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Effect of post shooting bunch spray of chemicals on maturity and quality of banana (*Musa Paradisiaca* L.) cv. Grand Naine

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Abstract
An experiment entitled "Effect of post shooting bunch spray of chemicals on maturity and quality of banana (*Musa paradisiaca* L.) cv. Grand Naine" was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during the year 2015-2016. The experiment was laid out in Randomized Block Design (RBD) with twelve treatments and three replications. The treatments included GA_3 @ 50 mg l^{-1} (T_1), GA_3 @ 100 mg l^{-1} (T_2), NAA @ 50 mg l^{-1} (T_3), NAA @ 100 mg l^{-1} (T_4), Ethephon @ 0.1 ml l^{-1} (T_5), Ethephon @ 0.2 ml l^{-1} (T_6), CPPU @ 1 mg l^{-1} (T_7), CPPU @ 2 mg l^{-1} (T_8), Brassinosteroid @ 1 mg l^{-1} (T_9), Brassinosteroid @ 2 mg l^{-1} (T_{10}), SOP @ 1.5% (T_{11}) and Control (T_{12}). The first spray was given immediately after complete opening of the bunch and second spray was given at 20 days after first spray. The results of present investigation revealed that the banana bunches when sprayed with Ethephon @ 2 ml l^{-1} shortened the maturity period of cv. Grand Naine banana. Whereas, bunches sprayed with Brassinosteroid @ 2 mg l^{-1} found higher TSS and Pulp: Peel ratio of banana.

Keywords: Banana, Bunch, Brassinosteroid, Spray, Grand Naine.

Introduction
India has remained the largest producer of banana in the world for past one decade. In India, banana is well adopted in the regions varying from humid tropic to humid subtropics and semi-arid subtropics, and up to 2,000 m above mean sea-level. In India, banana is fourth important crop in terms of gross value and is exceeded only by paddy, wheat and milk products. It is also a dessert fruit for millions, apart from a staple food owing to its rich and easily digestible carbohydrates with a calorific value of 67-137/100 g fruit. It is a good source of Vitamin A (190 IU per 100 g of edible portion) and Vitamin C (100 mg/100g) and fair source of Vitamin B_1 and B_2. Fruits are also rich source of minerals like magnesium, sodium, potassium, phosphorus and a fair source of calcium and iron. It makes healthy and salt free balanced diet than many other fruits. One hectare of banana yields 37.5 million calories of energy as compared to 2.5 million calories from wheat and multifarious uses. As a diet, it is highly satisfying, easy to digest, nearly fat free, rich source of carbohydrate with calorific value of 375 kJ per 100 g. It contains various vitamins and has therapeutic values for the treatment of many diseases (Singh, 2007) [12]. Now-a-days, the practice of application of plant growth regulators, chemicals and bunch management treatments are taken for improving the growth, maturity, yield and quality of banana fruits are gaining popularity. Plant growth regulators are perhaps the most powerful tool to achieve the goal. PGRs have been successfully used as foliar spray to increase flowering, synchronize bloom or change the time of flowering to avoid the adverse climatic condition or to shift harvest to a time when the market price is more remunerative. PGRs are applied to delay or advance maturity and also to increase the fruit quality directly or indirectly by altering the chain of physiological activities inside the cell.

Materials and Method
The present investigation on “Effect of post shooting spray of chemicals on bunch characters and yield of banana (*Musa paradisiaca* L.) cv. Grand Naine” was carried out at Regional Horticultural Research Station, Navsari Agricultural University, Navsari. Uniform tissue cultured grand naine banana were planted and sprayd twice once at complete opening of infloesence and other after 20 datreatment comprised of the spray of viz., GA_3 @ 50 mg

l^{-1} (T_1), GA_3 @ 100 mg l^{-1} (T_2), NAA @ 50 mg l^{-1} (T_3), NAA @ 100 mg l^{-1} (T_4), Ethephon @ 0.1 ml l^{-1} (T_5), Ethephon @ 0.2 ml l^{-1} (T_6), CPPU @ 1 mg l^{-1} (T_7), CPPU @ 2 mg l^{-1} (T8), Brassinosteroid @ 1 mg l^{-1} (T_9), Brassinosteroid @ 2 mg l^{-1} (T_{10}), SOP @ 1.5% (T_{11}) and Control (T_{12}) were evaluated in Randomly block design with three repetition. The experimental plot was prepared by deep ploughing, harrowing and levelling. The pits of 30 x 30 x 30cm were dug out at a spacing of 2.4 x 1.2 m^2 and well-decomposed fine textured Farm Yard Manure (FYM) at the rate of 10 kg per pit was applied at planting. Well hardened, healthy tissue culture plants of Grand Naine banana having 5-6 leaves were used for planting. After full emergence of inflorescence the male bud was removed and sprayed with chemicals first after the complete opening of inflorescence and second 20 days after first spray. Bunches were covered with blue polythene covers of 50 micron in all the treatments immediately after second spray. Observations were recorded daily for maturity and quality characters *i.e*. Days required from flowering to harvest, Pulp :skin ratio, TSS (^{0}Brix), Acidity (%), Ascorbic acid (mg/100g), Reducing sugars (%), Total sugars (%), Physiological loss in weight (%) and Shelf life (days) were recorded. The number of days taken from flowering to harvest were recorded and then averaged.The fruits which were used for recording the weight loss during ripening, were used to calculating pulp: skin ratio. Pulp to skin ratio was calculated by dividing respective pulp weight by respective skin weight. The TSS value of the fruit was recorded by using hand refractometer having range of 0-32 ^{0}Brix. Acidity (%) was calculated by the method described by Rangana (1977) [11] was adopted for estimation of titrable acidity. Titrable acidity was expressed as percentage malic acid equivalent adopting the following formula.

$$\text{Acidity (\%)} = \frac{\text{Titre x Normality of alkali}}{\text{Volme of sample taken for estimation}} \times \frac{\text{Volume made up}}{\text{Weight of sample}} \times \frac{\text{Eq. Wt. of Malic acid}}{1000} \times 100$$

Reducing sugar (%) was assessed by the titrimetric method of Lane and Eynon described by Rangana (1977) [11]. was adopted for estimation of reducing sugar.

The percentage of reducing sugar was calculated according to following formula.

$$\text{Reducing sugar (\%)} = \frac{\text{Glucose Eq. (0.05)}}{\text{Titre}} \times \frac{\text{Total volume made up}}{\text{Weight of the pulp}} \times 100$$

The total sugars content was expressed as percentage in terms of invert sugars according to the formula.

$$\text{Total sugar (\%)} = \frac{\text{Glucose Eq. of Fehling's solutions (0.05)}}{\text{Titre}} \times \frac{\text{Total volume made up}}{\text{Weight of pulp taken}} \times \frac{\text{Volume made up after inversion}}{\text{Aliquot taken for inversion}} \times 100$$

Ascorbic acid (Vitamin – C) content (mg/ 100 g pulp) was calculated by the titrimeter method described by Ranganna (1977) [11] was adopted. Ascorbic acid content was calculated adopting the following formula.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre x Dye equivalent (0.04) x Dilution}}{\text{Weight of sample}} \times 100$$

The shelf life of fruit was noted by keeping the fruits at room temperature and humidity conditions. The shelf life of fruits was recorded as the days taken from harvesting to optimum eating stage.

The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Panse and Sukhatme (1967) [7].

Results and Discussion

For assessing the influence of different treatments on maturity and quality parameters viz., TSS, acidity, ascorbic acid, reducing sugars, non-reducing sugar, total sugars, pulp :peel ratio, physiological loss in weight and shelf life in banana fruit were determined. Among these parameters, all the parameters were significantly affected due to different treatments of the study except acidity content in fruit.

In present investigation Ethephon @ 2 ml l^{-1} shortened the maturity period of cv. Grand Naine banana. Also increase TSS and Pulp: Peel ratio was found superior in Brassinosteroid @ 2 mg l^{-1}. Minimum physiological loss in weight and maximum shelf life of banana fruit was observed when bunches sprayed with CPPU @ 2 mg l^{-1}.

Days required from bunch opening to harvest was significantly influenced by different chemicals. The minimum days required for bunch opening to harvest were observed in Ethephon @ 0.2 ml l^{-1} (T_6) treatment. The maximum days required for bunch opening to harvest was noted in control (T_{12}). The activity of ethephon has been attributed primarily

to its ability to release ethylene in plant tissues. Ethylene stimulates respiration and protein synthesis in certain immature fruits, which may trigger a chain of biochemical events required for ripening.

Presently ethylene is considered to be one of the main ripening phyto-hormone and plant responses, which were formerly believed to be due to presence of auxins, are now being ascribed to induced ethylene production. Further, the dramatic influence of ethylene on fruit maturity and ripening has been demonstrated. Similar findings are in conformity with those of Parmar and Chundawat (1984) [8] and Gandhi (1984) [4] and Patel *et al.* (2011[a]) [9] in banana.

The data clearly revealed the significant differences and the maximum TSS (21.41 ^{0}Brix) was observed in bunch spray of Brassinosteroid @ 2 mg l^{-1} (T_{10}), The minimum TSS (18.15 ^{0}Brix) was observed in control (T_{12}).Total soluble solid concentration (TSS, measured as % Brix) of fruits is an important variable which is used to determine fruit quality because TSS is most commonly associated with sugar and organic acid concentrations (Young *et al*., 1993) [13]. The % Brix index includes all soluble solids like sucrose, fructose, glucose, vitamins, amino acids, protein, organic acids, minerals and hormones. Each % of Brix is equal to 1 gram of soluble solids in 100 g of fresh mass. It can thus be postulated that Brassinosteroid ameliorate the fruit quality, because it is associated with sugar and organic acid concentrations (Young *et al*. 1993) [13]. Similar result was found by Anitha *et al*. (2005) [1] in banana and Gomes *et al*. (2006) [5] in passion fruits.

The perusal of the data showed that different post-shooting bunch spray of chemical treatments had significant effect on pulp: peel ratio. Significantly the highest pulp: peel ratio (3.31) was noted in T_{10} (Brassinosteroid @ 2 mg l^{-1}) treatment. The minimum pulp :peel ratio (2.22) was noticed in NAA @ 50 mg l^{-1} (T_3). Higher pulp weight recorded in the treatment of BRs can be further attributed to the accelerated rate of cell division and enlargement favoured by auxin biosynthesis prompted by sulphur and potsaasium and as well as accelerated sink development aided by the brassinosterods. A similar effect can be attributed to peel weight. Similar results has been registered by Mulagund *et al*. (2015) [6] in banana.

The changes in the reducing sugars content in banana fruits as influenced by different chemical treatments showed that the different post-shooting treatments had significant effect on reducing sugars content and it was analyzed at eating ripening stage. Significantly the maximum reducing sugars content in banana fruit (6.59) was recorded in Brassinosteroid @ 2 mg l^{-1} (T_2). The minimum reducing sugars content (4.08) was recorded in control (T_{12}). Brassinosteroids treatment cause efficient conversion of starch into sugars thus bringing about increased value of sugar in percentage. Similar results were obtained by Anitha *et al*. (2005) [1] in banana.

It is evident from the data that the different post-shooting bunch spray of chemicals failed to show any significant differences in ascorbic acid content. However, the maximum ascorbic acid content was observed in Brassinosteroid @ 2 mg l^{-1} (8.58) and minimum ascorbic acid (5.32) content was noticed in Control (T_{12}). Ascorbic acid content of fruit was non-significant found minimum in all the treatments because rapid destruction of ascorbic acid during ripening of banana fruit due to presence of active enzymes, the conversion of starch to dextrose, levulose and sucrose. However, the maximum ascorbic acid (8.58) was noticed in Brassinosteroids (T_{10}).

The data indicated that the different post-shooting chemical treatments had significant effect on acidity content. The minimum acidity content (0.212 mg/100g) was found in T_8 (CPPU @ 2 mg l^{-1}). However the maximum acidity (0.332) was observed in control (T_{12}). Acidity when present at higher level in fruits is limiting factor for banana. Among the various treatments tried NAA gave low acid percentage which is due to the fact along with the NAA and polythene sleeves favoured the higher temperature inside which cause efficient conversion of starch into sugars thus bringing about reduction in acid percentage. Similar results were obtained by Chattopadhyay and Jana (1985) [2]. And Pradhan *et al*. (1988) [10]. In banana.

Data concerning to physiological loss in weight as influenced by different chemical treatments. The perusal of data showed that the different post-shooting bunch spray of chemical treatments had significant effect on physiological loss in weight and minimum physiological loss in weight (10.28%) at eating ripening stage was noted under spray of CPPU @ 2 mg l^{-1} (T_8) treatment. The maximum physiological loss in weight (16.57 %) during ripening eating stage was observed in T_6 (Ethephon @ 2 ml l^{-1}). The weight loss during ripening was significantly influenced by chemical sprays. Weight loss of fruit during ripening decreased as the concentration of ethephon increased. The probable reason for lesser weight, with an increase in concentration of ethephon, is that ethephon accelerates the chain of biochemical events required for ripening. Hence, it could be presumed that fruits under ethephon treatments took minimum time for ripening and thereby resulted in the minimum losses. This might be due to rapid rate of dehydration and respiration of fruits. More or less similar results were noticed by Parmar and Chundawat (1984) [8]. And Gandhi (1984) [4].

The data presented indicated that the different post-shooting treatments had significant effect on shelf life of banana fruit. The fruits were stored at ambient temperature for the maximum period of time (11.66 days) with the treatment of CPPU @ 2 mg l^{-1} (T_8). The minimum shelf life (7.89 days) was registered in T_6 (Ethephon @ 0.2 ml l^{-1}). CPPU (Forchlorfenuron) is a plant growth regulator, mostly used in to improve shelf life and quality. CPPU plays vital role in enhancing the physiological activities in many fruit crops including grapes. Similar results were obtained by Curry and Greene (1993) [3] in grape.

Table 1 : Effect of post shooting bunch spray of chemicals on days required from bunch opening to harvest, Pulp :Peel ratio, TSS (^{0}Brix), Acidity (%), Ascorbic acid (mg/100g), Reducing sugars (%), Total sugars (%), Physiological loss in weight (%) and Shelf life (days) of banana cv. Grand Naine**.**

1. Treatments	Days required from bunch opening to harvest	Pulp :Peel ratio	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)
T_1 – GA_3 @ 50 mg l^{-1}	91.00	2.91	20.25	0.256	8.00
T_2 – GA_3@ 100 mg l^{-1}	90.33	2.87	20.61	0.252	8.15
T_3 - NAA @ 50 mg l^{-1}	87.33	2.22	20.39	0.220	6.45
T_4 - NAA @ 100 mg l^{-1}	89.00	2.25	19.81	0.252	7.52
T_5- Ethephon @ 0.1 ml l^{-1}	82.00	2.63	20.50	0.257	6.12
T_6 - Ethephon @ 0.2 ml l^{-1}	80.33	2.29	20.09	0.258	6.37
T_7 - CPPU @ 1.0 mg l^{-1}	96.00	2.85	19.78	0.269	6.67
T_8 - CPPU @ 2.0 mg l^{-1}	92.33	2.73	19.79	0.212	6.99
T_9 - Brassinosteroid @ 1.0 mg l^{-1}	86.67	3.00	20.68	0.302	8.03
T_{10}- Brassinosteroid @ 2.0 mg l^{-1}	84.67	3.31	21.41	0.231	8.58
T_{11} - SOP @ 1.5%	93.67	3.17	20.01	0.287	5.75
T_{12} - Control	106.67	2.50	18.15	0.332	5.32
S.Em. ±	4.48	0.16	0.51	0.007	0.84
C.D. at 5%	13.13	0.47	1.49	0.021	NS
CV%	8.62	10.18	4.36	4.690	20.71

Table 2: Effect of post shooting bunch spray of chemicals on Reducing sugars (%), Total sugars (%), Physiological loss in weight (%) and Shelf life (days) of banana cv. Grand Naine.

Treatments	Reducing sugars (%)	Total sugars (%)	Physiological loss in weight (%)	Shelf life (days)
T_1 - GA_3 @ 50 mg l^{-1}	4.98	13.27	12.17	8.82
T_2 - GA_3 @ 100 mg l^{-1}	5.39	12.90	13.29	9.81
T_3 - NAA @ 50 mg l^{-1}	5.25	12.85	14.70	8.97
T_4- NAA @ 100 mg l^{-1}	5.59	12.91	14.93	9.01
T_5- Ethephon @ 0.1 ml l^{-1}	5.86	13.33	15.84	8.01
T_6 - Ethephon @ 0.2 ml l^{-1}	6.23	13.35	16.57	7.89
T_7 - CPPU @ 1.0 mg l^{-1}	4.82	11.29	10.57	10.21
T_8 - CPPU @ 2.0 mg l^{-1}	4.95	12.16	10.28	11.66
T_9 - Brassinosteroid @ 1.0 mg l^{-1}	6.47	13.98	11.03	9.35
T_{10}- Brassinosteroid @ 2.0 mg l^{-1}	6.59	14.11	11.17	10.10
T_{11}- SOP @ 1.5%	5.80	13.16	12.13	8.97
T_{12}- Control	4.08	9.93	16.33	8.07
S.Em. ±	0.17	0.54	0.76	0.29
C.D. at 5%	0.51	1.59	2.24	0.85
CV%	5.48	7.33	9.98	5.42

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