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Effect of Pre-harvest Fruit Bagging on Physical and Physiological Properties of Pomegranate (*Punica granatum*, L.) cv. Phule Bhagwa Super

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A B S T R A C T

An investigation was undertaken to study the effect of pre-harvest fruit bagging on physical and physiological properties of pomegranate (*Punica granatum* L.) cv. Phule Bhagwa super during 2019-2020 in Randomized Block Design. Pomegranate fruits were bagged 30 days after fruit set with different types of bags viz.Butter paper bag (T_1), Brown paper bag (T_2), Parchment bag (T_3), English newspaper bag (T_4) (60 gsm), Marathi newspaper bag (T_5) (35 gsm) and Control (T_6) (without bagging).Significant influence of bagging treatments was observed on the physical and physiological characters of the pomegranate fruit. Result showed that pomegranate fruit bagged with Parchment bag (T_3)recorded maximum fruit length (6.61 cm), fruit diameter (6.34 cm) , fruit weight(316.44 g), marketable yield (25.68 kgplant^{-1} and 19.00 tonha^{-1}) and aril percentage (72.89 %). This treatment also recorded minimum PLW (5.76 %, 12.23 % and 18.03 % at 3rd, 6th, 9th days after harvest, respectively) and maximum shelf life (24.71 days). Bagged fruits were totally free from cracking and sunburn injury.

Introduction

Pomegranate (*Punica granatum*, L.) being hardy in nature and versatile in adaptability to different soil and climatic conditions and high yield potential, its cultivation is increasing Maharashtra. In India, pomegranate is grown on an area of 233.93 thousand hectare with the production of 2844.52 thousand million tons. Maharashtra has the highest area under pomegranate in India which is grown on 147.91 thousand hectare with the production of 1789.46 thousand million tons (Saxena, 2018). Not only yield, but the quality of fruit is equally important for domestic as well as export market. Fruit bagging appears to be eco-friendly and efficient toolto enhance the quality of fruit. There is increasing adoption of the practice of fruit bagging in pomegranate. However, there was felt need the asses the proficiency of different types of bags used in pomegranate. With this thought the present experiment was undertaken.

Materials and Methods

The field experiment was conducted on five years old orchard of the pomegranate cv. Phule Bhagwa Super at Pomegranate Research and Technology Transfer Centre

(PR&TTC), Lakhmapur, Tal. Satana, Dist. Nashik during the year 2019-20. The experiment was conducted on *Hast bahar*. The experiment was set in Randomized Block Design and each treatment was replicated four times. The treatments consisted of Butter paper bag (T_1), - Brown paper bag (T_2), Parchment bag (T_3), English newspaper bag (T_4) (60 gsm), Marathi newspaper bag (T_5) (35 gsm) and Control (T6) (without bagging).Perforations were made on all bags at the bottom of bag (4 mm) for ventilation for proper development of fruits. Bagging was done 30 days after fruit set. Five fruits were randomly selected per treatment per replication for recording different observations as described below.

Physical parameters

Length and diameter of fruit were measured with the help of Verniercaliper and was expressed in centimeters (cm), whereas weight of fruit was recorded by using electronic weighing balance and expressed in grams (g).

Aril percentage

Fruits were carefully cut opened and arils were separated from pericarp/membrane fractions and total aril weight per fruit was obtained. The aril percentage is calculated by using following formula (Wetzstein, *et al.*, 2011).

$$\text{Aril percentage (\%)} = \frac{\text{Weight of aril}}{\text{Weight of fruit}} \times 100$$

Physiological parameters

Physiological loss in weight (PLW) (%)

The weight of fruit was recorded at four days interval up to end of shelf life. PLW was calculated by using following formula (Shankar, *et al.*, 2009) and it was expressed in per cent.

$$\text{PLW (\%)} = \frac{\text{Initial weight fruit (g)} - \text{Final weight of fruit (g)}}{\text{Initial weight of fruit (g)}} \times 100$$

Shelf life (days)

The shelf life of fruits was determined by recording the number of days the fruits remained in edible condition during storage. When the spoilage of fruits exceeded 50 per cent, it was considered as the end of storage life of fruit. Shelf life was expressed in terms of days.

Cracked fruit percentage

The total numbers of cracked and uncracked fruits per plant were counted and fruit cracking was calculated on percent basis (Singh *et al.*,2014).

$$\text{Fruit cracking (\%)} = \frac{\text{No of cracked fruits per plant}}{\text{Total no of fruits per plant}} \times 100$$

Sunburn fruit percentage

The total numbers of sun burnt and normal fruits per plant were counted and sun burnt fruit percentage was calculated on percent basis (Abdel *et al.*, 2017).

$$\text{Sunburn fruit (\%)} \frac{\text{No of sunburn per plant}}{\text{Total no of fruits per plant}} \times 100$$

Results and Discussion

Physical parameters

Fruit length and fruit diameter (cm)

Pre-harvest bagging with different types of bag did not influence fruit length and fruit diameter as revealed from the Table 1.However, the maximum fruit length (6.51 cm) and fruit diameter (6.34 cm) was

recorded in Parchment bag (T_3). The lowest fruit length (5.96 cm) and fruit diameter (5.72 cm) was registered in control (T_6).

Similar results were obtained by Muchui *et al.,* (2010) in banana who didn't observe influence of polyethylene bunch covers on bunch weight, finger diameter (grade) and finger length. However, Hussien *et al.,* (1994) observed significant increase in fruit size and weight in pomegranate due to bagging. Islam *et al.,* (2017 b) also observed maximum fruit length (97.93 and 103.5 mm) in mango fruits bagged at 35 days after fruit set with white paper and brown paper bag.

Fruit weight (g)

Irrespective of the bagging material, there was increase fruit weight (Table1 and figure 1). Significantly, the highest fruit weight was observed in treatment Parchment bag (T_3)which recorded 316.44 g fruit weightThe next best treatments were Butter paper bag (T_1) and English news paper bag (T_4) which recorded 307.47 g and 305.42 g fruit weight. respectively. The results are in conformity with the findings of Abd El-Rhman (2010) and Samra and Shalan (2013) who reported higher weight in pomegranate bagging treatments. Salama *et al.,* (2018) also reported highest values for fruit weight of pomegranate trees treated with 780 g potassium sulphate tree^{-1} and fruit bagged with butter paper bag as compared to unbagged pomegranate fruits cv. Wonderful. Ehteshami *et al.,* (2015) also reported increased size and weight of fruits in pomegranate due to single layer white paper bag. Islam *et al.,* (2017a) observed maximum fruit weight of 329.2 g in mango bagged 35 days after fruit set with brown paper bags. Debnath and Mithra (2008) in litchi reported that Brown Paper and Newspaper bags showed an increase fruit weight than control and further observed that fruit weight was highest in Newspaper bag (23.20 g) as compared to control (22.51 g).Increased relative humidity and reduced fruit water loss would have increased fruit weight in bagging treatments.

Marketable Yield (kg plant^{-1} and tonha^{-1})

It is evident from the data presented in Table 2 and graphically in Figure 2 and 3, the treatment Parchment bag (T_3) recorded the highest yield of 25.68 kg plant^{-1} and 19.0 ton ha^{-1},respectively. However, the treatments T_1 (Butter paper bag), T_4(English newspaper bag), T_2 (Brown paper bag) and T_5 (Marathi newspaper bag) were on par with each other. Results are in accordance with Samra and Shalan (2013)who reported increase in fruit yield (kg/ tree)in pomegranate due to different bagging treatment. Hegazi *et al.,* (2014) recorded improvement yield in Manfaloty and Wonderfull cultivars of pomegranate due to bagging and spraying with 50 ppm GA_3, 2 or 4%$CaCl_2$ and 5% kaolin. Similar results were also obtained by Salama *et al.,* (2018) who reported highest values for yield of pomegranate trees treated with 780 g potassium sulphate tree^{-1} and fruit bagged with butter paper bag as compared to unbagged pomegranate fruits cv. Wonderful. Increase in yield (kg plant^{-1} and t ha^{-1}) of pomegranate is attributed to increase in the fruit size and fruit weight.

Aril percentage

As observed from the Table 2 and figure 4, pre-harvest fruit bagging with different types of bag significantly influenced Aril percentage. Maximum aril percentage was observed in the treatment. Parchment bag (T_3) recording 72.89 aril percentage. The treatments T_1 (Butter paper bag) and T_4(English newspaper bag) was on par with the treatment T_3 (Parchment bag). These treatments recorded 71.71 and 68.30 per cent aril, respectively. Lowest aril percentage was

observed in T_6 (control)which 58.87 per cent.(Table 03)The increase in aril weight and aril per cent might be due to increased cell size and intercellular spaces coupled with accumulation of water, sugars and other soluble solids in greater amount as a result of translocation of metabolites towards the fruits.

Similar findings were reported by Wassel*et al.*, (2015) who observed significant increase in total arils and red arils weight and percentage in pomegranate due to fruit bagging. Ehteshami *et al.*, (2015) also reported increased in aril weight in pomegranate cv. RababNeiriz due to single layer white paper bag. Salama *et al.*, (2018) also reported highest values for average total arils and red arils weight and percentage in pomegranate trees treated with 780 g potassium sulphate tree^{-1} and fruit bagged with butter paper bag as compared to unbagged pomegranate fruits.

Table.1 Effect of types of bag on fruit length (cm), fruit diameter(cm) and fruit weight (g), in pomegranate cv. Phule Bhagwa Super at harvest

Treatment	Treatment detail	Fruit length (cm)	Fruit diameter cm)	Fruit weight (g)
T_1	Butter paper bag	6.46	6.28	307.47
T_2	Brown paper bag	6.35	6.15	292.25
T_3	Parchment bag	6.51	6.34	316.44
T_4	English newspaper bag	6.43	6.25	305.42
T_5	Marathi newspaper bag	6.26	5.93	266.45
T_6	Control (without bag)	5.96	5.72	260.68
	S. E. ±	0.21	0.16	2.02
	C. D. 0.5%	NS	NS	6.10

Table.2 Effect of types of bag on Marketable yield and aril percentage of pomegranate cv. PhuleBhagwa Super at harvest

Treatment	Treatment details	Marketable yield		Aril percentage (%)
		Kgplant^{-1}	t. ha-1	
T_1	Butter paper bag	24.30	17.98	71.71
T_2	Brown paper bag	23.39	17.31	67.76
T_3	Parchment bag	25.68	19.00	72.89
T_4	English newspaper bag	23.96	17.73	68.30
T_5	Marathi newspaper bag	23.13	17.11	66.80
T_6	Control (without bag)	18.65	13.80	58.87
	S. E. ±	0.92	0.68	2.10
	C. D. 0.5%	2.77	2.06	6.33

Table.3 Effect of types of bag on physiological loss in weight (%) (PLW) and Shelf life(days) of pomegranate cv. Phule Bhagwa Super at harvest

Treatment	Treatment detail	Physiological loss in weight (PLW) (%)			Shelf life (Days)
		3 DAS	6 DAS	9DAS	
T_1	Butter paper bag	6.18 *(14.39)	12.45 (20.66)	18.14 (25.20)	24.33
T_2	Brown paper bag	6.41 (14.66)	12.71 (20.88)	18.58 (25.53)	23.12
T_3	Parchment bag	5.76 (13.88)	12.23 (20.46)	18.03 (25.12)	24.71
T_4	English newspaper bag	6.33 (14.57)	12.68 (20.86)	18.27 (25.30)	23.29
T_5	Marathi newspaper bag	6.71 (15.01)	13.43 (21.49)	19.31 (26.06)	22.67
T_6	Control (without bag)	7.88 (16.30)	14.48 (22.36)	20.47 (26.90)	20.51
	S. E. ±	0.1103	0.1422	0.2118	0.4575
	C. D. 0.5%	0.3326	0.4286	0.6386	1.3790

* Figures in parenthesis indicate Arc sin transformed value

Table.4 Effect of types of bag on Cracked fruit (%) and sunburn fruit (%) of pomegranate cv. Phule Bhagwa Super at harvest

Treatment	Treatment detail	Cracked fruit %	Sunburn fruit %
T_1	Butter paper bag	0.00	0.00
T_2	Brown paper bag	0.00	0.00
T_3	Parchment bag	0.00	0.00
T_4	English newspaper bag	0.00	0.00
T_5	Marathi newspaper bag	0.00	0.00
T_6	Control (without bag)	6.00	21.50
	S. E. ±	-	-
	C. D. 0.5%	-	-

Fig.1 Effect of types of bag on fruit Weight (g)

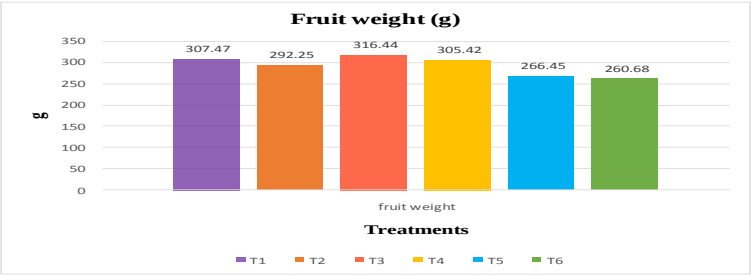


Fig.2 Effect of types of bag on Marketable yield (kg/plant)

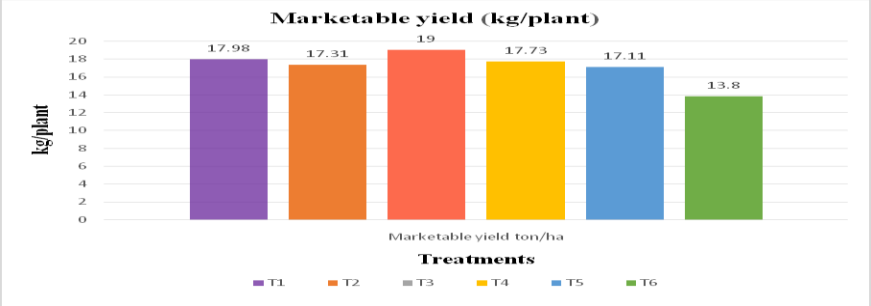


Fig.3 Effect of types of bag on Marketable yield (ton/ha)

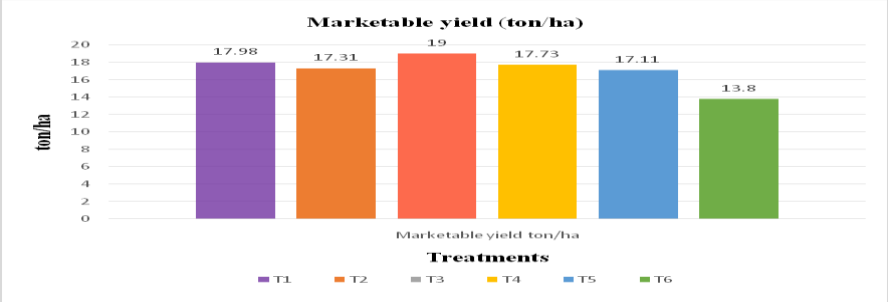


Fig.4 Effect of types of bag on Aril percentage (%)

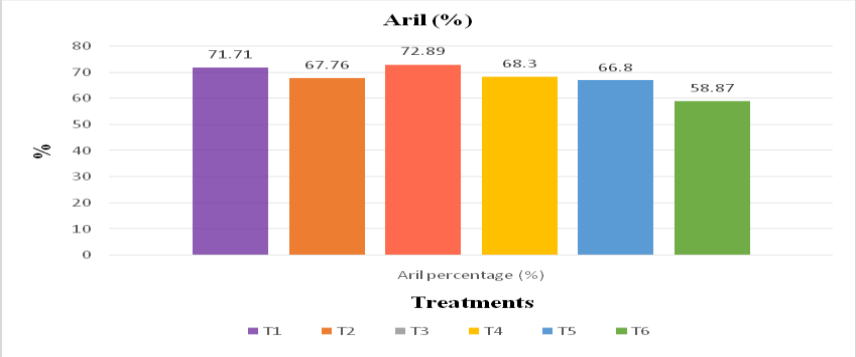


Fig.5 Effect of types of bag on Physiological Loss in Weight (%)

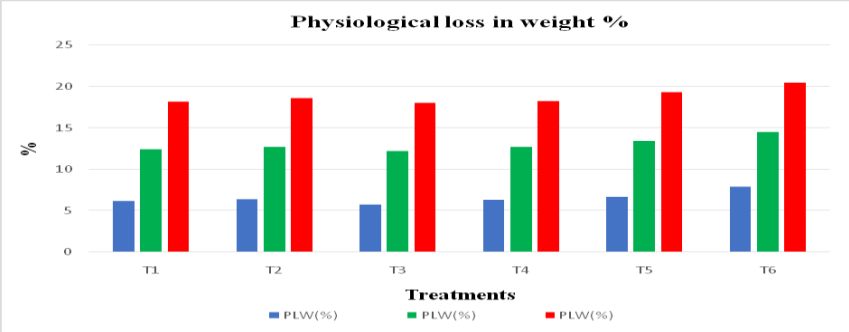


Fig.6 Effect of types of bag on Shelf life (days)

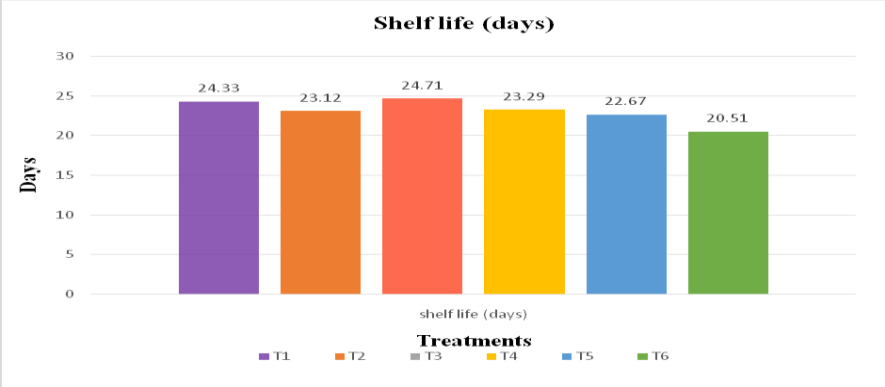


Fig.7 Effect of types of bag on cracked fruit %

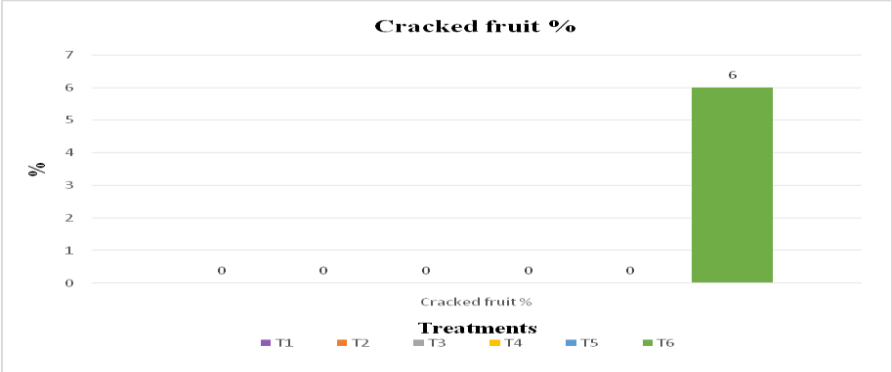
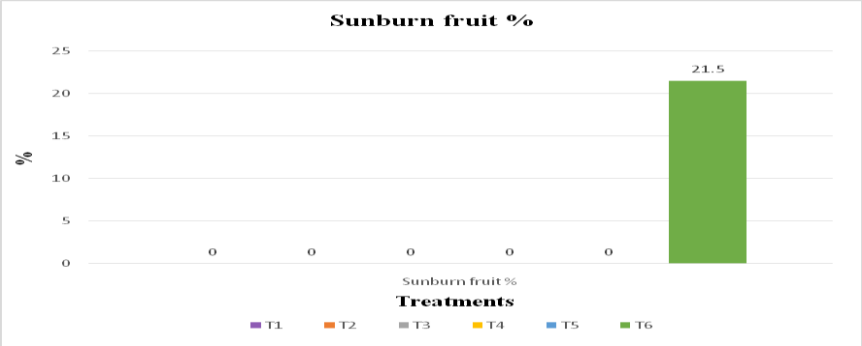


Fig.8 Effect of types of bag on Sunburn fruit %



Physiological Parameters

Physiological loss in weight (%)

Physiological Loss in weight indicated significant difference in weight loss among the different bagging treatments and ungagged (control) fruits which increased with the period of storage (Table 3 and figure 5). However, lowest loss in fruit weight was observed in the Parchment bag (T_3) which was 5.76,12.23and18.03 per cent against 7.88, 14.48 and 20.47 per cent **%**at 3, 6 and 9 days after harvest of fruit in the control. Malshe

and Parulekar (2017) reported lowest physiological loss in weight (14.67%) in mango fruits bagged at marble stage and removed bags at 75 days after bagging. In banana, Aryama *et al.,* (2019) noticed higher rate of loss of fruits in control (3.94 %) which was quite higher than the other bagging treatments and the lowest (1.76 %) rate of weight loss was recorded in bunch covered with non-woven sleeve that was followed by Blue HDPE (2.17 %) on harvesting day and on 9th day.

Maximum postharvest loss in weight in unbagged (control) fruits might be due to direct exposure of fruits to climate leading to high rate of respiration and transpiration from fruit surface as compared to fruits bagged with different bagging material.

Shelf life (days)

Bagging significantly improved the shelf life of pomegranate fruits. Maximum shelf life of 24.71 days was registered in Parchment bag (T_3) treatment. Butter paper bag (T_1)treatment was at par with the treatment Parchment bag (T_3) which recorded shelf life of 24.33 days (Table3 and figure 8) (Table 3 and figure 5).Modified microenvironment around the fruit would have delayed the ripening resulting in the improvement in shelf life of pomegranate fruits.

Haldankar *et al.,* (2015)observed maximum shelf life of 17.50 days in mango cv. Alphonso in newspaper bag followed by 16.50 days in brown paper bag.Jakharand Pathak (2016) also observed shelf life up to 12 days with lowest weight loss and highest organoleptic quality in mango cv. Amprapalliin the fruits treated with 2% $CaCl_2$+1% K_2SO_4+bagging as against 6 days of untreated fruits (control).Minigire *et al.,* (2017) reported significant effect of bagging on shelf life of mango cv. Ratna and found maximum shelf life of 17.83 days in new paper bag, skirting bag and muslin cloth bag.

Fruit cracking percentage

No fruit cracking was observed in all the bagging treatments as against 6.0 per cent fruit cracking in control (unbagged fruits) (T_6).(Table 04 and figure 9). Results are in accordance with Sarkomi *et al.,* (2018) and Grinan *et al.,* (2019) who reported significant reduction in fruit cracking in pomegranate. Rathore and Pal (2016) reported significant reduction in fruit cracking in mango in bagging treatments as compared to unbagged fruit and found blue paper bag most effective in controlling fruit cracking.

Modification of the microclimate around the fruit in pomegranate inside the bag and avoidance of contact with direct strong and hot winds to the skin of fruit would have been effective in reducing the cracking in pomegranate (Yilmaz and Ozguven, 2006).

Sunburn fruit percentage

No sunburnt fruit were recorded in the all the bagging treatments as against the 21.50 per cent in control (non-bagged fruit) (Table 04 and figure 10).Abou El –Wafa (2014) noticed significant reduction in sun-burn fruits in pomegranate and lowest significant sun burnt fruits (2%) were recorded in Prgmenbag, whereas it was 25 per cent in control.

Results are in agreement with Sarkomi *et al.,* (2018) and Grinan *et al.,* (2019) who reported significant reduction in peel burn in pomegranate. As reported by Karar *et al.,* (2019), bagged fruits of mango cv. Anwar Rataul had no sunburn injury. As bagging acts as a barrier between sun rays and fruit surface, no sunburn injury was observed in pomegranate.

In conclusion the results revealed significant effect of bagging treatments on physical parameters, fruit quality and fruit cracking and sun burnt fruits in pomegranate. Among the different bagging materials, Parchment bag appeared to be more promising bagging treatment followed by Butter paper bag and English newspaper bag which had positive effects on physical properties, aril percentage on pomegranate cv. Phule Bhagwa Super. These treatments also exhibited improved shelf life, minimum loss in weight (PLW) and maximum marketable yield.

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