USDA 846-1 Fractal Melon and Derived Recombinant Inbred Lines

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Genes residing in highly branched, fractal melons [*Cucumis melo* ssp. *agrestis* (Naud.) Pangalo] have the potential for increasing yield in desert melon types, *C. melo* L. ssp. *melo* (Zalapa et al., 2006). A horticulturally unique *C. melo* ssp. *agrestis* germplasm, designated CR1 (Fig. 1), was received in 1995 from Mr. Claude Hope, Cartago, Costa Rica, by the USDA-ARS Cucumber and Melon Breeding Project, Madison, WI. The early-flowering (in Wisconsin), monoecious CR1 is rapid-growing, indeterminate and bears many (up to 100 fruits/plant) small (3 to 6 cm in diameter) (Staub et al., 2004; Zalapa, 2005; Zalapa et al., 2006) fruits on an indeterminate, highly branched (six to 12 primary branches) plant with standard length internodes, i.e., not compact, *si* (Denna, 1962; Paris et al., 1984). The architectural type of CR1 is unique and distinct from vining (Rosa, 1924), dwarf (Denna, 1962; Mohr and Knavel, 1966), and birdnest (Paris et al., 1981, 1982, 1984) plant habits, and thus, is designated here as a “fractal” type (Prusinkiewicz and Lindenmayer, 1990) because of its highly branched, radiant growth habit when compared with standard vining phenotypes such as ‘Top Mark’ (Fig. 1). The fractal architecture of CR1 is, thus, a function of its internode length and comparatively high numbers of primary, secondary, and tertiary branches (Zalapa, 2005).

This report describes the highly branched, fractal-type melon USDA 846-1 line and 81 derived recombinant inbred lines (RIL) that

were made available to melon breeders for development of U.S. western shipping melons with a highly branched, fractal-type architectural growth habit to increase genetic diversity and yield potential for commercial field production. This germplasm will be useful in breeding and genetic studies for

deployment of marker-assisted selection for quantitative traits associated with fruit yield and quality.

Origin

Line USDA 846-1. In 1995, a horticulturally unique *Cucumis melo* ssp. *agrestis* (Naud.) Pangalo germplasm designated CR1 was received by the USDA-ARS, Madison, WI. The fractal habit of CR1 was transferred into elite melon (*C. melo*) germplasm by crossing it with an F₁ plant from a cross of FMR#3 × SC#6. Breeding line FMR#3 is an F₃ selection from the cross Galia × Qalya (Paris et al., 1989) and may be characterized as *C. melo* var. *inodorus*. Breeding line SC#6 was an S₅ from a complex cross of Eastern U.S. market-type melons (*C. melo* var. *reticulatus*) selected by Perry E. Nugent (retired, USDA-ARS, U.S. Vegetable Laboratory, Charleston, SC) for germinability at low temperature. A monoecious, early-flowering (Wisconsin) plant was chosen from this three-way cross and self-pollinated four generations with concomitant selection for branching, earliness, and monoecy to produce an S₄ line designated USDA 846-1. Fruit of this line are slightly netted, non-ribbed, and typically ovoid (Fig. 1).

Derived recombinant inbred lines. A set of 81 recombinant inbred lines (F₇) was

Fig. 1. Vegetative growth habit, branching, and fruit-set patterns in melon (*Cucumis melo* L.) germplasm CR1, ‘Top Mark’, and USDA 846-1.

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Table 1. Best linear unbiased estimations (BLUE) of USDA 846-1 (P₁), 'Top Mark' (P₂), 'Esteem' (ES), 'Sol Dorado' (SD), 'Hale's Best Jumbo' (HB), and best linear unbiased predictions (BLUP) of a melon RIL population and their SEs and 95% confidence intervals (CIs) for yield and fruit quality components of plants grown at Hancock, WI, and El Centro, CA, in 2002 and 2004.^z

Trait (year of evaluation)	BLUE ^y					BLUP ^x ± SE	95% CI	
	P ₁	P ₂	ES	SD	HB		Lower	Upper
<i>Hancock</i>								
Primary branch number (2002)	5.33*	3.45*	4.25 NS	3.75*	3.63*	4.30 ± 0.11	3.96	4.64
Fruit number/plant (2002)	2.33*	2.13 NS	1.78 NS	2.40*	1.78 NS	1.92 ± 0.0	1.64	2.20
Fruit weight/plant (kg; 2002)	1.35*	1.22*	1.62*	1.38*	1.66*	1.01 ± 0.03	0.90	1.12
Average weight/fruit (kg; 2002)	0.58 NS	0.58 NS	0.93*	0.60 NS	0.93*	0.56 ± 0.02	0.50	0.62
Percentage of mature fruit/plot (2002)	88.75*	87.50*	88.75*	76.25*	92.50*	60.06 ± 2.01	53.67	66.46
Soluble solids content (2004) ^w	12.7*	9.5*	7.9*	9.5*	—	11.2 ± 0.17	10.5	11.9
Mesocarp pressure (2004) ^v	4.3 *	4.6*	5.2*	4.3*	—	2.8 ± 0.08	2.5	3.2
Fruit diameter (2004) ^u	11.5 NS	9.7*	11.4 NS	10.5*	—	11.9 ± 0.15	11.3	12.6
Seed cavity diameter (2004) ⁱ	5.2 NS	4.7 NS	5.1 NS	4.7 NS	—	4.9 ± 0.08	4.6	5.3
Seed cavity: fruit diameter (2004) ^s	0.5*	0.5*	0.5*	0.5*	—	0.4 ± 0.01	0.4	0.4
<i>El Centro</i>								
Primary branch number (2002)	5.70*	3.58*	2.96*	3.23*	3.10*	4.08 ± 0.15	3.59	4.57
Fruit number/plant (2002)	5.55*	3.86 NS	4.27 NS	3.47 NS	2.62 NS	4.30 ± 0.18	3.72	4.88
Fruit weight/plant (kg; 2002)	2.55*	2.00 NS	2.94*	2.41*	2.14 NS	1.93 ± 0.08	1.66	2.19
Average weight/fruit (kg; 2002)	0.47 NS	0.52 NS	0.74*	0.70*	0.81*	0.48 ± 0.02	0.42	0.53
Percentage of mature fruit/plot (2002)	87.50 NS	88.75 NS	92.50 NS	100.00*	97.52*	82.86 ± 3.11	72.96	92.77
Soluble solids content (2004) ^w	12.0*	11.4*	10.2 NS	10.7*	—	10.2 ± 0.18	9.7	10.8
Mesocarp pressure (2004) ^v	2.6*	2.5*	1.4*	1.3*	—	5.4 ± 0.23	4.6	6.1
Fruit diameter (2004) ^u	12.3*	12.5*	12.4*	13.4*	—	10.6 ± 0.12	10.2	11.0
Seed cavity diameter (2004) ⁱ	4.7 NS	5.2*	4.7 NS	4.6*	—	4.9 ± 0.73	4.7	5.2
Seed cavity: fruit diameter (2004)	0.4*	0.4*	0.4*	0.3*	—	0.5 ± 0.01	0.4	0.5

^zData abstracted from Paris et al. (2008) and Zalapa et al. (2008).

^yNS = The BLUE of the a parental line, their hybrid, and/or 'Hales Best Jumbo' for yield components are considered not significantly different ($P_{0.05}$) from the average of the RIL when values were within the CI limit of the RIL population BLUP.

^x*Significantly different ($P_{0.05}$) from the average of the RIL when values were outside the CI limit of the RIL population BLUP.

^wMelon fruit from each entry were analyzed for total sugar using a digital BRIX refractometer (Model DR103L; QA Supplies, Norfolk, VA).

^vPunch test at stem end and blossom end using a penetrometer with a 0.79cm tip (Model # FT 011; Effigi, Alfonsine, Italy).

^uMelon fruit cut horizontally for fruit diameter measurement.

ⁱSeed cavity diameter measured at the center-most portion of horizontally sectioned fruit.

developed from a cross between USDA 846-1 and Western shipping type 'Top Mark' using single-seed descent from a single F₁ plant (Zalapa, 2005; Zalapa et al., 2008).

Description

The indeterminate, monoecious USDA 846-1 produces two to five concentrated crown-set fruit on a highly branched (five to eight primary branches) fractal architectural habit and is capable of multiple fruiting cycles at a commercial spacing (0.35 m within-row spacing on 2-m center; 72,600 plants/ha) (Zalapa, 2005). Primary branch number and concentrated fruit set is higher than 'Top Mark', 'Hale's Best Jumbo', 'Esteem', and 'Sol Dorado', as evaluated in Hancock, WI, and El Centro, CA (Table 1) (Zalapa, 2005; Zalapa et al., 2006, 2008). The fruit quality characteristics (exterior and interior quality, sugar content, β-carotene content) of USDA 846-1 tend to be inferior to these commercial varieties (Cuevas et al., 2008; Paris et al., 2008).

RIL derived from a USDA 846-1 × 'Top Mark' mating possess different vegetative, flowering, and fruit characteristics. Some individual RIL transgress the performance of either parent or control commercial cultivars (above) for primary branch number, fruit number per plant, fruit weight per plant, average weight per fruit, percentage of mature fruit per plot, soluble solids content, mesocarp pressure, fruit diameter (mesocarp +

exocarp), seed cavity diameter (endocarp), seed cavity to fruit diameter ratio, fruit shape, percentage of exocarp netting, and β-carotene (Table 1) (Cuevas et al., 2008; Paris et al., 2008; Zalapa et al., 2008). The β-carotene content in fruit of these RIL, which ranged from 8.1 to 22.3 μg·g⁻¹ fresh weight (FW) in California and from 3.7 to 24.4 μg·g⁻¹ FW in Wisconsin, also differs considerably from the parental means (USDA 846-1 = 13.0 and 9.9 μg·g⁻¹ FW and 'Top Mark' = 11.9 and 14.7 μg·g⁻¹ FW, respectively, in California and Wisconsin). Fruit of the RIL are slight to variable for fruit shape (oblate, ovoid, or round), heavily netted, and can be slightly ribbed (vein tracts). Inheritance of these traits is complex and expression predictably is affected by growing environment (e.g., soil type and climatic conditions, plant spacing, etc.; Zalapa et al., 2008). For example, overall melon productivity (e.g., fruit number and weight) was considerably different across growing locations, but productive genotypes remained consistent regardless of locations. Quantitative trait loci and genetic marker associations have been characterized for all the traits mentioned here and provide the opportunity for deployment of marker-assisted selection during plant improvement of elite germplasm.

Availability

Seed of 846-1 and the 81 derived RILs from a hand-pollinated greenhouse increase

may be obtained by written request to J.D. McCreight (jim.mccreight@ars.usda.gov).

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