Journal of Applied Horticulture, 23(3): 357-359, 2021
https://doi.org/10.37855/jah.2021.v23i03.65
Journal of Applied Horticulture
ISSN: 0972-1045

# Effect of trellis orientation on *Passiflora incarnata* growth and production

**Eric T. Stafne[1]* and Amir Rezazadeh[2]**

*[1]Extension and Research Professor, South Mississippi Branch Experiment Station, Mississippi State University, Poplarville, MS, 39470, P.O. Box 193, USA. [2]Extension Agent II/Fruit and Field Crops, University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Cooperative Extension St Lucie County, 8400 Picos Rd, Fort Pierce, FL 34945. *E-mail: eric.stafne@msstate.edu*

## Abstract

*Passiflora incarnata* L., often referred as 'maypops', has showy flowers and large fruit. This species has been identified in historical documents as being a food crop, although it is not presently grown as a commercial crop. To better facilitate harvest, *Passiflora* vines must be trellised to keep flowers and fruit off the ground. There are different methods to accomplish this, but there is little consensus as to the best model. Simple trellis systems made from t-posts, wire fencing, and cement blocks were erected onto a crushed rock covered nursery pad. One trellis was made horizontal to the ground roughly 0.3 m off the pad. The other trellis was vertical (perpendicular to the ground) and reached a height of 1.5 m. Three *Passiflora* species were used: *P. caerulea* L. (blue passion flower), *P. edulis* Sims f. *flavicarpa* O. Deg. (yellow passion fruit), and *P. incarnata* (maypop). There were no statistically significant differences between vertical and horizontal trellised passion fruit vines in our study. Overall, trellis orientation did not appear to significantly impact vine growth, fruit growth, or fruit quality of *P. incarnata*. We recommend employing a vertical trellis system for this species.

**Key words:** Horizontal trellis, maypop, *Passiflora caerulea*, *Passiflora edulis*, *Passiflora incarnata*, vertical trellis

## Introduction

Most *Passiflora* species originated in South America, especially Brazil (Morton, 1987; Sulladmath *et al*., 2012; Deshmukh *et al*., 2017), however, there are species from North America, with the most prominent being *Passiflora incarnata* (Arjona *et al*., 1991). *P. incarnata*, often referred to commonly as 'maypops', has showy flowers and large fruit. This species has been identified in historical documents as being a food crop, although it is not presently grown as a commercial crop. Archaeological evidence in the southeastern U.S. identified it as an important food crop for Native Americans dating back to the Late Archaic period. The Algonkian and Creek tribes may have been the first to domesticate the plant and Europeans may have also consumed it after coming to North America (McGuire, 1999). An early description of the fruit described it as growing in fields of corn and being a good summer-eating fruit (McGuire, 1999). Yet there are reasons for its lack of production, such as numerous number and size of seeds, lack of juice, and no improved fruit-bearing cultivars.

Some South American species are similar to *P. incarnata*, with *P. edulis* bearing a close resemblance. *P. edulis* is the most widely consumed edible passion fruit and is grown in many tropical areas (Deshmukh *et al*., 2017). While *P. incarnata* is also edible, it is seedy and not as sweet as *P. edulis*. However, there is great potential for *P. incarnata* in North America as a multipurpose ornamental and fruit crop. Researchers in Florida and Georgia crossed *P. edulis* and *P. incarnata* (Knight, Jr., 1994) in an attempt to make an edible fruit that could be grown in temperate climates. Even though *P. edulis* and *P. incarnata* look similar, they are different species and crosses mainly resulted in sterile offspring which is a significant problem in breeding fruit-bearing vines.

To better facilitate harvest, *Passiflora* vines must be trellised to keep flowers and fruit off the ground. There are different methods to accomplish this, but there is little consensus as to the best model. Often trellis systems identifical, or similar, to those designed for grapevines such as the two-arm and four-arm Kniffen systems or the pergola (Deshmukh *et al*., 2017) are used, but these are used primarily for *P. edulis* types. Other studies have examined different trellis systems for various *Passiflora* species (Ramnanan, 1993; Colon *et al*., 1997; Sulladmath *et al*., 2012; de Carvalho *et al*., 2018; D'abadia *et al*., 2019), but none have included *P. incarnata*.

The purpose of this study was to determine if trellis orientation could help improve vine growth, fruit production, and fruit quality of *P. incarnata* when grown under southern Mississippi conditions.

## Materials and methods

The study was performed in 2017 at the Mississippi State University South Mississippi Branch Experiment Station in Poplarville, Mississippi, United States. Simple trellis systems made from t-posts, wire fencing, and cement blocks were erected onto a crushed gravel-covered nursery pad with drip irrigation. One trellis was horizontally oriented, roughly 0.3 m off the gravel pad. The other trellis was vertical (perpendicular to the ground) and reached a height of 1.5 m. Three *Passiflora* species were used: *P. caerulea* (blue passion flower), *P. edulis* forma *flavicarpa* (yellow passion fruit), and *P. incarnata* (maypop). The primary species of interest was *P. incarnata* with *P. caerulea* and *P. edulis*

f. *flavicarpa* used solely for observational comparison. Within each trellis treatment there were 2 vines of *P. caerulea*, 4 vines of *P. edulis* f. *flavicarpa* and 8 vines of *P. incarnata*. Vines were randomized within each trellis treatment. All vines were grown in 11.4 L pots. Pots were irrigated twice daily and fertilized monthly with 13-13-13. The study was terminated on 26 Sept, 2017. Fruits were harvested by hand and measured with a Mitutoyo Absolute Digimatic caliper (Mitutoyo Corp., Kawasaki, Japan). The soluble solids content was measured with a digital hand-held refractometer (3810 PAL-1; Atago, Osaka, Japan). Titratable acidity (TA) was measured by titration with 0.1N of sodium hydroxide (NaOH) to an endpoint of pH 8.2 using a compact titrosampler (Metrohm 862, Herisau, Switzerland). Fruit density, a measure of how full the passion fruit is without disturbing the outer skin, as determined by the formula:

$$Fd = W/(HxD)$$

where W = fruit weight (g), H = fruit height (cm), and D = fruit width (cm)

After the final fruit harvest, all vines were cut at the soil line and air-dried for several days at room temperature. Upon fully drying, vines were individually weighed.

Data were analyzed by JMP (version 12; SAS Institute, Cary, NC) using a one-way analysis of variance and means were compared using a t-test where appropriate. The main effect in the model was trellis orientation. Statistical analysis did not include a comparison of species.

## Results and discussion

There were no statistically significant differences between vertical and horizontal trellised passion fruit vines in our study. Overall plant growth did not differ (Fig. 1) for *P. caerulea*, *P. edulis* f. *flavicarpa*, or *P. incarnata*. However, based on the mean aboveground growth, the vertical trellis system may be preferred by *P. caerulea* and *P. edulis* f. *flavicarpa*, while *P. incarnata* did not appear to grow better on one system over the other. Ramnanan (1993) reported that *P. quadrangularis* preferred a vertical trellis system because of possibility of increased planting density for higher yields, intercropping with other food crops, ease of integrating mechanization, lower incidence of pests, and reduced cost. Colon *et al*. (1997) found that growers in Puerto Rico may use simpler trellis systems primarily due to lower cost rather than any potential improvement in fruit production or fruit quality.

Fruit production of *P. caerulea* and *P. edulis* f. *flavicarpa* was extremely limited and therefore not reported here. The *P. incarnata* vines averaged 7.9 fruit per vine on the horizontal trellis and 6.9 on the vertical trellis (Table 1). These values are similar to those reported by McGuire (1998), but there is much variability within the species for many traits (McGuire, 1999). Fruit size, measured by height and width, was also similar between the two trellis systems for *P. incarnata*. Height of the fruit on the horizontal trellis and the vertical trellis did not differ (4.56 vs. 4.48 cm, respectively). This was the same case for fruit width (3.59 vs. 3.66 cm, respectively). The fruit size was also consistent with McGuire (1998). While the present study and McGuire (1998) were done in different regions of the U.S. with different sources of *P. incarnata*, there is probably a genetic limit to how large the fruit can develop. The roundness of the fruit, determined by dividing fruit height by fruit width, was nearly the same for both trellis types.

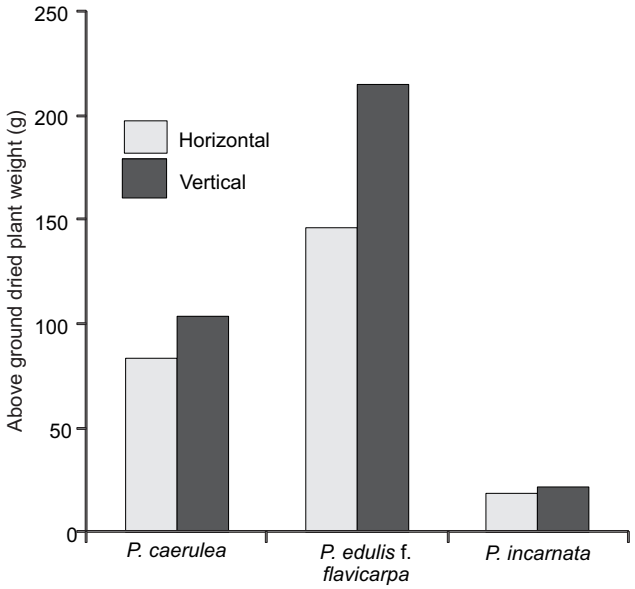


Fig. 1. Vine growth on two trellis orientation systems of three *Passiflora* species. None of the trellis treatments within species were significantly different based on t-test ($P \leq 0.05$).

When fresh fruits were weighed, those on the vertical system were slightly numerically heavier, but not statistically different from the horizontal trellis (Table 1). The total fruit weights in this study were similar to greenhouse-grown fruit (Arjona *et al*., 1991), but less than wild harvested fruit in other studies (Arjona *et al*., 1991; Senter *et al*., 1993). The reason for differences is unknown but may be attributed to an increased presence of available pollinizer vines. Fruit density, a measure of how full the passion fruit is without disturbing the outer skin, is not an established metric and best values change depending on species. In general, *P. incarnata* values > 1 indicate better-filled fruit than values < 1. The range within *P. incarnata* was 0.63 to 1.46 (data not shown). In this case, there was no difference in fruit density for *P. incarnata* on either system.

Numerically, sugars were higher and acids lower on the horizontal trellis orientation; however, these values were not significantly different from the vertical system. D'abadia *et al*. (2019) found similar results for *P. cincinnata* grown in Brazil. In their study, vines grown on a vertical system versus a horizontal system did not show differences for sugar or acid levels. Another study on *P. setacea* grown on different trellis systems also showed no

Table 1. Trellising orientation impact on aspects of *Passiflora incarnata* fruit production and fruit quality.

| Trellis | Fruit # per vine | Fruit height (cm) | Fruit width (cm) | Fruit roundness (ht/width) | Fruit weight (g) | Fruit density (g/cm$^2$) | Soluble solids (%) | Total acidity (%) | Sugar:Acid ratio |
|---|---|---|---|---|---|---|---|---|---|
| Horizontal | 7.9 | 4.56 | 3.59 | 1.27 | 17.86 | 1.07 | 9.98 | 1.61 | 7.59 |
| Vertical | 6.9 | 4.48 | 3.66 | 1.22 | 18.62 | 1.07 | 9.45 | 1.92 | 7.30 |
| *P* value$^z$ | 0.60 | 0.85 | 0.80 | 0.41 | 0.86 | 0.99 | 0.79 | 0.55 | 0.92 |

$^z$*P* values were derived from t-test and significance level of 0.05.

differences for many of the measured variables (de Carvalho *et al*., 2018). Sugar levels in our study were similar to those reported by Arjona *et al*. (1991) for wild fruit growing in central Mississippi. The relatively low sugar levels compared to *P. edulis* as reported by others (Senter *et al*., 1993; Sulladmath *et al*., 2012; Nunes de Jesus *et al*., 2016) is an area where improvement could potentially be made through intra- and interspecific breeding (McGuire, 1999) and evidenced by Senter *et al*. (1993). The sugar to acid ratio was not different between the two trellis systems. This ratio is a determining factor in desirable fruit quality (D'abadia *et al*., 2019). Ratios are higher in *P. edulis* f. *flavicarpa* (Nunes de Jesus *et al*., 2016) and *P. cincinnata* (D'abadia *et al*., 2019).

Overall, trellis orientation did not appear to significantly impact vine growth, fruit growth, or fruit quality of *P. incarnata*. As this study had a limited number of vines of *P. caerulea* and *P. edulis* f. *flavicarpa*, a larger study may have shown differences in growth suggested in Fig. 1. However, others have reported there are significant advantages to a vertical trellis system. Therefore, as no differences were observed for *P. incarnata*, we recommend employing a vertical trellis system for this species.

## References

Arjona, H.E., F.B. Matta and J.O. Garner, Jr., 1991. Growth and composition of passion fruit (*Passiflora edulis*) and maypop (*P. incarnata*). *HortScience*, 26: 921-923.

Colon, R.V., A.A. Santiago and S.A. Henriquez, 1997. Evaluation of two yellow passion fruit (*Passiflora edulis* var. *flavicarpa*) trellis systems. *Proc. Caribbean Food Crops Soc*., 33: 115-120.

D'abadia, A.C.A., A.M. Costa, F.G. Faleiro, J.V. Malaquias and F.P. de Araujo, 2019. Physical-chemical and chemical characterization of *Passiflora cincinnata* Mast fruits conducted in vertical shoot positioned trellis and horizontal trellises system. *Rev. Bras. Frutic., Jaboticabal*, 41(6): e-452.

de Carvalho, M.V.O., L. de Lacerda de Oliveira and A.M. Costa, 2018. Effect of training system and climate conditions on phytochemicals of *Passiflora setacea*, a wild Passiflora from Brazilian savannah. *Food Chem*., 266: 350-358.

Deshmukh, N.A., R.K. Patel, S. Okram, H. Rymbai, S.S. Roy and A.K. Jha, 2017. Passion fruit (*Passiflora spp*.). In: *Underutilized Fruit Crops: Importance and Cultivation*. S.N. Ghosh, A. Singh and A.Thakur, (eds). JAYA publishing, Delhi, India. p. 979-1005.

Knight, Jr. R.J. 1994. Problems and opportunities in passion fruit culture and development. *Fruit Var. J.*, 48: 159-162.

McGuire, C.M. 1998. Field performance and phenotypic variation of *Passiflora incarnata* L. in New York state. *HortScience*, 33: 240-241.

McGuire, C.M. 1999. *Passiflora incarnata* (Passifloraceae): A new fruit crop. *Econ. Bot*., 53: 161-176.

Morton, J. 1987. Passionfruit. In: *Fruits of Warm Climates*. Miami, FL. p. 320-328.

Nunes de Jesus, O., T.L. Soares, E.A. Girardi, R. Castro, C. Rosa, E.J. de Oliveira, A.J. da Cruz Neto, V.T. dos Santos and J.R.P. Oliveira, 2016. Evaluation of intraspecific hybrids of yellow passion fruit in organic farming. *African J. Agric. Res*., 11: 2129-2138.

Rannanan, N. 1993. An intensive and sustainable cultivation system for barbadine (*Passiflora quadrangularis* L.). *Proc. Caribbean Food Crops Soc*., 29: 531-540.

Senter, S.D., J.A. Payne, R.J. Knight and A.A. Amis, 1993. Yield and quality of juice from passion fruit (*Passiflora edulis*), maypops (*P. incarnata*) and tetraploid passion fruit hybrids (*P. edulis* x *P. incarnata*). *J. Sci. Food Agric*., 62: 67-70.

Sulladmath, V.V., K. Srinivas and R.H. Laxman, 2012. Yield and quality of passion fruit in relation to training system. *J. Hort. Sci*., 7: 46-50.

Received: July, 2021; Revised: August, 2021; Accepted: August, 2021