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Studies on Biorational Strategies and Management Techniques for Controlling Major Pest Infestations in Litchi (*Litchi chinensis* Sonn.)

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Abstract: **The Litchi (*Litchi chinensis* Sonn., family: Sapindaceae), is a significant, nutrient rich evergreen and subtropical, commercial fruit crop of Bihar. In North Bihar districts such as Muzaffarpur, Darbhanga, Sitamarhi and Samastipur are the major hubs for litchi cultivation. Generally, farmers harvest an average of 5000 to 6000 fruits per tree, with yield potentially reaching up to 10000 fruits per tree.**

The present study was conducted to compare the field effectiveness of different biorational pest management strategies, including bio-pesticides, organic manures and other biorational components, against key pests of litchi viz. litchi fruit borer, litchi leaf roller and litchi mite. Spraying with 100% plant nutrition through organic sources provided the highest level of protection. This treatment recorded the minimum leaf infestation of 6.11% by litchi mite (*Eriophyes litchi* Keifer), 7.31% fruit damage by litchi fruit borer (*Conopomorpha cramerella* Snellen), 9.61% leaf infestation by litchi leaf roller (*Dudua aprobola* Meyrick) and the highest marketable fruit yield of 127.81 kg per tree.

The NSKE at 5% concentration also offered considerable protection to litchi trees against pest infestation, recording 9.00% leaf damage due to litchi mite, 10.51% fruit damage caused by litchi fruit borer, 13.81% leaf infestation by litchi leaf roller and a fruit yield of 122.21 kg per tree during the investigation period of 2024 and 2025. The primary LEM strategy involves the removal and destruction of infested twigs by burning (Waite 2005; Castro et al. 2018). In the present study, an effort has been made to compile comprehensive information on the management of major pests. These pest management modules were also found to be economically viable, especially the organic protection modules comprising NSKE (C/B=1:9.9) and spinosad (C/B = 1:10.3).

Keywords: **Litchi major plant (*Litchi chinensis*), Litchi shoot and fruit borer (*Conopomorpha cramerella*), Litchi mite (*Eriophyes litchi*), Litchi leaf roller (*Dudua aprobola*), Biorational strategies, Management.**

1. INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is recognized as one of the most valuable fruits in the world. India ranks as the second-largest producer of litchi after China. The litchi crop is infested by several insect pests and mites throughout its growth period, among which the litchi fruit borer (*Conopomorpha cramerella* Snellen), litchi mite (*Eriophyes litchi* Keifer) and litchi leaf roller (*Dudua aprobola* Meyrick) have been identified as major constraints to litchi production.

The litchi erineum mite is considered one of the most destructive pests of litchi across all litchi- growing countries. Due to its feeding, the lower surface of infested leaves exhibits abnormal proliferation of epidermal cells in the form of hair-like, velvety growth of chocolate-brown colour.

The litchi fruit borer (*Conopomorpha cramerella* Snellen) causes serious damage to both fruits and foliage. This pest has now emerged as one of the major pests of litchi in India, particularly in Bihar and Uttar Pradesh. The newly hatched larvae bore into the fruits and feed on the pulp. Such infested fruits become unfit for both domestic consumption and export, leading to heavy economic losses.

The litchi leaf roller (*Dudua aprobola* Meyrick), also causes severe damage to litchi foliage. The leaf injury caused by the leaf roller ranges from 17.71 to 72.61 per cent, while tree infestation varies from 13.89 to 54.55 per cent during August to February.

Since litchi fruits are primarily consumed fresh, they are highly prone to contamination from chemical plant protection measures. Therefore, the present investigation was undertaken to evaluate the potential of biorational methods for managing major pests of litchi within the framework of organic fruit production. This approach aims to conserve the natural enemies of these pests and the pollinators associated with this crop, especially honey bees, which are highly sensitive to synthetic pesticides.

2. MATERIALS AND METHODS

A field experiment was carried out at Mushahari Farm, Muzaffarpur District, Bihar, from 2024 to 2025 to assess different pest management strategies.

The trial was set up using a randomized block design (RBD) with litchi cultivar cv. Shahi. The spacing between two trees was maintained at 11 m x 11 m. Pruning of infested leaves and shoots followed by burning for their destruction was performed during June and November. Castor and neem cakes were applied in the root zone at their recommended doses immediately after the first monsoon shower in the first half of July in both years. Nutrients were also applied in the trees at their respective doses during the first fortnight of July. Inorganic fertilizers used as sources of NPK were urea, single super phosphate (SSP) and muriate of potash (MOP). The organic nutrient sources included farm yard manure (FYM), poultry manure, vermicompost and neem cake. All fertilizers and manures were applied in circular rings made at a distance of 2 to 3 meters from the main trunk, depending on the canopy spread. The rings were prepared with a width of 31 cm and a depth of 16 cm, and were covered with soil after application.

Neem Seed Kernel Extract (NSKE 5%) was freshly prepared by dissolving 500g of finely ground powder of well-dried neem seeds (with moisture content of 9-11%) in 11 litres of water. The seed powder was wrapped in a cloth, soaked in water overnight, and thoroughly stirred to prepare a sprayable suspension. All bio-pesticides were sprayed two times at their recommended doses, first at the time of new flush emergence (September - October) and second at the fruit colour break stage. Freshly prepared NSKE formulation was sprayed, whereas commercial formulations were used for Neem oil, *Verticillium lecanii*, an entomopathogenic fungal biopesticide, and spinosad, which is a fermented metabolite of the soil bacterium *Saccharopolyspora spinosa*. Following the application of treatments, observations were recorded in the orchard to assess suppression of the pest population. After treatment application, 10 twigs were randomly sampled from all directions of each tree to calculate the mean percent leaf infestation in order to evaluate the efficacy of treatments / pesticides on pest incidence. Similarly, 50 fruits were randomly collected from each tree to record the mean percent fruit infestation for both years. Finally, the data were statistically analyzed under Randomized Block Design (RBD). At the time of fruit harvest, fruit yield (kg / tree) was also estimated for both years.

3. RESULTS AND DISCUSSION

Organic farming has gained significant global popularity due to the rising demand for organic products. Because litchi fruits are delicate and juicy, they are highly susceptible to chemical contamination from residual toxicity. Consequently, evaluating the efficacy of organic elements paired with bio-pesticides is essential to combat pests. This approach aims to secure sustainable yields while minimizing the negative impacts of chemical fertilizers on soil health and the surrounding environment. Driven by these factors, the current study was conducted. Testing these organic components alongside specific bio-pesticides against primary litchi pests yielded notable outcomes.

The field efficacy data for the various organic protection modules against major litchi pests show that applying a natural pesticide, spinosad 45 SC (0.045%), twice specifically during the flush and fruit colour break stages combined with supplying plant nutrients entirely through organic sources (100%), provided the highest level of protection. This treatment recorded the lowest rates of litchi leaf infestation (6.11%), litchi mite damage (7.31%) and litchi leaf roller damage (9.61%). It also produced the highest fruit yield (127.81 kg per tree).

In comparison, spraying NSKE (5%) led to a 10.51% leaf infestation rate from litchi mite, a 10.51% fruit damage rate from litchi fruit borer, a 13.81% leaf infestation rate from litchi leaf roller, and a fruit yield of 122.21 kg per tree. Looking at the remaining treatments, neem oil (0.3%) applications resulted in an 11.81% leaf infestation rate from mite, a 13.51% fruit damage rate from fruit borer, and a 14.81% leaf infestation rate from leaf roller, yielding 115.81 kg of fruit per tree. Meanwhile, applying the *Verticillium lecanii* formulation (5 g/L of water) resulted in a 12.91% leaf infestation rate, a 15.81% fruit damage, and a 16.21% leaf damage, with a total fruit yield of 108.71 kg per tree (Table 1 and Fig. 1).

Using only organic manures, without any pesticides, outperformed the RDF

(Control) by registering lower damage rates. Specifically, this organic–only approach recorded a 27.41% leaf infestation rate from mites, 23.31% fruit damage from fruit borers, and 24.31% leaf damage from leaf rollers, while producing a fruit yield of 99.51 kg per tree.

Furthermore, combining the RDF with the pruning of infested twigs showed superior results compared to the control group (which had 57.01% leaf damage, 47.51% fruit damage, and 45.31% leaf infestation). This integrated pruning treatment reduced damage significantly, showing 35.81% leaf damage, 33.21% fruit damage, and 28.91% leaf infestation.

While the individual yields of these specific modules did not differ dramatically, the overall differences among all tested modules varied significantly. However, the interplay between the test years and the treatments did not show statistical significance (Table 1). From an economic standpoint, the organic protection systems using NSKE (with a cost-benefit ratio of 1:10) and spinosad (with a cost –benefit ratio of 1:11.4) proved to be highly cost-effective (Table 1). The notable decline in pest pressure and the positive fruit yields observed under organic management could potentially be linked to the vital role soil fauna plays in balancing ecosystem nutrient dynamics (Kumar, 2007; Moore et al., 1988; Tripathi *et al*., 2003) .

Furthermore, organic cultivation methods boost the activity of arbuscular mycorrhizal (AM) fungi associated with litchi crops. These fungi are documented to enhance nutrient uptake in plants and offer defense mechanisms by stimulating the synthesis of specific allelochemicals, particularly terpenoids and phenolics (Maier *et al*., 1995; Ray and Rajan, 1999). Lavie (1967) also observed that the active insecticidal elements found in neem cake (such as azadirachtin and meliantriol) possess systemic properties, thereby shielding the entire tree. Historically, numerous efforts have been made using neem products and oil cakes to manage litchi mites, fruit borers, and leaf rollers (Mallik and Vaidya, 1979; Mukherjee *et al*., 2007; Ranjan *et al*., 2003; Ranjal *et al*., 2011). However, these studies were not conducted within a fully organic (100%) production framework targeted at these pests. Consequently, the current investigation aims to substantially optimize the efficiency of indigenous natural predators, keeping pest populations beneath economic injury levels while preserving environmental quality for surrounding organisms.

Relevant Photography Plates.

Fig. 1. *Eriophyes litchi* - (A) Sample collection of *Eriophyes litchi* (B), (C) and (D) Infestation of *Eriophyes litchi* showing tea-like, chocolate-brown colour appearance on undersurface of leaves.

Fig. 2. *Conopomorpha cramerella* - (E) Field observation, Fig: (F) Adult moth, Fig: (G) Larva infested fruit, (H) Damaged fruits, (I) Internal view of infested litchi fruit showing larval feeding and (J) Damaged aril

Fig. 3. *Dudua aprobola* - (K) *Dudua aprobola* (Litchi leaf roller) (L) Litchi leaf affected by *Dudua aprobola*.

Table 1: Efficacy of organic pest management approaches against major Litchi pests in relation to fruit yield during 2024-2025 (Pooled)

Treatments		**Mean % leaf infestation due to *Eriophyes litchi***	**Mean % fruit infestation due to *Conopomorpha cramerella***	**Mean % leaf infestation due to *Dudua aprobola***	**Yield (kg / tree)**	**Cost : Benefit**
T1	**RDF with Pruning & incineration of infested twigs/leaves in June & November**	35.81 (36.91)	33.21 (30.51)	28.91 (32.31)	82.71	2:6.1

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T2	**100 % Organic nutrients from various sources + pruning & burning of infested twigs/leaves in June & November**	27.41 (31.61)	23.31 (29.01)	24.31 (29.61)	99.51	1:10
T3	**T2 + Foliar spray of 5% NSKE at flush (September-October)**	9.01 (16.91)	10.51 (18.91)	13.81 (21.61)	122.21	2:11.5
T4	**T2 + Neem oil @ 0.3% at flushing (September-October) and at fruit colour break stage**	11.81 (19.71)	13.51 (21.51)	14.81 (22.41)	115.81	3:1
T5	**T2 + Verticillium lecanii (3 x 10^8 c.f.u./g) @ 3 g / I water at flush and fruit colour break stage**	12.91 (20.61)	15.81 (23.51)	16.21 (23.51)	108.71	3:6.1
T6	**T2 + spinosad 46 SC @0.046% at flush stage (September - October) and fruit colour break stage**	6.11(14.41)	7.31(15.41)	9.61(17.51)	127.81	3:1
T7	**RDF (Control)**	57.01(49.41)	47.51(44.01)	45.31(42.61)	71.91	-
CD (P = 0.05)		(7.99)	(8.25)	(8.08)	22.33	-
CV		(14.22)	(15.17)	(14.42)	11.13	-
Year x Treatment		NS	NS	NS	NS	-

Values in parenthesis ( ) are angular values, RDF (1001g N, 501g P2O5 and 501g K2O)

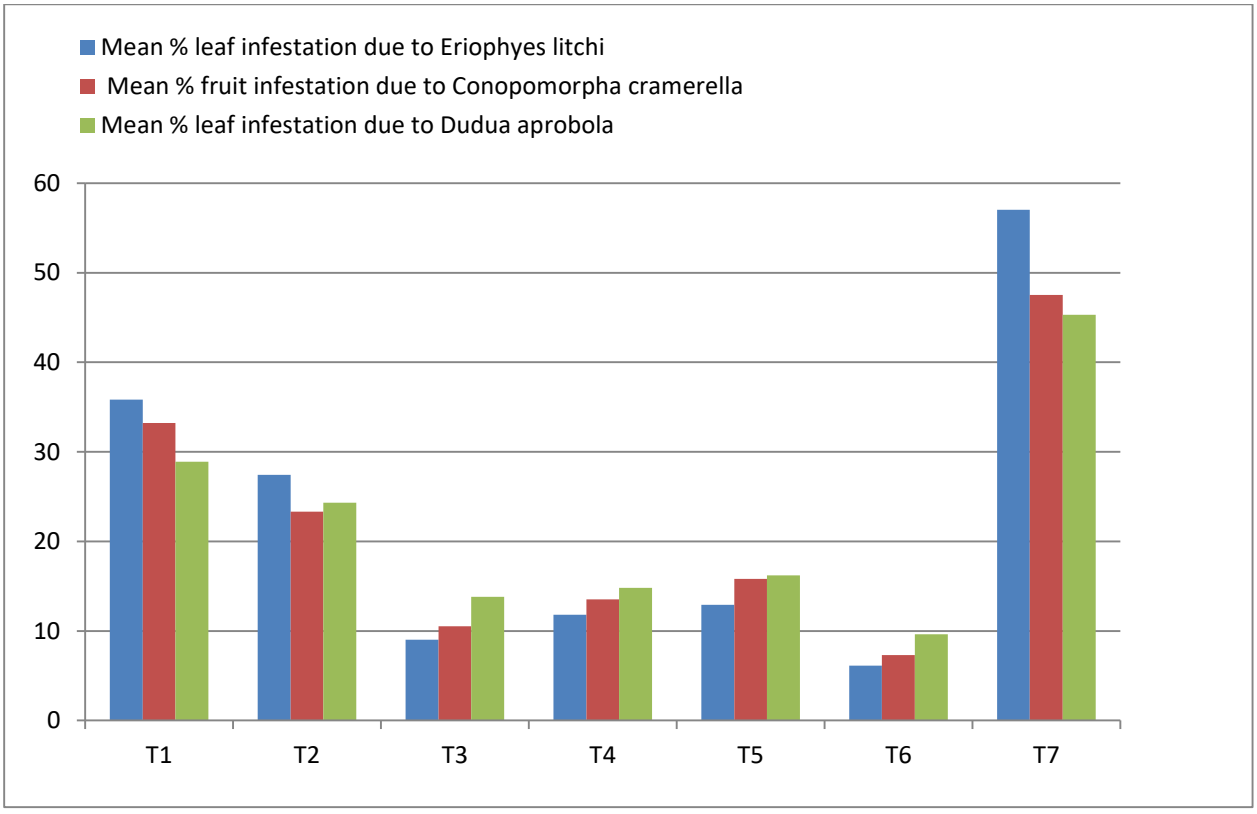


Fig 1: Effect of organic protection strategy to manage major pests of litchi during 2024-2025.

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Fig. (A)

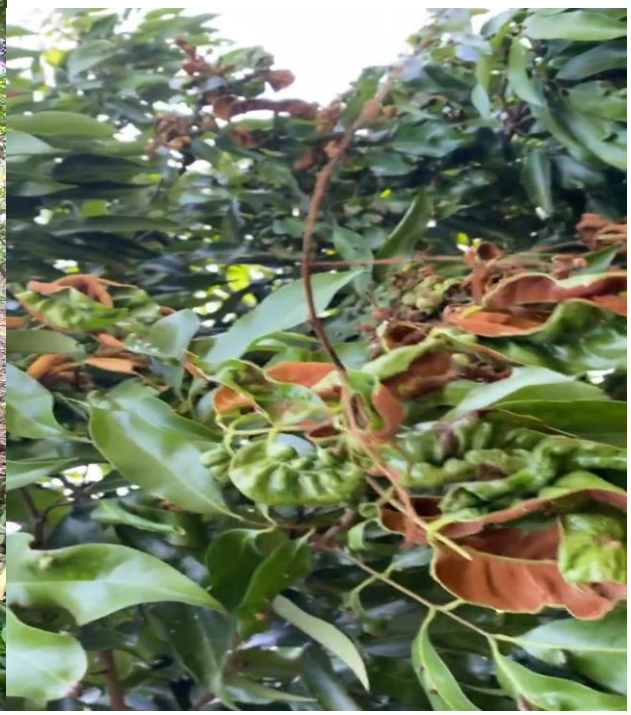


Fig. (B)



Fig. (C)



Fig. (D)

Fig. 1. *Eriophyes litchi* - (A) Sample collection of *Eriophyes litchi* (B), (C) and (D) Infestation of *Eriophyes litchi* showing tea-like, chocolate-brown colour appearance on undersurface of leaves.

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Fig.(E)



Fig. (F)



Fig. (G)



Fig. (H)



Fig. (I)



Fig. (J)

Fig. 2. *Conopomorpha cramerella* - (E) Field observation, Fig: (F) Adult moth, Fig: (G) Larva infested fruit, (H) Damaged fruits, (I) Internal view of infested litchi fruit showing larval feeding and (J) Damaged aril

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Fig. (J) **Fig. (K)**

Fig. 3. *Dudua aprobola* - (K) *Dudua aprobola* (Litchi leaf roller) (L) Litchi leaf affected by *Dudua aprobola.*

4. CONCLUSION

Utilizing these pest management strategies may offer greater cost-effectiveness, as a one-to-two-year timeframe is insufficient for organic treatments to deliver optimal outcomes. Adopting a pest control strategy within an organic production system not only safeguards crops from pest infestations but also yields high- quality fruit while preserving environmental standards. Consequently, the results of this research offer valuable insights for growers aiming to cultivate premium fruits under organic production frameworks. Futhermore, it opens up avenues for exporters to maximize revenue by supplying high-quality produce to global markets.

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