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Effects of weather parameters on Guava fruit fly (*Bactrocera zonata*) population at IARI, New Delhi

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ABSTRACT

Relationship of each of the weather parameters *viz*., maximum temperature (Tmax), minimum temperature (Tmin), rainfall (RF), morning relative humidity (RH), evening relative humidity (RH_2) and bright sunshine hours (BSS) of six years (2007-2012) at IARI (New Delhi) was individually explored with peaks of guava fruit fly, *Bactrocera zonata* MAT (Male Annihilation Technique) trap catches. Peaks of fruit fly trap catches exhibited significant correlation with Tmax, RH_1, RH_2, RF and BSS of April 1st week and Tmin of March 3rd week. Weather-based prediction model for guava fruit fly was developed by regressing peaks of fruit fly trap catches on mean values of different weather parameters of aforesaid weeks (R^2=0.80). Of the weather parameters, only Tmax, Tmin, RH_2 and BSS were found to be relevant through stepwise regression.

Keywords: Guava fruit fly, MAT trap catches, regression model, weather parameters

Fruit flies (Diptera: Tephritidae) cause significant damage to fruits and vegetables in the Indo-Pak subcontinent (Rauf *et al*., 2013). The peach fruit fly, *Bactrocera zonata* is one of the most harmful species of Tephritidae and is one of the most destructive pests of more than 50 economically important fruit crops including peach, mango, apricot, guava, and figs (Reddy *et al*., 2013). *Bactrocera zonata* is native to India and was first recorded in Bengal (Anonymous, 2013). However its presence has now been recorded in several states of the country and many others countries (Kapoor, 1993; EPPO, 2005). It is one of the three most destructive fruit flies, causing crop losses to the extent of 25 to 100% in peach, apricot, guava and figs in India. Economic impact may result from costly eradication measures and quarantine restrictions imposed by important domestic and foreign import markets, and from direct yield losses from infested fruit. Recently European Union has banned import of mangoes from India because of the presence of fruit flies in the Alphonso variety which was imported during 2012-13. Injury to fruit occurs through oviposition punctures and subsequent larval development. Adults of the pests occur throughout the year however, monitoring and management of immature stages of fruit fly in field is difficult as the maggots remain inside the fruit and pupation and overwintering occur in soil. Monitoring is important to keep track of changes in population levels of fruit fly and to implement controls.

The trap catches are helpful in monitoring the field population of fruit flies. The male annihilation technique (MAT) employs methyl eugenol to attract the males of fruit fly populations. Climatic factors such as temperature, rainfall and relative humidity greatly influence the insect population (Siswanto *et al.,* 2008). Agarwal and Pramod Kumar (1999) observed maximum fly populations during the third week of June, whereas the lowest numbers were observed during the last week of August. Keeping this in view, present study was undertaken to develop and validate weather based guava fruit fly prediction model at IARI, New Delhi.

MATERIALS AND METHODS

Weekly trap catches of fruit fly were recorded from different locations for six years, at Indian Agricultural Research Institute, New Delhi using Male annihilation technique. Data on weather parameters *viz*., maximum temperature (Tmax), minimum temperature (Tmin) , rainfall (mm), morning relative humidity (RH_1) (%), evening humidity (RH_2) and bright sunshine hours (BSS) for 6 years during 2007-2012 was collected from Meteorological observatory, IARI, New Delhi, India. Weekly weather data for six years and Square root transformed fruit fly MAT trap catches were used for model formulation, wherein peak fruit fly trap catches of different years were correlated with weekly mean values of each of the weather parameters individually, beginning with 3rd week of March until attainment of peak

Table 1 : Peak fruit fly population with weather parameters affecting the population

Year	Peak population of fruit fly	Tmax (°C) (Apr. 1st week)	Tmin (°C) (Mar. 3rd week)	RH_2(%) (Apr. 1st week)	BSS (hr day^{-1}) (Apr. 1st week)
2007	35.341	34.4	15.8	40	8.7
2008	45.022	28.7	14.4	42	5.3
2009	9.165	34.2	16.0	27	7.2
2010	12.165	37.8	16.6	13	9.3
2011	15.843	33.0	15.0	21	8.4
2012	19.442	36.8	15.2	30	7.8

Table 2 : Correlation of fruit fly trap catches with different weather parameters.

Factor	April 2nd week	April 1st week	March 4th week	March 3rd week
T_{max}	-0.100	-0.757	0.125	-0.210
T_{min}	0.257	-0.328	-0.563	-0.614
RH_1	-0.147	0.819*	-0.584	-0.173
RH_2	-0.024	0.845*	-0.328	0.305
BSS	0.172	-0.642	0.462	0.058
RF	-0.380	0.839	-0.212	0.351

*Significant (P<0.05)

fruit fly catch. Most important week with respect to each of the weather factors could thus be identified and relevant values were used to develop a multiple linear pest-weather model using SAS statistical software.

RESULTS AND DISCUSSION

Peak fruit fly trap catches ranged from 9.2 – 45.0 adults per week during 2007-2012, with the maximum population having been recorded during 2008 and the minimum in 2009. On the other hand T_{max}, T_{min}, RH_2 and BSS varied from 28.7 – 37.8 °C in April 1st week, 14.4 – 16.6 °C in March 3rd week, 13 – 42% in April 1st week and 5.3 – 9.3 hrs in April 1st week, respectively. Out of four weeks namely March 3rd week, March 4th week, April 1st week and April 2nd week, peak fruit fly trap catches had the highest correlation with T_{max}, RH_1, RH_2, BSS and RF of April 1st week while with T_{min} of March 3rd week. However, as RH_1 and RF were not observed to have a significant influence on the trap catches, through stepwise regression and these weather parameters were not considered for developing the weather based prediction model for the pest.

Peaks of fruit fly trap catches exhibited significant correlation with Tmax, RH_1, RH_2, RF and BSS of April 1st week and Tmin of March 3rd week (Table 1). As peaks of fruit fly trap catches during different years occurred between April 3rd week and May 3rd week, weather parameters only up to April 2nd week were considered for developing regression relationship. Pest-weather model between fruit fly trap catches and weather parameters *viz*., T_{max}, T_{min}, RH_2 and BSS was established. Final model with Tmax, Tmin, RH_2 and BSS accounted for 80% variability in fruit fly trap catches and clearly brought out the significant role of these factors on them (Table 1).

$\sqrt{FFA}$ = 57.483 -1.730*Tmax(Apr. 1st week) -1.772* Tmin(Mar. 3rd week) +0.958*RH_2 (Apr. 1st week) +3.119*BSS(Apr.1st week) (R^2=0.80)

Pest weather model clearly suggested the Tmax, Tmin, RH_2 and BSS to be important weather parameters influencing fruit fly trap catches. Besides, satisfactory validation of the model endorsed importance of these parameters in affecting fruit fly population dynamics. Tmax and Tmin exhibited negative whereas RH_2 and BSS exhibited positive relationship with fruit fly trap catches. On the other hand, RH_1 and RF did not influence the fruit fly trap catches. Trap catches indirectly represented its population level on crops. Insects are cold-blooded animals and ambient temperature plays very important role in their development. Higher the temperature within favourable range of the species, quicker is the development. Role of Tmax and Tmin in influencing fruit fly trap catches is thus understandable. Qureshi *et al.* (1993), investigating development of *B. zonata* at different temperatures, showed that no stages developed at temperatures of 15°C or below, the optimum being at 25–30°C. Larvae of the fruit fly pupate and overwinter in the soil. For tropical tephritid species, soil moisture and soil temperature have been identified as the major pupal mortality factors. Rainfall affected fruit fly trap catches indirectly through relative humidity. The RH_1, which is generally high, might not be beyond critical limit for fruit fly development, whereas RH_2, which is generally low might prove critical for the insect and rainfall might play important role in ensuring higher RH_2. Sunshine hours also influence fruit fly trap catches.

Although empirical pest-weather models have significantly contributed in understanding pest population dynamics but these are influenced by local conditions and thus behave in a location-specific manner (Pinnschmidt *et al.,* 1995 and Teng *et al*., 1998). The pest population is thus shown to be affected by different factors at various locations.

CONCLUSION

Peach fruit fly is a generalist tephritid species infesting many host species throughout the entire geographical range. The population build-up of the pest was found to be influenced by different weather parameters. Pest weather model developed for the fruit fly would be helpful in gauging likely build-up of the pest population, thereby aiding in forewarning and timely action.

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