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Effect of pre-harvest bagging on fruit yield, physiological disorders, pest and diseases in pomegranate

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Abstract
An experiment was conducted to study the effect of bagging on fruit weight, fruit yield physiological disorders, pest and diseases in pomegranate cv. Phule Bhagwa Super during 2019-2020 in a Randomized Block Design with six treatments which were replicated four times. The fruit were bagged 30 days after the fruit set. The bagging treatments were 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). The results showed that bagging treatments significantly influenced the fruit weight and yield. Bagging treatments also significantly reduced the physiological disorders namely fruit cracking and sun burn injury as well as incidence of insect-pests namely fruit borer, mealy bug and bacterial disease oily spot. Thus pre-harvest bagging appears to be environmental friendly and effective tool to protect pomegranate fruits from physiological disorders, pest and diseases and also to improve the quality of fruit.

Keywords: physiological disorders, bagging, fruit cracking, sun burn, pest and diseases, fruit quality

Introduction
Pomegranate is an important fruit crop of arid and semiarid regions due to its nature to withst and harsh and hostile climate. Because of which there is increase in the area under this crops in 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). However, pomegranate suffers from many biotic stresses such oily spot, mealy bug, fruit borer and abiotic stresses such as fruit cracking and sunburn injury which affects the appearance of the fruit and this greatly reduces the marketability of fruits. Several horticultural practices are followed to boost the fruit quality and to protect fruits from pest, diseases and physiological disorders. Fruit bagging is one of the ecofriendly techniques which has promise many fruit crops such as apple, banana, litchi (Sharma *et al*., 2014) [29], mango (Hofman *et al*., 1997, Haldakar *et al*., 2015) [14, 11] and guava (Martin *et al*., 2007 and Jat, 2019) [18]. Fruit bagging technique is also used in pomegranate, but flimsy information is available on pomegranate. Therefore present investigation was planned to evaluate the performance of different bagging material on fruit weight, fruit yield, physiological disorders, pest and diseases of pomegranate.

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 (PRTTC), Lakhmapur, Tal. Satana, Dist. Nashik during the year 2019-20. The experiment was conducted on *Hast bahar*. The experiment was conducted 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 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

Weight of fruit was recorded by using electronic weighing balance and expressed in grams (g). For computing yield produced by individual plant was summed up and was expressed in kg plant^{-1}.

Physiological disorders

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) [31].

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

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) [3].

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

Pest incidence (%)

The incidence of fruit borer or *anar* butterfly on pomegranate fruits was made by counting the number of infected fruits at maturity stage. Thus the percentage of pest incidence was calculated as below.

$$\text{Incidence of pest (\%)} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits}} \text{ X } 100$$

Diseases incidence (%)

The diseased fruits were identified symptomatically and incidence disease was measured by counting the number of infected fruits at maturity stage. The percentage disease incidence was calculated as follows-

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

Results and Discussion

Fruit weight (g)

The data regarding fruit weight (g) has been shown in Table 1 and graphically in Fig. 1. Significantly, the highest fruit weight was observed in treatment Parchment bag (T_3) which recorded 316.44 g fruit weight followed by Butter paper bag (T_1). The lowest fruit weight was observed in control (T_6) and it was 260.68 g. Results are in agreement with Hussien *et al.* (1994) [16]; Abd El-Rhman (2010) [2] and Samra and Shalan (2013) [27] in pomegranate

Similar results were also reported by Wang *et al.* (2007) [32] in Tomato; Debnath and Mithra. (2008) [6]; Harshash and Al-Obeed (2010) [12] in date palm; Haldankar *et al.* (2015) [11] in mango; Islam *et al.* (2019) [17] in mango; Purbey and Kumar (2015) [25] in litchi, Hossain *et al.* (2020) [15] in mango and Jat (2019) [18] in guava.

Bagging Improvement in microclimate around the fruit due to bagging would have helped in the improvement of fruit weight (Kireeti *et al.*, 2016) [21].

Yield (kg plant^{-1})

As evident from the data on yield (kg plant^{-1}) presented in Table 1 and graphically in Fig. 2, increase in the fruit yield was observed in all bagging treatments over the control. Among the treatments, Parchment bag (T_3) recorded the highest yield of 25.68 kg plant^{-1}. But in case of yield ton/ha^{-1}, the treatment it was at par with treatment 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 and T_3 which recorded 17.98, 17.73, 17.31 and 17.11 yield (t ha-1). The results are in close agreement with El-Wafa (2014) [8] in pomegranate and Abdel Gawad Nehad, *et al.* (2017) [3] in mango.

Increase in yield (kg plant^{-1}) of pomegranate might be due to increase in fruit weight.

Fruit cracking percentage

It is apparent from the data presented in Table 2 and Fig. 3, bagging had significant effect on fruit cracking. No fruit cracking was observed in all the bagging treatments as against 6.0 percent fruit cracking in control (unbagged fruits) (T_6). El –Wafa (2014) [8] noticed significant reduction in cracked fruits and sun-burn fruits in bagged pomegranate who noticed significantly lowest cracking (1%) in Prgmen bag as against 24 percent in control. Sarkomi *et al.* (2019) [28] observed significant reduction in cracking in bagging with different bagging materials as compared to non-bagged fruit and reported highest percentage of cracking (65%) in control and the lowest (5%) in white-bagged fruits in pomegranate. Reduction in the incidence of fruit cracking was also reported in litchi (Oosthuizen, 1989) [24] and nectarine (Ding *et al.*, 2004) [7] fruit. Yang *et al.* (2009) [33] in Longan fruit, observed significant reduction in fruit cracking in black adhesive-bonded fabric bag and white adhesive bonded fabric bag treatments compared with the control. Rathore and Pal (2016) [26] 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.

Maintenance of moisture around bagged fruit 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 & Ozguven, 2006).

Sunburn fruit percentage

Results showed (Table 2 and Fig. 4) that bagging had a significant effect on controlling the sun burn injury. No sunburnt fruit were recorded in the all the bagging treatments as against the 21.50 percent in control (non-bagged fruit). El –Wafa (2014) [8] noticed significant reduction in sun-burn fruits in pomegranate and lowest significant sun burnt fruits (2%) were recorded in Prgmen bag, whereas it was 25 percent in control. Hegazi *et al.* (2014) [13] obtained No sunburnt fruits in both the cultivars of pomegranate (Manfaloty and Wonderful pomegranate). Results of Sarkomi *et al.* (2019) [28] showed that bagging had a significant effect on the percentage and severity of sunburnt fruits in pomegranate who obtained lowest percentage of sunburnt fruits (25%) in bagged fruit with white bags as against 90 percent in control (non-bagged fruit). Significant reduction in peel burn in pomegranate was also reported by Grinan *et al.* (2018). As reported by Karar *et al.* (2019) [20], bagged fruits of mango cv. Anwar Rataul had no sunburn injury. Abdel Gawad- Nehad *et al.* (2017) [3] also observed significant reduction in sun burn fruits in mango cv.

Keitt and in Agrail red bag no fruit was affected by sunburn injury. Goodwin *et al*. (2018) [9] showed a clear decrease in sunburn (amount and severity) in red-blushed pear fruit from the netted trees.

Maintenance of moisture around bagged fruit and avoidance direct of contact fruit surface to sunlight due to barricade of bagging would have kept the fruits free from sun burn injury.

Pest incidence (%)

Fruit borer infestation (%)

The data pertaining to fruit borer infestation presented in Table 2 and Fig. 5 indicated that pre- harvest bagging of pomegranate fruits had significant effect on controlling fruit borer infestation. No infestation of fruit borer was observed in the bagging treatments except marathi news paper bag. In Marathi news paper bag the infestation was 2.50 per cent, whereas in Control (T_6) it was 5.12 per cent.

In tomato, Leite *et al.* (2014) [22] noticed that bagging of fruit with either organza fabric or tissue non-tissue (TNT) covering reduced insect borer damage by 99.9 %. Results of Karar *et al.* (2019) [20] indicated that the attack of fruit flies and other insect-pests complex were zero in bagged mango fruits of cv. Anwar Rataul indicating high degree of protection by bagging fruits. Studies of Mondal *et al.* (2014) clearly showed that fruit bagging is best bio-friendly practice to control guava fruit fly and wrapping fruits with transparent poly-propylene bag (20 µ gauge) and transparent poly-propylene (20 µ gauge) bag + paper within the poly-propylene bag as partial cover against sunlight was found to be the best wrapping material in significant reduction of fruit fly infestation.

Mealy bug infestation (%)

As revealed from the data presented in Table 2 and Fig. 6, different bagging treatment significantly reduced the incidence of mealy bug. The lowest infestation of mealy bug was noticed in Parchment bag (T_3) which was 1.46 percent, whereas highest infestation of 12.02 percent was observed in unbagged fruits (T_6).

Haldankar *et al.* (2015) [11] reported fruits of mango cv. Alphonso covered with news paper bag, plastic paper bag with perforations and butter paper bag were free from mealy bug incidence. Studies of Abbasi *et al.* (2014) [1] on guava showed that bagging treatments significantly reduced the damage by fruit fly. Shinde (2015) [30] observed significant reduction in disease incidence and pests due to preharvest bagging of mango fruits and newspaper bag and scurting bags were found to be meritorious. Kireeti *et al.* (2016) [21] observed significant effect of bagging mealy bug infestation and fruits enclosed in news paper bag, brown paper bag, polythene bag, butter paper bag and brown paper bag with polythene coating were free from mealy bug infestation. Bahadure *et al*. (2019) [4] also reported significant reduction in mealy bug incidence in mango cv. Mallika.

Bagging acts as a barrier between fruit and insect avoiding contact with fruit and reducing the damage by insect pests.

Disease incidence

Oily spot

As apparent from the data given in Table 2 and Fig 7, no incidence of oily spot was observed in all the bagging treatments as well as in control i.e. non-bagged control and pomegranate fruits were 100 percent free from oily spot incidence. No infested fruit due to bagging in guava was found as reported by Behera and Pathak (2017) [5].

Significant reduction in diseases was also observed by Karajeh (2018) [19] in grape clusters bagged with or without pesticide treatment, using brown paper bag. Hofman *et al.* (1997) [14] also observed significant reduction in anthracnose and stem end rot (SER), caused by *Colletotrichum* and *Dothoriella* spp., respectively due to bagging in mango cv. cv. Keitt. Sharma (2014) [29] reported that, the incidence of sooty blotch and fly speech was significantly reduced (0.0%) over non-bagged apples (22.6%) in apple bagged with single-layered spun-bounded fabric bags in apple cv. Royal Delicious.

Fruits in the present were free from oily spot disease might be due to tolerant nature of this variety to oily spot disease and due to no contact between disease propagules and fruit.

It is clearly revealed from the present that pre-harvest bagging is effecting in keeping the fruits free from physiological disorders, pests and diseases.

Table 1: Effect of types of bag on fruit weight (g) and fruit yield (kg plant^{-1}) in pomegranate cv. Phule Bhagwa Super at harvest.

Treatment	Treatment detail	Fruit weight (g)	Fruit yield (kg plant^{-1})
T_1	Butter paper bag	307.47	24.30
T_2	Brown paper bag	292.25	23.39
T_3	Parchment bag	316.44	25.68
T_4	English newspaper bag	305.42	23.96
T_5	Marathi newspaper bag	266.45	23.13
T_6	Control (without bag)	260.68	18.65
	S. E. ±	2.02	0.92
	C. D. 0.5%	6.10	2.77

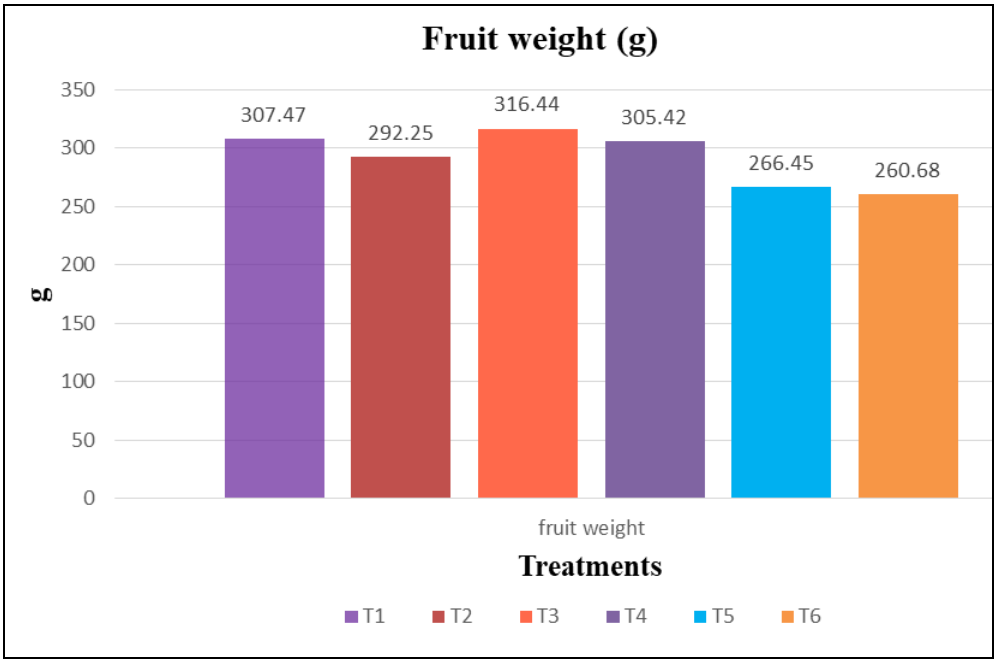

Fig 1: Effect of types of bag on fruit weight (g)

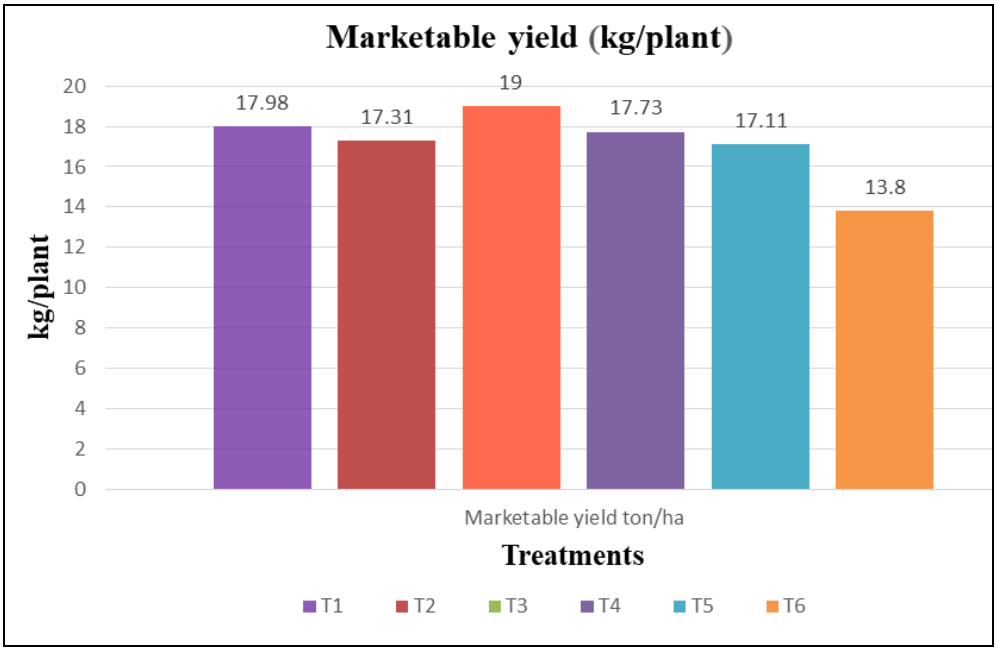

Fig 2: Effect of types of bag on Marketable yield (kg plant^{-1})

Table 2: Effect of types of bag on Cracked fruit (%) and sunburn fruit (%) of pomegranate cv. Phule Bhagwa Super at harvest.

Treatment	Treatment detail	Physiological disorders		Pest and diseases		
		Cracked fruit %	Sunburn fruit %	Fruit borer (%)	Mealy bug (%)	Oily spot (%)
T_1	Butter paper bag	0.00	0.00	00	8.18 *(16.61)	00
T_2	Brown paper bag	0.00	0.00	00	9.24 *(17.69)	00
T_3	Parchment bag	0.00	0.00	00	1.46 *(6.94)	00
T_4	English newspaper bag	0.00	0.00	00	7.54 *(15.93)	00
T_5	Marathi newspaper bag	0.00	0.00	2.50 *(9.09)	9.97 *(18.40)	00
T_6	Control (without bag)	6.00	21.50	5.52 *(13.58)	12.02 *(20.28)	00
	S. E. ±	-	-	-	0.6966	-
	C. D. 0.5%	-	-	-	2.0998	-

* Figures in parenthesis indicate arc sin transformed value.

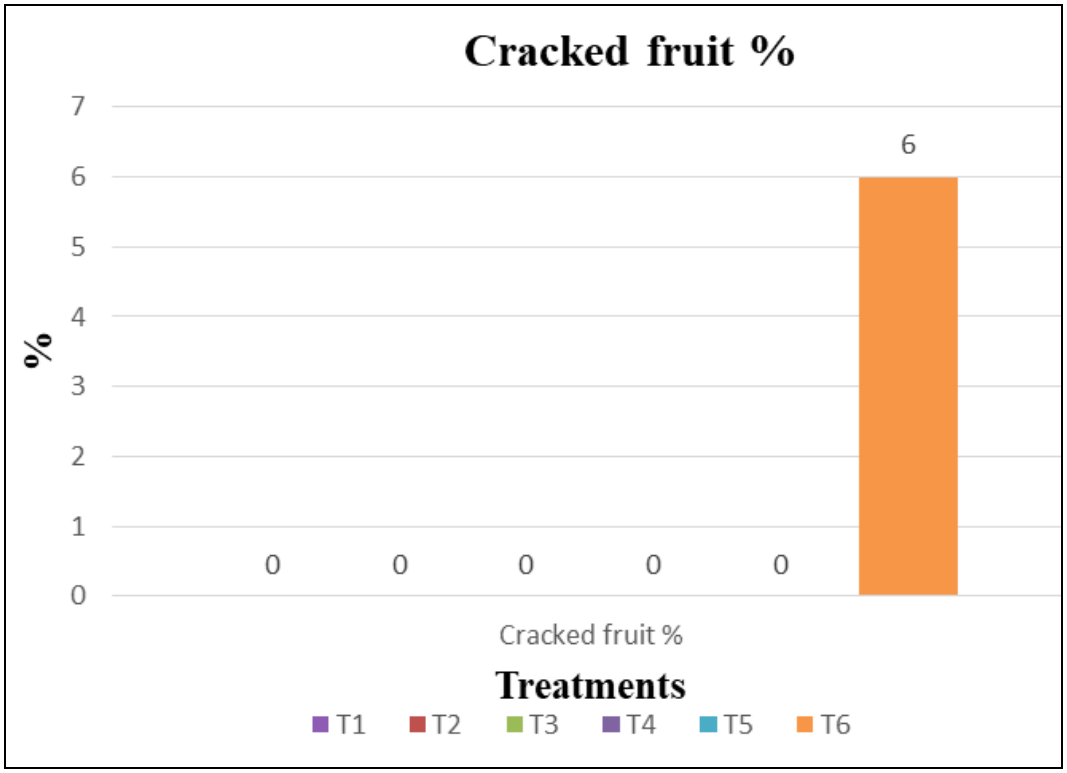

Fig 3: Effect of types of bag on Cracked fruit %

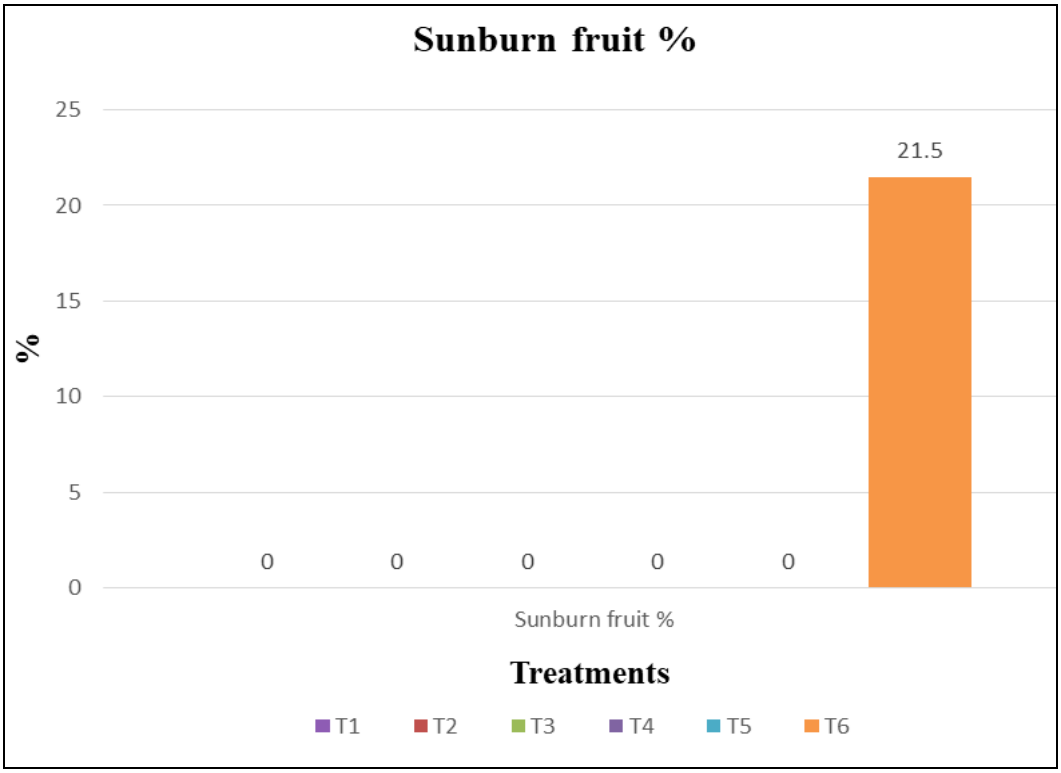

Fig 4: Effect of types of bag on Sunburn fruit %

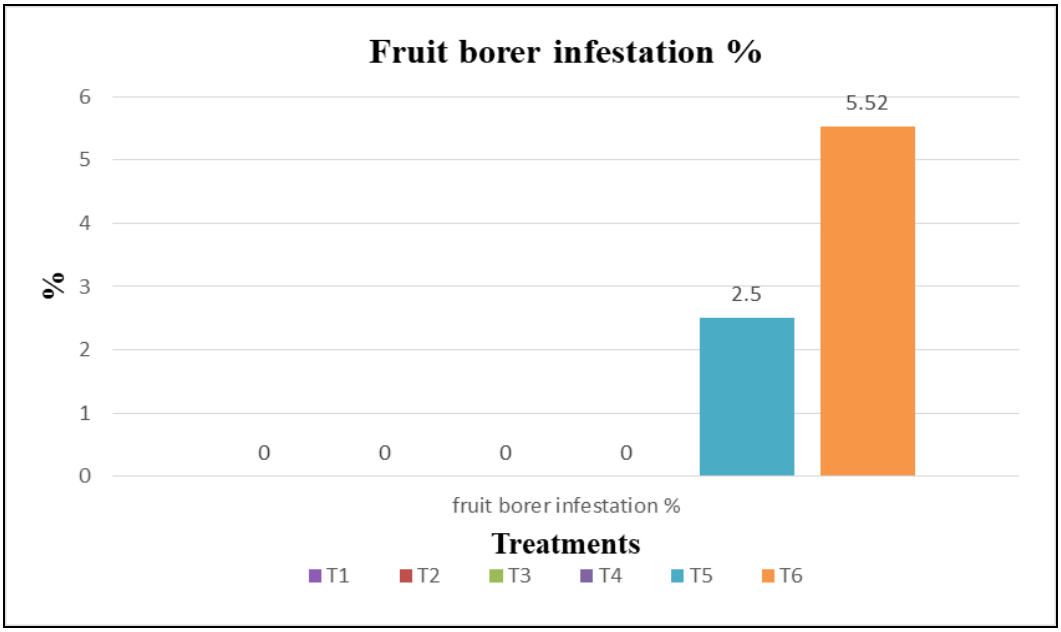

Fig 5: Effect of types of bag on Fruit borer infestation (%)

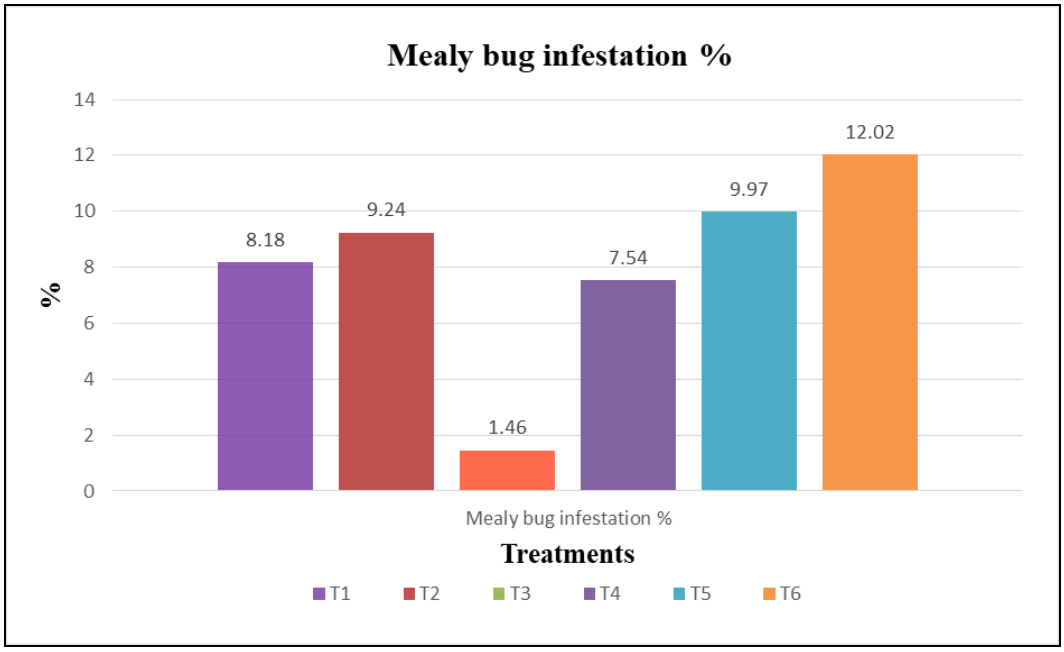

Fig 6: Effect of types of bag on Mealy bug infestation (%)

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