Effect of pre-harvest glyphosate application on Canada thistle control and alfalfa seed production in commercial alfalfa seed fields

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An effective means of controlling Canada thistle is a pre-harvest glyphosate application in annual crops. However, this treatment is not currently registered in crops grown for seed as information is lacking, with regards to its effect on seed quality. Glyphosate is registered for application in forage alfalfa 3-7 days before the final cut. Used in this manner, glyphosate will seriously injure or kill the alfalfa thus facilitating removal. On the other hand, there is evidence to suggest that glyphosate application, during the reproductive stage, is much less injurious (22-33% stand reduction) and does not affect seed quality.

Field studies were conducted on commercial alfalfa seed fields in northeast Saskatchewan (Tisdale #1, Tisdale #2, Pilger, St. Brieux, Arborfield) from 1995 to 1997. The objectives were to determine Canada thistle control and alfalfa seed production response to pre-harvest glyphosate. Pre-harvest glyphosate (0 to 1760 g ai/ha) was applied to alfalfa at Tisdale #1, Tisdale #2, Pilger and St. Brieux when 60-70% of the seed pods were brown and at Arborfield when 90% of the seed pods were brown. Quality (%germination, %hard seed, %abnormal seedlings, %dead seed) of the alfalfa seed harvested following an application of pre-harvest glyphosate was determined by an accredited lab. Harvested seed was tested for seedling emergence and vigour by growing the alfalfa in climate controlled growth cabinets. Visual ratings of alfalfa regrowth and Canada thistle control; Canada thistle density and alfalfa seed yield were taken in the year following an application of pre-harvest glyphosate.

Results

In one of five site-years, in 1996, abnormal seedlings increased as the rate of pre-harvest glyphosate increased at Tisdale #1 (Table 1). In four of five site-years, the rate of pre-harvest glyphosate did not affect alfalfa seed quality. Alfalfa seedling emergence and alfalfa seedling vigour was not affected by the different rates of pre-harvest glyphosate (data not shown).

Table 1. Effect of pre-harvest glyphosate on alfalfa seed quality at Tisdale #1 in 1996.

Treatments	Germination (%)	Hard Seed (%)	Abnormal Seedlings (%)	Dead Seed (%)
Control	39	43	10	9
Glyphosate 220 g ai/ha	36	44	12	9
Glyphosate 440 g ai/ha	40	42	10	9
Glyphosate 660 g ai/ha	39	39	12	10
Glyphosate 880 g ai/ha	39	40	13	9
Glyphosate 1760 g ai/ha	38	35	17	11

Alfalfa regrowth and alfalfa seed yield in the year following the application of pre-harvest glyphosate decreased as the rate of pre-harvest glyphosate increased (Table 2).

Table 2. Effect of pre-harvest glyphosate on alfalfa regrowth (% of control) and alfalfa seed yield (kg/ha) in the year following the application averaged over 4 sites.

Treatments	Alfalfa Regrowth (% of control)	Alfalfa Seed Yield (kg/ha)
Control	100	266
Glyphosate 220 g ai/ha	87	254
Glyphosate 440 g ai/ha	59	183
Glyphosate 660 g ai/ha	40	173
Glyphosate 880 g ai/ha	23	138
Glyphosate 1760 g ai/ha	25	108

Pre-harvest glyphosate at 220 g ai/ha controlled Canada thistle by 51-95% at 3 sites (Table 3). Using rates higher then 220 g ai/ha did not increase visual ratings of Canada thistle control. Canada thistle density decreased in 2 of 4 site-years with increased rates of pre-harvest glyphosate (data not shown).

Table 3. Effect of pre-harvest glyphosate on Canada thistle control (% of control) in the year following the application at Arborfield in 1996, Pilger in 1996 and Tisdale #1 in 1997.

	Canada Thistle Control (% of control)		
Treatments	Arborfield	Pilger	Tisdale #1
Control	0	0	0
Glyphosate 220 g ai/ha	70	51	95
Glyphosate 440 g ai/ha	66	39	91
Glyphosate 660 g ai/ha	75	30	99
Glyphosate 880 g ai/ha	65	44	99
Glyphosate 1760 g ai/ha	---	50	98

Conclusion

Pre-harvest glyphosate increased abnormal seedlings in 1 of 5 site-years but did not affect alfalfa seedling emergence or alfalfa seedling vigour. The reduction in alfalfa regrowth and alfalfa seed yield may be acceptable at the 220 g ai/ha rate. Using rates of pre-harvest glyphosate higher than 220 g ai/ha did not increase visual ratings of Canada thistle control. More field trials are needed to determine if pre-harvest glyphosate reduces alfalfa seed quality at different rates and times of application.

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Effect of pre-harvest glyphosate application on alfalfa seed quality, alfalfa seedling emergence and alfalfa seedling vigour

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Glyphosate is registered for application in forage alfalfa 3-7 days before the final cut. Used in this manner, glyphosate will seriously injure or kill the alfalfa thus facilitating removal. Pre-harvest glyphosate could be used in the final year of alfalfa seed production to help remove the stand from production and control perennial weeds. However, pre-harvest glyphosate has reduced seed quality in some annual and perennial crops.

Field studies were conducted in northeastern Saskatchewan (Melfort) from 1995 to 1997 to determine the effects of pre-harvest glyphosate on alfalfa seed quality, alfalfa seedling emergence and alfalfa seedling vigour. Two trials examined various application rates (0 to 1760 g ai/ha) of pre-harvest glyphosate applied at 60 to 70% brown seed pod. Two trials examined pre-harvest glyphosate (880 and 1760 g ai/ha) application at different stages of seed maturity (1, 26, 51 and 76% brown seed pod). Diquat (400 g ai/ha) was used as a comparison treatment in all trials. Alfalfa seed was harvested in the year of pre-harvest glyphosate application. The seed was then tested for quality (%germination, %hard seed, %abnormal seedlings and %dead seed), seedling emergence (field and growth cabinet) and seedling vigour (field and growth cabinet).

Results

The rates of pre-harvest glyphosate applied had no consistent effect on alfalfa seed quality (Table 1). In 1995, there was a decrease in germination, a decrease in abnormal seedlings and an increase in hard seed as the rate of pre-harvest glyphosate increased. In 1996, after 6 months of storage, alfalfa seed quality did not differ from the control (data not shown). However, after 18 months of storage, there was an increase in abnormal seedlings and a decrease in hard seed with increased rates of pre-harvest glyphosate. Also, abnormal seedlings increased after 18 months of storage with the use of diquat (data not shown). Alfalfa seedling emergence (growth cabinet) and alfalfa seedling vigour (growth cabinet) were not reduced by different rates of pre-harvest glyphosate (data not shown).

Table 1. Effect of pre-harvest glyphosate on alfalfa seed quality at Melfort in 1995 and 1996.

	Germination (%)		Hard Seed (%)		Abnormal Seedlings (%)		Dead Seed (%)	
Treatments	1995	1996	1995	1996	1995	1996	1995	1996
Control	65	38	10	49	21	8	4	5
Glyphosate 440 g ai/ha	60	51	19	31	18	13	4	6
Glyphosate 880 g ai/ha	62	38	19	45	13	11	5	6
Glyphosate 1320 g ai/ha	59	41	23	31	15	24	3	5
Glyphosate 1760 g ai/ha	56	47	27	40	12	17	5	7

When pre-harvest glyphosate had an affect on alfalfa seed quality, it occurred at an earlier stage of seed maturity (Table 2). In 1995, alfalfa seed quality was similar to the control if pre-harvest glyphosate was applied at 51% or greater brown seed pod. In 1996, alfalfa seed quality was similar to the control if applied at 76% brown seed pod. Pre-harvest glyphosate did not reduce alfalfa seedling emergence (field) and alfalfa seedling vigour (field) when applied at different stages of seed maturity (data not shown).

Table 2. Effect of pre-harvest glyphosate (880 and 1760 g ai/ha combined) on alfalfa seed quality at Melfort in 1995 and 1996.

	Germination (%)		Hard Seed (%)		Abnormal Seedlings (%)		Dead Seed (%)	
Seed Maturity (% brown seed pod)	1995	1996	1995	1996	1995	1996	1995	1996
1	61	34	21	20	12	42	6	4
26	52	50	21	20	20	26	8	3
51	58	54	9	18	23	23	8	5
76	57	48	12	40	21	9	8	3
Control	59	54	9	35	21	8	11	4

Conclusion

76% brown seed pod was the best time to apply pre-harvest glyphosate to maintain alfalfa seed quality. The response of alfalfa seed quality to both rate and timing of pre-harvest glyphosate application was not consistent. Whenever there was a response, earlier applications of pre-harvest glyphosate reduced alfalfa seed quality. However, pre-harvest glyphosate did not reduce alfalfa seedling emergence or alfalfa seedling vigour. The change in alfalfa seed quality after an extended period in storage is a concern. More testing is needed to determine if pre-harvest glyphosate reduces alfalfa seed quality after extended periods of storage.

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