Field horsetail (*Equisetum arvense*) management with an herbicide layering strategy

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Field Horsetail (*Equisetum arvense*)

- One of the most troublesome creeping perennial weeds (CPW) in horticultural crop production in BC

Field Horsetail (*Equisetum arvense*)

- A 10 cm length of rhizome can produce a total of 64 m of rhizome in 1 year
- Potential to infest an area of 1 hectare within 6 years of introduction

Field horsetail in cranberry field

Challenge: CPW Management

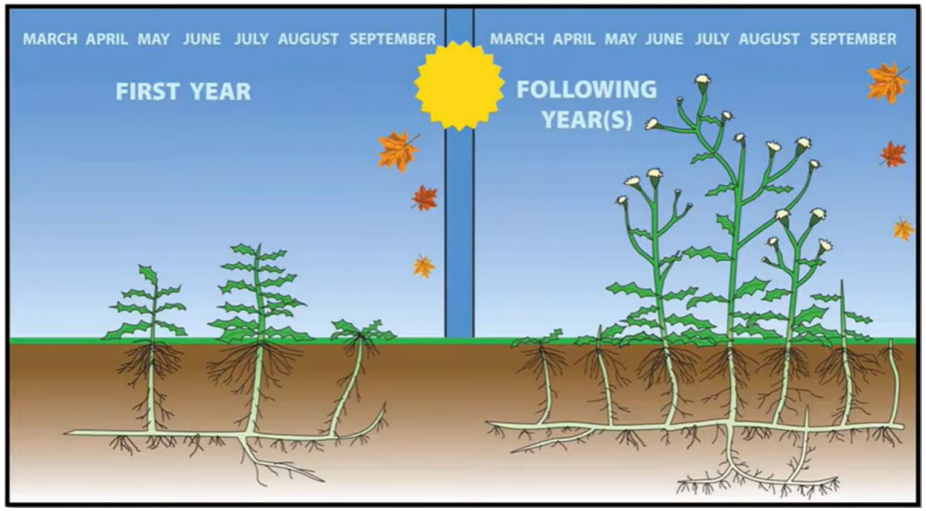
- The majority of conventional herbicides registered for use are primarily useful for annual weed management.
- Seldom controlled by a single herbicide application due to deep and extensive root and shoot systems

Weed Management

- Development of weed management strategies
  - **Life cycles of weeds**
    - ✓ How they develop
    - ✓ How they reproduce

CPW – How they develop/reproduce

- Larger starting capital and longer growth period
  - Nutrient reserves in storage organs
  - Rhizomes, stolons, tubers, horizontal roots
  - Ability to regrow a new set of leaves and stems until the nutrient reserves run out



CPW Weed Management

- Forcing weeds to deplete their nutrient reserves
  - Killing storage organs
  - Forcing growth of leaves/stems without opportunity to photosynthesize and replenish nutrient reserves

(Chicouene 2007; Melander et al. 2012)

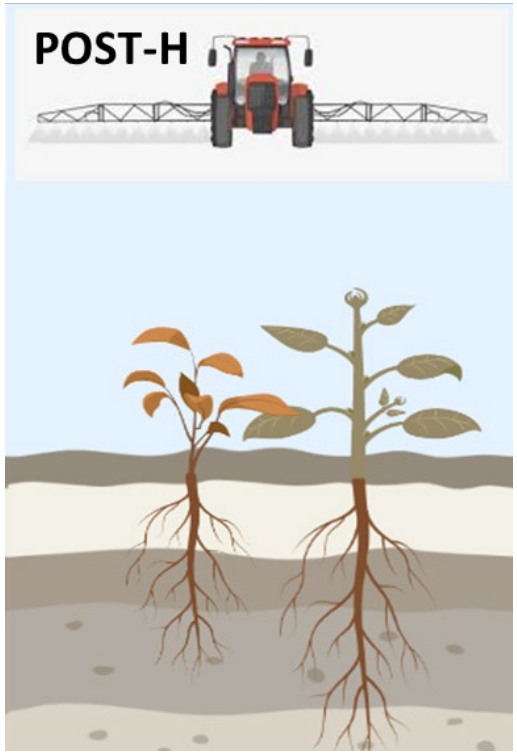
- Herbicide layering strategy composed of post-harvest (POST-H), pre-emergence (PRE) and post-emergence (POST) herbicide applications

Herbicide Layering Strategy

- **Post-harvest herbicide (January-February)**
  - Region with relatively mild winters (e.g., southern coast BC)
  - Little reported use in BC growers
  - Translocate carbohydrate reserves to the overwintering organs
  - Post-harvest herbicides are absorbed into the plants and translocate with the carbohydrates to the storage organs

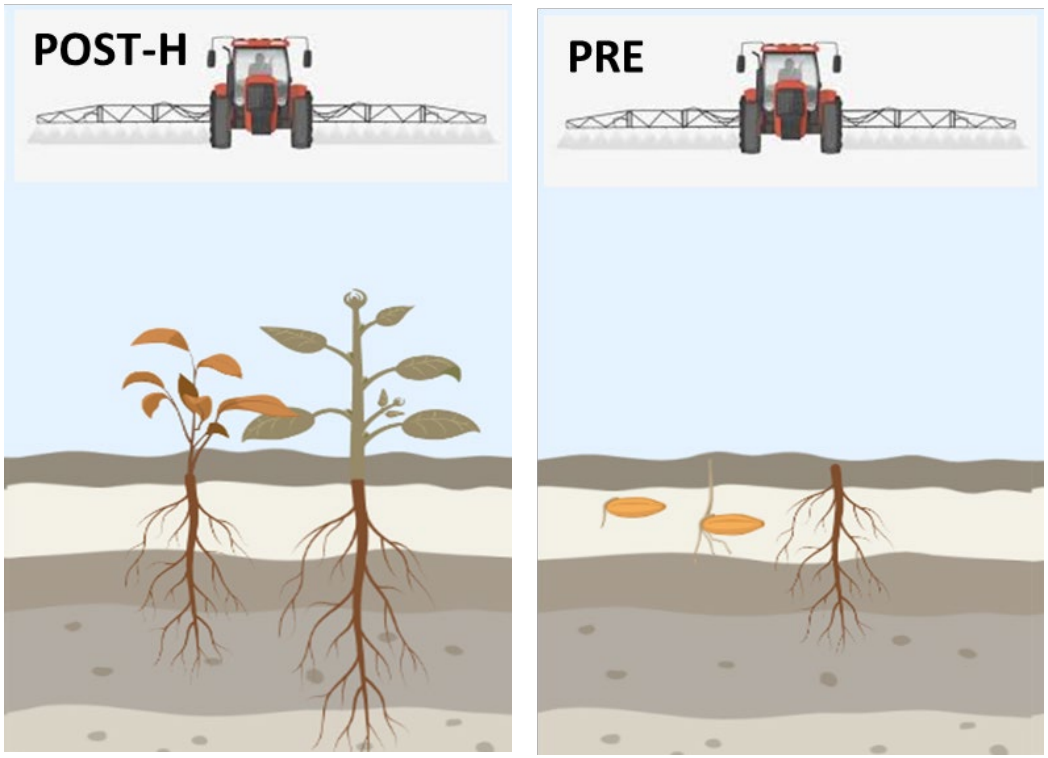
Herbicide Layering Strategy

- **Post-harvest herbicide (January-February)**
  - Damaging/killing overwintering storage organs
  - Prevent new spring growth
  - Residual effects that carry into spring



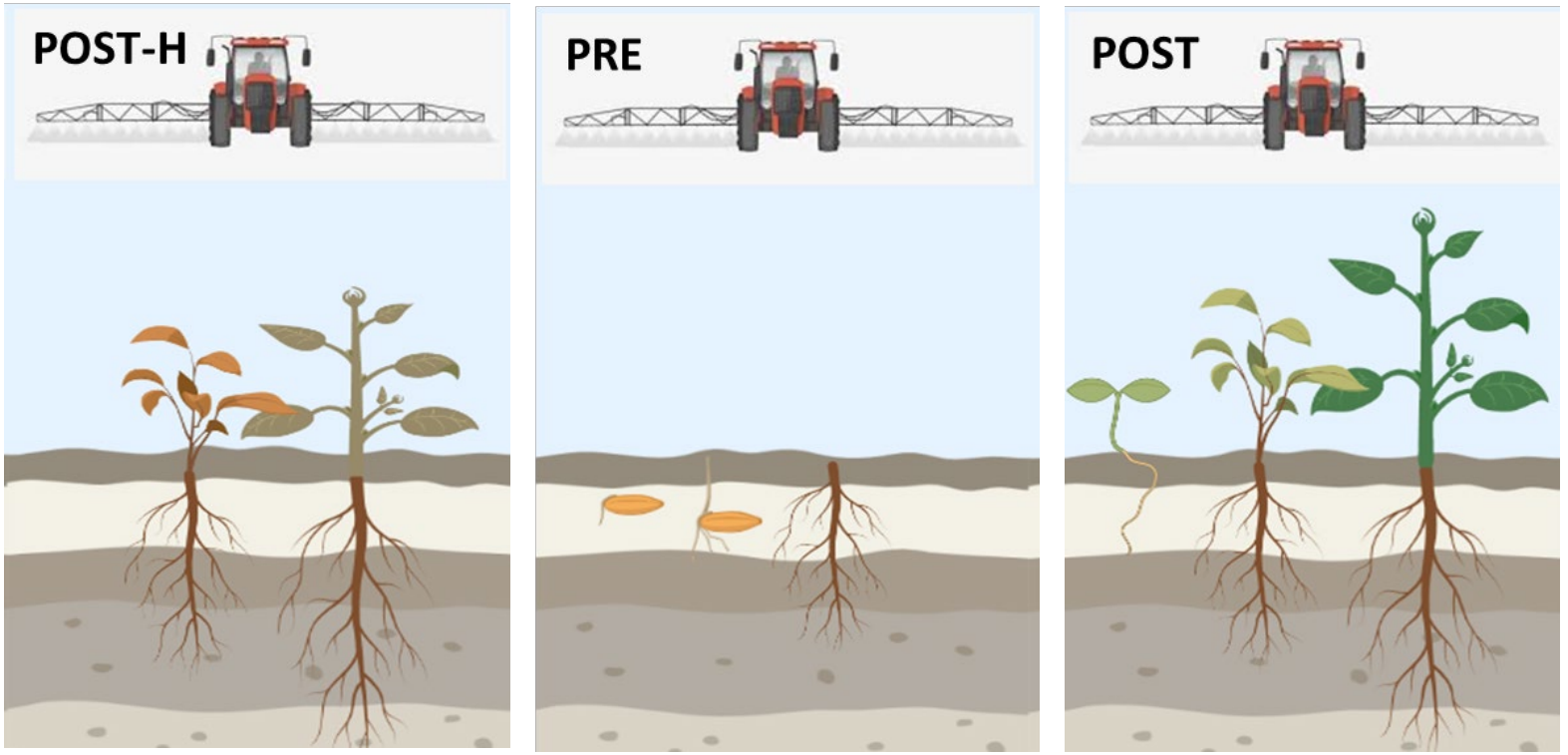
Herbicide Layering Strategy

- **Pre-emergence herbicide at lower label rate**
  - Spring (pre-bud break)
  - Suppress any new growth from seedbank and delay/suppress the growth of established weeds



Herbicide Layering Strategy

- **Post-emergence herbicides**
  - Spring and Summer (Bud break and Hook)
  - Damage/kill perennial weed plants
  - Prevent photosynthesizing and replenishing nutrient reserves



BCCMC Research (2021- Present)

- **Research Objectives**
  - To identify and evaluate **an effective and safe herbicide layering strategy** to manage persistent perennial weeds
  - To establish **the safety of the herbicide layering strategy** for use in cranberry production in both crop tolerance and subsequent fruit residues.

Study site

- Cranberry farm in Pitt Meadows, BC
- Established (~ 6 years old) Mullica Queen®
- Field horsetail (*Equisetum arvense*)
  - Dominant species in all the experimental plots (70 to 90% density)

Herbicide types and application rates

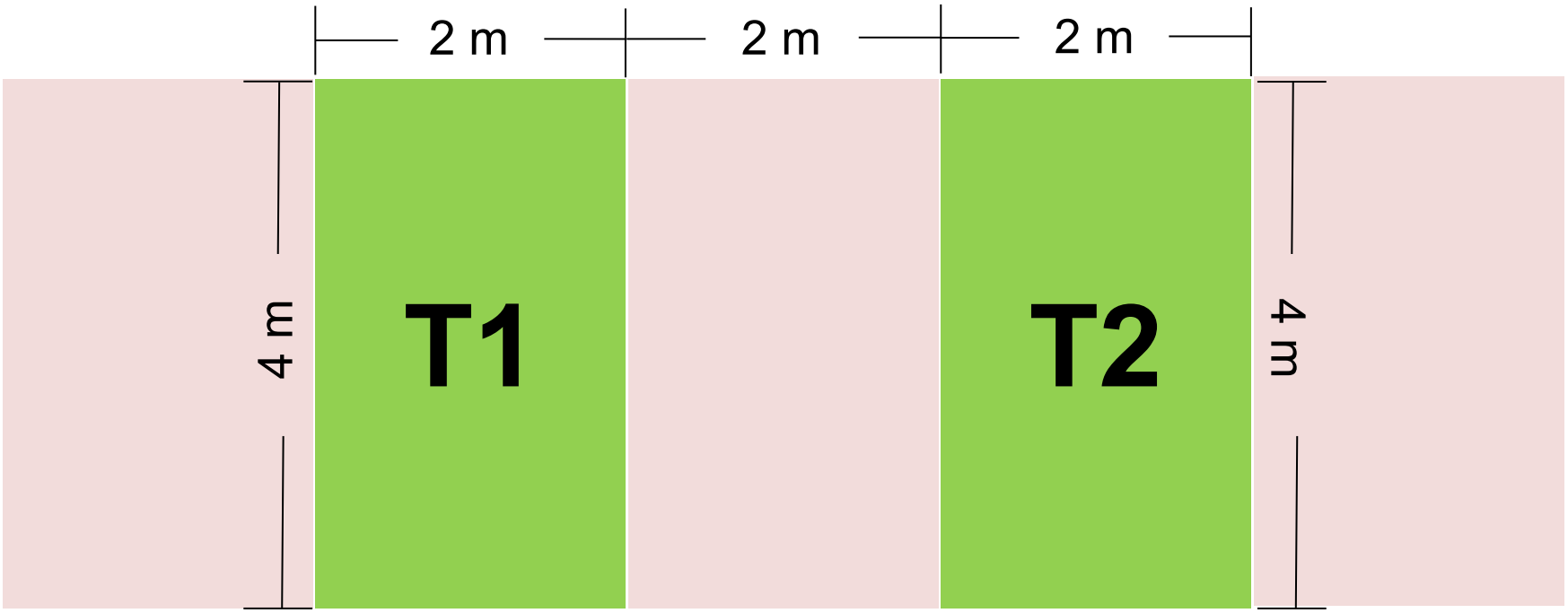
Trade Name	Active Ingredient	Application rate	Surfactant (if needed)
Casoron G-4	Dichlobenil	4400 g ai ha^{-1}	
Devrinol 2XT	Napropamide	4500 g ai ha^{-1}	
Authority 480	Sulfentrazone	140.16 g ai ha^{-1}	
Lontrel XC	Clopyralid	102 g ai ha^{-1}	
Callisto 480SC	Mesotrione	100.8 g ai ha^{-1}	Agral 90 (0.2% v/v.)
Poast Ultra	Sethoxydim	495 g ai ha^{-1}	Merge (1L ha^{-1})

Timing of treatment applications

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
1	-	Napropamide	Clopyralid	Mesotrione + Sethoxydim
2	-	Napropamide	Mesotrione	Mesotrione + Sethoxydim
3	-	Sulfentrazone	Clopyralid	Mesotrione + Sethoxydim
4	-	Sulfentrazone	Mesotrione	Mesotrione + Sethoxydim
5	Dichlobenil	-	Clopyralid	Mesotrione + Sethoxydim
6	Dichlobenil	-	Mesotrione	Mesotrione + Sethoxydim
7	Dichlobenil	Napropamide	Clopyralid	Mesotrione + Sethoxydim
8	Dichlobenil	Napropamide	Mesotrione	Mesotrione + Sethoxydim
9	Dichlobenil	Sulfentrazone	Clopyralid	Mesotrione + Sethoxydim
10	Dichlobenil	Sulfentrazone	Mesotrione	Mesotrione + Sethoxydim

Experiment Design

- Randomized complete block design with 4 replications
- Each plot is 4 x 2 m with 2 m untreated buffers on all sides
- Buffers used as weedy-check plots (vs. the adjacent treated plots)

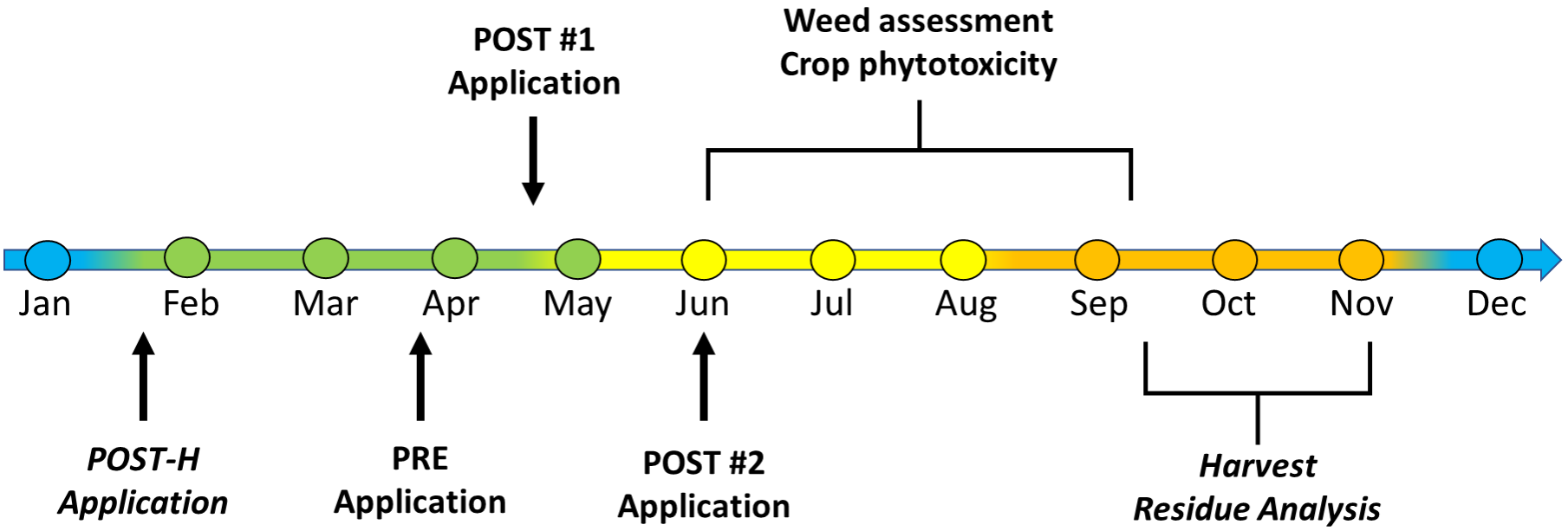


Assessment

- Weed and crop assessment
  - Bi-weekly starting after 2nd POST application
  - Phytotoxicity – 0% (no injury) to 100 % (complete crop loss)
  - Weed coverage (0-100%) of individual weed species

- Crop yield and safety
  - Yield - all fruits harvest from two 0.25 m^2 quadrats
  - Subsample sent to laboratory for residue analysis

Timeline/Procedures



- POST-H: January 26, 2022 | January 26, 2023
- PRE: March 29, 2021 | March 31, 2022
- POST #1: April 20, 2021 | April 21, 2022
- POST #2: May 26, 2021 June 7, 2022

Results

- Napropamide PRE + POST

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
1	-	Napropamide	Clopyralid	Mesotrione + Sethoxydim
2	-	Napropamide	Mesotrione	Mesotrione + Sethoxydim

- Poor field horsetail control (1 to 26% control)

TRT#	14 DAT (Late Jun)	28 DAT (Early Jul)	56 DAT (Early Aug)	Harvest (Late Sep)
1	6 ± 5% a	1 ± 1% a	26 ± 13% a	18 ± 11% a
2	13 ± 9% a	7 ± 7 % a	11 ± 7% a	17 ± 15% a

Results

- Sulfentrazone PRE + POST

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
3	-	Sulfentrazone	Clopyralid	Mesotrione + Sethoxydim
4	-	Sulfentrazone	Mesotrione	Mesotrione + Sethoxydim

- Poor to fair field horsetail control (29 to 50% control)

TRT#	14 DAT (Late Jun)	28 DAT (Early Jul)	56 DAT (Early Aug)	Harvest (Late Sep)
3	45 ± 21% a	44 ± 20% a	38 ± 19% a	29 ± 23% a
4	50 ± 18% a	49 ± 12% a	47 ± 11% a	44 ± 6% a

Results

- POST-H + POST

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
5	Dichlobenil	-	Clopyralid	Mesotrione + Sethoxydim
6	Dichlobenil	-	Mesotrione	Mesotrione + Sethoxydim

- Excellent field horsetail control (>95% control)

TRT#	14 DAT (Late Jun)	28 DAT (Early Jul)	56 DAT (Early Aug)	Harvest (Late Sep)
5	97 ± 1% a	95 ± 2% a	95 ± 2% a	97 ± 1% a
6	97 ± 2% a	99 ± 1% a	97 ± 2% a	98 ± 1% a

Results

- POST-H + PRE + POST

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
7	Dichlobenil	Napropamide	Clopyralid	Mesotrione + Sethoxydim
8	Dichlobenil	Napropamide	Mesotrione	Mesotrione + Sethoxydim
9	Dichlobenil	Sulfentrazone	Clopyralid	Mesotrione + Sethoxydim
10	Dichlobenil	Sulfentrazone	Mesotrione	Mesotrione + Sethoxydim

Results

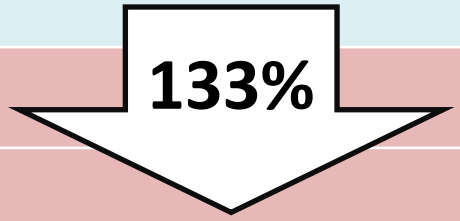
- POST-H + PRE + POST
- Excellent field horsetail control (79 to 99% control)

TRT#	14 DAT (Late Jun)	28 DAT (Early Jul)	56 DAT (Early Aug)	Harvest (Late Sep)
7	98 ± 1% a	99 ± 1% a	95 ± 9% a	94 ± 5% a
8	99 ± 1% a	99 ± 1% a	90 ± 9% a	79 ± 18% a
9	98 ± 1% a	99 ± 1% a	97 ± 1% a	97 ± 1% a
10	98 ± 2% a	97 ± 1% a	97 ± 1% a	97 ± 2% a

Results

- None of the active ingredients was detected from the residue analyses
- Yield was ranged from 50 to 260 g m^{-2}
  - The treated plots had 25 to 390% higher yields than the non-treated control plots.
- Significant difference in yields among the treatments ($p < 0.01$)

Herbicide Layering	Yield
PRE + POST	90 ± 9 g m^{-2}
POST-H + POST	200 ± 8 g m^{-2}
POST-H + PRE + POST	210 ± 1 g m^{-2}



Discussion

- Excellent field horsetail control (>95% control) was maintained until the harvest when post-harvest application of dichlobenil was included in the herbicide layering

Discussion

- Pre-emergence herbicide application may not be necessary for field horsetail control when post-harvest of dichlobenil is included in the herbicide program

TRT#	Phenological stage of cranberry			
	Post-harvest	Pre-bud break	Bud break	Hook
5	Dichlobenil	-	Clopyralid	Mesotrione + Sethoxydim
6	Dichlobenil	-	Mesotrione	Mesotrione + Sethoxydim

TRT#	14 DAT (Late Jun)	28 DAT (Early Jul)	56 DAT (Early Aug)	Harvest (Late Sep)
5	97 ± 1% a	95 ± 2% a	95 ± 2% a	97 ± 1% a
6	97 ± 2% a	99 ± 1% a	97 ± 2% a	98 ± 1% a

Future study

- Whether the post-harvest application of dichlobenil can reduce or eliminate the need for post-emergence herbicides while providing excellent season-long field horsetail control

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Thank you

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