



Chemical Mowing as an Integrated Weed Management Strategy for Michigan Christmas Tree Production

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Introduction

- Weeds compete for light, moisture, soil nutrients, and growing space resulting in substantial reductions in Christmas tree yield and quality
- Prolonged weed pressure induces dropping of lower needle, irregular crown development compromising marketable value
- Interfere with tree growth at any stage of life cycle
- Unmanaged weeds extend the production cycle, increasing costs and reducing grower profitability.





Introduction

- Growers mostly rely on herbicide applications and mechanical mowing
- Mechanical mowing can be
 - time consuming
 - laborious
 - can cause root damage or tree damage
 - can spread perennial weeds
 - may not be efficient & effective
- Too much herbicide can have environmental concerns and issues (leaching & runoff, resistance development etc.)





Introduction

- Chemical mowing is a weed control technique that has been implemented to Florida citrus production and in North Carolina's Christmas tree production along the steep slopes.
- In both the cases it has been successful.
- Chemical mowing consists of the use of sublethal rates of postemergence herbicides in conjunction with reduced mechanical mowing.





Introduction

- Chemical mowing uses herbicides at lower rates to suppress weeds growth instead of physically cutting them
- It stops plants from elongating and prevent seed head formation
- Eliminates weed root systems and prevents regrowth from occurring
- Can be applied to all types of terrain (steep, flat, rocky, or obstructed)
- Helps controlling the taller vegetation (mostly perennial weeds) and cause a shift in weed population (herbaceous close to ground such as clover)
- Weed suppression-close to ground- can be beneficial to stop soil erosion
- Total weed elimination is not recommended





Introduction

- In North Carolina, this technique has been beneficial as it provides effective weed control as well as prevents soil erosion along the steep slopes of the mountains where the Christmas trees are grown.
- NC using mostly glyphosate lower rates can lead to herbicide resistant issues.
- However, there is no data or research showing whether this can be implemented in other locations of United States, especially to the flat land Christmas tree production system or not.
- Also, no research data on how different postemergence herbicides (MOA) and tank mixes will perform



Christmas tree plantation along the mountain slopes in North Carolina



Objectives

- **Objective 1:** Evaluate the weed control efficacy of four different types of postemergence herbicides and their combinations at their lower rates along with mechanical mowing.
- **Objective 2:** Evaluate the phytotoxic effects of four different types of postemergence herbicides and their combinations at their lower rates on different varieties of Christmas trees.



Hypotheses

- **Hypothesis 1:** Postemergence herbicides and their combinations at lower doses along with mechanical mowing can provide effective weed control.
- **Hypothesis 2:** Lower doses of postemergence herbicides and their combinations will show minimal injuries to the Christmas tree varieties.



Locations

MICHIGAN STATE
UNIVERSITY

Extension

WHISPERING PINES TREE FARM,
FLUSHING, MI



SCOTCH PINES

RUNYANS COUNTRYTREE FARM,
CLIO, MI



CANAAN FIRS

WAHMOFF FARMS
GOBLES, MI



FRASER FIRS



NORWAY SPRUCE



Locations



Locations of the trials in Michigan



Materials and Methods:

- Field experiments were established across 3 farms in Michigan (2025) on 4-5-year-old trees of four species.
- Dominant weed species in each plot were recorded prior to treatment application.
- Experiments were arranged in a Randomized Complete Block Design with 4 replications.
- Directed application of herbicide was made only once using a CO₂ backpack sprayer calibrated to spray 27 gpa output at 30 psi pressure.
- Mowing was done in every 30 days as per the requirement for management practice.
- Control was included which remained untreated.





Dominant Weed Species

Table 1: Dominant weed species found in Scotch Pines field at **Whispering Pine Tree farm**.

SN	Common Name	Scientific Name
1	Sheep Sorrel	<i>Rumex acetosella</i> L.
2	Thyme-leaf sandwort	<i>Arenaria serpyllifolia</i> L.
3	Spotted Knapweed	<i>Centaurea stoebe</i> L.
4	Horseweed	<i>Erigeron canadensis</i> L.



Table 2: Dominant weed species found in Canaan Fir field at **Runyan's Country Tree Farm**.

SN	Common Name	Scientific Name
1	Canada Goldenrod	<i>Solidago canadensis</i>
2	Virginia Creeper	<i>Parthenocissus quinquefolia</i>
3	Reed Canary Grass	<i>Phalaris arundinacea</i>
4	Horseweed	<i>Erigeron canadensis</i>
5	Common Ragweed	<i>Ambrosia artemisiifolia</i>



Table 3: Dominant weed species found in Fraser Fir field at **Wahmhoff's Tree Farm**.

SN	Common Name	Scientific Name
1	Milkweed	<i>Asclepias incarnata</i>
2	Nutsedge	<i>Cyperus rotundus</i>
3	Reed Canary Grass	<i>Phalaris arundinacea</i>
4	Velvetleaf	<i>Abutilon theophrasti</i>
5	Common Ragweed	<i>Ambrosia artemisiifolia</i>
6	Horseweed	<i>Erigeron canadensis</i>





Materials & Methods

S. No	Treatments	Trade Names	Rate of Application	Notes
1	Glyphosate	Roundup Pro concentrate	4 fl oz/A	As mentioned in the label for chemical mowing of annual weed control
2	Clopyralid	Stinger	4 fl oz/A	Half of the highest label rate (8 fl oz/A); 0.5X
3	Topramezone	Frequency	2 fl oz/A	Half of the highest label rate (4 fl oz/A); 0.5X
4	Oxyfluorfen	GoalTender	8 fl oz/A	Eight times less the highest label rate (62.94 fl oz/A)
5	Glyphosate + clopyralid	Roundup Pro concentrate + Stinger	4 fl oz /A + 4 fl oz /A	
6	Glyphosate + topramezone	Roundup Pro concentrate + Frequency	4 fl oz /A + 2 fl oz/A	
7	Glyphosate + oxyfluorfen	Roundup Pro concentrate + GoalTender	4 fl oz /A + 8 fl oz/A	
8	Clopyralid + topramezone	Stinger+ Frequency	4 fl oz /A + 2 fl oz/A	
9	Clopyralid + oxyfluorfen	Stinger + GoalTender	4 fl oz /A + 8 fl oz/A	
10	Topramezone + oxyfluorfen	Frequency + GoalTender	2 fl oz/A+ 8 fl oz/A	
11	Glyphosate + clopyralid + topramezone + oxyfluorfen	Roundup Pro concentrate+ Stinger + Frequency + GoalTender	4 fl oz /A + 4 fl oz /A + 2 fl oz/A + 8 fl oz/A	
12	Control (no herbicides, no mowing)	NA	NA	



Materials and Methods:

Data collection and analysis

- Weed control efficacy were visually assessed at 30, 60, and 90 days after treatment (DAT)
- Based on a scale 0%-100% (where 0% meaning no weed control and 100% meaning complete control)
- Crop phytotoxicity were visually assessed at 30, 60, and 90 DAT
- Based on a scale 0%-100% (where 0% meaning no injury and 100% meaning complete death of a branch)
- Data were analyzed using ANOVA and ANCOVA in R (2025.9.2.418); means separated by Tukey's HSD test.
- Plant Growth Indices were recorded at the beginning and the end of the trial.

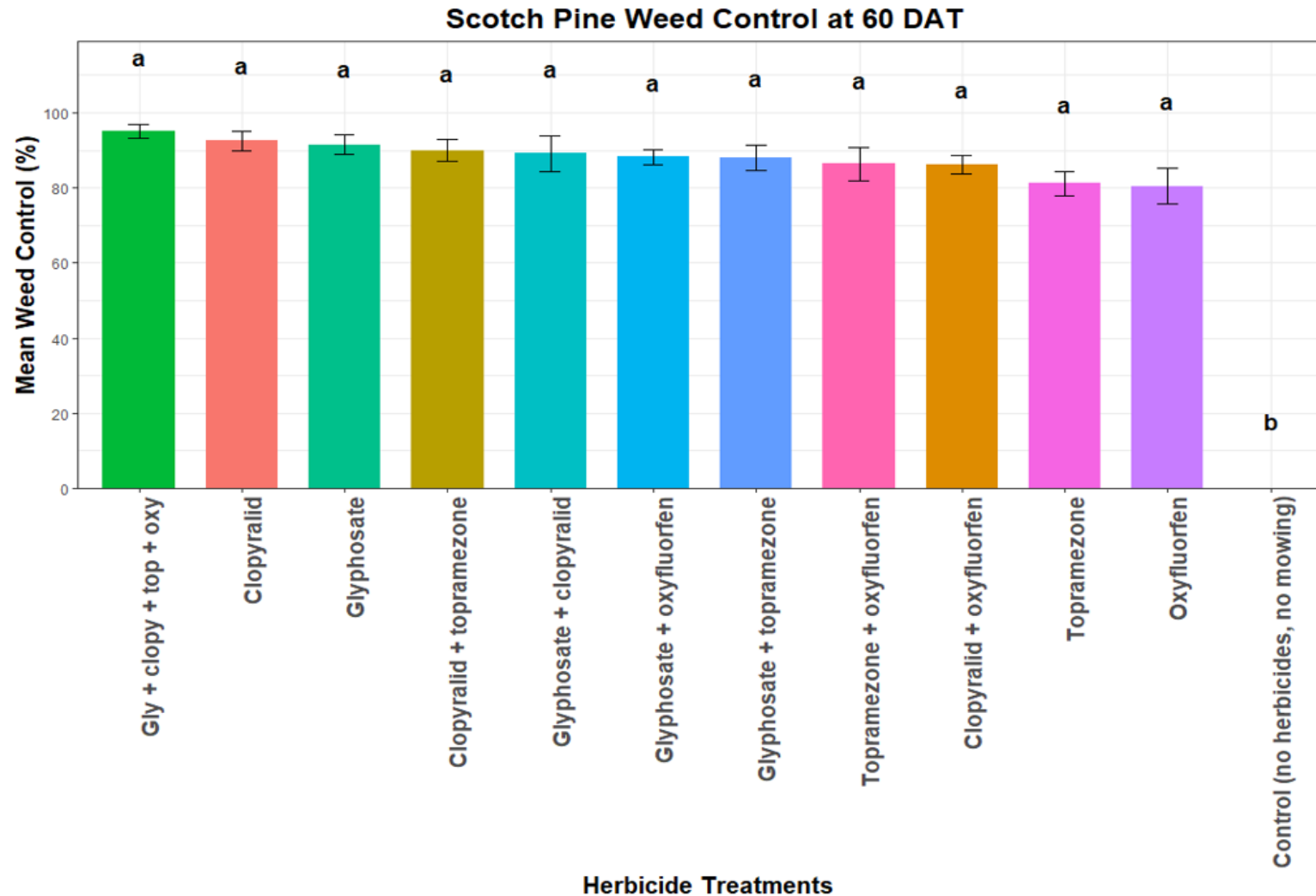




Results

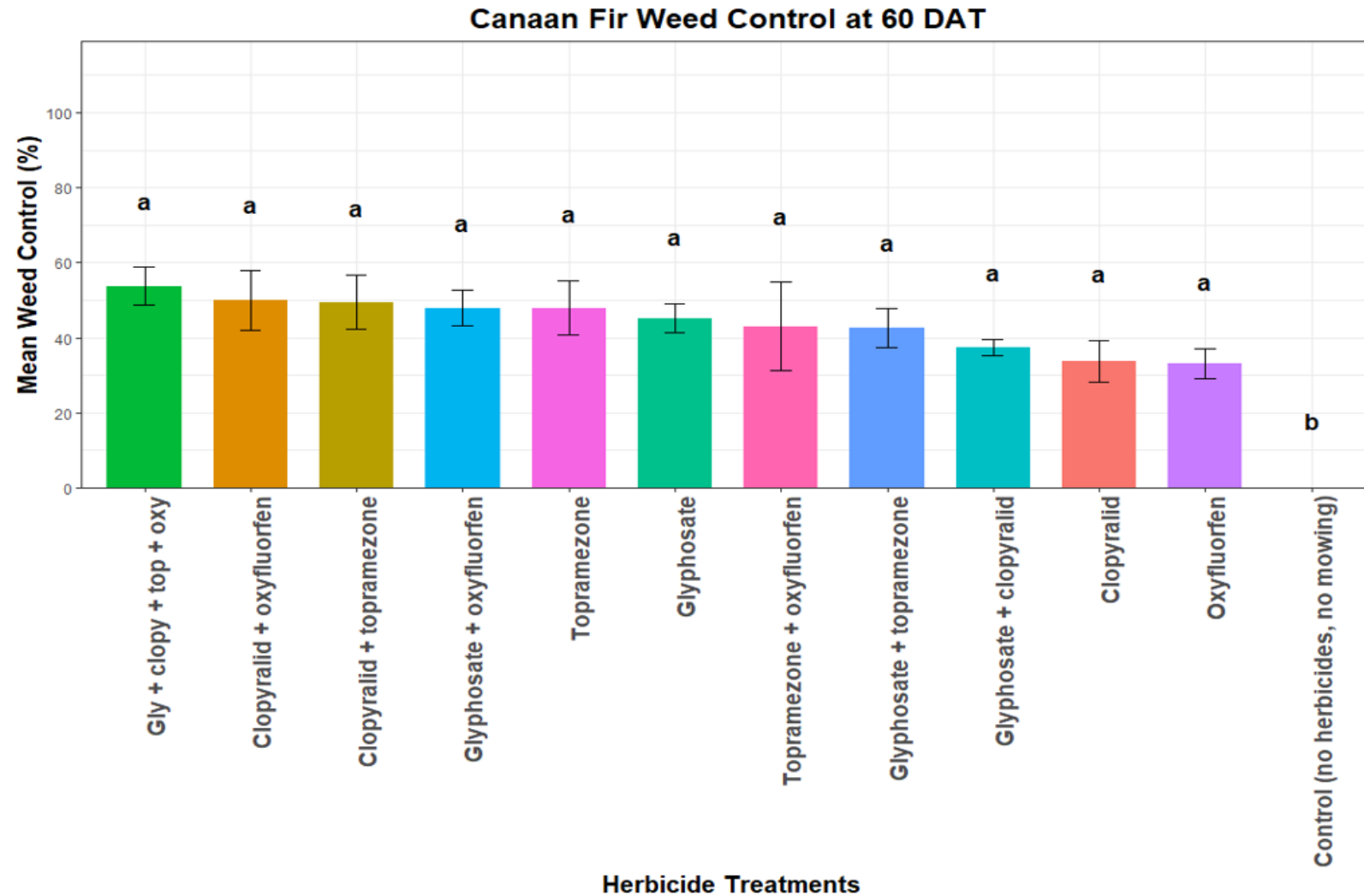


Results: Weed Control Response at 60 DAT



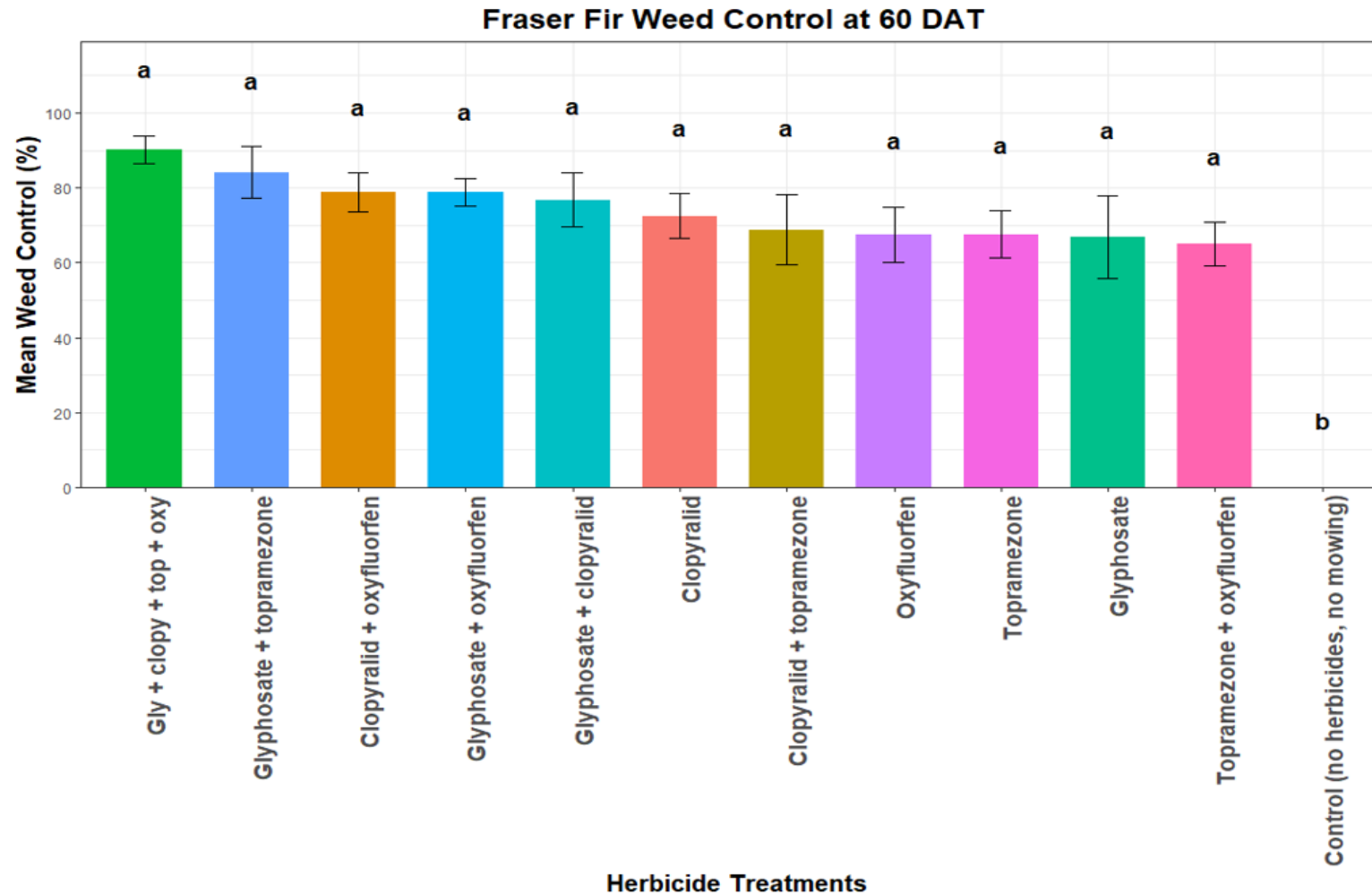


Results: Weed Control Response at 60 DAT



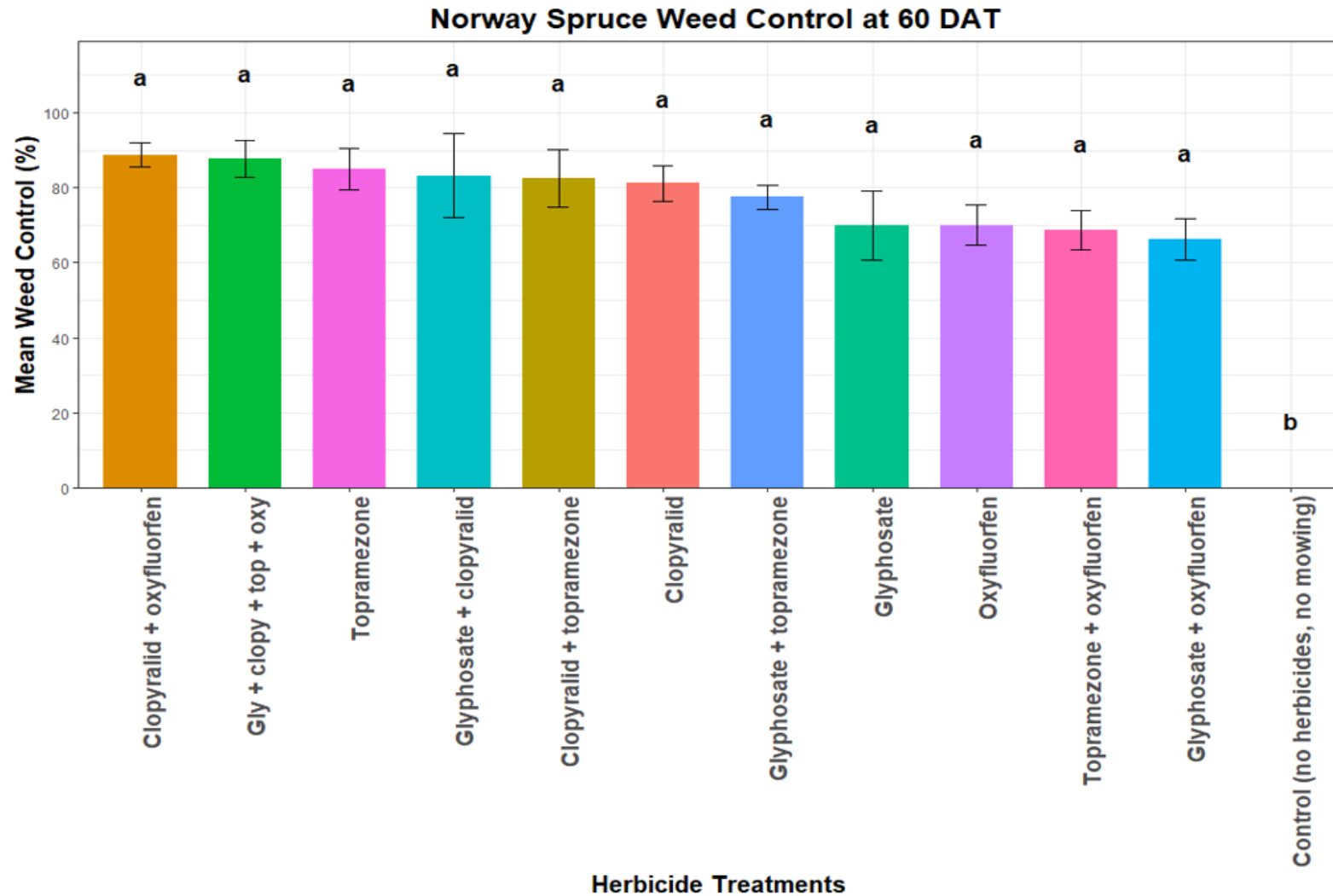


Results: Weed Control Response at 60 DAT





Results: Weed Control Response at 60 DAT





Results: Weed Control Response

- At 60 DAT, all herbicide treatments, including single active ingredients and combinations, achieved significantly higher weed control (33–95%) compared to the untreated control across all 4 Christmas tree species ($P < 0.05$; Tukey HSD).
- Weed control was notably lower in Canaan fir (33–54%); potentially attributable to higher initial weed pressure at the Canaan fir site rather than differential herbicide efficacy.



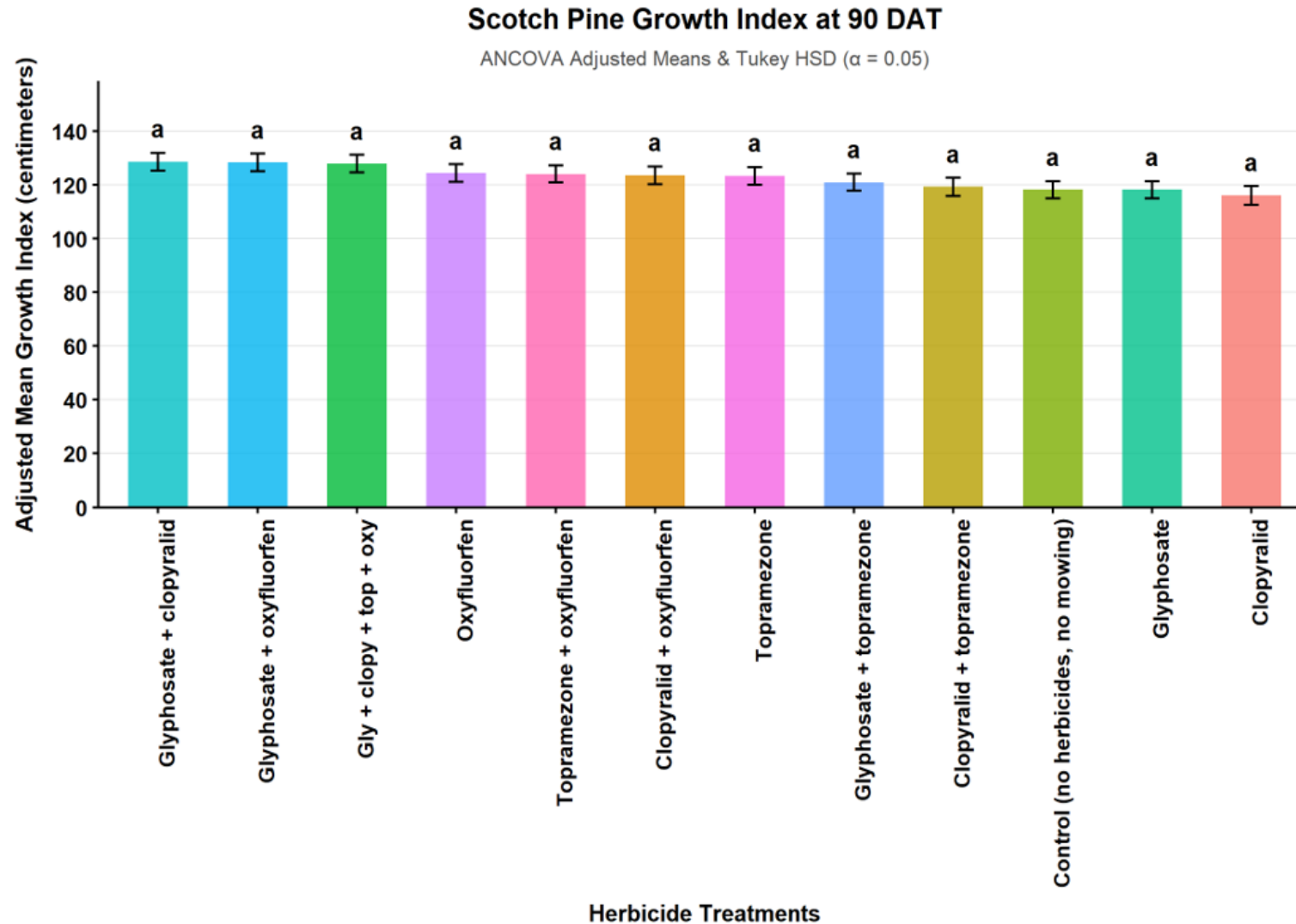
Untreated control plot (heavy weed pressure)



Gly + Clo + Top + Oxy treated plot at 60 DAT

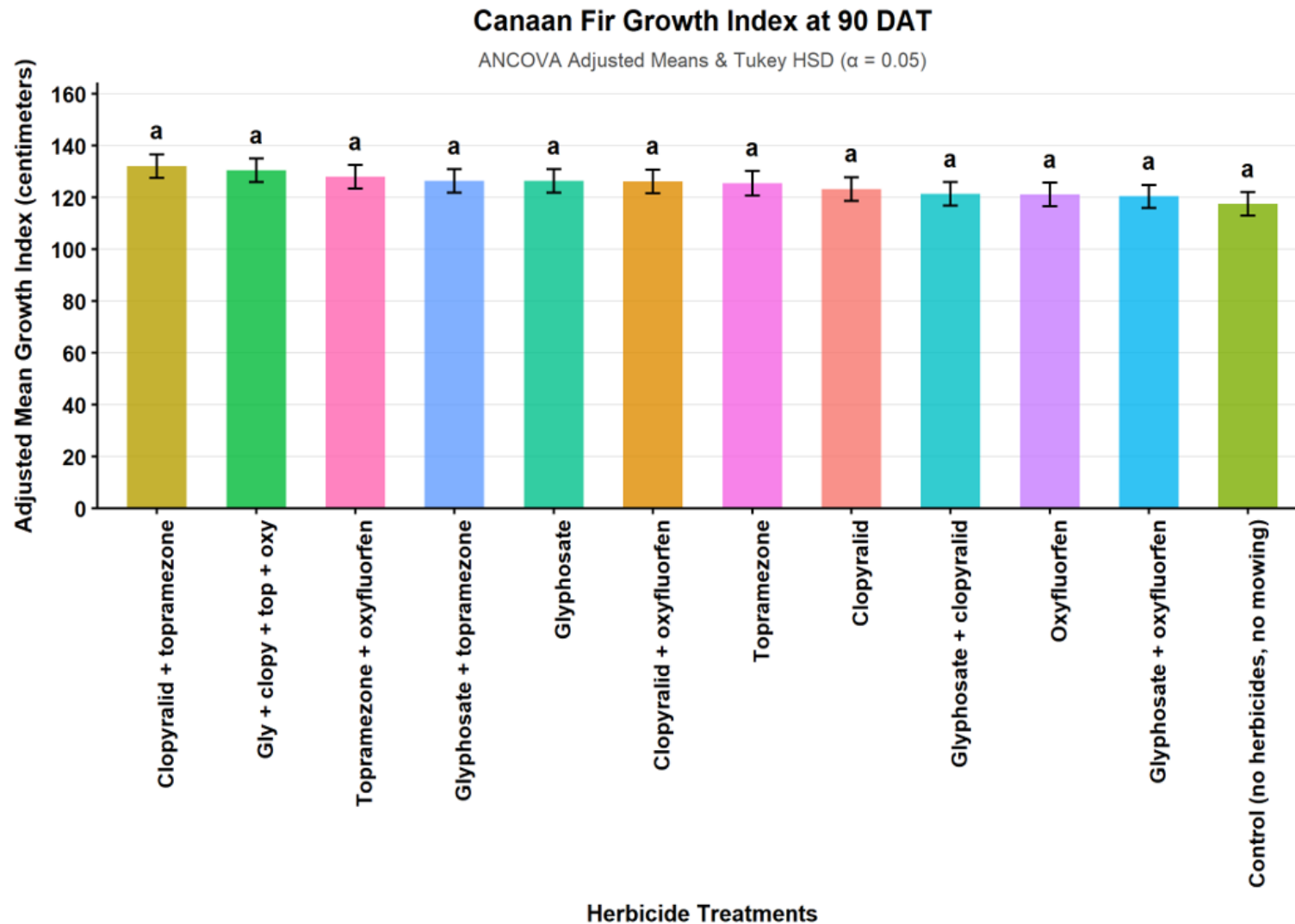


Results: Growth Response at 90 DAT



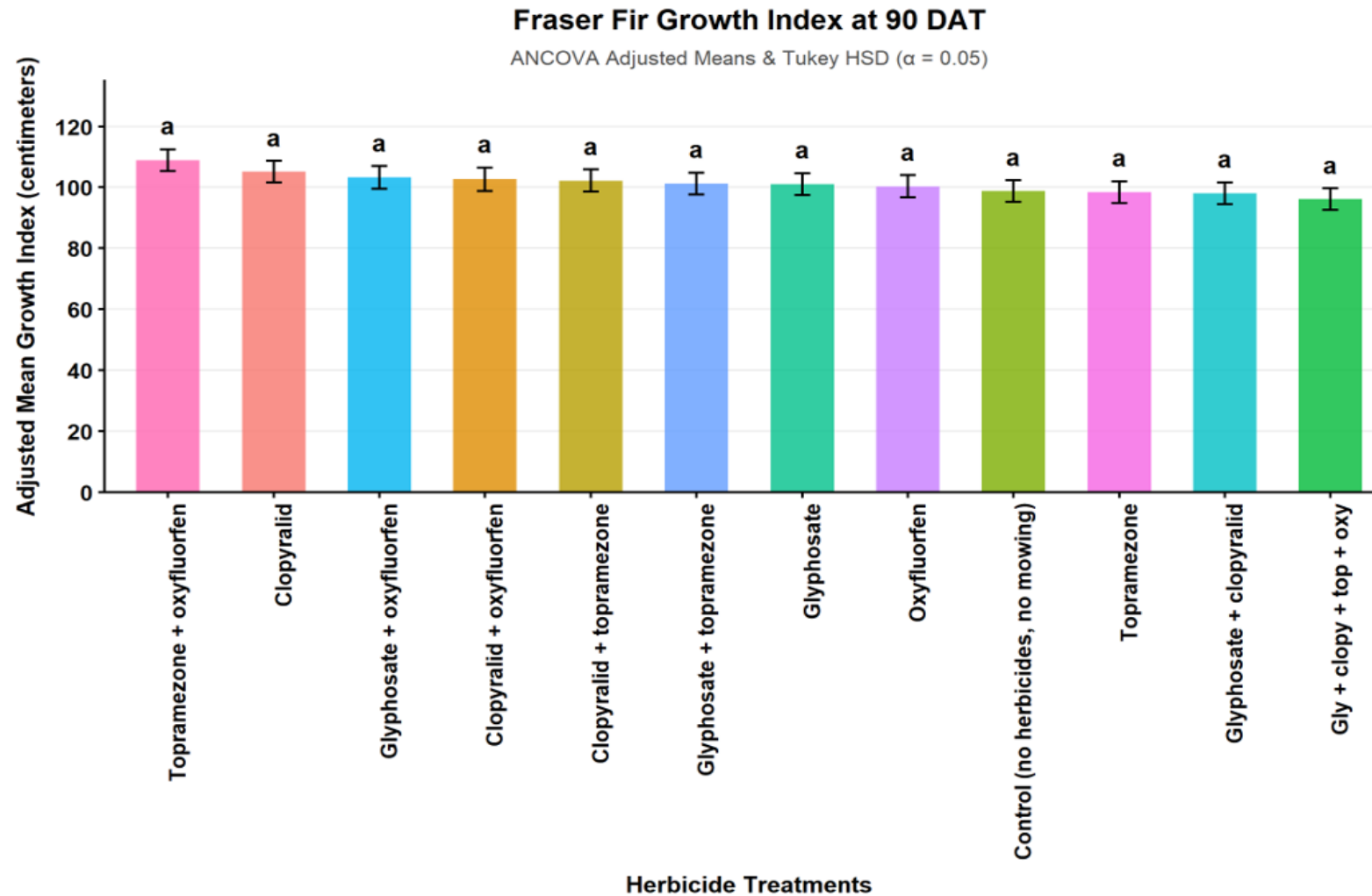


Results: Growth Response at 90 DAT



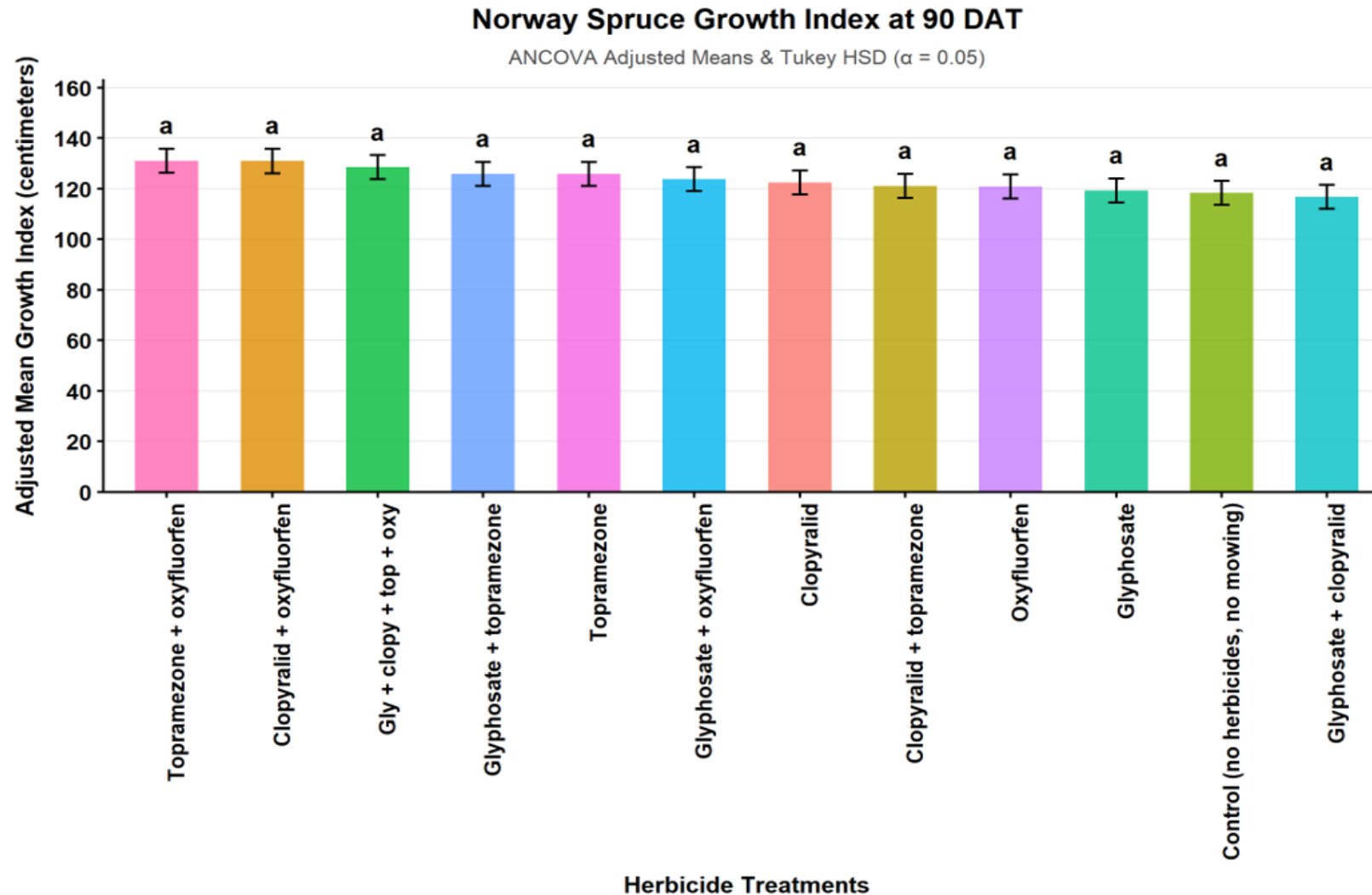


Results: Growth Response at 90 DAT





Results: Growth Response at 90 DAT





Results: Phytotoxicity at 90 DAT

Table 4: Phytotoxicity percentages at 90 days after treatment at three Christmas tree varieties.

Note: None of the herbicide treatment produced statistically significant differences in phytotoxicity injury for any species

Treatments	Fraser Fir Phytotoxicity (%)	Canaan Fir Phytotoxicity (%)	Scotch Pine Phytotoxicity (%)
Glyphosate	0	0	0
Clopyralid	2.5	0	0
Topramezone	0	0	0
Oxyfluorfen	0	2.5	0
Glyphosate + clopyralid	0	3.75	0.75
Glyphosate + topramezone	0	0	2.5
Glyphosate + oxyfluorfen	0	0	0
Clopyralid + topramezone	0	0	0.75
Clopyralid + oxyfluorfen	0	0	0
Topramezone + oxyfluorfen	0	1.25	0
Glyphosate + clopyralid + topramezone + oxyfluorfen	0	2.5	0
Control (no herbicides, no mowing)	0	0	0



Results: Growth Response & Phytotoxicity

- Growth indices did not differ significantly from the untreated control across all treatments at trial conclusion ($\alpha = 0.05$; Tukey HSD)
- Results confirm combination of herbicide application and mowing do not affect tree growth, affirming treatment safety for use in chemical mowing programs.
- Phytotoxicity ratings were negligible across all herbicide treatments at 90 DAT, indicating that minimal plant injury risk by chemical mowing.



Scotch pine tree growth at 90 DAT



Scotch pine needles (no herbicide injury)



Summary

- All herbicide treatments (Clopyralid, Glyphosate, Oxyfluorfen, Topramezone) and their combination demonstrated comparable weed control efficacy, supporting their potential integration into chemical mowing programs.
- Weed control efficacy is species and site dependent, likely influenced by differential initial weed pressure.
- Absence of significant phytotoxicity and unaffected growth indices confirm the crop safety of all evaluated treatments across species



Current Ongoing Trials

- Currently second round field trials are going on (completed 60 DAT data collection)
- Greenhouse trials are going on at MSU HTRC to determine the herbicide treatment efficacies on large crabgrass
 - Comparing the low doses with their highest label rate.
 - To determine whether the low doses can suppress/ control crabgrass at an acceptable rate





Future Directions

- Phytotoxicity of these treatments need to be studied on younger (1-2-year-old) Christmas tree varieties during their establishment phase.
- Dedicated studies are needed to quantify the independent contribution of mowing in chemical mowing.
- Future studies should incorporate baseline weed pressure assessments as covariates to better account for site specific variability.
- Future research should focus on optimizing herbicide application rated to maximize weed control efficacy.
- Long-term studies assessing the sustainability and economical viability of chemical mowing.



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- All collaborating growers (Runyan, Whispering Pines, Wahmhoff)





Thank You!

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