2013. A novel organic fertilizer of banana pseudostem. *Patent WO 2013001478 A1*.

8. Kumar, C. P. 2010. Studies on effect of growth substances spray, bunch sleeving and urea bunch stalk feeding on improvement of yield and quality attributes of banana cv. Nanjanagudu Rasabale. *M. Sc. Thesis*, University of Agricultural Sciences, Bangalore, Karnataka, India.

9. Kumar, T. K. and Sharma, M. K. 2016. Effect of GA_3 in combination with urea phosphate and BA on yield and physical quality parameters of grape cv. Thompson Seedless. *BioScan.* **11**: 49-52.

10. Majumder, I., Sau, S., Ghosh, B., Kundu, S., Roy, D. and Sarkar, S. 2017. Response of growth regulators and micronutrients on yield and physio-chemical quality of ber cv. BAU Kul-1. *J. Appl. Nat. Sci.* **9**: 2404- 409.

11. Panse, V. G. and Sukhatme, P. V. 1985. "*Statistical Methods for Agricultural Workers*", ICAR, New Delhi, pp. 152-61.

12. Patel, C. M., Patel, N. L., Gaikwad, S. S. and Patil, S. J. 2011. Effect of post-shooting treatments on yield and it's attributes of banana (*Musa paradisiaca* L.) cv. Grand Naine. *Green Farming* **2**: 210-12.

13. Prasad, M., Minz, M., Kumar, R. and Das, B. 2012. Effect of mulching and PGRs on growth, yield and economics of strawberry (*Fragaria ananassa* Duch.) cv. Douglas. *J. Interacad.* **16**: 44-55.

14. Priya, G. and Pandian, B. J. 2019. Effect of post shooting foliar spray on yield attributes, yield and economics of tissue culture Nendran banana. *J. Pharmacogn. Phytochem.* **8**: 2146-49.

Received : September 2021; Revised : June 2022;
Accepted : June 2022