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EFFECT OF PRE-HARVEST BAGGING ON QUALITY AND YIELD OF LITCHI (*LITCHI CHINENSIS* SONN.) FRUITS

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ABSTRACT

The present experiment was done at farm of ICAR-NRC on Litchi, Mushari, Muzaffarpur during 2011 and 2012. The bagging of litchi fruit bunches with four different type of bags namely plastic bag, brown paper/kraft paper bags, butter paper bags and muslin cloth bags at 40 and 50 days after anthesis were done to study their effects on fruit borer infestation management and quality improvement of litchi fruit cv. Shahi. The results showed that irrespective of bagging date and type, there was significant decrease in fruit borer infestation, sunburn, spotted and cracked fruits with slight decrease in TSS and acidity. The minimum fruit borer infestation (6.12 %), brown/ black spotted fruits (3.43%), cracked fruits (1.85%) were observed with white butter paper bagging at 40 days after anthesis whereas maximum fruit weight (25.12g) with WBPB and firmness (1.61 Kg cm⁻²) was recorded with brown paper bagging at 40 days after anthesis. The highest ascorbic acid content (64.93 mg/100pulp) of fruit were found with WBPB at 40 days after anthesis. Hence, it is concluded that bagging of litchi bunches at 40 days after anthesis with white butter paper bags can be used to get healthier and quality litchi fruits.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.), a member of soapberry family, is one of the important sub-tropical evergreen fruit crops of South-East Asia. Litchi fruits are highly prized in fresh form due to their attractive red skin, semi-translucent juicy white aril, high nutritive value, strong aroma and rosy flavor, (Wall, 2006 and Singh *et al.*, 2012). It is commercially grown in limited countries and India ranks 2nd in production after China with 585,300 MT in 2013 from 84,170 ha area during 2013 (NHB data base, 2013-14).

Litchi, being a non climacteric fruit, ripens on tree itself and reaches maturity in 50-60 days after fruit set depending on the cultivar, environmental conditions and cultural practices. The quality of the fruit is highly influenced by the climatic condition particularly during fruit growth and development period. During favourable climatic condition, several pests mainly fruit borer (*Conopomorpha chinensis*), birds and bats affect the quality and yield (Kumar *et al.*, 2014). If conditions are cloudy and erratic rainfall during fruit development, fruit borer infestation is more than 60 percent and control of this devastating damage through spray of pesticide is neither possible nor recommended from health point of view. The 2nd phase of litchi fruit growth and development takes place during April-May in North eastern India which often synchronized with the period of high temperature and low humidity resulting in localized light brown blotches on the fruit skin (0.9-19.1%) and fruit cracking (0.7-11.5%) as reported by Sanyal *et al.*, (1990). The fruiting and fruit quality is highly dependent on climatic condition (Singh *et al.*, 2014). During adverse climatic condition when continuous dry heat (40±2 °C temp. and <50% RH) along with dry hot winds prevails, there is severe problem of sunburn and fruit cracking. These factors result in considerable loss of yield as well as quality of the litchi fruits in conventional method of litchi production. Bagging is commonly applied to many fruits for improving quality, protecting from pests, extreme environmental conditions, and pesticide residues (Xu *et al.*, 2010; Sharma *et al.*, 2014). Fruit bagging has been found effective to improve fruit quality, reduce pest damage, sun burning and cracking in apples (Wang *et al.*, 2002), mango (Wu *et al.*, 2009) and peach (Kim *et al.*, 2008). There are few reports of fruit bagging for litchi fruit with improved quality (Debnath and Mitra, 2008; Tyas *et al.*, 1998). It was, thus, hypothesized that by employing appropriate bagging to litchi fruit bunches, the physical losses and quality can be improved. The ultimate aim of the producer is to produce fruits of better quality, and consumer also wants to have fruits of high quality. Hence, the present investigations were carried out to study the effect of different type of bags and time of fruit bagging on production of quality litchi fruits.

MATERIALS AND METHODS

Experimental site and materials

The experiment was carried out at National Research Centre on Litchi, Mushahari Farm, Muzaffarpur of Bihar state in India. The weather is characterized as subtropical climate, with hot and dry condition (38-42°C and 40-60% RH) during fruit growth

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and development stage. The soil of this region was loamy to sandy loam with 7.8-8.5 pH. The experiments were conducted on seven year old trees of litchi (*Litchi chinensis* cv. Shahi). The four kinds of bags such as 40 μ m polyethylene bags (PB), white butter paper bags (WBPB), brown/Kraft paper bags (BPB) and muslin cloth bags (MCB) with 350 mm x 250 mm (L x W) size having perforation at lower end were used in experiment during 2011 and 2012. The microclimate developed inside the different kind of bags is given in table 1.

Experimental treatments

The litchi fruit bunches (45 no) were randomly selected from three trees and bagged at 40 days after bloom (DAB) and 50 DAB which was during 2nd fortnight of April, when the average fruit weight was approximately 3.5 g. The fruits with bag were picked at full maturity during last week of May and fruit characters were analyzed in laboratory. Five randomly selected fruit bunches in each tree were also marked for un-bagged control treatment.

Determination of fruit characteristics/quality

Thirty fruit per treatments were tested for outer and inner quality. The major outer characteristics or physical parameters included were percent pest infestation, fruit colour, average fruit weight, percent fruit cracking and brown/ black spotted fruit percentage. The main chemical parameters included were TSS (digital hand refractometer, model Pal-1), acidity (pH of the juice), and ascorbic acid by using 2,6-Dichlorophenol-indophenol dye (Rangana, 1986). The firmness of the peel was measured using a penetrometer (FT 02, Italian) with 2 mm probe at two equatorial points of the fruits and data were recorded in kg cm⁻².

Statistical Design and Data Analysis

The data generated during 2011 and 2012 for different parameters were pooled and subjected to analysis as per standard procedures (Panse and Sukhatme, 1984). The significance of the treatments was determined by developing analysis of variance (ANOVA) and the means were compared by calculating critical difference (C.D.) at $p < 0.05$.

RESULTS AND DISCUSSION

Effect of bagging on physical quality of fruits

The infestation of fruit borer, browning/blackening of skin and fruit skin cracking is a serious problem of litchi fruits (Debnath and Mitra, 2008). The data on these parameters (Table 2) revealed that irrespective of time and type of bagging material all the treatments exhibited highly significant control of fruit borer infestation, browning/blackening of skin and fruit skin cracking. The highest percent of healthy marketable fruits was

obtained with white colour butter paper bags (90.77%) and brown paper bags (89.60%) when bagged at 40 DAB. There were 33.58 - 41.38 percent more healthy marketable fruits in all bagged fruits as compared to control (un-bagged) when bagged at 40 DAB. These results are in close conformity with the findings of Tran *et al.* (2015). Bagging of litchi fruits with paper or polythene bags might have prevented the contact of female moth and other pest with the fruits, thereby protecting the fruits from borer and disease infestation.

The main physical parameters comprises of fruit weight, colour and firmness are shown in table 3. The fruits weight of Shahi litchi was significantly increased in all treatments and maximum fruit weight (25.12 g and 23.36 g) at both stages of bagging was recorded with WBPB followed by BPB (24.67g and 23.28 g). Minimum spotted and bright red colour fruit was also found with WBPB (3.43%) whereas un-bagged fruits were 18.57% spotted and dull/dark red in colour when bagged at 40 DAB. The highest firmness value was observed in BPB (1.61 kg cm⁻² and 1.53 kg cm⁻²) and minimum with PB 91.35 kg cm⁻² and 1.30 kg cm⁻² at 40 DAB and 50 DAB respectively. Bagged litchi fruits can improve the physical quality of fruit through modifying fruit micro-environment conducive for better physical parameters of fruit. Similar findings were also reported by Sarker *et al.* (2009) in mango.

Fruit color is the basic point of attraction for the consumers. Attractive colour improves the physical appearance of the fruit, which helps to get better price in the domestic or export market. It has now been established that fruit bagging is an effective way to promote anthocyanin synthesis and improve fruit coloration in apples (Ritenour *et al.*, 1997). It is believed that bagging increases light sensitivity of fruit and stimulates more anthocyanin synthesis when fruits are kept in WBPB and MCB (61.38 and 59.16 % photo-permeability respectively) than fruit kept in BPB (3.90 % photo-permeability) during maturation, which indicates medium light intensity could be imperative for anthocyanin synthesis.

Effect of bagging on internal quality of Shahi fruits

Eating quality of fruit includes attributes such as total soluble solids (TSS), acidity; vitamins etc are shown in Table 4. It appears from our study that bagged litchi had significantly higher level of ascorbic acid content (64.39 mg/100 ml juice) at harvest than non-bagged litchi fruit (52.27 mg/100 ml juice) with WBPB at 40 DAB. The improvement in ascorbic acid has also been reported in apple by Sharma *et al.*, (2013). The TSS concentration was lower in BPB and PB bagged fruits as compare to un-bagged fruits and found lesser when bagged earlier i.e. 40 DAB. However the TSS content in WBPB and MCB fruits were at par with control. There was a decreasing trend of soluble solid content by all treatments, consistent

Table 1: Microclimate developed inside the bags

| Type of bags | Colour | Photon permeability* (%) | Max ^m . Temp.(^o C) | Min ^m . Humidity (%) |
|----------------------|-------------|--------------------------|---|---------------------------------|
| Maslin cloth | White | 59.16 | 36.53 | 37.45 |
| Butter paper | White | 61.38 | 35.20 | 41.67 |
| Kraft paper | Brown | 3.90 | 34.26 | 45.10 |
| Poly ethylene (LDPE) | Transparent | 84.23 | 35.63 | 47.60 |
| Control | | 100 | 39.06 | 33.25 |

* Determined with the help of digital Lux meter

Tables 2: Effect of bagging for the control of discarded fruits*

| Treatments | 40 days after bloom (40 DAB) | | | | 50 days after bloom (50 DAB) | | | |
|------------|---------------------------------|----------------------------------|--------------------|-------------------------------|---------------------------------|----------------------------------|--------------------|-------------------------------|
| | Fruit borer infested fruits (%) | Brown/black spotted fruits** (%) | Cracked fruits (%) | Healthy marketable fruits (%) | Fruit borer infested fruits (%) | Brown/black Spotted fruits** (%) | Cracked Fruits (%) | Healthy marketable fruits (%) |
| MCB | 8.63 | 05.67 | 04.82 | 85.51 | 11.68 | 06.63 | 05.92 | 81.29 |
| WBPB | 6.12 | 03.43 | 01.85 | 90.77 | 09.36 | 04.21 | 03.33 | 86.42 |
| BPB | 6.44 | 05.40 | 02.22 | 89.60 | 09.61 | 03.71 | 02.59 | 87.96 |
| PB | 7.26 | 09.66 | 04.07 | 82.97 | 08.88 | 06.8 | 05.18 | 82.83 |
| C | 21.30 | 18.57 | 20.74 | 49.39 | 20.73 | 19.08 | 21.48 | 48.74 |
| CD at 5% | 2.01 | 1.76 | 2.21 | 4.84 | 2.07 | 1.92 | 2.23 | 4.69 |

*Discarded fruits consist of borer infested fruits; black/brown spotted and cracked fruits; **Black/ brown spotted fruits consist of sunburn and anthracnose affected fruits; MCB- Maslin cloth bagging; WBPB- White butter paper bagging; BPB- Brown paper bagging; PB- Polyethylene bagging; C- Control (no bagging)

Table 3: Effect of bagging on physical parameters of litchi fruits cv. Shahi

| Treatments | 40 days after bloom (40 DAB) | | | 50 days after bloom (50 DAB) | | |
|------------|------------------------------|--------------------|--------------------------------|------------------------------|------------------|--------------------------------|
| | Fruit wt. (g) | Fruit colour | Firmness(Kg cm ⁻²) | Fruit wt. (g) | Fruit colour | Firmness(Kg cm ⁻²) |
| MCB | 23.10 | Bright red | 1.40 | 22.74 | Bright red | 1.38 |
| WBPB | 25.12 | Bright red | 1.42 | 23.36 | Bright red | 1.40 |
| BPB | 24.67 | Bright pinkish red | 1.61 | 23.28 | Bright light red | 1.53 |
| PB | 22.74 | Bright dark red | 1.35 | 21.60 | Bright dark red | 1.30 |
| C | 20.03 | Dull red | 1.45 | 19.78 | Dull red | 1.40 |
| CD at 5% | 1.17 | | 0.047 | 1.26 | | 0.042 |

MCB- Maslin cloth bagging; WBPB- White butter paper bagging; BPB- Brown paper bagging; PB- Polyethylene bagging; C- Control (no bagging)

Table 4: Effect of bagging on inner quality of Shahi litchi fruits

| Treatments | 40 days after bloom (40 DAB) | | | 50 days after bloom (50 DAB) | | |
|------------|------------------------------|-------------|-----------------------------|------------------------------|-------------|-----------------------------|
| | TSS(°Brix) | Acidity(pH) | Ascorbic acid (mg/100 g FW) | TSS(°Brix) | Acidity(pH) | Ascorbic acid (mg/100 g FW) |
| MCB | 18.70 | 4.00 | 61.67 | 18.90 | 3.95 | 60.12 |
| WBPB | 18.25 | 4.10 | 64.93 | 18.40 | 4.00 | 63.46 |
| BPB | 17.05 | 4.20 | 60.06 | 17.60 | 4.15 | 61.82 |
| PB | 16.50 | 4.35 | 57.14 | 17.15 | 4.30 | 58.39 |
| C | 19.05 | 3.85 | 52.27 | 19.25 | 3.90 | 54.10 |
| CD at 5% | 0.84 | 0.085 | 4.06 | 0.89 | 0.077 | 3.86 |

MCB- Maslin cloth bagging; WBPB- White butter paper bagging; BPB- Brown paper bagging; PB- Polyethylene bagging; C- Control (no bagging)

with the results with double layer bag in Chinese olive as reported by Zhou *et al.* (2012). The increasing trend of pH value of the juice was found in all the bagged fruits with minimum acidity with PB (3.85) irrespective of the bagging date, however longer the duration of bagging lower was the acidity. Our results are similar to those of Huang *et al.* (2009) in pear, who reported that concentration of titratable acid in Red Chinese sand pears (*Pyrus pyrifolia* Nakai) was notably lowered, but the content of soluble sugar was not decreased so much. It may be due to the light transmission rate, fruit transpiration rate and the liquid flowing rate toward fruit, which were directly or indirectly reduced because of the different kind of micro-environment inside the bags. Several studies have reported increase in fruit quality attributes following fruit bagging for example in apple (Sharma *et al.*, 2013), guava (Singh *et al.*, 2007) and mango (Watanawan *et al.*, 2008).

The high quality Shahi litchi fruits with least cracking, borer infestation, brown/black spotting and bright red colour appearance can be produced when bagged with white butter paper (60% of light transmittance), at 40 DAB till the harvest time. It is a simple, cost-effective and eco-friendly technology for quality litchi production. Further more, in order of obtaining

more durable and efficient fruit bagging, desirable bags with quality materials, different colours and size could be investigated.

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