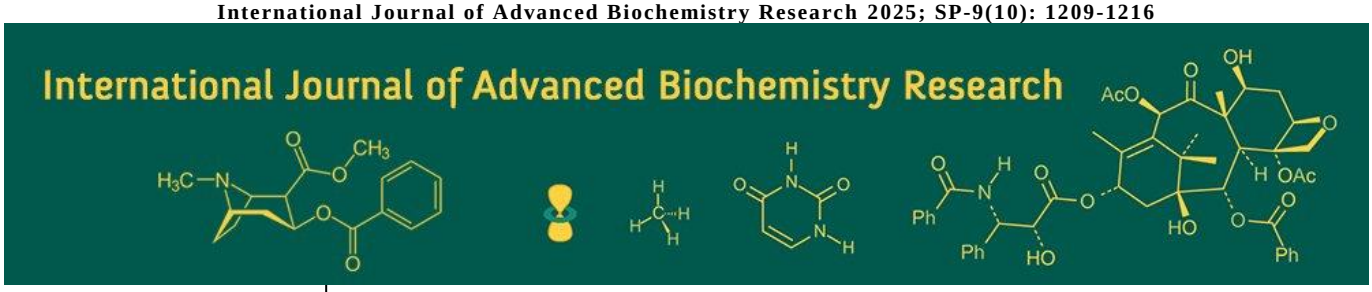

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Effect of pollen parents on increase and/ or decrease in fruit characteristics of Kesar and Sonpari

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Abstract
A phenomenon known as the xenia effect describes how the genotype of the pollen that fertilizes the ovule influences the traits of fruits and nuts for many species. When compared to self-pollination, cross-pollination improves mango fruit attributes at maturity. On the other hand, nothing is known about the xenic effects of various mango cultivars employed as cross-pollen parents on the fruit's development and constituent parts. The present study was conducted during 2023-24 and 2024-25 to evaluate the influence of pollen parents on fruit development traits in two prominent cultivars, Kesar and Sonpari. Twenty one male parents were crossed with Kesar and Sonpari. Observations were recorded on mature fruit weight, ripen fruit weight, fruit length, fruit diameter, and fruit volume. The data obtained were compared with fruits developed through open pollination, which served as the reference standard. For uniformity of comparison, the fruit characteristics under open pollination were considered as 100% and the relative performance of fruits derived from other pollination treatments was expressed as a percentage of this standard. Results revealed significant variation among treatment combinations. In Kesar, pollination with Vashi Badami, Neeleshan, Dasheri, Dadmiyo, Langra, Rajapuri, Amrapali, and Pairi resulted in a significant increase over in all fruit characteristics compared with open pollination, whereas pollination with Sonpari, Ratna, Fazli, Lal Katra, Vanraj, Sardar, Jamadar, Rumani, Alphonso, and Jahangir lead to a marked reduction in these traits. Kesar pollinated with Kesar (geitenogamy) and Karanjiyo failed to produce mature fruits. Similarly, in Sonpari, pollination with Vashi Badami, Karanjiyo, Langra, Rajapuri, Alphonso, Sardar, and Jamadar promoted significant improvement in fruit attributes over open pollination, while Totapuri, Dasheri, Ratna, Fazli, Lal Katra, Vanraj, Rumani, Neeleshan, Jahangir and Pairi exerted a negative influence in fruit characteristics over open pollination. Sonpari pollinated with Sonpari (geitenogamy), Amrapali and Dadmiyo failed to produce mature fruits.

Keywords: Pollen parents, kesar, sonpari, open pollination, geitenogamy

Introduction
Mango (*Mangifera indica* L.) is one of the most important fruit crops of tropical and subtropical regions, prized worldwide for its exceptional flavour, aroma, and nutritional richness. In India, mango is cultivated in an area of 2.39 million ha with an annual production of 22.83 million tonnes with a productivity of 9.55 metric tonnes per ha (Anon., 2024b) [4]. However, the sector continues to face challenges related to decreasing productivity consistently and variable fruit quality. These variations are largely attributed to genotype-environment interactions and the complex reproductive biology of the crop, where pollination dynamics play a pivotal role in determining fruit yield and quality (Huda *et al.*, 2015) [5].

Mango is predominantly cross-pollinated, with pollinizer varieties providing viable pollen to receptive stigmas, ensuring fertilization and fruit development. Evidence from earlier studies indicates that the choice of pollinizer substantially modifies fruit development parameters such as fruit weight, volume, length, pulp-to-seed ratio, and biochemical composition. Certain pollinizers have been associated with enhanced pulp recovery, higher sugar accumulation, and improved fruit shape, while others contribute negatively by reducing fruit size or retention (Kim *et al*., 2001) [10].

The present study was therefore undertaken to evaluate the influence of diverse male parents on fruit development traits of *Kesar* and *Sonpari* across two consecutive flowering seasons.

Specifically, the study focused on quantifying the effects of different pollinizers on mature and ripened fruit weight, fruit length, diameter and volume by comparing these parameters with fruits obtained under open pollination, the work aims to identify promising pollinizers capable of enhancing fruit size, quality, and overall commercial value, thereby providing insights for mango breeding and orchard improvement strategies.

Materials and Methods

The investigation was conducted during the years 2023-24 and 2024-25 at Regional Horticultural Research Station, ASPEE College of Horticulture, NAU, Navsari. The experiment involved two female parents (Kesar and Sonpari) and twenty one pollen parents (Sonpari, Totapuri, Kesar, Rajapuri, Dasheri, Ratna, Fazli, Amrapali, Langra, Lal Katra, Vashi Badami, Vanraj, Sardar, Dadmiyo, Jamadar, Rumani, Alphonso, Neeleshan, Jahangir, Karanjiyo and Pairi).

The traditional method involving the continued pollination of flowers on a panicle over several days when the flowers were open. Six healthy panicles of cvs. Sonpari and Kesar were selected to serve as female parents. These panicles were initially bagged with polythene bags to prevent unintended cross-pollination by insects or foreign pollen carried by wind. The hermaphrodite flowers those opened on the previous evening (prior to anthesis) were carefully identified, emasculated and retained for desired pollination. All remaining flowers, including male flowers and unopened buds, were removed to ensure uniformity and avoid self-pollination. The panicles were then re-bagged immediately after emasculation.

On the subsequent morning, for cross-pollination, open flowers were collected from the panicles of selected male (pollen) parents before the dehiscence of their anthers. These flowers were placed in separate petri dishes and exposed to sunlight to promote anther dehiscence. Once the anthers dehisced, they were promptly used for pollination. The bags from the female panicles were temporarily removed and pollination was carried out by holding the dehisced anthers of the pollen parent flowers with forceps and gently touching them onto the stigma of the emasculated flowers. Immediately after pollination, the panicles were re-bagged to prevent cross pollination. The polythene bags of the experimental panicles were removed after fruit reaching the pea size and replaced with non-woven bags. After reaching maturity, the fruits were harvested and observations were recorded on fruit development traits including mature fruit weight, ripened fruit weight, fruit length, fruit diameter, and fruit volume. Fruits obtained from open pollination served as the reference standard, with their values considered as 100% for comparative analysis of other pollination treatments.

Results and Discussion

Fruit characteristics

The fruit characteristics as influenced by various pollen parents are presented in Fig. 1 to 10. Fruit was not obtained in Kesar and Sonpari when Kesar and Karanjiyo; Sonpari, Amrapali and Dadmiyo, respectively used as pollen parents. The changes are measured as a percentage increase or decrease relative to open-pollinated fruits.

1. Mature fruit weight (%)

The significant differences in mature fruit weight Kesar and Sonpari when pollinated with different pollen parents (Fig. 1). The pollination in Kesar with Vashi Badami recorded the highest enhancement in mature fruit weight, exhibiting a (21.08%) gain over open-pollinated fruits. This was followed by Neeleshan (17.06%), Dasheri (16.58%), Dadmiyo (14.44%), Langra (10.51%), Rajapuri (4.73%), Amrapali (3.04%), Totapuri (1.63%), and Pairi (0.01%). While pollination with Sonpari (-41.07%), Rumani (-32.68%), Vanraj (-28.66%), Ratna (-25.94%), Alphonso (-22.62%), Jamadar (-21.55%), Fazli (-21.25%), Jahangir (-19.09%), Sardar (-5.90%) and Lal Katra (-4.34%) resulted in a reduction in mature fruit weight relative to open pollination.

The pooled data on mature fruit weight in Sonpari, as presented in Fig. 2, revealed considerable variation among the different pollen parents. Pollination with Vashi Badami (46.28%), Karanjiyo (34.22%), Langra (28.63%), Rajapuri (15.82%), Alphonso (10.78%), Sardar (6.57%), Jamadar (3.77%) and Kesar (0.27%) resulted in a significant increase in mature fruit weight compared with open-pollinated fruits. While pollination with Ratna (-24.99%), Pairi (-15.87%), Fazli (-15.30%), Rumani (-15.28%), Neeleshan (-13.96%), Jahangir (-9.21%), Vanraj (-7.59%), Totapuri (-4.92%), Lal Katra (-2.57%) and Dasheri (-2.53%) lead to a reduction in mature fruit weight compared to open pollination.

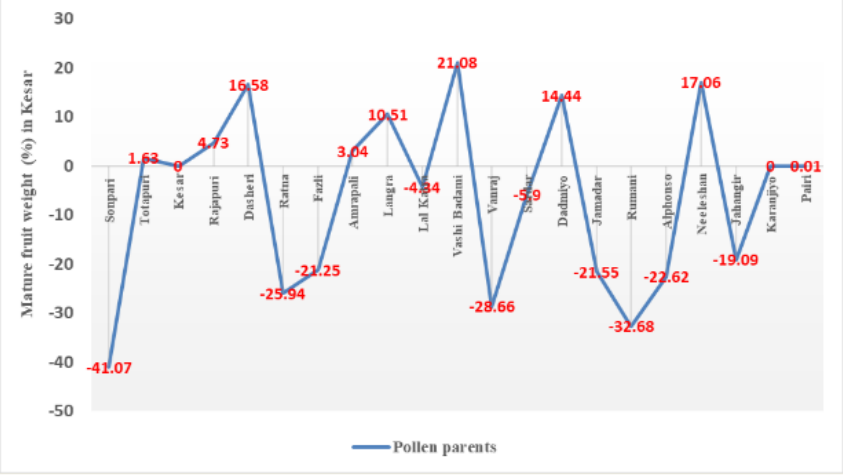

Fig 1: Effect of pollen parents on mature fruit weight (%) of Kesar

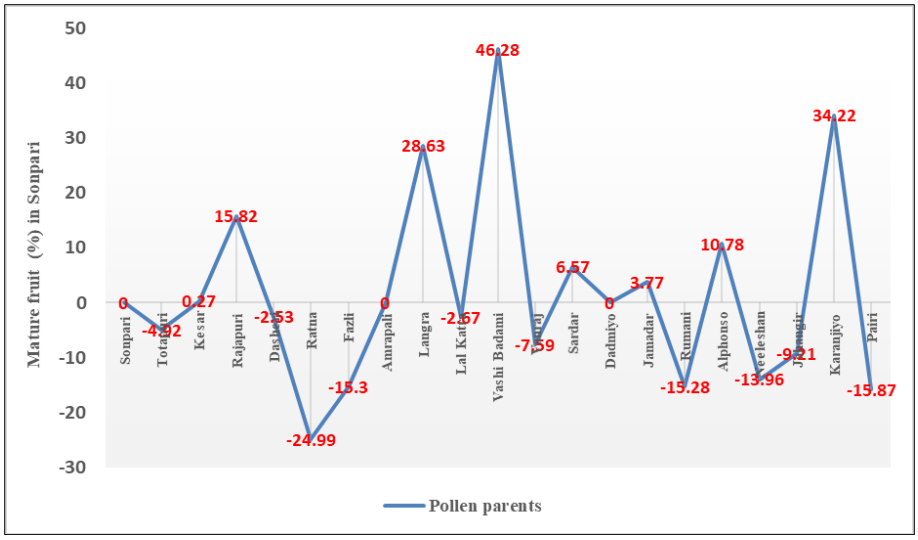

Fig 2: Effect of pollen parents on mature fruit weight (%) of Sonpari

2. Ripen fruit weight (%)

The data on ripen fruit weight, presented in the Fig.3, indicated significant differences in Kesar when pollinated with different pollen parents. In Kesar, pollination with Vashi Badami recorded the greatest improvement in ripen fruit weight, with an increase of 18.31% over open-pollinated fruits. It was followed by Dasheri (16.44%), Neeleshan (14.33%), Dadmiyo (14.30%), Langra (9.17%), Totapuri (1.40%) and While pollination with Sonpari (−46.90%), Rumani (−38.62%), Ratna (-31.78%), Vanraj (-32.66%), Alphonso (-25.96%), Jamadar (-25.00%), Jahangir (-24.62%), Fazli (-27.40%), Sardar (-8.79%), Lal Katra (-6.71%), Amrapali (-0.84%) Karanjiyo (-2.83%) and Rajapuri (-0.14%). resulted in a reduction in ripen fruit weight relative to open pollination.

In Sonpari, the significant variation in Sonpari when pollinated with different pollen parents (Fig. 4). Among them, pollination with Vashi Badami recorded the highest improvement in ripen fruit weight, showing a 42.67% increase over open pollination. This was followed by Karanjiyo (29.33%), Langra (25.64%), Rajapuri (14.23%), Alphonso (7.41%), Sardar (4.41%) and Jamadar (1.93%). While pollination with Ratna (−25.16%), Pairi (−17.49%), Rumani (−17.49%), Neeleshan (−15.36%), Jahangir (−11.00%), Vanraj (−9.07%), Totapuri (−7.78%), Lal Katra (−4.20%), Dasheri (−4.43%) and Kesar (−1.60%) resulted in a reduction in ripen fruit weight relative to open pollination.

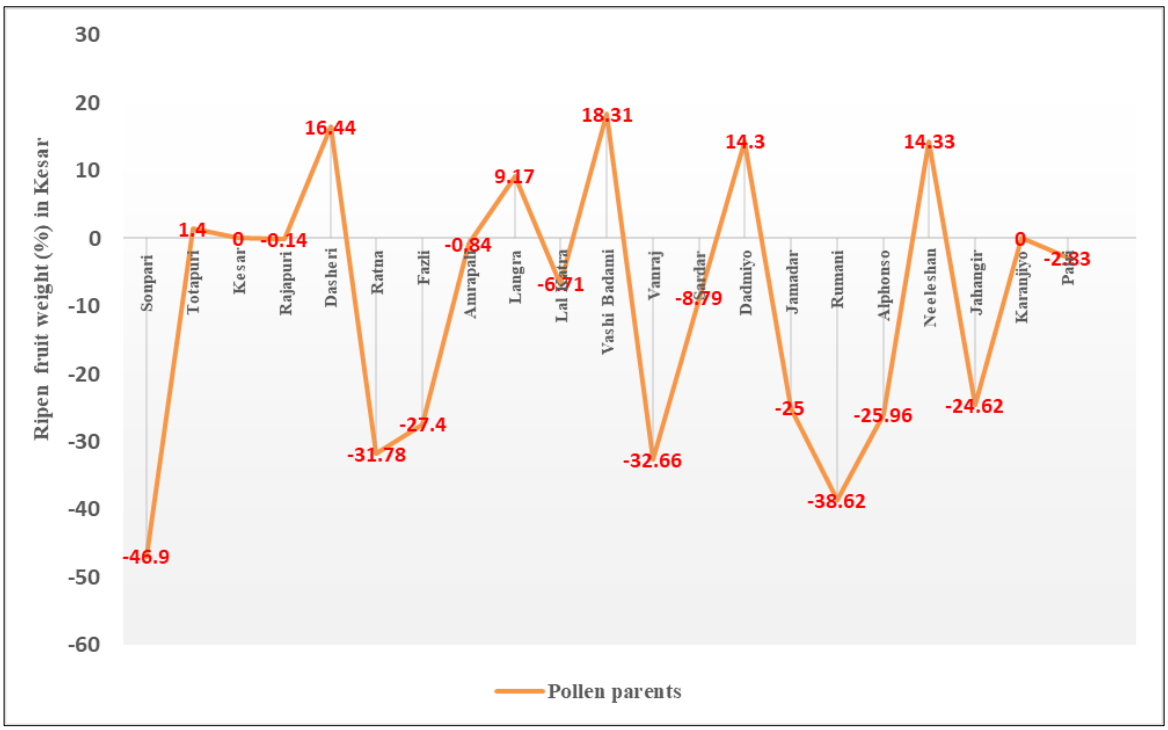

Fig 3: Effect of pollen parents on ripen fruit weight (%) of Kesar

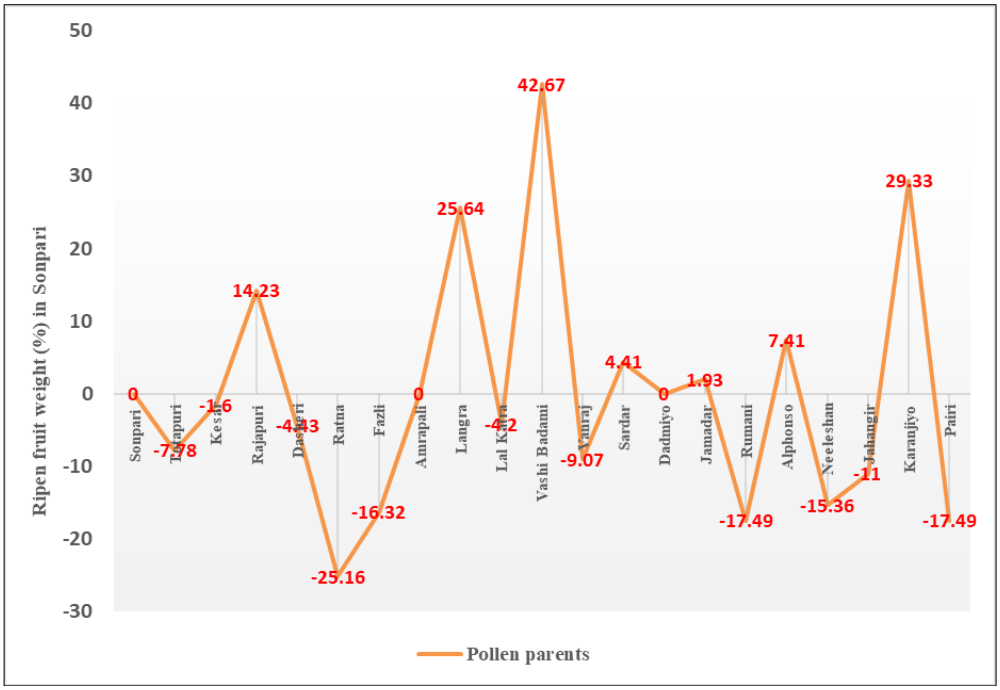

Fig 4: Effect of pollen parents on ripen fruit weight (%) of Sonpari

3. Fruit length (%)

The data on fruit length in the Kesar variety as illustrated in Fig. 5, indicated significant differences when Kesar was pollinated with various pollen parents. Pollination with Vashi Badami resulted in the most substantial enhancement of fruit length, recording the highest gain at (17.08%). It was closely followed by Neeleshan (14.38%), Dasheri (13.72%), Dadmiyo (10.81%), Langra (8.28%), Rajapuri (6.42%), Amrapali (5.56%) and Totapuri (4.38%). While the use of several pollen parents resulted in a reduction of the fruit length relative to the open-pollinated. The maximum decreases were observed with Sonpari (−16.61%), Vanraj (−11.43%), Rumani (−12.04%), Ratna (−8.98%), Jamadar (−8.70%), Alphonso (−8.5%), Jahangir (−7.49%), Sardar (−4.55%) and Lal Katra (−4.36%).

The fruit length in the Sonpari variety, as illustrated in Fig. 6, revealed significant differences among pollen parents. Pollination with Karanjiyo producing the greatest enhancement, recording a 23.87% increase over open pollination, which was followed by Langra (11.53%), Vashi Badami (6.81%), Alphonso (2.83%) and Sardar (1.05%). While several pollen parents lead to a reduction in fruit length compared with open-pollinated fruits, the maximum decreases were observed with Neeleshan (-11.88%) which was followed by Kesar (-10.38%), Vanraj (-9.43%), Ratna (-9.21%), Dasheri (-9.02%), Fazli (-6.87%), Rumani (-6.97%), Jamadar (-6.29%), Pairi (-6.23%), Jahangir (-5.17%), Totapuri (-3.18%), Lal Katra (-2.52%), and Rajapuri (-0.98%).

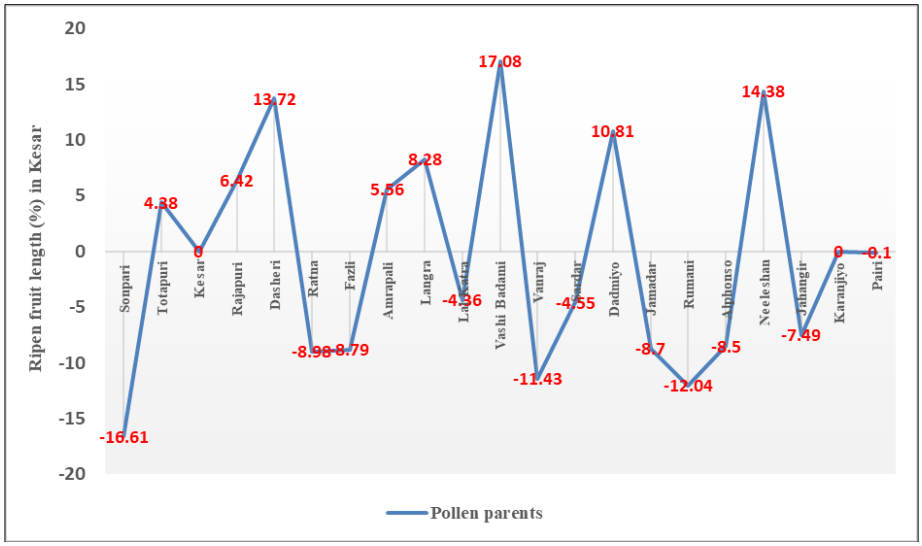

Fig 5: Effect of pollen parents on fruit length (%) of Kesar

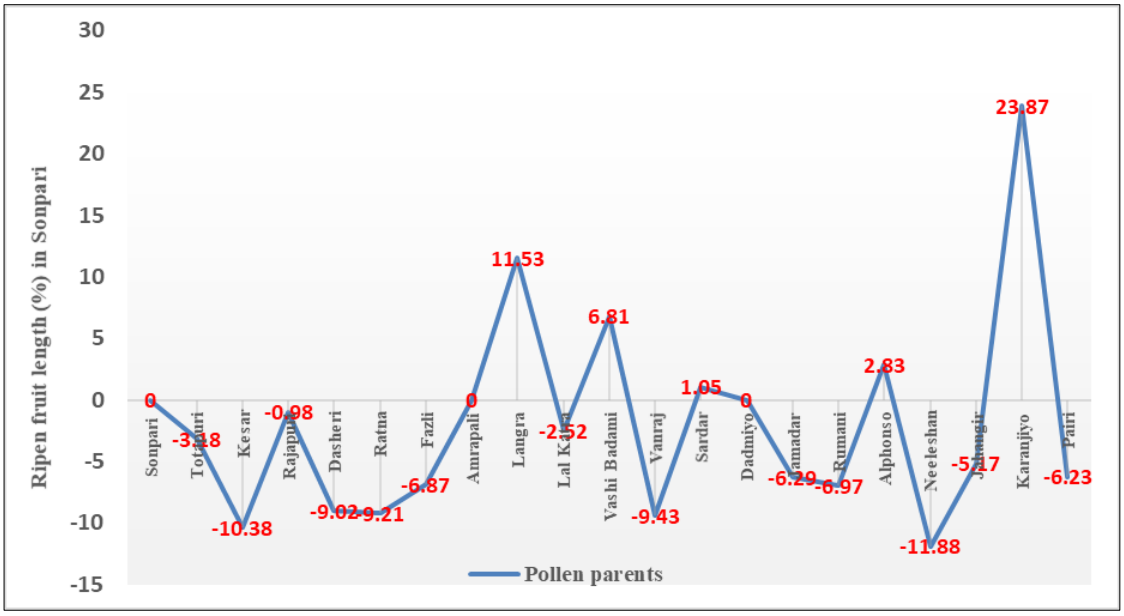

Fig 6: Effect of pollen parents on fruit length (%) of Sonpari

4. Fruit diameter (%)

The significant differences in fruit diameter of Kesar fruits when pollinated with different pollen parents (Fig. 7). Pollination with Vashi Badami resulted in the most substantial enhancement of fruit diameter, recording the highest gain at (14.84%). This was followed by Dasheri (11.56%), Neeleshan (9.27%), Dadmiyo (7.78%), Langra (6.54%), Rajapuri (5.12%), Amrapali (4.32%), Totapuri (2.05%), and Pairi (1.56%). While the use of several pollen parents resulted in a reduction of the fruit diameter relative to the open-pollinated fruit. The maximum decreases were observed with Sonpari (-17.62%) which was followed by Rumani (-13.19%), Vanraj (-9.62%), Ratna (-7.95%), Alphonso (-7.38%), Jamadar (-7.24%), Fazli (-5.40%), Jahangir (-4.51%), Sardar (-2.07%), and Lal Katra (-0.95%).

The fruit diameter in Sonpari variety showed significant variations when pollinated with different pollen parents (Fig. 8). Pollination with Karanjiyo resulted in the maximum fruit diameter recording the highest gain (32.69%). It was followed by Langra (6.03%), Rajapuri (4.75%), Jahangir (3.76%), and Alphonso (0.61%). While the use of several pollen parents resulted in reduction of the fruit diameter relative to the open-pollinated fruit. The maximum decreases were observed with Jamadar (-10.96%) which was followed by Dasheri (-9.85%), Rumani (-8.80%), Pairi (-7.96%), Fazli (-7.65%), Vanraj (-7.16%), Ratna (-6.59%), Lal Katra (-5.67%), Kesar (-3.97%), Neeleshan (-3.62%), Totapuri (-3.56%), Sardar (-2.89%), and Vashi Badami (-0.23%).

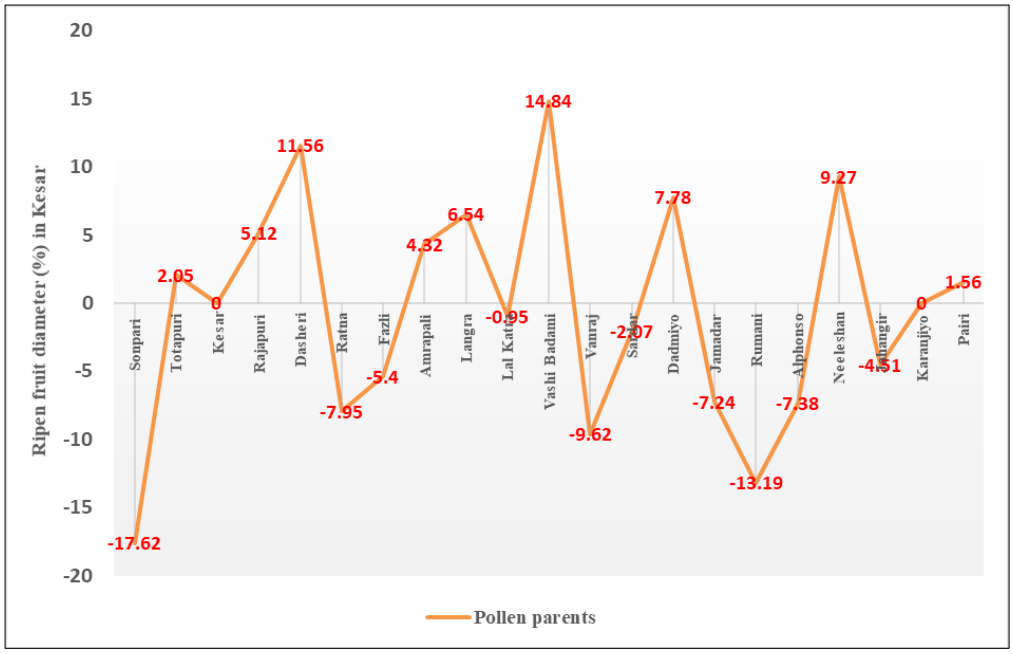

Fig 7: Effect of pollen parents on fruit diameter (%) of Kesar

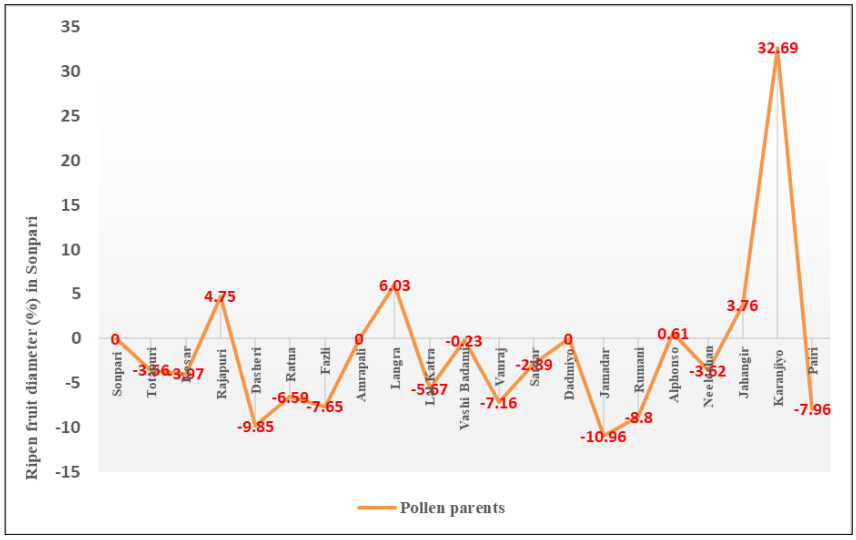

Fig 8: Effect of pollen parents on fruit diameter (%) of Sonpari

5. Fruit volume (%)

The data on fruit volume as illustrated in the Fig.9, indicated that the pollination of Kesar with Vashi Badami resulted in the most substantial enhancement of fruit volume, recording the highest gain at (22.06%) which was followed by Neeleshan (19.44%), Dadmiyo (18.23%), Dasheri (17.15%), Langra (11.00%), Totapuri (3.21%), Amrapali (0.69%), Rajapuri (0.35%) and Pairi (0.14%). While the use of several pollen parents resulted in a reduction of the fruit volume relative to the open-pollinated fruit. The maximum decreases were observed with Sonpari (-45.22%), Rumani (-35.70%), Vanraj (-30.09%), Ratna (-29.95%), Fazli (-26.23%), Alphonso (-22.40%), Jamadar (-22.04%), Jahangir (-22.11%), Sardar (-5.39%), and Lal Katra (-3.84%).

In Sonpari, when pollination with Vashi Badami resulted in the most substantial enhancement of fruit volume, recording the highest gain at (46.75%) which was followed by Karanjiyo (29.94%), Langra (27.19%), Rajapuri (15.41%), Alphonso (11.88%), Sardar (7.58%), Jamadar (5.60%), and Kesar (0.84%). While the numerous pollen parent reduces fruit volume relative to the open-pollinated fruit (Fig.9). The maximum decreases were observed with Ratna (-23.46%), Fazali (-19.85%), Pairi (-16.26%), Rumani (-14.18%), Neeleshan (-13.47%), Jahangir (-8.44%), Totapuri (-7.05%), Vanraj (-5.87%), Daheri (-5.43%) and Lal Katra (-2.03%).

Pollen can trigger changes in endogenous hormone levels within fruit tissues. auxin, GA, ethylene, ABA, brassinosteroids and jasmonic acid that modifies cell growth, sugar metabolism, ripening and overall fruit development. Larger fruits have higher levels of hormones (Denney, 1992). RNA can be transported from cell to cell via intercellular plasmodesma and phloem for long-distance delivery and regulation of gene expression (Voinnet, 2009). Liu *et al*. (2020) hypothesized that the signals trigger the metaxenia effect by mRNAs. These mRNAs could be released by the pollen tube and transported to the seeds and other parent tissues. The translocated mRNAs are functional, which can cause changes in fruit or seed characteristics. Xenia includes metaxenia; which is the effect of pollen on fruit characteristics, such as size, shape, colour and sugar content (Herbert *et al*., 2019 and Li *et al*., 2021) [11, 9]. A similar effect on the above-mentioned fruit physical parameters has also been documented by Rymbai *et al*. (2015) [12] and Mithapra *et al*. (2025) [13] in mango; Nambiar (2005) [14], Patel *et al*. (2011) [16], Usman *et al*. (2013) [15], Singh *et al*. (2018) [17], Sohi *et al*. (2019) [18], Sarkar and Sarkar (2022) [20] in guava; Atawia *et al*. (2016) [21], Yildiz and Kaplakaran (2017) [22], Wang *et al*. (2019) [23] in citrus; Omar *et al*. (2014) [24], Mohammed *et al*. (2024) [25] in date palm; Nageshwari *et al*. (2000) [26].

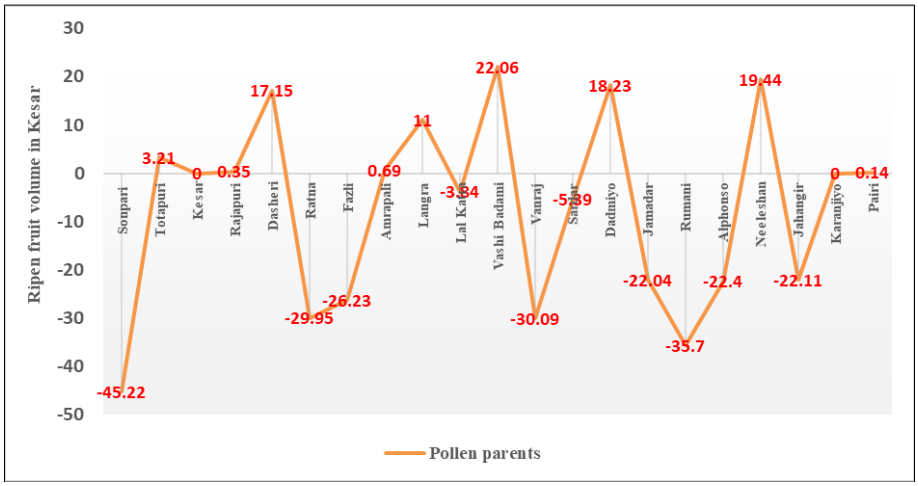

Fig 9: Effect of pollen parents on fruit volume (%) of Kesar

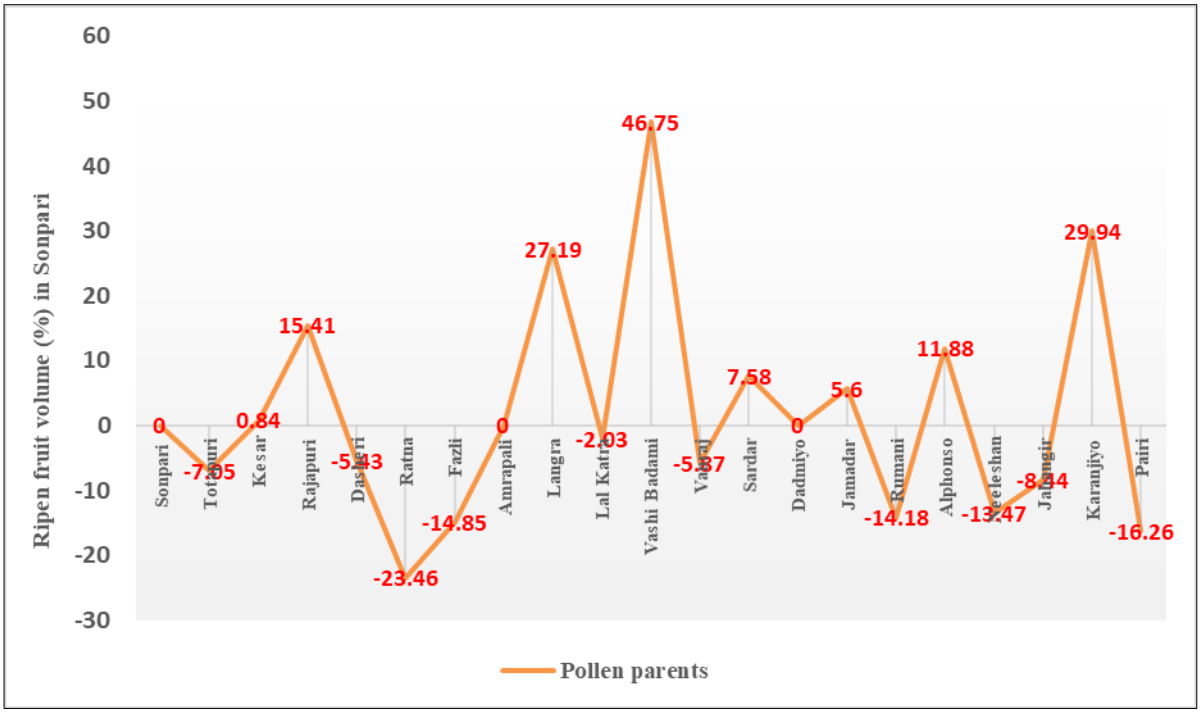

Fig 10: Effect of pollen parents on fruit volume (%) of Sonpari

Conclusion

According to the findings of this study, growers can strategically plant these cultivars to optimize fruit size and marketable yield by using Vashi Badami, a highly effective pollinizer for both, in conjunction with other high-performing partners like Neeleshan (for Kesar) and Karanjiyo (for Sonpari). Conversely, the identified incompatibilities and negatively influential pollen parents should be avoided in close proximity to the female parents. This study provides a scientific foundation for enhancing mango production through planned varietal cross-pollination.

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