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Original Research Article

Effect of Different Bagging Materials on Fruit Quality of Mango

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Abstract: During the fruit development stage, mangoes experience numerous physical and chemical changes and are susceptible to insect pest infestations, various pathogens, bird attacks and mechanical damage. The affected fruits gain low prices in the market and such fruits are also rejected for processing. It causes significant yield and serious economic loss to mango growers. Pre-harvest fruit bagging has emerged as a good agricultural practice (GAP), which is simple, grower-friendly, safe and beneficial for the production of quality fruits. An experiment was conducted at the existing seven-year-old mango orchard of BARI Aam-3, which is locally called 'Amrapali' at the hill valley of Hill Agricultural Research Station at Raikhali in Rangamati Hill District during 2020-21. The least number of fruit drop, insect infestation, disease infection, bird attack, maximum individual fruit weight and shelf-life was found in two-layer brown bags. Marketable mango as well as grade-1 mango also maximum in a layer brown bag. On the other hand, a minimum number of marketable mangoes was found in the control treatment but minimum self-life was recorded in polythene bags.

Keywords: Mango bagging, Amrapali, Fruit drop, shelf-life, Marketable mango.

INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae and originated in Southeast Asia at an early date (Bose *et al.*, 2001). It is acknowledged as the king of fruits in Bangladesh. It covers the largest area (50,000 ha.) and the total production (1,90,000 tons) being in the 3rd position after banana and jackfruit (Bhuyan *et al.*, 2003) in Bangladesh. According to the BBS (2022) report, In general, mango is produced very well in the northern region of Bangladesh, especially in Rajshahi area. Now in eastern regions like Chittagong Hill Tracts, mango grows well and produces the desired number of fruits. However, they are affected by different insects and diseases because of unfavorable climatic conditions at the ripening stage. Though the demand for mango is high in the local and export markets, there is a limited supply mainly due to a lack of quality fruit production. As a result, mangoes suffer badly from several post-harvest diseases and disorders during storage and transportation. The total average loss of mango in Bangladesh was found as much as 34% (Sarker *et al.,* 2011). Farmers are spraying toxic pesticides 15-62 times on their mango orchards (Uddin *et al.,* 2015) to get disinfected and disinfested fruits from mango trees but it is unhygienic and undesired for human health. These man-made chemicals and fungicides may cause severe health problems for consumers. Hence, efforts worldwide have been started to find some non-chemical approaches to reduce the incidence of diseases and disorders in fruits that will ensure worker safety, consumer health, and environmental protection (Sharma *et al*., 2009).

Pre-harvest fruit bagging has emerged as one of the best methods in different parts of the world like Australia, Japan, Taiwan and China (Joyce, 1997; Senghor *et al*., 2007). In this practice, individual fruit or fruit bunches are bagged on the tree for a specific period to get desired fruits. It is a physical protection technique commonly applied to many fruits, such as mango (Wu *et al*., 2009; Nagaharshitha *et al*., 2014; Haldankar *et al*.,

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2015; Jakhar *et al*., 2016; Islam *et al*., 2017), apple (Santos and Wamser, 2006; Hao *et al*., 2011), pear (Feng *et al*., 2011; Hudina *et al*., 2012), peach (Jia *et al*., 2005; Wang *et al*., 2010), longan (Yang *et al*., 2009), loquat (Xu *et al*., 2010), to enhance the marketable value of the crop, explicitly, improving fruit coloration (Kim *et al*., 2010), internal quality of mango (Zhao *et al*., 2013), reducing splitting (Ding *et al*., 2003), mechanical damage (Amarante *et al*., 2002) and skin sunburn (Muchui *et al*., 2010). It also decreases pesticide residues in the fruit (Amarante *et al*., 2002) and improves insect (Sarker *et al*., 2009), disease (Wang *et al*., 2011) and bird damage control (Amarante *et al*., 2002). Therefore, pre-harvest bagging has been an important technical measure in improving the commercial value and bringing down the postharvest losses. The reduced postharvest losses, attractive appearance and peel color may help to bring optimum production of high-quality exportable mango. Hence, this experiment was conducted to investigate the effect of bagging on the postharvest quality of mangoes and the reduction of postharvest losses due to diseases and insects in this eastern region of Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at the existing seven-year-old mango orchard of BARI Aam-3 at the hill valley of Hill Agricultural Research Station at Raikhali in Rangamati Hill District during 2020-21. Seven types of the bag were used as treatments in this experiment viz.; T_1: two-layer brown bag, T_2: one-layer white bag, T_3: brown paper bag, T_4: cellophane paper bag, T_5: black polythene bag, T_6: transparent polythene bag, T_7: transparent polythene with open lower side and T_8: Control (without bagging). The two-layer brown bag and one-layer white bag were imported from China as mango fruit bags. Rests of the bags were made of locally collected materials. The bags of all the treatments were not perforated. Among all the treatments only in the T_7 treatment, the bottom side of the transparent polythene was open for proper ventilation. All types of bags were used on 10^{th} March when the fruits were 35 days old. In case of more than two fruits in a cluster, the smaller underdeveloped, deformed fruits, and spotted fruits were removed by secateurs and only one healthy fruit was bagged. While bagging the two-layer brown bag and one-layer white bag, were tied with the help of inbuilt wire thread. The brown paper bag, cellophane paper bag, black polythene bag, transparent polythene bag, and transparent polythene with open lower side were tied with the help of thread. Particular bags were wrapped properly at the stalk of each healthy fruit of respective treatments so that it would not fall as well and there would not be open space for entry of insects or rain etc. The experiment was conducted in a Randomized Complete Block Design (RCBD) with eight treatments and three replications with a unit of 10 fruits per treatment per replication. Harvested fruits were stored under ambient temperature (storage at room temperature) and observations were taken daily for up to 10 days. To record different physical and chemical properties five fruits were randomly selected per treatment per replication. Data on yield and yield contributing characters were taken duly and estimated by the following procedure:

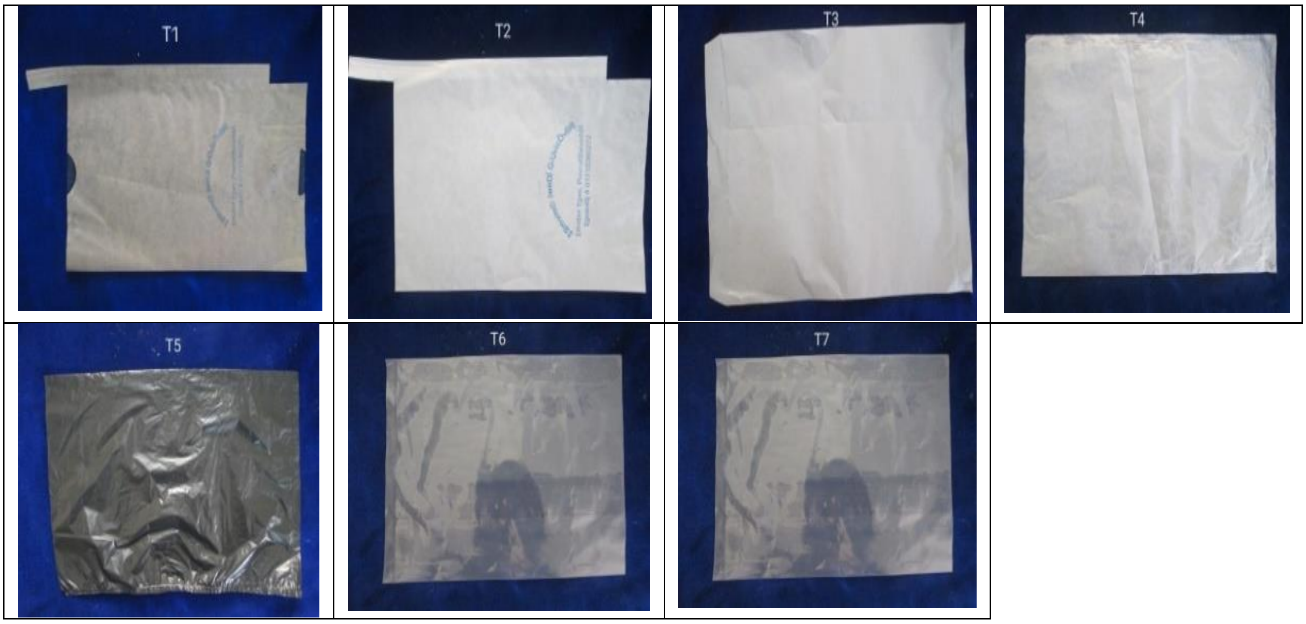

Figure 1: Seven types of the bag were used as treatments in this experiment viz.; T1: two-layer brown bag, T2: one-layer white bag, T3: brown paper bag, T4: cellophane paper bag, T5: black polythene bag, T6: transparent polythene bag and T7: transparent polythene with open lower side

Figure 2: Image of mango just after the harvest according to treatment

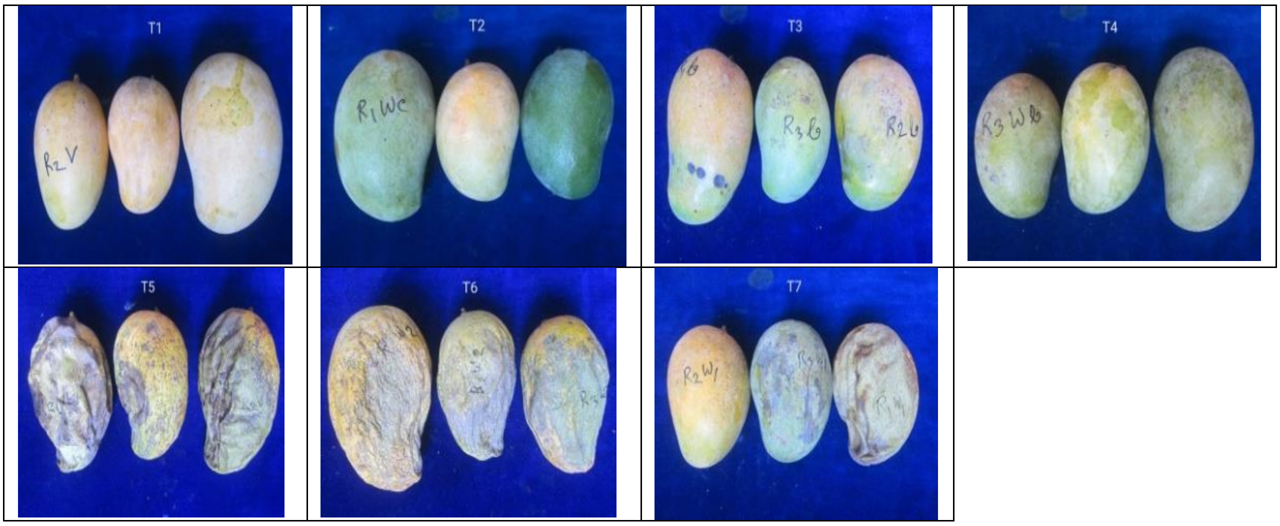

Figure 3: Image of mango five days after the harvest according to treatment

Figure 4: Image-1-fruit droping, Image-2-water stagnation, Image-3- torn brown paper bags, Image-4-fruit damage by bird, Image-5-fruit fly attack

Fruit Drop (%)

It means percentage of fruits dropped after the fruit bagging. Some fruits were dropped with fruit bag and some were dropped within the bag. This was measured by calculating the percentage of fruits dropped in each replication of each treatment. The percentage of fruits drop was calculated as follow:

$$\text{Fruit drop (\%)} = \frac{\text{Number of fruits drop in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

Insect Infestation (%)

Insect infestation means percentage of fruits infested with insect. This was measured by calculating the percentage of fruits infested in each replication of each treatment. The infested fruits were identified symptomatically. The Insect infestation was calculated as follow:

$$\text{Insect infestation (\%)} = \frac{\text{Number of infested fruits in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

Disease Incidence (%)

Diseases incidence means percentage of fruits infected with disease. This was measured by calculating the percentage of fruits infected in each replication of each treatment. The diseased fruits were identified symptomatically. The disease incidence was calculated as follow:

$$\text{Disease incidence-1 (\%)} = \frac{\text{Number of infected fruits (consumable) in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

$$\text{Disease incidence-2 (\%)} = \frac{\text{Number of infected fruits (inconsumable) in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

$$\text{Total disease incidence (\%)} = \text{Disease incidence-1 (\%)} + \text{Disease incidence-2 (\%)}$$

Birds or other Hazard (%)

It means percentage of fruits damaged by birds or other hazards (bat, rat, squirrel etc.) other than insect and disease after the fruit bagging to fruit harvest. This was measured by calculating the percentage of fruits damaged in each replication of each treatment. The percentage of fruits damaged was calculated as follow:

$$\text{Birds or other hazard (\%)} = \frac{\text{Number of fruits damaged in each replication}}{\text{Total number of fruits in each replication}} \times 100$$

Marketable mango (%)

Some fruits were damaged by different factor such as fruit drop, insect infestation, disease infection, birds or other hazards during the period of fruit bagging to harvest. All the fruits were harvested at the same time. Then the spoiled or inconsumable fruits were separated and only marketable fruits were recorded according to treatment and replication. Marketable mango was counted in two groups that is grade-1 (disease and insect free) and grade-2 (diseased but consumable). The grade-1 fruits were best quality fruits or export quality fruits. This was measured by calculating as follow:

Total marketable mango (%) = 100- {Fruit drop (%) +Insect infestation (%) +Birds or other hazard (%) +Inconsumable diseased fruit (%)}

Grade-1 fruits (%) = Total marketable mango (%) - Grade-2 fruits (%) (Diseased but consumable mango)

Individual Fruit Weight: It was recorded by using electronic balance and expressed in grams (g).

Total Soluble Solid (TSS)

Total soluble solids were estimated with a portable digital hand refractometer (0 to 32°Brix) of ATAGO CO., LTD from Japan. A drop of mango juice is extracted from the flesh, and the TSS content is the percentage of Brix obtained by direct reading from the device maintaining the temperature correction chart (AOAC, 2004) for temperature correction.

Shelf Life of Fruits (Days)

The fruits were harvested at full maturity stage. After harvesting the shelf life (days) were recorded of the ripened fruits. The end of shelf life was noted when the fruits were partially spoiled or up to consumable stage.

Statistical Analysis

Field data were recorded and a table for statistical analysis was created. The analysis of variance (ANOVA) for individual traits was carried out using R software version 4.3.1 (R, 2017) and a multiple range test (DMRT) is used to separate treatment, so the least significant difference (LSD) test significance level and a 5% significance level are used to determine the significance of the difference between a pair of means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Fruit dropping ranged between 3.3-20%. The maximum number of fruit drops (20%) occurred in the control treatment whereas the minimum (3.3%) was in two-layer brown bag, one layer white bag, cellophane paper bag and black polythene treatment. It means pre-harvest fruit bagging helps the fruit retention of mango.

Pre-harvest fruit bagging reduced the insect infestation because they could not enter the bag. So, the infestation was absent in all the treatments except the control (13.3%) and Brown paper bag (3.3%) treatments. The fruits of two-layer of brown paper bag and one layer of white paper bag were free from fruit flies (Buganic *et al.*, 1997; Islam *et al.*, 2019b; Sarker *et al.*, 2009) infestation and reduced mealy bug attack (Islam *et al.*, 2019a). Brown paper bags became torn after some days because of rainy water and storms then fruit became open.

Fruit disease was counted into two groups that is consumable (spotted) and inconsumable (cracked or damaged). Maximum disease-infected fruits were counted in polythene bags where water stagnation was found. Bagging significantly ($p \leqslant 0.05$) reduced diseases and blemishes (Chonhenchob *et al.*, 2011). The highest diseased fruit (66.7%) was found in Black polythene followed by transparent polythene bag (60.0%). But the minimum (10.0%) was in two-layer brown paper bag. All types of polythene bags produce inconsumable fruit. In the Philippines, the mango industry suffers from problems of fruit defects such as scabs, misshapen fruit, distinct veins, undersized fruit, wind scar, mottling, sooty mold, and sap burn. Bayogan *et al.*, (2006) reported that bagging the fruit helped to reduce these problems significantly, which improved the acceptability of the mango fruit for export. Fruit bagging has been reported to reduce the incidence of anthracnose and stem-end rot in mango (Buganic *et al.*,1997; Hofman *et al.*, 1997; Senghor *et al.*, 2007; Chonhenchob *et al.*, 2011).

In mango, birds are major pests at the fruit-ripening stage and cause considerable yield losses (Sharma *et al.*, 2014). Different approaches such as beating drums, stretching reflecting ribbons in the field, etc., are adopted to control birds, but they soon become acclimatized to these practices (Sharma, 2009). Fruit bagging has helped to reduce bird damage in various fruit (Kitagawa *et al.*, 1992; Hofman *et al.*, 1997; Joyce *et al.*, 1997; Amarante *et al.*, 2002a; Harhash and Al-Obeed, 2010). In this experiment, open fruits were attacked by birds. Maximum damage (6.7%) occurred in the control treatment and minimum (3.3%) in brown paper bags. So, fruit bagging may be the best practice to produce bird-damage-free fruit, if used at the right time of fruit development.

Table 1: Fruit loss by different factors

Treatments	Fruit drop (%)	Insect infestation (%)	Birds or other hazard (%)	Diseased fruit (%)		
				Inconsumable	Consumable	Total
Two layer brown bag	3.3 e	0 c	0 c	0 e	10.0 de	10.0 e
One layer white bag	3.3 e	0 c	0 c	0 e	16.7 c	16.7 d
Brown paper bag	16.7 b	3.3 b	3.3 b	0 e	13.3 cd	13.3 de
Cellophane paper bag	3.3 e	0 c	0 c	3.3 d	33.3 b	36.6 c
Intact black polythene	3.3 e	0 c	0 c	16.7 a	50.0 a	66.7 a
Intact transparent polythene	10.0 d	0 c	0 c	13.3 b	46.7 a	60.0 b
Transparent polythene with open lower side	13.3 c	0 c	0 c	10.0 c	6.7 e	16.7 d
Control (without bagging)	20.0 a	13.3 a	6.7 a	0 e	33.3 b	33.3 c
CV (%)	11.24	42.66	26.98	10.16	11.57	8.78
Level of Significance	**	**	**	**	**	**

Mean followed by different letter(s) are significantly different at DMRT, **5% level of probability

Maximum marketable mango (96.7%) was found in two-layer brown bag and one layer white bag as well as highest grade-1 mango (86.7%) was in two-layer brown bag followed by one layer white bag (80.0%). Minimum marketable mango (60.0%) was found in the control treatment where only 26.7% of mango was grade-1 level. It means a 36.7 % yield loss can be checked through pre-harvest fruit bagging with a two-layer brown bag in mango.

Maximum individual fruit weight (244g) was found in a two-layer brown bag whereas the minimum was in a transparent polythene bag (157g). Bagging increased fruit growth and development, resulting in more weight and larger-sized fruit over control (Chonhenchob *et al.*, 2011). Similar results were found by other researchers (Watanawan *et al.*, 2008; Islam *et al.*, 2019b).

Maximum TSS was recorded in a Black polythene bag (24.4%) and minimum in transparent polythene with an open lower side (19.9%). Improvements in TSS have been reported in mango (Watanawan *et al.*, 2008).

Maximum shelf-life (8 days) was also found in the two-layer brown bag and one-layer white bag. According to Islam *et al.*, 2019a, pre-harvest bagging delayed ripening resulting in an extended shelf-life of mango. A similar result was found by Islam *et al.*, 2019b. The shelf-life of mango might be increased if the fruits were harvested at the 80-85 % maturity stage. But in this study, we harvest the mango at the full maturity stage. Intact polythene bag showed the minimum shelf-life (2 days). Fruits of polythene bags shrinkage and eventually damage rapidly. A similar result was found by Islam *et al.*, 2019a.

Table 2: Effect of Different Bagging Materials on BARI Aam-3 at Chittagong Hill Tracts

Treatments	Marketable mango (%)			Individual fruit weight (g)	TSS (%)	shelf-life (days)
	Total	Grade-1	Grade-2			
Two layer brown bag	96.7 a	86.7 a	10.0 de	244 a	20.3 d	8 a
One layer white bag	96.7 a	80.0 b	16.7 c	230 bc	22.5 b	8 a
Brown paper bag	76.7 d	63.4 d	13.3 cd	237 ab	21.7 c	6 c
Cellophane paper bag	93.4 b	60.1 d	33.3 b	221 d	21.9 c	7 b
Intact black polythene	80.0 c	30.0 e	50.0 a	227 cd	24.4 a	2 e
Intact transparent polythene	76.7 d	30.0 e	46.7 a	157 e	21.5 c	2 e
Transparent polythene with open lower side	76.7 d	70.0 c	6.7 e	221 d	19.9 d	3 d
Control (without bagging)	60 e	26.7 e	33.3 b	228 cd	21.6 c	7 b
CV (%)	1.85	5.32	11.57	2.21	1.27	8.61
Level of Significance	**	**	**	**	**	**

Mean followed by different letter(s) are significantly different at DMRT, **5% level of probability

CONCLUSION

Finally, it can be concluded that the result of this pre-harvest fruit bagging test is in BARI Aam-3 exceptionally operative in improving the quality of the fruit. According to this experiment, it is revealed that maximum quality mango can be obtained through pre-harvest bagging technology. Among all types of the bag; a two-layer brown bag and a one-layer white bag were better but a two-layer brown bag can develop attractive fruit color. So, two-layer brown bags are best among all types of bags. However intact polythene bag is not suitable for pre-harvest mango bagging.

REFERENCES

- Amarante, C., Banks, N. H., & Max, S. (2002). Preharvest bagging improves packout and fruit quality of pears (Pyrus communis). *New Zealand Journal of Crop and Horticultural Science*, *30*(2), 93-98.
- AOAC, (2004). Official Methods of Analysis. Association of Official Analytical Chemists (12th Ed.) Washington, DC, USA.
- Bayogan, E. R. V., Esguerra, E. B., & Campeon, R. T. (2006). Carabao Mango Harvest Quality and production Practices and Problems of Growers in Davao Oriental, Philippines. *Acta Horticulturae*, *699*, 103.
- BBS. Year book of agricultural statistics-2022, Bangladesh Bureau of statistics, Statistics Division, Ministry of planning, *Government of the people's Republic of Bangladesh*, 212-213.
- Bhuyan, M. A. J., Uddin, M. N., Mortuza, M. G., Islam, M. S., & Sarker, B. C. (2003). Catalogue on mango germplasm. Vol 1 (Indigenous Collection). Horticulture Research Centre. *Bangladesh Agricultural Research Institute*, Joydebpur, Gazipur and IPGRI-ADB-TFT Project Publ. ll7p.
- Bose, T. K., Mitra, S. K., & Sanyal, D. (2001). Fruits: Tropical and Subtropical, Vol. 1 (3rd edt.), *Naya Udyog*, Calcuta. pp. 1-108.
- Buganic, Jr, R. D., Lizada, M. C. C., & De-Ramos, M. B. (1997). Disease control in Philippine 'Carabao' mango with pre-harvest bagging and post harvest hot water treatment. *Acta Horticulturae*, *455*, 797–804.

- Chonhenchob, V., Kamhangwong, D., Kruenate, J., Khongrat, K., Tangchantra, N., Wichai, U., & Singh, S. P. (2011). Preharvest bagging with wavelength-selective materials enhances development and quality of mango (Mangifera indica L.) cv. Nam Dok Mai# 4. *Journal of the Science of Food and Agriculture*, *91*(4), 664-671.
- Ding, Q., Han, M. Y., & Tian, Y. M. (2003). Effect of bagging on nectarine fruit quality and fruit cracking. *Jour. of Northwest Sci-Tech Univ. of Agri. and For. Nat. Sci. Ed*., *31*(2), 59-61.
- Feng, S., Chen, X., Zhang, Y., Wang, Y., Song, Y., Chen, X. L., ... & Liu, M. (2011). Differential expression of proteins in red pear following fruit bagging treatment. *The Protein Journal*, *30*, 194-200.
- Haldankar, P. M., Parulekar, Y. R., Kireeti, A., Kad, M. S., Shinde, S. M., & Lawande, K. E. (2015). Studies on influence of bagging of fruits at marble stage on quality of mango cv. Alphonso. *Journal of Plant Studies*, *4*(2), 12.
- Hao, Y., Ren, H., & Guo, P. (2011). Effects of bagging on the accumulation and transformation of photosynthates in apple fruits. *Acta Horticulturae Sinica*, *38*(2), 233-239.
- Harshash, M. M., & Al-Obeed, R. S. (2010). Effect of bunch bagging color on yield and fruit quality of date palm. *American-Eurasian Journal of Agricultural and Environmental Science*, *7*(3), 312-319.
- Hofman, P. J., Smith, L. G., Joyce, D. C., Johnson, G. I., & Meiburg, G. F. (1997). Bagging of mango (Mangifera indica cv.Keitt') fruit influences fruit quality and mineral composition. *Postharvest biology and technology*, *12*(1), 83-91.
- Hudina, M., Stampar, F., Orazem, P., Petkovsek, M. M., & Veberic, R. (2012). Phenolic compounds profile, carbohydrates and external fruit quality of the 'Concorde'pear (Pyrus communis L.) after bagging. *Canadian Journal of Plant Science*, *92*(1), 67-75.
- Islam, M. T., Rahman, M. S., Akter, M., Hasan, M. N., & Uddin, M. S. (2019). Influence of pre-harvest bagging on fruit quality of mango (Mangifera indica L.) cv. Langra. *Asian Journal of Agricultural and Horticultural Research*, *4*(4), 1-10.

- Islam, M. T., Rahman, M. S., Akter, M., Hasan, M. N., & Uddin, M. S. (2019). Influence of pre-harvest bagging on fruit quality of mango (Mangifera indica L.) cv. Langra. *Asian Journal of Agricultural and Horticultural Research*, *4*(4), 1-10.

- Islam, M. T., Rahman, M. S., Shamsuzzoha, M., Chowdhury, A. K. M. M. B., & Alom, R. (2017). Influence of pre-harvest bagging on fruit quality of Mango (Mangifera indica L.) cv. Mishribhog. *International Journal of Biosciences*, *11*(3), 59-68.
- Jakhar, M. S., Pathak, S. (2016). Effect of pre-harvest nutrients application and bagging on quality and shelf life of mango (*Mangifera indica* L.) fruits cv. amrapali. *Journal of Agricultural Science and Technology*, *18*, 717-729.
- Jia, H. J., Araki, A., & Okamoto, G. (2005). Influence of fruit bagging on aroma volatiles and skin coloration of 'Hakuho'peach (Prunus persica Batsch). *Postharvest Biology and Technology*, *35*(1), 61-68.
- Kim, Y., Kang, S., Cho, K., & Jeong, S. (2010). Effects of bagging with different pear paper bags on the color of fruit skin and qualities in'Manpungbae'. *Korean Journal of Horticultural Science & Technology*, *28*(1), 36-40.
- Kitagawa, H., Manabe, K., & Esguerra, E. B. (1992). Bagging of fruit on the tree to control disease. *Acta Horticulturae*, *321*, 871–875.
- Lamine Senghor, A., Liang, W. J., & Ho, W. C. (2007). Integrated control of Colletotrichum gloeosporioides on mango fruit in Taiwan by the combination of Bacillus s ubtilis and fruit bagging. *Biocontrol science and technology*, *17*(8), 865-870.
- Muchui, M. N., Mathooko, F. M., Njoroge, C. K., Kahangi, E. M., Onyango, C. A., & Kimani, E. M. (2010). Effect of perforated blue polyethylene bunch covers on selected p ostharvest quality parameters of tissue-cultured bananas (*Musa spp*.) cv. Williams in Central Kenya. *Journal of Stored Products and Postharvest Research*, *1*(3), 29-41.
- Nagaharshitha, D., Khopkar, R. R., Haldankar, P. M., Haldavanekar, P. C., & Parulekar, Y. R. (2014). Effect of bagging on chemical properties of mango (Mangifera indica L.) cv. alphonso. *Agrotechnology*, *3*, 124.
- Santos, J. P. D., & Wamser, A. F. (2006). Fruit bagging effect on the damage caused by biotics and abiotics factors in an organic apple orchard. *Revista Brasileira de Fruticultura*, *28*, 168-171.
- Sarkar, K. M., Alam, M. M., Rahman, A., & Bhuiyan, M. G. K. (2011). Post harvest losses in mango value chain. *International Journal of Bio Research*, *10*, 25-31.
- Sarker, D., Rahman, M. M., & Barman, J. C. (2009). Efficacy of different bagging materials for the control of mango fruit fly. *Bangladesh Journal of Agricultural Research*, *34*(1), 165-168.
- Sharma, R. R. (2009). Fruit production: problems and solutions. *International Book Distributing Company, Lucknow*, India, 649.
- Sharma, R. R., Reddy, S. V. R., & Jhalegar, M. J. (2014). Pre-harvest fruit bagging: a useful approach for plant protection and improved post-harvest fruit quality–a review. *The Journal of Horticultural Science and Biotechnology*, *89*(2), 101-113.
- Sharma, R. R., Singh, D., & Singh, R. (2009). Biological control of postharvest diseases of fruits and vegetables by microbial antagonists: A review. *Biological control*, *50*(3), 205-221.
- Shorter, A. J., Beasley, D. R., & Joyce, D. C. (1997). Effect of preharvest bagging on fruit calcium levels, and storage and ripening characteristics of 'Sensation'mangoes. *Australian Journal of Experimental Agriculture*, *37*(3), 383-389. doi: 10.1071/EA96074

- Steel, R. G. D., Torrie, J. H., & Dickey, D. A. (1997). Principles and procedures of statistic a biometrical approach. Third Edition. *The Mc Graw Hill company*, New York.
- Team, R. C. (2017). R: A language and environment for statistical computing; r foundation for statistical computing: Vienna, Austria, 2017; Available online: https://www.R-project.org/ (accessed on 1 December 2017).
- Uddin, M. S., Islam, M. S., Uddin, M. Z., Alam, M. A., Hossain, M. M., & Rashid, M. H. (2015). Modern production technology of mango and its marketing system. *Regional Horticulture Research Station, BARI, Chapainawabganj*, *46*.
- Wang, Y., Li, X., Li, Y., Li, L., & Zhang, S. (2011). Effects of bagging on browning spot incidence and content of different forms of calcium in'Huangguan'pear fruits. *Acta Horticulturae Sinica*, *38*(8), 1507-1514.
- Wang, Y., Yang, C., Liu, C., Xu, M., Li, S., Yang, L., & Wang, Y. (2010). Effects of bagging on volatiles and polyphenols in "Wanmi" peaches during endocarp hardening and final fruit rapid growth stages. *Journal of food science*, *75*(9), S455-S460.
- Watanawan, A., Watanawan, C., & Jarunate, J. (2008). Bagging 'Nam Dok Mai' mango during development affects color and fruit quality. *Acta Horticulture sinica*. *787*, 325- 330.
- Wu, H., Wang, S., Shi, S., Ma, W., Zhou, Y., & Zhan, R. (2009). Effects of bagging on fruit quality in Zill mango. *Journal of Fruit Science*, *26*(5), 644-648.
- Xu, H. X., Chen, J. W., & Xie, M. (2010). Effect of different light transmittance paper bags on fruit quality and antioxidant capacity in loquat. *Journal of the Science of Food and Agriculture*, *90*(11), 1783-1788.
- Yang, W. H., Zhu, X. C., Bu, J. H., Hu, G. B., Wang, H. C., & Huang, X. M. (2009). Effects of bagging on fruit development and quality in cross-winter off-season longan. *Scientia Horticulturae*, *120*(2), 194-200.
- Zhao, J. J., Wang, J. B., Zhang, X. C., Li, H. L., & Gao, Z. Y. (2013). Effect of bagging on the composition of carbohydrate, organic acid and carotenoid contents in mango fruit. *Acta Horticulturae*, *992*, 537-542.

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