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Effects of Bagging of the Panicles of Philippine Carabao Mango (*Mangifera indica* L.) Using Waxed Paper Bags

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Abstract

The present study was conducted in Brgy. Dangcol, Balanga City, Bataan to evaluate the effect of bagging the whole panicle (cluster) of carabao mango fruit with waxed paper bag as compared to traditional method of bagging and without bagging in terms of fruit yield and quality as well as in cost-benefit analysis. Results revealed that fruits bagged per cluster using waxed paper (T3) obtained the highest number of marketable fruits (130.60) and highest total weight of 34.21 kg while the number and weight of XL fruits with no bag (T1) were significantly higher as compared to those bagged in cluster using waxed paper (T3). Insect damage was observed in fruits bagged per cluster using waxed paper bag (T3) while there is a scab in fruit with no bag (T1). Meanwhile, there is a wind scar observed in the two bagging methods (conventional bagging method and fruits bagged per cluster using waxed paper bag). All bagging treatments were comparable in terms of physical and chemical characteristics except for peel color which is lighter green in bagged fruits. In terms of income, mango fruits bagged per cluster using waxed paper bag (T3) had the highest gross income of PhP 3,056.27 while the highest net income and ROI was recorded in fruits bagged in conventional method (T2) earning PhP 616.09 per tree with 27.23% ROI. The conventional method (T2) also obtained the lowest cost per tree (PhP 2,262.36) while the lowest cost per kilogram (PhP 73.05) and cost per fruit (PhP 19.14) was recorded in mango trees bagged per cluster using waxed paper bag (T3).

Keywords: bagging, Bataan, carabao mango, panicle bagging, conventional bagging, waxed paper bag

1. Introduction

In the report of the Department of Agriculture (2018), the Philippines, which had earned a reputation for innovation in the mango industry has now lagged behind in the world market despite the claim for having the best mango variety. The local yield of 4.1 mt/ha is way below the world average of 7.65 mt/ha and is not even half that of Thailand with almost 8.20 mt/ha. Meanwhile, out of the seven provinces in Central Luzon, Bataan is second to the last in terms of volume of production which only has 3.0 thousand metric tons (PSA, 2020). Obviously, there is a lot of work to doing order to catch up with other leading mango producers. This is an indicator that yield must sustainably increase and the quality of both fresh and processed products be improved in order to be competitive in the international markets.

In view of the current trend in mango industry, the Bataan Peninsula State University conducted a project under CHED DARE TO Project which aims to educate, train and encourage the farmers to adopt and practice the correct S&T interventions to improve the quality and quantity of the harvested fruits as well as to protect the environment and the consumer. In the study conducted by Jorge et al. in 2021, results revealed that there was an increase in yield in the adoption of the sustainable farming technology introduced in the program but the problems in the farmers fight against pests was a cause for failure to achieve the farms' maximum potential to profit.

Pest like cecid fly, fruit flies, scale insects, hoppers mealy bugs and thrips are still one of the major cause of lower

yield and quality of the mango fruits and usually addressed using chemical mixes with multiple active ingredients in varying levels. To reduce the pesticide spray, bagging of mango fruit is one of the practices that provide physical protection against pest and believed to have a long term effects in the environment and to the consumer. Evaluation of some other bagging materials and techniques need to be consider as an alternative bagging method. Hence, this study was conducted as an offshoot of observed practices from the completed studies under the CHED DARE TO Project of Bataan Peninsula State University on Innovative Mango Farming Technologies extended to participating farm across the province of Bataan. This study conducted was an experimental study on the use of two interventions namely the use of waxed brown bag as the fruit bagging material and in the method of bagging covering the whole panicle (cluster) as opposed to the traditional bagging where the bags are specifically used directly on the fruit that requires protection. Data were collected as to the effect of the material and process mentioned in the equality and quantity of the harvest within one fruiting season.

The result of the study may be used as a baseline data in crafting a modified package of technology in mango farming that would promote higher quality yield and profit. The result could also address the sustainable development goal of responsible consumption and production through utilization of technology that is environment friendly and safe for human consumption. As a matter of fact, as stated in the works of Sharma & Sanikommu (2017), fruit bagging has gained popularity in several countries as a number of studies on fruit bagging results in the reduction of disease and insect-pest incidence, mechanical damage, sunburn, fruit cracking, agrochemical residues, and damage by birds in various fruit crops.

2. Method

2.1 Experimental Area

One participating mango farm (orchard) at Brgy. Dangcol, City of Balanga, Bataan, Philippines was the study locale; which is owned and managed by one of the farm cooperators of Bataan. The fifteen (15) experimental carabao mango trees were randomly selected and considered in the experiment. The application of the bags was supervised with constant monitoring was all throughout the fruiting season to observe other possible elements/ factors that may arise and be on guard to mitigate and manage to control other variables.

2.2 Experimental Design and Treatments

The study is a single factor experiment arranged in Completely Randomized Design (CRD). The pre-determined farm is located in the Province of Bataan where three (3) sets of observable clusters of mango trees were marked. The fifteen (15) experimental trees was randomly distributed with three (3) major treatments consisted of five (5) replications per treatment with one (1) tree per replicate. The experimental treatments were as follows - T1 (control): no bagging of mango fruits, T2 (conventional bagging method): traditional fruit bagging methods in which each developing mango fruits at 35-55 days after flower induction (DAFI) will be wrapped manually using Triangular/Marsman style brown paper bag by the skilled bagger, and T3 (Waxed paper Bagging of mango fruit clusters or panicles): bagging of the mango fruit clusters or panicles during the early fruit development stage using the brown waxed paper bag sized 12”X15” #60 with 90 GSM thickness.

2.3 Data Gathered

2.3.1 Farm Profile

This include the farm location, farm size, number of mango trees, distance in between trees, age of trees, crops under the trees, agents/ chemicals applied, last date of application of agents/ chemicals, type of bag used for bagging, size of bag used, paste/ sealer used in bagging, size/age of mango fruit when bagging is implemented, date of bagging, date of harvest, method of harvest procedure/ system applied.

2.3.2 Yield Quantity

To determine the effect of bagging in terms of quantity of yield, the total number of fruits, total weight of fruits, percentage of fruit drop as well the number and weight of marketable fruits per sizes (Extra Small-160-199 g, Small- 200-249 g, Medium-250-299 g, Large-300-349 g, and Extra Large-350 g and above) were gathered in the experiment.

2.3.3 Yield Quality

To determine the effect of bagging in terms of quality of the fruit, the physical characteristics (presence of insect damage, scab and winds car, and color) and chemical properties (firmness, pH, total soluble solid, titratable acidity, and total soluble solid over titratable acidity) were determined and analyzed in the study.

2.3.4 Cost-Benefit Analysis

This is analyzed and computed by getting the production cost per tree, gross income, net income, return on investment, cost per kilogram and cost per fruit.

2.4 Statistical Analyses

All data gathered from the experiment were analyze using analysis of variance (ANOVA) for single factor experiment in Completely Randomized Design (CRD). Treatment means were compared using Least Significant Difference (LSD) at 5% level of significance. Statistical analyses were performed using a statistical package software, Statistical Tool for Agriculture Research (STAR).

3. Results and Discussion

3.1 Farm Profile

The experimental farm is located at Brgy. Dangcol, City of Balanga, Bataan, an upland area with a total farm size of 4.0 hectares. Out of the 200 total number of mango trees in the farm, fifteen (15) participating trees were randomly selected for the experiment with 10 x 10 m planting distance in between trees with age ranging from 20 to 25 years old. There is no crops planted in between trees (no intercrop) .

The prime objective of the study is to observe the difference in the fruit quality and yield of mango from non-bagging of fruit to the use of conventional brown paper bag and the experimental waxed paper bag. The bag specifications and significant dates were as follow:

Table 1. Bag specification and significant dates during the conduct of the experiment

Method of Bagging	Type of Bag	Size	Paste/ sealer used	Age of Mango Fruit When Bagging was implemented	Date of Bagging	Date of Harvest	Method of harvest procedure/ system applied
Conventional bagging method	Triangular/ Marsman style brown paper bag	15 cm x 20 cm	Stapler wire	48-52 DAFI	March 6-7, 2022	May 5, 2022	Manual Harvesting
Experimental Bagging covering the whole panicles (cluster)	brown paper bag	12”X15” (20 cm x 30 cm) #60 with 90 GSM thickness	Stapler wire	48-52 DAFI	March 6-7, 2022	May 5, 2022	Manual Harvesting

3.2 Effects of Fruit Bagging

To determine the effects of the fruit bags used in the experiment, the harvests were collected. Each of the mango fruit harvested were sorted and classified according to size and quality.

In terms of the effect of bagging on the quantity of yield, it can be observed in Table 2 that there was no significant difference among bagging treatments in terms of total number of harvested marketable fruits, total weight and in percentage of fruit drops. However, although statistically not significant, we can note that the highest number of marketable fruits was recorded in fruits bagged per panicle (cluster) using waxed paper (T3) with 130.60 fruits followed by fruits individually bagged which is the conventional bagging method (T2) with 112.40 fruits while the lowest number of fruits was observed in fruits with no bag with only 90.40 fruits. In terms of total weight, it is also the fruits bagged per cluster using waxed paper (T3) which obtained the highest weight of 34.21 kg followed by fruits individually bagged which is the conventional bagging method (T2) with 30.91 kg while the lowest yield was observed in fruits with no bag with only 26.52 kg.

Table 2. Number of marketable fruit harvested, total weight of marketable fruit harvested and percentage of fruit drop

Bagging Methods	Total Number of Marketable Fruit Harvested	Total Weight of Marketable Fruit Harvested	Percentage of Fruit Drops
T1- No bagging	90.40[a]	26.52[a]	30[a]
T2.Conventional bagging method	112.40[a]	30.91[a]	30[a]
T3-Bagging of fruits per panicle (cluster) using waxed paper bagging method	130.60[a]	34.21[a]	30[a]

Means with the same letter within the same column are not significantly different at 5% level of significance

For the percentage of fruit drop, all the bagging treatments have 30% fruit drop which is inflicted by harsh weather condition and series of tropical depression, tropical storm and very strong typhoon during the duration of the conduct of the study which also resulted to dropping of bagged fruits, removal of covered bags and much lower yield.

Table 3. Total number and weight of mango fruits according to size

Bagging Methods	Total Fruits per Size					Total Weight (in kg) per Size				
	XL	L	M	S	XS	XL	L	M	S	XS
T1- No bagging	24.60[a]	24.60[a]	24.60[a]	9.60[a]	7.00[a]	8.78[a]	7.94[a]	6.52[a]	2.06[a]	1.22[a]
T2. Conventional bagging method	18.80[ab]	24.00[a]	39.60[a]	17.80[a]	12.20[a]	6.71[ab]	7.75[a]	10.50[a]	3.83[a]	2.12[a]
T3-Bagging of fruits per panicle (cluster) using waxed paper bagging method	14.60[b]	26.80[a]	40.40[a]	27.60[a]	21.20[a]	5.21[b]	8.66[a]	10.71[a]	5.94[a]	3.69[a]

Means with the same letter within the same column are not significantly different at 5% level of significance

Harvested fruits per treatment were also sorted and classified according to size and weight. As presented in Table 3, in terms of total number of fruit classified as extra large (XL), the fruits with no bag (T1) significantly had the highest number of fruits (24.60) as compared to trees with waxed paper bagged in cluster (T3) with 14.60 fruits. This result implies that the fruits are much bigger when there is no bagging material use as fruit covering or protection.On the other hand, the number of XL fruits of trees bagged in conventional method was comparable with the number of XL fruits of trees with waxed paper and without bag. Meanwhile in terms total number of fruits in sizes large (L), medium (M), small (S), and extra small (XS), it can be noted that there were no significant differences observed among the three bagging methods, although we can observe that the highest number of fruits produced in sizes large to extra small was recorded in trees bagged in cluster using waxed paper bag (T3).

Presented also in Table 3 is the total weight of harvested marketable fruits in various sizes. There is a significant difference among bagging treatments in terms of total weight of fruits classified as extra large (XL) wherein the fruits with no bag (T1) significantly had the heaviest weight of XL fruits having 8.78 kg as compared to trees with waxed paper bagged in cluster (T3) with only 5.21 kg of fruits. Meanwhile in sizes large (L), medium (M), small (S), and extra small (XS), the highest weight was all recorded in trees bagged in cluster using waxed paper bag (T3), although statistically all the bagging treatments were just comparable with each other.

Bagging Methods	Insect Damage	Scab	Wind Scar	Color	Firmness (Kg-F)	pH	Total Soluble Solid (TSS) % Brix	Titratable Acidity (TA), %	TSS/TA
T1- No bagging	0.00[a]	0.20[a]	0.00[a]	Darker green	1.19[a]	4.36[a]	18.24[a]	0.39[a]	47.18[a]
T2- Conventional bagging method	0.00[a]	0.00[a]	0.20[a]	Light green/Pale green	0.83[a]	4.38[a]	17.28[a]	0.44[a]	42.02[a]
T3-Bagging of fruits per panicle (cluster) using waxed paper bagging method	0.20[a]	0.00[a]	0.20[a]	Green	1.32[a]	4.28[a]	18.00[a]	0.42[a]	44.50[a]

Scale used for Insect damage, scab, and wind scar: 0=absent; 1=present

Means with the same letter within the same column are not significantly different at 5% level of significance

In terms of the effect of bagging on the presence of disease, scar and physical damage, the harvested fruits were examined carefully to check the presence or absence of damage. As presented in Table 4, there is an insect damage in the collected sample harvest in fruits bagged per cluster using waxed paper bag (T3) with 0.20 while there is no observed insect damage in fruits with no bag (T1) and in the conventional bagging method (T2). On the other hand, there was a presence of scab in collected fruits with no bag (T1) while there is none observed in the two bagging methods (conventional bagging method and fruits bagged per cluster using waxed paper bag). Similar result on scab was reported on the study of Buganic et al. (1997) wherein the rejection in unbagged fruits was due to scab. Meanwhile there is a presence of wind scar observed in the two bagging methods (conventional bagging method and fruits bagged per cluster using waxed paper bag) while no wind scar was detected in fruits with no bag.

Color, firmness and chemical parameters such as pH, total soluble solid, percentage of titratable acidity and TSS/TA were determined using the sample harvest and was submitted in the regional laboratory for analysis. As observed in the Table 4, in terms of color, the fruits bagged in the conventional bagging method (T2) had much lighter green color and has a much appealing visual appearance as compared to the fruits with no bag which has a darker green color. Similar result was reported in the study of Wu et al. (2013) that bagged fruits has higher peel lightness due to reduced content of chlorophyll. This result also supports the study of Muhammad et al. (2021) which revealed that bagging resulted to improved fruiting color as also mention in the result of the study of Xu et al. (2010) which revealed that fruit weight decreased but the fruit appearance improved with bagging. The color of fruit bagged in conventional method also had much lighter green color as compared to the fruits bagged in waxed paper bag. On the other hand, for the rest of the other chemical parameters, all the bagging methods (T1, T2, T3) were comparable with each other. This result support the study of Hofman et al. (1997) which revealed that TSS and TA were not generally affected by bagging. Similar study on bagging were conducted by Allran et al. (2019), Islam et al. (2019), and Campbell et al. (2021) which all revealed no significant difference between the bagged and control fruit (no bag) in terms of Brix degree (TSS).

However, although statistically insignificant, it can be observed that fruits bagged per cluster using waxed paper bag (T3) have much firmer fruits (1.32 Kg-F) while fruits bagged in conventional method had higher pH of 4.38, and highest titratable acidity of 0.44%. Meanwhile, the fruits having no bag obtained the highest TSS of 18.24, as well as the highest TSS/TA of 47.18.

3.3 Cost- Benefit Analysis Per Tree

Particulars	No Bagging (T1)	Conventional Bagging (T2)	Bagging of Fruit Per Panicle (Cluster) using waxed paper bag (T3)
l. Cost of Agricultural Supplies			
Bagging materials	-	100.00	320.00
Fertilizers	100.00	100.00	100.00
Pesticides	933.60	549.16	549.16
Flower Inducer	36.00	36.00	36.00
Growth Regulators	300.00	300.00	300.00
Litter materials	100.00	100.00	100.00
Kaing	40.00	60.00	60.00
Manila Paper	7.76	130.00	130.00
Gasoline and Oil	70.00	70.00	70.00
Sub-Total	1,587.36	1,445.16	1,665.16
ll. Labor Cost			
Pruning	126.00	126.00	126.00
Bagging	-	223.20	240.00
Fertilizing	18.00	18.00	18.00
Flower Induction	54.00	54.00	54.00
Spraying	432.00	270.00	270.00
Harvesting	126.00	126.00	126.00
Sub-Total	756.00	817.20	834.00
Total	2,343.36	2,262.36	2,499.16
Gross Income (in PhP)	2,056.94[a]	2,878.45[a]	3,056.27[a]
Net Income (in PhP)	(-286.42)[a]	616.09[a]	557.11[a]
ROI (%)	-12.22[a]	27.23[a]	22.29[a]
Cost per tree (in PhP)	2343.36[a]	2262.36[a]	2499.16[a]
Cost per kg (in PhP)	88.36[a]	73.19[a]	73.05[a]
Cost per fruit (in PhP)	25.92[a]	20.13[a]	19.14[a]

Means with the same letter within the same column are not significantly different at 5% level of significance

1$ = 55.63 PhP

The gross and net income as well as the return on investment were also gathered in the unbagged treatment and in the two bagging methods. Statistically, there were no significant difference observed among treatments in these parameters. Based on the gathered data, in terms gross income, it can be noted that mango fruits bagged per panicle (cluster) using waxed paper bag (T3) had the highest gross income of PhP 3,056.27 followed by fruits bagged in conventional method (T2) with PhP 2,878.45 income while the lowest income was recorded in trees with no bag having PhP 2,056.94 gross income. Meanwhile, in terms of net income, the highest income was recorded in fruits bagged in conventional method (T2) earning PhP 616.09 per tree followed by fruits bagged per cluster using waxed paper bag (T3) PhP 557.11 while the lowest net income was recorded in trees with no bag having a negative income (loss) of PhP 286.42. The loss recorded in fruits with no bag is primarily due to higher cost of production with eight sprays of pesticide but lowest in yield among treatments. On the other hand, in terms of return on investment (ROI), the highest ROI was recorded in conventional bagging method (T2) of 27.23% followed by mango fruits bagged per cluster using waxed paper bag (T3) with 22.29% ROI while a negative ROI was observed in trees with no bag (T1) with -12.22%.

Based on gathered data, in terms of cost per tree, it can be observed that mango fruits bagged in conventional method (T2) had the lowest cost (PhP 2,162.36) of production per tree while fruits bagged per cluster using waxed paper bag (T3) had the highest cost of production of PhP 2,499.16 which is primarily attributed to the added cost

in price of the waxed paper bag and the labor of bagging the panicles/clusters. As stated in the works of Orden et al. (2005), the use of bagging and pruning entails more cost however, it has the potential to have a long term effects in the environment and to the consuming public as less chemical sprays me be lessen as fruit bag provide physical protection against insects and pests.

Meanwhile, in terms of cost per kilogram of produce, the lowest cost was recorded in mango trees bagged per cluster using waxed paper bag (T3) with PhP 73.05 while the highest cost was recorded in mango trees with no bag having PhP 88.36 as cost per kilogram. Lastly, in terms of cost per fruit, the lowest cost was also observed in mango trees bagged per cluster using waxed paper bag (T3) with PhP 19.14 while the highest cost per fruit was recorded in mango trees with no bag (T1) having PhP 25.92. However, statistically, all treatments were comparable with each other in terms of the mentioned cost parameters.

4. Conclusion and Recommendations

Based on the results of the study, it can be concluded the trees with no bag significantly produced more extra large size of mango fruits as compared with trees with bag because there is no physical barrier that hinder is growth as reflected in the result of the study. On the other hand, the physical and chemical quality of the mango fruit were not significantly affected by bagging except for the color which is much appealing and lighter in conventional bagging method of individual bagging of fruits.

The conventional bagging method revealed to be the most cost efficient among the treatments for having the highest net income, ROI, and lowest cost per tree while bagging the whole panicle (cluster) of fruit using waxed paper bag has a promising effect in the quality and quantity of the produce. Although statistically insignificant with the other treatments, it can be noted the highest number and highest weight of marketable fruits was observed in this bagging method. In addition, it also obtained the highest gross income, lowest cost per kilogram and lowest cost per fruit.

Based on the research results and conclusions, it can be stated that to produce much larger fruits, it is not recommended to bag the mango fruit while the conventional bagging method is recommended for much improved color and appearance, highest net income, ROI, and lowest cost per tree. Further study and improvement on bagging the whole panicle (cluster) using waxed paper bag is also recommended for validation of its effect on fruit quality and quantity. Although initial data revealed that it has the highest yield but the expenses incurred in this method also increased due to additional bagging material which is much larger and much expensive, thus, added to the cost of production. On the other hand, further study and establishment in another farm setting, season and different kinds of paper bags is also recommended.

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