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Pavan Singh
Senior Research Fellow, NICRA, Krishi Vigyan Kendra, Kishanganj, Bihar, India

Hemant Kumar Singh
Subject Matter Specialist (Horticulture), Farm Science Center, Kishanganj, Bihar, India

Rajeev Singh
Senior Scientist & Head, Krishi Vigyan Kendra, Kishanganj, Bihar, India

MK Roy
Senior Scientist & Head, Krishi Vigyan Kendra, Gaya, Bihar, India

Amrendra Kumar
Principal Scientist (Fruit Science), Agricultural Technology Application Research Institute, Zone -IV, Patna, Bihar, India

Anjani Kumar
Director, ICAR - Agricultural Technology Application Research Institute, Zone – IV, Patna, Bihar, India

Corresponding Author:
Hemant Kumar Singh
Subject Matter Specialist (Horticulture), Farm Science Center, Kishanganj, Bihar, India

Effect of bunch cover on production, fruit quality and damage by scarring beetle of banana (*Musa paradisiaca* L.)

Pavan Singh, Hemant Kumar Singh, Rajeev Singh, MK Roy, Amrendra Kumar and Anjani Kumar

Abstract
Fruit scarring beetle (*Basilepta subcostata* Jacoby) is a harmful pest that can cause major damage to banana production. About 40 households cultivated banana in the upland area at NICRA village with the major problem faced by scaring beetle of Banana cultivation. The carried out demonstrated with randomized block design of Banana bunch cover at 10 farmer's fields of NICRA village in Khanabadi, Kishanganj, Bihar, India during 2021-22 under the supervision of KVK, Kishanganj. Demonstration of banana bunch cover for evaluating the efficacy of a few management strategies against the Banana fruit scarring beetle on Banana cv. Jahaji. The banana bunches that were covered with non-woven polypropylene bags were compared to the farmers' practice of leaving the bunches uncovered. The result of conducted field experiment revealed that among all the treatments application of bunch, cover was found significantly superior in all terms of yield characters. The significant maximum yield (455 q ha^{-1}) with minimum scarring beetle infestation (1.5%) was recorded in bunch cover Banana. The maximum gross return (Rs 8,64,500 ha^{-1}), net return (Rs 5,84,500 ha^{-1}), and benefit-to-cost ratio (2.08) under bunch cover than control. Significant increase in average fruit weight, bunch weight and yield of banana were recorded to the tune of 9.9%, 11.0%, and 10.9% respectively, over control.

Keywords: Polypropylene bag, scarring beetle, bunch covert, NICRA, B: C ratio

Introduction
The cultivation of Banana (*Musa Paradisiaca* L.) is a major occupation for fruit growers around the world, due to the income it generates. However, success in banana farming relies heavily on selecting the appropriate variety, using the right inputs, and implementing proper intercultural practices. Bananas are grown in over 150 countries and yield an annual total of 105 million tonnes of fruit. India, Brazil, and China are responsible for half of all global banana production, with India alone accounting for 11% of the world's banana-growing areas and contributing 23% of the world's banana production (Anonymous, 2016) [5]. Bananas are a significant crop in India, occupying an area of 8.83 lakh ha and producing 308.07 lakh tonnes with a productivity rate of 34.9 t/ha. However, the banana crop is susceptible to damage from adverse weather conditions and pests, which can negatively impact its appearance, production, and fruit quality. To protect against these threats, farmers often practice intercultural techniques such as bunch covering. This practice has a significant positive impact on all aspects of banana growth, leading to better market prices for growers. The quality of bananas can be affected by numerous factors, such as production practices. One effective physical protection method for bananas is the use of banana bunch covers. These covers can help improve the appearance of the fruit by encouraging skin coloration and decreasing blemishes. Additionally, it can improve the micro-environment for fruit development, which can result in better internal fruit quality (Fan and Mattheis, 1998; Santosh *et al*. 2017) [11, 22]. Banana bunch covers can also help reduce the incidence of scarring beetles, mechanical damage, sunburn, fruit cracking, agrochemical residues, and bird damage (Harhash and Al-Obeed, 2010) [14]. According to Mohamed and Al-Qurashi (2012) [19], this technique has also been applied to various other fruits to protection them against cold temperatures. Banana cover is made of polypropylene spun bond non-woven fabric, which is an agricultural fabric that controls the ripening of the banana while also keeping out dust and insects. This non-woven fabric is enhanced with UV-protective agents and can be pigmented as desired. It's important to note that the amount of light that reaches an agricultural product can significantly affect its development and ripening (Anonymous, 2012) [4]. Covering bunches of bananas has become increasingly important as it improves the overall quality of the fruit and reduces the duration of

crop production. The timing of flowering and fruiting depends on the variety of banana. A single flower stalk takes the banana plant 6 to 8 months to produce, and it takes an additional four to six months for the fruits to ripen. This is a long time to wait for delicious bananas, and it would be unfortunate to lose them to birds, insects, or environmental damage. In banana growing regions, fruit protection cover bags of various colors, both perforated and non-perforated, are extensively used to enhance yield and quality. (Stover and Simmonds, 1987) [25]. Covering banana bunches with synthetic material can create a modified microclimate that increases the temperature around the bunch by up to 10 °C. This helps with proper finger growth and development, as well as reducing the time between shooting and harvest, regardless of the season. Additionally, bunch covers have been found to reduce scarring beetle infestations on fruits. On average, the temperature inside the cover increases by 0.5 °C over a 24-hour period (Ganry, 1975) [12], and can increase by as much as 7 °C during the warmest hours (Vezina, 2016) [26]. The microclimate can shorten the time between flower and harvest by up to 14 days and increase the weight of the bunch depending on the cover type and environmental conditions. This information was found in studies by DP-Heenan in 1973 and EW-Hewett in 2006. Bunch covering has also been credited with improving the appearance and color of the fruit's skin, increasing finger length and bunch weight, and reducing fruit defects such as sunburn and splitting (Amarante *et al*., 2002; Cuneen *et al*., 1988) [2, 10]. By covering the banana bunch just after pollination, significant reductions in surface damage from insect pests can be obtained. Bunch covers have also been found to eliminate chaffing of fruit from leaves during growth (Weerasinghe and Ruwapathirana, 2002) [27]. The net effect of using bunch covers is better fruit quality and an increased marketable yield. This allows for the production of good-quality, visually appealing banana fruits that are less likely to be bruised, making them more attractive to consumers (Shewfelt, 2009; Sarkar *et al*., 2016) [24, 23].

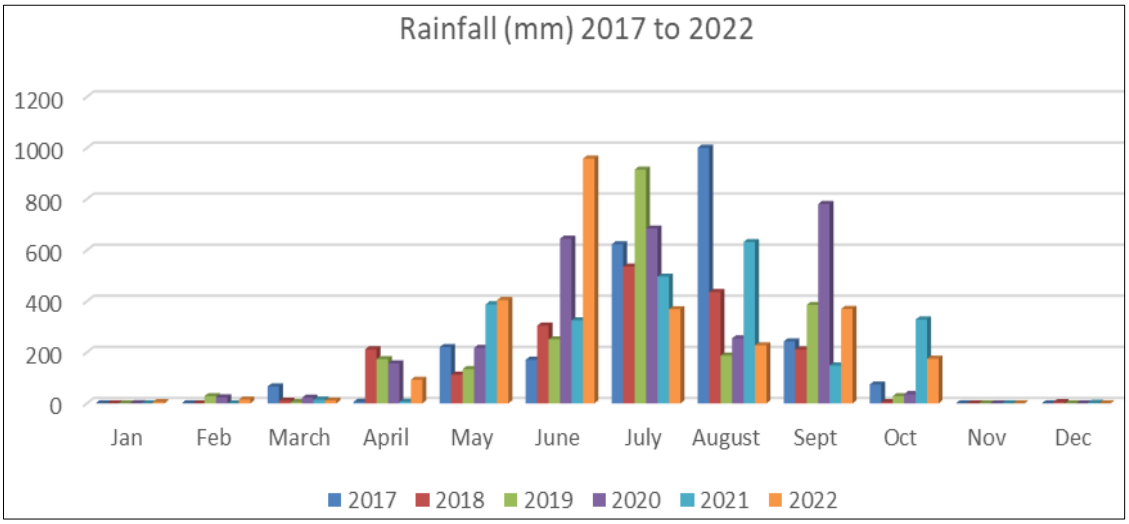
Materials and Methods

The experiment followed a randomized block design with ten replications. Two materials for covering bunches were used. *viz*., T_0: Control (non-cover), T_1: (nonwoven polypropylene bag) at 10 farmer's field of NICRA village, Khanabadi, under the supervision of Farm Science Centre, Kishanganj, Bihar, India during 2021-22. Comprising 10 plots at different locations. Demonstration of banana bunch cover for evaluating the efficacy of few management strategies against banana fruit scarring beetle on banana cv. Jahaji. Each plot consisted of 500 numbers of banana plants in 0.2 ha. For this study, we carefully chose plants that were of the same size and had equal vigor. Throughout the investigation, we maintained uniform cultural practices for all plants. Bunch covers, measuring 1.5 meters in length, 75 centimeters in diameter, and 5 micrometers thick, were used in the experiment. We put on the covers when the bracts that covered the hands had fallen and the fingers had curled up. The covers were hanging open at the bottom and extended at least 15 cm below the lowest fruit-hanging point. We did not cover the control plants with bagging materials. The bunch covers remained on the bunches until harvest. We picked the bunches of fruit once the edges on the surface became angular to round and the skin color changed from green to light green. We recorded the fruit and bunch weights using a digital weight balance and expressed them in grams (g) and kilograms (kg). Insect incidence refers to the percentage of bananas infected with fruit-scarring beetles. We calculated the insect incidence as below:

Insect Incidence (%) = Number of banana infested by scarring beetle/ Total number of banana/bunches × 100

Climate & Rainfall

The district has a moist and humid climate with distinct seasons. Winter begins in November and lasts until February, with January being the coldest month. During this time, the average daily temperature ranges between 5-10 oC, while the mean daily maximum temperature falls between 32-41oC. Summer starts from March and lasts until June. The season that follows is the monsoon, lasting until September. The district is commonly referred to as the "Cherapunji of Bihar" due to its high levels of rainfall, surpassing that of all other districts in the state of Bihar. On average, the district experiences 2355 mm of rainfall annually, with approximately 85% of it occurring during the south-west monsoon from June to September. Graph-1 provides rainfall data for the district over a six-year period, from 2017 to 2022.



Graph 1: Rainfall (mm) 2017 to 2022, Source: IMD, Pune, 2022

Statistical Analysis

Data collected from multiple observations will be statistically analyzed using the standard techniques of Analysis of Variance (ANOVA) with the assistance of computer software OP STAT. The randomized block design procedure will be followed, and if the "F" test shows significance at a 5% level of significance (p<0.05), the critical difference (C.D) will be calculated to determine the significance of differences between two treatment means.

Result and Discussion

Yield and yield attributes traits of Banana

Data pertaining to the all parameters of banana under different treatments are presented in Table 1. Bunch weight (kg), fruit weight (g), number of fruits infested by scarring beetle (%), and yield (q/ha) of banana were found significantly higher under demo with bunch cover compared to control. The bunches of the plants covered with nonwoven polypropylene bags were compared against the selected farmers' practice of without covering the bunch. During the observation, it was noted that fruits covered by a bunch had less beetle infestation (1.5%) than uncovered fruits (98.5%). This could be because the bunch cover acted as a physical barrier between the fruit and the insects. Similar results were found by Alam *et al.* (2000) [1], and Choudhury *et al.* (1996) [9]. Robinson (1996) also reported that the use of polyethylene bunch covers was widespread in the banana-growing world to control banana fruit scaring beetle. This aligns with the findings of Anonymous (2003) [3] and Bhagawati *et al.* (2013) [8]. Additionally, an increase in fruit weight and bunch weight was observed under cover, with fruit weighing 107.5 (g) and bunches weighing 18.2 (kg), compared to the farmer's practice of fruit weighing 97.8 (g) and bunches weighing 16.4 (kg). Cuneen *et al.* (1988) [10] also reported that bunch covers with different colored polyethylene bags significantly increased the fruit's length, girth, and weight compared to uncovered fruits throughout the day, the temperature increased under the cover, causing changes in the yield and its components. As a result, it can be inferred that covered bunch banana fruits are more appealing to consumers. This phenomenon has allowed farmers to obtain higher market prices and significantly increase their net profit compared to the control. The yield of banana was found significantly higher under bunch cover 455 (q/ha) as compared to control 410 (q/ha). Hence, yield of banana increased by 10.9% under bunch cover over control supported by Weerasinghe and Ruwapathirana (2002) [27]. As a consequence, yield was also increased significantly. Increase in yield and yield attributing characters may be because temperature is increased and microclimate is changed around bunch under cover, which provides a congenial environment for better fruit growth and development similar result found by Bashir *et al.* (2015) [7], Kutinyu, R. (2014) [18], Hasan *et al.* (2001) [15], Rodrigues *et al.* (2001) [21] and Sarkar *et al.* (2016) [23].

Table 1: Effect of bunch cover on different parameters of banana

Treatment	Bunch weight (kg)	Fruit weight (g)	Number fruit infested by scarring beetle (%)	Yield (q/ha)
Demo (PP Bag*)	18.20	107.50	1.50	455
Control (Farmer Practices)	16.40	97.80	98.50	410
Sem ±	0.46	2.74	2.48	12
CD (P=0.05)	1.50	8.90	8.07	37

***** Polypropylene bag

Economics

The economics of treatments was affected by bunch cover under different treatment which increase cost of treatments accordingly and presented in Table 2. The treatment wise cost of cultivation, gross income, net return and benefit: cost ratio as influenced by bunch cover, which revealed that the highest net return (Rs 584500 ha^{-1}, 2.08) was obtain in bunch cover followed by non-bunch cover (Rs 509000 ha^{-1}, 1.88) respectively. Difference in gross return were due to difference in grain yield. Treatment having higher grain yield exhibited more gross return. Variation in net return were due to differences in gross return and cost of cultivation. B: C ratio depends on net return and cost of cultivation. Differences in net return and cost of cultivation caused differences in B: C ratio under different treatments.

Table 2: Economic impact of banana production under bunch cover

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
Demo (PP Bag*)	280000	864,500	584,500	2.08
Control (Farmer Practices)	270000	779,000	509,000	1.88
Sem ±	-	21,974	14,660	0.17
CD (P=0.05)	-	71,291	47,561	0.05

***** Polypropylene bag

Conclusion

Through experimentation, it was discovered that covering banana bunches with polypropylene bags is highly effective in preventing scarring beetle infestations and maximizing yield attributes. The use of bunch covers also resulted in the highest gross return, net return, and benefit-to-cost ratio. Hence, the 'Jahaji' variety of banana performed exceptionally well under bunch covers. This practice resulted in more visually appealing fruits, improved appearance, and increased productivity, which led to higher market prices and significantly higher net profit for farmers compared to the control. Ultimately, covered bunches proved to be a more attractive option for consumers.

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