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On-farm testing of different bunch cover materials to improve fruit quality of banana cv. grand Nain under high density planting during winter season

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Abstract

An On Farm Testing of bunch covering materials on improving the fruit quality of banana cultivar Grand Nain was conducted during winter season on farmer's field at Kolhari village, Gudihatnoor mandal, Adilabad district, Telangana, India. Bunch covers play a vital role in modifying the microclimate around developing fruits, enhancing fruit size and reducing surface blemishes. Traditionally, natural materials like dry banana leaves (DBL) and Jute bags (JB) were used, but modern alternatives such as transparent polyethylene (TPB), silver non-woven polypropylene bags (S-NWPB), and red and green leno bags (RLB and GLB) were commercially used and their effect on fruit quality in winter season was not well studied. Among the bunch covering materials, the RLB and GLB showed promising results as their bunch weights and extended shelf life. Early fruit maturity was observed in TPB bunches, and increased the number of fingers per hand, and improved fruit quality by raising total soluble solids. The RLB and GLB were resulted in higher additional income and an improved incremental benefit-cost ratio compared to un-covered bunches. The minimal chilling injury scores (1.16), thrips damage scores (0.33), and fruit scarring beetle incidence (0.69%) were observed RLB and GLB covered bunches when compared to control. Use of RLB or GLB bunch covers proved as valuable and economical practice for improving the fruit yield and quality there by higher returns to the farmers.

Keywords: Banana bunch covering materials, chilling injury index, scarring beetle damage, bunch weights, quality

1. Introduction

Banana (*Musa paradisiaca* L.) ranks among the earliest fruit crops to be cultivated and holds significant importance in Indian agriculture. It ranks as the leading fruit crop in India in terms of production. Globally, Bananas are grown in over 150 countries worldwide, with an estimated annual production of 105 millions of tons. India is the leading producer of banana worldwide, accounting for around 25.7% of total global production. The banana plant is a large, herbaceous, perennial, monocotyledonous, and monocarpic species (Ashutosh *et al.* 2024) [7]. The 'Grand Nain' cultivar, which belongs to the AAA genome group of the Cavendish subgroup of *Musa accuminata*, is widely grown due to its excellent taste, high yield potential (averaging 30 kg per plant), and good post-harvest shelf life. A typical bunch of Grand Nain bananas contains 10 to 12 hands, comprising 175 to 225 individual fruits. The fruits are elongated, cylindrical, and slightly curved (Anonymous, 2012; Anonymous, 2024b) [4, 6].

In India, bananas are cultivated over 961,000 hectares, producing around 3.6 million metric tonnes annually. In the state of Telangana alone, banana cultivation spans 2,300

hectares with an output of 109.61 thousand metric tonnes (Anonymous, 2024a) [5]. Banana farming is a vital livelihood for many growers due to its economic value. However, successful banana production depends on several factors, including the choice of cultivar, proper agronomic practices, and effective protection against environmental stresses and pests (Olumba & Olumba, 2020) [25].

Among various agronomic practices, bunch covering has gained significance in recent years due to its positive effects on fruit quality and reduced crop duration (Purnima *et al.* 2017) [31]. The timing of flowering and fruiting varies by variety, typically requiring 6 to 8 months for flowering and an additional 4 to 6 months for fruit maturity. Given this long growth cycle, protecting the fruit from birds, insects, and climatic extremes is crucial. Wind damage is particularly problematic, as it can scar the fruit skin by carrying dust and debris. Uniform, blemish-free appearance is essential for both export and domestic markets, as larger and cleaner fruits fetch higher prices (Ghani *et al.* 2023) [14]. To address these challenges, banana growers across the world have adopted the use of fruit protection bags, commonly referred to as bunch covers, ripening bags, or

crop covers. These covers serve multiple purposes: they physically protect the fruit, enhance visual quality by promoting uniform coloration, reduce fruit cracking, and help create a favourable micro-environment that influences internal fruit characteristics (Fan & Mattheis, 1998). These bags come in various colours and designs to suit different climatic conditions (Jannoyer & Chillet, 1998; Muchui *et al.* 2010).

In Agricultural plantations, high-quality plastic protective covers for bunches are widely used, often treated with insecticides for enhanced protection. In addition, some farmers directly spray pesticides onto the bunches. While traditional methods included wrapping bunches with old banana leaves or using paper bags on a limited scale, plastic covers are now prevalent in countries like Australia, India, and tropical regions of the Americas. Colored plastic bags such as green, blue, black, orange, and silver are used to promote early ripening, improve fruit quality, and guard against sunburn, pests, and physical damage (Rajan *et al.* 2020)^[32].

More recently, non-woven fabric bags have emerged as significant innovation for the banana cultivation. These bags are breathable, allowing moisture and gas exchange, which supports uniform ripening and minimizes pest damage. However, the timing of bag application is crucial; it should be done around 21 days after the emergence of the flower stalk, once the young fruit fingers are firm enough to resist abrasion from the bag. While blue bags have been traditionally favoured, more recent options, including green, yellow, and clear covers with or without silver linings are being used more frequently. These color variations not only protect the fruit but also serve as visual indicators for bunch maturity. Silver linings, in particular, help prevent sunburn (Santosh *et al.* 2017)^[12].

Bunch covers have become an essential application in improving banana fruit quality and protecting against biotic and abiotic stresses. They enhance skin color uniformity, reduce blemishes, and defend against pests, chilling, sunburn, diseases, and mechanical injury. By altering the micro-environment, they can also lead to increased bunch weight and reduced time to harvest. These covers are typically made from lightweight plastic in various colors (e.g., white, blue, silver) and may be perforated or non-perforated, depending on local climatic conditions and production goals (Pavan Singh *et al.* 2023)^[30].

Research has demonstrated that bunch covering enhances appearance, physicochemical properties, yield and prevent various fruit disorders caused by extreme temperatures, pest attacks, and seasonal changes (Harvey, 2005; Pathak *et al.*, 2017; Chaiwong *et al.*, 2020)^[16, 28, 9]. During the fruit development stage, the plant is sensitive to extreme temperatures; exposure to temperatures below 13 °C or above 36 °C may cause chilling injury or sunburn, respectively (Harvey, 2005; Ogunsua *et al.* 2018; Chaiwong *et al.* 2020)^[16, 23, 9].

Farmers have used various materials such as jute bags, newspaper, old cloth, dried banana leaves, and polyethylene bags of varying thickness and color based on availability, cost, and climate (Debnath *et al.* 2001; Rubel *et al.* 2019)^[13, 35]. While bunch covering reduces leaf chafing and disease

incidence, drawbacks such as sunburn and fruit splitting can still occur (Amarante *et al.* 2002; Weerasinghe & Ruwaphathirana, 2002; Rubel *et al.* 2019)^[2, 38, 35]. Red and green Leno bags have proven effective in minimizing blemishes and protecting fruits from sunburn. Transparent polyethylene bags reduce the risk of chilling injury but may trap excess heat, leading to sunburn during late winter (Chaiwong *et al.*, 2020)^[9]. These benefits not only improve market value but also reduce post-harvest losses. Considering these factors, the objective of this study is to determine the effect of different bunch covering materials on the quality of the 'Grand Nain' banana cultivar.

2. Materials and Methods

2.1 Experimental Location

The on-farm testing of banana bunch covering materials was conducted during the winter season of 2024 - 2025 (November - March) in Kolhari village, Gudihatnoor Mandal, Adilabad district. Kolhari village is located at latitude of 19.56° N, longitude of 78.53° E and altitude in Adilabad district. The area has an average annual temperature of 30.08 °C and receives an average yearly rainfall of approximately 1157.6 mm, with July being the wettest month. On-farm testing was conducted in the farmer field planted at a spacing of 2.01 m × 2.01 m (2400 plants / ha) with the banana cultivar Grand Nain on 1st August 2023, accommodating. The crop is 2 years old and in second ratoon crop. Drip irrigation and standard fertigation practices were adopted for efficient water and nutrient management.

2.2 Bunch covering materials

In the second ratoon crop of banana, bunch covers were wrapped after denavelling (removal of male bud). The covers were positioned once the bracts had naturally shed from the hands, at the stage when the banana fingers started to curl upward and the floral remains had become firm. Rubber bands were used to secure these bunch sleeves to the bunch peduncle. The covers remained open at the bottom and reached at least 15 cm below the lowest hand of the fruit. The control plants were left without bagging. The covers remained on bunches until harvest. Two foliar sprays were given, consisting of 13-0-45 and 0-52-34 fertilizers (50 g per 15 liters of water), a micronutrient complex (1 ml per litre of water), and calcium nitrate with boron (3 ml per litre). Harvesting was carried out when the fruit ridges became rounded instead of angular, and the peel color changed from green to light green, as described by Rubel *et al.* (2019)^[35]. Two types of bunch sleeves were used: non-woven polypropylene bags (31.5 inches wide, 17 GSM) and transparent polyethylene bags (200 gauge, 1.5 m × 1 m). The green and red Leno bags had vents for air circulation, whereas the transparent polyethylene, jute bags did not have vents, which made foliar spraying of bananas more difficult. Bunch bagging was performed on November 12, 2024

The experiment was conducted using a randomized block design consisting of seven treatments and replicated six times. A total of 84 banana plants were used in the experiment. Treatment details for the banana bunch covers are presented in Table 2.

Table 2: Different bunch covering materials used in the study.

S. No.	Treatments	Bunch Sleeves
1	T ₁	Silver non-woven polypropylene bag (S-NWPB)
2	T ₂	Green leno bag (GLB)
3	T ₃	Transparent polyethylene bag (TPB)
4	T ₄	Red leno bag (RLB)
5	T ₅	Jute bag (JB)
6	T ₆	Dry banana leaves (DBL)
7	T ₇	Control / No cover (NC)



(Abbreviations: S-NWPB Z: Silver non-woven polypropylene bag; GLB: Green leno bag
 TPB: Transparent polyethylene bag, RLB: Red leno bag (RLB), JB: Jute bag
 DBL: Dry banana leaves NC: Control / No cover)

Fig 1: Different Banana Bunch covering materials used in the study.

2.3 Data collections

Bunches were collected when they attained full maturity, and the weight of each bunch was measured immediately after harvest using a digital weighing balance. The peduncle was included in the weight measurement up to the first bract leaf node situated above the first hand. Bunch weight was recorded in kilograms (kg). The number of days to harvest was determined by counting the total days from spadix emergence to bunch maturity and recorded in days. The

number of fingers per bunch was determined through manual counting. The average number of fingers per bunch was then calculated and recorded. The total number of hands in each bunch was counted manually. The average number of hands per bunch was then calculated and recorded. Finger length was recorded using a measuring scale and recorded in centimetres (cm). Finger girth was measured by wrapping a thread around the widest midpoint of each fruit and then determining the circumference using a scale. The average finger girth was calculated and measured in centimetres. The pulp and peel weights of ripe fruit was measured using an electronic weighing balance after separating it from the peel. The average pulp weight per bunch was calculated and expressed in grams. The pulp-to-peel ratio was determined by dividing the weight of the pulp by the corresponding weight of the peel. The average ratio was then calculated and recorded (Vitthal, 2019). To estimate yield per hectare, the individual plant yield was multiplied by the number of plants per hectare and recorded in tons per hectare

$$\text{Yield (t/ha)} = \frac{\text{Yield (kg per bunch)} \times \text{Number of plants per hectare}}{1000}$$

The incremental benefit cost ratio was calculated by using the formula

$$\text{Incremental Benefit Cost Ratio} = \frac{\text{Additional Income}}{\text{Additional cost of cultivation}}$$

2.4 Quality Characters

Total Soluble Solids (°Brix)

The TSS content of the pulp was measured using a handheld Brix refractometer (RHB-32ATC, Erma Tokyo, Japan) at room temperature and expressed in °Brix. The TSS percentage was obtained through a direct reading from the instrument.

Shelf Life

The storage duration of banana fruits was determined by storing samples from each treatment at room temperature (25 ± 1 °C). It was determined by counting the number of days required for the fruits to fully ripen while retaining desirable marketability and eating quality (Rubel *et al.* 2019)^[35].

Chilling Injury

In banana fruit chilling Injury at mature green stage, based on intensity of surface browning, was scored from 1 to 5 rated as follows: score 1 = no CI, score 2 = mild CI, score 3 = moderate CI, score 4 = severe CI, and score 5 = very severe CI (Chaiwong *et al.* 2021)^[9]

Thrips damage score (%)

Thrips damage score as 0-10% = 1 (no thrips damage), 11-20% = 2 (Low thrips damage), 21-50% = 3 (medium thrips damage), and above 50% = 4 (high thrips damage) (Ogunsua *et al.* 2018)^[24]

Scarring beetle incidence

Scarring beetle disease incidence percentage can be calculated by given formula (Pavan Singh *et al.* 2023)^[30]

$$\text{Scarring beetle disease incidence (\%)} = \frac{\text{Number of banana infested by scarring beetle}}{\text{Total number of banana/bunches}} \times 100$$

2.5 Statistical Analyses

Statistical analyses were performed as randomized block design, comprising seven treatments with six replications. For fruit characteristics analyses, the data for each replication represented the average of five fruits. Analysis of variance (ANOVA) was conducted using GRAPES statistical software (Gopinath *et al.*, 2021)^[15]. Significant differences among treatments ($P < 0.05$) were compared by using the Tukey's Honest Significant Difference (HSD) test.

3. Results and Discussion

Days to Harvest

The shortest harvest duration was noted in the bunch sleeve with transparent polyethylene bag (111.90 days), followed by the bunch sleeve with GLB (113.00 days) and the bunch sleeve with RLB (113.66 days), as compared to the control (118.50 days). Altering the microclimate to create slightly warmer conditions has a beneficial effect on fruit maturity, yield, and quality by using banana bunch covers (Mukharjee, 2006; Purnima *et al.*, 2017)^[1, 31].

Number of fingers per hand and Number of hands per bunch

The highest number of fingers per hand was observed in the bunch sleeve with TPB (17.05), followed by the bunch sleeve with GLB. These results are in conformity with Cunnen and Entyre (1988); Reddy (1989)^[33]; Patil *et al.* (1989)^[29]; Anon (1993)^[3]; and Purnima *et al.* (2017)^[31]. Larger fruit size in the distal hand contributes to enhanced fruit quality. (Irizarry *et al.* 1992)^[18].

The greatest number of hands per bunch was recorded in the bunch sleeve with RLB (9.33), followed by the bunch sleeve with S-NWPB (9.16) and bunch sleeve with GLB (8.50). In terms of total number of fingers per bunch, the bunch sleeve S-NWPB with recorded the highest (148.66), followed by the bunch sleeve with TPB (141.66) and the bunch sleeve with GLB (132.83).

Bunch weight

The maximum bunch weight was noted in the bunch sleeve with RLB (21.50 kg), followed by the bunch sleeve with GLB (19.83 kg) and the bunch sleeve with TPB (19.33 kg). The higher individual fruit weight was found in the bunch sleeve with S-NWPB (164.30 g), followed by the bunch sleeve with GLB (150.73 g) and bunch sleeve with GB (149.70 g). The increased fruit weight can be attributed to improved microclimatic conditions within the covers, which enhance photosynthetic efficiency and metabolite assimilation. These favourable conditions may promote better carbohydrate conversion and nutrient accumulation, ultimately contributing to higher finger and bunch weight (Kalukhe *et al.*, 2024)^[19].

Finger length and finger girth

The higher finger length was observed in bunch sleeve with GLB (15.73 cm), followed by the bunch sleeve with RLB (15.35 cm) and bunch sleeve with S-NWPB (15.33 cm). The maximum finger girth was observed in the bunch sleeve with GLB (16.98 cm), followed by the bunch sleeve with TPB (16.29 cm) and the bunch sleeve with RLB (14.02 cm).

It might be due to better development of fruits observed when the fruits are covered with bunch cover helps in filling of fingers and also facilitates more temperatures during cool climates. These results conform to Pathak *et al.*, 2016 and Kalukhe *et al.*, 2024^[27, 19].

Pulp weight, peel weight and pulp-to-peel ratio

The highest pulp weight was observed in the bunch sleeve with GLB (101.83 g), followed by the bunch sleeve with S-NWPB (101.33 g) and the bunch sleeve with RLB (96.66 g). The maximum peel weight was found in the bunch sleeve with DBL (34.33 g), followed by the control (without bunch covering) (33.50 g). The higher pulp-to-peel ratio was noticed in the bunch sleeve with GLB (3.85), followed by the bunch sleeve with S-NWPB (3.56) and the bunch sleeve with TPB (3.27). These results are in line with Khataniar (1989)^[20] and Purnima *et al.* (2017)^[31].

Banana yield

The significantly highest banana yield was obtained in the bunch sleeve with RLB (51.60 kg), followed by the bunch sleeve with GLB and bunch sleeve with TPB (46.40 kg), compared to the control. Temperature may increase inside the cover, leading to changes in yield-related components and overall yield. Banana bunch covers acted as a physical barrier between the fruits and insects, helping to prevent fruit scarring caused by beetles and also reducing the incidence of Fusarium wilt (Pavan Singh *et al.*, 2023)^[30]. These results conform to Cunnen and Entyre (1988), Reddy (1989)^[33], Patil *et al.* (1989)^[29], Anon (1993)^[3], Choudhury *et al.* (1996)^[10], Robinson (1996)^[34], Alam *et al.* (2000)^[1] and Purnima *et al.*, (2017)^[31].

Total soluble solids

The highest total soluble solids (TSS) were recorded in bunch sleeve with TPB (21.40 °Brix), followed by the bunch sleeve with GLB (20.87 °Brix) and bunch sleeve with S-NWPB (20.86 °Brix). It might be due to the accumulation of polysaccharides are rapidly degraded and mostly transformed into soluble sugars, which constitute a major portion of the total soluble solids in bananas (Marriot, 1980; Parmar and Chundawat, 1984; Seymour *et al.* 1993; Purnima *et al.* 2017; Hasan *et al.* 2007;)^[21, 26, 37, 31, 17]. While non-significant differences were observed, these were attributed to an increase in water content within the fruits caused by higher relative humidity (Suchitra *et al.* 2021).

Shelf life and Incremental benefit-cost ratio

Shelf life was the more in bunch sleeve with TPB (9.66 days), which was statistically on par with the bunch sleeve with RLB and bunch sleeve GLB (9.00 days). According to Chaiwong *et al.* (2019)^[9], an experiment conducted in late winter in Thailand revealed that non-woven banana covering materials effectively reduce visual defects caused by sunburn injuries due to temperature fluctuations during this season. Bunches covered with these materials were more appealing to consumers, resulting in higher market prices. The use of RLB (with an incremental benefit-cost ratio of (430) and GLB (386) significantly increased additional income. The only challenge associated with

banana covers is during foliar spraying; however, they remain cost-effective for farmers, with a single banana bunch cover costing approximately Rs. 10.

Chilling Injury Score

A significantly lower chilling injury score was also observed in plants with bunch covers compared to the control. These findings are in agreement with those reported by Ogunsua *et al.* (2018) [23] and Chaiwong *et al.* (2021) [9]. During fruit development, banana plants are sensitive to both low temperatures in winter and high temperatures in summer. In the present study, chilling temperatures are prevalent throughout night in the December 2024 to January 2025 months (Figure 2). The use of bunch covers helped reduce chilling injury, possibly because they maintained a more stable internal temperature. In contrast, the uncovered (control) plants were directly exposed to low winter temperatures, resulting in low chilling injury scores.

Thrips damage score (%)

In banana, various species of thrips cause damage to the fruit, with flower thrips (*Frankliniella* spp.) being the most common. These pests typically cause small, raised pimples capped with black spots on the fruit surface. Significantly No thrips damage was observed in banana bunches covered

with sleeves compared to the control (11.33%). Thrips damage tends to increase marginally during the rainy season due to a rise in temperature, leading to soft peel damage at the time of bunch emergence. However, this does not affect the eating quality of the fruit. Bunch covers made from non-woven materials have been found effective in reducing thrips damage. These findings are consistent with the study of Santosh *et al.* (2017) [12] and Ogunsua *et al.* (2018) [24].

Scarring beetle disease incidence (%)

The fruit scarring beetle (*Colaspis hypochlora*) is a common pest in banana cultivation, with its incidence being particularly high during the rainy season. This pest causes raised lesions and scars along the peel surface, primarily in the midrib area, and typically invades banana bunches when the fruits are still very young. A significantly lower incidence of scarring beetle was observed in bunches covered with protective sleeves compared to the control (26.58%). According to Pavan Singh *et al.* (2023) [30], covering banana bunches with polypropylene bags is highly effective in preventing scarring beetle damage and also contributes to increased yield. These findings are consistent with the results reported by Santosh *et al.* (2017) [12] and Pavan Singh *et al.* (2023) [30].

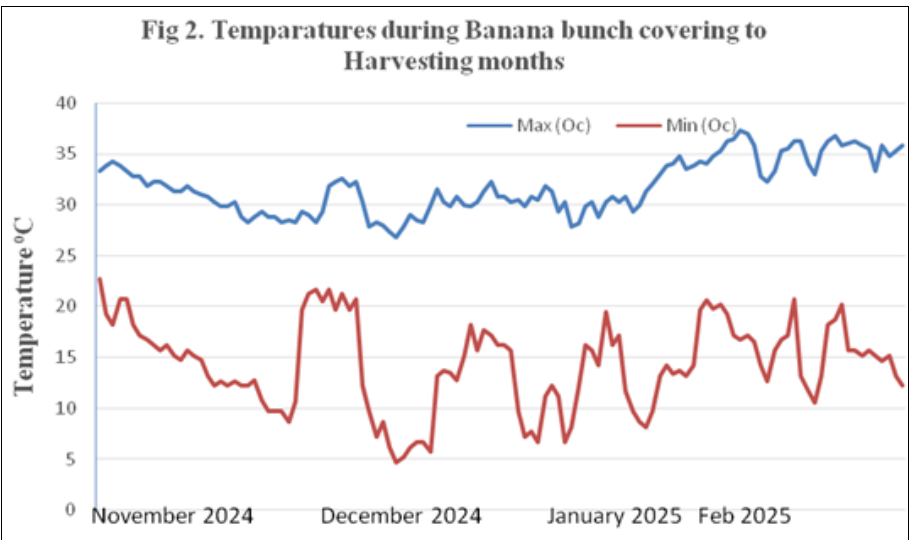


Fig 2: Minimum and maximum air temperatures (°C) during the banana bunch covering to harvesting months.

Table 1: Effect of different bunch covers on fruit yield and quality on banana cv. Grand Nain

Treatments	Days to harvest	Number of fingers per hand	Number of hands per bunch	Number of fingers per bunch	Average fruit weight (g)	Bunch weight (Kg)	Finger length (cm)	Finger girth (cm)	Pulp weight (g)	Peel weight (g)	Pulp-to-peel ratio	Banana yield (t/ha.)	Total soluble solids (°Brix)	Shelf life (days)
T ₁	113.16	16.16	9.16	148.66	164.30	19.00	15.33	13.41	101.33	29.00	3.56	45.60	20.86	8.50
T ₂	113.00	15.66	8.50	132.83	150.73	19.83	15.73	16.98	101.83	27.50	3.85	47.60	20.87	9.00
T ₃	111.90	17.05	7.16	120.56	140.66	19.33	14.63	16.29	99.16	30.33	3.27	46.40	21.40	9.66
T ₄	113.66	15.16	9.33	141.66	127.93	21.50	15.35	14.02	96.66	31.83	3.04	51.60	20.68	9.66
T ₅	116.83	15.16	7.16	109.66	149.70	16.16	13.68	13.36	88.83	28.66	3.15	38.80	20.52	7.16
T ₆	117.00	13.16	7.16	96.33	141.23	17.66	14.96	12.28	90.50	34.33	2.77	42.40	20.05	6.66
T ₇	118.50	12.50	6.33	79.83	135.83	15.50	13.73	11.77	84.33	33.50	2.52	37.20	19.23	6.66
SE (m)±	0.84	0.62	0.51	9.302	2.56	0.64	0.19	0.56	2.56	1.43	0.19	1.55	0.35	0.51
C.D. (P=0.05)	2.45	1.79	1.475	26.99	7.43	1.87	0.56	1.64	7.44	4.14	0.54	4.49	1.03	1.48
CV	1.79	10.09	15.898	19.22	4.34	8.57	3.21	9.87	6.63	11.38	14.40	8.57	4.23	15.26

Significant differences among treatments ($p < 0.05$) were assessed using Tukey's Honest Significant Difference (HSD) test. (Treatments: T₁-Silver non-woven polypropylene bag (S-NWPB); T₂-Green leno bag (GLB); T₃-Transparent polyethylene bag (TPB); T₄-Red leno bag (RLB), T₅- Jute bag (JB); T₆- Dry banana leaves (DBL); T₇-Control / No cover)

Table 2: Effect different bunch covers on incremental yield, additional cost of cultivation, additional income and incremental benefit cost ratio over control.

Treatments	Incremental yield (Kg/ha)	Additional cost of cultivation (Rs/ha)	Additional Income (Rs/ ha.)	Incremental Benefit- Cost Ratio
T ₁	8400	1800	126000	70
T ₂	47592	1800	713880	396.6
T ₃	46392	1800	695880	386.6
T ₄	51600	1800	774000	430
T ₅	38784	2490	581760	233.63
T ₆	42384	1700	635760	373.97

(Treatments: T₁-Silver non-woven polypropylene bag (S-NWPB); T₂-Green leno bag (GLB); T₃-Transparent polyethylene bag (TPB); T₄-Red leno bag (RLB), T₅- Jute bag (JB); T₆- Dry banana leaves (DBL); T₇-Control / No cover)

Table 3: Effect of different bunch covers on chilling injury score, thrips damage, Scarring beetle disease incidence (%)

Treatments	Chilling injury score	Thrips damage score	Scarring beetle disease incidence (%)
T ₁	1.00	2.83	0.78
T ₂	1.33	0.33	0.69
T ₃	1.83	2.66	2.12
T ₄	1.16	1.50	0.70
T ₅	1.50	4.00	2.58
T ₆	2.50	4.16	6.36
T ₇	3.33	11.33	26.58
SE (m)±	0.22	1.13	1.35
C.D. (P=0.05)	0.63	3.27	3.91
CV	29.53	72.44	58.27

Significant differences among treatments ($p < 0.05$) were assessed using Tukey's Honest Significant Difference (HSD) test.

Treatments: T₁-Silver non-woven polypropylene bag (S-NWPB); T₂-Green leno bag (GLB); T₃-Transparent polyethylene bag (TP); T₄-Red leno bag (RLB), T₅- Jute bag (JB); T₆- Dry banana leaves (DBL); T₇-Control / No cover (C)

4. Conclusion

The use of banana bunch covers significantly influenced growth, yield, and quality parameters. Transparent polyethylene sleeves promoted early maturity and improved fruit quality, including more fingers per bunch and higher total soluble solids. Red and green leno bags enhanced bunch weight, yield, and shelf life, while silver non-woven polypropylene bags increased individual fruit weight and finger count. Bunch covering also reduced sunburn, chilling injury, thrips, and scarring beetle damage, thereby improving fruit quality. Overall, banana bunch covers proved to be a cost-effective intervention, contributing to higher returns and a better incremental benefit-cost ratio for farmers.

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