Herbicide application with a pulse width modulation sprayer for Canada thistle control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Pulse Width Modulation (PWM) technology has been developed to improve precision application of pesticides. PWM involves rapidly switching an electrically-actuated solenoid on and off (duty cycle) in order to control the flow rate of the nozzle. This cycling takes place so quickly the flow appears to be constant and the coverage remains reasonably uniform. Controlling flow rate by adjusting duty cycle and cycling frequency of an electric nozzle while maintaining a constant pressure provides advantages over controlling flow by adjusting pressure. Normally, increasing spray pressure results in increased flow rate. However, increased pressure also changes the spray angle and droplet size which may result in increased spray particle drift. PWM flow control provides an extremely wide range of flow rates from a single nozzle, maintaining a consistent spray angle and droplet size without adjusting pressure.

The PWM technology has yet to be adapted for weed control in pasture, rangelands, and wildlands. Use of a PWM sprayer would allow both drift reduction and more precise application at the variable speeds required when driving in uneven and rugged terrain. The PWM sprayer will reduce the duty cycle (percent of time a nozzle is open) when the applicator slows to avoid obstacles and then increases the cycle as the sprayer returns to normal speed. The pressure and droplet size remain the same, so application rate is unaffected by changes in speed.

Two experiments were established to evaluate Canada thistle control using the PWM sprayer. The objective was to evaluate the effect of droplet size on weed control. Various nozzles and pressures were used with the PWM sprayer to apply aminopyarlid so that the spray pattern consisted of 150, 300, 450, 600, 750, or 900 micron droplets at 10 gpa. Application speed was 10 mph and a NIS at 0.25% was included with all treatments (Induce). A tractor mounted boom sprayer with XR8002 nozzles calibrated to apply treatments at 17 gpa and 35 psi was included as the standard. The application rate of aminopyralid was 1.25 oz/A. Separate spring and fall studies were established on June 23, 2016 or September 14, 2016. Canada thistle was in the rosette to bolting stage when the spring treatments were applied and in the rosette growth stage in the fall. Plots were 15 by 40 feet and treatments were replicated three times.

Canada thistle control was similar when herbicides were applied with the PWM system compared to a standard boom sprayer at all droplet sizes except 150 microns (Tables 1 and 2). Canada thistle control averaged 98% 12 MAT with all spring applied treatments except when application was made with nozzles that applied primarily 150 micron droplets which only averaged 63% (Table 1). Control averaged 96% 14 MAT regardless of droplet size with the exception of the 150 micron droplet treatment which declined to 55%.

Canada thistle control averaged 95 and 10% 9 MAT when aminopyralid was applied using 300 or greater micron droplets compared to 150 micron droplets, respectively in the fall (Table 2). Canada thistle control was similar when aminopyralid was applied with the conventional boom sprayer which averaged 97% 9 MAT. Control averaged 92% 21 MAT with all treatments except the 150 micron droplet size application.

In summary, herbicides applied with the PWM system provided similar Canada thistle control compared to traditional boom sprayer with XR8002 nozzles as long as the average droplet size exceeded 150 microns. These results along with previously published NDSU studies indicate the PWM sprayer can be used to apply herbicides in pasture and rangeland while maintaining medium sized spray droplets resulting in reduced drift and uniform coverage.

Table 1. Canada thistle control with aminopyralid applied on June 23, 2016 with a pulse width modulation (PWM) sprayer using various nozzles compared to a tractor mounted boom sprayer at Fargo, ND.

| | | | | | Months after treatment | | | |
|---|---|---|---|---|---|---|---|---|
| Treatment | | | | Rate | 1 | 2 | 12 | 14 |
| | | Nozzle | Droplet | —— oz/A —— | ———— % control ———— | | | |
| Aminopyralid + NIS[a] | PWM | ER110015 | 150 | 1.25 + 0.25% | 75 | 83 | 63 | 55 |
| Aminopyralid + NIS | PWM | SR11002 | 300 | 1.25 + 0.25% | 89 | 99 | 98 | 99 |
| Aminopyralid + NIS | PWM | MR11004 | 450 | 1.25 + 0.25% | 92 | 100 | 99 | 99 |
| Aminopyralid + NIS | PWM | DR11005 | 600 | 1.25 + 0.25% | 98 | 100 | 96 | 91 |
| Aminopyralid + NIS | PWM | DR11006 | 750 | 1.25 + 0.25% | 96 | 100 | 98 | 98 |
| Aminopyralid + NIS | PWM | UR11006 | 900 | 1.25 + 0.25% | 95 | 99 | 100 | 95 |
| Aminopyralid + NIS | $CO_2$ | XR8002 | Medium[b] | 1.25 + 0.25% | 94 | 99 | 94 | 96 |
| LSD (0.05) | | | | | 11 | 12 | 25 | 29 |

[a]Surfactant at 0.25% applied with all treatments - Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[b]Medium-size droplet range is 281 - 429 microns.

Table 2. Canada thistle control with aminopyralid applied on September 14, 2016 with a pulse width modulation (PWM) sprayer using various nozzles compared to a tractor mounted boom sprayer at Fargo, ND.

| Treatment | | | | Rate | Months after treatment 9 | 12 | 21 |
|---|---|---|---|---|---|---|---|
| | | Nozzle | Droplet | oz/A | % control | | |
| Aminopyralid + NIS[a] | PWM | ER80015 | 150 | 1.25 + 0.25% | 10 | 8 | 0 |
| Aminopyralid + NIS | PWM | SR8002 | 300 | 1.25 + 0.25% | 95 | 92 | 94 |
| Aminopyralid + NIS | PWM | MR8004 | 450 | 1.25 + 0.25% | 100 | 100 | 88 |
| Aminopyralid + NIS | PWM | DR8005 | 600 | 1.25 + 0.25% | 99 | 99 | 96 |
| Aminopyralid + NIS | PWM | DR8006 | 750 | 1.25 + 0.25% | 100 | 98 | 93 |
| Aminopyralid + NIS | PWM | UR8006 | 900 | 1.25 + 0.25% | 100 | 98 | 84 |
| Aminopyralid + NIS | $CO_2$ | XR8002 | Medium[b] | 1.25 + 0.25% | 100 | 97 | 94 |
| LSD (0.05) | | | | | 3 | 15 | 16 |

[a]Surfactant at 0.25% applied with all treatments - Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[b]Medium-size droplet range is 281 - 429 microns.