

Cultivar and Germplasm Release

RELEASE OF TROPICAL PUMPKIN ‘VERDE LUZ’^{1,2}

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‘Verde Luz’ is an open-pollinated (OP) tropical pumpkin (*Cucurbita moschata* Duchesne) released by the Agricultural Experiment Station of the University of Puerto Rico, Mayagüez Campus. It was developed using two cycles of recurrent selection with the open-pollinated (OP) cultivar ‘Soler’ (Wessel-Beaver, 2005) as the base population. ‘Soler’ is the most widely planted cultivar in Puerto Rico, but its large, heavy fruits (often weighing more than 8 kg) cannot be packaged easily into boxes or sacks, the preferred method for sales to supermarkets. The program to develop ‘Verde Luz’ focused on selecting smaller fruits with a darker orange flesh color than ‘Soler’ and resistance to the silverleaf disorder induced by the silverleaf whitefly (*Bemisia tabaci* Gennadius biotype B) (Syn. *B. argentifolii* Perring and Bellows). In previous publications, ‘Verde Luz’ was referred to by the experimental designations “Soler GL” (Wessel-Beaver, 2005) and “PRLongvineSLR” (Wessel-Beaver et al., 2006). The standard cultivars ‘Soler’ (Wessel-Beaver, 2005) and ‘Taína Dorada’ (Wessel-Beaver, 2013) were used in the evaluation of ‘Verde Luz’. In previous publications (Wessel-Beaver, 2005; Wessel-Beaver et al., 2006) ‘Taína Dorada’ is referred to as “PRShortvine”.

Origin

The heterogenous OP cultivar ‘Soler’ was the base population for the recurrent selection program leading to the development of ‘Verde Luz’. ‘Soler’ exhibits segregation for fruit size and other fruit characteristics, and for leaf phenotype. Leaves of tropical pumpkin can have grey areas in the leaf vein axils (“mottled-leaf”) or can be completely green (“green-leaf”). The mottled-leaf gene, *M*, is dominant to the recessive green-leaf gene, *m* (Coyne, 1970) although modifiers likely exist and the degree of leaf mottling can vary (Ribiero and da Costa, 1989). No formal linkage study has been reported between the green-leaf trait and silverleaf resistance, but multiple years of field observations by the author suggest a strong association. Silverleaf resistance is controlled by the recessive gene *sl* (González-Román and Wessel-Beaver, 2002). ‘Soler’ is therefore a mixture of the genotypes *M_Sl_* (mottled-leaf, silverleaf susceptible), *M_slsl* (mottled-leaf, silverleaf resistant), *mmSl_* (green-leaf, silverleaf susceptible) and *mmslsl* (green-leaf, silverleaf resistant).

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'Verde Luz' was developed using one cycle of S_1 recurrent selection followed by one cycle of half-sib recurrent selection. The base population, 'Soler', was exposed to a natural infestation of silverleaf whitefly, and self-pollinations were made of plants exhibiting solid green leaves and silverleaf resistance. The S_1 lines were evaluated in a non-replicated trial in 2000. Lines with mottled leaves and/or silverleaf were culled. Fruits were harvested and lines not meeting the selection criteria (dark green rind, dark orange flesh, fruits weighing less than 5 kg) were eliminated. Remanent seed of the 35 selected S_1 lines was bulked. Approximately 300 seeds of this bulk were planted in isolation at the Isabela substation of the University of Puerto Rico at Mayagüez, Agricultural Experiment Station (UPRM-AES) in September 2001, and allowed to intermate. Plants with mottled leaves (*MM* or *Mm*) and/or silverleaf symptoms (*SiSl* or *Sisl*) were culled before anthesis. From this population, approximately 100 OP fruits were chosen based on rind color (very dark green), fruit size (3 to 4 kg), and fruit shape (flattened). These fruits were cut open to evaluate flesh color and thickness. Seed was saved separately from 40 fruits (each considered a half-sib family) with the best color (deep orange-yellow) and greatest flesh thickness. The 40 half-sib families were field tested in a replicated trial in February 2002 at the Isabela station to identify the best 10 families based on yield and rind color (dark green), fruit shape and weight (flat fruit weighing less than 4 kg) and flesh thickness (at least 3 cm). Remanent half-sib seed from selected families was bulked, and the bulked seed used to plant an intermating block in isolation. Bulked seed from about 150 fruits harvested from the first intermating block was used to plant a second intermating block in isolation. All fruits were harvested and seed was bulked. 'Verde Luz' originates from bulked seed obtained after the second intermating. Since the original intermatings, additional seed of 'Verde Luz' has been produced by planting at least 200 plants in isolation and bulking seed of all harvested fruits.

Cultivar Description

The leaves of 'Verde Luz' are completely green and resistant to silver leaf (genotype = *mmslsl*) in contrast to 'Soler' and 'Taína Dorada' which segregate for silverleaf resistance/susceptibility and for leaf phenotype. 'Verde Luz' has a viny growth habit like 'Soler' and in contrast to the semi-bush habit of 'Taína Dorada'. Vine growth of 'Verde Luz' is less vigorous than that of 'Soler'. The fruits of 'Verde Luz' have a dark green skin like 'Soler' and in contrast to the mottled green-orange skin of 'Taína Dorada'. The flattened fruits of 'Verde Luz' are about 1.5 times greater in diameter than in length: not as flattened as fruits of 'Soler' but more flattened than fruits of 'Taína Dorada'. Fruits of 'Verde Luz' are relatively small, generally weighing about 3.3 kg, but with a small fruit cavity and comparatively thick fruit flesh. The flesh color of 'Verde Luz' is slightly more orange than that of 'Soler'.

Adaptation and Yield

Among the three cultivars, 'Taína Dorada' exhibits the earliest flowering, followed by 'Verde Luz'. Full flowering in 'Soler' begins about one week later than 'Taína Dorada' and 'Verde Luz'. By 56 days post-transplanting during the winter months in Puerto Rico, virtually all 'Taína Dorada' plants are flowering compared to 80% of plants of 'Verde Luz' and 50% of plants of 'Soler'. For all three cultivars, flowering is delayed in the summer months.

In five replicated field trials conducted at Lajas, Isabela and Juana Díaz, Puerto Rico, in 2004 and 2005, yields of 'Verde Luz' ranged from 9,807 to 31,705 kg/ha (Table 1). Yields of 'Verde Luz' did not differ from those of 'Soler' and 'Taína Dorada'. By contrast, the number of fruit per hectare of 'Verde Luz' was greater than that of 'Soler', although the difference was not always significant at $P = 0.05$. The number of fruit per hectare was often like that of 'Taína Dorada'. 'Verde Luz' was selected to have a smaller fruit size than 'Soler'. In these

TABLE 1.—Yield and yield components of tropical pumpkin cultivars ‘Verde Luz’, ‘Soler’ and ‘Taína Dorada’ evaluated at various locations in Puerto Rico during 2003 to 2005. Data from Wessel-Beaver et al. (2006).

Cultivar	Planting distance (m) ¹		Yield (kg/ha)	No. of fruit/ hectare	Average fruit weight (kg)
	Within row	Between row			
Isabela – November 2003 to February 2004					
Verde Luz	0.9	1.8	25,122 a ²	9,712 a	2.6 a
Verde Luz	1.8	1.8	14,673 ab	5,910 b	2.5 a
Soler	1.8	1.8	25,980 a	3,256 c	8.0 b
Taína Dorada	0.9	1.8	21,204 ab	5,572 b	3.8 a
Taína Dorada	1.8	1.8	13,050 b	3,058 c	4.3 a
Lajas – March to June 2004					
Verde Luz	0.9	1.8	31,705 a	12,704 a	2.5 d
Verde Luz	1.8	1.8	27,739 a	8,736 b	3.2 b
Soler	1.8	1.8	24,728 a	4,578 c	5.4 a
Taína Dorada	0.9	1.8	24,348 a	8,409 b	2.9 c
Taína Dorada	1.8	1.8	24,283 a	9,347 b	2.9 c
Juana Díaz – April to August 2004					
Verde Luz	0.9	1.8	26,250 a	11,734 a	2.2 c
Verde Luz	1.8	1.8	15,957 a	8,222 a	1.8 c
Soler	1.8	1.8	36,470 a	7,288 a	5.0 a
Taína Dorada	0.9	1.8	35,410 a	9,026 a	3.9 b
Taína Dorada	1.8	1.8	36,774 a	10,337 a	3.4 b
Lajas – April to August 2004					
Verde Luz	0.9	1.8	9,807 a	5,230 ab	1.8 cd
Verde Luz	1.8	1.8	10,542 a	6,157 a	1.7 d
Soler’	1.8	1.8	12,838 a	3,393 b	3.7 a
Taína Dorada	0.9	1.8	15,378 a	6,671 a	2.3 c
Taína Dorada	1.8	1.8	15,341 a	5,948 ab	2.6 bc
Juana Díaz – March to June 2005					
Verde Luz	1.8	1.8	27,055 ab	6,827 a	4.0 c
Verde Luz	0.9	3.7	19,350 b	4,895 a	4.0 c
Soler	1.8	1.8	34,410 a	5,034 a	6.9 a
Soler	0.9	3.7	25,432 ab	3,765 b	6.8 a
Taína Dorada	1.8	1.8	32,670 a	6,143 a	5.5 b
Taína Dorada	0.9	1.8	29,261 ab	6,277 a	4.8 bc

¹The 0.9 m x 1.8 m, 1.8 m x 1.8 m, and 0.9 m x 3.7 m planting distances (within row x between row) result in planting densities of approximately 5,875; 2,922; and 2,922 plants per hectare, respectively.

²Within a trial, means within a column followed by a common letter are not significantly different according to Fisher’s Protected Least Significant Difference at the 0.05 probability level.

trials, the average fruit weight of ‘Verde Luz’ ranged from 1.7 to 4.0 kg. By contrast, the average fruit weight of ‘Soler’, ranging from 3.7 to 8.0 kg, was often twice that of ‘Verde Luz’, explaining the difference in number of fruit per hectare produced by each cultivar. The average fruit weight of ‘Taína Dorada’ tended to be intermediate between ‘Verde Luz’ and ‘Soler’.

Fruit Quality

Flesh color is an important attribute for the Puerto Rican consumer (Carbonell et al., 1990). 'Verde Luz' has an attractive flesh color, somewhat more orange than 'Soler' as indicated by its lower average hue angle (Table 2). Over four trials, the hue angle of the mesocarp of 'Verde Luz' was significantly less than that of 'Soler' and not different from 'Taína Dorada'. (The hue angle of orange is 45°; the hue angle of yellow is 90°). Color saturation or intensity (chroma) of 'Verde Luz' was equal to, or less than, 'Soler' and 'Taína Dorada'. In two of the four trials, the flesh of 'Verde Luz' had a darker appearance (lower L*) than 'Soler'.

To better understand the differences in relative fruit size and shape of 'Verde Luz' compared to 'Soler' and 'Taína Dorada', fruit diameter (at the widest part of the fruit) and length (from the attachment of the peduncle to the blossom end) were measured to determine the average diameter to length ratio (D/L) (Table 3). Globe-shaped fruits like those of 'Taína Dorada' have a D/L ratio slightly greater than 1.0, while very flat fruits have a D/L ratio close to 2.0. The fruit shapes of 'Verde Luz', 'Soler' and 'Taína Dorada' are distinct. Fruits of 'Verde Luz' are flattened in shape, but distinctly less so than fruits of 'Soler'; fruits of 'Taína Dorada' have a flattened globe shape.

Flesh thickness tends to be slightly less in 'Verde Luz' compared to 'Soler' and 'Taína Dorada' (Table 3). However, a very large percentage of the fruit diameter of 'Soler' is

TABLE 2.—*Flesh color characteristics of tropical pumpkin cultivars 'Verde Luz', 'Soler' and 'Taína Dorada' evaluated in trials at Isabela, Lajas and Juana Díaz, Puerto Rico from 2003 to 2005¹. Data from Wessel-Beaver et al. (2006).*

Cultivar ²	Hue angle (°)	Chroma	Lightness value (L*)
Isabela – November 2003 to February 2004			
Verde Luz	62.7 b ³	73.3 a	60.2 b
Soler	66.9 a	74.3 a	68.8 a
Taína Dorada	64.5 ab	74.5 a	68.2 a
Lajas – March to June 2004			
Verde Luz	64.6 b	76.8 a	62.1 a
Soler	68.5 a	72.2 a	71.2 a
Taína Dorada	67.0 ab	72.9 a	72.6 a
Juana Díaz – April to August 2004			
Verde Luz	66.1 b	74.7 b	61.6 b
Soler	69.0 a	77.0 a	69.9 a
Taína Dorada	66.7 b	75.5 b	69.5 a
Lajas – April to August 2004			
Verde Luz	64.1 b	70.5 c	59.1 a
Soler	67.8 a	77.8 a	66.7 a
Taína Dorada	64.9 b	73.6 b	68.8 a

¹Means of 10 to 40 fruits per cultivar, depending on the trial. CIELAB color space (L*a*b*) was measured using a HunterLab ColorFlex™ spectrophotometer (45°/0° optical geometry). Hue angle = arctangent b*/a*, where 0° = red, 90° = yellow, 180° = green, 270° = blue. Chroma = [(a*² + b*²)^{1/2}].

²For 'Verde Luz' and 'Taína Dorada', means are an average of data from two within-row planting distances.

³Within a trial, means within a column followed by a common letter are not significantly different according to Fisher's Protected Least Significant Difference at the 0.05 probability level.

TABLE 3.—*Fruit and flesh characteristics of tropical pumpkin cultivars ‘Verde Luz’, ‘Soler’ and ‘Taína Dorada’ evaluated at various locations in Puerto Rico from 2003 to 2005. Data from Wessel-Beaver et al. (2006).*

Cultivar	Fruit diameter ¹ (m)	Fruit length ² (m)	Diameter to length ratio ³	Flesh thickness (cm)	Width of fruit cavity size as percentage of fruit diameter (%)
Isabela – November 2003 to February 2004					
Verde Luz	20.0 b ⁴	12.6 b	1.59 b	3.8 b	62 b
Soler	28.6 a	16.3 a	1.76 a	5.0 a	65 a
Taína Dorada	21.7 b	16.8 a	1.29 c	4.9 a	55 c
Lajas – April to August 2004					
Verde Luz	17.6 c	12.6 c	1.40 b	4.2 a	52 b
Soler	24.7 a	14.2 b	1.74 a	4.8 a	61 a
Taína Dorada	19.3 b	15.7 a	1.23 b	4.6 a	52 b
Juana Díaz – March to June 2005					
Verde Luz	22.3 b	15.5 b	1.44 b	4.5 a	60 b
Soler	28.3 a	16.6 b	1.70 a	4.6 a	67 a
Taína Dorada	24.0 b	17.7 a	1.37 b	4.7 a	61 b

¹Diameter at the widest part of the fruit

²Distance from the attachment of the peduncle to the blossom end of the fruit.

³Larger values correspond to flatter fruit.

⁴Means within a column followed by a common letter are not significantly different according to Fisher’s Protected Least Significant Difference at the 0.05 probability level.

taken up by its seed cavity (61 to 67%). In ‘Verde Luz’, this percentage is significantly smaller (52 to 62%) resulting in a compact fruit with considerably more of its total volume dedicated to edible flesh compared to that of ‘Soler’.

Insect and Disease Susceptibility

The susceptibility/resistance of various genotypes of tropical pumpkin to silverleaf, induced by the silverleaf whitefly (*Bemisia tabaci* Gennadius biotype B [syn. *B. argentifolii*]), melon worm (*Diaphania hyalinata*) and downy mildew (*Pseudoperonospora cubensis*) is documented in Wessel-Beaver et al. (2006). The reaction of ‘Verde Luz’ to silverleaf was evaluated from November 2003 to June 2005 in five trials in Juana Díaz, Lajas and Isabela. No silvering was observed in ‘Verde Luz’; ‘Soler’ and ‘Taína Dorada’ were usually observed to be susceptible. Compared to ‘Soler’ and ‘Taína Dorada’, ‘Verde Luz’ was less susceptible to melonworm in a 2004 trial in Juana Díaz, but no different from those two cultivars in a trial in 2004 in Lajas. ‘Verde Luz’ was markedly less susceptible to downy mildew than was ‘Taína Dorada’ in a 2004 trial in Lajas.

Seed Production

‘Verde Luz’ produces about the same number of seeds per fruit as ‘Taína Dorada’, but only about 60% of the number of seeds per fruit as ‘Soler’. However, because ‘Verde Luz’ produces more fruits per hectare than does ‘Soler’ (Table 1), seed production of ‘Verde Luz’ (about 270 kg/ha) is expected to be slightly greater than that of ‘Soler’ (about 210 kg/ha) (data from Wessel-Beaver et al., 2006). Weight of seeds of ‘Verde Luz’ and ‘Soler’ are similar, about 11,000 seeds per kilogram.

Uses

'Verde Luz' has been tested in multiple locations during both dry and rainy seasons in Puerto Rico. It is adapted to a variety of environmental conditions and can be grown wherever 'Soler' and 'Taína Dorada' are grown. Its resistance to whitefly-induced silvering may make it more attractive than the other two cultivars in locations or seasons expected to have high populations of the silverleaf whitefly. The small fruit size of 'Verde Luz' makes it a good choice for growers wishing to sell fruits boxed or in standard 23 kg (50 lb) sacks for sale to supermarkets. It is not well suited for marketing to farmers' markets (*plazas de mercado*) where customers prefer to purchase slices from large fruits.

Availability of Seed

If importation regulations of the country of the recipient researcher permit sending seed by mail, small samples of 'Verde Luz' for testing are available from the author. Costs of procuring necessary phytosanitary permits must be paid by the recipient. For commercial-sized seed lots, contact the Deputy Director, University of Puerto Rico Agricultural Experiment Station, Jardín Botánico Sur, 1193 Guayacán, San Juan, PR 00926, USA.

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