



## Effect of bagging materials and time on fruit quality of litchi (*Litchi chinensis*) cv. Shahi in Nagaland

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In Nagaland, Shahi, China and Tezpur litchi (*Litchi chinensis* Sonner) cultivars are grown and cultivar Shahi being predominant in the state. The foothills and midhills of Dimapur, Mokokchung, Wokha, Peren, Kohima and Zunhebeto districts were found congenial for litchi cultivation. At Molungyimsen village of Mokokchung district, a 12.79 m tall 138 years old litchi tree planted by Dr. Clark in June 1878, is probably the oldest litchi tree known to still bear fruits in north east of our country (Marboh *et al.* 2022). The major problems responsible for low economic potential of litchi in India in general and Nagaland in particular are poor fruit set and inferior fruit quality as well as other factors like irregular flowering, heavy fruit drop, poor fruit retention, alternate bearing, fruit cracking, small fruit size, low and erratic yields. The main complications in crop production are browning and rotting of fruits, fruit borer, mite, poor shelf life and recalcitrant seeds and are some of the factors hindering the growth of litchi industry at commercial scale in India and Nagaland in particular (Marboh *et al.* 2022).

Bagging is commonly applied to many fruits and a simple protection technique for improving fruit size, skin colour, taste, decreases cracking, protecting from pests, extreme environmental conditions, and pesticide residues, thus increasing commercial value (Sharma *et al.* 2014, Xu *et al.* 2023). Fruit pre harvest bunch bagging is an innovative technology and was first described in litchi by National Research Centre on Litchi, Muzaffarpur, Bihar and popularized by G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The technique saves the fruits from the insect and pest attacks including litchi fruit borer, fruit sucking moth and fruit nut borer as well as affected by various physiological disorders such as fruit cracking and sun burn (Sharma *et al.* 2014). In this

technique, fruits bunch is bagged on the tree for a specific period to get desired results. It is a physical protection technique, which not only improves fruit visual quality by promoting fruit coloration but can also alter the micro environment for fruit. Considering all these genuine issues and scattered information related with litchi production, an experiment was designed with the following objective to mitigate and find out the solutions.

The present study was carried out during 2020–22 at the research farm of School of Agriculture Sciences, Nagaland University, Medziphema campus, Nagaland. The prevailing climatic condition of Medziphema Campus is humid and falls under sub-tropical region with an average annual rainfall ranging from 2000–2500 mm, with predominantly high humidity of 70–90%. The mean temperature ranges from 21 to 32°C during summer and 10 to 15°C during winter, rarely goes below 8°C in winter.

The bunch of clove size fruits were bagged with different bagging materials like white, pink coloured polypropylene bags and brown paper bags during March-April. The experiment was conducted by using 10 number of treatments with three replications and thirty bags for each replication. The treatment combinations like T<sub>1</sub>, Polypropylene white at 15 days after fruit set; T<sub>2</sub>, Polypropylene white at 25 days after fruit set; T<sub>3</sub>, Polypropylene white at 30 days after fruit set; T<sub>4</sub>, Polypropylene pink at 15 days after fruit set; T<sub>5</sub>, Polypropylene pink at 25 days after fruit set; T<sub>6</sub>, Polypropylene pink at 30 days after fruit set, T<sub>7</sub>, Brown paper bag at 15 days after fruit set; T<sub>8</sub>, Brown paper bag at 25 days after fruit set, T<sub>9</sub>, Brown paper bag at 30 days after fruit set and T<sub>10</sub>, Control (No bagging) in cv. Shahi. The experimental plants were 22 years old planted at 5 m × 5 m spacing. The parameters like fruit colour, fruit weight, sunburn percentage, cracking percentage, borer infestation percentage, pericarp anthocyanin content, total sugar, TSS were analysed and recorded under lab conditions. The data collected during the investigation were subjected using randomized block design (RBD) by the standard method of statistical analysis (Gomez and Gomez 2010).

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*Fruit colour:* Results (Table 1) shows fruit colour of different treatments moderate purple red to deep purple red B. The good colour was noticed when fruits were bagged with brown paper bag and polypropylene pink bag at 30 days after fruit set i.e. deep purple red colour as compared to the unbagged fruits with moderate purple red colour. Similarly, Chand *et al.* (2022) reported that polypropylene bagged fruits showed the dark pinkish colour compared with un-bagged fruits shown light pinkish and an even ripening. Increased relative humidity and temperature will create a better microclimate inside bags than outside un bagged fruits was helped to improve fruit colour.

*Fruit weight:* Data indicates brown paper bags in combination with bagging time 30 days after fruit set exhibited maximum fruit weight followed by pink polypropylene bags in treatment combination with 15 days after fruit set, while minimum fruit weight was recorded in unbagged fruits. Similarly, Purbey and Kumar (2015) reported maximum fruit weight was recorded with Brown Paper Bag. According to Dutta and Majumdar (2012), pre-harvest fruit bagging improved the fruit weight and size through the conducive effects such as increased relative humidity and a consequently reduced fruit water loss.

*Fruit sunburn per cent:* The data in Table 1 shows the percentage of pericarp sunburn of litchi fruits. The maximum pericarp sunburn per cent was recorded in unbagged fruits, whereas minimum sunburn percentage was recorded in pink polypropylene bagged at 15 days after fruit set. The

reduction in fruit sun-burn might be due to protection of fruits from direct sun light inside bags.

*Fruit cracking per cent:* Results (Table 1) shows that there was significant effect of different bagging material on fruit cracking. Minimum fruit cracking was observed in pink polypropylene bags in combination with 15 days after fruit set which was significant over all treatments and maximum was observed in control (un bagged) fruits.

*Fruit borer infestation:* Brown paper bags in combination with bagging time 15 days after fruit set exhibited minimum borer infestation followed by brown paper bags in treatment combination with 25 days after fruit set, while maximum infestation was recorded in unbagged fruits. Similar findings recorded that borer incidence was found in control while other treatments were unaffected with borer incidence. It may be due to bagging served as a physical barrier and successfully protected the fruits against borer infestation (Debnath and Mitra 2008).

*Pericarp anthocyanin content:* Results showed (Table 2) that anthocyanin content of fruit pericarp was significantly influenced by different bagging time and bagging materials. The maximum anthocyanin content was recorded in brown paper bag at 30 DAFS, whereas minimum was recorded in un-bagged fruits. The reason might be that due to increase in temperature inside the bags the anthocyanin synthesis might have got hastened than un-bagged one.

*Total sugar:* Data on effect of different bagging time and bagging materials on total sugar in litchi was recorded

Table 1 Effect of various bagging materials on litchi fruit quality attributes

Treatment	Fruit colour	Fruit weight (g)			Fruit sunburn percentage (%)			Fruit cracking percentage (%)			Fruit borer infestation (%)		
		2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T <sub>1</sub>	Purple red	16.84	17.06	16.95	23.67	20.16	21.91	8.54	7.87	8.20	2.67	2.19	2.43
T <sub>2</sub>	Moderate purple red A	16.09	16.23	16.16	20.42	16.84	18.63	4.00	3.34	3.67	2.00	0.82	1.41
T <sub>3</sub>	Deep purple red B	21.43	21.26	21.34	17.38	15.81	16.59	2.67	1.58	2.12	2.66	0.00	1.33
T <sub>4</sub>	Deep purple red B	22.92	23.50	22.75	7.09	6.87	3.59	2.03	1.40	1.71	1.08	0.00	0.54
T <sub>5</sub>	Moderate purple red A	22.84	22.66	21.77	4.00	3.18	6.98	3.00	2.64	2.82	0.53	0.00	0.26
T <sub>6</sub>	Deep purple red B	15.12	17.93	16.52	7.97	9.66	8.81	1.87	1.92	1.89	1.00	0.00	0.50
T <sub>7</sub>	Moderate purple red A	18.54	19.12	18.83	10.38	11.66	11.02	2.54	2.34	2.44	0.02	0.04	0.03
T <sub>8</sub>	Deep purple red B	22.21	21.33	19.51	7.42	8.88	8.15	2.37	2.50	2.43	0.14	0.00	0.07
T <sub>9</sub>	Deep purple red B	19.59	19.44	23.12	10.60	9.65	10.12	2.67	1.85	2.26	1.00	1.22	0.56
T <sub>10</sub>	Moderate purple red A	10.20	9.16	9.68	29.80	27.95	28.87	12.07	9.48	10.77	89.67	84.66	87.16
SEm±		0.16	0.65	0.53	0.14	1.3	0.95	0.15	1.81	0.38	0.17	1.72	0.78
CD(P=0.05)		0.51	1.94	1.72	0.45	3.89	3.09	0.50	5.43	1.25	0.51	5.15	2.55

Refer to the methodology for treatment details.

Table 2 Effect of various bagging materials on bio chemical parameters of litchi fruits

Treatment	Pericarp anthocyanin (mg/100 g)			Total sugar (%)			TSS (°B)			Titratable acidity (%)			TSS: acid ratio		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T <sub>1</sub>	19.45	21.99	20.72	11.29	12.00	11.64	17.89	18.65	18.27	0.58	0.55	0.56	30.84	34.13	32.48
T <sub>2</sub>	21.02	20.43	20.72	13.48	13.76	13.62	18.14	20.10	19.12	0.55	0.50	0.52	32.98	40.20	36.59
T <sub>3</sub>	20.44	22.34	21.39	12.90	11.72	12.31	20.38	20.40	20.39	0.50	0.45	0.47	40.76	45.72	43.24
T <sub>4</sub>	23.12	23.66	25.39	14.23	14.09	14.16	21.06	21.55	21.30	0.44	0.41	0.42	47.86	52.83	50.34
T <sub>5</sub>	19.70	21.39	20.54	15.00	15.03	15.01	18.48	17.90	18.19	0.50	0.60	0.55	36.96	29.83	33.39
T <sub>6</sub>	24.61	26.18	23.39	15.01	15.41	15.21	18.00	18.95	18.47	0.45	0.40	0.42	40.00	47.37	43.68
T <sub>7</sub>	24.63	24.87	24.75	12.37	12.64	12.50	17.68	18.85	18.26	0.65	0.60	0.62	27.20	31.65	29.42
T <sub>8</sub>	23.51	23.79	23.65	12.54	12.83	12.68	19.23	19.50	19.36	0.60	0.63	0.61	32.05	31.24	31.64
T <sub>9</sub>	25.94	26.28	26.11	14.49	14.20	14.34	20.12	20.40	20.26	0.50	0.47	0.48	40.24	44.25	42.24
T <sub>10</sub>	14.14	16.36	15.25	9.64	10.29	9.96	11.80	13.25	12.52	0.65	0.70	0.67	18.15	18.92	18.53
SEm±	0.15	0.2	0.51	0.16	0.75	0.27	0.16	0.49	0.37	0.01	0.04	0.02	0.18	4.10	2.17
CD (P=0.05)	0.51	0.65	1.68	0.55	2.45	0.89	0.52	1.59	1.20	0.03	0.15	0.08	0.56	13.30	7.04

Refer to the methodology for treatment details.

(Table 2) and results shows that different bagging material and bagging time had a significant effect on total sugars (%) of litchi. The maximum total sugars of litchi fruit were recorded in pink polypropylene bags in combination with 30 days after fruit set and minimum in control (un-bagged) fruits. The activity of sucrose synthase in bagged fruits increases during fruit development and found higher than unbagged fruits. These results are in conformity with the results of Harhash and Al-Obeed (2010) in date palm and Shinde *et al.* (2015) in mango.

**TSS content:** The maximum TSS was recorded in litchi fruits bagged with pink polypropylene bags in combination with 15 days after fruit set followed by white polypropylene bags and brown paper bags in combination with 30 days after fruit set and minimum was in unbagged fruits.

**Titratable acidity:** Results showed (Table 2) that there were significant effects of different bagging materials on titratable acidity of litchi fruits. Minimum acidity was recorded in litchi fruit bagged with pink polypropylene bags in combination with 15 days after fruit set and maximum in unbagged fruits, i.e. in control.

**TSS: acid ratio:** The maximum TSS: acid ratio of litchi fruit was recorded in pink polypropylene bags in combination with 15 days after fruit set whereas, it was minimum in unbagged fruits. Which was at par with PPP 30 DAFS. These findings are also in agreement with those reported by Ma *et al.* (2009) in peach, Wanichkul and

Subrugroeng (2011) in carambola and Shah *et al.* (2021) in litchi.

## SUMMARY

The present experiment was conducted during 2020–22 at research farm of School of Agriculture Sciences, Nagaland University, Medziphema campus, Nagaland on effect of bagging in quality of litchi fruits cv. Shahi was Experiment conducted by using 3 different bagging materials, i.e. Non-woven Polypropylene White (PPW), Polypropylene Pink (PPP), Brown paper Bag (BPB) and control (no bagging) were used to bagged the fruit bunches at three different days after fruit set, viz. 15 DAFS, 25 DAFS and 30 DAFS. Results indicated that PPP bags gave the best result with higher total sugar (15.21%), TSS (21.30 °B), TSS: acid ratio (50.34) and low incidence of sunburn (3.59%), fruit cracking (1.71%) in comparison to control, whereby, higher values of anthocyanin content (26.11 mg/100 g) and fruit weight (23.12 g) were recorded in BPB. PPP and BPB bagging materials were found to be the best of the treatments to create mean microclimate inside bag to improve fruit colour and other quality parameters. In the case of time of bagging, 15 DAFS was found to give higher performance as compared to 25 DAFS and 30 DAFS with maximum individual TSS content (21.30 °B), TSS-acid ratio (50.34) and low Sunburn (3.59%) and cracking percentage (1.71%). As such, bagging with PPP at 15 DAFS was found to give the best treatment.

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