2024 Corn Conservation Practices and Pest Prevalence

NORTHWEST CROPS & SOILS PROGRAM

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2024 CORN CONSERVATION PRACTICES AND PEST PREVALENCE

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Farmers are adopting conservation practices to improve soil health and crop productivity. Practices like no-till, cover crops, and manure applications can increase organic matter and overall soil health. These practices can in turn provide ecosystem service benefits like water quality protection through reduced erosion, climate change mitigation through carbon sequestration, and flood risk reduction through increased infiltration and water holding capacity. However, these practices may create soil conditions that attract insect pests like wireworm and seedcorn maggot (SCM), which could negatively impact corn yield. This study evaluated the impact of conservation practices on seed and crop damage from early season pests like wireworm and seedcorn maggot and corn silage yield and quality.

MATERIALS AND METHODS

In 2024, UVM Extension's Northwest Crops & Soils Program initiated a trial at Borderview Research Farm in Alburgh, VT. Treatments consisted of plots with or without cover crops, plots with or without tillage, and with manure injected or broadcast or no manure, for a total of ten treatments (Table 1).

Table 1. Corn cropping system specifics for corn yield and soil health, Alburgh, VT, 2024.

Management method	Treatment abbreviation
Tilled	T
No-till	NT
Broadcast manure	BM
Broadcast manure, incorporated with tillage	TM
Injected manure	IM
Cover crop, tilled	CCT
Cover crop, no-till	CCNT
Cover crop, broadcast manure	CCBM
Cover crop, broadcast manure, incorporated with tillage	CCTM
Cover crop, injected manure	CCIM

Crop Management

The experimental design was a randomized complete block with four replicated treatments of corn silage managed with different practices in 20' x 40' plots (Table 2). The soil type at the research site was a Benson rocky silt loam with 8-15% slopes. On 11-Oct 2023, 100 lbs ac^{-1} variety not stated (VNS) rye cover crop was planted. On 7-May, all cover crop plots (CCT, CCNT, CCBM, CCTM, and CCIM) were terminated with 2 qts ac^{-1} of Lumax® EZ and 1 qt ac^{-1} of Glystar®. Manure was also applied on 7-May at a rate of 6,200 gallons ac^{-1} to BM, TM, IM, CCBM, CCTM, and CCIM. That same day, tilled plots (T, TM, CCT, and CCTM) were plowed to a depth of 8 inches with a Kverneland Accord DL 5 bottom plough and finished with Pottinger TerraDisc™. On 10-May, corn variety RT41T19-D2 (91 RM), was seeded in 30" rows at 34,000 seeds ac^{-1} with a John Deere 1750 corn planter with 220 lbs ac^{-1} of starter (19-19-19). The corn seed was not treated with neonicotinoids but did have fungicide treatment. On 28-May, 1 quart ac^{-1} GlyStar®

Plus, followed by 3 quarts ac^{-1} of Lumax® EZ on 30-May was applied for weed control. On 17-Jun, 350 lbs ac^{-1} of 30-0-20 with ContaiN™ MAX, a nitrogen urease inhibitor, was applied.

Corn was harvested for silage on 18-Sep with a John Deere 2-row chopper and weighed in a wagon fitted with scales. Dry matter yields were calculated and adjusted to 35% dry matter. Silage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely-ground plot samples were brought to the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and Net Energy-Lactation (NE_L).

Table 2. Agronomic information for corn cropping system, Alburgh, VT, 2024.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam with 8-15% slopes
Previous crop	Wheat
Plot size (ft)	20 x 40
Replications	4
Management treatments	See Table 1 above.
Cover crop planted	100 lbs ac^{-1} VNS winter rye, 11-Oct 2023
Cover crop termination	7-May with 2 qts ac^{-1} of Lumax® EZ and 1 qt ac^{-1} of Glystar® (CCT, CCNT, CCBM, CCTM, and CCIM)
Tillage	7-May (T, TM, CCT, and CCTM)
Manure application	7-May, 6,200 gallons ac^{-1} (BM, TM, IM, CCBM, CCTM, and CCIM)
Corn variety	RT41T19-D2 (91 RM),
Seeding rates (seeds ac^{-1})	34,000
Planting equipment	John Deere 1750 corn planter
Planting date	10-May
Row width (in.)	30
Corn starter fertilizer (at planting)	10-May, 220 lbs ac^{-1} of starter (19-19-19)
Weed control	28-May, 1 quart ac^{-1} GlyStar® Plus
Weed control	30-May, 3 quarts ac^{-1} of Lumax® EZ
Corn nitrogen sidedress	17-Jun, 350 lbs ac^{-1} of 30-0-20 with ContaiN™ MAX
Corn harvest	18-Sep

Seed Corn Pest Damage Assessment

One wire mesh trap with 20 corn seeds was placed in each plot just following corn planting on 10-May. Mesh traps were made of 0.25" opening hardware clothe cut into an 8x20" rectangle, slightly folded into a V-shape, and with the crease placed at a depth of 3.0 inches. Corn seeds of the same variety planted were spaced approximately 1 inch apart within the mesh trap and covered with soil to be level with the field. On 24-May, mesh traps were removed and corn seed was assessed for wireworm and SCM damage by determining type of insect damage and counting the number of seeds with damage.

Forage Quality Analysis

Mixtures of true proteins, composed of amino acids and non-protein nitrogen, make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. In recent years, the need to determine rates of digestion in the rumen of the cow has led to the development of NDFD. This in vitro digestibility calculation is very important when looking at how fast feed is being digested and passed through the cow's rumen. Higher rates of digestion lead to higher dry matter intakes and higher milk production levels. Similar types of feeds can have varying NDFD values based on growing conditions and a variety of other factors. In this research, the NDFD calculations are based on 30-hour in vitro testing.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

Milk per acre and milk per ton of harvested feed are two measurements used to combine yield with quality and arrive at a benchmark number indicating how much revenue in milk can be produced from an acre or a ton of corn silage. This calculation relies heavily on the NE_L calculation and can be used to make generalizations about data, but other considerations should be analyzed when including milk per ton or milk per acre in the decision-making process.

Statistical Analysis

Corn seed pest damage, yield, and crop quality data were analyzed using mixed model analysis in *R* (Rstudio, 2024) using the *dplyr* (Wickham, et al., 2023), *lmerTest* (Kuznetsova, et al., 2017), *emmeans* (Lenth, 2024), and *agricolae* (de Mendiburu, 2023) packages. Corn seed pest damage was analyzed for significance using a general linear model (glm) and corn yield and quality was analyzed with analysis of variance (ANOVA). Replications within trials, manure applications, tillage method, and cover crop treatments were treated as fixed effects. Interaction terms between treatments were considered. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table for quality a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Treatments that did not perform significantly different from each other share the same letter. In this example, treatment C is significantly different from treatment A, but not from treatment B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these treatments did not differ in yield. The difference between C and A is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields with these treatments were significantly different from one another. The shared letter indicates that treatment B was not significantly lower than the top yielding treatment C, indicated in bold.

Treatment	Yield
A	6.0[b]
B	7.5[a]
C	**9.0[a]**
LSD	**2.0**

RESULTS

Weather Data

Weather data was collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2024 growing season (Table 3). Historical weather data are from 1991-2020 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

On average, the 2024 corn growing season was 1.1°F cooler than the 30-year average. Although there was a rainfall deficit early in the season (May), from June through August, there was 7.24 more inches than the 30-year average. The corn growing season had a total of 2,263 Growing Degree Days (GDDs) from May through August—102 GDDs more than the historical average (Table 3). Only August, when the corn is reaching physiological maturity, had lower than average GDDs.

Table 3. Consolidated weather data and GDDs for corn, Alburgh, VT, 2024.

Alburgh, VT	May	June	July	August
Average temperature (°F)	61.9	68.5	73.7	69.2
Departure from normal	3.47	0.95	1.33	-1.45
Precipitation (inches)	2.27	6.65	6.67	5.78
Departure from normal	-1.49	2.39	2.61	2.24
Corn GDDs (base 50°F)	388	548	732	595
Departure from normal	87	25	37	-47

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Corn Seed Pest Damage Assessment

There was not a significant difference among treatments in the percentage of corn seed damage by seedcorn maggot (SCM). However, the variability of SCM damage varied widely (Figure 1, Table 4) with the least variability in CCNT (10%) and most variability in the T and TM (50%) treatments.

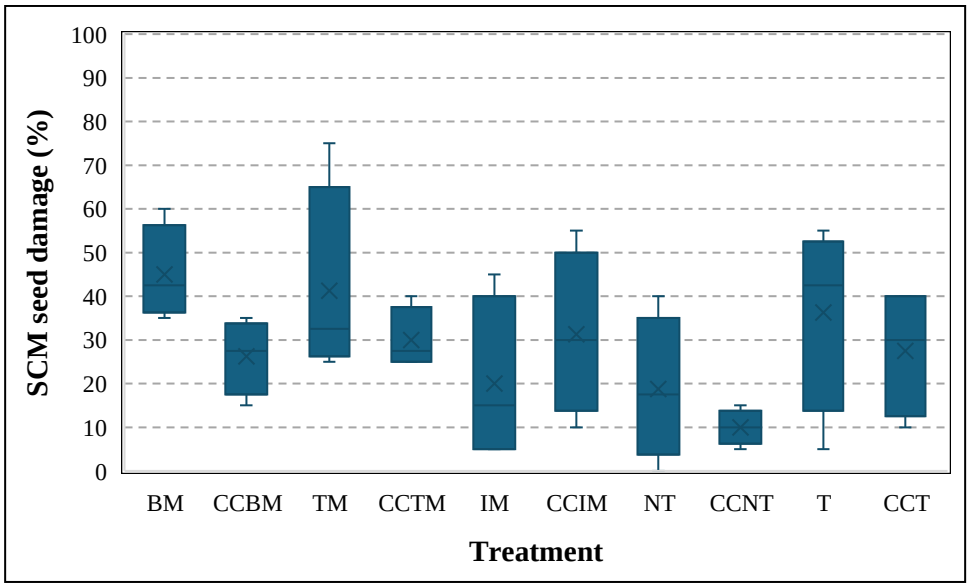

Figure 1. Probability of SCM damage, Alburgh, VT, 2024.

Table 4. SCM percent damage and variability by treatment, Alburgh, VT, 2024.

Management Method	Average %	Minimum %	Maximum %	Spread %
CCNT	10.0	5.00	15.0	10.0
CCTM	30.0	25.0	40.0	15.0
CCBM	26.3	15.0	35.0	20.0
BM	45.0	35.0	60.0	25.0
CCT	27.5	10.0	40.0	30.0
IM	20.0	5.00	45.0	40.0
NT	18.8	0.00	40.0	40.0
CCIM	31.3	10.0	55.0	45.0
TM	41.3	25.0	75.0	50.0
T	36.3	5.00	55.0	50.0
Average	28.7	13.5	46.0	32.5

Tillage (p=0.0005) and manure applications (p=0.0051) had an impact on the probability of SCM damage and there was an interaction between tillage and manure applications (p=0.0164). Cover crops did not impact the probability of SCM damage (p=0.1805). The probability of SCM damage on seed was 16.7% under no-till, no manure practices (Figure 2). The probability more than doubled or increased by about 20% when manure was added (35.0%) or when tilled (37.7%). The probability of SCM damage was highest (40.5%) when manure was tilled.

Damage by wireworm was negligible. There were 46 incidences of wireworm damage or about 6% of total seed evaluated, compared to 229 incidences of SCM damage or about 29% of total seed evaluated. There was no impact of tillage (p=0.6000), manure applications (p=0.3470), or cover crop (p=0.6860) on probability of wireworm damage.

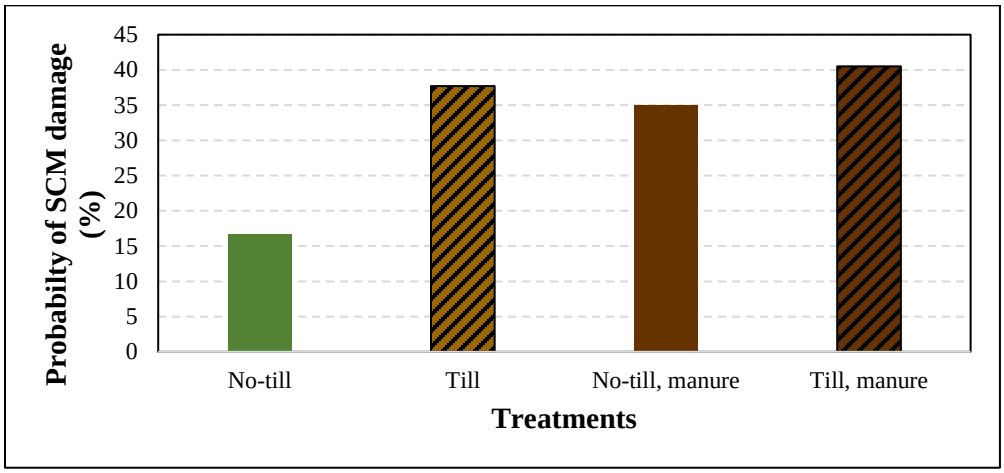

Figure 2. Probability of SCM damage, Alburgh, VT, 2024.

Corn Yield and Quality Results

On 18-Sep, corn plots were harvested to determine moisture and yield. There were no statistical differences in yield (p=0.9748) among treatments or when comparing with and without tillage, cover crops, or manure (Table 5). However, yield variability within treatments was high with the least variability in TM and the greatest in CCT. There were no statistical differences in crop quality among treatments or when comparing with and without cover crops (Table 6). However, there were few quality differences when comparing with and without tillage and manure. Average TDN was higher when the treatment included tillage (63.0% TDN) than without (62.2% TDN) and average NDFD30 was higher with manure (49.4% NDFD30) than without (47.5% NDFD30).

Table 5. Yield by conservation practice, Alburgh, VT, 2024.

Management method	Average ton ac^{-1}	Minimum ton ac^{-1}	Maximum ton ac^{-1}	Spread ton ac^{-1}
TM	20.7	19.1	23.7	4.52
IM	23.0	20.3	25.5	5.13
CCBM	22.3	18.9	24.5	5.62
CCIM	22.1	18.5	25.5	6.95
CCTM	23.2	19.8	27.3	7.50
NT	24.0	18.9	27.9	8.98
BM	24.0	18.2	28.0	9.87
T	23.4	16.2	28.6	12.4
CCNT	22.9	18.8	32.1	13.3
CCT	21.0	16.1	29.7	13.6
LSD (0.10)‡	NS§	NA†	NA	NA
Trial mean	22.7	18.5	27.3	8.79

‡ LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.
† NA – Not applicable.

Table 6. Crop quality by conservation practice, Alburgh, VT, 2024.

Cropping system	CP % of DM	ADF % of DM	NDF % of DM	NDFD 30 % of NDF	TDN % of DM	NE_L Mcal lb^{-1}	Milk lbs ton^{-1}	Milk lbs ac^{-1}
TM	8.30	22.5	37.5	48.8	63.0	1.47	3,327	24,120
IM	8.18	23.1	38.7	49.0	62.0	1.42	3,204	25,877
CCBM	8.55	24.0	39.0	49.4	63.3	1.45	3,303	25,705
CCIM	8.10	22.3	38.4	50.1	63.0	1.46	3,296	25,483
CCTM	8.32	23.4	38.8	49.9	62.5	1.45	3,258	26,422
NT	8.30	22.5	39.4	48.8	63.0	1.45	3,282	27,644
BM	8.08	24.0	39.9	49.3	63.0	1.44	3,263	27,361
T	8.05	24.0	40.1	49.1	62.0	1.42	3,214	26,405
CCNT	8.00	22.4	36.7	46.9	64.0	1.49	3,314	26,527
CCT	7.98	25.4	40.5	45.3	61.4	1.40	3,119	23,212
LSD (0.10)‡	NS§	NS	NS	NS	NS	NS	NS	NS
Trial mean	8.19	23.3	38.9	48.7	62.7	1.44	3,258	25,876

† Within a column, treatments with the same letter did not perform significantly different from each other.
‡ LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.

DISCUSSION

The goal of this project was to assess the impact of conservation practices of no-till, cover cropping, and additions of manure on the incidence of SCM and wireworm damage to seed, corn yield, and corn quality. Data from the first year of this trial indicates that conservation practices did not impact incidence of wireworm damage on corn seeds. However, some conservation practices did impact the probability of SCM damage on corn seed. Both tillage and manure increased the probability of SCM damage, but unincorporated cover crops and no-till without manure did not. Despite the increased damage to corn seed under certain management practices, there were no differences in yield and yield quality was not impacted by combined practices. This indicates that neonicotinoid-free seeds performed equally well under different conservation management practices. However, there was a lot of variability of SCM damage and yield within treatments. The data presented here only represents one year and data analysis over multiple years provides an opportunity to make observations about long-term trends. In 2025, we will collect more data to inform long-term trend analysis.

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