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Role of Insect Pollinators in Fruit Setting, Economic Value of Pollination, and Pollinator Fauna on Different Commercial Mango Varieties in South Punjab Pakistan

Asifa Hameed[1]*, Haider Karar[2], Abdul Ghaffar[1], Abid Hameed Khan[1], Muhammad Mubashir[1] and Ghulam Mustafa[1]

[1]*Mango Research Institute, Multan, Pakistan*
[2]*Agriculture Secretariat South Punjab, Multan, Pakistan*

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Pollinators, Netting, Mango inflorescence, Economic value of insect pollination, South Punjab

ABSTRACT

Mango is known as the second most important fruit crop in Pakistan after citrus. Pakistani mangoes are famous globally for their unique sweet taste and are exported to the Middle East, China, Afghanistan, and different European countries. Although mangoes have been cultivated in Punjab, Pakistan since ancient times, yield of mangoes is still very low, about 8-10 tons per hectare. Successful pollination is required to achieve a bumper crop. In this regard, an experiment was conducted at Mango Research Institute, Multan to understand the role of insects' in successful pollination and fruit setting in Southern Punjab-Pakistan. The experiment consisted of three varieties (Sindhri, Retaul No.12, and SB Chaunsa) and two treatments (netted and open trees). The netted trees of each variety were covered with mosquito net before initiation of flowering, while the open trees of the same varieties were not covered with net. Overall, we found that insects are necessary for pollination and fruit setting. There was no fruit setting i.e. zero fruits per panicle in netted trees where the insects could not visit, the inflorescence during peak period. Maximum fruit setting occurred on trees where the trees were not covered with net. The most abundant insect was blue bottle flies. The other insects in the order of abundance were house flies, syrphid flies, native drones, zebra flies, stingless bees, bumble bee, wild bees, and flesh flies. Honey bees *Apis florea* can be utilized as the pollinator but honey bee species *A. dorsata*, and *A. melliferae* visitation was almost negligible. The total value of insect pollination was estimated as 1299 million dollars. Overall, this is the first study describing the role of pollinators in successful fruit setting in southern Punjab Pakistan and describing the pollinating insects of mango orchards during peak flowering season.

INTRODUCTION

Pakistan is a developing country, which depends on agricultural product export for enhancing the gross domestic product (GDP) of the country (Azam and Shafique, 2017; GoP, 2005), with mangoes comprising a significant share of exported product (Ullah *et al*., 2018). Pakistan earned the foreign currency equivalent of 72 million dollars by exporting these valuable mangoes to different countries including Iran, Afghanistan, China, Saudi Arabia, Dubai, and other middle East countries in 2020 (Jing, 2020). Enhancing productivity through increasing the population of the pollinators visiting mango orchards may increase per acre production of mangoes for Pakistani farmers.

Mango (*Mangiferae indica* L.) (Anacardiaceae: Plantae) is the second most important fruit of Pakistan after citrus (MNFSA, 2015). Pakistan is the 6th largest producer of mangoes (Malik *et al*., 2018; Usman *et al*., 2003) and third largest exporter of this valuable commodity (Galán-Saúco, 2002) in the world. However, they are facing decline in mango production (Usman *et al*., 2003) due to inconsistent quality (not uniform size of mangoes) and lower profitability. It is observed that the uniform size of fruits and enhanced productivity can be achieved through successful pollination (Dag and Gazit, 2000; Gajendra, 1989).

A mango inflorescence is a branched terminal panicle, 10.16-60.96 cm long, containing 500-10,000 individual flowers, depending upon the cultivar (Free and

* Corresponding author: asifa_hameed_sheikh@yahoo.com
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Williams, 1976b; McGregor, 1976; Mukherjee and Litz, 2009). The number of panicles range from 200 to 3000 per tree depending on tree size, variety and extent of branching system (McGregor, 1976). The arrangement of mango flowers is of cymose type. The panicle has perfect, hermaphrodite, staminate or purely male, or pistillate or having both pistil female flowers (Ramírez and Davenport, 2012; Ramírez *et al*., 2014). Mango has entomophilic flowers, which attract insects for successful pollination. Gajendra (1989) conducted an experiment on mangoes and found that no fruit setting was recorded on the trees where the flowers were bagged at full bloom stage.

Earlier, it was accepted that self-pollination in mangoes may be possible (Dijkman and Soule, 1951), while other scientists believed that pollination in mangoes is through gravity (Maheshwari, 1934). However, it was later demonstrated through experiments that mango inflorescences require insect pollinators for successful pollination (Gajendra, 1989). Understanding the pollinator fauna of mango is vital for enhancing productivity of mangoes. An experiment conducted on insect pollinators of mangoes in India demonstrated that major pollinators were from Diptera (17 species), Coleoptera (3 species), Hymenoptera (3 species), Heteroptera (3 species) and Lepidoptera (3 species) (Gajendra, 1989). However, in Israel, the major pollinators were Diptera (26 species), Hymenoptera (12 species) and Coleoptera (06 species) (Dag and Gazit, 2000). A major difference between the studies was that in Israel, honey bees played a key role in the pollination process while in India, the honey bee was not evident on mangoes during flowering. Similarly, in Australia the large Diptera played a significant role in mango pollination, and a species of bees *Trigona* proved an efficient pollinator (Anderson *et al*., 1982).

Farmers place honey bee colonies near orchards to enhance the fruit setting and pollination around the world (Breeze *et al*., 2019). Based on this common practice, a study was designed to understand role of pollinators in fruit setting and characterize pollinator fauna of mango in southern Punjab Pakistan. The hypothesis was to confirm whether pollinators were necessary in fruit setting. If the pollinators are necessary to fruit setting, which insects are abundant during inflorescence and fruit setting time in Southern Punjab-Pakistan? Another question addressed for this study was whether honey bees *Apis melliferae* can be utilized to enhance fruit setting in mangoes.

MATERIALS AND METHODS

The experiment was conducted at the Mango Research Institute, Multan during the flowering period in 2019 and 2020. The available mango varieties were selected and, if part of a netted treatment, covered with mosquito net before initiation of inflorescence in the month of February. The detailed procedure is described below.

Trees selection and experimental layout

Mango trees of cultivar Sindhri, Retaul-12, and SB Chaunsa were selected from the experimental orchard of the Mango Research Institute, Multan. The selected plants were divided in two treatments: Netted and open trees. Pictures of netted trees of these cultivars are shown in Figure 1. In Pakistan, flowering of mangoes starts at the end of February or beginning of March. Inflorescences of these cultivars are shown in Figure 2. Each treatment comprised of three replications. There were 6 total trees per variety (three netted trees and three open trees). There were 18 total trees per experiment.

Fig. 1. Netted trees of cultivars SB Chaunsa (A), Retaul 12 (B), and Sindhri (C).

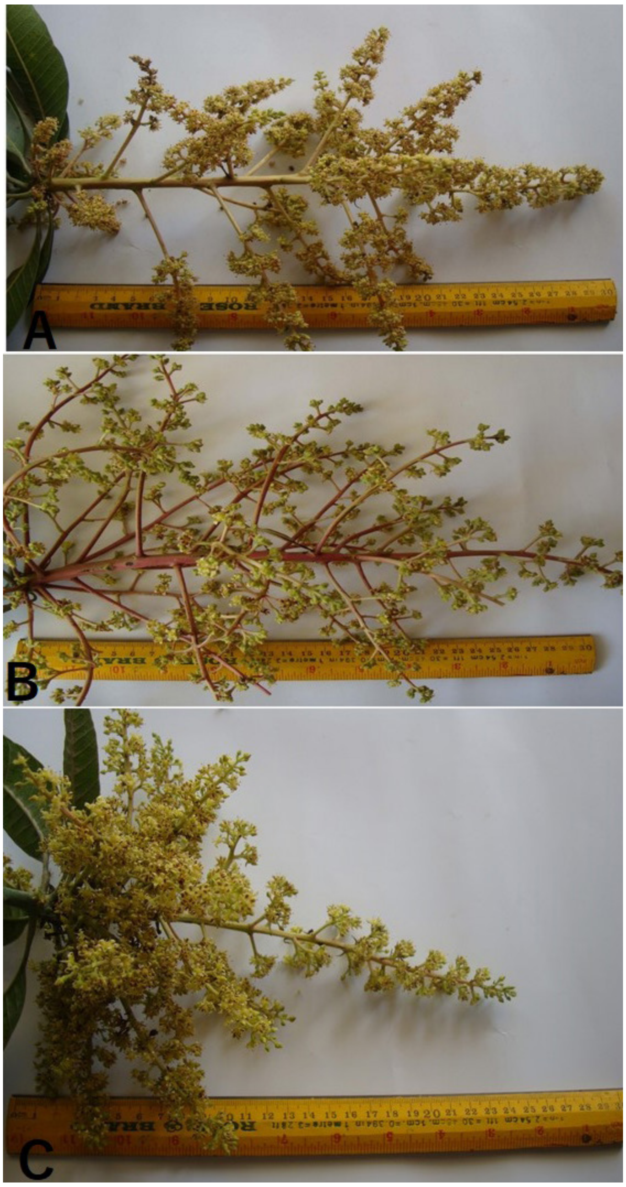

Fig. 2. Inflorescence of cultivars Retaul-12 (A), SB Chaunsa (B) and Sindhri (C).

Honey bee hives

At the start of flowering, honey bees (*Apis melliferae*) hives were added to the orchard to supplement to natural pollinators (Fig. 3).

Data collection

The data of pollinators, including honey bees and natural fauna, was recorded daily from twenty inflorescences beginning at 10.00 AM till the end of flowering season ie 25th Feb to 31st March 2019. Twenty inflorescences (panicles) were observed per tree for the collection of data through recording visual observation of pollinators sitting or crawling on the inflorescence. Pollinators that visited the flowers during the data recording were also noted. The net was removed after fruit setting at stone stage on 15th of April, 2019. At fruit harvest, ten fruits of both netted and open trees were picked for fruit analysis. The net was removed after fruit setting at stone stage.

Fig. 3. Honey bee *Apis melliferae* colonies kept in mango orchard for pollination.

Calculation of different values of insect pollination

The value of insect pollination was assessed by using the bio-economic approach as described by Gallai *et al*. (2009). The insect pollinator dependency ration was calculated using median value for essential crops (Klein *et al*., 2007).

The total economic value of insect pollination was calculated using equation obtained from Gallai *et al*. (2009).

$$\text{IPEV} = \sum_{i=1}^{n} (Qi \; x \; Pi \; x \; Di)$$

Where, i is 1-n, Qi is total quantity of crop production, Di is dependence ration of crop on insect pollinators, Pi is price per ton of the crop.

The ratio of vulnerability was defined as "potential production value loss attributable to the lack of pollination" was calculated using the equation.

$$RV = \frac{IPEV}{EV} = \frac{\sum_{i=1}^{n} \quad (Qi \; x \; Pi \; x \; Di)}{\sum_{i=1}^{n} \quad (Qi \; x \; Pi\;)}$$

The impact of pollinators on consumer welfare was calculated using the equation described by Breeze *et al*. (2021).

$$\text{CSL} = \frac{PiQi}{1+\varepsilon} \{\Phi^{\frac{1}{\varepsilon}+1} - 1)$$

Where E is price elasticity of demand, Φ is value equivalent to one minus dependence ration of each crop.

The price elasticities established by Gallai *et al.* (2009) was used in between -0.5 to -1.5

Statistical analysis

The data was analyzed using R version 3.1. Mean was calculated using function mean. Standard error was determined using function (sd (x, na.rm = TRUE)/(length(x)-sum(is.na(x)))^0.5). ANOVA analysis was performed using library agricolae. The groups were ranked through Tukey HSD at 0.05 using library agricolae. Figures were developed using library ggplot 2 in R.

The annual data for 2020-2021 prices of mangoes exported and consumed in Pakistan was obtained from planning commission report from ministry of planning development and special initiative (Planning commission of Pakistan, 2020). The total area on which mangoes were produced in Pakistan during 2020 was obtained from crop reporting system in Pakistan.

RESULTS

Effect of date on average fruit set per inflorescence

ANOVA results showed that most fruit setting of these varieties was completed in mid-April (15.04. 2020) while only a smaller fraction of fruit setting occurred after this until June 2, 2020 (P= 0.001953; F= 11.28; DF= 1) (Fig. 4).

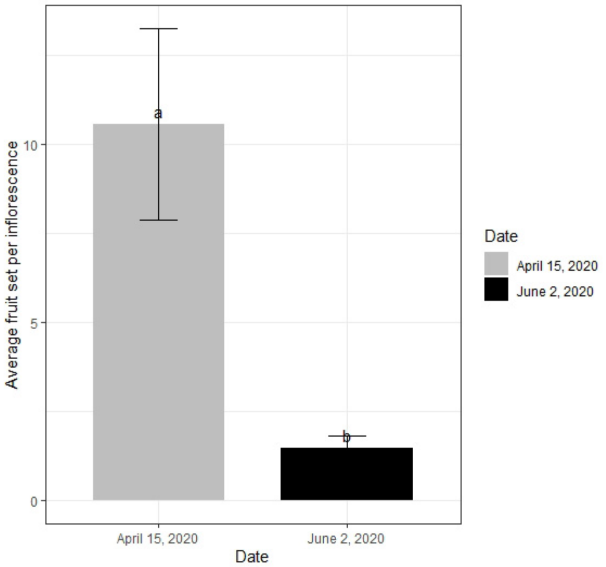

Fig. 4. Fruit setting had a seasonal response in mangoes.

Effect of netting on the fruit setting and pollination

Overall, the fruit set was higher in the open trees treatment, where insects were free to visit the plant, while pollination of mangoes was significantly lower in the netted inflorescences (P<0.001; F= 21.88; DF= 1) (Fig. 5).

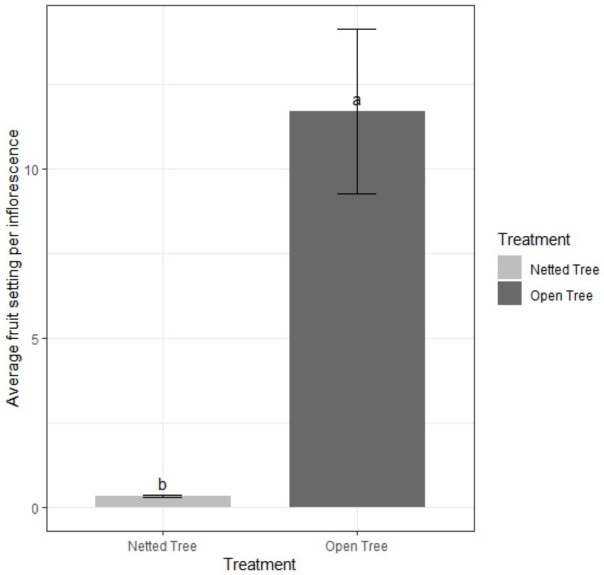

Fig. 5. Effect of netting on fruit setting in different cultivars of mangoes.

Effect of interaction of treatment and variety on fruit setting

ANOVA analysis of treatment (netted tree vs open tree) and varieties was not significant (DF= 2; F= 0.98; P= 0.38) (Fig. 6).

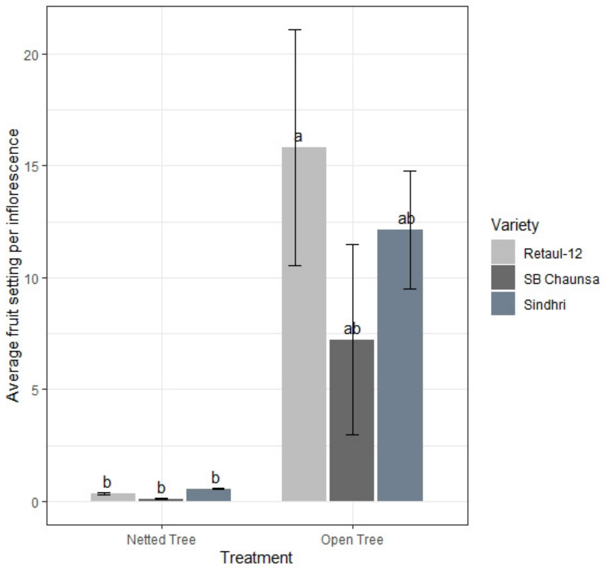

Fig. 6. Average fruit set per inflorescence in netted tree vs open tree on different varieties of mangoes.

Overall, the fruit setting was different for different varieties but was not significantly affected by a variety and pollinator interaction. Maximum fruit setting was observed on open trees and significantly lower fruit setting was observed on netted trees.

Visitation of different species of pollinators during flowering season of Sindhri mangoes

ANOVA analysis of different species of pollinators during mango flowering season on cultivar Sindhri showed that the most common and abundant visitor was blue bottle flies (DF= 11; F= 17.125; p <0.001) (Fig. 7). The other species of insects observed, in order of abundance, were house flies (0.37), syrphid flies (0.247), native honey bee drones (0.115), zebra flies (0.104), stingless bees (0.087), bumble bees (0.083), wild bees (0.077), flesh flies (0.057), and the honey bees *A. florea* (0.001), *A. dorsata* (0.00), and *A. melliferae* (0.00) (Fig. 7). The population of blue bottle flies was significantly higher (2.80 per inflorescence) than all other pollinators, while similar among all other pollinators.

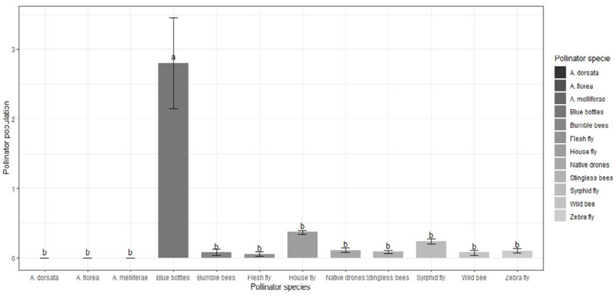

Fig. 7. Abundance of different species of pollinator during flowering on Sindhri Cultivar.

Population dynamics of the various species of pollinators during mango flowering on cultivar Sindhri

Mixed model ANOVA analysis on different species of pollinators during mango flowering showed that on Sindhri variety of mangoes, there was significant variation in abundance of various species of pollinators (DF=11, F=1851.20; P<0.001) by date. Pollinators were significantly abundant in April compared to March during 2020 (DF=2; F=350.66; P<0.001). Pollinator and date interaction was also significant (DF=22; F=436.56; P<0.001). Overall, the most abundant pollinator was blue bottle flies. The population of blue bottle flies significantly increased from the end of March to mid-April (Fig. 8). The second most abundant insect was house flies. The housefly population non-significantly decreased from March to mid-April. The third most abundant insect was syrphid flies (Fig. 8). The population of syrphid flies increased significantly from the end of March to April (Fig. 8). The fourth most abundant insect was bumble bees at the end of March, while its population was lower on March 20, and April 4. Wild bees were only observed on March 26, while no wild bee was observed on March 20, or April 4. The native drone population significantly decreased between March 20 and April 4. The zebra flies population significantly increased from March 20 to March 26, while no further increase was observed on April 1, 2020. Flesh flies were only observed on March 20. The stingless bee population was non-significantly different among dates during March, however, they were not observed on April 1, 2020. *Apis florea, Apis dorsata* and *Apis melliferae* populations were negligible.

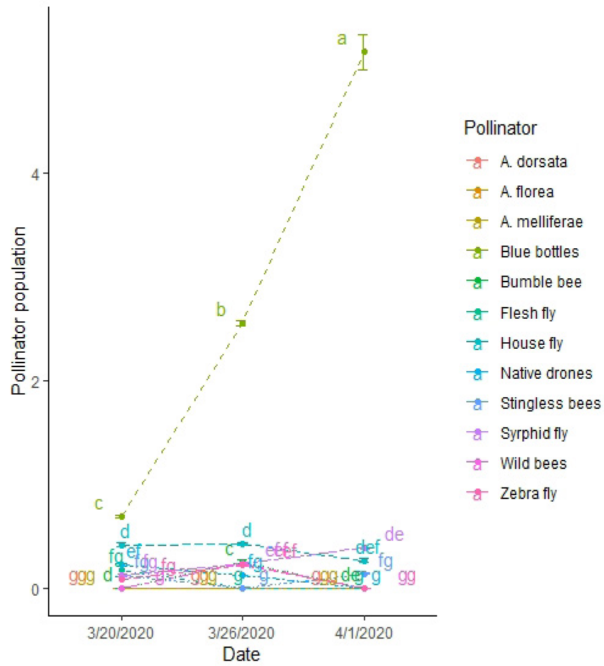

Fig. 8. Mixed model ANOVA analysis of different species of pollinators and flowering time during mango flowering on Sindhri cultivar.

Visitation of different species of pollinators during flowering season of Retaul 12 mangoes

ANOVA analysis of different species of pollinators during mango flowering on cultivar Retaul-12 showed that the most common and abundant visitor was blue bottle flies (DF=11; F=14.021; p <0.001) (Fig. 9A). The other species of insects, in order of abundance, were syrphid flies (1.90), native honey bee drones (1.30), wild bees (1.273), stingless bees (1.166), flesh flies (1.027), house flies (0.22), zebra flies (0.155), the honey bees *A. florea* (0.146), *A. dorsata* (0.00), and *A. melliferae* (0.00), and bumble bees (0.00) (Fig. 9B). The population of blue bottle flies was significantly higher (2.95) than all other species.

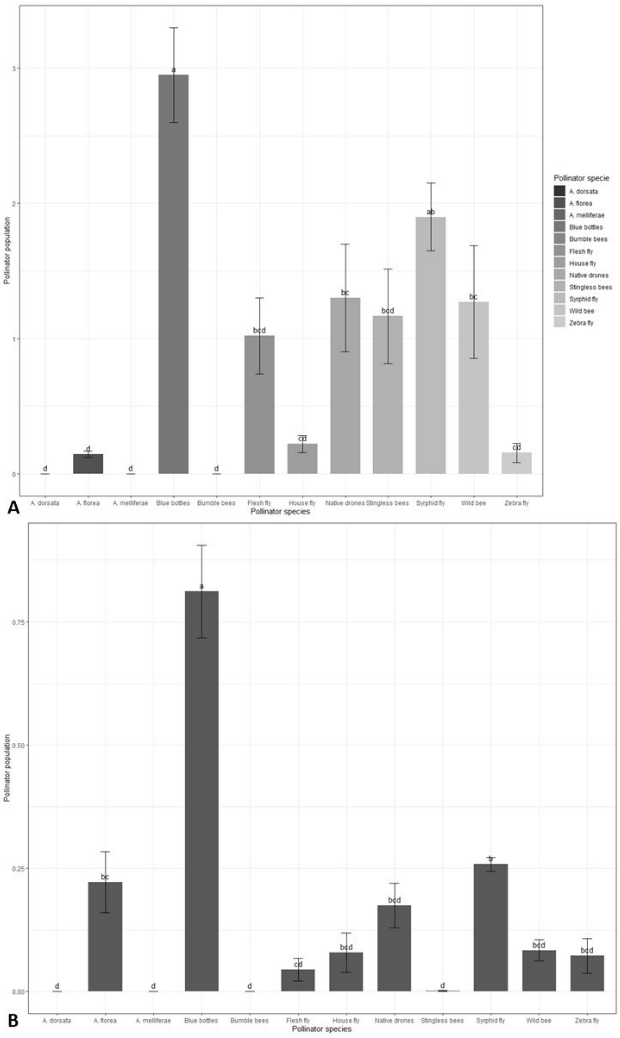

Fig. 9. Abundance of different species of pollinator during flowering season on Retaul-12 (A) and Chaunsa (B) Cultivar.

Cultivar population dynamics of the various species of pollinators during mango flowering on cultivar Retaul-12

ANOVA analysis of different species of pollinators showed that there was significant difference in total abundance of pollinators (DF=11; F=352.568; P <0.001) on Retaul-12 trees. Pollinators population was also significantly different on the dates March 20, 2020, March 26, 2020, and April 01, 2020 (DF=2; F=505.195; P<0.001). Mixed model ANOVA analysis on different species of the pollinators during mango flowering season showed that on Retaul-12 variety of mangoes, there was significant variation in abundance of various species of pollinators (DF=22, F=60.529; P<0.001) on the dates March 20, 2020, March 26, 2020 and April 1, 2020 (Fig. 10A). Overall, the most abundant pollinator was blue bottle flies on Retaul-12 as well (Fig. 10A). The population of blue bottle flies significantly increased from the end of March to mid-April (Fig. 10A). The second most abundant insect was syrphid flies (0.25) (Fig. 10A). The syrphid flies population significantly increased from March to April. The third most abundant insect was native honey bee drones (0.4) (Fig. 10A). The population of native drones increased significantly from the end of March to April (Fig. 10A). The fourth most abundant insect was wild bees (0.417) (Fig. 10A). The wild bees population increased with time (Fig. 10A). The population of wild bees was 0.0 on March 20, while population increased to 2.78 in April (Fig. 10A). The fifth most abundant insect was stingless bees (1.16) (Fig. 10A). The population of stingless bees increased significantly from end of March until April 4. The flesh flies population was noticeably higher on March 26, while its population was lower in April (Fig. 10A). The zebra flies population significantly increased from March 20, to March 26 while no further increase was observed in April 1, 2020 (Fig. 10A). The house flies population significantly increased with time. On March 20, 2020 the population of house flies was 0.0, which increased to 0.233 on March 26 and 0.433 later on in April 2020 (Fig. 10A). *Apis dorsata, Apis florea,* and *Apis melliferae* populations were negligible (Fig. 10A).

Abundance of different species of pollinators during flowering of SB Chaunsa mangoes

ANOVA analysis of different species of pollinators during mango flowering on cultivar SB-Chaunsa showed that the most common and abundant visitor was blue bottle flies (DF=11; F=32.764; p <0.001) (Fig. 9B). The other species of insects in order of abundance were syrphid flies (0.2577), *A. florea* (0.22), native honey bee drones (0.174), wild bees (0.0833), house flies (0.0788), zebra flies (0.072), flesh flies (0.044), stingless bees (0.001), *A. dorsata* (0.0), *A. melliferae* (0.00), and bumble bees (0.00) (Fig. 9B). The population of blue bottle flies was significantly higher (0.811) than all other species, followed by syrphid flies, *A. florea*, native drones, wild bees, houseflies, zebra flies, flesh flies, and finally the populations of stingless bees, *A. dorsata*, *A. melliferae*, and bumble bee were similar to each other (Fig. 9B).

Population dynamics of the various species of pollinators during mango flowering on cultivar SB Chaunsa

ANOVA analysis of different species of pollinators showed that there was significant difference in abundance

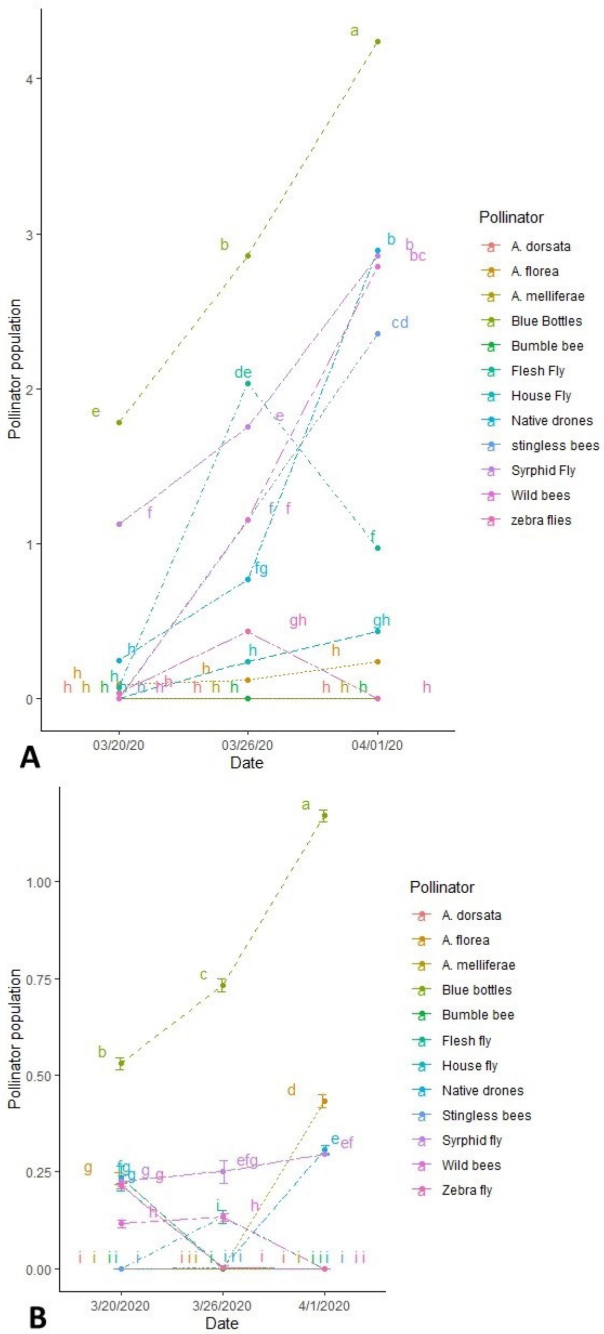

Fig. 10. Mixed model ANOVA analysis of different species of pollinators and flowering time during mango flowering on Retaul-12 (A) and Chaunsa (B) cultivar.

of pollinators (DF=11; F=12.5.45; P <0.001). Total pollinator visitation was significantly different on March 20, 2020, March 26, 2020, and April 01, 2020 (DF=2; F=147.40; P<0.001). Mixed model ANOVA analysis on different species of the pollinators during mango flowering showed that on SB Chaunsa variety of mangoes, there was significant variation in abundance of various species of pollinators (DF=22, F=147.87; P<0.001) on March 20, 2020, March 26, 2020, and April 1, 2020 (Fig. 10B). Overall, the most abundant pollinator was blue bottle flies on SB Chaunsa, as well (Fig. 10B). The population of blue bottle flies significantly increased from the end of March (0.53) to mid-April (1.17) (Fig. 10B). *A. florea* was only observed in the month of April. The syrphid fly population increased gradually from March 20, 2020 (0.22) to April 1, 2020 (0.29) (Fig. 10B). The house fly population was highest (0.233) on March 20, 2020 while not observed on mango inflorescences later in the season on cultivar SB Chaunsa (Fig. 10B). The native drones population decreased gradually from 0.21 on March 20 to 0.00 native drones on April (Fig. 10B). The zebra flies population decreased gradually from 0.21 in March 20 to 0.00 in the month of April (Fig. 10B). The flesh flies population decreased gradually from 0.13 on March 26 to 0.00 in month of April (Fig. 8). Wild bees were only observed in the month of March and not found in the month of April (Fig. 8). The stingless bees' population was minimal (Fig. 10B).

Estimation of the economic value of insect pollination in mango crop

The economic value of insect pollination, ratio of vulnerability, and consumer surplus loss were calculated as described earlier. Economic value of insect pollination (IPEV) for mango crop was 1299 million dollars. Overall, we found that if pollinators were not observed during mango inflorescence period, the yield would be negligible. Pollinators were essential for mango fruit setting.

DISCUSSION

Mango flowering and pollination is an important event that must occur for successful fruit setting. In the present experiment, we determined the role of pollinators in fruit setting of mangoes, characterized mango pollinator fauna, and calculated the economic value of insect pollination. Overall, we observed that insect borne pollination in mangoes is vital for successful fruit setting (Figs. 4-6). We reject the hypothesis that wind pollination or gravity might be sources of pollination in mangoes, as there was no fruit setting in the netted trees of any cultivar we studied. In the present study, we also found that most abundant insect visiting mango inflorescences during the flowering period was blue bottle flies. The honey bee *A. florea* was observed on SB Chaunsa and Retaul-12, while *A. melliferae*, and *A. dorsata* populations were negligible during mango fruit setting period. We therefore hypothesize that honey bees

A. melliferae, and *A. dorsata* might not be involved in pollination of mango. The other minor insects abundant during mango inflorescence and fruit setting time during the month of March to April were syrphid flies, native drones, house flies, zebra flies, flesh flies, wild bees and stingless bees. The total value of insect pollination was 1299 million dollars (Table I).

In the present study, we found that insects are necessary for successful mango fruit setting (Figs. 4-6). The results of our study were similar to Gajendra (1989) who described that in mangoes, insects are required for pollination and there was no fruit setting on completely bagged mango inflorescences while maximum fruit setting took place on the open trees where insects were visiting inflorescences. Although there are many hypotheses described for successful fruit setting in mangoes including wind (Heartless, 1914) and gravity (Mallik, 1957), we conclude that insect pollinators are required for successful fruit setting in mangoes.

In the present study, we found that the blue bottle fly was the most abundant insect in the mango trees. The results of our study were similiar to Gajendra (1996), who described that the most abundant insect in Pantanagar Uttar Pardesh India on mango inflorescences during the pollination period were Calliphoridae. Gajendra (1996) also described that maximum fruit setting was achieved when 5 blue bottle flies were enclosed with 10 syrphid flies, along with unopened inflorescences of mangoes. We suggest that in Pakistan, these blue bottle flies can be utilized to enhance fruit setting in mangoes and achieve maximum fruit yield per acre basis. The results of our study were also similar to Dag and Gazit (2000) who found that the most abundant pollinators in mango orchards in Israel were Diptera, including blow flies (*Chrysoma albiceps* and *Lucilia sericata*) and house flies (*Musca domestica* L.). Anderson *et al*. (1982) described the mango pollinator fauna of Australia and described large Diptera as major pollinators. We also found Diptera (blue bottles flies) to be a major insect abundant during mango bloom. Thus, we hypothesize that though pollinator fauna in mango orchards vary in different agroclimatic regions of the world, the major pollinators are Diptera in Israel (Dag and Gazit, 2000), Australia (Anderson *et al*., 1982), India (Gajendra, 1996), South Africa (Eardley and Mansell, 1995) and Pakistan.

In our study, we observed syrphid flies and house flies in low numbers on the open trees. The results of our study were also similar to Gajendra (1989, 1996) and Dag and Gazit (2000), who described that syrphid flies and house flies had a minimum role in fruit setting. Furthermore, Gajendra (1989, 1996) reported that the mango inflorescences enclosed in bags in which syrphid and house flies were released had low number of fruit setting. Although we could not establish the role of syrphid flies and house flies in successful fruit setting, we observed syrphid flies and house flies in the open trees. We suggest that some percentage of pollination might be achieved through these tiny insects in south Punjab Pakistan. Our results were similar to many authors (Eardley and Mansell, 1994; Gajendra, 1989; Jirón-Porras and Hedström, 1985; Lb, 1960; Saúco *et al*., 1996) who reported low number of house flies and syrphid flies on mango trees.

In our study, we document that honey bees *A. melliferae* and *A. dorsata* were not attracted to mango flowers. The results of our study were similar to Free and Williams (1976a), who reported that mango flowers were unattractive to *A. melliferae*. However, a different species of honey bee *A. florea* was observed on few cultivars of mangoes. We therefore conclude that *A. florea* might be involved in pollination but *A. melliferae* and *A. dorsata* don't pollinate mango inflorescence. Our results were similiar to Kumar *et al*. (2016) who described that honey bees species vary in different regions of world but native honeybee species of specific regions may be involved in mango pollination. Our results were also similar to Anderson *et al*. (1982), who found that native wild bees *Trigona* sp. visited mango flowers and can be utilized as pollinators, since the pollen attaches to their bodies. Although the native honey bee in Pakistan *A. florea* was not mentioned as a pollinator of mangoes in Israel (Dag and Gazit, 2000) or India (Gajendra, 1996), we found it to be a frequent visitor on SB Chaunsa and Retaul-12 mangoes in our study.

In Pakistan, mango inflorescence timing occurs from the end of February through March, but varies by variety. Sindhri, which is the most exportable cultivated variety, bears inflorescence and fruits in clusters. Successful pollination in this cultivar can ensure maximum farmer profit and increased foreign exchange earnings. Increasing blue bottle flies and syrphid flies population during the peak inflorescence period may enhance yield of mangoes. Moreover, further research on mango fruit inflorescence morphology and pollen bearing insects in controlled experiments should be done to understand the role of each pollinator in pollination.

Overall, this is the first scientific study elaborating the pollinators fauna of mango orchards in Southern Punjab Pakistan. This is the first scientific study describing the role of insect pollinators in successful fruit setting in southern Punjab Pakistan. The finding of this research will help scientists to further design research experiments to elaborate the role of each pollinator and utilization of these insects for successful fruit setting in mangoes. Overall, this study provides a platform for the further experiments. The finding of this study would help growers to increase their farm income.

Table I. Total value of insect pollination in dollars in mango crop.

Average value per kg in US dollar	Total value of the crop (USD)	Economic value of insect pollination (IPEV)	Ratio of vulnerability (RV)	Consumer surplus loss with elasticity (CSL)
0.804	1,367,816.091	1299 Million USD	0.095	499.8MD

CONCLUSIONS

It is concluded that insects are required for pollination in mangoes. We reject the hypothesis that insect pollinators are not required for the successful pollination and fruit setting. The honey bee *Apis melliferae* is not involved in mango pollination in South Punjab, Pakistan. The main pollinators observed on different mango cultivars were blue bottle flies, house flies, syrphid flies, native drones, zebra flies, stingless bees, bumble bees, wild bees, and flesh flies. The native honey bee *A. florea* was observed on SB Chaunsa and Retaul-12 while *A. dorsata* and *A. melliferea* were not found during mango fruit setting and pollination period. The economic value of insect pollination was 1299 million dollars. Future studies on understanding the role of individual pollinator in fruit setting is needed.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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