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Varun Pal
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Kiran Kour
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Parshant Bakshi
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Nikhil Thakur
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

M Iqbal Jeelani
Division of Statistics and Computer Science, Faculty of Basic Sciences, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Sarbdeep Kour
Division of Soil Science and Agriculture Chemistry, Faculty of Agriculture and Registrar Office Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Deep Ji Bhat
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Bharat Bhushan
Division of Soil Science and Agriculture Chemistry, Faculty of Agriculture and Registrar Office Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Corresponding Author:
Nikhil Thakur
Division of Fruit Science, Faculty of Agriculture, Skuast-J, Chatha, Jammu, Jammu and Kashmir, India

Effect of pre-harvest panicle bagging on the physico-chemical characteristics of litchi cv. Dehradun

Varun Pal, Kiran Kour, Parshant Bakshi, Nikhil Thakur, M Iqbal Jeelani, Sarbdeep Kour, Deep Ji Bhat and Bharat Bhushan

Abstract
The experiment was carried out at Fruit nursery, Department of the Horticulture, Marallia (Miran Sahib) Jammu during 2018-19. Different bagging materials (brown paper bag, newspaper bag, muslin cloth bag, butter paper bag, laminated brown paper bag, white polypropylene bag. pink polypropylene bag) were used in combination with different time of bagging (20 days, 30 days and 40 days after fruit set). Results shows that panicles bagged with pink polypropylene bag 40 days after fruit set showed least fruit cracking (14.02%) and pericarp sunburn (18.85%) however this treatment also resulted in maximum fruit retention per panicle (54.92%) and fruit yield (78.81 kg/tree). Among the various physical parameters studied, fruit weight (21.64 g), fruit length (4.21cm), fruit breadth (3.96 cm) fruit volume (21.32 cc), specific gravity (1.02). pulp weight (15.94 g) and stone weight (3.06 g) were also found maximum in pink polypropylene bag in combination with 40 days after fruit set. Pink polypropylene bag in combination with bagging at 40 days after fruit set also showed great effects in terms of chemical parameters of fruits *viz*., total soluble solids (22.48°Brix), titratable acidity (0.40%), TSS: acid ratio (56.20). ascorbic acid (24.68 mg/100 g), total sugars (17.10%), reducing sugars (12.83%), non-reducing sugars (4.06%), anthocyanin content (54.35 mg/100g).

Keywords: Bagging material, pink polypropylene bag, yield, quality

Introduction
Litchi (*Litchi chinensis* Sonn.) is one of the most significant sub-tropical evergreen fruit crops, with over 150 genera and 2000 species belonging to the Sapindaceae family and Nepheleae subfamily. It is said to have originated in China. Litchi fruits are renowned for their gorgeous red exterior, semi translucent juicy white aril, high nutritious content, strong fragrance, and rose flavour, which makes it a great thirst quencher when eaten fresh. Litchi is mostly used as a table fruit, with a few exceptions such as dried litchi (litchi nuts), canned litchi in syrup, and squashes. It has unique climatic requirements and is only grown in a few countries, including China, India, Taiwan, Thailand, and Vietnam. After China, India is the world's second-largest producer of litchi. It is mostly grown in Bihar, West Bengal, Uttar Pradesh, Punjab, J&K, and Uttarakhand in India, where it has a significant production and productivity position. Litchi may be cultivated in a variety of soil types, including sandy loams, alluvial sand, and calcareous soil, but it thrives best in alluvial sandy loam soils with appropriate drainage. The fruits are available from mid- May to mid-July and have a short shelf life of 3 to 5 days. There is a serious problem of sunburn and fruit cracking under poor weather circumstances, such as persistent dry heat (40±2 ^{0}C temp and <50% RH) and dry hot winds. Several pests, namely fruit borer, birds, and bats, have an impact on quality and productivity when the weather is favourable. Climate anomalies such as rapid increases in temperature and humidity, as well as irregular precipitation, especially during fruit growth, have been more common in recent years. Litchi growers suffer significant financial losses as a result of this. Several good agricultural practises (GAPs) are becoming more popular across the world to avoid losses caused by biotic and abiotic causes. Preharvest fruit bagging has emerged as one of the finest ways in many regions of the world among multiple such choices. Individual fruit or fruit bunches are bagged on the tree for a certain period of time to get the desired effects in this technique. It is a physical protection method that is often used on various fruits. It not only improves the external quality of the fruit by boosting colour, but it also improves the internal quality of the fruit. Pre-harvest fruit bagging is used in peach, apple, pear, grape, and loquat cultivation in Japan, Australia, and China to improve fruit quality by minimising physiological and pathological diseases and improving fruit coloration to raise market value [5] and [6].

The date of bagging, bagging material, and bagging time, all have a significant impact on fruit quality and other metrics. The type of bag and the material it is made of may have a major impact on the fruit. The bag that is prescribed for one fruit may not be suitable for another [4]. Hence considering importance of bagging being a part of Good Agricultural Practices (GAP), the experiment was under taken to study the effect of different type of bags and appropriate time of fruit bagging on production and quality of litchi cv. Dehradun.

2. Materials and Methods

The research was carried out on 24 years old litchi cv. "Dehradun" planted in square system at 10-meter distance at Fruit Nursery (Department of Horticulture) situated at Maralia, Jammu during the year 2018-19. It falls under subtropical zone at 32.73° N latitude and longitude of 74.87 °E which is 327 m above sea level. The 24 treatments combinations were carried out which comprised of seven different bagging material (News paper bag, muslin cloth bag, white butter paper bag, laminated brown paper bag, white polypropylene bag and pink polypropylene bag) with one un-bagged (control) and bagged at time interval of 20, 30 and 40 days after fruit set. The experiment was statistically analysed in R- studio utilizing library GGplot2. Graphical representation was depicted by Gg Balloon plots.

2.1 Fruit physical and biochemical quality analysis

The physical parameters namely fruit weight, pulp weight, stone weight and pulp: seed ratio were measured with the help of electronic weighing balance while, fruit size was measured with the help of vernier calliper. Fruit volume, specific gravity, fruit retention per panicle, fruit cracking and pericarp sunburn were calculated as per standard methods. Chemical parameters namely total soluble solids (°Brix) was recorded with the help of hand refractometer, titratable acidity (%) and ascorbic acid (mg/100g juice) were determined by the method of [1]. Reducing sugars, non-reducing sugars, anthocyanin content were estimated according to the method given by [8].

3. Results and Discussions

3.1 Physical Parameters

Perusal of data presented in the figure 1, 2 and 3 revealed significant influence of pre-harvest panicle bagging on physical parameters of litchi fruit. Maximum fruit weight (21.64 g) was recorded in pink polypropylene bags in combination with a bagging time of 40 days after fruit set, followed by white polypropylene bags (21.13 g) in treatment combination with a bagging time of 40 days after fruit set while minimum fruit weight (15.78 g) was recorded in unbagged fruits. Maximum fruit size (4.21 x 3.96 cm) was also reorded in same treatment whereas, control fruits had a minimum fruit size (2.43 x 2.32 cm). Maximum fruit volume (21.32 cc) was observed pink polypropylene in combination with a bagging period of 40 days after fruit set, followed by white polypropylene bags (20.87 cc) bagged after 40 days of fruit set and minimum fruit volume was observed in control. Using different bagging materials in conjunction with bagging duration has no effect on the specific gravity of litchi fruit. The maximum pulp weight (15.94 g) was recorded in pink polypropylene bags with a bagging time of 40 days after fruit set, which was comparable to pink polypropylene bags (15.78 g) with a bagging time of 30 days after fruit set, and the minimum pulp weight of litchi (10.79 g) in control. The maximum stone weight of litchi fruit (3.88 g) was reported in brown paper bags, followed by newspaper bags, 20 days after fruit set, while the least stone weight (2.39 g) was found in a laminated brown paper bag 40 days later. Fruit panicles packaged with laminated brown paper bags had the greatest pulp to stone ratio (5.55), followed by pink polypropylene bags (5.21) at 40 days after fruit set, while newspaper bags had the lowest value (2.97) at 20 days after fruit set. Pink polypropylene bags had the highest fruit retention per panicle (54.92 percent), followed by white polypropylene bags (50.98 percent) in combination with 40 days after fruit set, and laminated brown paper bags had the lowest fruit retention per panicle (40.07 percent) in combination with 20 days after fruit set. Fruits bagged with pink polypropylene bags after 40 days of fruit set had the least amount of fruit cracking (14.02%) followed by fruits bagged with white polypropylene bags after 40 days of fruit set (15.04%), and control had the most (26.92%). Pink polypropylene bags bagged 30 days after fruit set took minimum days from fruit set to harvest (71 days), followed by white polypropylene bags and laminated brown paper bags (72 days), while it was maximum (81 days) in unbagged fruits. The highest fruit yield (78.81 kg/tree) was observed in fruit bagged with pink polypropylene bags followed by white polypropylene bags (75.10 kg/tree) which were bagged 40 days after fruit set and lowest was observed in unbagged fruits (48.94 kg/tree).

These results are in support with the findings of [3] in date palm where they reported that increase in fruit weight, size, volume, pulp weight, pulp to stone ratio, fruit retention, yield might be ascribed to the favourable microclimate established inside the bagging materials, which promoted assimilate accumulation. Abiotic elements such as temperature and humidity play an essential part in the overall growth and development of fruit. Because of the great size of the fruits inside the bagged panicles, the stone weight may increase. The results are also in conformity with the findings of [2] in litchi reported bagging reduced time from fruit set to harvest by providing more heat and raise the temperature of microclimate in which fruits are growing as a result faster rate of transpiration and ethylene production thus, took less time period for ripening as compared to unbagged fruits. The trend of decline in fruit cracking may be due to less moisture stress inside the bagged fruits. [7] found similar results in grape fruit. [9] reported that the reduction in pericarp sunburn in bagged fruits might be attributed to the fruits being shielded from direct sunlight during the hot summer months.

3.2 Chemical Parameters

Based on results presented in figure 2 and 3, litchi fruits bagged after the 40 days of fruit set with pink polypropylene bags had the highest T.S.S. (22.48°Brix), followed by fruits bagged after 40 days of fruit set with white polypropylene bags (22.26°Brix) and minimum was in unbagged fruits (16.84°Brix). The lowest titratable acidity (0.40 percent) was found in litchi fruit bagged with pink polypropylene bags 40 days after fruit set, while the highest (0.62 percent) was found in unbagged fruits (control). The highest concentration of ascorbic acid (25.44 mg/100 g) was found in litchi fruit bagged with pink polypropylene bags 20 days after fruit set, while the lowest concentration (19.64 mg/100 g) was found in unbagged fruits (control). The highest reducing sugar of litchi fruit (12.83%) was found in pink polypropylene bags which were bagged 40 days after fruit set, whereas the lowest

reducing sugar (10.40%) was found in unbagged fruits. The highest non-reducing sugar content of litchi fruit (4.06%) was found in pink polypropylene bags which were bagged 40 days after fruit set, followed by white polypropylene bags (3.88%) which were bagged after 40 days of fruit set and the lowest (2.03%) in the control. The highest total sugars of litchi fruit (17.10%) were found in pink polypropylene bags which were bagged after 40 days after fruit set, whereas the least (12.54%) was found in the control. The highest TSS: acid ratio of litchi fruit (56.20) was found in pink polypropylene bags bagged 40 days after fruit set, whereas the lowest was found in unbagged fruits (27.16). Litchi fruit had the highest anthocyanin concentration (54.35 mg/100g) in pink polypropylene bags where bagged 40 days after fruit set, whereas it had the lowest (46.21 mg/100g) in control.

These results are in conformity with the observations of [3] in date palm and they found that the wrapped panicles had more total soluble solids than the unbagged fruits, owing to the greater temperature within the bags, which favoured the conversion of starch and other polysaccharides into sugars. The enhanced enzymatic activity of sucrose synthase (SS) and sucrose-phosphate synthase (SPS) owing to the changing ambient climate/micro environment around bagged fruit might explain the rise in total sugars, reducing sugars and non-reducing sugars inside the bagged fruits. Bagging increases fruit light sensitivity, which stimulates anthocyanin synthesis, and that the increased temperature within the bags expedited anthocyanin synthesis during harvesting, that is why bagged treatments acquired more anthocyanin content than unbagged treatments. The findings of [10] in mango support the current findings.

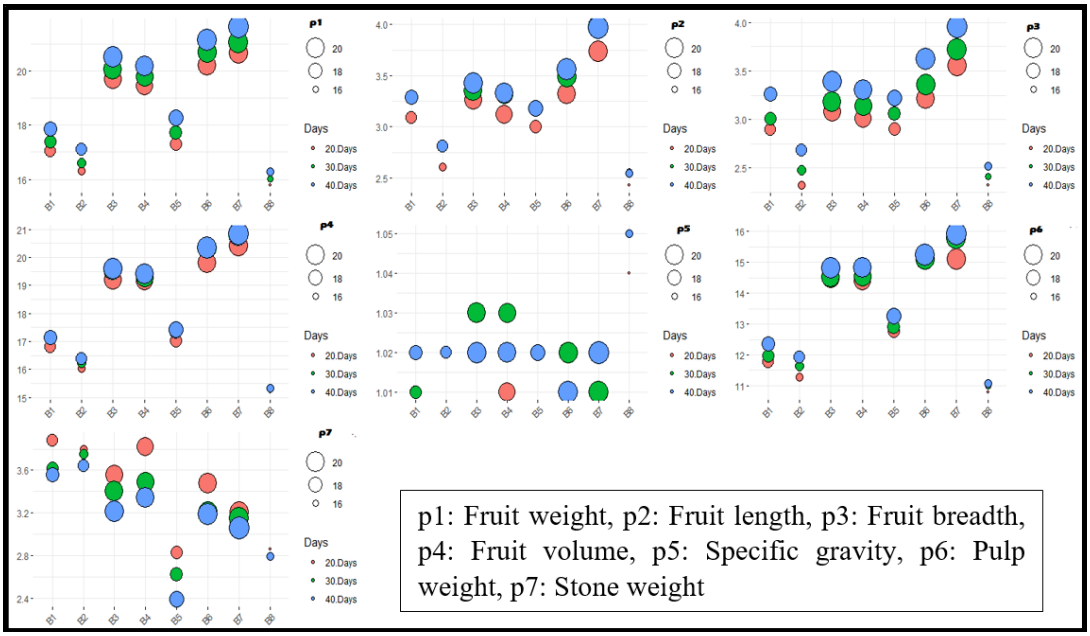

Fig 1: Effect of bagging material and time of bagging after fruit set on fruit weight, fruit length, fruit breadth, fruit volume, specific gravity, pulp weight, stone weight of litchi fruit cv. Dehradun

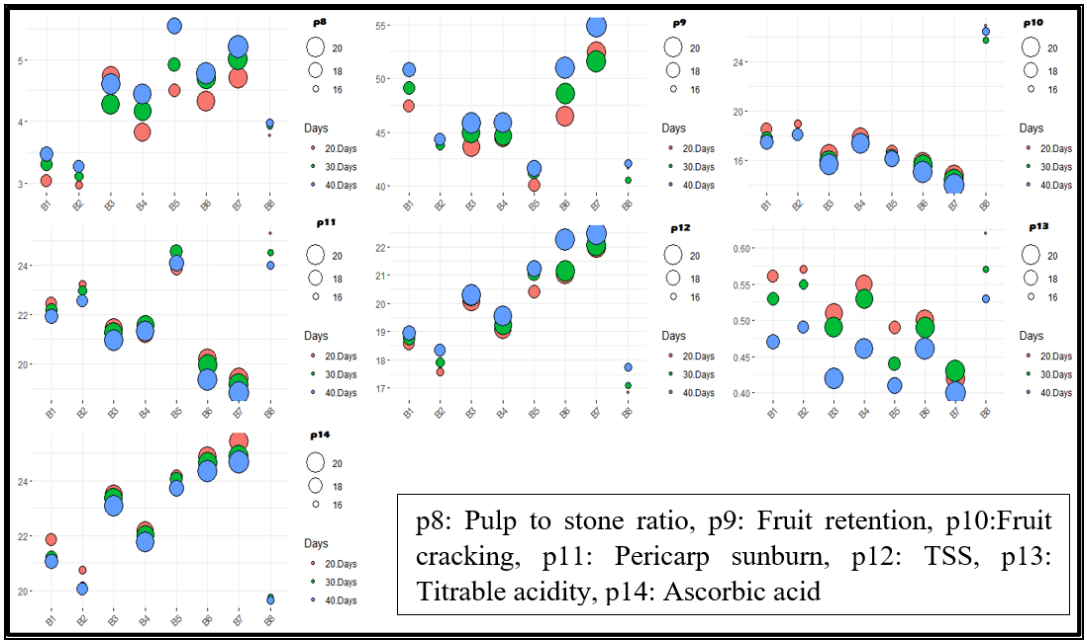

Fig 2: Effect of bagging material and time of bagging after fruit set on pulp to stone ratio, fruit retention, fruit cracking, pericarp sunburn, TSS, titrable acidity, ascorbic acid of litchi fruit cv. Dehradun

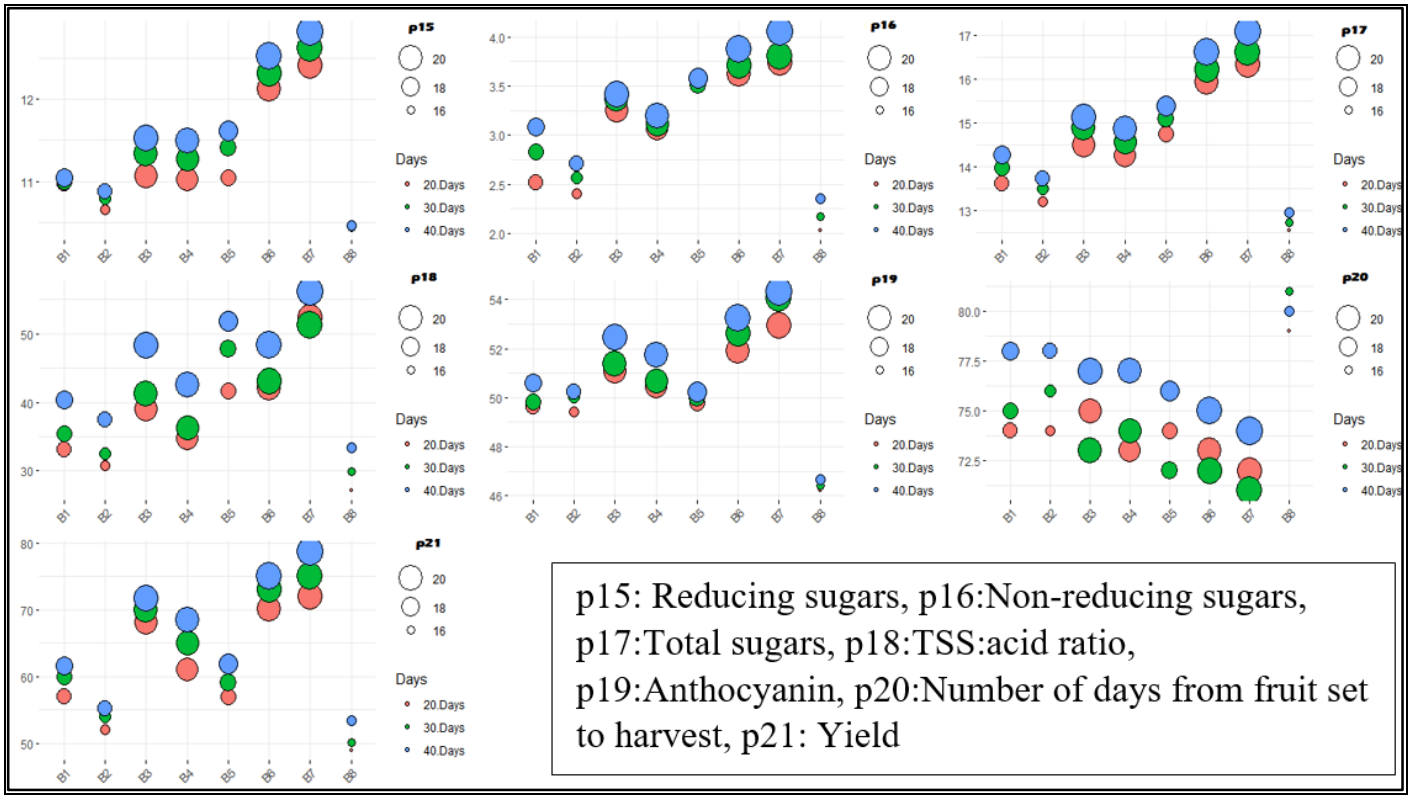

Fig 3: Effect of bagging material and time of bagging after fruit set on reducing sugars, non-reducing sugars, total sugars, TSS: Acid ratio, anthocyanin, number of days from fruit set to harvest, yield of litchi fruit cv. Dehradun

4. Conclusions

According to the findings of this study, pink polypropylene bags bagged 40 days after fruit set were found superior for improving the physical parameters of litchi fruit in terms of improved fruit weight, fruit size, fruit volume, specific gravity, pulp weight, fruit retention per panicle and biochemical attributes i.e TSS, ascorbic acid, reducing sugars as well as total sugars. Bagging also reduced the percentage of fruit cracking and pericarp sunburn.

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