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INTRODUCTION

The demand for tropical fruits has increased more than 33% during the last decade as consumers seek healthy and more diverse food products. Dragon fruit or pitahaya (*Hylocereus* spp.) is a member of the Cactaceae family and native to the tropical forest regions of Mexico and Central and South America. The fruit was practically unknown 15 years ago but it occupies a growing niche in Europe's exotic fruit market. The crop adapts to different ecological conditions ranging from very dry regions to wet ones receiving over 3,500 mm/year of rainfall. Dragon fruit tolerates temperatures ranging from 12 °C to 40 °C. U.S. commercial production of dragon fruit occurs mainly in Southern California and Hawaii. As growers learn more about this crop and how productive it can be, the acreage planted will increase significantly. Dragon fruit has a very high antioxidant activity, a characteristic that should help its marketability among health-conscious consumers.

There is considerable variation in fruit size and shape among varieties ranging from nearly round to oblong and weighing between 70 - 680 grams per fruit. Dragon fruit flowers are hermaphroditic, however, some cultivars are self-incompatible. The number of flowering flushes depends on the species: seven to eight for *H. costaricensis* and five to six for *H. undatus*, there is a period of 3 to 4 weeks between flowering flushes. *Hylocereus* spp. can be easily propagated through cuttings which produce fruit about one year after planting. A trellis system for stem support is required for commercial production of dragon fruit. Spacing varies depending upon the trellis system. Minimum distances of 1.5 - 3 m between plants and 1.5 - 5 m between rows have been used commercially. The fruit is non-climacteric and once harvested can maintain its quality for two weeks when stored at 14°C.

Grown cuttings of lines NOI-13, NOI-14, NOI-16, N97-15, N97-17, N97-18, N97-20, N97-22, and cultivars American Beauty, Cosmic Charlie, Halley's Comet, and Purple Haze were transplanted to the field on 27 Aug. 2009 and were arranged in a randomized complete block design with five replications. Lines were introduced from the USDA-ARS Tropical Plant Genetic Resources and Disease Research Unit, Hilo, Hawaii and cultivars from Pine Island Nursery, Miami, Florida and shipped air freight to Puerto Rico. Within a replication, plots for each genotype contained three plants spaced 3.05 m apart and 4.6 m between adjacent rows, 717 plants (posts)/ha. Plants were supported by a "T" trellis support system with three plants planted per post. The experiment was surrounded by a guard row of two plants each of cultivars Alice, Bloody Mary, Dark Star, Vietnam, Delight, Makisupa, Red Jaina, David Bowie, and Seoul Kitchen.



Measuring fruit length

Measuring fruit diameter

Measuring Brix

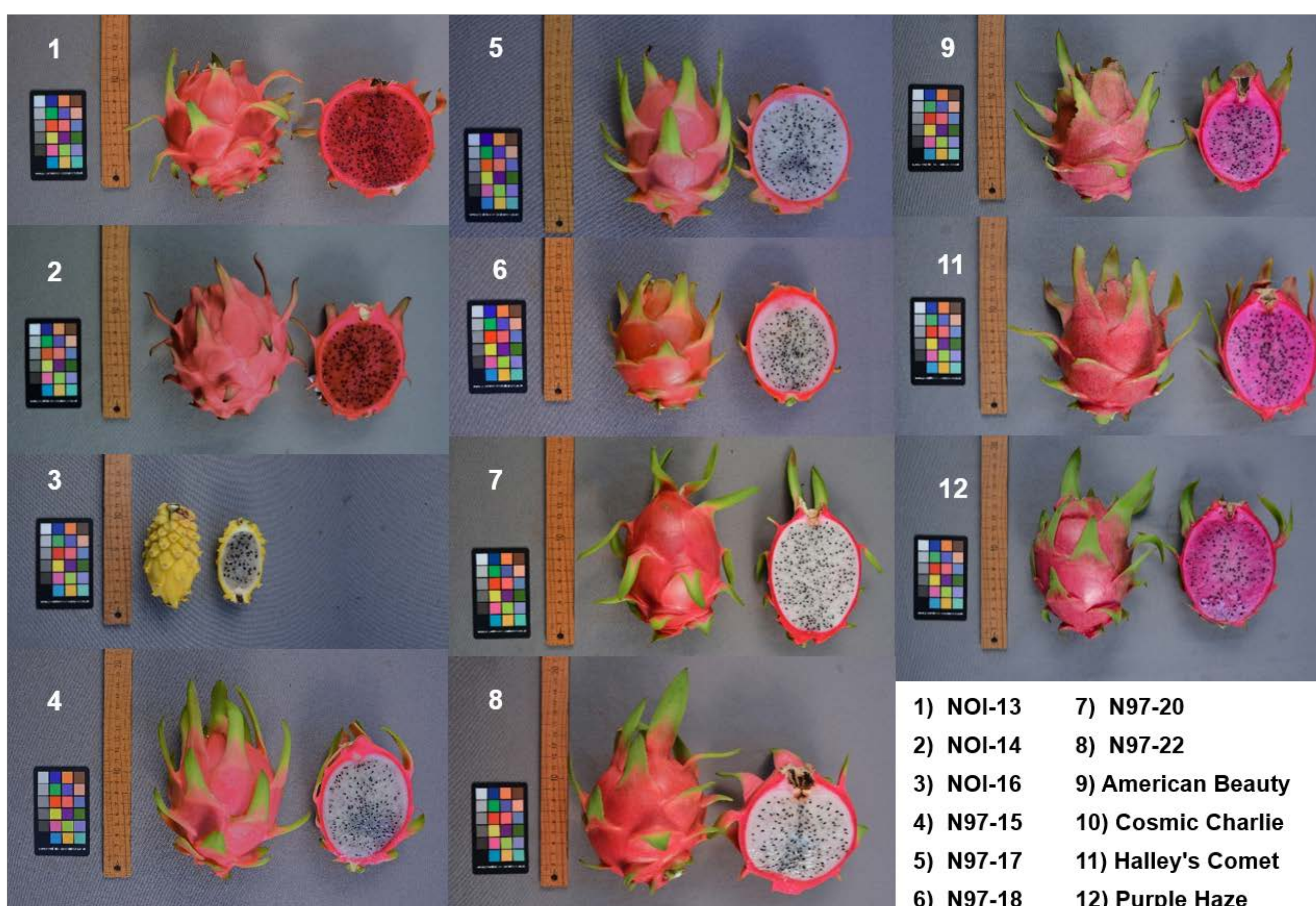


Fig. 1. Representative fruit of each cultivar

Formal experiments to determine yield and fruit quality traits of *Hylocereus* spp. are needed to assist in the expansion of the tropical fruit industry. The investigators in this project are conducting an experiment in Isabela, Puerto Rico to evaluate 12 dragon fruit cultivars, including eight new cultivars from China, for adaptability, insect pest susceptibility, yield performance and fruit quality traits (Fig. 1).

There is very little information available on total production area of dragon fruit worldwide. The largest producer in the U.S is California but the largest planting is about 7 hectares. Production in Florida has increased significantly during the last few years with total acreage estimated at 350 acres. The average seasonal price is about \$1.35/lb, but the fruit is sold in markets at a price as high as \$5.99 per/lb. Production of fully mature plants is estimated at 19,000 pounds/acre. However, results from replicated field trials to evaluate cultivars are very limited. We report herein preliminary data on yield and fruit quality traits of various dragon fruit cultivars grown in Puerto Rico. This work is part of USDA-ARS National Program 305, Crop Production and 301, Plant Genetics Resources, Genomics, and Genetic Improvement.

Irrigation was provided with spinner jets (model DXMAG368X; Maxijet, Dundee, FL) spaced 20 ft apart and providing 13.5 gal/h at 20 psi when the soil water tension at a depth of 30 cm exceeded 50 kPa. Fertilization was provided every 3 months using a 15N-2.2P-16.3K-1.8Mg commercial mixture at a rate of 163, 651, 813 and 1301 kg/ha in 2009, 2010, 2011, and 2012-13, respectively. Herbicide (glyphosate) for weed control was applied only in strips within the planting row. Weeds between rows were controlled with a tractor mower.

Harvests were initiated in September 2010. At this time, plants were about 10-months old and producing fruit for the first time. At each harvest, number and weight of fruit were recorded and weighed. Fruits were harvested at color break when they started to show a slight reddish color on the skin (exocarp). Representative fruit totaling 10% of those harvested in each treatment were used to determine fruit length and diameter. Soluble solids readings were also recorded using a temperature-compensated digital refractometer when the fruit ripened, about 2 d after harvest. Analysis of variance was carried out using the GLM procedure of SAS (release 9.1 for Windows; SAS Institute, Cary, NC). After significant F test at $P = 0.05$, mean separation was performed with Tukey's Studentized range test. Results are reported for harvests made in 2010, 2011, 2012 and 2013.

RESULTS AND DISCUSSION

Year, cultivars, and the year x cultivar interaction showed highly significant effects ($P \leq 0.01$) on all fruit parameters measured in the study (Table 1). The only exception was total soluble solids (Brix), which did not show a significant year and year x cultivar effect.

Table 1. Yield and fruit quality traits of 12 dragon fruit cultivars planted in Puerto Rico.

Cultivar	Total fruit (no./ha)	Fruit yield (kg/ha ¹)	Individual fruit wt. (g)	Fruit length (cm)	Fruit diameter (cm)	Total soluble solids (%)
NOI-13	42,394	16,292	379.0	6.96	6.47	12.4
NOI-14	62,970	15,057	246.6	7.21	6.54	13.1
NOI-16	27,916	2,262	78.7	7.18	3.86	17.8
N97-15	61,858	13,077	228.0	8.21	6.73	12.1
N97-17	69,952	14,634	206.7	7.31	5.88	12.1
N97-18	51,540	7,118	143.6	6.11	5.01	17.0
N97-20	26,302	12,660	487.9	8.43	6.46	12.9
N97-22	57,984	17,268	308.4	7.05	6.65	13.2
American Beauty	944	318	328.7	5.58	4.80	14.0
Cosmic Charlie	84	31	403.7	1.87	1.69	17.3
Halley's Comet	20,683	7,242	350.2	7.86	6.26	15.3
Purple Haze	9,230	2,747	312.5	8.65	6.77	14.6
Average	35,988	9,059	278.8	6.87	5.59	14.1
HSD (0.05) ²	13,875	3,793	89.4	2.31	1.88	2.38
Year (Y)	***	***	***	***	***	NS
Cultivar (C)	***	***	***	***	***	***
YxC	***	***	**	***	***	NS

²Tukey's Honest Significant Difference test ($R \leq 0.05$)

³NS, **, *** not significant or significant at $P \leq 0.01$ or 0.001, respectively, based on analysis of variance.

Overall, cultivars exhibited a significant increase in the number of fruit and yield during the first 4 years of production. In 2010, average number of fruit and yield were 120 fruit/ha and 22.5 kg/ha, respectively. By 2013, these values had increased to 66,517 fruit/ha and 18,110 kg/ha. This response was expected as trees increased in age. However, the magnitude of this response varied among cultivars as expected by the significant year x cultivar interaction (Table 1). Total number of fruits was significantly different among cultivars (Table 1). Cultivars 'N97-17', 'NOI-14', 'N97-15', and 'N97-22' produced a significantly higher number of total fruit averaging 63,191 fruit/ha. Significantly higher fruit yield was obtained by lines N97-22, NOI-13, NOI-14, and N97-15, averaging 15,813 kg/ha. There were no significant differences in fruit yield among 'NOI-13', 'NOI-14', 'N97-17', 'N97-15', and 'N97-20', averaging 14,344 kg/ha (Table 1).

Individual weight of marketable fruit averaged over cultivars was 279 g (Table 1). Individual weight of fruit was significantly higher in cultivars line 'N97-20' and 'Cosmic Charlie' which averaged 446 g. There were few significant differences in fruit length but the diameter of 'N97-18', 'American Beauty', 'NOI-16', and 'Cosmic Charlie' was significantly smaller than the rest. Significantly higher soluble solids concentration values were obtained from fruit of 'NOI-16', 'Cosmic Charlie', and 'N97-18' which averaged 17.4% (Table 1).

The authors want to acknowledge the excellent field, lab, and IT assistance of Jose Luis Rodriguez, Tomás Miranda, Pablo Rios, Delvis Perez, and Carlos Rios, USDA-ARS, TARS.
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Field Harvest and weighing

Measuring fruit titratable acidity

MATERIALS AND METHODS

This study was conducted in Puerto Rico at the USDA, Agricultural Research Service Research Farm in Isabela (Coto clay: clayey, kaolinitic isohyperthermic Typic Hapludox). The soil has a pH of 5.68, NH₄-N 154 mg/kg, NO₃-N 6.2 mg/kg, P 5.8 mg/kg, K 63.5 mg/kg, Ca 1192 mg/kg, Mg 93 mg/kg, Fe 39 mg/kg, Mn 245 mg/kg, Zn 2.80 mg/kg, and 1.42% organic C. The 92-year mean annual rainfall is 1649 mm and Class A pan evaporation is 1672 mm. Mean monthly maximum and minimum temperatures are 29.8 and 19.9 °C.