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RESEARCH ARTICLE

INFLUENCE OF BUNCH COVERS ON QUALITY OF BANANA CV. JAHAJI (AAA) UNDER HIGH DENSITY PLANTING SYSTEM

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ABSTRACT

Inferior quality of fruit has been considered as a drawback of fruits grown and developed in low temperature conditions. In addition to it, higher planting densities create a microclimate which also affects the quality of fruits. Regarding this problem, an investigation was carried out in the Experimental Farm, Department of Horticulture, Jorhat during 2013-2014 in order to find out the best bunch cover material among white non-woven polypropylene bag, blue non-woven polypropylene bag, transparent polyethylene bag, leno bag, gunny bag, dry banana leaves and Control (no cover) in banana cv. Jahaji (AAA) under the high density planting system. Various quality characters were found to be significantly influenced by bunch cover application. The fruits under white non-woven polypropylene cover registered highest TSS (22.84°Brix) and lowest titrable acidity (0.23%). On the contrary, lowest TSS (19.36°Brix) and highest titrable acidity (0.27%) was obtained in the control bunches. Sugar-acid ratio and pulp-peel ratio was found uniform in all the treatments without showing any significant differences among them. However, reducing, non-reducing and total sugars were lowest in blue non-woven polypropylene (8.70%, 8.71% and 17.42%, respectively) compared to the highest in control (9.03%, 9.01% and 18.04%, respectively).

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INTRODUCTION

The quality of the fruits that grow in the cool seasons are inferior in all aspects compared to fruit developing in other seasons (Dhua *et al*., 1988). Khataniar (1989) found that banana fruits which grew and developed in higher temperature (24.55°C- 31.05°C) have significantly higher pulp weight, peel weight, pulp-peel ratio, TSS, sugar-acid ratio and sugar than that of winter harvested fruits which received low temperature (14.34°C-25.82°C). Plant growth regulation using synthetic materials has opened new vistas in plantation crop production and has helped in mitigating certain complicated problems regarding banana production round the year. Traditionally, old banana leaves have been wrapped around maturing bunches (Turner, 1984). According to research conducted by Kutinyu (2014), banana bunch covers allows production of high quality bananas that are not bruised and hence of acceptable visual appearance. Banana bunch covers are used throughout the commercial banana growing areas of the world. Bunch covers with synthetic material alters the microclimate by increasing the temperature up to 10°C in a modified microclimatic condition around the bunch (Reddy, 1989).

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This microclimate helps in proper finger growth and development as well as reduction in shooting-harvest interval irrespective of season. Bunch covers of various colours and conditions (perforated and non-perforated) have been extensively used in both tropical and subtropical banana growing countries with the aim of improving yield and quality (Stover and Simmonds, 1987; Robinson, 1996).

MATERIALS AND METHODS

The field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2013-2014. The experimental site was situated at 26°47'N latitude and 94°12'E longitude and at an elevation of 86.8 m above mean sea level. The climatic condition of Jorhat city is characterized by a subtropical environment with hot-humid summer and relatively dry and cool winter. The average rainfall is about 1875 mm to 2146 mm which is unevenly distributed throughout the year. The temperature reaches a maximum of 34-36°C during summer and the minimum of 7°C during winter. The experiment was laid out in Randomized Block Design (RBD) with three replication comprising seven treatments. There were twenty one plots each having twelve numbers of plants with the spacing of 1 m × 1.2 m × 2 m. Individual plot size was 8.8 m^2

and the total area of the experimental site was 313.2 m^2. Healthy three months old uniform sword suckers of cv. Jahaji weighing about 2 kg each were collected from healthy mother plants and used as planting materials. Seven treatments viz., bunch cover with white non-woven polypropylene bag(T_1), bunch cover with blue non-woven polypropylene bag(T_2), bunch cover with transparent polyethylene bag(T_3), bunch cover with leno bag(T_4), bunch cover with gunny bag(T_5), bunch cover with dry banana leaves(T_6), Control(T_7) were allotted randomly in each block. Bunches with uniform number of hands and almost same date of shooting were randomly selected. The bunch covers of size 1.5m x 0.8m were applied ten days after the full formation of the last hand. Uniform perforations of 0.05% were provided in the Polyethylene bags. The male buds were removed before bagging. Covers were slid up from the bottom of the stalk and securely tied to the peduncle above the first hand of the fruit. Covers were left on bunches until harvest. The fruits were considered to be physiologically matured and ready for harvest when the angular girth of fruit skin disappeared and the colour of fruits turned from dark green to light green.

Total Soluble Solids (TSS)

TSS of the fruit samples was determined by Zeiss Hand Juice Brix Refractometer and the result was expressed in °Brix.

Titrable acidity

The titrable acidity was estimated by using standard method of A.O.A.C. (1975). Ten g of pulp was dissolved in 100 ml of distilled water and filtered. Ten ml of filtrate was titrated against 0.1 N NaOH using the indicator phenolpthalein where the light pink color indicated the end point. Titrable acidity was calculated by the following formula and expressed in percentage in terms of anhydrous citric acid.

$$\text{Titrable acidity} = \frac{\text{Titre value x Normality of alkali x Volume made up x Equivalent weight of citric acid}}{\text{Weight of sample x Aliquot x 1000}} \text{ x } 100$$

Reducing sugar

Reducing sugars was also estimated by using the standard method of A.O.A.C. (1975). Ten ml of standard lead acetate solution and 5 g of sodium oxalate were added to 25 g of pulp which was already ground in a mortar and the volume was made up to 250 ml with distilled water, centrifuged and then filtered. The filtrate was titrated against 10 ml boiling Fehling's solution mixture (5 ml of Fehling' solution A + 5 ml of Fehling's solution B) using methylene blue as indicator, where deep brick red color of the solution indicated the end point. Reducing sugar was calculated by using the following formula and expressed in percentage.

$$\text{Reducing sugar} = \frac{\text{Factor} \times \text{volume made}}{\text{Titre value} \times \text{weight of sample}} \times 1000$$

Where, Factor = 0.05 (mg of invert sugar).

Total sugar

It was estimated by using the standard method of A.O.A.C. (1975) from the solution of 250 ml made up for estimation of reducing sugar, 50 ml was taken and 5 ml of concentrated HCL was added to it and kept overnight. The solution was then neutralized with 1 N NaOH and the volume was made up to 150 ml with distilled water and titrated against 10 ml boiling Fehling's solution mixture. Total sugar was calculated with the following formula and expressed in percentage.

Total sugar = (% sucrose - % reducing sugar)
Sucrose = (Total invert sugar % - reducing sugar %) x 0.95

$$\text{Total invert sugar} = \frac{\text{Factor} \times \text{volume made up} \times \text{volume stock solution}}{\text{Titre value} \times \text{weight of the sample} \times \text{Aliquot taken}}$$

Factor = 0.05 (mg of invert sugar)

Non-reducing sugar: Non-reducing sugar was estimated by subtracting the value of reducing sugar from the value of total sugar.

Sugar-acid ratio: Sugar-acid ratio was calculated by dividing the mean of total sugar by the mean of titrable acidity.

$$\text{Sugar-acid ratio} = \frac{\text{Total sugar (\%)}}{\text{Titrable acidity (\%)}}$$

Pulp-peel ratio: Pulp-peel ratio was calculated by dividing the mean pulp weight by the mean of peel weight.

$$\text{Pulp-peel ratio} = \frac{\text{Pulp weight (g)}}{\text{Peel weight (g)}}$$

RESULTS AND DISCUSSION

In any High Density Planting (HDP) system, the primary objective is to obtain the maximum fruit yield per unit area without affecting the fruit quality. The use of bunch covers helped to improve quality of fruits in HDP, which might have got inferior due to the microclimate within the system due to closer spacing (as in control). As far as the total soluble solids was concerned, there was significant differences among the TSS of fruits belonging to different treatments. The highest TSS (22.84°Brix) was found in fruits covered with white non-woven polypropylene bags followed by blue non-woven polypropylene bags (21.41°Brix) as compared to control (19.36°Brix). The increase in TSS of fruit pulp could be due to the breakdown of starch into soluble sugars. Temperature triggers the climacteric stage in banana, in which the accumulated polysaccharides are rapidly converted in soluble sugars which forms large portion of TSS. This is in close conformation with the results of Shanmugavelu *et al*. (1992) who supported that banana fruits that grew and developed in higher temperature had more TSS in comparison to fruits of lower temperatures. Cuneen and Entyre (1988) observed that the temperature inside the bags were 10°C warmer than the outside temperature during the day which increased the TSS of the fruits in covered bunches.

Table. Influence of various bunch covers treatments on quality characters of banana cv. Jahaji

Treatments	Total soluble solids (°Brix)	Titrable acidity (%)	Reducing sugar (%)	Total sugar (%)	Non-reducing sugar (%)	Sugar-acid ratio	Pulp-peel ratio
T_1	22.84^{a}	0.23^{c}	8.73^{d}	17.52^{cd}	8.78^{bc}	76.23	2.20
T_2	21.41^{b}	0.24^{bc}	8.70^{d}	17.42^{d}	8.71^{c}	71.63	2.34
T_3	21.22^{b}	0.24^{bc}	8.79^{cd}	17.53^{cd}	8.73^{c}	73.04	2.16
T_4	19.91^{c}	0.26^{ab}	8.94^{ab}	17.84^{ab}	8.90^{ab}	69.69	2.17
T_5	20.91^{b}	0.24^{bc}	8.83^{bcd}	17.63^{bcd}	8.79^{bc}	73.56	2.15
T_6	20.17^{c}	0.26^{ab}	8.89^{abc}	17.74^{bc}	8.84^{bc}	68.66	2.12
T_7	19.36^{d}	0.27^{a}	9.03^{a}	18.04^{a}	9.01^{a}	66.86	2.34
S.Ed. (±)	0.28	0.01	0.06	0.12	0.06	-	-
$C.D_{0.05}$	0.62	0.02	0.14	0.27	0.13	NS	NS

Means within column separated by Duncan's multiple range test P = 0.05
Means followed by the same letter shown in superscript(s) are not significantly different.
NS: Not significant, S. Ed : Standard Error, C.D: Critical Difference.

Fruit acidity is due to the presence of organic acids mainly malic and citric acids (Seymour *et al.,* 1993). It is evident from table below that the percentage of titrable acidity differed significantly among the treatments. Results indicated that all the covered fruits had comparatively less percentage of titrable acidity than the uncovered fruits. The highest 0.27 per cent titrable acidity was obtained in the control while the lowest was obtained in the bunch covered with white non-woven polypropylene bags (0.23%). The significant variation in titrable acidity was mainly due to variation in temperature around the bunch with different bunch covers treatments in comparisons to open atmospheric temperature. Understanding the factors that influence the concentration of acids in fruit cells is thus of primary importance for fruit quality improvement. The processes involved in the metabolism and accumulation of malic and citric acid in mesocarp cells is under both genetic and environmental control. Increasing the temperature during fruit growth or storage decreases fruit titrable acidity (Kliewer, 1973; Rufner, 1982; Wang and Camp, 2000 and Gautier *et al.,* 2005) as well as malate and citrate concentrations in banana (Bugaud *et al.,* 2009). Modifications in organic acid metabolism in response to temperature probably results from the impact of temperature on the reaction rates of glycolysis and of the TCA cycle (Araujo *et al.,* 2012) by modifying enzyme activities (Lakso and Kliewer, 1975), and also on the kinetic properties of the mitochondrial transport systems involved (Halestrap, 1975). The main effect of increasing temperature would be to stimulate respiration, with the above-mentioned effects on citrate metabolism (increasing citrate production during green stages and decreasing citrate production during ripening).

Temperature probably affects vacuolar storage of organic acids via several mechanisms. Temperature is a key variable in the thermodynamic equations that limit the operation of the proton pumps and the diffusion of organic anions through the tonoplast. Increasing the temperature reduced the ability of the fruit to accumulate malate, which is in accordance with observations made in agronomic studies (Lobit *et al.*, 2006). Temperature also affects membrane fluidity by modifying lipid properties (Murata and Los, 1997). Thus, high temperatures may change the tonoplastic permeability of fruit cells, which could increase leakage of solutes such as protons or protonated forms of organic acids. The increase in tonoplastic permeability could explain the increased activity of vacuolar proton pumps in response to an increase in temperature (Terrier *et al*., 1998).

The increase in proton pump transport activity may compensate for the leakage of solutes, which is known to occur during fruit ripening, but only partially, resulting in a net efflux of malic and citric acid to the cytosol and their further degradation (because of the cytosolic pH homeostasis), leading to a decrease in fruit acidity. Among the treatments, control fruits had significantly highest reducing, non-reducing and total sugars (9.03%, 9.01% and 18.04%, respectively) in comparison to the lowest in blue non-woven polypropylene cover (8.70%, 8.71% and 17.42%, respectively). This was because at low temperature stored starch gets converted into sugar (Curtis and Clark, 1950). Therefore, the fruit sugar content at low temperature was higher than the fruits of warmer temperature (Dhua *et al*., 1988). The low temperature probably governed the enzymatic system involved in catabolism of sugar. No significant difference regarding sugar-acid ratio was found among the treatments. However, the highest sugar-acid ratio was obtained in fruits covered with white non-woven polypropylene bags (76.23). Data presented in Table below showed uniform pulp-peel ratio in all the treatments indicating no significant influence of bunch covers in proportionate increase of pulp and peel in the fruits. From the above results it can be concluded that most of the bunch covers had positive influence in improving the quality of fruits. Total soluble solids content significantly differed among the treatments. The highest TSS (22.84°Brix) content was obtained in the fruits under white non-woven polypropylene covers whereas the uncovered fruits registered the lowest (19.36°Brix) TSS content. Significant reduction in titrable acidity was observed due to the application of bunch covers. The highest titrable acidity (0.27%) was obtained in uncovered fruits while the same was lowest (0.23%) in fruits under white non-woven polypropylene cover. Significant effect of bunch covers was also observed in fruits regarding total sugar, reducing sugar and non-reducing sugar present in the fruits. All the three parameters were highest (18.04%, 9.03% and 9.01%, respectively) in uncovered fruits compared to the lowest under blue non-woven polypropylene covers. Sugar-acid ratio and pulp-peel ratio were found uniform in all treatments indicating no significant influence of bunch covers.

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