Journal of Scientific Research & Reports

27(11): 129-136, 2021; Article no.JSRR.79509
ISSN: 2320-0227

Influence of Post Shooting Spray and Bunch Bagging on Per Day Productivity and Fruit Quality of Banana (*Musa paradisiaca* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2021/v27i1130464
Editor(s):
(1) Dr. Kleopatra Nikolopoulou, University of Athens, Greece.
Reviewers:
(1) Okunlola Oluwajuwon Olaolu, Oyo state college of Agriculture and Technology, Nigeria.
(2) Radhwan Nidal Al-Zidan, University of Mosul, Iraq.
Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: https://www.sdiarticle5.com/review-history/79509

Original Research Article

Received 07 October 2021
Accepted 14 December 2021
Published 14 December 2021

ABSTRACT

Aims: To determine the effect of post shooting spray and bunch bagging on per day productivity and quality of banana (*Musa paradisiaca* L.)"
Study Design: Completely Randomized Design (Factorial) with three repetitions.
Place and Duration of Study: Experiment was carried out at the Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, AAU, Anand during the year 2017-18 and 2018-19
Methodology: The experiment comprises of twenty four treatment combinations involving two varieties *viz*. Grand Naine and William with 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 bunch bagging *viz*., non- woven material bag covering and blue colour polyethylene sleeve (6 % perforated) bag covering. Post shooting sprays were given twice *i.e.* 1st spray after complete opening of inflorescence and 2nd spray after 30 days of first spray with covering the bunch immediately after second spray.

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Results: The results indicated that the Grand Naine variety recorded significantly minimum harvest days, maturity days. Whereas, William variety was recorded significantly shelf life and fruit appearances. In case of per day productivity is concerned, both the varieties were equally important. The post shooting spray of GA_3 100 mg/l recorded significantly improves per day productivity and fruit appearances. Whereas, post shooting spray of SOP 2 % recorded minimum harvest day and maturity days. While, post shooting sprays of CPPU 4 mg/l showed significantly maximum shelf life. The non-woven material bag covering was significantly better among all quantitative and qualitative parameters as compared to blue colour polyethylene sleeve bag covering. While, post shooting spray of CPPU 4 mg/l with non-woven material bag covering showed significantly expand the shelf life of fruit.

Conclusion: Grand Naine variety recorded significantly minimum harvest and maturity days. Whereas, William variety was recorded significantly shelf life and fruit appearances. The post shooting spray of GA_3 100 mg/l was improved per day productivity and fruit appearances. Whereas, post shooting sprays of CPPU 4 mg/l showed significantly enhancing the shelf life. The non-woven material bag covering on banana bunches was found significantly better among all quantitative and qualitative parameters.

Keywords: Banana; post shooting spray; bunch bagging; quality and per day productivity.

1. INTRODUCTION

Banana (*Musa paradisiaca* L.) is one of the major fruit crop in the tropics and subtropics region of the country and make a crucially affected to the economies of a number of countries in the World. It is very important in the nutrition of local population as well as tradable commodities with a large market throughout the developed world.

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. These are defined as organic compounds other than nutrients which in small amount promotes/inhibit or modify any physiological response in plants and they are artificially synthesized. Plant growth regulators (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 increase the fruit size directly by stimulating cell division or to increase fruit size and yield [1].

In case of dessert type banana, when bunches are not covered, show appearance of spots, bruises, harbour of spiders and insects with deterioration in quality of the produce. Banana bunch protection sleeves are used throughout the commercial banana growing area of the world [2]. Therefore the present study main objective was standardization of different post shooting spray with bunch bagging for the per day productivity with quality under different varieties.

2. 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. 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 30cm 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 and uniform tissue cultured banana plant having 5-6 leaves (cv. Grand Naine and Willium) were used for planting. The experiment comprises of twenty four treatment combinations involving two varieties *viz*. Grand Naine and William with six levels of post shooting sprays namely; control, humic acid 2 %, 2, 4-D 30 mg/l, gibberellic acid (GA_3) 100 mg/l, N-(2-Chloro-4-pyridyl)-N′-phenylurea (CPPU) 4 mg/l and sulphate of potash (SOP) 2 %with two bunch bagging *viz*., non- woven material bag covering 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*. 1st spray after complete opening of inflorescence and 2nd spray after 30 days of

first spray with covering the bunch immediately after second spray. Observation of harvest days was recorded no. of days taken from planting to harvest. Maturity days were recorded no. of days taken from complete opening of bunch to harvest and then average was calculated. However, PLW ratio and ascorbic acid were also had been taken after harvesting of banana. Per day productivity is calculated on the basis of fruit yield divided by harvest days. Fruit appearances was recorded visually by sensory evaluation for assessing the colour, texture and over all appearances of banana fruit at the time of optimum eating stage by scientist teams. Scoring techniques by hedonic 0 to 9 scale basis. The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Gomez and Gomez [3].

3. RESULTS AND DISCUSSION

3.1 Harvest Days

3.1.1 Effect of varieties

Data (Table 1) revealed that the significantly minimum harvest days was recorded in V_1 *i.e.* Grand Naine (374.68, 379.67 and 377.17) days during the years 2017-18, 2018-19 and in pooled data, respectively. It might be due to genetically characteristics of variety Grand Naine and its an early maturity variety than William.

3.1.2 Effect of post shooting sprays

Results indicated that the post shooting spray was found non-significant affected in respect to harvest days.

3.1.3 Effect of bunch bagging

The bunch bagging affected on harvest days was found non-significant during the year 2017-18 and 2018-19, but it was found significant in pooled analysis. The significantly minimum harvest days (399.90 days) was recorded with treatment B_1 (non-woven material bag covering). Banana bunch bagging with non-woven material has faster maturity and thus reduced harvest days due to increased temperature and change in microclimate inside bunch cover triggered faster fruit growth and development as a result of early maturity. The present finding was correlated with work of Pathak *et al*. [4], Sarkar *et al*. [5], Samantaray [6] and Anon. [7] in banana.

3.2 Maturity Days

3.2.1 Effect of varieties

From the data (Table 1) showed that the maturity days was found significant and minimum days required for maturity was taken in Grand Naine variety (85.77, 87.03 and 86.40 days) as compared to William variety (V_2) during the both experimental years as well as in pooled analysis, respectively.

3.2.2 Effect of post shooting sprays

The data pertaining to different post shooting sprays significantly influenced the maturity days. Significantly minimum maturity days took with post shooting spray of SOP 2 % (85.83 days) and it was found at par with treatments S_5 (CPPU 4 mg/l), S_3 (2,4-D 30 mg/l) and S_2 (humic acid 2 %) in the year 2017-18. Similarly, same treatment S_6 (SOP 2 %) was found significantly taken minimum maturity days (87.22 and 86.53 days) which was found at par with treatments S_3 (2, 4-D 30 mg/l) and S_5 (CPPU 4 mg/l) in the year 2018-19 and in pooled analysis, respectively. It might be due to reduction in days required from bunch opening to harvesting is due to faster growth rate of fingers and higher leaf chlorophyll contents owing to additional nutrient supply and faster rate of translocation of assimilates from source to sink, aided by additional potassium because it is a general metabolic activator increasing the respiration and photosynthetic rate. Thus, additional K application as foliar spray minimized days from flowering to harvesting [8]. Similar results were also reported by Gamit *et al.* [9] and Kachhadia *et al.* [10] in banana.

3.2.3 Effect of bunch bagging

From the result (Table 1) revealed that the non-woven material bag covering (B_1) had significantly minimum days required for maturity (86.11. 88.20 and 87.16 days) during the years 2017-18, 2018-19 and in pooled, respectively. It might be due to increased temperature and change in microclimate inside bunch cover triggered faster fruit growth and development hence faster maturity. Moreover, non-woven allows free air and moisture circulation unlike plastic material [11]. The results are in conformity with the findings of Pathak *et al.* [4], Sarkar *et al.* [5] and Samantaray [6] in banana.

3.3 Per Day Productivity (kg/day)

3.3.1 Effect of varieties

The data (Table 2) indicates that per day productivity was found non-significant in respect to varieties. Per day productivity is calculated on the basis of fruit yield divided by harvest days of plant. William variety gave higher fruit yield as compared to Grand Naine variety but it's taken more number of days to harvest so that both varieties had similar per day productivity. These findings are in conformity with others in banana by Parmar *et al*. [12].

3.3.2 Effect of post shooting sprays

Per day productivity was significantly found maximum with post shooting spray of $GA_3$100 mg/l (204.78 kg/day) and it was found at par with treatments S_6 (SOP 2 %), S_3 (2,4-D 30 mg/l) and S_5 (CPPU 4 mg/l) in the year 2017-18. Similarly, same treatment *i.e.* post shooting spray of GA_3 100 mg/l was found significantly superior over other treatments in regard the per day productivity (186.68 and 195.73 kg/day) and which was found at par with treatments S_6 (SOP 2 %) and S_3 (2, 4-D 30 mg/l) during the year 2018-19 and in pooled analysis, respectively. It might be due increased finger length, girth, bunch weight and fruit yield as compared to control.

3.3.3 Effect of bunch bagging

A perusal of data (Table 2) indicates that non-woven material bag (B_1) was significantly better in respect to per day productivity (201.54, 184.97 and 193.26 kg/day) during both individual year as well as in pooled, respectively. Maximum per day productivity is depending on fruit yield and harvest days of plant. Non-woven material bag covering on bunch had early maturity and higher fruit yield as compare to blue colour polythene sleeve covering.

3.4 Shelf Life of Fruit (days)

3.4.1 Effect of varieties

An appraisal of data (Table 2) indicates that shelf life was found significant influenced by different varieties of banana. Significantly maximum shelf life was recorded with variety William with numerical value 9.94, 9.55 and 9.75 days during the experimental years 2017-18, 2018-19 and in pooled analysis, respectively. It might be due to William has bigger fruit size and pulp : peel ratio due to genetic character hence, shelf life was better.

3.4.2 Effect of post shooting sprays

The post shooting spray with CPPU 4 mg/l (S_5) recorded significantly maximum shelf life (10.12, 9.88 and 10.00 days) which was found at par with treatments S_6 *i.e.* SOP 2 % (9.84, 9.70 and 9.77 days) and S_4 *i.e.* GA_3 100 mg/l (9.74, 9.58 and 9.66 days). However, significantly minimum shelf life was noted under control (7.98, 7.85 and 7.92 days) during the years 2017-18, 2018-19 and in pooled analysis, respectively. This might be due to the reason that CPPU plays vital role in enhancing the physiological activities in suppressed fruit softening in association with the delayed peaks of respiration and the inhibition of the peaks of ethylene production rate banana [13 and 14].

3.4.3 Effect of bunch bagging

Non-woven material bag covering (B_1) recorded significantly enhancing the shelf life of banana (9.98, 9.71 and 9.84 days) during the years 2017-18, 2018-19 and in pooled, respectively. It might be due to banana bunch bagging with non-woven material bag had less physical as well as insect pest damage thus delayed ripening ultimately extend the shelf life of fruit. Further, bunch covered bag with any material extends the green life as well as the shelf life of fruits compared to uncover bunch [15].

3.4.4 Interaction effect

The interaction effect of post shooting sprays x bunch bagging (S x P) was found non-significant during 2017-18 and 2018-19, but in pooled results it was found significant. The data showed (Table 2) that significantly maximum shelf life was found in treatment combination of CPPU 4 mg/l with non-woven material bag (S_5B_1) with numerical value 10.83 days and which was at par with treatment SOP 2% with non-woven material bag (S_6B_1) and GA_3 100 mg/l with non-woven material bag (S_4B_1).

3.5 Fruit Appearances

3.5.1 Effect of varieties

Fruit appearances score at mature stage was recorded significantly higher with V_2 (William)

Table 1. Response of varieties, post shooting sprays and bunch bagging on harvest days and maturity days of banana

Treatments	Harvest days			Maturity days		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Varieties (V)						
V_1: Grand Naine	374.68	379.67	377.17	85.77	87.03	86.40
V_2: William	424.91	432.64	428.78	91.68	93.99	92.84
S.Em.±	3.01	2.52	1.96	0.76	0.87	0.58
C.D. at 0.05	8.56	7.16	5.51	2.15	2.47	1.62
Post shooting sprays (S)						
S_1 : Control	407.87	411.27	409.57	92.25	94.32	93.28
S_2 : Humic acid 2%	401.68	408.28	404.98	89.55	91.91	90.73
S_3 : 2,4-D 30 mg/l	398.85	404.13	401.49	88.58	89.52	89.05
S_4 : $GA_3$100 mg/l	399.92	407.56	403.74	89.87	91.60	90.73
S_5 : CPPU 4 mg/l	396.46	404.80	400.63	86.27	88.49	87.38
S_6 : SOP 2%	394.00	400.90	397.45	85.83	87.22	86.53
S.Em.±	5.22	4.36	3.40	1.31	1.51	1.00
C.D. at 0.05	NS	NS	NS	3.73	4.28	2.80
Bunch bagging (B)						
B_1: Non-woven material bag covering	396.49	403.32	399.90	86.11	88.20	87.16
B_2: Blue colour polyethylene sleeve	403.10	408.99	406.05	91.34	92.81	92.08
S.Em.±	3.01	2.52	1.96	0.76	0.87	0.58
C.D. at 0.05	NS	NS	5.51	2.15	2.47	1.62
Sig. Interaction	-	-	-	-	-	-
CV %	4.52	3.72	4.13	5.12	5.77	5.46

Table 2. Response of varieties, post shooting sprays and bunch bagging on per days productivity and shelf life of fruit of banana

Treatments	Per days productivity			Shelf life of fruit (days)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Varieties (V)						
V_1: Grand Naine	192.77	177.05	184.91	8.79	8.73	8.76
V_2: William	188.85	173.13	180.99	9.94	9.55	9.75
S.Em.±	3.00	2.27	1.88	0.11	0.10	0.07
C.D. at 0.05	NS	NS	NS	0.32	0.27	0.21
Post shooting sprays (S)						
S_1 : Control	162.74	149.80	156.27	7.98	7.85	7.92
S_2 : Humic acid 2%	185.65	170.63	178.14	9.13	8.83	8.98
S_3 : 2,4-D 30 mg/l	198.00	182.51	190.25	9.38	9.02	9.20
S_4 : $GA_3$100 mg/l	204.78	186.68	195.73	9.74	9.58	9.66
S_5 : CPPU 4 mg/l	191.46	174.44	182.95	10.12	9.88	10.00
S_6 : SOP 2%	202.21	186.50	194.35	9.84	9.70	9.77
S.Em.±	5.19	3.93	3.26	0.19	0.17	0.13
C.D. at 0.05	14.77	11.19	9.15	0.55	0.48	0.36
Bunch bagging (B)						
B_1: Non-woven material bag covering	201.54	184.97	193.26	9.98	9.71	9.84
B_2: Blue colour polyethylene sleeve	180.07	165.21	172.64	8.76	8.58	8.67
S.Em.±	3.00	2.27	1.88	0.11	0.10	0.07
C.D. at 0.05	8.53	6.46	5.28	0.32	0.27	0.21
Sig. Interaction	-	-	-	-	-	SxB
CV %	9.43	7.78	8.73	7.20	6.35	6.80

Table 3. Response of varieties, post shooting sprays and bunch bagging on ascorbic acid and fruit appearances of banana

Treatments	Ascorbic acid (mg/100g pulp)			Fruit appearances		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Varieties (V)						
V_1: Grand Naine	8.20	8.13	8.16	7.59	7.62	7.60
V_2: William	7.74	7.59	7.66	8.05	7.96	8.00
S.Em.±	0.09	0.11	0.07	0.09	0.10	0.07
C.D. at 0.05	0.27	0.31	0.20	0.25	0.28	0.19
Post shooting sprays (S)						
S_1 : Control	7.84	7.68	7.76	7.56	7.37	7.47
S_2 : Humic acid 2%	7.92	7.84	7.88	6.63	6.85	6.74
S_3 : 2,4-D 30 mg/l	7.92	7.84	7.88	8.12	8.03	8.07
S_4 : $GA_3$100 mg/l	8.00	7.87	7.93	8.26	8.20	8.23
S_5 : CPPU 4 mg/l	8.10	7.94	8.02	8.23	8.17	8.20
S_6 : SOP 2%	8.03	7.98	8.00	8.10	8.11	8.11
S.Em.±	0.16	0.19	0.12	0.15	0.17	0.11
C.D. at 0.05	NS	NS	NS	0.43	0.49	0.32
Bunch bagging (B)						
B_1: Non-woven material bag covering	8.03	7.91	7.97	7.87	7.86	7.86
B_2: Blue colour polyethylene sleeve	7.90	7.81	7.86	7.76	7.72	7.74
S.Em.±	0.09	0.11	0.07	0.09	0.10	0.07
C.D. at 0.05	NS	NS	NS	NS	NS	NS
Sig. Interaction	-	-	-	-	-	-
CV %	7.11	8.22	7.68	6.66	7.67	7.18

Table 4. Interaction effect between post shooting sprays and bunch bagging on shelf life of fruit (days)

	Pooled	
B / S	Non-woven material bag (B_1)	Blue colour polyethylene sleeve (B_2)
S_1 : Control	8.25	7.58
S_2 : Humic acid 2%	9.40	8.57
S_3 : 2,4-D 30 mg/l	9.65	8.74
S_4 : GA_3 100 mg/l	10.40	8.93
S_5 : CPPU 4 mg/l	10.83	9.17
S_6 : SOP 2%	10.53	9.01
S.Em.± (S x B)	0.18	
C.D. at 0.05 (S x B)	0.51	
CV %	6.80	

i.e. 8.05, 7.96 and 8.00 out of 10.00 during 2017-18, 2018-19 and in pooled analysis, respectively. William variety showed better score (hedonic 9 scale basis) due to better visual observations like, fruit length, girth and pulp: peel ratio as a result of this fruit appearances score was better.

3.5.2 Effect of post shooting sprays

The higher fruit appearances score was recorded with post shooting spray of GA_3 100 mg/l (8.26, 8.20 and 8.23) which was found at par with treatments CPPU 4 mg/l (8.23, 8.17 and 8.20), SOP 2 % (8.10, 8.11 and 8.11) and 2, 4-D 30 mg/l (8.12, 8.03 and 8.07) during both individual years as well as in pooled analysis, respectively. Post-shooting bunch spray with GA_3 100 mg/l had better fruit appearance score because of better visual observations like fruit length and fruit girth as a result of that fruit appearance score was better. The lowest score of fruit appearances recorded with bunch spray with humic acid 2%. It might be

due to post shooting spraying with humic acid fruit colour became dark gradually and continue to advanced stage of maturity so that fruit appearances score very low even without any spray (control).

3.5.3 Effect of bunch bagging

Both the treatment of bunch bagging were found non-significant in regard to fruit appearances score during the years 2017-18, 2018-19 and in pooled analysis.

3.6 Ascorbic Acid (mg/100g pulp)

3.6.1 Effect of varieties

An appraisal of data (Table 3) showed that the ascorbic acid content of fruit was found significant and higher ascorbic acid obtained with variety Grand Naine (8.20, 8.13 and 8.16 mg/100 g) as compared to variety William (7.74, 7.59 and 7.66 mg/100g) during the years 2017-18, 2018-19 and in pooled analysis, respectively.

3.6.2 Effect of post shooting sprays and bunch bagging

All the treatments of post shooting sprays and bunch bagging were found non-significant in respect to ascorbic acid during the years 2017-18, 2018-19 and in pooled analysis.

3.6.3 Interaction effect

All interaction effects of V x S, V x B, S x B and V x S x B were found non-significant with respect to harvest days, maturity days, per days productivity, fruit appearances and ascorbic acid content in fruit during the years 2017-18, 2018-19 and in pooled data (Table 4).

4. CONCLUSION

From the two years of field study, it can be concluded that the Grand Naine variety recorded significantly minimum harvest days and maturity days. Whereas, William variety was recorded significantly shelf life and fruit appearances. In case of per day productivity is concerned, both the varieties were equally important. The post shooting spray of GA_3 100 mg/l was recorded maximum per day productivity and fruit appearances. Whereas, post shooting spray of SOP 2 % recorded minimum harvest day, maturity days. While, post shooting sprays of CPPU 4 mg/l showed significantly enhancing the shelf life. The non-woven material bag covering on banana bunches was found significantly better among all quantitative and qualitative parameters as compared to blue colour polyethylene sleeve bag covering.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/79509