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Monitoring and Varietal Preference of Mango Midge, *Procontarinia mangicola* (Diptera: Cecidomyiidae)

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Abstract.- The current study was planned to evaluate the efficiency of colored sticky traps and plastic sheets in capturing adults and larvae of *Procontarinia mangicola*, respectively. The susceptibility of different varieties of mango against *P. mangicola* was also explored. Amongst the eight types of color traps, orange colored traps captured the highest number (145.6±19.7/trap) of *P. mangicola* adults while white-colored traps captured the lowest numbers (23.7±3.4/trap). The peak adult and larval population was observed on February 11, 2010 (138.9±25.4/m^2) and March 2, 2010 (216.9±24.9/m^2), respectively. The highest numbers of galls were recorded on Sufaid Chaunsa (2.91±0.2/leaf) followed by Dusehri (2.8±0.2/leaf), Ratol (2.3±0.2/leaf) and Kala Chaunsa (1.74±0.2/leaf). Maximum numbers of larvae were obtained under the canopy of Sufaid Chaunsa (25.6±3.9/m^2), followed by Dusehri (22.4±3.7/m^2), Ratol (10.3±1.3/m^2) and Kala Chaunsa (8.6±0.7/m^2). The highest numbers of galls/leaf and larvae/trap recorded on Sufaid Chaunsa indicated that it was the most preferred mango variety. The research findings will be helpful for the proper management of *P. mangicola* and to avoid losses to the mango industry.

Key words: Mango midge, *Procontarinia mangicola*, sticky traps, varietal preference.

INTRODUCTION

Mango (*Mangifera indica* L.) is an important fruit crop of tropical and subtropical regions of the world, especially on the Indian subcontinent and in South-East Asia (Purseglove, 1968; Parsad, 1972). In Pakistan, mango crop is commercially grown in the provinces of Punjab and Sindh on an area of 167.5 thousand hectare with an average production of 1732 thousand metric tons (Balal *et al.*, 2011). However, various biotic (pests) and abiotic (climatic) factors affect its yield (Talpur and Khuhro, 2003; Malik *et al.*, 2005; Masood *et al.*, 2009; Masood *et al.*, 2010). Among insect pests, about 260 species of insect and mites have been recorded as major and minor pests of mango. Among these, 87 are fruit feeders, 127 are foliage feeders, 36 feed on the inflorescence, 33 inhabit buds, and 25 feed on branches and the trunk (Veerish, 1989). The most prevalent insect pests in Pakistan are mango hopper, *Idioscopus clypealis* Leth, and *Amritodus atkinsoni* Leth, midges, *Erosomya indica* Grover and Prasad, mealybug, *Drosicha stebbingii* Green, scales, *Aulacaspis tubercularis* Newstead, fruit flies, *Bactrocera. Zonata* Saunders, *B. dorsalis* Hendel, thrips, *Frankliniella occidentalis* Pergande and bark beetles, *Hypocryphalus mangiferae* Stebbing (Brown, 1992; Masood *et al.*, 2009; Grieshbach, 2011).

Mango midges (Diptera: Cecidomyiidae) are considered much more important pests of mango and have been recorded from all mango growing areas of the world. About 16 species of gall midges attack mango in Asia where this plant is indigenous. This causes curling and drying of leaves, fruit falling, and in severe cases makes the trees completely devoid of leaves and fruits (Uechi *et al.*, 2002; Rehman *et al*, 2013). Mature larvae of some species fall on the ground and pupate in the soil while some species pupate in the galls.

Procontarinia mangicola attacks fresh mango leaves and produces circular blister galls, causing the leaves to crinkle (Uechi *et al.*, 2002). In most mango orchards surveyed, heavily galled leaves fell to the ground much earlier than usual and most galled leaves remaining on trees suffered from anthracnose inoculums (Harris and Schreiner, 1992). The development of comprehensive

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management strategy for mango leaf gall midges is urgently needed. Thus an effort was made to investigate a potential control measure against the mango gall midge in Multan, Pakistan. In the current study, we determined the susceptibility of four different mango varieties to the gall midge, *P. mangicola* and reported the details of a field survey in the Multan region.

MATERIALS AND METHODS

The study was conducted in the mango orchards of Multan, Pakistan during February-April 2010. Four mango cultivars including Kala Chaunsa, Dusehri, Sufaid Chaunsa and Anwar Ratol, were selected for monitoring the population of *P. mangicola* and to study varietal tolerance. For this purpose, plants of almost the same age ($\geq$10 years) and height ($\geq$10 m) were selected to avoid the difference due to their phenology. Two different techniques were used to monitor adults and larvae of *P. mangicola*.

Color attraction and monitoring of P. mangicola *adults*

The adult population was monitored by using flat sticky traps (28 cm × 22 cm) of eight different colors. The names of the colors along with Hex number were blue (0000FF), green (008000), orange (FF8000), pink (FF00FF), red (FF0000), violet (7F00FF), white (FFFFFF) and yellow (FFFF00). Polybutene material was used as a sticky material that remained durable for 2–3 weeks (Kappmeier and Venter, 2007). The old traps were replaced weekly with new fresh traps. The colored sticky traps were hung 3-4 m above ground within the canopy of selected trees in a randomized complete block design (RCBD) with four replications (trees). The traps having adult midges were brought to the Laboratory, Department of Entomology, Bahauddin Zakariya University, Multan, Pakistan. *P. mangicola* adults from each trap were counted under stereoscope. The adults were identified using the description described by Gagne (1994). The abundance of *P. mangicola* adults captured on the traps along the 3 mo was co-related with temperature (°C) and relative humidity (% RH). The temperature and relative humidity was recorded by using data logger (HOBO® Pro Series).

Monitoring of P. mangicola *larvae*

The larval population was monitored by placing transparent plastic sheets traps (1 m^2) on four sides under the canopy of twelve selected mango trees. The plastic sheets traps were covered with a 2 cm thick sterilized sand layer. The sand from each trap was sieved weekly with a fine cloth to separate the midge larvae. The larvae were brought to Mango Laboratory, Department of Entomology, Bahauddin Zakariya University, Multan, Pakistan and reared in the sterile sand to the adult stage at 25±5°C. After emergence, these adults were preserved in 80% ethanol and were identified using the description described by Gagne (1994). The assumption was made that the number of *P. mangicola* larvae and *P. mangicola* adults that emerged from pupae was equal. No visible signs of parasitism were observed during the study. The larval population was correlated with the temperature (°C) and relative humidity (% RH) during the season.

Varietal susceptibility

The population of galls on fresh flushes and the number of larvae captured on the plastic sheet were recorded to study the susceptibility of Kala Chaunsa, Dusehri, Sufaid Chaunsa and Anwar Ratol against *P. mangicola*. Three trees of each mango variety were selected randomly and newly emerged flushes (having 7-10 leaves) on four sides (north, south, east and west) of each tree were tagged. The number of galls on each tagged flush was counted on a weekly basis. The number of galls per flush was converted into number of galls per leaf prior to data analysis. The larval population of *P. mangicola* on each variety was counted by placing transparent plastic sheets traps (1 m^2) on four sides under the canopy of selected mango trees as described earlier.

Data analysis

The data of *P. mangicola* adults on different colored traps, and numbers of galls and larvae on different varieties was analyzed by using analysis of variance (ANOVA) and means were compared by Turkey HSD test (Statistix" version 8.1, Analytical Software, 2000).

RESULTS

Color attraction and monitoring of P. mangicola *adults*

The mean population of *P. mangicola* adults differed significantly on different colored sticky traps (F = 22.90; df = 7, 21; P < 0.001). The adults were most attracted to orange colored traps (145.6±19.7/trap) and were least attracted to white colored traps (23.7±1/trap) (Fig. 1). The efficiency of other colored sticky traps is also shown in Figure 1. The average abundance of *P. mangicola* adults across all traps peaked on February 11, 2010 (138.9±25.4/trap) after which it declined until March 11, 2010 (27.2±6.5/trap) (Fig. 2). A subsequent peak was observed on April 8, 2010 (87.6±27.4/trap) and the number of trapped adults eventually decreased to 7.8±1.5/trap at the end of the study period (April 22, 2010) (Fig. 2).

The correlation coefficient values (r) in Table I indicated that the correlation between the population of *P. mangicola* adults and temperature and relative humidity was non-significant (P > 0.05). Although the correlation was non-significant, the adult population was negatively correlated with temperature but positively correlated with relative humidity (Table I).

Table I.- Correlation coefficients (r) of mango midge, *Procontarinia mangicola* population/trap against mean temperature and relative humidity during 2010

Population of *P. mangicola*	Relative humidity (%)	Temperature (°C)
Adult	0.50^{ns}	-0.90^{ns}
Larva	0.96^{ns}	-0.94^{ns}

P>0.05

Monitoring of P. mangicola *larvae*

Peak population of *P. mangicola* larvae was recorded on March 2, 2010 (216.9±24.9/trap) which decreased thereafter on subsequent dates. On the final observation date (April 20, 2010), no larvae were found in any trap (Fig. 3). The results in Table I showed a non-significant negative and positive correlation of larval population with temperature and relative humidity, respectively.

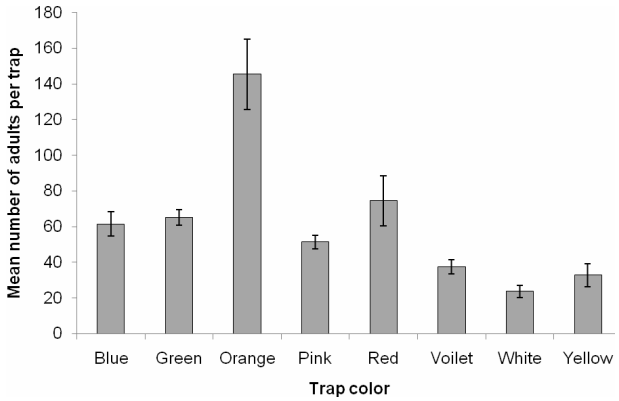

Fig. 1. Mean number of *Procontarinia mangicola* adults gall midge per trap (±SEM) captured on different colored sticky traps all over three months

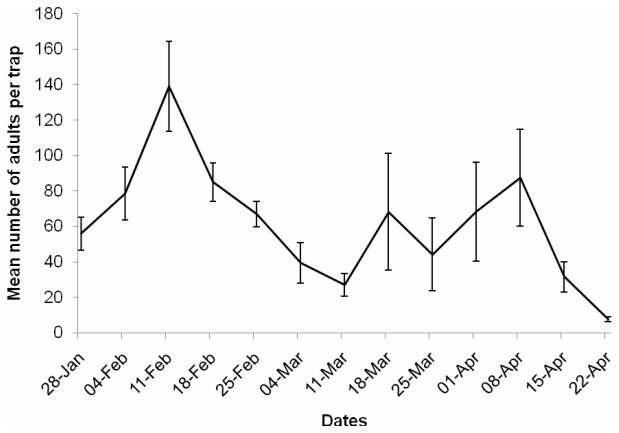

Fig. 2. Mean number of *Procontarinia mangicola* adults gall midge per trap (±SEM) at each sampling date in 2010

Varietal susceptibility

The varieties vary significantly in their susceptibility on the basis of numbers of galls per leaf (F = 5.62; df = 3, 11; P = 0.003) and numbers of larvae per trap (F = 10.9; df = 3, 33; P < 0.001). The data of the varietal susceptibility against *P. mangicola* showed that the highest numbers of galls were recorded on Sufaid Chaunsa (2.9±0.2/leaf), followed by Dusehri (2.8±0.2/leaf), Ratol (2.3±0.2/leaf) and Kala Chaunsa (1.74±0.2/leaf) (Fig. 4). The mean numbers of galls per leaf on the four sides of each variety did not vary significantly

(F = 1.3; df = 3, 13; P = 0.29). Mean number of galls per leaf and their range on east, west, north and south were 2.3 (0.5-4.1), 2.4 (1.1-3.8), 2.3 (1.4-3.1) and 2.8 (0.8-4.6), respectively. Maximum numbers of larvae were obtained under the canopy of Sufaid Chaunsa (25.6±3.9/trap), followed by Dusehri (22.4±3.7/trap), Ratol (10.3±1.3/trap) and Kala Chaunsa (8.6±0.7/trap) (Fig. 5).

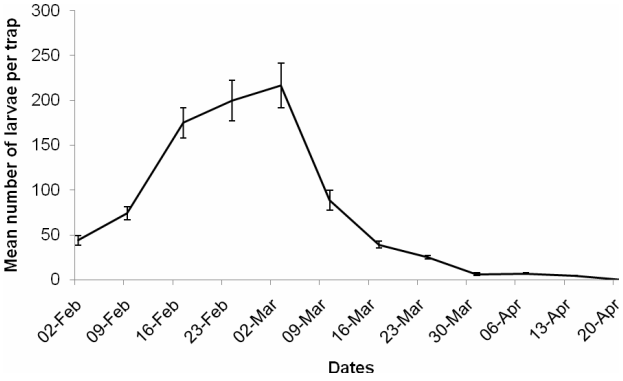

Fig. 3. Mean population of *Procontarinia mangicola* larvae gall midge per trap (±SEM) at each sampling date in 2010

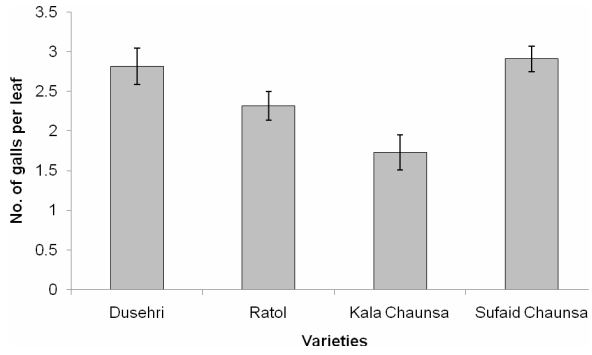

Fig. 4. Mean number of galls per leaf (±SEM) on four mango varieties from February-April, 2010

DISCUSSION

Mango midges are considered as serious destructive pest of mango orchards throughout the mango growing areas of the world. *Procontarinia mangicola* is a very serious pest of mango and can cause severe losses to the mango industry (Uechi *et al.*, 2002). Currently, midges are commonly controlled by the heavy use of synthetic insecticides (Ahmad *et al.*, 2005; Rebecca *et al.*, 2009). In this study, we evaluated some less-common techniques to manage the population of *P. mangicola* in mango orchards. Sticky colored traps can be effectively used for pest monitoring and management. Prokopy and Hauschild (1979) evaluated the effectiveness of unbaited, sticky coated dark red colored and pre-baited yellow colored rectangle traps. Their results indicated that unbaited red colored traps captured more numbers of apple maggot flies, *Rhagoletis pomonella* (Walsh). Trapping of the adult midges can be an efficiently used in IPM program to initiate control activities (Nelson *et al.*, 1976; Reissig and Tette, 1979; Leeper, 1980). The trapping technique can also be used to reduce the pesticide use by improving timing of sprays (Grieshbach, 2011).

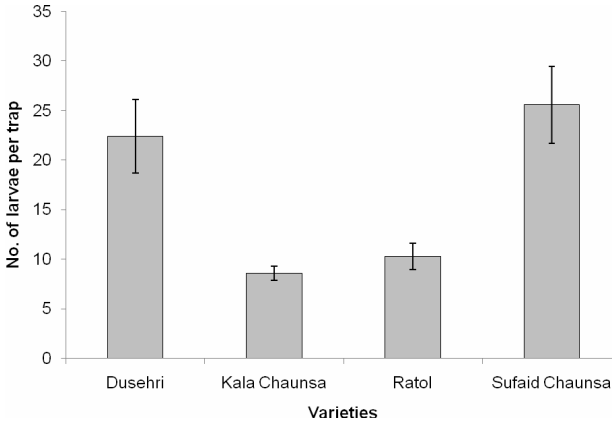

Fig. 5. Mean population of *Procontarinia mangicola* larvae per trap (±SEM) under canopy of four mango varieties from February-April, 2010.

In the present study, we used the trapping techniques to monitor *P. mangicola* adults and larvae. The adults were monitored by using flat and rectangular sticky traps of eight different colors. The results indicated that the highest numbers of adults were attracted to orange colored traps compared to all other traps (Fig. 1). These findings suggested that hanging of the orange colored traps in the mango orchards at the start of the season would save expenses due to insecticide usage against this pest. This study revealed that maximum numbers of larvae were captured in the months of February

(Fig. 3). So by placing of plastic sheet traps under the canopy of the tress during peak activity period, we can reduce the population of the midges by destroying the larval catch manually.

Procontarinia mangicola infestation is usually very high under high humidity conditions resulting from thick undergrowth and inadequate pruning of offshoots (Harris and Schreiner 1992; Uechi *et al.,* 2002). In the present study, the population of *P. mangicola* adults and larvae was greatly reduced when the temperature increased above the 31.2°C and relative humidity decreased below 40 % (Table I). So, farmers should keep their orchards dry by adequate pruning which will ultimately reduces the population of many insect pests of mango, as suggested by Uechi *et al.* (2002) for *P. mangicola*.

In the present study, Sufaid Chaunsa and Dusehri cultivars were highly susceptible to *P. mangicola* attack as the greatest number of galls/leaf and larvae/trap was recorded on these two varieties. Rao (1991) also stated that Dusehri was the most susceptible variety of mango in India. Based on the findings of the present study, it may be concluded that *P. mangicola* attack can be minimized if we hang orange colored sticky traps and place plastic sheets under the canopy.

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