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Effect of mode of pollination on fruit set and quality of sweet cherry (*Prunus avium* L.) in kullu valley of Himachal Pradesh

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Abstract

The present investigation was conducted to study the effect of mode of pollination on fruit set and quality of sweet cherry at Beekeeping Horticulture Research Sub Station, Katrain and in private orchard at village Dobhi, district Kullu, Himachal Pradesh during 2014-2015. The experiment was laid down in randomized block design (RBD) factorial and different modes of pollination viz., bee pollination, open pollination, hand pollination and controlled pollination were practised. The experimental results revealed that bee pollination (70.95 %) was equally superior to open (63.47 %) and hand pollination (70.35 %). No fruits were obtained from the flowers caged before flowering indicating that cherry requires insect pollination for fruit set. Besides this, the effect of different modes of pollination on fruit quality revealed that there was no difference in width, length, TSS, weight and volume of fruits under open and bee pollination. Further, one colony per hectare is recommended for orchards planted in such areas, where natural insect population including *A. cerana* is abundant, suggesting that area like Katrain, Kullu, HP surrounded by natural habitat and with rich floral diversity is providing natural habitat for different insect pollinators.

Keywords: pollination, fruit set, quality, bee colony and sweet cherry

1. Introduction

Sweet cherry (*Prunus avium* L.) is one of the most appreciated fruit by the consumers due to its excellent fruit quality. Its fruits are very attractive and delicious, which are used in the ripe form and for culinary purpose [1]. Fruits of sweet cherry are first to ripe in early summer, which along with its limited production and more demand make it a high value cash crop [2]. Besides this, with the improved transportation facilities, now it is easy to transport the cherry from the centre of production to the centre of consumption and thus the overall scope for cherry cultivation has improved.

Cherry is highly cross pollinated crop and requires pollinizer varieties and insect pollinators for effective pollination and fruit set. Hence, pollination and fruit set in sweet cherries play an important role in enhancing the fruit yield and quality. Despite the availability of compatible pollinizers, sufficient pollinating insects are also required to carry the pollen for cross pollination and hence good fruit harvest. Various investigators have found positive correlation between the numbers of colonies moved annually in cherry grown areas and the fruit crop obtained [3, 4].

The detailed knowledge on the pollination requirements of different crops and possible pollinators species, including fruit crops such as sweet cherry, is often lacking and it is of the utmost importance that more research on these aspects of crop pollination is undertaken [5, 6]. Therefore, in the present study an attempt has been made to study the effect of mode of pollination on fruit set and quality of sweet cherry in Kullu Valley of Himachal Pradesh.

2. Materials and Methods

The present investigations were carried out in the department of entomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, during 2014-2015. The field experiments were laid out at Beekeeping Horticulture Research Sub Station, Katrain and in private orchard at village Dobhi, district Kullu, Himachal Pradesh. The methodologies followed for carrying out the current research are described below:

2.1 Different modes of pollination

2.1.1 Bee pollination: Cage of insect proof nylon net was erected to cover cherry tree. Specially prepared colony of *A. mellifera* was kept inside the cage. The cage was erected on a cherry tree of commercial variety and provided with bee colony. The number of flowers was

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counted when flowers were in balloon stage. The observations on fruit set were recorded 3 weeks after petal fall. Per cent fruit set was calculated from the number of flowers counted.

2.1.2 Open pollination: Observations were recorded in cherry trees exposed to all insect pollinators under open condition. Fruit set was recorded on the flower basis. Flowers (100-150) were counted in a tree at balloon stage for recording data on fruit set. The observations on fruit set were recorded 3 weeks after petal fall. Per cent fruit set was calculated from the number of flowers counted.

2.1.3 Hand pollination: The flowers at balloon stage were enclosed in the selfing bags. At the time of anthesis selfing

bags were removed and pollen was applied on the stigma by means of camel brush. The stigma receptivity was examined by magnifying hand lens and stigma showing greenish yellow to yellowish colour with droplets of secreted fluid was considered to be receptive. After application of pollen, flowers were bagged to avoid any contamination after pollination.

2.1.4 Controlled pollination: The flowers at balloon stage were enclosed in the selfing bag. After petal fall the selfing bags were removed.

Observations recorded

(A) Fruit set-

$$\text{Per cent fruit set (both in caged and open condition)} = \frac{\text{Number of fruits}}{\text{Total numbers of flowers}} \times 100$$

(B) Fruit quality: i) Fruit size, ii) Fruit weight, iii) Fruit volume and iv) TSS

2.2 Colony Requirement

For assessing the number of *A. mellifera* colonies required per hectare for optimum pollination, four plants of sweet cherry of almost equal canopy were selected at different distances of 25, 50, 75, 100 and 125 m. Two *A. mellifera* colonies were kept in the cherry orchard. Observations on the activity of honey bees were recorded on these plants / m² bloom per 5 min at three different day hours of (1000 h, 1200 h and 1500 h) for three sunny days. Average of each day observation was taken as one replication. So, in all three replications were computed. The data on fruit set was recorded for each day of the above distances from the colony after 21 days of flowering. On this basis, appropriate distances were calculated and keeping this distance as a radius, optimally served area was worked out. To work out the total number of colonies per hectare, one hectare area was divided by the area optimally served by one honey bee colony.

2.3 Statistical analysis

The data were analyzed statistically by using randomized block design (RBD) factorial and t- test as per the formulae given by Gomez and Gomez, 1986^[7].

3. Results and discussion

3.1 Bee activity under caged conditions

Activity of *A. mellifera* under caged condition was more (11.50 bees/ m²/ 5 min) in comparison to its activity under open condition (8.24). Normal *A. mellifera* activity under caged condition has also been reported by earlier workers on apple bloom^[8,9]. Dev^[10] reported that under caged condition, the activity of *A. mellifera* was 10.50 visits per square meter per 5 minutes on apple bloom. Brittain^[11] have also reported (8.45 to 10.5 bees/m²/5min) under caged condition on apple bloom.

3.2 Fruit set (%)

3.2.1 Bee pollination: The data in Fig. 2 revealed that commercial fruit set was recorded (70.95 %) on bee pollinated cherry tree caged with insect proof nylon net.

3.2.2 Open conditions: The data in Fig. 1 indicated that maximum fruit set (82.86%) was recorded at 25 m distance which was statistically same to the fruit set recorded at 50 m (78.06%). The fruit set recorded at different distances from

the placement of *A. mellifera* colonies showed decreasing trend with the increase in distances and it was 72.45 per cent at 75 m, 61.09 per cent at 100 m distance. Commercially low fruit set (22.89%) was obtained at 125 m.

3.2.3 Hand pollination: The flowers at balloon stage which were enclosed in the selfing bags were removed and pollen was applied on the stigma with camel hair brush. Average fruit set by hand pollination was recorded to be 70.35 per cent (Fig. 2).

3.2.4 Controlled pollination: The cherry flowers bagged before flowering and deprived of insect visitors did not set fruits.

The data on comparative modes of pollination presented in Fig. 2 showed that highest fruit set (70.95 %) was recorded under bee pollination, which was closely followed by fruit set in the hand pollinated flowers (70.35 %), being statistically same. The fruit set recorded under open condition was 63.47 per cent which was significantly different from all other modes of pollination. However, no fruits were obtained from the flowers under controlled pollination (no insect visitors). Klein *et al.*^[6] classified sweet cherry as greatly dependent upon pollinators based on the assumption that fruit set declines 40-90% in the absence of pollinators. Holzschuh *et al.*^[12] reported that bagged flowers (wind pollination only) produced only 3% of the fruits in comparison to open pollination (17%) and hand pollination (16%). The low fruit set under selfing by bagging and self- hand pollination was attributed to their inherent tendency towards self- fruitfulness^[13]. Poor fruit set under net caging can be attributed to the heavy size of pollen grains not carried by the wind^[14]. Present findings are supported with observation of Abrol^[15], who reported that flowers covered with muslin cloth did not set any fruit while those left for open pollination set 38-56 per cent fruits. These observations are also similar to Rana and Verma^[16], who reported maximum fruit set (35.55 %) in sweet cherry at 25 m from the colonies and as the distance increased fruit set percentage decreased.

3.3 Fruit quality

The data on effect of different modes of pollination on fruit quality of cherry (Table 1) showed that there was no difference in width, length, TSS, weight and volume of fruits under open pollination and bee pollination. The present investigations on fruit set and quality differ from Chaudhary *et al.*^[17] who have found significant increase in the weight,

length, breadth and volume of fruits developed from flowers exclusively pollinated by honey bees (6.2 g, 2.18 cm, 2.12 cm and 5.40 ml, respectively) as compared to open pollinated flowers (5.93 g, 2.16 cm, 2.02 cm and 5.05 ml, respectively) in cherry at Narkanda, Shimla. No such information is available in literature on impact of modes of pollination on fruit quality. The present findings are in close proximity to those of Dev ^[10], who found no significant variation in the fruit quality of apple obtained from bee pollination and open pollination. Fruit weight and TSS have been reported to vary from year to year and within samples from cherry at Katrain, Kullu ^[18, 19].

3.4 Colony requirement

The data in Fig. 1 and 3 clearly showed that *A. mellifera* activity and fruit set both decreased with the increase in distance from *A. mellifera* colonies, which indicate the impact of increased *A. mellifera* activity on the fruit set of cherry. The data further indicate that commercial fruit set was obtained up to 100 m distance. Hence two *A. mellifera* colonies are sufficient to pollinate cherry orchard up to 100 m distance. So, on the basis of fruit set (keeping 100 m as radius at which optimum fruit set obtained) one colony (15700 m²) of *A. mellifera* on 8 frame bee strength is sufficient to

pollinate one hectare of cherry orchard where natural insect population including *A. cerana* is abundant. The colony requirement is kept on higher side since the climatic conditions vary on yearly basis.

The data on fruit set recorded during 2015 showed that there was favourable climatic condition during the flowering period of cherry at Katrain. The impact of such condition is evident from the higher fruit set from 82.86 (25 m) to 61.09 per cent (100 m). Sharma *et al* ^[20] reported high fruit set (35.55 %) in sweet cherry at 25 m from the colonies and as the distance increased fruit set percentage decreased. They also reported that foraging activity of *A. mellifera* in sweet cherry at 50 m radius was significantly higher (6.81 honey bees/ m²/ 10 min) than *A. cerana* (3.92 honey bees/ m²/ 10 min) because Indian bees attracted more toward the nearby grown brassica crop and other ground flora. The present findings are in close proximity to earlier results. The number of colonies recommended per hectare for pollination of sweet cherry varied greatly i.e. 3.8 colonies ^[21], one colony ^[22] and two colonies ^[20]. The present finding are in close proximity to the standard recommendation by ^[23, 24, 25] who reported that 1.5-5 colonies of honey bees per hectare (according to local conditions) should be placed in the cherry orchard by the time of first bloom to facilitate pollination in sweet cherry.

Table 1: Effect of different modes of pollination on fruit size and quality of cherry

Mode of pollination	Fruit quality parameters				
	Width (cm)	Length (cm)	TSS (°B)	Weight (g)	Volume (cc)
Open pollination	19.49	18.94	11.08	4.42	5.08
Bee pollination	18.24	17.73	8.97	4.85	5.28
t _(0.05,4) *	0.06	0.10	0.07	0.14	0.30

* Non-significant at (P=0.05)

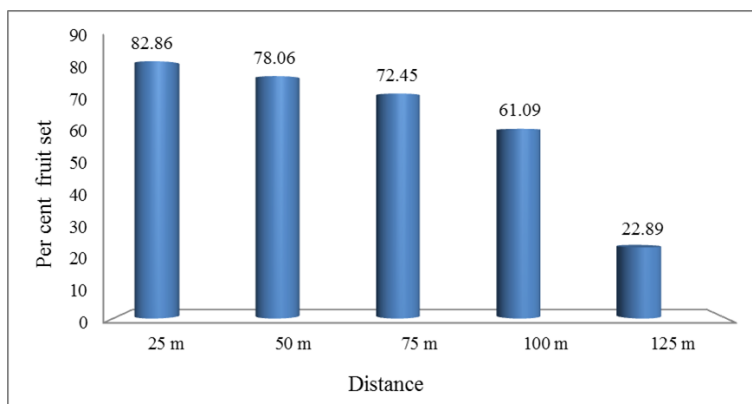


Fig 1: Fruit set (per cent) at different distances from the bee colony in cherry orchard

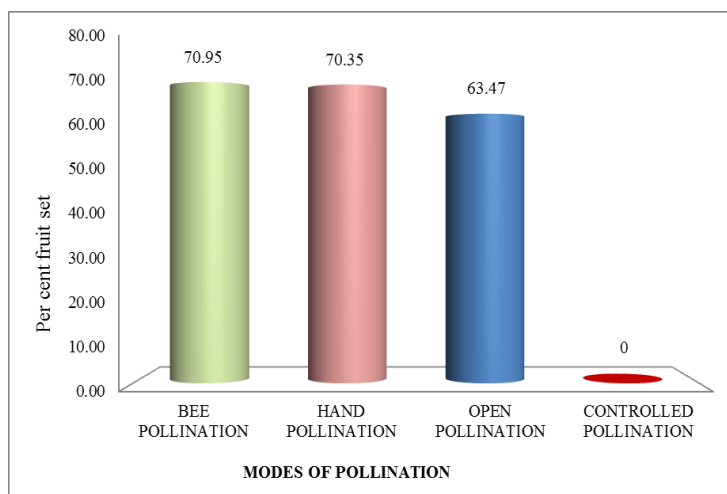


Fig 2: Per cent fruit set by different modes of pollination in cherry orchard

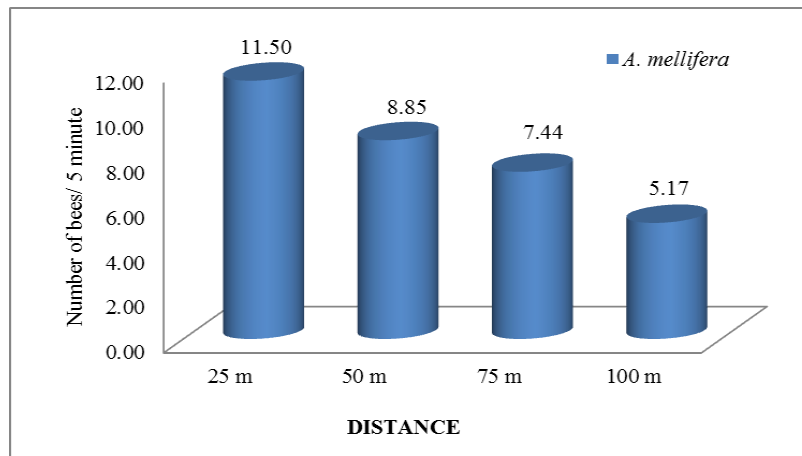


Fig 3: Activity of *Apis mellifera* at different distances

4. Conclusion

The present investigations conclude that bee pollination was equally superior to open and hand pollination. No fruits were obtained from the flowers caged before flowering indicating that cherry requires insect pollination for fruit set. Further, one colony per hectare is recommended for orchards planted in such areas, where natural insect population including *A. cerana* is abundant, suggesting that area like Katrain, Kullu, HP surrounded by natural habitat and with rich floral diversity is providing natural habitat for different insect pollinators.

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