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Pollination Deficit in Mango Orchards at Multan, Pakistan

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ABSTRACT

Mango, *Mangifera indica* is an indigenous fruit of the Indian sub-continent, where it has been cultivated for thousands of years. In Pakistan it is grown mainly in Sindh and Southern Punjab. Despite its long history of cultivation the potential yield has not been achieved. Mango is dependent on insect pollinators to set fruit. Farmers in Pakistan are generally not aware of pollination needs of mango. A study was conducted in different orchards of Multan for relationship of different pollinator groups with the crop. It was observed that fruit weight and fruit quality is enhanced with increasing number of visitors per panicle, as well as vice versa. Similarly inter-cropping was also strongly associated with the average number of visitors. It can also be concluded that inter-cropping attracted pollinators which increased the fruit weight and quality. Moreover, inter cropping also increased the number of observed hives. Same trend was also observed between number of hives and floral diversity at the orchards. Conclusively, it can be depicted safely that intercrop, diversity and average number of visiting pollinators contributed positively to the fruit weight and fruit quality. Pollinators collected from Multan belonged to seventeen different species under 15 genera and 07 families. *Ceratina binghami* apparently seems to be the dominant bee species followed by *Apis andreniformis* though no significant difference was observed. Among flies, *Episyrphus balteatus* seems to be dominant fly visiting mango orchards compared to other pollinators.

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Authors' Contributions
MKR and Q collected and analyzed the data. RM wrote the article. ES initiated the project and was involved in experimental work. MI identified the pollinators. GS monitored the experimental site.

Key words
Pollination deficit, mango orchards, insect pollinators, *Ceratina binghami*, *Apis andreniformis*, *Episyrphus balteatus*.

INTRODUCTION

Pollination is the mechanical transfer of pollen from the male to female portion of the same or different flower. This is fastening phenomenon for the development of fruit and seeds in flowering plants. Pollination is as important as other inputs (seed, fertilizer, and irrigation) for better production and is rather inevitable for fruit production (Khan and Chaudhry, 1988). Approximately 80 percent of all flowering plant species are specialized for pollination by animals, mostly insects (Ascher and Rasmussen, 2010).

Mango is indigenous fruit of the Indian subcontinent, where mangoes have been cultivated for thousands of years. In Pakistan, mango are mainly grown in Sindh and southern Punjab. Mirpur Khas and Multan are on top of mango as production both in quality and quantity. Other important areas include Hyderabad, Nawabshah, Naushahroferoz, Khairpur, Rahim Yar Khan, Bahawalpur and Muzaffargarh. There are many mango varieties but only a select few have commercial significance in the country. Some of the principal varieties in Pakistan are Sindhri, Chaunsa, Dasehri, Langra, Anwar Ratole, Fajri and Malda. The markets for mango are strong both at national and international level. The yearly pango production in Pakistan is 1888.5 thousand tones (GOP, 2011).

Pollinators are essential for crop production. Reproduction of nearly 70 percent of the world's flowering plants, including more than two-thirds of the world's crop species is due to pollinators (Ollerton *et al.*, 2011). Pollinator decline will have serious socio-economic consequences for some countries which host a large population of small and marginal farms for whom falling yield level would be critical for subsistence (Klein *et al.*, 2007). In many places, the essential service of pollination is at risk from habitat loss, pesticide use, and introduced diseases. According to Gallai *et al.* (2008) the decline of pollination will have main affects on three main crops categories. Fruits and vegetables are especially affected with a loss estimated at 50 billion each followed by edible oil seed crops with 39 billion Euros. Munir *et al.* (2015) concluded that more seeds were produced in fruits which pollinated by bumblebee as compared to manually and self-pollinated fruits.

A study in Pakistan shows that inflorescence and fruit seed set was 42.5 and 28.3% in uncaged and caged trees, respectively. As a result yield reduced 33.4% due to pollination deficit (Aslam *et al.*, 2004). It has been reported that by increasing bee hives, mustard production increased up to 30% and toria and sarsoon 47%. The

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cauliflower and cucumber yield increased 23% and 28-32.5% due to bee pollination, respectively. Seed set increased in onion 62-93%, yield in Radish (18.7%) and in sunflowers (22%) by bee pollination in Matli and Golarchi, district Badin, Pakistan (Stephen and Irshad, 2012).

The present study was undertaken to see if pollination in mango is affected by the type and variety of pollinators.

MATERIALS AND METHODS

The study was conducted in different mango orchards in 2011. For this purpose a nucleus Study, Training, Education and Promotion (STEP) site was established in Multan, Pakistan. Twenty five mango fruit orchards were selected from around this STEP site. Data were collected in good weather condition with no rain and dry weather. Maximum flowering was observed in March. Data recording was done on the onset of blooming when 10% of the trees had started to bloom. Data was recorded on weekly basis during the main flowering period by scanning method as per Vaissiere *et al*. (2011). The sampling was done by walking slowly along a path, in between rows and recording the number of pollinators seen when scanning at floral unit one by one in sequence. Floral units were inflorescence of mango. A total of 100 floral units were scanned on 8 trees of the same variety which was Chounsa in four transects. Monitoring was done by keenly looking each floral unit and counting different visiting pollinators.

Pollinators were collected by putting different plastic pan traps (blue, yellow and silver) having detergent water in mango orchards spread at 9:00 AM and removed at 4:00 PM. Pollinators were also collected by hand net sweeping for half an hour at each site. Collected pollinators were sieved and dried and sent to National Insect Museum, NARC, Islamabad for identification.

RESULTS AND DISCUSSION

Co-efficient of correlation was calculated for all the observed variables. All the variables were found to be positively associated with one another. However, some variables had strong (Correction value close to 1) relationship. Pollinator's visitation has strong positive correlation with fruit quality and fruit weight (Table I, Fig. 1A). It can also be interpreted from the results that with increasing number of visitors per panicle, fruit weight and fruit quality is enhanced. Similarly inter-cropping was also strongly associated with the average number of visitors. It can also be concluded that inter-cropping attracted pollinators which increased the fruit weight and quality. Moreover, inter crop also increased the number of observed hives. Same trend was also observed between number of hives and floral visitation at the orchards. Conclusively, It can be depicted safely that intercrop, pollinators diversity and average number of visiting pollinators contributed to the fruit weight and fruit quality.

There is a weak but highly significant relationship between fruit weight per panicle and average number of insect visitors. It was just not one bee hive of *Apis mellifera* which was placed at each study site but there was a wide variety of pollinators such as bumble bee, syrphid, *Apis* and others that make this relationship significant (Fig.1A). Diversity in insect pollinators, therefore, significantly enhanced the per panicle increase in fruit weight in the farm.

The site that intercropped has good crop diversity and tolerates weeds and is attractive wild plants are attractive to pollinators *Apis dorsata* and others. It is not the *Apis* sp. alone, but the whole complex of pollinators that significantly increase fruit weights and fruit quality (Table I). There is no relationship between the number of *Apis* hives observed and fruit weight, fruit set, and fruit quality, but there is a relationship between number of hives and intercropping, number of hives and crop diversity and number of hives and presence of weeds or wild trees (Fig.1B). Similarly syrphids have positive relationship with various parameters (Fig.1C).

The pollinators collected from 35 different mango sites belonged to seventeen different species under 15 genera and 07 families. Among flies *Episyrphus balteatus* seemed to be in abundance compared to others.

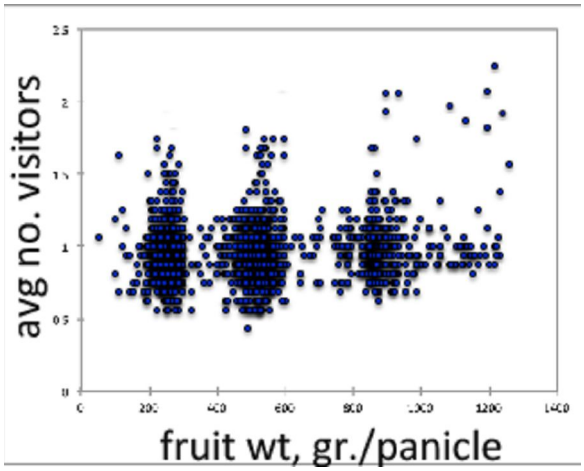
In spite of the fact that inadequate studies exists in Pakistan on pollination deficit still the previous work shows that production of certain crops can be enhanced by putting some efforts on pollination activity in the field. There was considerable variation in levels of pollinator dependency which could be due to effects of site, varieties of crops grown and inputs, which we could not test because of limitations of study design.

Our results did not support many cases in literature: For example orchards having low levels of reliance on pollinators for crop production (Klein *et al*., 2007) showed significant levels of pollinator dependency in our study described as having moderate levels of pollinator dependence. Therefore, more data from different sites are required to get a realistic picture of pollinator dependence of sub tropical crops.

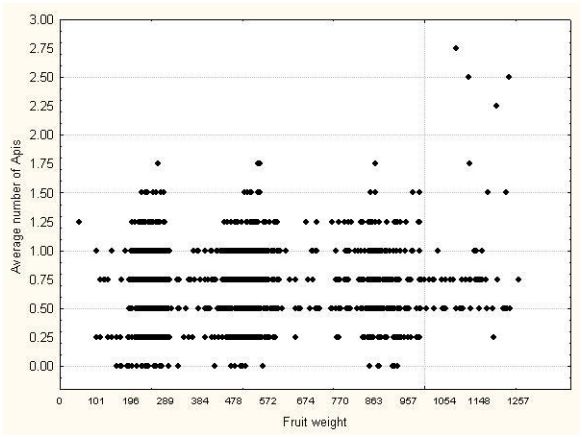
Diverse pollinator assemblages visiting flowers in this study. This could be due to small scale farms having adequate shrubbery and weedy vegetation that could

Table I.- Correlation of various variables with one another regarding fruit weighty, fruit set and number of pollinators visited.

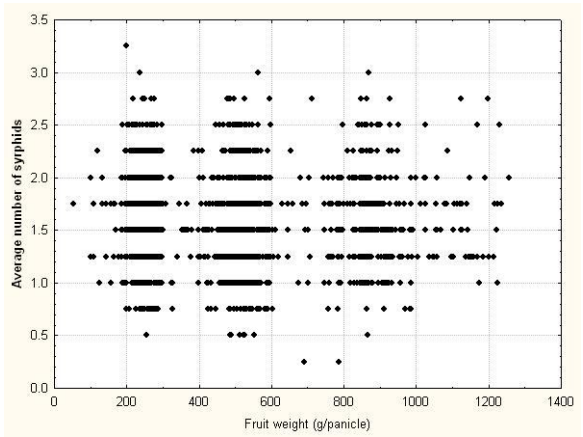
Variables	Avg. Visit	F. Set	F. Quality	F. Wt.	No. hives	Intercrop	Diversity	Weeds/wild
Avg.Visitors	1	0.054	0.289	0.063	0.085	0.145	0.072	0.109
F. Set	0.054	1	0.067	0.969	0.007	0.007	0.000	0.012
F. Quality	0.289	0.067	1	0.069	0.028	0.077	0.018	0.024
F. weight	0.063	0.969	0.069	1	0.003	0.022	0.013	0.006
No. hives	0.085	0.007	0.028	0.003	1	0.386	0.459	0.263
Intercrop	0.145	0.007	0.077	0.022	0.386	1	0.217	0.163
Diversity	0.072	0.000	0.018	0.013	0.459	0.217	1	0.514
Weeds/wild	0.109	0.012	0.024	0.006	0.263	0.163	0.514	1



A



B



C

Fig. 1. Correlation between insect pollinators visited and fruit weight (A), number of *Apis* and fruit weight, g/ panicle (B), numbers of Syrphid flies and fruit weight (C).

provide foraging and nesting habitats for pollinators despite the extensive use of pesticides. Uncultivated areas and shrubbery around farms are an important refuge for insects and buffer the effects of insecticides (Lee *et al*., 2001).

Our study also identifies syrphid flies as a possible major pollinator group. Bees, particularly honeybees have rightly been given the key role of pollinating crops worldwide (Potts *et al*., 2010).

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