# INVESTIGATING THE IMPACT OF ROW SPRAYING ON ESTABLISHED WHITE CLOVER

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**Introduction**

White clover seed producers in the Willamette Valley struggle with highly variable yields from year to year. Seed yield is most dependent on flower head density, which in turn is affected by environment, management, and cultivars (FAR, 2006). In Oregon, white clover seed yields vary widely due to the difficulty in managing crop vigor with grazing and to variability in weather. Researchers in New Zealand have managed to increase clover seed yield and stability by refining the timing of sheep removal from the field and through irrigation practices, row spacing, and management of second-year clover growth with herbicides.

White clover spreads by stolons. Flowers are produced on the tip of a stolon as long as the stolon continues to grow outwards; therefore, creating space for stolon elongation is deemed a critical factor contributing to seed yield. Second-year growth needs to be "managed" (reduced) to create space for growth of primary stolons, which produce the most seed heads.

Optimal production of primary stolons is difficult to manage with grazing alone, as over-grazing leads to high production of secondary and tertiary stolons. These later-developing stolons are less likely to produce seed and thus reduce yield (Clifford, 1980). In New Zealand, herbicides have long been used in second-year crops to reduce stolon density. More recently, row spraying with herbicides has been used to optimize primary stolon number and length, as well as flower density (Thomas et al., 2009).

Growers are aware that Willamette Valley growing conditions are different than those in New Zealand. However, they are interested in the feasibility of row spraying in rainfed white clover seed production systems. Several growers in the Willamette Valley have experimented with row spraying in established white clover stands (Aldrich-Markham, 2011), but no measurable data have been collected to quantify impacts on seed yield. Herbicides and timing of application need to be evaluated in order to determine whether row spraying is a viable tool for local seed producers.

The goal of this research was to evaluate the effectiveness of row spraying in second-year white clover stands in the Willamette Valley. More specifically, the objectives were to: (1) evaluate herbicides for row spraying white clover based on row formation, row persistence, clover crop tolerance, and clover seed yield; and (2) evaluate different row spray application timings to determine the optimal timing window to achieve maximum flower head density and seed yield.

**Materials and Methods**

The trial was conducted in 2016 on a second-year stand of ladino-type white clover (VNS) established at Hyslop Research Farm in the fall of 2014. The clover stand was not fertilized in 2016, and no pesticide applications outside of the herbicide treatments were made during the growing season. Field sweeps were conducted for white clover seed weevils, but weevil numbers were well below the threshold for an insecticide application. Beehives were present at a nearby trial, and bees were seen actively foraging in the plots.

The trial was arranged as a randomized complete block design with four replications of each treatment. Plot size was 8 feet x 30 feet. A bicycle sprayer was used to apply eight herbicide treatments (Table 1) at three

Table 1. Herbicide treatments used for row spraying in established white clover stands. ***Note***: None of the listed herbicide treatments is currently labeled for use in white clover grown for seed.

| Treatment | Active ingredient | Rate |
|---|---|---|
| | | (lb ai/a) |
| Control | — | — |
| Alion + Rely | Indazaflam + glufosinate | 0.0196 + 0.88 |
| Express | Tribenuron | 0.0078 |
| Goal[1] | Oxyfluorfen | 0.0625 |
| Rely | Glufosinate | 0.88 |
| Sharpen | Saflufenacil | 0.0445 |
| Sharpen broadcast | Saflufenacil | 0.0445 |
| Chateau | Flumioxazin | 0.128 |

[1]Goal is labeled for use as a dormant application, but is not labeled for row spraying use.

timings in the late winter/early spring of 2016: "early timing" (February 22), "mid timing" (March 30), and "late timing" (May 18). In total, there were 24 treatment combinations per replicate. The sprayer was set up to create a 4-inch white clover row by spraying out an 8-inch band using six nozzles (40 03) mounted to the boom at 12-inch spacing. Sheep did not graze the field, and the trial site was flail mowed April 25 and May 11 to manage crop height. (Crop residue was left in the field.)

Visual evaluations of row persistence and crop injury were made six times between March 17 and June 21. Flower head density was measured by counting the number of flowers in two 0.5 $m^2$ quadrats per plot on May 5, June 18, and July 17. Plots were cut and raked into swaths on July 18. Seed was harvested with a plot combine on July 29. Seed was cleaned with a clipper cleaner, and seed yield was determined.

**Results and Discussion**

Visual evaluations conducted on May 30 showed low row persistence and low crop injury in many of the early and mid application plots (Figure 1). Early applications of Goal and Chateau resulted in negligible crop injury and short-term row persistence. On the other hand, late row spraying resulted in unacceptable crop injury.

Flower head density counts taken just before swathing on July 17 revealed very similar flower head densities between the control plots and herbicide treatments applied early and mid (Table 2). None of the treatments evaluated in the trial produced significantly higher flower density than the control (31 flowers/$ft^2$). However, average flower head density was significantly reduced in the late treatments (20 flowers/$ft^2$).

Overall, seed yields were very low (0–200 lb/acre), due to equipment challenges during harvest. Seed was lost during both swathing and combining. The yields in this trial are not representative of typical white clover seed yields. However, all plots were treated the same, and results within the trial can be compared relative to each other. Some of the treatments with high flower head density, such as Goal and Chateau at early and mid timings, also had high seed yields, but none was significantly higher than the control plots (Table 3). Overall, yield in the control plots (154 lb/acre) was significantly higher than in the early (102 lb/acre) and mid (99 lb/acre) application timings. These application timings produced higher yields than the late application (31 lb/acre).

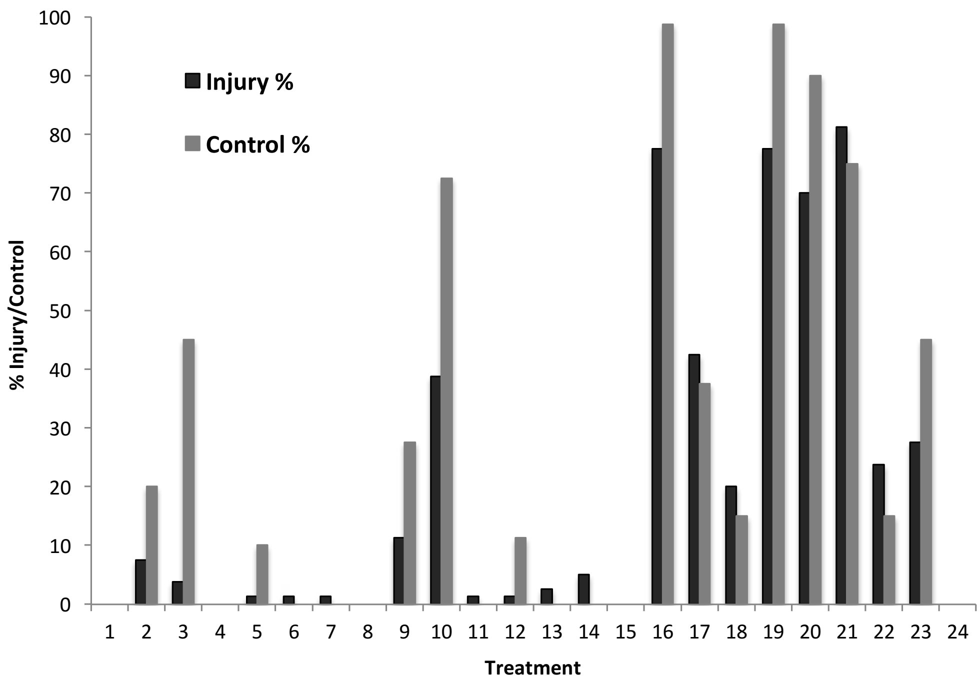


Figure 1. Percent crop injury and percent control (row persistence) in each treatment evaluated on May 30, 2016. Treatments 1 and 24 are control plots, 2 to 8 are early application, 9 to 15 are mid application, and 16 to 23 are late application.

**Conclusions and Next Steps**

Early applications of Goal (Treatment 4) and Chateau (Treatment 8) stood out as treatments with higher yields, but they did not yield significantly higher than the control plots. The late application timing (May 18) was too late, and spray timings will be made earlier in 2017. Based on the first year of data, there is no yield benefit to row spraying in second-year white clover fields, especially with the added cost and time of an additional field spray.

The trial will be repeated in the late winter/early spring of 2017.

**References**


Aldrich-Markham, S. 2011. Clover seed production in Oregon. Oregon Clover Commission.

Clifford, P.T.P. 1980. Research in white clover seed production. In J.A. Lancashire (ed.). Herbage Seed Production. New Zealand Grassland Association Grassland Research and Practice Series No.1:64–67.

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Table 2. Average flower head density measured on July 17, 2016 with 24 row-spraying treatments in a second-year white clover seed field. Ranked from highest to lowest number of flower heads/ft$^2$.

| Treatment | Herbicide | Timing | Flower density[1] |
|---|---|---|---|
| | | | (heads/ft$^2$) |
| 4 | Goal | Early | 36 a |
| 18 | Goal | Late | 36 a |
| 8 | Chateau | Early | 35 a |
| 10 | Express | Mid | 33 ab |
| 11 | Goal | Mid | 32 abc |
| 15 | Chateau | Mid | 32 abc |
| 14 | Sharpen broadcast | Mid | 32 abc |
| 1 | Control | — | 31 abc |
| 12 | Rely | Mid | 31 abc |
| 7 | Sharpen broadcast | Early | 31 abc |
| 13 | Sharpen | Mid | 31 abc |
| 22 | Chateau | Late | 31 abc |
| 24 | Control | — | 31 abc |
| 23 | Aim[2] | Late | 30 abcd |
| 6 | Sharpen | Early | 30 abcd |
| 5 | Rely | Early | 29 abcd |
| 3 | Express | Early | 29 abcd |
| 2 | Alion + Rely | Early | 28 bcd |
| 9 | Alion + Rely | Mid | 26 cd |
| 20 | Sharpen | Late | 23 de |
| 21 | Sharpen broadcast | Late | 18 ef |
| 19 | Rely | Late | 13 fg |
| 16 | Alion + Rely | Late | 10 g |
| 17 | Express | Late | 2 h |
| LSD ($P$ = 0.05) | | | 6.7 |

[1]Means followed by the same letter are not significantly different at LSD ($P$ = 0.05).

[2]Aim was used as a row-spray treatment only at the late timing because there was an extra plot.

Table 3. Average white clover seed yield with 24 row-spraying treatments in a second-year white clover seed field. Ranked from highest to lowest yield (lb/a). Yields were very low due to equipment challenges during harvest and are not representative of typical yields in the Willamette Valley.

| Treatment | Herbicide | Timing | Seed yield[1] |
|---|---|---|---|
| | | | (lb/a) |
| 8 | Chateau | Early | 186 a |
| 24 | Control | — | 160 ab |
| 1 | Control | — | 148 abc |
| 4 | Goal | Early | 147 abc |
| 15 | Chateau | Mid | 121 abcd |
| 13 | Sharpen | Mid | 120 abcd |
| 6 | Sharpen | Early | 112 bcde |
| 11 | Goal | Mid | 107 bcde |
| 9 | Alion + Rely | Mid | 105 bcde |
| 12 | Rely | Mid | 102 bcde |
| 22 | Chateau | Late | 98 bcde |
| 18 | Goal | Late | 92 bcde |
| 14 | Sharpen broadcast | Mid | 84 cde |
| 7 | Sharpen broadcast | Early | 75 def |
| 5 | Rely | Early | 71 defg |
| 3 | Express | Early | 67 defgh |
| 2 | Alion + Rely | Early | 58 defgh |
| 10 | Express | Mid | 54 defgh |
| 23 | Aim[2] | Late | 44 efgh |
| 21 | Sharpen broadcast | Late | 10 fgh |
| 20 | Sharpen | Late | 6 gh |
| 16 | Alion + Rely | Late | 0 h |
| 17 | Express | Late | 0 h |
| 19 | Rely | Late | 0 h |
| LSD ($P$ = 0.05) | | | 69 |

[1]Means followed by the same letter are not significantly different at LSD ($P$ = 0.05).
[2]Aim was used as a row-spray treatment only at the late timing because there was an extra plot.