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Effect of Post Shooting Spray and Covering Material on Banana Bunch on its Yield Attributes and yield

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ABSTRACT
The experiment was carried out during the year 2017-18 and 2018-19 to study the effect of post shooting spray and covering material on bunch for yield, yield attributes of banana (*Musa paradisiaca* L.) cv. Grand Naine. The experiment comprised of involving six levels of post shooting sprays namely; control, humic acid 2 %, 2, 4-D 30 mg/l, gibberellic acid (GA_3) 100 mg/l, CPPU 4 mg/l and sulphate of potash (SOP) 2 % with two levels of bunch covering material viz., non-woven material bag and blue colour polyethylene sleeve (6 % perforated) bag covering. Experiment was laid out in a Completely Randomized Design (Factorial) with three repetitions. Post shooting sprays were given twice i.e. 1^{st} spray after complete opening of inflorescence and 2^{nd} spray after 30 days of first spray with covering the bunch immediately after second spray. The results of present investigation banana bunches sprayed GA_3 100 mg/l with non-woven material bag covering was recorded significantly maximum bunch length, length of finger, girth of finger, weight of bunch and fruit yield.

KEYWORDS
Banana, Post shooting spray, Covering Materials and Yield

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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 semiarid 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 B1 and B2.

One of the challenges being faced by banana growers is the enormous shelf life and quality due to lack of adequate pre harvest practices. Losses due to spoilage are very high. The high tropical temperature enhances disease occurrence and deterioration of stored fruits. The abundant flow of the banana fruit in a short span of the period causes glut in the market resulting in very low price to the producer. Fruit of banana is highly perishable in nature and cannot be stored for longer time. Due to high water content and respiration rate fruits are easily deteriorated and subject to rapid weight loss and quick discoloration. Owning to get good returns, appropriate pre harvest practices should be practiced to extend the shelf life, to reduce post harvest losses and to improve the quality of banana fruits.

Gibberellic acid (GA3) controls multiple plant responses, including stem and petiole elongation (Damasco *et al*, 1996). In banana, GA_3 induces elongation of the pseudostem, abscission of flower parts, and increases fruit size and delays senescence of fruit (Kumar and Reddy, 1998).

Bunch covers provide protection to the fruit surface against pathogens, wind damage, leaf and petiole scarring, dust, light hail, sunburn, bird feeding, and handling damage during harvest and transport. Bunch covers have also been used to protect bunches from low temperatures, especially in temperate countries (Harhash and Al-Obeed, 2010). The bagging technique has also been used on several fruits, to protect them from low temperatures (Mohamed and Al-Qurashi, 2012) and has been shown to reduce winter stress under optimal condition, which resulted in early fruit maturation (Muchui *et al*, 2010). Export quality includes appealing skin colour, reduced sunburn, reduced fruit splitting, and increased finger length and bunch weight (Amarante *et al*, 2002). The present investigation was undertaken with the objective to the standardization of post shooting spray and covering material on bunch for yield, yield attribute characters and interaction effect on banana (Musa paradisiaca L.) cv. Grand Naine.

MATERIALS AND METHODS

An experiment was conducted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during the years 2017-18 and 2018-19. The soil of the experimental site was loamy sand. The soil is alluvial by their nature of ori-

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gin, very deep, well drained and fairly moisture retentive. Soils respond well to manures and irrigations. The climate of Anand region is semi-arid and sub-tropical type. Winter is mild cool and dry, while summer is hot and dry and average annual rainfall is 830 mm. Experiment was laid out in a Completely Randomized Design (Factorial) with three repetitions. The experimental plot was prepared by deep ploughing, harrowing and levelling. The pits of 30 x 30 x 30 cm were dug out at a spacing of 1.8 x 1.8 $m^2$and well decomposed fine textured Farm Yard Manure (FYM) at the rate of 10 kg per pit was applied at planting. Well hardened, healthy, Uniform tissue cultured tissue culture plants of Grand Naine banana having 5-6 leaves were used for planting. The experiment comprises of involving six levels of post shooting sprays namely; control, humic acid 2%, 2, 4-D 30 mg/l, gibberellic acid (GA_3) 100 mg/l, CPPU 4 mg/l and sulphate of potash (SOP) 2 % with two levels of bunch covering material viz., non- woven material bag covering and blue colour polyethylene sleeve (6 % perforated) bag covering. Post shooting sprays were given twice i.e. 1^{st} spray after complete opening of inflorescence and 2^{nd} spray after 30 days of first spray with covering the bunch immediately after second spray. All other cultural operations including weeding and plant protection measures were carried as per the package of practices of mango. Observations were recorded daily for bunch and yield characters. Bunch length (cm), length of finger (cm), Girth of finger (cm), Bunch weight (kg), Fruit yield (t/ha) were recorded. Bunch characters were counted from each bunch at the harvest when fruits reached full growth stage and mean was calculated. The data of the yield per net plot was recorded and multiplied by multiple factor computed on area basis to give the final data for total yield in tonnes per hectare. The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Gomez and Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Harvest days

The data pertaining in Table 1 revealed that effect of post shooting sprays and bunch covering materials on banana and all interaction effects were found non-significant with respect to harvest days during year 2017-18 and 2018-19 as well as in pooled data.

Bunch length at harvest (cm)

Effect of post shooting spray

The data pertaining to different post shooting sprays significantly influenced the bunch length at harvest and which was found maximum in treatment S_4(GA_3 100 mg/l) with numerically value 81.97 and 75.88 cm, respectively and it was at par with treatments S_6 i.e. SOP 2 % (80.95 and 74.20 cm), S_3 i.e. 2,4-D 30 mg/l (79.74 and 73.50 cm) and S_5 i.e. CPPU 4 mg/l (76.81 and 70.46 cm) during both the experimental years. Whereas, in pooled analysis significantly maximum bunch length was recorded with spraying of GA_3 100 mg/l (78.92 cm) and it was at par with treatments S_6 i.e. SOP 2 % (77.58 cm) and S_3 i.e. 2,4-D 30 mg/l (76.62 cm). Present finding is in accordance with that of Van Overbeck, 1966 and they reported that GA_3plays a major role in cell enlargement by synthesis of enzymes that weaken the cell wall and thus offer scope for cell elongation thus increased length. It is conformity with observation of Kuraishi and Muri, 1963. GA_3 may also help in increasing auxin content and they may get transported to the site of action in plant. Similar effect of bunch length was observed by Patel et al. (2011a), Biswas and Lemtur (2014) Biswas and Lemtur (2014), Kachhadia *et al* (2017) in banana

Effect of bunch covering material

From the perusal of data (Table 1)E non-woven material bag covering (B_1) had significantly higher bunch length at harvest with numerically value 82.65, 75.34 and 78.99 cm as compared to blue colour polythene sleeve (B_2) with numerically value 71.85, 66.19 and 69.02 cm during years 2017-18 and 2018-19 as well as in pooled, respectively. This might be due to better filling of finger under the bunch cover treatments which had more temperature than that of open air temperature particularly during season. The higher temperature inside the bunch covers triggered nitrate reductase activity in the plants. Nitrate reductase is one of the most important enzymes in the assimilation of exogenous nitrate which helped in better development of the fruits and increased length of bunch. Similar result also reported by Anonymous (2013) , Samantaray (2015), Sarkar *et al* (2016) and Pathak *et al* (2017) in banana.

Length of finger (cm)

Effect of post shooting spray

The data (Table 2) showed that the effect of post shooting sprays significantly influenced on finger length and which was recorded maximum with spraying of GA_3 100 mg/l (23.25 and 22.97 cm) and it was statistically found at par with treatments S_6 (SOP 2 %), S_3 (2, 4-D 30 mg/l) and S_5(CPPU 4mg/l) during the years 2017-18 and 2018-19, respectively. Whereas, significantly maximum finger length was recorded with spraying of GA_3 100 mg/l (23.11 cm) and it was at par with treatments S_6 i.e. SOP 2 % (22.86 cm) and S_3 i.e. 2,4-D 30 mg/l (22.65 cm) in pooled analysis. This might be due to gibberellins are phyto-hormones, known to contribute the growth by cell division and cell elongation. Exogenous application of GA_3in the present investigation might have kept the protein synthesis in active state, allowed the fruit to continue growth for longer period. The increase in length associated with fruit growth, is largely as a result of cell division and cell elongation and therefore, GA_3 is responsible for increase in fruit size. The increase in fruit size with gibberellins is presumably primarily due to augmentation of the native supply of those hormones; which, in present investigation have also been found to markedly increase the fruit size, when given at the time of flowering and later on. Favourable effect of

Table 1: Effect of post shooting sprays and bunch covering materials on harvest days and bunch length at harvest

Treatments	Harvest days			Bunch length at harvest (cm)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Post shooting spray (S)						
S_1 : Control	383.17	384.17	383.67	68.02	61.69	64.85
S_2 : Humic acid @ 2%	376.83	380.83	378.83	76.00	68.85	72.43
S_3 : 2,4-D @ 30 mg/l	374.50	377.67	376.08	79.74	73.50	76.62
S_4 : GA3 @ 100 mg/l	375.27	381.67	378.47	81.97	75.88	78.92
S_5 : CPPU @ 4 mg/l	371.27	379.00	375.14	76.81	70.46	73.63
S_6 : SOP @ 2%	367.03	374.67	370.85	80.95	74.20	77.58
S.Em ±	8.45	5.22	4.97	2.03	1.86	1.38
CD at 5%	NS	NS	NS	5.93	5.42	3.91
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	371.79	377.06	374.42	82.65	75.34	78.99
B_2: Blue colour polyethylene sleeve	377.57	382.28	379.92	71.85	66.19	69.02
S.Em ±	4.88	3.01	2.87	1.17	1.07	0.79
CD at 5%	NS	NS	NS	3.42	3.13	3.91
Interaction effect (S X B)						
S.Em ±	11.96	7.38	0.85	2.87	2.62	2.36
CD at 5%	NS	NS	NS	NS	NS	NS
Pooled Interaction						
Source	Y x S	Y x B	YxSxB	Y x S	Y x B	YxSxB
S.Em ±	7.03	4.06	9.94	1.95	1.12	2.75
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	5.53	3.37	4.56	6.44	6.42	6.44

GA_3 in increasing the size of seedless fruits is now a well-established fact (Weaver, 1972). These findings are in conformity with observations of Athani and Hulamani (2001), Patel et al. (2011a), Biswas and Lemtur (2014) Biswas and Lemtur (2014), Kachhadia *et al* (2017) in banana.

Effect of bunch covering material

The data showed that non-woven material bag covering (B_1) had significantly higher length of finger (22.75, 22.62 and 22.68 cm) as compared to blue colour polythene sleeve (B_2) (21.31, 21.05 and 21.18 cm) during the years 2017-18, 2018-19 and in pooled, respectively. It might be due to change in micro climate condition like; non-woven material allows free air, temperature, moisture circulation, photosynthetically active radiation and light interception inside bunch cover. The higher temperature inside the bunch cover triggered the nitrate reductase activity in the plants. Nitrate reductase is one of the most important enzymes in the assimilation of exogenous nitrate which helped in better development of the fruits. These results are in conformity with the findings of Cuneen and Entyre (1998), Choudhury (1994), Anon. (2013) and Pathak *et al* (2017) in banana.

Girth of finger (cm)

Effect of post shooting spray

The data (Table 2) showed that the different post shooting sprays significantly influenced the girth of finger at harvest and which was found maximum in treatment S_4 ($GA_3$100 mg/l) with numerically 12.81 cm and it was found at par with treatments S_6 (SOP 2 %), S_3 (2,4-D 30 mg/l) and S_5(CPPU 4mg/l) during the year 2017-18, whereas significantly maximum girth of finger was observed in treatment S_4 i.e. $GA_3$100 mg/l (12.59 and 12.70 cm) and it was found at par with treatments S_6 i.e. SOP 2 % (12.46 and 12.56 cm) and S_3 i.e. 2,4-D 30 mg/l (12.37 and 12.45 cm) during the year 2018-19 and in

Table 2: Effect of post shooting sprays and bunch covering materials on length of finger and girth of finger (cm)

Treatments	Length of finger (cm)			Girth of finger (cm)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Post shooting spray (S)						
S_1 : Control	19.41	19.11	19.26	10.70	10.47	10.58
S_2 : Humic acid @ 2%	21.60	21.67	21.64	11.90	11.88	11.89
S_3 : 2,4-D @ 30 mg/l	22.74	22.57	22.65	12.53	12.37	12.45
S_4 : GA3 @ 100 mg/l	23.25	22.97	23.11	12.81	12.59	12.70
S_5 : CPPU @ 4 mg/l	22.20	21.94	22.07	12.23	12.02	12.13
S_6 : SOP @ 2%	22.97	22.74	22.86	12.66	12.46	12.56
S.Em ±	0.44	0.40	0.29	0.23	0.19	0.15
CD at 5%	1.27	1.15	0.84	0.66	0.56	0.42
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	22.75	22.62	22.68	12.54	12.39	12.47
B_2: Blue colour polyethylene sleeve	21.31	21.05	21.18	11.74	11.53	11.64
S.Em ±	0.25	0.23	0.17	0.13	0.11	0.09
CD at 5%	0.73	0.67	0.84	0.38	0.32	0.42
Interaction effect (S X B)						
S.Em ±	0.62	0.56	0.43	0.32	0.27	0.24
CD at 5%	NS	NS	NS	NS	NS	NS
Pooled Interaction						
Source	Y x S	Y x B	YxSxB	Y x S	Y x B	YxSxB
S.Em ±	0.42	0.24	0.59	0.21	0.12	0.30
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	4.85	4.43	4.64	4.55	3.94	4.26

pooled, respectively.

Effect of bunch covering material

The results pertaining to the effect of bunch covering materials on girth of finger showed significant. The bunch covering with non-woven material (B_1) observed better finger girth (12.54, 12.39 and 12.47 cm) as compared to blue colour polythene sleeve (B_2) (11.74, 11.53 and 11.64 cm) during individual years as well as in pooled data, respectively.

Weight of bunch (kg)

Effect of post shooting spray

The data (Table 3) revealed that different post shooting sprays significantly influenced the weight of bunch at harvest and which was found maximum with spraying of GA_3 100 mg/l (S_4) with numerically value 25.20 kg and it was found at par with treatments S_6 (SOP 2 %), S_3 (2, 4-D 30 mg/l) and S_5 (CPPU 4mg/l) during the year 2017-18 whereas, significantly maximum bunch weight was recorded with treatment S_4 i.e. $GA_3$100 mg/l (23.46 and 24.33 kg) and it was found at par with treatments S_6 i.e. SOP 2 % (23.02 and 23.74 kg) and S_3 i.e. 2,4-D 30 mg/l (22.61 and 23.41 kg) during the year 2018-19 and in pooled, respectively. The increase in fruit size, length and girth of finger with gibberellin is presumably primarily due to augmentation of native supply of hormone. After anthesis, it is the cell expansion and cell density, which contributes the most for fruit growth, and a positive correlation between growth of fruit and gibberellins level is well known (Wiltbank and Krezdorn, 1969). Moreover, GA_3 does bring about certain metabolic changes, which are reflected by more accumulation of food constituents in the fruit and thereby increased weight of fruit and finally bunch weight. These findings are in conformity by Athani and Hulamani (2001), Kumar and Kumar (2007), Patel et al. (2011a), Biswas and Lemtur (2014), Kachhadia *et al* (2017) in banana.

Table 3: Effect of post shooting sprays and bunch covering materials on weight of bunch and yield

Treatments	Weight of bunch (kg)			Yield (t/ha)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Post shooting spray (S)						
S_1 : Control	20.11	18.67	19.39	62.06	57.63	59.85
S_2 : Humic acid @ 2%	22.73	21.11	21.92	70.16	65.16	67.66
S_3 : 2,4-D @ 30 mg/l	24.20	22.61	23.41	74.69	69.78	72.24
S_4 : GA3 @ 100 mg/l	25.20	23.46	24.33	77.78	72.39	75.08
S_5 : CPPU @ 4 mg/l	23.16	21.54	22.35	71.47	66.48	68.97
S_6 : SOP @ 2%	24.47	23.02	23.74	75.50	71.04	73.27
S.Em ±	0.80	0.54	0.49	2.48	1.68	1.50
CD at 5%	2.35	1.59	1.38	7.24	4.90	4.26
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	24.48	22.89	23.68	75.53	70.64	73.08
B_2: Blue colour polyethylene sleeve	22.15	20.58	21.37	68.35	63.52	65.94
S.Em ±	0.46	0.31	0.28	1.43	0.97	0.87
CD at 5%	1.36	0.92	1.38	4.18	2.83	4.26
Interaction effect (S X B)						
S.Em ±	1.14	0.77	1.02	3.51	2.37	3.16
CD at 5%	NS	NS	NS	NS	NS	NS
Pooled Interaction						
Source	Y x S	Y x B	YxSxB	Y x S	Y x B	YxSxB
S.Em ±	0.69	0.40	0.97	2.12	1.22	3.00
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	8.45	6.13	7.47	8.45	6.13	7.47

Effect of bunch covering material

Data presented in Table 3 indicated that different bunch covering materials were found significant. The non-woven material bag covering (B_1) was recorded significantly higher bunch weight at harvest with numerically value 24.48, 22.89 and 23.68 kg as compared to blue colour polythene sleeve (B_2) with numerically value 22.15, 20.58 and 21.37 kg during both the experimental years as well as in pooled, respectively. Reason behind increasing bunch weight by non-woven bag might be due to higher temperature; photosynthetically active radiation and light interception within the bunch cover. There is a positive association of temperature from shooting to harvest. Similarly, Robinson and &nel (1985) and Singh (1988) indicated that rise in temperature with an increased trend of bunch weight occur in banana. Moreover, larger size, volume and weight of individual finger had exerted influence in augmentation of bunch weight. The present result is agreed with findings by Mukherjee (2006) and Pathak *et al* (2017) in banana.

Yield (t/ha)

Effect of post shooting spray

At a glance of data presented in Table 3 clearly indicated that different post shooting sprays significantly influenced the estimated fruit yield and which was found maximum with spraying of GA_3 100 mg/l (77.78 t/ha) and it was found at par with treatments S_6 i.e. SOP 2 % (75.50 t/ha), S_3 i.e. 2,4-D 30 mg/l (74.69 t/ha) and S_5 i.e. CPPU 4mg/l (71.47 t/ha) during the year 2017-18 whereas, in year 2018-19 and pooled data indicated that significantly maximum yield was observed with treatment S_4 i.e. $GA_3$100 mg/l (72.39 and 75.08 t/ha) and it was found at par with S_6 i.e. SOP 2 % (71.04 and 73.27 t/ha), S_3 i.e. 2,4-D 30 mg/l (69.78 and 72.24 t/ha).

Effect of bunch covering material

A perusal of data indicates that non-woven material bag covering (B_1) had significantly estimated fruit yield at harvest with numerically value 75.53, 70.64 and 73.08 t/ha as compared to blue colour polythene sleeve (B_2) with numerically value 68.35, 63.52 and 65.94 t/ha during both the individual years as well as in pooled, respectively.

Interaction effect

All interaction effects were found non-significant with respect to maximum bunch length, length of finger, girth of finger, weight of bunch and fruit yield of banana during both experimental years as well as in pooled data.

CONCLUSION

From the two years of field study and pull analysis, it can be concluded that the banana post shooting bunches spraying GA_3 100 mg/l with non-woven material bag covering (i.e. 1^{st} spray after complete opening of inflorescence and 2^{nd} spray after 30 days of first spray with covering the bunch immediately after second spray) was significantly increase maximum bunch length, length of finger, girth of finger, weight of bunch and yield of banana cv. Grand Naine.

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