Northern NY Agricultural Development Program
2021-2022 Project Final Report

The Effect of Western Bean Cutworm Damage on the Nutritional Quality and Aerobic Stability of Corn Silage

Project Leader

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Background

Since its first discovery in New York in 2009, the western bean cutworm (WBC) has become a significant field crops pest that has spread throughout Northern New York and surrounding agricultural communities. In corn, WBC moths lay eggs on developing corn plants in July. When the eggs hatch, the larvae feed on the corn pollen, silks, and, eventually, the ear tip kernels. This leaves ear damage and even some stalk damage when the corn is harvested. Yield losses from WBC are most easily observed when corn is harvested for grain, and yet, corn silage yield losses are considered to be negligible. However, few controlled studies have been done in the region that examined both yield and quality losses resultant from WBC damage in silage corn.

Silage aerobic stability is a major concern with corn silage due to corn's ability to produce large amounts of lactic acid during fermentation. Silages with poor aerobic stability are prone to microbial bunk-face heating which results in dry matter losses and reduced dry matter intakes when fed to livestock. Little is known about the impact of WBC damage on the aerobic stability of corn silage. WBC-damaged kernels may allow aerobic yeasts and molds to proliferate on the standing corn crop before it is ensiled. This may put WBC-damaged silage at increased risk of aerobic stability issues after fermentation.

The objective of this research was to compare the yield, silage quality, and aerobic stability of undamaged corn with that of corn that had been damaged by WBC.

Methods

Treatments:

On May 17, 2021, six plots (4 rows, 10x40 ft) of 99 RM dual-purpose corn were planted to a hybrid that expressed the SmartStax® trait package (Bt endotoxins: Cry1F, Cry1A.105, Cry2Ab2, Cry3Bb1, Cry34 & Cry35Ab1). At the same locations, six corn plots were planted to a hybrid that expressed the Trecepta® trait package (Bt endotoxins: Vip3A, Cry1A.105, Cry2Ab2). The latter corn was a genetic isoline to the former so the two forages differed only in their Bt trait packages. This was done intentionally to create a vulnerable set of corn plots in close proximity to a similar set of plots that were protected from WBC damage.

While SmartStax® corn originally provided some control of WBC, the population at Miner Institute had previously been shown to be resistant to the trait package. Thus, the Trecepta® trait package was expected to serve as an undamaged control, in respect to WBC, for comparison with the susceptible, SmartStax® corn. Since a difference in WBC control was observed in the study, the SmartStax® corn treatment will be referred to as damaged, while the Trecepta® corn will be referred to as the control.

Data Collection:
Prior to harvest, each corn plot was examined to determine the proportion of WBC-damaged plants. This was done by examining ten (10) plants for evidence of ear tip feeding in each corn plot. For the purposes of this experiment, all ear tip feeding accompanied by insect frass was considered to be WBC damage. All plots were harvested on September 27, 2021, with a two-row research harvester. Only two rows of each plot were harvested so that the additional two could serve as buffer rows. In addition to yield data collection, a 7.6 L forage sample was collected from each plot and these were ensiled in polyethylene bucket mini-silos for 120 days prior to analysis.

Analysis:
Upon opening, subsamples of silage from each bucket were sent to Cumberland Valley Analytical Services for forage quality analysis via near-infrared spectroscopy. Yeast and mold counts were also conducted by this laboratory. An aerobic stability analysis was conducted by returning 6 L of silage to the bucket mini-silos without a lid for 9 days at ~22°C. A Hobo® temperature data logger probe (Onset Computer Corporation, Bourne, MA) was placed at the geometric center of the loose forage mass and was set to record temperature every 10 min. Each bucket mini-silo was covered with a double layer of sterile cheesecloth to avoid contamination and drying out of the forage, yet allowing air to infiltrate the forage mass (*Kleinschmit et al., 2005*). All bucket mini-silos were stored in a temperature-controlled room during the analysis. Aerobic stability was defined as the length of time silage was exposed to air before a 2°C increase in temperature above ambient temperature occurred. All results from this study were tested for statistical significance ($P \leq 0.05$) using a dependent samples t-test. A trend was declared at $P \leq 0.10$.

Results and Discussion

Insect Pressure:
The objective of this experiment was to compare the yield, silage quality, and aerobic stability of undamaged corn with that of corn that had been damaged by WBC. The first step in meeting this objective was to create a scenario in which some plots would be damaged, while others would not. As mentioned above, this was done by using corn isolines that differed only in their Bt insect protection package. Fortunately, WBC pressure was high during the growing season, and 53.3% of the susceptible plants had signs of WBC infestation in the tip of the ear. In contrast, the control corn that expressed the Vip3A endotoxin had negligible WBC damage. The effects of the differing trait packages on the WBC damage, yield, silage quality, and aerobic stability of silage corn is listed in Table 1.

Yield and Quality:
While yield loss in silage has generally been considered to be negligible for WBC, this study showed a trend for lower yields in damaged corn of almost two tons of as-fed silage per acre. Regarding silage quality, a slight, but significant increase in crude protein was associated with the damaged corn in this study. While it is unclear why this was the case, it is possible that this

effect resulted from greater dilution of plant protein in the control corn as a result of higher yields and greater starch content. While the difference in starch content was not statistically significant, when expressed as a percentage of plant non-fiber carbohydrates, a significant difference in starch was observed. It seems likely that the difference in absolute starch content was not significant because of the high variability in the starch measurement. Expressing starch as a percentage of non-fiber carbohydrates was able to control for some of this variability.

Aerobic Stability:

The WBC-damaged corn in this comparison was not found to have significantly greater aerobic stability than the control corn. However, the duration of heating once it occurred was significantly greater for the damaged corn. It is not clear why this was the case, but there was a trend for higher yeast counts in the damaged corn in comparison to the control.

Table 1. The effect of western bean cutworm damage on the yield, nutritional quality, and aerobic stability of corn silage; NNYADP "The Effect of Western Bean Cutworm Damage on the Nutritional Quality and Aerobic Stability of Corn Silage, 2022.

	Damaged (No Vip3A)	Control (Vip3A)	SE	*P*-Value[1]
WBC damage, % infested ears	53.3	1.7	11.7	0.003
Dry matter (DM), % as-fed	40.7	40.4	1.0	0.377
Yield, tons/acre (35% DM)	27.3	29.2	1.2	0.085
Crude protein, % DM	8.18	7.77	0.17	0.031
Soluble protein, % DM	4.18	3.83	0.13	0.021
Acid detergent insoluble protein, % DM	0.78	0.75	0.03	0.210
Neutral detergent insoluble protein, % DM	0.93	0.89	0.03	0.099
Acid detergent fiber, % DM	22.1	21.4	1.1	0.273
Neutral detergent fiber, % organic matter	36.1	34.7	1.8	0.223
Lignin, % DM	2.84	2.86	0.08	0.412
Ethanol soluble carbohydrates, % DM	1.15	1.18	0.17	0.425
Starch, % DM	35.8	38.9	2.1	0.104
Starch, % non-fiber carbohydrates	72.8	76.2	0.02	0.039
Either extract, % DM	2.97	2.95	0.12	0.445
Non-fiber carbohydrates	48.9	51.0	1.9	0.169
Non-structural carbohydrates, % DM	37.0	40.1	2.0	0.091
Ash, % DM	4.21	4.07	0.18	0.236
Ca, % DM	0.22	0.21	0.01	0.206
P, % DM	0.24	0.23	0.01	0.095
Mg, % DM	0.19	0.18	0.01	0.128
K, % DM	1.09	1.00	0.06	0.106
pH	3.95	3.97	0.02	0.129
Mold, colony forming units/g	25,500	500	24,900	0.181
Yeast, colony forming units/g	1,246,917	328,750	557,217	0.080
Aerobic stability, hours (< 2°C over ambient)	80.5	83.7	18.8	0.435
Heating duration, hours (>2°C over ambient)	78.5	30.7	31.7	0.096

[1] *P*-values generated from t-tests were considered significant at $P < 0.05$.

Conclusions

- High populations of WBC do appear to have the ability to cause measurable losses to the yield and quality of silage corn. Integrated pest management should be used to manage WBC in silage corn as well as grain corn.

- Ear tip feeding in corn may result in higher populations of undesirable microorganisms (such as yeasts) in corn silage. While aerobic stability differences may not be noticeable, there may still be palatability differences that impact animal performance.

- The Vip3A endotoxin (Viptera) remains an effective means to control WBC in northern New York. It virtually eliminated ear damage in the control corn for this experiment and should be considered as a management strategy for silage and grain growers alike in locations where WBC pressure is consistently high.

Education and Outreach

Outcomes of this study are being shared with the 6-counties in this region by summarizing data and reporting results in the Miner Institute Farm Report as well as other publications that may reach the targeted audience. These results have, and will continue to be shared with growers and industry professionals through presentations as well. The following presentations have already taken place at the time of report submission:

- Wilder, A.M. (2022). Western Bean Cutworm Implications for Silage. Northern New York Crop Congress. February 11, 2022.

- Wilder, A.M. (2022). Scouting and Controlling Western Bean Cutworm. Brevant Grower Meeting. August 16, 2022.

Next Steps

Further research would be necessary to develop more precise recommendations for WBC integrated pest management programs in silage corn. Specifically, action thresholds for silage corn should be developed and further research and education should take place regarding cultural, biological, and chemical control measures for WBC in northern New York.

Acknowledgments

This work was funded by the Northern New York Agricultural Development Program.

For More Information

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Reference

Kleinschmit, D. L., R. J. Schmidt, and L. Kung, Jr. 2005. The effects of various antifungal additives on the fermentation and aerobic stability of corn silage. J. of Dairy Sci. 88:2130-2139.

Photos

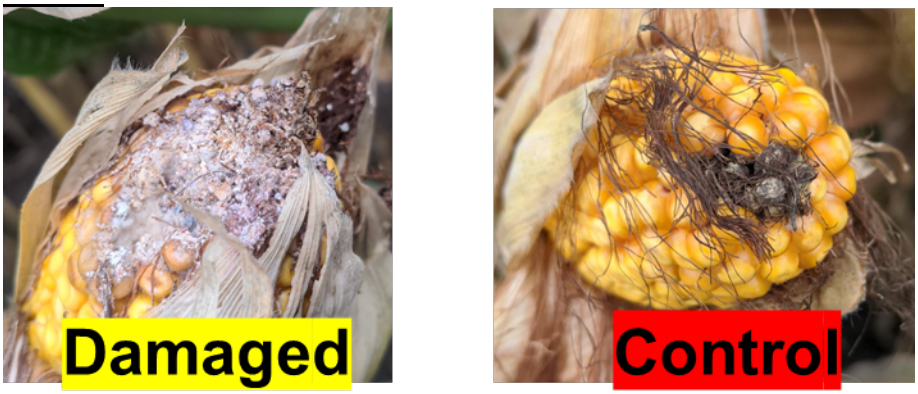

Photo 1. Visual differences between damaged (No Vip3A) and control (Vip3A) corn ears; NNYADP "The Effect of Western Bean Cutworm Damage on the Nutritional Quality and Aerobic Stability of Corn Silage, 2022. Photo credit: Allen Wilder.

Photo 2. Corn silage plot harvest; NNYADP "The Effect of Western Bean Cutworm Damage on the Nutritional Quality and Aerobic Stability of Corn Silage, 2022. Photo credit: Allen Wilder.

Photo 3. Aerobic stability test for one replication of mini-silos; NNYADP "The Effect of Western Bean Cutworm Damage on the Nutritional Quality and Aerobic Stability of Corn Silage, 2022. Photo credit: Allen Wilder.