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RESEARCH NOTE

A push-pull strategy for the management of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel) in mango

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ABSTRACT: Studies were conducted to refine the existing management strategies of fruit fly, *Bactrocera dorsalis* (Hendel) in mango by including a foliar application of a neem based pesticide on fruits that acts as a repellent. It was evident that azadirachtin applied on trees during fruiting stage coupled with methyl eugenol traps created a push-pull environment to female and male fruit flies respectively, thus significantly bringing down the fruit fly infestation.

Keywords: *Bactrocera dorsalis*, mango, fruit fly, azadirachtin, male annihilation, repellent

The push-pull strategy was first conceived for insect pest management (IPM) in Australia by Pyke *et al*. (1987) who investigated the use of a repellent and an attractive stimuli to manipulate the distribution of *Helicoverpa* spp. in cotton ecosystem. The concept was later termed as stimulo-deterrent diversion for developing alternatives to insecticides for control of the onion maggot (*Delia antiqua*) (Miller and Cowles, 1990). In this paper we discuss a similar push-pull strategy management of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel) in mango.

Fruit flies are important pests of tropical fruit crops around the globe. However, the main species of concern in the Indian subcontinent is *B. dorsalis* that infests mango, causing up to 80% losses (Verghese *et al*., 2002). The broad host range, ability to adapt to a wide range of climate and high reproductive rate make this fruit fly a serious pest with high invasive potential. The IPM of *B. dorsalis* is mainly surveillance through MAT (male annihilation technique) followed by sanitation and bait application technique (BAT) (Verghese *et al*., 2004; Anonymous, 2014); this IPM recommendation has been affording up to 90% control of infestation.

In a study conducted on the repellence of neem-based product, azadirachtin (10,000ppm) on males and females of *B. dorsalis*, it was found that both the sexes were repelled to the extent of 86 - 92.5 % in a two year study conducted during in 2014 and 2015 (Table 1). Based on the attraction of males to methyl eugenol and repellence to azadirachtin to both sexes, a pull-push IPM was envisaged and validated for three years (2017-2019) in a mango orchard (*cv.* Alphonso) of about two acres, on the outskirts of Bengaluru.

Field trial consisted of placement of para-pheromone (methyl eugenol) traps @10 /acre on the border trees from 45 days prior to harvest. Sprays of azadirachtin (3000 ppm) or azadirachtin (10,000 ppm) @ 2 or 1ml/ litre, respectively were given. The first spray was given within a week after the trap placement to the whole tree from the base of the tree to the whole canopy. The second and third sprays were given at fortnightly interval on the trunks and lower branches. Fruits were harvested at 80% maturity. At harvest, 50-80 fruits, taken randomly, were examined. It was found that no fruits were infested in all the three years. At harvest all the fallen fruits (n= 18 - 47) were examined and they too showed no infestation. This case study helped in inferring the principle of pull (trap attraction)-push (azadirachtin repellence) strategy is effective and is an improvement over the earlier recommendation. The trap catch by harvest showed a decline by >80% of initial catch indicative of a probable reduced breeding of the fruit fly population in the orchard. The male fruit flies 'pulled' (trapped) out to the borders of the orchard deprive the female of mating and perhaps mating disruption may occur due to cross odour olfaction from repellent odours from neem derived azadirachtin.

Table 1. Repellency of azadirachtin-treated* fruits to males and females of *B. dorsalis* (based on Mouly, 2018)

Year	Per cent repellency (over control)		Pooled Mean (%)
	Males	Females	
2014	90	82	86
2015	93	92	92.5

[n= 12 flies (19-day old) observed for landing response on fruits for one hour in laboraory with 10 replicates. *Mango fruits at 80% maturity dipped in azadirachtin 1.0%, @ 1.0ml/litre of water, for 5 minutes and air dried at room temperature were used for the study.]

Egg-laden female fruit flies, if any, are 'pushed' (repelled by azadirachtin odour) off the fruits/tree canopies preventing oviposition. In comparison, an adjacent orchard about one km away with only traps placed in old geometry style (Anon, 2014) for fruit fly control, recorded 8 - 16 per cent infestation between 2017 and 2019. This showed that the fruit fly was quite active in the study area and that pull-push strategy was an effective residue-free IPM.

In this study the BAT with jaggery 10% or protein hydrolysate, poisoned with insecticides (Anon, 2014) was not used indicating it could be dispensed with.

We found at mid-season that maggots in already infested fruits which dropped, could emerge out, pupate in soil and emerge as adults, while fallen uninfested fruits attracted females but could not support a full life cycle of the fruit fly; maggots perished in the rotting fruits. So sanitation initially is beneficial but to maintain sanitation is desirable as it brings down the load of anthracnose in the orchard. Further gallic acid can also serve as deterrent for fruit fly female which can detect the gallic acid/tannins through some sensory stimulii. Any deterrence to female fruit fly attack can act as a push strategy Therefore it is suggested to breed mangoes with peels having high tannins in future (Rashmi *et al*., 2017 and 2020).

The updated IPM recommended that is residue-free would be as follows:

1. Placement of methyl eugenol traps @ 10/acre (surveillance and MAT), 45 days prior to harvest till complete harvest along the orchard borders.

2. Collection and destruction of all fallen fruits immediately after trap placement.

3. Sprays of commercial azadirachtin 1.0%, @ 1.0ml/ litre of water, to the whole canopy a week after trap placement and thereafter two more sprays on the trunk and primary branches at fortnightly intervals. It was also found that spraying neem oil emulsion 0.5%, is equally effective (David *et al.,* 2020)

4. In case of organic orchards the traps have to be placed outside beyond the perimeters of the orchards.(David et al., 2020)

From experience the authors recommend that the above be followed as an area-wide practice for best results.

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