FAMU COLLEGE OF AGRICULTURE + FOOD SCIENCES
FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY

Evaluating Traits to Efficiently Select New High-Quality Muscadine Cultivars for Florida Industry

PRESENTED BY

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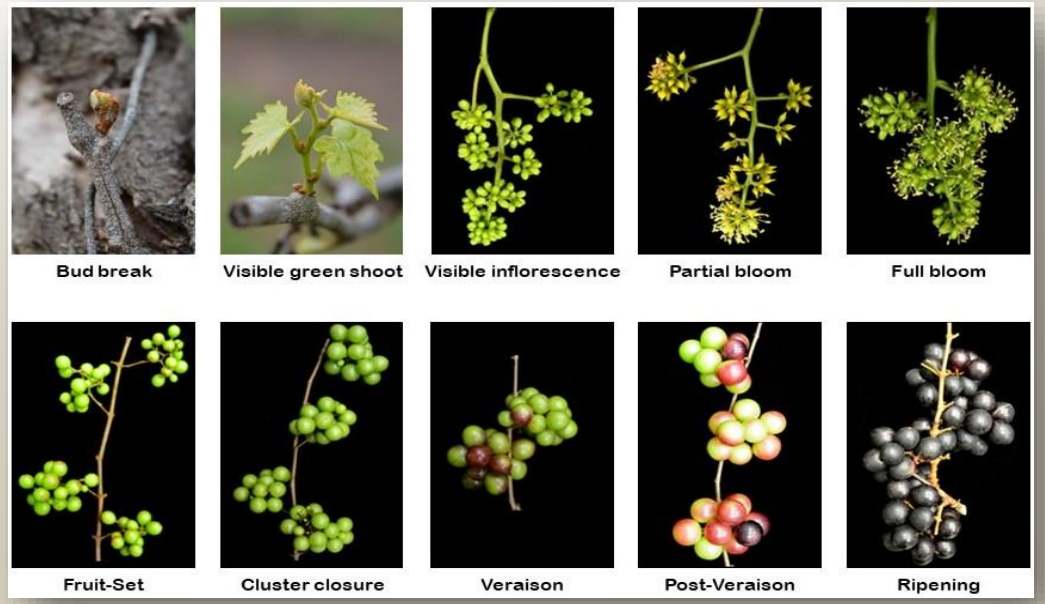
Generation of a trait-wide database for muscadine grapes

Characterization of a 90 muscadine genotypes (21 standard cultivars, 60 breeding lines, and 9 *Vitis x Muscadinia* hybrids) that are carefully selected to ensure diversity. This population is subjected to:

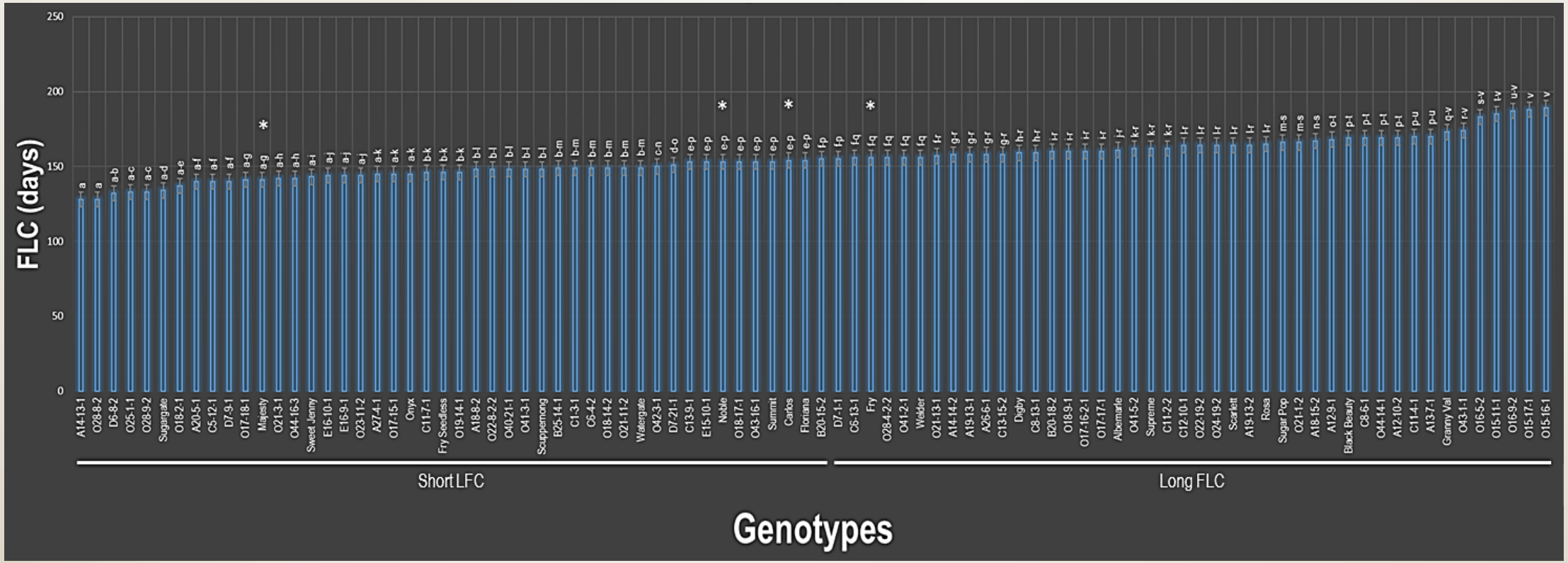
1. Phenological characterization

- Bud break (4-22 d).
- Visible green shoot (4-19 d).
- Visible inflorescence (9-34 d).
- Partial bloom (4-26 d).
- Full bloom (3-13 d).
- Fruit-set (2-24 d).
- Pre-véraison (7-48 d).
- Véraison (3-63 d).
- Post-véraison (3-69 d).
- Ripening (3-34 d).

Bud break can vary from March 9th to April 3rd in Tallahassee, FL.

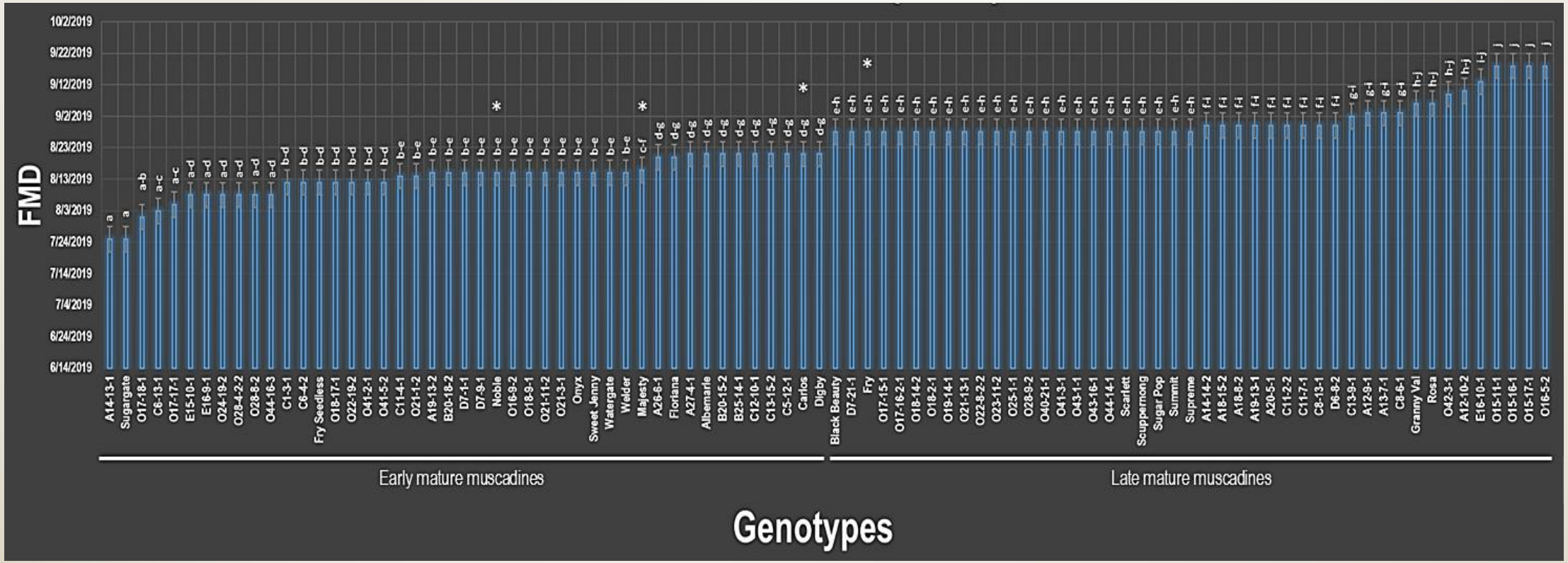


Fruit life-cycle (FLC): The number of days from bud-break to ripening.



- FLC showed moderate diversity among population (129 – 189 days).
- On average, berries from individuals required 155 ±13 days to complete their life-cycle and reach the harvest stage.
- Based on the median FLC (~154.5 days), the population was divided into two equal groups that displayed long and short FLC duration.
- The standard cultivars, Majesty (141 ±4.2 days), Noble (153 ±4.6 days), and Carlos (154 ±3.1 days) were classified among muscadine genotypes showing short FLC; however, Fry (156 ±2.6 days) statistically belonged to the group representing long FLC.

Fruit maturation date (FMD)



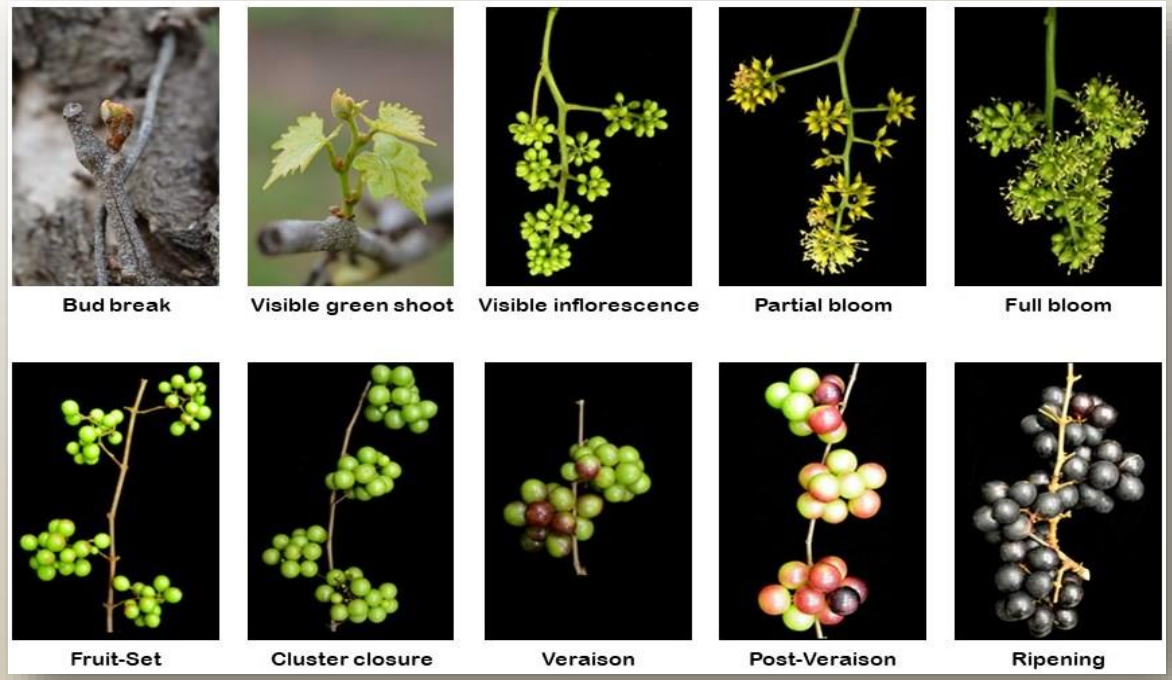
- FMD showed high diversity among population (July 25 – September 18).
- On average, berries reach ripening by August 22 ±11.5.
- Based on the median FLC (August 24), the population was divided into two equal groups of early and late maturing genotypes.
- The standard cultivars, Noble (August 15 ±3.2), Majesty (August 16 ±4.1), and Carlos (August 21 ±2.9) were classified among early maturing muscadines; however, Fry (August 28 ±3.6) was member of late maturing.

Developmental stages coordinating the FLC and FMD durations:

Based on cross-correlation analysis, we identified that:

- The longer duration of developmental stages visible green shoot (4–19 days), pre-véraison (7–48 days), and véraison (3–63 days), the more extended FLC and delayed FMD.

- The longer duration of post-véraison stage (3–69 days), the shorter FLC and earlier FMD.



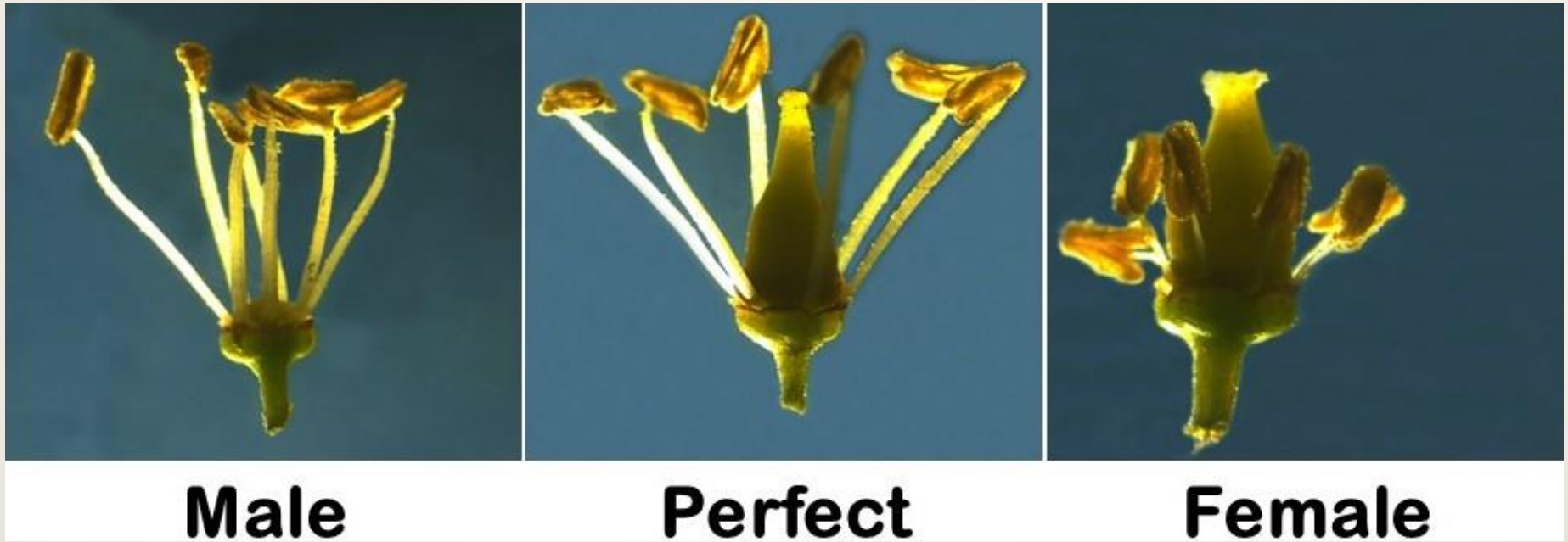
Generation of a trait-wide database for muscadine grapes

Characterization of a 90 muscadine genotypes that are carefully selected to ensure diversity. This population is subjected to:

2. Fertility-related traits

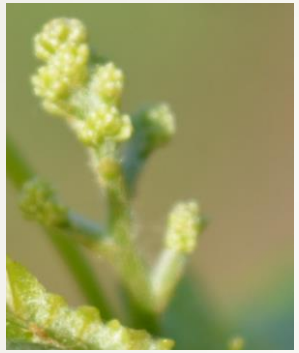
- **Flower structure.**
- **Bud fertility.**
- **Bud fertility coefficient.**
- **Fruit-set efficiency.**
- **No. Clusters/vine.**
- **Yield.**

Flower structure



Evaluating the muscadine population for the type of flower indicated that 68.9% (62 genotypes) bear perfect flowers and 31.1% (28 genotypes) produce female flowers; however, no male muscadine vines were included in this study.

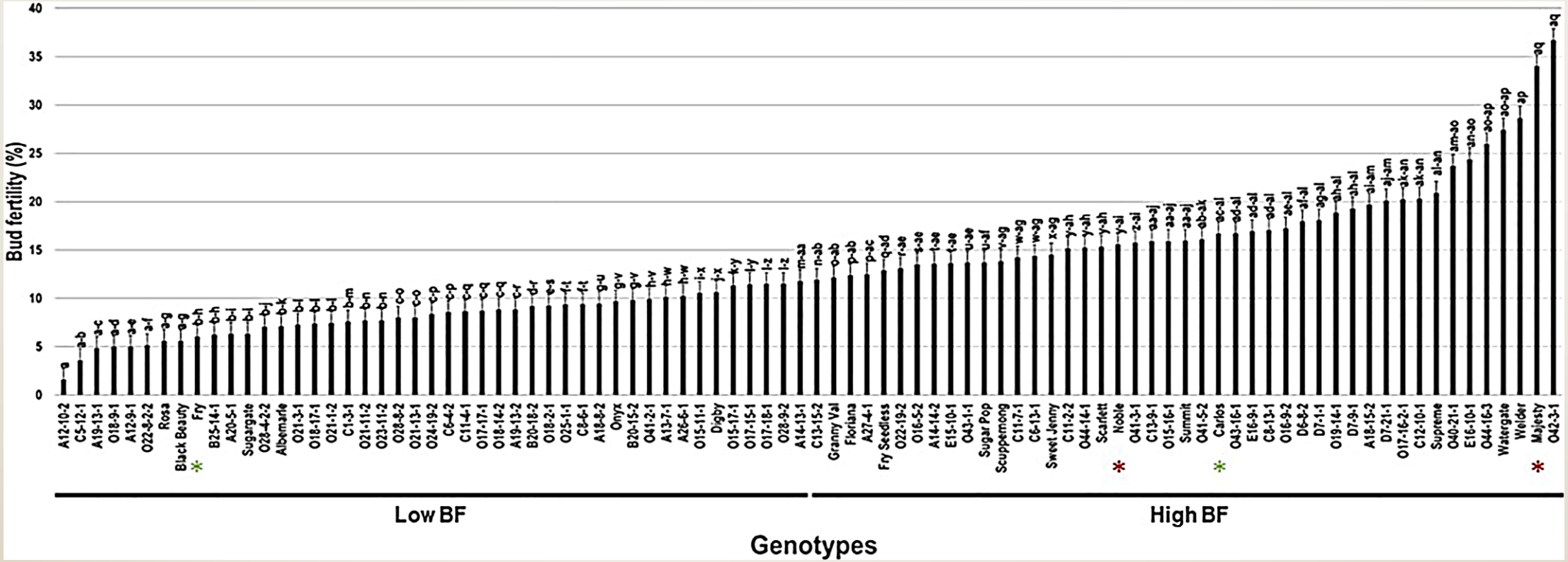
Bud fertility = (No. fruiting buds per vine/No. buds per vine) x 100.



Fruiting bud

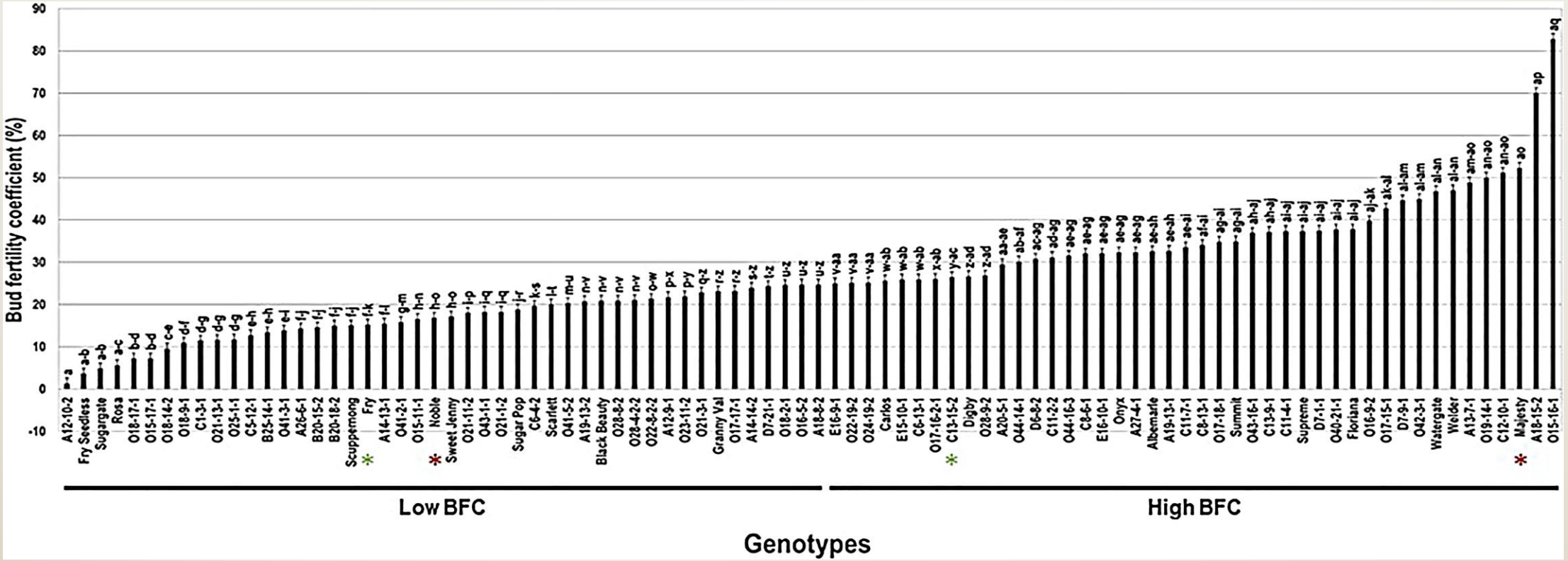
Vegetative bud

%Bud fertility



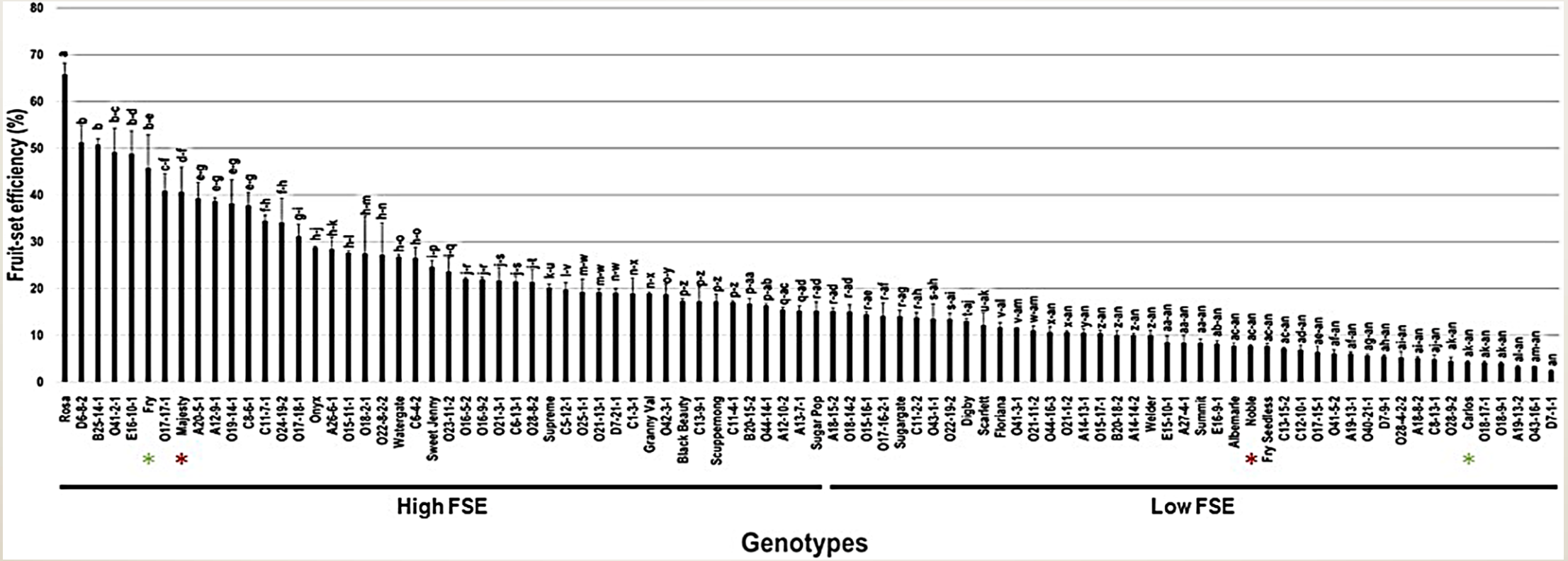
- Bud fertility showed high diversity among population (1.6 – 36.7%).
- The average bud fertility for the population was estimated at 12.9% ± 6.5.
- Based on the median bud fertility (~11.8%), the muscadine population was divided into two groups that showed low (44 genotypes, 48.9% of the population) and high bud fertility (46 genotypes, 51.1% of the population).
- The standard cultivars, Majesty (34.0% ± 1.2), Carlos (16.7% ± 0.6), and Noble (15.6% ± 0.5), were classified as members of the muscadine group exhibiting high bud fertility. However, Fry was a member of the low bud fertility group (6.0% ± 0.2).

%Bud fertility coefficient = (No. clusters per vine/No. buds per vine) x 100.



- Bud fertility coefficient trait considerably differed within the population (1.3 – 82.8%).
- The average bud fertility coefficient for the population was estimated at 26.4% ± 13.8.
- Based on the median bud fertility coefficient (~24.7%), divided the population into two equal groups of high and low bud fertility coefficient.
- Population analysis placed the commercial cultivars Majesty (52.3% ± 2.6), Carlos (25.7% ± 1.3) among the genotypes displaying high bud fertility coefficient levels, whereas the Noble (16.8% ± 0.8) and Fry (15.3% ± 0.8) cultivars were members of the low bud fertility coefficient group.

%Fruit-set efficiency = (No. berries per cluster/No. flowers per flower cluster) x 100.



- The fruit-set efficiency trait varied considerably among the population (2.4 – 65.7%).
- The average fruit-set efficiency for the population was estimated at 18.7% ± 13.3.
- The median fruit-set efficiency (~15.2%), divided the population into two groups of high (43 genotypes, or 47.8%) and low (47 genotypes, 52.2%) fruit-set efficiency.
- The commercial table cultivars Fry (45.7% ± 7.1) and Majesty (40.6% ± 5.3) were classified as members of the muscadine group exhibiting high fruit-set efficiency. In contrast, the wine muscadines Noble (7.8% ± 0.2) and Carlos (4.3% ± 0.2) were members of the low fruit-set efficiency group.

Wine grapes display much lower fruit-set efficiency than table grapes.

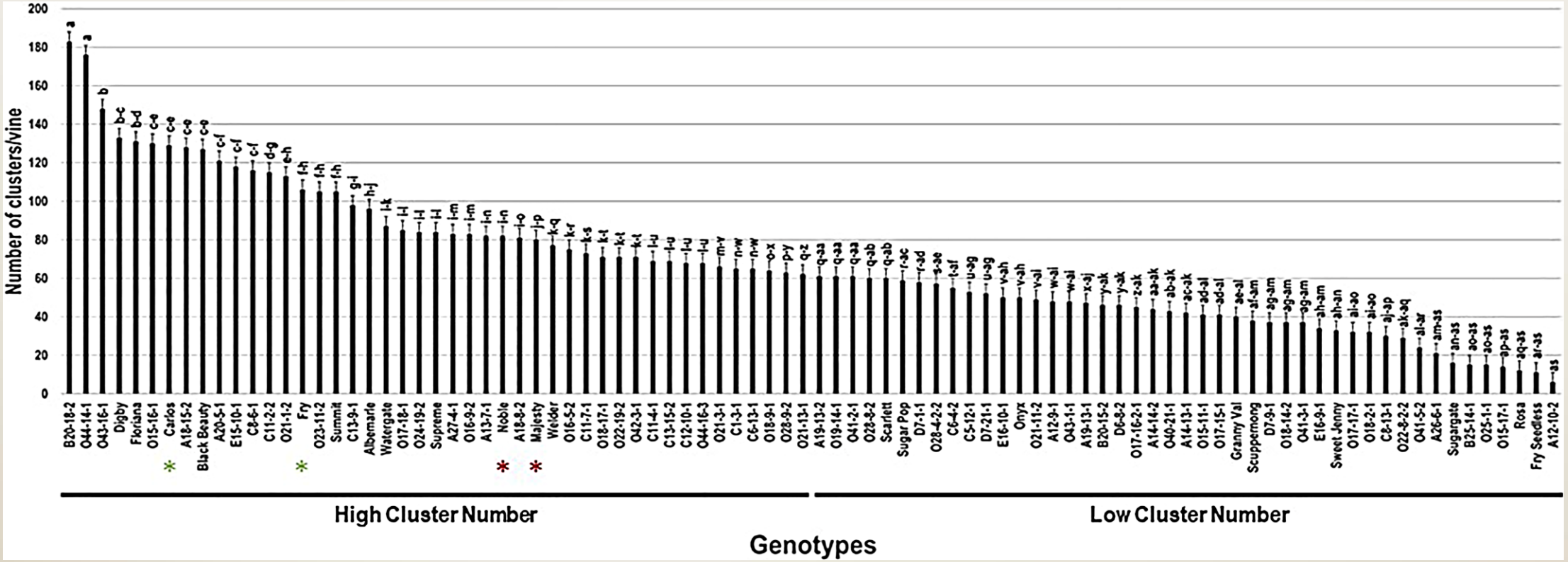
Wine grape (Noble):

- No. flowers/flower cluster (158.7 ±6.5).
- No. berries/cluster (12.2 ±0.4).
- Low fruit-set efficiency (7.8% ±0.2).

Table grape (Majesty):

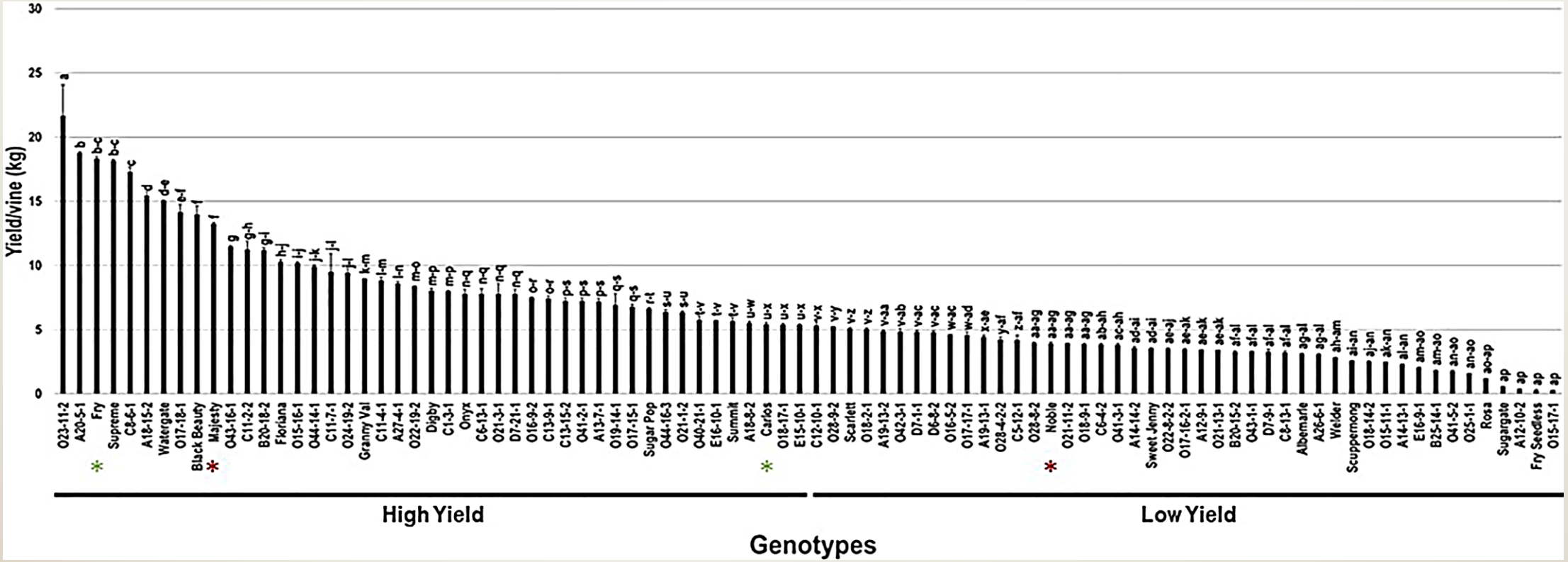
- No. flowers/flower cluster (21.7 ±4).
- No. berries/cluster (8.6 ±0.5).
- High fruit-set efficiency (40.6 ±5.3).

No. clusters/vine



- The No. clusters/vine trait varied considerably among the population (6 – 183).
- The average No. clusters/vine for the population was estimated at 67.7 ± 36.9.
- The median fruit-set efficiency (~61.5) separated the population into two equal groups that displayed high and low clusters/vine.
- Population analysis classified all the selected commercial cultivars, Carlos (129 C/V ± 11.6), Fry (106 C/V ± 9.5), Noble (82 C/V ± 7.4), and Majesty (80 C/V ± 7.2), among the genotypes displaying high clusters/vine.

Yield/vine

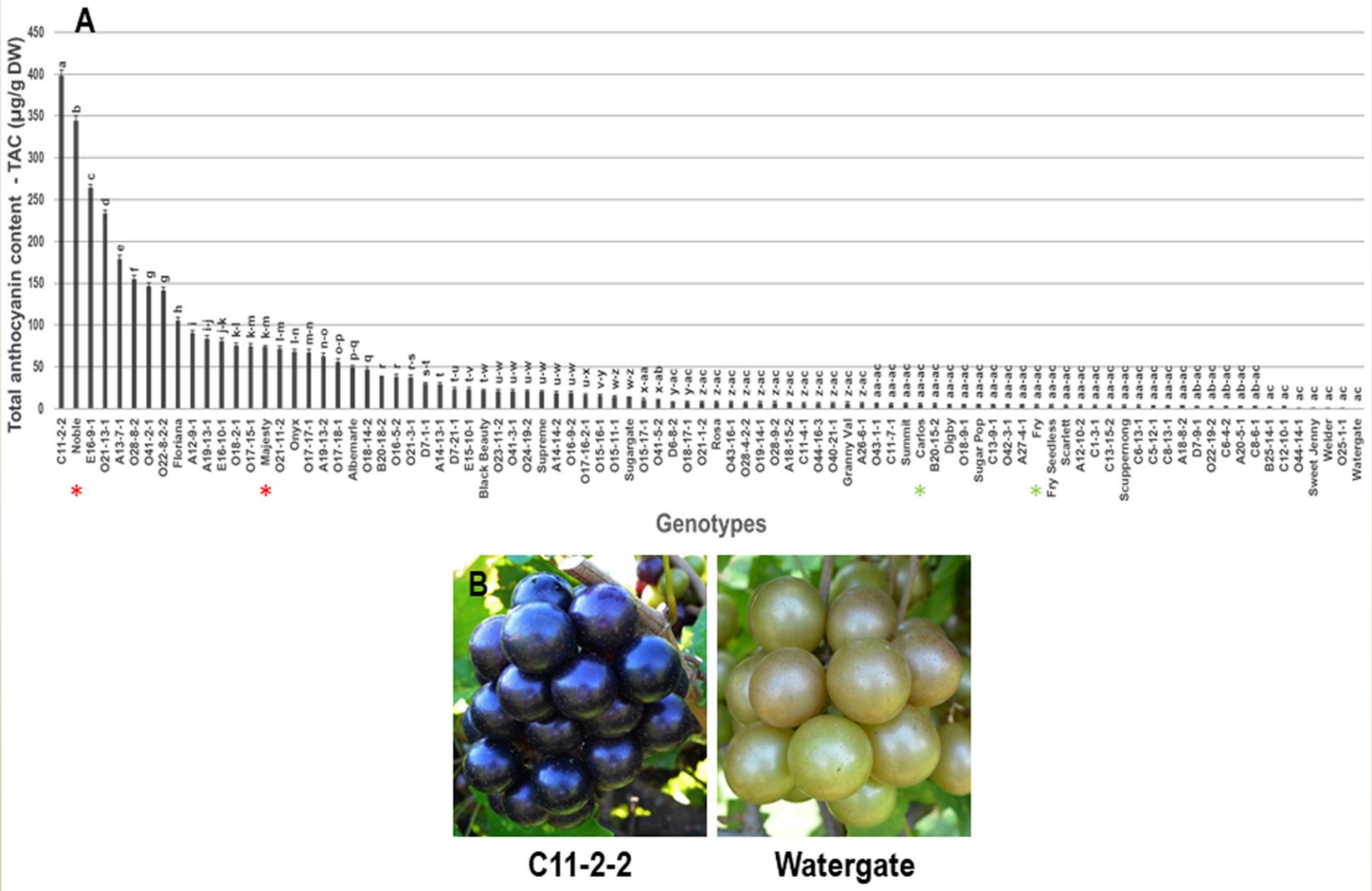


- The yield/vine trait varied considerably among the population (0.3– 22.6 kg/V).
- The average yield/vine for the population was estimated at 6.6 kg ± 4.5.
- Based on median yield/vine (~5.3 kg/vine), the muscadine population was divided into two groups that exhibited high yield (46 genotypes, 51.1% of the population) and low yield (44 genotypes, 48.9% of the population).
- Population analysis positioned the commercial cultivars Majesty (18.3 kg ± 1.6), Fry (13.3 kg ± 1.2), and Carlos (5.4 kg ± 0.5) among genotypes displaying high Y/V, whereas the Noble (3.9 kg ± 0.4) cultivar was a member of the low Y/V group.

Berry Color

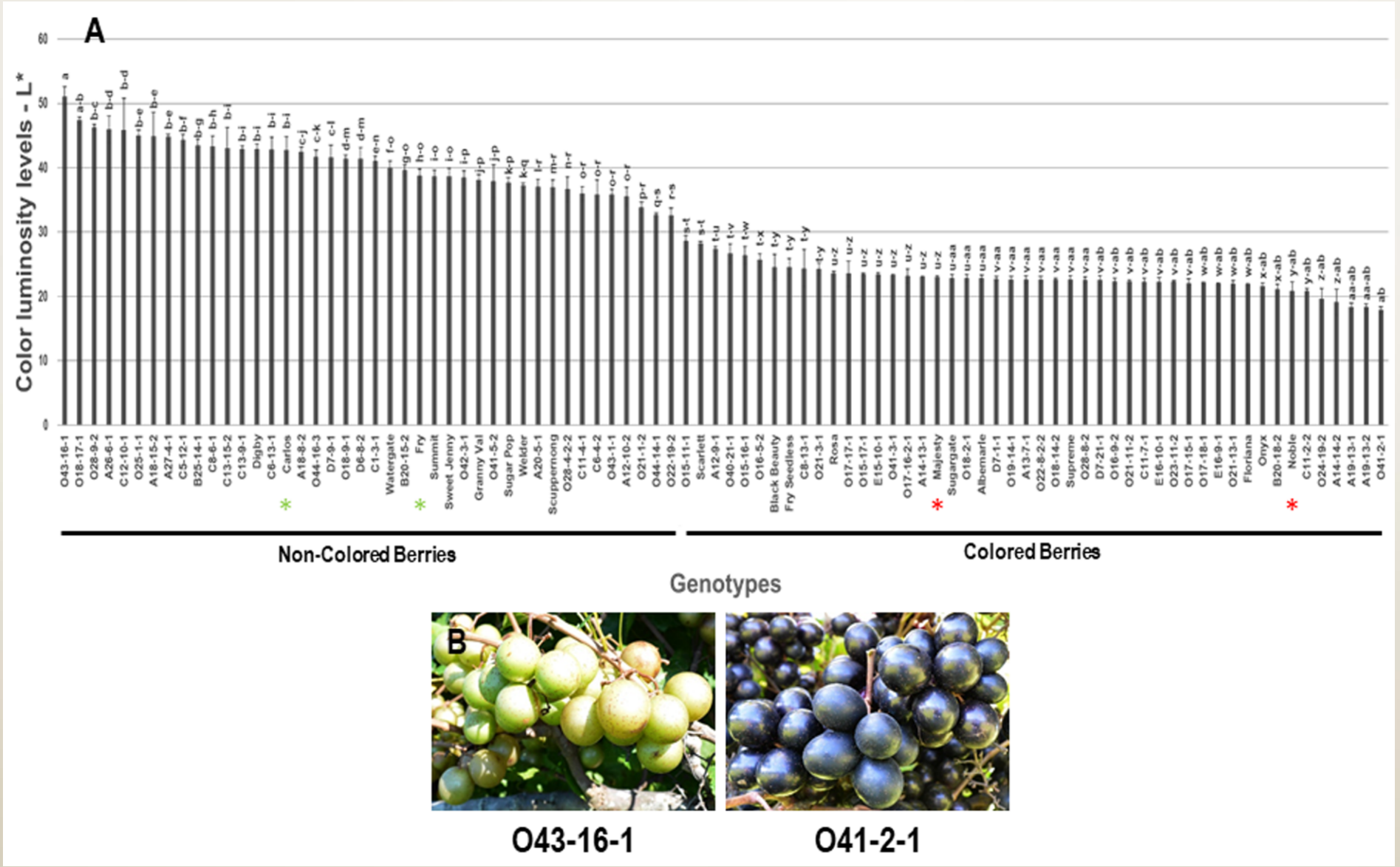
The individuals of the muscadine population were carefully selected to represent the diversity in color berries of muscadine grapes. Based on visual assessment of berry colors, the population was classified into genotypes producing colored berries (black, dark-red, and red; 48 genotypes of 53.3% of the population), and non-colored berries (red-bronze, bronze, and green; 42 genotypes of 46.7% of the population)

Total anthocyanin content (TAC)



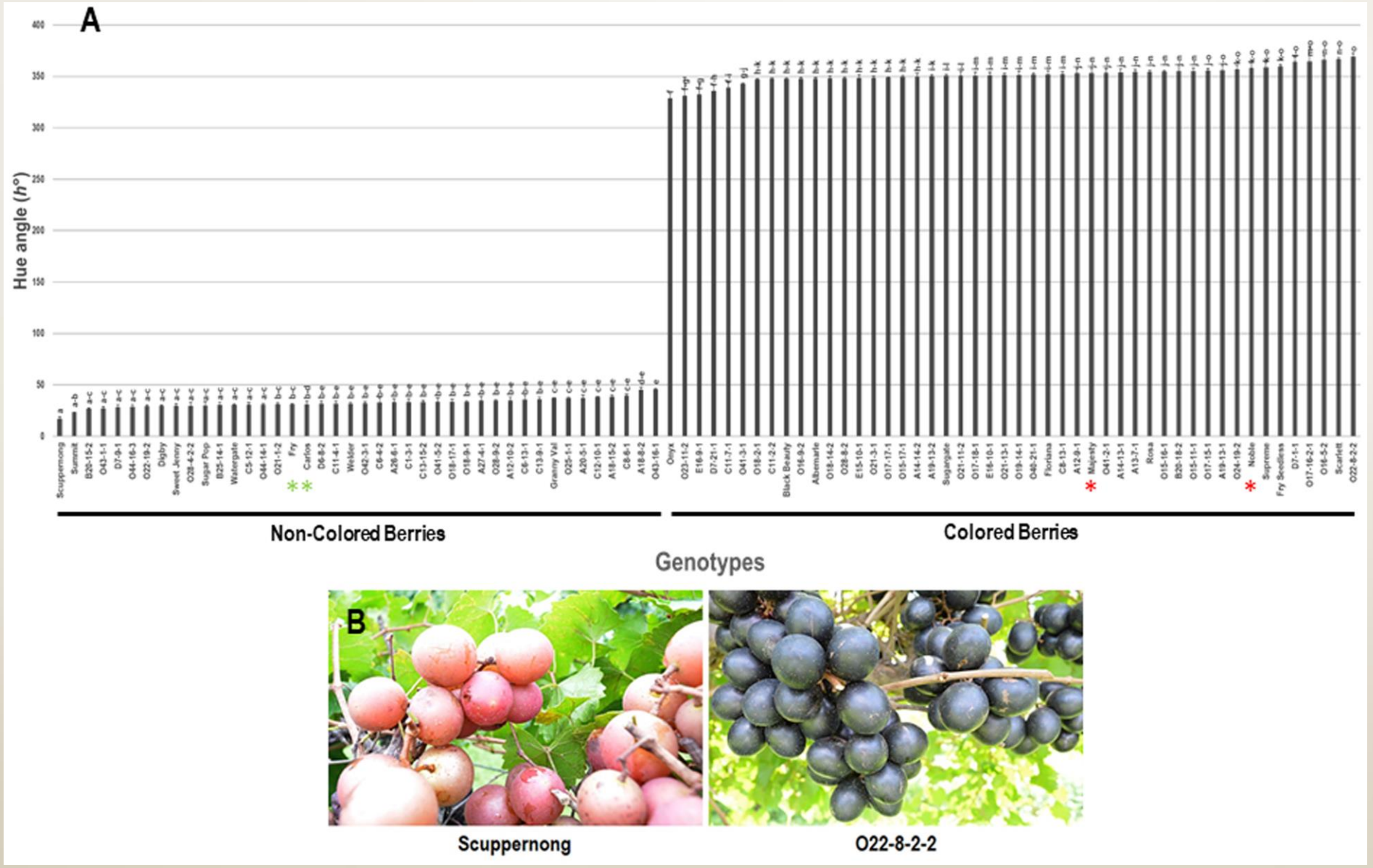
- The TAC trait varied considerably among the population [colored (3 – 398 µg/g DW) and non-colored (0.2 – 10.1 µg/g DW)].

Color luminosity



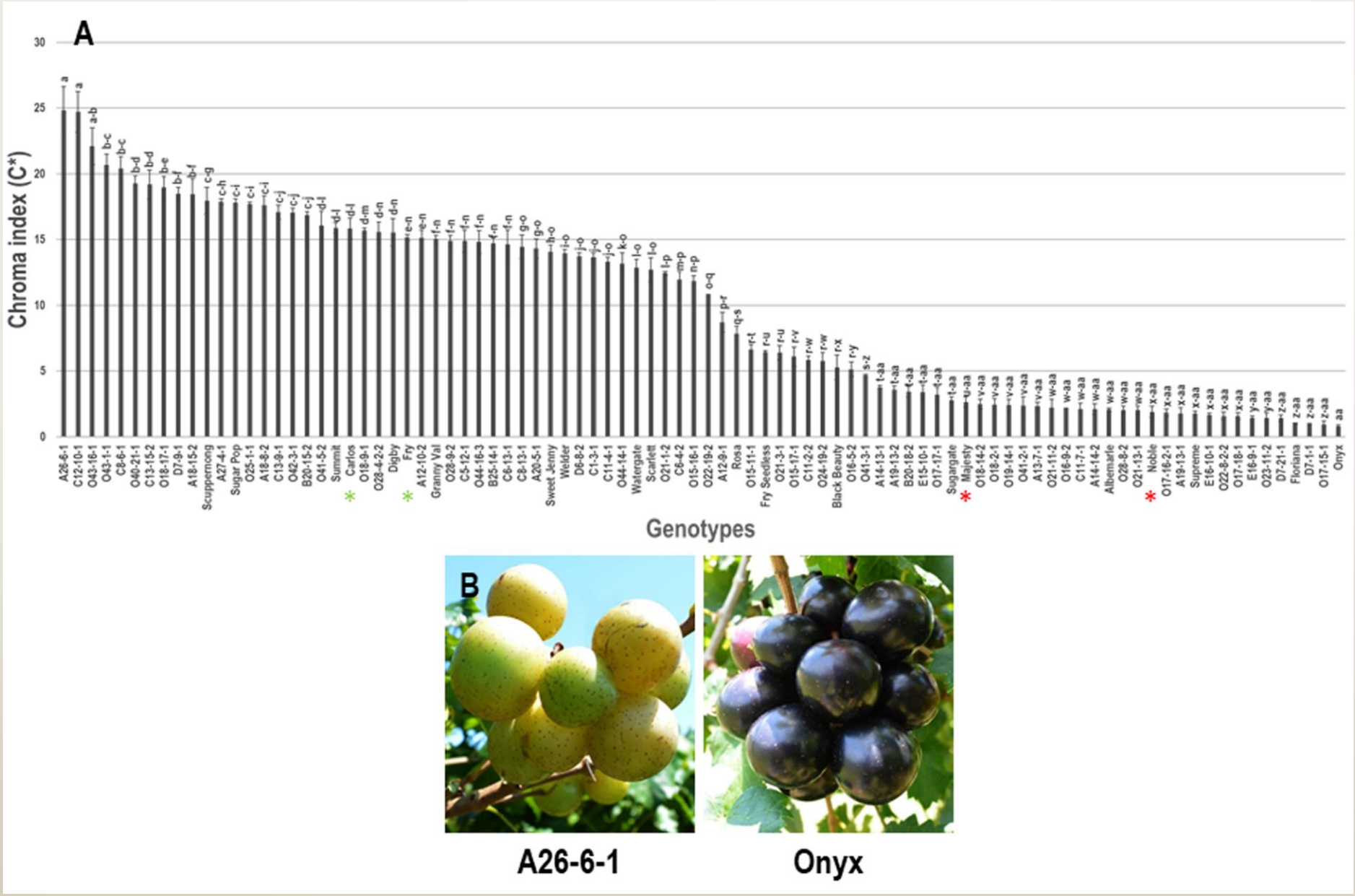
- The luminosity trait varied considerably among the population [colored (17.9 – 28.6) and non-colored (32.6 – 51.1)].

Hue angle



- The hue angle trait varied considerably among the population [colored (328.7 – 369.1) and non-colored (17.0 – 45.4)].

Chroma index



- The chroma index trait varied considerably among the population [colored-Black/Dark-Red (0.8 – 6.5), colored-Red (6.6 – 19.3), and non-colored (10.8 – 24.8)].

OUTCOMES

- Accelerate muscadine breeding process through developing marker-assisted breeding and selection.

2-weeks old plants

DNA extraction
15-min

PCR
2-hrs

KNOWING

Traits with DNA-markers

- Flower structure (female or perfect).
- No. clusters/vine.
- Yield/vine.
- No. berries/cluster.
- Berry size.
- Berry weight.
- Berry color.

Noble

Floriana

B20-18-2

C11-2-2

Character	Noble	Floriana	B20-18-2	C11-2-2
Fruit Maturation Date – FMD	Aug-15	Aug-20	Aug-21	Aug-30
Fruit Life Cycle – FLC (d)	153 ±5	156 ±4	160 ±6	162 ±5
Flower Structure – FLS	P	P	P	P
Bud Fertility – BF (%)	15.6 ±1.2	12.4 ±1.0	13.5 ±1.0	7.4 ±0.8
Bud Fertility Coefficient – BFC (%)	16.8 ±1.6	37.8 ±2.2	15.0 ±1.5	31.2 ±2.3
Fruit-set Efficiency – FSE (%)	7.8 ±0.2	11.7 ±1.0	10.0 ±1.0	13.7 ±1.1
Cluster Intensity	Loose	Semi-Compact	Loose	Semi-Compact
Cluster Compactness – CC	6.9 ±0.8	16.9 ±1.2	9.2 ±1.0	18.9 ±1.3
Cluster Weight – CWE (g)	47.8 ±1.5	78.6 ±1.1	61.1 ±1.1	97.9 ±2.7
No. of Berries/Cluster – N.B/C	12.2 ±0.4	13.2 ±0.6	13.2 ±1.1	27.6 ±4.7
Berry Weight – BWE (g)	4.0 ±0.3	6.1 ±0.4	5.2 ±0.3	3.0 ±0.3
No. of Seeds/Berry – N.S/B	3.8 ±0.5	4.0 ±0	4.2 ±0.5	3.2 ±0.5
Dry Scar Pattern – SP (%)	28 ±3.0	60 ±4.3	18 ±1.3	64 ±5.2
Berry Color	Black	Black	Black	Black
Total Anthocyanin Content – TAC (µg/g DW)	344.5 ±5.8	75.7 ±2.6	38.1 ±1.0	398.1 ±6.8
Color Lightness – L	20.8 ±1.5	21.9 ±0.2	21.1 ±0.8	20.8 ±0.5
Hue – H	358.0 ±5.3	353.9 ±4.4	355.1 ±6.4	347.6 ±1.1
Chroma – C	1.9 ±0.4	1.0 ±0.2	3.4 ±0.4	5.9 ±0.3
Total Color Difference – ΔE	-	1.39	1.68	4.00
50-Berries Pomace Weight – PW.50-B (g)	75.2 ±4.7	83.5 ±1.4	104.0 ±6.6	48.4 ±5.0
50-Berries Juice Volume – JV.50-B (ml)	120.2 ±7.4	185.0 ±3.1	132.5 ±8.5	101.7 ±10.5
No. of Clusters/vine – N.C/V	82 ±5.4	131 ±7.9	183 ±10.5	115 ±8.3
Yield/Vine – Y/V (kg)	3.9 ±0.6	10.3 ±0.8	11.2 ±0.9	11.3 ±1.2
Total Soluble Solids – TSS (°Brix)	13.1 ±0	17.6 ±0.7	11.9 ±0.4	12.6 ±0
Acidity – Acid (mg tartaric acid/L)	3.8 ±0.2	4.7 ±0.3	4.1 ±0.2	3.2 ±0.7
TSS/Acid Ratio – (T/A)	3.5 ±0.7	3.8 ±0.5	2.9 ±0.6	3.9 ±0.9
pH	3.36 ±0.12	3.62 ±0.19	3.26 ±0.15	3.48 ±0.20
Total Phenolic Content – TPC (mg GAE/g DW)	59.9 ±5.1	83.9 ±5.9	62.9 ±6.9	73.9 ±6.7
Total Flavonoid Content – TFC (mg QE/g DW)	30.0 ±3.5	30.9 ±2.6	26.4 ±2.8	29.7 ±2.5
DPPH – (% inhibition)	29.9 ±3.0	34.6 ±3.5	31.4 ±3.2	31.8 ±3.3

Carlos

C8-6-2

O26-15-1

O44-14-1

Character	Carlos	C8-6-1	O26-15-1	O44-14-1
Fruit Maturation Date – FMD	Aug-21	Aug-30	Sep-2	Aug-28
Fruit Life Cycle – FLC (d)	154 ±5.3	169 ±6.8	162 ±6.0	169 ±7.0
Flower Structure – FLS	P	F	P	P
Bud Fertility – BF (%)	16.7 ±1.8	9.4 ±0.6	17.4 ±1.0	15.2 ±1.2
Bud Fertility Coefficient – BFC (%)	25.6 ±2.5	32.0 ±2.3	57.7 ±4.5	30.1 ±1.9
Fruit-set Efficiency – FSE (%)	4.3 ±0.2	27.7 ±1.9	33.4 ±2.6	10.7 ±1.1
Cluster Intensity	Loose	Compact	Semi-Compact	Semi-Compact
Cluster Compactness – CC	6.8 ±0.8	28.9 ±1.5	16.2 ±1.0	11.4 ±1.1
Cluster Weight – CWE (g)	41.9 ±1.4	149.1 ±3.1	165.4 ±2.2	56.4 ±0.6
No. of Berries/Cluster – N.B/C	7.6 ±0.9	20.8 ±2.7	30.8 ±1.1	13.8 ±0.4
Berry Weight – BWE (g)	6.7 ±0.4	8.6 ±0.5	6.3 ±0.3	4.6 ±0.5
No. of Seeds/Berry – N.S/B	4.0 ±0	4.0 ±0	3.0 ±0.3	3.2 ±0.5
Dry Scar Pattern – SP (%)	54 ±4.4	18 ±2.1	12 ±1.3	72 ±6.3
Berry Color	Bronze	Bronze	Bronze	Bronze
Total Anthocyanin Content – TAC (µg/g DW)	5.4 ±1.4	2.3 ±0.9	4.0 ±0.9	0.3 ±0.1
Color Lightness – L	42.8 ±2.1	43.3 ±1.7	37.5 ±0.8	32.7 ±0.3
Hue – H	31.3 ±2.6	39.3 ±1.5	32.2 ±1.4	30.7 ±1.4
Chroma – C	15.8 ±0.8	20.4 ±0.9	17.0 ±0.9	13.2 ±0.8
Total Color Difference – ΔE	-	5.55	5.44	10.45
50-Berries Pomace Weight – PW.50-B (g)	92.5 ±4.9	116.4 ±6.5	81.0 ±3.0	69.2 ±7.0
50-Berries Juice Volume – JV.50-B (ml)	204.2 ±10.9	288.8 ±16.0	165.0 ±6.2	150.5 ±15.2
No. of Clusters/vine – N.C/V	129 ±4.9	116 ±6.5	153 ±7.5	176 ±7.1
Yield/Vine – Y/V (kg)	5.4 ±0.7	17.3 ±1.5	25.3 ±3.1	9.9 ±0.6
Total Soluble Solids – TSS (°Brix)	12.8 ±0.3	9.4 ±0	14.3 ±0.4	14.7 ±0.3
Acidity – Acid (mg tartaric acid/L)	3.6 ±0.2	3.7 ±0.2	3.5 ±0.2	3.1 ±0.3
TSS/Acid Ratio – (T/A)	3.6 ±0.6	2.6 ±0.6	4.1 ±0.6	4.7 ±0.9
pH	3.27 ±0.16	3.14 ±0.15	3.54 ±0.15	3.57 ±0.13
Total Phenolic Content – TPC (mg GAE/g DW)	45.3 ±4.4	103.3 ±6.1	79.9 ±6.9	60.0 ±4.7
Total Flavonoid Content – TFC (mg QE/g DW)	24.8 ±2.5	28.6 ±2.1	27.4 ±2.6	22.1 ±2.0
DPPH – (% inhibition)	20.7 ±2.3	27.1 ±2.8	29.4 ±2.2	28.3 ±2.6

Acknowledgement

FLORIDA SPECIALTY CROP FOUNDATION

Florida Wine & Grape Growers Association
Established 1923

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

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Thank You