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Research and Extension Efforts in the Vidalia Onion Region in Georgia, USA to Reduce Losses From Center Rot Caused by *Pantoea* spp. Complex

Chris Tyson

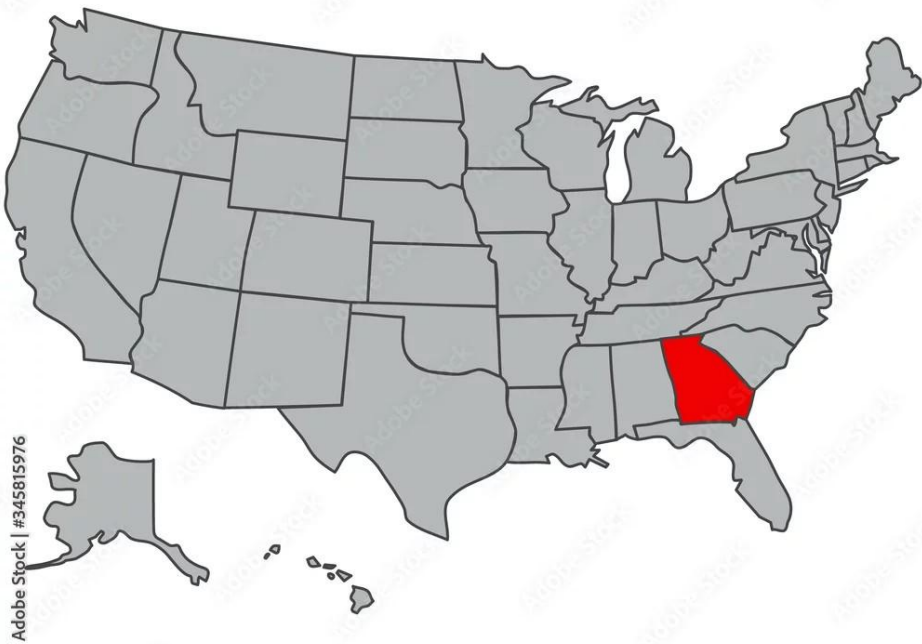
Area Onion Agent and Superintendent
Vidalia Onion and Vegetable Research Center
University of Georgia

Vidalia Onions

Only Grown in the State of Georgia

Georgia receives avg annual precip of
50 – 55 inches per year.

Hot, humid subtropical climate

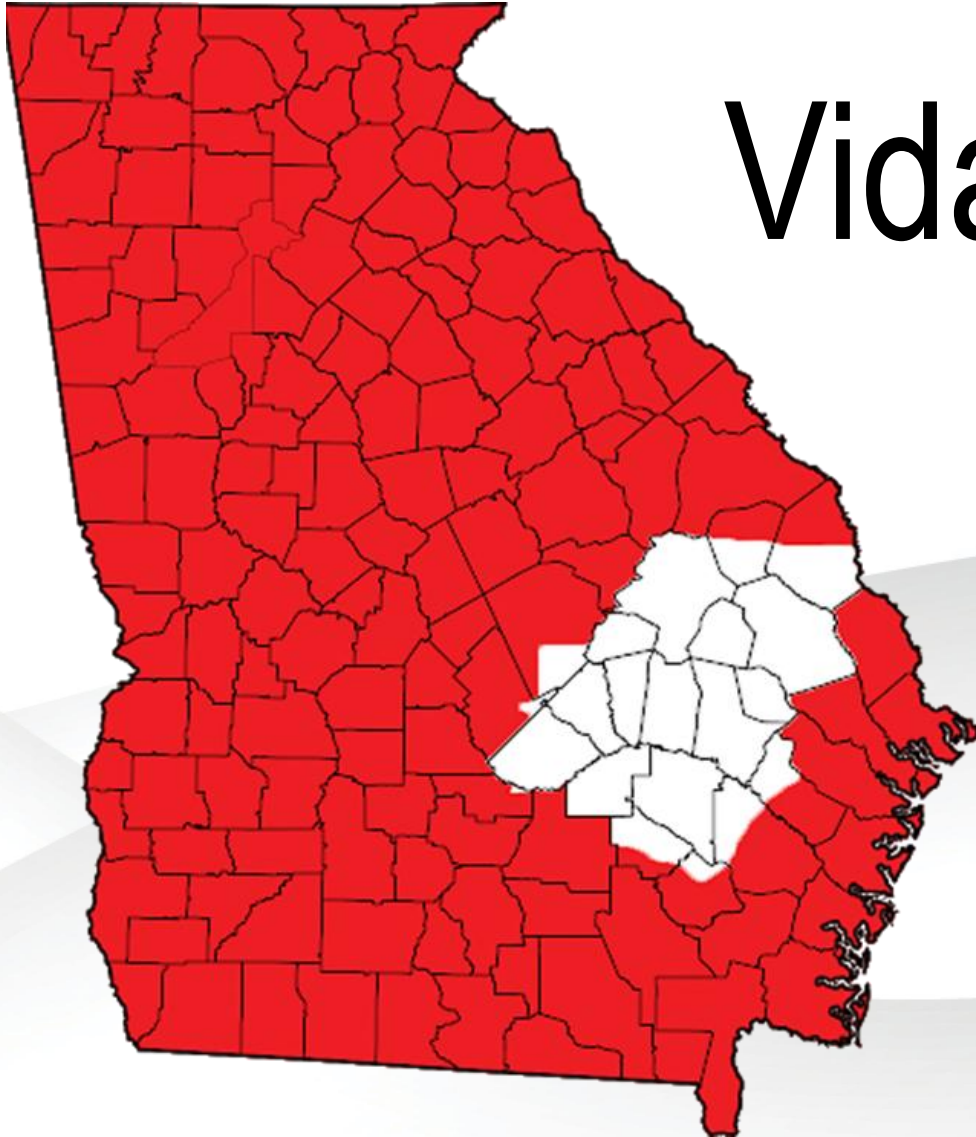


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Vidalia Onions



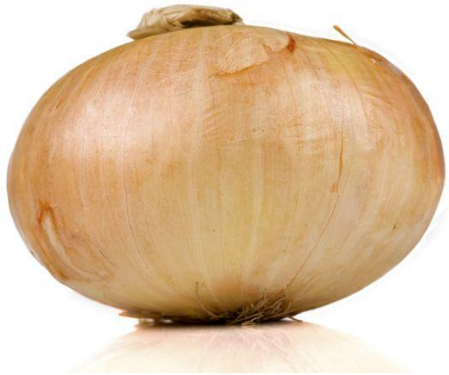
Grown in Southeast Georgia in 20 county area.

The name and brand Vidalia Onion is protected by federal and state laws.



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Vidalia Onions – What makes a Vidalia a Vidalia?



- Grown in defined area of GA
- Yellow granex short day
- Evaluated by University of Georgia for quality
- Varieties must be approved by the Georgia Department of Agriculture



Vidalia Onion Facts

- 10,000 acres grown
- Growing season: September - April
- Harvested April – May
- 98% are transplant production
- Hand Transplanted
- Hand Harvested
- Very few direct seeded or mechanical harvest
- Famous for sweet, mild flavor
- Grown in low sulfur soils
- Along with soil type, variety and fertility affect flavor.
- H2-A labor is used for the labor intense production.
- Annual farmgate value of \$175,000,000



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Vidalia Onion Committee



Provides funding each year for our research.

Grower assessments fund our research

Over \$3 million in research funds in past 10 years.

UGA Vidalia Onion and Vegetable Research Center



- University of Georgia
- Located in growing region
- Research funded by VOC



UGA Extension Onion Team

- Local Extension Agents
- Conducting applied research
- Grower funded
- Focus on finding solutions and delivering information to growers



Center Rot in Vidalia Onions

- *Pantoea* spp.
- First identified in GA 1997
- Inoculum sources: weeds and seed
- Tobacco thrips and onion thrips are vectors of the disease



F. fusca



T. tabaci



Center Rot in Vidalia Onions

- Can cause up to 100% yield loss in severe outbreaks
- Avg annual losses of 5-15%
- 2023 Grower Survey: 69% of respondents say center rot causes average annual losses of \$1000/acre or more, 94% say it is a serious production issue
- Extremely frustrating for growers because it may not be detected until after harvest

A Grower's Viewpoint

- Extremely frustrating....
- Not always detected in field
- May show up in storage after grower has paid to have the onions clipped, harvested, graded, and cooled/stored
- Or worse, after they make it to the grocery shelf
- 5% incidence can create a total loss....

A Grower's Viewpoint

- “When we are cutting the onions we are finding about 8-10 percent of the onions with internal damage, however, we are only allowed 4 % before they would be rejected. So , we are at a potential of losing 90% of really good onions.”

Early Research Efforts

Which growth stage of onion is highly susceptible to bulb infection?

Onion ipmPIPE
Diagnostic Pocket Series



Bulb Growth Stages of Onion *Allium cepa* L.



Seedling stage



True leaf stage (4-6)



First leaf senescens



Bulb initiation



Bulb swelling



Bulb maturation



Pseudostem hardening stage



Flowering stage

- Seedling stage
- True leaf stage (4-6)
- First leaf senescence
- Bulb initiation
- Bulb swelling
- Pseudostem hardening
- Flowering

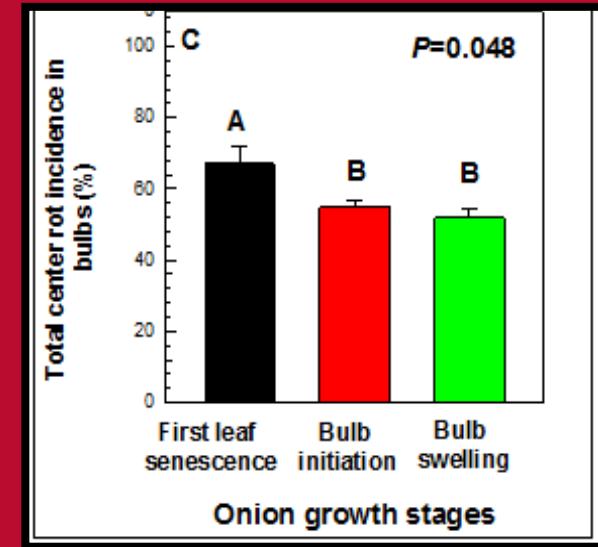


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Early Research Efforts

Growth stages, variety	df ^a	F-value	P > F
Experiment ^b	1	3.17	0.248
Growth stages of onion ^c	2	24.2	0.037
Variety ^d	4	29.2	<0.001
Growth stages of onion × variety	8	48.3	0.923

^a Degrees of freedom.
^b Number of experiments.
^c Inoculation was done at first leaf senescence, bulb initiation, and bulb swelling growth stages.
^d Five Vidalia onion variety (1518, 1407, Granex YPRR, Pirate, and Sweet harvest) were used



- Onion growth stage can influence incidence of *P. ananatis* in bulbs
- Can we protect these growth stages using antimicrobials (Cu-bactericide) and growth regulator (Actigard)?

Stumpf et al., 2017 Plant Dis.



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Growth stage targeted foliar protection: Field trial 2017 and 2018 (collaboration with six onion county agents)

At First Leaf Senescence

Treatment 1: Kocide 3000 @ 1.5 lb/A for 3 consecutive weeks

Treatment 2: Actigard @ 0.5 oz/A for 3 consecutive weeks

Treatment 3: Kocide+Actigard at previously mentioned rate. Actigard were applied 24 hours prior to Kocide application.

Treatment 4: No treatment

At Bulb Initiation

Treatment 5: Kocide 3000 @ 1.5 lb/A for 3 consecutive weeks

Treatment 6: Actigard @ 0.5 oz/A for 3 consecutive weeks

Treatment 7: Kocide+Actigard at previously mentioned rate. Actigard were applied 24 hours prior to Kocide application.

Treatment 8: No treatment

At Bulb Swelling

Treatment 9: Kocide 3000 @ 1.5 lb/A for 3 consecutive weeks

Treatment 10: Actigard @ 0.5 oz/A for 3 consecutive weeks

Treatment 11: Kocide+Actigard at previously mentioned rate Actigard were applied 24 hours prior to Kocide application.

Treatment 12: No treatment

All Growth Stages

Treatment 13: Kocide 3000 @ 1.5 lb/A throughout growing season

Treatment 14: Actigard @ 0.5 oz/A throughout growing season

Treatment 15: Kocide+Actigard at previously mentioned rate. Actigard were applied 24 hours prior to Kocide application.

Treatment 16: No treatment

Treatment 17: No treatment



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Intensive insecticide program was followed for thrips control

5 reps of these treatments, test conducted in 2017 and 2018

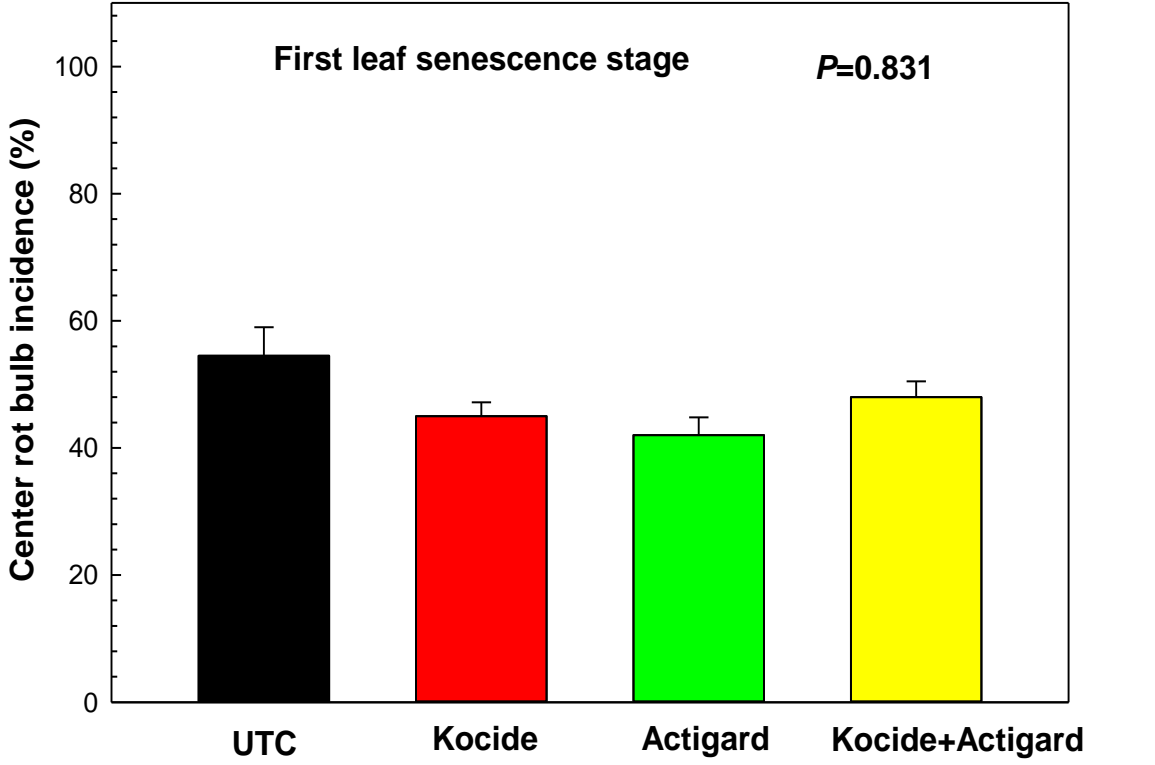


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Field incidence + post curing incidence (7 days) = Total bulb incidence

>9000 onion bulbs were cut open and individually rated for center rot symptoms

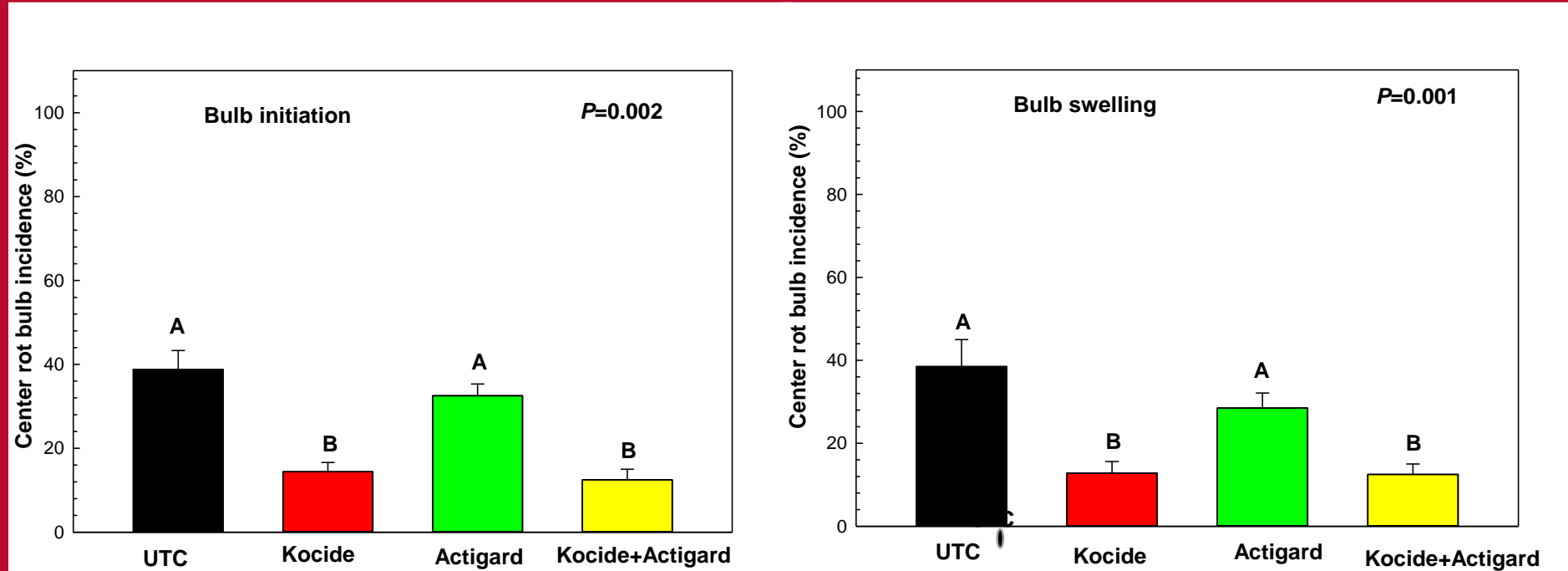
Bulb incidence of center rot of onion



Significant effect of treatments were not observed for onions that were treated during first leaf senescence stage



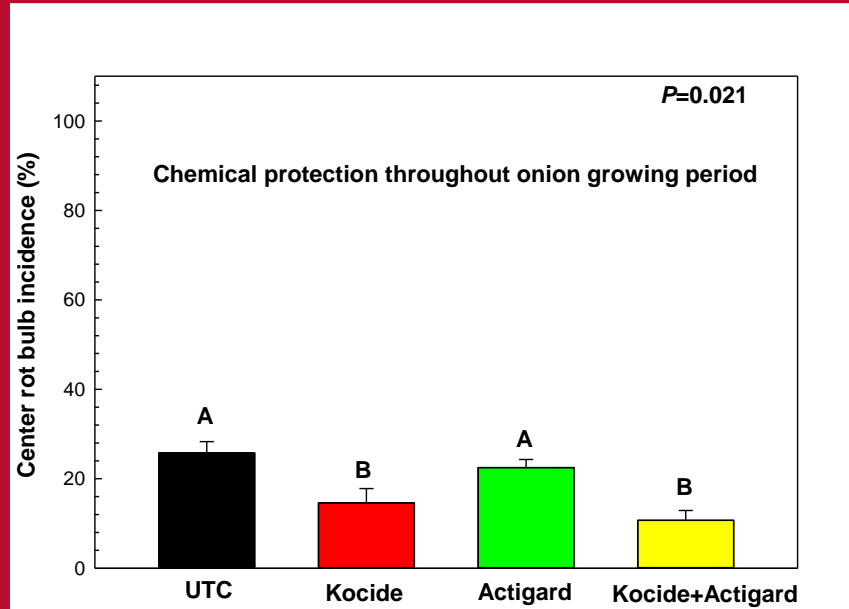
Bulb incidence of center rot of onion



Bulb incidence of center was significantly lower for Kocide or Kocide+Actigard treatments

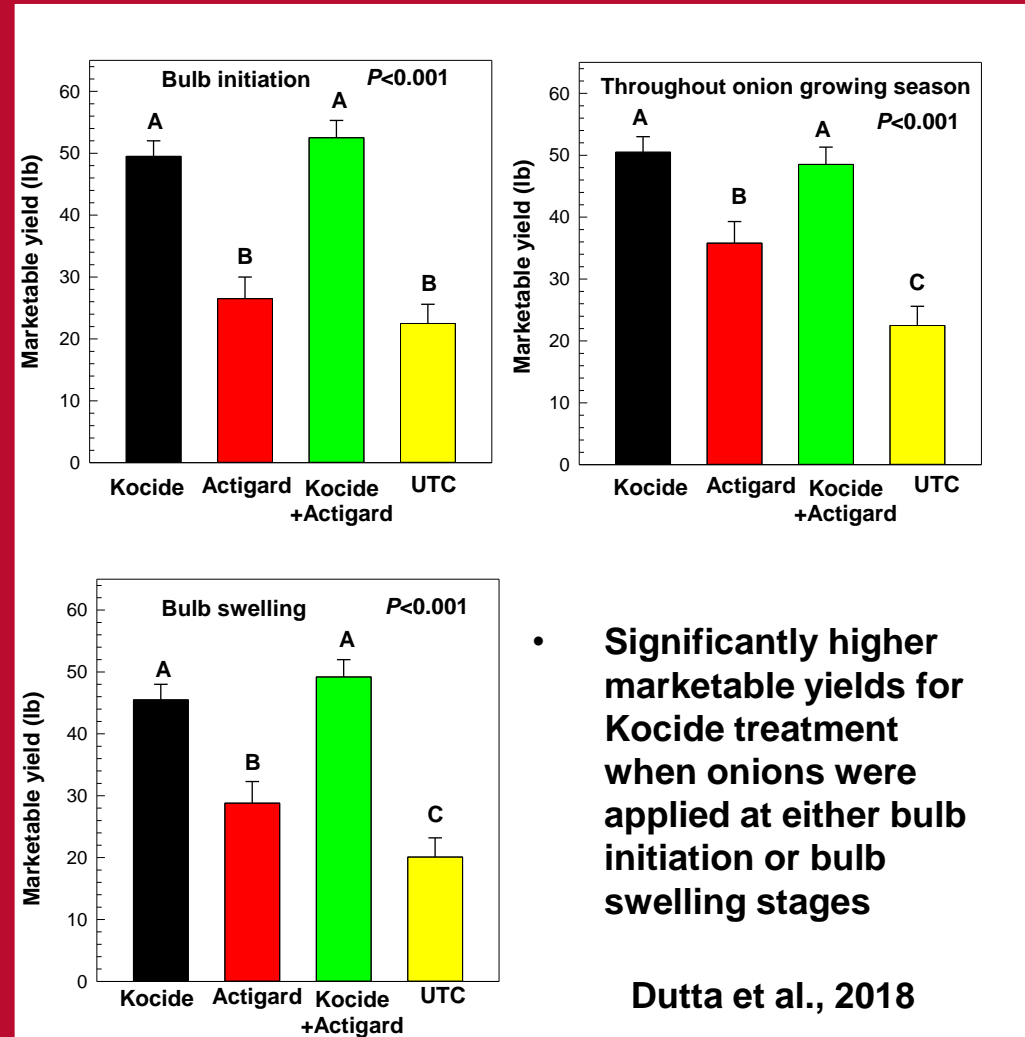


Bulb incidence of center rot of onion



Bulb incidence of center was significantly lower for Kocide or Kocide+Actigard treatments

Marketable yield (lb)



- Significantly higher marketable yields for Kocide treatment when onions were applied at either bulb initiation or bulb swelling stages

Dutta et al., 2018



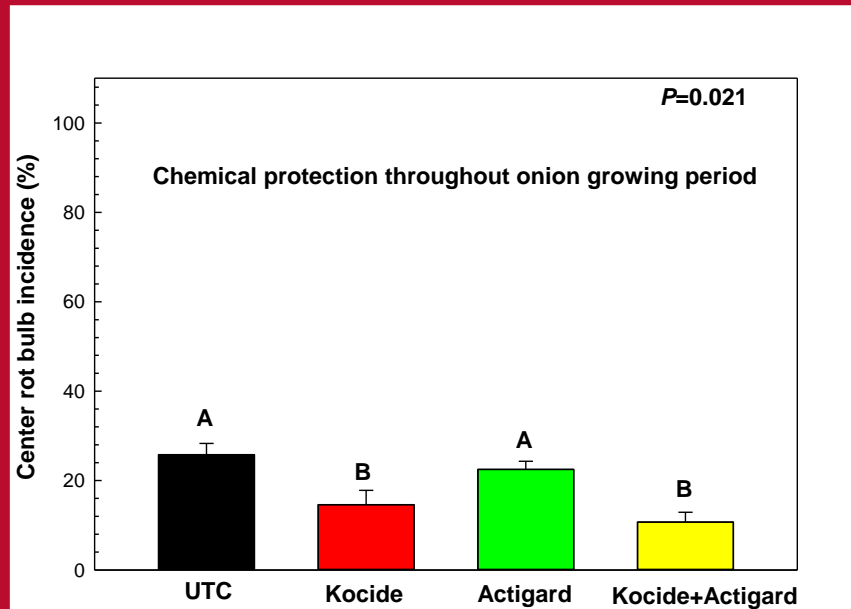
2017 and 2018 data

Growth Stage, Treatment and Rate Per Acre	2018 Center rot bulb incidence (%)	2017 Center rot bulb incidence (%)	2018 Marketable yield (lb/plot)	2017 Marketable yield (lb/plot)
First Leaf Senescence				
Kocide 3000 1.5 lb	32.6 a ^x	58.5 a	33.5 x	23.5 x
Actigard 50 WG 0.5 fl oz	30.2 a	48.2 a	39.8 x	19.8 x
Kocide 3000 1.5 lb +Actigard 50 WG 0.5 fl oz	30.3 a	52.5 a	38.5 x	22.5 x
Untreated check	34.2 a	54.2 a	35.2 x	20.3 x
P-value	0.315	0.831 a	0.725	0.624
Bulb Initiation				
Kocide 3000 1.5 lb	20.4 b	18.5 b	58.5 x	54.5 x
Actigard 50 WG 0.5 fl oz	39.8 a	37.8 a	35.5 y	32.8 y
Kocide 3000 1.5 lb +Actigard 50 WG 0.5 fl oz	17.6 b	16.2 b	59.2 x	55.2 x
Untreated check	36.2 a	40.2 a	27.2 y	30.5 y
P-value	0.015	0.002	<0.001	<0.001
Bulb Swelling				
Kocide 3000 1.5 lb	25.5 b	15.5 b	52.2 x	50.5 x
Actigard 50 WG 0.5 fl oz	39.8 a	35.2 a	32.8 y	30.0 y
Kocide 3000 1.5 lb +Actigard 50 WG 0.5 fl oz	23.9 b	14.8 b	59.4 x	52.8 x
Untreated check	42.5 a	38.8 a	29.5 y	20.2 y
P-value	0.025	0.001	0.002	0.021
All Three Growth Stages				
Kocide 3000 1.5 lb	27.5 b	12.5 b	58.0 x	51.0 x
Actigard 50 WG 0.5 fl oz	40.8 a	20.8 a	39.2 y	35.8 y
Kocide 3000 1.5 lb +Actigard 50 WG 0.5 fl oz	28.2 b	12.4 b	60.5 x	55.2 x
Untreated check	44.5 a	22.5 a	35.5 y	20.0 y
P-value	0.001	0.023	<0.032	<0.001



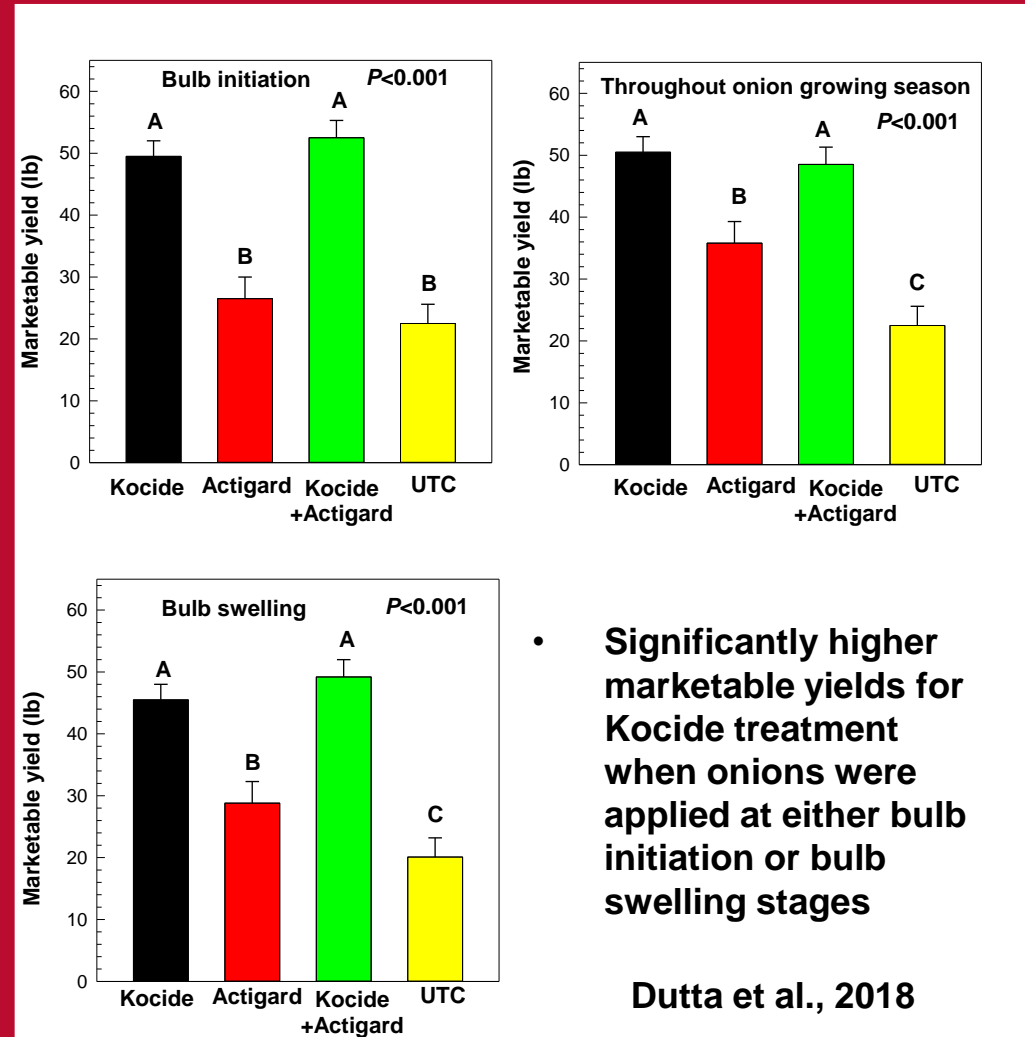
Copper can help. Timing is important

Bulb incidence of center rot of onion



Bulb incidence of center was significantly lower for Kocide or Kocide+Actigard treatments

Marketable yield (lb)



- Significantly higher marketable yields for Kocide treatment when onions were applied at either bulb initiation or bulb swelling stages

Dutta et al., 2018



Going Forward-2019-2020 Trial

Thrips Control

- Trial set up for the current season to focus on thrips management and control
- Combining insecticide program with copper sprays at these growth stages to evaluate center rot incidence



2019 Trial-with and without thrips protection

Growth stage, treatment and rate per acre	App timing ^z
<u>Without thrips management program</u>	
Bulb initiation and bulb swelling	
Kocide 3000 1.5 lb	1-6
Agrititan 1% (v/v)	1-6
Kocide 3000 1.5 lb	1-6
+Agrititan 1% (v/v)	1-6
Nordox 1lb	1-6
Untreated check	-
<i>P-value</i>	
<u>With thrips management program</u>	
Bulb initiation and bulb swelling	
Kocide 3000 1.5 lb	1-6
Agrititan 1% (v/v)	1-6
Kocide 3000 1.5 lb	1-6
+Agrititan 1% (v/v)	1-6
Nordox 1lb	1-6
Untreated check	-
<i>P-value</i>	



2019 Trial

- Kocide (copper hydroxide)
 - Agrititan- Titanium Dioxide nano-formulation (not commercially available yet)
 - Kocide + Agrititan
 - Nordox (Cuprous oxide)
-
- Applied during bulb initiation+bulb swelling period (weekly for 6 week period)



2019 Trial

- The trial area (about ½ acre) was split in half.
- One half (20 plots) received thrips control treatments, the other did not.
- The “threshold” for thrips in GA is when 5 or more thrips are found per plant
- Trial area never reached threshold, but received 3 applications of thrips control product.



Thrips management program

- Radiant-applied Feb 21
- Exirel- applied March 7 and March 29
- Thrips were scouted throughout growing season, but only low levels below threshold were seen (less than 5 per plant)



Results

Growth stage, treatment and rate per acre	App timing ^z	Center rot bulb incidence (%) ^y	Marketable yield (lb/plot) ^v
Without thrips management program			
Bulb initiation and bulb swelling			
Kocide 3000 1.5 lb	1-6	48.4 b	52.2 x
Agrititan 1% (v/v)	1-6	31.2 c	55.5 y
Kocide 3000 1.5 lb	1-6	27.6 c	69.2 x
+Agrititan 1% (v/v)	1-6		
Nordox 1lb	1-6	44.6 b	
Untreated check	-	69.7 a	27.5 z
<i>P-value</i>		0.025	<0.001
With thrips management program			
Bulb initiation and bulb swelling			
Kocide 3000 1.5 lb	1-6	34.2 c	58.5 x
Agrititan 1% (v/v)	1-6	41.6 b	35.5 y
Kocide 3000 1.5 lb	1-6	18.4 d	62.7 w
+Agrititan 1% (v/v)	1-6		
Nordox 1lb	1-6	33.5 c	
Untreated check	-	53.5 a	18.2 z
<i>P-value</i>		0.036	<0.001
^z Bactericide-treatment applications were made: 1 = 18 Feb, 2 = 25 Feb, 3 = 4 Mar, 4 = 11 Mar, 5 = 18 Mar, 6 = 25 Mar.			
^y Mean center rot bulb incidence was calculated as number of bulbs with center rot/total number of bulbs evaluated × 100.			
^x Means followed by the same letter(s) within each growth stage are not significantly different according to Fisher's protected LSD test at $P \leq 0.05$.			
^v Mean marketable yield (lb) per treatment calculated as difference between mean field weight (lb) and weight of cull (lb).			



Thrips program over-lapped with a bactericide program (bulb-initiation and bulb-swelling) can significantly reduce center rot bulb incidence

Percent bulb-rot incidence (field and storage)

Bactericide treatments	Bulb rot % (No-Thrips control)	Bulb rot % (Thrips control)
Kocide 3000 1.5 lb (Cu product)	48.4	34.2*
Agrititan 1%	46.2	31.2*
Kocide 3000+Agrititan 1%	37.5	18.4**
Nordox (Cu product)	44.6	31.5*
Control (water)	72.5	59.2*

* $P < 0.05$; ** $P < 0.001$

Dutta et al., 2020-22





A "Systematic"
Approach to
Managing Center Rot
in Vidalia Onions
2021-2023

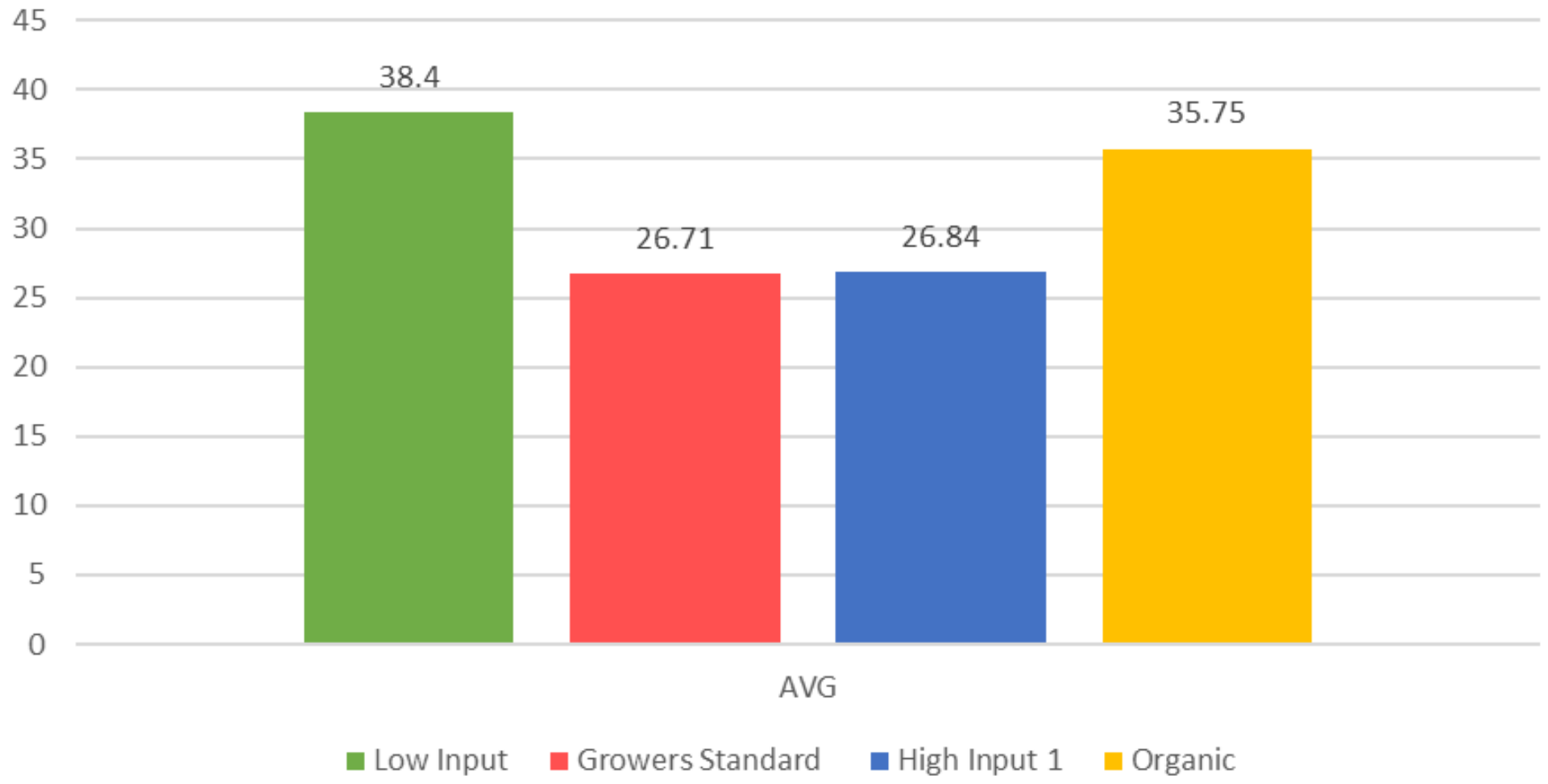


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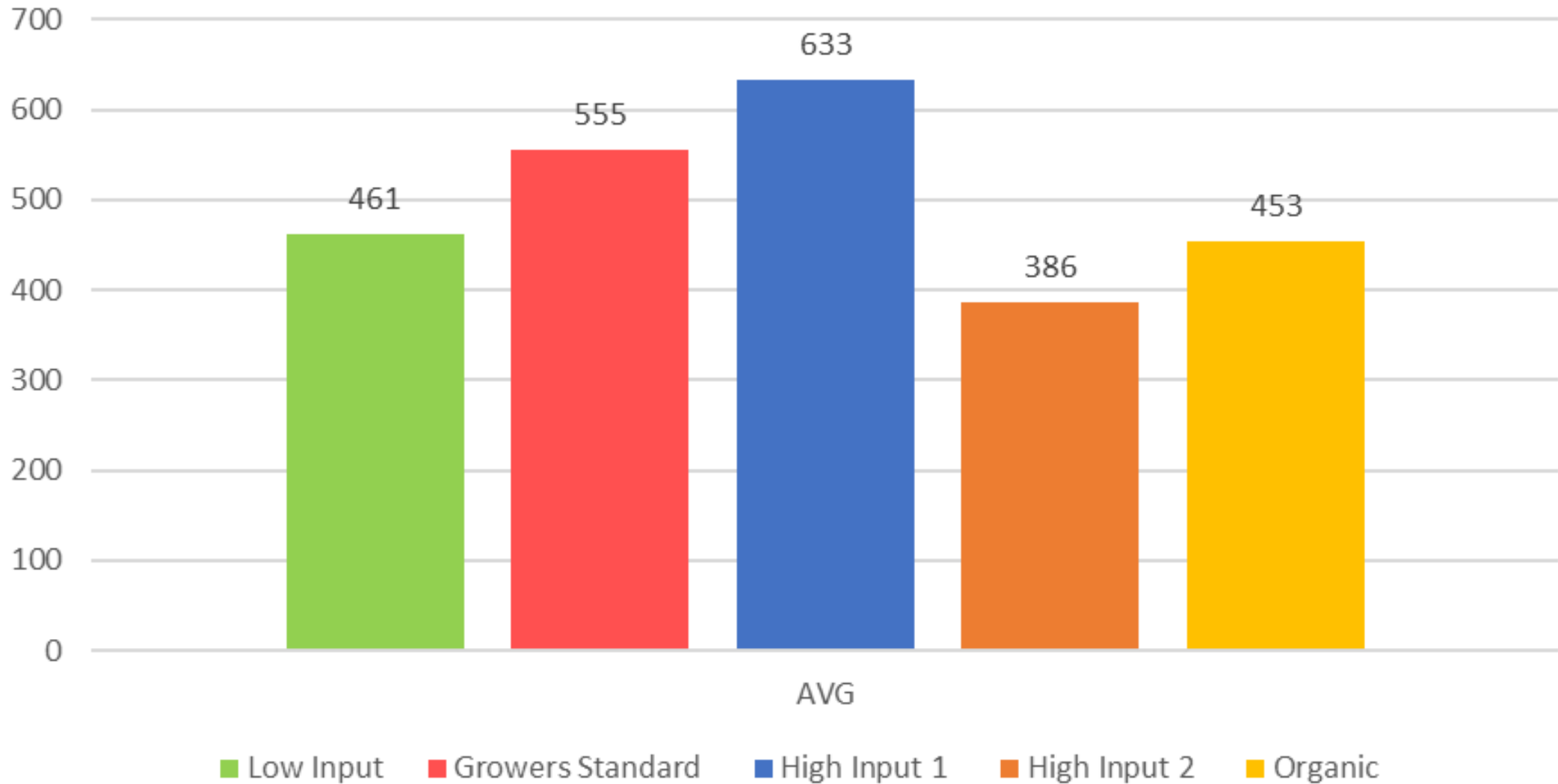
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Low Input	Growers Standard	High Input 1	High Input 2 (2023)	Organic (2022/2023)
Goal @ 1 Quart	Goal @ 1 Quart	Goal @ 1 Quart Goal @ 3oz	Goal @ 1 Quart	Hand Weeding
Prowl @ 1 Quart	Prowl @ 1 Quart	Prowl @ 1 Quart	Prowl @ 1 Quart	Prowl @ 1 Quart
Kocide 3000 @ 1.5 lbs. 1 app- 2022 2 apps- 2021/ 2023	Kocide 3000 @ 1.5 lbs. 3 apps- 2022 4 apps- 2021/ 2023	Kocide 3000 @ 1.5 lbs. 8 apps- 2021 5 apps- 2022 7 apps- 2023	Kocide 3000 @1.5 lbs. 7 apps- 2023	Nordox @ 1 lbs. 3 apps- 2022 4 apps- 2023
No insecticide app	Mustang Maxx @ 4oz.	Torac @ 24 oz 1 app- 2021/ 2022 2 apps- 2023	Torac @ 24 oz 1 app- 2021/ 2022 2 apps- 2023	No insecticide app
		Radiant @ 10 oz 1 app- 2021/ 2022 2 apps- 2023	Radiant @ 10 oz 1 app- 2021/ 2022 2 apps- 2023	
			Lifeguard @ 2 oz 4 apps	

3 Year AVG Center Rot %

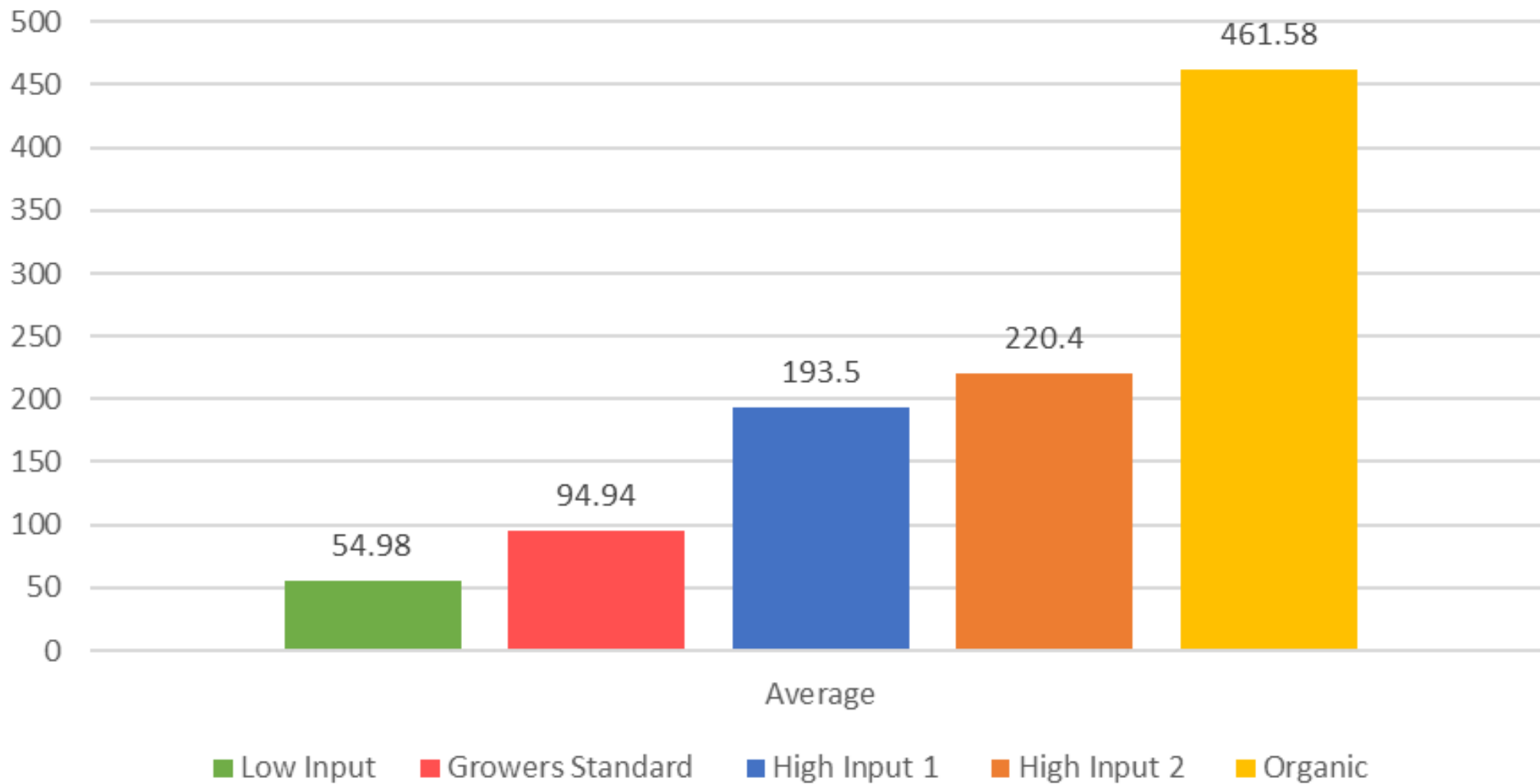


AVG Marketable Yield, 40 lbs. Boxes

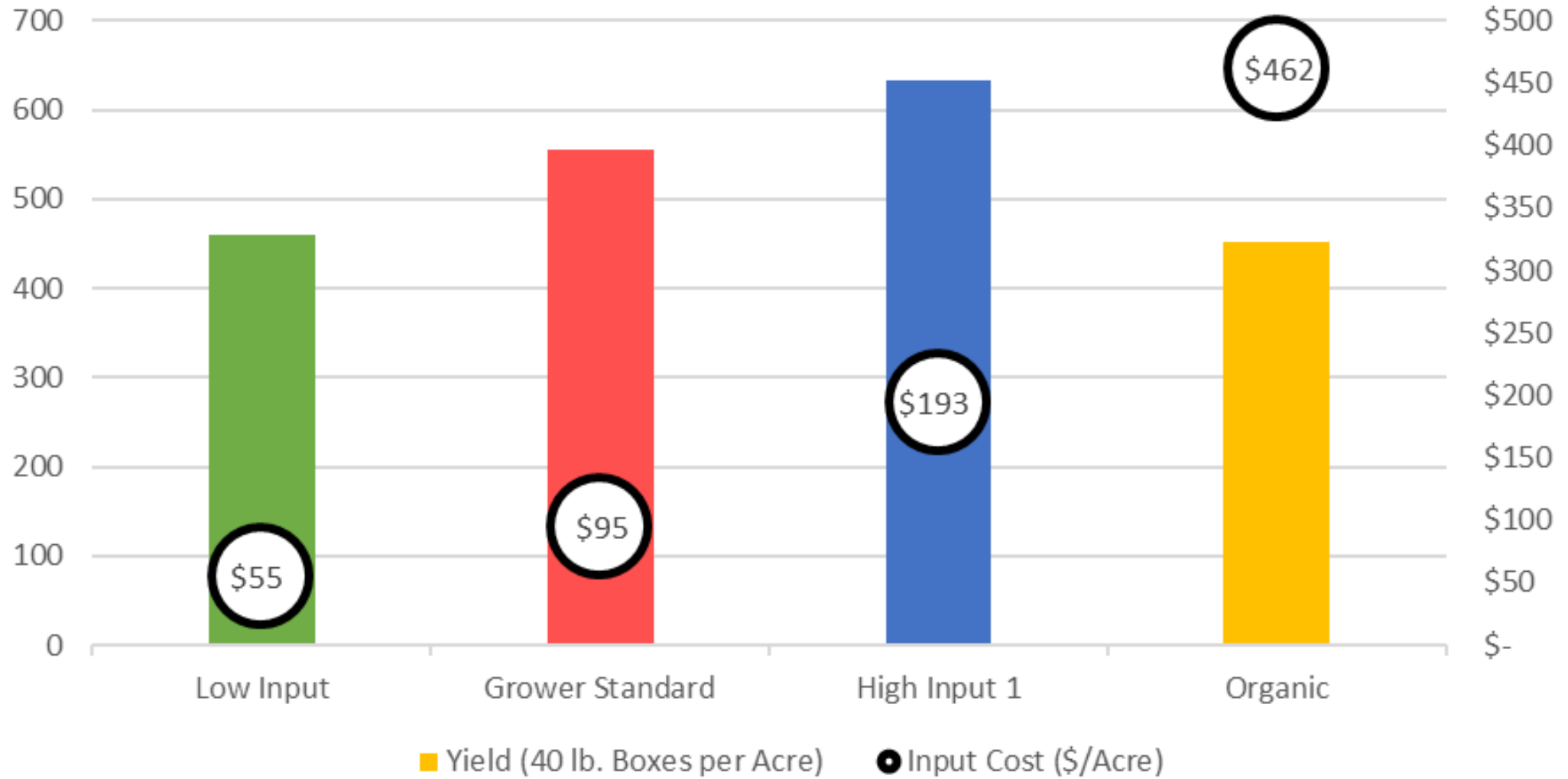


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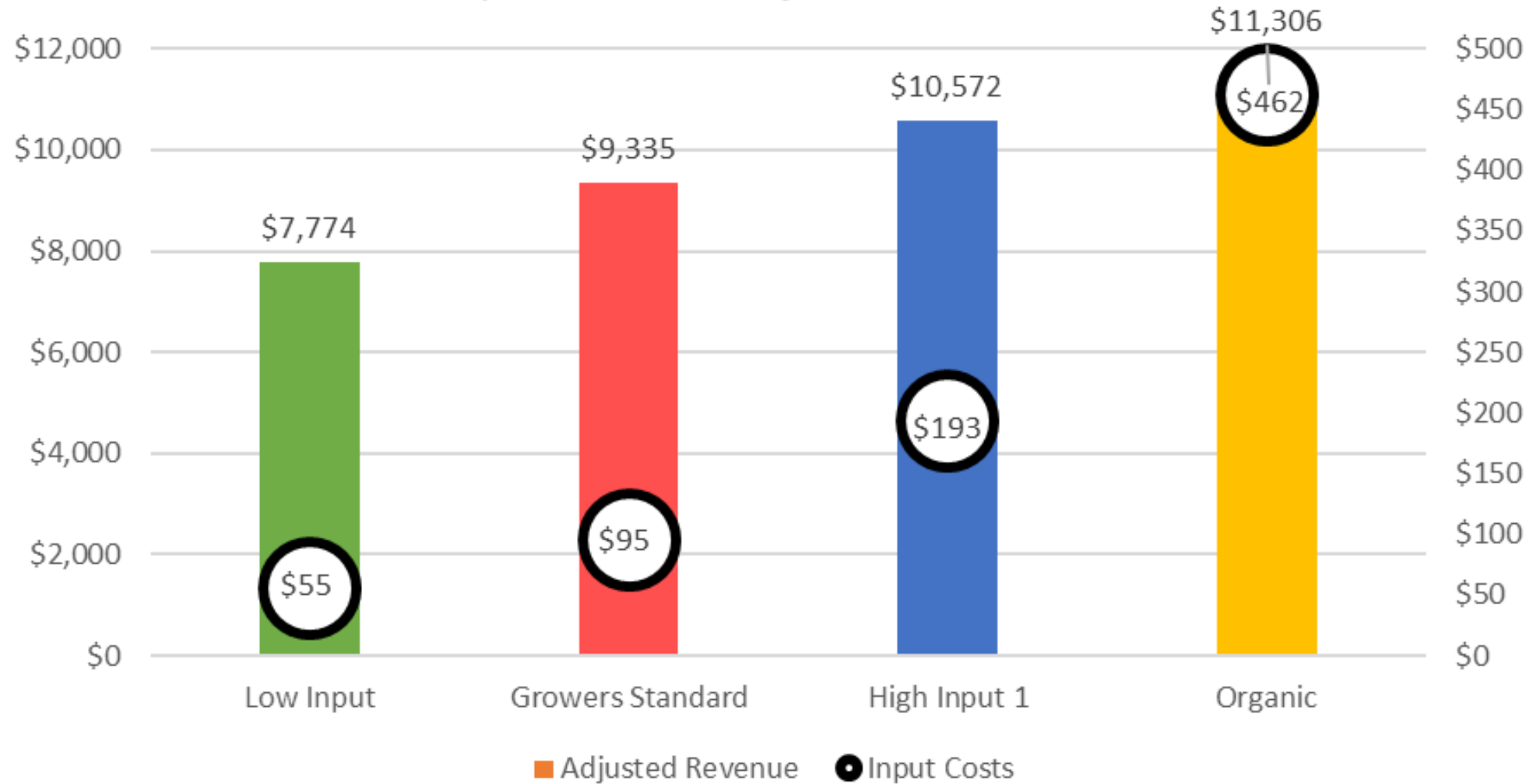
3 Year Average Input Costs



3 Year Average Yield & Input Costs



Input Costs & Adjusted Revenue





Evaluation of digging methods on post-harvest incidence of bacterial rot (2021 and 2022)

Methods of onion digging	Internal rot (%) (2021)	Internal rot (%) (2022)
Chain digger	9.0 B	1.3 B
Straight-blade undercutter	20.5 A	10.7 A
P-value	<0.001	<0.001



Dutta et al., 2022 and 2023 PDMR

Evaluation of harvesting methods on post-harvest incidence of bacterial rot (2021 and 2022)

Methods of onion harvest	Internal rot (%) (2021)	Internal rot (%) (2022)
Mechanical harvest (Top Air Onion harvester)	4.5 B	3.0 B
Manual harvest	14.5 A	12.5 A
P-value	<0.001	0.002



Mr. Chris Tyson

Dutta et al., 2022 and 2023 PDMR



Harvesting can be done manually (95%) or mechanically (5%)



TopAir Onion Harvester



Nicholson Onion Harvester

Assessment of internal bacterial rot after 30 days of storage



Optimized neck length that improves storability of onions (2022 and 2023) (Ross Greene)

Neck length clipped	Bacterial rot (internal) (%) (2022)	Bacterial rot (internal) (%) (2023)
Clipped at the shoulder	18.5 A	14.5 a
Neck clipped after field curing (1")	18.0 A	4.0 b
Neck clipped after field curing (2")	13.0 B	5.5 b
Neck clipped after field curing (3")	13.0 B	6.5 b

Optimized neck length that improves storability of onions (2022 and 2023) (Ross Greene)



Evaluation of neck clipping length on post-harvest incidence of bacterial rot (2021)

Neck length clipped	External rot (%)	Internal rot (%)
5-inches	10.0 a	4.5 B
3-inches	9.5 a	4.0 B
1-inch	14.2 a	19.0 A

- Field curing was done prior to clipping
- Internal rot was associated with mainly *Pantoea* spp., and external rot was associated with *Burkholderia* spp. and *Pectobacterium* spp. based on arbitrarily-collected symptomatic samples.

Dutta et al., 2022

RDMP



Optimized neck length that improves storability of onions (2022) (Ross Greene)

Neck length clipped	Bacterial rot (center rot) after 30-day of storage (%)
Neck clipped at flush green stage	18.5 A
Neck clipped after field curing (1")	18.0 A
Neck clipped after field curing (2")	13.0 B
Neck clipped after field curing (3")	13.0 B



Dutta et al., 2023
PDMR



**NECK CLIPPED CLOSER TO THE
SHOULDER DECREASE
STORABILITY (BACTERIAL AND
OTHER DISEASES)**



Summary of Research Findings

- Copper/Lifeguard Applied At Specific Growth Stages Reduces Incidence
- Controlling Thrips Can Reduce Incidence
- Spray programs that increase frequency of bactericide/insecticide applications can be profitable for growers
- Chain Diggers Speed Up Curing Process, reduce incidence
- Mechanical Harvesters better than hand clipping when necks longer
- Clip necks at least 2 inches long



Field Days and Grower Meetings



County Agents at Work



Extension Efforts to Share Findings Since 2017

- 11 local educational meetings for growers
- 4,705 contacts through meetings, field days, one-on-one consults, newsletters, emails, blogs, etc.
- 17 peer reviewed publications
- 6 national presentations
- 11 state presentations



Impact - 2023 Survey

- 66% of growers have changed their spray programs to target center rot based on our findings (use Lifegard/copper, specific growth stage)
- 46% of growers have made efforts to clip onion necks longer than 2 inches because of our research.
- Most growers prefer chain diggers and use them when time permits
- The changes to grower practices have an economic impact of \$5 million annually to the industry.



What Impact Has This Research Had on the industry?



**Vidalia Onion Sold with
2-inches of dried neck in Publix
(Tifton, GA) in 2023**





Thanks!

Savannah Tanner, Jason Edenfield, Derrick Bowen, Ross Greene, Aubrey Shirley, Lauren Stanley, Savannah Tanner, Bhabesh Dutta

