

Cole Crops in Delaware with Lessons for Indiana

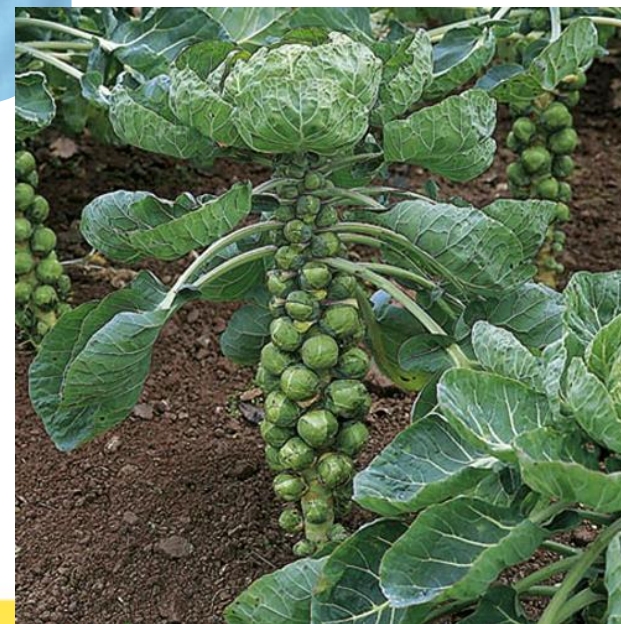
Dr Gordon Johnson
Extension Vegetable Specialist, retired
University of Delaware



Stress Tolerance Differences Between Cole Crops



Climate change is making it more difficult to grow broccoli, cauliflower, and Brussels sprouts



Cabbage is the most adaptable to all seasons



- Field planting dates
 - March, April
 - July, August
 - Summer possible
- Transplanted usually
 - Plants started 6 weeks ahead
 - Greenhouse, field possible for fall crop
 - Direct seeding possible
- Spacing
 - 2-3' between rows
 - 9"-15" in-row
- Irrigation required
- Mineral nutrients
 - Nitrogen 100-150 lbs/a in split applications
 - P and K according to soil test
 - Sulfur 25-40 lbs/a
 - Boron 1.5-3 lbs/a

Crop	Variety	F1 ¹	Maturity ²	Lbs	Shape	Use ³	Y ⁴	BR ⁴	TB ⁴	Thr ⁴	SH ⁴
Green Cabbage	Bajonet	Yes	Midseason	3-5	Round	F	H				
	Blue Dynasty	Yes	Midseason	4	Round	F	H	H			H
	Blue Lagoon	Yes	Early	3-5	Round	F	H	M			
	Blue Vantage	Yes	Midseason	4	Round	F	H	L	H	H	
	Bobcat	Yes	Midseason	4-6	Round	F	H		H	H	H
	Bravo	Yes	Late	4-10	Round	F, P	H	H			
	Bronco	Yes	Midseason	3-5	Round	F	H		M	M	
	Bruno	Yes	Late	4	Round	F	H	H			

Cabbage, continued next page.

Crop	Variety	F1 ¹	Maturity ²	Lbs	Shape	Use ³	Y ⁴	BR ⁴	TB ⁴	Thr ⁴	SH ⁴
Green Cabbage	Caraflex	Yes	Early	2-3	Pointed	F	H			H	
	Charmant	Yes	Early	3	Round	F	H	H		L	H
	Cheers	Yes	Midseason	5	Round	F	H	H		H	
	Early Thunder	Yes	Midseason	3-4	Round	F	H	M	M	H	
	Emblem	Yes	Late	3-5	Round	F	H	H	H		H
	Grand Vantage	Yes	Midseason	5-6	Round	F	H				
	Megaton	Yes	Late	10-20	Round	P	H		H		
	Padoc	Yes	Midseason	5-8	Round	P	H		H		
	Platinum Dynasty	Yes	Midseason	4-10	Round	F, P	H	H	H		H
	Primo Vantage	Yes	Midseason	4-5	Round	F	H				
	Quick Start	Yes	Early	3-4	Round	F	H		H	M	
	Ramada	Yes	Late	3-6	Round	F	H	H			
	Royal Vantage	Yes	Midseason	3-5	Round	F	H	H	H	H	
	Superstar	Yes	Late	3-4	Round	F	H	H	H	M	
	Supreme Vantage	Yes	Early	4-5	Round	F, P	H				
	Thunderhead	Yes	Midseason	3-5	Round	F	H	H	H	H	
Vantage Point	Yes	Late	5-6	Round	F	H	H	H	H		
Viceroy	Yes	Late	4-8	Round	F, P	H	I	H	H		

¹F1=Hybrid. ²Early, Midseason (Mid), or Late. ³F=Fresh market, P=Processing (slaw, kraut). ⁴Pest or Abiotic Stress Reaction: Y=Yellows, BR=Black rot, TB=Tip Burn, Thr=Thrips, SH=Split Head; M=Moderate or intermediate and H=high level of resistance or tolerance.

Green Savoy Cabbage	Alcosa	Yes	Early	2-4	Round	F	H		H		
	Clarissa	Yes	Midseason	2-3	Round	F	H		H		
	Melissa	Yes	Midseason	2-4	Round	F	H		H		
	Miletta	Yes	Late	3-4	Round	F			H		
	Savoy Ace	Yes	Midseason	3-4	Round	F	M				
	Savoy Blue	Yes	Late	3-5	Round	F					
	Savoy King	Yes	Midseason	4	Round	F			H		
Red Cabbage	Azurro	Yes	Midseason	3-4	Round	F			H	H	
	Cairo	Yes	Late	3-6	Round	F	M		H	H	H
	Red Dynasty	Yes	Midseason	5-12	Round	F, P			H		H
	Red Jewel	Yes	Midseason	3-5	Round	F			H		
	Ruby Perfection	Yes	Late	3-4	Round	F	M	M	M	H	
Red Savoy Cabbage	Deadon	Yes	Late	3-5	Round	F					

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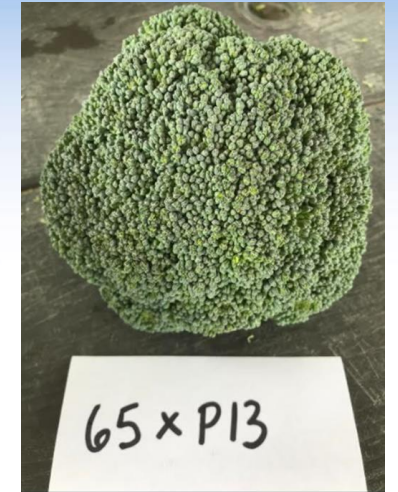
<https://www.udel.edu/academics/colleges/canr/cooperative-extension/sustainable-production/commercial-crops/vegetable-crops/midatlantic-vegetable-recommendations/>

2024/2025

Mid-Atlantic Commercial Vegetable Production Recommendations



Heat stress in broccoli and cauliflower is a problem and varietal susceptibility needs to be tested locally





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Challenges in Expanding Broccoli Production in Delaware

*Dr. Gordon Johnson,
Extension Fruit & Vegetable Specialist
Department of Plant and Soil Sciences*

*Emmalea G. Ernest
Associate Scientist
University of Delaware*

Delaware a Challenge

- Delmarva Peninsula
- South of north and north of south
- Becoming more southern
- Heavy disease and insect pressure



Heat Stress Effects on Broccoli



Temperatures above 86° F during early head formation causes uneven floret development and “rough” heads.






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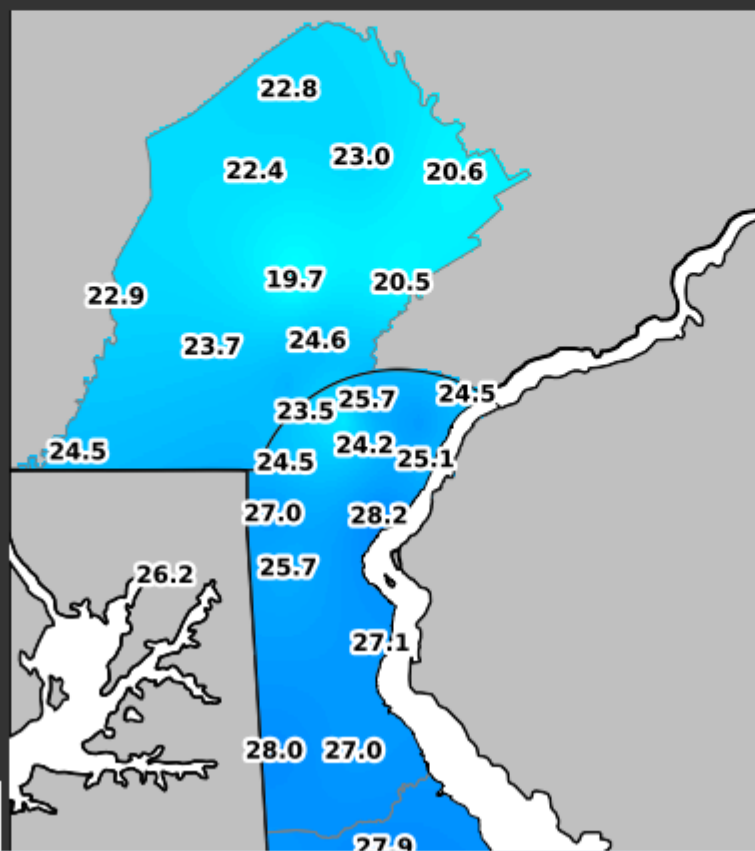
Forecasted Weather Hazard ▾

Current Conditions

Select a layer to draw:

- Air Temperature
- Feels Like
- Dewpoint Temperature
- Barometric Pressure
- Relative Humidity
- 1-hr Rain
- 24-hr Rain
- Wind
- 1-hr Peak Wind Gust
- Radar
- Satellite

AIR TEMPERATURE



Station Conditions

Newark, DE-Ag Farm ▾

Elevation: 106 feet
Location: 39.6695°N, -75.7503°W

CURRENT

TEMPERATURE: **27.0 °F**

FEELS LIKE: 22.0 °F

DEWPOINT: 14.3 °F

RELATIVE HUMIDITY: 58 %

PRESSURE: 1013 mb

1-HR RAIN: 0.00 in

24-HR RAIN: 0.00 in

WIND: 4.2 mph SW

120

- Spring Transplant Date
 - 4/29
- 8 Varieties spring (commercial)
- White plastic, double row, 1' in-row
- Drip irrigated
- 160 lbs./a N
- 80 plant plots
- RCB, 4 blocks
- Harvested June-July
- Number, weight, grades, defects, and diseases



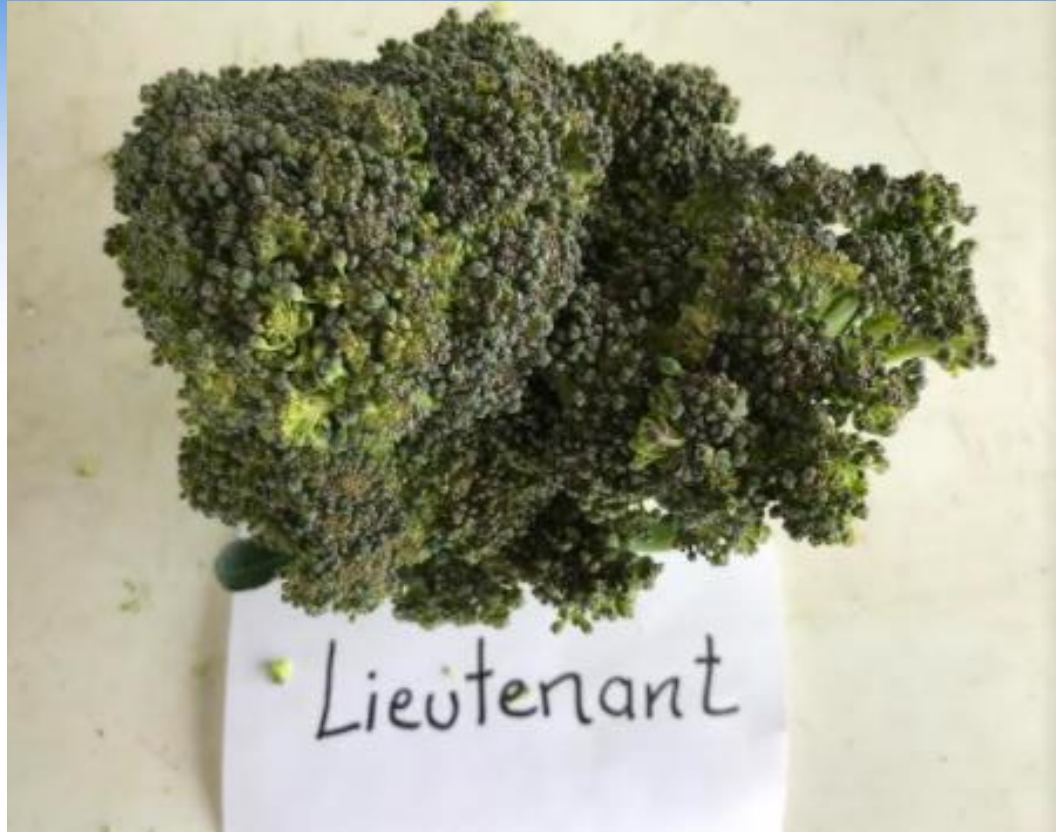
Variety	Boxes/a (23 lb)	% Market	
Eastern Crown	433	79	a
Emerald Crown	350	65	ab
Imperial	321	67	abc
Millenium	230	56	bcd
Lieutenant	173	52	cd
Burney	170	43	cd
Bay Meadows	168	43	cd
Abrams	112	30	d



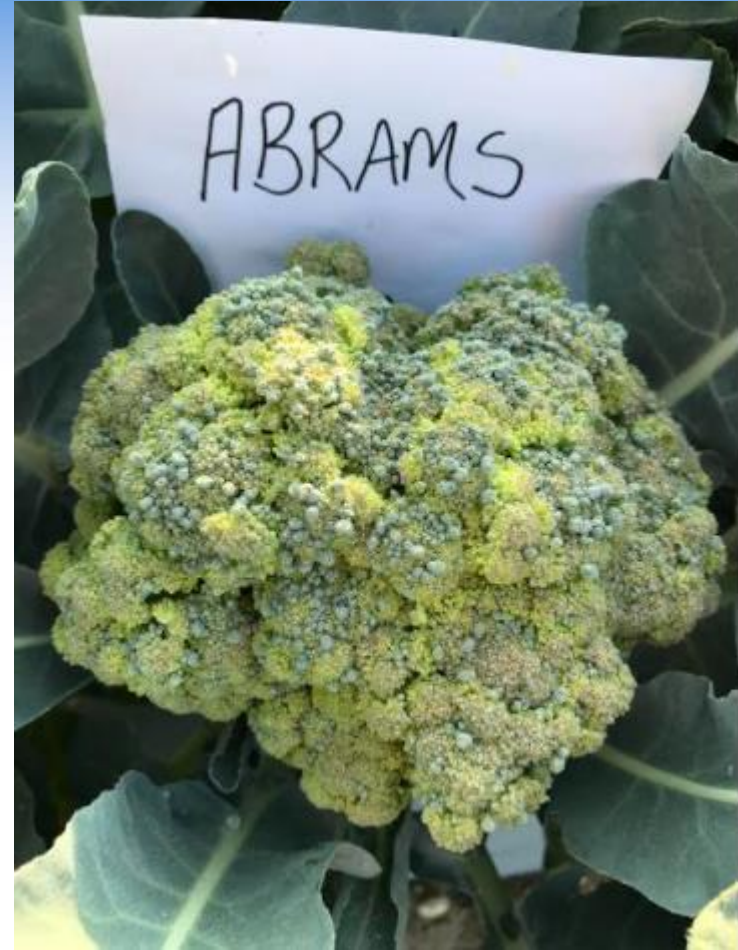








Bay
Meadows



Major Defects

- Unevenness, not domed
- Florets not formed properly
- Brown bead
- Loose
- No head disease
- Some black rot

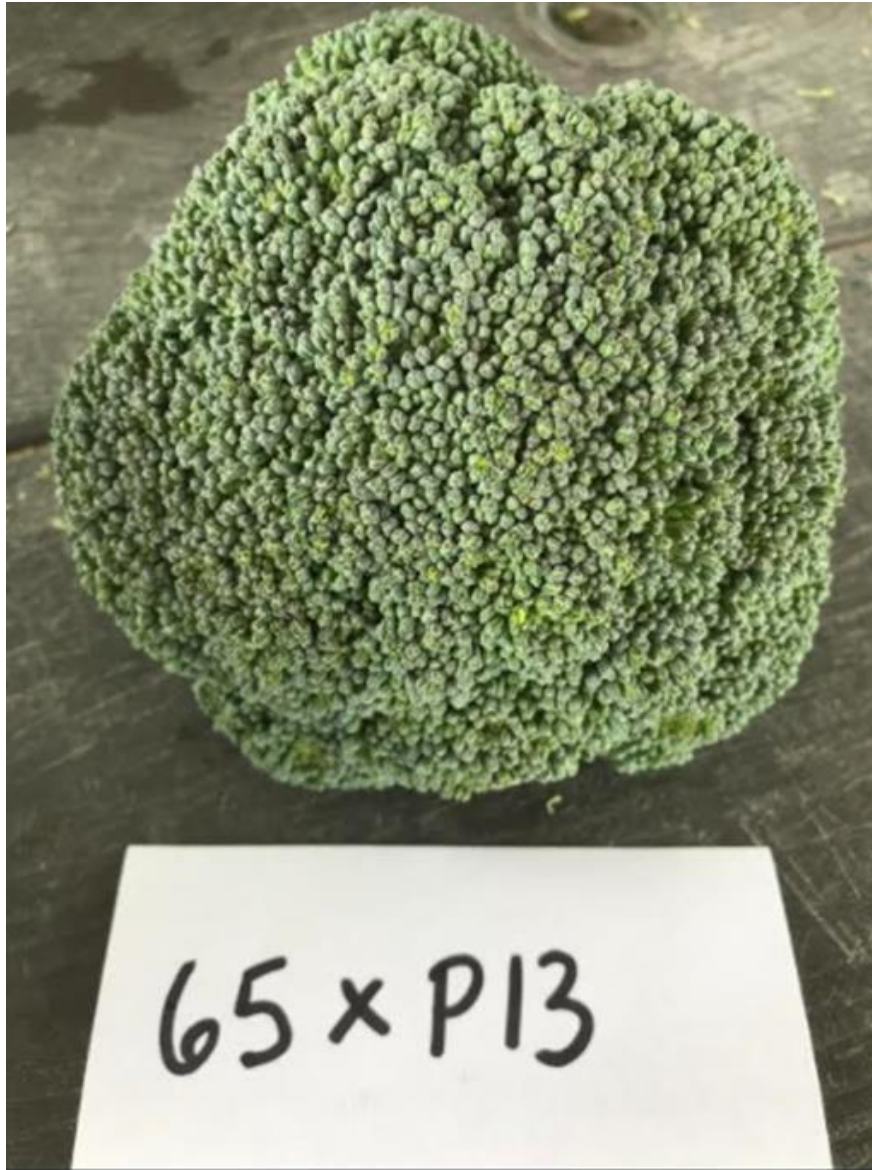


- Fall Transplant Date
 - 8/15
- 9 varieties fall (commercial + experimental)
- White plastic, double row, 1' in-row
- Drip irrigated
- 160 lbs./a N
- 40 plant plots
- RCB, 4 blocks
- Harvested October-November Number, weight, grades, defects, and diseases



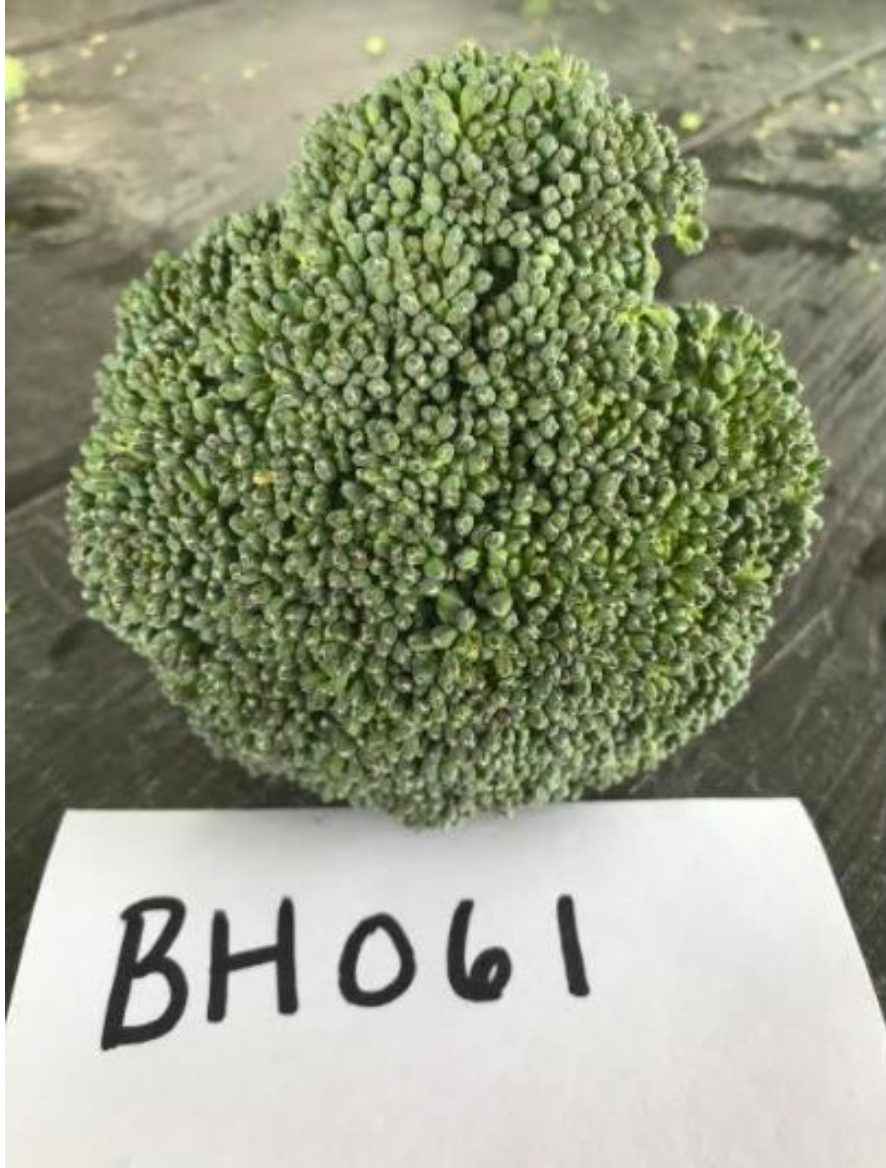
Variety	Boxes/a (23 lb)	
BE 16-3-13	445	a
Emerald Crown	430	a
Eastern Crown	388	ab
65 X P13	367	ab
BE 16-2-13	349	ab
BH 053	310	ab
Montague	227	bc
BH 055	183	bc
BH 061	115	c











Major Defects

- Brown Bead
- Loose
- Unevenness, not domed
- Small
- Thin stem

- No head disease
- Some black rot



Foliar diseases but no head diseases



Mostly
Black Rot

Broccoli Planting Date and Variety Trials – Spring/Fall Georgetown, 2017

- Spring Transplant Dates
 - 4/3, 4/17
- Fall Transplant Dates
 - 7/25, 8/10
- 22 Varieties
- High density – 28 plants per plot
- RCB, 4 blocks
- Harvested June (Spring),
September/October (Fall)
- Number, weight, grades,
defects, and diseases



Table 1. Broccoli marketable yields and cull percent, UD-REC, Georgetown, Spring 2017, April 3 planting.

Variety	Marketable Yield		Cull
	lbs/acre	boxes/acre	%
Eastern Crown	10742	467	9
Luna	10390	452	16
Sakata 6316	9866	429	39
Sakata 6317	9097	396	30
Emerald Crown	8680	377	16

Table 2. Broccoli marketable yields and cull percent, UD-REC, Georgetown, Spring 2017, April 17 planting.

Variety	Marketable Yield		Cull
	lbs/acre	boxes/acre	%
Millennium	14735	641	0
Eastern Crown	11214	488	3
Emerald Crown	9732	423	9
Sakata 6316	9342	406	16
Gypsy	9033	393	7
Green Gold	8433	367	6

Broccoli Planting Date and Variety Trials – Spring/Fall Georgetown, 2018

- Spring Transplant Dates
 - 4/3, 4/17, 4/30
- Fall Transplant Dates
 - 7/25, 8/17
- 22-26 Varieties
- High density – 28 plants per plot
- RCB 4 blocks
- Harvested June (Spring),
September/December (Fall)
- Number, weight, grades,
defects, and diseases



Green Gold	269 boxes	8593 lbs	a
Diamante	261	8361	a
SVBL 2085	219	7012	ab
Imperial	209	6682	ab
Gypsy	207	6621	ab
Millennium	184	5902	ab
Lieutenant	172	5498	abc
Eastern Crown	171	5460	abc
Durapak	166	5327	abcd
Diplomat	130	4163	abcde

Below commercial yields (<400 boxes) in the early April 2018 planting. Best were Green Gold and Diamante

	Boxes	Lbs	
Millennium	193	6169	a
Eastern Crown	146	4677	ab
Durapak	117	3735	bc
Lieutenant	114	3663	bc

Top varieties
In the Mid-April
planting
were Millennium
and Eastern
Crown but yields
were very low

Variety	%mkt
Eastern Crown	34.8
Millenium	29.5
Lieutenant	26.8
Emerald Crown	20.5

BEJO 3019	215 Boxes	6873 lbs	a
Luna	201	6443	a
Lieutenant	176	5632	ab
SVBL 2036	170	5441	abc
Green Magic	168	5361	abc
Virgo	159	5091	abc
Everest	149	4757	abcd
Burney	140	4483	abcd
Eastern Crown	107	3436	abcde

Bejo 3019
and Luna on
top but very
low yields in
late April
planting

Variety	%mkt
BEJO 3019	42.5
Lieutenant	35.0
Luna	33.8
SVBL 2036	30.0

	Boxes/A		lbs/a
Diamante	629	a	14475
SVBL 2036	580	ab	13334
Eastern Crown	565	ab	12991
Emerald Crown	473	abc	10888
Hydra	432	abcd	9944
Virgo	428	abcd	9850
Diplomat	416	abcde	9558
Lieutenant	409	abcde	9404

Many varieties did well in the August planting – Diamante, SVBL 2036, Eastern Crown, Emerald Crown, Hydra, Virgo, Diplomat and Lieutenant all had commercial level yields above 400 boxes per acre.

Variety	%mkt
Eastern Crown	88
Diamante	73
Virgo	66
Diplomat	61

- Eastern Broccoli Project
- Many student and summer workers
 - Jennifer Jones, Joseph Jones
- Participating Companies



2021 Fall Cauliflower Trial

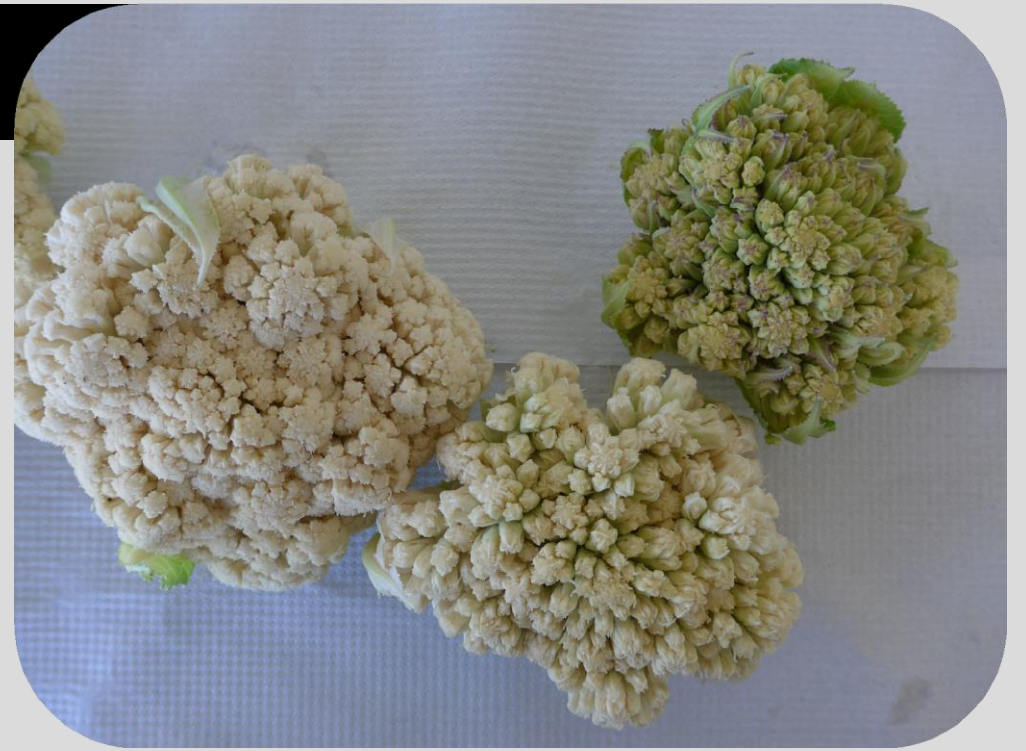
Seeded: July 7 (128 cells, 1.2 inches)

Transplanted: August 5

Harvested: Oct 25 – Dec 22



2021 Fall Cauliflower Trial



2021 Fall Cauliflower Trial

Trial Yields in Pounds/Acre

	Total Wt	Mkt Wt	% Marketable
Twister	18,868 a	15,780 a	81.0 a
Caniego	13,703 b	12,555 a	91.3 a
Bermeo	12,133 b	12,004 a	98.8 a
Flamenco	15,273 ab	11,480 a	71.0 a
Toledo	12,771 b	11,480 a	89.5 a
Alcala	13,263 b	10,153 ab	72.3 a
Skywalker	13,306 b	4,829 bc	31.0 b
B-3277	12,678 b	4,648 bc	34.0 b
Adona	11,427 b	2,654 c	23.0 b
<i>p-value</i>	0.0300	0.0013	0.0001
C.V.	19.733	42.25	33.63
LSD	3949	5863	32.27

2021 Fall Cauliflower Trial

Percent of Total Yield at Each Harvest

	25-Oct	28-Oct	1-Nov	8-Nov	19-Nov	22-Dec
Bermeo	98%					2%
Flamenco		92%	2%	1%	3%	2%
Caniego		19%	75%	6%		
Alcala		40%	49%	4%	6%	
Twister			77%	6%	17%	
Toledo			5%	26%	56%	13%
Skywalker					35%	65%
B-3277				5%	22%	74%
Adona					27%	73%



Twister



Caniego



Bermeo



Flamenco



Toledo



Alcala

2021 Fall Cauliflower Trial



Twister



Toledo



Caniego



Alcala

Successful Spring Varieties 2020

Bishop 64 days

Rijk Zwaan

87% Marketable



Bermeo 62 days

Bejo

80% Marketable



Denali 67 days

Rijk Zwaan

73% Marketable



Successful Fall Varieties 2019

Candid Charm 80 days

Sakata

95% Marketable



Tended to be a bit fuzzy

Bermeo 95 days

Bejo

86% Marketable



Also a bit fuzzy

Freedom 82 days

Bejo

82% Marketable



Flamenco 88 days

Bejo

78% Marketable



Bishop 93 days

Rijk Zwaan

78% Marketable



Alcala 94 days

Bejo

76% Marketable



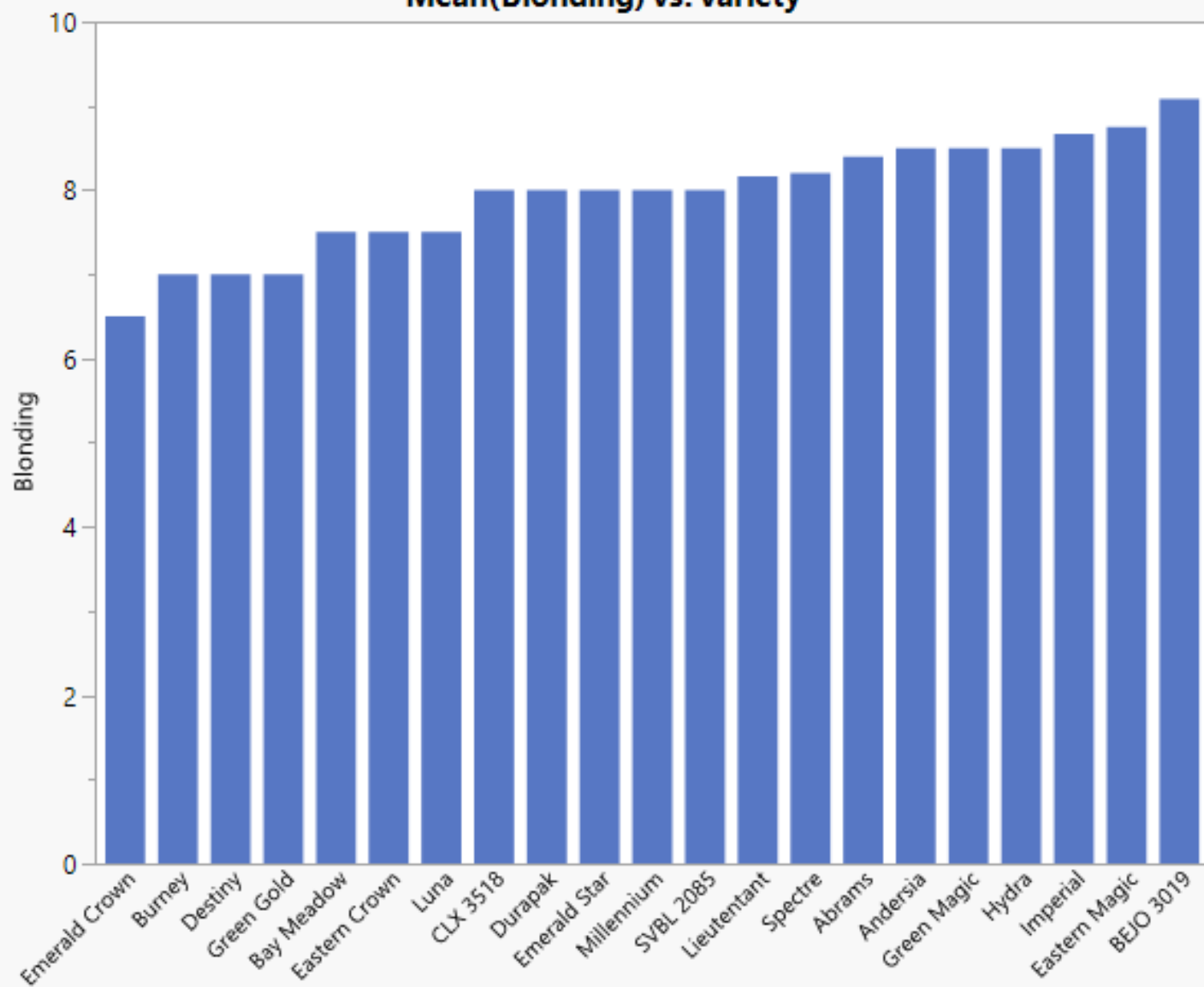
Images by E Ernest.

Processing Broccoli Evaluations 2022





Mean(Blonding) vs. Variety



Variety ordered by Blonding (ascending)





Imperial



Imperial



Spectre



Emerald
Crown

Specialty Cole Crops – Broccolini, Caulilini, Sprouting Broccoli, Gai Lan











Brussels Sprouts 2023

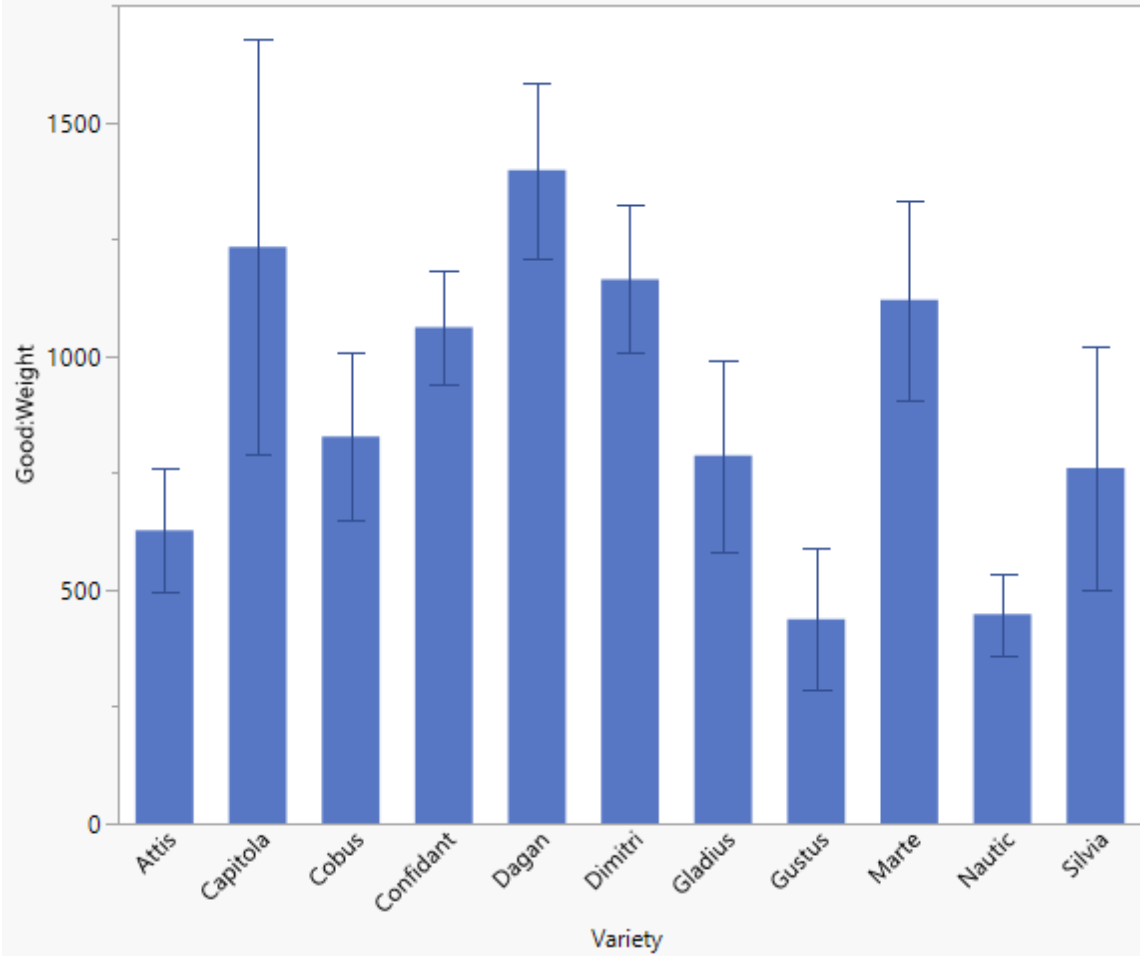


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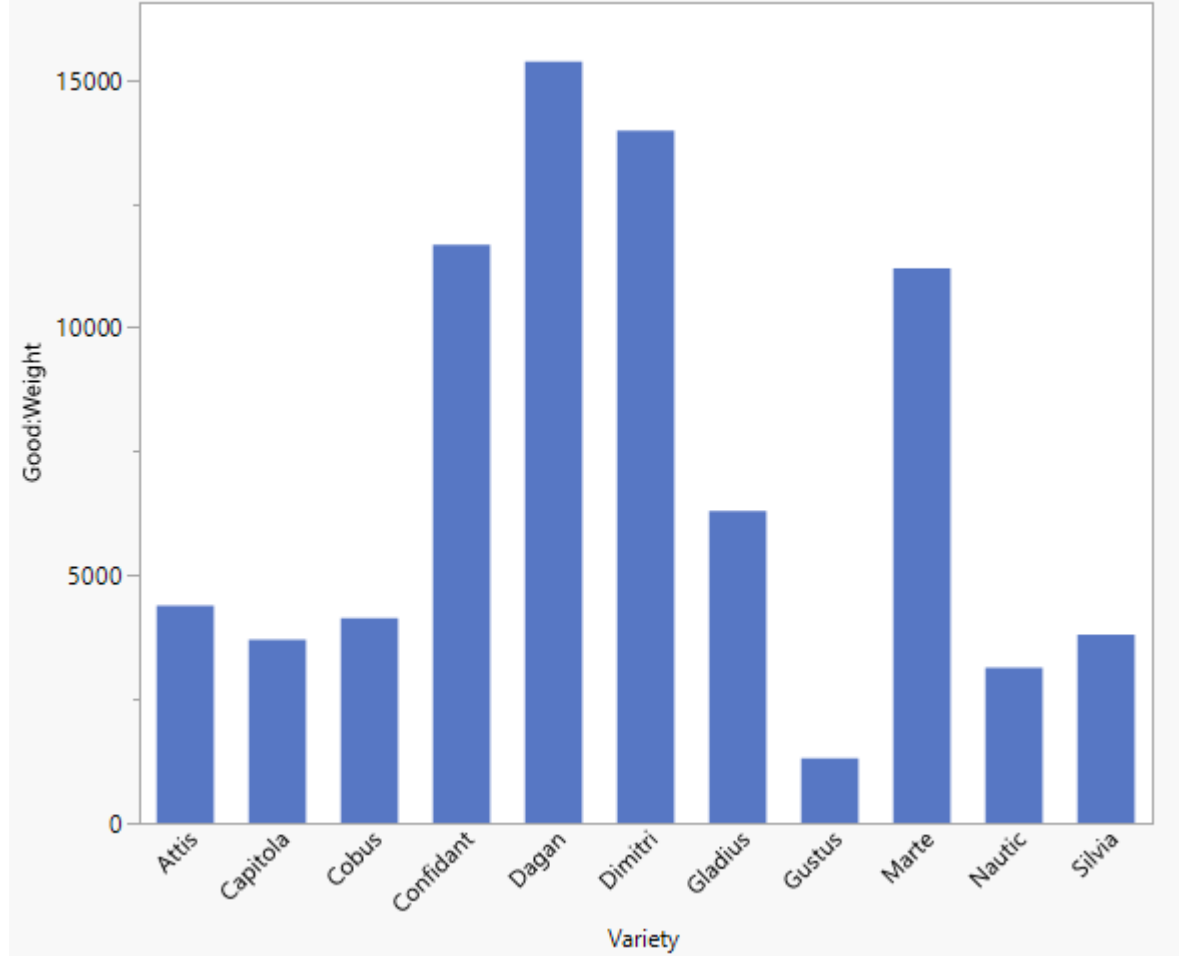


Brussels Sprouts 2023

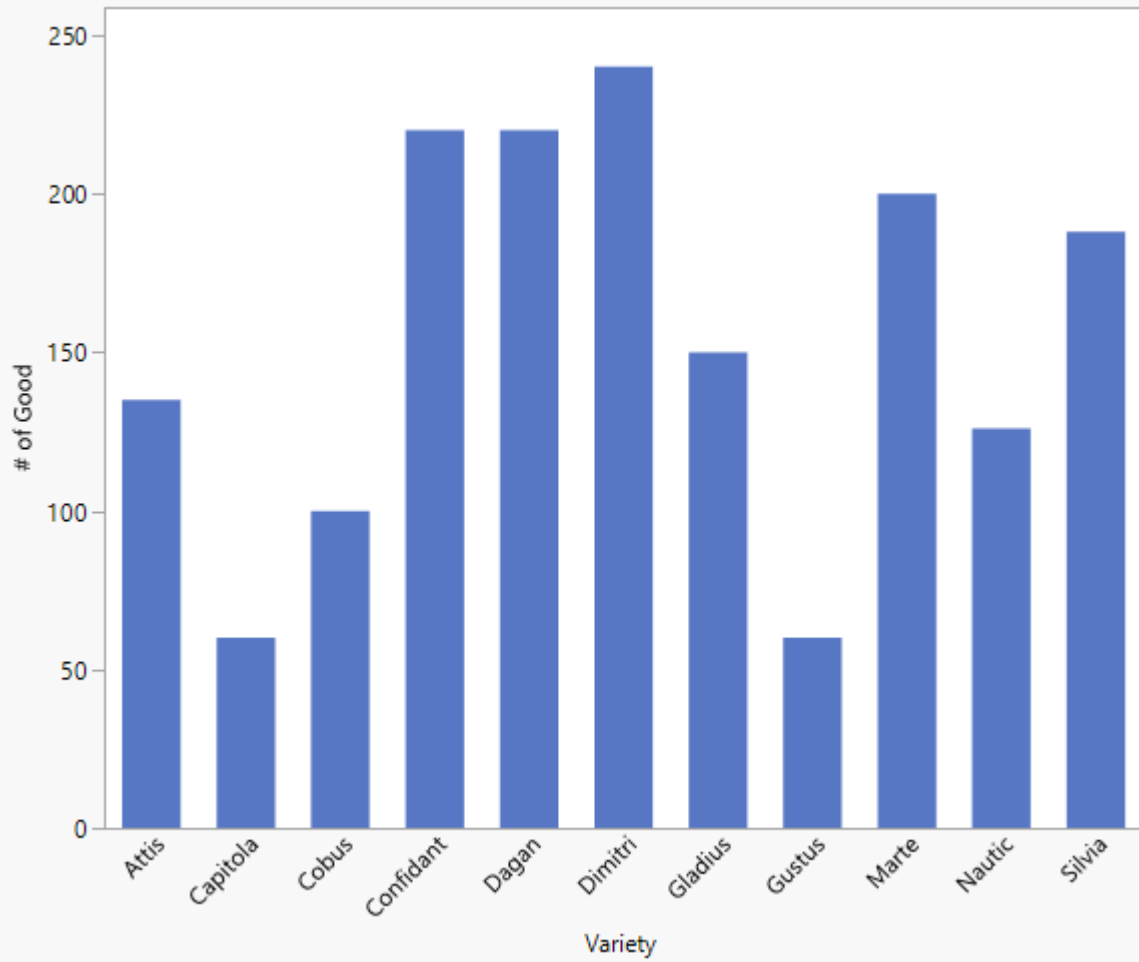
Mean(Good:Weight) vs. Variety



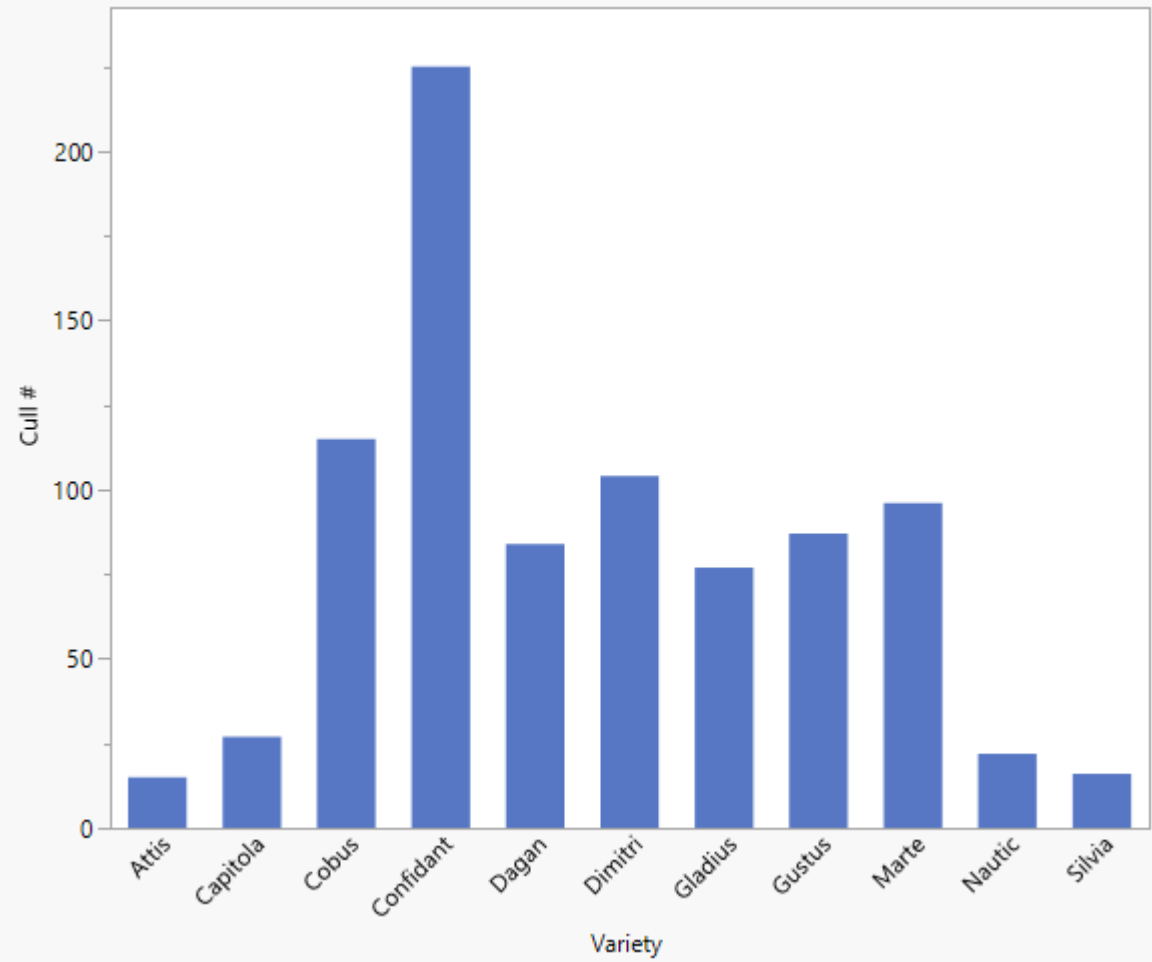
Sum(Good:Weight) vs. Variety

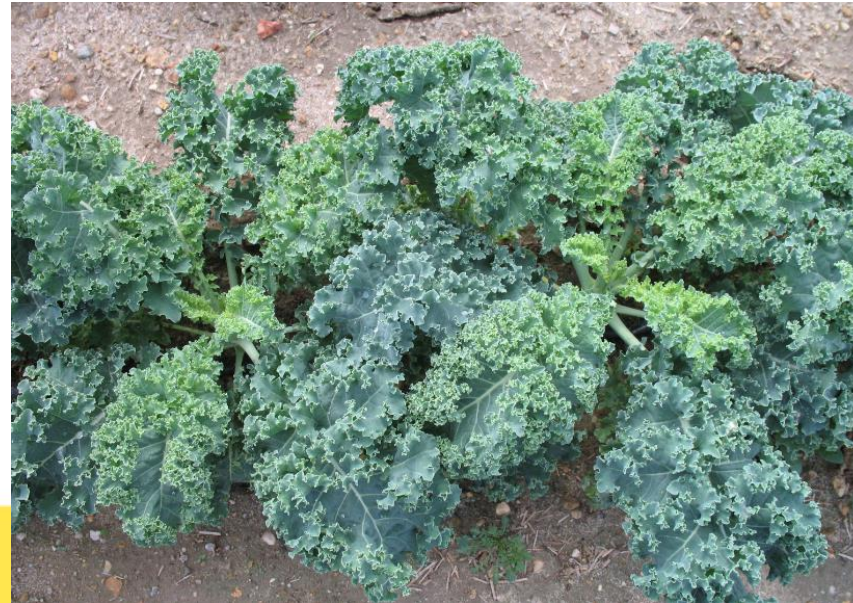


Sum(# of Good) vs. Variety



Sum(Cull #) vs. Variety





Variety	Type	Harvest Date					Total
		21-Sep-11	7-Oct-11	10-Oct-11	2-Nov-11	20-Dec-11	
		lbs/a	lbs/a	lbs/a	lbs/a	lbs/a	
Reflex	Kale	.	6962	544	.	717	8223
Red Bor	Kale	.	.	304	.	396	700
Blue Ridge	Kale	.	.	1131	.	1355	2486
Blue Knight	Kale	.	.	1184	1191	1381	3756
Blue Armor	Kale	.	.	874	.	1134	2008
Starbor F1	Kale	.	.	954	.	1398	2352
Winterbor F1	Kale	.	.	869	.	2834	3703
Ripbor F1	Kale	442	442
Vates	Kale	.	.	746	.	1800	2546
Dwarf Siberian	Kale	.	6293	5313	5529	3898	21033



Hi Crop	Collard	.	.	1310	5764	1881	8955
Flash	Collard	.	.	970	394	1460	2824
Top Bunch	Collard	.	.	471	.	1244	1715
Bulldog	Collard	.	.	2010	1470	1640	5120
Champion	Collard	.	.	1045	889	689	2623

