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Modified tree trunk banding technology for mango mealybug, *Drosicha mangiferae* (Green) management: A techno-economic analysis

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ABSTRACT: Mango mealybug *Drosicha mangiferae* (Green) is a univoltine seasonal pest, affecting a series of trees from December to April in north Indian conditions. Once it crawls up the tree in the season, insecticidal control becomes cumbersome and costly therefore tree trunk banding with plastic, supplemented with a sticky barrier was recommended long back for the management of this pest. Owing to various factors, this old technology is obsolete now and many farmers have shifted to insecticide dust-based trunk banding which is costly and environmentally harmful. We modified the old technology, replaced the materials and their specification and worked out its techno-economic studies. Modified banding technology has been found highly effective, its tree application rate is very fast; a team of two persons can apply the band to more than 100 trees in a day at a total cost of Rs 1750 whereas, in the old method of banding, it comes around Rs 4775 and that of in dust application, around Rs 2375 which ecologically also costly.

Key words: Mango, mealybug, banding, management

INTRODUCTION

Mango is well known for its excellent exotic flavor and usually referred to as the king of fruit (Sivakumar *et al.* 2011). The major mango-growing states are Andhra Pradesh, Uttar Pradesh, Karnataka, Bihar, Gujarat, and Tamil Nadu. Uttar Pradesh ranks first in mango production with a share of 23.47 % and the highest productivity (APEDA, 2021). Insect pests attack the mango and consume the nutrients from various parts of the plant system. Tandon and Varghese (1985) reported mealybug, *Drosicha mangiferae* (Green) as dangerous for the mango crop. It is not only the pest of mango but also attacks more than 70 other plants (Tandon and Lal 1978: Narula, 2003; Bandana *et al.*, 2017). It is a serious, dilapidating, polyphagous, dimorphic, and notorious insect pest of mango in the Indian sub-continent, distributed in Indo-Gangetic plains, feeding on other fruits crops, forest trees, ornamental plants, and weeds. During peak infestation, mango mealybug has been reported in different forest trees and an enormous number of crawlers and females get approach to tree *Dalbergia sissoo, Bombyx ceiba, Ficus religiosa*, and *Populus alba* via stem (Khan, 2001).

The eggs are laid in the soil around the tree trunk. There is great variation in the time of hatching of eggs (December to January) in different states due to variation in soil conditions. First instar nymphs are found during December-January and third instar females are found from March to the middle of April. Fertilized females start reverse migration from the third week of April to May to soil. Generally, the females migrate through the main stem but some of them also fall on the ground directly from the infested panicles and lay eggs in the soil around the tree trunk. The eggs remain in diapause in soil from May to December. Just after hatching, the minute pink to brown-coloured nymphs crawls up the tree. Nymphs and adult females suck the sap from tender leaves, shoots, and inflorescence. The insect also secretes honeydew over which sooty mold develops as a result, leaves and inflorescence become shiny black and sticky (Gundappa *et al.,* 2018).

The presence of a large alternative host range of mealybug makes them a great threat in orchard. The long-term control strategy is required in repeated approach due to its hiding habit and protective body covering. For this reason, chemical treatment is not advised till satisfactory control is achieved by other alternative methods. Alteration of environmental factors may affect their life cycle thereby affecting the time of infestation. By following the life cycle and seasonal dynamics, the mango mealybug population can be checked, therefore, the spatial and temporal separations in the life cycle of this insect have been worked out that provides an opportunity to apply a range of cultural, biological, and chemical control measures alone or in combinations.

Keeping the habit of tree ascending of mealy bugs and congregation, some of the management technologies like tree banding with plastic, chemical tree trunk banding, and insecticidal spray were developed by various workers. Banding of tree trunks with a polythene sheet (400-gauge, 30 cm wide) at a height of about 30 cm from the ground level and grease applied at the lower edge of the band during the 3rd/4th week of December was

recommended in the eighties. Due to cumbersomeness and cost, this technology became obsolete and another method of insecticide banding was introduced wherein, the tree trunk is mounted with raked soil up to a height of 6 -8" from the ground level followed by the application of 1.5 percent chlorpyriphos dust @ 250 g/ tree around tree trunk preferably in 3rd or 4th week of December. This method has its limitation such as ineffectiveness in rains and the related application and ecological costs. Nowadays readymade sticky bands (brown cello tape) are available in the market which may be equally effective. However, it needed standardization before recommendation hence, an attempt was made to economize the trunk banding technology in the present investigation.

MATERIALS AND METHODS

The body size of the mealy bug ranges from a few mm (at early instar) to 18 mm (last instar). In the first instar, their leg size is a few mm and hence, it covers the very small surface area on the tree trunk while crawling up. The tree banding with polythene provides a slippery surface that does not allow them to crawl up. Since their leg expansion is too little, a smaller slippery surface (3-4 inches) may give the same efficacy as given by 30 cm wide polythene sheet recommended in old technology, hence there was a scope of cost reduction on polythene by reducing its size. In old technology, mud application on the whole banding area is recommended before the fixing of polythene to seal the cracks and crevices below the sheet so that bugs don't find a way to crawl up. It was presumed that whole area mud application is not needed rather a band of sticky mud may seal the cracks and crevices effectively and therefore, the cost of labour on the application of mud can be reduced. In the old method, both the end of the polythene sheet needs to be fastened with twine. The grease application at the lower end of the band in old technology is recommended to seal the cracks and crevices so that mealybug does not find a way to crawl up from inside of the band, however, getting grease at village level and its associated cost is inhibitory in the application of this technology. Keeping this assumption in view, the experiment was designed and carried out at ICAR-CISH, Rahmankheda mango farm during 2019-2021. Various combinations of wrapping materials, soil paste, and sticky bands were applied during the 3rd week of December as below:

T1- Polythene banding (existing technology): Banding of tree trunks with a polythene sheet (400-gauge, 30 cm wide) at a height of about 30 cm from the ground level with grease banding at the lower edge.

T2- Brown cello tape wrapping over the soil band with grease band on the upper edge.

T3- Brown cello tape wrapping over the soil band with grease paste at the lower edge.

T4- Brown cello tape wrapping over the soil band with glue band at the lower edge

T5- Brown cello tape wrapping over the soil band with glue band on the upper edge.

T6- Chemical banding: Chemical raking in tree basin, the tree trunk mounting and raking soil up to a height of 6 -8" from the ground level than the application of 1.5 percent chlorpyriphos dust @ 250 g/ tree around the tree trunk.

T7- Control

In T2-T5, the materials used were i) locally available brown cello tape band of 4 inches wide having glue on its inner surface, ii) mixture of 1 kg clay soil with 50 ml of burnt Mobil oil, 250 gm POP, and water, kneaded to make it a dough (like loosely kneaded atta) paste, iii) a locally designed hand tool to remove the old and dead bark and iv) glue embedded twine.

To apply the treatment in T2-T5, around 7–8-inch bark area was cleaned on the tree trunk above 30 cm or any approachable trunk height by using bark remover to reduce the cracks and crevices on the trunk surface. Wherever the trunk surface was smooth, this exercise was avoided. Around about the center of the cleaned tree trunk area, the soil paste was applied in the form of a band of 2-inch width. The cello tape was wrapped wrinkle-free over the soil band in such a way that the soil band comes in the middle of the wrapped sheet. The cello tape was rolled twice tightly. The glue embedded twine was tied as per the treatment requirement.

All the treatments (except in control treatment) were supplemented with a second sticky band with brown cello tape over soil mud as data recording band, a foot above the treatment band on the tree trunk to count the number of mealybugs that succeeded in crossing the treatment band.

Each treatment was replicated 3 times in a randomized block design. The experiment was continued up to April when the bugs were matured and started reverse migration from the tree. The number of nymphs congregated below the first band as well as on the second band (data recording band) was recorded weekly whereas, on buds it was recorded when most of the bugs completed their crawl up. The cumulative population was subjected to analysis. The relative merit of the three most effective

Table 1. Efficacy of different banding methods in restricting the mealybug ascending on tree trunk and canopy

Treatments	Mean no. of mealybugs restricted at a lower band	Mean no. of Mealybugs succeeded to reach the second band	Mean no. of mealybugs / random buds
T1- Polythene banding (old technology).	73.17^{ab} (7.09)	61.54^{ab} (5.34)	0.0^{b} (0.50)
T2- Brown cello tape wrapping over the soil band with grease band on the upper edge.	172.5^{ab} (7.61)	118.83^{a} (6.60)	1.04^{b} (0.84)
T3- Brown cello tape wrapping over the soil band with grease paste at the lower edge.	120.17^{ab} (8.87)	22.5^{b} (3.46)	0.0^{b} (0.50)
T4- Brown cello tape wrapping over the soil band with glue band at the lower edge.	248.08^{a} (11.86)	0.54^{b} (0.79)	0.12^{b} (0.57)
T5- Brown cello tape wrapping over the soil band with glue band on the upper edge.	30.54^{b} (5.01)	7.42^{b} (2.42)	0.0^{b} (0.50)
T-6 Chemical banding	0.0^{b} (0.50)	0.0^{b} (0.50)	0^{b} (0.50)
T-7 Control	0.0^{b} (0.50)	0^{b} (0.50)	23^{a} (3.47)

Means with the same letter are not significantly different in Tukey's Honest Significant Difference (HSD) Test; Values in parenthesis are square-root transformed

Table 2. Comparison of application issues of modified banding method under field condition as against prevailing technologies.

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Parameters	T1- Polythene banding (old technology)	T4- Cello tape wrapping over the soil band with glue band at lower edge	T-6 Chemical banding
Amount of toxic chemicals added to the ecosystem	Nil	Nil	25 kg per ha
Application frequency	Once	Once	Repetition may be needed
Cost per 100 trees	4775	1750	2375 (ecological cost is high)
Application easiness	Labour intensive Needs re-sizing of polythene for application	Less labour, the required size is a market available.	Labour intensive Market available
Efficacy of the technology	No crawling up	No crawling up	No crawling up, but fails if rains and therefore re-application is needed
Alertness in timing of application	High	High	Very high

treatments and their associated cost was also worked out.

RESULTS AND DISCUSSION

The results indicated that the number of mealybugs ascended and assembled at the lower band (lower edge of treatment band) was found significantly different among the treatments ($F_{6, 159}$ =4.69; p<0.001). The highest number of mealybugs (248) stopped at the lower edge was found in T4 (cello tape wrapping over the soil band with glue band at lower edge)followed by T2 (cello tape wrapping over the soil band grease band on upper edge) numbering 172. The number of mealybugs congregated at the upper band (data recording band) was also found different among the treatments ($F_{6, 159}$ =4.71; p<0.001. The lowest number (0.54) was found in the treatment T4 (cello tape wrapping over the soil band with glue band at lower edge)followed by T5 (cello tape wrapping over the soil band glue band on upper edge) numbering 7.42. The number of mealybugs found in the buds of mango was also found significant among the treatments ($F_{6, 159}$ =7.92<0.001). Among the banding methods compared, mealybug was found (1.04) only in T2 (cello tape wrapping over the soil band and grease band on upper edge when compared to control (23 mealy bugs /bud) (Table 1). Very few numbers of mealybugs were found on buds in most of the treatments except control because they were prevented by a second band fixed a foot above the treatment band to restrict them for data purposes. Among the banding methods compared mealybug was found only in modified method with cello tape banding without upper restriction (1.04) when compared to control (23 mealy bugs /bud) (Fig 2). These findings were in agreement with Yousuf (1993) Mohmmad *et al*. (2004) who also found similar results of tree banding treatments of another kind for the control of mango mealybug.

The system of banding in T4 recorded maximum nymphs as they failed to crawl up and congregated at the bottom due to reasons such as i) closing bark cracks and crevices by soil mud band prevented the first and second instar nymphs crawling through cracks and crevices, ii) soil mud band curve formation with slippery surface changed center of gravity of crawling mealybug, therefore, they fell from the trunk in the later instars and iii) sticky band with glue dipped twine at lower edge prevented the crawling of young ones at the base of the band.

The superiority of the most effective treatment (T4) is presented in Table-2 which indicates that the technology requires less labor, the material is available in the market, all the stages of the mango mealybug are perfectly prevented from crawling on the trunk and no re-sizing of wrapping material is needed, hence can be recommended as modified tree trunk banding technology as an alternative to old banding technology. The cost estimation indicated that application and material cost for 100 trees comes around Rs 1750 in this modified tree trunk banding technology whereas, in the old method of banding, it comes around Rs 4775 and that of in dust application, around Rs 2375 which ecologically also costly. Adoption of this technology may be useful for the eco-friendly management of the mealybug.

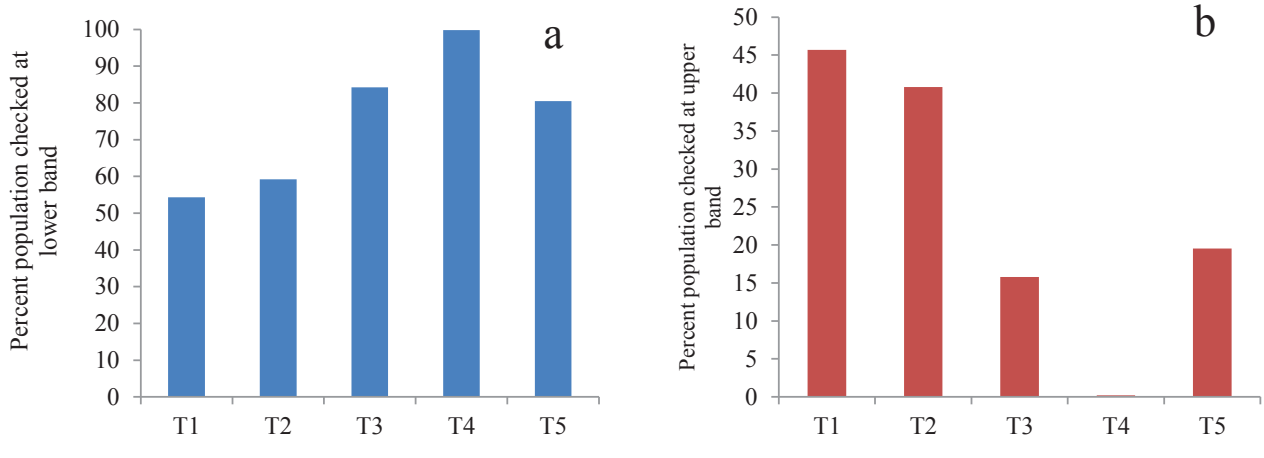

Fig. 2 Per cent mealy bug population checked at lower (a) and upper(b) band

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