Effect of Temperature on Efficacy of 2,4-D and Glyphosate for Control of Common Ragweed

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AGRONOMY AND HORTICULTURE

Introduction

- Common ragweed (*Ambrosia artemisiifolia* L.) is an important broadleaf weed in diverse agroecosystems, roadsides, and wastelands.
- Glyphosate and 2,4-D are very effective for control of common ragweed, however, limited information is available on the effect of environmental factors including temperature on the efficacy of these herbicides.

Objective

- The objective of this study was to evaluate the efficacy of 2,4-D and glyphosate on common ragweed control under different growth temperatures.

Materials and Methods

Dose-response experiments:

- 2,4-D/glyphosate dose-response studies were conducted under two growth temperatures (day/night, ^{0}C): low (LT) 20/11 and high (HT) 29/17, at a relative humidity of 70% (±5).
- Glyphosate-resistant and –susceptible biotypes (susceptible to 2,4-D) of common ragweed were used.
- Plants were treated at 8 to 12 cm height with 2,4-D or glyphosate rates varying from 0.06x to 8x (1x of 2,4-D and glyphosate were 560 and 1,260 g ae ha^{-1}, respectively).
- Visual control estimates and above ground biomass reduction (21 days after treatment) data were fit to a four-parameter log logistic model in drc package of R software.

Absorption and translocation experiments:

- Absorption and translocation studies were conducted by applying approximately 200,000 dpm ^{14}C labelled 2,4-D or glyphosate on a newly mature leaf of 8 to 12 cm plants grown at LT and HT (Figure 1a).
- Plants were harvested at 24, 48, 72 and 96 h after treatment and separated into treated leaf (TL), tissues above the TL, and below the TL (Figure 1b).
- Treated leaves were washed with 5 ml wash solution (10% methanol and 0.05% polysorbate 20) for 1 min to measure unabsorbed radiolabeled herbicide.
- Plant sections were dried at 60 ^{0}C for 48 h and radioactivity absorbed or translocated was recovered by combusting the samples in biological oxidizer (Figure 1c) and quantified by liquid scintillation spectrometry (Figure 1d).
- Herbicide absorption was calculated as; % absorption=(total radioactivity applied−radioactivity recovered in wash solution) × 100/total radioactivity applied; % translocation=100−% radioactivity recovered in TL, where radioactivity in TL=radioactivity in TL × 100/ radioactivity absorbed.
- Data were subjected to ANOVA and graphs were generated in Graphpad Prism version 6.

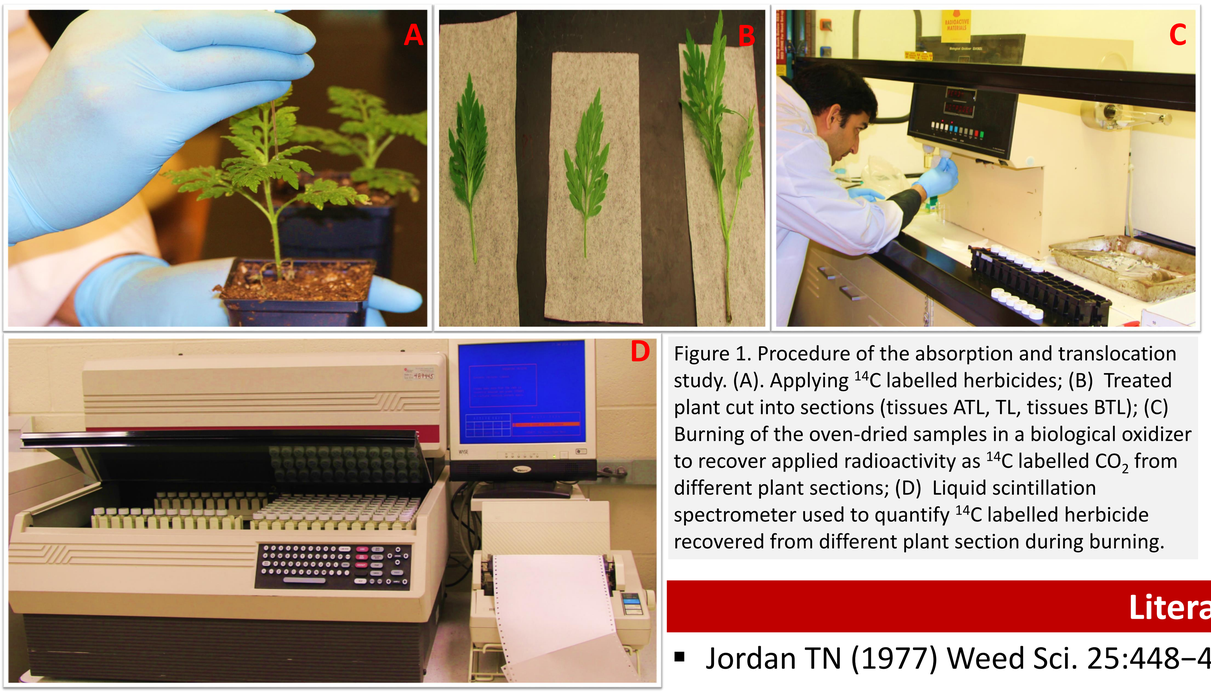

Figure 1. Procedure of the absorption and translocation study. (A). Applying ^{14}C labelled herbicides; (B) Treated plant cut into sections (tissues ATL, TL, tissues BTL); (C) Burning of the oven-dried samples in a biological oxidizer to recover applied radioactivity as ^{14}C labelled CO_2 from different plant sections; (D) Liquid scintillation spectrometer used to quantify ^{14}C labelled herbicide recovered from different plant section during burning.

Results and Discussion

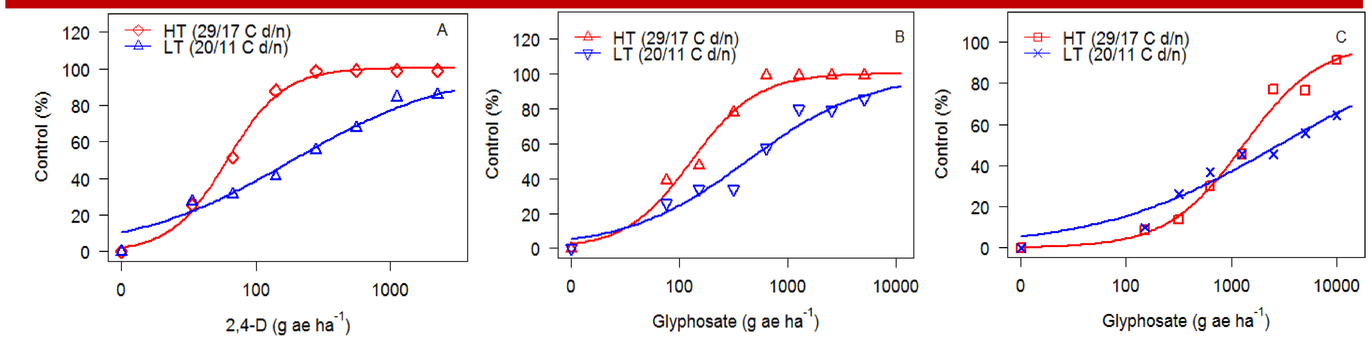

Figure 2. Visual control estimates of common ragweed at two different temperatures (^{0}C, day/night): low temperature (LT) 20/11; and high temperature (HT) 29/17; (A) 2,4-D, (B) glyphosate on glyphosate-susceptible and (C), and glyphosate on glyphosate-resistant common ragweed.

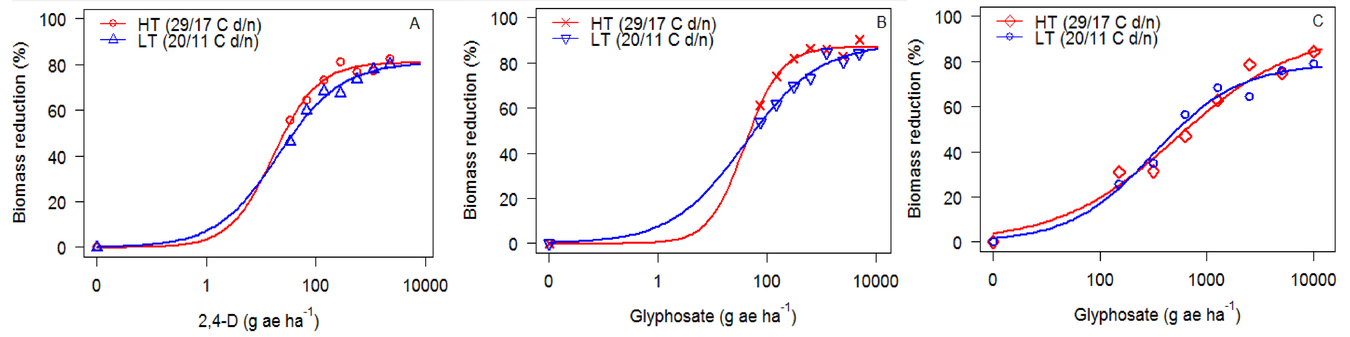

Figure 3. Biomass reduction of common ragweed at two different temperatures (^{0}C, day/night): low temperature (LT) 20/11; and high temperature (HT) 29/17; (A) 2,4-D, (B) glyphosate on glyphosate-susceptible and (C), and glyphosate on glyphosate-resistant common ragweed.

- 2,4-D dose-response study suggested ED_{90} of 177(±21) and 3,805 (±1,166) g ae ha^{-1} based on visual control estimates at HT and LT, respectively (Figure 2A, 3A and 4A).
- Glyphosate dose-response study suggested ED_{90} of 587 (±96) and 6,963 (±2,159) g ae ha^{-1} for susceptible biotype (Figure 2b, 3b and 3c) and 8,354 (±3,154) and 218, 014 (±95,247) g ae ha^{-1} for resistant biotype at HT and LT, respectively (Figure 2c, 3c and 4c).
- Similarly, previous studies have reported higher efficacy of 2,4-D (Kelly 1948) and glyphosate (Jordan 1977) at warm temperatures (≥25 ^{0}C) compared to cool temperatures (<20 ^{0}C).

Figure 4. Dose-response pictures at two different temperatures (^{0}C, day/night): low temperature (LT) 20/11; and high temperature (HT) 29/17; (A) 2,4-D, (B) glyphosate on glyphosate-susceptible and (C) glyphosate on glyphosate-resistant common ragweed.

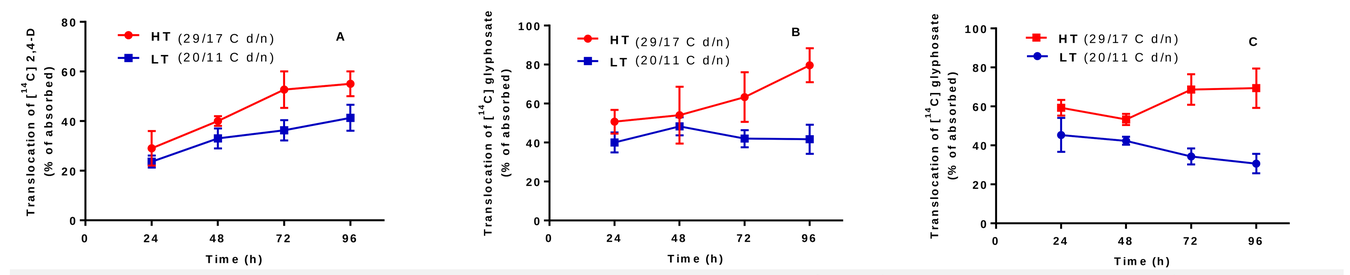

Figure 5. Translocation of 2,4-D or glyphosate in common ragweed at two temperatures (^{0}C, day/night): low temperature (LT) 20/11; high temperature (HT) 29/17. 2,4-D translocation (A); glyphosate translocation in glyphosate-susceptible (B) and in glyphosate–resistant biotype (C)

- Absorption and translocation experiments indicated more translocation for both 2,4-D (Figure 5a) and glyphosate (Figure 5b and 5c) at HT compared to LT.

Conclusion

- The efficacy of 2,4-D and glyphosate for common ragweed control improved at warm temperatures (29/17 ^{0}C d/n) (Figure 2 and 3) due to increase in translocation of these herbicides (2,4-D, glyphosate) compared to cooler temperatures (20/11 ^{0}C d/n).
- Further investigation including metabolism, gene expression is needed to fully understand the molecular basis of differences in 2,4-D or glyphosate efficacy under varying temperatures.

Literature Cited

- Jordan TN (1977) Weed Sci. 25:448–451
- Kelly S (1949) Plant Physiol. 24:534–536

Acknowledgement

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