Head Smut (*Tilletia maclaganii*) on Switchgrass (*Panicum virgatum* L.) in Ontario

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Head Smut (*Tilletia maclaganii*)

- Fungal pathogen
  - Basidiomycete
- Main source of inoculum are the Teliospores
- Disease cycle believed to be similar to *Tilletia controversa* (dwarf bunt of wheat))
  - Soil/seed-borne
  - Enters through roots
  - Grows systemically within plant
  - Takes over developing panicles and replace the seeds with spores

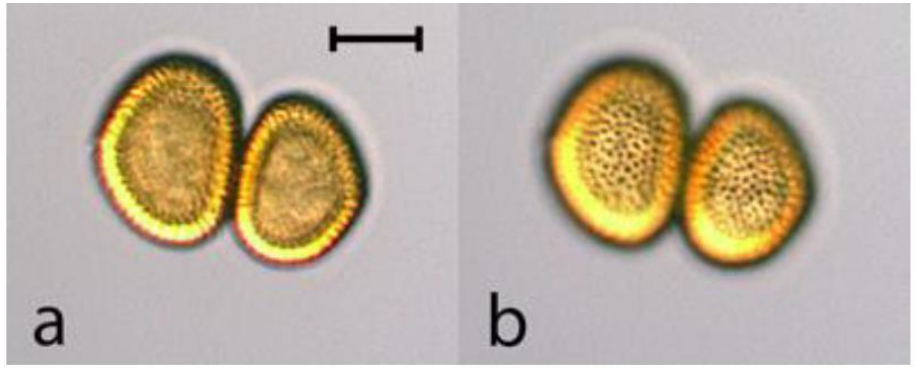

Figure 1.6: Teliospores of *Tilletia maclaganii*. (a), Plane view to show the lack of a sheath and the presence of a thick exospore and (b), in surface view to show the finely verrucose ornamentation. Bar = 10 µm (41).

Layton, C.N., 2014

Head Smut (*Tilletia maclaganii*)

- Host range appears to be restricted to *Panicum* species and primarily *P. virgatum*
- Symptoms:
  - ➢Stunted growth (~1m)
  - ➢Premature flowering (~1 month earlier)
  - ➢Replacement of floral organs with reddish-brown spores
  - ➢Purple glumes
  - ➢Panicle appear clubbed/swollen

Figure 1.4: Switchgrass panicles showing the characteristic symptoms of head smut. (a), Affected panicles have a stunted, clubbed appearance and (b), a healthy panicle (left) in comparison to a smutted panicle (right).

Layton, C.N., 2014)

Head Smut in Ontario

- As switchgrass production in Ontario increases, so has the threat of head smut
- Very little information on this relationship is known
  - No information on smut incidence in Ontario fields
  - No information on susceptibility of cultivars to head smut

Past Surveys of Head Smut

- Iowa, 1999 (Gravert & Munkvold)
  - 17 fields in Chariton Valley, Iowa
    - Switchgrass fields predominantly Cave-in-Rock
  - Smut incidence ranged from 0 to 70% of tillers in individual fields
  - Cave-in-Rock especially susceptible to head smut
  - Fields with >50% smut incidence resulted in half the expected yield
- Iowa, 2008 (Thomsen et al.)
  - 10 fields in Chariton Valley, Iowa surveyed (all Cave-in-Rock)
    - Same counties as above survey
  - Smut incidence ranges from 0.7 to 55.4% of tillers
  - Reported 17% loss in Iowa

Surveys (cont.)

- New York, 2007-2010 (Layton & Bergstrom)
  - Head smut reported in several switchgrass fields in New York from 2007 to 2010
- Texas, 2018 (Kenaley et al
  - First report of *T. maclaganii* in Texas
- **Ontario, 2018 (Celetti & Thimmanagari)**
  - **Surveyed 10 switchgrass fields in Ontario**
  - **Head smut observed in 90% of surveyed fields**
  - **Smut incidence ranging from 0 to 68% infected tillers/field**
  - **Positive relationship between age of field and smut incidence**

Previous work on the disease

- Layton 2014
  - ➢ Identification of infection pathways of *T. maclaganii*
    - ❖ Post-seedling inoculation has a higher infection rate than seed and seedling inoculation
  - ➢ Lowland cultivars (Kanlow and BoMaster) less susceptible to head smut than upland
  - ➢ Variable effectiveness of seed treatment against *T. maclaganii*

Objectives

1. Conduct a field survey to investigate the extent of head smut in Ontario switchgrass fields
2. Examine various cultivars in the greenhouse for resistance to head smut
3. Investigate the effectiveness of various seed treatments at preventing head smut establishment on seeds
4. Examine various cultivars and mixed species in the field to assess cultivar resistance and to determine the impact of growing switchgrass with smut-tolerant species (big bluestem) on biomass and the spread and development of head smut

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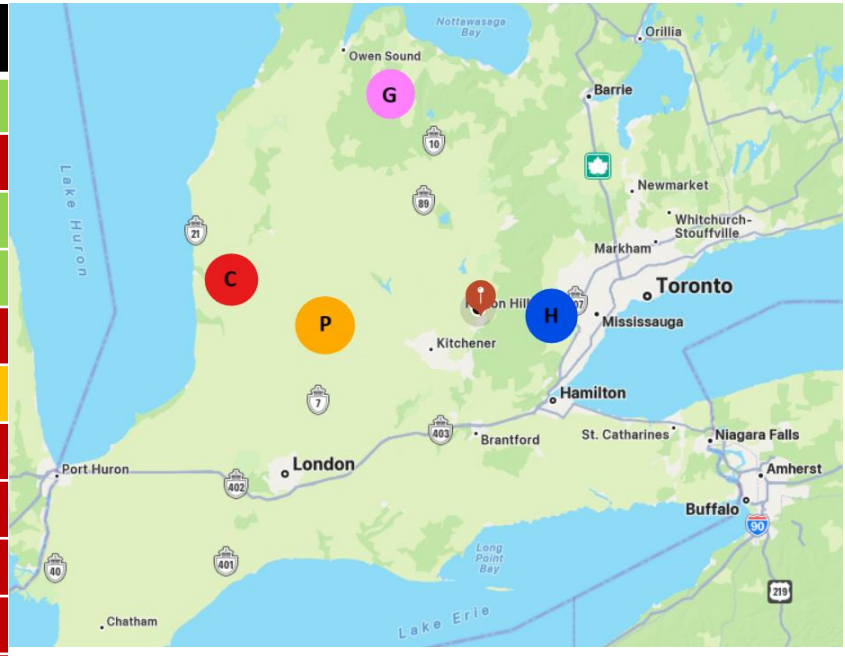
Objective 1: Field Survey

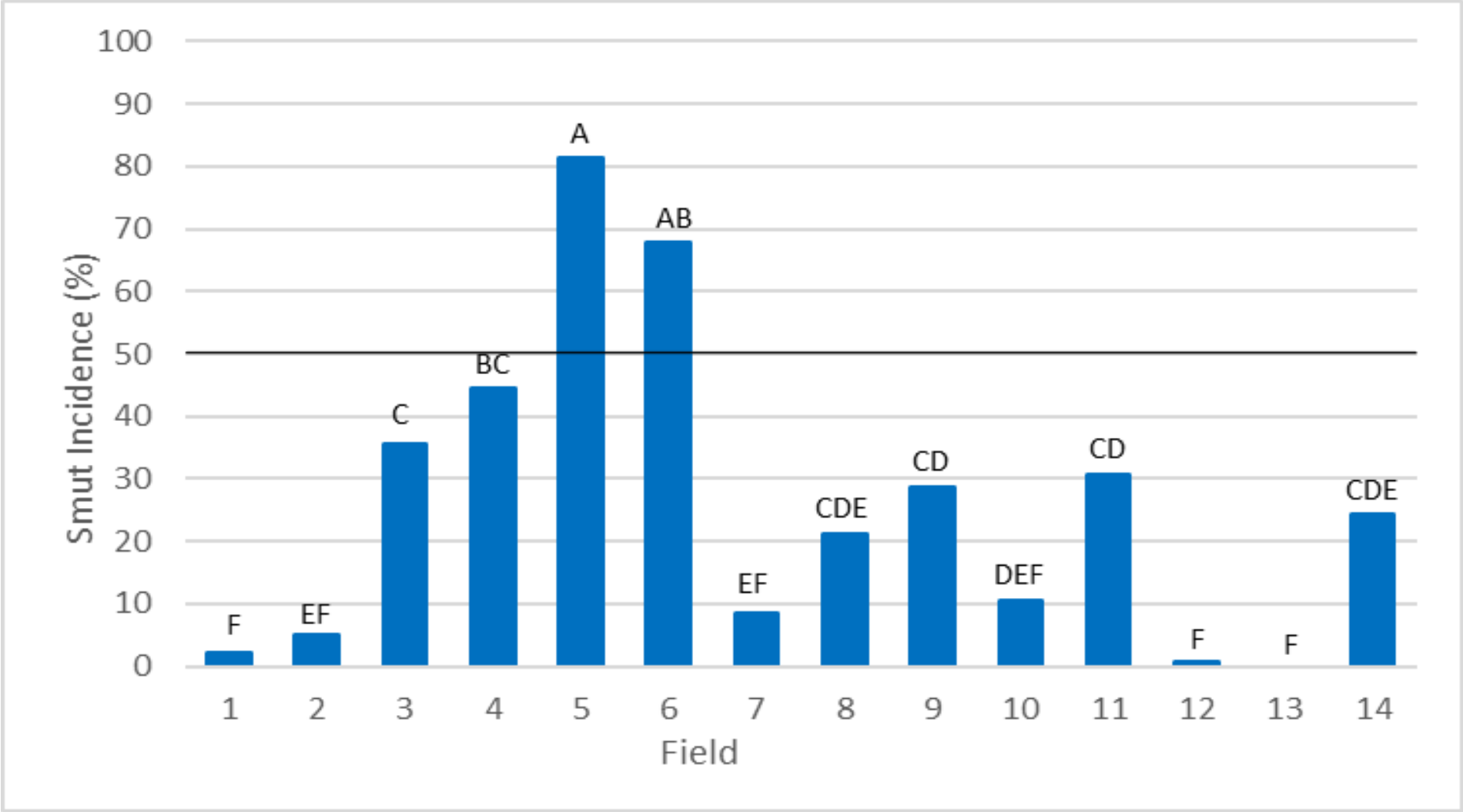
- 15 switchgrass field surveyed

Field No.	Year Surveyed	County	Acres	Year Planted	Age
1	2019, 2021	Halton	17	2015	5
2	2019, 2020, 2021	Halton	26	2015	5
3	2019, 2021	Halton	9	2013	7
4	2019, 2021	Halton	17	2012	8
5	2019, 2020, 2021	Halton	15	2010	10
6	2019, 2020	Halton	35	2009	11
7	2019, 2020, 2021	Halton	35	2014	6
8	2019, 2020, 2021	Halton	15	2013	7
9	2019, 2020, 2021	Grey	7	2010	10
10	2019, 2020, 2021	Grey		2012	8
11	2019, 2020, 2021	Grey	5	2009	11
12	2019, 2020	Clinton	44	2016	4
13	2019, 2020	Clinton	8	2017	3
14	2019, 2020	Perth	10	2011	9
15	2020, 2021			2017	3

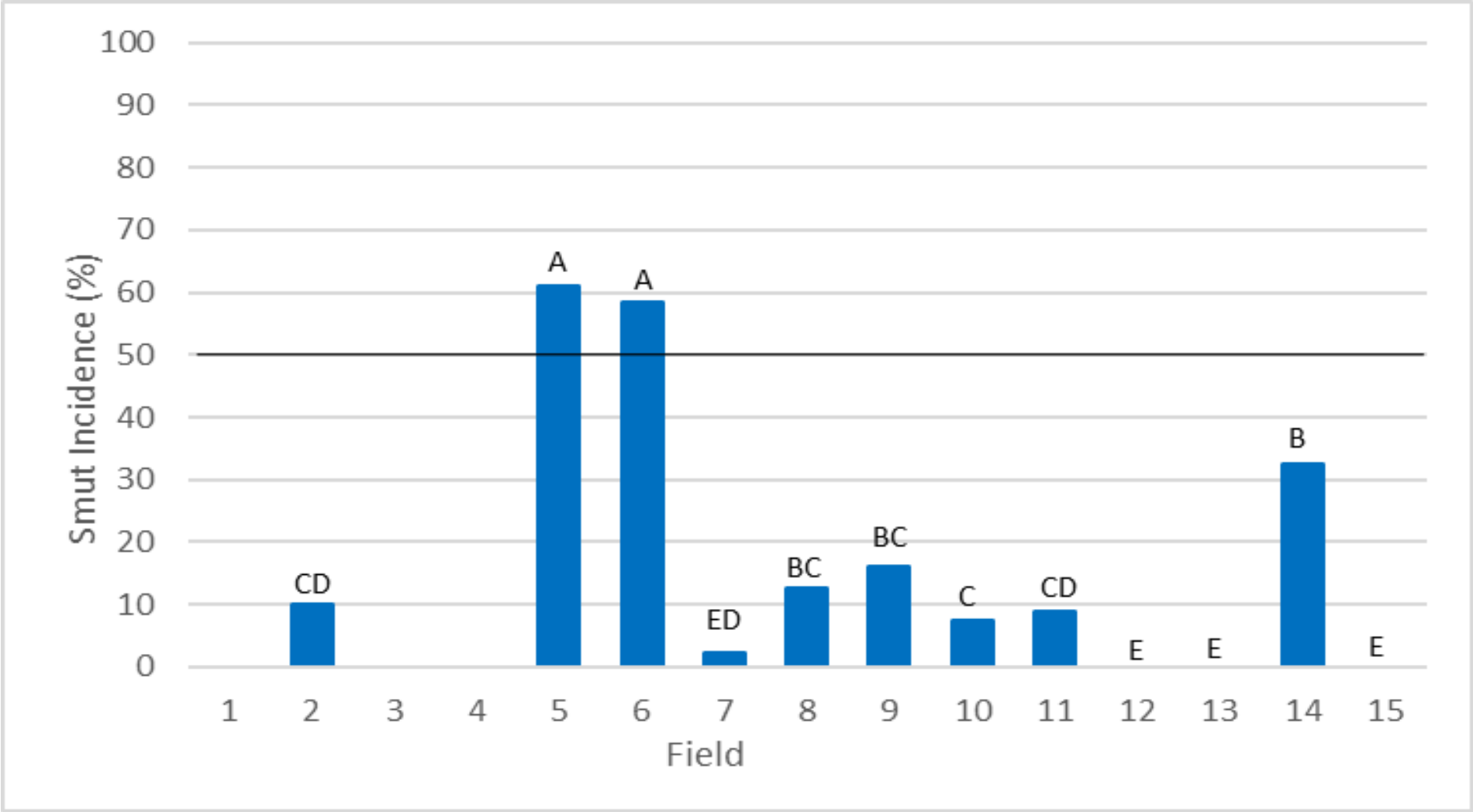


Field Survey Results

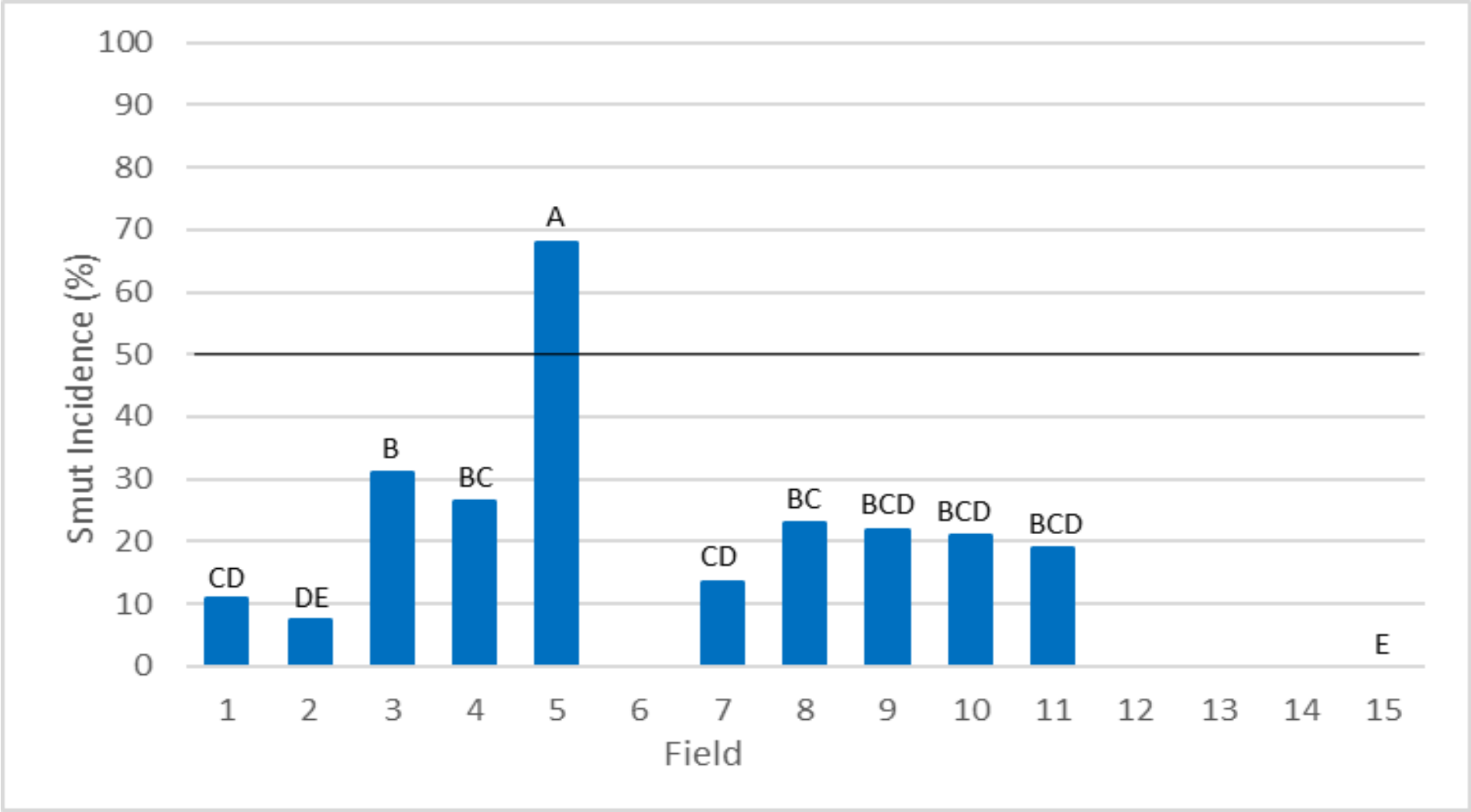
- 2019 Head Smut Incidence



- 2020 Head Smut Incidence



- 2021 Head Smut Incidence



- Head Smut Incidence (by age)

Year Planted	Year Surveyed								
	2019			2020			2021		
	Age[z]	Smut Incidence (%)[y]		Age	Smut Incidence (%)		Age	Smut Incidence (%)	
2009	10	36.4	a	11	24.9	a	12	19.9	a
2010	9	26.6	a	10	24.3	a	11	21.8	a
2011	8	44.5	a	9	-		10	26.5	a
2013	6	35.0	a	7	36.8	a	8	33.9	a
2014	5	16.3	ab	6	6.3	b	7	17.3	a
2016	3	0.8	b	4	0	b	5	-	
2017	2	0	b	3	0	b	4	0	b

[z] Age of the field in the year the survey was conducted.
[Y] Analysis done separately for each survey year.

Year	Field
2017	13, 15
2016	12
2014	2, 3, 7
2013	1, 5, 8
2011	4
2010	9, 14
2009	6, 10, 11

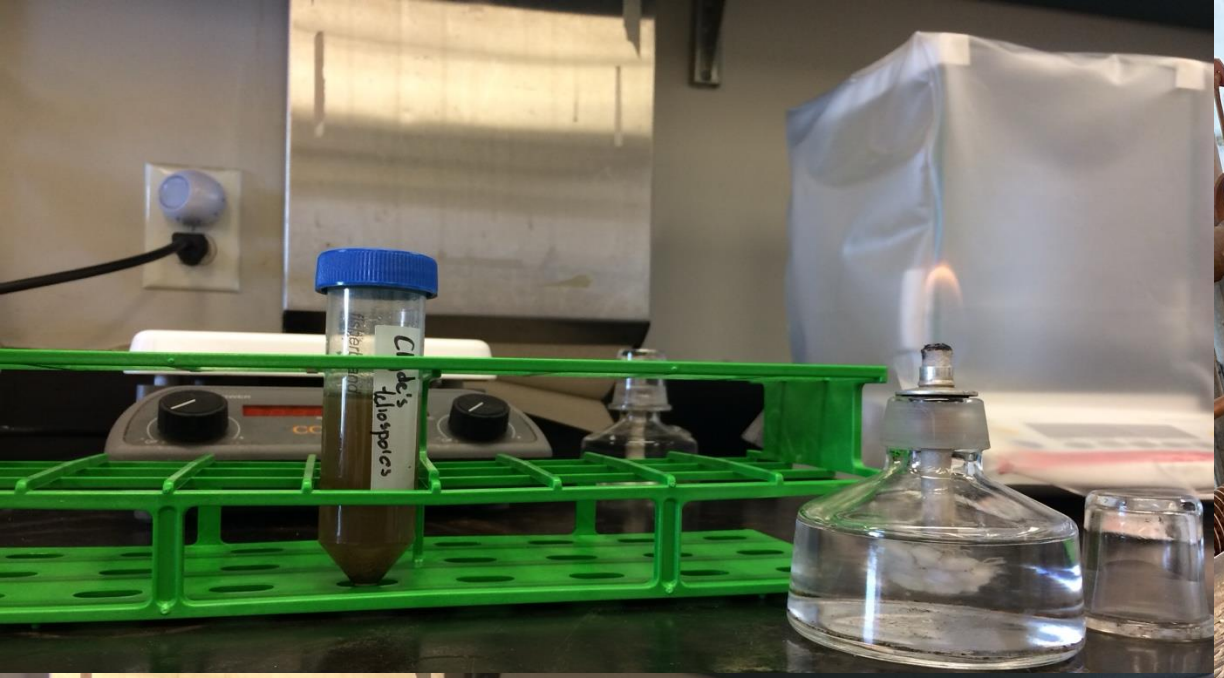
Field Survey Summary

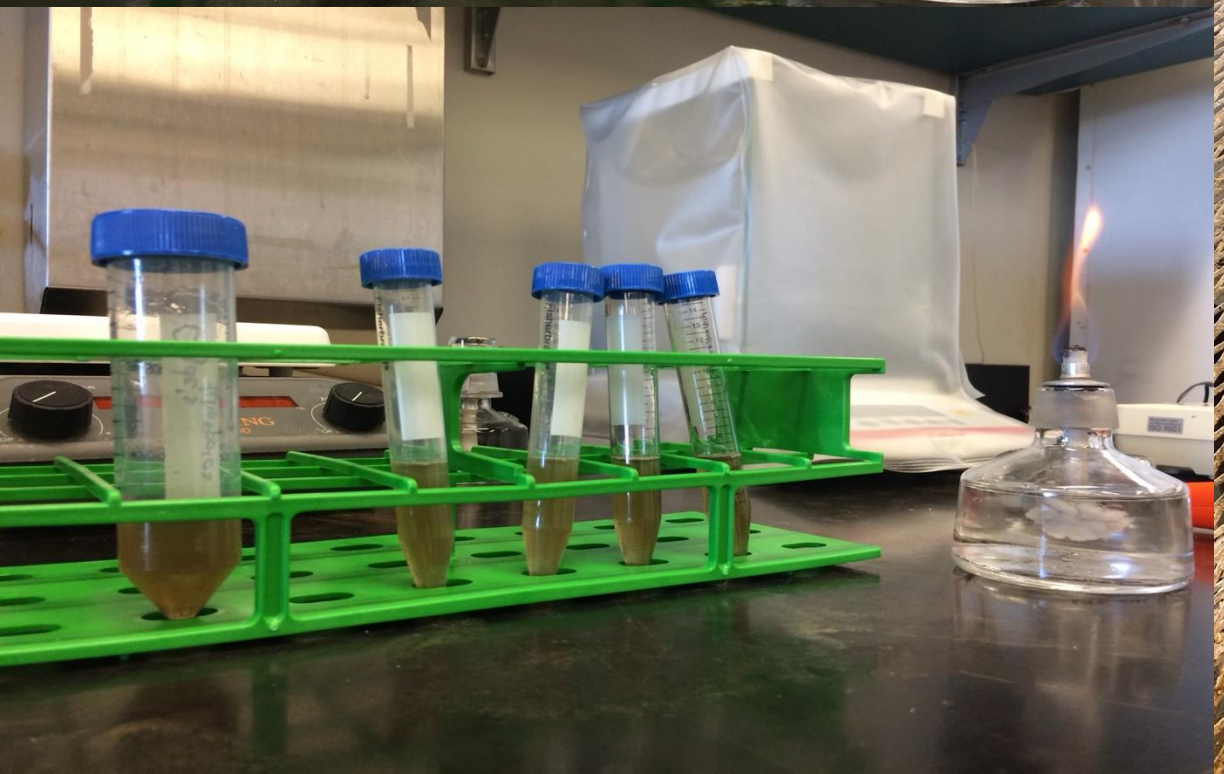
- Smut incidence greater than 50% observed in 2 fields in 2019 and 2020, 1 field in 2021 (missing data from 2nd one)

- Age of field correlated to smut incidence
  - ➢Takes 4-5 years to start seeing head smut
  - ➢Smut incidence increases until ~8 years before declining

Objective 2: Cultivar GH Trials

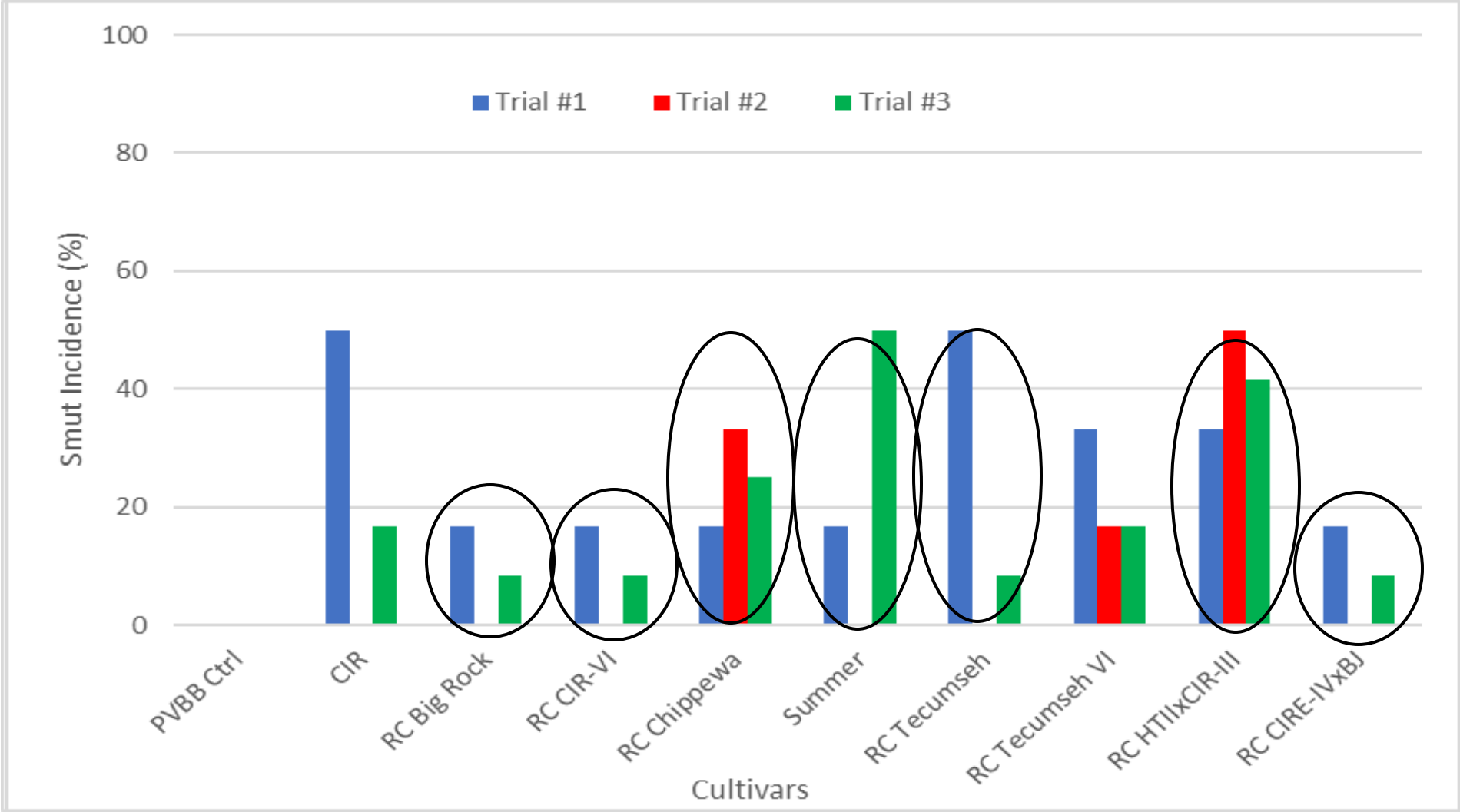
- Treatments:
  - Nine cultivars of switchgrass + Prairieview big bluestem
- Inoculated using teliospore suspension
- Assess for smut incidence (SI) and smut severity (SS)



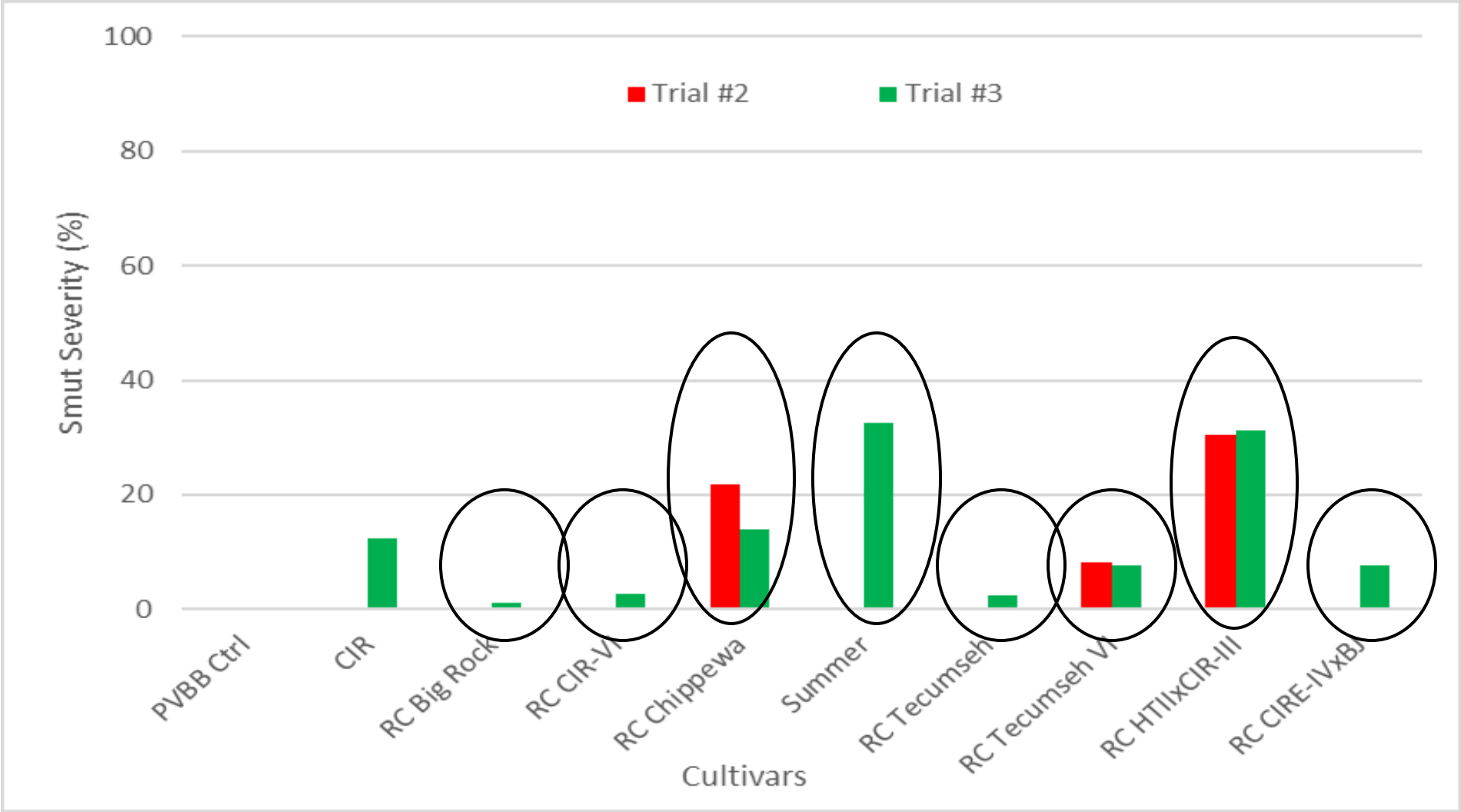


Cultivar GH Trial Results

- Head Smut Incidence



- Head Smut Severity



Cultivar GH Trial Summary

- All switchgrass cultivars are susceptible to head smut
  - Saw some differences in susceptibility
    - RC Chippewa, Summer, and RC (High Tide x CIR-III) consistently more susceptible than CIR
    - RC Big Rock, RC CIR-VI, RC CIRE-IVxBJ appeared to be les susceptible than CIR

Objective 4: Mixed Species Field Trial

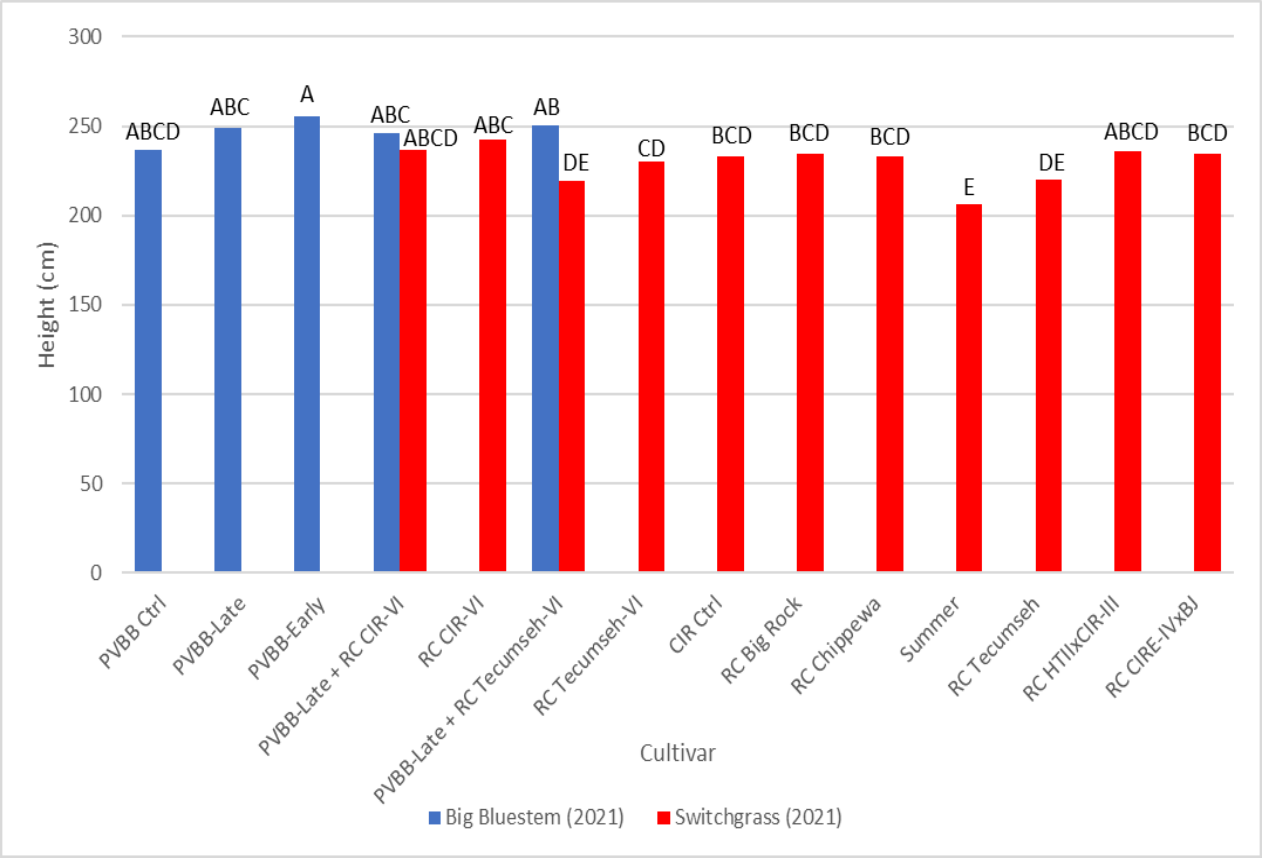
1. Prairie-View Big Bluestem (control)
2. Prairie-View Big Bluestem Late C5
3. Prairie-View Big Bluestem Early C4
4. Cave-in-Rock
5. RC Big Rock
6. RC CIR-VI
7. RC Chippewa
8. Summer
9. RC. Tecumseh
10. RC Tecumseh-VI
11. RC (High-Tide II x Cave-in-Rock III)
12. RC (Cave-in-Rock IV x Blue Jacket)
13. Prairie-View Big Bluestem + RC CIR-VI
14. Prairie-View Big Bluestem + RC Tecumseh-VI

ELORA Field

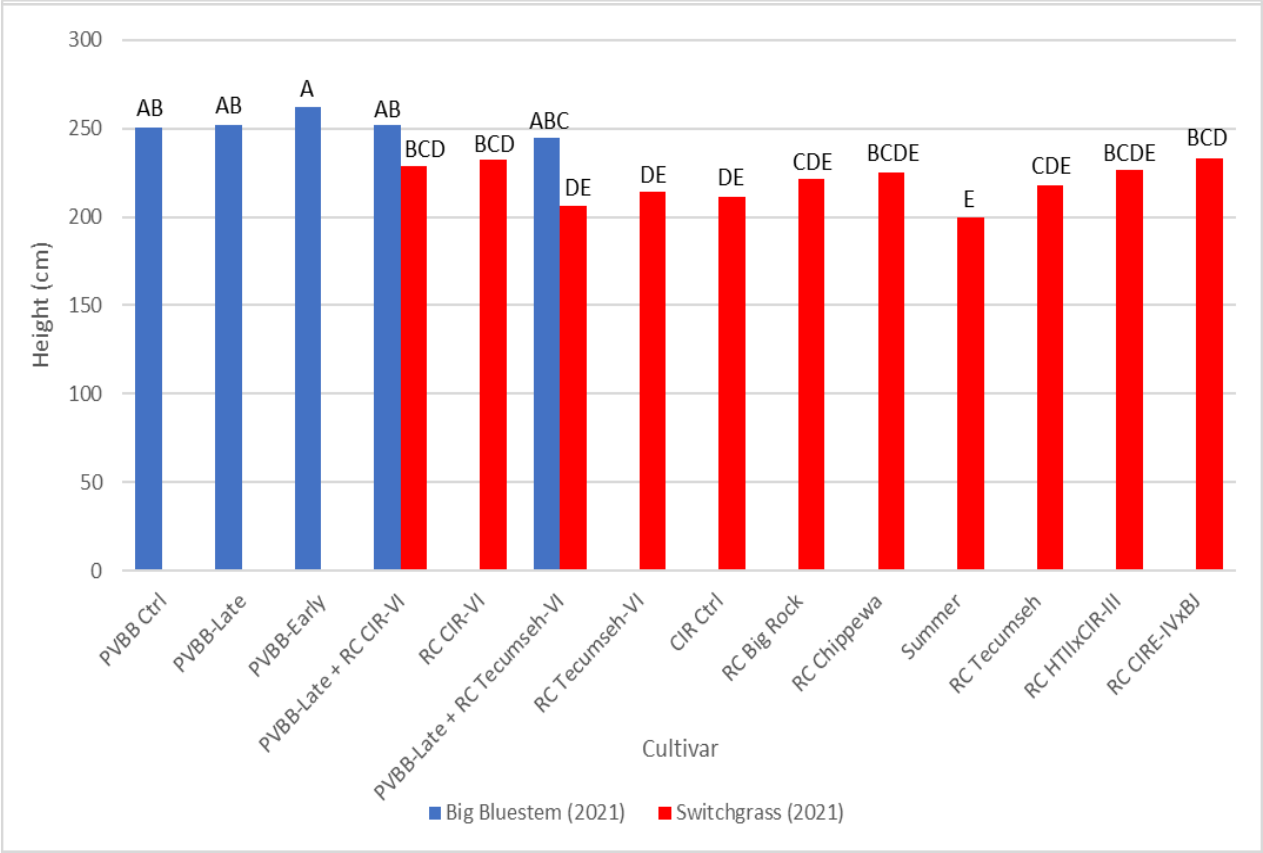
SIMCOE Field

BCS

- Simcoe and Elora 2021 Height (cm)

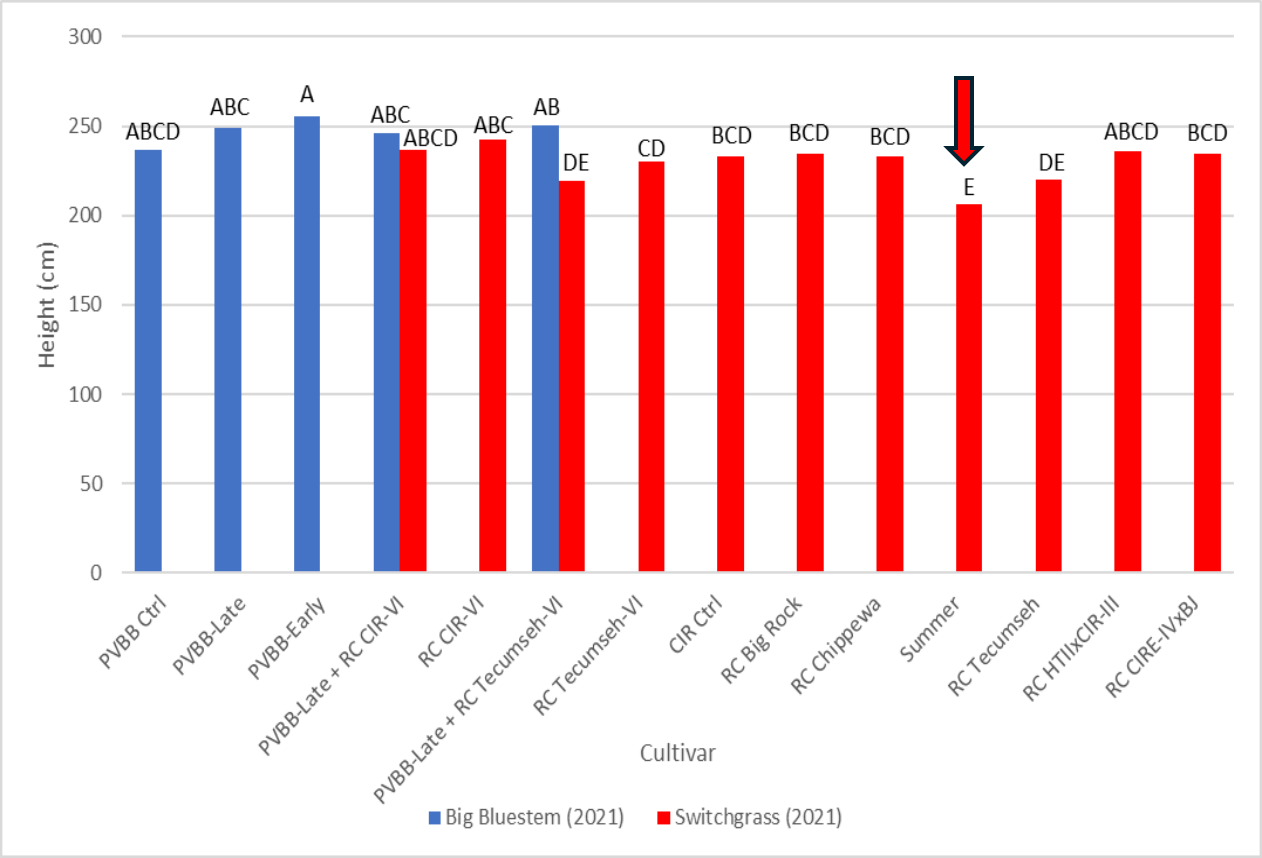


Simcoe



Elora

- Simcoe and Elora 2021 Height (cm)



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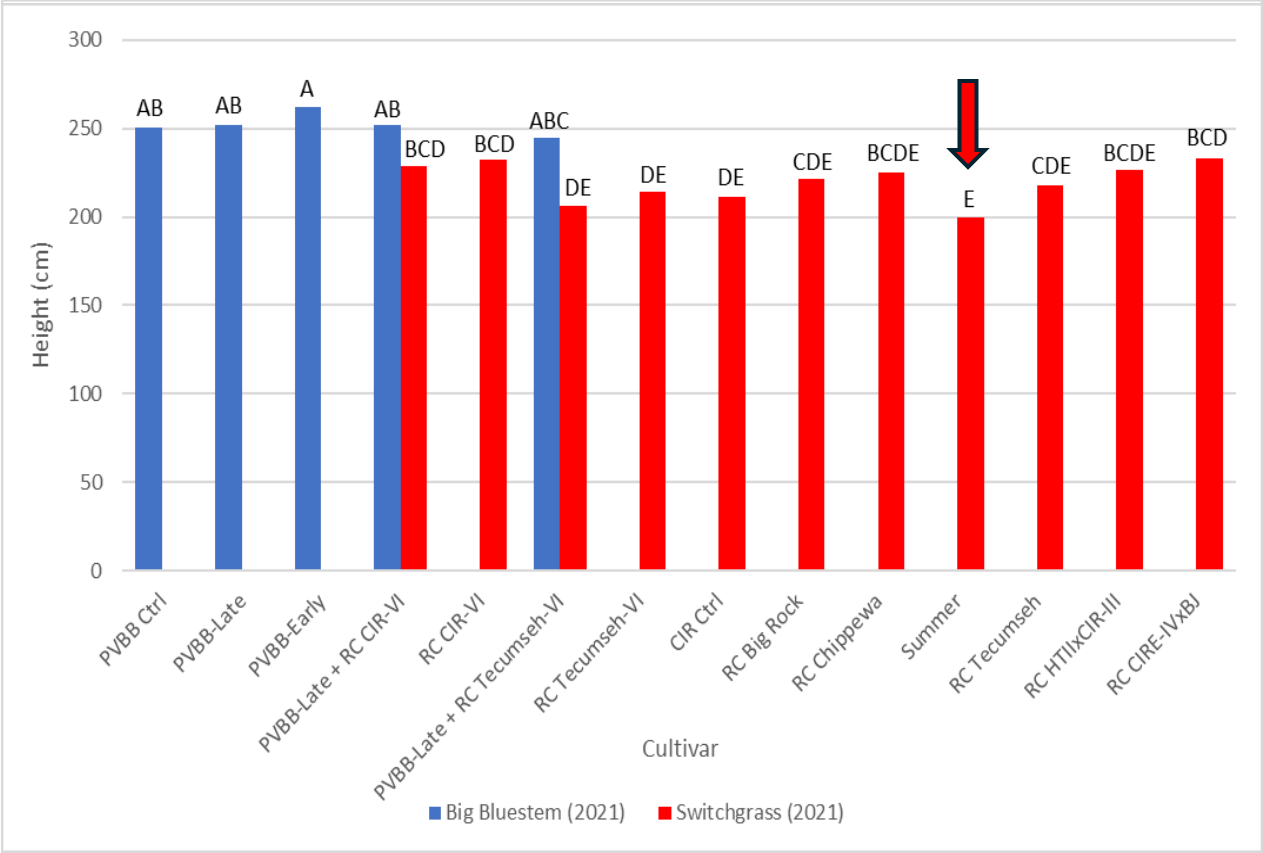

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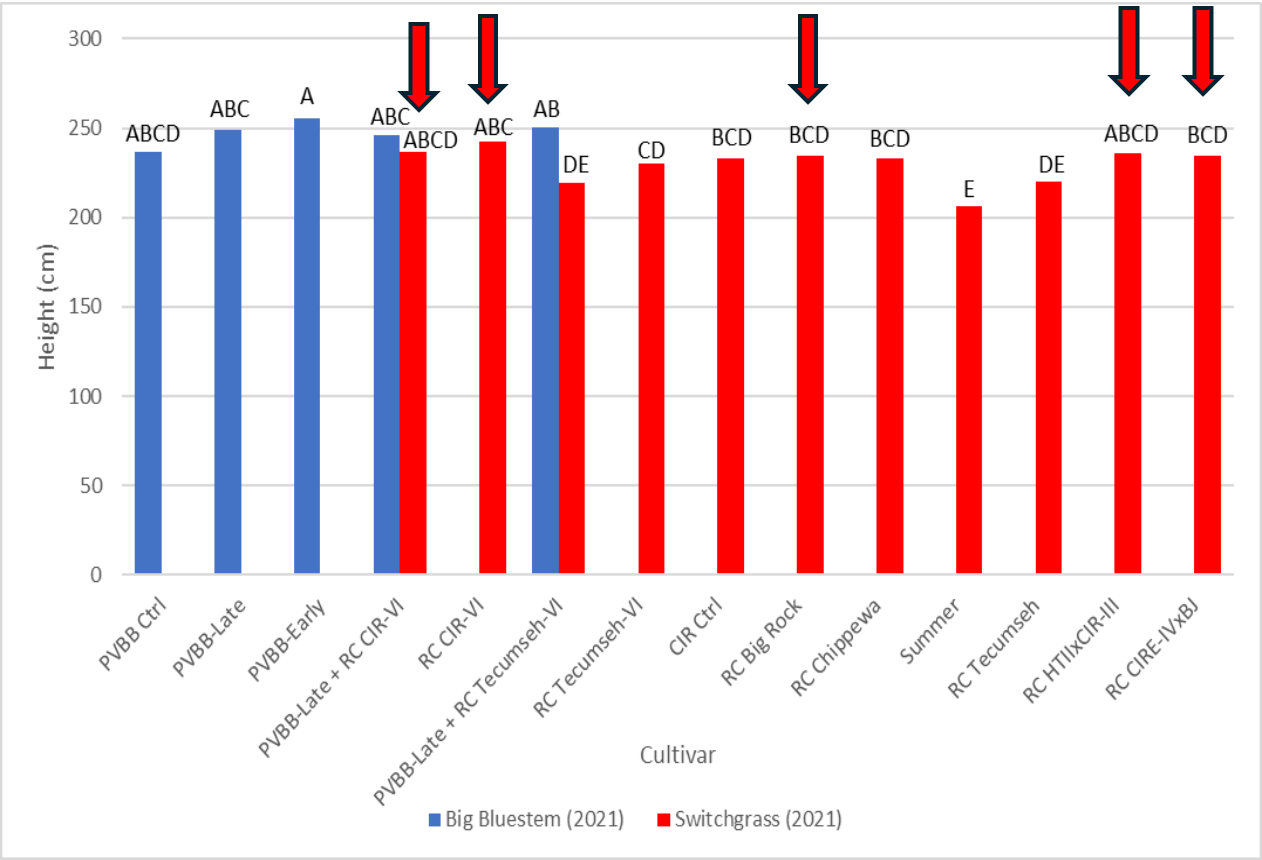

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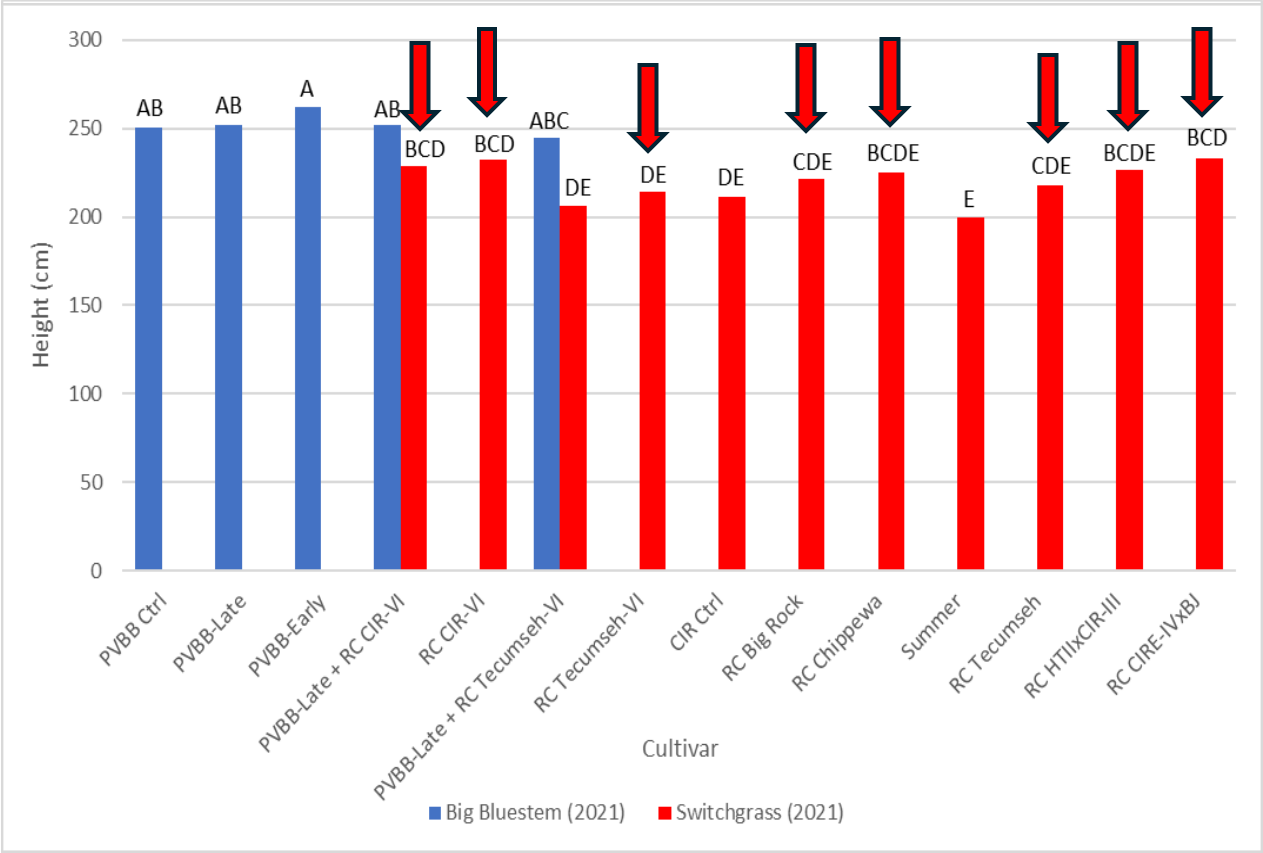

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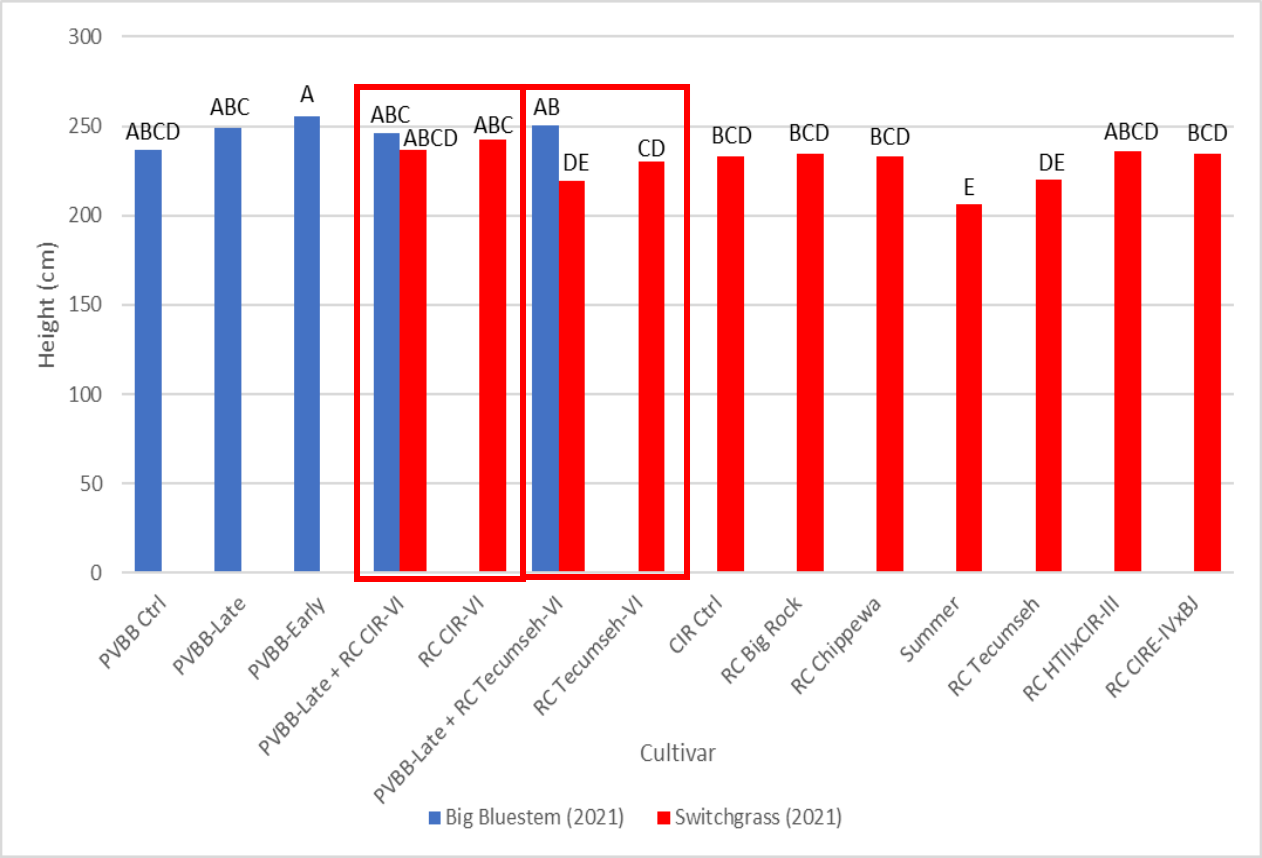

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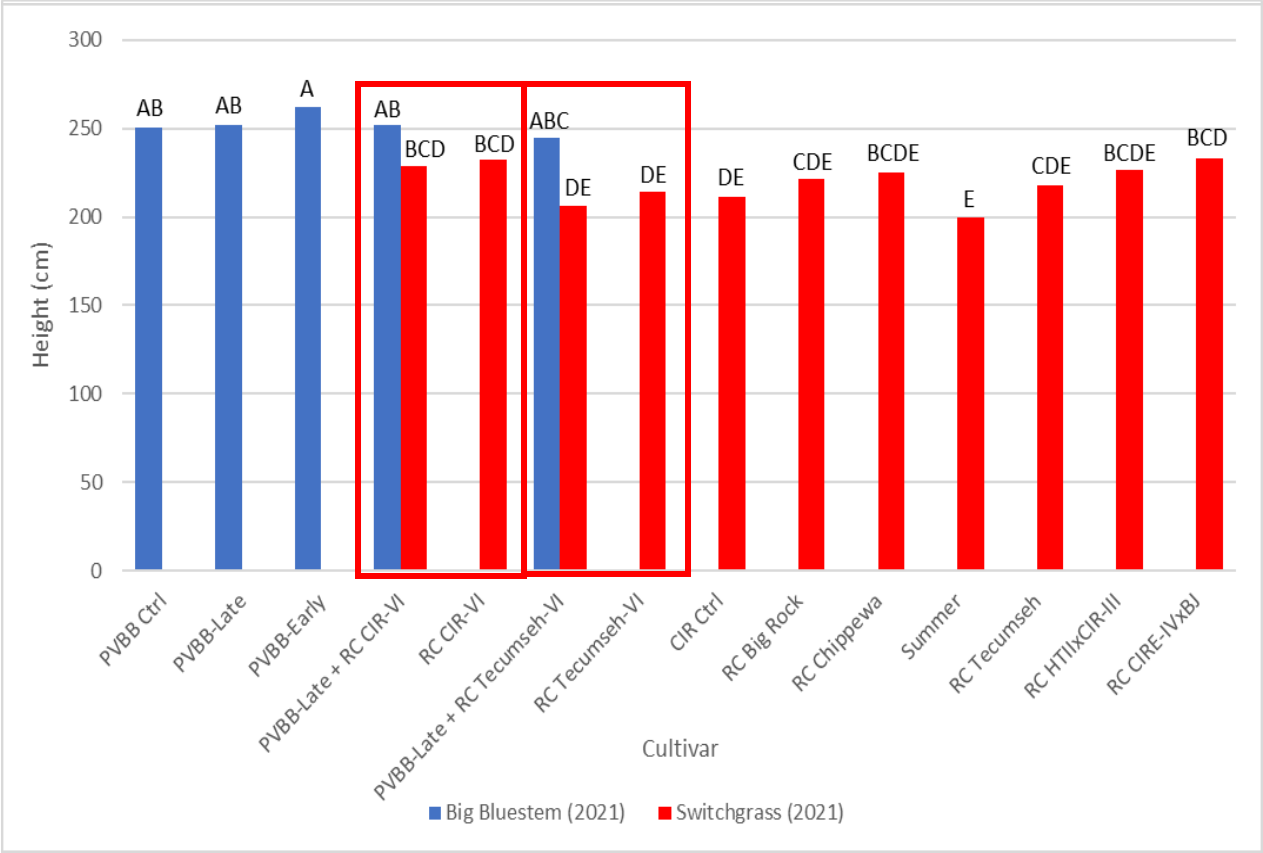

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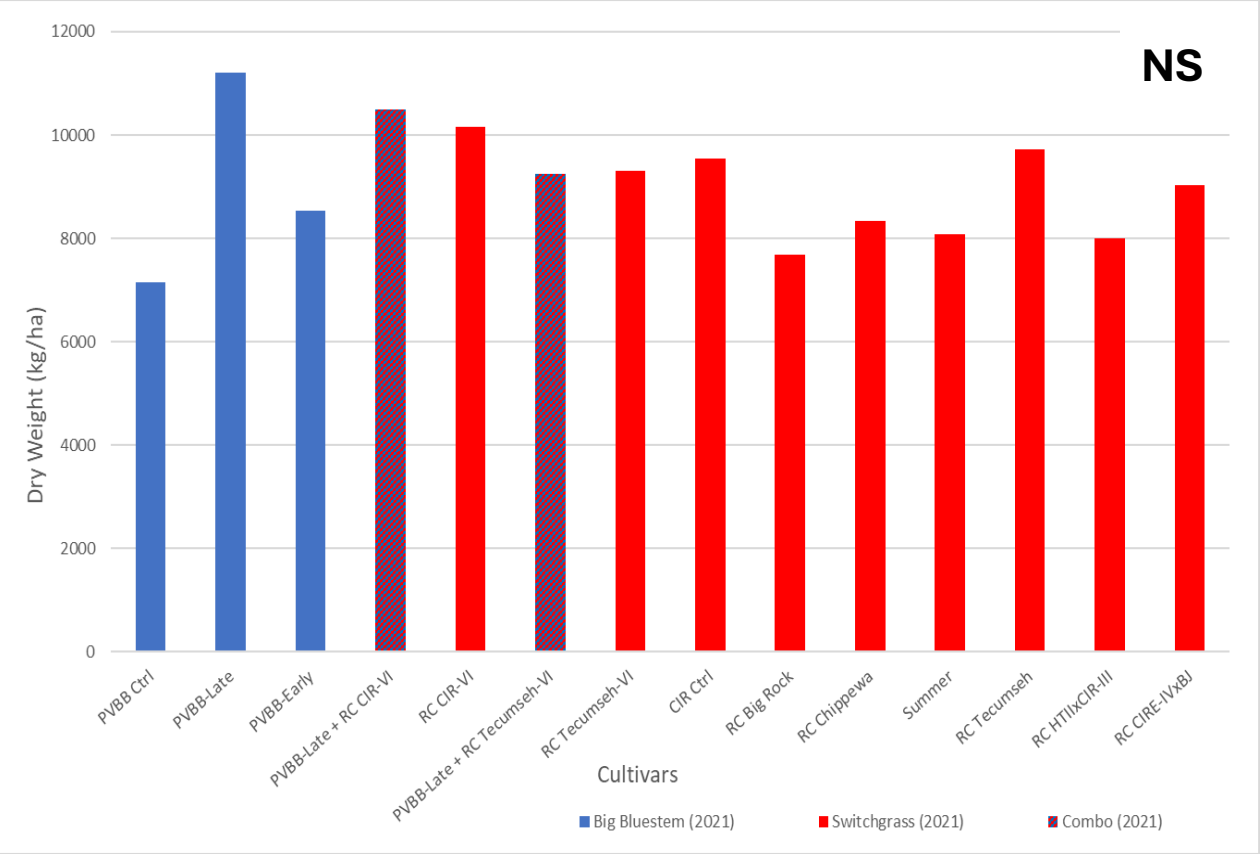
- Simcoe and Elora 2021 Dry Weight(kg/ha)



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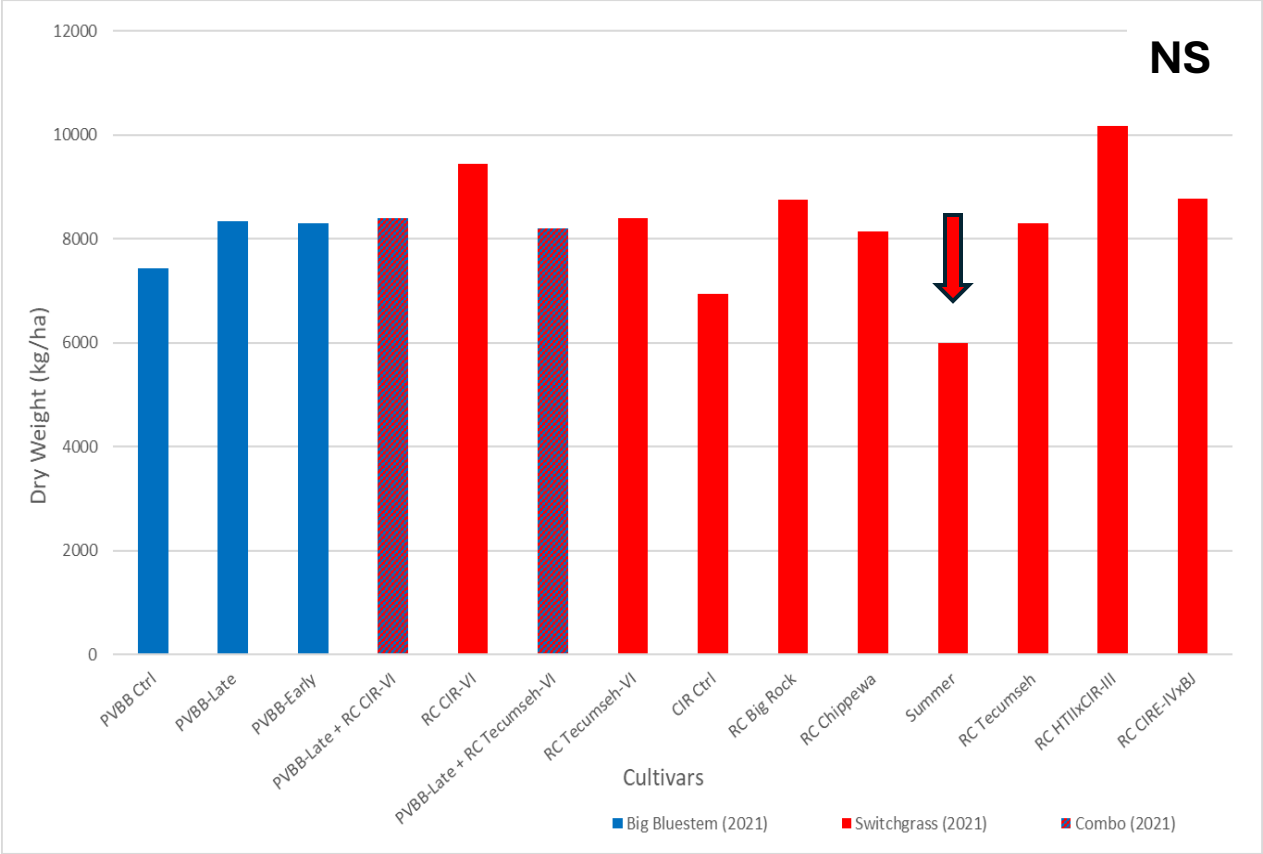

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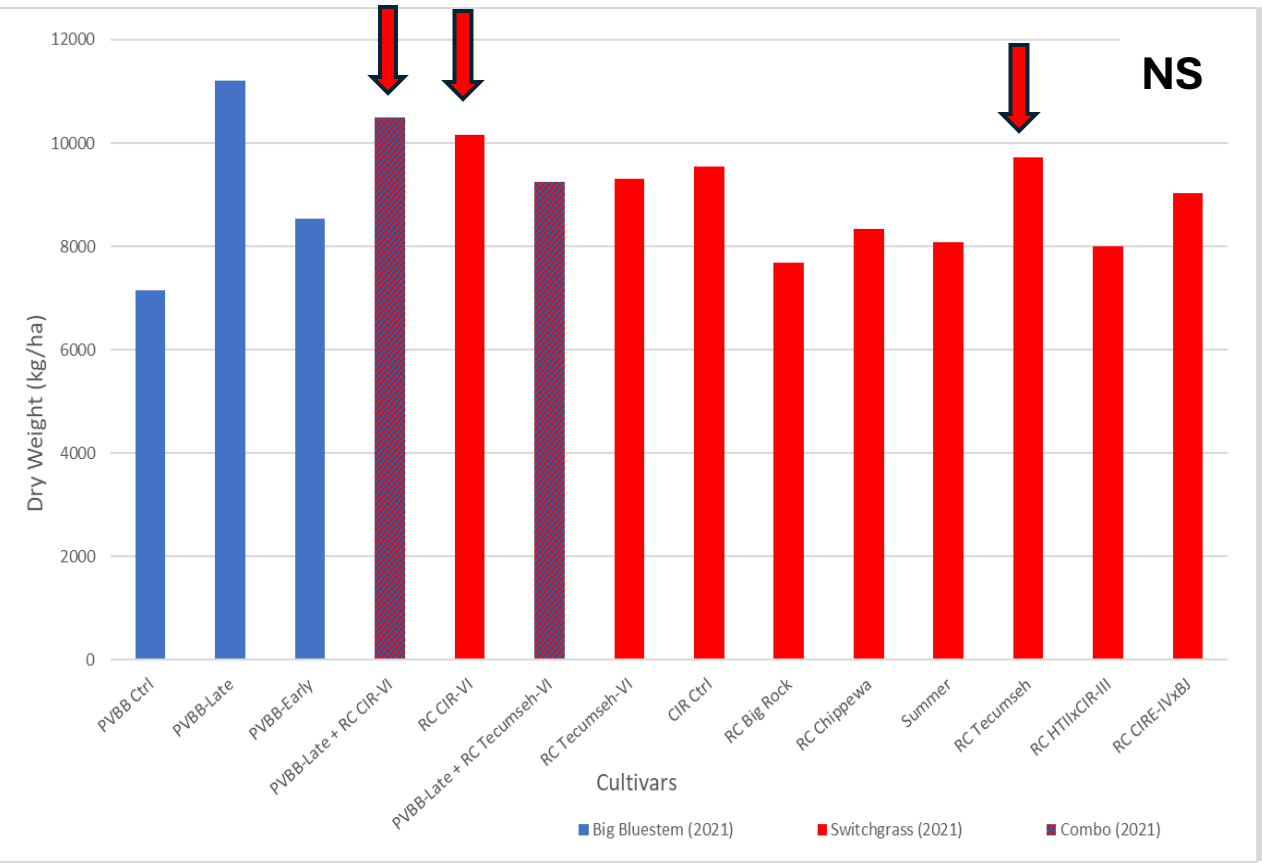
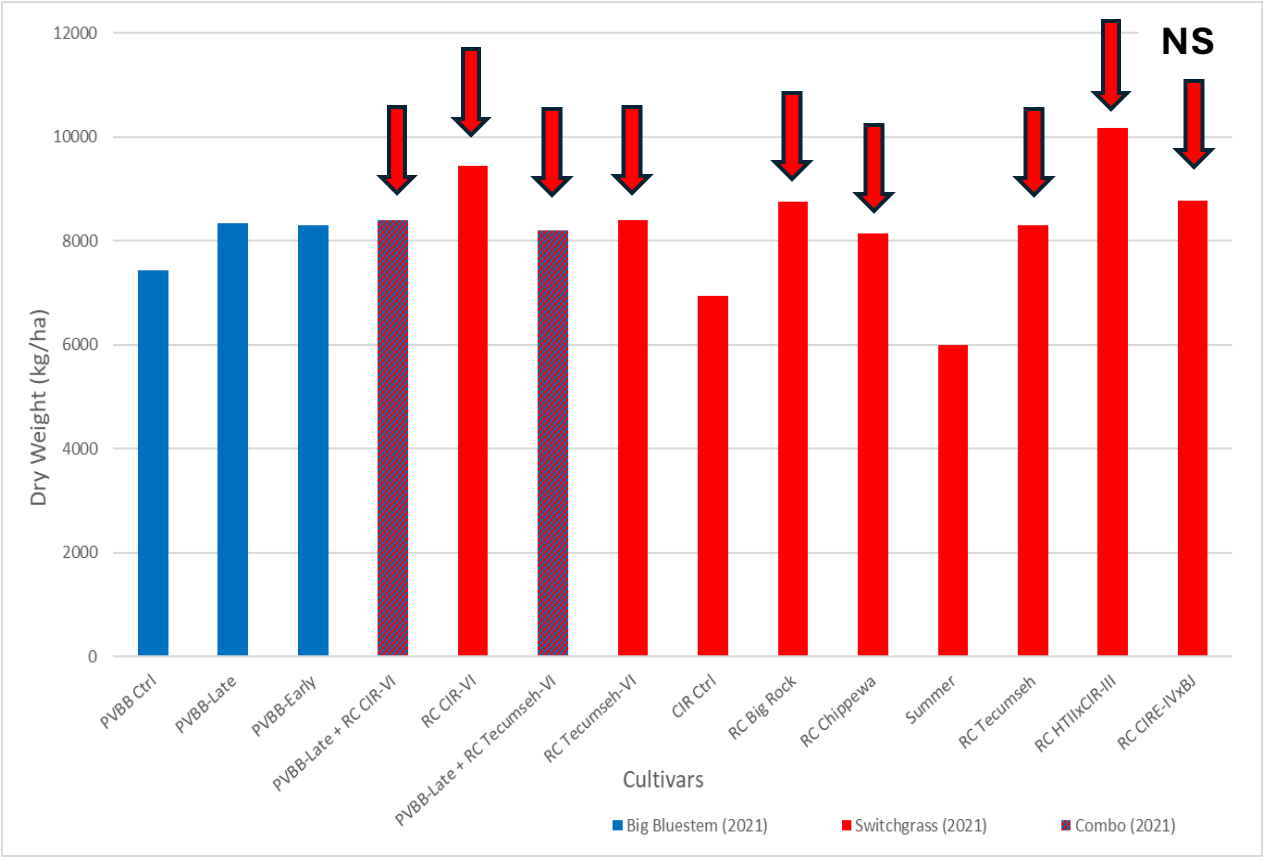
- Simcoe and Elora 2021 Dry Weight(kg/m^2)



Simcoe



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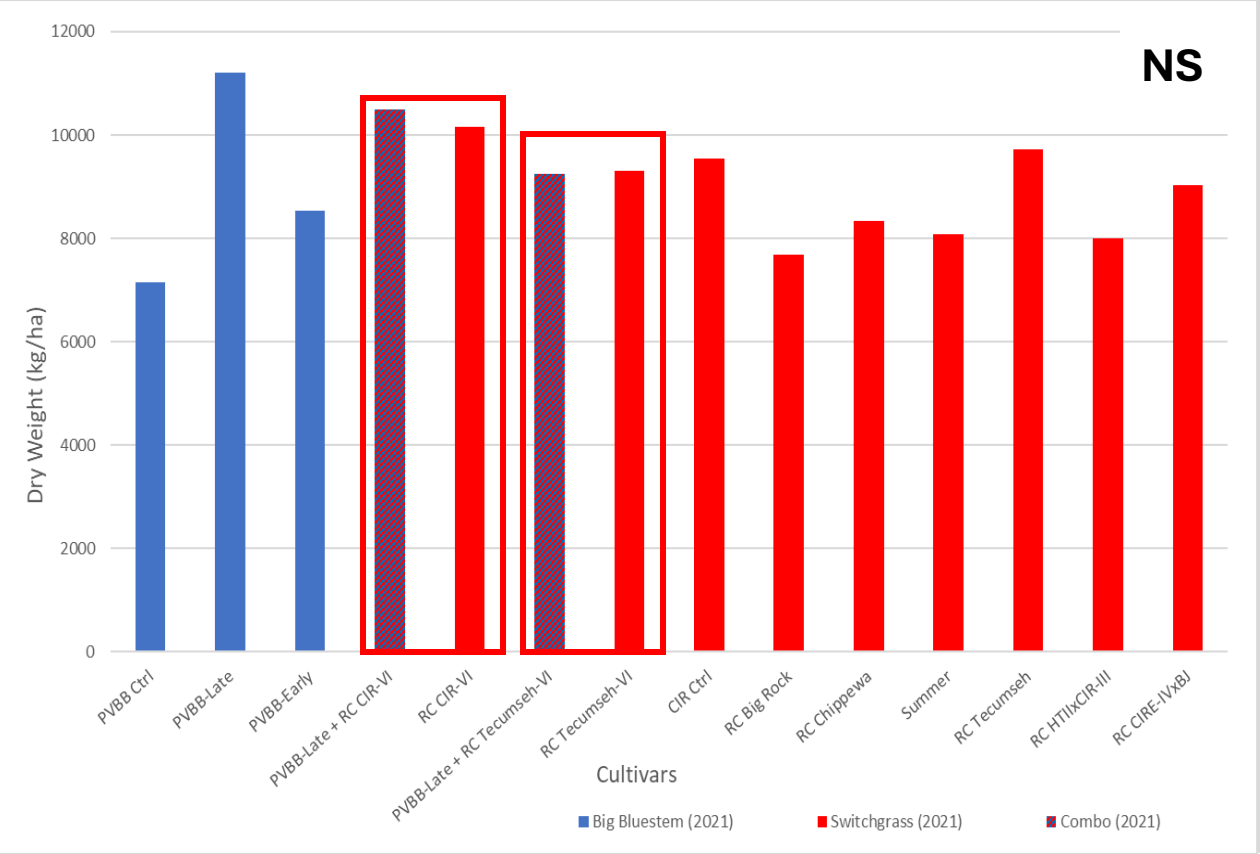

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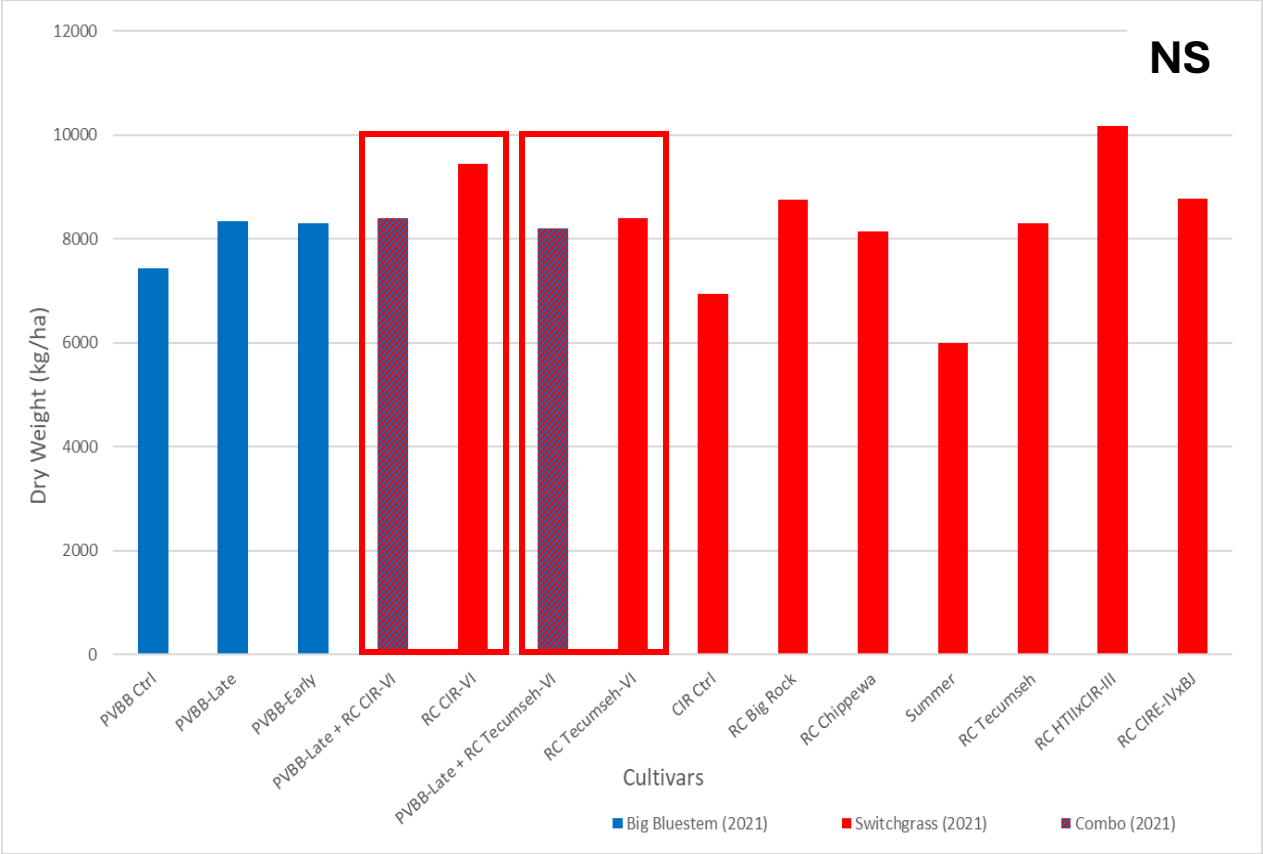

Elora

Mixed Species Field Trial Summary

- Cultivars Summer and RC Tecumseh tend to be the lowest in height and yield
- Cultivars RC CIR-VI, RC (HT-II x CIR-III), RC (CIRE-IV x Blue Jacket), and Cave-in-Rock are the highest in height and yield
- No difference in switchgrass measurements (both height and yield) between mixed and un-mixed plots

Overall Conclusions

- Of the 15 fields, 2 fields had smut incidence greater than 50% for 2019
- Age of field correlated to smut incidence
- Inoculating via teliospore suspension on injury results higher infection rates
  - Is *T. maclaganii* really seed-borne?
- All switchgrass cultivars show some degree of susceptibility to head smut
- Same cultivars are consistently higher in height and yield compared to CIR
  - RC CIR-VI and RC (CIRE-IV x Blue Jacket) recommended

Acknowledgement

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  - Dr. Katerina Jordan
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