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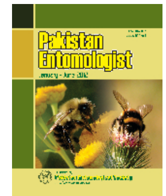

FRUIT SETTING AND YIELD OF LOQUATS (*ERIOBOTRYA JAPONICA*) AS AFFECTED BY POLLINATORS

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ABSTRACT

A field experiment was conducted during loquat's growing season, 2008 at National Agricultural Research Centre, Islamabad to evaluate the effect of different pollination treatments on fruit setting and quality of loquat as well as to determine the types of pollinators visiting loquat flowers during different times of the day. Open and covered pollination treatments were imposed on the selected trees. Extremely higher fruit-set was obtained under open-pollination as compared to the covered treatment. Fruits obtained under open pollination were also heavier and larger which was partly due to a significant increase in seeds and flesh weight. Loquat flowers attracted number of bee visitors. Insects belonging to Muscidae, Calliphoridae, Syrphidae (Diptera) and Apidae (Hymenoptera) were recorded as the main visitors. They showed a slight variation in their visiting time; however, the highest numbers of visitors were attracted to loquat flowers during the morning time of the day.

Keywords: Pollination, loquat, fruit set, fruit weight, Hymenoptera, Diptera

INTRODUCTION

The loquat, *Eriobotrya japonica* Lindl.,(Rosaceae), a fruit of wide appeal, is also called Japanese plum or Japanese medlar. The tree is of moderate size which is indigenous to South-Eastern China and possibly Southern Japan, though it may have been introduced into Japan into very early times (Rodriguez, 1983). The loquats are unusual among fruit trees in a way that the flowers appear in the autumn or early winter and the fruits ripe in late winter or early spring. The fruits growing in clusters are oval, rounded or pear shaped, 3-5cm long with a smooth or downy, yellow orange skin. The fruit contains laevulose, sucrose and malic acid and lower amounts of citric, tartaric and succinic acid. The pulp contains the carotenoids *B*-carotene (33%), *Y*-carotene (6%), cryptoxanthin (22%), lutein, violaxanthin, neoxanthin (3-4% each) (Demir, 1987). The peel is five times richer than the pulp in carotenoids which are similar to those in apricots (Morton, 1987).

Loquat total world production is over 500,000 tons and China, with more than 80% of the world production is the main producing country followed by Spain, Turkey, Japan and Pakistan (Caballero and Fernández-zamudio, 2003; Lin, 2007). In Pakistan the local variety comprises an area of 10,000 hectare and an estimated production of 128,000 tonnes which usually do not reach the commercial quality necessary for export and are, therefore, consumed on the home market. In the other group of plantations, the main variety found is Tanaka which was introduced in 1965 with 1000 ha in production from which 16,000 tons are harvested and 10% is exported to the Middle East, principally Dubai (Caballero and Fernández-zamudio, 2003). Loquat is grown to limited extent in Haripur and Peshawar in view of its early fruit arrival in the market when no fresh stone fruit is available. The inflorescence contains a copious quantity of nectar in the open cavity around the ovary below the base of anther.

The loquat is normally pollinated by bees. The pollination requirement seems to vary with cultivars of loquat, but all are benefited by cross pollination. It was also reported that honeybees are the primary visitors of loquat,s flowers and one bee is adequate for 100 flowers (McGregor, 1976). Crescimanno (1958) found that bagged blossom set only 0.0, 16.5 and 1.3 % seeds, whereas open blossoms set 4.2, 12.0 and 21.7 % seeds; while cross pollinated flowers set 60 and 55 % of blossoms during different years. Receptivity period of loquat flowers is not well known. Singh (1963) found that pollen remains viable for 35-45 days at room temperature, 22 months at 0^0 C and 26 months in a deep freezer.

The Honeybee, *Apis mellifera* L., is of great economic importance in terms of increased yield and quality of

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commercially grown insect pollinated crops and also assists self-pollinated crops in the world (Free, 1993). Many field and fruit crops in the United States and Canada are dependent on the rental of managed honeybee colonies for high quality fruit (Free, 1993; Delaplane and Mayer, 2000). In the United States, it is estimated that the honeybee foraging provides $ 14.6 billion annually in yield and quality out put of crops (Morse and Calderone, 2000). In Pakistan use of bees, except honeybees in few cases, for pollination is still missing dimension in crop production. *A. mellifera* is the only most abundant and ecologically important introduced pollinator and is mostly managed for honey production. However, it is not so active during inclement weather which is very common at the time of early blooming period of fruit trees like apricot, cherry, almond, apple and pear. There is, therefore, a vast scope of improving the pollination of crops by designing and implementing strategies to manage economically important insect pollinator's especially native bees for seed and fruit production in agricultural ecosystem. Since the manpower on the topic is meager, more people should be trained in pollination management to address the above issue.

Keeping in view the role of pollinators (mostly honey bees), the present study was conducted to determine their effect on loquat production with respect to seed set and yield and to raise their awareness about the pollination services among the loquat growers.

MATERIALS AND METHODS

The field area of National Agricultural Research Centre Islamabad during November 2008 was selected for this study. Nine trees of nearly 10 years age and almost of equal size, grown at 12 ft spacing were selected randomly before flower initiation. Six panicles on the marked trees were tagged and the numbers of buds were counted. Treatments applied include open panicles (three on each tree) allowing free visits of pollinators (T1) and panicles covered with muslin cloth (T2) (three on each tree). The bags were removed after the fruit setting. On maturity, i.e. 8/04/2009, fruits we counted from each panicle, removed and weighed separately.

Number of foraging bees and other pollinators

The bees and other pollinators foraging in the open treatment were collected with the help of sweep net for 10 minutes during five days of each week during the whole flowering period. The data was recorded at 9:00 am, 12:00 noon and 3:00 pm of each day. The pollinators were collected, pin set, identified up to order and family level and counted.

Statistical analysis

SPSS statistical programme version fourteen was used for the statistical analysis of the collected data. Comparisons between means were made using the Least Significant Difference (LSD) test at 0.05 probabilities.

RESULTS AND DISCUSSION

The mean fruit set from the pollinated flowers was 23.5 % ($\pm$1.26 SE), while that of un-pollinated caged flowers was 1.80 % ($\pm$0.31 SE) (Fig. 1). Apart from the importance of pollination in fruit or seed set, the process enhances higher yields of better quality (McGregor, 1976; Free, 1993). Some crops benefit also in terms of uniform ripening, which reduces yield losses in the field. The number of fruit set was analyzed and significant difference was found among the treatments (Two Way ANOVA, $F_{(1, 36)} = 272.33$, $P < 0.001$). This effect is in agreement with Cuevas *et al.* (2003) who obtained higher fruit set in loquat with cross and open-pollination as compared to self pollination treatments. The effect of replications (trees) on the percent fruit set of loquat showed nonsignificant effects (Two Way ANOVA, $F_{(8, 36)} = 0.287$, $P > 0.001$). Similarly, the interaction between the treatments and trees did not show any difference (Two Way ANOVA, $F_{(8, 36)} = 0.645$, $P > 0.001$) for fruit set.

The total numbers of fruits produced from the pollinated flowers (448 fruits) were significantly higher than that of un-pollinated flowers (47fruits). Similar results have been reported in Pakistan by Khan (2003) who showed that the bagged panicles of loquat had a 4% set, compared to 83% in an orchard with honeybee colonies and 46% set in an orchard without honeybee colonies. The mean weight (in grams) of individual fruits from the pollinated flowers was 14.6 g ($\pm$0.218 SE), while that of fruits from un-pollinated caged flowers was 6.36 g ($\pm$0.81 SE) (Fig. 2). The weights showed significant difference among the treatments (Two Way ANOVA, $F_{(1, 495)} = 279.9$, $P < 0.001$). Nawaf *et al.* (2008) also found significantly higher fruit set in loquat with open - pollination treatments while the fruit set under self-pollination was extremely low (average close to one fruit per panicle). Increase of fruit size was also apparent for fruit diameter as well as for fresh fruit weight. The higher fruit size in open than cross pollination may be attributed to its lower fruit set. Kasina (2007) also found a significant difference in the quantity and quality of fruits obtained from bagged and un-bagged flowers of tomatoes and capsicum. The findings of the present research regarding fruit quality and quantity are also highly in agreement with those of Khan *et al*. (1916). Higher weight and seed number were recorded for fruits obtained from un-bagged flowers due to pollination. The fruits were also larger, implying that they benefited in quality due to bee visits. The weight of fruits and their size depend on the number of developed seeds. The seeds usually trigger development of mesoderm, hence the more the seeds, the more 'flesh', and thus weight as we observed in our experiment. Seed production follows successful pollen deposition in the stigma and subsequent pollen tube germination. More pollen deposited, the higher the likelihood of fertilization of more ovules, resulting in an increased number of seeds. Thus, better pollinated flowers produced a higher fruit weight. The effect of replications (trees) on the fruit weight and seed setting of loquat did not show any significant effects (Two Way ANOVA, $F_{(8, 495)} = 1.385$, $P > 0.001$).

Insect and other organisms play major role in boosting agricultural production by significantly increasing the yields of vegetables and fruits through visiting flowers and helping in pollination. Self-pollinated crops are benefited from insect pollination and yield increases up to 30% from pollinator visits. Lack of pollinators causes decline in fruit and seed production (Partap, 2001). The number of insect pollinators were collected and all of them were identified up to order level while most of them up to family level. No difference in the number of pollinators with respect to the time of collection was observed (Fig. 3). Over all 509 pollinators were collected and Diptera was found the most prominent order followed by Hymenoptera (Fig. 4). Among the Dipterans, most of the pollinating insects belong to *Muscidae, Calliphoridae* and *Syrphidae* family, while in case of Hymenopterans, the major family observed was *Apidae.* Mann and Sagar (1987) conducted a survey study in the Punjab and reported that the loquat fruit set on bagged flowers was 15% less than on open pollinated ones. Their finding that *Apis dorsata* was the primary flower visitor is not in agreement with our results that sowed Dipterans as the major insects visiting loquat.

For the animal-pollinated agricultural crops, bees are the most important pollinator worldwide especially because of their foraging behaviour and floral constancy (ability to visit flowers of only one plant species on every foraging bout). However, only about 15% of the world's crops are pollinated by a few managed bee species, e.g., *A. mellifera* and *Bombus* spp., while the rest are pollinated by un-managed solitary bees

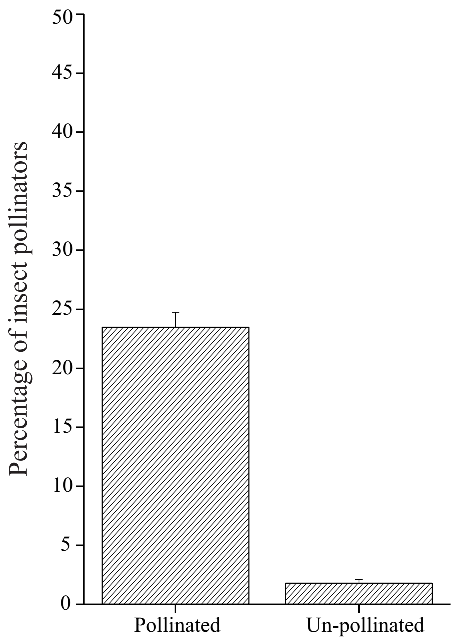

Fig. 1
Percentage fruit set from pollinated and Un-pollinated flowers.

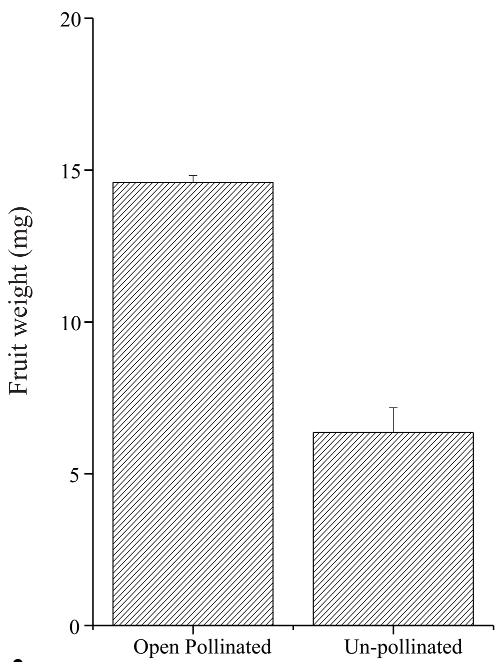

Fig. 2
Mean weight of fruits (mg) from pollinated and Un-pollinated flowers.

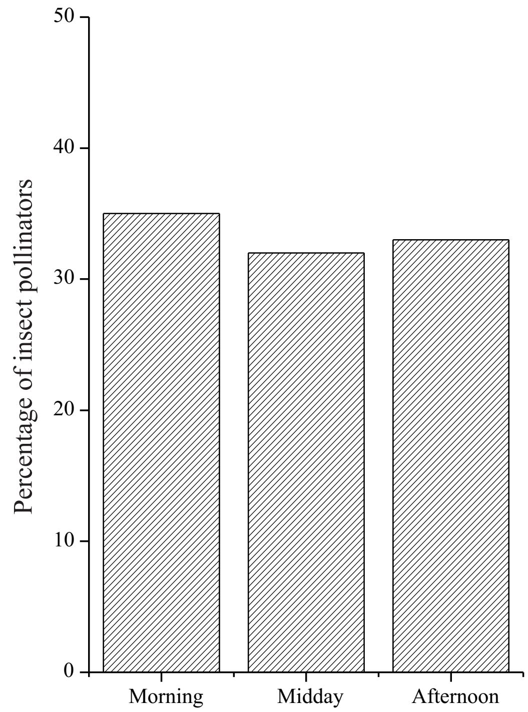

Fig. 3
Number of insects (%) collected on loquat trees during different times of the day. flowers.

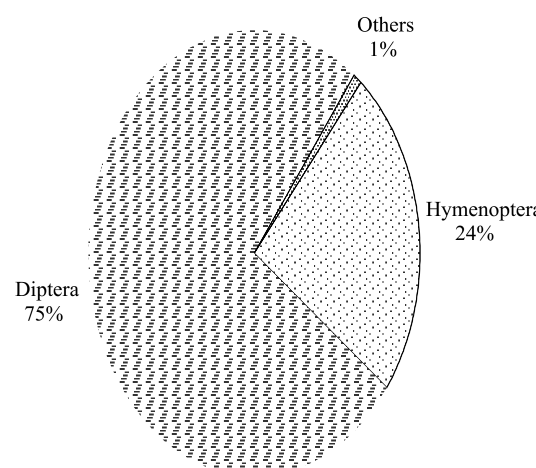

Fig. 4
Percentage of pollinators belonging to different orders collected from loquat trees.pollinated flowers.flowers.

in providing services of pollination in developing countries cannot be ignored, although this service is mainly feral there. It is only in plantations where we find farmers having *A. mellifera* colonies for pollination purposes. This is done even without determining whether this bee species is the most effective pollinator for those crops (Goulson, 2003). Management of bees for commercial pollination purposes only began in the 1940s and the results showed that bees were found important in crop production due to their pollinating activities (Olmstead and Wooten, 1987). Pollinator diversity is also important in pollination as bees complement each other in pollination. A more diverse bee community provides better pollination service especially in areas where mixed cropping is done. Diversity can help to reduce the risk that may arise due to lack of a pollinator during the critical period of crop flowering. Nawaf *et al.*, (2008) reported that loquat flowers attracted limited number of bee visitors and a significant variation was found in their visiting time with the highest rate and number during the mid of the day. These results are in contrary to our results as we did not find any difference regarding pollinators visiting times. The reason may be due to the different environmental conditions like radiation rate and daily temperatures prevailing in the experimental area.

In conclusion, further research on various aspects of pollinator-flower interactions is direly needed to determine the ways of enhancing crop pollination in the orchards. Farmers should be advised and encourages managing bee pollination in order to improve their crop yields. This can be done through farmer field campaigns to create awareness about the scope of pollinators in earning better prices of crop commodities produced in pollinator-cropping systems. Such campaigns would encourage farmers to improve populations of different bee species on their farmland insuring better quality fruits.

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