Socio-economic analyses of area-wide management of mango fruit fly in South India

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Abstract

Background: Mango is the most economically important fruit crop of India. The most important mango belt in Karnataka is Srinivasapura taluk (subdistrict) of Kolar district and it is the main crop of the taluk and hence the economy is dependent on it. One of the major limitations to mango productivity is the loss due to Oriental fruit fly (*Bactrocera dorsalis*) infestation. So the objective of the present study was to demonstrate the Integrated Pest Management (IPM) technology for fruit flies to mango farmers and to study the social impacts, constraints, economic improvements from adoption and the acceptability and potential uptake of the technology by farmers.

Methods: Fruit fly methyl eugenol traps developed at the Institute were placed in selected orchards with the help of local horticultural officers. Fruit flies trapped were brought to the laboratory, labelled and processed for taxonomic examination. The study was carried out with the help of the Karnataka State Horticulture Department and the Mango Growers Federation of Srinivasapura. In the mango seasons of 2007 to 2009 fruit fly infestation levels were monitored by field surveys. Mature fruits (n=200 to 400 fruits of assorted culivars) were sampled at random from 2-3 different orchards/per village. At least eight villages spread across the taluk at one to seven days prior to harvest were sampled. Percent infestation was calculated and adult flies were labelled for taxonomic processing. The fruits examined were mainly from cultivars Totapuri, Alphonso, Banganpalli and Neelum. The Integrated Pest Management consisted of male annihilation using methyl eugenol traps (15-20 traps/ha), destroying fallen fruits and bait splashes with jaggery (10%) +dichlorvos 78 EC (toxicant 2ml/l of bait) on the base of the main trunk, approximately 30cm above the ground @ 50ml bait/ tree.

Results: Surveys conducted from 2007 to 2009 showed that mean infestation of fruit fly was 48.3% on assorted cultivars of mango grown in Srinivasapura. Productivity enhancement was achieved to an extent of 45.8% in the 62.3ha of demonstration area. This clearly indicated that a fruit lost to fruit fly, if saved, is a fruit gained. The impact of this intervention was found to give a mean yield increase of 124.53 tonnes across the 62.3ha. This resulted in a productivity increase from 4.37 tonnes to 6.37 tonnes/ha, an increase of 1998.9 kgs of fruit/ha.

Conclusions: Economic analysis in 2012 showed that the technology spread to at least 55% of the mango area across south India with a net benefit of Rs. 5156 crores (approximately

US$825mn at 2014 exchange rate) of increase in mango revenue. The impact analysis showed that these farmers realized at least 20-40% yield increase, with a cost:benefit ratio ranging from 1:4 to 1:57, depending on the commercial value of the mango variety.

Keywords: Bactrocera dorsalis, integrated pest management, area-wide, mango

Introduction

Mango is the most important fruit crop of India. In south India, Karnataka is the second most important mango growing state after Andhra Pradesh. The most important mango belt in Karnataka is Srinivasapura taluk (subdistrict) of Kolar district. The main commercial varieties grown there are Totapuri, Neelam, Banganapalli and Alphonso. In addition, the area has other varieties such as Himayun Pasand, Raspuri, Kalapad, Mallika, Amarapalli, etc. Srinivasapura is a locally important market hub for mango, where nearly 80,000 tonnes of mango are marketed from makeshift packhouses. During the season, several middlemen and traders with temporary possession of orchards (through auction) also operate here. Mango is the main crop of the taluk and hence a major portion of the local economy is dependent on it. The taluk is one of the main feeders of fresh fruits to major urban markets of India such as Bengaluru, Mumbai, Chennai, Delhi, Kolkata, etc, besides the Gulf countries, Singapore and Malaysia. It also supplies (especially the variety Totapuri) to processing industries in Chitoor (Andhra Pradesh), Krishnagiri (Tamil Nadu), etc. Therefore, maximizing mango productivity is crucial to the economy of Srinivasapura.

One of the major limitations to mango productivity is the loss due to Tephritid fruit fly (Diptera: Tephritidae) infestation, mainly due to *Bactrocera dorsalis (*Hendel) species. The average national loss of mango due to fruit flies is estimated to be 27% (Verghese et al., 2006), with higher losses in the southern mango belts and lower losses in the northern belts. It was felt that if the mango farmers in Srinivasapura adopt the Integrated Pest Management (IPM) technology, developed by the Institute through an ICAR-DFID (UK) collaborative programme between 2001-2005 (Stonehouse et al., 2005) and further refined by the Division of Entomology and Agriculture Technology Information Centre, on an area-wide basis, the loss of mature fruits due to fruit flies could be substantially reduced, thus enhancing yield. So the objective of the present study was to demonstrate the IPM technology of fruit flies to mango farmers and to study the social impacts, constraints and economic improvements from adoption and the acceptability and potential uptake of the technology by the farmers.

Material and Methods

In Karnataka, Kolar district has the highest mango area with 40,769 ha, and so this district was chosen for transfer of technology (TOT) related to area-wide integrated pest management (awIPM) of fruit fly. Srinivasapura taluk of Kolar has more than 21,125 ha, of mango. So, this taluk was the focal point for the TOT of awIPM. Fruit fly parapheromone traps developed at

the Institute were placed in selected orchards with the help of local horticultural officers. Fruit flies trapped were brought to the laboratory, labelled and processed for taxonomic examination.

The study was carried out with the help of the Karnataka State Horticulture Department and the Mango Growers Federation of Srinivasapura. In the mango seasons of 2007 to 2009, fruit fly infestation levels were monitored by field surveys. Mature fruits (n=200 to 400 fruits of assorted varieties) were sampled at random from 2-3 different orchards/per village. At least eight villages spread across the taluk at one to seven days prior to harvest were sampled. These fruits were cut and examined in the field and percent infestation was assessed. Harvested fruits were also sampled from the market yard, with the help of traders. Sampled fruits were bought (at wholesale rate) and brought to the laboratory for ripening and observation of infestation (n=3-10 kgs). Percent infestation was calculated and adult flies that eclosed were killed with ethyl acetate vapour in the post-teneral phase and labelled for taxonomic processing. The fruits examined were mainly Totapuri, Alphonso, Banganpalli and Neelum varieties. The Integrated Pest Management consisted of male annihilation using methyl eugenol traps (15-20 traps/ha), destroying fallen fruits and bait splashes with jaggery (10%) + dichlorvos 78 EC (toxicant 2ml/l of bait) on the base of the main trunk, approximately 30cm above the ground @ 50ml bait/ tree.

Technology dissemination

The awIPM consisted of placing parapheromone traps @ 15-20/ha in mango orchards at preharvest stage (from approximately 30-45 days prior to harvest). Weekly collection and destruction of fallen fruit during the same period was advocated, followed by application of the bait described above on tree trunks twice before harvest at one week interval. The technology had no components of insecticidal spray either on the tree canopy or fruits and was therefore relatively environment-friendly and completely residue-free on the fruit. These measures were recommended to be implemented on wide-area, preferably in contiguous belts. There were several ways by which the TOT took place through extension folders, farmer campaigns, field demonstration, radio/television programmes, etc.

Results and Discussion

Infestation and species of fruit fly

Surveys conducted from 2007 to 2009, prior to the IPM introduction, showed that mean infestation of fruit fly was 48.27% on assorted varieties of mango grown in Srinivasapura, higher than the national average levels. The flies that emerged from fresh fruits were all identified as *Bactrocera dorsalis*, based on the key developed by Madhura and Verghese (2004). Despite three fruit fly species were identified in the traps (Table 1) only *B. dorsalis* was found infesting mango.

Table 1. Total of different fruit fly species of Srinivasapura caught in parapheromone traps (n=2 traps, village).

	B. dorsalis	***B. zonata***	***B. correcta***	**Remarks**
2007	25	0	0	Site A
2008	329	2	22	Site A
2009	80	6	8	Site B

The economy of the Srinivasapura taluk (Kolar district of Karnataka, South India) is largely dependent on mango. Productivity enhancement was achieved to an extent of 45.8% in the 62.3 ha of demonstration area. During seminars, the farmers were made aware of the species of fruit fly infesting mango and the nature of damage, biology of the pest, the loss being caused in the area and details of the intervention required on an area-wide basis. Each farmer was asked to take up this intervention on at least 0.80 ha for which 12 free traps were to be given to them. It was felt that farmers may hesitate to invest in the traps at the initial awareness stage, but if the farmers personally experience the benefit of IPM, they would adopt it in subsequent years. It is estimated that there are around 10,500 mango farmers in Srinivasapura taluk. In and around Srinivasapura town, there are approximately 500 mango farmers who might potentially respond to invitations for free distribution of traps. The publicity through two local newspapers and Department of Horticulture elicited a response from only 116 farmers, even though the traps were free. All these farmers were ones who managed their mango orchard without auctioning to a trader. This also gave an indication that those farmers who had auctioned their orchards prior to harvest were not interested in the IPM using fruit fly traps. According to the President of the local mango growers association, 50% of farmers in the area were self-marketing farmers, so the group of 116 farmers out of 250 self-marketing farmers accounted for 46.40% of the likely uptake group.

The seriousness of the farmers who took the traps, for the adoption of IPM, can be gauged from the fact that only 32% of the farmers placed the traps within the first week of obtaining them. Another 34% placed the traps the following week, thus in the first fortnight only 66% of the farmers installed the traps. This was approximately a month prior to harvest and hence the right time of intervention. Thus an adoption of 66% was obtained for the technology transfer, while the remaining 34% either did not place the traps or installed them too late to get any effective control. The 66% constituted 77 farmers. This accounted for 30.50% of the self-marketing target farmers in the area. The overall percentage of farmers who adopted the IPM was 15.2%. The traders, who auctioned or took farms by lease, did not show interest in collecting and implementing the traps. However this group will stand to immensely benefit if IPM is adopted, as fruit flies affect the mango crop directly. A fruit saved means extra income to the trader. As each farmer installed the trap in 0.80 ha, the total area covered was 62.3 ha in the selected area of Srinivasapura taluk. All these 77 farmers were interviewed for their satisfaction with the AWIPM intervention. It was found that the level of satisfaction

expressed by the farmers was positively correlated to the level of fruit fly catch. All the 77 farmers were interviewed for their perceived yield increase by mitigating loss due to fruit flies. For smaller land holdings the perception of yield increase was higher, while farmers with a higher land holding perceived less yield increase. One main reason which could be attributed to this is that small farm holders are invariably present in and around the orchards and are able to assess IPM interventions more accurately than larger farm holdings, where absentee landlords are the norm. The mean loss due to fruit flies estimated in the three years prior to the transfer of technology was 48.27% and the mean yield increases perceived was 45.8%. This clearly indicated that a fruit lost to fruit fly, if saved, is a fruit gained.

The estimated impact of this intervention in the 62.3 ha of IPM implementation was a yield increase of 124.53 tonnes, compared to farmer reports of recent previous harvests. This resulted in a productivity increase from 4.37 tonnes to 6.37 tonnes/ha, which is an increase of 1998.9 kgs of fruit/ha. If the fruit is sold at an average cost of Rs 20/kg (minimum prevailing market rate across commercial varieties) the farmer gains Rs. 39,978/ha which works out to a benefit of approximately Rs 57 for every rupee spent on IPM. The cost of IPM was approximately Rs. 700 for every hectare. This huge benefit served as an ideal demonstration to local farmers and hopefully more farmers would adopt the technology. Then in this context, it should also be mentioned that the technology should be also adopted by non-farming traders who temporarily take the orchards on lease through auction as they can also realize more yield and hence income, as they constitute 50% of the market. It is hoped that they would also adopt the technology.

Economic analysis in 2012 showed that the technology had subsequently spread to at least 55% of the national mango area with a net benefit of Rs. 5156 crores (approximately US$825mn at 2014 exchange rates) of increase in mango revenue. FAOStat figures for 2012 estimate total mango production in India at around 15mn tonnes, worth approximately US$ 5bn at farm-gate prices. The impact analysis showed that these farmers adopting IPM realized at least 20-40% yield increase, with a cost:benefit ratio ranging from 1:4 to 1:57, depending on the commercial value of the mango variety. All the farmers expressed high satisfaction with the area-wide IPM of fruit flies. Furthermore, the loss saved resulted in increased business in the mango pulp industry with gainful employment of women especially in rural areas.

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