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EFFECT OF FRUIT BAGGING ON THE CONTROL OF MANGO FRUIT FLY (CV. AMRAPALI)

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Abstract: An investigation was undertaken in two consecutive fruiting seasons during 2012 and 2013 at the Germplasm Centre of Bangladesh Agricultural University, Mymensingh. The fruits were bagged with five types of bags which constituted the various treatments viz: T_0 : Control (no bagging),T_1 : Perforated white polythene bag, T_2 : Perforated black polythene bag, T_3 : Perforated brown paper bag and T_4 : Perforated white paper bag. Bagging of fruits was performed approximately one month before harvest. The experiment was conducted in a Randomised Complete Block Design with three replications. Bagging with perforated white polythene bag improved fruit retention, fruit weight, fruit length, fruit breadth and TSS at ripe stage. Results of the experiments in relation to management practices revealed that bagging of fruits with perforated white polybag checked fruit fly infestation fully and produced almost 100 percent non-infested fruits per plant. The results also indicated that the pre-harvest proper management practices for fruit fly control, especially fruit bagging with perforated white polybag, may be useful in extending the shelf life and minimizing losses of mango, and producing better quality and safe fruits for the consumers assuring higher returns to the growers.

Key words: Mango, fruit bagging, fruit fly control

Introduction

Fruit fly is a major pest of several fruits and vegetables throughout the tropical and subtropical worlds. Nearly 35 percent of the known fruit fly species attack soft fruits such as mango, guava, citrus, ber, peach and several cucurbitaceous vegetables. The fruits are attacked by this pest during May-July and the level of injury varies from variety to variety. Singh (1991) reported 4-10% damage in "Dashehari" and 56.9% in "Mallika" followed by 18.7% in "Langra". Sarker and Rahman (1993) reported 37.5% infestation in mango due to fruit fly. Most of the Bangladeshi farmers do not follow the modern practices of mango cultivation. They are not aware of the harmful effects of these pests and do not take proper control measures against them. However, present management strategies of farmers mostly focus on chemical insecticides. Indiscriminate and improper use of pesticides create major

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problems such as development of pest resistance to pesticide, outbreak of secondary pests, destruction of beneficial organisms, hazards to the human health and pollution of the environment. As fruit is consumed by the people directly after harvest, toxic residues on the harvested fruits may cause illness to the consumers. Residual toxicity has been reported to cause cancer to the human health (Troetschler 1983; Hoy and Dahlsten 1984; Marty *et al*., 1994. To overcome the above problems of pesticide use, it is imperative to identify some methods or approaches which are environmentally safe and sound for fruit fly management. Among several good agricultural practices (GAPs), preharvest fruit bagging has become popular in several countries of the world. It is a physical protection technique, which improves fruit appearance by promoting fruit colouration and reducing blemishes. It brings multiple effects to internal fruit quality. Fruit bagging reduces disease and insect-pest incidence, mechanical damage, sunburn, fruit cracking, agrochemical residues, and damage by birds. Preharvest fruit bagging has also emerged as a novel technology in practice, which is simple, grower friendly, safe and beneficial for production of quality fruits. In this bagging technique, individual fruit or fruit bunches are bagged on the tree for a specific period. Bagging has been used extensively in several fruit crops to improve skin colour 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.*, 2002; Xu *et al.*, 2010). Continuous researches in the development of efficient bagging systems afford several new opportunities in the efforts to control the fruit flies. This bagging technique has high specificity, low cost and is environmentally quite safe (White and Elson-Harris, 1992; Suresh Babu and Viraktamath, 2003). With the foregoing discussion, the present research was undertaken to find out suitable bagging technique to protect the mango from fruit fly.

Materials and Methods

The experiment was carried out to identify suitable bagging materials for controlling fruit fly to obtain higher yield and quality of mango. The above experiment was first conducted in 2012, and then repeated in 2013 for ensuring the reproducibility of the results for technology recommendation. The single-factor experiment for both the growing seasons was laid out in a randomized complete block design (RCBD) with 3 replications. Each replication consisted of approximately 8-10 years old single plant. Therefore, the total number of plants required for conducing the experiment was 30 (2×5×3). Statistical analysis was performed using computer package MS Stat C. Statistical devices such as percentage, mean, standard deviation, standard error of mean, regression & correlation and analysis of variance (ANOVA) were used for describing the variables. The significant differences among the treatment means were identified by Least Significance Difference (LSD) test (Gomez and Gomez, 1984). For the percentage data, statistical analysis was performed on the arc-sine transformed data. In case of repeated experiments, pooled analysis was performed. From each plant, randomly-selected 15

fruits were used for assessment. The experiment consisted of 5 treatments, namely T_0 : Control (no bagging), T_1 : Perforated white polythene bag, T_2 : Perforated black polythene bag, T_3 : Perforated brown paper bag, T_4 : Perforated white paper bag. The bags were of 20 cm × 15 cm size. Prior to bagging, perforations were made with the help of a punching machine. Each bag was 10-15 perforations for aeration. Then the fruits were individually-bagged approximately one month before harvest. The parameters studied were individual fruit weight (weighing balance), fruit size including length, breadth (slide calipers), number of non-infested fruits per plant, number of infested fruits per plant, percent of non-infested fruit per plant, percent of infested fruit per plant, cost-benefit analysis, total soluble solids (Refracto meter).

Results and Discussion

Keeping in view the human health and environmental hazards resulted from the indiscriminate use of synthetic pesticides, it was thought to be important to control mango fruit fly through non-chemical means. To achieve this goal, covering fruits before ripening with different types of bagging materials, was examined. The results are presented and discussed in the following heads:

Physico-chemical properties as influenced by fruit bagging

Fruit bagging treatment caused highly significant effects on fruit weight, fruit size and TSS (Table 1). In the case of using different bagging materials, the highest individual fruit weight, fruit length and breadth were noticed in fruit bagging with perforated white polythene bag treatment followed by the perforated brown paper bag (Table 1). The result could be attributed to the effective control of fruit fly and the consequent proper growth and development of fruits. Similar findings were reported by Watanawan *et al.* (2008), Yang *et al.* (2009), Harhash and Al-Obeed (2010), Chonhenchob *et al.* (2011), and Zhou *et al.* (2012). They reported positive effects of pre-harvest fruit bagging on fruit growth, size, and weight. In terms of chemical parameter, the highest TSS content (24.17 %Brix) was recorded in control followed by the perforated brown paper bag(23.37 %Brix) and perforated white polybag (23.18 % Brix), whereas perforated white paper bag and perforated black polythene bag resulted in lower TSS contents, and the latter lower TSS in bagging, and these findings were partially supported by the reports of Rahman *et al.* (2001) and Rahman (2005). They reported that un-bagged condition as well as white transparent polybag captured more sunlight and therefore, TSS was recorded higher in this treatment, while other bagging materials (black polythene bag and white paper bag) created some barriers to sunlight and resulted in lower TSS content. Growing seasons caused significant influence on fruit weight and fruit breadth and TSS but not fruit length. These significant variation may be due to the variation of atmospheric conditions during 2012 and 2013.

Table 1. Effect of growing years and different management practices on physico-chemical properties of mango

Years and Treatments	Fruit characteristics			TSS (% Brix)
	Individual fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	
Year-1 (2012)	179.91	8.55	5.55	23.29
Year-2 (2013)	182.36	8.53	5.72	23.15
LSD 0.05	1.62	0.42	0.19	0.18
LSD 0.01	2.22	0.57	0.27	0.25
Level of significance	**	NS	**	*
T_0	164.71	8.35	5.36	24.17
T_1	189.19	8.71	5.81	23.18
T_2	185.19	8.56	5.60	22.38
T_3	186.69	8.59	5.75	23.37
T_4	179.89	8.47	5.67	22.98
LSD 0.05	2.19	0.13	0.09	0.19
Level of significance	**	**	**	**

**:Significant at 1% level; NS: Non-significant

T_0: Control; T_1: Perforated white polythene bag; T_2: Perforated black polythene bag; T_3: Perforated brown paper bag; T_4: Perforated white paper bag

Level of fruit infestation as influenced by fruit bagging

Number of non-infested fruits per plant: Effect of growing years on number of non-infested fruits per plant was recorded significant (Table 3). Higher number of non-infested fruits per plant (12.64) was obtained from the Year-2 than that of the Year-1 (12.47) . Similarly, different management practices also significantly influenced the number of non-infested fruits per plant. Maximum of non-infested fruits per plant were observed in the treatment of fruit bagging with perforated white polybag (15.00) followed by perforated brown paper bag (13.22), whereas minimum number (8.95) of non-infested fruits was obtained from the control fruit (Table 2).

Number of fruit fly-infested fruits per plant: Effect of growing years on the number of fruit fly-infested fruits per plant was not significant, whereas, the different management practices caused significant effects on the number of fruit fly-infested fruits per plant (Table 2). The highest number of fruit fly-infested fruits was recorded in the control fruit(5.61). Whereas, the fruits under bagging treatment with perforated white polybag had no infestation at all.

Number of other insect-infested fruits per plant: Effect of growing years on the number of other insect-infested fruits per plant was noticed non-significant but, different management practices caused significant effects on the number of other insect-infested fruits per plant (Table 3). The highest number of other insect-infested fruits was recorded in the treatment of

perforated black polythene bag(1.89). The fruits under bagging treatment with perforated white polythene bag, T_1 had no infestation at all.

Per cent of non-infested fruits per plant: Effect of growing years on percentage of non-infested fruits per plant was recorded significant (Table 2). The highest percentage of non-infested fruits per plant (84.29) was obtained from Year-2 than that of Year-1 (83.11). Similarly, different management practices also significantly influenced percentage of non-infested fruits per plant. The highest percentage of non-infested fruits per plant was observed in the treatment of fruit bagging with perforated white polybag (100) followed by perforated brown paper bag(88.15), whereas the lowest percentage (59.63) was obtained from the control fruit (Table 2).

Per cent of fruit fly-infested fruits per plant: Effect of growing years on the percentage of fruit fly-infested fruits per plant was non-significant but different management practices had significant effects on the percentage of fruit fly-infested fruits per plant. Higher percentage of fruit fly-infested fruits was recorded in the control fruit(37.41). The fruits under bagging treatment with perforated white polybag had no infestation at all (Table 2).

Per cent other insect-infested fruits per plant: Effect of growing years on the number of other insect-infested fruits per plant was non-significant (Table 2). Different management practices exhibited significant effects on the percentage of other insect-infested fruits per plant. The highest percentage of other insect-infested fruits was recorded in the treatment black polythene bag (12.59). The fruits under bagging with white polythene baghad no infestation at all (Table 2).

Different types of fruit bagging exerted significant influence on the levels of fruit fly infestation in mango. The highest percentage of non-infested fruits was found in the treatment, perforated white polybag followed by perforated brown paper bag and the lowest percentage of non-infested fruits was found in control (no bagging). The fruit fly attacks mango before ripening when sweetness starts in its pulp. Bagging of fruits with white polybag effectively checked the infestation of fruit fly thus resulted in 100% non-infested fruits. Similar results were also published by several authors (Buganic *et al.*, 1997; Hofman *et al.,* 1997; Rahman 2005; Sarker *et al.,* 2009 and Islam 2012). They observed that pre-harvest mango bagging reduced the incidence of fruit fly by almost 100%. Black polybag and brown paper bag although checked fruit fly infestation fully but black polybag became the habitat of some other insects like black cockroach, ant, etc. due to dark environment inside the bag which ultimately made some fruits unfit for consumption and caused lower numbers of non-infested fruits per plant from this treatment (Rahman 2005). On the other hand, brown paper bags and white paper bags were destroyed by rain water and infestation was higher. These findings were partially similar to that of Abbasi *et al.* (2014) who reported that the newspaper bags were cheap but less durable as compared to the perforated polyethylene bags. In case of newspaper bags, repeated bagging was done (increasing material as well as labour cost) whenever torn off by rains and winds, so costs were higher.

Table 2. Effect of growing years and different management practices on the levels of fruit fly infestation of mango

Years and Treatments	No. of non-infested fruits plant^{-1}	No. of fruit fly infested fruits plant^{-1}	No. of other insect infested fruits plant^{-1}	% Non-fruit fly infested fruits	% Fruit fly infested fruits	% Other insect infested fruits
Year-1 (2012)	12.47	1.64	0.89	83.11	10.96	5.92
Year-2 (2013)	12.64	1.62	0.76	84.29	10.81	5.04
LSD 0.01	0.20	1.80	1.67	1.38	0.13	0.09
LSD 0.05	0.15	1.31	1.22	1.00	0.09	0.07
Level of significance	*	NS	NS	*	NS	NS
T_0	8.95	5.61	0.44	59.63	37.41	2.96
T_1	15.00	0.00	0.00	100.00	0.00	0.00
T_2	12.89	0.22	1.89	85.93	1.48	12.59
T_3	13.22	0.39	1.39	88.15	2.59	9.26
T_4	12.72	1.94	0.39	84.81	12.96	2.59
LSD 0.05	0.31	0.22	0.30	1.67	1.66	1.42
LSD 0.01	0.42	0.31	0.42	2.30	2.29	1.96
Level of significance	**	**	**	**	**	**

**: Significant at 1% level, * : Significant at 5% level; NS: Non-significant

T_0: Control; T_1: Perforated white polythene bag; T_2: Perforated black polythene bag; T_3: Perforated brown paper bag; T_4: Perforated white paper bag.

Economic analysis

The total cost of production of mango as influenced by different fruit fly management practices were calculated considering the costs incurred for manures and fertilizers; pesticides; and labourers required for weeding, spading, sanitation, application of fertilizers, irrigation water and pesticide, and for harvesting. In the 1st Year (2012), the highest net return (Tk.1217167 ha^{-1}) was obtained from the treatment of fruit bagging with perforated white poly bag with a BCR of 9.99, whereas the lowest net return (Tk. 331597 ha^{-1}) and BCR (5.12) were obtained from the control treatment (Table 3). In the 2nd Year (2013) higher net returns of Tk. 1091175 was found from the treatment perforated white polybag . On the other hand, the lowest net return of Tk. 295125 was obtained from control in the same year as mentioned above (Table 4). From the economic analysis, it was observed that the treatment with perforated white polythene bag gave the highest net return (Tk. 1217167 and 1091175 ha^{-1}) than those of control in the years 2012 and 2013, respectively. Perforated polyethylene bagging provided maximum protection of fruits from severe attack of mango fruit fly and resulted in producing more fruits having better quality and as compared to other treatments. The above treatment also had maximum benefit cost ratio (BCR) of 9.99 and 9.18, which were in agreement with the findings of Abbasi *et al.* (2014) who reported BCR of 21.02 in the polyethylene-bagged guava fruits.

Table 3. Economic analysis of mango production as influenced by different bagging materials in 2012

Treatments	Yield of non-infested fruits(t/ha)	Gross return (Tk.)	Total cost of production (Tk.)	Net return (Tk.)	Benefit Cost Ratio (BCR)
T_0	4.24	412000	80403	331597	5.12
T_1	27.05	1352500	135333	1217167	9.99
T_2	23.17	1158500	163953	994547	7.06
T_3	23.35	1167500	181593	985907	6.42
T_4	22.50	1125000	184750	940250	6.08

Table 4. Economic analysis of mango production as influenced by different bagging materials in 2013

Treatments	Yield of non-infested fruits (t/ha)	Gross return (Tk.)	Total cost of production (Tk.)	Net return (Tk.)	Benefit Cost Ratio (BCR)
T_0	7.51	375500	80375	295125	4.67
T_1	24.49	1224500	133325	1091175	9.18
T_2	19.53	976500	155890	820610	6.26
T_3	18.35	917500	175420	742080	5.23
T_4	17.91	895500	172550	722950	5.18

T_0: Control; T_1: Perforated white polythene bag; T_2: Perforated black polythene bag; T_3: Perforated brown paper bag; T_4: Perforated white paper bag

BCR: Gross return/Total cost of production

Note: Price of mango was consider to be Tk. 50kg^{-1}. Age of plant 8-10 years, Spacing 4 m × 4 m.

Conclusion

It was found that pre-harvest bagging of fruit could be a simple and grower-friendly technology, which is safe to use and possesses several beneficial effects on the physical appearance and quality of fruit. Furthermore, it is the safest approach to protect fruit from insect pests, diseases and other disorders. This approach is an integral part of fruit production in many parts of the world including Bangladesh. The study concluded that perforated white polyethylene bagging technique on trees gives maximum protection to fruit from the heavy attack of fruit fly during summer leading to better quality of mango fruits with maximum benefit cost ratio. Even though brown paper and white paper bags were somewhat effective but were of lesser durability as compared to those of perforated polyethylene bags. The overall costs of the bagging treatments were found affordable and the benefits were greater as the poor quality fruits of the untreated control would not get customer's attention.

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