

## Narrow-leaved Hawk's-beard (*Crepis tectorum*) — Its Suitability as a Target Weed for Biological Control

Diether P. Peschken<sup>1</sup> and A. Lloyd Darwent<sup>2</sup>

<sup>1</sup>Research Station, Agriculture Canada, Box 440, Regina, Saskatchewan, Canada S4P 3A2.

<sup>2</sup>Research Station, Agriculture Canada, Box 29, Beaverlodge, Alberta, Canada T0H 0C0.

### Abstract

The density of and losses in yield in terms of quantity and quality due to narrow-leaved hawk's-beard (*Crepis tectorum*) (NLHB) were investigated in fields of perennial forage crops located in the Parkbelt Region of Saskatchewan and the Peace River Region of British Columbia. NLHB was most frequent in mixed perennial forage crops. In alfalfa (*Medicago sativa*) fields, NLHB constituted only 5% of the biomass in 1982 and 1.2% in 1983. In first year alfalfa plots including replicates with and without NLHB, there were no significant differences in yield. Although excellent control was achieved in creeping red fescue (*Festuca rubra*) by the use of herbicides no significant increases in the yield of seed could be shown. Therefore, NLHB seems to be an excellent colonizer but a weak competitor. In 1983, less than 2% of the pollen collected from the middle of June to 13 July originated from NLHB. These results, based on data collected in only two years, suggest that NLHB does not warrant the relatively large expenditure of a biological control of weeds project.

### La Mauvaise Herbe *Crepis tectorum* (Narrow-leaved Hawk's-beard) — Sa Convenance Comme Cible de la Lutte Biologique

On a recherché la densité du *Crepis tectorum* (narrow-leaved hawk's-beard, NLHB) et les pertes, en termes de rendement et de qualité, dûs à cette mauvaise herbe dans des champs de fourrages vivaces, situés dans la région 'Parkbelt' de Saskatchewan et de la région 'Peace River' de la Colombie britannique. La fréquence du NLHB était le plus élevée dans des fourrages mixtes. Dans des champs d'alfalfa (*Medicago sativa*), le NLHB n'a formé que 5% de la biomasse en 1982, et 1.2% en 1983. Dans des plantations d'alfalfa de première année, y compris des replicats avec ou sans NLHB, il n'y avait pas de variations significatives de rendement. Quoique la lutte contre le NLHB dans des plantations de *Festuca rubra* (creeping red fescue), au moyen d'herbicides, ait donné d'excellents résultats, on n'a pas pu montrer des augmentations significatives de rendement des graines. Ainsi, le NLHB paraît être colon excellent mais compétiteur faible. En 1983, moins de 2% du pollen récolté entre le mi-juin et le 13ième juillet provenait du NLHB. Ces résultats, basées sur des données récoltées en deux années seulement, indiquent que le NLHB ne justifie pas la dépense assez grande d'une lutte biologique.

### Introduction

A biological control of weeds project requires 10-20 years to complete and costs at least \$2 million (Harris 1979). To warrant such expenditure it is important to first establish that a weed is causing sufficient crop losses.

Narrow-leaved hawk's-beard (NLHB) (*Crepis tectorum* L.) (Compositae) often becomes very prevalent and showy in the first year after sowing and in poor stands of perennial forage crops (Van den Born 1972). The purpose of this paper is to determine crop losses from this weed, in particular in alfalfa (*Medicago sativa* L.) (Leguminosae) and mixed perennial forage crops and to determine the general suitability of this weed for biological control with insects.

### *Origin and Distribution in Canada*

NLHB is a herbaceous annual or winter annual of the family Compositae with a deeply penetrating root system. It was introduced from Eurasia prior to 1890 (Babcock 1947; Darwent and McKenzie 1978). According to Najda *et al.* (1982) it occurs in every Province of Canada except Newfoundland. In Manitoba it may be found in isolated locations in all regions and it is particularly frequent from the U.S. border north to Dauphin (Thomas 1978*a, b*, 1979; Thomas and Wise 1981). In Saskatchewan, it is frequent in the Parkbelt region north of latitude 51° (Thomas 1976, 1977, 1978*a, b*, 1979). In Alberta, moderate to heavy infestations occur north of Olds (latitude 51°47') (Dew 1981) including the Peace River region of British Columbia (Thomas and Wise 1983).

### *Biology*

NLHB grows as a winter or summer annual depending on the date when seedlings emerge (Darwent and McKenzie 1978). In general winter annuals bloom earlier than the summer annuals. The blooming period extends from May to October with a peak in July. NLHB requires a long daylength to flower.

### **Materials and Methods**

#### *Occurrence in Alfalfa-brome Hayland*

In 1982 and 1983, surveys were conducted in all agricultural districts of Saskatchewan where NLHB was reported to occur frequently (Thomas 1976, 1977, 1978*a, b*, 1979). At least one hayfield containing smooth brome (*Bromus inermis* Leyss.; Gramineae) and at least 5% alfalfa was surveyed in each agricultural district. Fields were selected by surveying the first field encountered when driving into a new agricultural district. Twenty 0.25 m<sup>2</sup> samples were taken using the method described by Thomas (1976). In 1982, only the number of seedlings of NLHB were recorded, and in 1983 the number of seedlings, the area covered by NLHB, other weeds (including grasses) and alfalfa in each 0.25 m<sup>2</sup>. A total of 12 fields was surveyed in 1982 and 18 in 1983.

#### *Biomass Sampling in Alfalfa*

For this study alfalfa fields, used in the dehydration industry, were surveyed just prior to the first harvest of the season. The goal was to survey at least four fields under contract by each of the dehydration plants in Choiceland, Arborfield and Tisdale, Saskatchewan. A total of 13 fields was sampled in July 1982, 14 in June 1983, and 12 in July 1983. Fields were selected by asking the operators of the dehydration plants for the location of fields ready to be harvested in the next few days. In each field 20 samples, 0.25 m<sup>2</sup> in size, were taken. The quadrats were selected according to the method described by Thomas (1976), with the exception of one field with a uniform infestation of NLHB. Only 10 samples were taken in this field. The vegetation was clipped, separated into alfalfa, NLHB, and other weeds, dried at 100°C for 24 h, and weighed. At the time of surveying, samples of NLHB were collected in the Choiceland, Arborfield and Tisdale areas, packed in ice for transport to the laboratory, where they were frozen at -15°C. The samples were freeze dried, pulverized with a Thomas Mill, passed through a 0.5 mm sieve, and then analysed for their content of carotene, crude protein and crude fibre. (Association of Official Analytical Chemists 1970.)\*

\*Analysis carried out by the Alfalfa Dehydrators Research Laboratory, Tisdale, Saskatchewan. Director Dr. Dale Pulkinen.

### *Hand-weeded Plots of Alfalfa and NLHB*

Plots were established 20 km south-west of Melfort, Saskatchewan to follow population changes in NLHB and to determine its effect on the yield of alfalfa. Alfalfa (variety Beaver) was seeded in the fall of 1982 in rows spaced 35 cm, on grey-wooded soil. There were 70 cm between each plot consisting of 5 rows. Using a Latin square design, the rows were arranged into plots  $175 \times 300$  cm with the following treatments: (1) check (no weeds removed); (2) all weeds except NLHB removed; (3) only NLHB removed; and (4) all weeds removed. All weeding was done by hand. In the fall of 1982, several NLHB plants bearing mature seeds were placed on the control and 'NLHB-only' plots to ensure the presence of plenty of seeds. Only the central  $1 \text{ m}^2$ , consisting of 3 rows 1 m long, were evaluated. The plots were clipped once in July and August. The clipped vegetation was separated into NLHB, other weeds, and alfalfa, dried for 24 h at  $100^\circ\text{C}$  and weighed.

### *Effect of Chemical Control of NLHB on the Yield of Creeping Red Fescue*

Plots of  $3.7 \times 15$  m in size, were established on a two-year old stand of creeping red fescue (*Festuca rubra* L. var. Boreal; Gramineae) near Dawson Creek, British Columbia. The stand, located on a clay loam soil, was heavily infested with NLHB. Fall treatments were applied on 16 October 1972, when the fescue regrowth was 7–10 cm in height and when the NLHB was mainly in the rosette stage. Spring treatments were applied on 12 May 1973 when the fescue was in the vegetative stage (7–10 cm in height). On this date, the flowering stems of the NLHB were just starting to elongate. All treatments were applied in 165 l/ha of liquid. Fall treatments were replicated five times; spring treatments were replicated three times. Precipitation was considerably above normal during the fall of 1972 but below normal during the 1973 growing season. Crop injury evaluations, weed counts and harvest were obtained on 19 June 1983.

### *NLHB as a Source of Pollen*

Pollen was collected by means of pollen traps from 24 May to 13 July 1983 on sites near Arborfield, Saskatchewan. At each collection date, subsamples of 5 g were taken. The orange pollen pellets were separated from those of other colours and weighed. NLHB was observed to yield yellow pellets while dandelions were observed to yield orange pellets (Mr. D. Valteau, beekeeper, Aylsham, Saskatchewan, pers. comm.). From the orange pellets and from pellets of the other colours, slides were prepared using the method given by Adams and Morton (1972). On these slides, the proportion of pollen grains resembling NLHB and dandelion was determined out of 1000 grains. Pollen grains of these two species were counted together as Wodehouse (1965) has shown that they cannot be distinguished with certainty. Using these percentages and assuming that pollen grains of the various species have approximately the same density, the percent of NLHB–dandelion type of pollen was determined by weight for the orange and the assorted pellets.

## **Results and Discussion**

### *Occurrence in Alfalfa-brome Hayland*

In 1982 there was a mean of 14.5 seedlings/ $0.25 \text{ m}^2$ , and in 1983, 6.2. In 1983, NLHB covered 2% and other weeds (including grasses) 48% of the area within the

quadrats. The small area covered by NLHB combined with the fact that it is readily eaten by cattle, means that NLHB causes little loss in perennial mixed forage crops.

### Biomass Sampling in Alfalfa

NLHB constituted an average of only 5.7% and alfalfa 89.7% of the total biomass in the 13 alfalfa fields sampled in 1982 (Table 1). In June and July 1983, the alfalfa content remained near the same level while the NLHB content declined. Thus, NLHB constituted only a small portion of the total biomass produced in the fields. The carotene content of NLHB was about 1.5 times higher, the crude protein content 1.5 times lower, and the crude fibre content of NLHB was about the same as that reported by Waddington *et al.* (1976) for alfalfa (Table 2). In Table 3, the protein content of alfalfa hay is calculated when mixed with various proportions of NLHB. A protein content of 19% is assumed for alfalfa (Waddington *et al.* 1976) and 12% for NLHB. The minimum required crude protein level of dehydrated alfalfa pellets is 17%. Therefore, the NLHB content would have to exceed 25% to lower the protein content to less than 17%.

Table 1. Dry weight of narrow-leaved hawk's-beard, *Crepis tectorum* L. (NLHB), other weeds, and alfalfa in alfalfa fields used in the dehydration industry in the Parkbelt region of Saskatchewan.

Date of Sampling	Mean Dry Weight (g/m <sup>2</sup> )			
	NLHB	Other Weeds	Alfalfa	Total Biomass
vii.82	8.8	7.6	143.2	159.6
vi.83	1.6	16.4	131.2	149.2
vii.83	2.8	28.4	170.8	202.0

Table 2. Crude protein, crude fibre and carotene content of NLHB (narrow-leaved hawk's-beard, *Crepis tectorum* L.) collected at the time of harvest of alfalfa in July 1982 and July 1983 in the Choiceland, Arborfield and Tisdale districts of Saskatchewan. For comparison, the crude protein, crude fibre and carotene content of alfalfa is given, as reported by Waddington *et al.* (1976).

Species	Date Collected	Crude Protein Mean % <sup>1</sup>	Crude Fibre Mean % <sup>1</sup>	Carotene Mean mg/kg <sup>1</sup>
NLHB	vii.82 <sup>2</sup>	13.5 (±1.8)	27.6 (±0.44)	288.2 (±29.9)
	vii.83 <sup>3</sup>	11.7 (±0.5)	26.6 (±1.27)	197.6 (±3.8)
Alfalfa	Fall 1973	20.4	28.4	174
	Fall 1974	17.3	31.4	152

<sup>1</sup>Standard error of the mean in brackets.

<sup>2</sup>*n* = 3.

<sup>3</sup>*n* = 6.

### Hand-weeded Plots of Alfalfa and NLHB

The number of NLHB plants was very low in all plots. Removal of NLHB and other weeds did not significantly increase the yield of alfalfa in July and August (Table 4). Quite dense NLHB occurred in an uncultivated strip, about 4 m wide, bordering the plots. Thus it is obvious that the alfalfa suppressed the NLHB.

*Effect of Chemical Control of NLHB on the Yield of Creeping Red Fescue*

Chemical treatment, especially if applied in fall, was very effective in reducing the number of NLHB plants (Table 5). Crop tolerance was excellent except when higher rates of a mixture of dicamba (3,6-dichloro-O-anisic acid), 2,4-D ([2,4-dichlorophenoxy] acetic acid) and mecoprop (2[(4-chloro-o-tolyl)oxy] propionic acid), and 2,4,5-T ([2,4,5-trichlorophenoxy] acetic acid) and MCPA ([4-chloro-o-tolyl)oxy] acetic acid) were applied. Despite the effectiveness of the chemical treatments crop yields were not increased. This confirms results obtained by Waddington *et al.* (1976) who reported no consistent increase in the yield of alfalfa and significant reductions in carotene and xanthophylls and increases in crude fibre content after some of the chemical treatments. Therefore, NLHB seems to be a poor competitor.

Table 3. Crude protein content of alfalfa hay at various levels of infestation with NLHB (narrow-leaved hawk's beard, *Crepis tectorum* L.). The crude protein content of pure alfalfa is assumed to be 19% (Waddington *et al.* 1976) and that of NLHB 12%.

Percent NHLB in Alfalfa Hay	Percent Crude Protein in Alfalfa Hay
5	18.7
10	18.3
15	18.0
20	17.6
25	17.3

Table 4. Number of NLHB (narrow-leaved hawk's-beard, *Crepis tectorum* L.), dry weight of NLHB, other weeds and alfalfa in grams on plots near Melfort, Saskatchewan, in July and August 1983.<sup>1</sup>

Mean No. and Dry Weight	All Weeds ( $\bar{x}$ ) <sup>2</sup>	All Weeds Except NLHB $\bar{x}$	NLHB Only ( $\bar{x}$ )	No Weeds $\bar{x}$
July				
No. of NLHB	6.3 ( $\pm 2.7$ ) <i>ab</i>	2.3 ( $\pm 1.3$ ) <i>ab</i>	10.0 ( $\pm 2.6$ ) <i>a</i>	0.8 ( $\pm 0.5$ ) <i>b</i>
Dry wt: NLHB	0.8 ( $\pm 0.3$ ) <i>b</i>	0.3 ( $\pm 0.2$ ) <i>b</i>	5.1 ( $\pm 1.8$ ) <i>a</i>	0.1 ( $\pm 0$ ) <i>b</i>
Dry wt: other weeds	18.6 ( $\pm 5.2$ ) <i>a</i>	23.6 ( $\pm 9.5$ ) <i>a</i>	2.5 ( $\pm 1.1$ ) <i>a</i>	1.1 ( $\pm 0.6$ ) <i>a</i>
Dry wt: alfalfa	299.0 ( $\pm 42$ ) <i>a</i>	289.0 ( $\pm 25$ ) <i>a</i>	382.1 ( $\pm 47$ ) <i>a</i>	396.2 ( $\pm 50$ ) <i>a</i>
August				
No. of NLHB	0.8 ( $\pm 0.5$ ) <i>a</i>	1.3 ( $\pm 1.3$ ) <i>a</i>	0.5 ( $\pm 0.3$ ) <i>a</i>	0.8 ( $\pm 0.8$ ) <i>a</i>
Dry wt: NLHB	0 ( $\pm 0$ ) <i>a</i>	0 ( $\pm 0$ ) <i>a</i>	0 ( $\pm 0$ ) <i>a</i>	0.1 ( $\pm 0.1$ ) <i>a</i>
Dry wt: other weeds	1.1 ( $\pm 0.3$ ) <i>a</i>	1.4 ( $\pm 0.7$ ) <i>a</i>	0.4 ( $\pm 0.2$ ) <i>a</i>	0.1 ( $\pm 0$ ) <i>a</i>
Dry wt: alfalfa	81.4 ( $\pm 10.9$ ) <i>a</i>	102.2 ( $\pm 8.0$ ) <i>a</i>	103.9 ( $\pm 14.3$ ) <i>a</i>	103.5 ( $\pm 10$ ) <i>a</i>

<sup>1</sup>ANOVA — means followed by the same letter in each row are not significantly different at  $P = 0.05$ .

<sup>2</sup>Standard error of the mean is given in brackets.

*NLHB as a Source of Pollen*

In 1983 the proportion of NLHB-dandelion type of pollen rose to a peak of 57% during the period of 1-8 June in the orange pollen pellets. In the assorted pellets, which included the yellow ones, this type of pollen increased to a maximum of 3.4% during the period of 15-17 June. This pattern is similar to that observed by Murrell and Szabo (1981) in the Peace River region. At the end of the blooming period of

dandelion in about the middle of June, the content of pollen resembling NLHB and dandelion declined sharply (Table 6). If NLHB would have filled the gap from the end of the dandelion blooming season to the main honey flow, then the percent of NLHB-dandelion type of grains should have increased in the assorted pollen, which contained the yellow pollen. But this was not the case. Therefore it seems that in 1983 NLHB did not provide a significant amount of pollen.

Table 5. Effect of chemical control of NLHB (narrow-leaved hawk's beard, *Crepis tectorum* L.) on yield of creeping red fescue, var. Boreal, near Dawson Creek, British Columbia.

Treatment	Rate kg/ha	Crop Tolerance (0-9)	NLHB <sup>1</sup>		Fescue
			Plants/m <sup>2</sup>	Dry Weight (g/m <sup>2</sup> )	Seed Yield <sup>1</sup> (g/m <sup>2</sup> )
<b>Fall-applied Treatments</b>					
Check, weedy	—	9	168 <i>a</i>	48.7 <i>a</i>	76 <i>a</i>
2,4-DB ester	1.1	9	25 <i>d</i>	4.6 <i>c</i>	82 <i>a</i>
2,4-DB ester	1.4	9	20 <i>d</i>	3.4 <i>c</i>	81 <i>a</i>
2,4-DB ester	1.7	9	10 <i>d</i>	1.6 <i>c</i>	73 <i>a</i>
2,4-DB ester	0.6	9	34 <i>cd</i>	4.2 <i>c</i>	94 <i>a</i>
2,4-DB ester	1.1	9	15 <i>d</i>	2.6 <i>c</i>	81 <i>a</i>
2,4,5-T + MCPA	0.2 + 0.2	9	88 <i>bc</i>	20.6 <i>b</i>	75 <i>a</i>
2,4,5-T + MCPA	0.4 + 0.5	9	53 <i>bcd</i>	10.2 <i>b</i>	70 <i>a</i>
MCPB	1.1	9	52 <i>bcd</i>	15.7 <i>b</i>	83 <i>a</i>
MCPB	1.7	9	53 <i>bcd</i>	21.7 <i>b</i>	82 <i>a</i>
Dicamba + 2,4-D + mecoprop	0.06 + 0.18 + 0.04	9	91 <i>b</i>	13.6 <i>b</i>	80 <i>a</i>
Dicamba + 2,4-D + mecoprop	0.13 + 0.35 + 0.08	8.5	44 <i>bcd</i>	6.8 <i>b</i>	72 <i>a</i>
<b>Spring-applied Treatments</b>					
Check, weedy	—	9	69 <i>a</i>	31.5 <i>a</i>	71 <i>a</i>
2,4-DB ester	1.4	9	10 <i>b</i>	2.3 <i>b</i>	53 <i>b</i>
2,4-DB ester	1.1	8	19 <i>b</i>	3.1 <i>b</i>	39 <i>a</i>
Dicamba + 2,4-D + mecoprop	0.13 + 0.35 + 0.08	8	20 <i>b</i>	4.4 <i>b</i>	71 <i>a</i>
2,4,5-T + MCPA	0.36 + 0.48	8	40 <i>ab</i>	9.5 <i>b</i>	71 <i>a</i>

<sup>1</sup>Within each season of treatment, means followed by the same letter are not significantly different at  $P = 0.5$ .

### Suitability as a Target for Biological Control

From the data we have collected so far, it appears NLHB does not cause significant crop losses in mixed perennial forage crops in Saskatchewan. The populations found in alfalfa used in the dehydration industry did not reduce yield nor the quality below the required minimum. However, according to observations by farmers and personnel involved in the alfalfa dehydration industry, NLHB populations fluctuate greatly from year to year. In 1982 and particularly in 1983, alfalfa was very vigorous and therefore was able to suppress NLHB. Any agronomic practices that would increase the vigour of alfalfa would therefore reduce NLHB.

NLHB spreads by seed. Copious amounts of seed are produced if the plant is not cut before maturity. Therefore, seed-feeding insects should be given preference in any biological control program. There should be large reservoirs of seed setting NLHB for seed-feeding insects that might be introduced from abroad so that they could build up high populations. In 1982 and 1983 by far most infestations were less than 10 m<sup>2</sup> in size and alfalfa was harvested before most of the NLHB started to bloom. There were no large reservoirs for insects to develop in the seed heads. Therefore, on the basis of the limited data collected in 1982 and 1983, it is concluded that a seed-feeding insect could not control the large fluctuations of this weed. A full-scale biological control

project, whereby several insects such as a leaf-feeder, seed-feeder, and a gall insect would be introduced, seems too costly in relation to the losses caused by NLHB. However, observations in 1984 indicated that NLHB became much more prevalent again and additional data were collected which could not be included in this paper. Reliable assessment of the damage caused by a strongly fluctuating weed such as NLHB must be based on data collected in 3 to 5 years.

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Table 6. Content of pollen grains of the NLHB (narrow-leaved hawk's-beard, *Crepis tectorum* L.) and dandelion-type in pollen collected from 24 May to 13 July 1983 in the area of Arborfield, Saskatchewan.

Date Collected	Weight of Total Sample (g)	Percent of the NLHB-Dandelion Type Pollen in		
		Orange Pollen Pellets	All Other Pellets	Total Sample
24-28 May	186.6	0.1	0.4	0.5
30 May	207.6	2.8	0.1	2.9
31 May	182.2	7.3	0.8	8.1
1-8 June	119.8	56.7	0.6	57.4
8 June	224.7	24.4	3.3	27.6
15-17 June	202.7	25.5	3.4	8.9
27 June	164.0	15.3	1.3	16.6
3 July	278.8	1.2	0.2	1.4
10 July	167.0	0.0	0.1	0.1
13 July	119.5	0.0	0.2	0.5

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