Bee Vectoring of Biologicals in Sunflowers as a Crop Protection Tool

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Bee Vectoring: An Alternative to Spraying

Bee Vectoring: Use of commercial bees to deliver natural control agents to flowering crops to manage key crop diseases and pests and enhance quality and yields of crops

- **115 crops** worldwide; 85 require pollination
- **Bees contribute** to 1/3 of food in human diet
- **80+ million** honey beehives globally; 5 million bumblebee hives grown every year

Rationale for Vectoring

- Same principles as natural pollination
- The flower is the primary portal of entry for many diseases & insects
- Flowers are the best place for the active ingredient to inoculate the plant

Benefits of Vectoring

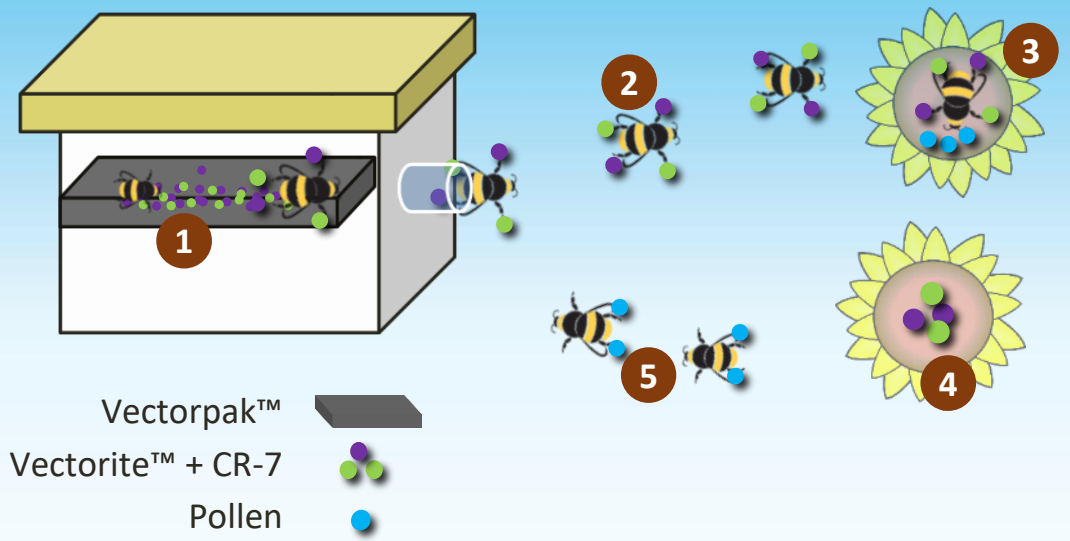
- Substantially minimizes waste of control agent; no water
- Micro targeted delivery precisely deposits product where its needed over spraying entire fields
- Continual delivery throughout the bloom period (spraying can miss blooms)
- Additional yield, residue & quality benefits from improved pollination

Bee Vectoring: How it works

Bumble bees

Mechanical dispenser

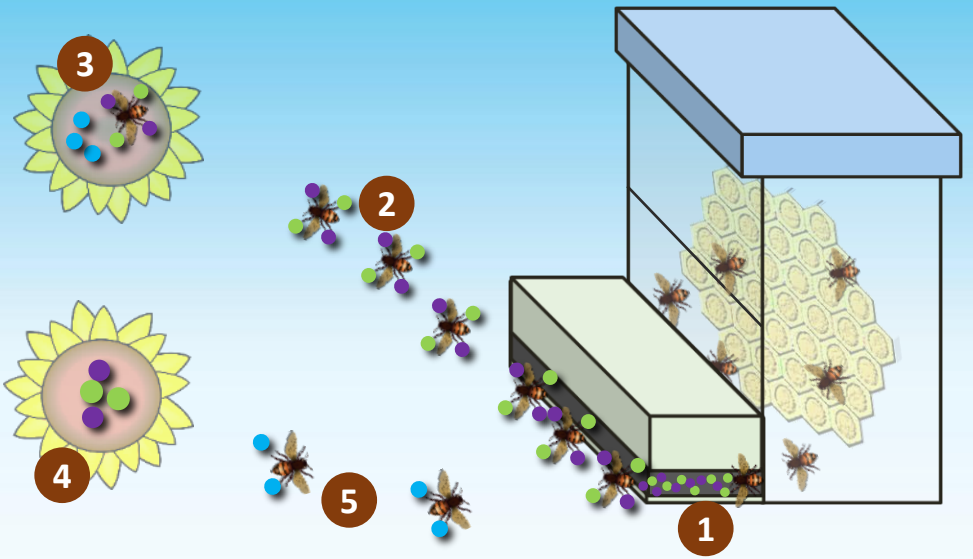
Vectorpak™ trays contained inside the hive



Honeybees

Electromechanical dispenser

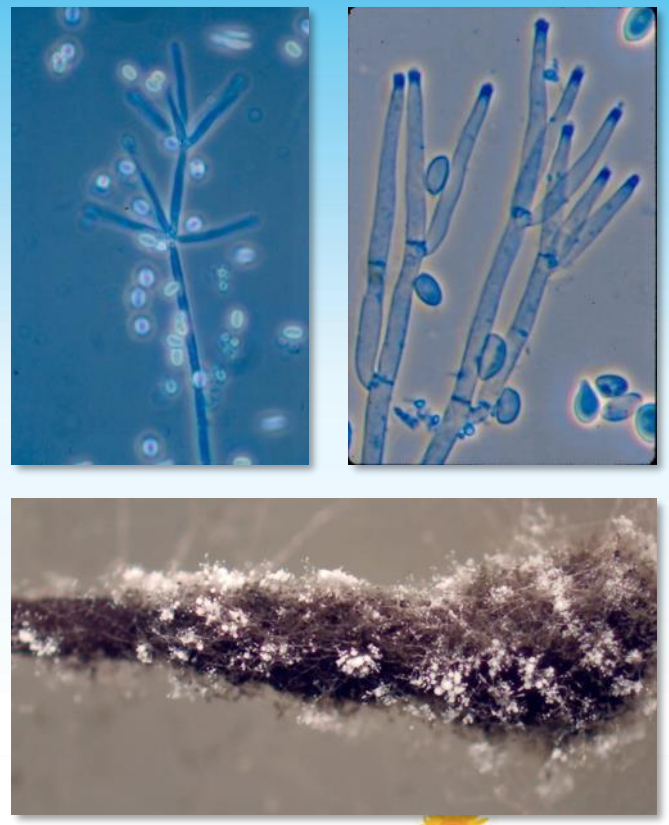
Vectorpak™ cartridges secured outside the hive



1. **Pollinating bees walk through dispensers containing biological control agent (specially formulated VECTORITE™ powder)**
2. **Biocontrol agents attach safely to bees**
3. **Bees visit flowers containing pollen and deposit the biocontrol agents**
4. **Biocontrol agent colonize plant tissue and protect plant against pests**
5. **Bees return to their hives carrying pollen**

Microbial Fungicide

Clonostachys rosea strain CR-7: A unique beneficial endophytic fungus



Where it is found

- Sub-arctic to humid tropics
- Found in numerous soils (agricultural, forest, natural, salt marshes)
- Associates with an extraordinarily wide array of plant species.

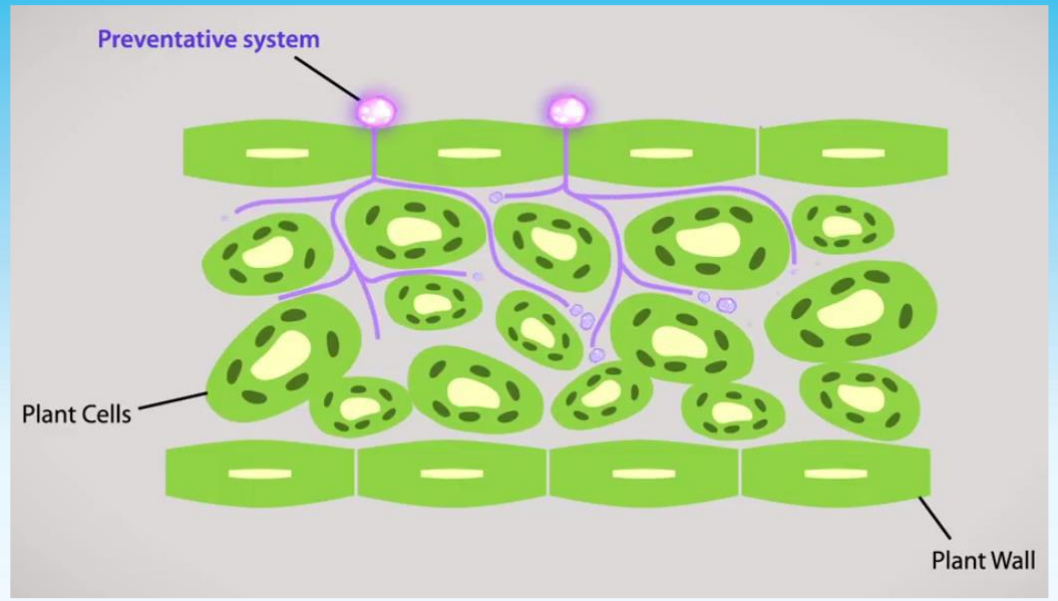
Selected from 1400 fungal isolates

- Rapid reproduction
- Stability in the field
- Spore size and commercialization

Unique characteristics

- Remains protected while inside the tissue throughout the growing season
- Remains stable in temperate climates where its sexual state does not occur

C. rosea CR-7: How it Works



Competitive displacement via tissue occupation

- *Clonostachys* remains as tiny colonies within plant tissues until the tissues senesce or are stressed (such as by pathogens)
- When the tissues begin to senesce or become stressed *Clonostachys* grows rapidly and quickly occupies the tissues; *C. rosea* is a ***pioneer*** colonizer.
- *C. rosea* occupies the tissues ahead of other fungi.
- *C. rosea* blocks other fungi by spatial occupation of the flowers, leaves, etc.

VECTORITE with CR-7 | EPA United States Environmental Protection Agency | OMRI LISTED For Organic Use

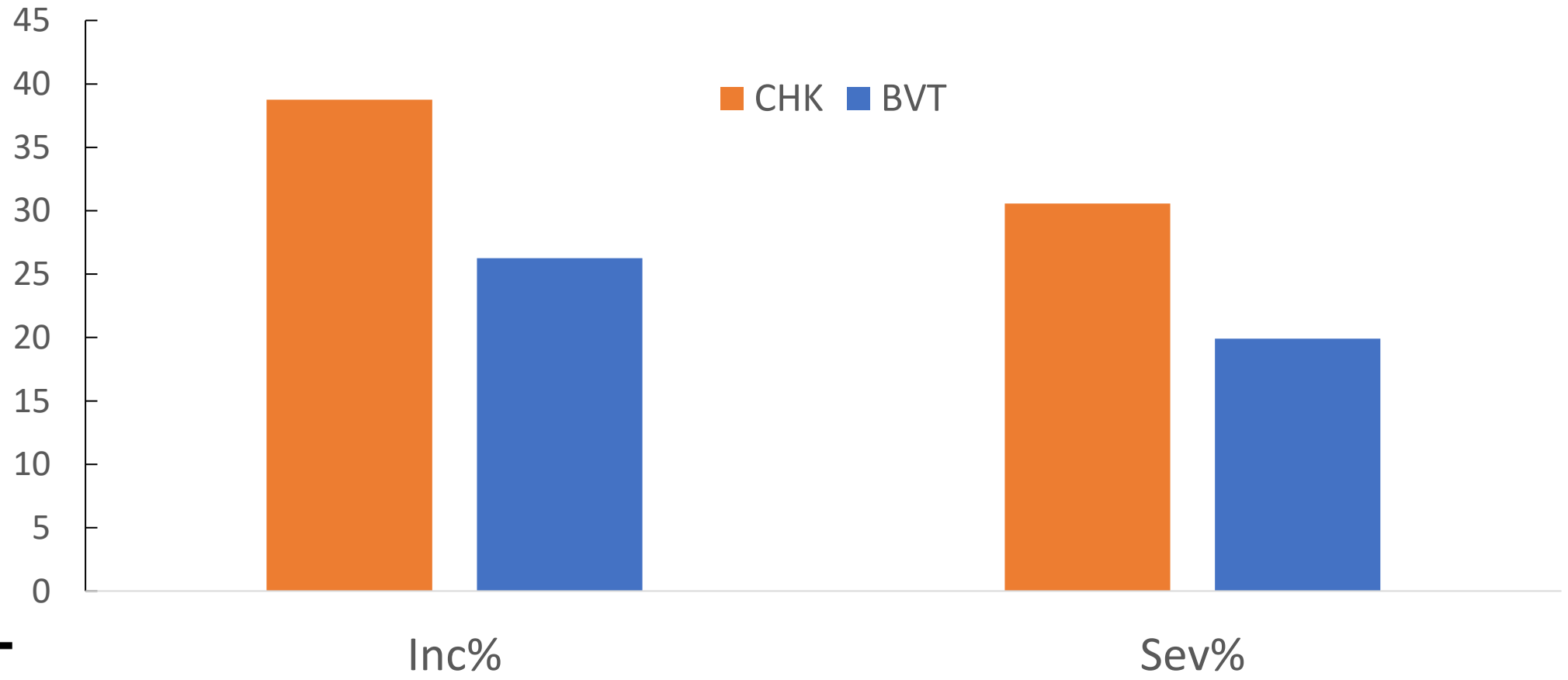
2016 North Dakota State University (NDSU) Sunflower Trial

- Objective:
  - Determine efficacy of bumblebee-vectored BVT Cr-7 against *Sclerotinia sclerotiorum* in sunflower

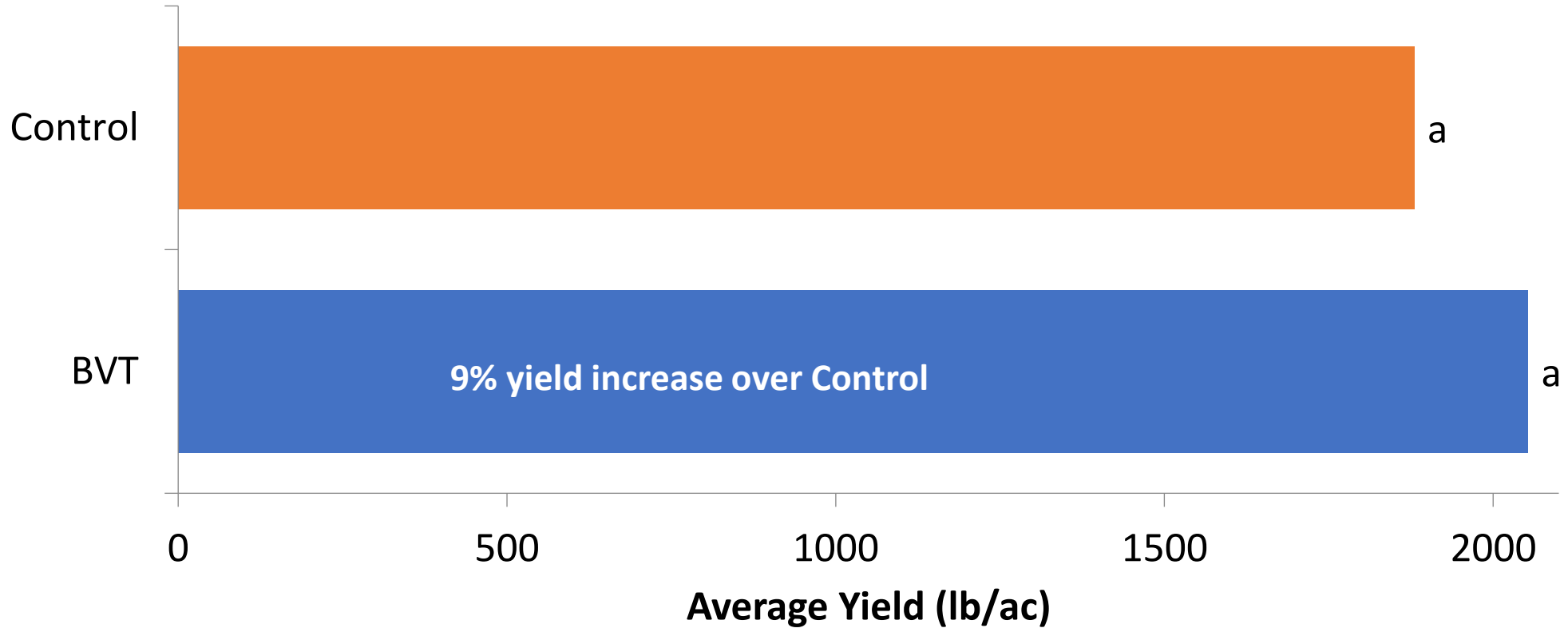
- Experiment:
  - Completely randomized block
  - BVT Vectorpak changed every 3-5 days
  - Two artificial inoculations made ($1.5x10^4$ ascopores/application)
  - Heads visually assessed for severity of Sclerotinia head rot

BVT
Bee Vectoring Technology™

2016 NDSU Sunflower- Disease Assessment



2016 NDSU Sunflower- Yield



2016 and 2017 Serbia Sunflower trial

- Objective:
  - Determine efficacy of bumblebee-vectored BVT Cr-7 against *Sclerotinia sclerotiorum* in sunflower

- Experiment:
  - BVT Vectorpak changed every 3-5 days
  - Two artificial inoculations ($1.5x10^4$ ascopores/application)
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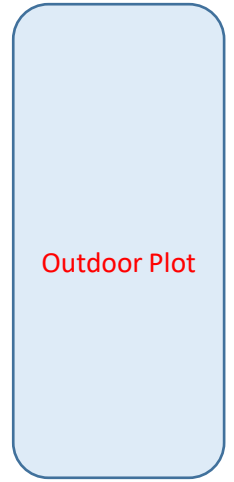
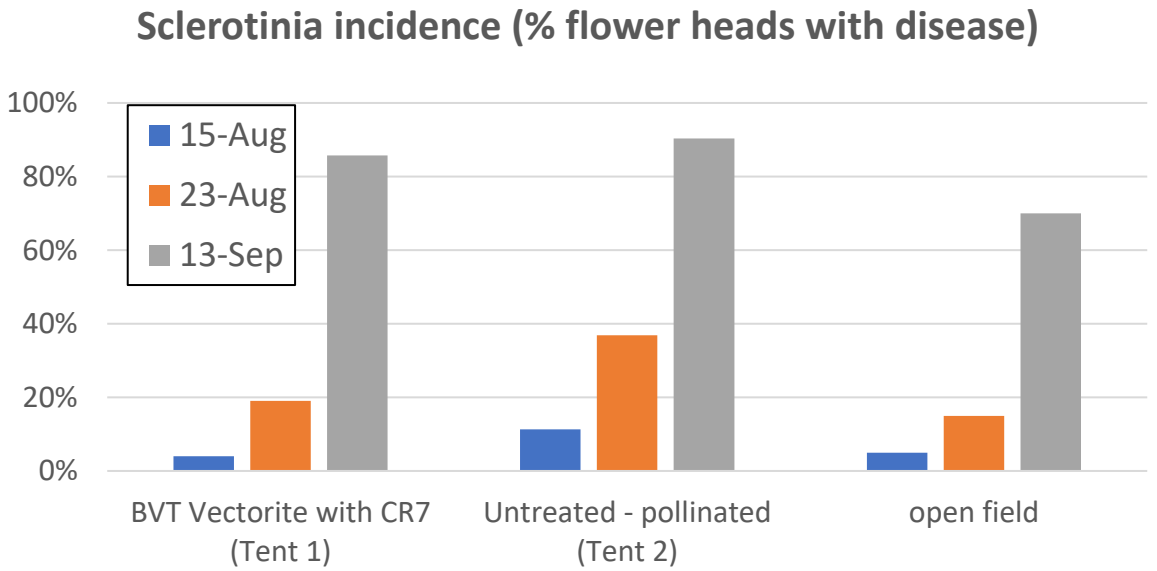


Bumblebee hives

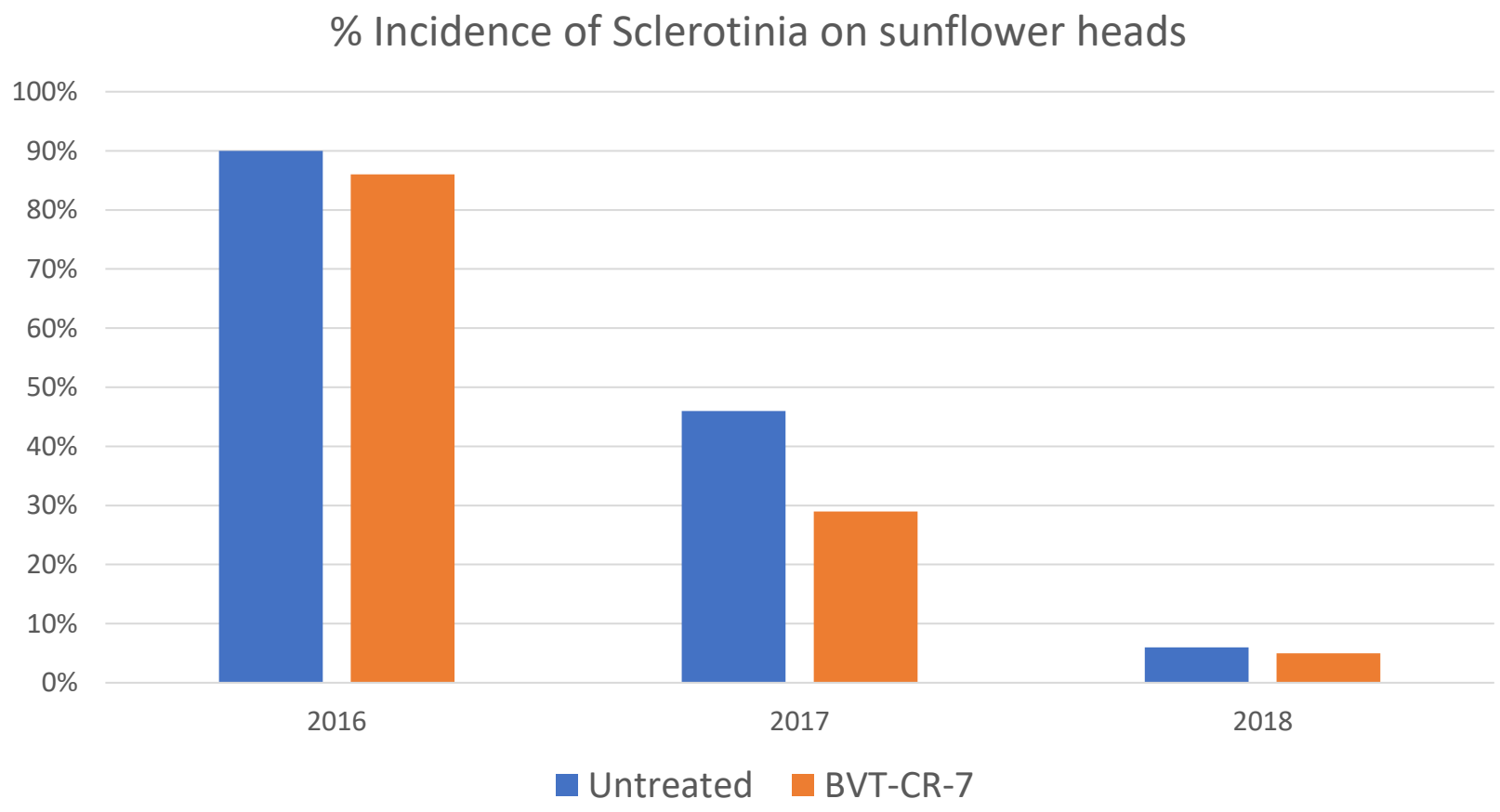
Sunflower trial (2016) NSSeme

Seed yield and quality parameters of the CR7 treated and control sunflower plants

	Yield (kg) from 20 sampled heads		1000 seed weight (g)		Hectoliter mass (kg/hl)	
Reps	**Con.**	**BVT CR-7**	**Con.**	**BVT CR-7**	**Con.**	**BVT CR-7**
1	1.02	1.22	47.5	48.2	39.6	38.8
2	0.92	1.17	49.2	52.7	39.6	42.4
3	1.01	1.03	47.2	48.8	38.8	41.2
4	0.78	1.25	44.4	47.0	36.4	40.4
Average	**0.93**	**1.17**	**47.1**	**49.4**	**38.6**	**40.7**



2016-2018 Serbia Sunflower- Disease Incidence



Artificial inoculation and overhead irrigation in 2017 and 2018

NDSU Trials

Objective: Quantify the impact of bee vectored applications of CR-7 on agronomic performance of sunflowers under Sclerotinia head rot disease pressure

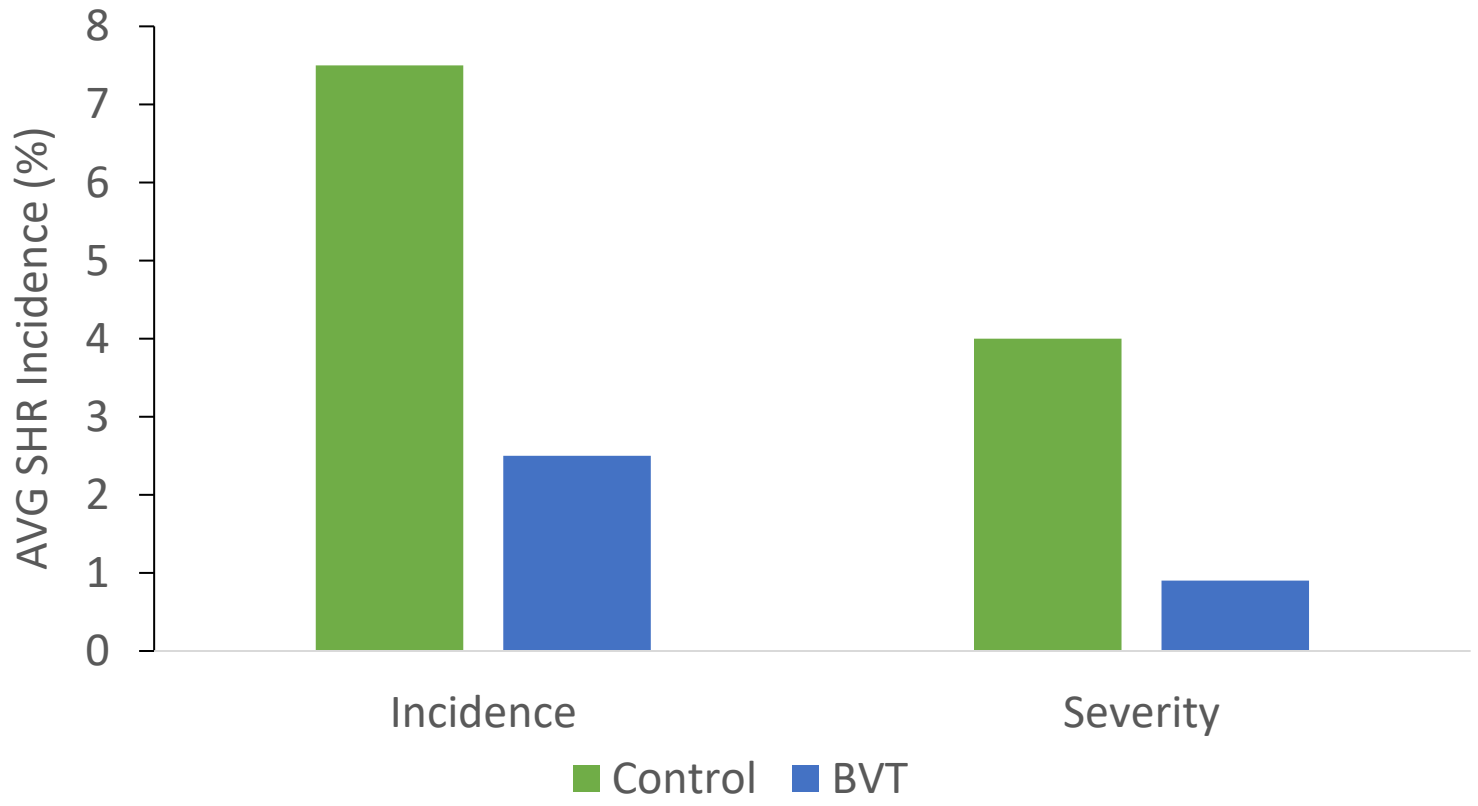
Langdon

- 2016-2018 non irrigated, BB
- 2019 irrigated, HB
- Inoculation + exclusion bags
- Disease ratings + yield

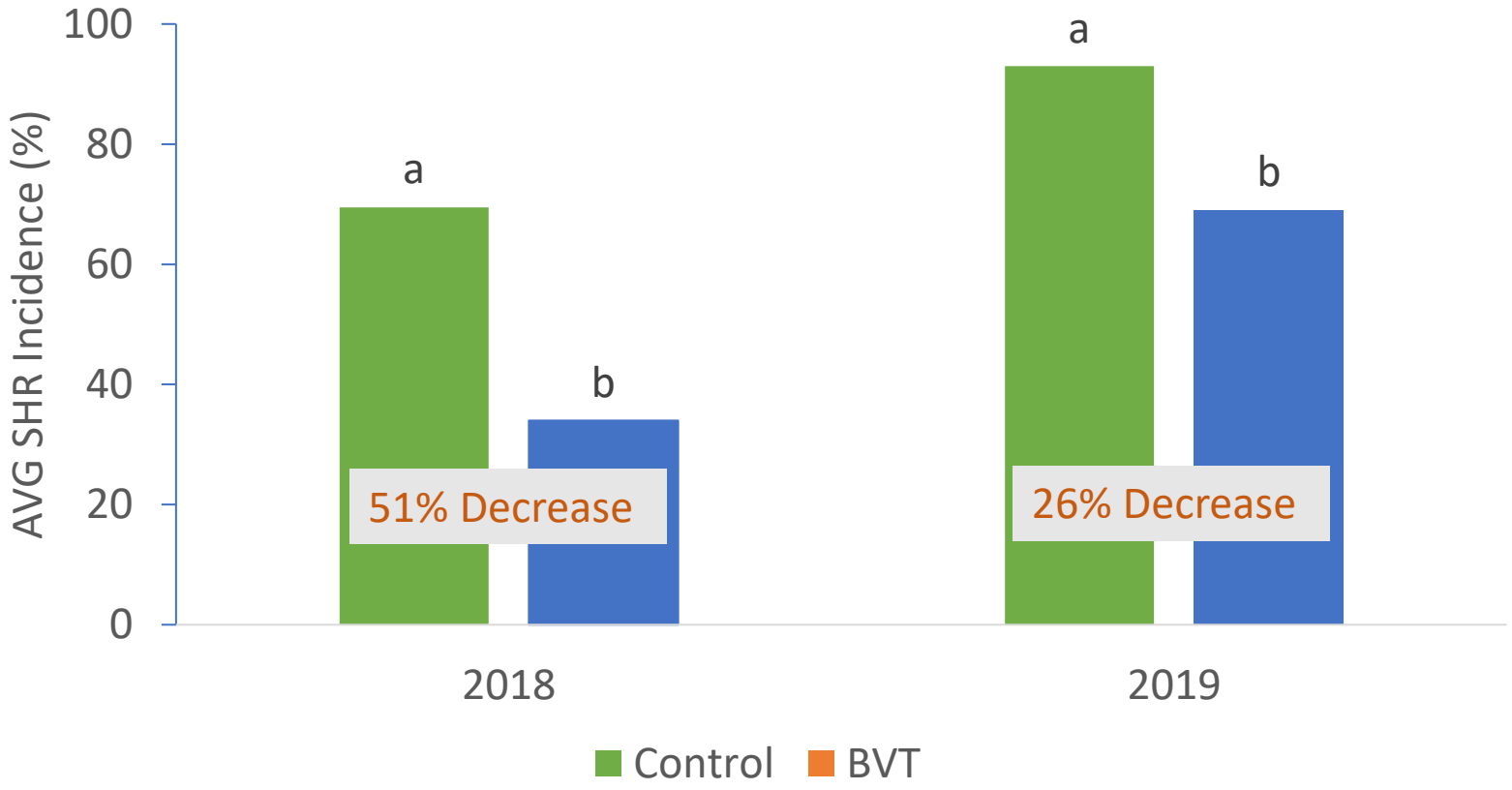
Carrington

- 2018 BB, 2019 HB
- Irrigated
- Inoculation + exclusion bags
- Disease ratings + yields

Langdon 2019

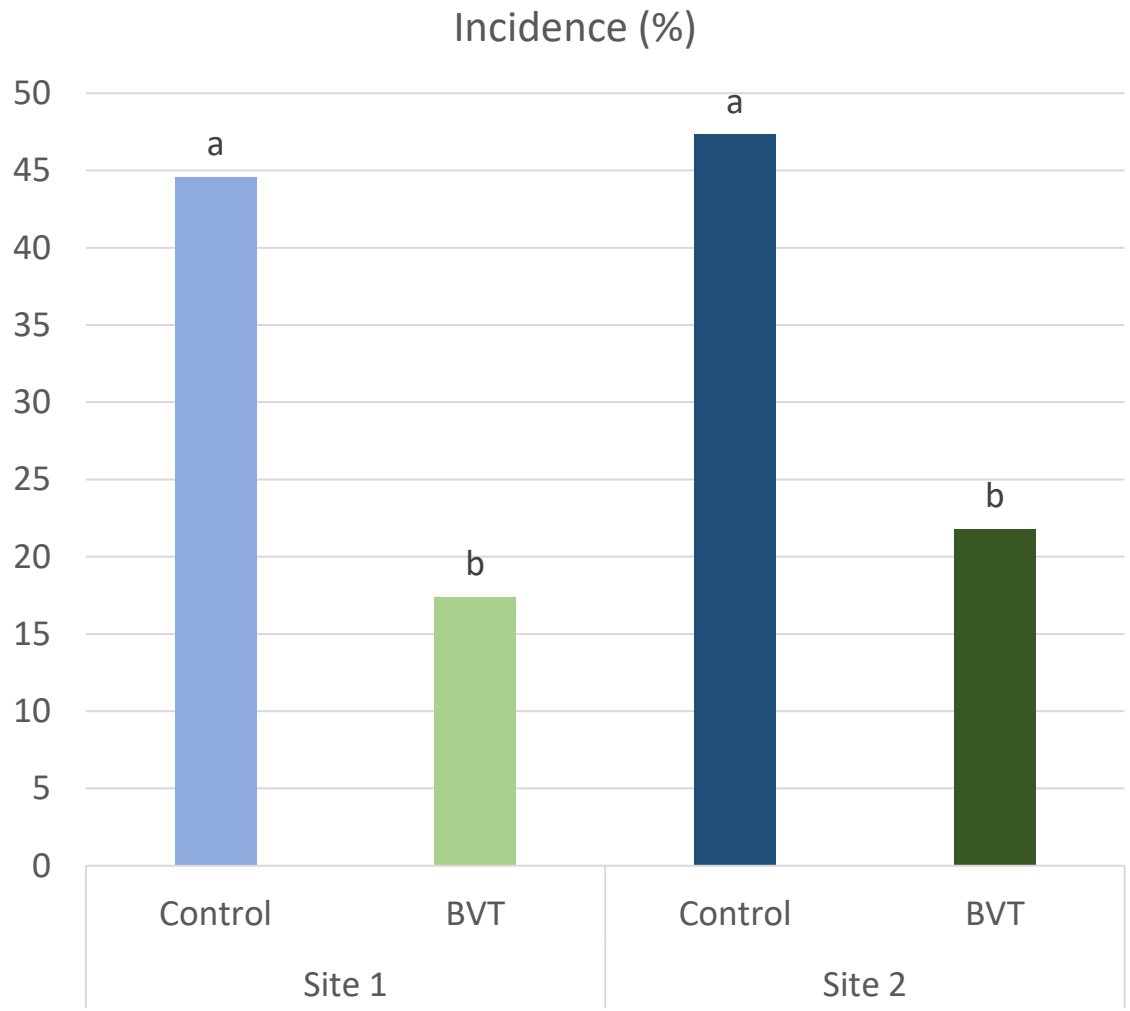


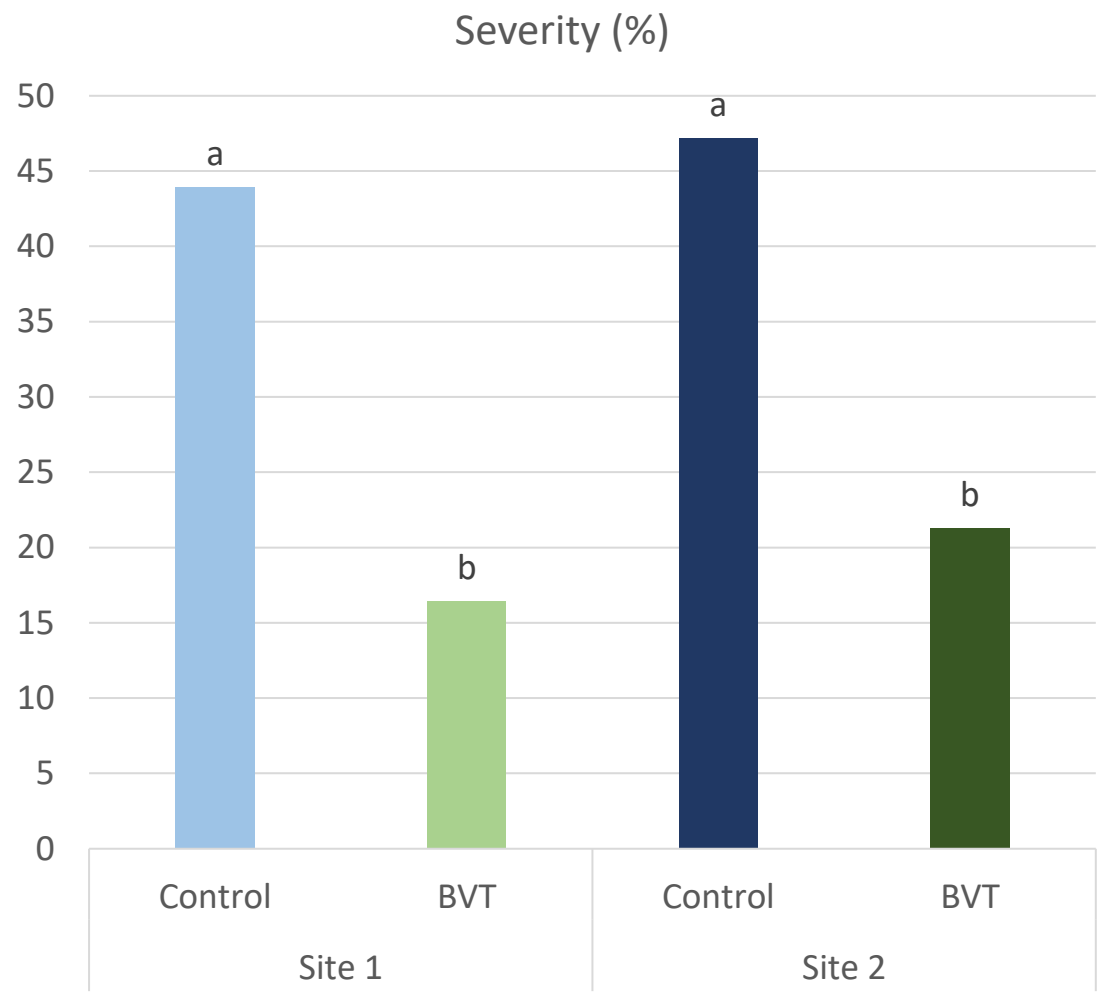
Carrington- disease incidence



Bars denoted with a different letter are significantly different at P≤0.05 (2018), and P≤0.10 (2019)

Carrington 2020





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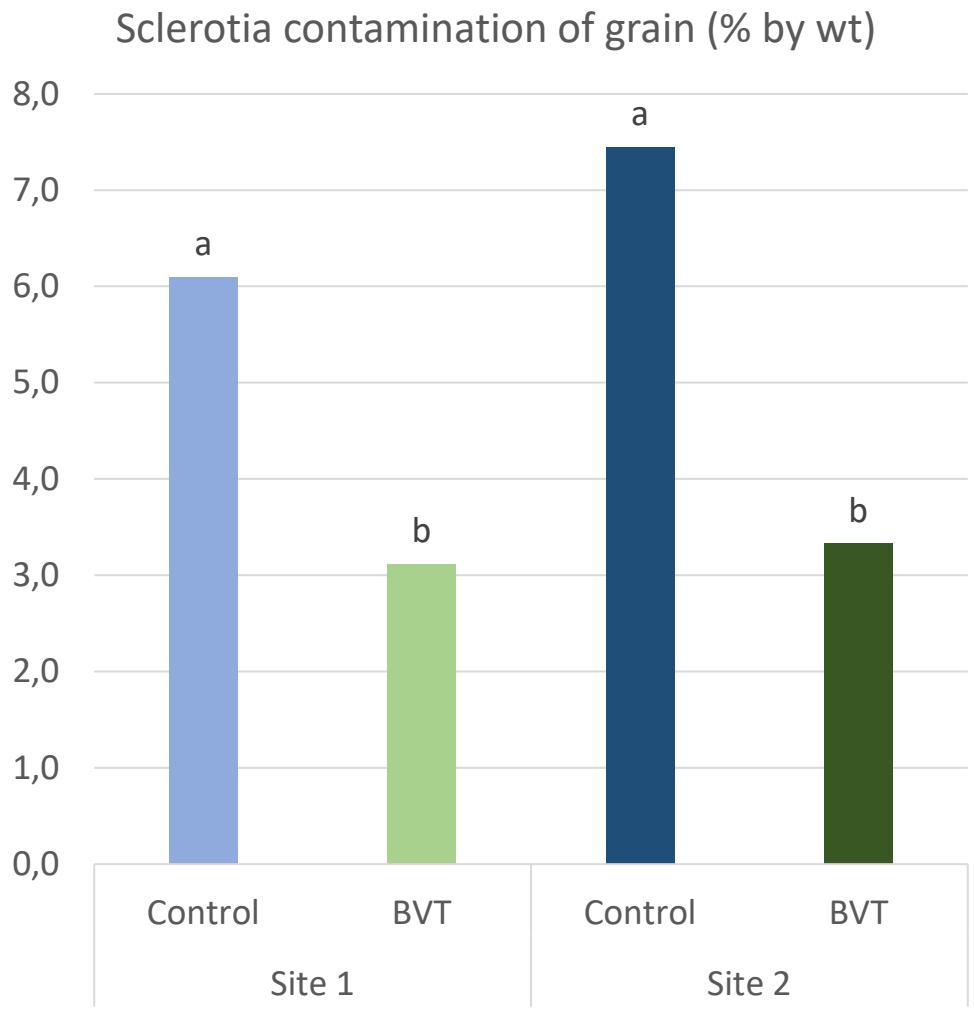
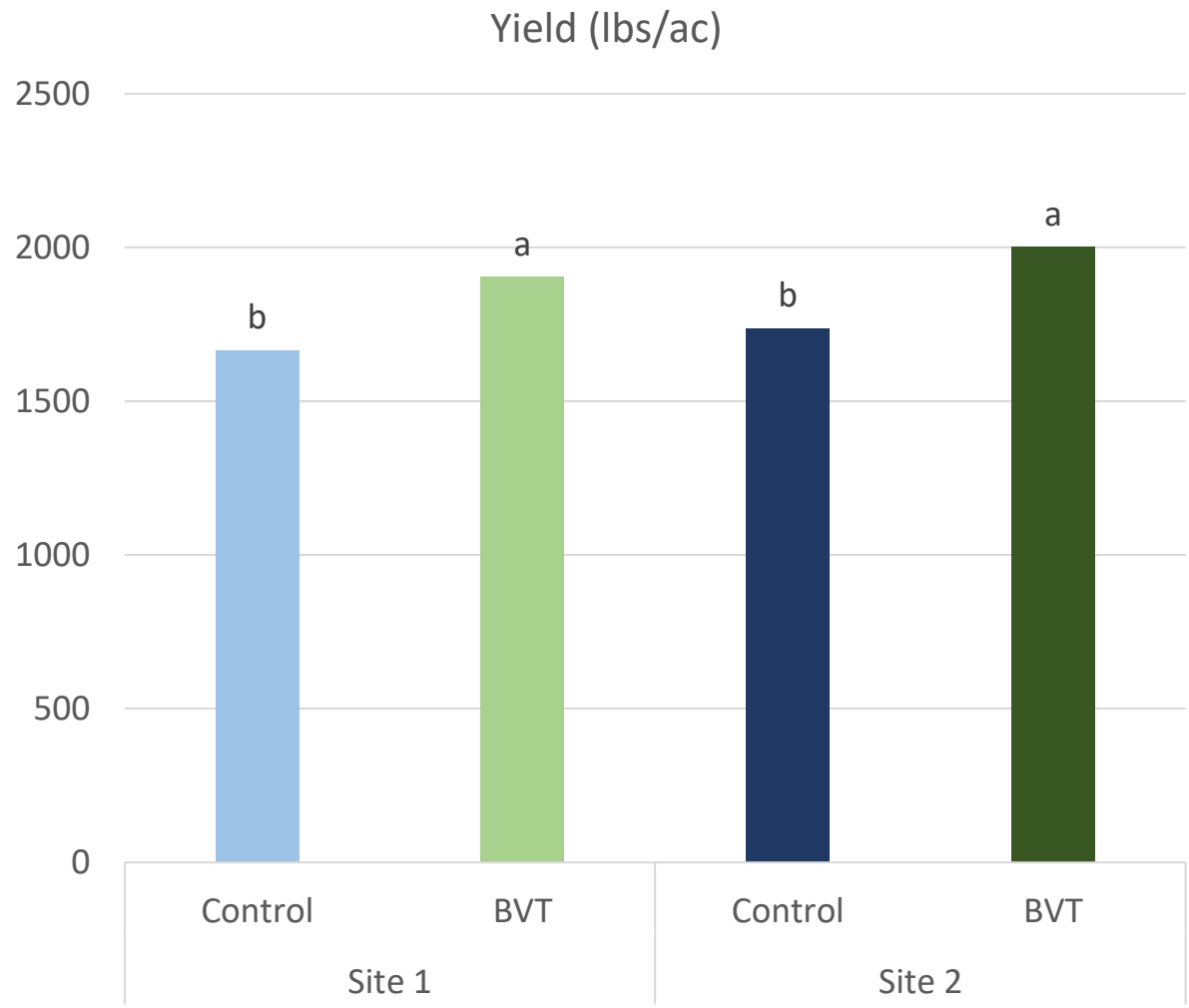
Carrington 2020





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Thank you for your attention