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# Effect of pollen source on fruit set and quality of sweet cherry (*Prunus avium* L.)

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**Abstract**
The effect of pollen from three introduced sweet cherry cultivars (Stella, Sweet Heart and Lappins) was studied on fruit and stone properties of two sweet cherry cultivars (Bing and Rainier). Significant variations in percentage of fruit set, fruit characters and ripening time were observed. The pollens of Stella recorded highest fruit set (78.66 %) and retention (89.33 %) when used on Rainier and minimum fruit set and retention was recorded in open pollinated Bing (30.66% and 75.89 %) respectively. All strains of pollens used in this study had greatly influenced the stages of maturity in seed parents. Pollen from early maturing cultivar Stella accelerated maturity in Bing and Rainier by two days but pollen from late maturing cultivars Lappins and Sweet Heart delayed maturation in both by 2 days. Highest fruit weight (8.02g) and fruit thickness (21.67mm) in Rainier was achieved when Lappins when used as pollen parent. However, pollens from Sweet Heart resulted in highest fruit length (21.84mm) in Bing and fruit diameter (23.47mm) in Rainier. Significant differences in TSS and total sugars were observed among all cross combinations. Pollens of Lappins gave highest total soluble solids (19.96º Brix) and total sugars (11.15%) when used on Rainier and Bing respectively. There was remarkable difference regarding fruit color (L*, a*, b*) in open and cross combinations. Highest L* and b* value (45.89) and (22.60) respectively were recorded in open pollinated 'Rainier' where as pollens from 'Sweet Heart' resulted in highest a* (29.73) when used on 'Bing' seed parent.

**Keywords:** cherry, fruit set, pollination, quality, stone

## Introduction
Sweet cherry (*Prunus avium* L.) belongs to genus *Prunus* and family Rosaceae is a non-climacteric stone fruit, mainly grown in temperate zones of world. In India, the state of Jammu and Kashmir, Himachal Pradesh and Uttarakhand are the main contributors of cherry production in which Jammu and Kashmir alone produces more than 95 per cent of the total production of commercial cherries. An area of 2816 ha is under cherry cultivation in J&K with an annual production of 10244 metric tones (Anonymous, 2015) [3]. Sweet cherry is a species with a great economic importance, due to the nutritional and commercial value of its fruits (Pérez-Sánchez *et al*., 2010) [18]. The sufficient pollination and successful fertilization are essential for fruit set and high yield in many deciduous fruit crops. In cherries, sufficient pollination and fertilization is also important factor that affects the rate of fruit set and fruit quality. Fruit set of different sweet cherry cultivars have been shown to be influenced by pollen donors (Sutyemez, 2011) [24] Although fertilization and fruit set are the two major results of pollination, there is still another interesting but uncommon effect called meta xenia: the direct influence of pollen on the maternal tissues of the fruit (Janick, 1979) [11]. In cherries in addition to causing pollination and fruit set effects (Imani *et al*., 2013) [10], the pollen source is also affecting fruit and seed size, fruit quality (Nyeki *et al*., 2008) [17] and also the time of maturation (Stancevic, 1972) [23]. The objective was to study the effects of pollen source on percentage of fruit setting, fruit and stone properties of two sweet cherry cultivars.

## Materials and Methods
In the present investigation the effects of pollination and pollen samples introduced from three sweet cherry cultivars (Stella, Sweet Heart and Lappins) were studied on fruit and stone properties of two maternal parent cultivars (Bing and Rainier) grown at Centre for Temperate Fruits, Zangam, Pattan, Jammu and Kashmir during 2014-15. In this investigation flowers of pollen donors (Stella, Lappins and sweet Heart) were transferred to laboratory at late balloon

stage. Anthers were removed and placed into a dark coloured bottle to promote pollen dehiscence at room temperature. For carrying out open/natural pollination, four different branches of selected seed parents (Bing and Rainier) were selected and number of healthy female flowers at full balloon stage were counted and fruit set per cent was recorded after petal fall. During this process full bloom, closed, undeveloped flowers and those which had finished flowering were removed from these branches. For carrying out pollination, emasculation of flowers of seed parents was done at late balloon stage. Pollination treatments consisted of three hundred flower buds from each seed parent and after pollination these flowers were bagged with double cheese cloth. The muslin bags covering the cross pollinated flowers were removed after 3 weeks of pollination. The average weight of thirty selected fruits from both open and cross pollination and weight of the stones extracted from the previously weighed fruit was measured by using Top Balance and the weight was recorded in grams. The length of these thirty selected fruits and stones for each treatment was measured from distal to proximal end by using vernier calliper. The diameter of selected fruits and stones was measured from cheek to cheek and thickness of the selected fruits and stones were measured from suture to suture with the help of vernier calliper.

Fruit color was measured on two opposite cheeks in the equatorial zone using chromameter (Hunter Lab). The colour assessment with the instrument specified by the cordates L*, a*, b* in a three dimensional colour space, where L* represents the lightness whereas a* is the yellow to red and b* blue to green component. Total soluble solids (TSS) and total titrable acidity were determined as described by (Ranganna, 1979). TSS content of fruit pulp was determined by using hand-held Abbe's Refractometer. The total titrable acidity was determined by titration method. Total Sugars were determined by

$$\text{Total Sugars (\%)} = \frac{0.05 \times \text{volume make up}}{\text{Titer value} \times \text{Weight of the sample}} \times 100$$

The data generated during an experiment was analyzed in a completely randomized and block randomized design. Data were analysed statistically by using SPSS 17.0 using MS Excel software and the significance of differences between mean values was determined by Duncan's Multiple Range Test (DMRT) at (P = 0.05).

**Results and Discussion**

Data presented in Table 1 indicates that fruit set corresponded with specific pollen combination, varied from (78.66%) to (63.33%) in cross combinations. However, under open pollination it varied from (30.66%) to (38.97%) in Bing and Rainier respectively. Highest fruit set (78.66%) was recorded in Rainier when Stella was used as pollen donor whereas, lowest fruit set (63.33%) was recorded when Lappins was used as pollen donor. However in Bing highest fruit set was achieved with Lappins (73.33%) and lowest with Stella (69.66%). Similar results were observed by (Sutyemez, 2011) [24] who recorded highest fruit set in sweet cherry under cross combinations than free pollinated sweet cherry cultivars. In Rainier fruit retention was highest (89.33%) with pollens from Stella and lowest retention (80.45%) was recorded under open pollination. Regarding Bing highest retention was recorded with Lappins (88.66%) which was reduced to 75.89 per cent under open pollination. The effect of pollen source in controlling the maturation time of cherry seed parents was clear. All three types of pollens used in this study influenced the stage of maturity, thus showing metaxenia effect. Pollen from early maturing Stella promoted maturity of Bing and Rainier seed parents by two days. However, pollens when used from late maturing cultivars i.e., Sweet Heart and Lappins delayed the fruit maturity by two days in both seed parents. Radunic *et al*., 2014 [19] also reported that pollen from early ripening, sweet cherry cultivars accelerated maturation and pollen from late ripening cultivars delayed maturation. Different sources of pollen also caused several variations in the fruit and stone characteristics of seed parents (Table 2). It was observed that all cross pollination treatments partially caused increase or decrease in fruit and stone characteristics. Pollination with pollen from 'Stella' produced smaller fruits than other two pollen sources. Highest fruit length (21.84mm) was achieved in Bing when pollen from Sweet Heart was used, however highest fruit diameter (22.04mm) and thickness (19.16mm) resulted in Bing when Lappins pollen was used. Maximum fruit length (20.89mm), fruit diameter (23.47mm) and thickness (22.85mm) was achieved in Rainier when pollen from Sweet Heart was used. The results of the present investigation are in agreement with (Ansari and Davarynejad, 2008) [4] who reported that different pollen donors had significant effect on fruit length. Results regarding fruit weight showed that pollinizers had no significant effect. However maximum fruit weight (6.85g) was recorded in Bing x Sweet Heart combination, whereas in Rainier it was recorded with Lappins pollen (8.02 g). No clear significant effect of pollen donor was found on stone of fruit, with only slight variation among the different treatments. However, maximum stone weight (0.354g) was observed in Bing fruits when crossed with Lappins and in Rainier maximum stone weight (0.365g) was recorded with pollen from Sweet Heart. The results of the present investigation are in agreement with (Naderiboldaji *et al*., 2008 and Radunic *et al*., 2014) [15, 19] who reported that the various fruit and stone characteristics of sweet cherry fruit are determined by pollen source. The pollen from different sources affect readily discernible characteristics of fruit and seed in the period immediately following fertilization and as such immediate or direct effects termed as "Xenia" have been described and explained by various workers under different fruit and nut crops (Froneman *et al*., 2012 ; Militaru *et al*., 2015) [8, 14].

A significant increase in TSS and Total sugars was observed in cross pollinated Bing and Rainier when compared with open pollination (Table 3). Under controlled cross combinations Lappins pollen resulted in highest TSS (18.61% and 19.96%) and total sugars (11.15% and 10.97%) in Bing and Rainier respectively. Under open pollination TSS (17.86% and 18.87%) and total sugar (10.69% and 10.71%) was recorded in Bing and Rainier respectively. Acidity in fruit showed decreasing trend under Bing cross combinations when compared with open pollinated Bing. However in Rainier it showed partial increase or decrease in cross combinations. Perusal of the data (Table 4) indicates that fruit colour varied significantly between both Bing and Rainier under open and cross combinations. Rainier which is a bi-colour cherry differed from Bing. Highest L* (45.89) was recorded in open pollinated Rainier which represents a good reflecting diffuser and Bing showed L* value of (30.56) under open pollination. a* values increased under cross combinations in both cultivars. Highest a* (29.73) was recorded when Sweet Heart pollen was used on Bing (red skin colour). Regarding b* values, they showed partial decrease in controlled cross

combinations, however Stella as a pollen source showed a slight increase in this value as compared to control. Highest b* (22.60) was recorded in open pollinated Rainier (yellow colour). Similar results were recorded by (Martino *et al*., 2008) [13] for determination of fruit colour values in different sweet cherry varieties.

**Table 1:** Effect of pollination method and pollen parent on fruit set, retention, fruit maturity and days from full bloom

| Pollination method | Female parent | Pollinizer | Fruit Set (%) 21 days after pollination | Fruit retention (%) at harvest | Date of fruit maturity | Days from full bloom |
|---|---|---|---|---|---|---|
| Controlled | Bing | Stella | 69.66$^{c}$ | 83.66$^{bc}$ | 22/6 | 68 |
| | | Sweet Heart | 70.33$^{c}$ | 86.00$^{abc}$ | 26/6 | 72 |
| | | Lappins | 73.33$^{bc}$ | 88.66$^{a}$ | 26/6 | 72 |
| Open | Bing | - | 30.66$^{f}$ | 75.89$^{e}$ | 24/6 | 70 |
| Controlled | Rainer | Stella | 78.66$^{a}$ | 89.33$^{a}$ | 24/6 | 70 |
| | | Sweet Heart | 74.33$^{b}$ | 86.33$^{ab}$ | 28/6 | 74 |
| | | Lappins | 63.33$^{d}$ | 82.66$^{bc}$ | 28/6 | 74 |
| Open | Rainer | - | 38.97$^{e}$ | 80.45$^{c}$ | 26/6 | 72 |

*Mean values within a column having the same alphabet are not significantly different (P = 0.05)

**Table 2:** Effect of pollination method and pollen parent on physical attributes of fruit and stone characteristics of seed parent

| Pollination method | Seed parent | Pollen parent | Fruit Length (mm) | Fruit Diameter (mm) | Fruit Thickness (mm) | Fruit Weight (gm) | Stone Weight | Stone Diameter | Stone Length | Stone Thickness |
|---|---|---|---|---|---|---|---|---|---|---|
| Controlled | Bing | Stella | 21.05$^{c}$ | 21.28$^{h}$ | 19.02$^{e}$ | 6.70$^{d}$ | 0.341$^{b}$ | 10.95$^{c}$ | 6.48$^{f}$ | 8.15$^{f}$ |
| | | Sweet Heart | 21.84$^{a}$ | 21.97$^{f}$ | 19.12$^{g}$ | 6.85$^{d}$ | 0.342$^{b}$ | 10.99$^{b}$ | 6.50$^{f}$ | 8.37$^{d}$ |
| | | Lappins | 21.39$^{b}$ | 22.04$^{e}$ | 19.16$^{f}$ | 6.82$^{d}$ | 0.354$^{a}$ | 11.02$^{a}$ | 6.73$^{d}$ | 8.26$^{e}$ |
| Open | Bing | - | 21.05$^{c}$ | 21.35$^{g}$ | 18.42$^{h}$ | 6.73$^{d}$ | 0.335$^{b}$ | 10.94$^{c}$ | 6.57$^{e}$ | 8.08$^{g}$ |
| Controlled | Rainier | Stella | 20.84$^{f}$ | 22.89$^{d}$ | 22.11$^{b}$ | 7.72$^{abc}$ | 0.344$^{b}$ | 9.66$^{f}$ | 7.22$^{bc}$ | 9.10$^{e}$ |
| | | Sweet Heart | 20.89$^{e}$ | 23.47$^{a}$ | 22.85$^{a}$ | 7.84$^{ab}$ | 0.365$^{a}$ | 9.87$^{d}$ | 7.59$^{a}$ | 9.20$^{b}$ |
| | | Lappins | 21.03$^{d}$ | 23.19$^{b}$ | 21.67$^{c}$ | 8.02$^{a}$ | 0.349$^{b}$ | 9.80$^{e}$ | 7.24$^{b}$ | 9.25$^{a}$ |
| Open | Rainer | - | 20.79$^{g}$ | 23.01$^{c}$ | 21.56$^{d}$ | 7.79$^{ab}$ | 0.344$^{b}$ | 9.66$^{f}$ | 7.20$^{bcd}$ | 9.13$^{c}$ |

*Mean values within a column having the same alphabet are not significantly different (P = 0.05)

**Table 3:** Effect of pollination method and pollen parent on Fruit chemical and colour characteristics of seed parent

| Pollination method | Seed parent | Pollen parent | Total soluble solids (ºBrix) | Acidity (% Malic acid) | Total sugars (%) | Fruit colour | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | L | a* | b* |
| Controlled | Bing | Stella | 18.05$^{b}$ | 0.69$^{ab}$ | 10.97$^{bc}$ | 30.42 c | 28.67 a | 14.93 d |
| | | Sweet Heart | 18.44$^{bc}$ | 0.66$^{bc}$ | 11.08$^{ab}$ | 29.97 c | 29.73 a | 12.80 e |
| | | Lappins | 18.61$^{bc}$ | 0.63$^{c}$ | 11.15$^{a}$ | 29.73 c | 29.71 a | 12.87 e |
| Open | Bing | - | 17.86$^{d}$ | 0.71$^{a}$ | 10.69$^{e}$ | 30.56 c | 27.05 b | 14.78 d |
| Controlled | Rainier | Stella | 19.21$^{a}$ | 0.66$^{bc}$ | 10.85$^{cd}$ | 45.11 a | 22.80 c | 21.79 a |
| | | Sweet Heart | 19.89$^{a}$ | 0.65$^{bc}$ | 10.89$^{cd}$ | 42.12 b | 21.95 c | 19.27 c |
| | | Lappins | 19.96$^{a}$ | 0.63$^{c}$ | 10.97$^{bc}$ | 42.30 b | 22.85 c | 21.13 b |
| Open | Rainer | - | 18.87$^{cd}$ | 0.65$^{bc}$ | 10.71$^{e}$ | 45.89a | 20.93 d | 22.60 a |

*Mean values within a column having the same alphabet are not significantly different (P = 0.05)
L*= Lightness, a*= Green to Red, b* = Blue to Yellow

## Conclusion

Based on these finding, it can be inferred that the pollen source has significant effect on physic-chemical characters and date of maturity of sweet cherry fruit thus showing metaxenia effect. Pollens from early maturing cultivars significantly advance the fruit maturity in maternal parents and vice versa. Besides pollen parent, method of pollination also showed a significant influence on fruit set and fruit quality characters. There was remarkable difference regarding fruit colour (L*, a*, b*) in open and cross combinations.

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