# CANADA THISTLE [Cirsium arvense (L.) Scop.] CONTROL IN WINTER WHEAT

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## Abstract

Field trials have been conducted since 1983 to evaluate herbicides for crop tolerance and Canada Thistle control in winter wheat. Winter wheat has shown excellent tolerance to a variety of herbicides, both fall and spring applied. Stage of development of shoot apices does not correlate with leaf number in winter wheat as it does in spring wheat. The Zadok scale of development may be preferable to leaf counts in winter wheat in establishing preferable time for treatment with herbicides. Preliminary indications are that the timing of application of systemic herbicides such as 2, 4-D is not as critical in winter wheat as it is in spring wheat.

Sampling adjacent to and in untreated Canada thistle patches demonstrated a competitive relationship between Canada thistle density and winter wheat yield. Good to excellent top growth control of Canada thistle has been obtained with clopyralid, chlorsulfuron and metsulfuron applied in late spring. In general, top growth control of Canada thistle has been acceptable with 2, 4-D and dicamba until late July. Significant yield increases of winter wheat with effective top growth control from spring-applied herbicides have not been obtained.

Introduction. Recent weed survey results show that about 40% of winter wheat fields in the black and gray soil zones of Saskatchewan are infested with Canada Thistle (8). Canada Thistle has been shown to be a strong competitor in many crops. Increasing density of shoots is very closely correlated to decreased crop yields, and yield loss prediction formulas have been developed for some crops (5, 6).

The requirement for seeding winter wheat directly into standing stubble to increase the probability of winter suvival leaves little opportunity for the effective control of Canada Thistle. Effective control with fall-applied herbicides requires adequate new growth of the Canada Thistle to absorb the herbicide, with at least two weeks between application and a killing frost (1). Many of the recommended treatments involve non-selective herbicides such as glyphosate or high rates of dicamba. The emergence of winter wheat precludes the use of glyphosate except for sacrificial patch treatment. These herbicide treatments do not provide complete control of Canada Thistle, and in-crop control measures the following spring or summer are usually required. When Canada Thistle control is neglected, patches can increase in size and density of shoots (4).

Cereal crops, although tolerant to many herbicides used to control Canada Thistle, show differential responses to application depending on the type of herbicide and stage of growth at application. Growth abnormalties, decreased yield and reduced cold hardiness of winter wheat have been reported as a result of 2, 4-D application at some growth stages (2, 3, 7).

The objectives of the investigations are as follows:

1. To examine the competitive relationship between Canada Thistle and winter wheat.
2. To evaluate the tolerance of winter wheat to a variety of commercially available and developmental herbicides useful for Canada Thistle control.
3. To determine the time of floret initiation in Winter Wheat under Saskatchewan conditions and identify a morphological characteristic corresponding to this growth stage.
4. To examine any relationship between winter wheat tolerance to herbicides and stage of apical development at application.
5. To evaluate the level of control of Canada Thistle that can be achieved with some commercially available and developmental herbicides, and the resulting yield benefit.

Competitive Effects. In order to investigate the competitive effect of Canada Thistle on winter wheat yield, three sites were examined in 1986. These sites consisted of untreated Canada Thistle patches in farm fields that had been seeded to Norstar winter wheat. All the patches examined were well defined and very dense. This was believed to be the result of a lack of effective control measures and soil disturbance for at least 15 months. All fields had been seeded to canola the year previous to our examinations and had not received treatment in that crop, or in the fall when winter wheat was seeded. By the time the winter wheat was nearing maturity, the patches were very well established.

At crop maturity, the boundaries of the patches were identified and $m^2$ samples of winter wheat were harvested from the boundary line, and from points approximately 3 meters outside and inside the boundary line. Canada Thistle shoot numbers from three to five replications per patch were recorded at each sampling point. Table 1 summarizes the data obtained at one location which typifies the findings at all sites.

Table 1: Results of Winter Wheat/Canada Thistle Patch Sampling

Location: Sonningdale #2

| Sampling Location | Canada Thistle shoots/$m^2$ | Winter Wheat heads/$m^2$ | Grain Yield grams/$m^2$ |
|---|---|---|---|
| Outside patch | 0 | 307A[1] | 176A[1] |
| Boundary | 20 | 217A | 131A |
| Inside patch | 116 | 91B | 53B |

[1]Means followed by the same letter are not difference at the 5% level according to Duncan's Multiple Range test.

There was a strong negative correlation between Canada Thistle shoot numbers and winter wheat heads per $m^2$. Grain yield was reduced by 70% within this patch, compared to yield of wheat produced outside the patch.

Tolerance of Winter Wheat to Herbicides. Tolerance to herbicide treatment can vary with the stage of development of the crop. This variable tolerance is evident in spring wheat when treated with growth regulator type herbicides such as 2, 4-D at various stages of growth. The timing of herbicide application by the crop leaf stage has become an accepted practice due to the relationship between leaf number and tolerant or susceptable stages of growth. Cereal crops are considered more tolerant to growth regulator herbicides after floret initiation and before sporogenesis. No precise timing guide such as this has been developed for winter wheat.

A) Winter Wheat Development. Plants were chosen at random at weekly intervals starting in early May and leaf number, tiller number and height were recorded. The main shoot of these plants was then dissected and the apex examined under a binocular microscope to determine if floret initiation had occurred.

There was no correlation between height, tiller number or leaf number and floret initiation which supported earlier work by Paquette. However, when the plants were categorized using the decimal growth scale developed by Zadoks *et al*. (9) a pattern became apparent.

Table 2: Results of Random Sampling and Dissection

| Sample date | 14/05/86 | 21/05/86 |
|---|---|---|
| % of plants in Zadok stage 30[1] | 55 | 70 |
| % of plants in stage 30 showing floret initiation | 55 | 57 |
| % of plants in Zadok stage 31[2] | 0 | 30 |
| % of plants in stage 31 showing floret initiation | - | 100 |

1 pseudo stem erection, most advanced stage of growth at 14/05/86
2 first node detectable, most advanced stage of growth at 21/05/86

The pivotal growth stage for floret initiation was Zadok growth stage 30 categorized as the stage of pseudo stem erection. At the May 14 and May 21 sampling dates, 55% and 57% respectively of plants in this stage had switched to the reproductive phase of development. By May 21, 30% of plants sampled had reached Zadok growth stage 31, when the first node was detectable. All plants at this stage had initiated florets on the main shoot.

B) Tolerance to Herbicides. A series of field trials were conducted to evaluate the tolerance of winter wheat to various herbicides suitable for Canada Thistle control. Norstar winter wheat was seeded at 67 kg/ha on August 28 and 29, 1985 on two sites at the University of Saskatchewan. The crop was fertilized with 67 kg/ha of 11-51-0 placed with the seed and 300 kg of 34-0-0 broadcast the following May.

All herbicide treatments were applied with a bicycle-wheel mounted sprayer equipped with 80015 nozzles calibrated to deliver 100 l/ha total solution. All trials consisted of 2.5 x 6-m plots, replicated four times.

Four trials were designed to evaluate tolerance to fall and spring applications of miscellaneous herbicides at various rates. These herbicides were 2, 4-D amine, MCPA amine, bromoxynil, bromoxynil/MCPA, dicamba, dicamba + 2, 4-D amine, clopyralid and chlorsulfuron. Rates tested were commonly used field rates, and rates which were either 50% or 100% higher. Application dates were October 15, 1985 and April 29, 1986.

Four other trials consisted of either fall or spring applications comparing formulated mixtures of clopyralid/2, 4-D or clopyralid/MPCA (1:5.6) with the component herbicides alone. Dicamba/phenoxy tank mixes, chlorsulfuron, and metsulfuron-methyl were included in some trials. Fall treatments were applied October 15, 1985, and spring treatments were applied from May 28 to June 6, 1986. Winter wheat was in the flag-leaf stage at the June 6 application.

The treatments were visually scored for crop tolerance using the 0-9 rating scale several times after application. Number of plants per meter of row were counted for all fall applied treatments and plant heights were recorded for all treatments. The plots were harvested by combine and the grain cleaned and dried prior to recording grain yield.

Norstar winter wheat showed excellent tolerance to fall-applied herbicides at commonly used field rates. Some visual effects and yield reduction resulted from the highest rates tested of clopyralid/2, 4-D (150 + 850 g/ha). Excessive rates of dicamba + 2, 4-D (280 + 850 g/ha), 2, 4-D amine (1700 g/ha), and MCPA amine (1700 g/ha) which were fall-applied also reduced yields but did not produce any visual symptoms. Plant counts showed no effect on winter survival due to any treatment.

Spring application of high herbicide rates tended to show more damage symptoms than the fall treatments, but in most cases there was no corresponding yield reduction. The April 29 treatments of 2, 4-D amine (1700 g/ha), MCPA amine (1700 g/ha), dicamba (420 g/ha) and dicamba + 2, 4-D amine (280 + 850 g/ha) produced some stem bending and resulted in slight yield reductions. Treatments of dicamba + 2, 4-D ester (140 + 560-850 g/ha), clopyralid/2, 4-D (100 + 560 and 150 + 850 g/ha) and dicamba + MCPA ester (140 + 560-850 g/ha) applied May 29 produced similar results.

Application of many of the same herbicide treatments at the flag-leaf stage of the winter wheat on June 6, 1986 did not result in crop damage. Dicamba + MCPA amine (100 + 420 g/ha) was the only treatment resulting in a decresed yield over the untreated check. Yield reductions of up to 13% were recorded in 1984 resulting from 2, 4-D ester at 840 and 1120 grams/hectare applied at the flag-leaf stage.

In general, Norstar winter wheat showed excellent tolerance to a variety of herbicides suitable for control of Canada Thistle when applied at recommended field rates. Preliminary indications are that the timing of application of growth regulator herbicides, such as 2, 4-D, is not as critical in winter wheat as it is in spring wheat. Damage symptoms were related to high rates of application rather than stage of growth at treatment. Treatments of clopyralid alone, chlorsulfuron, metsulfuron-methyl, bromoxynil and many combination treatments did not injure winter wheat regardless of the time of application.

Canada Thistle Control. Application of many herbicides used for control of Canada Thistle is recommended when the thistles are approaching the bud stage, and cereals have preferably not reached an advanced flag-leaf stage. Canada Thistle emergence at the sites selected for the 1986 control trials commenced around May 20. The winter wheat at these sites was entering the flag-leaf stage around June 1. This type of time frame does not allow for extensive thistle growth prior to the flag-leaf stage of winter wheat.

Three trials were carried out in farm fields which had been seeded to Norstar winter wheat in September 1985. The chosen sites were heavily infested with Canada Thistle. The experiments were designed and conducted in the same manner as the herbicide tolerance trials previously outlined and consisted of field rate herbicide treatments applied in late May and early June. The number of treatments in experiments varied due to the size of the Canada Thistle patches available. All sites had approximately 30 Canada Thistle shoots per square meter at application.

Canada Thistle control was visually scored on a 0-9 scale several times after application and thistle shoot numbers and dry matter yield per square meter were recorded for some of the trials. Winter wheat grain yield was taken for all trials by harvesting $m^2$ samples. Table 3 summarizes the data collected at one characteristic site.

Table 3: Canada Thistle Control with Miscellaneous Herbicides

| Treatment | Rate (g/ha) | Canada[2] Thistle (0-9 score) | Thistle[3] DM ($g/m^2$) | Grain Yield ($g/m^2$) |
|---|---|---|---|---|
| 1. Check | 0 | 0.0 | 83A | 137 |
| 2. 2, 4-D Ester | 560 | 4.8 | 56B | 129 |
| 3. MCPA Ester | 560 | 5.8 | 53B | 149 |
| 4. Clopyralid/2, 4-D (E)[1] | 100 & 560 | 8.4 | 37B | 126 |
| 5. Clopyralid/MCPA (E)[1] | 100 & 560 | 7.9 | 46B | 147 |
| 6. Clopyralid | 100 | 7.0 | 46B | 144 |
| 7. Clopyralid | 300 | 8.1 | 42B | 155 |
| | | | | NS |

1 Commercially formulated mixtures.
2 Visual weed control 0-9 rating scale, 0 = no control, 9 = complete kill; scored 11/08/86.
3 Means followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test; thistle dry weight determined on 14/07/86.

All treatments containing clopyralid demonstrated good to excellent top growth control of Canada Thistle when visual scores are examined. Canada Thistle dry matter was reduced by all treatments equally. Grain yield was unaffected by the level of Canada Thistle control obtained.

The herbicide treatments in this series of experiments can be categorized into two groups. The highest levels of control were obtained with clopyralid and clopyralid/phenoxy mixtures as outlined in Table 3, and by chlorsulfuron (22 g/ha) and metsulfuron-methyl (6 g/ha). Less effective treatments were 2, 4-D amine and ester (up to 840 g/ha), MCPA amine and ester (up to 840 g/ha), dicamba (100 g/ha) and dicamba plus 2, 4-D or MCPA (amines) mixtures (100 + 420 g/ha). Results from previous trials would place bromoxynil/MCPA (280 + 280 g/ha) in the less effective catgory.

Generally, all treatments tested in 1986 provided acceptable top growth control until late July, when considerable regrowth from the less effective treatments occurred.

## Conclusions

1. Winter wheat yields are severely depressed in Canada Thistle patches. It is suspected that moisture and nutrient availability plays a major role in the degree of competition.
2. Spring, in-crop herbicide treatments for Canada Thistle control in winter wheat can be effective but yield benefits have not been obtained regardless of the level of top growth control. Possible reasons for this are that the competitive effect has occurred prior to herbicide treatment, or that the root mass competes with the winter wheat even when the above ground shoots have been destroyed.
3. Winter wheat shows excellent tolerance, including winter survival, to a variety of herbicide treatments that are suitable for Canada Thistle control. Excessive rates of some herbicides can injure winter wheat but yield losses have not been severe.
4. Stage of crop growth does not unduly restrict herbicide application. Timing herbicide application to more susceptible stages of Canada Thistle growth is possible. Some herbicides recommended for application in advanced stages of Canada Thistle growth can be applied well into the flag leaf stage of winter wheat with relative safety.

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