Turia pepino

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Rodríguez-Burruezo, A., Prohens, J., Leiva-Brondo, M. and Nuez, F. 2004. **Turia pepino**. Can. J. Plant Sci. **84**: 603–606. Turia is a new salad pepino cultivar adapted to greenhouse cultivation in a wide range of environments with high yield and improved fruit quality. Its fruit is ovate in shape and has golden yellow skin covered with purple stripes, mild flavour and intense aroma. Turia is the first pepino cultivar tolerant to tomato mosaic virus.

Key words: *Solanum muricatum*, cultivar description, tomato mosaic virus

Rodríguez-Burruezo, A., Prohens, J., Leiva-Brondo, M. et Nuez, F. 2004. **Le pépino Turia**. Can. J. Plant Sci. **84**: 603–606. Turia est un nouveau cultivar de pépino à salade adapté à maints milieux pour la culture en serre. Cette variété se caractérise par un rendement élevé et des fruits de meilleure qualité. Ces derniers ont une forme ovale et leur peau dorée est striée de pourpre. Très odoriférants, ils ont une saveur délicate. Turia est le premier cultivar de pépino a tolérer le virus de la mosaïque de la tomate.

Mots clés: *Solanum muricatum*, description de cultivar, virus de la mosaïque de la tomate

Abbreviations: **SSC**, soluble solids content; **ToMV**, tomato mosaic virus

Pepino (*Solanum muricatum* Aiton) is an herbaceous vegetable crop native to the Andean region. It is grown for its juicy fruit. Depending on the variety, fruit can be consumed either as a piece of fruit (sweet varieties) or a vegetable salad in the same way as cucumber (salad varieties). This fruit has been introduced in North American, European, Japanese and South East Asia markets as a speciality fruit, where it has raised an increasing interest among consumers despite the high prices at which it is usually sold (Prohens et al. 1996). The attractive appearance of the pepino fruit, a berry with yellow skin usually covered by purple stripes, and the intense aroma and subacid, slightly sweet, taste anticipates a promising future for this new vegetable crop in many specialty markets. Pepino also has high ascorbic acid content, similar to those of citrus fruits and above that of tomato, and exhibits diuretic properties. Furthermore, researchers from Virotech Canada discovered antitumoral activity in pepino extracts (Ren and Tang 1999).

Pepino is phylogenetically close to tomato and has similar physiological requirements, although it develops more slowly and requires at least 7–8 mo from transplanting to the completion of the growing cycle. Therefore, in North America and Europe, in most cases, it cannot complete the cycle if grown in the open air, and has to be grown in green housesor plastic tunnels. Until now, most pepino fruits found in markets have been produced in South America or in New Zealand, where pepinos are cultivated outdoors. Our pepino breeding program (Prohens and Nuez 1999) has resulted in the release of new cultivars, like Sweet Long,Sweet Round, and Puzol, adapted to cultivation under greenhouse conditions. These cultivars have had good performance in a wide range of environments and locations, and have offered North American and European growers new varieties well adapted to their growing conditions. The high-yielding cultivar Turia (named after the river that flows through Valencia) is the latest release from this program and it has been selected for its consumption in salads, for which a medium soluble solids content (SSC) (7–8°Brix), firm flesh and herbaceous-green aroma are key characteristics. In addition, Turia is the first pepino cultivar with field tolerance to tomato mosaic virus (ToMV), the main disease affecting this crop.

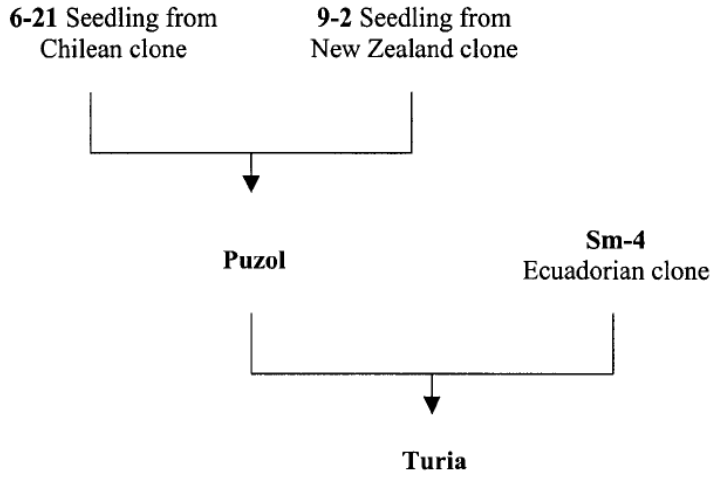

Fig. 1. Pedigree of Turia

Table 1. Yield, fruit weight and fruit traits (Mean ± SE) of Turia pepino and control cultivars under greenhouse cultivation (1999–2002). Each mean was estimated on 10 or more replicates

Clone	Autumn-winter 1999/2000	Autumn-winter 2000/2001	Autumn-winter 2001/2002	Spring-summer 2002
		Yield (t ha^{-1})		
Turia	71.5 ± 3.5	48.8 ± 2.4	68.9 ± 4.7	69.3 ± 3.6
Puzol	58.9 ± 3.2	39.2 ± 2.0	51.2 ± 3.2	50.1 ± 2.9
Sm-4[z]	–	–	–	–
Sweet Long	19.7 ± 1.6	18.5 ± 1.4	29.9 ± 1.8	20.1 ± 1.6
		Mean fruit weight (g)		
Turia	268 ± 10	211 ± 18	229 ± 13	348 ± 25
Puzol	413 ± 37	272 ± 45	252 ± 12	278 ± 18
Sm-4	160 ± 14	231 ± 21	215 ± 11	–
Sweet Long	137 ± 14	161 ± 15	145 ± 7	125 ± 11
		Soluble solids content (°Brix)		
Turia	8.0 ± 0.3	7.2 ± 0.2	7.6 ± 0.2	7.4 ± 0.4
Puzol	5.7 ± 0.4	6.3 ± 0.2	7.0 ± 0.3	5.1 ± 0.2
Sm-4	8.8 ± 0.5	7.1 ± 0.4	8.1 ± 0.1	–
Sweet Long	8.3 ± 0.2	7.8 ± 0.1	8.3 ± 0.4	6.7 ± 0.2
		Ascorbic acid content (mg kg^{-1})		
Turia	–	260 ± 24	280 ± 29	340 ± 37
Puzol	–	328 ± 23	298 ± 16	235 ± 19
Sm-4	–	369 ± 25	320 ± 11	–
Sweet Long	–	283 ± 24	349 ± 13	301 ± 25
		Titratable acidity (mmol kg^{-1})		
Turia	–	6.9 ± 0.6	11.2 ± 0.3	6.7 ± 0.3
Puzol	–	7.2 ± 0.4	7.0 ± 0.6	8.2 ± 0.4
Sm-4	–	8.4 ± 1.2	7.5 ± 0.3	–
Sweet Long	–	7.2 ± 0.6	7.3 ± 0.6	8.5 ± 0.5

[z]Clone *Sm-4* did not set fruits on its own; hand-pollination with pollen from other clones was necessary to obtain fruits for evaluating fruit traits. Consequently, *Sm-4* is not included in the yield statistics.

Breeding Methods and Pedigree

Turia was derived from a cross between clone *Sm-4* and parthenocarpic cultivar Puzol (Fig. 1). *Sm-4* is an Ecuadorian clone with round, attractive fruits, medium-high SSC, and is tolerant to ToMV (Pérez-Benlloch et al. 2001). However, *Sm-4* is male sterile and, due to the autogamy of this species (Mione and Anderson 1992), it sets fruit only if hand pollinated. Puzol is a facultative parthenocarpic high-yielding salad cultivar with elongated fruits, firm flesh, and low SSC. Puzol is a clonal selection from the segregating offspring of a cross made by us between clone 9-2 (chance seedling from a NewZealand clone, with high yields but sour off-flavour) and clone6-21 (chance seedling from a Chilean clone, with medium yields and sweet fruits). Parents *Sm-4* and Puzol were chosen for three reasons: (a) They are complementary for relevant traits in breeding salad pepinos: high yields, parthenocarpy, firm flesh and vegetable-like aroma in Puzol, and ToMV tolerance and medium-high SSC in *Sm-4*. (b) Both parents are highly heterozygous, especially Puzol, which is in itself a hybrid, and, consequently, their hybrid offspring was expected to be genetically very heterogeneous and amenable to selection. (c)In a previous study carried out with several pepino clones, *Sm-4* and Puzol had the highest genetic distance estimated by AFLPs markers (0.325). High genetic distance among parents is positively correlated with heterosis for yield traits (Rodríguez-Burruezo et al. 2002). Therefore, high-yielding genotypes from the offspring of that cross were expected.

Preliminary evaluations for yield, mean fruit weight and SSC were conducted on the segregating offspring of *Sm-4* Puzol and other crosses (more than 400 individual genotypes). Advanced evaluations on pre-selected hybrid clones were carried out by considering additional traits, like titratable acidity (expressed as citric acid concentration), ascorbic acid content and aroma, until the definitive selection of Turia. Trials were performed for several seasons in commercial greenhouses after the definitive selection. The parental cultivar Puzol (salad cultivar), the parental clone *Sm-4* and the cultivar Sweet Long (sweet cultivar) were used as checks.

Performance

ENVIRONMENTAL REQUIREMENTS. Turia is well adapted to greenhouse cultivation. A range of temperatures from 10 to25ºC is the optimum for the development of plants and for achieving maximum yields. Although plants can resist light frosts (up to –2ºC), temperatures below 10ºC cause growth retardation. On the other hand, temperatures above 30ºCinduce luxurious vegetative growth, which competes with fruit set, and decreases fruit quality, manifested in a reduction in the soluble solids content. Relative humidities above70% (common in greenhouses) favour pollination and fruit set of this cultivar. Turia can flower and set fruits all year round, although flowering is stimulated by high light intensity and moderate temperatures (below 25ºC).

Fig. 2. Turia vine in which the ripening sequence of fruits can be observed: ripe fruits (lower cluster) and unripe full sized fruits (higher clusters).

PLANT TRAITS. The Turia plant is vigorous and semi-erect inhabit. In order to avoid excessive vegetative growth, which may compete with fruit set, and contact of fruits with the soil, the vine should be trained

with vertical strings in a 1–3leader system. From our experience, the best results in terms of yield and fruit quality are obtained when plants are cultivated at a planting density of 3–4 plants m–2 and trained in a one leader system. Turia is highly heterozygous and must be vegetatively propagated, either by stem cuttings, which root easily in a wet substrate (e.g., peat, vermiculite), or by in vitro micropropagation, to maintain its characteristics. Leaves are simple, lanceolate (34 x10 cm), though old leaves on the base of the plant may develop some leaflets. Flowers are rotate, measure 2–3 cm in diameter and have white petals with purple stripes. Each inflorescence contains10–15 flowers, of which typically between two and five set fruits. Turia produces abundant pollen with a high percentage of viability (70%), though its facultative parthenocarpy, inherited from cultivar Puzol, guarantees fruit set and acceptable yields even when environmental conditions are adverse for pollination. Turia is the first pepino cultivar showing tolerance to ToMV, which has been inherited from parent *Sm-4*; in several trials where ToMV infection was detected, plants of Turia did not show visual symptoms and provided high yields, while the virus spread among the other cultivars, causing severe losses in yield and fruit quality. DAS-ELISA tests performed in conditions of natural infection confirmed that Turia plants were either not infected by ToMV or had viral concentrations much lower than those of the susceptible cultivars.

FRUIT DESCRIPTION. Fruits of Turia are harvested 165–175 dafter the trasplanting date, 15–20 d earlier than other salad cultivars like Puzol. Fruit yield ranges between 50 and 70t ha–1, 20–40% and 130–260% more than Puzol and Sweet Long, respectively (Table 1).

Turia fruit has a size considered normal for pepino and weighs 250–350 g on average (Table 1). Fruit shape is ovate, with a mean height: diameter (H/D) ratio of 1.3, intermediate between those of its parents (3.0–3.3 in Puzol and0.7–1.1 in Sm-4). Skin colour is golden (L = 74.2, a = –0.9, b = 51.9; according to CIE Lab 1976 colour space) with well-defined purple stripes (L = 32.5, a = 13.8, b = 4.2), covering between 10 and 30% of the total surface of the skin (Fig. 2). The flesh is yellow and slightly paler than the skin (L = 55.8, a = –5.7, b = 31.9).

The fruit of Turia is sweeter than that of Puzol, and has a SSC above 7ºBrix. Unlike other cultivars such as Puzol and Sweet Long, Turia is highly stable in SSC in the range of7.2–8.0ºBrix (Table 1). Turia fruit has a higher concentration of aldehydes (Z-6-nonenal and E,Z-2,6-nonadienal) than sweet cultivar Sweet Long (Table 2). Aldehydes are key volatiles for the aroma in cucumber and muskmelon. Therefore, the aroma of Turia is more herbaceous than that of sweet cultivars, which makes it suitable for use in vegetable salads.

As usual in pepino, ascorbic acid content in Turia is moderately high, with values between 250 and 350 mg kg–1(Table 1). Turia titratable acidity values range between 7and 11 mmol kg–1 of citric acid, which is within the range of this species, and contributes to the mild subacid taste of the fruit (National Research Council 1989).

Turia fruits have a high resistance to bruises; the firmness of Turia fruits, as measured by an Instron firmness tester (speed = 20 mm min–1, probe diameter = 5 mm; model5544, Instron Corporation, Canton, MA), was of 17.1 N,which favours their postharvest handling. Turia fruits can be stored for 4–5 wk at 5–10ºC without loss of texture or taste.

Availability of Propagating Material

Virus-free micropropagated material is available from the Centro de Conservación y Mejora de la Agrodiversidad Valenciana, Universidad Politécnica de Valencia, Camino de Vera, 46022 Valencia, Spain.

Table 2. Concentration (□g kg–1) of volatiles with vegetable-like aroma and sensory importance in the volatile fraction of cultivars Turia and Sweet Long

Compound	Odour quality**z**	Turia	Sweet Long
Hexanal	Green	974	42
(E) 2-Hexenal	Green, vegetable-like	1842	256
(E,Z) 2,6-Nonadienal	Powerful, green, vegetable-like	278	235
(Z) 6-Nonenal	Green, melon/cucumber-like	438	55

Z Detected at sniffing port.

Fig. 3. Turia fruits.

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