Response of quality attributes of banana (*Musa paradisiaca* L.) cv. Willium to post shooting spray and bunch covering material

ABSTRACT

Aims: To study the post harvest shooting 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 % and covering materials *viz*., non- woven material bag and blue colour polyethylene sleeve (6% perforated) bag on bunch of banana cv. Willium

Study Design: Experiment was laid out in a 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 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 willium banana having 5-6 leaves were used for planting. 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. The fruits which were used for recording the weight loss during ripening, were used to calculating pulp: peel ratio. Pulp to peel ratio was calculated by dividing respective pulp weight by respective peel 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) was adopted for estimation of titrable acidity.

Results: The results revealed that the banana bunches spraying of CPPU 4 mg/l with bunch covering with non woven materials were recorded significantly lower physiological loss in weight (12.80, 13.60 and 13.20 %) and (13.26, 14.14 and 13.70 %), respectively. Whereas, post shooting spray of SOP 2 % with non-woven material bag covering were recorded significantly maximum TSS (21.42, 21.05 and 21.17 ºBrix; 21.39, 20.93 and 21.16 ºBrix), reducing sugar (12.55, 12.34 and 12.45 %; 12.21, 12.16 and 12.18 %) and total sugar (21.42, 20.82 and 21.12 %; 20.84, 20.50 and 20.67 %) as compared to rest of the treatments of post shooting sprays and bunch covering materials on banana quality.

Conclusion: From the two years of field study, it can be concluded that the post shooting spraying of CPPU 4 mg/l and SOP 2 % with non woven bunch covering bags were improve fruit quality of banana

KEYWORDS: Banana, post shooting spray, bunch covering materials and quality

INTRODUCTION:

Banana (*Musa paradisica* L.) belongs to family Musaceae, is the cheapest, plentiful and most nourishing fruit crop of the world. It is a premier fruit having great socio-economic significance in India. Indeed many consider the banana to be one of man's first foods. Owing to its shallow roots, banana is a moisture and nutrient loving plant so judicious doses of nutrients has to be applied at the proper

stage to improve its productivity and quality of fruits. The major nutrients namely nitrogen, phosphorus and potassium as well as the micronutrients are essential for normal growth and fruiting of plants.

Many reports have indicated the usefulness of post shooting spray of various nutrients during fruit development in influencing the fruit yield, shelf life and quality(Swietlik and Faust. 1984).Banana has been found to respond well to potash spray supplied through muriate of potash (MOP) or potassium di-hydrogen phosphate 2 4 (KH PO) (Mahalakshmi and Sathiyamoorthy, 1999).

For covering the fruit or bunches, different kinds of materials have been used so far. Brown paper, gunny bag, newsprint, old cloths, dried banana leaves, and polythene bags of different colors and thicknesses have been used (Debnath *et al*., 2001). The decision of using a bagging material depends on the availability, price, local climate, and type of fruit. All of these materials have some advantages and disadvantages. Blue polyethylene perforated bunch covers have been used elsewhere in the tropics and have been shown to improve fruit visual appeal among other postharvest qualities (Robinson, 1996). But there is very limited information found in India on effect of bunch covering and its impacts quality of banana cv. willium. Therefore, this present research work has been undertaken to find out the effect of post shooting spray and bunch covering materials on fruit quality of banana cv. willium.

MATERIALAND METHODS:

An experiment entitled Response of quality attributes of banana (*Musa paradisiaca* L.) cv. Willium to post shooting spray and covering material on bunch 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 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 willium 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 and blue colour polyethylene sleeve (6 % perforated) bag. 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. Observations were recorded daily for quality characters *i.e*. Pulp : peel ratio, TSS (^{0} Brix), Acidity (%), Reducing sugars (%), Total sugars (%) and Physiological loss in weight (%) were recorded. The fruits which were used for recording the weight loss during ripening, were used to calculating pulp: peel ratio. Pulp to peel ratio was calculated by dividing respective pulp weight by respective peel 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) was adopted for estimation of titrable acidity. The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION:

Physiological loss in weight (%):

Effect of post shooting spray

The result revealed that physiological loss in weight of banana was influenced significant by various post shooting sprays during the both experimental years 2017-18, 2018-19 and in pooled basis. The post shooting spray of CPPU 4 mg/l (S_5) recorded significantly lower physiological loss in weight (12.80, 13.60 and 13.20 %) and which was found at par with treatment SOP 2 % (13.02, 13.53 and 13.28 %) and GA_3 100 mg/l (13.52, 14.03 and 13.77 %). Whereas, significantly higher physiological loss in weight was found under control (17.52, 18.33 and 17.93 %) 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 in banana reported by Huanga *et al.,* 2014 and Rajan, 2017. Similar results were obtained by Marzouk and Kassem (2011) in grapes.

Effect of bunch covering material

It is evident from the observations on bunch covering materials exerted significant effect on physiological loss in weight. Bunch covering with non woven materials gave significantly minimum physiological loss in weight (13.26, 14.14 and 13.70 %) as compared to blue colour polythene sleeve (15.30, 15.85 and 15.58 %) during 2017-18, 2018-19 and in pooled, respectively.

Decreased in fruit weight during the storage period could be due to physiological process such as higher rate of respiration and transpiration from fruit surface degradation of reserve carbohydrate with release of water and transpiration through fruit skin. It could be also due to decrease in peel thickness with passage of ripening period which accelerates the weight loss of fruit (Patil and Shanmugasundaram, 2015; Santosh *et al*., 2017). The decline in fruit weight has faster rate in control as compare to non-woven bags. These results are accordance with Pathak *et al*. (2017) in banana

Pulp: peel ratio:

Effect of post shooting spray

Data (Table 1) pertaining to various post shooting sprays exerted significantly effect on pulp: peel ratio. The post shooting spray with CPPU 4 mg/l (S_5) recorded significantly maximum pulp: peel ratio with numerical value 3.22, 3.17 and 3.19 which was statistically found at par with treatments S_6 *i.e.* SOP 2 % (3.18, 3.17 and 3.18) and S_4 *i.e.* GA_3 100 mg/l (3.15, 3.04 and 3.10) as compared to rest of the treatments. Whereas, significantly minimum pulp : peel ratio was found under control (2.58, 2.64 and 2.61) in 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 in banana (Rajan 2017). Similar results were obtained by Curry and Greene (1993) in apple, Marzouk and Kassem (2011) in grapes.

Effect of bunch covering material

It is evident from observations that bunch covering materials significant effect on pulp : peel ratio. The significantly increasing the pulp : peel ratio was observed with non-woven material bag (3.18, 3.13 and 3.16) as compared to blue colour polythene sleeve (2.84, 2.81 and 2.83) during both experimental years as well as in pooled data, respectively. Pulp : peel ratio of banana fruit tends to increase with the advancement from harvest to ripening. In banana fruit moisture content of peel reduced gradually during ripening while that of the pulp increased with ripening hence pulp: peel ratio increased gradually (Burdon *et al.,* 1994). Pulp portion continues to grow even in later stage of maturation and bunch protection material enhances the fruit quality (Nakasone and Paul, 1998) in banana. Similar results were also noted by Sarkar (2014) and Santosh *et al.*(2017).

Total soluble solids (ºbrix):

Effect of post shooting spray

The result revealed that total soluble solids of banana fruit was significantly influenced by various post shooting sprays. Post shooting spray with SOP 2 % (S_6) recorded significantly higher total soluble solids (21.42 ºBrix) and which was found at par with all treatments except Control in the year 2017-18. Whereas, significantly higher total soluble solids was recorded with post shooting spray of SOP 2 % (21.23 and 21.33 ºBrix) and which was found at par with treatments S_5 *i.e.* CPPU 4 mg/l (21.05 and 21.17 ºBrix) and S_4 *i.e.* GA_3 100 mg/l (20.45 and 20.60 ºBrix) in the years 2018-19 and in pooled analysis, respectively. The maximum TSS was noted in bunch spray with SOP 2 % treatment. This might be due to post-shooting application of K favours the conservation of starch into simple sugars during ripening by activating sucrose syntheses enzyme, resulting higher total soluble solid content in fruits. Similar results were also noted by Kumar *et al.* (2008), Kumar and Kumar (2010), Gamit *et al.* (2017) and Kachhadia *et al.* (2017) in banana.

Effect of bunch covering material

It is evident from the observations (Table 2), bunch covering materials significant effect on total soluble solids. The significantly the maximum total soluble solids was recorded under non-woven material bag covering (B_1) with numerical value 21.39, 20.93 and 21.16 ºBrix as compared to blue colour polythene sleeve (B_2) with numerical value 19.24, 19.18 and 19.21 ºBrix during individual years as well as in pooled, respectively. It might be due to during the climacteric stage, the accumulated polysaccharide is rapidly degraded and most of it is converted into soluble sugars which form a large proportion of TSS in the banana (Seymour *et al.*1993). The present result of non-woven bag is coincide with findings of Sarkar (2014) and Santosh *et al.* (2017) in banana.

Acidity (%):

Effect of post shooting spray

All the treatments of post shooting sprays, bunch covering material and all interaction effect were found non-significant in regarding of acidity during the years 2017-18, 2018-19 and in pooled analysis (Table 2).

Reducing sugar (%):

Effect of post shooting spray

Results revealed (Table 3) that various treatments of post shooting sprays was found significant in respect to reducing sugar of banana fruits. The significantly maximum reducing sugar was recorded with SOP 2 % (S_6) *i.e.* 12.55 % and which was at par with all the treatments except control in year 2017-18. Whereas, significantly maximum reducing sugar was recorded with spray of SOP 2 % (12.34 and 12.45 %) and which was at par with treatments S_4 (GA_3 100 mg/l) and CPPU 4 mg/l (S_5) in the years 2017-18, 2018-19 and in pooled analysis, respectively.

Effect of bunch covering material

The result revealed that reducing sugar of banana fruits was influenced significantly by different bunch covering materials. The reducing sugar was recorded higher with non-woven material bag covering (B_1) *i.e.* 12.21, 12.16 and 12.18 % as compared to blue colour polythene sleeve (B_2) *i.e*. 11.13, 10.87 and 11.00 % during the year 2017-18, 2018-19 and in pooled, respectively.

Total sugar (%):

Effect of post shooting spray

The results revealed that various post shooting sprays was found significant for total sugar of banana fruits. The significantly maximum total sugar was recorded with spraying of SOP 2 % (21.42 %) and it was found at par with all the treatments except control (S_1) in first year of experiment. Whereas, significantly maximum reducing sugar was recorded with treatment SOP 2 % (20.82 and 21.12 %) and which was statistically found at par with treatments S_4 *i.e.* GA_3 100 mg/l (20.33 and 20.40 %) and S_5 *i.e.* CPPU 4 mg/l (20.10 and 20.35 %) in the year 2018-19 and in pooled analysis, respectively. This might be due to

potassium is involved in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids (Tisdale and Nelson, 1966). Potassium is responsible for energy production in the form of ATP and NADPH in chloroplast by maintaining balanced electric charges. Besides, K is involved in phloem loading and unloading of sucrose and amino acids and storage inform of starch in developing fruits by activating the enzymes starch synthase (Mengel and Kirkby, 1987). In plants well supplied with K, the osmotic potential of the phloem sap and the volume flow rate are higher than untreated plants and as a result, sucrose concentration in the phloem sap is increased. Similar results were also recorded by Kumar *et al.* (2008), Kumar and Kumar (2010), Kachhadia *et al.*(2017) and Pebbudi *et al.* (2017) in banana.

Effect of bunch covering material

The result revealed that total sugar of banana fruit was influenced by different bunch covering materials. The significantly higher total sugar was recorded with non-woven material bag covering (20.84, 20.50 and 20.67 %) as compared to blue colour polythene sleeve (19.00, 18.34 and 18.67 %) during the years 2017-18, 2018-19 and in pooled, respectively. It might be due to significantly positive association with temperature. The covered bunches had more total sugar, probably higher temperature inside bunch which is favorable for conversion of starch into sugar. A similar result was reported by Sarkar (2014) in banana.

Interaction effect

All interaction effects of post shooting sprays x bunch covering materials were found non-significant with respect to physiological loss in weight, pulp: peel ratio, total soluble solid, acidity, reducing sugar and total sugar of banana during both experimental years as well as in pooled data.

CONCLUSION:

From the two years of field study, it can be concluded that the post shooting bunches spraying of CPPU 4 mg/l was obtained minimum physiological weight of fruit and higher pulp : peel ratio. Whereas, post shooting spray of SOP 2 % was recorded maximum TSS, reducing sugar and total sugar with bunches covering of non-woven material bag was significantly better for improving the quality of banana.

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Table 1: Effect of post shooting sprays and bunch covering materials on physiological loss in weight and pulp: peel ratio

Treatments	Physiological loss in weight (%)	Pulp: peel ratio

	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Post shooting spray (S)						
S_1 : Control	17.52	18.33	17.93	2.58	2.64	2.61
S_2 : Humic acid @ 2%	14.57	15.23	14.90	2.96	2.95	2.95
S_3 : 2,4-D @ 30 mg/l	14.25	15.27	14.76	2.96	2.87	2.92
S_4 : GA3 @ 100 mg/l	13.52	14.03	13.77	3.15	3.04	3.10
S_5 : CPPU @ 4 mg/l	12.80	13.60	13.20	3.22	3.18	3.19
S_6 : SOP @ 2%	13.02	13.53	13.28	3.18	3.17	3.18
S.Em ±	0.31	0.35	0.23	0.08	0.06	0.05
CD at 5%	0.89	1.02	0.66	0.23	0.18	0.14
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	13.26	14.14	13.70	3.18	3.13	3.16
B_2: Blue colour polyethylene sleeve	15.30	15.85	15.58	2.84	2.81	2.83
S.Em ±	0.18	0.20	0.13	0.05	0.04	0.03
CD at 5%	0.52	0.59	0.66	0.13	0.10	0.14
Interaction effect (S X B)						
S.Em ±	0.43	0.49	0.47	0.11	0.09	0.12
CD at 5%	NS	NS	NS	NS	NS	0.14
Pooled Interaction						
Source	Y x S	Y x B	YxSxB	Y x S	Y x B	YxSxB
S.Em ±	0.33	0.19	0.46	0.07	0.04	0.10
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	5.25	5.69	5.48	6.39	5.07	5.78

Table 2: Effect of post shooting sprays and bunch covering materials on total soluble solids and acidity

Treatments	Total soluble solids (ºBrix)			Acidity (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled

Post shooting spray (S)						
S_1 : Control	18.37	18.28	18.32	0.294	0.305	0.299
S_2 : Humic acid @ 2%	19.78	19.58	19.68	0.280	0.292	0.286
S_3 : 2,4-D @ 30 mg/l	20.28	19.75	20.02	0.280	0.295	0.287
S_4 : GA3 @ 100 mg/l	20.75	20.45	20.60	0.275	0.290	0.282
S_5 : CPPU @ 4 mg/l	21.28	21.05	21.17	0.278	0.286	0.282
S_6 : SOP @ 2%	21.42	21.23	21.33	0.276	0.283	0.279
S.Em ±	0.58	0.47	0.37	0.010	0.006	0.006
CD at 5%	1.71	1.37	1.07	NS	NS	NS
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	21.39	20.93	21.16	0.281	0.292	0.287
B_2: Blue colour polyethylene sleeve	19.24	19.18	19.21	0.280	0.291	0.286
S.Em ±	0.34	0.27	0.22	0.006	0.004	0.003
CD at 5%	0.99	0.79	1.07	NS	NS	NS
Interaction effect (S X B)						
S.Em ±	0.83	0.66	0.66	0.015	0.009	0.004
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 ±	0.53	0.31	0.75	0.008	0.005	0.012
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	7.05	5.71	6.42	8.960	5.210	7.260

Table 3: Effect of post shooting sprays and bunch covering materials on reducing sugar and total sugar (%)

Treatments	Reducing sugar (%)			Total sugar (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled

Post shooting spray (S)						
S_1 : Control	10.52	10.19	10.35	17.95	17.18	17.57
S_2 : Humic acid @ 2%	11.42	11.31	11.36	19.48	19.07	19.28
S_3 : 2,4-D @ 30 mg/l	11.49	11.29	11.39	19.60	19.00	19.30
S_4 : GA3 @ 100 mg/l	11.99	12.05	12.02	20.47	20.33	20.40
S_5 : CPPU @ 4 mg/l	12.07	11.92	12.00	20.60	20.10	20.35
S_6 : SOP @ 2%	12.55	12.34	12.45	21.42	20.82	21.12
S.Em ±	0.39	0.33	0.25	0.67	0.55	0.43
CD at 5%	1.13	0.95	0.72	1.94	1.60	1.23
Bunch Covering Material (B)						
B_1: Non- woven material bag covering	12.21	12.16	12.18	20.84	20.50	20.67
B_2: Blue colour polyethylene sleeve	11.13	10.87	11.00	19.00	18.34	18.67
S.Em ±	0.22	0.19	0.15	0.38	0.32	0.25
CD at 5%	0.65	0.55	0.72	1.12	0.92	1.23
Interaction effect (S X B)						
S.Em ±	0.55	0.46	0.46	0.94	0.78	0.78
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 ±	0.36	0.21	0.50	0.61	0.35	0.86
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	8.10	6.92	7.54	8.19	6.92	7.60