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

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Introduction

• Common ragweed (Ambrosia artemisiifolia L.) is an important broadleaf weed in diverse agroecosystems, roadways, 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, °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 ¹⁴C 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 unabsoled radiolabeled herbicide.
• Plant sections were dried at 60 °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) x 100/total radioactivity applied; % translocation=100–% radioactivity recovered in TL, where radioactivity in TL=radioactivity in TL x 100/ radioactivity absorbed.
• Data were subjected to ANOVA and graphs were generated in Graphpad Prism version 6.

Results and Discussion

• 2,4-D dose-response study suggested ED₉₀ 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 ED₉₀ 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 °C) compared to cool temperatures (<20 ºC).

Conclusion

• The efficacy of 2,4-D and glyphosate for common ragweed control improved at warm temperatures (29/17 °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 °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

• Kelly S (1949) Plant Physiol. 24:534–536

Acknowledgement

Graphpad

Figure 1. Procedure of the absorption and translocation study. (A) Applying ¹⁴C 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 ¹⁴C labelled CO₂ from different plant sections; (D) Liquid scintillation spectrometer used to quantify ¹⁴C labelled herbicide recovered from different plant section during burning.

Figure 2. Visual control estimates of common ragweed at two different temperatures (°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 (°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 4. Dose-response pictures at two different temperatures (°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 (°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)