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Impact of bagging on mango fruits on incidence of different insect pests and physico-chemical characteristics of mango fruits (*Mangifera indica* L.) cv. Neelum

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Abstract
An experiment was conducted at Department of fruit Science, College of horticulture, Anantharajupeta to access the effect of bagging on mango fruits (cv. Neelum) on the incidence of different insect pests during 2021-2022 in a randomized block design with ten treatments which were replicated three times. The fruits were bagged at marble stage (30 days after fruit set). The fruits were bagged with brown paper bag, two layered yellow paper bag and white plane paper bag and control, removed for every 15 days intervals (forth night) at 30, 45 and 60 days from bagging when the pest population is contact the data was recorded. The results showed that bagging treatments had significantly reduced the incidence of insect pests like thrips, fruit borer, mealy bug and fruit fly. Thus, bagged come out to be environment friendly and also effective tool to protect mango fruits from different insect pests, helping to improve fruit quality.

Keywords: Brown paper bags, two layered yellow paper bags, white plane paper bags, insect pests, (*Mangifera indica* L.) cv. Neelum

Introduction
Mango (*Mangifera indica* L.) belongs to the family of Anacardiaceae is renowned for its colour, taste, and variety, thus called as "King of Fruits" (Karar *et al.*, 2019) [14]. It is cultivated in an area of 1.23 MH with an annual production of over 10.99MT that constituted more than 55% of global production (NHB database-2015) It known to be a good source of antioxidant-rich phytonutrients and polyphenolic compounds, as well as vitamins including A, C, niacin, riboflavin, thiamine, ascorbic acid, and β-carotene (Ribeiro *et al.*,2007) [15]. Ripe mango reported to have moisture content of 73.0-86.7%, 0.5-1.0% of protein, 0.1-0.8% of fat, 11.6 to 24.3% of carbohydrates, 0.413% of calcium, 6375-20750 of vitamin A (µg 100^{-1} β-carotene), 50.00 mg$100g^{-1}$ of riboflavin and 6.8-38.8 mg$100g^{-1}$ of ascorbic acid, 12.0-23.0 ^{o}B (TSS) and 0.12-0.38% acidity (Bose and Mitra., 2001) [1] According to Pena *et al*. (1998), the quality of mango fruits is mainly deteriorated by insect-pest complex and diseases. Among which fruit flies, are the single largest group of insects attacking fruits at mature and semi ripened stages during the month of April causes yield loss upto 80% worth of Rs 29,460 million annually in crops like mango, guava and sapota. Patel *et al*. reported that fruit flies cause upto 40% yield loss in heavy rainfall zone of south Gujarat. According to Kanaka Maha Lakshmi (2021) fruit fly is one of the deadliest pest that causes extensive damage and the damage accounts for about 27% to 42% of loss in harvest and as per Patel *et al*. (1999) [16] reported that fruit flies cause upto 40% yield loss in heavy rainfall zone of south Gujarat. In Andhra Pradesh, the loss has been found to be up to 48% when proper measures were not taken.

In the recent years, the fluctuations in the climate factors during fruit development had an impact on the fruits external appearance and quality but have also increased the incidence of various insect pests and physiological disorders like spongy tissue, which has further increased yield losses. Despite of adopting many traditional practices, bagging was found to be successful in protecting fruits from mechanical damage, sunburn, fruit cracking, bird damage, blemishes and can maintain good appearance and size, increases the fruit quality and can extend their shelf life. It is an eco-friendly technique of covering the fruits with plastic or cloth bags provides a physical barrier and prevents the pests, especially fruit flies from reaching the

fruits, prevent its ovi-position (egg laying) through ovi-positor and can even protects fruits from latex burn and fungal spots also improves their visual quality as a result of increased relative humidity in bagged fruits (Wang *et al*., 2007) [17]. This alternative method appears to be boon against the backdrop of random use of pesticides and fungicides causes serious threat to environment showing residual effect of toxic chemicals within fruits leads to its rejection for export.

Materials and Methods

The present investigation was conducted at fruit Science block in department of Entomology, College of horticulture, Anantharajupeta in 2022 to study the impact of bagging on mango fruits on incidence of different insect pests and physico-chemical characteristics of mango fruits (*Mangifera indica* L.) cv. Neelum. The present investigation was constructed in Randomized block design, carried out using three different types of bagging material with dimensions 20×28 cm –Brown paper bag with black coating inside, 18×28 cm – Two layered yellow paper bag with black coating inside and 20×24 cm – white plane paper bag at two different fruiting stages. For this purpose, five fruits were randomly selected per treatment per replication. At marble stage of fruit bagging on mango fruits (cv. Neelum) the percent incidence of thrips was recorded and at lemon sized fruiting stage average number of grubs per fruit of fruit borer, percent incidence of mealy bug and fruit fly was recorded.

The percentage fruit damage/infestation was worked out using the following formula

$$\text{Percent incidence of insect pest} = \frac{\text{Number of infested fruits in each replication}}{\text{Total number of fruits}} \times 100$$

$$\text{Insect pests per fruit (No.)} = \frac{x_1+x_2+x_3+x_4+x_5}{\text{Total number of fruits in each replication}} \times 100$$

Results and Discussion

1. Percent incidence of thrips

The data pertaining to thrips incidence presented in Table 1 indicated that bagging of mango fruits (cv. Neelum) had statistically significant effect on controlling the thrips damage. Among different treatment combinations imposed the percent incidence of thrips in fruits bagged with brown paper bag (T_7) and two layered yellow paper bag (T_8) respectively which were removed, 60 days after fruit bagging at marble stage by (0.00%) followed by 6.66% in fruits bagged with white plane paper (T_9) and with the maximum percent fruit damage (46.66%) was observed in control fruits (T_{10}). This might be due to type of bagging material used and duration for which the bags remained intact to fruits giving maximum protection to fruits from pest attack and external environment conditions.

2. Fruit borer per fruit (No.)

As disclosed from the data presented in Table 2 below where fruits were bagged at lemon sized fruiting stage and observed that no infestation of fruits from fruit borer was observed in (T_7), (T_8), (T_9) respectively bagged with brown paper bag, two layered yellow paper bag and white plane paper bags, which were removed after 50 days which was followed by (T_4) by 0.06% and 2.73% in control (T_{10}). This might be due to covering of fruits different types of bags, acting as a barrier between fruit and the external environment.

3. Percent incidence of mealy bug

As depicted from the data represented in Table 3 indicating different bagging treatments significantly reduced the percent damage of mealy bug. The treatments (T_7) and (T_8) were free from mealy bug incidence (0.00%) and the lowest incidence of mealy bug was noticed in T_4 and T_9 (6.66%), whereas highest percent incidence (26.66%) of mealy bug was observed in unbagged fruits (T_{10}). This was due to bagging of fruits in turn acting as a between fruit and insect avoiding the direct contact with fruit.

4. Percent incidence of fruit fly

The data pertaining to fruit fly incidence presented in Table 4 indicated that bagging of mango fruits (cv. Neelum) had statistically significant effect on controlling the thrips damage. Among different treatment combinations imposed the percent fruit damage in fruits bagged with brown paper bag (T_7) and two layered yellow paper bag T_8) respectively which were removed, 50 days after fruit bagging at lemon sized fruiting stage by (0.00%) followed by 6.66% in fruits bagged with white plane paper (T_4) and with the maximum percent fruit damage (40.00%) was observed in control fruits (T_{10}). This might be due to type of bagging material used and duration for which the bags remained intact to fruits giving maximum protection to fruits from pest attack and external environment conditions.

Table 1: Effect of bagging on percent incidence of thrips in mango (cv. Neelum) at marble stage

Treatments	Percent incidence of thrips
T_1: (Bagging with brown paper bags at marble stage and removal of bags 30 days after bagging)	26.66 *(31.09)
T_2: (Bagging with 2 layered yellow paper bags at marble stage and removal of bags 30 days after bagging)	26.66 *(31.09)
T_3: (Bagging with white plane paper bags at marble stage and removal of bags 30 days after bagging)	33.33 *(35.26)
T_4: (Bagging with brown paper bags at marble stage and removal of bags 45 days after bagging)	13.33 *(21.41)
T_5: (Bagging with 2 layered yellow paper bags at marble stage and removal of bags 45 days after bagging)	13.33 *(21.41)
T_6: (Bagging with white plane paper bags at marble stage and removal of bags 45 days after bagging)	13.33 *(21.41)
T_7: (Bagging with brown paper bags at marble stage and removal of bags 60 days after bagging)	0.00 *(0.00)
T_8: (Bagging with 2 layered yellow paper bags at marble stage and removal of bags 60 days after bagging)	0.00 *(0.00)
T_9: (Bagging with white plane paper bags at marble stage and removal of bags 60 days after bagging)	6.66 *(14.96)
T_{10}: (control- without bagging)	46.66 *(43.04)
S.Em ±	0.35
CD at 5%	1.05

Table 2: Effect of bagging on average number of fruit borers in mango (cv. Neelum) at lemon sized fruiting stage

Treatments	Fruit borer per fruit (No.)
T_1: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	1.06 *(5.91)
T_2: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bag 20 days after bagging)	1.20 *(6.29)
T_3: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	1.46 *(6.94)
T_4: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	0.06 *(1.40)
T_5: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	0.13 *(2.07)
T_6: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	0.26 *(2.92)
T_7:(Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_8:(Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_9: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_{10}: (control- without bagging)	2.73 * (9.51)
S.Em ±	0.11
CD at 5%	0.35

Table 3: Effect of bagging on percent incidence of mealybug in mango (cv. Neelum) at lemon sized fruiting stage

Treatments	Percent incidence of mealy bug
T_1: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	13.33 *(21.41)
T_2: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bag 20 days after bagging)	13.33 *(21.41)
T_3: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	26.66 *(31.09)
T_4: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	6.66 *(14.96)
T_5: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	13.33 *(21.41)
T_6: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	20.00 *(26.57)
T_7: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_8: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_9: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	6.66 *(14.96)
T_{10}: (control- without bagging)	26.66 *(31.09)
S.Em ±	0.26
CD at 5%	0.79

Table 4: Effect of bagging on percent incidence of fruit fly in mango (cv. Neelum) at lemon sized fruiting stage

Treatments	Percent incidence of fruit fly
T_1: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	20.00 *(26.52)
T_2: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bag 20 days after bagging)	20.00 *(26.57)
T_3: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 20 days after bagging)	26.66 *(31.09)
T_4: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	6.66 *(14.96)
T_5: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	13.33 *(21.41)
T_6: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 35 days after bagging)	20.00 *(26.57)
T_7: (Bagging with brown paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_8: (Bagging with 2 layered yellow paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	0.00 *(0.00)
T_9: (Bagging with white plane paper bags at lemon sized fruiting stage and removal of bags 50 days after bagging)	13.33 *(21.41)
T_{10} (control- without bagging)	40.00 *(39.23)
S.Em ±	0.33
CD at 5%	0.98

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