Wheat Stem Sawfly Economic Impact Study

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Executive Summary: The wheat sawfly is causing approximately $31-33 million in damage annually to wheat producers in Colorado. Federal funding is needed to enhance research at land grant universities and USDA-ARS research stations to prevent future losses and mitigate the spread of losses to larger geographical areas. Estimated economic losses in 2022 are $41 million due to increases in price per bushel and wheat stem sawfly damage.

INTRODUCTION - The wheat stem sawfly (WSS, *Cephus cinctus* Norton) was first discovered in Colorado in1872 in non-cultivated grasses (Norton, 1872). While WSS has been considered a pest in Canada and Montana for more than 100 years (Ainslie, 1920), only until recently has Colorado wheat been impacted by WSS (Cockrell et al., 2021). In 2010 it was discovered in wheat fields in Weld County, Colorado, and has since spread to most wheat-producing counties on Colorado's eastern plains. Since 2011, the Wheat Entomology lab at Colorado State University has conducted a WSS state-wide survey, funded by the Colorado Wheat Administrative Committee, to assess the presence and abundance of WSS. By 2018 the pest was causing major economic damage to wheat producers in several Northeastern counties, precipitating management strategies by farmers to avoid or mitigate losses incurred from the pest.

This study briefly examines the economic impact caused by WSS in Colorado, and focuses on the lowered yields due to WSS feeding on stems and losses sustained at harvest. Other factors, such as WSS impacts on crop rotation, soil fertility, and moisture retention, will need to be considered in future studies.

WSS LIFE HISTORY - The WSS life cycle makes it particularly difficult to control using conventional methods. The adult wheat stem sawfly lay their eggs within the stem of their host, and as the larvae develop, they consume parenchyma tissue (Ainslie, 1920). Towards the end of the season, the last instar larva creates a hibernaculum (stub) by cutting at the base of the stem, causing the seed head to fall to the ground. Cut stems are difficult to harvest and are easily blown over (Ainslie, 1920). Current management methods include biological control and solid stem genotypes (Delaney et al., 2010; Beres et al., 2011; Rand et al., 2012; Peairs et al., 2014). A comprehensive review of wheat stem sawfly biology and management practices is reported by Beres et al. (2011b)

WSS SURVEY METHODS - A formal survey of production wheat fields in Eastern Colorado was performed from 2012 to 2020. Sites were selected based on the number of acres each county had in wheat production in 2010, proportional to 100 total samples; however, counties were occasionally over or under-sampled, leading to a different total number of samples each year. Sites included wheat fields in production, directly adjacent to wheat-fallow fields with no barriers or grass strips between. Sites were a minimum of 10 miles apart to keep even mapping distribution within the counties, and to fully represent the region spatially.

GPS coordinates were recorded at each site using a Garmin model GPSmap64st (Garmin Ltd. Olathe, KS). A hand-drawn map, including crossroads and relevant landmarks, was also made to aid in finding sites in later years as well as to confirm any discrepancies in recorded GPS coordinates. Each subsequent year, the same sites were visited; however, sampled fields would change due to crop rotations. The previous crops, presence of nearby alternate grass hosts, tillage type, an estimated percentage stubble

residue cover, and irrigation type (if any), were recorded for future analysis. Field sites were visited after the conclusion of the adult wheat stem sawfly flight, as determined by weekly monitoring a heavily infested site near New Raymer, CO. Larval sawfly infestation levels were determined at each site by collecting wheat stems from the field edge and transporting stems to the lab to be bisected. Larval infestation was noted as presence/absence from 100 random stems from each collected sample, where presence included live larvae, dead larvae, or the presence of wheat stem sawfly frass.

A more in depth overview of survey results and methods can be found at (Cockrell et al., 2021).

The resulting data from the WSS survey were used to calculate the economic impact for 2020 – 2021. Counties for which all sampled fields had WSS present were lowered from 100% to 90% under the assumption that not every field in a given county is infested.

WSS DAMAGE –
Damage occurs from:
• larval consumption of plant during development
• stem lodging due to cutting
• difficult and costly to pick up fallen heads
• remaining stubble is easily blown away, leading to less moisture retention in soil

However, not every infested tiller will result in a 100% yield loss. We estimated that there is about a 25% yield loss attributable to vascular damage and a 50% yield loss due to an infested stem becoming unharvestable.

ACREAGE - The WSS survey has documented economic levels of damage in eleven counties: Adams, Arapahoe, Kit Carson, Lincoln, Logan, Morgan, Phillips, Sedgwick, Washington, Weld, and Yuma . Estimated wheat acreage in these counties for crop years 2020 and 2021 was calculated by using a combination of National Agricultural Statistics Service (NASS) data (source: NASS Quick Stats database) and Farm Service Agency (FSA) data. Since NASS sequesters county-level data below a certain number of survey responses to protect anonymity, FSA data must be used to fill in missing county data.

CALCULATIONS –

$$Infested\ acreage = county\ acres\ \times percent\ acres\ with\ infestation$$

$$Normal\ production = county\ acres\ \times average\ county\ yield$$

$$Bushels\ lost = normal\ production\ \times infestation\ rate\ \times percent\ yield\ loss\ of\ infested\ tillers$$

$$Economic\ loss = bushels\ lost\ \times price\ per\ bushel$$

Table 1. Estimated economic loss due to WSS damage in 2020.

Affected county	County acres	Percent acres Infested	Infested acreage	NASS average county yield (bu/ac)	Annual production	Infestation rate	Percent yield loss of infested tillers	Bushels lost	Price ($/bu)	Economic loss
Adams	108,884	82%	89,087	36.5	3,969,733	26.20%	75.00%	780,053	$4.62	$3,603,843
Arapahoe	45,253	67%	30,169	28	1,264,821	11.50%	75.00%	109,091	$4.62	$504,000
Kit Carson	245,271	36%	89,189	44.2	10,834,826	4.50%	75.00%	365,675	$4.62	$1,689,420
Lincoln	100,139	67%	66,760	32.1	3,217,814	13.30%	75.00%	320,977	$4.62	$1,482,914
Logan	92,161	70%	64,513	40.5	3,729,179	30.70%	75.00%	858,643	$4.62	$3,966,932
Morgan	55,719	90%	50,147	41.5	2,313,585	46.30%	75.00%	803,392	$4.62	$3,711,673
Phillips	91,566	80%	73,253	42.9	3,931,627	4.00%	75.00%	117,949	$4.62	$544,924
Sedgwick	57,116	90%	51,405	41.3	2,360,617	29.60%	75.00%	524,057	$4.62	$2,421,143
Washington	204,112	90%	183,701	36.9	7,533,591	26.60%	75.00%	1,502,951	$4.62	$6,943,635
Weld	93,977	90%	84,579	36.3	3,407,606	29.20%	75.00%	746,266	$4.62	$3,447,747
Yuma	102,783	90%	92,505	47.3	4,859,087	26.00%	75.00%	947,522	$4.62	$4,377,552
Total	**1,196,983**		**875,308**		**47,422,487**			**7,076,576**		**$32,693,783**

Table 2. Estimated economic loss due to WSS damage in 2021.

Affected county	County acres	Percent acres Infested	Infested acreage	NASS average county yield (bu/ac)	Annual production	Infestation rate	Percent yield loss of infested tillers	Bushels lost	Price ($/bu)	Economic loss
Adams	120,655	67%	80,437	36.45833	4,398,894	18.20%	75.00%	600,449	$6.70	$4,023,008
Arapahoe	50,145	0%	0	27.95	1,401,558	0.00%	75.00%	0	$6.70	$0
Kit Carson	271,786	36%	98,831	44.175	12,006,159	1.70%	75.00%	153,079	$6.70	$1,025,626
Lincoln	110,965	90%	99,869	32.13333	3,565,686	6.20%	75.00%	165,804	$6.70	$1,110,890
Logan	102,125	90%	91,912	40.46364	4,132,333	15.00%	75.00%	464,887	$6.70	$3,114,746
Morgan	61,743	90%	55,569	41.52222	2,563,703	23.70%	75.00%	455,698	$6.70	$3,053,177
Phillips	101,465	50%	50,733	42.9375	4,356,668	4.50%	75.00%	147,038	$6.70	$985,152
Sedgwick	63,291	90%	56,962	41.33	2,615,819	11.30%	75.00%	221,691	$6.70	$1,485,327
Washington	226,178	90%	203,560	36.90909	8,348,033	24.70%	75.00%	1,546,473	$6.70	$10,361,370
Weld	104,137	90%	93,723	36.26	3,775,995	19.80%	75.00%	560,735	$6.70	$3,756,927
Yuma	113,895	90%	102,506	47.275	5,384,394	8.60%	75.00%	347,293	$6.70	$2,326,866
Total	**1,326,386**		**934,102**		**52,549,242**			**4,663,148**		**$31,243,089**

Table 3. Estimated Economic Loss due to WSS

Year	Bushels lost	Average price received	Economic Loss
2020	7,076,576	$4.62	$32,693,783
2021	4,663,148	$6.70	$31,243,089

LOOKING AHEAD TO 2022 CROP - Colorado wheat producers seeded 2.1 million acres of wheat for the 2022 harvest, down 100,000 acres or 4.5% from 2021. If the 2022 crop sees similar bushels lost as in 2021, on 4.5% less acreage, that would equal a loss of 4,453,000 bushels. However, prices have risen substantially since 2021, as of this writing, due to drought in the hard red winter producing areas of the United States, the ongoing war between Russia and the Ukraine, and other factors. Current wheat prices are hovering at around $10.40/bushel on the Kansas City Board of Trade, and around $9.40/bushel at local elevators. This leads us to expect closer to $41 million of economic losses in 2022.

SUMMARY - Economic losses suffered by Colorado wheat farmers are estimated at approximately $31-33 million during the 2020-21 crop years. These estimates only attempt to take in lowered yields due to WSS feeding on stems, and losses sustained at harvest. Anecdotal evidence points to many additional economic losses which the WSS causes not accounted for in this study:

1. Slower harvest speeds cost growers additional fuel and labor at harvest time.
2. Harvesting closer to the ground due to lodged wheat can cause machines to ingest soil or rocks, leading to increased wear on machinery and/or cost due to repairs.
3. Loss of standing wheat residue is very detrimental in a dryland wheat cropping system, and leads to:
    a. less snow capture during winter storms, a substantial component of yield for any crop that follows wheat in a rotation.
    b. Less shading of soil, which increases evapotranspiration and decreases soil surface and subsurface moisture
    c. Increased wind erosion and loss of topsoil

Further economic analyses that take into account and quantify more of the total factors which affect Economic losses suffered by Colorado wheat farmers are warranted.

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