Investigation note

Presence of metaxenia in fruits 40 days postpollination in *Vanilla planifolia* Andrews and *V. pompona* Schiede

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Abstract

The vanilla fruit (*Vanilla planifolia* Andrews) generates an important economic income; however, the best paid fruits are those of greater length (gourmet type), so strategies are needed to obtain fruits of that type. Given this, one option is the induction of metaxenia, understood as the increase in size of the fruits due to pollination with foreign pollen. In the case of vanilla, pollen of *V. pompona* Schiede could be used since it is usually a companion species, and its phenology coincides with that of *V. planifolia*. Cross-pollination between *V. planifolia* and *V. pompona* was performed during April 2021, and total length, diameter, weight and shape index were evaluated 40 days later. Influence of foreign pollen was found, manifested in longer and heavier fruits if the flower of *V. planifolia* was pollinated with pollen of *V. pompona*, while if the foreign pollen was from *V. planifolia* in flowers of *V. pompona*, the fruits were smaller and lighter. Cross-pollination between *V. planifolia* with *V. pompona* pollen is an alternative for producers to obtain gourmet-type fruits more easily.

Keywords: *Vanilla planifolia*, *Vanilla pompona*, crop.

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Vanilla (*Vanilla planifolia* Andrews) is an orchid of economic importance, this species is one of the few that can be used in the food industry (Teoh, 2019). The part used of this plant is the fruit, which is rich in aromatic molecules, highlighting vanillin (Ranadive, 2018). The most important fruits are those that reach lengths greater than 16 cm, the most appreciated are those that reach up to 22 cm, obtaining the category of 'gourmet' and therefore generating greater profits (Barrera-Rodríguez *et al*., 2009).

The obtaining of vanilla fruits is mainly through self-pollination (Hernández-Hernández and Lubinsky, 2011). Given the need to obtain fruits of greater length, an alternative is to resort to metaxenia. Metaxenia, understood as the effect of foreign pollen (from another species, but of the same genus) on fruit formation, including increase in size and changes in texture, shape, smell, taste, etc. (Olfati *et al*., 2014; Sabir, 2014).

It is considered that the seeds, resulting from hybridization, produce hormones responsible for changes in maternal tissues (Swingle, 1928). There are records of metaxenia in some crops, such as the case of apples (Bodor *et al*., 2008; Militaru *et al*., 2015), blackberry (Ehlenfeldt, 2003), cacti (Mizrahi *et al*., 2004), cucumber (Olfati *et al*., 2014), grape (Sabir, 2014), among others. In the case of vanilla, some authors have proposed the possibility of resorting to metaxenia (Sasikumar, 2010, Sarma *et al*., 2011; Menchaca-García, 2018).

Foreign pollen from *V. pompona* Schiede could be used, which is sometimes a companion species in the crop and has the advantage of phenologically coinciding with the commercial species (Lubinsky *et al*., 2008). In this way it would be possible to obtain larger fruits compared to that resulting from self-pollination. In the present study, the effect of *V. pompona* pollen on *V. planifolia* flowers and vice versa was studied to evaluate the presence of metaxenia after 40 days of pollination and propose it as a possible improvement in the crop for producers.

The present study was carried out in Chavarrillo, Veracruz (19° 25' 34" north latitude, 96° 47' 34" west longitude). Interspecific crosses were made between *V. planifolia* and *V. pompona* (PL ♀ × PO ♂) and vice versa (PO ♀ × PL ♂) (the first species mentioned is the pollen recipient and the second the donor), in addition to self-pollinations of *V. planifolia* (PL) and *V. pompona* (PO) during April 2021. Ten fruits were obtained in each case. Forty days after pollination, at which time vanilla fruits reach their maximum growth (Menchaca-García, 2018), total length (cm), diameter (cm), weight (g) and shape index, understood as the relationship between length and diameter, were evaluated.

To determine differences between treatments, data were analyzed using the Tuckey post hoc analysis of variance test (p= 0.05) with the R software (R Core Team, 2020). There were differences in total length between the different genotypes (DF= 3, F= 27.65, η^2= 0.674, p< 0.001). The highest values were found in the PL ♀ × PO ♂ cross, which was 18% larger than the self-fertilization of PL. The opposite occurs in the PO ♀ × PL ♂ cross, which was 67% smaller than the self-fertilization of PO (Figure 1A, Figure 2). Regarding the diameter, the highest value occurred in the self-fertilization of PO, followed by PO ♀ × PL ♂ (DF= 3, F= 20.84, η^2= 0.609, p< 0.01).

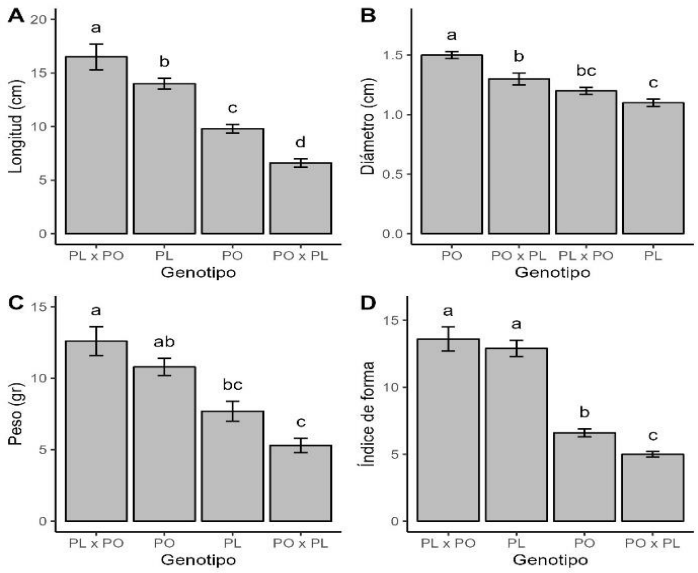

Figure 1. Characterization of vanilla fruits after 40 days of pollination. PL= *V. planifolia*. PO= *V. pompona*. PL x PO= *V. planifolia* ♀ × *V. pompona* ♂. PO x PL= *V. pompona* ♀ × *V. planifolia* ♂. The value of the mean ± standard error is displayed. The values are ordered from highest to lowest. Different letters indicate statistical differences between groups ($p< 0.05$).

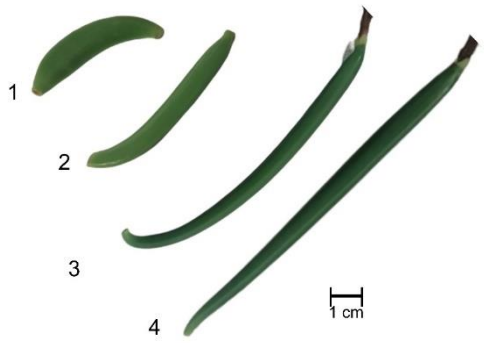

Figure 2. Comparison of vanilla fruits. 1= *V. pompona* ♀ × *V. planifolia* ♂; 2= *V. pompona*; 3= *V. planifolia*; and 4= *V. planifolia* ♀ × *V. pompona* ♂.

The lowest values were present in the self-fertilization of PL and PL ♀ × PO ♂, there was no difference between the latter two (Figure 1B, Figure 2). Weight was different between groups (DF= 3, F= 16.35, $\eta^2= 0.55$, $p< 0.01$). The highest value occurred in PL ♀ × PO ♂, where an increase of 64% with respect to the self-fertilization of PL was reported, representing a considerable weight gain. In contrast, PO ♀ × PL ♂ had a decrease of 50% with respect to the weight of the fruits, compared to the self-fertilization of PO (Figure 1C).

Regarding the shape index, differences were found between the different vanillas (DF= 3, F= 43.42, $\eta^2= 0.765$, $p< 0.01$). It is appreciated that between the self-fertilization of PL and PL ♀ × PO ♂, the shape is preserved; that is, they maintain the same proportion between length and diameter, while in PO ♀ × PL ♂, the shape index decreases with respect to that reported for the self-fertilization of PO (Figure 1D), expressed as greater diameter and reduction in length (Figure 2).

The pollination of vanilla flowers with foreign pollen induced changes in the formation of the fruits in both crosses made. Increases in the length and weight of the fruits as a result of metaxenia, compared to that obtained by self-pollination, have been reported in other cultivars, such as apple, blackberry, pitahaya and grape (Ehlenfeldt, 2003; Mizrahi *et al*., 2004; Bodor *et al*., 2008; Sabir *et al*., 2014), a phenomenon observed in the PL ♀ × PO ♂ cross, while this was not true for PO ♀ × PL ♂, since its fruits showed the shortest length and weight of all the vanillas studied (Figure 2).

Contrary to what was reported, the diameter did not present higher values than that of the parents (Bodor *et al*., 2008; Sabir *et al*., 2014; Militaru *et al*., 2015). The fruits of PL ♀ × PO ♂ had the same proportion between length and diameter (shape index) as the self-fertilization of PL, in addition to presenting greater weight, so potentially the induction of metaxenia in fruits of PL with pollen of PO could represent an improvement for producers, as they obtain longer and heavier fruits, as long as the aromatic qualities required in the industry are preserved or increased.

Conclusions

In the present study, it was shown how the pollination of flowers of *V. planifolia* with pollen from *V. pompona* causes metaxenia, which is manifested 40 days after pollination by fruits of greater size and weight than in those fruits resulting from self-pollination. The induction of metaxenia could be a potential alternative for vanilla producers because it facilitates the obtaining of fruits of greater length; nevertheless, it is still necessary to know the aromatic quality of these fruits to determine if they have any advantage compared to obtaining fruits by self-pollination.

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