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Record of melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) on tomato : A case of host range expansion

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ABSTRACT: Survey in different tomato fields from June, 2019 to February, 2020 revealed that the severity of fruit fly damage varied across locations as well as different tomato hybrids. Abhinav has recorded highest mean per cent fruit infestation (57%) followed by Saaho, US-448 and Alankar. Meghdoot hybrid recorded lowest mean per cent fruit infestation (26.50 %) by fruit fly among five major hybrids studied. The pest load of *Z. cucurbitae* in tomato was maximum in Abhinav with highest mean number of flies (71) emerged from ten sampled fruits followed by US-448, Saaho and Alankar. Lowest mean number of flies (45) were emerged from Meghdoot. At two APMC yards, Kolar and Chintamani, the data collected from tomato growers also showed that highest mean per cent fruit infestation was observed in Abhinav (62.70%) followed by Saaho, US-448 and Alankar.

Keywords: Fruit fly, infestation, Karnataka, tomato, *Zeugodacus cucurbitae*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is an important edible and widely grown vegetable in the world (Ganeshan and Chethana, 2009). Botanically it belongs to the family *Solanaceae*. The wild species of tomato were originated from the Andes Mountains of South America, mainly in Peru and Ecuador and was thought to have been domesticated in pre-columbian Mexico. Tomato is a commonly used vegetable in the Indian culinary. It is used in the form of soups, pickles, sauces, ketchups and also consumed as raw vegetable salad. Tomato is being cultivated in different parts of the world including India. It is the third most preferred vegetable after potato and onion in India and ranks second after potato in the world (Dorais *et al.*, 2008). Karnataka is the third major producer in India (Anonymous, 2018). Tomato crop is affected by various insect pests at different crop growth stages causing severe economic loss. But the incidence of fruit flies was unheard of. We report here the severe incidence of melon fruit fly (*Zeugodacus cucurbitae*) as an emerging threat in maintaining tomato fruit quality. Fruit flies are the major pests infesting tomato and the members of the genus *Zeugodacus* are widespread in different parts of the world. The first report on melon fruit fly from India was published by Bezzi (1913). Melon fruit fly, is a polyphagous pest known to attack 136 plant species belonging to 62 plant genera and 30 plant families. This fruit fly predominantly attacks vegetable crops belonging to the family *Cucurbitaceae*, with known records of incidence on 56 plant species. The plant family with the second highest number of documented plant species infested with melon fruit fly is *Solanaceae,* with 20 plant species (Grant *et al.,* 2017). The extent of loss caused by melon fruit fly ranges between 30 and 100 per cent based on the cucurbit crop species grown in different seasons (Dhillon *et al.,* 2005; Gupta and Verma, 1992).

There are reports of many other species of fruit flies known to cause serious damage to tomato such as, *Zeugodacus tau* (Walker) (Boopathi *et al.,* 2017), *Neoceratitis cyanescens* (Bezzi) (Brevault and Quilici, 1999), *Bactrocera latifrons* (Hendel) (Harris *et al.,* 2001). Tomato was reported as a host of *Z. cucurbitae* by Ranganath and Veenakumari (1996) but until now there are no reports on the economic damage of melon fruit fly, *Z. cucurbitae* on tomato from India. Kolar and Chikkaballapur districts are the major tomato growing areas of Karnataka (Anonymous, 2017). In the recent past, many farmers from Kolar and Chikkaballapur districts are observing a large number of tomato fruits damaged at the harvesting stage and incurring huge losses especially during August to October months. The farmers commonly called it as “uji damage”. However, most of the farmers were unable to distinguish the fruit damage caused by pin worm, *Tuta absoluta* and the melon fruit fly, *Z. cucurbitae*. Many farmers are taking up the chemical sprays indiscriminately at fruit harvesting stage that are recommended for *Tuta absoluta* by the input dealers or the neighboring farmers. There are many complaints received from the tomato growers about the fruits damage at ripening stage, which also leads to low price at APMC yards since fruits start rotting in one or two days and juice starts coming out from such fruits. This led to take up the survey to know the cause for damage to tomato fruits at ripening stage.

MATERIALS AND METHODS

The surveys for the melon fruit fly incidence and damage to tomato in Kolar and Chikkaballapur districts was carried out during 2019–20 in two phases as follows.

i) Survey conducted for the incidence of fruit fly at different villages of Kolar and Chikkaballapur districts

The survey was conducted at different tomato fields of selected villages in Kolar and Chikkaballapur districts (Fig. 1). In both the districts, a regular survey was made for a period of nine months from June 2019 to February 2020 in different tomato fields to check the incidence levels of fruit flies. A total of five major tomato hybrids were selected based on maximum number of seedlings sold in a year from the selected nurseries of Kolar and Chikkaballapur districts. They are Abhinav, US-448, Alankar, Saaho and Meghdoot. These are the five major tomato hybrids that are predominantly grown in both the districts. While surveying, villages were randomly chosen from different taluks of both the districts.

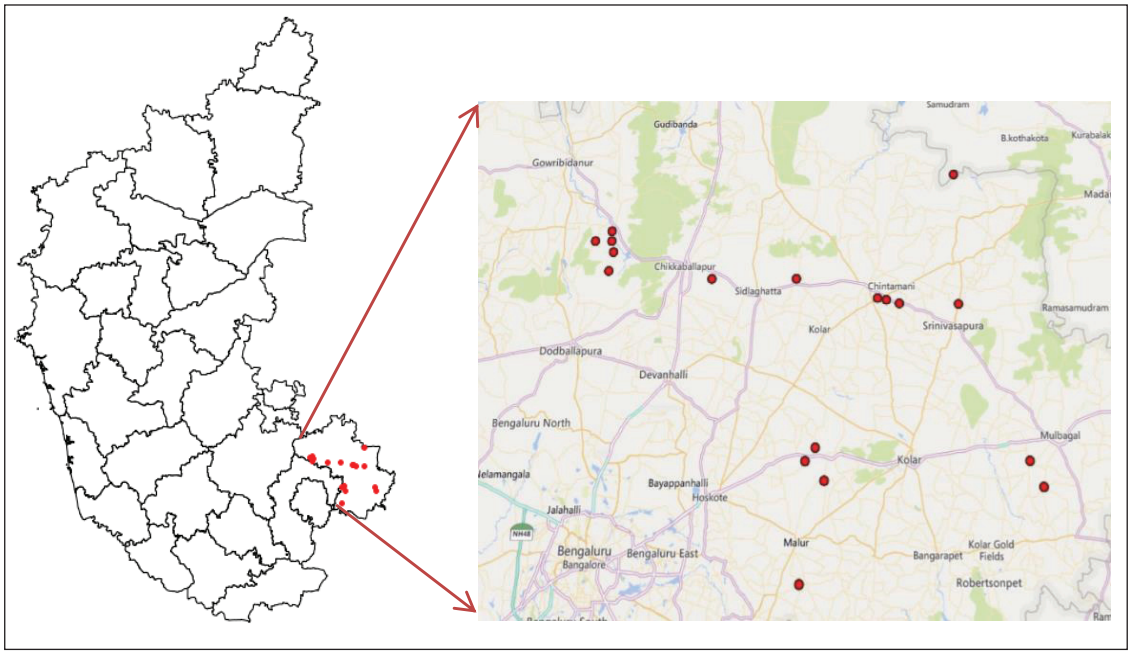

Fig 1. Map showing locations of tomato fields surveyed in Kolar and Chikkaballapur districts of Karnataka

In each village, a tomato field was selected to check the incidence of fruit flies on tomato. The fruit fly infestation was recorded by destructive sampling method by randomly selecting ripened fruits. A total of hundred fully matured/ripened tomato fruits were sampled from each tomato field and the per cent fruit infestation was calculated by dividing number of infested fruits by total number of fruits sampled. The selected fruits were either observed for eggs laid at the pedicel region or on epicarp region (Fig. 2a) or larvae in the decaying fruits. From each tomato field, ten infested fruits along with maggots were collected in polyethylene covers separately and brought to laboratory. The sampled infested fruits were kept on plastic trays locality wise with 5 cm thick sterilized fine sand and kept inside acrylic rearing cages in laboratory for pupation. Later, pupae were separated from sand carefully and kept in petri plates for adult emergence. The emerged adults were allowed to mate and used to maintain culture in the laboratory. The dead adults were cured and pinned and were taxonomically identified by Dr. David, K. J., Scientist (Entomology), Division of Germplasm and Characterization, ICAR-National Bureau of Agricultural Insect Resources, H. A. Farm post, Bellary Road, Bengaluru-560024, Karnataka, India.

ii) Data collection from farmers on incidence of fruit fly on tomato at Kolar and Chintamani APMC yards:

Since the data collection on the incidence of fruit fly from large number of tomato fields is quite difficult by making personal visits to each tomato fields, the data on fruit fly incidence and per cent fruit infestation of five major tomato hybrids was collected from various farmers at Agriculture Produce Marketing Committee (APMC) yards at Kolar and Chikkaballapur districts from November, 2019 to January, 2020. During survey, the data was collected using questionnaire. Later the survey data was compiled to assess the extent of damage

caused by fruit fly in five major tomato hybrids at different locations of both the districts.

RESULTS AND DISCUSSION

a) Survey conducted for the incidence of fruit fly at different villages of Kolar and Chikkaballapur districts:

During the study period from June 2019 to February 2020, we observed that the melon fruit fly has a peculiar mode of infestation in tomato, where adult female fly starts laying eggs under the fruit stalk of the tomato. Fruit flies lays eggs by making use of visual and olfactory cues (Brevault and Quilici, 1999) (Figure 2b). Immediately after hatching, neonate maggots penetrate into the fruit and feed on the internal content of the fruit without any external symptoms of damage (Figure 2c) to begin with. Infested fruits start to rot, liquid oozes out from the fruits, as the larvae complete their development, the infested fruits drop off and pupation takes place in the soil.

The fruit samples collected yielded fruit flies, which were identified as melon fruit fly, *Zeugodacus cucurbitae* (Figure 2 d & e) by Dr. David, K. J., ICAR-NBAIR, Bengaluru, Karnataka. Adult is a medium sized reddish-brown insect. Face with a dark spot in each antennal furrow, the vertical length of the face is as long as the combined length of pedicel and first flagellomere. Scutum is predominantly orange-brown in colour with two narrow yellow lateral post sutural vittae and a narrow medial vitta. Wings are predominantly hyaline with a complete costal band from sub-costa to wing apex. Costal band extended into an apical spot, subapical band and radio-medial band is also present. Abdomen is oval with reddish brown tergites except a dark black transverse band on tergite III.

The economic injury levels of the five major tomato hybrids were estimated during the survey. The per cent fruit infestation differed among different hybrids grown at different locations surveyed. The per cent fruit infestation by melon fruit fly on tomato ranged between 25–62 per cent. In general, highest per cent fruit infestation was noticed in abandoned tomato fields due to low market price during the survey and sampling period. From the survey results, it was found that Abhinav was the highly susceptible hybrid with highest mean per cent fruit infestation of 57.00 if there is a delay in fruits picking due to either low market price or some other reason. The per cent fruit infestation in Abhinav ranged from 53–62 per cent, followed by Saaho with the per cent fruit infestation ranging from 44–59 per cent with mean per cent fruit infestation of 53.00. These were followed by US-448 and Alankar with the per cent fruit infestation ranging from 39–48 and 31–36 and with mean per cent fruit infestation of 43.20 per cent and 33.50 per cent respectively. Lowest mean per cent fruit infestation (26.50) was observed in Meghdoot with per cent fruit infestation ranging between 25–28 (Table 1).

Among different hybrids, total number of flies emerged from 10 sampled fruits ranged between 44–83. The highest mean number of flies emerged from Abhinav hybrid (71.00) with minimum (64) and maximum (83) number of flies emerged from the samples collected from different locations. This followed by US-448 with 69.40 average number of flies emerged from ten sampled fruits with range of 63–78. These hybrids were followed by Saaho and Alankar with 63.66 and 56.50 mean number of flies emerged from ten sampled fruits. In Meghdoot hybrid number of flies emerged from ten sampled fruits ranged from 44–47 with mean of 45.50 per cent

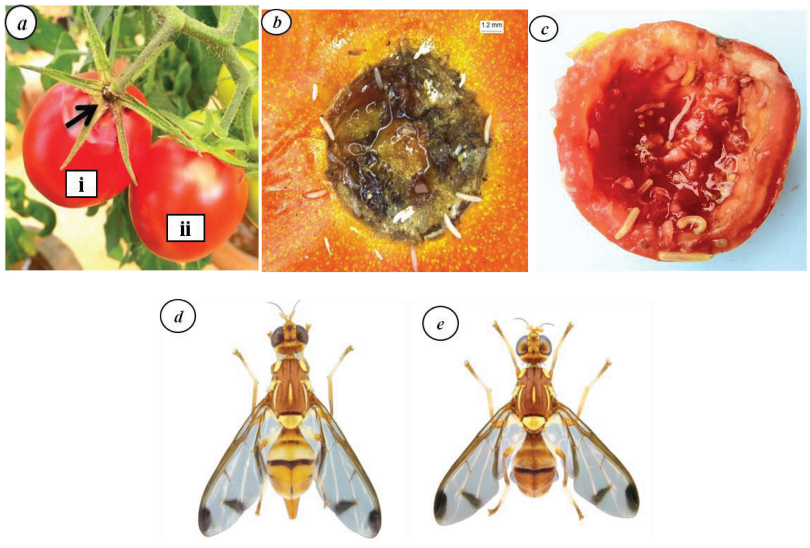

Fig 2. a, External symptoms of fruit fly infestation (i, Infested fruit; ii, Healthy fruit); b, Eggs laid at pedicel region; c, Larvae feeding on fruit pulp, d, Female; e, Male

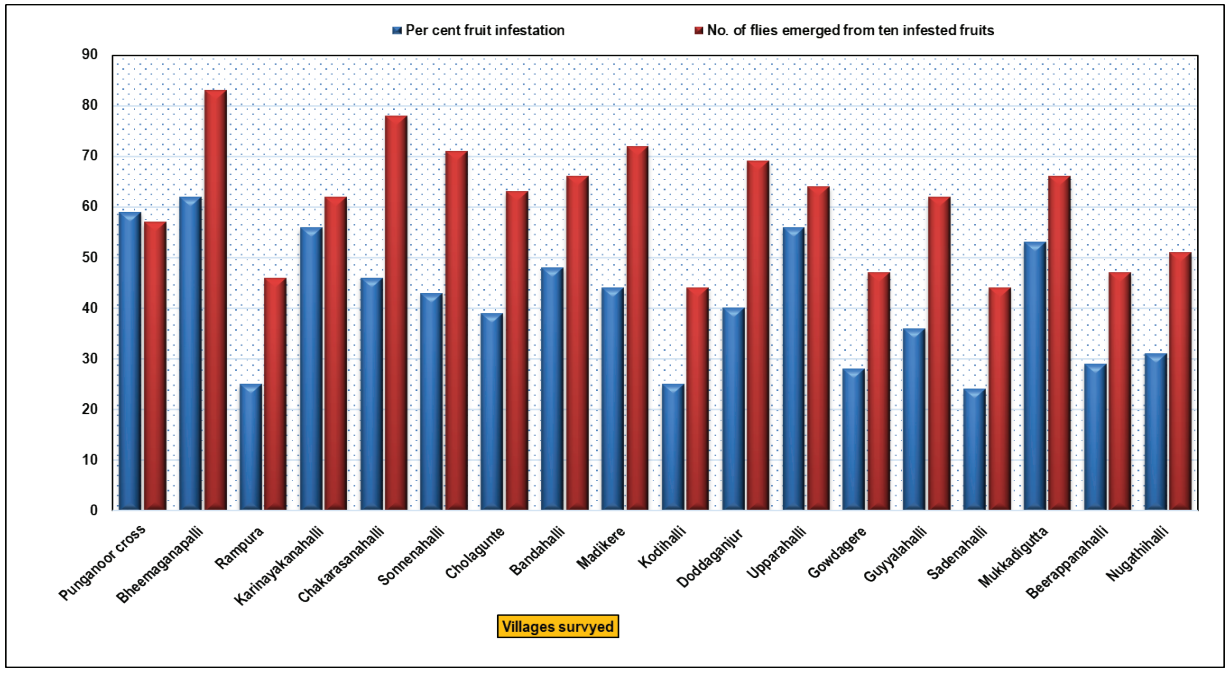

Fig 3. Location wise fruit infestation (per cent) and number of flies emerged from ten infested sampled fruits during survey

Table 1. These results indicate that the pest load was highest in Abhinav hybrid compared to all other hybrids.

Tomato hybrid	Per cent fruit infestation			No. of flies emerged/10 fruits		
	Minimum	Maximum	Mean± SD	Minimum	Maximum	Mean± SD
Abhinav	53	62	57.00±4.58	64	83	71.00±10.44
Alankar	31	36	33.50±3.54	51	62	56.50±7.78
Meghdoot	25	28	26.50±2.12	44	47	45.50±2.12
Saaho	44	59	53.00±7.94	57	62	63.66±7.64
US-448	39	48	43.20±3.83	63	78	69.40±5.68

Further cultivation of Abhinav tomato hybrid mainly takes during the months of April to September. If Abhinav seedlings were transplanted in the first week of April month, then fruit pickings will start from June second fortnight (usually 70 days after transplanting). Similarly, if the transplanting of seedlings takes in the first week of June, first fruit picking starts in the month of August during second fortnight. The reasons for farmers willing to grow Abhinav during the months of April-September every year are; i) Abhinav will sustain better to high temperature during summer compared to other hybrids. ii) Traders from various parts of the country prefer Abhinav over other hybrids, since Abhinav is suitable for transportation to long distances. So farmers fetch very good price for Abhinav compared to other hybrids. Further during the months of July and September, there will be good rainfall in Kolar and Chikkaballapur districts, which coincides with high fly activity (Farmers personal communication, 2019). This might be the reason for highest per cent fruit infestation and maximum number of fruit flies emerged from Abhinav compared to other hybrids.

b) Data collection from farmers on incidence of fruit fly at Kolar and Chintamani APMC yards

The survey data were compiled to assess the extent of damage caused by fruit fly in tomato hybrids at different locations of both the districts. The highest mean fruit infestation by the fruit fly was observed in hybrid Abhinav with 62.70 per cent with the range 35–75 per cent and standard deviation 13.52, followed by Saaho (49.65%),

US-448 (42.41%), Alankar (30.77%) and the lowest infestation was observed in Meghdoot with 22.07 per cent infestation (Table 2). The per cent fruit infestation by fruit fly vary among different seasons. In the current study, from June 2019 to February 2020, per cent fruit infestation was highest during August - October months and was lowest during February–March months.

Table 2. Incidence of fruit fly at Kolar and Chintamani APMC yards

Hybrid	Mean Per cent infestation
Abhinav	62.7
Saaho	49.6
US-448	42.41
Alankar	30.77
Meghdoot	22.07

These results were supported by earlier work done by Laskar and Chatterjee (2010), who reported that fruit fly incidence had positive correlation with rainfall, whereas negative correlation was observed with total sunshine hours. So the fruit fly infestation was lowest during summer months. Further, Haldhar *et al*. (2013) also observed that fruit fly infestation and larval density in musk melon varieties /genotypes were higher in the rainy season than in summer season. The melon fruit fly is a serious threat for the production of all kinds of cucurbitaceous vegetables and is a challenge to manage. Dense populations of the flies are very common in these cropping systems. Considering this, the potency of *Z. cucurbitae* to migrate to tomato under ideal conditions that favour high activity suggests that the insect is expanding its host status on solanaceous crops causing severe yield losses in tomato. The tomato fruits are increasingly susceptible to fruit fly attack at close to harvest and even more when the rainy season starts. The melon fruit fly infestation cannot be recognized with visual observation as the adult female lays eggs below the fruit stalk. The fruits go waste once the eggs are laid, so prevention of egg deposition and timely planting are to be verified as potential measures for the management of fruit fly.

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REFERENCES

Anonymous. 2017. *Indian Horticulture database-2017.* National Horticulture Board, Ministry of Agriculture, Govt. of India, 256 pp.

Anonymous. 2018. *Indian Horticulture database-2018.* National Horticulture Board, Ministry of Agriculture, Govt. of India, 203 pp.

Bezzi, M. 1913. Indian Tephritids (fruit flies) in the collection of the Indian Museum, Calcutta. *Memoirs of Indian Museum,* **3:**153-175.

Boopathi, T., Singh, S. B., Manju, T., Chowdhury, S., Singh, A. R., Dutta, S. K., Dayal, V., Behere, G. T., Ngachan, S. V., Hazarika, S. and Rahman, S. M. A. 2017. First report of economic injury to tomato due to *Zeugodacus tau* (Diptera: Tephritidae): Relative abundance and effects of cultivar and season on injury. *Florida Entomologist,* **100** (1): 63-69.

Brevault, T. and Quilici, S. 1999. Factors affecting behavioural response to visual stimuli in tomato fruit fly, *Neoceratitis cyanescens*. *Physiological Entomology*, **24**: 333-338.

Dhillon, M. K., Singh, R., Naresh, J. S. and Sharma, H. C. 2005. The melon fruit fly, *Bactrocera cucurbitae*: A review of its biology and management. *Journal of Insect Science,* **5 (4):** 1-16.

Dorais, M., Ehret, D. L. and Papadopoulos, A. P. 2008. Tomato (*Solanum lycopersicum*) health components: From the seed to the consumer. *Phytochemistry Reviews*, **7**: 231–250.

Ganeshan, G. and Chethana, B. S. 2009. Bio-efficacy of pyraclostrobin 25% EC against early blight of tomato. *World Applied Sciences Journal,* **7** (2): 227-229.

Grant, T. M., Nicanor, J. L., Kelly, A. A. and Nakamichi. 2017. Annotated world bibliography of host plants of the melon fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). *Insecta Mundi,* **527:** 1-339.

Gupta, D. and Verma, A. K. 1992. Population fluctuations of the maggots of fruit flies (*Dacus cucurbitae* and *Dacus tau*) infesting Cucurbitaceous crops. *Advances in Plant Sciences,* **5:**518-523.

Haldhar, S. M., Bhargava, R., Choudhary, B. R., Pal, G. and Kumar, S. 2013. Allelochemical resistance traits of muskmelon (*Cucumis melo*) against the fruit fly (*Bactrocera cucurbitae*) in a hot arid region of India. *Phytoparasitica,* **41**: 473-481.

Harris, E. J., Liquido, N. J. and Spencer, J. P. 2001. Distribution and host utilization of *Bactrocera latifrons* (Diptera: Tephritidae) on the Island of Kauai, Hawaii. *Proceedings of Hawaiian Entomological Society,* **35**: 55-66.

Laskar, N. and Chatterjee, H. 2010. The effect of meteorological factors on the population dynamics of melon fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) in the foot hills of Himalaya. *Journal of Applied Sciences and Environmental Management,* **14** (3): 53-58.

Ranganath, H. R. and Veenakumari, K. 1996. Tomato (*Lycopersicon esculentum* Miller): A confirmed host of the melon fly *Bactrocera (Zeugodacus) cucurbitae* (Coquillett). *Insect Environment,* **2**: 1-3.

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