ADVANCED SEEDLINGS AS A MEANS TO CONTROL PASSION FRUIT WOODINESS: INCIDENCE OF THE DISEASE AND YIELD AND QUALITY OF FRUIT*

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ABSTRACT – *Cowpea aphid-borne mosaic virus* (CABMV) incites a disease known as fruit woodiness.The introduction of healthy seedlings, recommendations include the use of plants at a more advanced phenological stage. We evaluated the influence of CABMV on the development, production and physico-chemical characteristics of the pulp of passion fruit produced by plants grown from young (30 cm) and advanced (80cm) seedlings. The use of advanced seedlings delayed the entry and spread of CABMV. The analysis of yield parameters and physico-chemical properties of fruits showed that treatments did not differ, and the same result was observed for the harvest periods adopted. However, passion fruit produced by advanced seedlings and picked in the first harvest period being categorized as class five. The introduction of advanced seedlings proved to be advantageous, because the fruits obtained in the first harvest presented commercial characteristics superior to those obtained from young seedlings.

Keywords: CABMV / *Passiflora edulis* / Passifloraceae / *Potyvirus*.

INTRODUCTION

P. edulis accounts for 95% of Brazil's production of passion fruit, with mean yield of 15 tonnes.ha^{-1}(RODRIGUES et al., 2016). Passion fruit woodiness (PFW) is currently the main disease to affect passion fruit orchards in Brazil. The disease is caused only by the *Cowpea aphid-borne mosaic virus* (CABMV) (*Potyvirus*, *Potyviridae*), transmitted non-persistently by various aphid species causing mosaic, blisters, leaf deformation and fruits with thickened pericarp and low pulp yield (RODRIGUES et al., 2015).

No gene that confers resistance to CABMV has been identified in passion fruits species. These initiatives have shown that every attempt to improve the commercial production of passion fruit should include appropriate management measures to minimize the effects of the virus. Such measures include: (i) the use of healthy seedlings; (ii) the elimination of orchards that have peaked their production lifecycle prior to the replacement or introduction of new plants; (iii) the systematic elimination of symptomatic passion fruit plants; (iv) the elimination of spontaneous vegetation; (v) the disinfection of tools used in the field during orchard management; and (iv) the cultivation of passion fruit orchards distant from the more traditional passion fruit belts (RODRIGUES et al., 2016; SAMPAIO et al., 2008).

In the effort to delay infection by the virus, the establishment of orchards using seedlings free of CABMV has been adopted side by side with the use of seedlings of a more advanced phenological status measuring at least 80 cm, instead of the young seedlings measuring 30 cm in height traditionally used (RODRIGUES et al., 2016). Although these recommendations have been accepted and implemented by several farmers, no proper evaluation of the outer and inner characteristics of passion fruit obtained from advanced seedlings has been conducted considering the effects of CABMV infection.

MATERIALS AND METHODS

The experiment was conducted during 14 months in an orchard of *P. edulis* var. 'Sul Brasil' established located in the municipality of Pariquera-Açu, SP. Passion fruit seedlings were produced in a nursery covered with an anti-aphid net. Advanced seedlings were transplanted measuring 80 cm, while young seedlings were transplanted measuring 30 cm. Before transplant all seedlings were submitted Plate-Trapped Antigen - Enzyme-Linked Immunosorbent Assay (PTA-ELISA) with a specific polyclonal antiserum for the detection of CABMV (RODRIGUES et al., 2016). One hundred seedlings were used in each treatment, but only the 40 seedlings in the inner treatment were monitored. The orchard was monitored monthly and the samples were submitted to PTA-ELISA. Simultaneous visual inspections helped identify symptomatic plants. The parameters were: (i) weight of fruit, (ii) number of fruit produced, (iii) diameter of fruit, (iv) titratable acidity (TA), (v) pH, and (vi) total soluble solids (TSS) of passion fruit pulps were determined at two harvest times. TA was determined using the protocol described by Pregnollatto & Pregnollatto (1985). TTS was analyzed placing one drop of the concentrated juice on the prism of a refractometer decimally graded between zero and 32 ºBrix. The values of each parameter evaluated in young and advanced *P. edulis* at two times were submitted to an analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Mean weight, diameter and estimated yield per hectare of fruits produced by plants grown from advanced seedlings were 276.00 g, 9.00 cm and 3.30 tonnes/ha, respectively, in the first harvest period. For plants grown from young seedlings, these values were 209.00 g, 8.30 cm and 3.70 tonnes/ha, respectively. However, in the second harvest, mean weight and diameter dropped to 156.00 g, 8.20 cm and 0.90 tonnes/ha, respectively, for passion fruit picked from plants that developed from advanced seedlings. These values were 155.00 g, 8.22 cm and 2.30 tonnes/ha, respectively, for passion fruit from young seedlings in the same harvest period (TABLE 1).

TABLE 1. Establishment of an orchard and production of *Passiflora edulis* var. 'Sul Brasil' from advanced (80 cm) and young (30 cm) seedlings and infection with the *Cowpea aphid-borne mosaic virus* (CABMV) in Pariquera-Açu, SP at two harvest times.

Variables	Treatments	Harvest time	
		First	Second
External characteristics			
Incidence by PTA-ELISA (%)	As	48.70 **aA**	100.00 **bB**
	Ys	79.40 **aA**	100.00 **bB**
Symptomatic plants (n°)	As	5.00 **aA**	100.00 **bB**
	Ys	54.70 **aB**	100.00 **bB**
Dead plants (n°)	As	2.50 **aA**	2.50 **aA**
	Ys	15.00 **bA**	15.00 **bA**
Number of fruits produced	As	22.00 **aA**	7.50 **bB**
	Ys	41.00 **aA**	18.80 **bB**
Diameter of fruit (cm)	As	9.00 **aA**	8.20 **aA**
	Ys	8.30 **aA**	8.22 **aA**
Weight of fruit (g)	As	276.00 **aA**	156.00 **bB**
	Ys	209.30 **aA**	155.00**bB**
Physico-chemical characteristics			
pH	As	2.47 **aA**	2.51 **aA**
	Ys	2.50 **aA**	2.45 **aA**
TSS	As	10.49 **aA**	10.31 **aA**
	Ys	9.68 **bA**	9.50 **bA**
TA	As	4.70 **aA**	4.50 **aA**
	Ys	4.14 **bA**	4.20 **bA**

As: Advanced seedlings (80 cm); **Ys:** Young seedlings (30 cm); **TSS:** Total soluble solids in pulp; **TA**: Titratable acidity of pulp. Means followed by identical uppercase letters in the same column and identical lowercase letters in the same line did not differ in the F ANOVA test at 5% probability.

Overall, the values of parameters directly associated with production (weight, diameter, and number of fruits) did not differ statistically between treatments in the same harvest period. Yet, weight and number of fruit differed significantly when the two harvest times are compared (TABLE 1). Values of both parameters were higher for fruit picked in first harvest period, compared with second harvest. It is possible that the drop in yield observed in second harvest for both treatments is not linked with the early manifestation of symptoms, noticed mostly in plants from young seedlings. Nevertheless, the decrease in weight and number of fruit recorded in the second harvest was significantly higher in the orchard established using young seedlings that expressed symptoms more precociously. The only parameter that did not differ statistically between treatments and harvest times was mean fruit diameter. Such result is comparable to that published by Sampaio et al. (2008), who reported that, in addition to smaller diameter values, passion fruit also exhibited deformation. The relevance of these symptoms lies in the fact that trade value of passion fruit *in natura* in Brazil is influenced by fruit size (diameter) and the presence of defects on the surface of fruits (NASCIMENTO et al., 1999).

On the other hand, the extent of the drop in fruit yield, independently of the comparison between treatments and harvest times, was similar to the value reported by Sampaio et al. (2008). The severity and symptomatology manifested by passion fruit are the environmental conditions, the genetic diversity of CABMV, and the irregular distribution of the virus on the passion fruit plant (RODRIGUES et al., 2015).

Within seven months of the introduction in the field, 79.4% of the passion fruit plants grown from young seedlings had CABMV infection, of which 14.7% were symptomatic and 20.6% were free of the virus. Interestingly, plants grown from advanced seedlings were asymptomatic during this period, although 48.7% of these individuals were already infected with CABMV and 51.3% remained healthy. However, 14 months after the introduction of orchards, 100% of the plants from both treatments were infected. This indicates that primary infection with CABMV occurred simultaneously in both treatments, and that advanced and young seedlings were equally susceptible. The expression of symptoms in plants grown from advanced seedlings occurred later due to the longer latency period (RODRIGUES et al., 2016). This finding was confirmed when results of PTA-ELISA were compared with the manifestation of symptoms induced by the virus. It was also observed that the higher incidence of CABMV influenced the severity of the disease directly. Another important result of the present study was the understanding that inoculum pressure in Vale do Ribeira is extremely high (YUKI et al., 2006).

As for TA, TSS, and pH, no statistically significant differences were observed between treatments and harvest periods, indicating that infection with CABMV did not affect the physico-chemical characteristics of *P. edulis* var. 'Sul Brasil'. TA values are used to characterize the quality of pulp in passion fruit traded *in natura* and for industrial applications.

The introduction of advanced seedlings only postponed the entry and dispersal of CABMV in the orchard. Nevertheless, the lack of statistically significant differences between fruit weight, diameter, and number does not afford to prove the efficacy of the advanced seedlings. In addition to the use of advanced seedlings, the delay in introducing seedlings in the field was more effective to control de spread of CABMV in the region. Also, no statistically significant difference was observed in yield parameters between young and advanced seedlings.

According to the classification standards adopted by the customer market (CEAGESP, 2015), which define the trade value of fruits based on diameter using five size ranges (class 1: ≤ 55 mm, class 2: ≥ 55 mm to 65 mm, class 3: ≥ 65 mm to 75 mm, class 4: ≥ 75 mm to 85 mm, and class 5: > 85 mm), the results of this work show that, even though CABMV was detected in the passion fruit orchards analyzed, fruits produced by plants grown from advanced seedlings were classified into class 5 already in the first harvest period (TABLE 1). Nevertheless, the quality of fruit produced by plants grown from advanced seedlings in the second harvest time decreased. In turn, the fruits obtained from plants produced by young seedlings in both harvests were also regarded as class 4. This result indicates that the use of more promising varieties, together with the transplantation of advanced seedlings free of virus, may help increase acceptance and commercialization figures of passion fruit produced in Vale do Ribeira.

CONCLUSION

In traditional areas of passion fruit planting, where the inoculum pressure of the CABMV is very high, the introduction of advanced seedlings delayed the appearance of symptoms, but did not prevent the occurrence of quantitative damages and losses in the production of passion fruit. However, the introduction of advanced seedlings proved to be advantageous, because the fruits obtained in the first harvest presented commercial characteristics superior (85 mm in diameter, categorized as class 5) to those obtained from young seedlings, guarantying better acceptance by the market, and adding value to the product with a consequent increase in the producer's income.

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