Project ID: 444

Competitive Research Grant

Sub-Project Completion Report

on

Effect of Different Fruit Bagging Materials on the Production of Quality and Safe Mango

Project Duration

May 2016 to September 2018

Department of Horticulture
Hajee Mohammad Danesh Science and Technology University, Dinajpur

Submitted to
Project Implementation Unit-BARC, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Published in: September 2018

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Executive Summary

The aim of this study was the production safe mango with minimum pesticides application to control mango pests and diseases as well as to improve the fruit quality through bagging technology. Three varieties such as Mishribhog (early season), Langra (mid season) and Amrapali (BARI Aam-3, late season) of mango were selected. The experiment had two factors (bagging materials and time of bagging) with RCBD at three marble stages of mangoes with five bagging with a unit of 10 fruits per treatment per replication. This research was conducted at five mango orchards located at Mohabolipur, sadar and Birol, Dinajpur during April 2017 to July 2017. After harvest, the chemical analysis was done in the laboratory of Dept. of Chemistry and Atomic energy commission, Savar, Dhaka. The five mango orchards were selected and made an agreement with the respective owner of the orchard. The mangoes were bagged at marble stage (35, 45 and 55 days after fruit set) with different types of bags which constituted the various treatments viz, T_1: White paper single layered bag; T_2: Brown paper single layered bag; T_3: Brown paper double layered bag; T_4: Perforated polythene bag and T_0: Control (no bagging). The mangoes were harvested at ripening stage, and samples collected randomly for physico-chemical analysis in the laboratory. This results showed that all different materials especially brown paper double layered bag and white paper single layered bag were found promising in improving quality of mango fruits by physio-chemical properties and shelf life as compared with control (without bagging). Bagging could effectively improve fruit quality such as physical, chemical and microbial properties. The longer shelf life of bagged fruits indicated that the effect of bagging persisted after ripening. Bagging provided physical barrier between fruit and pests and protection against both. So, bagging fruits was one of necessary techniques for producing high quality fruits, which had been universally adopted in some fruit production. By this time, the procurements were processed and most of the plans were completed. During the experiment heavy rainfall damaged one of the treatments (single layered brown paper bag).

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project: Effect of different fruit bagging materials on the production of quality and safe mango.
2. Implementing organization: Hajee Mohammad Danesh Science and Technology University, Dinajpur
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s): (i) Prof. Dr. Md. Tariqul Islam, Principal Investigator, Dept. of Horticulture, Mobile No. 01716017557, E-mail: tariqulhstu@gmail.com
   (ii) Prof. Dr. Md. Shamsuzzoha, Co-Principal Investigator, Dept. of Chemistry, Mobile No. 01718617882, E-mail: ms_zoha2006@yahoo.com
4. Sub-project budget (Tk):
   - 4.1 Total: 2,000,000/- (Twenty lac) taka only
   - 4.2 Revised (if any):
5. Duration of the sub-project:
   - 5.1 Start date (based on LoA signed): 07 May, 2017
   - 5.2 End date: 30 September 2018
6. Justification of undertaking the sub-project: Mango (*Mangifera indica* L.) belonging to the family Anacardiaceae, commonly known as the 'King of fruits' (Singh, 1996), is a popular tropical fruit, especially in Asia. In Bangladesh, it is one of the most important commercial fruits and choice fruit for all age's people. Currently, there are about 41676 hectares of land occupied with mango orchard and produced about 12.88 lac ton (BBS, 2017). The area under mango cultivation is increasing every year but safe and quality mango production not increased. Mango fruits and trees are subject to several animate and inanimate diseases. The outbreak of different mango diseases and insect-pest attack reduce the target mango yield every year. To control these problems farmers are using 15-62 times pesticides in their mango orchard and it is increasing as alarming ratio (Uddin *et al*., 2015). Because of favourable environment during fruit maturity, mango fruit fly is a major pest of Khirsapat, Langra, Fazli, BARI Aam-4, BARI Aam-7, BARI Aam-8 and Ashwina varieties of mango. Sarkar *et al*., (2009) reported that a huge quantity of mango fruits may be lost due to the fruit fly infestation every year. Bagging protects fruit from pests, fungal infections, diseases, mechanical damage, reduces spraying of insecticides and provides an estimate of harvestable fruits per tree (Nagaharshitha *et al*., 2014). Bagging approach has been tested to produce high quality unblemished mango fruits in Queensland (Hofman *et al*., 1997), South Africa (Oosthuyse and Jacobs, 1997), Philippines (Bugante *et al*., 1997) and in Bangladesh (Uddin and Reza, 2017). Many researchers (Hofman *et al*., 1997; Oosthuyse and Jacobs, 1997; Bugante *et al*., 1997) reported that fruit bagging at an early stage was the most effective method to control mango anthracnose disease. Similarly, Dutta and Majumder (2012)

reported that anthracnose and stem end rot (SER) caused by *Colletotrichum* and *Diplodia* spp. respectively were reduced by bagging. Pre-harvest fruit bagging has been used to many mango exporting countries effectively. Bags are used to prevent laying egg from oriental fruit fly. It was reported as efficient, safer and cheaper method for controlling mango insects and diseases. Kitagawa *et al*. (1992) reported that bagging has widely been used for preventing destruction of fruits by birds, insects and diseases, in order to produce unblemished and high-quality fruits. Sharma *et al*. (2014) reported that pre-harvest bagging is a physical protection method which not only improves the visual quality of fruit by promoting skin colouration and reducing blemishes, but can also change the micro-environment for fruit development, which can have several beneficial effects on internal fruit quality. He also reported that pre-harvest bagging of fruit can also reduce the incidence of disease, insect pest and/or mechanical damage, sunburn of the skin, fruit cracking, agrochemical residues on the fruit and bird damage. Sarkar *et al.* (2009) found that brown paper bag performed best considering fruit fly infestation, TSS (%) and physical injury on mango fruits. Therefore, this study was undertaken to produce safe and quality mango fruit with minimum spraying of pesticides.

7. Sub-project goal: Safe mango production through fruit bagging technology.
8. Sub-project objective (s): (i) To control the pest and diseases of mango by applying minimum pesticide.
   (ii) To investigate the effect of bagging materials on the fruit development, physico-chemical compositions and shelf- life extension of mango.
   (iii) To create awareness of the mango growers through motivation and encourage and increase the production of exportable safe mango.
9. Implementing location (s): Different mango orchards around Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
10. Methodology in brief:

The experiment was conducted at the five mango orchards which were located at Mohabolipur, sadar and Birol, Dinajpur during April 2017 to July 2017. Chemical analyses were done at the laboratory of Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur and Bangladesh Atomic Energy Commission, Savar, Dhaka and other parameters were evaluated at the Department of Horticulture, HSTU, Dinajpur, Bangladesh.
The experimental fields were a medium high land belonging to the non-calcareous dark gray floodplain soil under the agro-ecological zone (AEZ-1) of Old Himalayan Piedmont Plain. The soil was sandy loam under the Order Inceptisol. The experimental site is situated in the sub-tropical region characterized by heavy rainfall during the months from May to July and scantly rainfall in the rest of the year.

The experiment was conducted in two factors-

Factor A: Types of bagging materials

T_1: White paper single layered bag (like butter bag)

T_2: Brown paper single layered bag

T_3: Brown paper double layered bag

T_4: Perforated polythene bag and

T_0: Control (no bagging).

Factor B: Time of bagging

Different type of bags were used at different days after fruit setting such as 35, 45 and 55 days.

Three varieties such as Mishribhog (early season), Langra (mid season) and Amrapali (BARI Aam-3, late season) of mango were selected. The experiment was conducted in RCBD at three marble stages of mangoes with five bagging with a unit of 10 fruits per treatment per replication. Before bagging two perforations (≤ 4 mm diameter) were made for proper ventilation at the bottom of butter paper, brown paper and polythene bag.

Parameter studies:

The following parameters were studied in the experiment.

(i) Physical characters: Length, width and thickness of fruit, fruit weight and pulp weight, colour, firmness, total weight loss and shelf life.

(ii) Chemical characters: Total soluble solid (TSS), Citric acid, Reducing sugars, Non reducing sugar, Total sugars, Ascorbic acid, β-carotene and pulp pH. In our laboratory, Atomic Energy Commission's laboratory, chemical analyses were also performed.

(iii) Microbial character: Disease severity and disease incidence of anthracnose (*Colletotrichum gloeosporioides*), stem-end rot (*Dothiorella dominicana, Dothiorella mangiferae, Lasiodiplodia theobromae*), mango stone weevil (*Sternochetus mangiferae*) and fruit fly (*Ceratitis cosyra*) (Walker).

Method of studying parameters: Five fruits were randomly selected per treatment per replication to record various physical and chemical compositions estimated by the following procedures:

Length, Width and Thickness of Fruit (cm)

The length from stem end to the apex of fruit and width and thickness was measured with the help of digital Verneer caliper and expressed in centimeters (cm).

Fruit Weight and Pulp Weight (g)

The weight of fruit and pulp was recorded by using electronic balance and expressed in grams (g).

Colour: The changes in colour of mango were determined using a numerical rating scale of 1-6, where 1 = green, 2 = Breaker, 3 = Up to 25% yellow, 4 = 25-<50% yellow, 5 = 50- <75% yellow and 6 = 75-100% yellow.

Firmness: Firmness of mango was determined by hand feeling using a numerical rating scale of 1-5, where, 1= mature hard, 2= sprung, 3= between sprung and eating ripe, 4= eating ripe and 5= over ripe.

Weight loss: 10 fruits of each replication of each treatment were weighed initially and held under different treatments for data collection. Weight loss was monitored 48 hours interval until rotten and calculated using the following formula:

Percent weight loss (%WL) $=\frac{IW-FW}{IW}\times 100$

Where, WL = Percent total weight loss

IW = Initial weight of fruits (g)

FW = Final weight of fruits (g)

Total Soluble Solids (TSS)

Total soluble solids (TSS) content was determined using refractometer (type H1 96801; HANNA); pulp samples were homogenized in a blender. By placing a drop of thoroughly mixed sample on its prism, a direct refractometer reading was taken. Percent TSS obtained from direct reading.

Citric Acid (%)

The amount of citric acid was determined by titramatrically.

Total Sugars

Total sugar content of mango pulp was estimated by Anthrone reagent as per the method given by Hansen and Moller (1975). D- Glucose at the concentration of 20 to 100 g ml-1 was used to prepare the standard curve.

Reducing Sugars

Total reducing sugar content of the samples was determined according to the classical and widely used method (Nelson-Somogyi, 1944). Briefly, mango pulps were homogenized with benzoic acid solution (0.2%). An aliquote of the filtrate was mixed with the copper reagents (a mixture of alkaline Rochelle salt and acidic $CuSO_4$). After heating in boiling water (15 min) and cooling, arsenomolybdate color reagent was added. Finally a blue color produced, the absorbance measured at 520 nm and compared with a set of standard (glucose).

Non-reducing sugar

Non reducing sugar content was determined by subtracting the reducing sugar content from total sugar content (Banik, 1995). Non-reducing sugar content was determined by using the fillowing formula.

Percentage of non-reducing sugar = (% Total sugar-% Reducing sugar) × 0.95

Ascorbic Acid (mg/100g of Fruit Pulp)

The ascorbic acid content was determined by titrimetric method (Ranganna, 1986). Briefly, sample (1 g) was homogenized with 3% metaphosphoric acid (30 ml) and was filtered through filter paper (Whatman No. 1). Then an aliquot (5 ml) of filtrate was titrated with the 2, 6-dichloroindophenol dye to a pink end-point. Results were expressed on a fresh weight basis as mg ascorbic acid equivalent per 100 g sample.

β - Carotene (µg/100 g of Pulp)

Total carotenoid pigments were determined according to the method of Nagata and Yamashita (1992).

pH of fruit juice

The pH of each sample was determined by digital pH meter (JENWAY 3510). Fruit juice was made for each sample by homogenizing 10g of sample in a homogenizer. The value was noted after adjusting and stabilizing the pH meter.

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:

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

Disease severity

Disease severity represents the percent diseased portion of the infested mango fruit. The infected fruits of each replication of each treatment were selected to determine percent fruit area infected, and was measured based on eye estimation.

Mango stone weevil

After post harvest treatment of mango stone weevil will be checked.

Fruit fly infestation

At the time of crop harvest, harvested fruits of all treatments were checked for recording fruit fly infestation and physical fruit quality.

Shelf Life of Fruits (Days)

The end of shelf life was noted when the fruits were spoiled and lost consumers preferences. The mature fruits were harvested. Twenty harvested mature fruits of each treatment were ripened at ambient temperature by using traditional rice straw as ripening material. After ripening the various observations such as shelf life (days) and incidence of spongy tissue (%) was recorded. The end of shelf life was noted when the fruits were spoiled.

Sensory evaluation

The ripe fruits of both bagged and unbagged treatments were examined for their sensory qualities for assessing appearance, sweetness, colour, flavour, texture and overall expression by panel of ten judges with nine point Hedonic Scale *viz*.1-Dislike extremely, 2-Dislike very much, 3-Dislike moderately, 4-Dislike slightly, 6-Like slightly, 7-Like moderately, 8-Like very much and 9-Like extremely (Amerine *et al*. 1965).

Statistical analysis

The data were analysed by partitioning the total variance with the MSTATC programme. The treatment means were compared using Turkey's Test.

The activities of pesticide spray before bagging and performance of bagging:

Figures 1: The activities of pesticide spray before bagging

Figures 2: The activities of the first time bagging of mango

The activities of fruit bagging, harvesting and sample selection for analysis:

Figures 3: The activities of the second and third time bagging of mango

Harvesting

Control (no bagging)

Brown paper double layered bagging

Brown and white paper bagging

Figures 4: The activities of harvesting and selection of samples

Conducting the physical parameter analysis:

Figures 5: The arrangements for the physical parameters

The performance of chemical parameters:

Figures 6: the various performances of Chemical analysis

11. Results and discussion:

In traditional mango cultivation, grower use 15-20 times pesticides and now it is reduced to 2-3 times using fruit bagging. In the year 2009, 850 core taka was spent for the importing pesticides and last year it was 150 crore taka. It is observed from the available literatures that the practice of pre-harvest bagging has been extensively used in several fruits such as apple, pear, peach, longan, mango, etc. Bagging improves the commercial value of the fruits. Bagging reduces pesticide residues in the fruits and improves insect, diseases and bird damage control. The quality of mango was assessed through the physico-chemical analyses that are described as below-

Misribhog variety:

Physical parameters

Length of fruit (mm): Fruit bagging with brown paper bag (94.93, 90.27 and 89.20 mm, respectively), white paper bag (84.40, 84.93 and 83.33 mm, respectively) and polythene bag (88.13, 82.80 and 83.20 mm, respectively) gave the maximum fruit length at 35, 45 and 55 days after fruit set over the control (77.47 mm) (Table 1). There was no significant difference among the treatments. The highest length of the fruit was found in the treatment of brown paper bag (94.93 mm) at 35 days after fruit set which was statistically comparable with the treatment of polythene and white paper bag. The lowest length of the fruit was found in the treatment control (77.47 mm) (Table 1).

Diameter of fruit (mm): Statistically significant variation was observed in respect of this trait.

At the 35 days after fruit set, the maximum fruit diameter was recorded in the fruit bagging with brown paper bag (83.13 mm) with compared to control (69.13 mm). On the other hand, white paper bag (75.13 mm) and polythene bag (74.33 mm) are similar but more than control (Table 1). When the data were recorded at 45 days after fruit set, fruit bagging with white paper bag (77.27 mm) gave maximum fruit diameter which was similar to the brown paper bag (76.80 mm) over control (69.13 mm) (Table 1).

The maximum value of fruit diameter was in the treatment of brown paper bag (77.27 mm). It was followed by white paper bag (71.33 mm) and polythene bag (69.47 mm) which were almost similar to control (69.13 mm) at the 55 days after fruit set (Table 1).

After fruit set, fruit grow slowly, and increase in size to maturity. Covering with a bag at particular development stage influence their growth and size. These finding are in accordance with the previous reports that bagging bunch of date palm improved fruit weight and dimensions (Ghalib *et al.,* 1988; El-Kassas *et al.*, 1995; Rebah and Kassem, 2003). Reports on effects of fruit

bagging on the fruit size and weight were that it may be due to differences in the type of bag used, fruit age at bagging, fruit and cultivar responses (Sharma *et al*., 2014). Bagging also increased fruit size over un-bagged control fruits (Chonhenchob *et al*., 2011).

Weight of fruit (g): Variation among the treatment means in respect of fruit weight was highly significant.(Table 1)

Fruit bagging with white paper bag (267.0 g), brown paper bag (295.8 g) and polythene bag (256.7 g) were found to be highest compared to control fruit (211.1 g) at the 35 days after fruit set.

Bagged at 45 days after fruit set, the maximum fruit weight was recorded fruit bagging with white paper bag (260.8 g), brown paper bag (279.7 g) and polythene bag (259.6 g) over control (211.1 g).

The brown paper bag produced the highest fruit weight (278.0 g) compared with control (211.1 g) produced the lowest fruit weight. Similarly, white paper bag (260.8 g) and polythene bag (257.3 g) are higher than control, at the time of bagging 55 days after fruit set (Table 1).

The highest weight of the fruit was found in the treatment of brown paper bag (295.8 g) at 35 days after fruit set which was statistically comparable with the treatment of polythene bag and white paper bag with the values 256.7 g and 267.0 g, respectively. The lowest weight of the fruit was found in the treatment control (211.8 g) (Table 1).

These findings are in accordance with some previous reports that the effects of pre-harvest bagging increased fruit growth, size and weight (Yang *et al.*, 2009; Harhash and Al-Obeed, 2010 and Zhou *et al.,* 2012). Watanawan *et al.,* (2008) reported that bagging 'Nam Dok Mai #4' mango fruits with two-layer paper bags (black inside with brown, or brown and waxed, or white outside), newspaper, or golden paper bags and non-bagged fruit for 52 d increased the fruit weight. Similarly, Chonhenchob *et al.,* (2011) studied the effects of pre-harvest bagging with different wavelength-selective bags on mango in Taiwan and reported that bagging increased the fruit weight, size and sphericity over un-bagged fruit.

Pulp weight (g): Variation among the treatment means in respect of pulp weight was highly significant at all days of observations (Table 1). The maximum pulp weight was found in the treatment of brown paper bag at 35, 45 and 55 days after fruit set which was statistically comparable with the treatment of polythene bag, white paper bag and control (Table 1). At 35, 45, 55 days after fruit set, treatment of brown paper bag exhibited the maximum pulp weight

(267.4, 252.2 and 257.2 g, respectively) and the minimum pulp weights (182.8 g) were noted in control.

These results are in consistence with some previous report that the flesh weight of fruit increased with different bagging materials eg. palm fiber, kraft paper, canvas and gauze (El-Kassas *et al*. 1995; El-Salhy, 1999 and Moustafa, 2007).

Weight loss (%): The maximum weight loss was found in the treatment of polythene bag (18.58%) at 35 days after fruit set. Almost all treatments were statistically identical with the treatment of control, white paper bag and brown paper bag with the values 15.37, 15.35 and 13.31 %, respectively (Table 1).

Shelf life: Statistically highly significant variation in shelf life of mango was noticed in all treatments (Table 1). The control treatment (no bagging) had shelf life of 5.00 days. The fruits of brown paper bag (9.00 days) and white paper bag (6.00 days) at 35 days after fruit set had greater shelf life than control (5.00 days). On the other hand, polythene bag had similar shelf life (5.00 days) with control. For late bagging, the shelf life was decreased (Table 1).

The results of the present study have got support from Shahjahan*et al.* (1994) and Hasan*et al.* (1998). Haldankar *et al.* (2015) were reported that the un-bagged control fruits of 'Alphonso' had shelf life of 15 days. The fruits of newspaper bag (17.50days), brown paper bag (16.50days) and brown paper bag with polythene coating (16.00days) and white cloth bag (15.00days) had greater shelf life than control (15.00days). The fruit of scurting bag (13.50days) had shortest shelf life.

Table 1 Data shows the result of physical parameters of Misribhog

Treatments		LF(mm)	DF(mm)	FW(g)	PW(g)	WL(%)	SL(day)
Type of bag	Time of bagging						
Control (No bagging)		77.47	69.13	211.1	182.8	15.37	5.000
Polythene Bag	35 days	88.13	74.33	256.7	226.3	18.58	4.000
	45 days	82.80	72.07	259.6	235.0	14.74	5.000
	55 days	83.20	69.47	257.3	225.7	15.21	4.667
White Paper Bag	35 days	84.40	75.13	267.0	221.1	15.35	6.000
	45 days	84.93	77.27	260.8	246.1	13.00	6.000
	55 days	83.33	71.33	248.0	228.4	13.73	6.000
Brown Paper Bag	35 days	94.93	83.13	295.8	267.4	12.91	9.000
	45 days	90.27	76.80	279.7	252.2	13.31	8.333
	55 days	89.20	77.27	278.0	257.2	15.28	8.000
LSD(0.05)		12.46	11.49	13.55	13.88	4.885	1.779
CV(%)		8.68	9.18	3.16	3.64	14.42	17.59

LF=Length of fruit; DF= Diameter of fruit; FW= Fruit weight; PW=Pulp weight; WL= Weight loss; SL= Shelf life

Chemical parameters

Total sugars (%): The fruits of the control (non-bagged) had the highest total sugar (12.12%), which was significantly superior over brown paper bag (7.033%), while in the white paper bag and polythene bag fruits were 11.26 and 10.53%, respectively at 35 days after fruit set (Table-2).

At 45 days after fruit set, the total sugar was increased in brown paper bag treatment but white paper bag and polythene bag treatments were decreased (Table 2). On the other hand, at 55 days after fruit set, similar facts were observed.

Reducing sugars (%): At 35 days after fruit set, the fruit bagging with white paper bag (3.557%) recorded the highest reducing sugar which was followed by brown paper bag and the polythene bag (2.127 and 2.773%, respectively) over control (1.940%).

At 45 days after fruit set, the reducing sugar(2.437%) of fruit bagging with brown paper bag was slightly increased while decreased with the white paper bag and polythene bag (3.240 and 1.960%, respectively). The reducing sugar of all the treatments were increased at 55 days after fruit set (Table 2).

Non-reducing sugars (%): The treatments were resulted statistically significant variation in respect of non-reducing sugar. The maximum non-reducing sugar was observed in control treatment (9.860%) (Table 2). With late fruit bagging, the non-reducing sugar was increased.

Vitamin-C: At 35 days after fruit set, the fruit bagging with white paper bag (2.233 mg/100g) recorded highest vitamin-C. The lowest results were observed in polythene bag applied on 35 days after fruit set (1.36 mg/100g).

Total soluble solids (% Brix): As shown in table 2, the different bagging treatments exerted statistically significant variation in relation to percent total soluble solids (TSS) content at different time of bagging. The control treatment had significantly highest soluble solids content (15.95% Brix) which was statistically comparable with the other treatments. The lowest data was found in the treatment polythene bag (Table 2).

At the 35 days after fruit set, the percent of total soluble solid was lower than the control treatment. For late fruit bagging after fruit set the percent of total soluble solid increases (Table 2). The recorded data were almost similar in all treatments (Table-2).

Pulp pH: The content of pulp pH in the control treatment (4.880) was higher than the other treatments of fruit bagging with brown paper bag (4.42), white paper bag (4.37) and polythene bag (4.22) at the time bagging 35 days after fruit set (Table 2).

β-carotene (µg/100 g): The highest β-carotene (654.0 µg) content was recorded in the treatment

of polythene bag which was statistically similar with the treatments of white paper bag, brown paper bag and control with the values 640.6, 641.7 and 649.6 µg (Table 2).

Table 2 Data shows the result of chemical parameters of Misribhog

Treatments								
Type of bag	Time of bagging	TS(%)	RS(%)	NRS(%)	Vit-C	TSS(%)	pH	β-Carotene (µg/100 g)
Control (No bagging)		12.12	1.940	9.860	1.567	15.95	4.880	649.6
Polythene Bag	35 days	10.53	2.773	7.010	1.36	11.54	4.220	654.0
	45 days	5.520	1.960	4.52	1.60	10.76	4.170	652.0
	55 days	6.510	2.057	4.62	1.68	8.74	3.957	661.0
White Paper Bag	35 days	11.26	3.557	6.907	2.233	13.87	4.370	640.6
	45 days	10.94	3.240	7.160	1.807	14.72	4.260	644.0
	55 days	7.953	3.670	3.743	1.840	11.58	4.100	637.3
Brown Paper Bag	35 days	7.033	2.127	5.220	1.760	12.21	4.420	641.7
	45 days	8.777	2.437	5.210	1.680	12.54	4.330	641.3
	55 days	10.05	3.223	6.400	1.760	13.31	4.340	639.3
LSD(0.05)		2.952	0.4512	2.331	0.3824	3.783	0.4512	37.14
CV(%)		18.20	10.34	16.47	13.27	17.10	6.06	3.39

TS=Total sugar; RS= Reducing sugar; NRS= Non-reducing sugar; TSS= Total soluble solid

Disease severity

Statistically highly significant variation was observed in respect of stem end rot, anthracnose and fruit fly infestation among the fruit bagging with brown paper bag, white paper bag and polythene bag and control at 35, 45 55 days after fruit set (Table 3).

Stem end rot (%)

The fruit bagging with brown paper bag (1.16%) at 35 days after fruit set had the lowest infection of stem end rot closely preceded by the same bag at 45 days (30%) and 55 days(2.17%). The highest infection of stem end rot was observed in control (38.94%) (Table 3).

At 45 days after fruit set, the fruit bagging with different bags the infection of stem end rot was increased such as brown paper bag (1.30%) is more than bagging at 35 days after fruit set but the lowest among other treatments. It was followed by white paper bag (11.67%) and polythene bag (26.46%) (Table 3).

The fruit bagging with brown paper bag (2.17%) at 55 days after fruit set had the lowest infection of stem end rot than other treatments. It was followed by white paper bag and polythene bag (12.10 and 33.93%, respectively) (Table 3).

Antracnose (%)

The maximum percent of anthracnose was observed in control (29.37%). The brown paper bag treatment at 35 days after fruit set (0.17%) showed the lowest percent of anthracnose among the treatments and control (Table-3). The white paper bag and polythene bag treatment at 35 days after fruit set were found 3.1 and 4.96%, respectively (Table 3). For late bagging such as 45 and 55 days after fruit set, the percent of anthracnose was increased. At 55 days after fruit set, the maximum percent of anthracnose were found among other time treatments.

Fruit fly infestation (%)

The treatments exhibited statistically significant variation in respect of fruit fly infestation (Table 3). The maximum infestation of fruit fly was recorded in control (6.76%). Fruits of brown paper bag and white paper bag treatments showed the totally free from fruit fly infestation at 35 and 45 days after fruit set while fruits of polythene bag treatment showed some infestation (Table 3).

Table 3 Data shows the result of disease severity of Misribhog

Treatments		Stem End Rot (%)	Anthracnose (%)	Fruit fly infestation (%)
Type of bag	Time of bagging			
Control (No bagging)		38.94	29.37	6.760
Polythene Bag	35 days	22.43	4.960	2.463
	45 days	26.46	5.430	3.620
	55 days	33.93	5.540	9.333
White Paper Bag	35 days	13.94	3.100	0.0000
	45 days	11.67	3.200	0.0000
	55 days	12.10	3.400	5.927
Brown Paper Bag	35 days	1.160	0.1700	0.0000
	45 days	1.300	0.0000	0.0000
	55 days	2.170	0.7700	4.947
LSD(0.05)		3.773	2.972	1.388
CV(%)		11.50	19.71	19.83

Sensory Evaluation

Colour of the peel

The treatments showed statistically significant variation in respect of Colour (Table 4). At 35 days after fruit set, the highest score 8.43 was obtained in the treatment of brown paper bag. It was followed by white paper bag (5.70) over control (6.33).On the other hand, the lowest score (4.00) was obtained in polythene bag than control.

At 45 days after fruit set, the highest score (7.67) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.33) over than control (6.33).On the other hand, the lowest score (3.00) was obtained in polythene bag than control.

At 55 days after fruit set, the highest score (8.33) was obtained in the treatments of brown paper bag and white paper bag over control (4.47).On the other hand, the lowest score (3.30) was obtained in polythene bag than control.

Bagging improved the Colour of the fruits by increasing their anthocyanin content.

This result is comparable to that of Watanawan *et al*., (2008); they reported that bagging mango fruit with two-layer paper bags advanced their skin Colour development from green to yellow. Wang *et al*., (2013) and Liu *et al*., (2013) also claimed that bagging induced red Colour in green-type ('Granny Smith') and yellow-Coloured ('Golden Delicious') apples, respectively. Bagging has been used extensively in several fruit crops to improve skin Colour by increasing their anthocyanin contents and to reduce the incidence of disease, insect pests, mechanical damage, sunburn of the skin, agrochemical residues on the fruit and bird damage (Bentley and Viveros, 1992; Kitagawa *et al*., 1992; Hofman *et al*., 1997; Joyce *et al*., 1997; Tyas *et al*., 1998; Amarante *et al.,* 2002a and Xu *et al*., 2010.

Texture

At 35 days after fruit set, the same texture score i.e. 7.00 was recorded in all the treatments. So, there was no significant difference among the treatments (Table 4).

This result is paralled to that of Hofman *et al.,* (1997); who reported that mango fruit firmness was not affected by white paper bags. Faoro and Marcia (2004) studied the effects of bagging on fruit firmness and reported that bagging did not affect fruit firmness in 'Nashi' pear.

Appearance

Statistically significant variation in appearance of mango was noticed among treatments (Table 4).

At 35 days after fruit set, the highest appearance score (8.33) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.00) over control (5.33). In contrast, the lowest score (3.00) was obtained in the polythene bag than control.

At 45 days after fruit set, the highest appearance score (7.67) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.00) over than control (5.33). Oppositely, the lowest score (3.33) was obtained in polythene bag than control.

At 55 days after fruit set, the highest score (7.33) was obtained in the treatment of brown paper bag and white paper bag over control(5.33).On the other hand, the lowest score (3.00) was obtained in the polythene bag than control.

This result is at per with that of Amarante *et al.*(2002b); they reported that pre-harvest bagging improved the fruits appearance. After a fruit bagging experiment using the mango cv. Apple, Mathooko *et al.*, (2011) reported that bagged fruit had a smoother texture and a spotless, light green skin Colour.

Sweetness

Statistically no significant variation was found in the treatments in respect of sweetness (Table-4).

At 35 days after fruit set, the maximum score was obtained in control (7.67) than all the rest treatments.

At 45 days after fruit set, the maximum score (8.33) was obtained in the white paper bag while the minimum (7.00) was in the brown paper bag and the polythene bag too.

At 55 days after fruit set, the maximum score (7.67) was obtained in the white paper bag while the minimum (6.76) score was in the polythene bag.

Flavour

Statistically no significant variation was found among the treatments in respect of Flavour (Table-4).

At 35 days after fruit set, the maximum score was obtained in the brown paper bag (8.00) than control (7.00) while the minimum was in the polythene bag (5.33).

At 45 days after fruit set, the maximum score (8.67) was recorded in the brown paper bag while the minimum (6.33) score was in the transparent polythene bag over control (6.67).

At 55 days after fruit set, the maximum score (7.67) was noted in the brown paper bag while the minimum (5.33) was in the transparent polythene bag.

Overall impression

At 35 days after fruit set, the brown paper bag gave the highest result (8.33). It was followed by the white paper bag (7.33). The lowest result (3.33) was observed in the polythene bag than control (4.33).

At 45 days after fruit set, the highest result (8.67) was experienced in the brown paper bag while the white paper bag and polythene bag gave 7.67 and 5.33, respectively. Oppositely the lowest result (4.67) was observed in the control fruits.

At 55 days after fruit set, the highest result (7.67) was given by the brown paper bag while the white paper bag and the polythene bag gave 6.67 and 5.00, respectively). The lowest result (4.33) was observed in the control fruits. Bagged fruits had better overall impression than the control fruits.

Table 4 Data shows the result of sensory evaluation of Misribhog

Treatments		Color	Texture	Appearance	Sweetness	Flover	Overall Impression
Type of bag	Time of bagging						
Control (No bagging)		6.330	7.000	5.330	7.670	7.000	4.330
Polythene Bag	35 days	4.000	7.000	3.000	7.330	5.330	3.330
	45 days	3.000	7.670	3.330	7.000	6.330	5.330
	55 days	3.297	7.000	3.000	6.670	5.330	5.000
White Paper Bag	35 days	5.703	7.000	7.000	7.330	7.000	7.330
	45 days	7.330	7.000	7.000	8.330	7.000	7.670
	55 days	7.670	7.000	7.000	7.670	7.330	6.670
Brown Paper Bag	35 days	8.430	7.670	8.330	7.330	8.000	8.330
	45 days	7.670	7.670	7.670	7.000	8.670	8.670
	55 days	8.330	7.670	7.330	7.000	7.670	7.670
LSD(0.05)		1.542	1.976	1.300	1.792	1.842	1.398
CV(%)		14.85	16.16	13.09	14.43	15.99	13.52

Langra variety

Physical parameters

Length of fruit (mm): The treatment of brown paper bag and white paper bag were gave the maximum fruit length (103.5mm and 97.93 mm, respectively) at 35 days after fruit set. The treatment of control gave the fruit length (92.4 mm). However, minimum fruit length was recorded in the treatment of polythene bag (88.2 mm) at 45 and 55 days after fruit set (Table 5).

Diameter of fruit (mm): Statistically significant variation was observed in respect of this trait. The diameter of fruit with brown paper bag treatment was higher than any other treatments such

as white paper bag, polythene bag and control at different bagging time such as 35, 45 and 55 days after fruit set (Table 5). At the 35 days after fruit set, the maximum fruit diameter was recorded in the fruit bagging with brown paper bag (84.85 mm) and white paper bag (79.27 mm) over control (74.13 mm) while polythene bag (73.40 mm) was minimum fruit diameter than control (Table 5). The diameter of fruit was slightly decreased at 45 and 55 days after fruit set (Table 5).

After fruit set, fruit grow slowly, and increase in size to maturity. Covering with a bag at particular development stage influence their growth and size. These finding are in accordance with the previous reports that bagging bunch of improved fruit weight and dimensions (Ghalib *et al.,* 1988; El-Kassas *et al.*, 1995; Rebah and Kassem 2003). Reports on effects of fruit bagging on the fruit size and weight were that it may be due to differences in the type of bag used, fruit age at bagging, fruit and cultivar responses (Sharma *et al*., 2014; Zhen *et al*., 2000; Wang *et al*., 2002). Bagging also increased fruit size over un-bagged control fruits (Chonhenchob *et al*., 2011).

Weight of fruit (g): The maximum fruit weight was found in the treatment of brown paper bag at 35 days after fruit set (329.2 g) and minimum in the polythene bag treatment (248.6 g) (Table 5). Bagging increased fruit weight, size over control fruits (Chonhen chob et al., 2011).

The fruit weight was recorded at 45 days after fruit set, brown paper bag (280.7 g), white paper bag (246.3 g) and polythene bag (235.2 g) which are less than bagging at 35 days after fruit set. Similarly, bagging at 55 days after fruit set, the fruit weight was recorded which also less than bagging at 35 and 55 days after fruit set (Table 5)

Pulp weight (g): The maximum pulp weight was found in the treatment of brown paper bag (289.8 g) which was statistically similar with the treatment of white paper bag (278.9 g) at 35 days after fruit set. The lowest pulp weight of the fruit was found in the treatment polythene bag (164.2 g) which was also statistically different with the treatment of control (214.9 g) (Table 5).

Weight loss (%): The maximum weight loss was found in the treatment of white paper bag (14.51%) which was statistically similar with the treatment of polythene bag with the values 13.94 %. The lowest weight loss was found in the treatment of brown paper bag (7.56%) at 55 days after fruit set (Table 5).

These findings are accordance with some previous reports that the effects of pre-harvest bagging increased fruit growth, size, and weight (Yang et al., 2009; Harhash and Al-Obeed, 2010; Zhou et al., 2012; Sharma et al., 2014; Haldankar et al., 2015; Islam et al., 2017a and 2017b).

Shelf life (day): The maximum shelf life was found in the treatment of brown paper bag (7.667 days) which was statistically comparable with the treatment of white paper bag (6.000 days) and the minimum shelf life was found in the treatment polythene bag (3.000 days) due to the early retention of the fruit which was statistically similar with the treatment of control (4.0 days) (Table 5).

Table 5 Data shows the result of physical parameters of Langra

Treatments		LF(mm)	DF(mm)	FW(g)	PW(g)	WL(%)	SL(day)
Type of bag	Time of bagging						
Control (No bagging)		92.40	74.13bc	264.9	214.9	9.260	4.000
Polythene Bag	35 days	88.20	73.40	248.6	207.6	10.20	3.000
	45 days	86.20	72.13	235.2	195.2	12.22	3.333
	55 days	84.27	68.67	200.4	164.2	13.94	4.333
White Paper Bag	35 days	97.93	79.27	311.6	278.9	12.69	6.000
	45 days	87.53	74.93	246.3	205.1	14.51	5.000
	55 days	87.73	72.00	238.6	197.6	8.757	5.000
Brown Paper Bag	35 days	103.5	84.85	329.2	289.8	8.270	7.667
	45 days	99.47	85.13	280.7	241.2	9.980	8.000
	55 days	101.0	79.27	273.5	226.7	7.560	7.000
LSD(0.05)		13.69	7.532	17.52	16.39	2.899	1.761
CV(%)		8.71	5.86	3.93	4.38	16.32	15.34

LF=Length of fruit; DF= Diameter of fruit; FW= Fruit weight; PW=Pulp weight; WL= Weight loss; SL= Shelf life

Chemical parameters:

Total sugars (%): The total sugars were the highest in the white paper bag treatment (14.82 %) at 45 days after fruit set (Table 6). It was the lowest in the polythene bag treatment (10.44%). Earlier, Harhash and Al-obeed (2010) reported that date palm fruit bagged with blue color bag showed the highest total sugars as compared to control. (Table 6).

Reducing sugars (%): The highest reducing sugars were recorded in brown paper bag (3.63%) at 55 days after fruit set which is statistically identical with 45 days while the lowest was recorded in the polythene bag (1.80%) at 45 days after fruit set (Table 6). Similar findings were found in some previous research (Haldankar et al., 2015; Islam et at., 2017a). They reported that fruits of newspaper and white paper bag exhibited the maximum reducing sugars at ripe stage in mango due to pre-harvest bagging treatments.

Non-reducing sugars (%): The non-reducing sugar was observed in control (11.92%) while the other treatments of brown paper bag, white paper bag and polythene bag were observed 10.457, 8.877 and 11.27%, respectively at 35 days after fruit set.

At 45 days after fruit set, the non-reducing sugar was observed in the treatments of brown paper bag, white paper bag and polythene bag 7.157, 11.18 and 11.58%, respectively.

The brown paper bag, white paper bag and polythene bag showed the value of non-reducing sugar as 9.13, 11.34 and 8.23%, respectively at 55 days after fruit set (Table 6).

Vitamin-C

There was no significant different among the treatments (Table-6). The vitamin-C was observed in control treatment 44.74 mg/100g. At 35 days after fruit set, the bagging with brown paper bag, white paper bag and pothylene bag showed the value of vitamin-C as 38.67, 40.21 and 40.17 mg/100g, respectively. The similar results were found with bagging at 45 and 55 days after fruit set (Table 6).

Total soluble solids (% Brix): The treatments were statistically significant variation in respect to total soluble solids (TSS) at different time of bagging (Table 6). The higher percent of total soluble solid was recorded in control treatment (18.78%).

At the 35 days after fruit set, the percent of total soluble solid was in fruit bagging with brown paper bag, white paper bag and polythene bag as 15.36, 16.22 and 16.89%, respectively.

When the data was recorded at 45 and 55 days after fruit set, the fruit bagging with brown paper bag, white paper bag and polythene bag gave the similar to the bagging at 35 days after fruit set (Table-6).

Pulp pH: The content of pulp pH in the control treatment (5.853) is higher than the other treatments of fruit bagging with brown paper bag (5.40), white paper bag (5.31) and polythene bag (5.31) (Table 6).

β-carotene (µg/100 g): The treatments were statistically non-significant variation in respect of β-carotene (Table-6). Almost the similar β-carotene content was recorded in the all treatments (Table-6).

Table 6: Data shows the result of chemical parameters of Langra

Treatments								
Type of bag	Time of bagging	TS(%)	RS(%)	NRS(%)	Vit-C (mg/100g)	TSS(% Brix)	pH	β-carotene (µg/100 g)
Control (No bagging)		14.82	2.900	11.92	44.74a	18.78	5.853	598.2
Polythene Bag	35 days	13.22	1.95	11.27	40.17	16.89	5.210	608.4
	45 days	13.83	2.25	11.58	38.44	17.03	5.297	602.0
	55 days	10.44	2.210	8.23	40.21	15.34	5.310	614.6
White Paper Bag	35 days	10.83	1.953	8.877	40.21	16.22	5.310	613.4
	45 days	13.91	2.730	11.18	41.19	16.13	5.310	603.4
	55 days	13.50	2.160	11.34	39.65	17.11	5.220	611.4
Brown Paper Bag	35 days	12.26	1.803	10.457	38.67	15.36	5.400	616.3
	45 days	10.44	3.283	7.157	42.57	15.49	5.273	611.0
	55 days	12.76	3.630	9.13	41.41	15.68	5.403	611.0
LSD(0.05)		2.902	0.3748	2.174	6.747	4.028	0.3387	24.83
CV(%)		13.32	8.68	12.49	9.62	14.14	3.69	2.40

TS=Total sugar; RS= Reducing sugar; NRS= Non-reducing sugar; TSS= Total soluble solid

Pest and Disease incidence of Langra

Statistically highly significant variation was observed in respect of stem end rot, anthracnose and fruit fly incidence between the fruit bagging with brown paper bag, white paper bag and polythene bag at 35, 45 and 55 days after fruit set (Table 7).

Stem end rot (%)

The maximum infection of stem end rot was recorded in control (34.27%). The fruit bagging with brown paper bag (1.13%) at 35 days after fruit set had the lowest infection of stem end rot than control and other treatment. It was followed by white paper bag (15.27%) and polythene bag (27.10%) at 35 days after fruit set (Table 7).

At 45 days after fruit set, the fruit bagging with different bags the infection of stem end rot was in brown paper bag 0.40%, in white paper bag 10.77% and in polythene bag 25.43% (Table-7).

The fruit bagging with brown paper bag (2.170%) at 55 days after fruit set had the lowest infection of stem end rot than other treatments. It was followed by white paper bag and polythene bag (15.10 and 39.27%, respectively) (Table-7).

Anthracnose (%)

The treatments exhibited statistically significant variation in respect of Anthracnose (Table 7). The maximum percent of anthracnose was observed in control (32.03%). The brown paper bag treatment at 35 days after fruit set (0.17%) showed the lowest percent of anthracnose among the

treatments and control (Table-7). The white paper bag and polythene bag treatment at 35 days after fruit set were found 3.0 and 4.86%, respectively (Table-7). For late bagging such as 45 and 55 days after fruit set, the percent of anthracnose was increased. At 55 days after fruit set, the maximum percent of anthracnose were found among other time treatments.

Fruit fly infestation (%)

The different bagging treatment used exhibited statistically significant variation in relation to fruit fly infestation (Table-7). The maximum infestation of fruit fly was recorded in control (6.76 %). Fruits of brown paper bag and white paper bag treatments showed the totally free from fruit fly infestation at 35 and 45 days after fruit set while fruits of polythene bag treatment showed some infestation (Table-7).

Table 7 Data shows the result of pest and disease incidence of Langra

Treatments		Stem End Rot (%)	Anthracnose (%)	Fruit fly infestation (%)
Type of bag	Time of bagging			
Control (No bagging)		34.27	32.03	8.620
Polythene Bag	35 days	27.10	4.860	1.300
	45 days	25.43	5.430	3.600
	55 days	39.27	5.540	9.000
White Paper Bag	35 days	15.27	3.000	0.0000
	45 days	10.77	3.600	0.0000
	55 days	15.10	4.100	5.960
Brown Paper Bag	35 days	1.130	0.1700	0.0000
	45 days	0.4000	0.0000	0.0000
	55 days	2.170	0.7700	4.880
LSD(0.05)		3.545	2.513	1.458
CV(%)		10.20	15.81	19.50

Sensory Evaluation

Colour of the peel

The treatments showed statistically significant variation in respect of peel Colour (Table 8). At 35 days after fruit set, the highest score 8.43 was obtained in the treatment of brown paper bag. It was followed by white paper bag (5.703) over control (6.33). On the other hand, the lowest score (4.00) was obtained in polythene bag than control.

At 45 days after fruit set, the highest score (7.67) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.33) over than control (6.33). On the other hand, the lowest score (3.00) was obtained in polythene bag than control.

At 55 days after fruit set, the highest score (8.33) was obtained in the treatments of brown paper bag and white paper bag over control (7.67). The lowest score (3.30) was obtained in polythene bag than control.

Bagging improved the Colour of the fruits by increasing their anthocyanin content.

This result is comparable to that of Watanawan *et al*. (2008); they reported that bagging mango fruit with two-layer paper bags advanced their skin colour development from green to yellow. Wang *et al*. (2013) and Liu *et al*. (2013) also claimed that bagging induced red Colour in green-type ('Granny Smith') and yellow-coloured ('Golden Delicious') apples, respectively. Bagging has been used extensively in several fruit crops to improve skin colour by increasing their anthocyanin contents and to reduce the incidence of disease, insect pests, mechanical damage, sunburn of the skin, agrochemical residues on the fruit and bird damage (Joyce *et al*., 1997; Tyas *et al*., 1998; Amarante *et al.,* 2002a and Xu *et al*., 2010).

Texture

There was no significant difference in texture among the treatments. The same texture score i.e. around 7.00 was recorded in all the treatments (Table 8).

This result is paralled to that Hofman *et al.,* (1997); they reported that mango fruit firmness was not affected by white paper bags. Faoro and Marcia (2004) studied the effects of bagging on fruit firmness and reported that bagging did not affect fruit firmness in 'Nashi' pear.

Appearance

Statistically significant variation in appearance in mango was noticed in all the treatments (Table 8). At 35 days after fruit set, the appearance score (7.67) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.00) over control (5.33). In contrast, the lowest score (3.00) was obtained in the polythene bag than control.

At 45 days after fruit set, the highest appearance score (8.33) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.00) over than control (5.33). Oppositely, the lowest score (3.33) was obtained in polythene bag than control.

At 55 days after fruit set, the highest score (7.33) was obtained in the treatment of brown paper bag and white paper bag over control(5.33).On the other hand, the lowest score (3.00) was obtained in the polythene bag than control.

This result is at per with that of Amarante *et al.*(2002b); they reported that pre-harvest bagging improved the fruits appearance. After a fruit bagging experiment using the mango cv. Apple, Mathooko *et al.*, (2011) reported that bagged fruit had a smoother texture and a spotless, light green skin Colour.

Sweetness

Statistically no significant variation was found in the treatments in respect of sweetness (Table 8). At 35 days after fruit set, the maximum score was obtained in control (7.33) than all the rest treatments.

At 45 days after fruit set, the maximum score (8.33) was obtained in the white paper bag while the minimum (7.00) was in the brown paper bag and the polythene bag too.

At 55 days after fruit set, the maximum score (7.67) was obtained in the white paper bag while the minimum (6.67) score was in the polythene bag.

Flavour

Statistically no significant variation was found among the treatments in respect of Flavour (Table 8). At 35 days after fruit set, the maximum score was obtained in the brown paper bag (8.00) than control (7.00) while the minimum was in the polythene bag (5.33).

At 45 days after fruit set, the maximum score (8.67) was recorded in the brown paper bag while the minimum (6.33) score was in the transparent polythene bag over control (6.67).

At 55 days after fruit set, the maximum score (7.67) was noted in the brown paper bag while the minimum (5.33) was in the transparent polythene bag.

Overall impression

At 35 days after fruit set, the brown paper bag gave the highest result (8.33). It was followed by the white paper bag (7.33). The lowest result (3.33) was observed in the polythene bag than control (4.33).

At 45 days after fruit set, the highest result (8.67) was experienced in the brown paper bag while the white paper bag and polythene bag gave 7.67 and 5.33, respectively. Oppositely the lowest result (4.67) was observed in the control fruits.

At 55 days after fruit set, the highest result (7.67) was given by the brown paper bag while the white paper bag and the polythene bag gave 6.67 and 5.00, respectively). The lowest result (4.33) was observed in the control fruits. Bagged fruits had better overall impression than the control fruits.

Table 8 Data shows the result of Sensory evaluation of Langra

Treatments		Colour	Texture	Appearance	Sweetness	Flavour	Overall Impression
Type of bag	Time of bagging						
Control (No bagging)		6.330	7.000	5.330	7.670	7.000	4.330
Polythene Bag	35 days	4.000	7.000	3.000	7.330	5.330	3.330
	45 days	3.000	7.670	3.330	7.000	6.330	5.330
	55 days	3.297	7.000	3.000	6.670	5.330	5.000
White Paper Bag	35 days	5.703	7.000	7.000	7.330	7.000	7.330
	45 days	7.330	7.000	7.000	8.330	7.000	7.670
	55 days	7.670	7.000	7.000	7.670	7.330	6.670
Brown Paper Bag	35 days	8.430	7.670	7.670	7.330	8.000	8.330
	45 days	7.670	7.670	8.330	7.000	8.670	8.670
	55 days	8.330	7.670	7.330	7.000	7.670	7.670
LSD(0.05)		1.542	1.976	1.300	1.792	1.842	1.398
CV(%)		14.85	16.16	13.09	14.43	15.99	13.52

Results of Amrapali variety

Physical parameter

Length of fruit (mm): Variation among the treatment means in respect of length of fruit was highly significant. Fruit bagging with brown paper bag (106.4, 102.10 and 96.33 mm, respectively), white paper bag (91.20, 78.53 and 78.67 mm, respectively) and polythene bag (78.40, 82.00 and 75.33 mm, respectively) gave the maximum fruit length at 35, 45 and 55 days after fruit set over the control (70.87 mm) (Table 9). The highest length of the fruit was found in the treatment of brown paper bag (106.4 mm) at 35 days after fruit set which was statistically comparable with the treatment of polythene and white paper bag. The lowest length of the fruit was found in the treatment control (70.87 mm) (Table 9).

Diameter of fruit (mm): Statistically significant variation was observed in respect of this trait.

At the 35 days after fruit set, the higher fruit diameter was observed in all treatments with compared to control. The maximum fruit diameter was recorded in the fruit bagging with brown paper bag (78.67 mm) with compared to control (51.87 mm) and other treatments at 35 days after fruit set (Table 9). The white paper bag (65.13 mm) and polythene bag (64.60 mm) are also higher than control (Table 9).

When the data were recorded at 45 days after fruit set, fruit bagging with brown paper bag (75.33 mm) gave maximum fruit diameter over control (51.87 mm) and other treatments (Table 9).

The maximum value of fruit diameter at 55 days after fruit set was in the treatment of brown paper bag (69.67 mm) but lower than 35 and 45 days after fruit set. It was followed by white paper bag (65.27 mm) and polythene bag (64.13 mm) which were also higher than control (51.87 mm) at the 55 days after fruit set (Table 9).

After fruit set, fruit grow slowly, and increase in size to maturity. Covering with a bag at particular development stage influence their growth and size. These finding are in accordance with the previous reports that bagging bunch of date palm improved fruit weight and dimensions (Ghalib *et al.,* 1988; El-Kassas *et al.*, 1995; Rebah and Kassem 2003) reports on effects of fruit bagging on the fruit size and weight were that it may be due to differences in the type of bag used, fruit age at bagging, fruit and cultivar responses (Sharma *et al*., 2014; Zhen *et al*., 2000; Wang *et al*., 2002). Bagging also increased fruit size over un-bagged control fruits (Chonhenchob *et al*., 2011).

Weight of fruit (g): Variation among the treatment means in respect of fruit weight was highly significant at all days of observations. The maximum fruit weight was recorded in the fruit bagging with brown paper bag (380.6 g) with compared to control (171.0 g) and other treatments at 35 days after fruit set (Table-9). Fruit bagging with white paper bag (207.8 g), and polythene bag (174.3 g) were found to be higher compared to control fruit (171.0 g) at the 35 days after fruit set.

At 45 days after fruit set, the fruit weight was recorded fruit bagging with brown paper bag (272.7 g), white paper bag (178.3 g) and polythene bag (186.4 g) over control (171.0 g).

The brown paper bag produced the highest fruit weight (200.6 g) compared with control (171.0 g) produced the lowest fruit weight. It was followed by white paper bag (201.9 g) and polythene bag (166.4 g) than control, at the time of bagging 55 days after fruit set (Table 9).

The highest weight of the fruit was found in the treatment of brown paper bag (380.6 g) at 35 days after fruit set which was statistically comparable with the treatment of polythene bag and white paper bag with the values 174.3 and 207.8 g, respectively. The lowest weight of the fruit was found in the treatment control (171.0 g) (Table 9).

These findings are in accordance with some previous reports that the effects of pre-harvest bagging increased fruit growth, size and weight (Yang *et al.*, 2009; Harhash and Al-Obeed, 2010 and Zhou *et al.,* 2012). Watanawan *et al.,* (2008) reported that bagging 'Nam Dok Mai #4'

mango fruits with two-layer paper bags (black inside with brown, or brown and waxed, or white outside), newspaper, or golden paper bags and non-bagged fruit for 52 d increased the fruit weight. Similarly, Chonhenchob *et al.,* (2011) studied the effects of pre-harvest bagging with different wavelength-selective bags on mango in Taiwan and reported that bagging increased the fruit weight, size and sphericity over un-bagged fruit.

Pulp weight (g): Variation among the treatment means in respect of pulp weight was highly significant at all days of observations. The maximum pulp weight was found in the treatment of brown paper bag at 35, 45 and 55 days after fruit set which was statistically comparable with the treatment of polythene bag, white paper bag and control (Table 9). At 35, 45, 55 days after fruit set, treatment of brown paper bag exhibited the maximum pulp weight (195.4, 190.3 and 176.9 g, respectively) and the minimum pulp weights (125.5 g) were noted in control (Table 9).

These results are in consistence with some previous report that the flesh weight of fruit increased with different bagging materials eg. palm fiber, kraft paper, canvas and gauze (El-Kassas *et al*. 1995; El-Salhy, 1999 and Moustafa, 2007).

Weight loss (%): The maximum weight loss was found in the treatment of polythene bag (24.82%) at 35 days after fruit set compared to other treatments and control. Almost all treatments were statistically identical with the treatment of control, white paper bag and brown paper bag with the values 17.53, 18.68 and 11.15 %, respectively (Table 9).

Shelf life: Statistically highly significant variation in shelf life of mango was noticed in all treatments (Table 9). The control treatment (no bagging) had shelf life of 7.00 days. The fruits of brown paper bag (14.67 days) and white paper bag (11.00 days) at 35 days after fruit set had greater shelf life than control (7.00 days). On the other hand, polythene bag had less shelf life (5.00 days) than control. For late bagging, the shelf life was decreased (Table 9).

The results of the present study have got support from Shahjahan*et al.* (1994) and Hasan*et al.* (19 98). Haldankar*et al.* (2015) also reported that the un-bagged control fruits of 'Alphonso' had shel f life of 15 days. The fruits of newspaper bag (17.50days), brown paper bag (16.50days) and bro wn paper bag with polythene coating (16.00days) and white cloth bag (15.00days) had greater sh elf life than control (15.00days). The fruit of scurting bag (13.50days) had shortest shelf life.

Table 9 Data shows the result of physical parameters of Amrapali

Treatments							
Type of bag	Time of bagging	LF (mm)	DF (mm)	FW (g)	PW (g)	WL(%)	SL(Day)
Control (No bagging)		70.87	51.87	171.0	138.0	17.53	7.000
Polythene Bag	35 days	78.40	64.60	174.3	130.3	24.82	5.000
	45 days	82.00	60.87	186.4	125.5	17.68	5.000
	55 days	75.33	64.13	166.4	141.3	14.47	4.000
White Paper Bag	35 days	91.20	65.13	207.8	163.6	18.68	11.00
	45 days	78.53	58.67	178.3	133.0	14.77	10.00
	55 days	78.67	65.27	201.9	158.1	13.49	10.00
Brown Paper Bag	35 days	106.4	78.67	380.6	195.4	11.15	14.67
	45 days	102.1	75.33	272.7	190.3	12.09	14.00
	55 days	96.33	69.67	200.6	176.9	11.63	14.00
LSD(0.05)		10.99	12.26	27.52	17.26	4.129	2.602
CV(%)		7.77	11.46	7.81	6.69	15.34	16.97

LF=Length of fruit; DF= Diameter of fruit; FW= Fruit weight; PW=Pulp weight; WL= Weight loss; SL= Shelf life

Chemical parameters

Total sugars (%): There was no significant difference among the treatments (Table 10). The fruits of the control (non-bagged) had the total sugar 12.12%. The brown paper bag, in the white paper bag and polythene bag treatments were 14.57, 14.16 and 12.72%, respectively at 35 days after fruit set were almost similar to the control treatment (Table 10).

At 45 days after fruit set, the total sugar was observed similar results in brown paper bag treatment, white paper bag and polythene bag treatments (Table 10). On the other hand, at 55 days after fruit set, similar facts were also recorded.

Reducing sugars (%): There was no significant difference among the treatments (Table 10). At 35 days after fruit set, the reducing sugar was recorded 1.993, 1.800 and 1.510% the fruit bagging with polythene bag, white paper bag and brown paper bag, respectively over control 2.310%.

At 45 days after fruit set, the reducing sugar of fruit bagging was slightly increased with brown paper bag, white paper bag and polythene bag (1.723, 2.330 and 2.02%, respectively). The reducing sugar of all the treatments were increased at 55 days after fruit set (Table 10).

Non-reducing sugars (%): The treatments were resulted statistically non-significant variation in respect of non-reducing sugar. The minimum non-reducing sugar was observed in control treatment (9.790%) (Table 10). With late fruit bagging, the non-reducing sugar was increased.

Vitamin-C: The highest (8.97 mg/100 g) ascorbic acid content was recorded in the treatment of brown paper bag which was found statistically at per with white paper bag (7.77 mg/100 g) at 35 days after fruit set while the lowest (5.72 mg/100 g) was recorded in the control treatment (Table 10). The above results are very close to the findings of (Islam et al., 2017a; Haldankar et al., 2015 and Sharma et al., 2013) in mango.

Total soluble solid (% Brix): The different bagging treatments used exerted investigation statistically significant variation in relation to percent total soluble solids (TSS) at different time of bagging. The brown paper bag treatment had significantly higher soluble solids content (18.95% Brix) which was statistically comparable with the other treatments. The lowest data was found in the treatment control (Table 10).

At the 35 days after fruit set, the percent of total soluble solid was lower than the control treatment. For late fruit bagging after fruit set the percent of total soluble solid increases (Table-10). The recorded data were almost similar in all treatments (Table 10).

Pulp pH: There was no significant difference among the treatments (Table 10). The content of pulp pH was found in the control treatment (5.060) and other treatments were fruit bagging with brown paper bag (5.217), white paper bag (6.533) and polythene bag (4.967) (Table 10).

15.

β-carotene (µg/100 g): The treatments were statistically non-significant variation in respect of β-carotene (Table 10). The highest β-carotene content at 35 days after fruit set was recorded in the t reatment of brown, white paper and polythene bag (517.3 µg, 514.3 µg, and 509.7 µg, respectiv ely) while the lowest was recorded in the control fruits (495.1 µg). These findings are accordance with previous reports that a flesh lycopene and β-carotene content was increased due to pre-harve st bagging treatments in mango (Zhao et al., 2013; Haldankar et al., 2015; Islam et al., 2017a).

Table 10: Data shows the result of chemical parameters of Amrapali

Treatments								
Type of bag	Time of bagging	TS(%)	RS(%)	NRS(%)	Vit-C (mg/100g)	TSS (% Brix)	pH	β-carotene (µg/100 g)
Control (No bagging)		12.10	2.310	9.790	5.720	14.86	5.060	495.1
Polythene Bag	35 days	12.72	1.993	10.727	6.480	16.53	4.967	509.7
	45 days	13.41	2.020	11.390	6.720	15.54	5.273	511.0
	55 days	8.790	1.303	7.487	6.720	14.00	4.733	506.5
White Paper Bag	35 days	14.16	1.800	12.360	6.960	22.38	6.533	514.3
	45 days	14.78	2.330	12.450	7.773	21.57	5.987	514.3
	55 days	16.45	1.800	14.650	6.387	18.79	5.360	511.3
Brown Paper Bag	35 days	14.57	1.510	13.060	8.970	18.95	5.217	514.3
	45 days	13.59	1.723	11.867	6.920	16.30	5.420	511.3
	55 days	14.48	1.043	13.437	7.213	17.56	5.783	517.6
LSD(0.05)		3.385	0.3387	2.988	2.083	4.136	1.316	19.48
CV(%)		15.07	10.65	16.25	18.15	14.19	14.39	2.26

TS=Total sugar; RS= Reducing sugar; NRS= Non-reducing sugar; TSS= Total soluble solid

Pest and Disease incidence in Amrapali

Statistically highly significant variation was observed in respect of stem end rot, anthracnose and fruit fly infestation between the fruit bagging with brown paper bag, white paper bag and polythene bag at 35, 45 55 days after fruit set (Table 11).

Stem end rot (%)

The maximum infection of stem end rot was recorded in control (35.60%). The fruit bagging with brown paper bag (2.16%) at 35 days after fruit set had the lowest infection of stem end rot than control and other treatment. It was followed by white paper bag (15.94%) and polythene bag (22.43%) at 35 days after fruit set (Table 11).

At 45 days after fruit set, the fruit bagging with different bags the infection of stem end rot was in brown paper bag 1.40%, in white paper bag 12.67% and in polythene bag 27.80% (Table 11).

The fruit bagging with brown paper bag (2.170%) at 55 days after fruit set had the lowest infection of stem end rot than other treatments. It was followed by white paper bag and polythene bag (13.10 and 31.60%, respectively) (Table 11).

Anthracnose (%)

The treatments exhibited statistically significant variation in respect of Anthracnose (Table 11). The maximum percent of anthracnose was observed in control (32.03%). The brown paper bag treatment at 35 days after fruit set (0.17%) showed the lowest percent of anthracnose among the

treatments and control (Table 11). The white paper bag and polythene bag treatment at 35 days after fruit set were found 3.0 and 4.86%, respectively (Table-11). For late bagging such as 45 and 55 days after fruit set, the percent of anthracnose was increased. At 55 days after fruit set, the maximum percent of anthracnose were found among other time treatments.

Fruit fly infestation (%)

The different bagging treatment used exhibited statistically significant variation in relation to fruit fly infestation (Table 11). The maximum infestation of fruit fly was recorded in control (7.45%). Fruits of brown paper bag and white paper bag treatments showed the totally free from fruit fly infestation at 35 and 45 days after fruit set while fruits of polythene bag treatment showed some infestation (Table 11).

Table 11: Data shows the result of disease severity of Amrapali

Treatments		Stem End Rot (%)	Anthracnose (%)	Fruit fly infestation (%)
Type of bag	Time of bagging			
Control (No bagging)		35.60	32.03	7.450c
Polythene Bag	35 days	22.43	4.860	2.300
	45 days	27.80	5.430	4.300
	55 days	31.60	4.540	6.000
White Paper Bag	35 days	15.94	3.000	0.000
	45 days	12.67	3.600	0.000
	55 days	13.10	3.100	4.960
Brown Paper Bag	35 days	2.160	0.170	0.000
	45 days	1.400	0.000	0.000
	55 days	2.170	0.770	3.380
LSD(0.05)		4.357	3.105	1.068
CV(%)		12.93	19.83	16.18

Sensory Evaluation of Amrapali

Colour of the peel

The treatments showed statistically significant variation in respect of peel Colour (Table 12). At 35 days after fruit set, the highest score 8.363 was obtained in the treatment of brown paper bag. It was followed by white paper bag (6.670) over control (5.33).On the other hand, the lowest score (3.00) was obtained in polythene bag than control.

At 45 days after fruit set, the highest score (8.737) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.703) over than control (5.33).On the other hand, the lowest score (3.067) was obtained in polythene bag than control.

At 55 days after fruit set, the highest score (7.670) was obtained in the treatments of brown paper bag and white paper bag over control (7.737).On the other hand, the lowest score (3.363) was obtained in polythene bag than control (Table 12).

Bagging improved the Colour of the fruits by increasing their anthocyanin content.

This result is comparable to that of Watanawan *et al*., (2008); they reported that bagging mango fruit with two-layer paper bags advanced their skin Colour development from green to yellow. Wang *et al*., (2013) and Liu *et al*., (2013) also claimed that bagging induced red Colour in green-type ('Granny Smith') and yellow-Coloured ('Golden Delicious') apples, respectively. Bagging has been used extensively in several fruit crops to improve skin Colour by increasing their anthocyanin contents and to reduce the incidence of disease, insect pests, mechanical damage, sunburn of the skin, agrochemical residues on the fruit and bird damage (Joyce *et al*., 1997; Tyas *et al*., 1998; Amarante *et al.,* 2002a and Xu *et al*., 2010).

Texture

There was no significant difference in texture among the treatments. The similar texture score i.e. around 7.670 was recorded in all the treatments (Table 12).

This result is paralled to that Hofman *et al.,* (1997); they reported that mango fruit firmness was not affected by white paper bags. Faoro and Marcia (2004) studied the effects of bagging on fruit firmness and reported that bagging did not affect fruit firmness in 'Nashi' pear.

Appearance

Statistically significant variation in appearance in mango was noticed among the treatments (Table 12). At 35 days after fruit set, the appearance score (7.670) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.00) over control (5.43). In contrast, the lowest score (3.033) was obtained in the polythene bag than control.

At 45 days after fruit set, the highest appearance score (8.363) was obtained in the treatment of brown paper bag. It was followed by white paper bag (7.703) over than control (5.43). Oppositely, the lowest score (3.33) was obtained in polythene bag than control (Table 12).

At 55 days after fruit set, the highest score (7.33) was obtained in the treatment of brown paper bag and white paper bag over control(5.33).On the other hand, the lowest score (3.00) was obtained in the polythene bag than control.

This result is at per with that of Amarante *et al.*(2002b); they reported that pre-harvest bagging improved the fruits appearance. After a fruit bagging experiment using the mango cv. Apple,

Mathooko *et al.*, (2011) reported that bagged fruit had a smoother texture and a spotless, light green skin Colour.

Sweetness

Statistically no significant variation was found in the treatments in respect of sweetness (Table 12). At 35 days after fruit set, the maximum score was obtained in control (7.67) than all the rest treatments.

At 45 days after fruit set, the maximum score (8.43) was obtained in the white paper bag while the minimum (6.00) was in the brown paper bag and the polythene bag too.

At 55 days after fruit set, the maximum score (7.703) was obtained in the white paper bag while the minimum (6.67) score was in the polythene bag.

Flavour

Statistically no significant variation was found among the treatments in respect of Flavour (Table 12). At 35 days after fruit set, the maximum score was obtained in the brown paper bag (8.00) than control (7.00) while the minimum was in the polythene bag (5.363).

At 45 days after fruit set, the maximum score (8.713) was recorded in the brown paper bag while the minimum (6.33) score was in the transparent polythene bag over control (7.00).

At 55 days after fruit set, the maximum score (7.703) was noted in the brown paper bag while the minimum (5.33) was in the transparent polythene bag.

Overall impression

There was no significant different among the treatments in respect of overall impression (Table 12). At 35 days after fruit set, the brown paper bag gave the highest result (8.33). It was followed by the white paper bag (7.363). The lowest result (3.33) was observed in the polythene bag than control (4.33).

At 45 days after fruit set, the highest result (8.637) was experienced in the brown paper bag while the white paper bag and polythene bag gave 7.637 and 5.463, respectively. Oppositely the lowest result (4.33) was observed in the control fruits.

At 55 days after fruit set, the highest result (7.67) was given by the brown paper bag while the white paper bag and the polythene bag gave 6.637 and 5.00, respectively). The lowest result (4.33) was observed in the control fruits. Bagged fruits had better overall impression than the control fruits.

Table 12 Data shows the result of Sensory evaluation of Amrapali

Treatments		Colour	Texture	Appearance	Sweetness	Flover	Overall Impression
Type of bag	Time of bagging						
Control (No bagging)		5.330	7.670	5.430	7.670	7.000	4.330
Polythene Bag	35 days	3.000	7.703	3.033	7.330	5.363	3.330
	45 days	3.067	7.620	3.330	6.933	6.330	5.463
	55 days	3.363	7.680	3.033	6.703	5.330	5.000
White Paper Bag	35 days	6.670	7.670	7.000	7.363	7.000	7.363
	45 days	7.703	7.670	7.703	8.430	7.000	7.637
	55 days	7.737	7.670	7.330	7.703	7.397	6.637
Brown Paper Bag	35 days	8.363	7.703	7.670	7.297	8.000	8.330
	45 days	8.737	7.670	8.363	6.000	8.713	8.637
	55 days	7.670	7.670	7.330	7.000	7.703	7.670
LSD(0.05)		0.3971	0.6470	0.8433	1.087	1.059	1.003
CV(%)		3.88	5.06	8.34	8.84	9.15	9.68

The comparison among the bagging mangoes after removal of the bag: The treatment T_2 was damaged due to rainfall during the experiment. The treatment T_4 is not suitable for spotted mango and retention time was low.

Figures 7: Polythene bagging

Polythene bagging **Brown paper double layered bagging**

Figures 8: The comparison of bagging mangoes of polythene and brown paper bagging

Achievement

The practice of bagging has been extensively used in several fruit crops, such as mango, apple, pear, peach, longan to improve the commercial value of the fruit improving fruit colouration, reducing mechanical damage and sunburn of the skin. Bagging also reduces pesticide use in crop fruit and improves insect, disease and bird damage control. Therefore, bagging had been an

important technical measure in improving the commercial value and promoting the export of the fruit.

This research showed that all different materials especially brown paper double layered bag and white paper single layered bag were promising application as a technique in mango fruits through improve physico-chemical properties and shelf life as compared with control (without bagging).

Bagging increased fruit weight, size over non-bagged control fruits. In this study, microenvironment created by brown paper bag and white paper bag have congenial effect on fruit growth of mango. All these treatments recorded more periods for harvesting than that of non-bagged control fruits. The fruits bagged in polythene bag were harvested earlier than those of non-bagged fruits.

Bagging could effectively improve fruit quality such as physical, chemical and microbial properties. The variation observed in chemical composition of mango fruits can be attributed to the changed microenvironment around fruit during its growth and development.

The longer shelf life of bagged fruits indicated that the effect of bagging persisted after ripening. Bagging provided physical barrier between fruit and pests and protection against both which helped in reducing occurrence of spongy tissue in fruits. So, bagging fruits was one of necessary techniques for producing high quality fruits, which had been universally adopted in some fruit production.

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13. Research highlight/findings

i) The usage of pesticides is reduced. Pest and diseases free mango is produced.

ii) Quality of bagging mangoes is almost unchanged. Retention time is low. So production is increased.

iii) Some mango growers adopt bagging technology. Mango growers are going to motivate.

B. Implementation Position

1. Procurement

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	1. Secretariate table (01) 2. Visitor chair(04)	20,000/- 10,000/-	1. Secretariate table (01) 2. Visiting chair(04)	19,990/- 10,000/-	
(b) Lab &field equipment	1. Distillation plant (01) 2. UV-VIS spectrophotometer (01)	1,00,000/- 4,30,000/-	1. Distillation plant (01) 2. UV-VIS spectrophotometer (01)	1,00,000/- 4,26,500/-	
(c) Other capital items					

2. Establishment/renovation facilities: Not applicable

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/ seminar/workshop/conference organized: Not Applicable

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	4,32,380/-	4,22,380/-	4,22,380/-	0/-	98%	17 months salary of MS student in stead of 18 months
B. Field research/lab expenses and supplies	7,26,620/-	7,26,620/-	7,26,620/-	0/-	100%	
C. Operating expenses	1,71,170/-	1,63,215/-	1,63,215/-	0/-	95%	Lack of fund
D. Vehicle hire and fuel, oil & maintenance	50,000/-	50,000/-	50,000/-	0/-	100%	
E. Training/workshop/seminar etc.						
F. Publications and printing	75,000/-					Lack of fund
G. Miscellaneous	16,986/-	13,749/-	13,749/-	0/-	81%	Lack of fund
H. Capital expenses	5,27,844	5,22,666/-	5,22,666/-	0/-	99%	Lack of fund

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	**Major technical activities performed in respect of the set objectives**	**Output(i.e. product obtained, visible, measurable)**	**Outcome(short term effect of the research)**
To control the pest	Less amount of pesticide (one	(i) Disease and pest free	(i) The use of

and diseases of mango by applying minimum pesticide.	time) was used by mango growers in the project period.	mango were produced. (ii) The percentage of infection was minimum.	pesticide was minimum
To investigate the effect of bagging materials on the fruit development, physico-chemical compositions and shelf- life extension of mango.	(i) Physical and chemical analysis was performed. (ii) Self life was observed.	(i) The colour and appearance was attractive. (ii) The physical and chemical parameters were almost unaffected. (iii) Self life was more than unbagged.	(i) The better quality of mango was produced.
To create awareness of the mango growers through motivation and encourage and increase the production of exportable mango.	(i) Group discussion was conducted with farmers on bagging technology. (ii) A meeting was arranged on bagging technology in presence of mango growers and others.	(i) Discussion with mango growers.	(i) The farmers are interested. (ii) The farmers are understood the effect of bagging and motivated.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.			
Journal publication	02		(i) Effect of bagging time on fruit quality and shelf life of mango (*Mangifera indica* L.) cv. Langra in Bangladesh. (ii) Influence of bagging time on fruit quality and shelf life of mango (*Mangifera indica* L.) cv. Amrapali in Bangladesh
Information development			
Other publications, if any			

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

ii. **Generation of new knowledge that help in developing more technology in future**

iii. Technology transferred that help increased agricultural productivity and farmers' income

iv. Policy Support

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring[description & output of consultation meeting, monitoring workshops/seminars etc.):

ii) Field Monitoring (time& No. of visit, Team visit and output):

H. Lesson Learned/Challenges (if any)

i) Heavy rainfall which damaged one of the treatments (single layered brown paper bag) that created problems for conducting the experiments.
ii) Fund release was a great problem.
iii) Due to fund crisis, procurement was not conducted as the procurement plan.

I. Challenges (if any)

Signature of the Principal Investigator
Date …….

Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal