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Studies on influence of preharvest bagging of fruits on quality of mango cv. Ratna

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ABSTRACT

An investigation was undertaken to study the effect of different types of bag for pre-harvest bagging on physico-chemical properties of mango cv. Ratna during 2014-2016. The experiment was conducted in randomized block design with three replications. The fruits were bagged at marble stage (45 days from fruit set) with different types of bag, which constituted the various treatments, *viz*., T_1 = News paper bag; T_2 = Brown paper bag; T_3 = Scurting bag; T_4 = Transparent PP bag; T_5 = Butter paper bag; T_6 = Muslin cloth bag; T_7 = Brown paper bag with polythene coating; T_8 = Black polythene bag; T_9 = Opaque white polythene bag and T_{10} = control (no bag). Bagging with newspaper bag, scruting bag and muslin cloth bag improved fruit retention, fruit and pulp weight, fruit diameter, total and reducing sugars, ascorbic acid and shelf-life of fruits. Pre-harvest bagging with different types of bag did not change the sensory qualities of ripe fruits. The per cent spotted fruits; incidence of diseases and pests was significantly reduced by pre-harvest bagging. The newspaper bag, scurting bag and muslin cloth bag were found to be meritorious among the various bags tried.

Key words: Mango, pre-harvest bagging, physico-chemical composition, pests and diseases.

INTRODUCTION

Mango (*Mangifera indica* L.) is the 'National Fruit' of India. The Konkan region of Maharashtra is one of the major mango growing belts in India. In Konkan, 1.82 lakh ha area is under mango cultivation with annual production of 1.28 lakh MT (Anon, 3). Among the various mango varieties in the region, Ratna (Neelum × Alphonso) is a prominent hybrid under cultivation. It is a regular bearer, semi-dwarf and high yielding variety. The fruits are large (320 g) with firm and fibreless deep orange coloured pulp. The demand for this variety is increasing day by day due to its good keeping quality. It is free from spongy tissue, which is a prominent physiological disorder in Alphonso. In recent years, the climatic aberrations such as sudden rise in the temperature and humidity, abnormal rains especially during fruit development are often experienced in Konkan region. Such adverse climate not only affects the external appearance of the fruit but also aggravate the pests incidence such as mealy bug. Bagging provides physical barrier over fruit, which prevents mechanical damage and bruises to fruit. It also protects the fruit from pests and diseases and also helps for ideal fruit development (Sharma *et al*., 14). Pre-harvest bagging of fruits is done to prevent damage occurring due to bruises, wounds, scars and to produce cleaner fruit peel with attractive colour (Bayogan *et al*., 4). Several types of locally available materials can be used for bagging. Though pre-harvest bagging possess prospects in mango it was seldom attempted and standardized. Hence, an experiment was undertaken to study the influence of pre-harvest bagging of fruits at egg stage on mango cv. Ratna.

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MATERIALS AND METHODS

The trial was conducted at Department of Horticulture, College of Agriculture, Dr BSKKV, Dapoli, Maharashtra during 2014-2015 and 2015-2016 on mango cv. Ratna. The soil of experimental plot was red lateritic with uniform depth and good drainage conditions. Uniformly grown 20-year-old grafted Ratna mango trees were selected. The experiment was conducted in randomized block design with ten treatments replicated three times with a unit of 25 fruits per treatment per replication. Different types of bags constituted the treatments, *viz*. T_1 = News paper bag; T_2 = Brown paper bag; T_3 = Scurting bag; T_4 = Transparent PP bag; T_5 = Butter paper bag; T_6 = Muslin cloth bag; T_7 = Brown paper bag with polythene coating; T_8 = Black polythene bag; T_9 = Opaque white polythene bag and T_{10} = control (no bag). Uniformly grown fruits at egg stage (45 days after fruit set) were selected for bagging. The size of bags was 25 cm × 20 cm. Before bagging six perforations (≤ 4 mm dia.) were made for proper ventilation at the

bottom of all bags except for scurting and muslin cloth bags. The bags were stapled properly at the stalk of each fruit of respective treatments so that it would not fall down and there would not be any open space. The scurting and muslin cloth bags were tied with the help of thread to the fruit stalk. The observations, *viz.* fruit retention (%) and days required for harvesting after bagging were recorded. Five fruits were randomly selected per treatment per replication and observations on fruit length (cm), fruit diameter (cm), fruit weight (g), pulp weight (g), TSS (°Brix), acidity (%), reducing sugars (%), total sugars (%), ascorbic acid (mg/100 g of fruit pulp), β-carotene (µg/100 g of pulp) and shelf-life of fruits (days) were recorded. The length and diameter of the fruit were measured with the help of digital Vernier calipers. Total soiluble solids (°Brix) of the fruits were estimated using standard procedure (AOAC, 1). Titrable acidity was estimated by titrating known amount of pulp against 0.1 N NaOH using phenolphthalein as indicator (Ranganna, 12). Reducing sugar and total sugars were determined by method suggested by Lane and Eynon (9) as described by Ranganna (12). Ascorbic acid content of fruit was estimated using standardized 2,6-dichlorophenol indophenol dye. The total carotenoids of the pulp were calculated as per method suggested by Ranganna (12). The end of shelf-life was noted when the fruits were spoiled. The statistical analysis was performed as per the ANOVA suggested by Panse and Sukhatme (11) and standard deviation was computed as per the procedure advocated by Rangaswamy (13).

RESULTS AND DISCUSSION

The highest fruit retention was found in the treatment T_1 (89.33%), which was at par with T_3 (86.33%) (Table 1). It was followed by T_2 (82.4%) and T_6 (81.67%). The minimum fruit retention in mango was observed in T_4 (68.67%). The results indicated that newspaper, scurting, brown paper and muslin cloth bags were superior to unbagged control and other treatments. The average number of days required for harvesting of fruit after bagging was 53.42 days. Earliest harvesting was recorded in T_{10} (52 days), T_4 (52.17 days) and T_8 (52.33 days), which were significantly superior over rest of the treatments. Late harvest was noticed in T_1 (55.00 days) and T_3 (54.50 days). The fruits in butter paper bag, brown paper bag with polythene coating and opaque white polythene bag took similar days for harvesting, whereas, fruits in polythene and black polythene bags were harvested earlier. The abiotic factors, *viz.* temperature and humidity play critical role in fruit growth and development. Bagging on fruits alters the microenvironment (Sharma *et al*., 14). The favourable microclimate surrounding the fruit leads to more fruit retention. The less retention in T_4 (68.67%) and T_9 (72.67%) might be due to development of high temperature inside the bag as in both these treatments, the base material used was polythene. The delay in maturity due to fruit bagging was also reported earlier in tomato (Leite *et al*., 10).

Table 1. Effect of types of bag on fruit retention and days required for harvesting after bagging in mango fruit cv. Ratna.

Treatment	Fruit retention (%)	Days required for harvesting after bagging
T_1 (Newspaper bag)	89.33 ± 1.89	55.00 ± 0.94
T_2 (Brown paper bag)	82.42 ± 0.35	53.83 ± 0.71
T_3 (Scurting bag)	86.33 ± 1.41	54.50 ± 0.24
T_4 (Transparent PP bag)	68.67 ± 0.94	52.17 ± 0.24
T_5 (Butter paper bag)	79.33 ± 0.94	53.50 ± 0.71
T_6 (Muslin cloth bag)	81.67 ± 0.48	54.00 ± 0.47
T_7 (Brown paper bag with polythene coating)	77.14 ± 1.61	53.50 ± 0.24
T_8 (Black polythene bags)	76.67 ± 0.94	52.33 ± 0.47
T_9 (Opaque white polythene bag)	72.67 ± 0.94	53.50 ± 0.24
T_{10} Control (No bagging)	76.84 ± 1.18	52.00 ±0.94
Range	68.67-89.33	52.00-55.00
Mean	79.11	53.42
CD at 5%	5.75	0.87

Pre-harvest bagging with newspaper bag, scurting bag and muslin cloth bag significantly improved physical parameters, *viz*., weight of fruit, length of fruit, diameter of fruit, pulp weight and stone weight over unbagged control fruits (Table 2). The fruits of T_1 recorded the highest weight (477.28 g), which was at par with T_3 (470.65 g) followed by T_6 (468.35 g). The lowest fruit weight was seen in T_{10} (415.64 g). The longest fruit was observed in T_1 (11.45 cm), which was at par with T_6 (11.39 cm), T_3 (11.38 cm), T_2 (11.33 cm) and T_5 (11.32 cm). The highest diameter was found in T_3 (9.22 cm), which was at par with T_1 (9.20 cm), T_6 (9.19 cm) and T_2 (9.07 cm). The highest pulp weight was observed in T_1 (382.73 g), which was at par with T_3 (381.30 g) and T_6 (379.07 g). The highest stone weight was noted in T_1 (52.61 g), which was at par with T_3 (52.45 g), T_6 (52.28 g) and T_2 (50.45 g). The deviation observed for pulp to stone ratio at harvest was non-significant. Covering the fruit with a bag at a particular developmental stage influence their growth and size. Reports on effects of fruit bagging on fruit size and weight opined that it may be due to differences in the type of bag used, fruit and cultivar responses (Sharma

Table 2. Effect of types of bag on physical parameters of fruits of mango cv. Ratna at harvest stage.

Treatment	Fruit wt. (g)	Fruit length (cm)	Fruit dia. (cm)	Pulp wt. (g)	Stone wt. (g)	Pulp: stone ratio
T_1 (News paper bag)	477.28 ± 9.95	11.45 ± 0.01	9.20 ± 0.07	382.73 ± 2.16	52.61 ± 1.62	7.32 ± 0.22
T_2 (Brown paper bag)	450.66 ± 5.38	11.33 ± 0.17	9.07 ± 0.15	366.18 ± 1.03	50.45 ± 1.86	7.30 ± 0.29
T_3 (Scurting bag)	470.65 ± 8.53	11.38 ± 0.08	9.22 ± 0.07	381.30 ± 3.97	52.45 ± 1.24	7.28 ± 0.25
T_4 (Transparent PP bag)	423.09 ± 9.31	10.93 ± 0.14	8.84 ± 0.12	351.44 ± 2.57	45.15 ± 1.50	7.81 ± 0.19
T_5 (Butter paper bag)	448.16 ± 8.16	11.32 ± 0.03	9.04 ± 0.02	359.29 ± 0.21	47.50 ± 0.97	7.63 ± 0.12
T_6 (Muslin cloth bag)	468.35 ± 8.53	11.39 ± 0.04	9.19 ± 0.04	379.07 ± 3.54	52.28 ± 1.06	7.27 ± 0.21
T_7 (Brown paper bag with polythene coating)	426.45 ± 7.81	11.13 ± 0.13	8.83 ± 0.24	352.46 ± 7.31	47.36 ± 2.06	7.46 ± 0.48
T_8 (Black polythene bags)	424.59 ± 7.29	10.91 ± 0.37	8.86 ± 0.01	352.76 ± 1.08	46.82 ± 2.50	7.56 ± 0.42
T_9 (Opaque white polythene bag)	430.65 ± 9.55	11.11 ± 0.04	8.89 ± 0.05	358.39 ± 7.41	46.03 ± 1.30	7.80 ± 0.06
T_{10} Control (no bagging)	415.64 ± 8.14	11.06 ± 0.009	8.76 ± 0.10	347.33 ± 3.26	43.43 ± 1.34	8.01 ± 0.32
Range	415.64 - 477.28	10.91 - 11.45	8.76 - 9.22	347.33- 382.73	43.43 - 52.61	7.27 - 8.01
Mean	443.55	11.20	8.99	363.09	48.41	7.54
CD at 5%	8.46	0.18	0.17	11.84	3.48	NS

et al., 14). Bagging of 'Nam Dok Mai 4' mango fruits with two-layer paper bags, newspaper and golden paper bags increased fruit weight (Watanawan *et al*., 15). Microenvironment created by newspaper bag, scurting bag and muslin cloth bag had congenial effect on fruit growth. All these three treatments recorded more duration for harvesting than that of unbagged control fruits. The fruits bagged in polythene bag were harvested earlier than the unbagged fruits.

The pre-harvest bagging had significant effect on acidity, TSS, reducing sugars, total sugars, ascorbic acid and β-carotene content of fruits at harvest (Table 3). At harvest, the unbagged control fruits recorded minimum TSS (8.45°Brix), total sugars (3.21%) and ascorbic acid (58.40 mg/ 100 g). The fruits of T_4 had the highest reducing sugar (1.92%) and β-carotene (331.17 µg/ 100 g). The fruit of T_1 had the second highest performance for reducing

Table 3. Effect of types of bag on chemical composition of mango cv. Ratna fruits at harvest stage.

Treatment	Titratable acidity (%)	TSS (°Brix)	Reducing sugar (%)	Total sugars (%)	Ascorbic acid (mg/100 g)	β-carotene (µg /100 g)
T_1 (Newspaper bag)	1.75 ± 0.04	8.75 ± 0.07	1.91 ± 0.05	3.51 ± 0.01	69.60 ± 6.79	330.67 ± 1.24
T_2 (Brown paper bag)	1.78 ± 0.04	8.65 ± 0.07	1.88 ± 0.01	3.36 ± 0.01	67.20 ± 1.13	318.56 ± 2.59
T_3 (Scurting bag)	1.77 ± 0.05	8.80 ± 0.14	1.86 ± 0.01	3.50 ± 0.02	68.40 ± 5.09	325.37±2.42
T_4 (Transparent PP bag)	1.91 ± 0.06	8.62 ± 0.16	1.92 ± 0.01	3.46 ± 0.08	58.80 ± 3.96	331.17 ± 3.14
T_5 (Butter paper bag)	1.75 ± 0.01	8.93 ± 0.05	1.80 ± 0.01	3.28 ± 0.04	62.80 ± 3.96	323.76 ± 2.59
T_6 (Muslin cloth bag)	1.76 ± 0.02	8.88 ± 0.02	1.89 ± 0.05	3.47 ± 0.12	65.20 ± 5.09	324.97 ± 2.27
T_7 (Brown paper bag with polythene coating)	1.90 ± 0.01	8.63 ± 0.14	1.78 ± 0.02	3.24 ± 0.01	59.20 ± 5.66	326.09 ± 2.32
T_8 (Black polythene bags)	1.91 ± 0.03	8.73 ± 0.19	1.73 ± 0.01	3.28 ± 0.00	60.80 ± 4.53	318.40 ± 3.86
T_9 (Opaque white polythene bag)	1.88 ± 0.04	8.48 ± 0.02	1.77 ± 0.01	3.27 ± 0.08	60.40 ± 2.83	317.93 ± 0.94
T_{10} Control (no bagging)	1.92 ± 0.03	8.45 ± 0.07	1.74 ± 0.02	3.21 ± 0.05	58.40 ± 3.39	328.40 ± 2.37
Range	1.75 - 1.92	8.45 - 8.93	1.73 - 1.92	3.21 - 3.51	58.40 - 69.60	317.93 - 331.17
Mean	1.83	8.69	1.83	3.36	63.08	324.54
CD at 5%	0.05	0.19	0.04	0.08	3.95	1.41

sugar and β-carotene. The total sugars (3.51%) and ascorbic acid (69.60 mg/ 100 g) recorded in T_1 was the best. The fruits of T_5 (8.93°B) had the maximum TSS and those of T_{10} (1.92%) had the maximum acidity. The variation observed in chemical composition of mango fruits can be attributed to the changed microenvironment around fruit during its growth and development. The bagged fruits recorded the highest content of vitamin C, sucrose, glucose and fructose over control in Zill mango (Hongxia *et al*., 7). The bagging of date palm fruits improved the total sugars (Harhash and Al-Obeed, 6).

At ripe stage, the fruits of T_1 exhibited the maximum TSS (22.48°Brix), total sugars (13.96%) and ascorbic acid (58.40 mg/ 100 g) (Table 4). Fruits of T_8 (0.30%) had maximum acidity and T_6 had maximum reducing sugar (4.16%) and β-carotene (11575.59 µg/ 100 g). The fruits of T_1 and T_3 had recorded the minimum acidity (0.22%) and T_8 had minimum TSS (21.38°B), reducing sugars (3.89%) and ascorbic acid (49.60 mg/ 100 g). The fruits of T_9 had the minimum total sugars (9.74%) and T_{10} had minimum β-carotene (10617.19 µg/ 100 g). Sensory evaluation with respect to colour, flavour, texture was non-significant among various treatments under study. It indicated that the organoleptic qualities of fruit were not affected by pre-harvest bagging in mango cv. Ratna. The data show that the difference for fruit shelf-life was significant. The highest shelf-life was noticed in treatments T_1, T_3 and T_6 (17.83 days) and was significantly superior over other treatments. The lowest shelf-life was found in T_4 (14.17 days). The longer shelf-life of bagged fruits indicated that the effect of bagging persisted even after ripening. The bagging led to higher contents of chemical components such as TSS, total sugars, reducing sugar, acidity and ascorbic acid in guava fruit (Abbasi *et al*., 2).

The percentage of spotted fruits was significantly differed due to various bagging treatments (Table 5). The minimum spotted fruits in mango was observed in treatment T_1 (10.00%), which was at par with T_3 (13.33%), T_6 (16.67%) and T_2 (23.33%). maximum spotted fruits were recorded in T_{10} (76.67%). Similarly, the fruits of T_1, T_2, T_3, T_5 and T_6 were free from stem end rot and anthracnose. Whereas, in unbagged fruits the incidence was 6.67 and 7.33 per cent, respectively. The unbagged fruits had more infestation of mealy bug (8.67%) and fruit fly (11.33%). The fruits of T_1, T_3, T_5 and T_6 did not show incidence of mealy bug. Whereas, the treatments T_1, T_2, T_3, T_5 and T_6 produced fruits free from fruit fly infestation. Bagging provided physical barrier between fruit and pests. The bagging of mango fruits in cv. Amrapali was found superior to increase the quality of fruits in respect of minimum black spotted

Table 4. Effect of types of bag on chemical composition, sensory evaluation and shelf-life of mango cv. Ratna fruits at ripe stage.

Treatment	Titratable acidity (%)	TSS (°Brix)	Reducing sugars (%)	Total sugars (%)	Ascorbic acid (mg/100 g)	β-carotene (µg /100 g)	Sensory evaluation			Shelf-life (days)
							Colour	Flavour	Texture	
T_1 (Newspaper bag)	0.22 ± 0.02	22.48 ± 0.07	4.13 ± 0.04	13.96 ± 0.59	58.40 ± 3.39	11067.92 ± 134.82	7.67 ± 0.24	7.69 ± 0.03	7.71 ± 0.06	17.83 ± 0.71
T_2 (Brown paper bag)	0.23 ± 0.01	22.03 ± 0.57	4.09 ± 0.05	13.54 ± 0.68	55.20 ± 3.39	11416.26 ± 145.19	7.58 ± 0.24	7.64 ± 0.04	7.60 ± 0.26	16.50 ± 0.71
T_3 (Scurting bag)	0.22 ± 0.00	22.47 ± 0.28	4.14 ± 0.07	13.68 ± 0.72	57.60 ± 4.53	10952.66 ± 147.79	7.79 ± 0.06	7.58 ± 0.05	7.56 ± 0.27	17.83 ± 0.24
T_4 (Transparent PP bag)	0.29 ± 0.01	21.75 ± 0.12	3.98 ± 0.04	11.78 ± 0.64	56.80 ± 1.13	11497.76 ± 333.05	7.25 ± 0.12	7.17 ± 0.06	7.27 ± 0.27	14.17 ± 0.24
T_5 (Butter paper bag)	0.25 ± 0.02	22.10 ± 0.33	4.01 ± 0.05	10.68 ± 0.56	54.00 ± 2.83	10965.87 ± 129.64	7.62 ± 0.07	7.70 ± 0.06	7.61 ± 0.19	17.00 ± 0.47
T_6 (Muslin cloth bag)	0.23 ± 0.01	22.35 ± 0.21	4.16 ± 0.01	13.78 ± 0.71	58.00 ± 5.09	11575.59 ± 140.01	7.65 ± 0.21	7.61 ± 0.28	7.58 ± 0.35	17.83 ± 0.24
T_7 (Brown paper bag with polythene coating)	0.28 ± 0.00	21.85 ± 0.78	3.91 ± 0.15	9.80 ± 0.39	52.00 ± 3.39	10801.93 ± 44.79	7.75 ± 0.47	7.33 ± 0.70	7.30 ± 0.31	16.17 ± 0.24
T_8 (Black polythene bags)	0.30 ± 0.03	21.38 ± 0.07	3.89 ± 0.01	10.16±0.98	49.60 ± 2.26	10650.90 ± 82.93	7.78 ± 0.04	7.56 ± 0.32	7.25 ± 0.59	14.83 ± 0.24
T_9 (Opaque white polythene bag)	0.27 ± 0.00	21.52 ± 0.02	3.93 ± 0.09	9.74 ± 0.34	50.00 ± 2.83	10801.93 ± 304.06	7.61 ± 0.28	7.54 ± 0.29	7.25 ± 0.59	16.50 ± 1.18
T_{10} Control (No bagging)	0.26 ± 0.01	21.50 ± 0.33	3.90 ± 0.12	10.32 ± 1.03	53.20 ± 5.09	10617.79 ± 98.41	6.88 ± 0.29	7.36 ± 0.84	6.79 ± 0.88	15.33 ± 0.47
Range	0.22 - 0.30	21.38 - 22.48	3.89 - 4.16	9.74 - 13.96	49.60 - 58.40	10617.19 - 11575.59	6.88 - 7.79	7.17 - 7.70	6.79 - 7.71	14.17 - 17.83
Mean	0.25	21.94	4.01	11.74	54.48	11034.86	7.56	7.52	7.39	16.40
CD at 5%	0.02	0.42	0.11	0.77	3.57	170.70	NS	NS	NS	0.67

Table 5. Effect of types of bag on percent spotted fruits, and infestation of pest and disease on fruits at harvest in mango cv. Ratna.

Treatment	Spotted fruits (%)	Disease (%)		Pest (%)	
		Stem end rot	Anthracnose	Mealy bug	Fruit fly
T_1 (Newspaper bag)	10.00 ± 4.71	0.00	0.00	0.00	0.00
T_2 (Brown paper bag)	23.33 ± 4.71	0.00	0.00	3.33 ± 0.94	0.00
T_3 (Scurting bag)	13.33 ± 9.43	0.00	0.00	0. 00	0.00
T_4 (Transparent PP bag)	73.33 ± 9.43	4.00 ± 1.89	4.67 ± 0.94	2.00 ± 0.94	6.00 ± 0.94
T_5 (Butter paper bag)	40.00 ± 9.43	0.00	0.00	0.00	0.00
T_6 (Muslin cloth bag)	16.67 ± 4.71	0.00	0.00	0.00	0.00
T_7 (Brown paper bag with polythene coating)	53.33 ± 9.43	3.33 ± 0.94	1.33 ± 0.00	4.67 ± 0.94	3.33 ± 0.94
T_8 (Black polythene bags)	66.67 ± 9.43	3.33 ± 0.94	4.67 ± 0.94	7.33 ± 0.94	4.67 ±0.94
T_9 (Opaque white polythene bag)	60.00 ± 9.43	2.00 ± 0.94	4.00 ± 0.00	6.00 ± 0.94	4.00 ± 0.00
T_{10} Control (no bagging)	76.67 ± 4.71	6.67 ± 1.89	7.33 ± 0.94	8.67 ± 0.94	11.33 ± 0.94
Range	10.00 - 76.67	0.00-6.67	0.00 - 7.33	0.00-8.67	0.00-11.33
Mean	43.33	1.93	2.20	3.20	2.93
CD at 5%	15.02	2.75	1.75	1.90	1.37

fruits per cent among all treatments (Jakhar and Pathak, 8). In mango cv. Carabao, the incidence of fruit fly was reduced considerably by pre-harvest bagging (Buganic, 5).

Thus, the present study indicated that pre-harvest bagging (newspaper, scruting and muslin cloth) of mango cv. Ratna at egg stage by different types of bag proved to be beneficial for disease and pest-free fruit production with desirable fruit quality.

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