Scientia Horticulturae 234 (2018) 261–266

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Fig production under an intensive pruning system in the moist central area of Argentina

Norma Micheloud[a,b], Juan Carlos Favaro[a], Damián Castro[a,b], Marcela Buyatti[a], María Alejandra Favaro[a,b], María Soledad García[a], Norberto Gariglio[a,*]

[a] Universidad Nacional del Litoral, Facultad de Ciencias Agrarias, Kreder 2805, 3080, Esperanza, Santa Fe, Argentina
[b] Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Rivadavia 1917, Argentina

ARTICLE INFO

Keywords:
Crop load
Ficus carica
Fruit set
Harvesting period
Intensive pruning
Tree age

ABSTRACT

The aim of this work was to evaluate fruit yield and harvest distribution, and to identify the main factors that affect the fruit yield of two parthenocarpic fig varieties trained under an intensive pruning system in the temperate-humid central area of Santa Fe, Argentina. Fig trees of the cultivars 'Guarinta' and 'Brown Turkey' were planted 4 × 2 m apart and trained in small open vases. Fruit yield per plant, number of nodes and fruits per shoots, shoot length, and number of unripened fruits per shoot were registered during 10 years after planting (2006–2016). Relationships between meteorological data and plant parameters were determined. Fruit yield varied between 4.43 and 12.1 t ha^{-1} according to the year and variety. Commercial fruit yield tended to diminish four years after planting. Annual duration of the harvesting period ranged from 8 to 21 weeks and showed a positive relationship with the annual fruit yield. The harvesting period was negatively affected by both tree age and weather variables, such as the number of rainy days and the accumulated precipitation from January to May. The last three years of experimentation were the rainiest, so it was not possible to clearly establish if the declination of fruit yield and the duration of the harvesting period with tree age were a consequence of climatic conditions, tree age, or both factors. The end of the harvest period was not due to the absence of fruits but to the lack of ripeness in all years.

1. Introduction

The fig (*Ficus carica* L.) is a small-sized tree native of Western Asia distributed and cultivated throughout the Mediterranean region. Turkey, Egypt, Iran, Greece, Algeria, Morocco, Syria and Spain are the main producing countries (El Rayes, 1995; Flaishman et al., 2008). In the Americas its cultivation is widespread, mainly in the United States, Brazil, Peru, Bolivia, and Argentina (Dalastra, 2008; Morton, 2013).

The fig tree requires a warm climate with hot summers and mild winters (El Rayes, 1995; Gaaliche et al., 2011), although it can grow adequately under less favorable conditions (Nienow et al., 2002; Leonel and Tecchio, 2010; Limeira Da Silva et al., 2016). The tree has low chilling requirements and tolerates light frost. Even the most tolerant varieties can support temperatures as low as −15 to −20 °C (Andersen and Crocker, 2010). In general, it adapts well to different soils except for those with poor drainage, being one of the few fruit trees with greater salinity tolerance (Flaishman et al., 2008).

In Argentina, fig cultivation was increased by 391%, from 155 ha in 1988 to 606 ha in 2002 (INDEC, 2002), although FAOSTAT (2018) does not register significant changes in the cultivated area and fruit production during the same period. Crop technology has been modified over the last years by increasing the tree density and incorporating an intensive pruning system and localized drip irrigation. These technological changes have resulted in higher fruit yields and quality (Prataviera and Godoy Aliverti, 1991), which was reflected in the export of small volumes of fresh fruits to European markets (Miranda and Battistella, 2002). Despite increases of fig cultivation in Argentina, the production is not enough to supply the domestic market, and consequently 500 tons of dried figs must be annually imported from Turkey and Chile (Prataviera, 2003).

The traditional training system used for fig trees is an open vase with three main branches, which allows for a medium-size tree (Gaaliche et al., 2011). Instead, new plantations in Argentina have high tree density (> 1000 plants per hectare) and are intensely pruned so the canopy is annually renewed (Prataviera, 2003). This pruning system keeps the trees small, and consequently horticultural practices can be completed without ladders. Fruit yields obtained using this intensive pruning system were over 15,000 kg ha^{-1}. The best-performing

* Corresponding author.
E-mail address: ngarigli@fca.unl.edu.ar (N. Gariglio).

https://doi.org/10.1016/j.scienta.2018.02.035
Received 17 October 2017; Received in revised form 6 February 2018; Accepted 14 February 2018

cultivars were 'Brown Turkey', 'Guarinta', 'Brogiotto Bianco', 'Servantine' and 'Kadota' (Prataviera, 2003).

'Brown Turkey' produces large pear-shaped fruit that can reach 80–90 g, with white or light pink pulp and external copper-coloration at maturity. 'Guarinta' originated from a mutation of 'Málaga', and is also characterized by large, pear-shaped fruit, yellowish-green external coloration and reddish pulp (Prataviera and Godoy Aliverti, 1991).

During the last 10 years, small fig plots for experimental and demonstrative purposes were planted at different sites at the central area of Santa Fe province (Gariglio et al., 2014), allowing the adoption and spread of fig as a complementary commercial activity for traditional horticultural crops (Travadelo et al., 2017). The central area of Santa Fe has a temperate humid climate with no dry season (Köppen, 1931). However, fig trees grow wild in dry and sunny areas (Morton, 2013). The recent introduction of fig in the central humid area of Santa Fe merits further investigation in order to improve the knowledge of the crop production under an intensive pruning system optimizing fruit yield and harvest distribution. The aim of this work was to evaluate fruit yield, harvest distribution, and to identify the main factors that affect fruit yield of two parthenocarpic fig varieties trained under an intensive pruning system in the temperate-humid central area of Santa Fe, Argentina.

2. Materials and methods

The trial was carried out in a commercial orchard at the horticultural area known as 'Cinturón Hortícola Santafesino' located around Santa Fe city, in the central-east area of the province of Santa Fe, Argentina (31°26′ S; 60°56′ W; 40 m above sea level). The climate was classified as Cfa: temperate humid mesothermal, according to Köppen (1948). The main meteorological parameters of the area were recorded by an automatic meteorological station (LI-1400, LI-COR® Biosciences, USA) during the trial and are summarized in Table 1.

Fig trees of the cultivars 'Guarinta' and 'Brown Turkey' were planted at 4 × 2 m spacing (1250 trees ha^{-1}) during August 2005 in a well-drained sand-loamy soil, using complementary drip irrigation. Trees were trained to a small open vase with an intensive pruning system, consisting in the winter thinning of the current-year shoots or its heading back to one node. After pruning, the tree scarcely reached 0.8 m in height. Only three shoots per plant were left during the year of planting, which were duplicated each year until its stabilization at 24–30 shoots per plant from the fourth year. An educational video briefly explains the process of pruning (Gariglio, 2017). Fruit yield per plant was registered weekly during 10 years after planting. Relationships between meteorological data and plant parameters were determined, and the best regression model was selected using the following criteria: minimizing the conditional model estimator (CME), the Akaike information criterion (AIC), and the Bayesian information criterion (BIC).

During two growing seasons (2010/2011 and 2011/2012), four representative current shoots around each tree were labeled. In addition, 200 current shoots of different vigor for each variety were also randomly identified between the plants of the trials. Shoot lengths and the number of nodes per shoots were measured at the end of each of the two growing seasons, whereas the nodes with fruit and the number of fruits per shoots were counted weekly from the time they became visible. The percentage of nodes with fruits was determined as the ratio of the fruit number to the total number of nodes of each current shoot. Furthermore, the existence of a correlation within shoot length and fruit per shoot was observed.

The proportion of unripe fruits per current shoot was measured on 10 current shoots per plant at the end of the growing season in 6-year-old and 10-year-old plants during the last year of experimentation.

A completely randomized experimental design with one-tree plots and 10 replications per cultivar was used. Analysis of variance was performed on the data, and means were compared using the least significant difference (LSD Fisher) test with 5% significance. Statistical analysis was performed using InfoStat software (Di Rienzo et al., 2012) developed at the Universidad Nacional de Córdoba, Argentina.

3. Results and discussion

Commercial fruit yields of fig trees were affected by variety ($p = 0.0164$) and tree age ($p < 0.0001$), with an interaction between both variables ($p = 0.0087$). The average fruit yield (kg $plant^{-1}$) of the 10-year study was higher for the cv. 'Brown Turkey' (+15%) compared with 'Guarinta'. Fig behaved as a precocious tree that produced marketable fruit during the first growing season after planting (Fig. 1), as was previously mentioned (Ateyyeh and Sadder, 2006; Crane and Brown, 1950; El Rayes, 1995; Flaishman et al., 2008; Gaaliche et al., 2011; Limeira Da Silva et al., 2016). Tree yield increased annually during the first four years of plantation, during which time both varieties achieved their highest fruit production (12.1 and 10.5 kg pl^{-1} for 'Brown Turkey' and 'Guarinta' respectively) (Fig. 1). After four years, fruit yield declined 26% on average for three consecutive years, and subsequently it stabilized around 5 kg $plant^{-1}$ in the seventh year after planting (Fig. 1). The declination of fruit production after the fourth year of growth showed a polynomial relationship ($y = 0.3345x^2 - 5.6957x + 28.869$; $r^2 = 0.884$).

The interaction between the variables tree age and variety on fruit yield was explained because during the growing seasons 2013/2014 and 2014/2015, fruit yield of 'Guarinta' was higher than 'Brown Turkey,' in contrast with the others years (Fig. 1).

The annual fruit yield reached in our trial was in accordance with that observed in different areas of Brazil under an intensive pruning system using the cv. 'Roxo de Valinhos' (Leonel and Tecchio, 2010; Nienow et al., 2002). However, there are many factors that can modify the fruit yield and quality of fig trees, such as the agro-ecological

Table 1
Monthly medium values (M) and coefficient of variation (CV) of the main meteorological parameters recorded at the central area of Santa Fe province during 2007–2016.

ParameterMonths		J	F	M	A	M	J	J	A	S	O	N	D
Radiation (Mj m^{-2})	M	776	589	593	370	265	210	257	350	432	578	691	737
	CV (%)	7	6	28	20	13	14	22	11	7	9	12	7
T MAX (°C)	M	32.9	30.6	28.6	26.1	21.8	18.1	18.2	19.7	23.1	26.1	30.1	31.7
	CV (%)	4	3	4	6	7	7	10	15	7	6	4	6
T MED (°C)	M	26.7	24.5	22.5	19.6	15.9	11.7	11.5	12.9	16.4	19.8	23.9	25.6
	CV (%)	4	5	4	5	10	9	19	18	8	4	6	5
T MIN (°C)	M	20.2	18.9	16.6	13.7	10.9	6.1	5.6	6.8	10.2	13.9	17.2	19.2
	CV (%)	6	7	5	9	13	24	47	31	12	10	9	6
Precipitation (mm)	M	130	182	174	89	42	15	16	38	100	142	173	173
	CV (%)	72	41	54	64	43	103	169	111	115	84	89	95

T MAX: Maximum temperature; T MED: Medium temperature; T MIN: Minimum temperature.

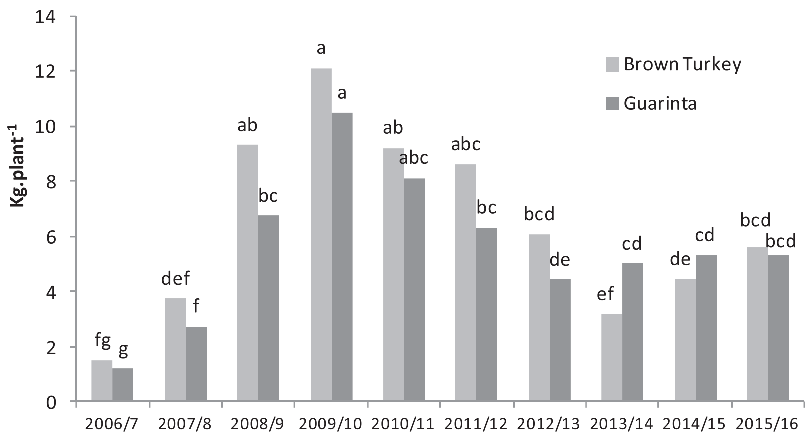

Fig. 1. Annual fruit yield (kg plant^{-1}) of fig (*Ficus carica* L.) cvs. 'Brown Turkey' and 'Guarinta' during 10 years after planting in the central-east area of the Santa Fe province, Argentina. Different letters in the columns indicate significant differences according to the LSD test ($p \leq 0.05$).

conditions and variety, different horticultural practices such as the time of pruning (Alvarenga Gonçalves et al., 2006), the use of complementary irrigation (Leonel and Tecchio, 2010), plasticulture (Nienow et al., 2002), and the conduction systems of the current shoot (Norberto et al., 1998), among others.

The annual duration of the harvest period was also affected by the variety ($p < 0.0001$) and tree age ($p < 0.0001$); however, unlike fruit production, no interaction between both variables was observed ($p = 0.5379$). The duration of the harvesting period for 'Brown Turkey' ranged from 10 to 21 weeks, which was 19 days longer (+17.8%) on average than the harvesting period for 'Guarinta' which ranged from 8 to 18 weeks. In relation to tree age, the longest harvesting period occurred at the fourth growing season after planting for both varieties, and later declined with tree age (Table 2).

'Brown Turkey' was one or two weeks more precocious than 'Guarinta' with the exception of three growing seasons (2012/13, 2014/15 and 2015/16) in which harvesting began at the same week for both varieties. In the cv. 'Brown Turkey' the beginning of harvest ranged between the last week of December and the third week of January, and the end of harvest ranged between the fourth week of March and the fourth week of May, depending on the year. In the same way, harvesting began between the first and fourth week of January for the cv. 'Guarinta' and ended between the second week of March and the third week of May, according to the year (Table 2). The harvesting period extended to May only in 43% and 29% of the years of study for 'Brown Turkey' and 'Guarinta' respectively (Table 2).

Table 2
Effect of the variety and tree age on the annual duration of the harvesting period (weeks) and time of harvest occurrence for two fig (*Ficus carica* L.) varieties in the central-east area of Santa Fe, Argentina.

Tree age (years)	Harvest period and duration			
	'Brown Turkey'		'Guarinta'	
	Duration (weeks)	Period (month-week/month-week)	Duration (weeks)	Period (month-week/month-week)
2	14 bcd	Jan-1/Apr-2	12 cd	Jan-3/Apr-2
3	16 bc	Jan-2/May-1	14 bcd	Jan-4/May-1
4	21 a	Dec-4/May-4	18 ab	Jan-2/May-3
5	14 bcd	Jan-1/Apr-2	11 def	Jan-2/Mar-4
6	16 bc	Jan-3/May-2	12 cd	Jan-4/Apr-3
7	14 bcd	Jan-1/Apr-2	12 cd	Jan-1/Mar-4
8	12 cd	Jan-1/Mar-4	9 ef	Jan-2/Mar-2
9	14 bcd	Dec-4/Apr-1	9 ef	Dec-4/Feb-4
10	10 de	Jan-3/Mar-4	8 f	Jan-3/Mar-2

Note: Different letters in the 'Duration' columns indicate significant difference between means, by LSD test ($p \leq 0.05$).

'Brown Turkey' showed the highest fruit production during the last week of January as an average of the 10 years of analysis. Furthermore, weekly fruit production was over 400 g pl^{-1} from mid-January until late-March (Fig. 2). On the other hand, the cv. "Guarinta" achieved the same level of fruit production between late-January and mid-March, which represents a shortening of four weeks in the high-yield harvesting period compared to "Brown Turkey" (Fig. 2).

Besides the effect of plant age and variety on fruit production, the duration of the harvest period showed a marked linear relationship with the annual fruit yield of both 'Brown Turkey' ($p = 0.0132$; $r^2 = 0.66$) (Fig. 3a) and "Guarinta" ($p = 0.0221$; $r^2 = 0.61$) (Fig. 3b) varieties. Fruit yield of "Brown Turkey" was more sensitive to changes in the duration of the harvest period; the slope of the linear equation was 56% higher in comparison with that of "Guarinta" (Fig. 3).

The duration of the harvest period (weeks) was negatively affected by the tree age in both fig varieties 'Brown Turkey' ($p = 0.0277$; $r^2 = 0.58$) (Fig. 4a) and 'Guarinta' ($p = 0.0099$; $r^2 = 0.70$) (Fig. 4b), diminishing around one week per year of age after the fourth year of planting. It is interesting that the reduction of the harvest period is a consequence of the modification of its ending but not of its beginning (Table 2). Furthermore, the end of the harvest period was not due to the absence of fruits but to the lack of ripeness.

The weather variables also affected the duration of the harvest period. The number of rainy days, the accumulated precipitation, and accumulated solar radiation from January to May were the variables that showed the best relationships (Table 3). The observed trend was that the duration of the harvest period decreased by one week for every 5–6 rainy days (75–100 mm of accumulated precipitation) from January to May of each year of study (Table 3). In contrast, the amount of accumulated radiation during the same period had a positive effect on the duration of the harvest period (Table 3).

The last three years of our study (2014–2016) were overly rainy, with precipitations of 674 mm on average from January to April, which was 54% higher compared to the previous years of this study. The fig tree is generally cultivated in semi-arid regions (El Rayes, 1995; Gaaliche et al., 2011; Limeira Da Silva et al., 2016) whereas the central area of Santa Fe has a humid climate (Köppen, 1931). Rain damages the fruits near maturation, causing cracking and rotting (Nienow et al., 2002), and also produces a vinegary flavor in the fruits. These negative effects can be partially prevented by the use of plasticulture (Nienow et al., 2002).

The growth of current shoots of fig trees normally has two annual flushes in the traditional pruning and training system of the Mediterranean area (Ateyyeh and Sadder, 2006), which allows an annual shoot growth of around 10 cm under rain-fed conditions (Gaaliche et al., 2011). Fig trees usually produce two crops a year (breba and

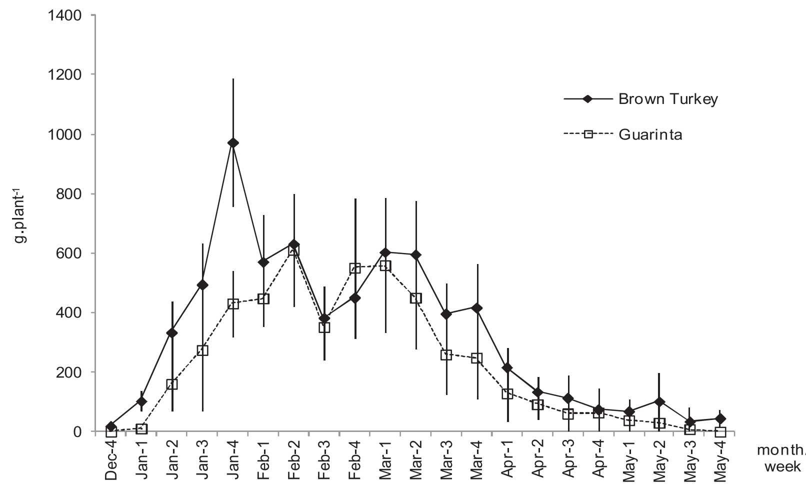

Fig. 2. Weekly distribution of the annual fruit harvest (g plant^{-1}) of two fig (*Ficus carica* L.) varieties, 'Brown Turkey' and 'Guarinta', exposed to an intensive pruning system in the central-east area of Santa Fe, Argentina. The vertical lines indicate the standard error. Data are the mean values of 10 years of experimentation (2006–2016).

main crop) (Gaaliche et al., 2011); however, the intensive winter pruning system, as utilized in the central area of Santa Fe, caused the loss of the breba crops (Puebla et al., 2003) and increased dramatically the current shoot growth, whose length was over 139 cm in both 'Brown Turkey' and 'Guarinta' varieties (Table 4). The number of nodes and reproductive buds are related to shoot length (Alvarenga Gonçalves et al., 2006; Gaaliche et al., 2011), thus intensive winter pruning allowed the harvest period of the main crop to extend up to five months (Table 2), which is as long as the harvest period of fig trees with two crops (breba and main crop) in the Mediterranean area (Crane and Brown, 1950).

In the northern Minas Gerais region of Brazil, which has an annual rainfall of 700–1200 mm, fig fruit production stabilized after the fifth year of plantation under the intensive pruning system (Alvarenga Gonçalves et al., 2006). Taking account of these results, we did not expect a decrease in plant fruit production after the fourth year of plantation. Gaaliche et al. (2011) reached a range of 50.2%–88.5% of fruit set in the main crop of five fig varieties during three years of study under Mediterranean climate conditions and a traditional pruning system. In our study, the percentage of nodes with fruit, which can be compared with the percentage of fruit set measured by Gaaliche et al. (2011), ranged between 45.0% and 49.9% according to the variety (Table 4). Comparing both trials, the change of the pruning system increased the growth of the current shoot about 15 times, whereas it decreased the fruit set in the range of 10%–43%. In contrast, the fig 'Roxo de Valinhos' produced one fruit per node under the intensive pruning system at Minas Gerais, Brazil, even with annual shoot growth up to 189 cm; therefore, under such conditions greater shoot growth should favor greater fruit production (Alvarenga Gonçalves et al., 2006).

We also observed that the number of harvested fruits per shoot did not show a correlation with shoot length over 80–100 cm of annual growth. In these long-current shoots a greater amount of fruits settled later in the growing season and were unable to reach maturity, remaining immature in the plant until the winter frost caused their abscission. In contrast, ripening of later fruits at the Minas Gerais region of Brazil occurred normally because of its tropical climate conditions (16°10′ S; 42°17′ W) (Alvarenga Gonçalves et al., 2006), partially explaining the different evolution of fruit yield with tree age, despite the same pruning intensity of both experiments.

Different factors may have contributed to the reduction of commercial fruit yield after the fourth year of plantation. The high precipitation of the last three years increased the amount of damaged fruits and decreased the duration of the harvesting period. On the other hand, it is possible that the development of a very extensive and wide-ranging root system (Flaishman et al., 2008) after four years of plantation became too vigorous under the intense pruning system and the agro-ecological conditions of our experiment. Vigorous plants showed increased current shoot length and established later fruits which increased the proportion of fruits that remain unripe on the tree. Furthermore, vigorous older plants seem to have a lower capacity to ripen fruits during April and May compared to the younger plants.

During fig fruit ripening, multiple ethylene regulatory pathways are involved, and each specific pathway depends on the inducer/stimulus (Owino et al., 2006). Furthermore, fig fruit ripening can be stimulated by the application of olive oil, ethephon, and auxin, treatments that

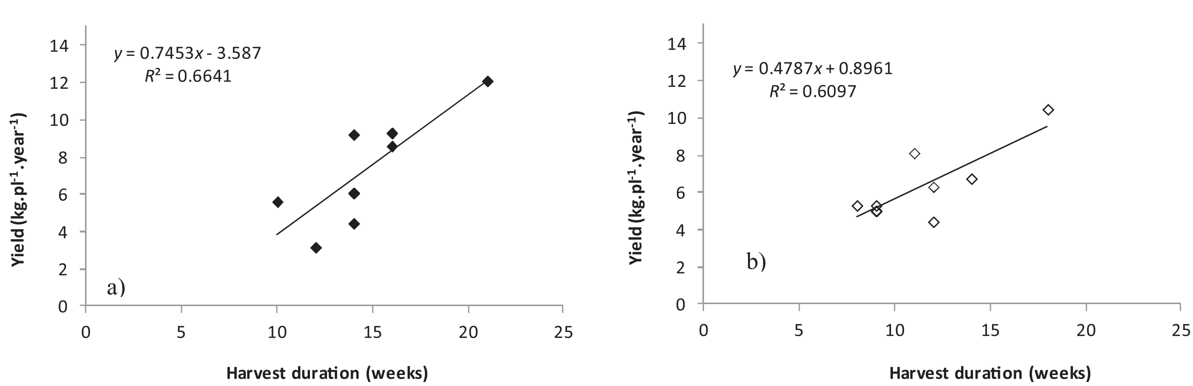

Fig. 3. Relationships between annual fruit yield (y; kg pl^{-1}) and the duration of the harvesting period (x; weeks) in fig (*Ficus carica* L.) cvs. 'Brown Turkey' (a) and 'Guarinta' (b) exposed to an intensive pruning system in the central-east area of the Santa Fe province, Argentina. Data are the mean values of eight years of study because the first two years after plantation were not considered.

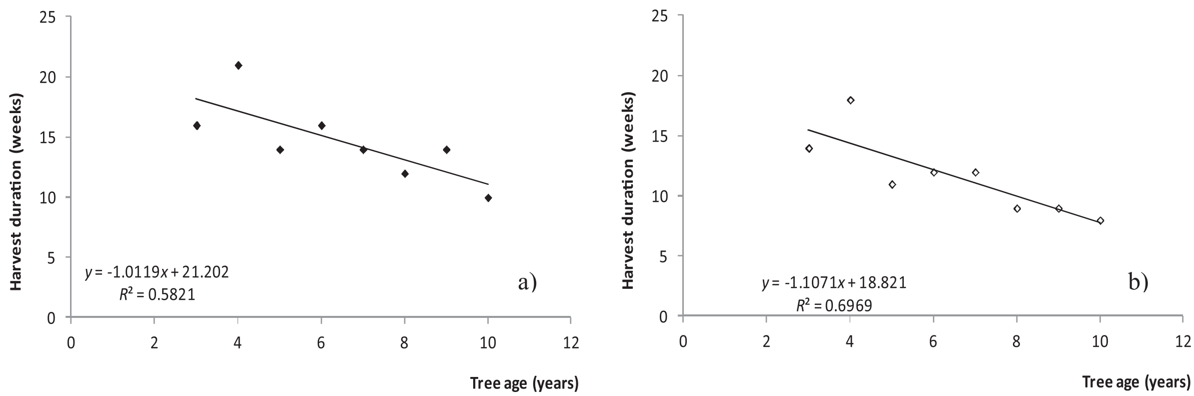

Fig. 4. Relationships between the duration of the harvesting period (*y*; weeks) and tree age (*x*; years) in fig (*Ficus carica* L.) cvs. 'Brown Turkey' (a) and 'Guarinta' (b) exposed to an intensive pruning system in the central-east area of the Santa Fe province, Argentina. Data are the mean values of eight years of study because the first two years after plantation were not considered.

Table 3
Relationships between the main weather variables which affected the duration of the harvest period (*y*; weeks) for two fig (*Ficus carica* L.) varieties, 'Brown Turkey' and 'Guarinta', grown at the central-east area of the Santa Fe province during 2008–2016.

	Cultivar	Model	r^2	*p (model)*
Rainy days (January–May)	Brown Turkey	$y = 19.387 - 0.1882x$	0.7940	0.0190
	Guarinta	$y = 16.044 - 0.1768x$	0.7008	0.0247
Accumulated precipitation (mm) (January–May)	Brown Turkey	$y = 19.531 - 0.0102x$	0.4879	0.0809
	Guarinta	$y = 18.165 - 0.013x$	0.8004	0.0065
Accumulated Radiation (Mj m^{-2}) (January–May)	Brown Turkey	$y = -1.0297 + 0.0065x$	0.8155	0.0053
	Guarinta	$y = -2.6517 + 0.0059x$	0.6813	0.0222

Table 4
Current year shoot length (SL), number of nodes and fruits per shoot, and percentage of nodes with fruit (%NF) of two fig (*Ficus carica* L.) varieties, 'Brown Turkey' and 'Guarinta', grown under an intensive pruning system in the humid central area of Santa Fe, Argentina. Data are the average values of two growing seasons (2010/2011 and 2011/2012).

VarietyParameter	SL (cm)	Nodes per shoot	Fruits per shoot	%NF
Brown Turkey	151.6 a	34.2 a	15.4 a	49.9 a
Guarinta	139.6 a	28.8 a	14.2 a	45.0 a

Note: Different letters in the columns indicate significant difference between means, by LSD test ($p \leq 0.05$).

induce ethylene production (Owino et al., 2006). On the other hand, the continuous supply of assimilates to fruit delays ripening in some fruit trees, such as pear, which is not usually able to ripen its fruits on the tree (Murayama et al., 2015). Thus, we raised the question of whether fig fruit that remain unripe at the end of the growing season was the cause of later fruit set, by physiological changes during fruit ripening caused by the increase of plant vigor associated with plant age under the intensive pruning system, or by both factors, all of them diminishing the fruit ripening capacity under unfavorable temperature conditions.

Clarifying the above question is important to define the best strategy for pruning and training fig trees in the central area of Santa Fe. Fruit yields can be increased by artificial stimulation of ripening of the remaining fig fruits at the end of the growing season, or by the reduction of pruning intensity in order to diminish annual current shoot growth and increasing the quantity of fruits per plant that mature under more suitable temperature conditions.

4. Conclusion

Intensive pruning of fig trees in the temperate-humid central area of Santa Fe resulted in fruit yields ranging between 4.43 and 12.1 t ha^{-1}. The annual duration of the harvest period ranged from 8 to 21 weeks, showing a positive relationship with the annual fruit yield. The end of the harvest period was not due to the absence of fruits but to the lack of ripeness. After the fourth year, fig plants became more vigorous and established later fruits, increasing the proportion of unripe fruit that remained on the tree. The current options to increase fig yield in the central area of Santa Fe seem to be the artificial ripening of late fruits or a slight reduction of pruning intensity in order to diminish annual current shoot growth and increase the quantity of fruits per plant that ripen under more suitable temperature conditions.

Acknowledgment

This work was supported by the Universidad Nacional del Litoral (grant CAID + D 2016, PI: 50120150100020LI).

References

Alvarenga Gonçalves, C.A., De Oliveira Lima, L.C., Nascimento Lopes, P.S., Teixeira De Souza, M., 2006. Poda e sistemas de condução na produção de figos verdes. Pesq. Agropecu. Bras. 41, 955–961.

Andersen, P.C., Crocker, T.E., 2010. Document HS27. Florida A & M University Cooperative Extension Program (Accessed 17 June 2017). http://edis.ifas.ufl.edu/pdffiles/MG/MG21400.pdf.

Ateyyeh, A.F., Sadder, M.T., 2006. Preliminary study on the vegetative and reproductive growth of six common fig (*Ficus carica* L.) cultivars in Jordan. Jordan J. Agric. Sci. 2, 1–7.

Crane, J.C., Brown, J.G., 1950. Growth of the fig fruit *Ficus carica* var mission. Proc. Am. Soc. Hortic. Sci. 56, 93–97.

Dalastra, I.M., 2008. Épocas de poda na produção de figos verdes "Roxo de Valinhos" em sistema orgânico na região oeste do Paraná. Rev. Bras. Frutic. 31, 447–453.

Di Rienzo, J.A., Casanoves, F., Balzarini, M.G., Gonzalez, L., Tablada, M., Robledo, C.W., 2012. InfoStat Versión 2012. Grupo InfoStat, FCA, Universidad Nacional de Córdoba, Argentina (Accessed 17 January 2017). http://www.infostat.com.ar.

El Rayes, R., 1995. The fig tree in the Mediterranean region and in Syria. In: Llácer, G., Aksoy, U., Mars, M. (Eds.), Underutilized Fruit crops in the Mediterranean Region. Options Méditerranéennes. CIHEAM, Zaragoza, pp. 79–83.

FAOSTAT. Food and Agriculture Organization of the United Nations, 2018. Website databases. http://www.fao.org/faostat/en/#data/QC (Accessed 10 January 2018).

Flaishman, M.A., Rover, V., Stover, E., 2008. The fig: botany, horticulture, and breeding. Hortic. Rev. 34, 113–197.

Gaaliche, B., Lauri, P., Trad, M., Costes, E., Messaoud, M., 2011. Interactions between vegetative and generative growth and between crop generations in fig tree (*Ficus carica* L.). Sci. Hortic. 131, 22–28. http://dx.doi.org/10.1016/j.scienta.2011.09.022.

Gariglio, N.F., 2017. Poda Intensiva de la Higuera (Intensive Pruning of Fig Tree). [Norberto Gariglio] (Accessed 26 January 2018). https://www.youtube.com/watch?v=9NwUwTwS3U4.

Gariglio, N.F., Favaro, J.C., Forte, R., Gariglio, N.F., 2014. Higuera (Cap. 5). In: Bouzo, C.A., Travadelo, M.R. (Eds.), Cultivos frutales y ornamentales para zonas templado-cálidas. Experiencias en la zona central de Santa Fe Ed. UNL, Santa Fe, Argentina, pp. 109–127.

INDEC, 2002. Censo nacional agropecuario (Instituto Nacional de Estadísticas y Censos). Resultados Generales. Secretaría de Planificación. Instituto Nacional de Estadísticas y Censos, Buenos Aires, Argentina.
Köppen, W., 1931. Grundriss der Klimakunde. Walter De Gruyter & Co., Berlin und Leipzig, Aufl. XII.
Köppen, W., 1948. Climatología: un estudio de los climas de la tierra. Trad. Pedro H.R. Pérez. Fondo de Cultura Económica, México.
Leonel, S., Tecchio, M.A., 2010. Épocas de poda e uso da irrigação em figueira "Roxo de Valinhos" na região de Botucatú, SP. Bragantia 69, 571–580.
Limeira Da Silva, F., De Araújo Viana, T.V., Gomes De Sousa, G., Caminha Costa, S., Moreira De Azevedo, B., 2016. Yield of common fig fertigated with bovine biofertilizer in the semiarid region of Ceará. Rev. Caatinga 29, 425–434 Mossoró.
Miranda, O., Battistella, M., 2002. El mercado de higo para consumo fresco: tendencias recientes. Frutic. Prof. 125, 47–59.
Morton, J.F., 2013. Fruits of warm climates. Echo Point Books & Media. LLC, Brattleboro, Vermont.
Murayama, H., Sai, M., Oikawa, A., Itai, A., 2015. Inhibitory factors that affect the ripening of pear fruit on the tree. Hortic. J. 84, 14–20. http://dx.doi.org/10.2503/hortj.MI-015.
Nienow, A.A., Chaves, A., Lajus, C.R., Calvete, E.O., 2002. Produção da figueira em ambiente protegido submetida a diferentes épocas de poda e número de ramos. Rev. Bras. Frutic. 28, 421–424.
Norberto, P.M., Chalfun, N.N.J., Pasqual, M., Delly Veiga, R., Mota, J.H., 1998. Efeito de época de poda, cianamida hidrogenada e irrigação na produção antecipada de figos verdes. Rev. Bras. Frutic. 36, 1363–1369.
Owino, W.O., Manabe, Y., Mathooko, F.M., Kubo, Y., Inaba, A., 2006. Regulatory mechanisms of ethylene biosynthesis in response to various stimuli during maturation and ripening in fig fruit (*Ficus carica* L.). Plant Physiol. Biochem. 4, 335–342.
Prataviera, A., 2003. Una producción alternativa en marcha. El cultivo de la Higuera. idia XXI 5. 142-126 (Accessed 17 January 2017). http://www.biblioteca.org.ar/libros/210394.pdf.
Prataviera, A., Godoy Aliverti, P., 1991. El Cultivo de la Higuera. Ed. INTA. Centro regional Catamarca-La Rioja, Argentina.
Puebla, M., Toribjo, F., Montes, P., 2003. Determination of fruit bearing pruning date and cutting intensity in San Pedro (*Ficus carica* L.) type fig cultivars. Acta Hortic. 605, 147–157.
Travadelo, M., Bortoluzzi, A., Maina, M., Justo, A., Micheloud, N., 2017. Localización de planta de empaque asociativa de productores frutícolas del centro de Santa Fe, Argentina. Agroalimentaria 23 (44), 123–131. http://erevistas.saber.ula.ve/index.php/agroalimentaria.