Tomato Germplasm Lines T4065, T4099, T5019, and T5020 with Unique Genotypes that Enhance Fruit Quality

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Four tomato (*Lycopersicon esculentum* Mill.) germplasm lines have been released that may be useful as parental material in breeding programs or in studies of genetic and physiological factors affecting fruit firmness and carotenoid synthesis. They were developed by inbreeding and backcross (BC) procedures to incorporate the *dark green* (*dg*), *high pigment* (*hp*) and *old gold/crimson* (*og*^c) genes that are known to affect important fruit quality characteristics. Fruit of the lines are extremely firm and highly pigmented when immature (chlorophyll) or ripe (carotenoids). While these germplasm lines have many desirable fresh-market characteristics, fruit size and productivity are less than current hybrid cultivars.

Origin

T4065 was derived from a series of crosses and backcrosses (Fig. 1). It carries the *high pigment* (*hp*) gene derived from Univ. of Illinois Accession No. 1252, a selection of 'Webb Special' (Thompson, 1955), and the *og*^c gene from Univ. of Illinois Accession No. 447. Following the final cross involving 'Flora-Dade' (Fig. 1), three backcrosses were made to 'Flora-Dade' with three or four inbred generations interposed after each backcross from which individuals with the desired genotype were selected.

T4099 was also derived from a series of crosses and backcrosses (Fig. 2). It received the *dark green* (*dg*) gene from a mutant that was discovered in the cultivar Manapal at North Carolina State Univ. (Konsler, 1973). The *og*^c gene in T4099 was derived from the Univ. of Illinois Accession No. 447 via 'Patriot' (Fig. 2). Following the final cross in-

volving 'Flora-Dade', three backcrosses were made to 'Flora-Dade' with three or four self-pollinated generations interposed after each backcross from which individuals with the desired genotype were selected.

T5019 is an F₅ *dg,og*^c selection derived from a cross between T4099 BC₂S₄ (one BC generation removed from the released T4099 shown in Fig. 2) and 'Campbell-22' (contributed by G.B. Reynard, Campbell Inst. Agricultural Research, Riverton, N.J.).

T5020 is an F₅ *hp,og*^c selection derived from a cross between T4065 BC₂S₄ (one BC generation removed from the released T4065 in Fig. 1) and 'Jet Star' (contributed by Harris Moran Seed Co., Rochester, N.Y.).

The final selections of all four germplasm lines were made from 1996 field plots at the South Central Agricultural Research Laboratory at Lane, Okla.

Description

Plants of the *hp,og*^c and *dg,og*^c genotypes are strongly determinate (*sp*) with short internodes. They are slow-growing during the seedling stage, a characteristic that has been described as a pleiotropic effect of the *hp* and *dg* genes (Jarret et al., 1984). Genes *hp* and *dg* produce similar phenotypes, but they are not allelic (Jarret et al., 1984). Plants of T4065, T4099, T5019, and T5020, when started and maintained under near-ideal conditions, are generally 20% to 30% smaller than 'Flora-Dade'.

T4065 and T5020 are homozygous recessive for the *hp,og*^c genotype and described as high pigment/crimson. Fruit of T4065 were medium sized (145 g), and had a yield of 1.8 kg/plant (Table 1). T5020 differs from T4065

Fig. 1. Pedigree of T4065 tomato line.

Fig. 2. Pedigree of T4099 tomato line.

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Table 1. Fruit yield, mass and firmness of tomato germplasm lines T4065, T4099, T5019, T5020, and 'Flora-Dade'.

Line no.	Yield ^y (kg/plant)	Fruit mass ^y (g)	Fruit firmness ^z	
			Mature green (N)	Ripe (N)
T4065 ^x <i>hp,og</i> ^c	1.8	145	53.6	17.9
T4099 ^w <i>dg,og</i> ^c	1.5	131	56.1	42.5
T5019 <i>dg,og</i> ^c	2.5	185	102.7	71.6
T5020 <i>hp,og</i> ^c	3.3	166	62.5	12.4
Flora-Dade	3.4	139	36.5	10.9
LSD (0.05)	---	---	12.2	12.7

^zFruit firmness was measured as force (N) required to cause cellular collapse in a cylinder of pericarp tissue 0.6 cm in diameter and 0.5 cm in length at mature green and ripe maturity, using a TA-XT2 Texture Analyzer (Texture Technologies Corp., Scarsdale, N.Y.).

^yYield and fruit mass are averages of 12 plants in a nonreplicated test with multiple harvests.

^xGenotype *hp,og*^c symbolizes *high pigment, crimson*.

^wGenotype *dg,og*^c symbolizes *dark green, crimson*.

Table 2. External and internal color characteristics of ripe fruit of tomato germplasm lines T4065, T4099, T5019, T5020, and 'Flora-Dade'.

Line no.	Fruit color characteristics ^z					
	External			Internal		
	L	a	b	L	a	b
T4065 ^y <i>hp,og</i> ^c	42.5	31.6	31.4	37.7	27.1	20.8
T4099 ^x <i>dg,og</i> ^c	42.5	30.6	30.4	34.8	30.4	20.6
T5019 <i>dg,og</i> ^c	44.0	29.0	32.1	35.5	30.7	21.6
T5020 <i>hp,og</i> ^c	40.8	33.5	27.8	33.8	31.7	19.3
Flora-Dade	42.2	32.4	29.6	42.1	22.9	18.5
LSD (0.05) ^w	NS	1.4	1.6	1.4	1.5	1.1

^zColor characteristics for lightness, hue, and chroma were determined with a Minolta Chroma Meter CR-300 calibrated with a standard white plate: L = 97.9, a = 0.12, and b = +1.98.

^yGenotype *hp,og*^c symbolizes *high pigment, crimson*.

^xGenotype *dg,og*^c symbolizes *dark green, crimson*.

^wStatistical analysis was based on four random fruit samples from each line and three color measurements on each fruit.

^{NS}Nonsignificant.

primarily by having larger fruit (166 vs. 145 g) and higher yield potential, which was nearly equal that of 'Flora-Dade' (Table 1). The two *hp,og*^c lines had firm fruit at the mature green stage, but they were not significantly different from 'Flora-Dade' when fully ripe (Table 1).

T4099 and T5019 are homozygous for recessive *dg,og*^c genotype and are referred to as dark green/crimson. T5019 differed from T4099 by having larger fruit and higher yield (Table 1). T4099 fruit were only slightly smaller

than 'Flora-Dade' (131 vs. 139 g), and yield was about half that of 'Flora-Dade'. Fruit of T4099 and T5019 are attractive, globe shaped and are somewhat slower to ripen than 'Flora-Dade'. They retain a high degree of pericarp firmness when fully ripe (Table 1).

All four of the germplasm lines are characterized by high chlorophyll content in leaves, stems, and immature fruit. They develop high levels of the carotenoid pigments beta carotene and lycopene in ripe fruit, typical of the

hp,og^c and *dg,og*^c genotypes (Wann et al., 1985). The homozygous recessive condition of the *og*^c gene may also be recognized by the appearance of dull yellow (gold colored) flower petals under cool (18–20 °C) growing conditions.

The internal color of ripe fruit of genotypes *hp,og*^c and *dg,og*^c is dark red. The internal pericarp had tristimulus color values for lightness, hue, and chroma (L, a, and b) obtained with a Minolta CR-300 Chroma Meter (Minolta Corp., Ramsey, N.J.) that depicted a darker color (lower L value) and a more vivid red than 'Flora-Dade' (Table 2). There were only minor differences in the external color of vine-ripened fruit.

Effective shelf life for marketable quality of ripe fruit from *hp,og*^c or *dg,og*^c genotypes extended to 8 weeks beyond the turning stage when stored on open trays at 20 °C, which was 2 weeks longer than for 'Flora-Dade' or 'Rutgers' (data not presented). Previous studies also showed that beta-carotene and ascorbic acid concentrations in ripe fruit was about twice that of normal genotypes (Wann et al., 1985).

Availability

Seed of T4065, T4099, T5019, and T5020 are available upon request from the USDA, ARS, South Central Agricultural Research Laboratory, P.O. Box 159, Highway 3 West, Lane, OK 74555; fax 405-889-5783.

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