Grape
response to simulated drift of
Auxin Herbicides

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Grapes are highly sensitive to auxin herbicides, and they are the most valuable horticultural crop in California. Winegrapes' high economic value and sensitivity to auxin herbicides makes herbicide drift a major concern for grape growers. Previous research on winegrapes has examined symptoms caused by 2,4-D drift (Al-Khatib et al. 1993, DOI:10.1017/S0890037X00036940). More research should investigate how auxin herbicide drift might impact winegrape **yield and quality**. Our **objective** was to compare the sensitivity of winegrapes to simulated auxin herbicide drift, including symptomology, harvest yield, and harvest quality.

Methods. We applied **four auxin herbicides at four simulated drift rates** each to a **mature Grenache vineyard** in Davis, CA. Plots were two vines long, separated by one vine and arranged in a **randomized complete block design** with three replicates. We applied treatments to one side of the vine canopy with a two-nozzle backpack sprayer calibrated to spray 187 l ha^{-1} through TeeJet AIXR11002 nozzles. The simulated **drift rates** were 1/900X, 1/300X, 1/100X, and 1/33X of a full field rate. The **herbicide common name, trade name, and full field rate (1X)** we used are in **Table 1**:

Common Name	2,4-D	Aminopyralid	Dicamba	Triclopyr
Trade Name	2,4-D Amine 4	Milestone	Clarity	Garlon 3A
1 X Rate (g ae ha^{-1})	1454	122.5	280	2240

Table 1. Herbicides and rates used in this study

Treatments were applied around the time of fruit set, on June 13, 2018 and again on June 11, 2019. The vines were monitored for visible symptoms after application, and then hand harvested when berries in nontreated plots reached approximately 20^{0}Bx, on August 29 both years. We measured grape yield and grape sugar content (using degrees Brix, a unit of dissolved solid content) from each treatment. Data were analyzed with ANOVA using **R 3.4.3**, with significance at $p<0.05$. Tukey's HSD was used for multiple comparisons.

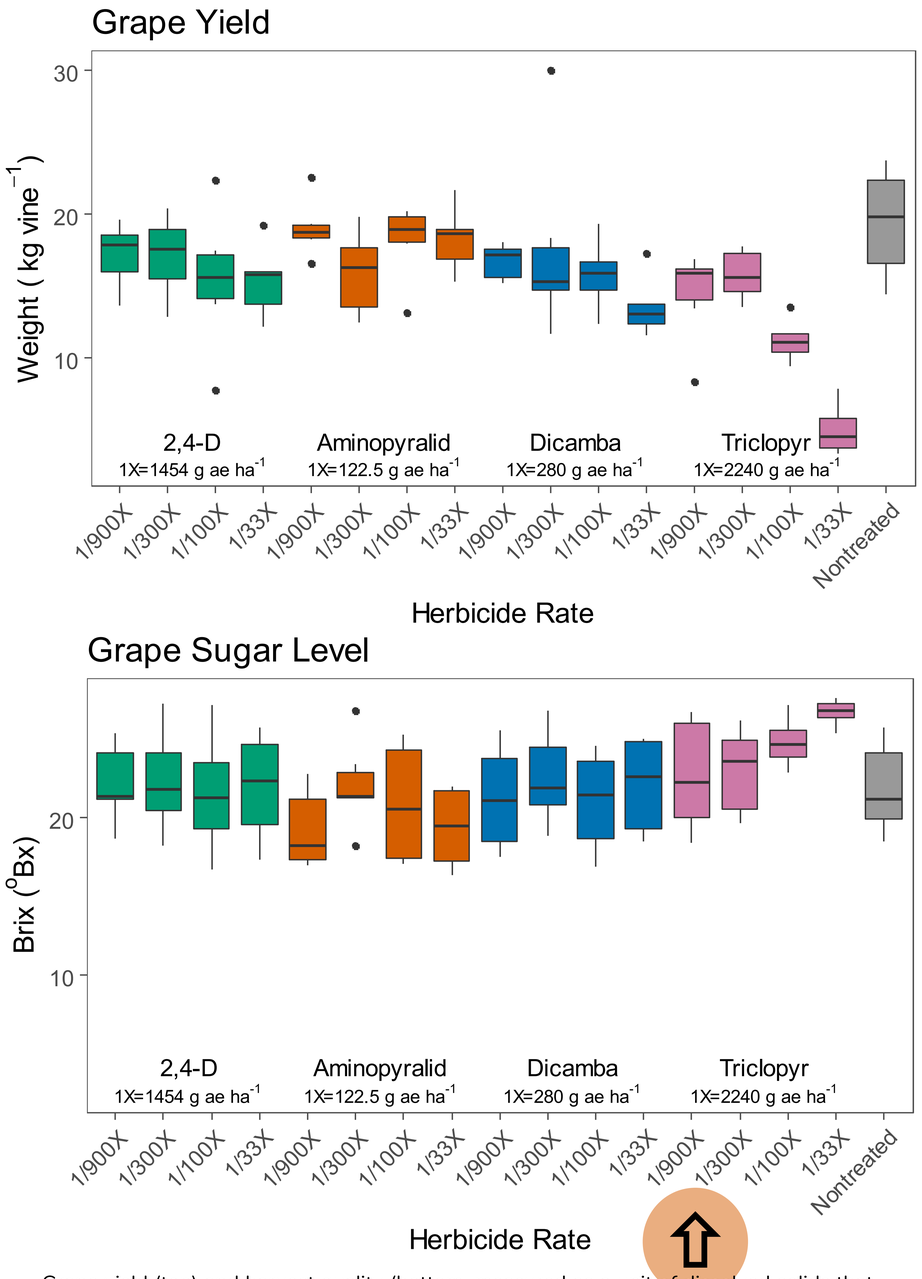
Results. All herbicide treatments caused visible symptoms from 7 to 56 days after treatment. Visible symptoms included tendril and apical death, leaf malformations such as leaf cupping, and inconsistent veraison (onset of ripening). See examples of symptoms in the photos to the right. **Only the two highest rates of triclopyr resulted in greater than 10% visible symptoms through the observation period**; greater than 10% symptomology was also observed with the 1/300X rate of triclopyr between 7 and 28 days after treatment and with the 1/33 rate of dicamba at 14 days after treatment (data not displayed). Triclopyr at all rates generally caused more severe symptomology than other treatments, especially defoliation and necrosis.

Triclopyr at 1/33X and 1/100X were the only treatments to cause a grape yield reduction. These two treatments were also the only treatments to have increased brix in either year of the study, though this difference was not significant when data were pooled across years.

Discussion. Simulated auxin herbicide drift caused less damage to winegrapes than we had expected. Though all herbicide treatments in this study caused some level of symptomology, symptoms were surprisingly subtle. Symptoms also did not have meaningful qualitative differences across 2,4-D, aminopyralid, and dicamba treatments. This research demonstrates that grapes are indeed sensitive to very low levels of various auxin herbicide drift, but **herbicide symptoms do not necessarily translate into significant impacts on yield or quality**. Previous research in annual cropping systems corroborates this finding that visible auxin herbicide symptomology is not necessarily predictive of final yield (Franklin Egan et al. 2014, DOI:10.1614/WS-D-13-00025.1).

Despite this finding, the highest rates of triclopyr used in this study caused both the most severe symptoms and the most detrimental impacts on grape yield and quality. **Herbicide drift remains a major concern to winegrape growers**, even if no yield or quality losses are realized. This study analyzed only one element of winegrape quality, and more complex factors like anthocyanin content may still be affected by low drift rates. Also, winemakers may reject grapes if they know that a vineyard was affected with herbicide symptomology because of perceived risks of herbicide residues that could affect product safety or reputation.

Photographs showing representative herbicide symptoms exhibited by the 1/33X rate of each herbicide 14 days after treatment. Healthy, nontreated foliage is displayed in panel 1. Panel 2 shows leaf crinkling and excessive tendril twisting caused by 2,4-D. Panel 3 shows tendril necrosis caused by aminopyralid. Panel 4 shows leaf cupping caused by dicamba. Panel 5 shows leaf and inflorescence necrosis caused by triclopyr.



Grape yield (top) and harvest quality (bottom, measured as a unit of dissolved solids that describes grape sugar content) across four herbicides applied with four simulated drift rates. Data are pooled across 2018 and 2019 grape harvests, and there was no interaction between herbicide treatments and study years. This boxplot uses the median for the center line, the first and third quartiles for the hinges, and 150% of the interquartile range for the whiskers. Each box represents a single combination of herbicide and fractional drift rate. Herbicides are grouped together, and each group is displayed in order (left-right) of increasing fractional rate. The 1/100X and 1/33X triclopyr treatments reduced grape yield and displayed a trend of increasing grape sugar content.

Many thanks to Drew Wolter, Matt Fatino, Sarah Morran, Katie Martin, Caio Brunharo, Alex Ceseski, Guy Kyser, Seth Watkins, Gale Perez, John Roncoroni, and Nate Kane for their field work assistance on this project.

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