

Assessment of Triploid Watermelon Cultivars Grown in Georgia for Yield and Quality Parameters

Manisha Kumari¹, Angelos Deltsidis¹, Xuelin Luo²,
Camille McAvoy³, and Theodore McAvoy¹

KEYWORDS. *Citrullus lanatus*, fruit count, marketable yield, seedless watermelon, soluble solids

ABSTRACT. Watermelon is the most important vegetable crop grown during the spring season; therefore, it is imperative that we screen and identify top-performing cultivars for growers. Research experiments were conducted at the University of Georgia, Tifton Vegetable Park Research Farm, during Spring 2022 and Spring 2023. The study compared commercially available large seedless watermelon (*Citrullus lanatus* L.) cultivars to assess their performance to determine marketable and unmarketable yields, average fruit weight, fruit size distribution, quality parameters, and hollow heart. The six top-yielding cultivars were Excursion, ACX 6177, Miramonte, El Capitan, Sierra Nevada, and Jetski. These high-performing cultivars had total yields that averaged more than 60,000 lb/acre. Of these cultivars, Excursion, Sierra Nevada, and El Capitan had a high percentage of 30/36 count watermelons, whereas cultivars ACX 6177, Miramonte, and Jetski had a large percentage of 45/60 count watermelons. ‘Powerhouse’ and ‘Captivation’ performed the worst, with lower average fruit weights and total yields. In terms of fruit quality, ‘Jetski’, ‘Warrior’, ‘Captivation’, ‘Sierra Nevada’, ‘Embassy’, and ‘Powerhouse’ had the highest soluble solid content among all the cultivars. However, all cultivars had an average soluble solid content of more than 10%, which represented “very good internal quality” according to the US Department of Agriculture standards. ‘Warrior’ and ‘Captivation’ had significantly higher hollow hearts in the fruits compared to those of all other cultivars. In summary, ‘Excursion’, ‘El Capitan’, ‘Miramonte’, ‘Sierra Nevada’, ‘ACX 6177’, and ‘Jetski’ are recommended for commercial cultivation in southern Georgia based on their high yield, sweetness, and low hollow heart incidence, with options available for growers based on desired fruit size distribution, rind color, and fruit shape, whereas ‘Warrior’, ‘Powerhouse’ and ‘Captivation’ performed poorly in terms of yield and/or hollow heart vulnerability.

In 2022, total melon (cantaloupe, honeydew, and watermelon) consumption per capita in the United States was 22.5 lbs/person, whereas the per capita watermelon consumption topped the chart, with 15.3 lb/person (US Department of Agriculture, Economic Research Service 2024). In 2023, the total fresh market watermelon production in the United States was 37.1 million cwt, with Georgia ranking second for output, accounting for approximately 17.4% of the total production, with 6.5 million cwt (US Department of Agriculture, National Agricultural Statistics Service 2024). Most of the watermelon during the late spring and summer months (4th of July market) in the United States is supplied by Georgia and Florida (US Department of Agriculture, Economic Research Service 2022). Because of the favorable spring weather, relatively

low disease pressure (compared with that in the fall), and large demand for watermelon during the summer, approximately 90% of the watermelon crop in Georgia is grown in the spring season (George et al. 2017). The major production region in Georgia for watermelon is in the central-southern part of the state, and the top-producing counties are Crisp, Turner, Telfair, and Tift, accounting for 12%, 10%, 9%, and 8% of the acres planted, respectively (University of Georgia, Centre for Agribusiness and Economic Development 2024).

The demand for seedless cultivars continues to increase (Freeman et al. 2007; NeSmith and Duval 2001), as demonstrated by the rise in seedless watermelon’s percentage of all shipments to the United States from 51% in 2003 to almost 85% in 2014 (Agricultural Marketing Resource Center

2024). Compared with seeded diploid watermelons, seedless triploid cultivars are more economically valued and have higher quality (Kaseb et al. 2023). Consumers also favor them and are more accepting of them (Fiacchino and Walters 2003; Wijesinghe et al. 2020).

Fruit quality characteristics greatly impact consumers’ willingness to purchase watermelon fruits. The main characteristics of fruit quality that affect repurchase and consumption are fruit size, soluble solids content (sweetness), flesh color, rind patterns, and fruit shape (Wehner 2008). Watermelon fruit varies in shape (round, oval, or elongated), size (3.3 to 33 lb), rind color (light to dark striped patterns), and flesh color (white, green, yellow, orange, and red) (Kyriacou et al. 2018). Commercially, watermelon fruits are grouped and sold by size, i.e., 30-count (>21.5 lb), 36-count (17.6–21.4 lb/fruit), 45-count (13.6–17.5 lb/fruit), and 60-count (9.0–13.5 lb/fruit) (Coolong 2015; Ernest 2023; Schultheis and Starke 2019).

Sunburn and hollow heart physiological disorders affect watermelon fruits in Georgia periodically. Sunburn is a visible gray patch on the upper fruit surface where the rind pigment has been destroyed. Ensuring that the vines grow well and shade the watermelon fruit is the best way to safeguard against sunburn damage (Maynard and Hopkins 1999). The selection of light-colored rind cultivars, which are less prone to sunburn than dark-rind cultivars, may help prevent sunburn damage to some extent.

A hollow heart is a crack in the core of the fruit that widens into an open cavity (Trandel et al. 2020). Although the hollow heart fruit tends to be slightly asymmetrical, it is difficult to tell from the outside if fruits have an intact or hollow heart. Because they are reliant upon a diploid (seeded) pollenizer with viable pollen, triploid (seedless) watermelons are generally more susceptible to inadequate pollination, which is believed to be one of the main causes of hollow heart in watermelons (Diezma-Iglesias et al. 2004; Fiacchino and Walters 2003). Consumers prefer dark rind 45- to 60-count seedless watermelons (Schultheis and Starke 2019) with brix above 10% (US Department of Agriculture, Agricultural Marketing Service 2021) without hollow heart. Although

consumers typically prefer medium (45-count) to smaller fruit (Keinath et al. 2019), large-sized fruits yield more total pounds per acre.

This study aimed to evaluate large seedless watermelon cultivars for 2 years during the spring in southern Georgia to determine performance for yield, fruit size distribution, and quality attributes to identify cultivars that exhibit superior yield performance and consumer-preferred qualities, thereby enhancing the efficiency and profitability of watermelon production in the region.

Materials and methods

EXPERIMENTAL SITE AND DESIGN.

The research trials were conducted in Tifton, GA, USA (lat. 31.4868407°N, long. -83.5226439°W) during Spring 2022 and Spring 2023. The Spring 2022 and 2023 weather data are presented in Fig. 1A and B, respectively. The type of soil at the field site was Tifton soil, which has a water-holding capacity of 2.2 inches (Harrison 2012). Sowing, transplant, and harvest dates for all trials are shown in Table 1. The field was fumigated with Pic-Clor 60 fumigant at 375 lb/acre. Raised bed tops, with a width of 2.5 ft, were covered with black plastic mulch, and drip tape was used for irrigation. Drip irrigation was implemented using drip tape (Streamline × 638 008 F; Netafim Irrigation Inc., Fresno, CA, USA) with an inner diameter of 0.638 inches, wall

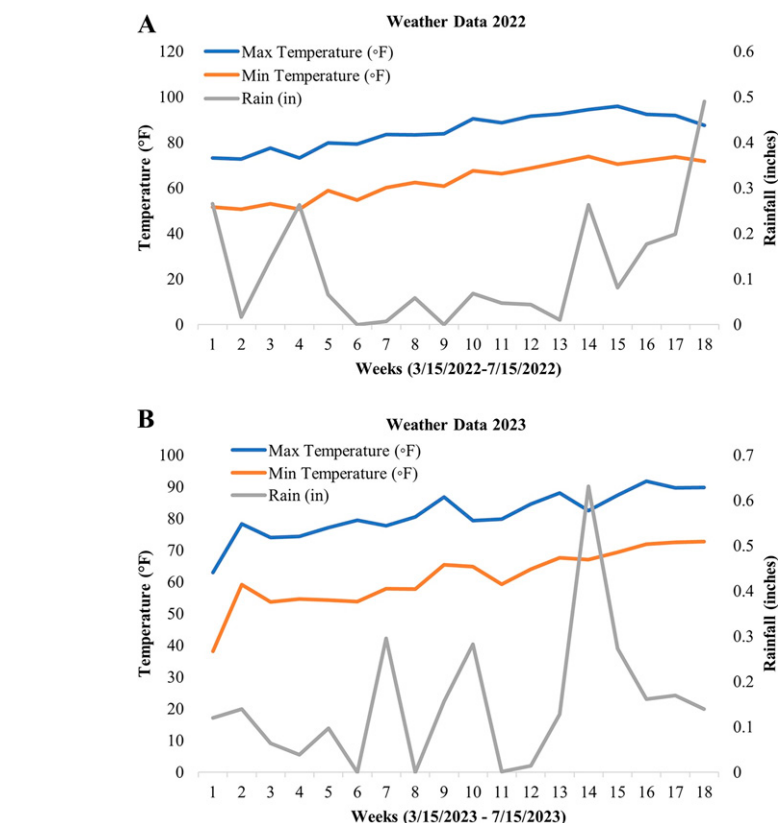


Fig. 1. Average maximum and minimum temperature and rainfall during (A) Spring 2022 and (B) Spring 2023. These weather data were obtained from the Coastal Plain Experimental Station, University of Georgia Weather Network, Tifton, GA, USA.

thickness of 8 mils, and an emitter spacing of 12 inches, with a flow rate of 0.24 gal/h/emitter. The irrigation regime consisted of two drip irrigation cycles/day of 20, 30, 40, and 60 min per irrigation event for the second, fourth, sixth, and eighth week, respectively. For fertilization, a total of 150 lb of nitrogen (N) and 150 lb of potassium (K) were applied in split doses, whereas 50 lb N, 50 lb phosphorus, and 50 lb K were broadcasted pre-plant before laying black plastic mulch using a 10–10–10 granular fertilizer, and the remaining 100 lb N and 100 lb K were delivered through fertigation with 7–0–7 liquid fertilizer at a rate of 10 lb/N/acre/week and 10 lb/K/acre/week, respectively, for 10 weeks (Coolong 2015; Silva 2019). Fertigation was delivered once per week using a battery-powered pump (Dayton 1/2 Horsepower Pump; W. W. Grainger, Inc., Lake Forest, IL, USA).

The experimental design of the research trials was a randomized complete block design (RCBD) with four

replications. Vines were trained toward the center of two rows of the same plot to prevent intermingling with other cultivars. Plant spacing was 4 ft in-row and 6 ft between-row, for a final planting density of 1815 plants/acre. Each plot was 20 ft long and consisted of two rows with 5 plants/row, for a total of 10 triploid watermelon plants. Super Pollinizer-7 (SP-7) was inter-planted between the triploid plants in the same row (2/row or 4/plot). According to Freeman et al. 2007, most in-row pollenizers should have a pollenizer-to-triploid ratio of 1:3. Four honeybee hives were placed within 500 ft of the field to ensure proper pollination.

EXPERIMENTAL MATERIAL. The experimental material comprised 12 large, triploid, seedless watermelon cultivars with a Crimson Sweet striped rind pattern. These cultivars, their original breeding source, and their respective disease resistance are presented in Table 2. Seeds of all the cultivars were purchased from Seedway, LLC (Hall, NY, USA).

HARVESTS. A total of three harvests were conducted approximately

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¹Department of Horticulture, University of Georgia, Tifton, GA 31793, USA

²Experimental Statistics, University of Georgia, Tifton, GA 31793, USA

³School of Agriculture and Natural Resources, Abraham Baldwin Agricultural College, Tifton, GA 31793, USA

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M.K. is the corresponding author. E-mail: manisha.kumari@uga.edu.

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Table 1. Sowing, transplant, and harvest dates of triploid watermelon cultivar trials at Tifton, GA, USA, during Spring of 2022 and Spring 2023.

Year	Sowing date	Transplant	First harvest	Second harvest	Third harvest
2022	13 Feb 2022	1 Apr 2022	9 Jun 2022	15 Jun 2022	22 Jun 2022
2023	17 Feb 2023	5 Apr 2023	27 Jun 2023	5 Jul 2023	13 Jul 2023

1 week apart in both years (Table 1). Fruits were harvested when base tendrils turned brown, ground spots were yellow, and a dull sound of the fruit occurred when thumping. All 10 plants from each plot were harvested and fruits were weighed and counted to estimate the total yield (lb/acre) and average weight (lb/fruit). Each fruit was weighed, graded, and categorized per the National Watermelon Research and Development Group Standards: 60-count (9–13.5 lb), 45-count (13.6–17.5 lb), 36-count (17.6–21.4 lb), and 30-count (≥ 21.5 lb) (Coolong 2015). Fruit size counts are based on the number of fruits that will fit in a standard bin. Sunburn (Fig. 2B) and fruits less than 9 lb were considered unmarketable (Schultheis and Starke 2019) in the yield analysis and were weighed separately to estimate yield loss per acre.

QUALITY PARAMETERS. Three representative fruits from each plot were used to estimate quality parameters, i.e., soluble solid content (SSC), rind color, shape, flesh color, and hollow heart disorder. The SSC was measured

using a digital refractometer (ATAGO Co., Ltd., Tokyo, Japan). Visual ratings were used to classify rind color, fruit shape, and flesh color. The rind color was considered dark (3), medium (2), or light (1). The shape was either oval (2) or round (1). The flesh color was either dark red (2) or light red (1). The hollow heart only occurred in the second year of the trial, and it was expressed as a percent incidence (Fig. 2A). Damage (cracks aggregating more than 1.25 inches in width) and serious damage (cracks aggregating more than 1.5 inches in width) were two different categories used for hollow heart estimation (US Department of Agriculture, Agricultural Marketing Service 2021).

STATISTICAL ANALYSIS. Data were analyzed using JMP Pro version 17.2.0 (JMP Statistical Discovery LLC., Cary, NC, USA) and an analysis of variance to determine the significance of the cultivar and year main effects and their interactions. Mean separation was performed using Fisher's least significant difference test ($P < 0.05$). There was no by-year interaction for

quality traits; therefore, results were combined for both years.

Results

Total, marketable, and unmarketable yields (lb/acre)

Regarding annual trends, there were significant increases in total, marketable, and unmarketable (sunburn and <9 lb fruits) yields from 2022 to 2023 (Table 3). Total yields rose from 45,931 lb/acre in 2022 to 73,082 lb/acre in 2023. Correspondingly, marketable yields also significantly increased from 44,941 lb/acre in 2022 to 70,790 lb/acre in 2023. Statistically significant increases in sunburn and <9 lb fruit count were recorded from 2022 (552 and 439 lb/acre) to 2023 (771 and 1521 lb/acre), respectively.

Regarding cultivar differences, there were no significant differences in total yield between cultivars. Total yields (combined from two harvests) of triploid watermelon cultivars varied from 71,268 to 50,089 lb/acre, while marketable yield ranged from 70,470 to 48,207 lb/acre. Six cultivars yielded above 60,000 lb/acre, including Excursion, ACX 6177, Miramonte, El Capitan, Sierra Nevada, and Jetski. Unmarketable yield (sunburn and <9 lb fruit) did not vary significantly among all the cultivars and year $\times$ cultivar interaction.

Percentage marketable (%) and average weight (lb)

Regarding annual trends, the marketable yield percentage did not differ significantly between years. However, average fruit weight significantly decreased slightly from 15.8 lb in 2022 to 15.2 lb in 2023 (Table 3).

Regarding cultivar differences, the percentage of marketable yield did not differ significantly among the cultivars. However, there was a significant difference in average fruit weight between cultivars. 'Excursion' (17.4 lb), 'Sierra Nevada' (16.7 lb), and 'Virtue' (16.5 lb) exhibited the highest average weight, which was significantly more than that of 'Powerhouse' (14.6 lb) and 'Captivation' (14.4 lb) (Table 3).

Table 2. Seed source and disease resistance in the seedless triploid watermelon cultivar trial at Tifton, GA, USA, during Spring 2022 and Spring 2023.

Cultivar	Source ⁱ	Disease resistance ^{vi}
Jetski	Seminis ⁱⁱ	IR: Fon 1
7197 HQ	Nunhems ⁱⁱⁱ	—
Virtue	Syngenta ^{iv}	IR: Co 1; Fon 1; Px 1
Miramonte	Sakata ^v	HR: Fon: 0, 1
ACX 6177	Nunhems	Co 1; Fon 1
Captivation	Syngenta	Co 1; Fon 1
El Capitan	Sakata	HR: Fon: 0, 1
Embassy	Nunhems	Co 1; Fon 1
Excursion	Syngenta	Co 1; Fon 1
Powerhouse	Syngenta	Co 1; Fon 1
Sierra Nevada	Sakata	HR: Fon: 0, 1
Warrior	Nunhems	Fon 0, 1
Pollinizer^{vii}		
SP-7	Syngenta	Co 1; Fon 1; Px 1

ⁱSource is the original parental breeding company that developed the particular cultivar, although all the cultivars were purchased from Seedway, LLC.

ⁱⁱSeminis, Inc., St. Louis, MO, USA.

ⁱⁱⁱNunhems USA Inc., Parma, ID, USA.

^{iv}Syngenta Seeds, Downers Grove, IL, USA.

^vSakata Seed America, Morgan Hill, CA, USA.

^{vi}Co = anthracnose resistance (*Colletotrichum orbiculare*); Fon = *Fusarium* wilt resistance (*Fusarium oxysporum* f. sp. *niveum*); HR = high resistance; IR = intermediate resistance; Px = powdery mildew resistance (*Podosphaera xanthii*).

^{vii}Pollinizer is a diploid seeded cultivar.

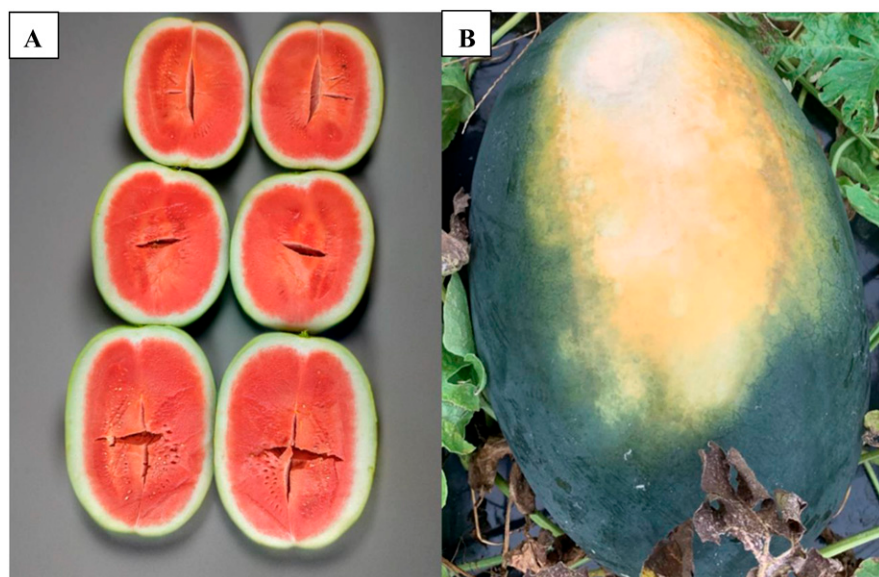


Fig. 2. Images indicating physiological disorders in watermelon fruit: (A) hollow heart and (B) sunburn. Hollow heart refers to when the flesh inside the fruit separates, which is one of the symptoms of hollow heart. Sunburn refers to a yellowish-gray patch where the pigment in the rind has been destroyed on the upper fruit surface.

Fruit weight categories

60-COUNT. A statistically significant increase in the total yield (lb/acre) of 60-count fruit yield was observed

from 2022 (8600 lb/acre) to 2023 (20,504 lb/acre) (Table 4). No statistically significant differences in the 60-count fruit class were observed among

cultivars and their interaction with year. However, ‘Embassy’ (18,734 lb/acre) had the highest numerical value for 60-count fruits.

The percentage marketable (%) of 60-count increased significantly from 22.2% in 2022 to 30.9% in 2023. Statistically significant differences were recorded among the cultivars for the percentage marketable of the 60-count fruit category. ‘Powerhouse’ (36.9%) had the highest percentage of 60-count fruit, whereas ‘Excursion’ had the lowest (13.5%). Those of all the other cultivars varied between 35.1% to 14.1% (Table 4).

45-COUNT (LB/ACRE). Similarly, there was a significant year-over-year increase in the total yield (lb/acre) of the 45-count fruit category from 20,619 lb/acre in 2022 to 24,593 lb/acre in 2023. All cultivars had similar weights of 45-count melons. The difference was statistically insignificant (Table 4).

A significant decrease from 46.9% in 2022 to 35.8% in 2023 was observed in the percentage marketable (%) of 45-counts. There was no significant difference among the cultivars (Table 4).

Table 3. Total yield, marketable yield, unmarketable,ⁱ percent marketable, and average weight, for seedless triploid watermelon cultivar trials at Tifton, GA, USA, during Spring 2022 and Spring 2023.

Treatments	Total yield ⁱⁱ (lb/acre) ⁱⁱⁱ	Marketable yield ^{iv} (lb/acre)	Sunburn ^v (lb/acre)	<9 lb count (lb/acre)	Percentage marketable (%) ^{vi}	Avg wt ^{vii} (lbs)
Year						
2022	45,931 b ^{viii}	44,941 b	552 b	438.5 b	97.4 a	15.8 a
2023	73,082 a	70,790 a	771 a	1520.8 a	96.3 a	15.2 b
Cultivar						
7197 HQ	58,659 a	57,448 a	454 a	756.4 a	97.6 a	15.1 cde
ACX 6177	66,326 a	64,547 a	476 a	1303.2 a	97.6 a	15.3 cde
Captivation	50,089 a	48,444.4 a	885 a	760.0 a	96.3 a	14.4 e
El Capitan	63,117 a	61,485.6 a	476 a	1155.3 a	97.6 a	15.9 bcd
Embassy	59,308 a	58,037.1 a	885 a	385.7 a	97.6 a	15.1 cde
Excursion	71,268 a	70,470.8 a	408 a	388.4 a	98.7 a	17.4 a
Jetski	60,639 a	58,219.8 a	885 a	1534.1 a	96.3 a	15.1 cde
Miramonte	64,363 a	61,922.4 a	726 a	1715.0 a	95.9 a	15.1 cde
Powerhouse	51,824 a	48,207.3 a	1021 a	2595.5 a	90.7 a	14.6 de
Sierra Nevada	60,875 a	60,330.4 a	545 a	0.0 a	98.8 a	16.7 ab
Virtue	52,255 a	51,071.2 a	590 a	593.5 a	97.6 a	16.4 abc
Warrior	55,359 a	54,200.2 a	590 a	569.0 a	97.4 a	15.1 cde
Significance						
Year (Y)	<0.0001*	<0.0001*	0.0227*	0.0040*	0.6889	0.0278*
Cultivar (C)	0.1959	0.1721	0.1039	0.2439	0.1337	0.0002*
Y × C	0.6298	0.5592	0.1504	0.422	0.3254	0.2012

ⁱ Unmarketable: sunburn + <9 count.

ⁱⁱ Total yield: cumulative yield of all the four different size classes, i.e., 60-count, 45-count, 36-count, and 30-count.

ⁱⁱⁱ 1 lb/acre: 2.47 lb/ha or 1.12 kg/ha.

^{iv} Marketable yield: 30-count + 36-count + 45-count + 60-count.

^v Sunburn is the burning of watermelon skin caused by direct sunlight.

^{vi} Percent marketable: total count (lb/acre)/total marketable × 100.

^{vii} Average weight: total yield/total count.

^{viii} Means followed by the same letter are not significantly different based on Fisher's least significant difference test at 95%.

Table 4. Fruit weight categories for seedless triploid watermelon cultivar trials at Tifton, GA, USA, during Spring 2022 and Spring 2023.

Treatments	60-Count ⁱ		45-Count ⁱⁱ	
	lb/acre ⁱⁱⁱ	Percentage ^{iv}	lb/acre	Percentage
Year				
2022	8,600 b ^v	22.2 b	20,619 b	46.9 a
2023	20,504 a	30.9 a	24,593 a	35.8 b
Cultivar				
7197 HQ	16,497 a	30.8 abc	20,008 a	37.5 a
ACX 6177	16,923 a	25.5 abcd	25,846 a	42.7 a
Captivation	16,729 a	35.1 ab	20,692 a	45.2 a
El Capitan	13,596 a	21.6 cde	23,874 a	41.0 a
Embassy	18,734 a	30.4 abc	21,156 a	36.1 a
Excursion	9,324 a	13.5 e	22,435 a	32.9 a
Jetski	16,121 a	30.4 abc	24,402 a	39.1 a
Miramonte	16,670 a	28.3 abc	23,664 a	39.0 a
Powerhouse	14,662 a	36.9 a	18,976 a	43.8 a
Sierra Nevada	8,647 a	14.1 de	24,681 a	46.8 a
Virtue	14,326 a	28.3 abc	17,907 a	38.6 a
Warrior	12,397 a	23.8 bcde	27,634 a	53.5 a
Significance				
Year (Y)	<0.0001*	0.0006*	0.0338*	<0.0001*
Cultivar (C)	0.0939	0.0019*	0.5972	0.1864
Y × C	0.3411	0.2926	0.6591	0.6856

ⁱ 60-count: 9 to 13.5 lb.ⁱⁱ 45-count: 13.6 to 17.5 lb.ⁱⁱⁱ 1 lb/acre: 2.47 lb/ha or 1.12 kg/ha.^{iv} Percentage: total count (lb/acre)/total marketable × 100.^v Means followed by the same letter are not significantly different based on Fisher's least significant difference test at 95%.

Year × cultivar interaction for fruit size

The year × cultivar interaction was statistically significant in the 36-count fruit

yield, percentage marketable of 36-count, and 30-count fruit categories. These findings suggest that the performance of cultivars in terms of fruit size distribution varied across years (Tables 5 and 6).

36-COUNT. There were statistically significant differences in the year × cultivar interaction for 36-count (lb/acre). ‘Sierra Nevada’ and ‘Powerhouse’ exhibited a statistically significant difference for this particular category by having a higher yield of 23,566 lb/acre in 2023 in comparison with that in 2022 (7043 lb/acre) (Table 5).

The percentage marketable (%) of 36-count expressed significant interaction effects for year and cultivars. For 2022, all the cultivars showed statistically significant differences. ‘Embassy’ (40.1%) had the highest percentage, whereas ‘Powerhouse’ (7.7%) and ‘Captivation’ (11.9%) had the lowest. ‘El Capitan’ and ‘Embassy’ expressed statistically significant differences for both years. ‘El Capitan’ and ‘Embassy’ represented a substantial decrease in 2023 (14.2% and 14.5%, respectively) as compared with 2022 (33.9% and 40.1%, respectively) (Table 5).

30-COUNT. Excursion and El Capitan cultivars showed significant interaction differences with year. Both ‘Excursion’ and ‘El Capitan’ exhibited significantly higher yields in 2023 (32,893 lb/acre and 17,407 lb/acre, respectively) than in 2022 (8322 and 2042 lb/acre, respectively) (Table 6). In 2023, ‘Excursion’ had the highest 30-count yield (32,893 lb/acre),

Table 5. Year × cultivar interactions for the fruit weight category 36-count for seedless triploid watermelon cultivar trial at Tifton, GA, USA, during Spring 2022 and Spring 2023.

Cultivar	36-Count ⁱ					
	lb/acre ⁱⁱ			Percentage ⁱⁱⁱ		
	2022	2023	P value ^{iv}	2022	2023	P value
7197 HQ	9,361 aA ^v	21,810 aA	0.217	20.7 abA	27.8 aA	0.3898
ACX 6177	14,628 aA	13,032 aA	0.764	25.2 abA	17.9 aA	0.3744
Captivation	5,941 aA	12,904 aA	0.193	11.9 bA	22.7 aA	0.1977
El Capitan	17,359 aA	11,224 aA	0.2507	33.9 abA	14.2 aB	0.0186*
Embassy	17,180 aA	10,390 aA	0.2041	40.1 aA	14.5 aB	0.0027*
Excursion	15,378 aA	20,831 aA	0.3068	33.7 abA	21.7 aA	0.1473
Jetski	10,219 aA ⁱⁱⁱ	18,404 aA	0.1269	24.4 abA	25.6 aA	0.8809
Miramonte	11,494 aA	17,488 aA	0.2617	22.9 abA	23.3 aA	0.9585
Powerhouse	4,297 aA	14,742 aA	0.0527	7.7 bA	19.4 aA	0.1598
Sierra Nevada	7,043 aB	23,566 aA	0.0027*	14.9 abA	30.0 aA	0.0697
Virtue	12,326 aA	11,153 aA	0.8254	25.8 abA	14.9 aA	0.1889
Warrior	10,394 aA	8,643 aA	0.7419	19.5 abA	12.6 aA	0.4025
P value	0.2396	0.0824		0.0073*	0.4742	

ⁱ 36-count: 17.6 to 21.4 lb per fruit.ⁱⁱ 1 lb/acre: 2.47 lb/ha or 1.12 kg/ha.ⁱⁱⁱ Percentage = total 36-count/total marketable yield × 100.^{iv} P ≤ 0.05 is considered statistically significant in Fisher's least significant difference test.^v Means followed by the same letter are not significantly different based on Fisher's least significant difference test (P ≤ 0.05). Different lowercase letters represent statistically significant differences (P ≤ 0.05) between cultivars, while different uppercase letters represent statistically significant differences (P ≤ 0.05) between years.

Table 6. Year × cultivar interactions for the fruit weight category 30-count for seedless triploid watermelon cultivar trial at Tifton, GA, USA, during Spring 2022 and Spring 2023.

Cultivar	30-Count ⁱ (lb/acre) ⁱⁱ		P value ⁱⁱⁱ
	2022	2023	
7197 HQ	2,046 aA ^{iv}	8,669.35 bcA	0.1324
ACX6177TSS FR	7,177 aA	8,718 bcA	0.7241
Captivation	1,035 aA	2,167 cA	0.7953
El Capitan	2,042 aB	17,407 bA	0.0008*
Embassy	4,193 aA	4,533 bcA	0.9378
Excursion	8,322 aB	32,893 aA	<0.0001*
Jetski	3,326 aA	3,445 bcA	0.9783
Miramonte	3,407 aA	10,787 bcA	0.0943
Powerhouse	2,251 aA	7,850 bcA	0.2022
Sierra Nevada	10,955 aA	12,440 bcA	0.7338
Virtue	5,268 aA	8,930 bcA	0.4026
Warrior	3,013 aA	6,289 bcA	0.4537
P value	0.5064	<0.0001*	

ⁱ 30-count: 21.5+ lb.ⁱⁱ 1 lb/acre: 2.47 lb/ha or 1.12 kg/ha.ⁱⁱⁱ $P \leq 0.05$ is considered statistically significant in Fisher's least significant difference test.^{iv} Means followed by the same letter are not significantly different based on Fisher's least significant difference test ($P \leq 0.05$). Different lowercase letters represent statistically significant differences ($P \leq 0.05$) between cultivars, while different uppercase letters represent statistically significant differences ($P \leq 0.05$) between years.

while 'Captivation' had the lowest (2167 lb/acre) (Table 6).

Fruit quality parameters

Fruit quality attributes are presented in Table 7.

SOLUBLE SOLIDS CONTENT (%). The SSC varied significantly among cultivars, with Jetski recording the highest average (12.8%), significantly differing from that of ACX 6177,

which had the lowest (11.3%). 'Warrior' (12.7%) and 'Captivation' (12.5%), 'Embassy' (12.4%), 'Powerhouse' (12.3%), and 'Sierra Nevada' (12.4%) also had more than 12% SSC. The SSC of other cultivars ranged from 11.8% to 11.4%. However, all cultivars were in the acceptable range (>10%) for the SSC, which indicated "very good internal quality" according to the (US Department of Agriculture, Agricultural Marketing Service 2021).

RIND COLOR. Significant differences were observed in rind color, with 'El Capitan' (3), 'Miramonte' (2.5), and 'Sierra Nevada' (2.33) having darker rinds than those of other cultivars. These ratings indicate that these cultivars had a dark to medium dark green rind color while others had a light green rind color.

SHAPE. Shape differences were significant, with 'ACX 6177' having a round shape and other cultivars having an oval shape. Fruit with rating 1 had a round shape, and rating 2 was associated with an oval shape.

FLESH COLOR. Significant variation was observed in flesh color, with most cultivars exhibiting light red flesh, except El Capitan, Miramonte, and Jetski, which had a darker red hue. On a scale of 1 to 3, 1 represented yellow flesh, and 2 and 3 represented light and dark flesh, respectively.

HOLLOW HEART (%). The total hollow heart (damage + serious damage) incidence was statistically significant between cultivars. 'Warrior' (66.7%), 'Captivation' (50%), and 'Sierra Nevada' (35%) had the highest percentage of total hollow hearts. 'Sierra Nevada' exhibited a moderate incidence of total hollow heart, which was not significantly higher than that of all the other cultivars, which all showed minimal (8.3%–16.7%) total hollow heart incidences (Table 7).

Table 7. Fruit quality characteristics and hollow heart of seedless triploid watermelon cultivar trial at Tifton, GA, USA.

Cultivar	Soluble solids content ⁱ (%)	Rind color ⁱⁱ	Shape ⁱⁱⁱ	Flesh color ^{iv}	Total hollow heart ^v (%)	Serious hollow heart damage ^{vi} (%)
7197 HQ	11.8 bcd ^{viii}	1.0 b	2.0 a	2.0 c	8.3 c	0.0 c
ACX 6177	11.4 d	1.0 b	1.3 b	2.0 c	8.3 c	0.0 c
Captivation	12.5 ab	1.0 b	1.8 a	2.0 c	50.0 ab	25.0 ab
El Capitan	11.8 bcd	3.0 a	2.0 a	3.0 a	16.7 c	0.0 c
Embassy	12.4 abc	1.0b	2.0 a	2.3 c	25.0 bc	8.3 bc
Excursion	11.5 cd	1.5 b	2.0 a	2.3 c	25.0 bc	0.0 c
Jetski	12.8 a	1.0 b	2.0 a	2.8 ab	8.3 c	0.0 c
Miramonte	11.4 cd	2.5 a	2.0 a	3.0 a	8.3 c	0.0 c
Powerhouse	12.3 abcd	1.0 b	1.8 a	2.3 c	8.3 c	0.0 c
Sierra Nevada	12.4 abcd	2.3 a	2.3 a	2.4 bc	35.0 abc	0.0 c
Virtue	11.7 bcd	1.0 b	2.0 a	2.3 c	16.7 c	0.0 c
Warrior	12.7 ab	1.0 b	1.8 a	2.0 c	66.7 a	41.7 a
P value ^{vii}	0.0293*	<0.001*	0.036*	0.001*	0.0113*	0.0031*

ⁱ Soluble solids refers to sweetness measured by using a digital refractometer.ⁱⁱ Rind color rating: 3 = dark; 2 = medium; and 1 = light.ⁱⁱⁱ Shape: 2 = oval; 1 = round.^{iv} Flesh color rating: 3 = dark red; 2 = light red; 1 = yellow.^v Total hollow heart: damage (cracks 1.25 inches in width) + serious damage (cracks 1.5 inches in width).^{vi} Serious hollow heart damage: cracks aggregating more than 1.5 inches in width.^{vii} $P \leq 0.05$ is considered statistically significant in Fisher's least significant difference test.^{viii} Means followed by the same letter are not significantly different based on Fisher's least significant difference test ($P \leq 0.05$).

Serious hollow heart damage revealed statistically significant differences among the cultivars. ‘Warrior’ (41.7%) had the highest number of fruit with serious hollow heart damage, while ‘Captivation’ (25.0%) had a moderate level of serious damage. ‘Embassy’ (8.3%) was not significantly different from all the remaining cultivars that did not show any fruit with serious damage (Table 7).

Discussion

The results of this study show that among 12 triploid watermelon cultivars, five had a total marketable yield above 60,000 lb/acre, although there was not a statistically significant difference in marketable yields among the cultivars. These yield values are similar to those obtained by Cushman et al. 2003, Boyhan et al. 2019, and Guan et al. 2019. Yield (lb/acre) based on total marketable fruits along with all four different fruit classes were significantly lower in 2022 compared with 2023, while the average weight was just the opposite.

As indicated in Table 1, the days to first harvest from transplanting were delayed by two full weeks in 2023 compared with 2022. We believe this was caused by cooler temperatures and wetter soils in May 2023 (Fig. 1B) that delayed fruit set and maturity, thus allowing the watermelon vines to grow larger before setting fruit, which may have led to increased yields. The average weight varied between 14.47 to 17.4 lb, which is slightly lower than the expected weight range of seed source companies for most of the cultivars in this study; similar results were found by Cushman et al. 2003. The 45-count fruit weight class had the highest portion of the yield (lb/acre), which is preferred by consumers. There was no by-year significant interaction for most of the yield parameters except 36-count (total count and percentage marketable) and 30-count fruit weight classes. For 30-count, the possible reason for the significant year $\times$ cultivar interaction is the weather, as mentioned, which had a profound effect on the cultivars Excursion and El Capitan between years. The US Department of Agriculture grade standards for watermelon require a minimum SSC of 10% soluble solids for “very good internal quality” (US Department of Agriculture, Agricultural Marketing Service 2021). All 12 cultivars averaged more

than 10% SSC in this experimental trial, with Jetski having the sweetest watermelons among all the cultivars. Triploid watermelon accumulates more fructose than sucrose in comparison with diploid cultivars, which results in a higher sweetness index in seedless cultivars (Elmstrom and Davis 1981; Kyriacou and Soteriou 2015). Flesh or pulp color is another determinant of flesh quality after SSC. El Capitan and Miramonte had darker red flesh in comparison with that of other cultivars, which indicates the presence of more carotenoids than that in lightly flesh cultivars (Yoo et al. 2012). ‘El Capitan’, ‘Miramonte’, and ‘Sierra Nevada’ had dark rinds. Consumers now tend to prefer darker rinds and flesh color; however, in the past, lighter colored rinds were more prevalent. ACX 6177 was somewhat round, while other cultivars tended to be more oval. This is consistent with the results found by Cushman et al. (2003). All the watermelon cultivars had fewer than 10 mature seeds, meeting the US standards for grades of watermelon’s definition of seedless (US Department of Agriculture, Agricultural Marketing Service 2021).

According to the (US Department of Agriculture, Agricultural Marketing Service 2021), 8% of long-type watermelons with hollow heart damage (cracks aggregating more than 1.25 inches in width) and 4% of long-type watermelons with hollow heart serious damage (cracks aggregating more than 1.5 inches in width) are considered unmarketable. The trends in hollow heart occurrence recorded in this experiment were similar to those of other studies in triploid watermelons (Freeman et al. 2007; Trandel et al. 2020). In this research experiment, sunburn did not cause a significant adverse impact on marketable yield, although ‘Powerhouse’, ‘Jetski’, ‘Captivation’, and ‘Embassy’ had more sunburned fruit numbers (lb/acre); however, these cultivars had a lighter color rind (Parris 1949). These results contradict those of Shrefler et al. (2017) and Maynard and Hopkins (1999), who claimed that cultivars with a dark rind are more susceptible to sunburn than those with a light color.

Conclusion

Of the 12 watermelon cultivars evaluated in this experiment, Excursion,

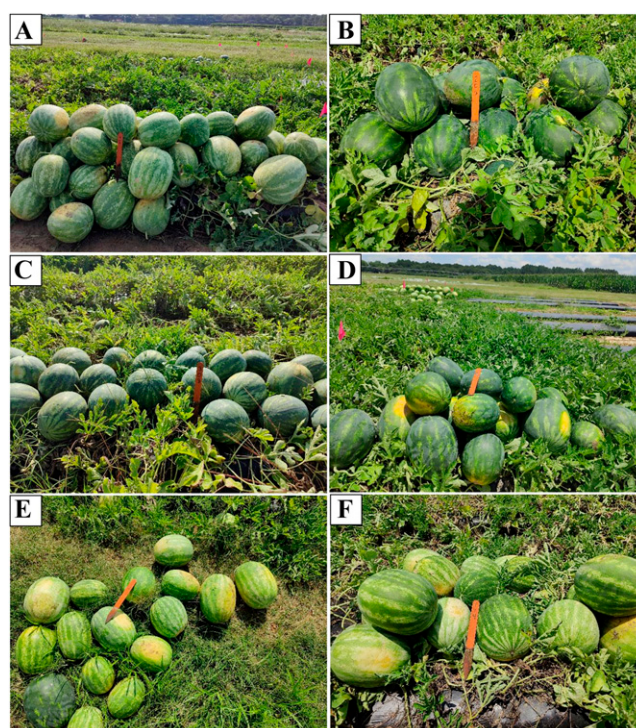


Fig. 3. Images indicating recommended watermelon cultivars: (1) 30- to 36-count: (A) Excursion (light medium green rind), (B) El Capitan (dark green rind), and (C) Sierra Nevada (medium dark green rind); and (2) 45- to 60-count: (D) Miramonte (medium dark green rind), (E) Jetski (light green rind), and (F) ACX 6177 (light green rind).

El Capitan, Sierra Nevada, Miramonte, Jetski, and ACX 6177 (Fig. 3) are recommended for commercial watermelon production in the southern Georgia region based on their commendable performance for total yield, average weight, sweetness index, outer appearance, and flesh quality. These cultivars also had minimum hollow heart and sunburn damage. Jetski had the highest percentage of SSC, although all the cultivars had an SSC of more than 10%, which is an indicator of the desirable sweetness index. For fruit weight class distribution, most of the cultivars had maximum yield in the 45-count class. For the high-yielding cultivars highlighted, Excursion, Sierra Nevada, and El Capitan had a higher rate of 30-/36-count watermelons, while ACX 6177, Miramonte, and Jetski had a large percentage of 45-/60-count watermelons. Furthermore, 'El Capitan' is a dark rind fruit, while 'ACX 6177', and 'Jetski' are light rind fruits. 'Sierra Nevada', 'Miramonte' and 'Excursion' have a medium dark rind. 'Warrior', 'Captivation', and 'Powerhouse' had the lowest average weight and marketable yield with a higher incidence of the hollow heart ('Warrior' and 'Captivation') and sunburn ('Powerhouse'); therefore, growing these cultivars in this region is no longer recommended.

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