The Wheat Stem Sawfly (Hymenoptera: Cephidae) and its Natural Enemies: Distribution and Impact

Thomas G. Shanower
USDA-ARS-Northern Plains Agricultural Research Laboratory
Sidney, MT 59270

Introduction

The wheat stem sawfly, *Cephus cinctus* (Fig. 1), has been a pest of wheat in the northern Great Plains since the late 1800s. Yield losses in Montana alone exceed $25 million annually. Females lay eggs in wheat and hollow stemmed grasses where the developing larva feeds. In the fall larvae move to the base of the stem, cut the stem and plug it. Larvae overwinter in these stubs , completing development in the spring.

A number of solid stemmed wheat cultivars have been developed for control of wheat stem sawfly (Berzonsky et al. 2003). The solid stems reduce larval survival but have lower yield and protein content than currently available hollow-stemmed cultivars. Solid stems are thought to provide a physical barrier or to increase dessication of the larvae (Holmes and Peterson 1962).

Several natural enemies attack sawfly larvae, the two most common are *Bracon cephi* (Fig. 2) and *Bracon lissogaster* (Hymenoptera: Braconidae) (Morrill et al. 1998). These parasitoids are biologically similar (larval konobionts with 1-2 generations per year) and have only recently been reliably differentiated (Runyon et al. 2001). Parasitism rates of up to 98% have been reported, but their impact varies widely across locations and years.

An ongoing classical biological control project is searching for natural enemies to complement these endemic parasitoids. Increased parasitism levels could lower wheat stem sawfly populations and reduce associated yield losses. Before proceeding with introductions however, knowledge of the distribution, impact and dynamics of endemic braconid parasitoids is needed.

The purpose of this study was to document the distribution and impact of the wheat stem sawfly and its endemic natural enemies.

Materials and Methods

Wheat stem sawfly infestations and parasitism levels were surveyed across eastern Montana (10 counties), western North Dakota (14 counties), northwestern South Dakota (1 county), eastern Wyoming (1 county) and western Nebraska (3 counties) in 1999-01 (see Figs 3 & 4). The survey was conducted during July and August, and samples were collected from each location in one of the three years. Wheat fields were selected randomly and the number of samples sites within a county varied from 1 to 29. At each sample site a minimum of 131 (range 131 - 309) stems were collected. Stems were sampled by walking into a field at right angles to the field margin nearest the road. Plants were randomly selected, and uprooted, at approximately 3 m intervals.

Stems were held in a cooler and returned to the laboratory, where the stems were split. The number and location of wheat stem sawfly larvae was recorded and the number of parasitized larvae was also assessed.

Six fields with high wheat stem sawfly infestations in northeastern Montana were selected and monitored since 2000 (Fig. 5). Fields were monitored weekly from emergence to harvest in the first three years (2000-02) and once per season in the fourth year. Farmers selected cultivars and followed their typical production practices. Two cultivars predominate in this region: 'McNeal', a hollow stemmed cultivar, high yielding cultivar released in 1995; and 'Ernest', a solid stemmed cultivar considered resistant to the wheat stem sawfly, also released in 1995. Stems were sampled as described above with a minimum sample size of 46 stems. Samples typically ranged from 85 to 120 stems. Stems were processed as described above.

Survey Results

Wheat stem sawfly was widespread across the northern Great Plains (Fig 3); wheat stem sawfly was recovered from 54% of randomly selected fields.

Infestation levels ranged from 0 to 82%, and infested fields averaging 7.8%.

Bracon spp. parasitoids were less widely distributed than their hosts, being present in 25% of infested fields (Fig. 4). Infested fields had a mean parasitism level of 35.2%.

Monitoring Results

Six fields were selected (Fig. 5) in high density wheat stem sawfly areas based on the survey results.

Sawfly infestations exceeded 20% in all but one field (Table 1). Sawfly infestations varied among fields and across years.

Bracon spp. parasitoids were present in all fields (Table 2).

With the exception of 2003, when parasitoids were not recorded in three fields, parasitism levels varied from 7 to 88%

Table 1. Wheat Stem Sawfly Infestations in Northeastern Montana

		Infestation (%)			
Field#/Location	Stem[a]	2000	2001	2002	2003
1. Glasgow	Hollow	47.6	26.4	29.8	28.3
2. Opheim	Solid	63.2	83.3	85.4	44.9
3. Richland	Solid	61.8	44.4	24.8	21.7[b]
4. Scobey	Solid	32.8			
4. Scobey	Hollow		28.6	5.9	0.0
5. Flaxville	Hollow	67.2	75.9		
5. Flaxville	Solid	87.1		84.8	51.9
6. Flaxville	Solid	21.3	30.4	26.5	20.5*

[a] Sample sizes from n = 50 to n = 151 stems.
[b] Changed to hollow-stemmed cultivar.

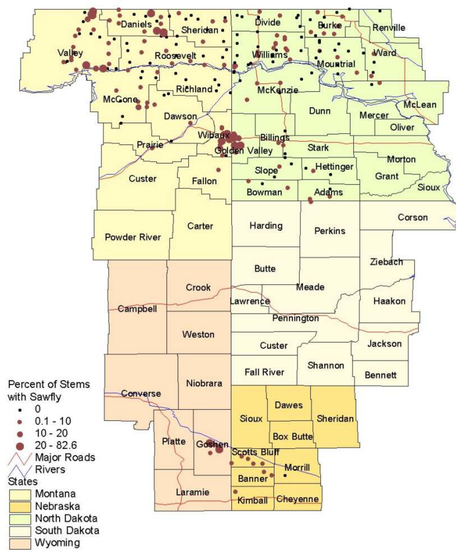
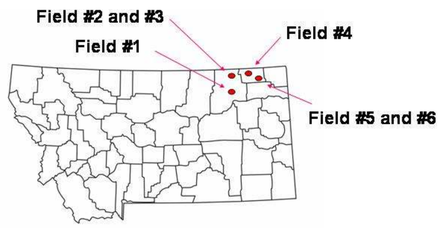


Table 2. Wheat Stem Sawfly Parasitism in Northeastern Montana

		Parasitism (%)			
Field#/Location	Stem[a]	2000	2001	2002	2003
1. Glasgow	Hollow	11.5	16.7	72.7	0
2. Opheim	Solid	14.4	48.7	52.1	38.1[b]
3. Richland	Solid	30.4	58.5	42.9	0
4. Scobey	Solid	17.6			
4. Scobey	Hollow		70.0	50.0	0
5. Flaxville	Hollow	15.6	29.9		
5. Flaxville	Solid	48.4		75.7	7.1
6. Flaxville	Solid	29.4	66.7	84.2	88.2[b]

[a] Sample sizes from n = 50 to n = 151 stems.
[b] Changed to hollow-stemmed cultivar.

Locations of six long-term wheat stem sawfly monitoring sites



Conclusions:

Wheat stem sawfly is widely distributed across the northern Great Plains. Infestation levels, below 5% in most counties, exceed 50% at some locations.

Parasitism levels are also low and generally absent where sawfly populations are low.

In the monitored fields, infestation levels exceeded 20%, and frequently exceeded 40%, producing a significant adverse impact on wheat production.

Wheat stem sawfly infestation levels vary across years and relatively small spatial scales, but the cause of these fluctuations is not readily apparent.

Parasitism levels generally increased across years but did not result in lower sawfly infestation rates.

Continuous planting of solid stemmed cultivars over four years did not reduce wheat stem sawfly infestation levels.

Despite high levels of parasitism, sawfly infestation remained high in some fields.

The solid stemmed wheat cultivar used by these growers did not provide protection against the wheat stem sawfly. High wheat stem sawfly infestations were supported in this cultivar, and significant stem cutting was observed.

Solid stemmed cultivars do not appear to adversely impact on parasitism; parasitism levels on solid stemmed cultivars often exceeded 50%.

Currently available solid stemmed cultivars and endemic natural enemies do not provide effective or sustainable regulation of the wheat stem sawfly.

Literature Cited

Berzonsky, W.A., H. Ding, S.D. Haley, M.O. Harris, R.J. Lamb, R.I.H. McKenzie, H.W. Ohm, F.L. Patterson, F.B. Peairs, D.R. Porter, R.H. Ratcliffe and T.G. Shanower. 2003. Breeding wheat for resistance to insects. Plant Breeding Reviews 22: 221-296.

Holmes, N.D. and L.K. Peterson. 1962. Resistance of spring wheat to the wheat stem sawfly, *Cephus cinctus* Nort. (Hymenoptera: Cephidae) II. Resistance to the larva. Canadian Entomologist 94: 348-365.

Morrill, W.L., G.D. Kushnak and J.W. Gabor. 1998. Parasitism of the wheat stem sawfly (Hymenoptera: Cephidae) in Montana. Biological Control 12: 159-163.

Runyon, J.B., R.L. Hurley, W.L. Morrill and D.K. Weaver. 2001. Distinguishing adults of *Bracon cephi* and *Bracon lissogaster* (Hymenoptera: Braconidae), parasitoids of the wheat stem sawfly (Hymenoptera: Cephidae). Canadian Entomologist 133: 215-217.