UVM Extension Northwest Crops and Soils Program

2019 Field Day

Twelve Years of Research- But Wait, There's More!

NORTHWEST CROPS & SOILS PROGRAM

THE UNIVERSITY OF VERMONT EXTENSION

Our mission is to provide the best and most relevant cropping information, both research-based and experiential, delivered in the most practical and understandable ways to farmers in the Northeast.

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UVM Extension
Northwest Crops and Soils Program
2019 Field Day Booklet

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This booklet contains a portion of our research data. Find more information, as well as copies of all our complete reports, at our website, www.uvm.edu/nwcrops, which is updated frequently.

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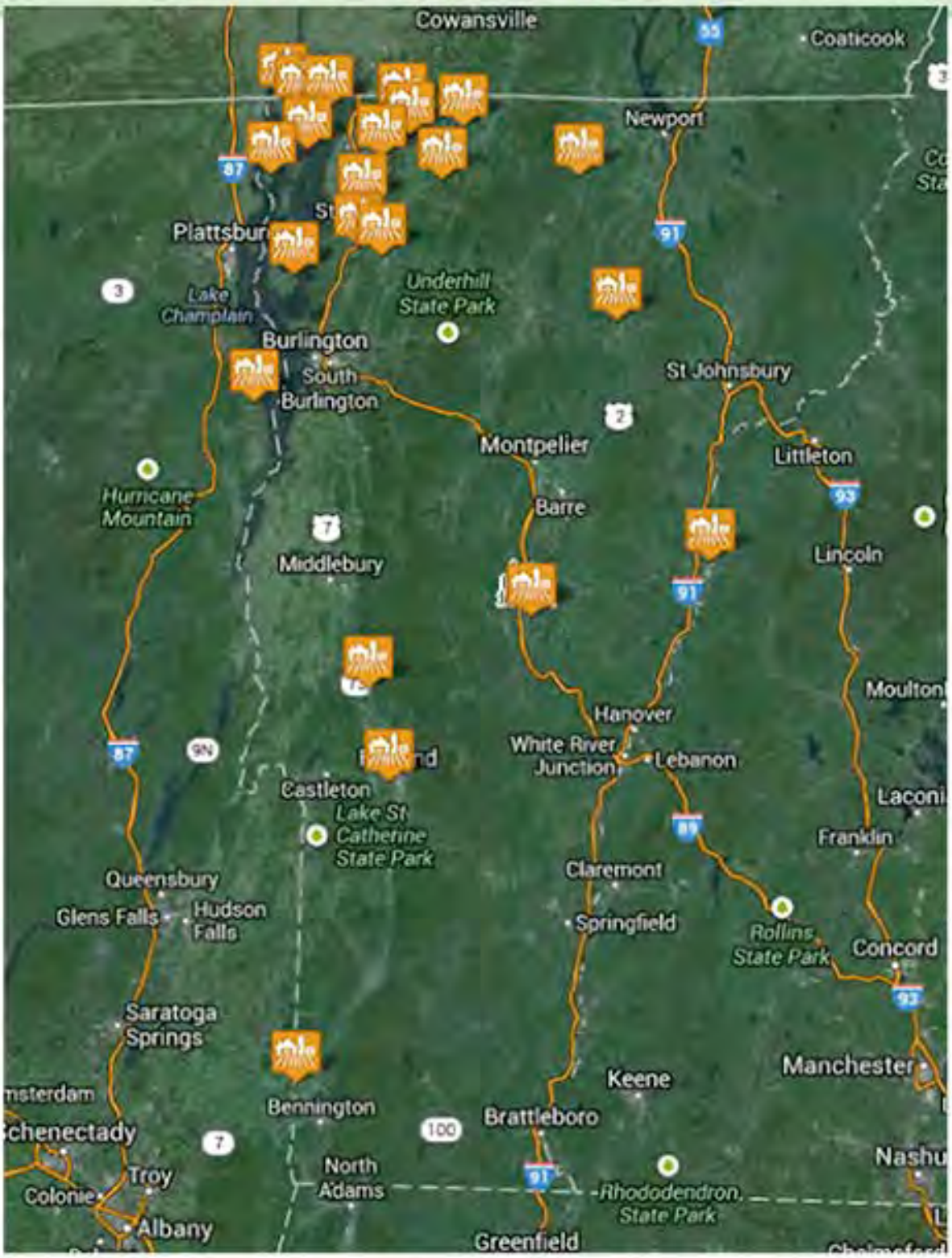
This material is based upon work supported by USDA/ NIFA under Award Number 2015-49200-24225.

RESEARCH SITES AND COLLABORATION LOCATIONS

IN ADDITION TO THE 3,000 RESEARCH PLOTS AT BORDERVIEW FARM, WE COLLABORATE WITH FARMERS ON PROJECTS THROUGHOUT VERMONT, NEW ENGLAND AND NEW YORK



2019 RESEARCH TRIALS

• • •

This season at Borderview Research Farm we have established over 3,000 plots on 28 acres of prime agricultural soils. This research is meant to provide Vermont producers with the most up-to-date and reliable agricultural information to help them reach their goals.

Contents

Stop # *Page #*

We hope you enjoy the UVM Extension Annual Crops & Soils Field Day!

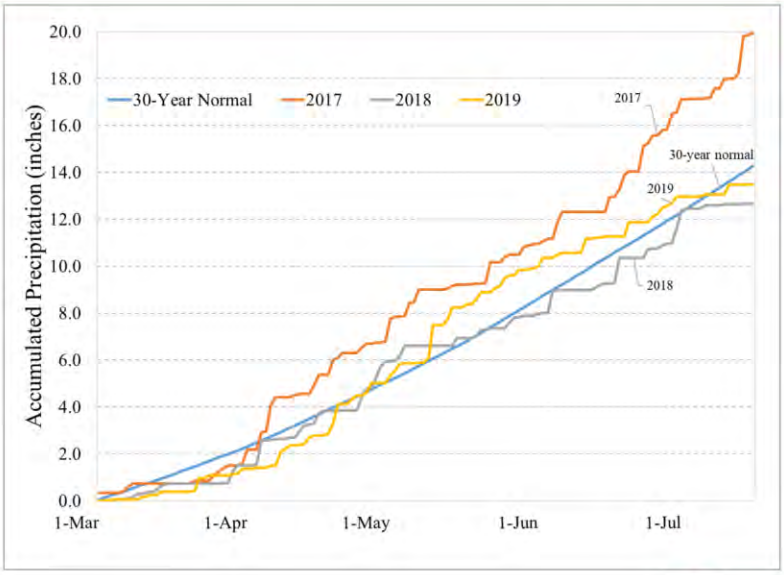
Contents, *continued*

RESEARCH TOUR

We hope you enjoy the UVM Extension Annual Crops & Soils Field Day!

2019 Weather Data

Precipitation March-June, Alburgh VT, 2017-2019



Month	Departure from Normal
March	-0.86
April	-0.03
May	1.42
June	0.79
July	-0.78

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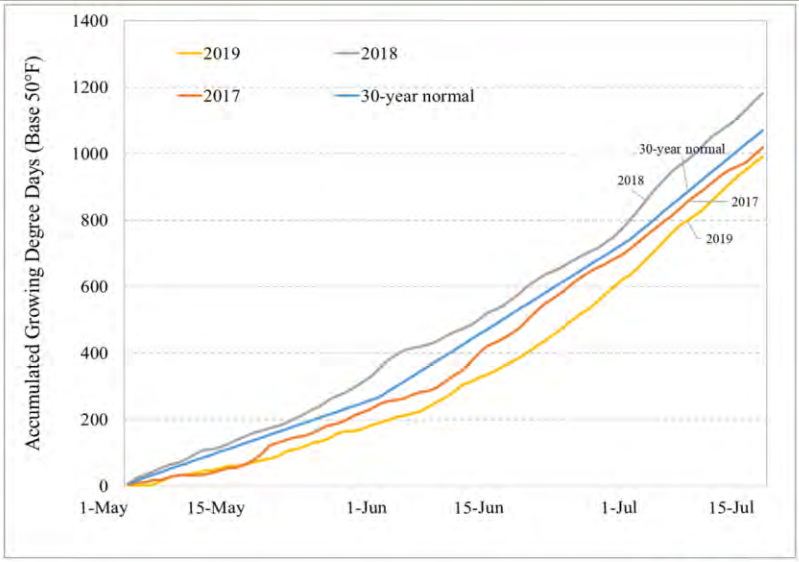
Growing Degree Day Accumulation Base 50°F, Alburgh VT, 2017-2019



Year	GDDs from 1-May to 16-Jul
2017	1017.9
2018	1180.65
2019	990.3
30-Year Normal	1070.2

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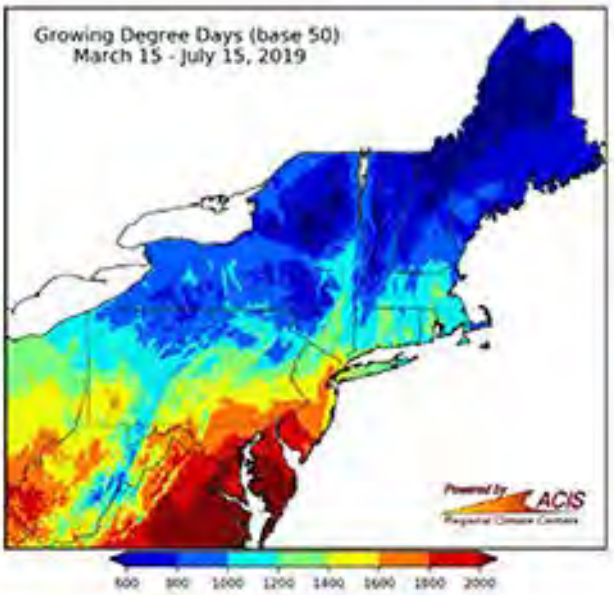
Corn growing degree days required and relative maturity, Alburgh VT 2019



RM (days)	GDDs to 50% kernel milkline
110-115	2450-2650
105-110	2250-2450
100-105	2150-2250
95-100	2050-2150
90-95	1950-2050
85-90	1800-1950
80-85	1500-1800

GDDs accumulated 1-Jun to 16-Jul 2019:	**801.4**
30-year normal of GDDs accumulated 17-Jul to 15-Oct:	**1223.1**

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2019 Oilseed Meal Fertility Trial

- Seed is pressed to make oil for food, fuel, cosmetics, and other purposes. The process leaves behind a highly nutritive meal, consisting of seed hull and meat.
- Seed meals can be used as a source of fertility for crops.

2019 Trial Design

Treatment	N (%)	P (%)	K (%)
Canola meal	4.81	1.09	1.21
Soybean meal	7.12	0.68	1.95
Feed-grade soybean meal	8.33	0.74	2.18
Hemp meal	5.65	1.05	1.1
Peanut meal	8.71	0.85	1.24
Urea	46	0	0

Concentrations shown on a dry matter basis.

Amendments applied and worked in 31-May 2019.

Sweet corn planted 6-Jun 2019.

Variety: Sugar Buns F1 Treated, Johnny's Selected Seeds.

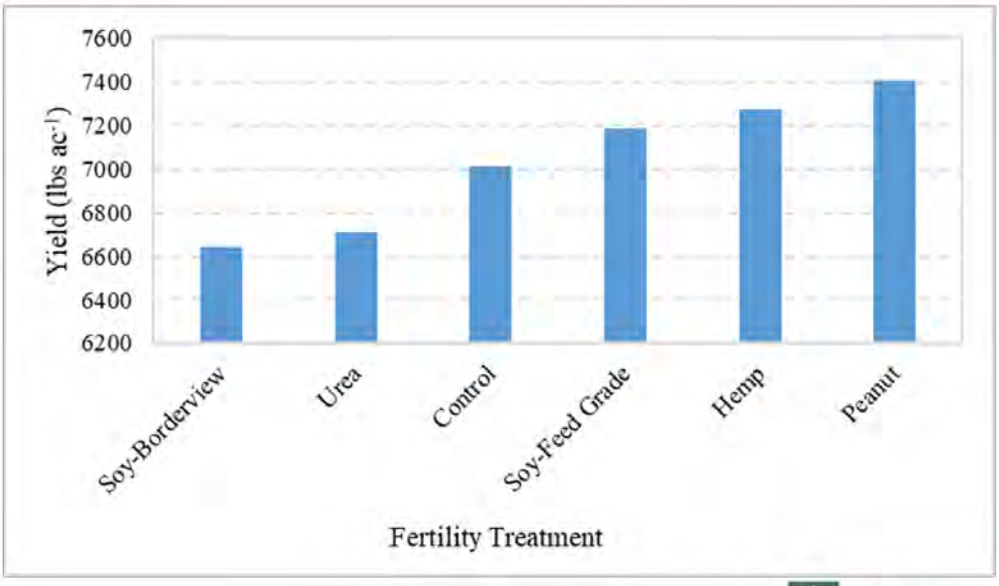
Seeding Rate: 24,000 seeds acre^{-1}

Plot size: 10’ x 20'

Fertility: 100lbs N acre^{-1}

2018 Trial Results

Oilseed meal fertility trial sweet corn yields, 2018



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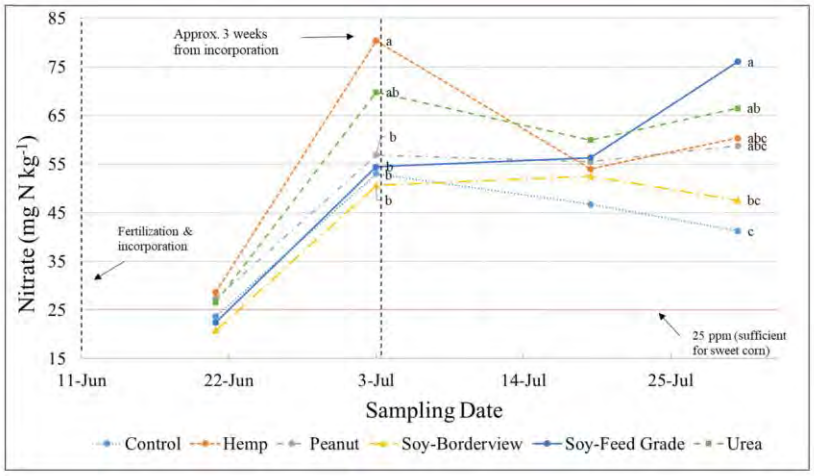
Oilseed meal fertility soil nitrate-N concentrations from 21-Jun to 30-Jul, Alburgh, VT, 2018

Amendments applied at 100lbs N acre^{-1}

Treatment	Nitrate (mg N kg^{-1})			
	21-Jun	3-Jul	19-Jul	30-Jul
Feed-grade soybean	22.4	54.4^{b}	56.3	76.0^{a}
Soybean meal	20.8	50.6^{b}	52.5	47.6^{bc}
Peanut meal	27.4	56.9^{b}	55.5	58.8^{abc}
Hemp meal	28.7	80.4^{a}	54.0	60.3^{abc}
Urea	26.5	69.8^{ab}	60.0	66.5^{ab}
Control	23.7	53.0^{b}	46.7	41.3^{c}
LSD (0.10)	NS	20.7	NS	22.5
Sample date mean	24.9	60.8	54.2	58.4



Treatments that share a letter were not significantly different from one another (p<0.10).

LSD – Least significant difference.
NS- Not significant

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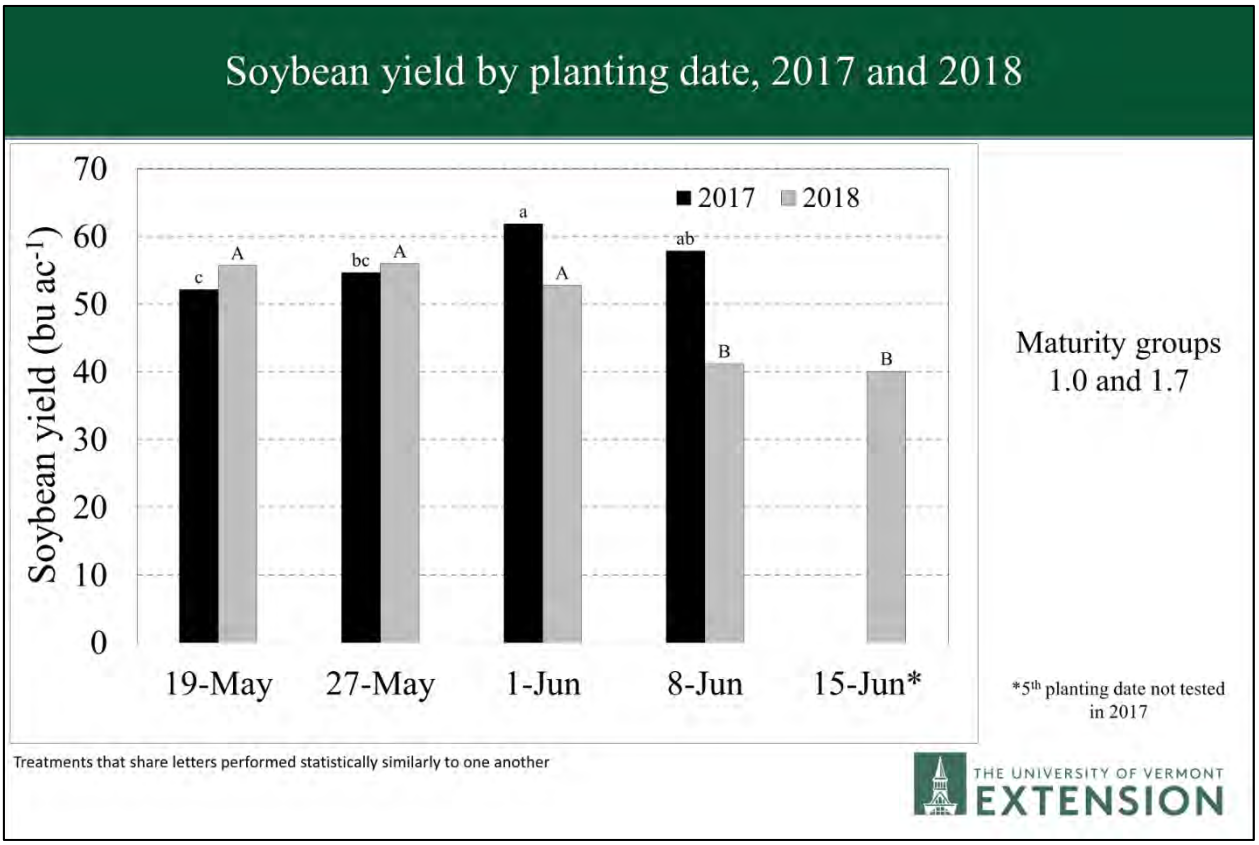
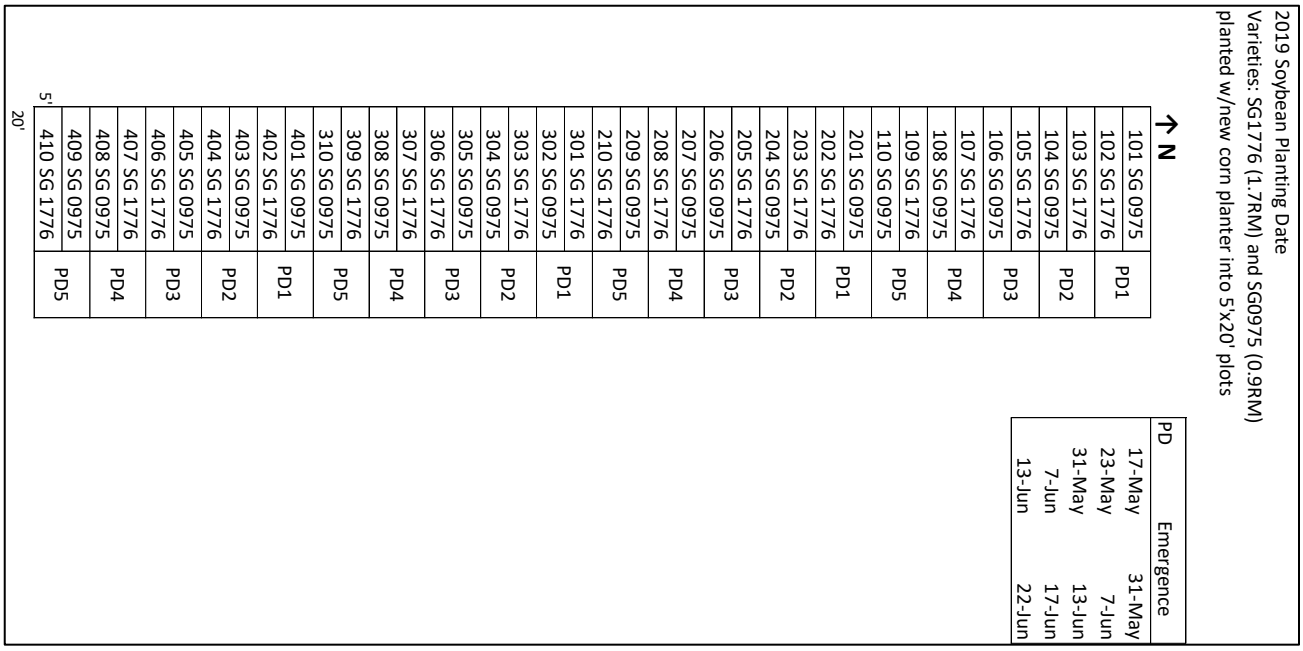
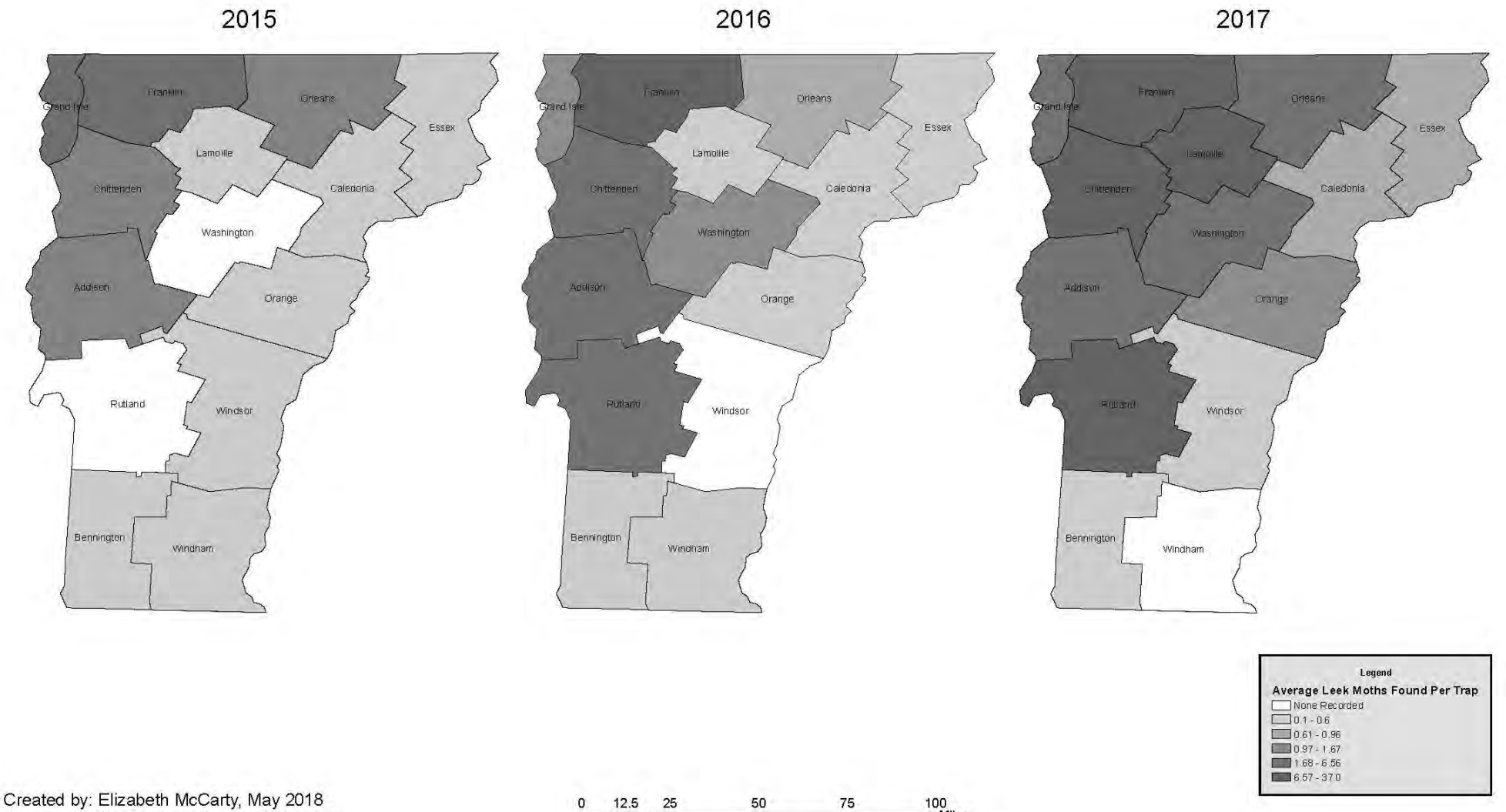
Soybean Planting Date Trials





Average leek moths found per trap



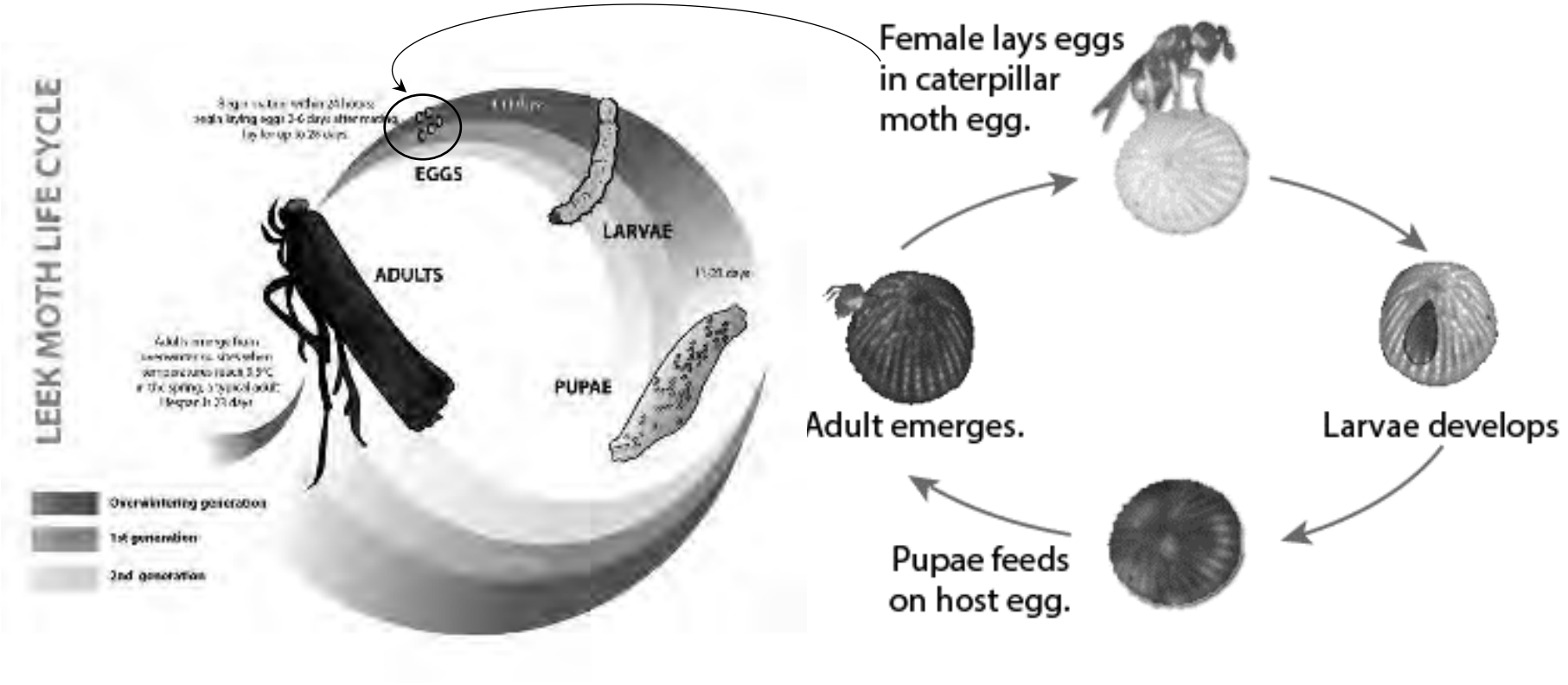
Created by: Elizabeth McCarty, May 2018
Source Credits: Scott Lewins and Victor Izzo

Managing leek moth with *Trichogramma* wasps

Victor Izzo, Scott Lewins and Heather Darby

Weekly *Trichogramma* releases:

- replicated on six farms throughout Vermont
- onion plots consist of three 100' beds at each site
- release and no release plots 200m apart
- sterlized Mediterranean flour moth eggs used to test for parasitism
- beginning of 2nd leek moth flight (late-June) through harvest (early August)

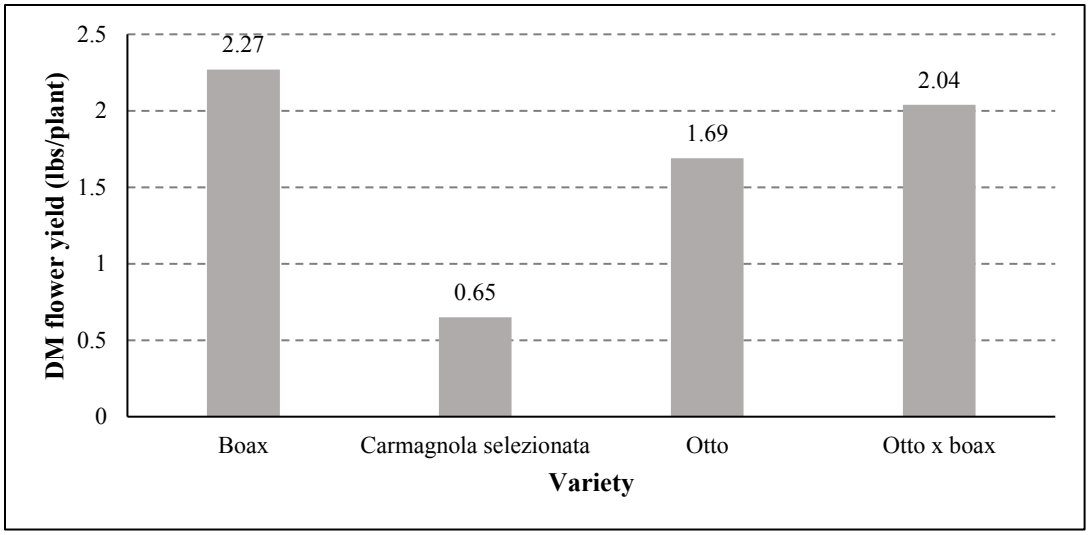


CBD Hemp Research

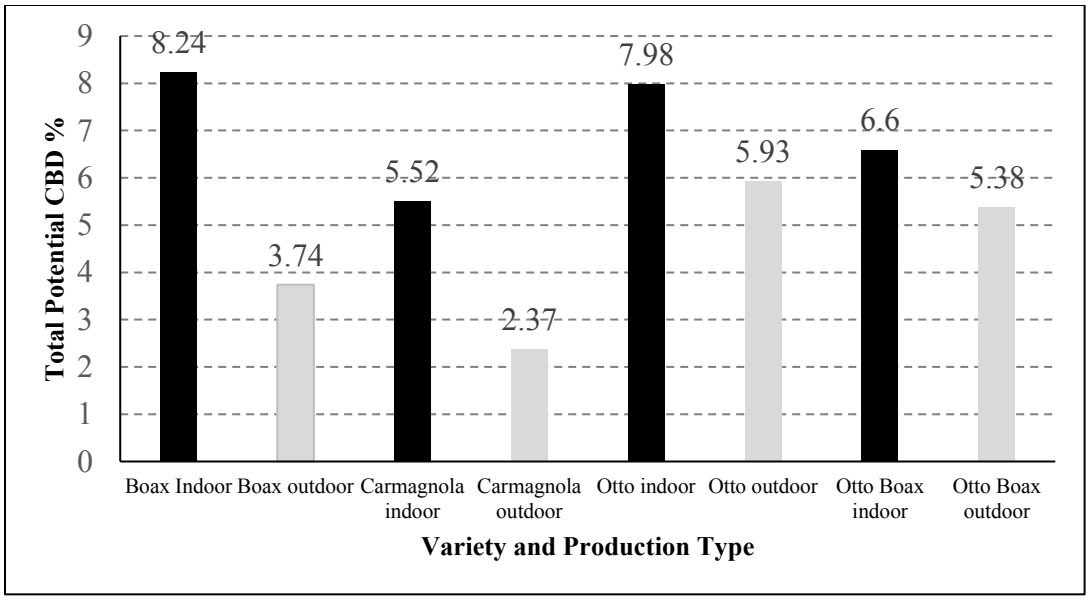
- Cannabidiol (CBD) is a type of cannabinoid in hemp. CBD hemp is a non-psychoactive variety of *Cannabis sativa* L. containing less than 0.3% tetrahydrocannabinol (THC). CBD has gained much attention for its potential as a health supplement. It is being sold in foods, capsules, and topical salves.
- CBD hemp is grown as a specialty crop, whereas fiber and grain hemp are grown as a row-crop.
- CBD is most concentrated in the female flower buds but can be found in lesser concentrations throughout the entire plant. As such CBD production most often focuses on maximizing plant flower growth.

2018 Indoor/Outdoor variety trial

- Varieties grown in our 2018 trial on average yielded 1.66 lbs/plant and contained anywhere from 2.37-8.24% total CBD depending on variety and growing conditions.



2018 Variety trial average flower yields



2018 Indoor/Outdoor variety trial total potential CBD

2019 High CBD varieties

2019 CBD Variety Trial	
Variety	**Source**
AC/DC	VT Natural CBD
Cosmic	VT Natural CBD
Alexa	VT Natural CBD
Dave's Haze	VT Natural CBD
VT Cherry	VT Natural CBD
Wulf	VT Natural CBD
Boax Wine	VT Natural CBD
Suzy Q	VT Natural CBD
River Rock	Chimney Rock Farms
Cherry Blossom	Kanape Collective
RN-13	GoFarmHemp
Ceiba	Northern Roots Nursery
Cherry Ceiba	Northern Roots Nursery
Cherry Wine	Northern Roots Nursery
Boax	Northern Roots Nursery
Apollo	Davis Farms
Skipper	Davis Farms
Eighty-Eight	Davis Farms
Painted Lady	Davis Farms
Otakarek	Davis Farms

2019 Organic No-till Spring Wheat Trial

2019 No-till Grains
Cover crops planted 8/23/18
6,000 gal/ac liquid
manure
Wheat Planted 4/26/2019
Variety: ND Vitpro organic seed at 150 lbs/acre.

Planted with sunflower grain drill
Plot dimensions 10' x 20'

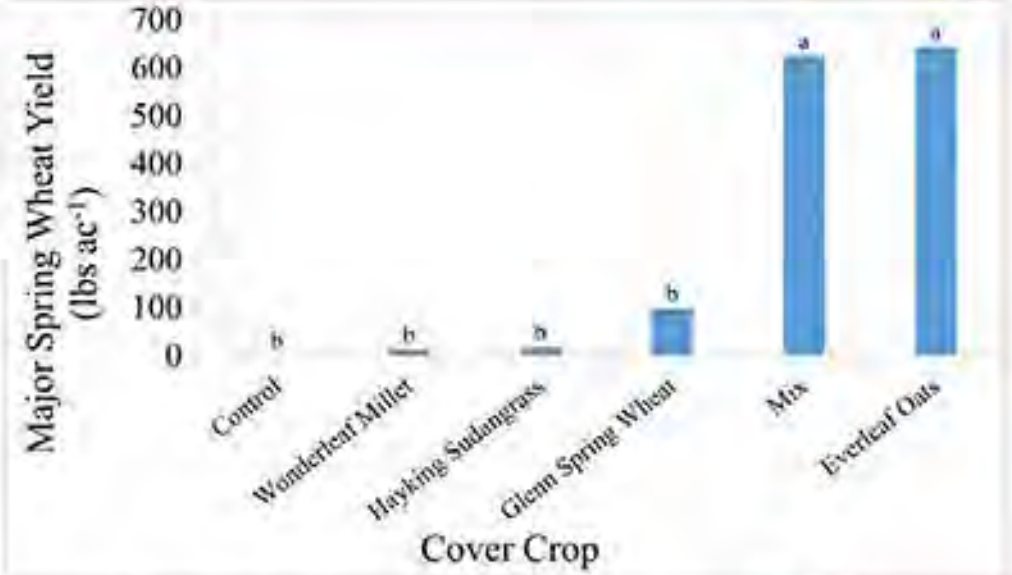
Cover Crop Treatments:

Piper sudangrass	50 lbs/ac
Wonderleaf millet	30 lbs/ac
Everleaf oats	125 lbs/ac
Tradition barley	125 lbs/ac
Mix	75 lbs/ac
oats crimson	60 lbs
clover	40 lbs
tillage radish	4 lbs

N→

Hopyard	road	CCPD								Milkweed
		106	Sudan	206	Control	306	Mix	406	Sudan	
		105	Millet	205	Mix	305	Control	405	Millet	
		104	Oats	204	Barley	304	Oats	404	Mix	
		103	Barley	203	Millet	303	Barley	403	Oats	
		102	Mix	202	Sudan	302	Millet	402	Control	
		101	Control	201	Oats	301	Sudan	401	Barley	

Impact of cover crops on no-till spring wheat production, 2018



Treatments that share a letter were not significantly different from one another (p<0.10)

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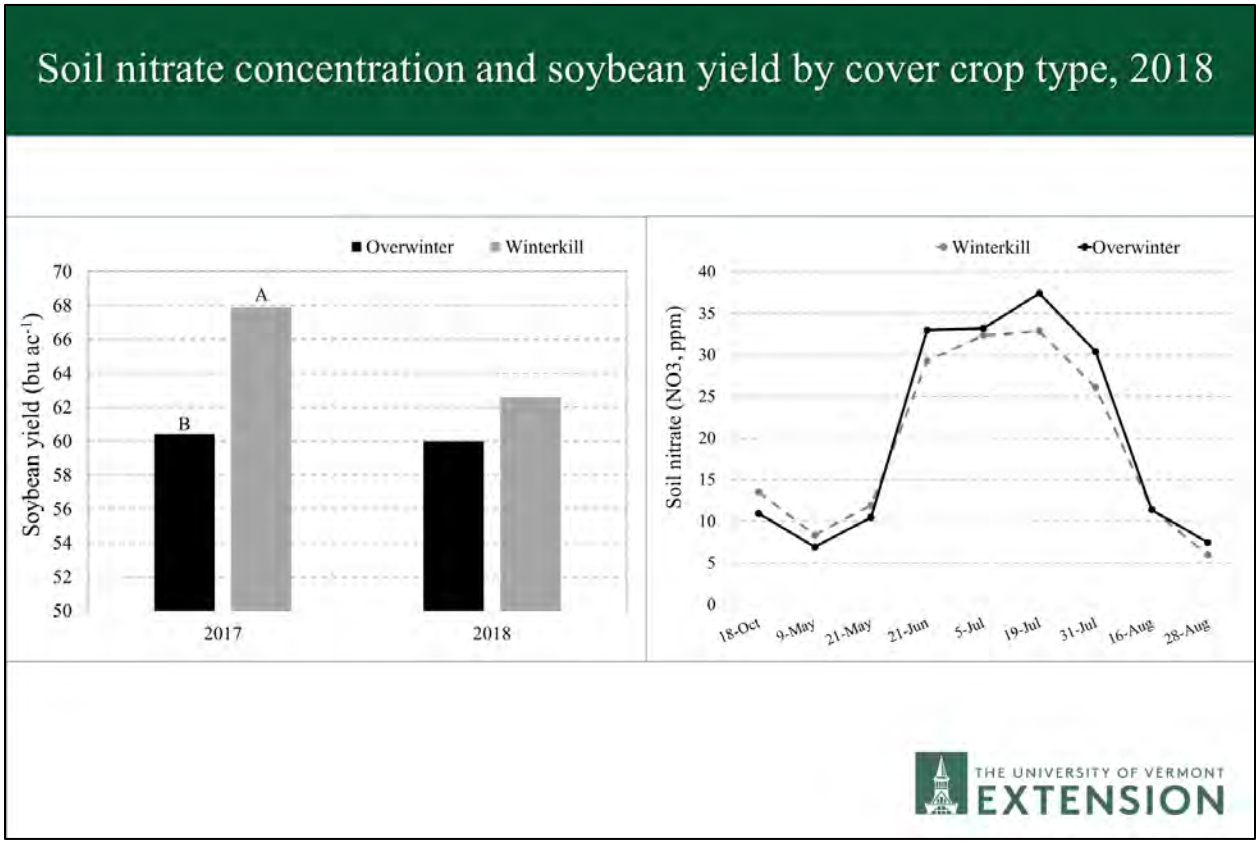
Soybean Cover Crop Trial

2019 Soybean Cover Crop Trial
planted into CCPD1
cc planted 9-19-18 **N→**
soybean planted 5-23-19
soybean variety SG0975
plots 7'x20' (planted 5' x 20', 2 rows)

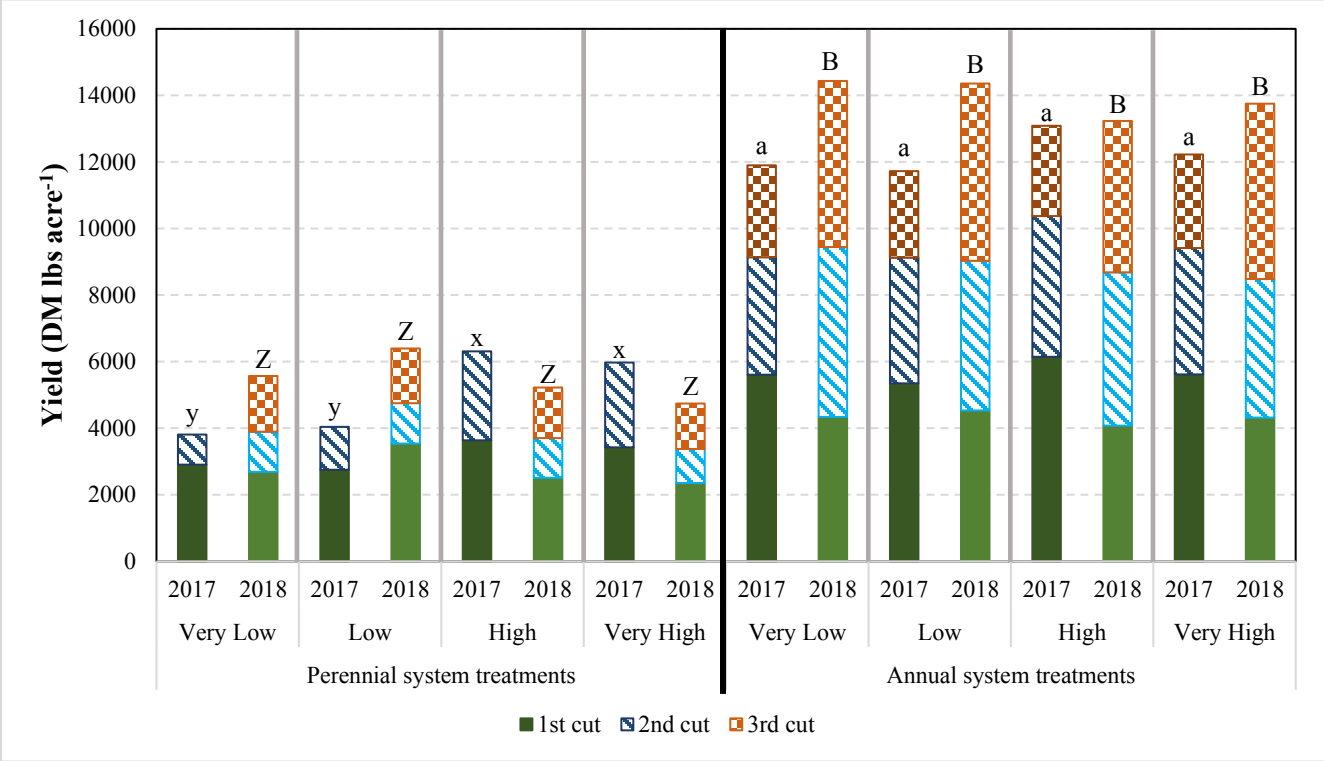
	Soybean CC-planted green							
	Soybean CC-sprayed prior to planting							
70'	101	4	201	6	301	3	401	8
	102	10	202	5	302	2	402	4
	103	9	203	8	303	9	403	10
	104	7	204	9	304	5	404	5
	105	1	205	1	305	7	405	2
	106	6	206	3	306	4	406	3
	107	3	207	4	307	10	407	6
21'	108	8	208	7	308	8	408	9
14'	109	5	209	10	309	1	409	7
7'	110	2	210	2	310	6	410	1
			20'	25'	45'	50'		95'
	No-till grains							

Milkweed field

Mix	variety	lb/a
1	centurion ryegrass	15
2	dixie crimson clover	8
	eco-till radish	2
	shelby oats	70
3	dixie crimson clover	15
	eco till radish	3
	VNS winter rye	50
4	medium red clover	12
	Eco till radish	3
	VNS winter rye	50
5	Hairy vetch	20
	VNS winter rye	75
6	centurion ryegrass	25
7	Eco till radish	6
8	dixie crimson clover	15
9	medium red clover	15
10	control	

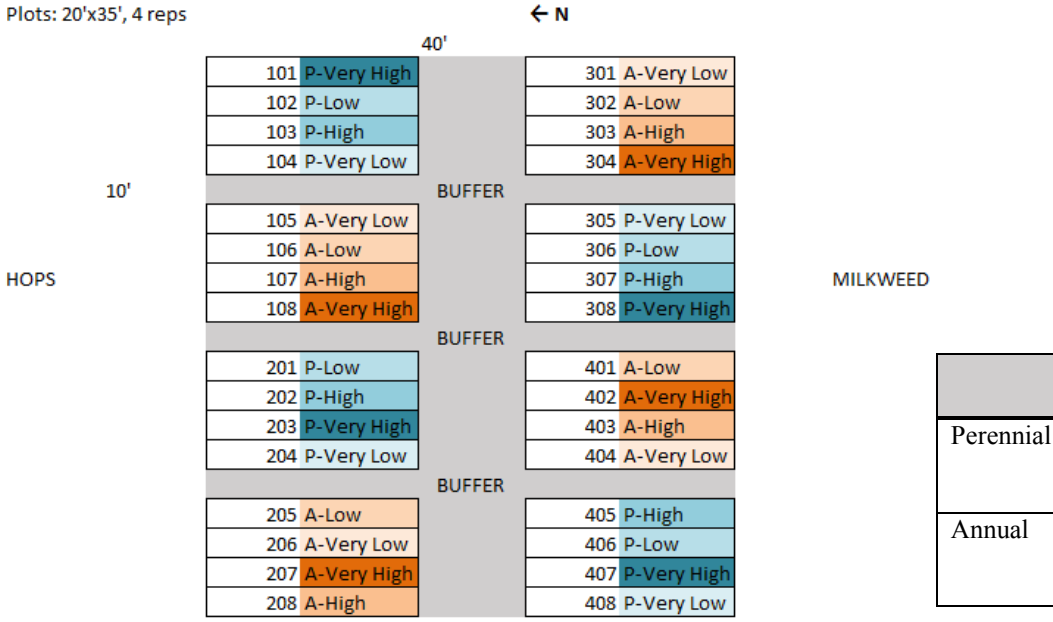


2017-2018 Forage Systems Cultivar Diversity Trial



Within a system or year, treatments that share a letter were not significantly different from one another (p=0.010).

Forage Systems Diversity Trial
Perennial treatments planted: 8/24/16; alfalfa replanted 09/01/17
Winter annual treatments planted: 9/11/17
Summer annual treatments planted 5/31/18
Perennial treatment applications: 1,000 lbs/acre Krehers (8-2-2) and 130 lb/acre Potassium Sulfate (0-0-51-18)
Annual treatment fertility applications: 1,250 lbs/acre Krehers (8-2-2) and 150 lb/acre Potassium Sulfate (0-0-51-18)
2016 crop: Sunflower, no-till
Plots: 20'x35', 4 reps



Harvest Dates		
	2017	2018
Perennial	31-May	30-May
	21-Jul	3-Jul
		13-Aug
Annual	27-May	25-May
	3-Aug	16-Jul
	6-Sep	20-Aug

2017-2018 Forage Systems Cultivar Diversity Trial- System Treatments

Perennial System Treatments			
Very Low 23.5 lbs acre $^{-1}$	**Low 23.5 lbs acre $^{-1}$**	**High 17.4 lbs acre $^{-1}$**	**Very High 17.4 lbs acre $^{-1}$**
Alfalfa (100%) *Viking 370HD*	Alfalfa (25% each) *Viking 370HD* *FSG 420LH* *KF Secure BR* *Roadrunner*	Alfalfa (34%) *Viking 370HD* Orchardgrass (34%) *Extend* Timothy (25%) *Climax* White Clover (7%) *Alice*	Alfalfa (34%) *Viking 370HD* *FSG 420LH* *KF Secure* *Roadrunner* Orchardgrass (34%) *Extend* *Benchmark Plus* *Niva* *Intensiv* Timothy (25%) *Climax* *Summit* *Glacier* *Promesse* White Clover (7%) *Alice* *Liflex* *Ladino* *KopuII*

Annual system cool season treatments			
Very Low 211.8 lbs acre $^{-1}$	**Low 211.8 lbs acre $^{-1}$**	**High 154.1 lbs acre $^{-1}$**	**Very High 154.1 lbs acre $^{-1}$**
Triticale (100%) *Trical 815*	Triticale (25%) *Trical 85* *Fridge* *NE426GT* *Hy octane*	Triticale (34%) *Trical 85* Cereal rye (34%) *Wheeler* Red clover (3%) *Mammoth* Winter pea (29%) *Austrian*	Triticale (34%) *Trical 85* *Fridge* *NE426GT* *Hy octane* Cereal rye (34%) *Wheeler* *Guardian* *Aroostook* *Spooner* Red clover (3%) *Mammoth* *Freedom* *Starfire* *Duration* Winter pea (29%) *Austrian* *Frostmaster* *Whistler* *Windham*

Annual system warm season treatments			
Very Low 52.9 lbs acre $^{-1}$	**Low 51.1 lbs acre $^{-1}$**	**High 44.7 lbs acre $^{-1}$**	**Very High 47.6 lbs acre $^{-1}$**
Sudangrass (100%) *Hayking*	Sudangrass *Hayking* (25.9%) *Piper* (18.7%) *SSG886* (30.9%) *Promax* (24.5%)	Sudangrass (29.6%) *Hayking* Pearl millet (21.0%) *Wonderleaf* Sorghum sudangrass (32.9%) *Greengrazer* Ryegrass (16.5%) *Enhancer*	Sudangrass *Hayking* (6.9%) *Piper* (5.0%) *SSG886* (8.3%) *Promax* (6.6%) Pearl millet *Wonderleaf* (5.0%) *FSG315* (5.0%) *Exceed* (6.1%) *Trileaf* (5.2%) Sorghum sudangrass *Greengrazer* (7.7%) *400 x 38* (9.2%) *AS6401* (9.5%) *Sweet 6* (10.2%) Ryegrass *Enhancer* (3.9%) *Tetraprime* (4.4%) *Marshall* (2.7%) *Kodiak* (4.3%)

2019 Hop Trials

2019 Nitrogen fertility trial treatments

- Fertilizer applied: Calcium ammonium nitrate (27-0-0)
- Spring applications made 10-May
- 8 weekly application starting 23-May, ending 10-Jul

Total Nitrogren (lbs/ac)	Spring applied (lbs/ac) 10-May	Weekly Nitrogen total (lbs/ac)	Weekly Nitrogen rate (lbs/ac)	Plots
100	100	0	0	107, 108, 311, 212, 115, 216, 217, 120
150	100	50	6.25	206, 307, 209, 210, 315, 316, 218, 219
200	100	100	12.5	205, 208, 309, 110, 215, 116, 317, 118
250	100	150	18.8	105, 308, 111, 112, 313, 114, 117, 320
150	50	100	12.5	306, 207, 109, 312, 213, 214, 119, 220
200	50	150	18.8	305, 106, 310, 211, 113, 214, 318, 319

North yard fertility trial treatments and plots.

2019 Crowning trial treatments

Treatment	Plots
Crown (25-Apr)	401, 402, 505, 406, 609, 510
Flame (10-May)	501, 502, 605, 506, 409, 410
Control	601, 602, 405, 606, 509, 610

South yard crowning experiment treatments and plots.

2019 Hop yard soil health treatments

- 22-Apr Soil samples taken and sent to Cornell Soil Health Lab for Comprehensive Assessment of Soil Health.
- Soil measured for physical, biological, and chemical characteristics and rated for soil function.
- 6-May Manure applied

Treatment	Plots
Manure, solid - 10 tons/ac (70#/plot)	503, 604, 407, 508, 611, 612
Manure, solid - 5 tons/ac (35#/plot)	403, 504, 607, 408, 511, 512
Control	404, 603, 507, 608, 411, 412

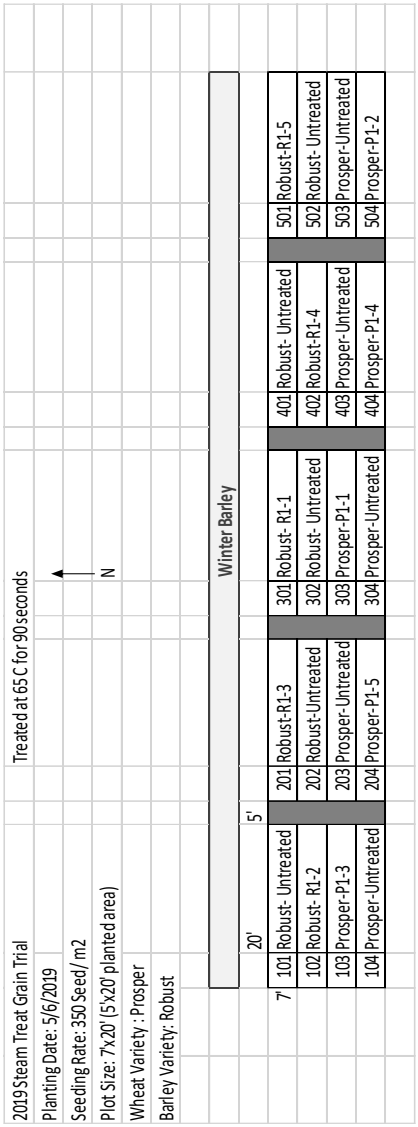
South yard soil health experiment treatments and plots.

Typical solid manure nutrient analysis (Dairy, solid):

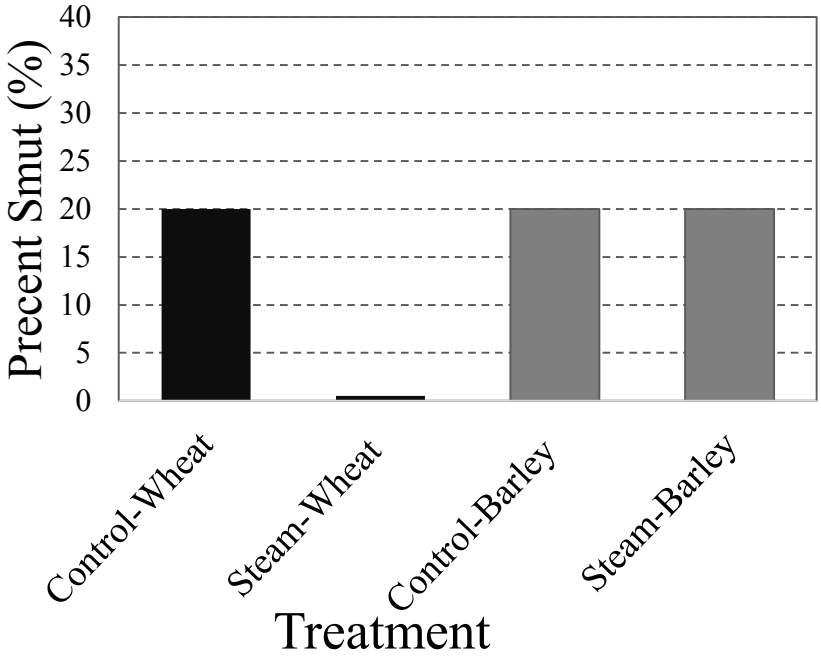
Dry matter	Total N	NH_4-N	Organic N	P_2O_5	K_2O	Mg	Ca
30.8	12.3	1.4	10.9	8.1	10.0	4.3	19.5

See “Resources” section for example soil health assessment.

2019 Steam Treated Grain Trial



Steam Treatment = Aerated steam seed treatment at 65ºC for 90 seconds and then immediately dried.



The impacts seen in 2018 of steam treatment on cereal grains foliar and insect pests, Alburgh, VT.

Treatment	Population	Loose Smut	Downy Mildew	Leaf Spot	Cereal leaf beetle	Thrips	Mites	Vigor
	m-2	%	%	%	%	%	%	%
Control-Barley	**366**	20	**20**	10	10	20	20	**97.6**
Steam-Barley	270	20	25	10	**5**	20	20	90
LSD	91.3	NS	NS	NS	NS	NS	NS	0.271
Trial mean	319	20	22	10	7	20	20	94
Control-Wheat	288	**0**	15	5	5	20	20	**95**
Steam-Wheat	**306**	20	**5**	5	**0**	20	20	90
LSD	NS	0	NS	NS	NS	NS	NS	NS
Trial mean	297	10	10	5	3	20	20	93

Values shown in **bold** are of the highest value or top performing.
NS-Treatments were not significantly different from one another.

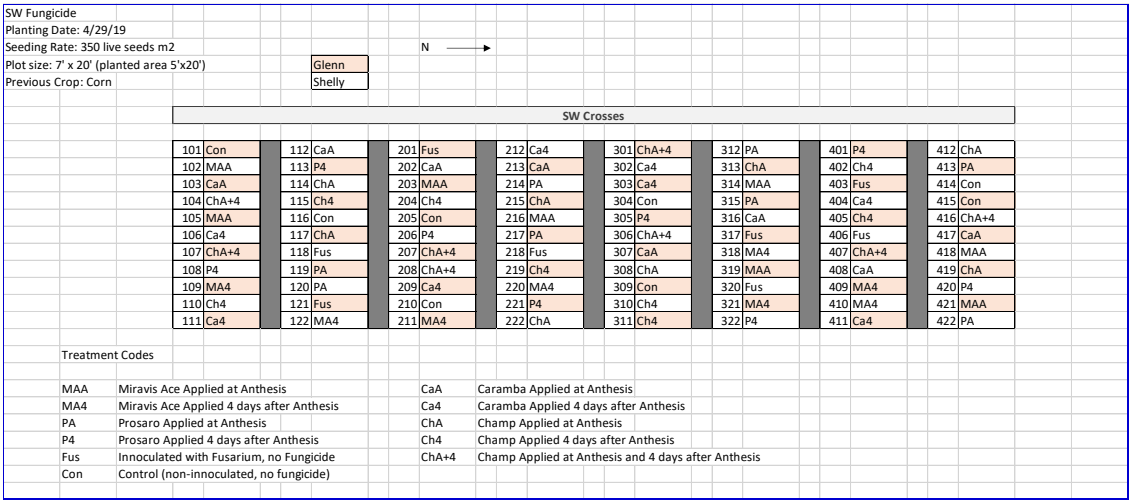
2019 Small Grains Fungicide Trials

Spring Wheat

11 treatments applied to two varieties:

Shelley (FHB susceptible) and Glenn (FHB resistant)

Treatments and Application Dates		
Treatment	**Application rate**	**Application dates**
Uninoculated control	sprayed with water	28-Jun Glenn, 2-Jul Shelly
Inoculated, untreated control	40,000 spores/ml	28-Jun Glenn, 2-Jul Shelly
Miravis Ace, applied at anthesis	13.7 fl oz/ac	28-Jun Glenn, 2-Jul Shelly
Miravis Ace, applied post-anthesis	13.7 fl oz/ac	2-Jul Glenn, 8-Jul Shelly
Prosaro, applied at anthesis	6.5 fl oz/ac	28-Jun Glenn, 2-Jul Shelly
Prosaro, applied post-anthesis	6.5 fl oz/ac	2-Jul Glenn, 8-Jul Shelly
Caramba, applied at anthesis	13.5 fl oz/ac	28-Jun Glenn, 2-Jul Shelly
Caramba, applied post-anthesis	13.5 fl oz/ac	2-Jul Glenn, 8-Jul Shelly
Champ WG, applied at anthesis	0.75 lb/ac	28-Jun Glenn, 2-Jul Shelly
Champ WG, applied post-anthesis	0.75 lb/ac	2-Jul Glenn, 8-Jul Shelly
Champ WG, applied at anthesis and post-anthesis	0.75 lb/ac	28-Jul & 2-Jul Glenn, 2 & 8-Jul Shelly

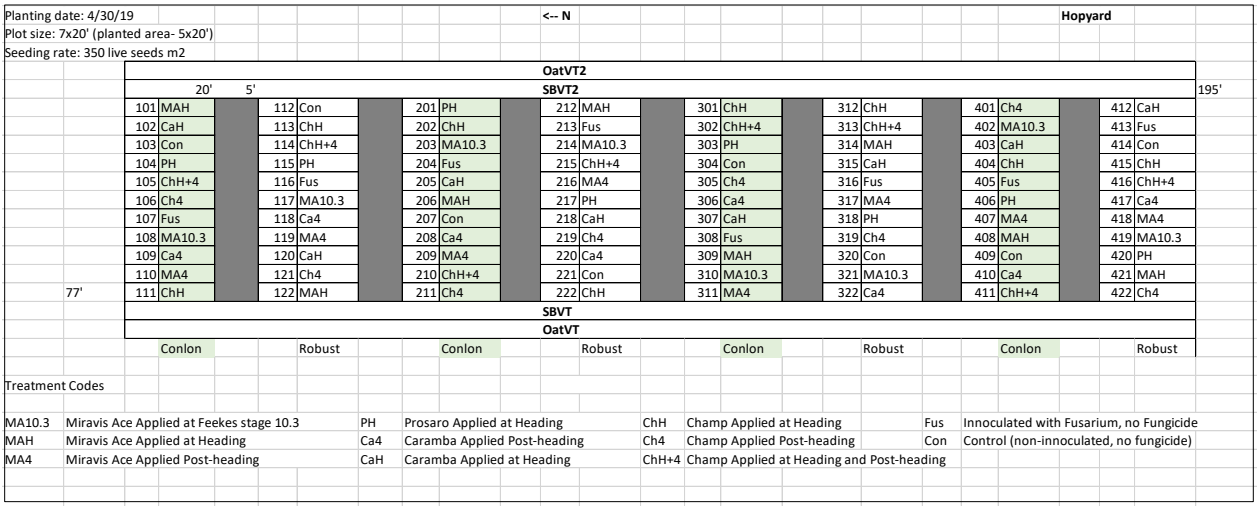


Spring Barley

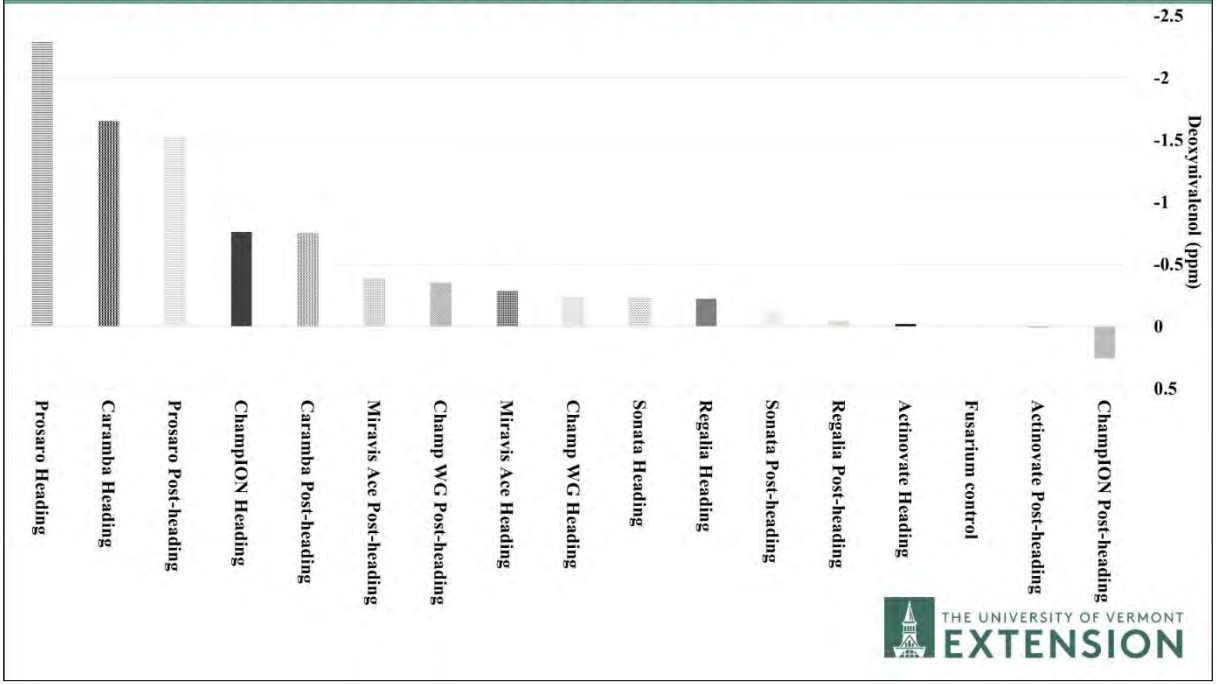
11 treatments applied to two varieties:

Robust (FHB susceptible) and Conlon (FHB resistant)

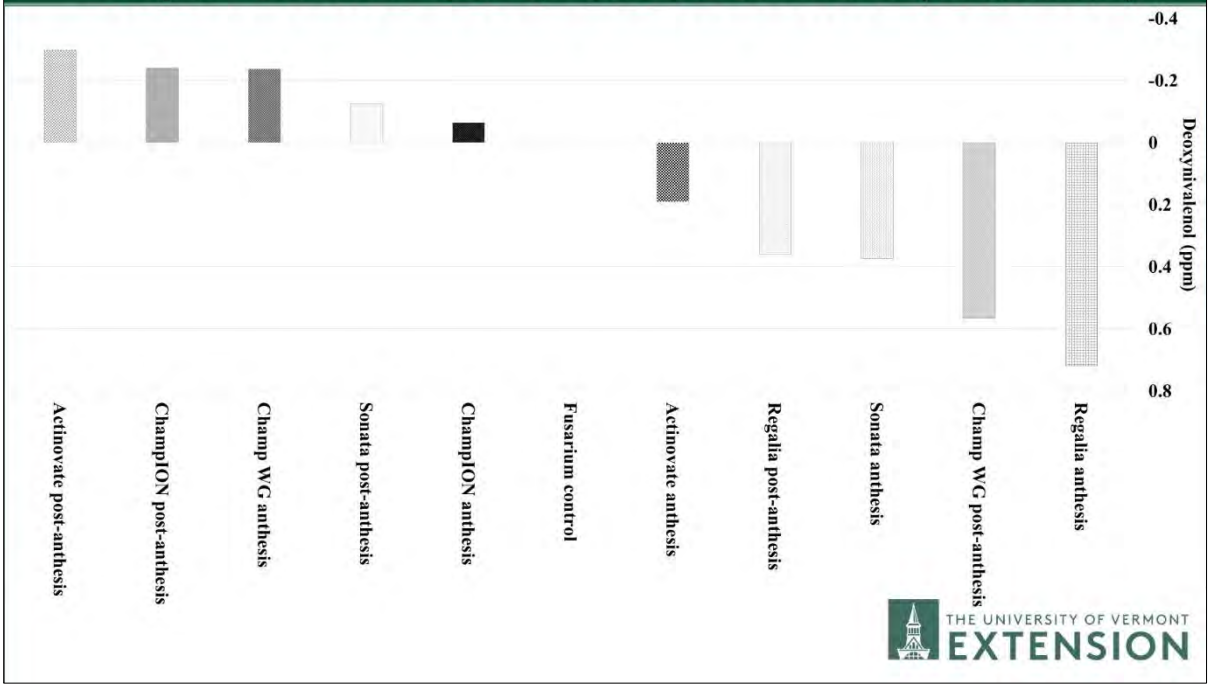
Treatments and Application Dates		
Treatment	**Application rate**	**Application dates**
Uninoculated control	sprayed with water	24-Jun Conlon, 29-Jun Robust
Inoculated, untreated control	40,000 spores/ml	24-Jun Conlon, 29-Jun Robust
Miravis Ace, applied at Feekes stage 10.3	13.7 fl oz/ac	22-Jun Conlon, 27-Jun Robust
Miravis Ace, applied at heading	13.7 fl oz/ac	24-Jun Conlon, 29-Jun Robust
Miravis Ace, applied post-heading	13.7 fl oz/ac	29-Jun Conlon, 2-Jul Robust
Prosaro, applied at heading	6.5 fl oz/ac	24-Jun Conlon, 29-Jun Robust
Caramba, applied at heading	13.5 fl oz/ac	24-Jun Conlon, 29-Jun Robust
Caramba, applied post-heading	13.5 fl oz/ac	29-Jun Conlon, 2-Jul Robust
Champ WG, applied at heading	0.75 lb/ac	24-Jun Conlon, 29-Jun Robust
Champ WG, applied post-heading	0.75 lb/ac	29-Jun Conlon, 2-Jul Robust
Champ WG, applied at heading and post-heading	0.75 lb/ac	24 & 29-Jun Conlon, 29-Jun & 2-Jul Robust



Change in deoxynivalenol concentration in spring barley compared to inoculated, untreated control (2014-2018)



Change in deoxynivalenol concentration in spring wheat compared to inoculated, untreated control (2016-2018)



Application of Biocontrol Nematodes for Control of Corn Rootworm

Elson Shields and Tony Testa, Entomology, Cornell Univ. Ithaca

Cornell University Cooperative Extension

Introduction

Biocontrol nematodes used for the control of Corn Rootworm are easily applied through slightly modified commercial pesticide sprayers by following the instructions listed below.

Sprayer Requirements

Any commercial pesticide sprayer can be used to apply biocontrol nematodes with a few minor modifications.

1) All screens and filters have to be removed. Nematodes cannot pass through them.
2) Sprayers need to be cleaned in a similar manner as required when changing pesticides for applications.
3) Non-chlorinated water must be used to fill the sprayer.
4) Standard pressures (40-60 psi) are best for nematode survival.
5) Sprayers need to apply a minimum of 50 gallons per acre (total from all nozzles) but we only use a portion of the nozzles so the actual application rate of water is less. A calibration example is below to help.

Nozzles: The best results require that a nematode-water stream is applied to the soil surface with as little as possible of the solution remaining on the plants. Any nozzle adjustment which sends a single stream down to the soil surface is best. The typical flat fan or flooding nozzle leaves too many nematodes on plant foliage or on the soil surface where they are killed with UV light. Total coverage typical of a pesticide application is neither required nor desired. The goal is a stream of water (with nematodes) wetting the soil surface in a narrow band with separation between the bands.

Open Nozzle Body Method

Fertilizer Stream Nozzles

These solid streams of water can be achieved in several ways. On sprayers with short booms, open nozzle bodies without screens and nozzles works great. On longer booms where maintaining pressure for the boom length is a problem, nitrogen drop nozzles or fertilizer stream nozzles (0010, 0015) in the nozzle bodies work great (no screens).

Application Strategies and Nozzle Spacing:

There are two different application strategies and cost structures depending on how quickly the farmer wants full activity.

Option one: Using the full rate of biocontrol nematodes and all the nozzles on the spray boom. With the "full rate" option, biocontrol nematodes become fully established during the first growing season and provide a measurable level of biological control against CRW. Full activity will be in effect in the spring of year two. Nematode cost for "full rate" is $90 per acre.

Option two: Applying nematodes at a 33% rate by blocking 2 nozzles and leaving the third nozzle open. Nematodes are then applied in high density strips separated by 6 ft. Driving the whole field results in only ⅓ of the field actually treated with nematodes. Within a year, the nematodes increase in population on insects in the soil and move into the open zones between application strips. Full biological control activity requires a minimum of 2 full growing seasons. Using the "Skip Nozzle" method, the biocontrol nematode costs are reduced to $30 per acre.

Calibration example:

Full Rate Application:

In a full rate application, all nozzles are used and the application rate of water needs to be a minimum of 50 gpa. The number of nematodes added to the sprayer is calculated in the following manner:

- Size of the sprayer in gallons (example – 300 gal) / 50 gpa = each sprayer fill treats 6 ac
- # of nematodes/ac (4 cups) x # of acres treated per sprayer fill (6 ac) = 24 cups of nematodes/sprayer fill

Remember that you are mixing two species of nematodes in the tank for application and they need to be added to the spray tank in approximate equal quantities

33% Rate Application:

Calculating the required flow rate from each nozzle (50 gpa)

1) Application speed = 6 mph or 528 ft. /min.
2) Sprayer has a 30 ft. boom with nozzles every 22 inches = 16 nozzles
3) 30 ft. boom covers an acre in 1,452 ft. of travel (43,560 sq. ft. per acre / 30 ft. boom)
4) 30 ft. boom at 6 mph (258 ft. /min) cover the acre in 2.75 min (1,452 ft. / 258 ft. per min)
5) 50 gpa / 2.75 min = spray output per min from all nozzles = 18 g/min
6) 18 g/min (all nozzles) / 16 nozzles = amount applied from each nozzle = 1.13 g/min/nozzle

Output from each nozzle at 6 mph needs to be 1.13 gallons per min (145 oz./min)

Calculating the amount of water actually applied using the 33% nematode application strategy (*Modified Application Rate or MAR*):

1) If application is at the 33% rate using our 30 ft. boom example, than every third nozzle is left unplugged to apply nematodes (16/3 = 5.33), leaving 5 nozzles unplugged applying nematodes.
2) Actual application rate of water per min is the number of unplugged nozzles (5 in our example) X the rate of water per nozzle (1.13 gal/min in our example) which equals the amount of water in the tank actually applied when driving over the entire field per min (5.65 gal/min)
3) Actual application rate of water per acre is the time it takes to drive an acre (2.75 min in our example) times the amount of water per min from all unplugged nozzles (in our example, 5.65 gallons per min from all nozzles X 2.75 min = 15.5 gallons of water per acre). This is your ***Modified Application Rate or MAR).***

Calculating the number of biocontrol nematode cups to be washed for the spray tank:

1) After calculating your ***MAR***, (our example is 15.5 gallons of water per acre), wash 1.3 cups of nematodes per ***MAR*** and add them to the tank. For example, if your ***MAR*** is 15 gallons per acre and your spray tank is 300 gallons then you need to wash 26 cups of nematodes (13 cups of each species) and add them to the spray tank. **Remember that you are mixing two species of nematodes in the tank for application and they need to be added to the spray tank in approximate equal quantities.**

Biocontrol Nematode Species:

S. carpocapsae 'NY001' *S. feltiae* 'NY04' *H. bacteriophora* 'Oswego'

Application Timing:

Biocontrol nematodes should be applied to corn field within the window from pre-plant to growth stage V4. Nematodes can be applied later, but establishment will be delayed due to a timing mismatch with corn rootworm larvae in the field. In addition, applications should be made **late in the day (after 6 pm)** or during cloudy and/or rainy days to minimize nematode death from intense UV sunlight.

Care of Nematodes after receiving them:

You will be receiving the biocontrol nematodes in 16 oz. plastic cups filled with saw dust/wood chips. If you open the containers, you will see numerous decomposing insect larvae on the surface of the wood chips, a dirty looking film on the sides/lid of the container and be greeted with an offensive odor. Most of the 25 million nematodes are distributed throughout the sawdust/wood chips. Until application, these cups of biocontrol nematodes need to be kept cool (60-70°F); biocontrol nematodes are living organisms. Upon receipt, these biocontrol nematodes can be held under cool conditions for 2-4 days without a major impact on nematode viability.

Nematode preparation for application:

In order to prepare the biocontrol nematodes for application, they have to be removed from the sawdust/wood chips and the sides of the 16 oz. container.

1) To remove the biocontrol nematodes from the wood shavings or saw dust and other biological material, the contents of the cup is dumped onto a wire screen (20 mesh, 841 µm openings) and the nematodes are washed through, into a lower container with a large volume of non–chlorinated water. Window screen is very close to 20 mesh and can be used to screen out the biological debris during the initial washing by fastening a single layer of window screen to a rigid frame.

2) The solution passing through the initial screen from the initial washing needs to be poured through a second finer screen to remove finer debris which will still clog nozzles. We recommend a 40 mesh (400 µm opening) screen. If window screen is doubled with the holes of each layer misaligned when fastened to a frame, the result is a screen similar to a 40 mesh screen.

3) After the second screening, the solution containing nematodes is ready to be dumped into the spray tank for application. Please remember to remove all internal filters and screens from the sprayer because those filters/screens will become plugged with nematodes and prevent them from being applied to the soil.

Initial washing (coarse screen)

Secondary filtering (fine screen)

4) Once the biocontrol nematodes are washed out of the sawdust/wood chips and poured into the spray tank, they need to be applied within an hour to reduce nematode death. Nematode death accelerates once they are placed in water due to the shortage of oxygen in the water. Agitating the spray tank help to incorporate more oxygen into the spray solution, but there are so many nematodes in solution, oxygen is quickly depleted and the nematodes begin suffocating.

5) Once the biocontrol nematodes are washed out of the sawdust/wood chips and poured into the spray tank, they need to be applied within an hour to reduce nematode death. Nematode death accelerates once they are placed in water due to the shortage of oxygen in the water. Agitating the spray tank help to incorporate more oxygen into the spray solution, but there are so many nematodes in solution, oxygen is quickly depleted and the nematodes begin suffocating.

Applications of biocontrol nematodes should be made late in the day (after 6 pm) or on days with thick clouds to protect the nematodes from UV light while they are entering the soil.

For More Information
Visit our website: www.alfalfasnoutbeetle.org or
Contact local CCE educator

NORTHEAST SARE Sustainable Agriculture Research & Education

We thank the following for their long-term and continuing support

Biological Control of Corn Rootworm with Native Persistent Biocontrol Nematodes

Elson Shields and Tony Testa
Entomology – Cornell University

The Insect:

Corn rootworm continues to be an economic pest of corn production. Current GE technology is currently effective in NY and the NE with a few exceptions where growers refuse to use crop rotation. However, market pressures on the milk producers are pushing corn silage production away from the use of GE-rootworm technology and back to the use of soil insecticides. This puts many growers in a bind because their corn planters do not have granular insecticide boxes.

Background:

Biocontrol nematodes (entomopathogenic nematodes) are obligate parasites of insects in the soil and occur in most soils. The native species evolved in the pre-agriculture habitat and are not usually effective on the soil insect pests in agriculture. By matching the different naturally occurring species found in different locations within NY, we have been able to find a combination which works in our NY agricultural fields and persist for multiple growing seasons from a single inoculation.

During our 20 years of research with Alfalfa Snout Beetle in NNY we noticed indications of activity on Corn Rootworm, so these plots were established in 2014 in continuous corn to investigate it further.

Results:

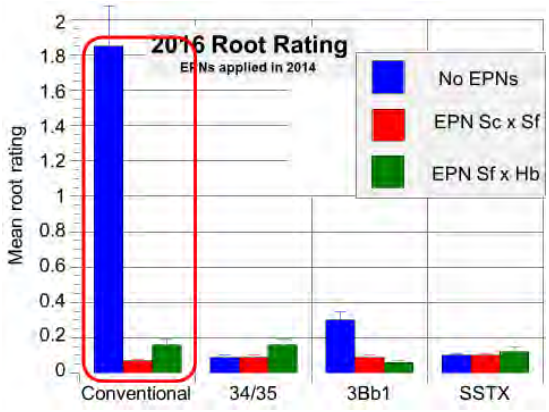


Figure 1.

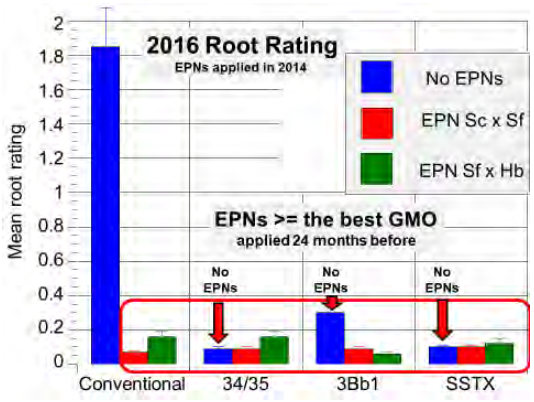


Figure 2.

Figures 1 & 2: CRW root feeding damage using the Iowa 0-3 scale where the ranking equals the number of root nodes damaged (i.e. 1.0 = 1 root node damaged). Figure 1 shows the level of CRW damage on conventional corn without any control (1.9 nodes damaged) and the level of damage on conventional corn with biocontrol nematodes present. Figure 2 compares the level of damage in conventional corn with biocontrol nematodes with the best GE-rootworm corn.

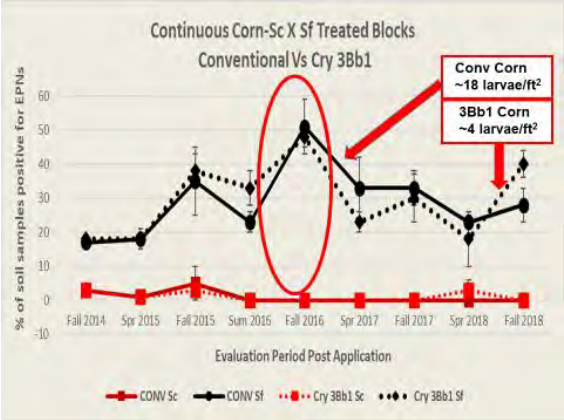


Figure 3.

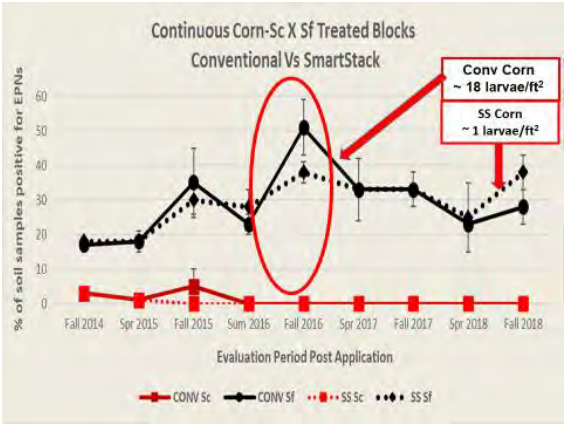


Figure 4.

Figures 3 & 4: Biocontrol population levels over growing seasons from 2014-2018 expressed as the percent of soil cores bioassaying positive for the presence of biocontrol nematodes. These data show that biocontrol nematodes are compatible with the use of GE technology and could also act as an independent mortality factor, targeting the GE surviving CRW larvae to reduce the development of resistance.

NE-SARE Project:

There is a newly funded NE SARE project to introduce NY farmers to this new technology. For producers interested in introducing this biological control in a 1st year corn field against corn rootworm, the lower inoculation rate for this application is $30/acre and the application window is planting-to-V5. In these first year fields, non-Bt corn varieties can be planted for the first and sequent years. For producers interested in inoculating a continuous corn field, the inoculation rate is 66% higher because of the presence of rootworms in the field. Normally, the cost of the biocontrol nematodes for inoculation in continuous corn fields is $90/acre. However for farmers wanting to give this technology a try in a single field, there is a discount price of $50/acre due to participating in the NE SARE project.

While this concept and biocontrol technology is new to corn producers outside of NNY, more than 20,000 acres have been inoculated in NNY against alfalfa snout beetle. When these fields are rotated to corn, the biocontrol nematodes established in the alfalfa then protect the corn from corn rootworm.

For more information please contact:

Elson Shields: email es28@cornell.edu

No-till cover crop trial

2019 No-till Cover Crop Trial

Fall Manure applied 9-24-18 and incorporated w/aerway 3x (all CT plots) 6000 gal/ac

Spring Manure applied 5-6-19 and incorporated w/chisel plow and disked (all CT plots) 6000 gal/ac

manure analyses taken at spreading

VNS winter rye planted 9-24-18 100 lbs/ac

plots 14' x 40' (winter rye planted 10')

winter rye sprayed w/roundup 5-x-19

corn planted 5-16-19 @ 35,500 seeds/ac w/200 lbs/ac 10-20-20

corn variety NK8618 (86 RM)

N ↑

Treatment abbreviations	
FM-CT	Fall manure, Conventional tillage, no cover crop
FM-CT-CC	Fall manure, Conventional tillage with cover crop
FM-NT	Fall manure, No-till, no cover crop
FM-NT-CC	Fall manure, No-till with cover crop
SM-CT	Spring manure, Conventional tillage, no cover crop
SM-CT-CC	Spring manure, Conventional tillage with cover crop
SM-NT	Spring manure, No-till, no cover crop
SM-NT-CC	Spring manure, No-till with cover crop

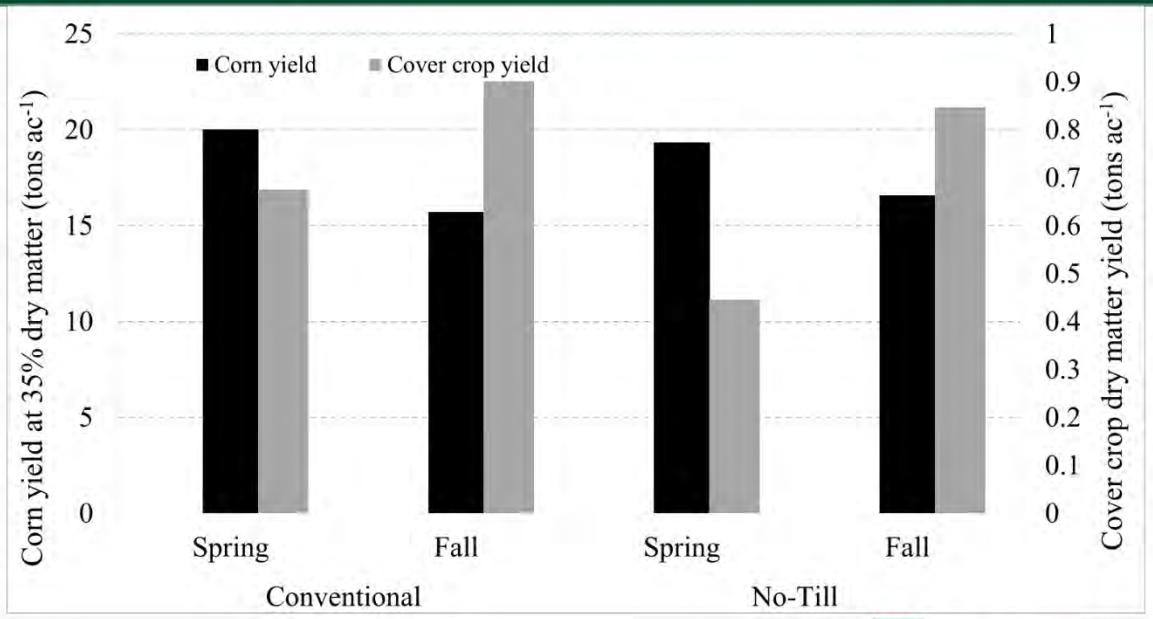
MINT trial

woods	301	FM-NT	101	SM-CT	14'
	302	FM-CT-CC	102	SM-NT-CC	28'
	303	FM-CT	103	SM-CT-CC	42'
	304	FM-NT-CC	104	SM-NT	56'
	305	SM-NT-CC	105	FM-CT	
	306	SM-CT	106	FM-NT-CC	
	307	SM-NT	107	FM-CT-CC	
	308	SM-CT-CC	108	FM-NT	
	401	FM-CT	201	SM-CT-CC	
	402	FM-NT	202	SM-NT	
	403	FM-NT-CC	203	SM-NT-CC	
	404	FM-CT-CC	204	SM-CT	
	405	SM-NT	205	FM-CT	
	406	SM-CT-CC	206	FM-NT-CC	
	407	SM-CT	207	FM-NT	
	408	SM-NT-CC	208	FM-CT-CC	224'
			40' buffer		

40' 80' 120'

old barn

Corn and cover crop yield by manure application timing and tillage type, 2018



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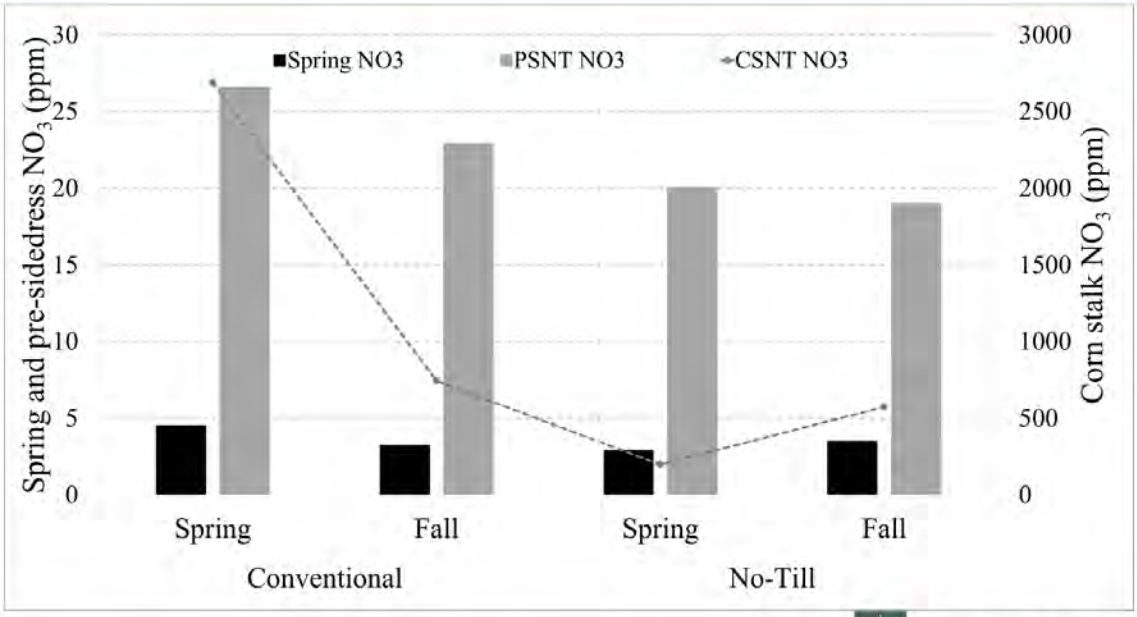
Soil and corn stalk nitrate by manure application timing and tillage type, 2018



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2019 Legume Forage Variety Trial

2019 Legume Trial

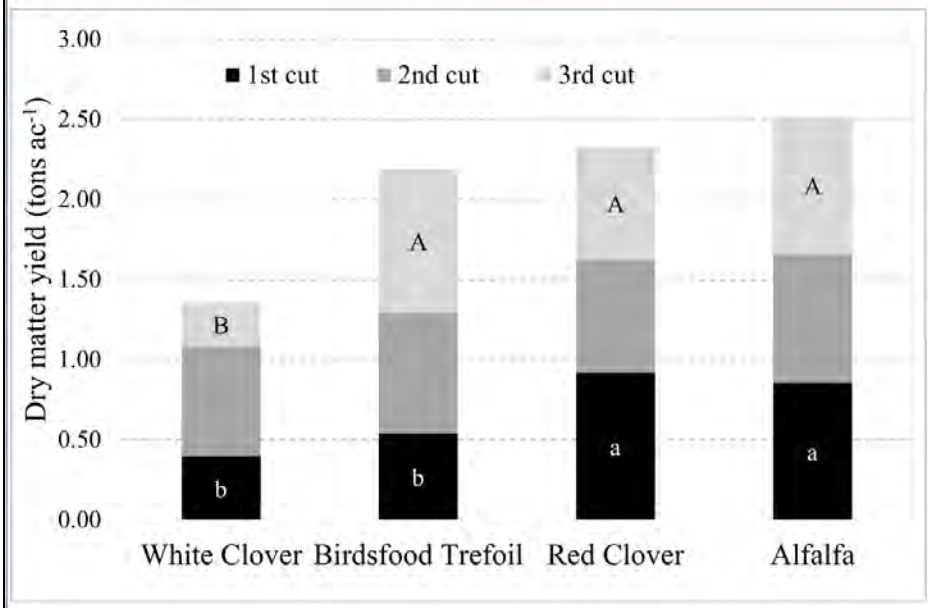
Planted 9-1-17 ← N

Road

	20'	25'	45'	50'						120'	
Road	101 FSG420	102 Road Runner	103 Traffic Pro	104 Leo	105 Wellington	7'
	106 Profusion	107 Viking 370	108 Viking 542	109 Viking 340	110 Secure	14'
	111 Arlington	112 Freedom	113 Milvus	114 Ruby	115 Manitoba	21'
	116 Alice	117 Kopu II	118 Ladino	119 Klondike	120 Liflex	
	201 Ruby	202 Milvus	203 Arlington	204 Manitoba	205 Freedom	
	206 Alice	207 Kopu II	208 Klondike	209 Ladino	210 Liflex	
	211 FSG420	212 Viking 340	213 profusion	214 Wellington	215 Leo	
	216 Viking 370	217 Road Runner	218 Viking 542	219 Traffic Pro	220 Secure	
	301 Liflex	302 Ladino	303 Klondike	304 Alice	305 Kopu II	
	306 Manitoba	307 Arlington	308 Freedom	309 Ruby	310 Milvus	
Perennial Sunflowers	311 profusion	312 Viking 340	313 FSG420	314 Traffic Pro	315 Road Runner	
	316 Viking 370	317 Secure	318 Viking 542	319 Wellington	320 Leo	
	401 Ruby	402 Manitoba	403 Arlington	404 Milvus	405 Freedom	
	406 Viking 542	407 FSG420	408 Traffic Pro	409 Wellington	410 Leo	
	411 Viking 340	412 profusion	413 Viking 370	414 Road Runner	415 Secure	
	416 Liflex	417 Kopu II	418 Alice	419 Ladino	420 Klondike	
	501 Leo	502 Wellington	503 profusion	504 Secure	505 FSG420	
	506 Viking 542	507 Traffic Pro	508 Viking 370	509 Road Runner	510 Viking 340	
	511 Freedom	512 Ruby	513 Manitoba	514 Arlington	515 Milvus	
	516 Klondike	517 Liflex	518 Alice	519 Kopu II	520 Ladino	140'

Variety	Species
Alice	White Clover
Arlington	Red Clover
Freedom	Red Clover
FSG420	Alfalfa
Klondike	White Clover
Kopu II	White Clover
Ladino	White Clover
Leo	Birdsfoot Trefoil
Liflex	White Clover
Manitoba	Red Clover
Milvus	Red Clover
Profusion	Alfalfa
Road Runner	Alfalfa
Ruby	Red Clover
Secure	Alfalfa
Traffic Pro	Alfalfa
Viking 340	Alfalfa
Viking 370	Alfalfa
Viking 542	Alfalfa
Wellington	Birdsfoot Trefoil

Legume dry matter yield by species, 2018 and 1st cut 2019



Species	1st cut 2019 DM tons ac^{-1}
Alfalfa	2.42
Birdsfoot Trefoil	2.26
Red Clover	2.26
White Clover	1.64

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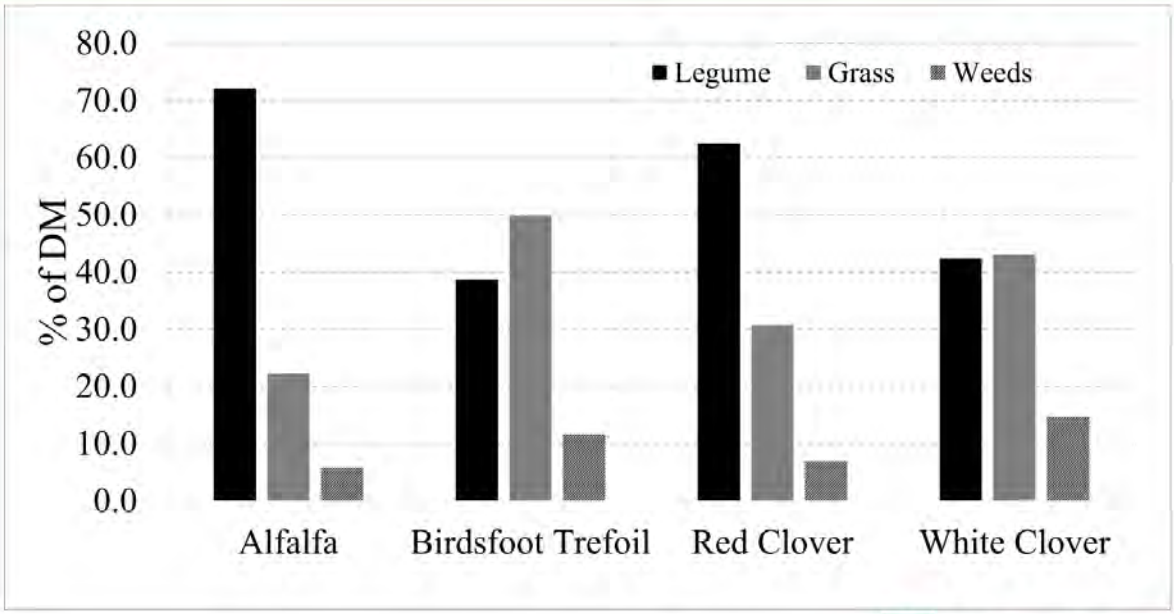
Legume survival, 1st cut, 2019



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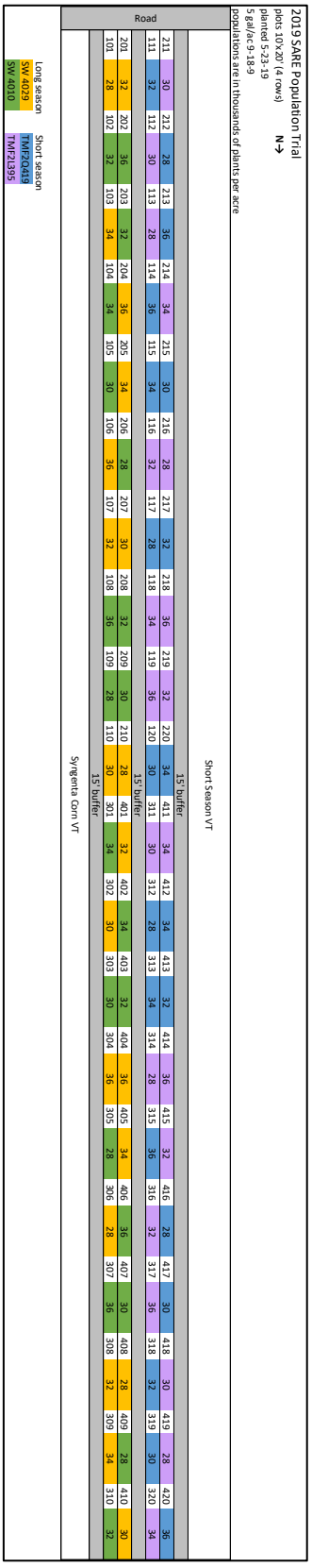
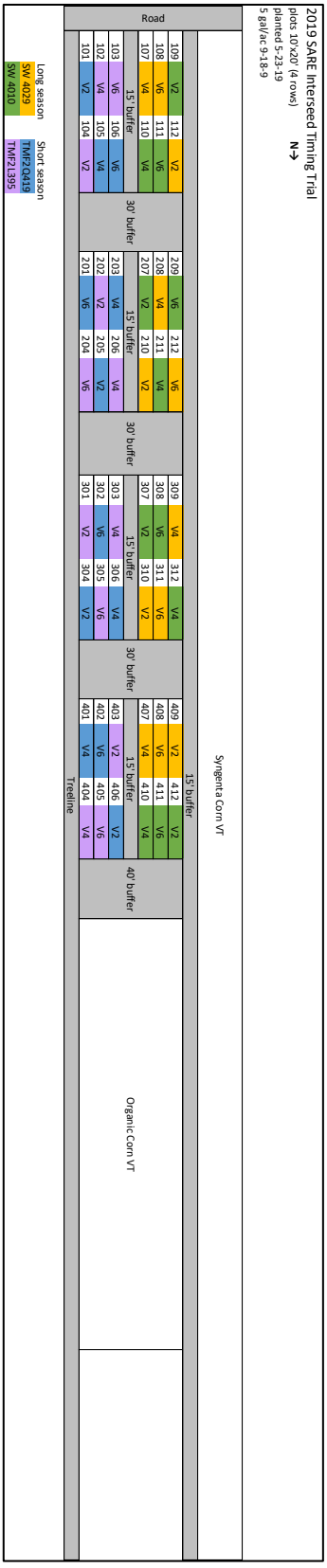
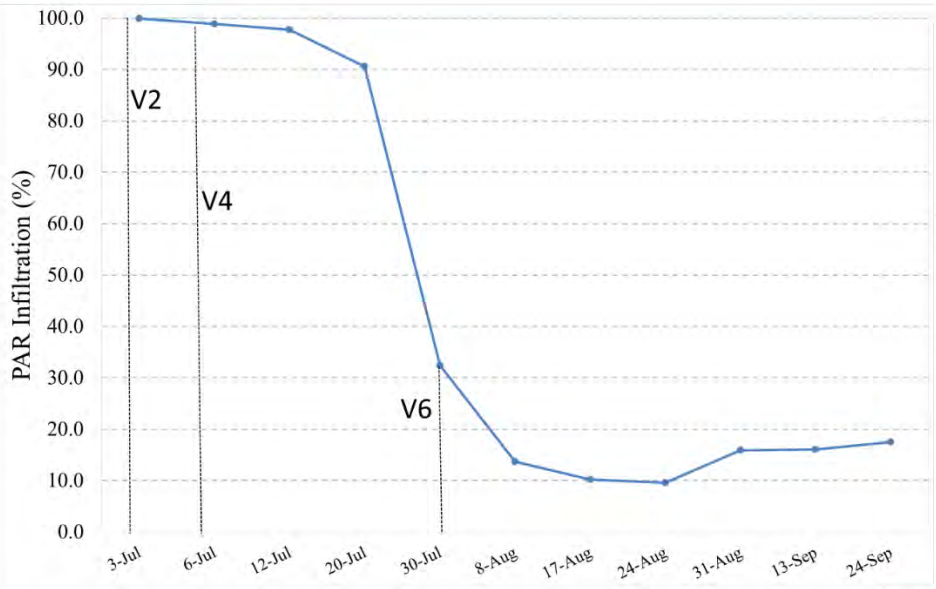
2019 Corn Silage Interseeding Trials





Corn canopy light infiltration, 2018



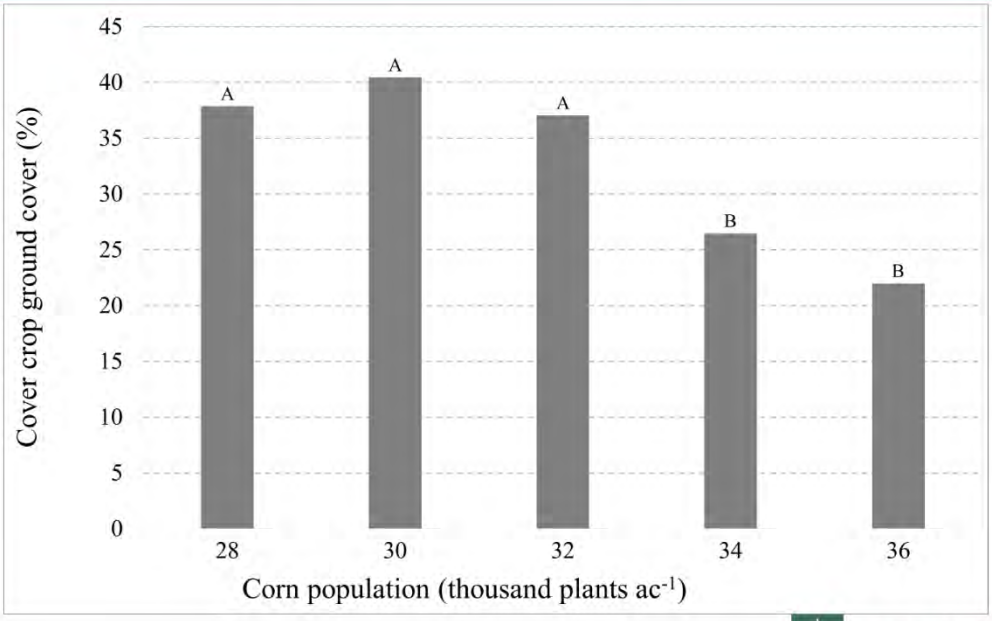
Corn planted 6-30-18
V2 interseeded 7-2-18
V4 interseeded 7-5-18
V6 interseeded 7-30-18

Corn planted 5-23-19
V2 interseeded 6-17-19
V4 interseeded 6-24-19
V6 interseeded 7-1-19

We are seeing <30% right now

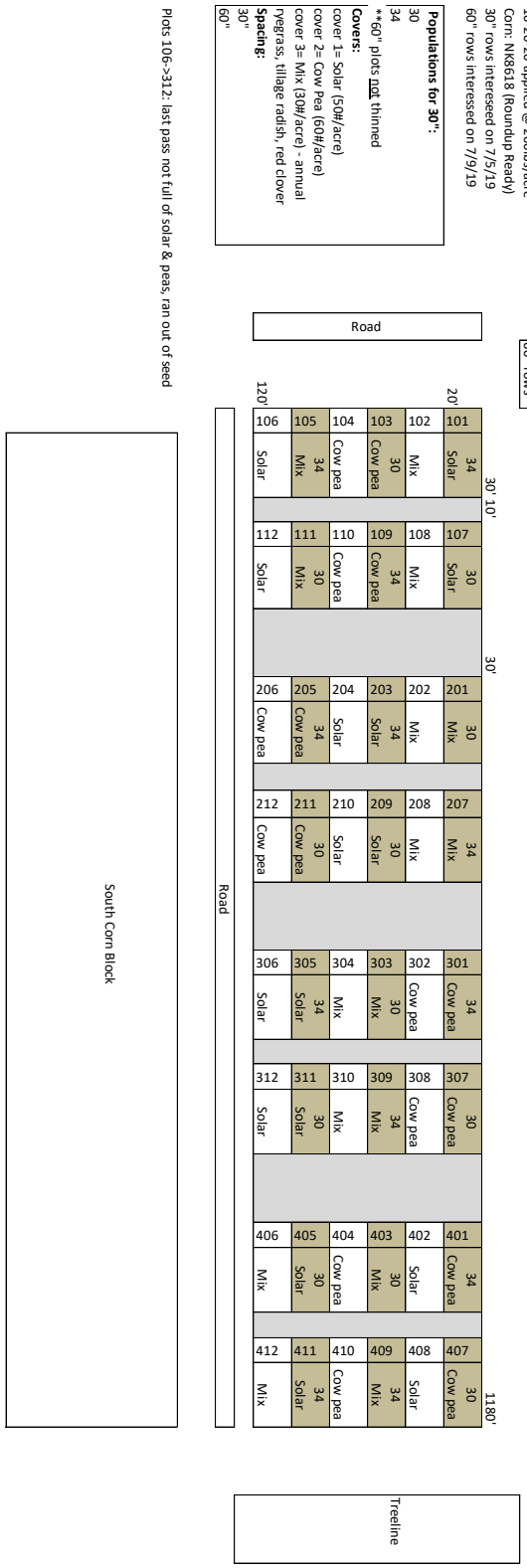
THE UNIVERSITY OF VERMONT EXTENSION

Cover crop ground cover by corn population, 2018



THE UNIVERSITY OF VERMONT EXTENSION

2019 60-inch corn interseeding trial



AFTERNOON SESSIONS

Tasting Tent - Enjoy Vermont grown products from locavores. 11:30 a.m. to 2:30 p.m.

Visit Von Trapp Brewing and Ben & Jerry's. Must show ID for alcohol samples.

Each afternoon session will run for 90 minutes, starting at 2:00.

- **Hemp and Hops** - with UVM Extension, Brookdale Farm Supplies and Toro. Learn about general agronomics, research results, irrigation, fertility management, and pest management..... 42-104
- **Cover Crop Intensive** - Come see our annual cover crop demo trials! Learn about what annuals can do for your soil and different cover cropping management systems. Ever wonder about the challenges of roller-crimping or why we would try 60" row spacing on corn? Come find out! 105-113
- **Getting Started with Grazing** - Do you want to start grazing your livestock or improve your current grazing system? Join UVM Extension Grazing Specialist Cheryl Cesario and Grazing Consultant Sarah Flack for a session on basic grazing management. They'll cover the basics of good grazing management, equipment, and will demo how to calculate and set up appropriately sized paddocks. 114-115
- **Beans and Corn** - Join Joe Bossen of All Souls Tortilleria and Seth Johnson of Morningstar Farm for a session on producing and marketing specialty corn and dry bean varieties in Vermont. We will hear an overview of UVM Extension's research on these crops, production experiences and strategies growing dry beans from Seth, and information on corn quality from Joe. 116-128
- **Precision Agriculture and UVM Innovative Equipment** - Join Scott Magnan's Custom Service to hear about Precision Ag as well as view our equipment 129-146

Von Trapp Brewery and Bierhall
1333 Luce Hill Rd
Stowe, VT 05672
(802) 253-5750
INFO@TRAPPFAMILY.COM

Facebook and Instagram: @vontrappbrewing

It was more than a decade ago when Johannes von Trapp started thinking about starting a brewery at his family's lodge in Stowe, Vermont. He had a dream to brew an American version of lagers he enjoyed while traveling to the countryside near his ancestral Austrian home. With this dream in mind, Johannes worked to start a brewery at Trapp Family Lodge. It became a reality in the spring of 2010, when von Trapp Brewery officially opened. The brewery was originally a modest facility located in the lower level of the Lodge's Kaffehaus. In 2015 we opened our new **30,000 sq. ft. brewery located on Luce Hill Rd.** featuring a Rolec Brew House and capable of producing up to 36,000 barrels of beer annually. You can enjoy our beers at the Lodge or in multiple restaurants and bars throughout Vermont, New Hampshire, Massachusetts, Maine, Rhode Island, New York, Connecticut, New Jersey and Pennsylvania.

Whether you prefer your beer light or heavy, hoppy or sweet, smooth or bold, you'll find something to satisfy your palate at von Trapp Brewing. We offer an array of year-round and seasonal lagers at our brewery located at the world-famous Trapp Family Lodge.

Located on the grounds of Trapp Family Lodge, the von Trapp Brewing Bierhall Restaurant conveniently situated on the cross-country ski and mountain bike trails. The Bierhall is a gathering place for friends to enjoy **"a little of Austria, a lot of Vermont,"** serving fresh lager beers and a selection of freshly prepared Austrian lunch and dinner selections. Many of the menu items are prepared on the wood-fired Parrilla grill that is the showcase feature of the Bierhall. Start and finish your mountain bike ride or cross-country ski at the Bierhall Restaurant, and shop the well-appointed gift shop.

Year-Round Lagers

Brewed on the grounds of Trapp Family Lodge in Stowe, Vermont, our lagers are crafted with the finest traditional ingredients and our pure Vermont spring water.

vonTrappBrewing.com

Helles GOLDEN LAGER | 4.9% ABV / 20 IBU

6-PK 12 OZ. BOTTLES & CANS

From the German word for "Bright", our golden lager displays a floral hop aroma with a bready malt bellance. Traditional in style, Helles is brewed with pilsner malt to produce a dry, snappy finish while Perle and Tettnanger hops create a spicy, herbal hop aroma. The result is an incredibly clean, yet complex, lager.

BRONZE MEDAL - 2018 NY International Beer Competition

Pilsner BOHEMIAN STYLE LAGER | 5.4% ABV / 42 IBU

6-PK 12 OZ. BOTTLES & CANS

Our award winning interpretation of a Bohemian Style Pilsner. Spicy, citrus peel botanicals combine with a dry, peppery finish to create a truly thirst-quenching lager. A beer that demands you take more than one sip.

Vienna AUSTRIAN STYLE LAGER | 5.2% ABV / 33 IBU

6-PK & 12-PK 12 OZ. BOTTLES & CANS

Named for the city that created the style, our amber lager is malt forward with a grassy, crackery hop aroma. A classic blend of German malts and hops gives this complex lager notes of biscuit and caramel in its finish.

BRONZE MEDAL - 2018 NY International Beer Competition

Dunkel DARK LAGER | 5.7% ABV / 22 IBU

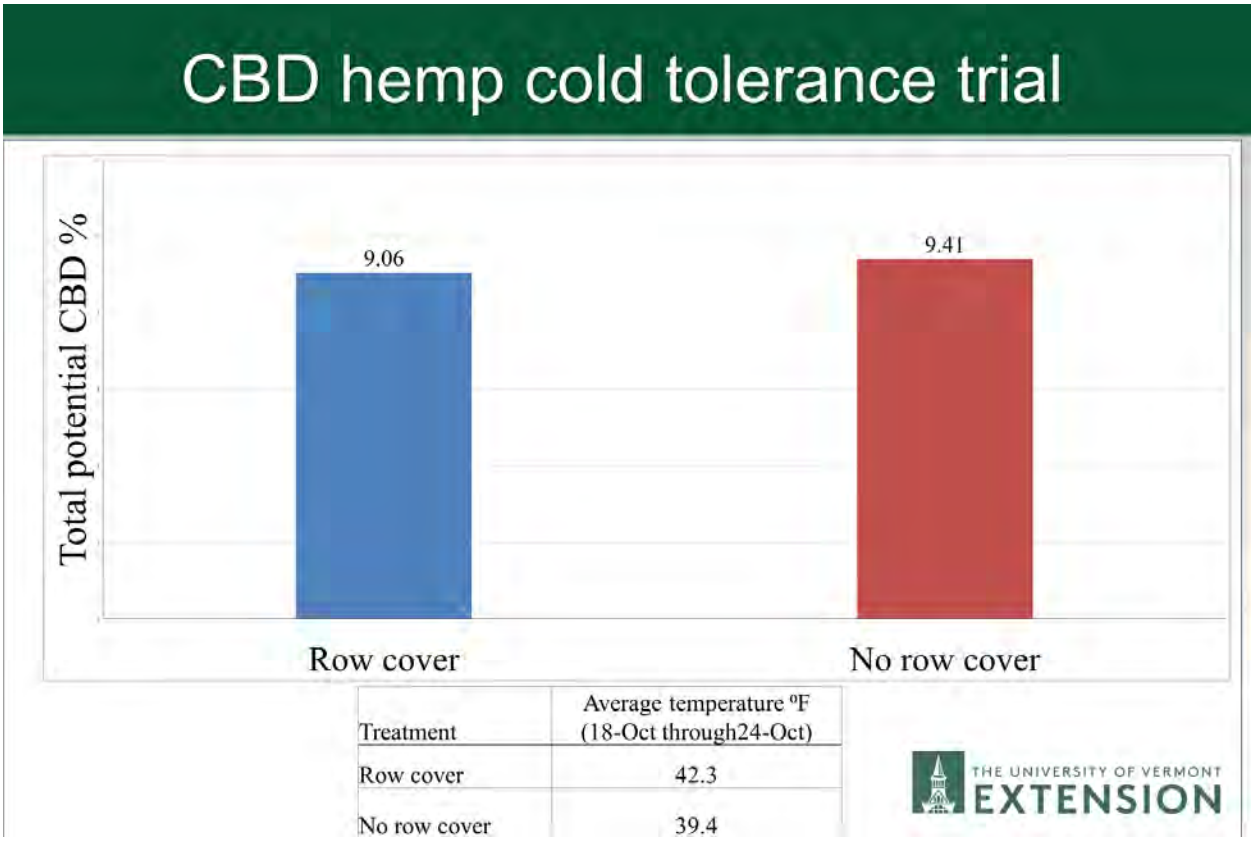
6-PK 12 OZ. BOTTLES & CANS

Creamy, toffee aromas balance the bitterness of Munich malts in our roasted brown lager. Although dark in color, Dunkel is medium in body and finishes dry and clean, resulting in a rich lager that can be enjoyed throughout the year.

SILVER MEDAL - 2017 and 2018 21st Great International Beer, Cider, Mead & Sake Competition, "Amber & Dark Lager"

2018 CBD Cold tolerance trial

- Temperatures were monitored from 18-Oct through 26-Oct with a maximum recorded temperature of 64.1°F and a minimum recorded temperature of 27.8ºF.
- Row cover had no significant impact on total potential CBD.

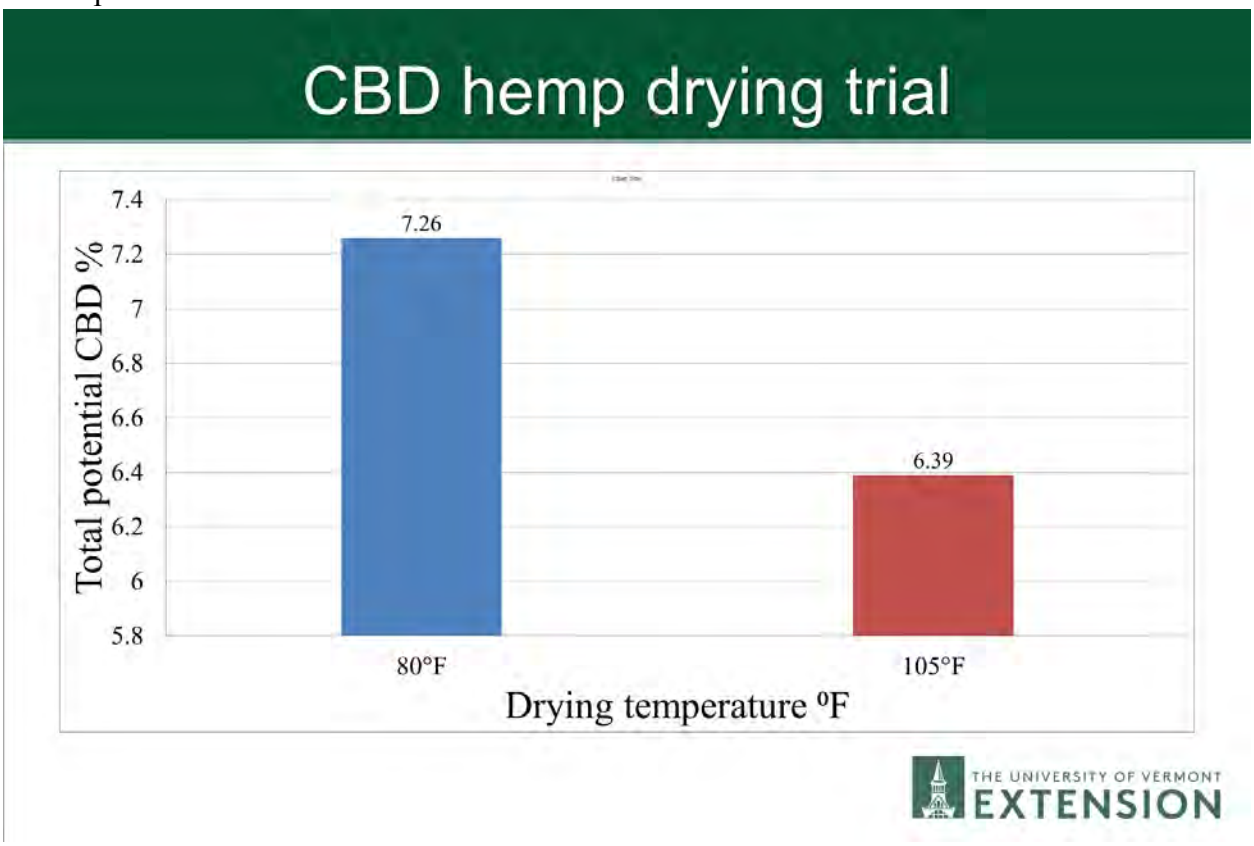


Treatment	Average temperature ºF (18-Oct through24-Oct)
Row cover	42.3
No row cover	39.4

2018 total potential CBD for covered and uncovered hemp

2018 CBD hemp drying trial

- There was a significant difference in total potential CBD when drying at temperatures above 80ºF.
- Drying at higher temperatures resulted in loss in total potential CBD in our trial.
- Lower temperatures may result in reduce loss of total potential CBD, but may also increase risk of molding during the drying process. Proper humidity control and air flow can help to reduce these risks.

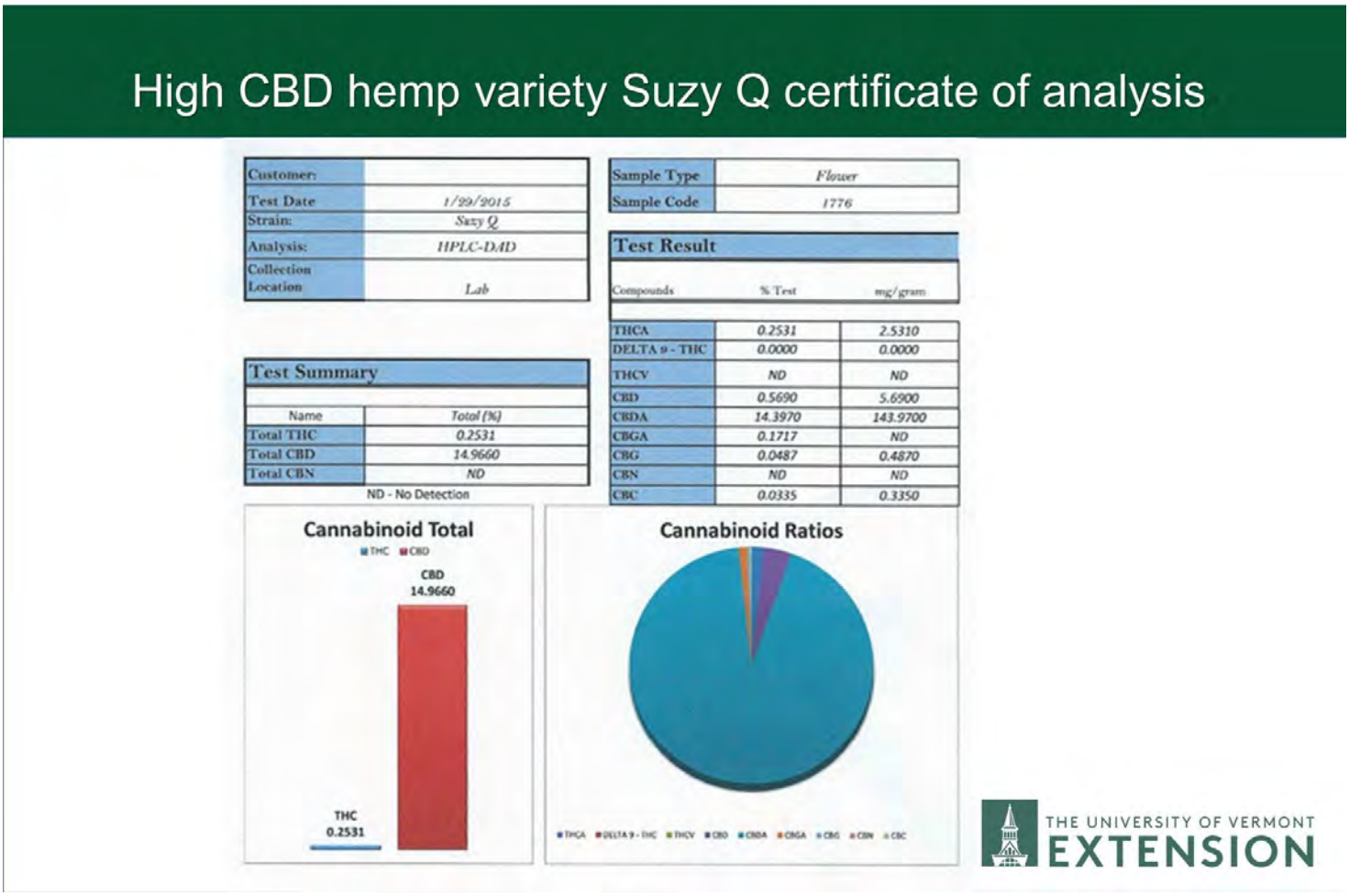


2018 Effect of temperature on total potential CBD

2019 CBD variety trial

- With increased access to seed and plant material there are a wide array of unknowns for CBD varieties on how they will react to our climate and how cannabinoid profiles will develop.
- Before growing any variety and determining you seed or plant source, it is important to request a certificate of analysis (COA) outlining cannabinoid profile to make sure you're growing a crop that will be less likely to exceed mandated <0.3% THC standards.

2019 CBD Variety Trial	
Variety	**Source**
AC/DC	VT Natural CBD
Cosmic	VT Natural CBD
Alexa	VT Natural CBD
Dave's Haze	VT Natural CBD
VT Cherry	VT Natural CBD
Wulf	VT Natural CBD
Boax Wine	VT Natural CBD
Suzy Q	VT Natural CBD
River Rock	Chimney Rock Farms
Cherry Blossom	Kanape Collective
RN-13	GoFarmHemp
Ceiba	Northern Roots Nursery
Cherry Ceiba	Northern Roots Nursery
Cherry Wine	Northern Roots Nursery
Boax	Northern Roots Nursery
Apollo	Davis Farms
Skipper	Davis Farms
Eighty-Eight	Davis Farms
Painted Lady	Davis Farms
Otakarek	Davis Farms



Additional examples of certificates of analysis for varieties within our 2019 variety trial included in "Resources" section.

2019 CBD variety trial

CBD Hemp Variety Trial
Planted 6/19/19
5' plant spacing
3 plants/plot
5' x 10' plots
Clones
Plots x13-x15 Seedlings

Hemp Indoor/Outdoor

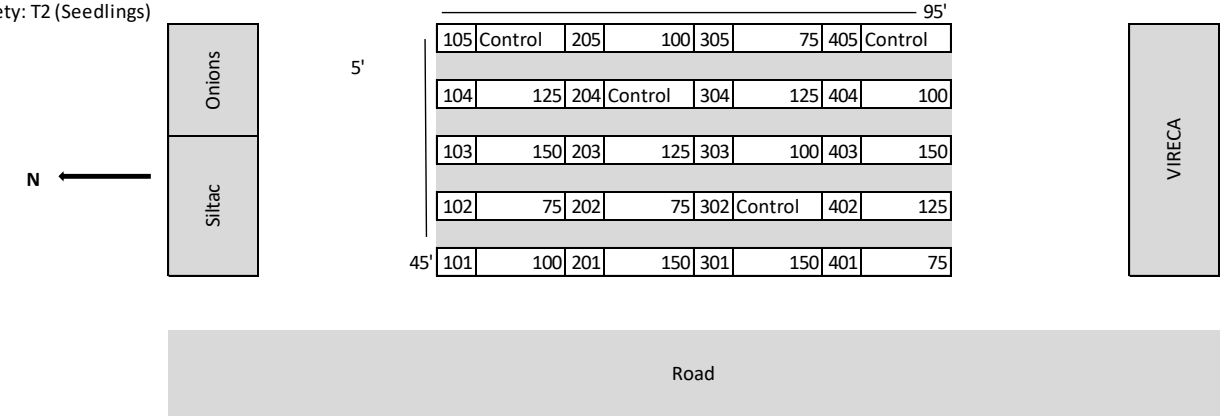
220'

N ⟵

101 VT Cherry	102 Alexa	103 RN13	104 Boax	105 Cherry Blo	106 River Rock	107 AC/DC	108 Wulf	109 Boax Wine	110 Daves Haze	111 Cosmic	112 Suzy Q	113 Cherry Wine	114 Ceiba	115 Cherry Ceiba
												CW1/CW2/CW3	C1/C2/C3	CC1/CC2
201 Cherry Blo	202 RN13	203 Suzy Q	204 Alexa	205 VT Cherry	206 Wulf	207 Boax	208 Daves Haze	209 River Rock	210 Cosmic	211 Boax Wine	212 AC/DC	213 Cherry Ceiba	214 Ceiba	215 Cherry Wine
												CC4/CC5/CC6	C4/C5/C6	CW4/CW5
301 VT Cherry	302 Daves Haze	303 Boax Wine	304 River Rock	305 Boax	306 Alexa	307 RN13	308 Wulf	309 Cherry Blossom	310 AC/DC	311 Cosmic	312 Suzy Q	313 Ceiba	314 Cherry Ceiba	315 Cherry Wine
												C7/C8/C9	CC7/CC8/CC9	CW6/CW7
401 AC/DC	402 Daves Haze	403 Boax Wine	404 VT Cherry	405 Alexa	406 River Rock	407 Suzy Q	408 Wulf	409 RN13	410 Cherry Bloss	411 Boax	412 Cosmic	413 Cherry Wine	414 Cherry Ceiba	415 Ceiba
												CW8/CW9/CW10	CC10/CC11/CC12	C10/C11
Onions							116 Apollo	119 Painted Lady	217 Skipper	220 Eighty-Eight	318 Painted Lady	416 Skipper	419 Eighty-Eight	
							117 Skipper	120 Otakarek	218 Apollo	316 Skipper	319 Otakarek	417 Painted Lady	420 Apollo	
							118 Eighty-Eight	216 Painted Lady	219 Otakarek	317 Apollo	320 Eighty-Eight	418 Otakarek		

2019 CBD Nitrogen fertility trial

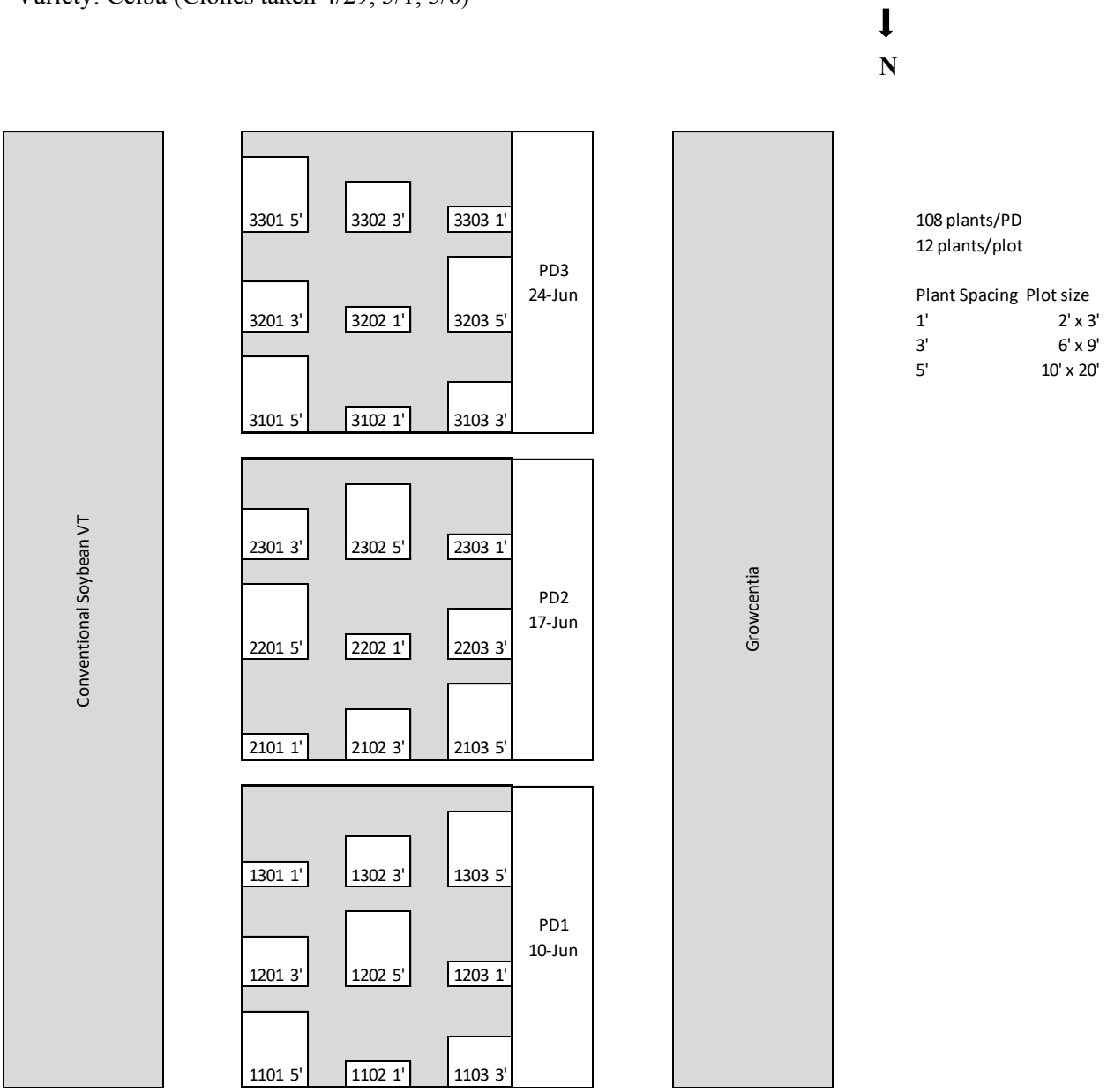
2019 CBD Nitrogen Fertility
Planted 6/19/19
5' plant spacing
5 plants / plot
5'x20' plot
Variety: T2 (Seedlings)



Nitrogen rate (#/ac)	ml/plant
Control (0)	0
75	6.27
100	8.36
125	10.46
150	12.53

2019 CBD Planting Date x Plant Spacing

PD1 - 6/10/19, PD2 - 6/17/19, PD3 - 6/24/19
12 plants per plot (3 plants wide x 4 plants long)
Planting date plots 28' x 65'
5' Buffer
Variety: Ceiba (Clones taken 4/29, 5/1, 5/6)

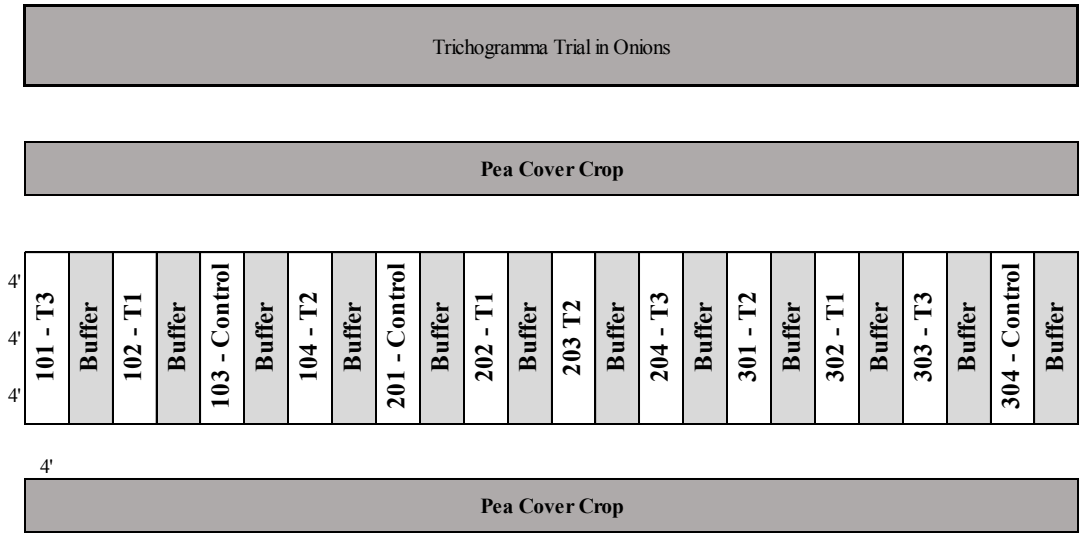


108 plants/PD
12 plants/plot

Plant Spacing	Plot size
1'	2' x 3'
3'	6' x 9'
5'	10' x 20'

2019 CBD Siltac trial

Siltac Trial
Planted 6/19/19
4' plant spacing
3 plants / plot
3 plant "plot buffer"
Variety: Boax (clones)
Cover crop planted:



Treatment	Rate (by volume)	Concentration ml /L
T1 - LN 1% PY	0.10%	1
T2 - LN 1% PY	0.15%	1.5
T3 - LN 1% PY	0.13%	1.25
Control - UTC	N/A	Buffered Spray Water

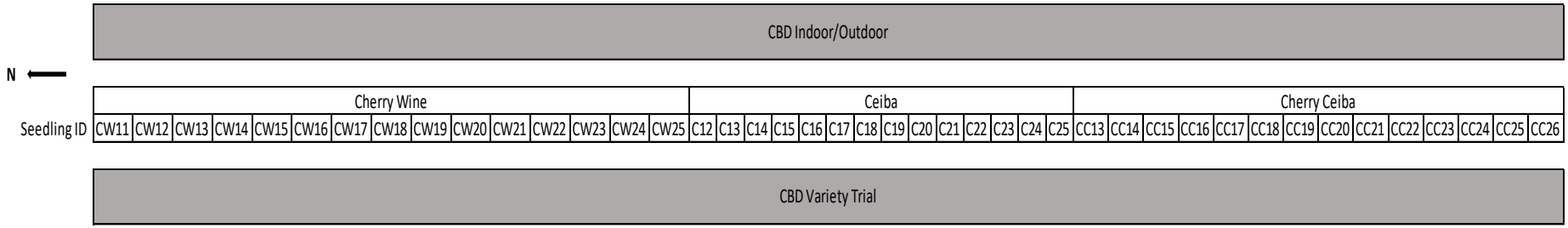
2019 CBD Seedling variability assessment

2019 CBD Seedling Assessment

Planted 6-19-19

5' plant spacing in row

Seedlings



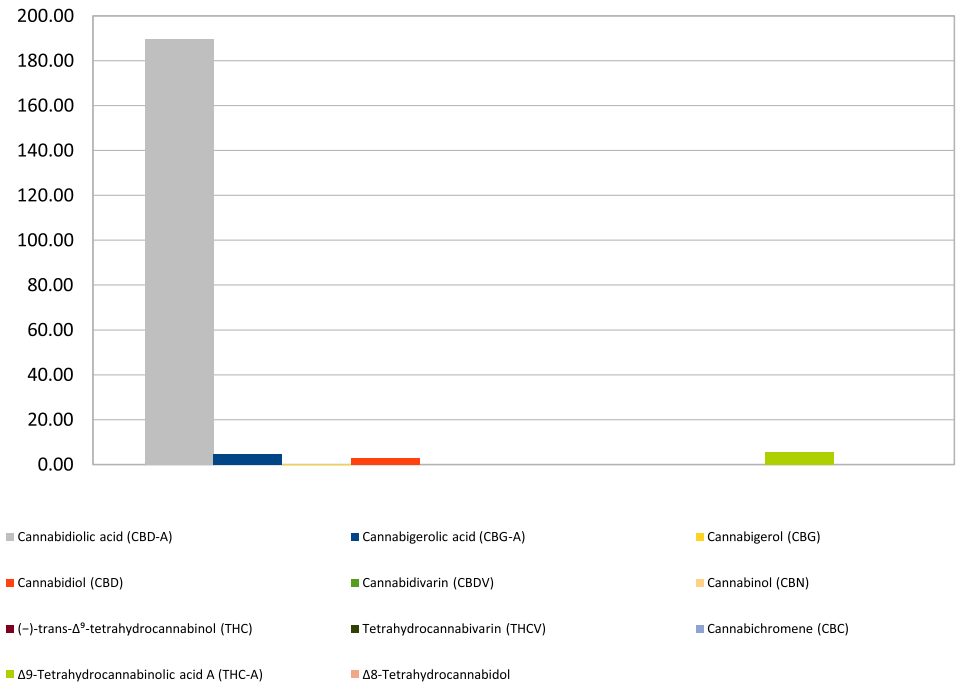
Cannabinoid Profile

Customer:	Go Farm Hemp
Customer Sample ID:	Relief Now J
Laboratory Number:	201812-0444
Extraction Technician:	RH
Analytical Chemist:	GB

Extraction Date(s):	Analysis Date(s)
12/11/2018	12/11/2018

Cannabinoid (HPLC)		Results	
	LOD (mg/g)	Percent	mg/g
Δ8-Tetrahydrocannabidol	<0.1		
Cannabidiolic acid (CBD-A)		18.99%	189.89
Cannabigerolic acid (CBG-A)		0.45%	4.48
Cannabigerol (CBG)		0.04%	0.36
Cannabidiol (CBD)		0.29%	2.85
Cannabidivarin (CBDV)	<0.1		
Cannabinol (CBN)	<0.1		
(−)-trans-Δ⁹-tetrahydrocannabinol (THC)	<0.1		
Tetrahydrocannabivarin (THCV)	<0.1		
Cannabichromene (CBC)	<0.1		
Δ9-Tetrahydrocannabinolic acid A (THC-A)		0.55%	5.45
Cannabinoids Total		**Percent**	**mg/g**
Max Active THC		**0.48%**	**4.78**
Max Active CBD		**16.94%**	**169.39**
T. Active Cannabinoids		**0.32%**	**3.22**
Total Cannabinoids		**20.30%**	**203.04**
Ratios			
35.36 :1 CBD to THC		**0.03 :1 THC to CBD**	

Cannabinoid (mg/g)



Altitude Consulting, LLC utilizes NIST traceable Reference Standards and Certified Reference Material to calibrate analytical instruments along with proven analytical methods.

The methods are applied in the most ethical manner following good laboratory practice guidelines. The results of this report are based solely on the sample submitted and cannot be reproduced.

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Certificate of Analysis

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http://www.juniperanalyticsllc.com
ORELAP: License # 4101-001

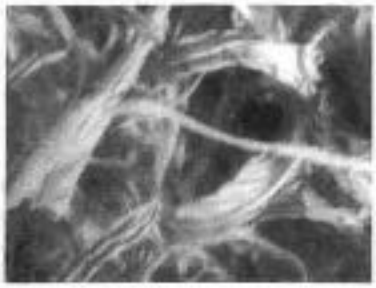
Davis Herb Farms
, OR 97702
(541) 480-9702
Lic. #

Sample: 18JA1801.13

Flower Potency - Not for Compliance - CAN, MC

Intake Date: 10/24/2018
Harvest/Prod. Date: 10/23/2018
Potency Analysis Date: 10/26/2018

Apollo



Cannabinoid Profile

0.265%
Total THC

7.924%
Total CBD

2.65 mg/g
Total THC mg/g

79.24 mg/g
Total CBD mg/g

Analyte	LOQ	Mass	Mass
	mg/g	%	mg/g
THCa	0.520	0.302	3.02
Δ9-THC	0.520	<LOQ	<LOQ
Δ8-THC	0.520	<LOQ	<LOQ
THCV	0.520	<LOQ	<LOQ
CBDa	0.520	8.903	89.03
CBD	0.520	0.116	1.16
CBN	0.520	<LOQ	<LOQ
CBG	0.520	<LOQ	<LOQ
CBC	0.520	0.154	1.54
Total		**9.475**	**94.75**

Total THC = THCa * 0.877 + Δ9-THC
Total CBD = CBDa * 0.877 + CBD
Instrument: HPLC/DAD; Method: JA-Potency-Proprietary; LOQ = Limit of Quantitation; The reported result is based on a sample weight with the applicable moisture content for that sample; Unless otherwise stated all quality control samples performed within specifications established by the Laboratory. Potency Analysis (Oregon Compliance Standard OAR 333-007-0430).

Ben Armstrong
QA Review

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Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

Grower:
Heather Darby
278 South Main St
Saint Albans, VT 5478
hdarby@uvm.edu
rhonda.true@uvm.edu

Sample ID: SS1455
Field ID: Main Field
Date Sampled: 04/22/2019
Given Soil Type: BeC
Crops Grown: HPT/HPT/HPT
Tillage: no till
Coordinates: Latitude: 45.009564000000
Longitude: -73.308767000000

Measured Soil Textural Class: **loam**

Sand: **44%** - Silt: **38%** - Clay: **17%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	**0.27**	**94**	
physical	Surface Hardness	**90**	**80**	
physical	Subsurface Hardness	**184**	**85**	
physical	Aggregate Stability	**66.7**	**97**	
biological	Organic Matter	**11.0**	**100**	
biological	ACE Soil Protein Index	**17.5**	**99**	
biological	Soil Respiration	**1.3**	**99**	
biological	Active Carbon	**1368**	**99**	
chemical	Soil pH	**7.3**	**100**	
chemical	Extractable Phosphorus	**31.1**	**30**	
chemical	Extractable Potassium	**154.1**	**100**	
chemical	Minor Elements Mg: 202.7 / Fe: 0.4 / Mn: 22.7 / Zn: 4.3		**100**	

Overall Quality Score: **90** / Very High

Measured Soil Health Indicators

The Cornell Soil Health Test measures several indicators of soil physical, biological and chemical health. These are listed on the left side of the report summary, on the first page. The "value" column shows each result as a value, measured in the laboratory or in the field, in units of measure as described in the indicator summaries below. The "rating" column interprets that measured value on a scale of 0 to 100, where higher scores are better. Ratings in red are particularly important to take note of, but any in yellow, particularly those that are close to a rating of 30 are also important in addressing soil health problems.

- **A rating below 20 indicates *Very Low (constraining)* functioning and is color-coded red.** This indicates a problem that is likely limiting yields, crop quality, and long-term sustainability of the agroecosystem. In several cases this indicates risks of environmental loss as well. The "constraint" column provides a short list of soil processes that are not functioning optimally when an indicator rating is red. It is particularly important to take advantage of any opportunities to improve management that will address these constraints.
- **A rating between 20 and 40 indicates *Low* functioning and is color-coded orange.** This indicates that a soil process is functioning somewhat poorly and addressing this should be considered in the field management plan. The Management Suggestions Table at the end of the Soil Health Assessment Report provides linkages to field management practices that are useful in addressing each soil indicator process.
- **A rating between 40 and 60 indicates *Medium* functioning and is color-coded yellow.** This indicates that soil health could be better, and yield and sustainability could decrease over time if this is not addressed. This is especially so if the condition is being caused, or not being alleviated, by current management. Pay attention particularly to those indicators rated in yellow and close to 40.
- **A rating between 60 and 80 indicates *High* functioning and is color-coded light green.** This indicates that this soil process is functioning at a non-limiting level. Field soil management approaches should be maintained at the current intensity or improved.
- **A rating of 80 or greater indicates *Very High* functioning and is color-coded dark green.** Past management has been effective at maintaining soil health. It can be useful to note which particular aspects of management have likely maintained soil health, so that such management can be continued. Note that soil health is often high, when first converting from a permanent sod or forest. In these situations, intensive management quickly damages soil health when it includes intensive tillage, low organic matter inputs, bare soils for significant parts of the year, or excessive traffic, especially during wet times.
- **The Overall Quality Score** at the bottom of the report is an average of all ratings, and provides an indication of the soil's overall health status. However, the important part is to know which particular soil processes are constrained or suboptimal so that these issues can be addressed through appropriate management. Therefore the ratings for each indicator are more important information.

The Indicators measured in the Cornell Soil Health Assessment are important soil properties and characteristics in themselves, but also are representative of key soil processes, necessary for the proper functioning of the soil. The following is a summary of the indicators measured, what each of these indicates about your soil's health status, and what may influence the relevant properties and processes described.

A Management Suggestions Table follows, at the end of the report, with short and long term

suggestions for addressing constraints or maintaining a well-functioning system. This table will indicate constraints identified in this assessment for your soil sample by the same yellow and red color coding described above. Please also find further useful information by following the links to relevant publications and web resources that follow this section.

Texture is an inherent property of soil, meaning that it is rarely changed by management. It is thus not a soil health indicator per se, but is helpful both in interpreting the measured values of indicators (see the Cornell Soil Health Assessment Training Manual), and for deciding on appropriate management strategies that will work for that soil.

> **Your soil's measured textural class and composition: loam**
>
> **Sand: 44% Silt: 38% Clay: 17%**

Predicted Available Water Capacity (AWC) is not a directly measured soil property but is modeled from a suite of measured soil health indicators including the percent sand, silt, clay and organic matter. By using a decision tree approach, the developed Random Forest model can predict the laboratory measured AWC value with no more error than that encountered in the raw laboratory analysis. Details of this modeling effort can be found in our Soil Health Management Series Fact Sheet Number 19-05b.

https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/f/5772/files/2016/12/05b_Soil_Health_Fact_Sheet_Available_Water_Capacity-Predicted-2019-002-132f3th.pdf

The Soil Health Lab continues to offer the laboratory measured AWC test as an add-on to the soil health package analyses.

The Predicted AWC value is presented as grams of water per gram of soil. This value is scored against an observed distribution in regional soils with similar texture. A physical soil characteristic, AWC is an indicator of the amount of plant-available water the soil can store, and therefore how crops will fare in droughty conditions. Soils with lower storage capacity will cause greater risk of drought stress. AWC is generally lower when total organic matter and/or aggregation is low. It can be improved by reducing tillage, long-term cover cropping, and adding large amounts of well-decomposed organic matter such as compost. Coarse textured (sandy) soils inherently store less water than finer textured soils, so that managing for relatively high water storage capacity is particularly important in coarse textured soils. While the textural effect cannot be influenced by management, management decisions can be in part based on an understanding of inherent soil characteristics.

> **Your Predicted Available Water Capacity value** is **0.27 g/g**, corresponding with a score of **94**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Surface Hardness is a measure of compaction that develops when large pores are lost in the surface soil (0-6 inches). Compaction is measured in the field using a penetrometer, and the resultant value is expressed in pounds per square inch (p.s.i.), representing the localized pressure necessary to break forward through soil. It is scored by comparison with a distribution observed in regional soils, with lower hardness values rating higher scores. A strongly physical characteristic of

soils, surface hardness is an indicator of both physical and biological health of the soil, as growing roots and fungal hyphae must be able to grow through soil, and may be severely restricted by excessively hard soil. Compaction also influences water movement through soil. When surface soils are compacted, runoff, erosion, and slow infiltration can result. Soil compaction is influenced by management, particularly in timing and degree of traffic and plowing disturbance, being worst when the soil is worked wet.

> **Your measured Surface Hardness value** is **90 p.s.i.**, corresponding with a score of **80**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Subsurface Hardness is a measure of compaction that develops when large pores are lost in the subsurface soil (6-18 inches). Subsurface hardness is measured and scored similarly to surface hardness, but deeper in the profile, and scored against an observed distribution in regional soils with similar texture. Large pores are necessary for water and air movement and to allow roots to explorethe soil. Subsurface hardness prevents deep rooting and thus deep water and nutrient uptake by plants, and can increase disease pressure by stressing plants. It also causes poor drainage and poor deep water storage. After heavy rain events, water can build up over a hard pan causing poor aeration both at depth and at the surface, as well as ponding, poor infiltration, runoff and erosion. Impaired water movement and storage create greater risk during heavy rainfall events, as well as greater risk of drought stress. Compaction occurs very rapidly when the soil is worked or trafficked while it is too wet, and compaction can be transferred deep into the soil even from surface pressure. Subsoil compaction in the form of a plow pan is usually found beneath the plow layer, and is caused by smearing and pressure exerted on the undisturbed soil just beneath the deepest tillage operation, especially when wet.

> **Your measured Subsurface Hardness value** is **184 p.s.i.**, corresponding with a score of **85**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Aggregate Stability is a measure of how well soil aggregates or crumbs hold together under rainfall or other rapid wetting stresses. Measured by the fraction of dried aggregates that disintegrate under a controlled, simulated rainfall event similar in energy delivery to a hard spring rain, the value is presented as a percent, and scored against a distribution observed in regional soils with similar textural characteristics. A physical characteristic of soil, Aggregate Stability is a good indicator of soil biological and physical health. Good aggregate stability helps prevent crusting, runoff, and erosion, and facilitates aeration, infiltration, and water storage, along with improving seed germination and root and microbial health. Aggregate stability is influenced by microbial activity, as aggregates are largely held together by microbial colonies and exudates, and is impacted by management practices, particularly tillage, cover cropping, and fresh organic matter additions.

> **Your measured Aggregate Stability value** is **66.7 %**, corresponding with a score of **97**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the

management suggestions table at the end of this document.

Organic Matter (OM) is a measure of the carbonaceous material in the soil that is biomass or biomass-derived. Measured by the mass lost on combustion of oven-dried soil, the value is presented as a percent of the total soil mass. This is scored against an observed distribution of OM in regional soils with similar texture. A soil characteristic that measures a physical substance of biological origin, OM is a key or central indicator of the physical, biological, and chemical health of the soil. OM content is an important influence on soil aggregate stabilization, water retention, nutrient cycling, and ion exchange capacity. OM acts as a long-term slow-release pool for nutrients. Soils with low organic matter tend to require higher inputs, and be less resilient to drought and extreme rainfall. OM is directly derived from biomass of microbial communities in the soil (bacterial, fungal, and protozoan), as well as from plant roots and detritus, and biomass-containing amendments like manure, green manures, mulches, composts, and crop residues. The retention and accumulation of OM is influenced by management practices such as tillage and cover cropping, as well as by microbial community growth. Intensive tillage and lack of organic matter additions from various sources (amendments, residues, active crop or cover crop growth) will decrease organic matter content and overall soil health with time.

> **Your measured Organic Matter value** is **11.0 %**, corresponding with a score of **100**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Soil Proteins are the fraction of the soil organic matter that are present as proteins or protein-like substances. This represents the large pool of organically bound N in the SOM, which microbial activity can mineralize, and make available for plant uptake. Measured by extraction with a citrate buffer under high temperature and pressure (hence Autoclave Citrate Extractable, or ACE proteins), the value given is expressed in mg extracted per gram of soil. As the method used extracts only a readily extractable fraction of the total amount of soil proteins in the SOM, we present this value as an index rather than as an absolute quantity. A measure of a physical substance, protein content is an indicator of the biological and chemical health of the soil, and is very well associated with overall soil health status. Protein content, as organically bound N, influences the ability of the soil to make N available by mineralization, and has been associated with soil aggregation and water movement. Protein content can be influenced by biomass additions, the presence of roots and soil microbes, and tends to decrease with increasing soil disturbance such as tillage.

> **Your measured ACE Soil Protein Index value** is **17.5** , corresponding with a score of **99**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Soil Respiration is a measure of the metabolic activity of the soil microbial community. Measuredby capturing and quantifying carbon dioxide (CO 2) produced by this activity, the value is expressed as total CO 2 released (in mg) per gram of soil over a 4 day incubation period. Respiration is scored against an observed distribution in regional soils, taking texture into account. A direct biological activity measurement, respiration is an indicator of the biological status of the soil community, integrating abundance and activity of microbial life. Soil biological activity accomplishes numerous important functions, such as cycling of nutrients into and out of soil OM

pools, transformations of N between its several forms, and decomposition of incorporated residues. Soil biological activity influences key physical characteristics like OM accumulation, and aggregate formation and stabilization. Microbial activity is influenced by management practices such as tillage, cover cropping, manure or green manure incorporation, and biocide (pesticide, fungicide, herbicide) use.

> **Your measured Soil Respiration value** is **1.3 mg**, corresponding with a score of **99**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Active Carbon is a measure of the small portion of the organic matter that can serve as an easily available food source for soil microbes, thus helping maintain a healthy soil food web. Measured by potassium permanganate oxidation, the value is presented in parts per million (ppm), and scored against an observed distribution in regional soils with similar texture. While a measure of a class of physical substances, active carbon is a good leading indicator of biological soil health and tends to respond to changes in management earlier than total organic matter content, because when a large population of soil microbes is fed plentifully with enough organic matter over an extended period of time, well-decomposed organic matter builds up. A healthy and diverse microbial community is essential to maintain disease resistance, nutrient cycling, aggregation, and many other important functions. Intensive tillage and lack of organic matter additions from various sources (amendments, residues, active crop or cover crop growth) will decrease active carbon, and thus will over the longer term decrease total organic matter.

> **Your measured Active Carbon value** is **1368 ppm**, corresponding with a score of **99**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Soil pH is a measure of how acidic the soil is, which controls how available nutrients are to crops. A physico-chemical characteristic of soils, pH is an indicator of the chemical or nutrient status of the soil. Measured with an electrode in a 1:1 soil:water suspension, the value is presented in standard pH units, and scored using an optimality curve. Optimum pH is around 6.2-6.8 for most crops (exceptions include potatoes and blueberries, which grow best in more acidic soil – this is not accounted for in the report interpretation). If pH is too high, nutrients such as phosphorus, iron, manganese, copper and boron become unavailable to the crop. If pH is too low, calcium, magnesium, phosphorus, potassium and molybdenum become unavailable. Lack of nutrient availability will limit crop yields and quality. Aluminum toxicity can also be a concern in low pH soils, which can severely decrease root growth and yield, and in some cases lead to accumulation of aluminum and other metals in crop tissue. In general, as soil OM increases, crops can tolerate lower soil pH. Soil pH also influences the ability of certain pathogens to thrive, and of beneficial organisms to effectively colonize roots. Raising the pH through lime or wood ash applications, and organic matter additions, will help immobilize aluminum andheavy metals, and maintain proper nutrient availability.

> **Your measured Soil pH value** is **7.3** , corresponding with a score of **100**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it**

currently indicates ideal soil functioning. Please refer to the management suggestions table at the end of this document.

Extractable Phosphorus is a measure of phosphorus (P) availability to a crop. Measured on a modified Morgan's extractant, using a rapid-flow analyzer, the value is presented in parts per million (ppm), and scored against an optimality curve for sufficiency or excess. P is an essential plant macronutrient, and its availability varies with soil pH and mineral composition. Low P values indicate poor P availability to plants, and excessively high P values indicates a risk of adverse environmental impact through runoff and contamination of surface waters. Most soils in the Northeast store unavailable P from the soil's mineral make up or from previously applied fertilizer or manure. This becomes more available to plants as soils warm up. Therefore, incorporating or banding 10-25 lbs/acre of soluble 'starter' P fertilizer at planting can be useful even when soil levels are optimum. Some cover crops, such as buckwheat, are good at mining otherwise unavailable P so that it becomes more available to the following crop. When plants associate with mycorrhizal fungi, these can also help make P (and other nutrients and water) more available to the crop. P is an environmental contaminant and runoff of P into fresh surface water will cause damage through eutrophication, so over-application is strongly discouraged, especially close to surface water, on slopes, and on large scales.

Your measured Extractable Phosphorus value is **31.1 ppm**, corresponding with a score of **30**. This score is in the **Low** range, relative to soils with similar texture. **This suggests that, while Extractable Phosphorus does not currently register as a strong constraint, management practices should be geared toward improving this condition, as it currently indicates suboptimal functioning.** Please refer to the management suggestions table at the end of this document.

Extractable Potassium is a measure of potassium (K) availability to the crop. Measured on a modified Morgan's extract using an ICP Spectrometer, the value is presented in parts per million (ppm), and scored against an optimality curve for sufficiency. K is an indicator of soil nutrient status, as it is an essential plant macronutrient. Plants with higher potassium tend to be more tolerant of frost and cold. Thus good potassium levels may help with season extension. While soil pH only marginally affects K availability, K is easily leached from sandy soils and is only weakly held by increased organic matter, so that applications of the amount removed by the specific crop being grown are generally necessary in such soils.

Your measured Extractable Potassium value is **154.1 ppm**, corresponding with a score of **100**. This score is in the **Very High** range, relative to soils with similar texture. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Minor Elements, also called secondary (calcium, magnesium and sulfur) and micro (iron, manganese, zinc, copper, boron, molybdenum, etc.) nutrients are essential plant nutrients taken up by plants in smaller quantities than the macro nutrients N, P and K. If any minor elements are deficient, this will decrease yield and crop quality, but toxicities can also occur when concentrationsare too high. This assessment's minor elements rating indicates whether four measured micronutrients (magnesium, iron, manganese, and zinc) are deficient or excessive. Micronutrient availability is strongly influenced by pH and organic matter. Low pH increases the availability of most micronutrients, whereas high pH increases the availability of molybdenum, magnesium and calcium. High OM and microbial activity tend to increase micronutrient availability.

Note that this test does not measure all important micronutrients. Consider submitting a sample for a complete micronutrient analysis to find out the levels of the other micronutrients.

> **Your measured Minor Elements Rating** is **100**. This score is in the **Very High** range. Magnesium (202.7 ppm) is sufficient, Iron (0.4 ppm) is sufficient, Manganese (22.7 ppm) is sufficient, Zinc (4.3 ppm) is sufficient. **This suggests that management practices should be geared toward maintaining this condition, as it currently indicates ideal soil functioning.** Please refer to the management suggestions table at the end of this document.

Overall Quality Score: an overall quality score is computed from the individual indicator scores. This score is further rated as follows: less than 20% is regarded as very low, 20-40% is low, 40-60% is medium, 60-80% is high, and greater than 80% is very high. The highest possible quality score is 100 and the least score is 0, thus it is a relative overall soil health status indicator. However, of greater importance than a single overall metric is identification of constrained or suboptimally functioning soil processes, so that these issues can be addressed through appropriate management. The overall soil quality score should be taken as a general summary rather than the main focus.

> **Your Overall Quality Score** is **90**, which is in the **Very High** range.

Management Suggestions for Physical and Biological Constraints

Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Predicted Available Water Capacity Low	• Add stable organic materials, mulch • Add compost or biochar • Incorporate high biomass cover crop	• Reduce tillage • Rotate with sod crops • Incorporate high biomass cover crop
Surface Hardness High	• Perform some mechanical soil loosening (strip till, aerators, broadfork, spader) • Use shallow-rooted cover crops • Use a living mulch or interseed cover crop	• Shallow-rooted cover/rotation crops • Avoid traffic on wet soils, monitor • Avoid excessive traffic/tillage/loads • Use controlled traffic patterns/lanes
Subsurface Hardness High	• Use targeted deep tillage (subsoiler, yeomans plow, chisel plow, spader.) • Plant deep rooted cover crops/radish	• Avoid plows/disks that create pans • Avoid heavy loads • Reduce traffic when subsoil is wet
Aggregate Stability Low	• Incorporate fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch	• Reduce tillage • Use a surface mulch • Rotate with sod crops and mycorrhizal hosts
Organic Matter Low	• Add stable organic materials, mulch • Add compost and biochar • Incorporate high biomass cover crop	• Reduce tillage/mechanical cultivation • Rotate with sod crop • Incorporate high biomass cover crop
ACE Soil Protein Index Low	• Add N-rich organic matter (low C:N source like manure, high N well-finished compost) • Incorporate young, green, cover crop biomass • Plant legumes and grass-legume mixtures • Inoculate legume seed with Rhizobia & check for nodulation	• Reduce tillage • Rotate with forage legume sod crop • Cover crop and add fresh manure • Keep pH at 6.2-6.5 (helps N fixation) • Monitor C:N ratio of inputs
Soil Respiration Low	• Maintain plant cover throughout season • Add fresh organic materials • Add manure, green manure • Consider reducing biocide usage	• Reduce tillage/mechanical cultivation • Increase rotational diversity • Maintain plant cover throughout season • Cover crop with symbiotic host plants
Active Carbon Low	• Add fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch	• Reduce tillage/mechanical cultivation • Rotate with sod crop • Cover crop whenever possible

Management Suggestions for Chemical Constraints

Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Soil pH Low	• Add lime or wood ash per soil test recommendations • Add calcium sulfate (gypsum) in addition to lime if aluminum is high • Use less ammonium or urea	• Test soil annually & add "maintenance" lime per soil test recommendations to keep pH in range • Raise organic matter to improve buffering capacity
Soil pH High	• Stop adding lime or wood ash • Add elemental sulfur per soil test recommendations	• Test soil annually • Use higher % ammonium or urea
Extractable Phosphorus Low	• Add P amendments per soil test recommendations • Use cover crops to recycle fixed P • Adjust pH to 6.2-6.5 to free up fixed P	• Promote mycorrhizal populations • Maintain a pH of 6.2-6.5 • Use cover crops to recycle fixed P
Extractable Phosphorus High	• Stop adding manure and compost • Choose low or no-P fertilizer blend • Apply only 20 lbs/ac starter P if needed • Apply P at or below crop removal rates	• Use cover crops that accumulate P and export to low P fields or offsite • Consider low P rations for livestock • Consider phytase for non-ruminants
Extractable Potassium Low	• Add wood ash, fertilizer, manure, or compost per soil test recommendations • Use cover crops to recycle K • Choose a high K fertilizer blend	• Use cover crops to recycle K • Add "maintenance" K per soil recommendations each year to keep K consistently available
Minor Elements Low	• Add chelated micros per soil test recommendations • Use cover crops to recycle micronutrients • Do not exceed pH 6.5 for most crops	• Promote mycorrhizal populations • Improve organic matter • Decrease soil P (binds micros)
Minor Elements High	• Raise pH to 6.2-6.5 (for all high micros except Molybdenum) • Do not use fertilizers with micronutrients	• Maintain a pH of 6.2-6.5 • Monitor irrigation/improve drainage • Improve soil calcium levels

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2018 Cannabidiol Hemp
Plant Spacing x Planting Date Trial

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2018 CANNABIDIOL HEMP PLANT SPACING X PLANTING DATE TRIAL

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Hemp is a non-psychoactive variety of *cannabis sativa L*. The crop is one of historical importance in the U.S. and re-emerging worldwide importance as medical providers and manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. Hemp grown for all types of end-use (health supplement, fiber, and seed) contains less than 0.3% tetrahydrocannabinol (THC). Some hemp varieties intended to produce a health supplement contain relatively high concentrations of a compound called cannabidiol (CBD), potentially 10-15%. The compound CBD has purported benefits such as relief from inflammation, pain, anxiety, seizures, spasms, and other conditions. The CBD compound is the most concentrated in the female flower buds of the plant, however, it is also in the leaves and other plant parts as well. To grow hemp for CBD production, the crop is generally grown intensively as a specialty crop and the flowers are cultivated for maximum growth. The CBD oil is extracted and incorporated into topical products (salves, lip balm, lotion) and food and is available in pill capsules, powder form, and more, which can be found in the market today. Industrial hemp is poised to be a "new" cash crop and market opportunity for Vermont farms that is versatile and suitable as a rotation crop with other specialty crops, small grains, and grasses.

To help farmers succeed, agronomic research on hemp being grown for CBD extraction is needed in our region. We evaluated three plant spacings (1x1', 3x3', 5x5') and planting dates (14-Jun, 21-Jun, and 27-Jun) to determine best management practices for hemp grown for CBD production in this region.

MATERIALS AND METHODS

The CBD hemp was grown at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact of plant spacing and planting date on CBD flower yield. Female plants grown from clonal propagation of the CBD variety, Boax, were planted on 14-Jun, 21-Jun, and 27-Jun (Image 1).

Table 1. Agronomic information for the CBD hemp plant spacing by planting date trial 2018, Alburgh, VT.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Silage corn
Plant spacing (ft)	1x1, 3x3, and 5x5
Planting date	14-Jun, 21-Jun, and 27-Jun
Fertilization	150 lbs N ac^{-1}, 70 lbs P ac^{-1}, 70 lbs K ac^{-1}
Harvest date	16-Oct

Image 1. The CBD hemp plant spacing by planting date trial plots, Alburgh, VT, 2018.

On 27-Jun, the plots were fertilized with 100 lbs N ac^{-1}, 70 lbs P ac^{-1}, 70 lbs K ac^{-1}, using Kreher's poultry manure (5-4-3) and Pro-Gro (5-3-4). An additional 50 lbs N ac^{-1} was applied on 20-Jul in the form of sodium nitrate (16-0-0). On 15-Oct, plant height was measured from the two middle plants of each plot. The plants were harvested by hand on 16-Oct by first using a chainsaw to cut down the entire plant. The whole plant weight was recorded. Then the plant was broken down into smaller branched sections and larger "fan" or "sun" leaves were removed, while smaller leaves were left attached since they subtend from the flower bract. Flower buds were removed by hand and by using the EZTrim Debudder (Broomfield, CO). Wet bud weight and unmarketable bud weight were recorded. The flower buds were then dried at 80° F until dry enough for storage without molding. A subsample of flower bud from each plant spacing at each planting date was dried in a small dehydrator and wet weights and dry weights were recorded in order to calculate the percent moisture of the flower buds. The percent moisture was used to calculate dry matter yields.

For each planting date and plant spacing, the data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$). Data was analyzed using the PROC MIXED procedure in SAS with the Tukey-Kramer adjustment, which means that each variable was analyzed with a pairwise comparison (i.e. 'planting date 1' statistically outperformed

'planting date 2', 'planting date 2' statistically outperformed 'planting date 3', etc.). Relationships between variables were analyzed using the GLM procedure.

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 a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown, except where analyzed by pairwise comparison (t-test). 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 treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid 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 hybrids 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 of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 2).

Table 2. Seasonal weather data collected in Alburgh, VT, 2018.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	64.4	74.1	72.8	63.4	45.8
Departure from normal	-1.38	3.51	3.96	2.76	-2.36
Precipitation (inches)	3.70	2.40	3.00	3.50	3.50
Departure from normal	0.05	-1.72	-0.95	-0.16	-0.07
Growing Degree Days (base 50°F)	447	728	696	427	81
Departure from normal	-27	88	115	109	81

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

The summer months were considered hot and dry when compared to the 30-year average. July through September were an average of 3.41° F warmer and received only 60% of normal precipitation. The tail end of the season received an expected amount of precipitation; however, it was cooler than historical averages. Overall, there were an accumulated 2379 Growing Degree Days (GDDs) this season, approximately 366 more than the historical average, with much of the heat coming mid-season. There was no additional water applied to hemp plants outside of natural rainfall.

Plant spacing results

Table 3. Plant spacing effect on plant weight and height, Alburgh, VT, 2018.

Plant spacing	Plant weight	Plant height
ft x ft	**lbs plant^{-1}**	**Cm**
1 x 1	0.640c‡	75.8
3 x 3	4.66b	81.2
5 x 5	**9.11a**	79.4
LSD (0.10)	**0.734**	**NS**
Trial mean	**4.80**	**78.8**

‡ Within a column treatments marked with the same letter were statistically similar (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

The 5'x5' spaced plants weighed significantly more than the 1'x'1 and 3'x3' spaced plants, since these plants had more room to grow per plant (Table 3). The average weight of a 5'x5' spaced plant was 9.11 lbs.

Table 4. Plant spacing effect on flower yield, Alburgh, VT, 2018.

Plant spacing	Dry matter flower yield†	Unmarketable dry matter flower yield†	Dry matter flower yield†	Unmarketable dry matter flower yield†
ft x ft	**lbs plant^{-1}**	**lbs plant^{-1}**	**lbs ac^{-1}**	**lbs ac^{-1}**
1 x 1	0.084c‡	**0.00a**	**3669a**	**7.16a**
3 x 3	0.600b	0.003a	2894b	12.4a
5 x 5	**1.35a**	0.049b	2354c	86.6b
LSD (0.10)	**0.093**	**0.019**	**411**	**35.9**
Trial mean	**0.678**	**0.017**	**2973**	**35.4**

† Dry matter is at 0% moisture.
‡ Within a column treatments marked with the same letter were statistically similar (p=0.10).

On a per acre basis, the 1'x1' had the best yield and least amount of unmarketable flower buds (Table 4). The 1'x1' spacing yielded 3669 lbs ac^{-1} of dry flower bud. The 3'x3' spacing had a comparably low amount of unmarketable flower buds. On a per plant basis, the 5'x5' spacing had the best yield of 1.35 lbs plant^{-1} and also had the highest amount of unmarketable flower buds. This larger plant had more branches that were near or touching the ground. Given the rainy fall, the lower branches and flower buds of these hemp plants became contaminated with soil. Hence, the unmarketable yield was primarily due to soil contaminated of the flower buds.

Planting date results

The plants planted on 14-Jun and 21-Jun weighed more than the plants planted on 27-Jun (Table 5). This is likely due to the earlier plantings experiencing a longer growing season.

Table 5. Planting date effect on plant weight and height, Alburgh, VT, 2018.

Planting date	Plant weight	Plant height
	lbs plant^{-1}	Cm
14-Jun	**5.38a**ŧ	82.1
21-Jun	4.83ab	80.5
27-Jun	4.20b	73.8
LSD (0.10)	**0.734**	**NS**
Trial mean	**78.8**	**4.80**

ŧ Within a column treatments marked with the same letter were statistically similar (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

When averaged across all plants spacings, there were no significant differences observed between planting dates for flower yield (Table 6). There was a significant plant spacing * planting date interaction indicating that plant spacing responded differently between plant dates. Data was analyzed for statistical significance by each individual planting date.

Table 6. Planting date effect on flower yield, Alburgh, VT, 2018.

Planting date	Dry matter flower yield†	Unmarketable dry matter flower yield	Dry matter flower yield	Unmarketable dry matter flower yield
	lbs plant^{-1}	lbs plant^{-1}	lbs ac^{-1}	lbs ac^{-1}
14-Jun	0.740	0.0151	2920	38.9
21-Jun	0.672	0.0223	3243	39.4
27-Jun	0.621	0.0149	2755	27.9
LSD (0.10)	**NS**	**NS**	**NS**	**NS**
Trial mean	**0.678**	**0.0174**	**2973**	**35.4**

† Dry matter is at 0% moisture.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Results for each planting date

Within the 14-Jun planting, the 5'x5' spaced plants showed the best yields and highest amount of unmarketable buds, on a per plant basis (Table 7). There were no significant differences between the plant spacing on a per acre basis.

Table 7. Plant spacing effect on yield and plant weight for the 14-Jun planting, Alburgh, VT, 2018.

Plant spacing	Plant weight	Dry matter flower yield†	Unmarketable dry matter flower yield	Dry matter flower yield	Unmarketable dry matter flower yield
ft x ft	lbs plant^{-1}	lbs plant^{-1}	lbs plant^{-1}	lbs ac^{-1}	lbs ac^{-1}
1 x 1	0.507c	0.066c	**0.000493a**	2893	21.4
3 x 3	5.00b	0.682b	0.00531b	3303	25.7
5 x 5	**10.6a**ŧ	**1.47a**	0.0397c	2563	69.1
LSD (0.10)	**1.04**	**0.0931**	**0.00335**	**NS**	**NS**
Trial mean	**5.38**	**0.740**	**0.0152**	**2920**	**116**

† Dry matter is at 0% moisture.
ŧ Within a column treatments marked with the same letter were statistically similar (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Within the 21-Jun planting, the 1'x1' spacing had the best yield and least amount of unmarketable buds, on a per acre basis (Table 8). The average yield for the 1'x1' spacing was 4647 lbs ac^{-1} of flower bud. The 3'x3'plant spacing had a comparably low amount of unmarketable buds, on a per acre basis. On a per plant basis, the 5'x5' spacing had the best yield, while the 1'x1' and 3'x3'spacing had the lowest amount of unmarketable flower bud.

Table 8. Plant spacing effect on yield and plant weight for the 21-Jun planting, Alburgh, VT, 2018.

Plant spacing	Plant weight	Dry matter flower yield†	Unmarketable dry matter flower yield	Dry matter flower yield	Unmarketable dry matter flower bud
ft x ft	lbs $plant^{-1}$	lbs $plant^{-1}$	lbs $plant^{-1}$	lbs ac^{-1}	lbs ac^{-1}
1 x 1	0.855c	0.107c	**0.00a**	**4647a**	**0.00a**
3 x 3	4.47b	0.567b	0.000531a	2742b	2.57a
5 x 5	**9.17a**ŧ	**1.34a**	0.0665b	2340b	116b
LSD (0.10)	**0.742**	**0.100**	**0.0458**	**657**	**79.3**
Trial mean	**4.83**	**0.672**	**0.0223**	**3243**	**35.4**

† Dry matter is at 0% moisture.
ŧ Within a column treatments marked with the same letter were statistically similar (p=0.10).

Within the 27-Jun planting, the 5'x5' spacing had the best yield and greatest amount of unmarketable buds on a per plant basis (Table 9).

Table 9. Plant spacing effect on yield and plant weight for the 27-Jun planting, Alburgh, VT, 2018.

Plant spacing	Plant weight	Dry matter flower yield†	Unmarketable dry matter flower yield	Dry matter flower yield	Unmarketable dry matter flower yield
ft x ft	lbs $plant^{-1}$	lbs $plant^{-1}$	lbs $plant^{-1}$	lbs ac^{-1}	lbs ac^{-1}
1 x 1	0.559c	0.0796b	**0.00a**	3468	**0.00a**
3 x 3	4.50b	0.545b	0.00181b	2637	8.76a
5 x 5	**7.53a**ŧ	**1.24a**	0.0429c	2159	74.8b
LSD (0.10)	**1.51**	**0.182**	**0.0284**	**NS**	**51.2**
Trial mean	**4.20**	**0.621**	**0.0149**	**2754**	**27.8**

† Dry matter is at 0% moisture.
ŧ Within a column treatments marked with the same letter were statistically similar (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

These results suggest that the 1'x1' plant spacing would yield the most flower bud on a per acre basis. However, plant and labor costs associated with planting at the 1'x1' density need to be considered to assess the feasibility of this growing scheme. In addition, CBD concentration was not measured in this experiment and would be another factor to consider before implementation.

Table 10. Plant population per acre for each plant spacing.

Plant spacing, ft x ft	Population*, plants ac^{-1}
1 x 1	43,560
3 x 3	4,840
5 x 5	1,742

*Population does not account for alleys or roads.

Surprisingly, the 5'x5' treatment generally had the greatest amount of unmarketable buds on a per acre and per plant basis. Flower buds were deemed unmarketable primarily due to soil contamination. These plants had numerous branches with some hanging very close to or on the ground. This allowed for easy soil contamination especially during the numerous rain events just prior to harvest. Closer plant spacings did not allow for as much branching and limited branches coming in contact with soil.

Although these results do not suggest that planting date would impact CBD hemp flower bud yields, the planting dates studied were relatively late and limited. Hemp is a photoperiod sensitive plant and produces vegetative growth as day length increases and switches to reproductive growth as day length decreases. The first planting date of 14-Jun was later than originally planned and close to the spring equinox (21-Jun), when day length would begin decreasing. These results suggest that mid to late June planting dates would produce comparable flower bud yields, considering that this time period is relatively close to the spring equinox. At the same time, it is worth noting that climatic variability may affect the yield benefit. For example, this year the 14-Jun planting yielded 165 lbs dry matter bud ac^{-1} more than the 27-Jun planting, while the 21-Jun planting yielded 488 lbs dry matter bud ac^{-1} more than the 27-Jun planting, even though it was planted 7 days after the 14-Jun planting. June was a relatively cold month, compared to historical averages, which may have stunted the 14-Jun planting.

While these results provide some suggestions for plant spacing and planting dates, it is important to remember that they represent only a one-year research trial.

ACKNOWLEDGEMENTS

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2018 Industrial Hemp Fiber Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2018 INDUSTRIAL HEMP FIBER VARIETY TRIAL

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Hemp is a non-psychoactive variety of *cannabis sativa L*. The crop is one of historical importance in the U.S. and reemerging in worldwide importance as manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. The fiber has high tensile strength and can be used to create a variety of goods. Hemp fiber consists of two types: bast and hurd. The bast fiber are the long fibers found in the bark of hemp stalks and are best suited for plastic bio-composites for vehicles, textiles, rope, insulation, and paper. The hurd fiber are short fibers found in the core of the stem and are suited for building materials, such as hempcrete and particle boards, bedding materials, and absorbents.

For twenty years, U.S. entrepreneurs have been importing hemp from China, Eastern Europe and Canada. Industrial hemp is poised to be a "new" cash crop and market opportunity for Vermont farms that is versatile and suitable for rotation with other small grains and grasses. To help farmers succeed, agronomic research on hemp is needed, as much of the historical production knowledge for the region has been lost. In this trial, we evaluated hemp fiber varieties to determine best cultivars for the region.

MATERIALS AND METHODS

Table 1. Agronomic information for the industrial hemp fiber variety trial 2018, Alburgh, VT.

Location	Borderview Research Farm Alburgh, VT
Soil type	Covington silty clay loam, 0-3% slope
Previous crop	Dry beans
Plot size (ft)	5 x 20
Planting date	8-Jun
Emergence date	15-Jun
Row spacing	7"
Planting equipment	Great Plains NT60 Cone Seeder
Planting rate (live seeds m^{-2})	250
Mowing date	3-Aug

A trial was conducted at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact of variety on hemp fiber yield. The experimental design was a randomized complete block with four replications. Seeding rates were adjusted after accounting for germination rates and a mortality rate of 30%. The typical seeding rate used by hemp fiber growers is ~40-50 lbs ac^{-1}. The trial was planted on 8-Jun into 5'x 20' plots.

Table 2. Hemp varieties evaluated in the industrial hemp fiber trial 2018, Alburgh, VT.

Variety	Days to maturity	Seed company
Anka	110	UniSeeds
Canda	100-120	Parkland Industrial Hemp Growers
Carmagnola	160-170	Schiavi Seeds
Carmagnola selezionata	160-170	Schiavi Seeds
CFX-1	100-110	Hemp Genetics International
CFX-2	100-110	Hemp Genetics International
CRS-1	100-110	Hemp Genetics International
Eletta campana	160-170	Schiavi Seeds
Ferimon	129-134	UniSeeds
Fibranova	160-170	Schiavi Seeds
Joey	110-120	Parkland Industrial Hemp Growers
USO-31	122-127	UniSeeds

Table 3. Participating seed companies and contact information.

Hemp Genetics International	Schiavi Seeds	Parkland Industrial Hemp Growers	UniSeeds
Jeff Kostuik Saskatoon, Saskatchewan (204) 821-0522 Jeff.kostuik@hempgenetics.com	Andrea Schiavi Lexington, Kentucky info@schiaviseeds.com	Clare Dutchysen Dauphin, Manitoba (204) 629-4367 info@pihg.net	Cobden, Ontario (613) 646-9737 orders@uniseeds.ca

There were a total of twelve hemp varieties evaluated (Table 2). Seed was sourced from four seed companies (Table 3). On 9-Jul, the trial was fertilized with 150 lbs ac^{-1} of nitrogen, 30 lbs ac^{-1} of phosphorus, and 40 lbs ac^{-1} of potassium. Fertility amendments were based on soil test results. All fertility amendments were approved for use in USDA certified organic systems.

On 31-Jul, just prior to mowing, plant populations were recorded by counting the number of plants in a foot-long section of a row, three times per plot. At that time, data was collected on plant heights by measuring three randomly selected plants per plot. On 31-Jul, wet weight harvest yields were calculated by sampling the hemp biomass within a $0.25m^2$ quadrat. Harvest moisture was calculated by taking a subsample of hemp yield and drying it at 105° F until it reached a stable weight. Stem diameter was measured on 5 plant stems per plot, using a digital caliper. Infection rates from the disease, *Sclerotinia sclerotiorum,* were recorded 1 month after planting, at female flower development stage on 13-Jul, and just before mowing on 3-Aug by counting the number of infected plants per plot. Pest pressure from arthropods was recorded at those times as well, by counting the number and variety of each arthropod present on two leaves from five plants per plot. On 3-Aug, the fiber plants were mowed using a 5-foot sickle bar mower.

Image 1. Custom built decorticator, Alburgh, VT, 2017.

When the stalks were still fresh, they were decorticated to separate the bast and hurd fibers, using a custom built decorticator (Image 1). As the stalks passed between the two moving gears, hurd fiber broke away and dropped to the floor or a bucket placed underneath.

The variety trial data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and variety treatments were treated as fixed. 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 a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown, except where analyzed by pairwise comparison (t-test). 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 treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid 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 hybrids 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 of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4).

Table 4. Seasonal weather data collected in Alburgh, VT, 2018.

Alburgh, VT	June	July	August
Average temperature (°F)	64.4	74.1	72.8
Departure from normal	-1.38	3.51	3.96
Precipitation (inches)	3.70	2.40	3.00
Departure from normal	0.05	-1.72	-0.95
Growing Degree Days (base 50°F)	447	728	696
Departure from normal	-27	88	115

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

June was unseasonably cool, but experienced the typical amount of rainfall. July and August were both warmer and dryer than historical averages. Overall, there were an accumulated 1871 Growing Degree Days (GDDs) from June to August, approximately 176 more than the historical average.

Table 5. The impact of variety on plant characteristics and harvest yield of industrial hemp fiber, Alburgh, VT, 2018.

Variety	Height @ harvest	Stem diameter	Harvest population	Dry matter yield	Dry matter @ harvest	Bast fiber
	cm	mm	plants ac^{-1}	lbs ac^{-1}	%	%
Anka	**135**	4.95*	325,448	7,127	32.3*	37.4*
Canda	108	4.06	682,190	7,109	33.3*	34.7
Carmagnola	129*	4.34	638,379	8,155*	29.1	34.7
Carmagnola selezionata	117	4.56*	744,776	**10,286**	29.4	35.0
CFX-1	86.8	3.43	657,155	5,225	33.6*	23.1
CFX-2	70.1	2.73	844,914*	4,829	33.6*	19.6
CRS-1	107	4.27	738,517	5,851	**33.8**	30.1
Eletta campana	128*	**5.34**	719,741	9,665*	27.4	33.5
Ferimon	118	4.58*	444,362	5,275	32.9*	**38.8**
Fibranova	135*	4.58*	757,293	8,147*	28.4	34.6
Joey	105	4.03	**976,345**	6,489	32.8*	28.6
USO-31	110	4.92*	381,776	5,094	31.8*	37.0*
LSD (0.10)	15.1	0.893	185,475	2597	2.47	3.55
Trial mean	112	4.31	659,241	6,938	31.5	32.3

*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment shown in **bold** (p=0.10).

The variety Carmagnola selezionata had the highest dry matter yield of 10,286 lbs ac^{-1} (Table 5). The varieties Carmagnola, Eletta campana, and Fibranova had comparable yields. It is important to consider the end use of the biomass along with yield. Each of these high yielding varieties, were not top performers for percent bast fiber. Bast fiber applications tend to be for finer materials like textiles, while the hurd fiber is a more crude material. The top performers for bast fiber were Anka, Ferimon, and USO-31.

Another factor to consider is stem diameter. Depending on the end use of the biomass, a producer will want either skinnier plants with a greater bast to hurd fiber ratio or thicker plants. Stem diameter can be influenced by plant population, with greater population generally contributing to skinnier stem diameter. As to be expected, the varieties with the thickest stem diameter did not have the highest population, compared to other varieties.

Table 6. The impact of variety on disease and arthropod presence in industrial hemp fiber at female flower development (13-Jul), Alburgh, VT, 2018.

Variety	Aphids	Leafhopper	Japanese beetle	Flea beetle	Tarnished plant bug	Physical damage
	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# leaves plant^{-1}†
Anka	0.050	0.000	0.000	0.000	0.050	1.45
Canda	0.200	0.000	0.000	0.000	0.050	1.10
Carmagnola	0.100	0.000	0.000	0.000	0.000	1.25
Carmagnola selezionata	0.250	0.000	0.000	0.050	0.050	0.850
CFX-1	0.100	0.000	0.050	0.050	0.050	0.850
CFX-2	0.000	0.000	0.050	0.050	0.100	0.800
CRS-1	0.050	0.000	0.000	0.000	0.200	1.15
Eletta campana	0.100	0.000	0.000	0.000	0.100	1.05
Ferimon	0.100	0.050	0.000	0.000	0.150	1.35
Fibranova	0.150	0.000	0.000	0.000	0.100	1.15
Joey	0.050	0.000	0.050	0.000	0.150	0.950
USO-31	0.000	0.000	0.000	0.000	0.150	1.05
LSD (0.10)	NS	NS	NS	NS	NS	NS
Trial mean	0.096	0.004	0.013	0.013	0.096	1.08

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Pests and diseases appeared to have a minimal effect on the overall health of the crop. There was no *Sclerotinia sclerotiorum* (Image 2) observed at the female flower development stage (13-Jul). Populations of aphid, leafhopper, Japanese beetle, flea beetle, tarnished plant bug, and overall physical damage to the crop was minimal and not significantly different between varieties (Table 6).

Image 2. Sclerotinia sclerotiorum on hemp plants, Alburgh, VT, 2016.

Table 7. The impact of variety on disease and arthropod presence in industrial hemp fiber before mowing (3-Aug), Alburgh, VT, 2018.

Variety	Aphids	Leafhopper	Japanese beetle	Flea beetle	Tarnished plant bug	Ladybug beetle	Fly	Thrips	Minute pirate bug	Physical damage
	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# leaves plant^{-1}†
Anka	0.200	0.000	0.000	0.000	0.050	0.000	0.000	0.000	0.050	1.70*
Canda	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.45*
Carmagnola	0.550	0.000	0.000	0.000	0.050	0.100	0.000	0.000	0.000	1.05
Carmagnola selezionata	0.300	0.100	0.000	0.000	0.050	0.000	0.000	0.050	0.000	1.05
CFX-1	0.100	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	1.20
CFX-2	0.100	0.150	0.000	0.050	0.050	0.000	0.000	0.000	0.000	1.45*
CRS-1	0.150	0.000	0.000	0.000	0.050	0.000	0.000	0.000	0.000	1.55*
Eletta campana	0.150	0.050	0.050	0.000	0.000	0.050	0.050	0.000	0.050	0.95
Ferimon	0.100	0.100	0.000	0.050	0.050	0.000	0.050	0.000	0.000	1.30*
Fibranova	0.050	0.050	0.000	0.000	0.000	0.050	0.000	0.000	0.050	0.90
Joey	0.300	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.050	1.55*
USO-31	0.450	0.000	0.100	0.100	0.000	0.050	0.000	0.000	0.000	**1.75**
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.46
Trial mean	0.238	0.042	0.013	0.017	0.0250	0.021	0.013	0.004	0.017	1.33

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment shown in **bold** (p=0.10).
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Ladybug beetles, flies, thrips, and minute pirate bugs appeared when scouting prior to mowing, in addition to the same insects seen during flowering (Table 7). Aphid and leafhopper populations were greater during this scouting session and it is not surprising that ladybug beetles appeared since they are a beneficial insect that prey on aphids. There were significant differences between varieties for physical damage to the plants, however, the damage overall was low. White mold was not present, which may have been partly due to the unseasonably dry, warm summer conditions experienced.

DISCUSSION

Yield and Quality

Generally, the male flowers (pollen source) appeared 60 days after planting for early season varieties. The hemp was mowed when plants were still young and green and seed had not formed. For fiber intended for textile use, it is best to mow the crop when the male plants are shedding pollen, since at that stage the bast fiber is not heavily lignified. Some hurd buyers prefer the hemp not to be retted, since the process changes the fiber color. If retting is not required, windrows of hemp stalks can be baled when the straw is 12-16% moisture. Rotary rakes can be used to help the hemp dry.

Average dry matter yield across all twelve varieties was 6938 lbs ac^{-1}, within the average yields from Canada, which range from 5000-6000 lbs ac^{-1}. Across all varieties, bast fiber comprised 32.3% of the stalk compared to the hurd fiber. Depending on variety and planting density, bast fiber typically represents 20-30% of the total fiber content. Across all varieties, the average population was 164 plants m^{-2}, which was lower than the target population of 250 plants m^{-2}. Plant populations will be indirectly related to stem diameter.

The average height across varieties was 1.12 m, while a desirable height is 2 m or greater. However, the taller varieties may leave more possibility for lodging. The lack of heat during the early part of the season may have contributed to shorter plants.

Pest Pressure in Hemp: Disease, insects, weeds

Hemp has the potential to host a number of diseases and insects. For the most part, hemp growing regions have not indicated that disease and arthropod pests are of economic significance. During the growing season, a survey of pest incidence was conducted to gain a better understanding of any pressures that exist on hemp in the region.

Aphids infested the hemp more heavily during later stages of plant development and but did not seem to affect plant yields, since most vegetative growth had already been completed.

Early season weeds can pose a threat to hemp populations, however, due to the higher seeding rate it seemed the weeds were less competitive with the fiber hemp as compared to grain hemp, which has a lower seeding rate. The primary weeds observed the hemp trials were lamb's quarter, ragweed, and foxtail. Currently, there are no pesticides (herbicides, insecticides, fungicides, nematicides, etc.) registered for hemp in the U.S, so growers must follow best practices to reduce the impact of pests, especially weeds.

It is important to remember that these data represent only one year of research, and in only one location. More data should be considered before making agronomic management decisions. Additional research needs to be conducted to evaluate varieties under more growing conditions.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to give a special thanks to Roger Rainville and the staff at Borderview Research Farm for their generous help with the trials. We would like to acknowledge John Bruce, Catherine Davidson, Hillary Emick, Amanda Gervais, Haley Jean, and Rory Malone for their assistance with data collection and data entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

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2018 INDUSTRIAL GRAIN HEMP VARIETY TRIAL

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Hemp is a non-psychoactive variety of *cannabis sativa L*. The crop is one of historical importance in the U.S. and reemerging in worldwide importance as manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. The crop produces a valuable oilseed, rich in Omega-3 and other essential fatty acids that are often absent in western diets. When the oil is extracted from the seed, what remains is a marketable meal co-product, which is used for human and animal consumption. The fiber has high tensile strength and can be used to create cloth, rope, building materials, and even a form of plastic. For twenty years, U.S. entrepreneurs have been importing hemp from China, Eastern Europe and Canada to manufacture travel gear, apparel and accessories, body care and cosmetics, foods like bread, beer, and salad oils, paper products, building materials and animal bedding, textiles, auto parts, housewares, and sporting equipment. Industrial hemp is poised to be a "new" cash crop and market opportunity for Vermont farms that is nutritious, versatile, and suitable for rotation with other small grains and grasses.

To help farmers succeed, agronomic research on hemp is needed, as much of the historical production knowledge for the region has been lost. In this trial, we evaluated hemp grain varieties to determine best cultivars for the region.

MATERIALS AND METHODS

Table 1. Agronomic information for the industrial hemp grain variety trial 2018, Alburgh, VT.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam, 3-8% slope
Previous crop	Dry beans
Plot size (ft)	5 x 20
Planting date	8-Jun
Emergence date	15-Jun
Row spacing	7"
Planting equipment	Great Plains NT60 Cone Seeder
Planting rate (live seeds m^{-2})	125
Harvest date	10-Sep

The trial was conducted at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact variety has on hemp grain yield. The experimental design was a randomized complete block with four replications. Nine grain varieties (Table 2) were planted on 8-Jun for the trial. Seeding rates were adjusted after accounting for germination rates and a mortality rate of 30%, to a target of 125 live seeds m^{-2}. The typical seeding rate used by hemp grain growers is approximately 25 lbs ac^{-1}.

Table 2. Hemp grain varieties evaluated in the hemp trial 2018, Alburgh, VT.

Variety	Seed company	Days to maturity
CFX-1	Hemp Genetics International	100-110
CFX-2	Hemp Genetics International	100-110
CRS-1	Hemp Genetics International	100-110
Katani	Hemp Genetics International	100-110
Canda	Parkland Industrial Hemp Growers	100-120
Joey	Parkland Industrial Hemp Growers	110-120
Anka	UniSeeds	110
Ferimon	UniSeeds	129-134
USO-31	UniSeeds	122-127

Table 3. Participating seed companies and contact information.

Hemp Genetics International	Parkland Industrial Hemp Growers	UniSeeds
Jeff Kostuik Saskatoon, Saskatchewan (204) 821-0522 Jeff.kostuik@hempgenetics.com	Clare Dutchysen Dauphin, Manitoba (204) 629-4367 info@pihg.net	Cobden, Ontario (613) 646-9737 orders@uniseeds.ca

Seed was sourced from three seed companies (Table 3). The trial was planted into 5'x20' plots. On 9-Jul, the trial was fertilized with 150 lbs ac^{-1} of nitrogen, 30 lbs ac^{-1} of phosphorus, and 40 lbs ac^{-1} of potassium. Fertility amendments were based on soil test results. All fertility amendments were approved for use in organic systems.

A few days before harvest, plant populations were recorded by counting the number of plants in a foot-long section of a row, three times per plot. At that time, data was also collected on plant heights by measuring three randomly selected plants per plot. Infection rates from the disease *Sclerotinia sclerotiorum* were recorded 1.5 months after planting, at female flower development stage, and just before harvest by counting the number of infected plants per plot. Pest pressure from arthropods was recorded at those times as well, by counting the number and variety of each arthropod present on two leaves from five plants per plot. On 10-Sep, the grain plots were harvested using an Almaco SPC50 small plot combine. Test weight was also measured using a Berckes Test Weight Scale, which weighs a known volume of grain. Harvest moisture was calculated by using an OHaus (Parsippany, New Jersey) MB 23 moisture analyzer.

The data was analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and varieties were treated as fixed. 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 a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown, except where analyzed by pairwise comparison (t-test). 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 treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid 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 hybrids 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 of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4).

Table 4. Seasonal weather data collected in Alburgh, VT, 2018.

Alburgh, VT	June	July	August	September
Average temperature (°F)	64.4	74.1	72.8	63.4
Departure from normal	-1.38	3.51	3.96	2.76
Precipitation (inches)	3.70	2.40	3.00	3.50
Departure from normal	0.05	-1.72	-0.95	-0.16
Growing Degree Days (base 50°F)	447	728	696	427
Departure from normal	-27	88	115	109

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

The summer months were hot and dry. July through September were an average of 3.41º F warmer than historical averages and received an average of 0.94 inches less precipitation than historical averages. June received an expected amount of precipitation; however, it was cooler than historical averages. Overall, there were an accumulated 2298 Growing Degree Days (GDDs) from June to September, approximately 285 more than the historical average.

Table 5. The impact of variety on plot characteristics and harvest yield of industrial grain hemp, Alburgh, VT, 2018.

Variety	Height @ harvest	Population	Moisture @ harvest	Test weight	Yield @ 10% moisture	Seed oil
	cm	plants m^2	%	lbs bu^{-1}	lbs ac^{-1}	%
Anka	**162**	388,035	14.7	35.6	854*	21.9
Canda	117	488,172	12.8	36.6	983*	20.2
CFX-1	100	356,741	14.0	37.3	**1035**	22.4
CFX-2	93.3	275,379	13.1	38.7	941*	22.1
CRS-1	118	388,035	14.5	**42.0**	923*	22.8
Ferimon	146*	400,552	19.3	34.1	776	23.1
Joey	117	425,586	14.1	38.5	846*	22.4
Katani	86.0	331,707	13.6	37.2	836*	19.2
USO-31	128	337,966	16.1	34.8	756	21.7
LSD (0.10)	16.1	NS	NS	3.11	225	NS
Trial mean	119	376,908	14.7	37.2	883	21.8

*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold.**
NS – There was no statistical difference between treatments in a particular column (p=0.10).

There were no significant differences for population, or percent seed oil between varieties (Table 5). Yields were low compared to past years and ranged from 1035 to 756 lbs of seed per acre. The variety CRS-1 had the highest test weight, however, this was still below the industry average of 44 lbs bu^{-1}. The varieties Anka and Ferimon were the tallest varieties, however, with tall varieties it is important to make sure the combine can accommodate their height and to consider the possibility of lodging.

Table 6. The impact of variety on disease and arthropod presence in industrial hemp at female flowering (31-Jul), Alburgh, VT, 2018.

Variety	Aphids	Leafhopper	Japanese beetle	Flea beetle	Tarnished plant bug	Physical damage
	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$†
Anka	0.100	0.000	0.050	0.000	0.200	1.50
Canda	0.000	0.000	0.000	0.000	0.150	1.30
CFX-1	0.000	0.000	0.000	0.000	0.250	1.15
CFX-2	0.150	0.000	0.000	0.000	0.100	1.10*
CRS-1	0.100	0.000	0.000	0.000	0.050	1.20
Ferimon	0.000	0.000	0.050	0.100	0.000	1.60
Joey	0.050	0.050	0.000	0.050	0.200	1.45
Katani	0.150	0.000	0.000	0.050	0.050	**0.750**
USO-31	0.100	0.050	0.050	0.000	0.000	1.40
LSD (0.10)	NS	NS	NS	NS	NS	0.360
Trial mean	0.0722	0.0111	0.0167	0.0222	0.111	1.27

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold.**
NS – There was no statistical difference between treatments in a particular column (p=0.10).

At the female flower development stage, pest pressure was minimal (Table 6). Aphids, leafhoppers, Japanese beetles, flea beetles, and tarnished plant bugs were present in very low populations and there were no significant differences in their incidence by variety. The varieties Katani and CFX-2 had the least physical damage from pests, however, damage was low overall.

Image 1. *Sclerotinia sclerotium* infection on industrial hemp, Alburgh, VT, 2016.

Table 7. The impact of variety on disease and arthropod presence in industrial hemp at harvest (7-Sep), Alburgh, VT, 2018.

Variety	Sclerotinia infection	Aphids	Leafhopper	Ladybug	Tarnished plant bug	Physical damage
	% of plants	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}†
Anka	0.000	0.050*	0.000	0.050	0.000	0.650
Canda	0.000	0.150*	0.000	0.000	0.100	1.00
CFX-1	0.058	0.500	0.000	0.000	0.050	0.900
CFX-2	0.000	0.100*	0.000	0.000	0.050	1.05
CRS-1	0.000	0.050*	0.050	0.100	0.000	1.15
Ferimon	0.080	0.200*	0.000	0.100	0.050	1.00
Joey	0.000	0.050*	0.000	0.100	0.000	1.00
Katani	0.000	0.100*	0.050	0.050	0.000	1.00
USO-31	0.000	**0.000**	0.000	0.000	0.050	1.10
LSD (0.10)	NS	0.253	NS	NS	NS	NS
Trial mean	0.015	0.133	0.011	0.044	0.033	0.983

*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10) shown **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

While there was no *Sclerotinia sclerotiorum* infection (Image 1) present during the flowering stage, the infection appeared prior to harvest. The infection incidence was not significantly different between varieties (Table 7). The presence of aphids increased, compared to earlier in the season, and incidentally beneficial ladybugs appeared as they prey on aphids. CFX-1 had the greatest incidence of aphids,

however, the pest pressure was low overall. Japanese beetles and flea beetles were not present at this stage of development, though they had been present earlier in the season.

DISCUSSION

Yield and Quality

All hemp varieties reached full plant maturity. Generally, the male flowers (pollen source) appeared after 40 days and late season varieties matured by 55 days after planting. Seed development began after 65 days and up to 75 days after planting, for the late season varieties.

The hemp was harvested on time, when plants were still young and green and seed was 50 to 70% ripe and seed moisture was within the acceptable range of 10-20% moisture. As recommended from growing hemp in Saskatchewan, Canada, hemp harvest can begin when field moisture is at 20% and plants are relatively pliable and less likely to get wrapped in the combine. However, seed would need to start drying within 4 hours as it otherwise will heat up. Seed should be dried to 8-10% moisture for long term storage. Ideally, hemp is harvested in the 12-15% range.

Average yield across all twelve varieties was 883 lbs ac^{-1} and was in the low range compared to average yields from Canada, which range from 500-1200 lbs ac^{-1}. Low yields were partially attributed to poor stands following planting. The cool and wet weather in June had an impact on stand establishment. Likely the largest impact on yield was due to bird predation. This was the first year that we observed such an impact from birds on the hemp yields. In some cases, seed heads were completely decimated by bird feeding. Across all varieties, the average population was 93.1 plants m^{-2}, which was lower than the target population of 125 plants m^{-2}. Poor early season establishment encourages the need to evaluate strategies to improve germination and early season vigor (i.e. seed treatments, seeding rates, starter fertilizers). None of the treatments in the trial met the standard test weight for hemp of 44 lbs bu^{-1}. This may be due to drought conditions through much of the growing season.

The differences in height may be of special interest for farmers who would like to grow these varieties for both grain and fiber production. A taller variety may be more advantageous for fiber production; however, it may leave more possibility for lodging and wrapping in the combine. All varieties used in this trial are dual purpose cultivars for both fiber and grain use, except for Katani, which is intended for grain production only.

Pest Pressure in Hemp: Disease, insects, weeds

Hemp has the potential to host a number of diseases and insects. For the most part, hemp growing regions have not indicated that disease and arthropod pests are of economic significance. During the growing season, a survey of pest incidence was conducted to gain a better understanding of any pressures that exist on hemp in the region.

Early in the season, lesions on hemp leaves were noticed and later identified as being *Alternaria* spp., *Aspergillus* spp., and *Cladosporium* spp. These diseases did not appear to negatively affect yields. Aphids infested the hemp more heavily during later stages of plant development and did not seem to affect plant

yields, since most vegetative growth had already been completed. Similarly, *Sclerotinia sclerotiorum* infection increased later in the season, but did not seem to affect yields.

During the early growth stages of hemp, plants were small, weak, and had poor root development while weeds quickly grew. In the 2016 hemp trials, about one month after planting, the hemp grew rapidly and successfully gained over the weeds without any weed control. However, due to low populations and stand establishment in 2017, the hemp was a poor competitor against the weeds. In 2018, the stand appeared better than in 2017, however, not as robust as in 2016. This was likely due to the cool start to the season and then the dry, very hot summer months. The primary weeds observed in the hemp trials were lamb's quarter, ragweed, and foxtail. Currently, there are no pesticides (herbicides, insecticides, fungicides, nematicides, etc.) registered for hemp in the U.S, so growers must follow best practices to reduce the impact of pests, especially weeds.

It is important to remember that these data represent only one year of research, and in only one location. More data should be considered before making agronomic management decisions. It was clear that due to unseasonably cool, wet, early season conditions, all varieties underperformed. Additional research needs to be conducted to evaluate varieties under more growing conditions.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to give a special thanks to Roger Rainville and the staff at Borderview Research Farm for their generous help with the trials. We would like to acknowledge Abha Gupta, Sara Ziegler, Lindsey Ruhl, John Bruce, Catherine Davidson, Hillary Emick, Amanda Gervais, Haley Jean, and Rory Malone for their assistance with data collection, and data entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

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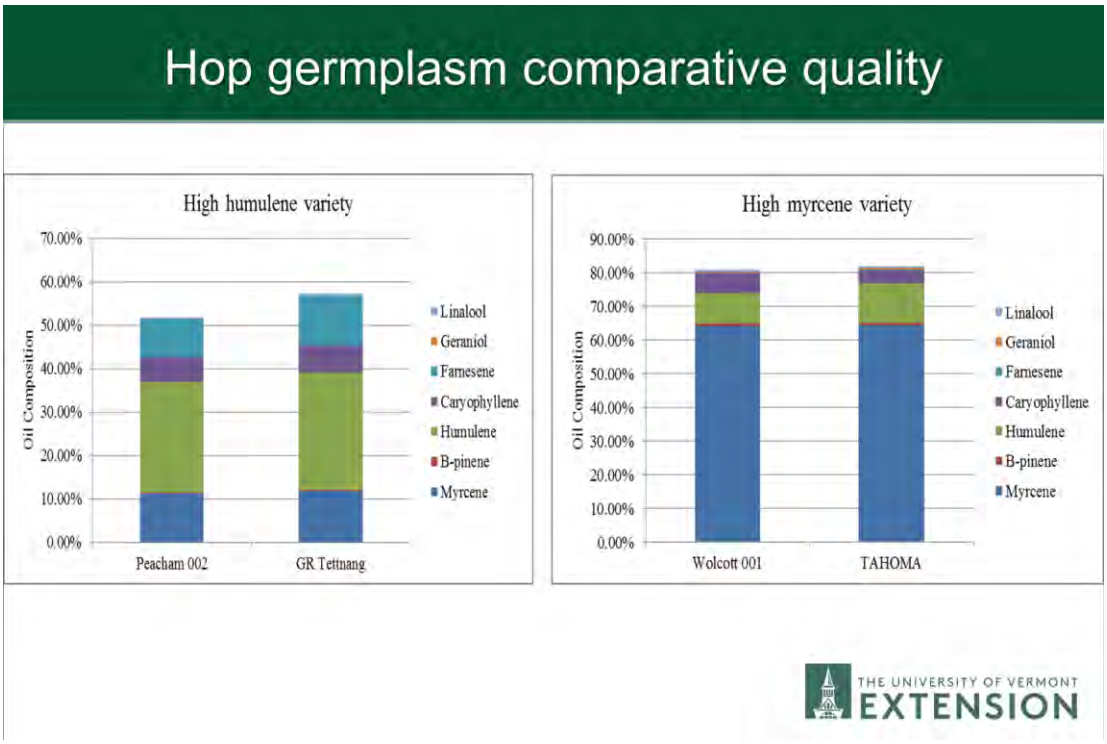
Hop germplasm

Plant	Plot	Total Plants	Town, State	Latitude	Longitude
Northfield 001	204	13	Northfield, MA	42.715015	-72.465087
Northfield 003	103	14	Northfield, MA	42.715015	-72.465087
Peacham 001	304	10	Peacham, VT	44.38361111	-72.18638889
Peacham 002	102	14	Peacham, VT	44.38361111	-72.18638889
Wolcott 001	302	14	Wolcott, VT	44.54416667	-72.41861111
Mount Toby 001	303	11	Sunderland, MA	42.503834	-72.531131
Argyle 001	203	14	Argyle, NY	43.237972	-73.495185
Kingdom 001	202	10	Tunbridge, VT	43.9218136	-72.5718315
Kingdom 002	104	14	Tunbridge, VT	43.9218136	-72.5718315
Ferrisburgh 001	101	7	Ferrisburgh, VT	44.1921461	-73.3450684
Plattsburgh 001	201	6	Plattsburgh, NY	44.6962042	-73.4917513
Morrisville 001	301	8	Morrisville, NY	42.832964	-75.567996

In the first year of analysis, harvested germplasm varieties displayed similar resin and oil profiles to commonly used commercially available hop varieties.

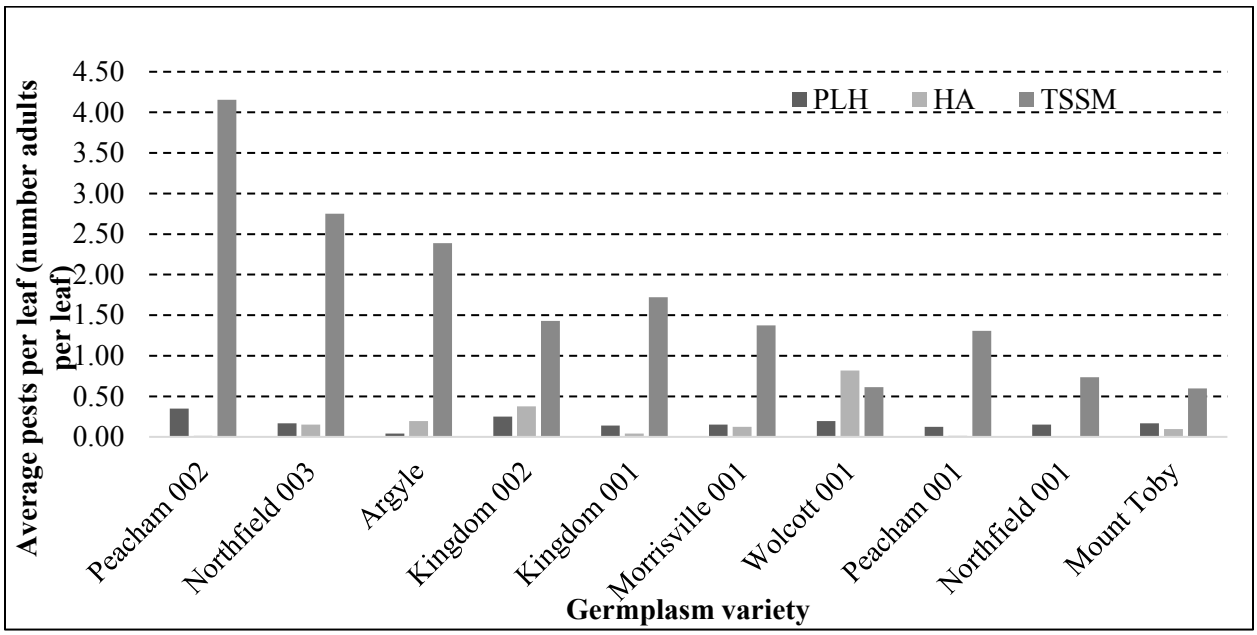
- Peacham 002 exhibited qualities similar to many Noble Hop varieties with low myrcene and high humulene.
- Wolcott 001 exhibited similar oil profile to many high myrcene and alpha acid varieties.



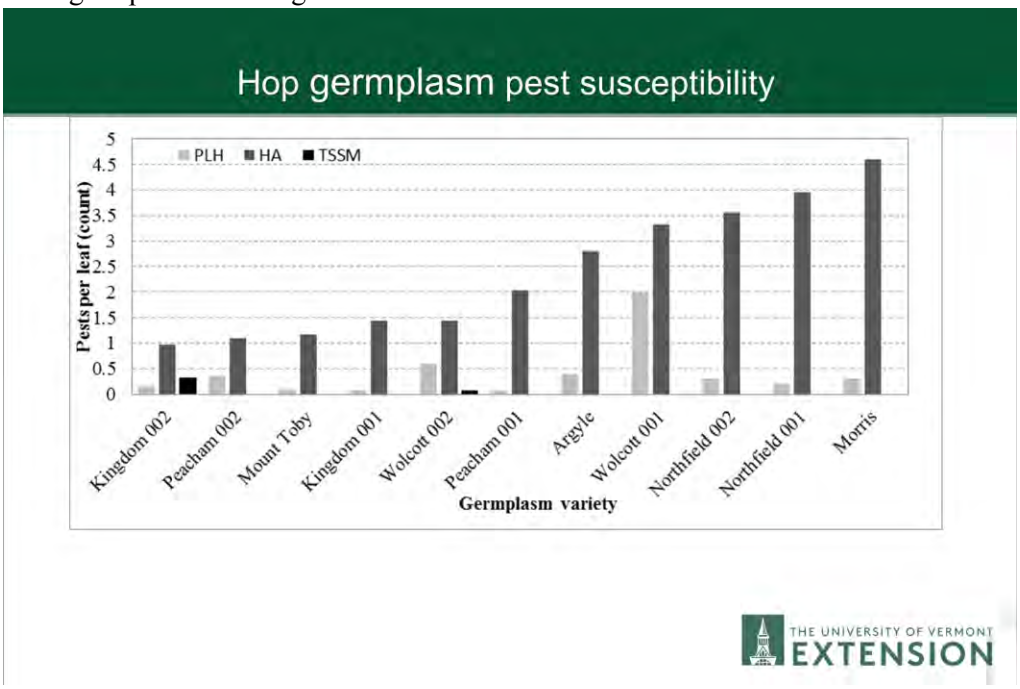
Oil and resin analysis of Peacham 002, Northfield 001, Morris, Argyle, Wolcott 001 germplasm variety analysis compared to similar commercially available hops.

Hop Variety	Myrcene - green, resinous	B-Pinene - spicy, piney	Humulene - piney, woody	Caryophyllene - woody	Farnesene - floral	Geraniol - floral, sweet, rose	Linalool - floral, citrus	Beta	Alpha
Peacham 002	11.24%	0.21%	25.41%	5.70%	8.77%	0.18%	0.33%	3.90%	5.00%
GR Tettnang	11.80%	0.22%	27.12%	6.20%	11.30%	0.14%	0.52%	4.90%	3.40%
UK EAST KENT GOLDING	15.63%	0.29%	45.95%	14.93%	1.07%	0.15%	0.56%	3.00%	5.10%
Fuggle	24.24%	0.35%	36.37%	14.01%	6.54%	0.11%	0.78%	2.70%	4.40%
GR HALLERTAU	24.93%	0.34%	36.18%	10.37%	2.08%	0.26%	0.79%	5.10%	3.80%
Northfield 001	41.05%	0.43%	18.09%	5.55%	0.05%	0.15%	0.46%	8.60%	3.00%
MT. HOOD	41.97%	0.65%	26.80%	12.49%	0.20%	0.26%	0.83%	6.90%	6.50%
Glacier	43.95%	0.58%	29.08%	9.11%	0.21%	0.23%	0.79%	7.20%	5.00%
CRYSTAL	44.67%	0.67%	26.58%	7.34%	0.12%	0.59%	0.90%	7.30%	4.60%
Morris	46.21%	0.58%	15.44%	5.37%	0.17%	0.39%	0.34%	5.00%	3.80%
Argyle	52.87%	0.68%	12.45%	4.23%	0.08%	0.41%	0.25%	3.40%	6.00%
AHTANUM™	54.11%	0.91%	20.69%	10.05%	0.12%	0.27%	0.36%	5.00%	4.30%
TRIPLEPEARL	55.89%	0.77%	7.20%	3.92%	0.28%	0.09%	0.80%	3.20%	9.30%
CASCADE	56.33%	0.83%	14.19%	6.23%	6.30%	0.18%	0.49%	7.00%	7.40%
Ultra	56.74%	0.91%	12.53%	7.99%	0.18%	0.21%	1.21%	3.80%	9.10%
Mt. Rainier	58.04%	0.78%	17.92%	7.66%	0.10%	0.29%	0.82%	7.30%	6.10%
Wolcott 001	64.02%	0.83%	9.07%	5.82%	0.07%	0.24%	0.71%	6.70%	3.60%
TAHOMA	64.23%	0.93%	11.68%	3.79%	0.21%	0.35%	0.71%	7.70%	6.80%

- From scouting in 2018 we noticed a large number of Two Spotted Spider Mites on plants due to the hot weather and highest average numbers occurring on Peacham 002, Northfield 003, and Argyle 001.
- In the 2019 season, Potato Leaf Hopper populations have been very high throughout the entire hop yard.



2018 germplasm scouting



2017 germplasm scouting

Hop Harvest Timing

Hop lupulin gland formation

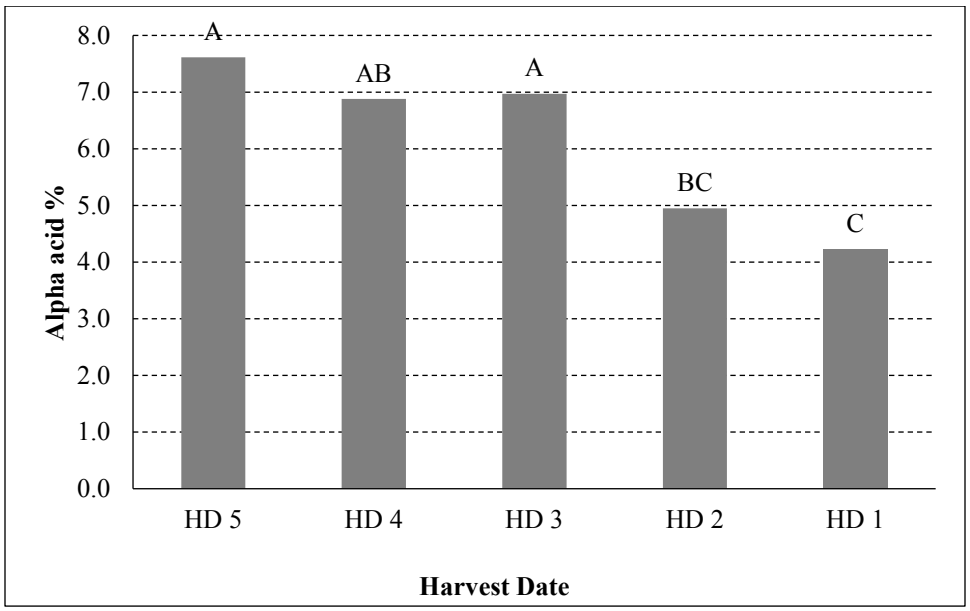
Oil	Associated Scents
β-pinene	Piney, green, turpentine
Myrcene	Citrus, bright, resinous
Linalool	Floral, rose, citrus
Caryophyllene	Woody, spicy, earthy
Farnesene	Floral, vegetative, herbal
Humulene	Piney, woody, spicy
Geraniol	Floral/rose, herbal, sweet

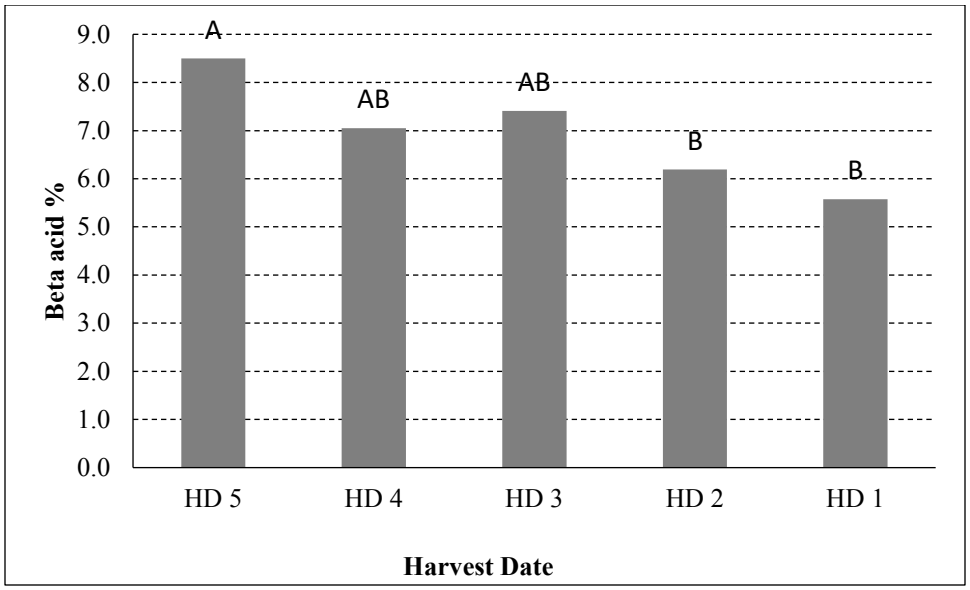
Descriptive chart of prominent hop oils and their associated scents.

- Cascade total oil content increased over time peaking during the late harvest period.
- Cascade resins peaked from Normal-Late harvest periods, maxing out in the final week of harvest.
- An "ideal" window could be developed over time for growers and brewers to determine the most desirable qualities for each hop variety in the Northeast.
- Harvesting 1-2 weeks early can result in significantly lower levels of essential oils and resins but may be necessary depending on pest and disease pressure to reduce crop loss.

Harvest Date		
Early	HD 1	20-Aug
Early	HD 2	27-Aug
Normal	HD 3	4-Sep
Late	HD 4	10-Sep
Late	HD 5	17-Sep

2018 Cascade harvest periods and dates.




9.0
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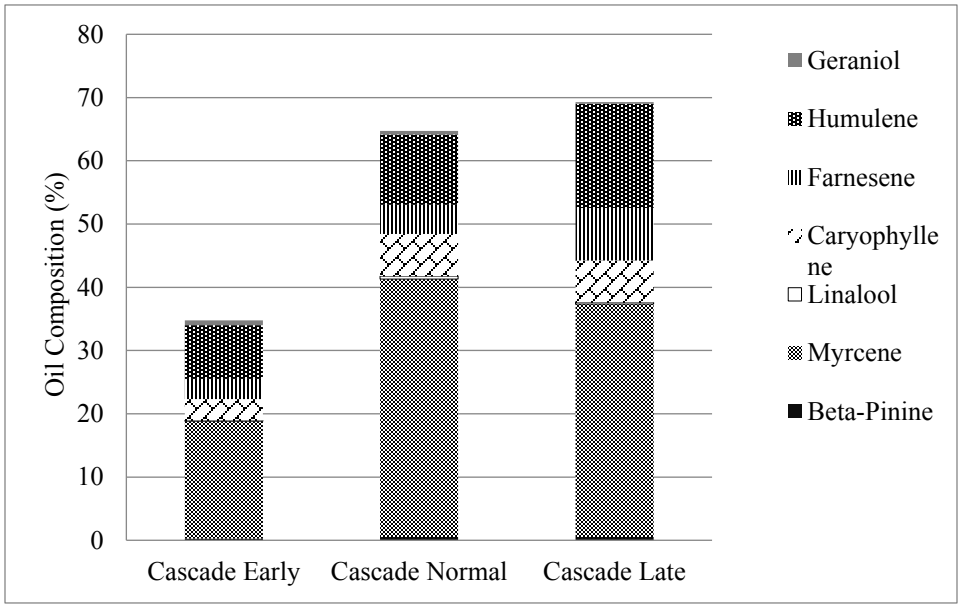
80
70
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50
40
30
20
10
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Oil Composition (%)
Cascade Early
Cascade Normal
Cascade Late
Geraniol
Humulene
Farnesene
Caryophyllene
Linalool
Myrcene
Beta-Pinine

Potato leafhopper, *Empoasca fabae* (Harris), in Northeastern Hopyards

Lily Calderwood, UVM Extension Ph.D. Candidate
Visit us on the web at www.uvm.edu/nwcrops

Severe injury to hop plants from potato leafhopper feeding has been observed in Vermont. Potato leafhoppers have an appetite for more than 200 broad leaf plants. This native leafhopper can arrive to northern Vermont anytime between late spring and mid-June depending on weather. Adults overwinter in southern states. Spring wind currents carry the 1/8th inch long, green, wedge shaped leafhoppers north.

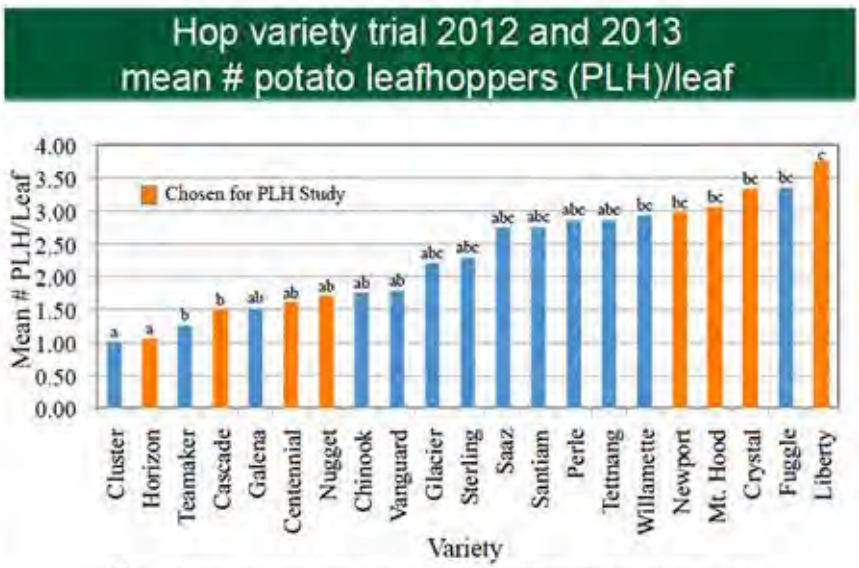
Adults are winged while nymphs do not have wings (Figure 1). Adults land in hopyards to feed and lay eggs in hop leaf and stem tissue. Please be aware that the yellow spots on the underside of hop leaves are not insects. They are lupulin glands of the hop leaf. Potato leafhopper movement is a signature side-to-side scuttle. Depending on spring arrival time and temperature potato leafhoppers will have 2 or 3 generations per season at northern latitudes.

Figure 1. Potato leafhopper nymphs

Potato leafhopper damage is necrosis of the leaf where the outer edges and tip of the leaf turn yellow and then brown, forming a distinctive "V". This damage is called "hopperburn" (Figure 2). This pest feeds with piercing-sucking mouthparts on leaf tissue and stem phloem. The first sign is yellowing of the leaf at the tip followed by necrosis and leaf curling. These symptoms are the result of the plant shutting down photosynthesis in the leaf as a response to leafhopper feeding. Potato leafhoppers move rapidly from side-to-side movement is their signature.

Potato leafhopper populations have not been severe in 2014 yet 2012 and 2013 exhibited very high populations in hops. The NW Crops and Soil Team is researching hop varietal susceptibility in first year hops. Under an EPA grant we hope to establish an economic threshold specific to hops and understand which varieties are more or less susceptible to PLH damage.

Figure 2. Potato leafhopper damage called "hopperburn"



Varieties that share a letter were not significantly different from each other (p = .05).

Managing Downy Mildew in Hops in the Northeast

Rosalie Madden, Crop and Soils Technician & Dr. Heather Darby, UVM Extension Agronomist
Find us on the web: www.uvm.edu/extension/cropsoil/hops

Downy mildew (*Pseudoperonospora humuli*, Miyabe and Takah., Wilson) is a significant issue in hops in the Northeast. Both *Humulus lupulus* and *H. japonicas* act as a host to *P.humuli*, as do certain nettles (*Uritca* spp.) (Johnson et al. 2009). *P. humuli* is closely related to the downy mildew that you can find on familiar crops such as cucumbers and watermelons, but is not so closely related that the downy mildew from your squashes will infect your hops and vice versa (Johnson et al. 2009). Downy mildew can cause the complete loss of marketable hop yield, and even hill death in sensitive varieties (Johnson et al. 2009). It is a very serious hindrance to successful hops production, but diligent integrated pest management (IPM) can help reduce disease infection, and/or help control downy mildew once the disease has reached your hopyard. The goal of IPM practices is to integrate a multipronged approach that includes prevention, observation, and various intervention strategies to reduce or eliminate the use of pesticides, while at the same time managing pests at an acceptable level. This article will provide some guidelines and strategies on how to control downy mildew in a sustainable manner.

Disease Symptoms

One of the most critical steps in IPM is proper pest identification. Downy mildew produces characteristic diseased shoots, called "spikes" (Figures 1, 2, 4). Spikes will be stunted with short internodes, and appear chlorotic with yellow-green, down curling or cupping leaves (Johnson et al. 2009). The leaves will often be brittle, and will dry up starting at the base of the spike. In the right conditions, necrosis will eventually move to the tip of the spike. When these spikes emerge out of the crown, they are called primary basal spikes (Figure 1). On a primary spike you will see symptoms on the shoot tissue from the ground up.

Figure 1. Primary basal spike. Note short internodes, yellowing, down-curled leaves, and leaf necrosis at the base.

Figure 2. Sidearm infected with downy mildew.

Secondary spikes are diseased shoots that appear from an infected apical meristem. An apical meristem is the growing point on a plant; in the case of hops this can either be a sidearm or the top of the growing plant (Figure 2). With a secondary spike, the plant tissue below the infection remains normal in appearance, and the spike itself will usually become necrotic and desiccated in dry weather. Compared to a primary spike, the internodes may not be as noticeably

Figure 3. Downy mildew infecting the apical meristem at the top of the plant. Note how bine is falling off the string.

shortened on a secondary spike. Trained bines that become infected will often be developmentally arrested, and the bines will fall off the string (Figure 3) (Johnson et al. 2009).

Spikes are fairly characteristic of this disease, and once you see it, it is hard to mistake them for anything else. However, be forewarned that frost damage can sometimes cause symptoms similar to downy mildew (chlorosis, and, in new growth, necrosis of the leaves and shoot tips). As a result of a late frost, shoots may be stunted and older leaves may have a rough, silvery appearance (Mahaffee et al. 2009b) (Figure 4). Recent weather patterns should be taken into consideration when evaluating your hopyard early in the spring. Plants will usually recover from frost damage.

Figure 4. Frosted hops, note stunted shoots and rough, silvery leaves.

Downy mildew will cause localized leaf lesions to appear on the underside of a leaf. Downy mildew lesions are usually delimited by leaf veins, appearing angular and water soaked (Figure 5). These lesions will become necrotic and light to dark brown. Sporangia (the structure in which spores are produced) may form a mass on the underside of the leaf or spike and appear as a purple-grey or black growth (Johnson et al. 2009).

Inflorescences that become infected are dark brown, shriveled and dried up, and can fall off the plant. Cones become brown and hardened and, with an early infection, will stop developing. Depending on when the infection occurred, the cone can either be completely dark brown, or only have a few discolored bracts, giving a striped or variegated appearance (Johnson et al. 2009).

Depending on the cultivar, the appearance of infected crowns can vary. Infected crowns can appear reddish-brown to black, or have streaks in the white crown tissue next to the bark. (Be sure to not confuse the reddish-brown tissue found in the center of healthy crowns that you will find in some cultivars!) Depending on the cultivar, infected crowns can be completely rotted, appear healthy, or

Figure 3. Localized leaf lesions on surface of leaf (top) and underside of leaf (bottom). Note how lesions are delimited by leaf veins.

anywhere in between (Johnson et al. 2009).

If you would like to confirm that downy mildew has infected your hop plants, you can submit a sample to your local University Extension Plant Diagnostic Laboratory. Visit their website or call them for specifications on how to prepare and submit a sample. A diagnosis will cost between $15 and $30, depending on the lab. Contact your local Plant Diagnostic Lab by following the links below or contacting your local Extension office.

Cornell University Plant Disease Diagnostic Clinic
334 Plant Science Building
Ithaca, NY 14853

UMass Plant Diagnostic Lab
101 University Drive, Suite A7
Amherst, MA 01002

University of Vermont Plant Diagnostic Clinic
201 Jeffords Building
63 Carrigan Drive
University of Vermont
Burlington, VT 05405

Downy Mildew Lifecycle

Understanding a pest's lifecycle is important when developing a management plan. In order for a disease outbreak to occur there must be a "disease triangle", consisting of a susceptible host, a conducive environment, and the pathogen.

Like most mildews, *P. humuli* will thrive in warm, moist environments. Sporangia are usually produced when the average relative humidity is greater than 71%, and the nightly minimum temperature is greater than 41°F. The number of hours with a relative humidity greater than 80% is the greatest predictor of a downy mildew outbreak. Plant tissue needs to be moist for spores to germinate. For shoot infection to occur, water needs to be sitting for three hours with temperatures ranging from 66° –73°F or for six hours at temperatures of 46°–50°F. Leaf infection doesn't require as long of a wetness period, and can occur in 1.5–2 hours, optimally at 59°–84°F, but will occur at temperatures as low as 41°F when the leaf is wet for greater than 24 hours. A general rule of thumb is that appreciable leaf and shoot infection will occur if it is wet at moderate temperatures for four to eight hours (Johnson et al. 2009).

Downy mildew can live on infected leaves, shoots, and cones, and will usually overwinter in infected dormant buds and crowns as intercellular mycelium. Mycelium that overwinters in the crown will spread into developing buds during winter and early spring, which is why shoots are already infected when dormancy breaks, resulting in primary basal spikes. However, infected crowns don't always yield basal spikes; sometimes infected crowns will yield both healthy shoots and infected basal spikes, and sometimes infected crowns will only yield healthy shoots (Johnson et al. 2009).

Sporangia are produced on the underside of leaves at night when the temperature and humidity are favorable. These spores are released in mid-morning to early afternoon, especially in rainy conditions.

Sporangia land and germinate, producing spores that enter the plant through open stomata. The spores can infect leaves, bud stipules, apical meristems, and cones if the conditions are favorable. As discussed, infected leaves will result in localized leaf spots (Figure 5), which produce secondary inoculum to further infect more shoots, leaves, and cones. Leaf lesions usually desiccate quickly in dry weather and don't last long. Apical meristem infections, however, become systemic, producing secondary spikes and more sporangia. With an apical meristem or a secondary spike infection, the mycelium will progress down the shoot tissue toward the crown during the growing season. If the mycelium reaches the crown, hill death can result, either immediately or over time, depending on the variety. The infected plant will often die as a result of reduced carbohydrate reserves caused by the disease (Johnson et al. 2009).

Strategies for Controlling Downy Mildew

The pathogen can appear in your yard through various means. Spores can be swept in on the wind, brought in on diseased root stock, or through the grower accidently carrying it into his or her field on their clothes after visiting another hop-growing friend. Planting disease-free hop plugs is one way to be certain that you are not bringing disease into your hopyard. The Northeast Hop Alliance has started a program to propagate disease-free stock for members. Various other commercial sources can be found for disease-free stock as well. Scouting for disease should be conducted on a regular basis (weekly) to determine the degree of infection as well as to evaluate if the pathogen is spreading further. In addition, monitoring the weather conditions will help to determine if the environment is right for disease infection. Control options can be both preventative and remediative in nature. A multifaceted approach should be used to have the best success.

Cultural/Mechanical Control

Planting resistant cultivars is the first important step in preventing a serious outbreak of downy mildew (Table 1). Cultivars vary in susceptibility to crown rot and to cone, leaf, and shoot infection, but no cultivars are immune. Cascade, Fuggle, Perle, Tettnang, and Willamette all display moderate resistance to downy mildew. Cluster, Galena, Hallertauer Mittelfrüh, Hersbrucker Spält, and Nugget are all susceptible to foliar infection (Johnson et al. 2009). Bullion, Brewer's Gold, and Cascade are considered by Skotland and Johnson (1983) to be tolerant to crown and foliage infection, while still requiring fungicides to control foliage infection. Crown rot susceptibility varies among cultivars, with Cluster being extremely susceptible, which is the reason that Cluster is usually not grown in high-rainfall areas (Johnson et al. 2009).

Strict sanitation is another important step in reducing the incidence of downy mildew in your yard. Heavily diseased plants should be completely removed early in the season. Primary basal spikes should be eliminated, either mechanically or chemically (Johnson et al. 2009). Spring pruning is usually done in the late winter or early spring. The goal is to remove buds, shoots, and the previous season's bines. Various levels of aggressiveness are often employed to do this. Pruning removes all shoots prior to training. Crowning removes the top 0.75-2 inches of the crown prior to bud break. Scratching scratches the soil surface, removing buds from the top 0.75-2 inches (Beatson et al. 2009). Removing the source of

Variety	Usage	Disease Susceptibility[a]		
		Powdery Mildew	Downy Mildew	Verticillium Wilt
Brewers Gold	Bittering	S	MR	MR
Bullion	Bittering	S	MR	R
Cascade	Aroma	MR	MR	MR
Centennial	Bittering	MR	S	U
Chinook	Bittering	MS	MR	R
Columbia	Aroma	MS	MR	S
Comet	Bittering	R	S	R
Crystal	Aroma	R	S	R
East Kent Golding	Aroma	S	S	MR
First Gold	Bittering	R	S	MR
Fuggle	Aroma	MS	R	S
Galena	Bittering	S	S	R
Glacier	Aroma	S	S	U
Hall. Gold	Aroma	MS	R	S
Hall. Magnum	Bittering	S	R	MR
Hall. Mittelfrüh	Aroma	MS	S	S
Hall. Tradition	Aroma	MR	R	MR
Horizon	Bittering	MS	S	MR
Late Cluster	Aroma	S	S	R
Liberty	Aroma	MR	MR	U
Mt. Hood	Aroma	MS	S	S
Newport	Bittering	R	R	U
Northern Brewer	Bittering	S	S	R
Nugget	Bittering	R	S	S
Olympic	Bittering	S	MS	R
Perle	Aroma	S	R	MR
Pioneer	Bittering	MR	MR	U
Saazer	Aroma	S	MS	S
Saazer 36	Aroma	S	MS	S
Spalter	Aroma	S	R	MR
Sterling	Aroma	MS	MR	U
Teamaker	Aroma	MR	MR	S
Tettnanger	Aroma	MS	MS	S
Tolhurst	Aroma	S	S	U
U.S. Tettnanger	Aroma	MS	MS	S
Vanguard	Aroma	S	S	U
Willamette	Aroma	MS	MR	S

[a] Disease susceptibility ratings are based on greenhouse and field observations in experimental plots and commercial yards in the Pacific Northwest as of 2009. Disease reactions may vary depending on the strain of the pathogen present in some locations, environmental conditions, and other factors, and should be considered approximate. S = susceptible; MS = moderately susceptible; MR = moderately resistant; R = resistant; U= unknown

Table 1. Disease susceptibility and chemical characteristics of major hop varieties. Reproduced from Field Guide for Integrated Pest Management in Hops, a Cooperative Publication Produced by Oregon State University, University of Idaho, U.S. Department of Agriculture - Agricultural Research Service, and Washington State University, 2009.

primary infection can effectively reduce the severity of the epidemic (Skotland and Johnson 1983). Skotland and Johnson (1983) advise removing basal spikes weekly as it reduces mildew infection by 75%, and enhances the efficacy of spray controls. In Washington, only 9-10% of hills where spikes were removed weekly had spikes at the end of May. Where basal spikes were not removed with the same tenacity, 21-33% of hills displayed signs of infection (Skotland and Johnson 1983). Another option is to prune later in the season, which can reduce the severity of an infection, particularly in areas with shorter growing seasons. However, if pruning is done too late in the season, it will reduce yields (Johnson et al. 2009), and some argue that it may not be overly effective in a damper climate (Skotland and Johnson 1983). Beatson et al. (2009) state that pruning timing is cultivar-specific, as it affects the training timing, which in turn impacts yield. Growers will often hill up around the crown in mid-season as it encourages the development of roots and rhizomes near the top of the crown. This helps to suppress downy mildew in the current season since the diseased shoots next to the crown are buried (Beatson et al. 2009).

After training, bines should be stripped. Stripping removes the superfluous growth of leaves and laterals from the lower five feet of the trained bine (Beatson et al. 2009). Stripping reduces inoculum density, and limits the disease's spread into the upper canopy (Beatson et al. 2009; Johnson et al. 2009). Stripping also reduces the humidity around the base of the plant by increasing airflow. Stripping can be done either manually or chemically (Beatson et al. 2009). A desiccant spray can be used to simultaneously take out basal spikes and strip, but bines must be trained and at least seven feet tall before a chemical desiccant can be used without hurting the crop, and at this point it is often too late to prevent serious infection (Skotland and Johnson 1983). The date and frequency of stripping can have a significant effect on the carbohydrate reserves in the plant's root system. When you are stripping, it is important to think of what will happen three months down the road at harvest. When the bine is harvested, there needs to be enough leaf tissue left in the field so that the plant can continue to photosynthesize and accumulate carbohydrates before winter dormancy. The deleterious effects of excessive stripping can be more severe in early-maturing varieties, or plants that are already weakened by soil-borne disease (Beatson et al. 2009).

Figure 4. Hops that have been stripped to 5', and all untrained shoots and basal spikes removed.

The success of your sanitation practices depends on your thoroughness, and can help delay an epidemic. Aside from pruning and stripping, there are other practices that are critical to disease management, such as avoiding excessive nitrogen fertilization. Using overhead irrigation should also be avoided, as it increases leaf wetness. In cases with high disease incidence, an early harvest can be a tool to reduce cone infection (Beatson et al. 2009; Johnson et al. 2009).

Chemical Control

When the weather conditions are favorable for downy mildew, spraying preventatively is key (Johnson et al. 2009). Disease prediction models exist for downy mildew and hops in the Pacific Northwest and in Europe. There are currently no disease prediction models for hops in the Northeast, but the Network for Environment and Weather Applications has grape forecasting models in our region for grape downy mildew, which will give you an idea of what to expect. Use your judgment in evaluating weather patterns to determine when inoculum levels might be high. Based on the temperature and weather, it may not be necessary to spray in the early spring if it is cool, below 41°F, or if there is low relative humidity. However, low temperatures don't prevent sporulation for extended periods. Rainy weather will help liberate the sporangia from spikes (Johnson and Skotland 1985), and it is still very important to keep on top of spike removal.

When using a fungicide, be sure to read the fungicide label in its entirety! It is illegal to use a chemical on a crop or on a pest for which it is not specifically labeled, and it can often do more harm than good. Keep in mind that not all chemicals are legal in every state; be sure to check with your local Extension or Agency of Agriculture. It is also important to remember that while a chemical may be legal and labeled for use in a state there is no assurance that the material is effective against a particular pest on a particular crop, even if it is on the label. Also be sure to adhere to pre-harvest intervals and use proper personal protection equipment. Downy mildew can develop resistance to fungicides fairly rapidly; it is very important to vary the mode of action of the fungicides that you use in your yard (Johnson et al. 2009). Each class should only be used a few times per season, which is usually specified on the label. If the label permits, it can be very beneficial to tank mix fungicides that have a high risk for resistance development with fungicides that have a low risk (Mahaffee et al. 2009a). Be sure to read the label carefully, as some mixtures are phytotoxic to some crops but not others. For example, using both oil and copper products in an apple orchard will result in phytotoxicity, but will work fine with tomatoes. It is always advisable to try out a new fungicide or tank mix on a few plants to evaluate a crop's reaction before spraying the whole yard. Also note that there are some varietal differences in reactions to certain pesticides. The burr is very susceptible to mechanical damage during pesticide applications, so if at all possible, try to avoid spraying during burr development. Instead spray a product that is a very effective protectant with a long residual just prior to flowering. Basal growth should also be removed just prior to flowering to minimize the spread of disease (Mahaffee et al. 2009a).

See Table 2 for a list of approved fungicides on hops in MA, NY and VT for 2012. This list is not exhaustive; please check with your local Extension or Agency of Agriculture.

Table 2. Approved fungicides on hops in, MA, NY, and VT for 2012.

Trade Name	EPA Reg. No.	Active ingredient	Group	Protectant	Systemic	Curative	OMRI approved	Target pest					Registered		
								Powdery mildew	Downy mildew	Mites	Aphids	Other	MA	NY	VT
Actinovate AG	73314-1	*Streptomyces lydicus* WYEC 108		X		X	Y	X	X					X	X
Badge SC	80289-3	copper oxychloride, copper hydroxide		X					X				X	X	X
Basic Copper 50W HB	42750-168	basic copper sulfate	M1	X			Y		X					X	
Biocover UL	34704-806	petroleum oil	NC					X		X			X	X	
Bonide Liquid Copper Fungicide Concentrate	67702-2-4	liquid copper	M	X				X	X			X	X	X	X
Bonide Liquid Copper Fungicide Ready to Use	67702-1-4	liquid copper	M	X				X	X			X			X
Carbon Defense	84846-1	potassium silicate	M	X				X		X	X	X		X	
Champ DP Dry Prill (Agtrol)	55146-57	copper hydroxide	M	X					X				X	X	X
Champ Formula 2 Flowable (Agtrol)	55146-64	copper hydroxide	M	X					X				X	X	X
Champ WG	55146-1	copper hydroxide	M	X			Y		X					X	X
Champion Wettable Powder (Agtrol)	55146-1	copper hydroxide	M	X					X					X	X
C-O-C-S WDG	34704-326	copper oxychloride, basic copper sulfate	M1	X					X				X	X	X
Cueva Fungicide Concentrate	67702-2-70051	copper octanoate		X			Y	X	X			X	X	X	X
Cuprofix Ultra 40 Disperss	4581-413-82695	basic copper sulfate	M1	X					X					X	
Cuprofix Ultra 40 Disperss	70506-201	basic copper sulfate	M1	X					X				X	X	X
Drexel Damoil	19713-123	petroleum oil	NC					X		X			X	X	X
DuPont Kocide 101	352-681	copper hydroxide	M	X					X				X	X	X
DuPont Kocide 2000	352-656	copper hydroxide	M	X					X				X	X	X
DuPont Kocide 3000	352-662	copper hydroxide	M	X					X				X	X	X
DuPont Kocide 4.5LF	352-684	copper hydroxide	M	X					X				X	X	X
DuPont Kocide DF	352-688	copper hydroxide	M	X					X				X	X	X
Ecomate Armicarb "0"	5905-541	potassium bicarbonate	NC			X		X	X			X	X	X	X
Flint Fungicide	264-777	trifloxystrobin	11	X		X		X	X				X	X	X
Fosphite Fungicide	68573-2	phosphorous acid mono- and di-potassium salts	33	X		X		X	X			X	X	X	X
Fungi-phite	83472-1	phosphorous acid mono- and di-potassium salts	33	X		X			X					X	X
Glacial Spray Fluid	34704-849	white mineral oil		X			Y	X		X			X	X	X
JMS Stylet Oil	65564-1	paraffinic oil	NC					X		X			X	X	X
JMS Stylet Oil, Organic	65564-1	paraffinic oil	NC				Y	X		X			X	X	X
Kaligreen	11581-2	potassium bicarbonate	NC	X			Y	X					X		X
Kentan DF	80289-2	copper hydroxide	M	X					X				X	X	X
Kphite 7LP Systemic Fungicide Bactericide (Ag Label)	73806-1	phosphorous acid mono- and di-potassium salts	33	X		X		X	X				X	X	X
Kumulus DF	51036-352-66330	sulfur	NC	X			Y	X					X	X	X
MilStop Broad Spectrum Foliar Fungicide	70870-1-68539	potassium bicarbonate	NC	X				X					X	X	X
Monsoon	34704-900	tebuconazole	3	X	X			X					X		X
Nordox 75 WG	48142-4	cuprous oxide		X			Y		X					X	
Nu-Cop 3L	42750-75	copper hydroxide	M	X					X				X	X	X
Nu-Cop 50DF	45002-4	cupric hydroxide	M	X					X				X	X	X
Nu-Cop 50WP	45002-7	copper hydroxide	M	X			Y		X				X	X	X
Nu-Cop HB	42750-132	cupric hydroxide	M	X					X				X	X	
Nutrol	70644-1	potassium dihydrogen phosphate		X				X					X	X	X
Omni Oil 6E	5905-368	mineral oil		X				X		X			X	X	X
Omni Supreme Spray	5905-368	mineral oil		X				X		X			X	X	X
Prev-AM Ultra	72662-3	sodium tetraborohydrate decahydrate						X		X				X	
Pristine Fungicide	7969-199	boscalid, pyraclostrobin	7,11	X				X	X				X	X	X
Procure 480SC	400-518	triflumizole	3	X		X		X	X				X	X	X
Purespray 10E	69526-5	petroleum oil	NC					X		X			X	X	X
Purespray Green	69526-9	petroleum oil	NC				Y	X		X			X	X	X
Quintec	62719-375	quinoxyfen	13	X				X					X	X	X
Rally 40WSP	62719-410	myclobutanil	3	X	X	X		X					X	X	X
Rampart	34704-924	phosphorous acid mono- and di-potassium salts	33	X		X		X	X				X	X	X
Regalia	84059-3	extract of *Reynoutria sachalinenis*		X			Y	X	X				X	X	X
Saf-T-Side	48813-1	petroleum oil	NC	?		?	Y	X		X	X	X	X	X	
Serenade ASO	69592-12	QST 713 strain *Bacillus subtilis*		X			Y	X					X	X	X
Serenade Max	69592-11	QST 713 strain of dried *Bacillus subtilis*		X			Y	X					X	X	X
Sil-Matrix	82100-1	potassium silicate	M	X				X		X	X	X		X	
Sonata	69592-13	*Bacillus pumilus* strain QST 2808		X			Y	X	X				X	X	X
Tebuzol 3.6F	70506-114	tebuconazole	3	X	X			X					X	X	X
Trilogy	70051-2	clarified hydrophobic extract of neem oil	NC	X			Y	X					X	X	

References

Beatson, R.A., S.T. Kenny, S.J. Pethybridge, D. H. Gent. 2009. Hop Production. In W. Mahaffee, S. J. Pethybridge, & D. H. Gent (Eds.), *Compendium of Hop Diseases and Pests* (pp. 5-8). St. Paul, Minnesota: The American Phytopathological Society.

Gent, D., J.D. Barbour, A.J. Dreves, D.G. James, R. Parker, D.B. Walsh, eds. 2009. Field Guide for Integrated Pest Management in Hops. Washington Hop Commission.

Johnson, D.A. & C.B. Skotland (1985). Effects of Temperature and Relative Humidity on Sporangium Production of *Pseudoperonospora humuli* on Hop. *Ecology and Epidemiology, 75* (2), *127-129.*

Johnson, D.A., B. Engelhard, and D.H. Gent. 2009. Downy Mildew. In W. Mahaffee, S. J. Pethybridge, & D. H. Gent (Eds.), *Compendium of Hop Diseases and Pests* (pp. 18-22). St. Paul, Minnesota: The American Phytopathological Society.

Mahaffee, W., B. Engelhard, D.H. Gent, & G.G. Grove. 2009a. Powdery Mildew. In W. Mahaffee, S. J. Pethybridge, & D. H. Gent (Eds.), Compendium of Hop Diseases and Pests (pp. 25-31). St. Paul, Minnesota: The American Phytopathological Society.

Mahaffee, W., S.J. Pethybridge, D.H. Gent. 2009b. Injuries Caused by Environmental Factors. In W. Mahaffee, S. J. Pethybridge, & D. H. Gent (Eds.), *Compendium of Hop Diseases and Pests* (pp. 73-74). St. Paul, Minnesota: The American Phytopathological Society.

Skotland, C.B. and D.A. Johnson. Control of Downy Mildew of Hops. *Plant Disease, 67, 1183-1185.*

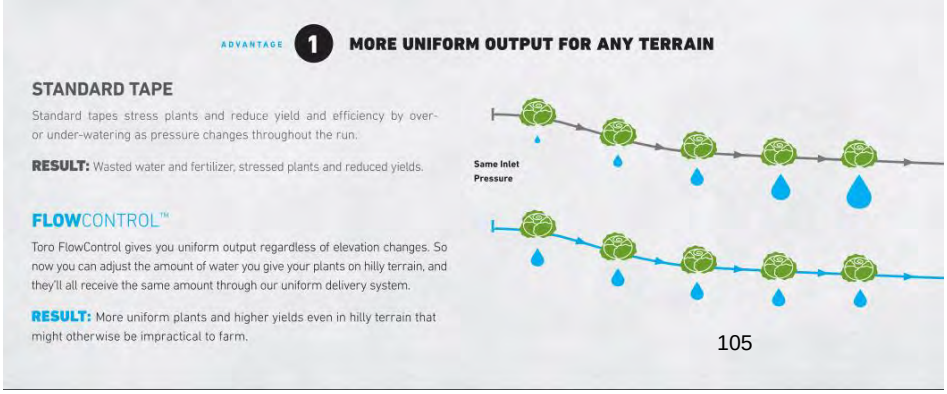
Hemp irrigation is typically set up with single use drip tape, the same way we grow vegetables. The most common way is to grow on raised bed plastic, but it can also be done on bare ground. Most hemp growers are using 12" emitter drip tape, this allows the entire root zone to get adequate water. There are six main components to the irrigation system: the pump, filter, injector, pressure regulator, drip tape and the supply hoses. Each part must be correctly sized for the operation. For the consumable products, drip tape and header hose, you are looking at around $240 an acre on 6 foot row centers. For the pump, filter and injector can be from $700-$4,000 depending on the water source and size of the operation. Many hemp growers are using the irrigation to also feed their plants throughout the season. For system design and components contact Brookdale for a free estimate and system design. Email tractortrv@aol.com

TORO Ag Irrigation

The length of the row determines the flow rate of the tape. With low flow tape we do not want to go over 800', if the rows are longer we need to split the rows in half and feed them from the middle. See the table for total row feet and gallons per minute per acre.

Length of Row	Type of Tape	Total Row Feet/Acre 6' on center	Total Row Feet/Acre 3' on center	GPM per Acre 6' center	GPM per Acre 3' center
less than 500'	High Flow, 0.45	7,315	14,630	33	66
more than 500'	Low Flow, 0.22	7,315	14,630	16	32

Toro FlowControl drip tape is the latest advancement in precision drip irrigation. FlowControl is the only flow-regulating drip tape available — giving you more control and uniformity wherever you farm. The innovative flow-regulating design provides you with the flexibility to increase or decrease flow while maintaining a uniform output across changing elevations. You now have more control of how much water your crops get, especially in long runs and hilly areas.



Plant Marvel

Fertilizers

We use and stock three different fertilizers. For the conventional grower the Plant Marvel Fertilizer is the best option, designed specifically for soils in the northeast. For the organic grower we have the NutriAg Enviroline and the Neptune's Harvest Fish fertilizers.

NutriAg
Innovators in the Field

Neptune's Harvest

UVM Extension Fact Sheet: Champlain Valley Crop, Soil and Pasture Team

Multi-Species Cover Crop Decision Tool (for Corn Silage Systems)

Champlain Valley Crop, Soil & Pasture Team
Middlebury, VT

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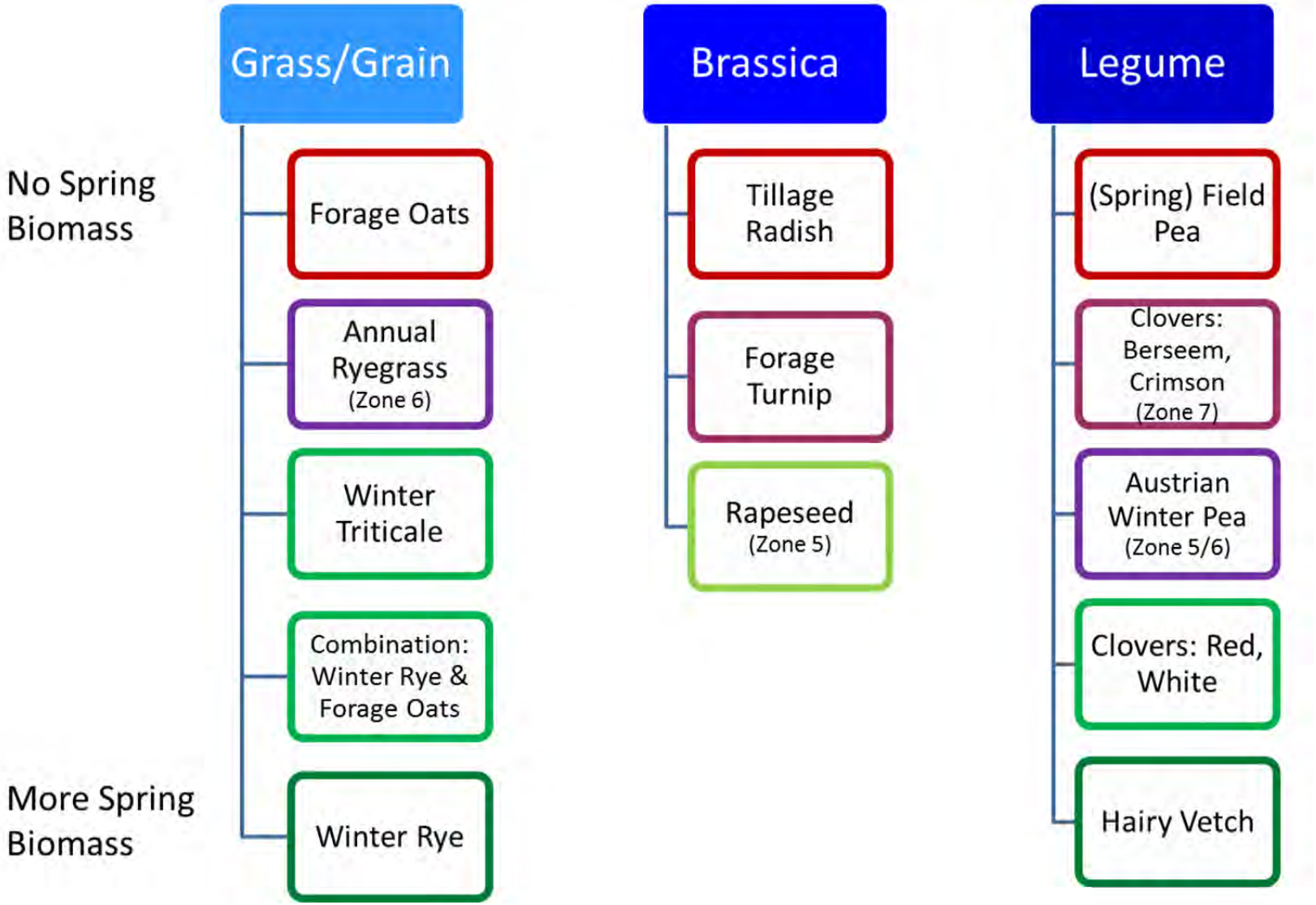
There is increasing discussion of using multi-species cover crop tools as a way to optimize the soil health and conservation benefits of cover cropping. Recent work at UVM Extension supports that this practice can be beneficial, however getting good establishment of the cover crop is crucial to see the 'fruit' of these practices. The most popular cover crop used in this region is winter rye (*Secale cereal*). Farmers attempting to decide how to diversify their cover crop mixes may be overwhelmed by the abundance of options and lack of clear guidelines for our region. Additionally, 'optimum' seeding rates can be variable based on a farmer's goals. While this guide was created specifically for corn silage systems, it can be adapted to other crops such as soybeans. Ultimately farmers will have to try it out on their farm and decide what works in their conditions, with the understanding that there will be year to year variation with weather fluctuations.

- **The important questions to ask are:** when will the cover crop will be planted, will the cover crop be just broadcast, or incorporated or drilled, how will the cover crop be terminated, and what are the primary goals of the mix. Cost will have to be weighed with objectives and the consideration of likelihood of success. Good seed to soil contact will make the investment pay. Broadcasting will require higher seeding rates.
- **Substituting Wheat or Triticale for Winter Rye:** Winter rye consistently provides fall and spring biomass. In harsher winters and when terminating earlier in spring, winter rye is more reliable and produces more spring biomass. In less harsh winters winter triticale may produce more spring biomass if planted early and terminated late. Feed value of winter triticale or winter wheat may be greater but generally mature later than winter rye.
- **Type and Use of Legume:** The nitrogen-fixing properties of a legume has to be weighed with cost, particularly when broadcast. For example, hairy vetch is better established drilling and probably isn't worth the cost if broadcasting. However, when drilling, you will want to make sure you have sufficient time after planting before hard frost for fall growth; otherwise it may not be worth the investment. Winter peas also have better success early, but should be planted for best establishment. Small seeded clovers may not visually produce as much biomass as desired, but may actually make the grass perform better than grass by itself. Surprisingly crimson clover overwintered the second year of our trial, but typically is not winter hardy in this area.
- **Type of Brassica:** Radish is a winter-killed brassica in our region. Radish produces a good taproot when planted early (i.e. August), and a pencil sized root when planted later (i.e. late September). Rapeseed and forage turnip had better success than radish in our trials comparatively when broadcast, and those mixes broadcast or drilled seemed to stimulate Winter Rye growth in spring. Rapeseed produces more above ground biomass as opposed to below ground biomass. Both rapeseed and turnip over-wintered during the second year of our trial, which was mild. Mustard is a good brassica for the specific purpose of biofumigation, but for the purposes of soil conservation, costs more and produced less biomass in our trial.
- **Annual Ryegrass Termination/Weed Concern:** In southern climates there is a concern of annual ryegrass becoming a weed. In our region we typically think of annual ryegrass as being winter-killed. However, in mild winters it will likely over-winter. Termination strategy must be considered when using annual ryegrass. When broadcasting, it has shown some promise over winter cereals with better establishment, though that can vary yearly.

A Relative Ranking of Select Cover Crops Based on Spring Biomass

Red - Winter Killed ---> Dark Green - Abundant Spring Biomass



Drilled/Planted Cover Crop Decision Tree

Inter-Seeded/Broadcast - See Over --->

Drilled Cover Crop

How much biomass do you want in the spring?

Winter Killed – No Spring Biomass

- Planting by Sept 1st Utilizing a Legume for N-Fixation
  - Forage Oats – 30 lb/ac
    Field Peas – 25 lb/ac
    Radish – 5 lb/ac
- Planting by Sept 15th Not Investing in a Legume
  - Forage Oats – 60 lb/ac
    Radish – 5 lb/ac

Moderate Spring Biomass

- Planting by Sept 1st Utilizing a Legume for N-fixation
  - Forage Oats – 40 lb/ac
    Winter Rye – 40 lb/ac
    Vetch – 10 lb/ac
  - Winter Rye – 50 lb/ac
    Winter Pea – 25 lb/ac
    Radish – 5 lb/ac
- Planting by October 1st Not Investing in a Legume
  - Forage Oats – 40 lb/ac
    Winter Rye – 40 lb/ac
    Forage Turnip – 4 lb/ac

Are you harvesting, grazing or rolling-crimping your cover crop?

High Spring Biomass

- Planting by Sept 1st Utilizing a Legume for N-fixation
  - Winter Rye – 75 lb/ac
    Vetch – 10 lb/ac
    Rapeseed – 5 lb/ac
- Planting by Sept 15st Not Investing in a Legume
  - Winter Rye – 125 lb/ac
    Radish – 5 lb/ac

*Always consult with NRCS when approving multi-species cover crop rates for EQIP conservation contracts.

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Inter-Seeded/Broadcast Cover Crop Decision Tree

Inter-Seeded Cover Crop

How much biomass do you want in the spring?

Winter Killed – No Spring Biomass

- Utilizing a Legume for N-Fixation
  - Forage Oats – 40 lb/ac
    Field Peas – 30 lb/ac
    Radish – 5 lb/ac
- Not Investing in a Legume
  - Forage Oats – 85 lb/ac
    Radish – 5 lb/ac

Moderate Spring Biomass

- Utilizing a Legume for N-fixation
  - Annual Ryegrass – 15 lb/ac
    Crimson Clover– 5 lb/ac
    Radish – 5 lb/ac
  - Annual Ryegrass – 15 lb/ac
    Winter Pea – 30 lb/ac
    Radish – 5 lb/ac
- Not Investing in a Legume
  - Annual Ryegrass – 20 lb/ac
    Radish– 5 lb/ac
  - Winter Rye – 50 lb/ac
    Forage Oats – 50 lb/ac
    Forage Turnip – 5 lb/ac

Are you harvesting, grazing or rolling-crimping your cover crop?

High Spring Biomass

- Utilizing a Legume for N-fixation
  - Winter Rye – 100 lb/ac
    Vetch – 10 lb/ac
    Rapeseed – 5 lb/ac
- Not Investing in a Legume
  - Winter Rye – 140 lb/ac
    Radish – 5 lb/ac

Annual Ryegrass should be planted by July for the most successful inter-seeding.

Cereal grains should be planted in August for the most successful inter-seeding.

*Always consult with NRCS when approving multi-species cover crop rates for EQIP conservation contracts.

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Table 1d - VT 340	Min.Seeding Rate (lbs/acre)		Seeding Depth	Latest Seeding Dates* (USDA Hardiness Zones 3b - 5a)				Primary Purpose**		
Cover Crop Mixes ǂ *(3-Species Mixes)*	Broadcast (incldues aerial)	Drilled	Inches	Fall Cover	Winter Cover	Spring Cover	Summer Cover	Erosion	Nitrogen Fixation	Nutrient Scavenge
2-1: *Winter Killed Mix* ǂ										
Forage Oat	40	30	1-1½	Aug. 15	Sept. 1	April 15	May 15	x	x	x
Field Pea	30	25								
Radish	5	3								
2-2: *Marginally Winter Hardy* ǂ										
Annual Ryegrass	15	12	½-1	Aug. 15	Sept. 1	April 15	May 15	x	x	x
Winter Pea	30	25								
Radish	5	3								
2-3a: *Winter Kill & Winter Hardy* (Brassica) ǂ										
Forage Oat	50	40	1-1½	Aug. 15	Sept. 15	NA	NA	x		x
Winter Rye	50	40								
Radish	5	3								
2-3b: *Winter Kill & Winter Hardy* (Legume) ǂ										
Forage Oat	50	40	1-1½	Aug. 15	Sept. 15	NA	NA	x	x	x
Winter Rye	50	40								
Hairy Vetch	15	10								
2-5: *Winter Hardy , Low Spring Biomass* ǂ										
Winter Rye	50	40	1-1½	Aug. 15	Sept. 15	NA	NA	x	x	x
Winter Pea	30	25								
Turnip	5	3								
2-6: *Winter Hardy, Moderate Biomass* ǂ										
Winter Rye	50	40	½-1½	Aug. 15	Sept. 1	NA	NA	x	x	x
Crimson Clover	12	10								
Winter Rapeseed	5	3								
2-7: *Winter Hardy , High Spring Biomass* ǂ										
Winter Rye	100	75	½-1½	Aug. 15	Sept. 15	NA	NA	x	x	x
Hairy Vetch	15	10								
Winter Rapeseed	5	3								

Table 1e - VT 340

ǂ Seeding Rates (in a three-way mix) Pounds/Acre		
Cover Crop Species	**Broadcast**	**Drilled**
Grasses & Grains		
Winter Rye	50	40
Winter Wheat	50	40
Winter Triticale	50	40
Spring Grain	50	40
Forage Oat	50	40
Annual Ryegrass	15	12
Legumes		
Red/White Clover	8	6
Crimson Clover	12	10
Berseem/Sweet Clover	10	8
Field Pea	30	25
Winter Pea	30	25
Hairy Vetch	15	10
Brassicas		
Radish	5	3
Turnip	5	3
Rapeseed	5	3

These rates are in pure live seed (PLS):

% PLS = % germination x % pure seed/100

To determine actual seeding rate, divide desired PLS seeding rate by your seeds' % PLS

Example: To achieve a 50 lb/acre PLS seeding rate with seed that has 85% PLS

50 ÷ 0.85 PLS = 59 lbs/acre actual seed

** Locations in USDA Hardiness Zone 5b may plant up to 5 days later for the Fall and Winter Cover dates.*

*** Other purposes may also be accomplished, but this is meant to help you select cover crops to address the primary resource concern in the conservation plan*

ǂ to substitute species in a mix listed above, or create your own mix, use seeding rates in Table 1e (only to be used in mixes that contain three different species)

Cover crop	Advantages	Challenges	Best establishment	Termination	Mixes well with	Rate[b] Cost/Acre: Drill[c]	Rate[b] Cost/Acre Broadcast[c]
Annual ryegrass[d]	Improves water infiltration, establishes well in poor, cool, rocky, or wet soils	Prefers well-drained soils, but can tolerate flooding once established, wait a few weeks after incorporation to reduce nitrogen tie-up before planting	Early spring, late summer, early fall, fall	Disking during early bloom, herbicide	Legumes, grasses	20 lbs/acre $18.00/acre	30 lbs/acre $27.00/acre
Buckwheat	Grows quickly, suppresses weeds, grows well in low-fertility soil, scavenges phosphorus, breaks down quickly, benefits pollinators	Not frost or drought tolerant, grows poorly in compacted or excessively wet soils.	Late summer, Fall	Within 7-10 days after flowering, herbicide	Sorghum-sudangrass hybrids, sunnhemp	60 lbs/acre $41.40/acre	70 lbs/acre $48.30/acre
Clover, balansa[d]	Fixes nitrogen, adapted to a wide variety of soil types, established stands tolerate waterlogging	High reseeding potential, requires 'Trifolium Special #2' inoculant, slow establishment	Early spring, early fall	Disking, herbicide	Small grains, grasses, and other clovers	5 lbs/acre $17.90/acre	8 lbs/acre $28.64/acre
Clover, berseem[d]	Fixes nitrogen, grows quickly, moderately tolerant of heat and shade, grows in all soil types except sands	Allelopathic compounds (wait one month to plant small seeded vegetables)	Early spring, early fall	Frost kills, will die after flowering, till, herbicide	Oats, ryegrass small grains	10 lbs/acre $25.60/acre	18 lbs/acre $46.08/acre
Clover, crimson[d]	Fixes nitrogen, suppresses weeds	Grows poorly in heavy clay or poorly drained soils, high capacity to reseed	Early to late summer (after danger of frost)	Mowing after early bud stage, tillage, or herbicide	Small grains, grasses, and other clovers	20 lbs/acre $24.80/acre	25 lbs/acre $31.00/acre

Cover crop	Advantages	Challenges	Best establishment	Termination	Mixes well with	Rate[b] Cost/Acre: Drill[c]	Rate[b] Cost/Acre Broadcast[c]
Cowpea	Fixes nitrogen, suppresses weeds, long vegetative stage, grows well in low-fertility soil, heat tolerant, attracts beneficial insects	Does not grows well on poorly drained soils	Early summer (consistent soil temperature of 65° F) until 9 weeks before frost.	Often mowed or rolled before incorporation, herbicide	Sorghum-sudangrass hybrids, millet, buckwheat	60 lbs/acre $17.40/acre	100 lbs/acre $29.00/acre
Radish[d]	Grows quickly, suppresses weeds, scavenges nitrogen, reduces compaction, breaks down quickly	Does not grows well on poorly drained soils, biotoxicity can stunt cash crop residue (wait until no longer green)	Spring, late summer, early fall (4 weeks before first 28° F freeze)	Winter kill, tillage, herbicide	Other brassicas, mustards, small grains, crimson clover	10 lbs/acre $19.40/acre	15 lbs/acre $29.10/acre
Sorghum-sudangrass hybrids	Scavenges nitrogen, grows quickly, suppresses weeds, heat and drought tolerant, tolerates low fertility soils	Quick growth can present management problems, may host pests	Late spring (two weeks after planting corn), early summer	Mow and then disk while in vegetative stage, flail chop after frost for mulch cover, herbicide	Buckwheat, sunnhemp, cowpeas	35 lbs/acre $53.20/acre	50 lbs/acre $76.00/acre
Sunnhemp	Grows quickly, breaks down quickly	More suitable for vegetable production, requires cowpea inoculant, not frost tolerant	Between harvest of summer crop and planting of fall cash crop.	Winter kill, disk, herbicide	Sorghum-sudangrass hybrids	30 lbs/acre $13.80/acre	50 lbs/acre $69.00/acre
Vetch, hairy[d]	Fixes nitrogen, suppresses weeds, improves water infiltration, winter hardy, can host beneficial insects	Hard seed can become weed in the next year, not suitable for planting with winter grain, can host pests	Early spring, early fall	Pre-bloom to bloom stage, disk, no-till, herbicide	Small grains, field peas, crimson clover, buckwheat	20 lbs/acre $42.40/acre	35 lbs/acre $74.20/acre

Cover crop mix	Advantages	Challenges	Best establishment	Termination	Rate Cost/Acre: Drill[a]	Rate Cost/Acre Broadcast[c]
Annual ryegrass (80%) Red clover (15%) Radish (5%)	Improves water infiltration, fixes nitrogen, suppresses weeds	Prefers well-drained soils, but can tolerate flooding once established, wait a few weeks after incorporation to reduce nitrogen tie-up before planting	Early summer	Disking, herbicide	25 lbs/acre $26.21/acre	35 lbs/acre $36.70/acre
Annual ryegrass (80%) Balansa clover (15%) Radish (5%)	Improves water infiltration, fixes nitrogen, suppresses weeds	Prefers well-drained soils, but can tolerate flooding once established, wait a few weeks after incorporation to reduce nitrogen tie-up before planting	Early summer	Disking, herbicide	25 lbs/acre $33.19/acre	35 lbs/acre $46.47/acre
Annual ryegrass (80%) Common vetch (15%) Radish (5%)	Improves water infiltration, fixes nitrogen, suppresses weeds	Prefers well-drained soils, but can tolerate flooding once established, wait a few weeks after incorporation to reduce nitrogen tie-up before planting	Early summer	Disking, herbicide	25 lbs/acre $24.19/acre	35 lbs/acre $33.87/acre
Annual ryegrass (85%) Radish (15%)	Improves water infiltration, suppresses weeds	Prefers well-drained soils, but can tolerate flooding once established, wait a few weeks after incorporation to reduce nitrogen tie-up before planting	Early summer	Disking, herbicide	25 lbs/acre $25.13/acre	35 lbs/acre $35.18/acre
Summer Solar Mix[b] Cowpeas (67%) Buckwheat (11%) Sunnhemp (11%) Sunflower (11%)	Fixes nitrogen, suppresses weeds, attracts pollinators	Does not establish well in compacted or poorly drained soil, requires cowpea inoculant, not frost tolerant	Early summer	Winter-kill, disking, herbicide	55 lbs/acre $71.50/acre	Not recommended

EXTENSION AGRICULTURE

BEN & JERRY'S

THE UNIVERSITY OF VERMONT EXTENSION

NORTHWEST CROPS & SOILS PROGRAM

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- Soil health can improve
- Animal welfare can benefit
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- Farm finances can become more sustainable

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Heather Darby, UVM Extension Northwest Crops and Soils (heather.darby@uvm.edu) 802-524-6501
Franklin County, VT & Grand Isle County, VT

Sara Ziegler, UVM Extension Northwest Crops and Soils (sara.ziegler@uvm.edu) 802-524-6501
Franklin County, VT & Grand Isle County, VT

Cheryl Cesario, UVM Extension Champlain Valley Crop, Soil & Pasture (cheryl.cesario@uvm.edu) 802-388-4969
Addison County, VT

Sarah Flack, Sarah Flack Consulting (sarahflackconsulting@gmail.com) 802-309-3714
Franklin County, VT

Brent Beidler, Beidler Family Farm, Randolph, VT (brentbeidler@gmail.com) 802-431-8530
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More information can be found at: **https://www.uvm.edu/nwcrops**

July 2019

Published by the University of Vermont Extension Northwest Crops and Soils Program. Learn more about the program at: **www.uvm.edu/nwcrops**

Paddock/Pasture Size & Acreage Needed – Calculation Worksheet

This worksheet will help you calculate how large a paddock needs to be for one grazing group for one day and the total acres you will need to practice well managed grazing to produce high quality livestock feed.

To use this worksheet, you need to know:

- The number of animals in the grazing group.
- How much pasture dry matter per animal you plan to provide.

Grazing Guidelines:

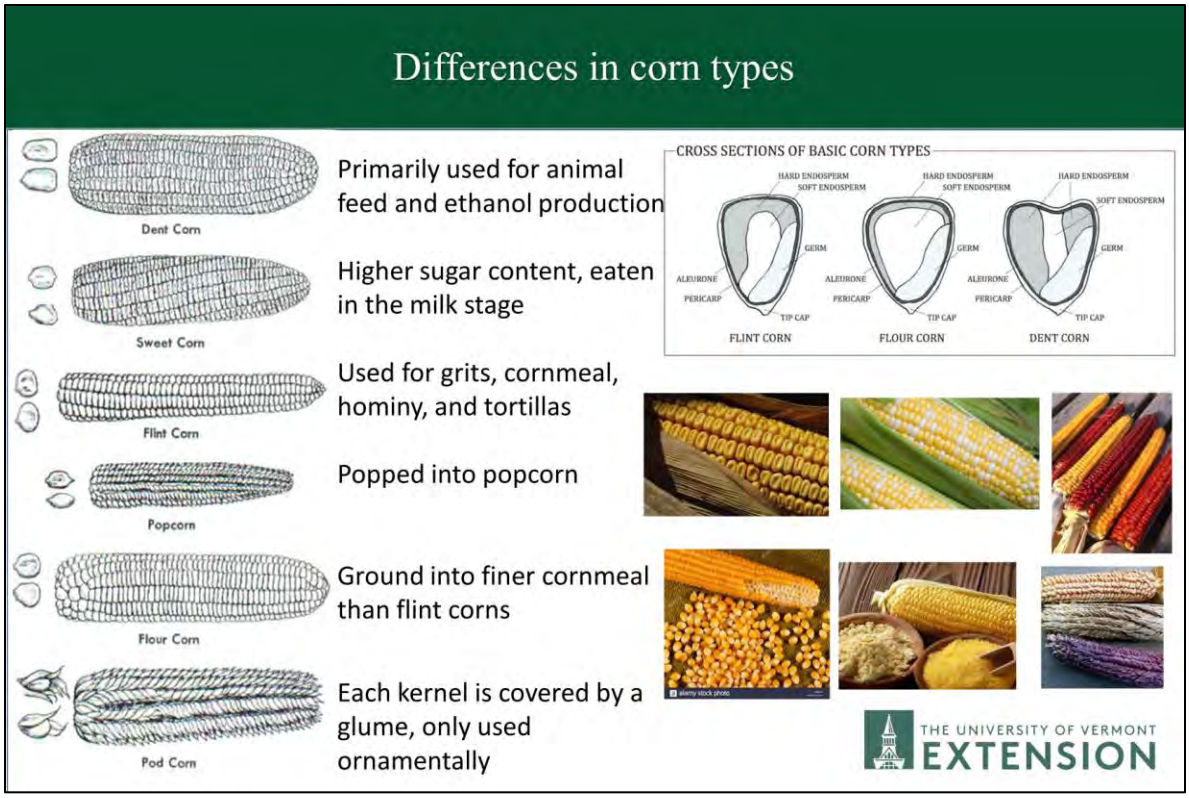
- Allow plants enough time to fully regrow and recover after each grazing.
- Graze livestock in each area for a relatively short time (short period of occupation) to prevent "re-grazing" of plants that are starting to regrow.

1	Type of livestock (example: sheep, dairy cows, heifers)	
2	Number of animals in group	
3	Estimated total daily dry matter requirement per animal	
4	If supplemental feed is fed, how much dry matter per animal is fed from hay, silage, grain or other non-pasture feeds?	
5	Dry matter to be provided from pasture per animal (total intake required less non-pasture feed fed) Line 3 – Line 4 = *If nothing other than pasture is fed, line 5 and line 3 will be the same*	
6	Calculated total dry matter intake for Group Line 2 x Line 5 =	
7	Estimated forage dry matter available per acre	
8	Calculated paddock size required for 24 hours (required amount divided by total available per acre) Line 6/Line 7 =	
9	Planned occupancy period (# of days the herd is left in the paddock)	
10	Calculate paddock size needed for full planned occupancy period. Line 8 x Line 9 =	

		May	**June**	**July**	**Aug.**	**Sept.**	**Oct.**
11	Estimated pasture recovery period						
12	Calculate number of paddocks needed (Line 11/ Line 9) + 1 =						
13	Calculated total number of acres needed for the grazing rotation Line 10 x Line 12 =						

Do you have enough land?

If not, what is your plan to avoid rotating back to paddocks that are not fully recovered?



2019 Flint Corn VT

planted 5-21-19 **N**

plots 10'x20' (4 rows) ↓

5 gal/ac 9-18-9

Road	Chosen Acre Corn Trial															
	414	Early Riser	407	Oaxacan Green	406	Abenaki	405	Canadian White	404	Elliot's White	403	Osage Brown	402	Roter Tessinermais	401	Minnesota 13
	413	Cascade Ruby-Gold	314	Abenaki	313	Wapsie Valley	312	Cascade Ruby-Gold	311	Minnesota 13	310	Bronze Orange	309	Early Riser	308	Dakota White
	412	Dakota White	307	Roter Tessinermais	306	Osage Brown	305	Elliot's White	304	Oaxacan Green	303	Gaspe	302	Canadian White	301	Flint's Flint
	411	Wapsie Valley	214	Roter Tessinermais	213	Abenaki	212	Wapsie Valley	211	Elliot's White	210	Gaspe	209	Canadian White	208	Osage Brown
	410	Gaspe	207	Minnesota 13	206	Cascade Ruby-Gold	205	Bronze Orange	204	Dakota White	203	Early Riser	202	Flint's Flint	201	Oaxacan Green
	409	Flint's Flint	114	Bronze Orange	113	Flint's Flint	112	Oaxacan Green	111	Osage Brown	110	Early Riser	109	Minnesota 13	108	Gaspe
	408	Bronze Orange	107	Canadian White	106	Wapsie Valley	105	Dakota White	104	Elliot's White	103	Roter Tessinermais	102	Cascade Ruby-Gold	101	Abenaki

Variety	Type	Source
Osage Brown	Flour	Bear Creek Heirlooms
Bronze Orange	Flint	Victory Seeds
Cascade Ruby-Gold	Flint	Adaptive Seeds
Abenaki	Flint	Adaptive Seeds
Oaxacan Green	Dent	Johnny's Selected Seeds
Minnesota 13	Dent	Albert Lea Seeds
Wapsie Valley	Flint	Aurora Farms (VT)
Early Riser	Dent	Butterworks Farm (VT)
Elliot's White	Dent	Albert Lea Seeds
Flint's Flint Corn	Flint	UVM Extension
Roter Tessinmais	Flint	Sylvia Davatz
Dakota White	Flint	Sylvia Davatz
Canadian White	Flint	Sylvia Davatz
Gaspe	Flint	Sylvia Davatz

2019 Dry Bean Variety Trial

2019 Dry Bean Variety Trial Map

Planting date: 6/28/19

Plot size: 5 x 20' (2 rows per plot)

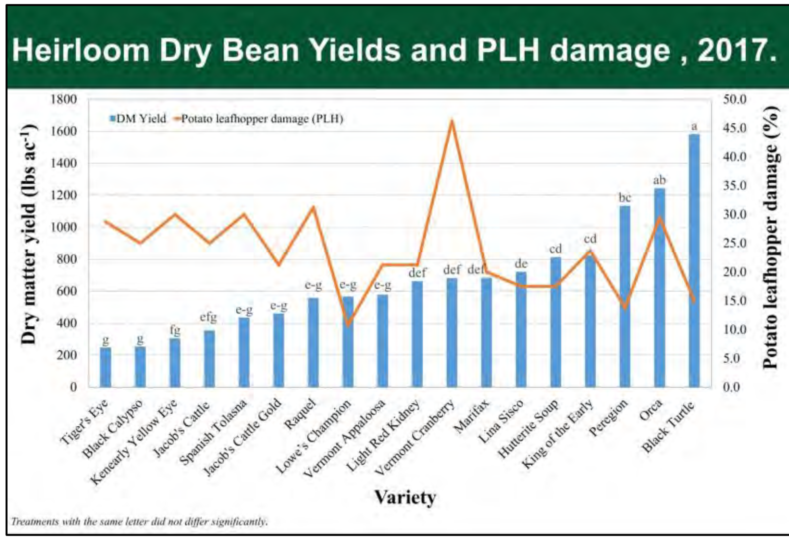
Seeding rate: 7 seeds/ft

N →

20' 5' 195'

5'	105 Light Red Kidney	110 Jacob's Cattle	205 Light Red Kidney	210 King of the Early	305 Lina Sisco	310 Black Calypso	405 Marifax	410 Kenearly Yellow Eye
	104 Black Calypso	109 Jacob's Cattle Gold	204 Lina Sisco	209 Jacob's Cattle Gold	304 Kenearly Yellow Eye	309 King of the Early	404 Peregion	409 Jacob's Cattle Gold
	103 Peregion	108 Marifax	203 Black Calypso	208 Kenearly Yellow Eye	303 Peregion	308 Marifax	403 Lina Sisco	408 Tiger's Eye
	102 Tiger's Eye	107 Lina Sisco	202 Jacob's Cattle	207 Marifax	302 Jacob's Cattle	307 Tiger's Eye	402 Black Calypso	407 Light Red Kidney
25'	101 Kenearly Yellow Eye	106 King of the Early	201 Peregion	206 Tiger's Eye	301 Jacob's Cattle Gold	306 Light Red Kidney	401 King of the Early	406 Jacob's Cattle

Short Season Corn



2017 Heirloom dry bean pre-harvest measurements, Alburgh, VT.

Variety	Plant height	Lodged	Pod distance to ground	Pod disease
	cm	%	cm	%
Black Calypso	22.8	2.50*	7.17	100
Black Turtle	**47.8***	**0.00***	**15.3***	**15.0***
Hutterite Soup	21.9	40.0	4.67	67.5
Jacob's Cattle	21.3	2.50*	4.75	80.0
Jacob's Cattle Gold	20.3	**0.00***	7.58	77.5
King of the Early	25.5	**0.00***	4.50	75.0
Light Red Kidney	27.3	**0.00***	6.50	60.0
Lina Sisco	23.6	**0.00***	8.08	100
Lowe's Champion	29.6	**0.00***	9.25	90.0
Marifax	27.8	2.50*	6.25	72.5
Orca	30.6	8.75*	8.58	47.5
Peregion	31.5	17.5	11.3*	**15.0***
Raquel	28.3	**0.00***	5.75	65.0
Spanish Tolasna	30.3	6.25*	6.17	85.0
Tiger's Eye	25.3	5.00*	4.83	80.0
Vermont Appaloosa	28.3	**0.00***	6.00	70.0
Vermont Cranberry	30.0	12.5	7.58	60.0
Kenearly Yellow Eye	21.9	2.50*	6.00	47.5
LSD (0.10)	7.75	8.81	4.12	25.8
Trial Mean	27.5	5.56	7.24	67.1

Values shown in **bold** are of the highest value or top performing.

* Dry beans that did not perform significantly lower than the top performing variety in a particular column are indicated with an asterisk.

Northeast Dry Bean Production Guide

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Visit us on the web at http://www.uvm.edu/nwcrops

This guide has been made possible with funding from Northeast SARE, project ONE15-234.

Introduction

Dry beans (*Phaseolus* spp.) come in a wide variety of shapes, colors, and sizes (Figure 1). Varieties like Jacob's cattle, European soldier, Black turtle, and Yellow-eyed beans are commonly grown in the Northeast. The edible field bean is considered a grain legume crop that is well-suited for our climate but requires good soil quality and diverse crop rotations. Beans are a staple food for much of the world due to their high protein content (generally 22% to 24%). They can serve as a great addition to a grain rotation and are a highly marketable crop. Dry beans are harvested once the shell and bean have matured and dried.

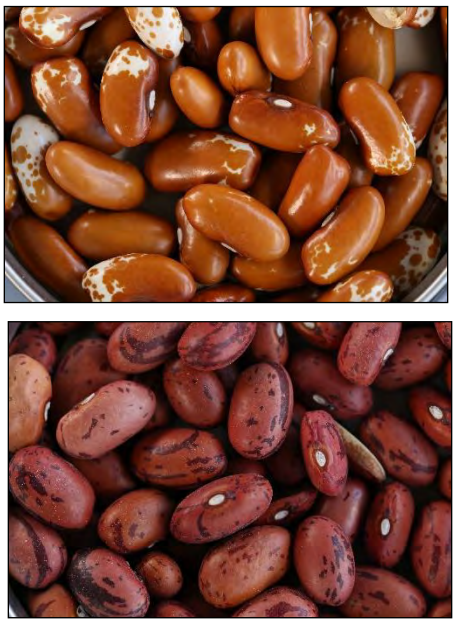


Figure 1. Raquel (top) and Vermont Cranberry (bottom) dry bean varieties.

Sourcing Quality Seed

There are many different types of dry beans, which are often classified by color. Generally, within each type, both bush (determinate) or trailing (indeterminate) varieties are available. Growers should carefully choose their dry bean varieties based on maturity, growth habit, and water requirements and buy certified, disease-resistant seed. White beans are often recommended for the Northeast because they tolerate poorer-quality soils and have a shorter growing season than colored beans. However, their light-colored seed coat can become stained in wet weather, especially in late summer.

To ensure desirable plant populations, high yields, and quality, it is important to purchase high quality seed with good germination (> 90%) that is free of weed seeds and seed-borne diseases. Buying 'Certified Seed' is your best bet for purchasing high quality seed. However, sourcing certified heirloom dry bean seed in quantities greater than a pound has proven to be a challenge. Much of the heirloom bean seed we have found thus far has not been 'Certified Seed'—rather it has been saved seed from growers or from businesses selling beans for food.

If the germination rate is not listed on the label, it is imperative to do a germination test before planting. Dry bean seed is easily damaged and therefore, seed quality is relatively short lived. It is not advisable to purchase seed known to be over three years old. A simple germination test can easily be conducted. It is recommended to test each bean variety in duplicate. Start by soaking two paper towels in water and spreading twenty seeds over one half of it, then fold the other half over the seeds. Fold and roll it up like a burrito, place it in a clear plastic bag or airtight container to keep it from drying out, and store in the dark. Open up each test daily to see if any seeds have germinated; remove any sprouted seed from the test. Add more water if paper towels dry out, making sure the tests remain damp but not dripping wet, and at a least 70 degrees Fahrenheit. Most seeds like to be warm, but not hot. Continue to check daily until you have concluded that

all the viable seeds have germinated. If you haven't seen a new sprout for 7 days, the test is probably complete. Dry beans will generally germinate in three to four days. Count how many seeds are left to calculate percent germination. For example, if you had 2 seeds left out of the original 20, then the germination rate would be 90% (20 – 2 = 18; 18/20 = .90). If you did the tests in duplicate, average the two tests to get the germination rate. Seeding rates should be adjusted to compensate for low germ seed. Planting seed with a germination below 80% is not advisable.

It is also important that dry beans be free of seed-borne diseases. Anthracnose is the primary seed-borne disease identified in Vermont. Unfortunately, there isn't a simple 'do-it-yourself' test you can conduct to determine whether your seed is infected. However, the University of Vermont Plant Diagnostic Clinic can screen seeds for Anthracnose and other diseases. For instructions on submitting a sample to the Clinic, visit their website at: http://pss.uvm.edu/pd/pdc/.

Production and Management

Soil & Fertility

Dry beans prefer a well-drained soil with relatively good fertility. Avoid planting dry beans in a field that floods easily, is heavily compacted, or regularly develops a thick crust. As with any crop, before selecting fields in which to plant dry beans, it is advisable to test the soil fertility first. Information on how to properly take and submit a soil test may be found at the University of Vermont's Agricultural and Environmental Testing Laboratory at: http://www.uvm.edu/pss/ag_testing/. The soil test report generated will provide information on the field's current fertility levels and recommendations for amendments that may be added to improve soil fertility specifically for dry beans.

Dry beans grow best in nearly neutral soil, with a pH around 7.0. More acidic soils will require the addition of limestone, preferably dolomitic lime, to raise the pH. However, dry beans are sensitive to soil zinc levels, especially in soils where the pH is above 7.0. To amend soil zinc levels, add 10 lbs per acre of zinc sulfate into your starter fertilizer. Broadcasting zinc onto fields is not recommended but foliar applications may be used if applied when the plants are young, before flowering. Depending on your soil test results, nitrogen, phosphorus, and potassium (N-P-K) may need to be applied.

Beans are sensitive to salt injury and ammonia burn; therefore, fertilizer should be band applied and separated from the seed by 2 to 3 inches. Beans should not require any additional amendments after planting. Dry beans are legumes, so they produce their own nitrogen through a symbiotic relationship with rhizobium bacteria. Over-applying chemical fertilizers or manure

may cause excessive vegetative growth, increase risk of disease, and/or slow down the natural rhizobium growth.

Seeding Rates

Dry beans come in a variety of different sizes. Since, there aren't as many seeds per pound in a large bean variety (eg., kidney) as there are in a smaller variety (eg., black), it takes more seed of a larger bean variety to get the same plant population as a smaller bean variety. Therefore, it is important to calibrate your planter for the type of bean before you plant. Beans can be planted with a corn planter fitted with bean cups appropriate for the seed size or using a corn planter with different size seed plates. As a general rule, adjust the planter to seed at about 60 lbs per acre; this should produce about 7 seeds per foot. You may need to adjust the settings depending on the variety and germination rate.

Planting

Dry beans are generally planted in late May to early June, once soil temperatures are reliably 60°F or higher. Beans can easily be injured or killed by frost, so it is best to delay planting until any chance of frost has passed. Most dry bean varieties need 90 to 100 days to mature.

Before planting, seeds should be inoculated with the bacteria *Rhizobium phaseoli* for optimal nitrogen fixation.

Beans are usually planted about 1½ to 2½ inches deep and in 30-inch rows. Some growers plant in narrower rows to suppress weed growth, but this can increase the likelihood of disease in leaves and stems and make cultivation and harvesting more difficult.

Beans are sensitive to day-length; when there are enough hours of sunlight, the plants produce small white or light purple flowers that are self-pollinating. Indeterminate varieties of dry beans will continue to expend energy in vegetative development for a few weeks after they flower. Most dry bean growth will occur when temperatures are between 65°F and 75°F. During extended periods of cold (below 46°F) or hot (above 95°F) weather, beans may shed blossoms and developing pods. Because beans cannot tolerate water-logged soils and require adequate moisture as they bloom and develop pods, water management is often the most crucial issue with dry beans. Drier conditions during the season (or heavy rainfall near harvest) will decrease yields.

Dry Bean Pest Management

Weed Control

Weeds may develop quickly in beans because the beans are slow to establish a canopy and do not compete well. Pre-emergent weed control can be accomplished with either a tine-weeder or a rotary hoe, depending on the weather and soil conditions and amount of plant residue in the field. Do not cultivate when the beans are starting to emerge as bean seedlings are very fragile and can easily snap. Cultivation can be undertaken when plants are between 2 and 3 inches tall until canopy closure.

A word of caution: bean taproots are easily torn from the ground during imprecise mechanical cultivation. To minimize damage to plants, beans should not be cultivated when they are wet or just after they have flowered.

Diseases

Dry beans are susceptible to various root rots including *Rhizoctonia, Fusarium,* and *Pythium*—all can cause seedling death and reduce yields. In addition, several bacterial leaf diseases including Bacterial Bean Blight, Bacterial Brown Spot, and Halo Blight are common (Figures 2 and 3). Bacterial diseases are challenging to identify, but samples of diseased plant tissue can be sent to the UVM Plant Diagnostic Clinic for positive identification; see http://pss.uvm.edu/pd/pdc/ for submission instructions.

Figure 2. Bean leaf infected with Bacterial Bean Blight.

Figure 3. Dry bean plant infected with Bacterial Brown Spot.

Fungal pathogens include *Sclerotinia* white mold (Figure 4), and one of the most destructive diseases, Anthracnose (*Colletotrichum lindemuthianum*). Anthracnose (Figure 5) begins with

Figure 4. White mold on dry bean plant.

discoloration as red spots on leaves that develops into lesions. As lesions develop, leaf veins turned reddish-dark brown and spread through the leaf. The fungus then spreads to the pods, causing black lesions. Mature circular lesions on pods are surrounded by reddish-brown to black borders with a grayish black interior that exuded pink masses of spores. Anthracnose can wipe out entire fields of beans, and is spread primarily by planting infected seed.

Figure 5. A. Typical symptoms of bean Anthracnose collected from an infected field. B. Leaf underside with dark lesions along veins. C. Circular pod lesions with gray-black centers. D. Distinctive interior of the lesion exuding tan to pink/salmon masses of spores.

Figure 6. Signs of Ascochyta pod blight. Cultivars 'tiger's eye' (right) and 'black turtle' (left). Sunken lesions with dark center visible. Detail of concentric rings of small pycnidia (dots) developing in the center of lesions were the most diagnostic characteristic (right).

While screening pods for anthracnose, another pathogen was detected on the surface of some of the examined bean pods. Microscopic examination revealed the fungus to be *Ascochyta* spp. Small black pycnidia were observed in dark brown sunken lesions, giving the lesions an appearance of a bullseye (Figure 6).

In our cool, moist climate, practices that are critical to managing the multitude of diseases that impact dry beans include:

- planting clean seed
- improving air flow
- rotating crops

Buying "Certified Seed' is highly recommended whenever possible. Certified seed guarantees that the seed meets or exceeds a strict set of quality control standards. In the case of beans, this includes rigid standards of seed diseases.

Weed management is especially important to improve air flow and assist with keeping the bean plant canopy as dry as possible. A dry canopy can help minimize the infection of disease. Spores from many of the fungal diseases can survive in the soil for 3 to 5 years, waiting for their host plant and/or ideal conditions.

Crop rotation is also crucial in minimizing disease presence during bean production. Dry beans should not be grown in the same field for more than 3 to 4 years. Small grains are well-suited to rotations with beans because they are not susceptible to the same diseases as beans. Conversely, crops like sunflower, canola, and soybeans should be spaced properly between dry bean plantings.

Insect Pests

The primary insect pest of dry beans in the Northeast is the Potato Leafhopper, *Empoasca fabae* (Harris). Potato leafhoppers have an appetite for more than 200 broad leaf plants. Adult females overwinter in southern states and are carried northward on spring wind currents. The migratory nature of this native pest makes its arrival time and population size unpredictable.

Adults land in alfalfa and bean fields upon arrival where they feed and lay eggs. Potato leafhoppers are light green, wedge shaped insects that can be found scuttling on the underside of leaves. Adults are 1/8th of an inch long. Wings do not develop until the adult stage (Figure 7). Depending on spring arrival time and temperature, growers have witnessed 2 to 4 generations per season in the Northeast.

Figure 7. Potato Leafhopper nymph and adult.

Potato leafhoppers feed with piercing-sucking mouthparts on host plant's vascular tissue. This restricts phloem and eventual xylem flow to the rest of the leaf resulting in leaf edge yellowing and curling. At high infestation levels, stunted internodes can be observed. Visual damage caused by potato leafhopper is called "hopper burn" (Figure 8). Hopper burn is not present until 5 to 7 days after leafhopper feeding has occurred. The first sign is yellowing of the leaf at the tip followed by necrosis and leaf curling. These symptoms are the result of the plant shutting down photosynthesis in the leaf in response to leafhopper feeding. As this pest weakens the plant, it becomes more vulnerable to disease.

Figure 8. Potato Leafhopper damage "hopper burn".

As with Integrated Pest Management (IPM) programs in other crops, weekly monitoring for pests is recommended. Scouting the undersides of three leaves per plant in each variety is recommended weekly. Potato leafhoppers have feeding preference for particular varieties. Leafhoppers tend to steer clear of varieties that have leaves with more leaf hairs that exude chemical compounds. Preliminarily, Tiger's Eye appears to be a dry bean variety more susceptible to potato leafhopper. Insecticide options are limited for organic growers but products with azadirachtin or pyrethrin as active ingredients are effective against potato leafhopper. For conventional management, products with active ingredients beta-cyfluthrin or imidicloprid may be used for potato leafhopper control. As always, pesticides used must be registered for use on

dry beans in your state. Read and follow pesticide labels carefully. Certified organic producers should ensure products are allowed by checking with their certifier before they apply any product.

Harvesting and Storing

Generally, dry beans take 60 to 90 days to mature in the Northeast depending on the variety. Bush varieties (including navy, kidney, and black beans) will mature more evenly and facilitate consistent harvesting. When the majority of the pods have turned yellow and dried down, beans are ready to be pulled and harvested. Harvesting can be difficult if the crop is weedy or not consistently ripe, and some field loss can occur during harvesting. Utilize the moisture in the early-morning dew to minimize pod shattering.

Figure 9. Bean pullers, Morningstar Farm, Glover, VT.

Because bean pods tend to lie close to the ground, most varieties need to be pulled either with a bean-puller (Figure 9) or, if weedy, by hand. A mechanized puller-cutter will uproot or cut the entire plant and lay it on the ground in windrows as the machine moves along the field. A puller followed by a separate tow-behind windrower will accomplish the same goal.

Figure 10. Dry bean combine, Morningstar Farm, Glover, VT.

Combine the windrows when the beans have dried to 18% moisture and adjust the spike-tooth combine's two cylinders for low speeds (150 to 200 RPMs) to minimize shattering; monitor continuously for seed damage while harvesting (Figure 10). A portable bean thresher can be used to harvest beans that are hand-pulled (Figure 11).

Each bean pod typically has 6 to 8 seeds, and good dry bean yields are about 1500 to 1800 lbs per acre (with a test weight of 60 lbs per bushel), but this is heavily dependent on variety.

Clean beans to remove broken seed, stones, weed seeds, and other debris, but beware that excessive handling will lead to damage to seed coats. Many growers use a conveyor table to grade beans; any that are split, cracked, or otherwise broken and not up to human consumption standards can be roasted and incorporated into livestock rations. Beans should be conditioned using a low temperature and dried to a moisture level of 15-16%, then stored in bins that are inaccessible to rodents, insects, contamination, and temperature extremes. Storing dry beans at low temperatures (35 to 55°F) will discourage mold growth. Field beans can be marketed as dry beans or processed and sold as pre-cooked, canned beans for customer convenience.

Figure 11. Portable bean thresher, Morningstar Farm, Glover, VT.

References

Copeland, L.O., O.B. Hesterman, F.J. Pierce, and M.B. Tesar. AG FACTS- Seeding Practices for Michigan Crops. Michigan State University Cooperative Extension Service. Accessed April 6, 2016. (http://fieldcrop.msu.edu/uploads/documents/E2107.pdf)

Hardman, L.L., E.S. Oplinger, E.E. Schulte, J.D. Doll, and G.L. Worf. May 1990. "Fieldbean." Alternative Field Crops Manual. Accessed April 6, 2016. (http://www.hort.purdue.edu/newcrop/afcm/fieldbean.html)

Hardman, and H.A. Lamey. May 1993. "Edible Bean Diseases and Disorder Identification." Crop Pest Management Series, University of Minnesota Extension. Accessed April 6, 2016. (http://www.extension.umn.edu/distribution/horticulture/dg6144.html)

Helm, J.L., K.F. Grafton, and A. A. Schneiter. May 1990. "Dry Bean Production Handbook". North Dakota State University Extension Service. Accessed April 20, 2015. (http://library.ndsu.edu/tools/dspace/load/?file=/repository/bitstream/handle/10365/17658/A-602-1990.pdf?sequence=2)

Logsdon, G. 2009. Small-scale grain raising. White River Junction, VT: Chelsea Green Publishing. Meronuck, R.A., L.L.

Robertson, L.S., and R.D. Frazier, ed. 1982. Dry bean production—principles & practices. E. Lansing: Michigan State University Cooperative Extension Service.

Wallace, Janet, ed. 2001. Organic field crop handbook. 2d ed. Ottawa: Canadian Organic Growers.

Way, A.W. 2010. Growing dry beans: A Vermont tradition. University of Vermont Extension. Accessed April 12, 2015. (http://www.uvm.edu/extension/cropsoil/wp-content/uploads/PM1-GROWING-DRY-BEANS.pdf)

THE UNIVERSITY OF VERMONT EXTENSION

UVM Extension's

Equipment Available for Use on Your Farm

White 8100 No-Till Planter – Promotes reduced tillage practices on farms. Rate is set by the custom operator who runs the planter for Extension.

Jamesway Manure Injector – Used to directly inject manure into the soil to mitigate risk from surface runoff. Rate is set by the custom operator who runs the injector for Extension.

ESCH 5512 No-Till Drill - Used to no-till seed pastures and cover crops. This drill features a 5 inch row spacing and narrow transport option. It is much easier to calibrate for seed mixes as it uses a sponge type metering system. The rate is $12.00 per acre.

Sunflower 9412 No-Till Drill – Used to no-till cover crops and perennial seedings without tilling the soil which reduces the risk of soil erosion and reduces the amount of preparation required to seed a field. This is a 10 foot drill capable of drilling large and small seed. The rate is $12.00 per acre.

John Deere No-Till Drill – Used the same as the Sunflower drill but is 15 foot wide. The rate is $12.00 per acre.

Tebbes MS140 Manure Spreader – This manure spreader can precisely apply many types of solid products from bedded packs to lime, wood ash, chicken litter in very efficient manner. The spreader tells you what you are applying per acre and done a very good job of spreading the material evenly. This spreader is operated by a custom applicator and the rate is $55.00 per hour, plus transportation at $100 per hour.

Hagie Highboy STS12 – This is a modified highboy herbicide sprayer apply cover mixtures into the standing corn crop. It will be operated by Extension staff and is available for demonstrations. The rate is $15.00 per acre.

Interseeder Tech. Interseeder – This piece of equipment also applies cover crops into standing corn at around topdress time. It can be modified to do cover crops like a no till drill after corn is harvested. It is a 15 foot unit and is three point hitch. The rate is $12.00 per acre.

BZ Manufacturing Duo Interseeder – This is interseeder that features the Dawn manufacturing DuoSeeder. It is a nice interseeder and it has the option for narrow transport on the road. It also uses only two interseeded rows per corn row to reduce corn damage. It is a 15 foot (six row) model. The rate is $12.00 per acre.

Krause No-Till Subsoilers – This machine removes compaction down to 16 inches deep with minimal surface disturbance. The price is $20.00 per acre to use.

Kelly Diamond Harrows – This new high speed harrow only works the ground an inch or two deep to help with soil to seed contact with minimal tillage.

ATV Frost Seeders – We have three ATV mount broadcast seeders available for use. Perfect for overseeding, frost seeding, and other small broadcast seeding projects.

VeenHuis Manure Injector – UVM Extension is working with the VAAFM to obtain a tank mounted grassland manure injector. This unit will be for use primarily in the Lake Carmi watershed.

If you are interested in using the equipment or having a trial planted on your farm, please contact:

Jeff Sanders, jeffrey.sanders@uvm.edu, 802-524-6501, ext. 453.

EUROJECT 3500

The Euroject 3500 is a solid injector design for pulled and self propelled slurry tankers.

FEATURES

WORKING WIDTHS FROM 6.30 TO 8.75 METRES

HEAVY FRAMECONSTRUCTION

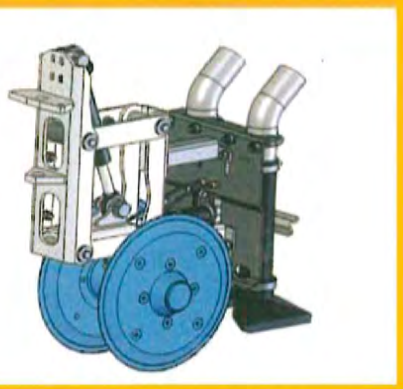
DISCS WITH A DIAMETER OF 350 MM AND WIDTH OF 24 MM

HOSE CARRIERS FOR SLOPING HOSES

THE SAME OPTION PACKAGE AS THE EUROJECT 3000

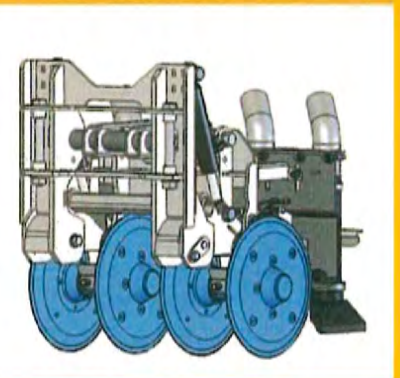
Single parallellogram version

The standard single parallellogram is provided with two discs, this version is available in the working widths 6.30, 7.00, 7.70, 8.40, and 8.75 metres.



HEAVY DUTY-version

The Euroject 3500 is also available as a Heavy Duty version. This HD-version has four discs per element (non-steering), and is available with a working width of 7.00 or 8.40 metres



NUTRIENT MANAGEMENT IS MORE THAN JUST A PLAN

By Kirsten Workman, Agronomy Outreach Professional

As spring begins, so does manure spreading in fields across Vermont. While many of our neighbors will notice the manure trucks becoming part of their commute once again, they might not realize just how valuable manure is or how much thought goes into every spreader load of it. Manure contains valuable nutrients and organic matter to feed crops; manure spreading requires a lot of science and decision-making.

We spent all winter with farmers working on Nutrient Management Plans (NMPs). Dozens of farmers across Vermont spent six weeks with UVM Extension and Conservation District staff meticulously planning every gallon on every field. Dozens more came in to update their plans – organizing and inputting their records from 2017 and making any necessary changes to their plans for the 2018 crop year. The simplest way to explain an NMP is that we test the soil, test the manure, figure out how much the crop needs to grow and then make sure it all balances – ensuring a healthy crop while minimizing runoff. An NMP is a complex binder full of maps, calculations and decisions.

One of the most important tools we use in preparing a nutrient management plan is the Phosphorus Index (P-Index). The P-Index is a comprehensive risk assessment tool that analyzes the details for each individual field and then figures out the possible risk of that field's phosphorus loss to surface water. A new version of the P-Index was released in 2018, calculating ratings for dissolved P loss in surface runoff, sediment-bound P Loss, and subsurface loss from tile drainage.

The P-Index analyzes a suite of factors and outputs a score with a rating of low, medium, high or very high. Fields with low and medium risk can be managed according to the nitrogen need for the crop, while fields with high risk are limited to University recommendations or crop removal. Fields with a very high risk have applications prohibited until the P-Index goes down. The P-Index is designed so that a field with a high or very high rating can be recalculated with different plans and lowered to reduce risk. This feature makes it an important planning tool for farmers.

One higher risk situation in the Champlain Valley is manure applied on the surface of hay fields. Even though erosion is low in a perennial hay field, when manure is applied on the surface it can be prone to dissolved phosphorus loss in surface runoff. This is a big challenge, because there has not been a good alternative to get manure below the surface in a hay field without damaging the crop or causing erosion. Aeration toolbars are a first step, but they still leave a substantial portion of the manure on the surface. Thanks to funding from the VAAFM Clear Water Fund, we were able to purchase a brand-new grassland injector from Holland designed to truly inject liquid dairy manure in grass and legume crops. This is exciting new technology! When comparing a theoretical hay field in Addison County with moderate applications of manure after two cuts of hay in the summer, the difference between surface applications versus injection led to a change in the P-Index from high to low! [See table.] We will be using this equipment this spring and will report on how it works, and host field days showing it in action.

Nutrient management is a complex process, but one that can be worth it for both the farm and the environment if done well and implemented effectively. The goal is to have thoughtful planning, resulting in sound farm management, and healthy and productive cropland.

Field Name	Hay-Surface Applied Manure	Hay-Injected Manure
P Index	82	14
Interpretation	High	Low
Pathway I: Sediment-bound P	12	5
Pathway II: Dissolved P in surface runoff	54	6
Pathway III: Subsurface loss of dissolved and sediment-bound P	15	2

(Above) P-Index ratings assuming a medium soil test phosphorus, Vergennes clay soil, 5000 gallons/acre dairy manure applied twice during the summer, tile drainage present, with a 25-foot buffer along a stream. (Above, left) By injecting manure with our new Veenhuis grassland injector, we reduce phosphorus loss.

VERMONT P-INDEX

Some of the factors the P-Index utilizes are inherent to the field, such as:

- Soil type
- Elevation
- Rainfall
- Slope and slope length
- Distance to surface water
- Soil test phosphorus

Some are management decisions made by the farmer or are inherent to the farm:

- Manure type
- Amount of phosphorus being applied in manure and fertilizer
- Timing of phosphorus applications
- Incorporation method of manure/fertilizer
- Erosion based on crop rotations and field management (tillage) calculated on an annual basis
- Presence of tile drainage
- Presence of spring vegetation
- Vegetative buffer width and/or manure spreading setbacks

Resources

Vermont's P-Index & Nutrient Recommendations for Field Crops in Vermont: *go.uvm.edu/vt-p-index*

goCrop: *www.gocrop.com*

CVCrops Soil Health and Nutrient Management Resources: *go.uvm.edu/soil-health*

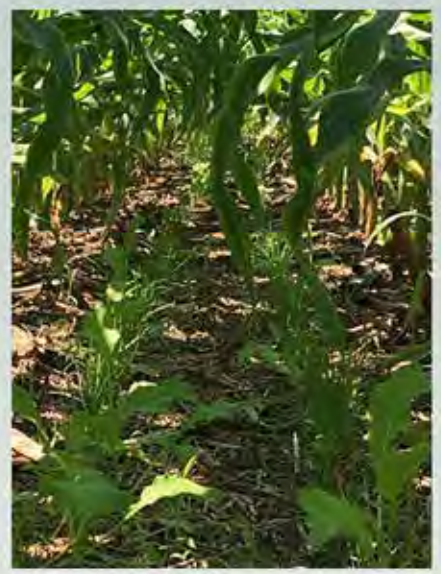
UVM DuoSeeder and ZRX Roller Crimper

- DuoSeeder used for interseeding cover crops into knee high corn (v4-v6).
- Helps farmers take advantage of a different window of opportunity to get cover crop seed down and incorporated into the soil.
- ZRX Roller Crimper system demonstrated on UVM White Planter for 2017-2018 seasons. Helps farmers plant into tall rye effectively by rolling and crimping the rye during the planting pass.
- Demonstrated on 8 farms in 2017 with very good results.
- Very good tool for those who no-till and cover crop.
- Both tools are available for demonstration on your farm in 2019.

Funded through ANR ERP grant

Interseeded Cover Crops 2017

Seeded 7/3



Penn State Interseeder

Seeded 7/8

Seeded 7/12

DuoSeeder Interseeder

DuoSeeder II- Early Establishment of Cover Crops. Manufactured by Dawn Biologic.

Description: The DuoSeeder II allows for early establishment of cover crops in order to maximize soil health benefits. The DuoSeeder is adjustable to interseed 1-3 rows of planting cover crops in between each row of your cash crop. The DuoSeeder planter offers excellent soil to seed contact, the ability to plant into moisture and pneumatic down pressure which provides favorable conditions for successful early cover cropping.

The DuoSeeder's planting window is around "last cultivation", between the weed free time after planting the cash crop and prior to having the cash crop canopy closing. Planting cover crops at this time gets the cover crop established but is then suppressed by the shading of the cash crop. As the cash crop dries down and is harvested, the cover crop rejuvenates with increased exposure to the sun and moisture.

Benefits: This practice provides an increase in cover crop growth and encourages soil health benefits, while reducing the labor demands for planting cover crops at the critical times of harvesting. The DuoSeeder allows for management flexibility in row spacing, planting and fertilizing. This practice is showing great promise with research being done by multiple universities. For further interest please contact Jeff Sanders at Jeffrey.sanders@uvm.edu or 1-802-524-6501.

ZRX (Zone Roller) - Maximize Cover Crop Growth by Planting Into Green Covers. Manufactured by Dawn Biologic.

Description: The ZRX planter attachment allows cover crops to continue to grow until the time of Spring planting, maximizing the growth potential of your cover crops. Come see the ZRX process cover crop biomass to provide ideal seeding conditions for your cash crop.

The ZRX is attached to the front two feet of the tool bar on your planter. Each 30" row runs on an independent parallel linkage so that the assembly can closely follow ground contours with hydraulic down pressure. The concave row opener splits green covers and delivers them into the blades of the roller. This provides an ideal seedbed that your planter directly plants into while mulch protects from intense rain, heat and smoothers potential weeds.

Benefits: This well engineered tool provides flexibility to plant into various soil conditions and serves as a row cleaner. Adjusting the row cleaner discs can be set to the level of disturbance that you are most comfortable with. Providing ease in the proper management of cover crops while increasing biomass, nitrogen production from legumes, suppress weed growth, control various pests and improve soil health and biodiversity. For further interest please contact Jeff Sanders at Jeffrey.sanders@uvm.edu or 1-802-524-6501.

White No-Till Corn Planter

- Helps protect the environment by reducing risk of erosion typically associated with traditional tillage practices.
- This unit has done demonstrations on over 40 farms and planted over 3000 acres of corn.
- This unit has helped demonstrate to farmers that many conservation practices can be profitable if properly managed on most soils.

- No-Till Corn planter and work done with it funded through NRCS, VAAFM, and ANR ERP grants over the last 6 years.

Hagie Highboy Seeder

- Allows for in-season cover crop seed application.
- Allows for a wide variety of seed types and mixes to be planted.
- Apply seed to 150-300 acres per day.
- Minimal end row damage.
- Less weather dependent than aerial seeding.
- However, seed establishment is more weather dependent relative to other methods which incorporate the seed into the soil.

Funded through a NRCS CIG grant.

Tebbes Precision Manure Applicator

- Precisely applies a wide variety of soil amendments to farm fields.
- Very uniform spread pattern allows for in-season nutrient application, no chunks.
- Records amounts applied so its easier to follow NMP recommendations.
- Holds up to 12 ton of material so it is fairly efficient to use.
- Helps farmers make better use of their solid manure sources.

Funded through an ANR ERP grant

No-Till Drills

- Used for seeding forages, cover crops, and cereal grains without tillage.
- Also good for rejuvenating pastures and hay meadows.

- When used for cover cropping, advantages include lower seeding rates and often faster, more even emergence of the cover crop.
- Helps farmers effectively grow forage and cover crops without disturbing the soil which reduces risk of erosion.
- Two drills available for farmers in the northern lake.

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Funded through ANR ERP grant and NRCS CIG grant

Innovative Tillage Solutions

Goal of project is to reduce tillage and ultimately erosion without sacrificing yield in a manure/corn cropping system on heavy clay soils.

Four step process

1) Apply cover crop and manure in fall to scavenge excess nutrients and reduce erosion.

2) Run sub-soiler in the fall to reduce compaction from manure applications.

3) Use Kelly Diamond Harrow in spring to loosen soil.

4) Plant corn with no-till or conventional planters.

Krause No-Till Sub-soiler

Kelly Diamond Harrows

Funding provided through an ANR ERP grant.

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Why cover crop?

- Improve soil health
- Improve yield potential over time
- Improve weed control of winter annuals
- Reduce erosion
- Increase earthworm populations
- Improve soil microbiology
- Build soil organic matter
- Produce and scavenge nutrients
- Help with manure management
- Provide excellent grazing opportunities
- Harvest energy from the sun

TOOLS YOU CAN USE:

- No-till drill after harvesting cash crop
- Broadcast after harvesting cash crop
- Aerial seed cover crops in September
- Other useful machines:
  highboys, modified vertical tillage

FUNDING IS AVAILABLE THROUGH:
NRCS EQIP program
State of Vermont FAP program

Cover cropping is an integral part of any on-farm conservation tillage/water quality improvement plan. Call UVM Extension to learn how you can successfully implement and manage this practice on your farm.

(802) 524-6501 or (800) 639-2130

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Double Crop Cover Crops

- Excellent winter cover
  - Early planting and higher seed rates
  - Tillering is the key to good stand
  - Need to pay attention to fertilizer rates in the fall
- Excellent supplemental feed source
  - High digestibility
  - Palatable feed during the summer heat
  - Up to 3# of milk per cow per day
  - Reduced grain inputs
- Excellent way to implement reduced tillage
  - No till into crop stubble
  - Utilize more nutrients with the extra crop
  - Need to pay attention to soil nutrient levels especially Nitrogen

NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

Tips for Interseeding Cover Crops

Interseeding cover crops has many benefits to the farmer. Like any new way of implementing an agronomic practice, there are certain considerations that should be addressed. This is a brief overview of those considerations. For a more detailed explanation, please refer to the UVM Extension Northwest Crop and Soils Program publication, *Under Cover: Integrating Cover Crops into Silage Corn Systems*.

Yield: Many farmers are concerned that interseeded cover crops will compete with the corn for moisture and nutrients resulting in reduced yields. Research conducted at Pennsylvania State University, McGill University and University of Vermont has shown no negative impact on the corn from interseeding cover crops. In fact, research in Pennsylvania has shown a slight yield boost to corn that has been interseeded with legumes.

Herbicides: Herbicide programs must be modified to accommodate the planting of a cover crop into the growing corn crop. This is especially true if the cover crop to be seeded is a broadleaf like radish or clover as they are especially sensitive to many corn herbicide residues. The farmer must work with the herbicide applicator and/or their crop consultant to make sure that there will be no damaging residues that may damage the cover crops. Please refer to Penn State University handout, *Herbicide Persistence and Rotation to Cover Crops by Bill Curran and Dwight Lingenfelter, Extension Weed Science, Penn State University, October, 2013.*

Proper Timing: Research shows that interseeding can be a cost effective way to establish cover crops in corn from the V6 developmental stage (normal time of fertilizer topdress) to roughly four weeks prior to corn harvest. When choosing cover crops, consider what soil health goals you want to achieve, planting date, and other labor demands at that time of year.

Special Considerations for Various Interseeding Methods

Fertilizer Spreaders:

- Convenient method to plant cover crops as no new seeding equipment is needed.
- Banding may occur when planting seed of different weight and size. For example, heavier, larger seed does not spread as far as light seeds. The fertilizer spreader may need to be calibrated to account for different seed weights and sizes.
- Mud can coat the spreader wheels and reduce accuracy of application.
- Seed is not incorporated so prolonged dry conditions can reduce germination and establishment. Time of application limited by height of the corn.

Interseeders / Seed Incorporation Planting Methods:

- Ensures seed to soil contact and hence better germination and establishment prior to corn canopy closure.
- Seeding rates can be reduced in many cases due to better germination rate from greater seed to soil contact.
- Seed depth must be calibrated and special consideration should be made for multi-species mixes.
- Soil moisture can be a problem if too wet (plugging) or dry (too hard to penetrate soil).
- Can help incorporate fertilizer if timed correctly.
- More labor intensive and slower than other methods and time sensitive due to corn height restrictions.

High Clearance / "Highboy" Seeders:

- Has a wider range of seeding potential than other ground driven processes due to the height of the machine.
- Accurate placement as it applies the seed under the canopy through drop tubes.
- In-field hazards must be identified (such as washouts, rocks, etc) as the operator will not be able to see the ground from mid-season on.
- Studies show highboy seeding only damages ½ of 1% of the corn, mostly on the end rows.
- Seed is not incorporated so prolonged dry conditions can reduce germination and establishment.

Aerial Seeding:

- Most versatile method of seeding due to lack of impediment by crop establishment or poor soil conditions.
- Weather, particularly wind, must be considered when aerial seeding. It can adversely affect the placement of seed.
- Landing zones must be established beforehand so the helicopter can safely operate.
- Seeding rates may need to be adjusted to account for seed caught in the leaves of crops and not reaching the ground. This is particularly important if number of seeds on the ground must meet standards placed by government contracts for payment.
- Banding of seed can occur depending on the seeding apparatus and if various types of seed are spread at the same time.
- Seed is not incorporated so prolonged dry conditions can reduce germination and establishment.

If you have any questions or concerns about interseeding cover crops into corn, please feel free to contact Heather Darby or Jeff Sanders at (802) 524-6501 or heather.darby@uvm.edu or Jeffrey.sanders@uvm.edu.

Precision Agriculture Technologies and Practices in Vermont

Farmer's Watershed Alliance
Franklin & Grand Isle

Working for Environmentally Positive Solutions for Farmers

FarmersWatershedAlliance.org

Precision agriculture technology is relatively new and underutilized on VT farms. Collecting accurate data helps farmers and stakeholders make better and more precise plans for farms and water quality with the goal of conservation. These types of technologies can directly help farmers meet state Required Agriculture Practices (RAPs) and improve farm profit through precision agriculture management. The FWA embraces opportunities to teach those interested about precision agriculture technologies and the local resources available. Our organization works to support a network connecting farmers and custom applicators with equipment and distributors, and present various funding opportunities available that can help cover the upfront costs of investing in these upgrades.

Popular in Vermont: Auto-steer, flow meters, GPS units, scales, TMR tracker, manure application record keeping units, no-till planters, roller crimpers, injectors, and more!

Thinking of making some upgrades on your farm and/or equipment? Here are some possible funding sources:

VAAFM—Vermont Agency of Agriculture
- CEAP Application; FAP

NRCS—Natural Resources Conservation Service Vermont
- EQIP; NMP 590 Basic Precision NM

VHCB—Vermont Farm & Forest Viability Program
- Dairy Improvement Grants; Water Quality Grants

SARE—Northeast Sustainable Agriculture Research & Education
- Farmer Grants

Please do not hesitate to contact the FWA with questions:
FarmersWatershedAllianceNW@gmail.com

Scott Magnan is the owner of Scott Magnan's Custom service in St.Albans Vermont. His company founded in 1997 has assisted farmers in the northwest corner of Vermont offering field services such as custom manure spreading, mowing, round baling and bunk packing. He farms as well, using his farm to explore markets and experiment with innovative and proven practices. In 2015 Scott became a dealer for Ag Leader technology and Yetter farm equipment utilizing his shop in St.Albans to assist area farmers with their precision farm needs. Scott has collaborated on many conservation efforts throughout the state of Vermont through his business and is currently the Chair of the Farmers Watershed Alliance.

Savanna Crossman is a native of Northwest Vermont where she has worked extensively with crop and dairy farmers. She graduated from the University of Vermont with a Bachelor's Degree in Agronomy and Soils and she has earned her CCA through the American Society of Agronomy. She is currently pursuing her Master's Degree in Agronomy at Kansas State University. Savanna has worked with farmers in New York state coordinating a study on variable rate planting since 2014.

ADDITIONAL INFORMATION

Water Quality Financial Assistance Programs

AGR.WaterQuality@Vermont.gov // 802-828-2431

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

PROGRAM	DESCRIPTION	DUE DATE	MORE INFORMATION
Farm Agronomic Practices **FAP**	Financial assistance to Vermont farms for implementation of soil-based agronomic practices that improve soil quality, and reduce erosion as well as financial assistance for educational or instructional activities. **Payments are per acre depending on the practice type.**	30 days prior to implementation. Cover cropping application due August 15	WEB: Agriculture.vermont.gov/FAP PHONE: Clark Parmelee 802-661-8284 
Best Management Practices **BMP**	Technical and financial assistance program to assist farmers with on-farm improvements designed to abate agricultural waste discharges into state waters. **Up to 90% State cost share towards eligible practices.**	April 1 Priority Due Date for Applications	WEB: Agriculture.vermont.gov/BMP PHONE: Jeff Cook 802-828-3474 
Conservation Reserve Enhancement Program **CREP**	Technical and financial assistance program designed to reduce sediment runoff and improve water quality by removing land from agricultural production and establishing vegetative buffers. **Incentive payments, annual rental payments, and up to 100% cost share towards implementation cost.**	Program inquiries accepted on a first come first serve basis	WEB: Agriculture.vermont.gov/CREP PHONE: Ben Gabos 802-461-3814 
Capital Equipment Assistance Program **CEAP**	Financial assistance for new or innovative equipment that will improve water quality, improve manure management, separate phosphorus (P) from manure, and decrease greenhouse gas emissions. **Funding limits dependent on equipment type up to 90% State cost share.**	Funding offered in late fall depending on funding availability	WEB: Agriculture.Vermont.gov/CEAP PHONE: Tyler Knapp 802-477-3649 
Grassed Waterway and Filter Strip Program **GWFS**	Technical and financial assistance for in-field agronomic best practices to address critical source areas, erosion, and surface runoff through establishment of perennially vegetated and harvestable grassed waterways, filter strips, and critical source area seedings. **Per acre incentive payments and up to 90% State cost share for implementation cost.**	Program inquiries accepted on a first come first serve basis	WEB: Agriculture.Vermont.gov/GWFS PHONE: Suzie Walsh Daloz 802-249-0367 OR Jeff Sanders 802-524-6062 
Pasture and Surface Water Fencing Program **PSWF**	Pasture management technical and financial assistance to Vermont farmers to improve water quality and on-farm livestock exclusion from surface waters statewide. Up to 90% State cost share for implementation costs.	Program inquiries accepted on a first come first serve basis	WEB: Agriculture.Vermont.gov/PSWF PHONE: Jenn Colby 802-656-0858 

Water Quality
Financial Assistance Programs

AGR.WaterQuality@Vermont.gov // 802-828-2431

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

Additional Financial and Technical Service Providers for Agricultural Water Quality Assistance

ASSISTANCE PROVIDER	SERVICES	CONTACT
USDA Natural Resources Conservation Service	• Financial Assistance	PHONE: (802) 951-6796 WEB: www.nrcs.usda.gov/wps/portal/nrcs/main/vt/contact/ to find your local NRCS office
Vermont Housing and Conservation Board	• Financial Assistance • Business Planning	PHONE: (802) 828-3250 WEB: www.VHCB.org
Vermont Association of Conservation Districts and your Local Conservation District	• Technical Assistance • Educational Events • GWFS Program • Land Treatment Planning • Nutrient Management Planning	Contact your local conservation district WEB: www.vacd.org
University of Vermont Extension	• Technical Assistance • Educational Events • Business Planning • Equipment Programs • Nutrient Management Planning Course	PHONE: (802) 656-2990 or (866) 622-2990 WEB: https://www.uvm.edu/extension/contact_us to contact your local Extension office
Champlain Valley Farmer Coalition	• Technical Assistance • Educational Events	WEB: www.champlainvalleyfarmercoalition.com
Farmers Watershed Alliance of Franklin and Grand Isle	• Educational Events • Technical Assistance • GWFS Program	WEB: farmerswatershedalliance.org
Connecticut River Watershed Farmers Alliance	• Equipment Rental Program	WEB: www.crwfa.org

goCrop About goCrop Features Pricing Support Buy Now Free Trial Sign In

Taking farming further with goCrop™

goCrop uses integrated web and mobile applications to help farmers plan, analyze and report nutrient management practices with streamlined speed. Designed by farmers who understand the virtue of efficiency, goCrop keeps you focused on farming.

TRY IT FOR FREE

A Comprehensive Tool.

With goCrop, nutrient management planning and record keeping has never been easier.
goCrop tracks and organizes your data directly from the field in real-time.
Comprehensive reports are created immediately for powerful planning and analysis. Learn more.

goCrop™
NUTRIENT MANAGEMENT PLANNING

goCrop Home Farm Fields Reports Flint Darby-Hermann's Farm Flint Darby-Hermann Sign out

Flintster [43-987] (3.8 a.) Field Info Soil Test Crops Nutrient Planning Record Keeping

Records for:

Corn Silage

+ Add Crop

Crops

Details

Yield Goal: 2500.0
Yield Unit: Lbs
Legume Percentage:
Surface Cover Percentage: 0 - 20 %
Planting Date: 2013-06-01

150

Nutrient Recommendations

Lime	N	P	K
0.0 tons/acre	200 lbs/acre	50 lbs/acre	50 lbs/acre

How goCrop Works

Build the NMP plan with the Web based application

Keep records and review the NMP plan on your mobile device

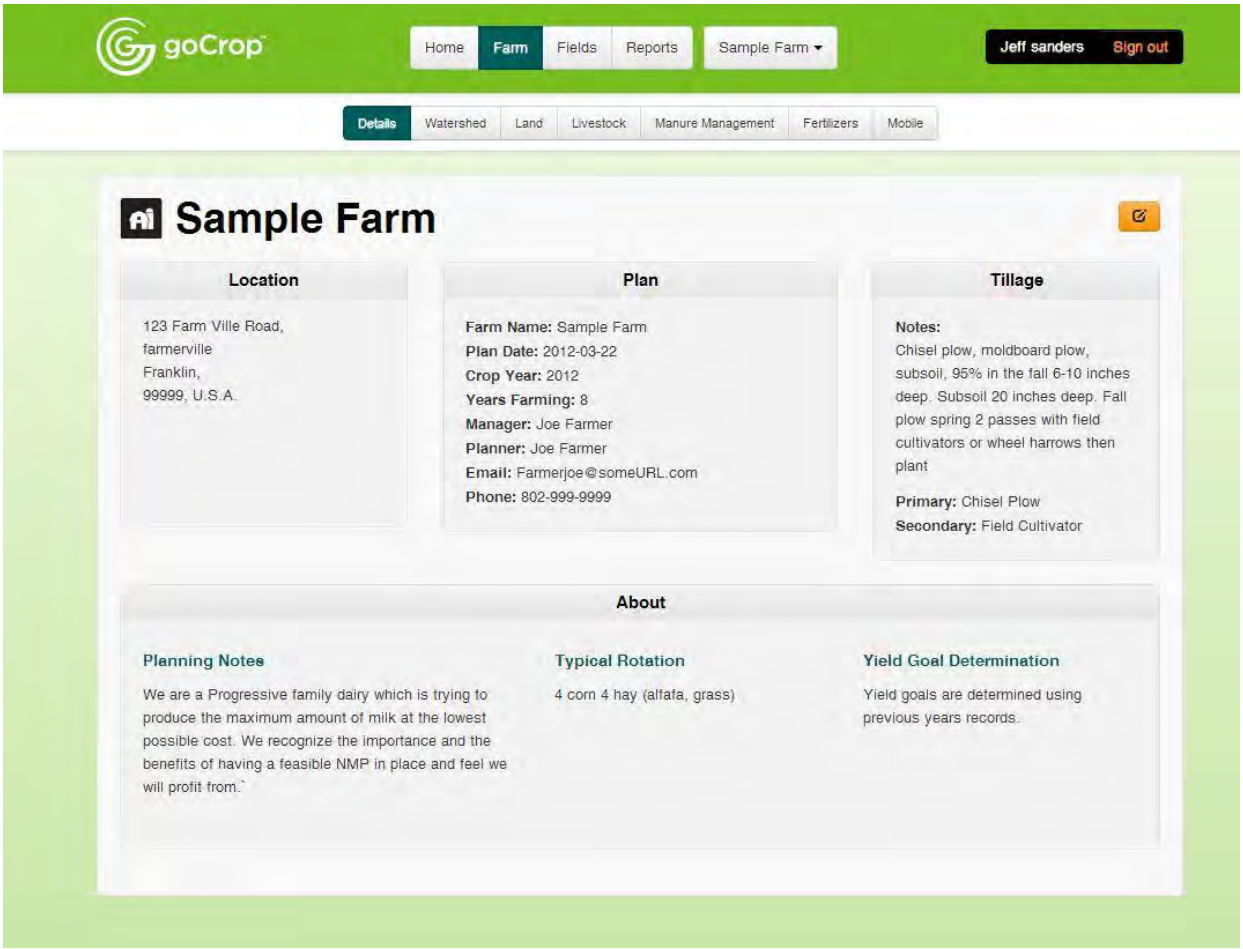
UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Online: gocrop.com
Email: info@gocrop.com
Call: (802) 524-4480 ext. 466
Northwest Crops & Soils Program

Types of farm information stored in goCrop

- Details about the farm
- Watershed Information
- General land Information
- Specific livestock information
- Manure management information
- Types of fertilizers used

This information is collected to use in producing the reports which goCrop generates to meet your NMP reporting requirements for government contracts (EQIP) and MFO and LFO permits.



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Call: (802) 524-4480 ext. 466
Northwest Crops & Soils Program

Summary of Benefits of goCrop

- Quick access to your data records without hassle of paper
- Build all the information you need for your reporting requirements as you work throughout the year
- Efficiently generates reports that can be submitted to meet state or federal requirements
- Much easier to manage specific field information with mobile application
- Functionality allows for on-the-go recordkeeping of fertility and pest management
- Significant cost savings associated with NMP reporting requirements
- Environmental and financial benefits of properly applying nutrients to meet crop requirements
- Safe and secure synchronization of web and mobile app data
- Do not have use all the functionality, if you do not want to. goCrop will work very well for only a recording keeping app. Without other background data the farmer will not be able to generate all necessary reports for NMP reporting to the state but keep very accurate up-to-date records.

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Northwest Crops & Soils Program

goCrop

In 2011, goCrop™ launched as an online web application to help farmers meet state required nutrient management planning standards for dairy operations. Today, goCrop™ has expanded to offer vegetable-specific nutrient management planning and record keeping functions. With goCrop™, you can

- Conveniently store records online, including soil tests, compost tests, fertilizer analysis, harvest, amendment applications, tillage, and many more.
- Map fields and map beds within fields (Figure 1).
- Plan crops and nutrients on a bed by bed basis and field by field (Figures 2 & 3).
- Export or print reports for planning and recordkeeping.

Figure 1. Map of beds within field.

Recommended	N	P	K
Beans, snap *		8.7	13.3
Beets *	8.3	5	6.7
Strawberries *	16.7	6.7	13.3
Total	**25**	**18.3**	**33.3**

Figure 2. Table of nutrient recommendations for each crop on a field.

Nutrients	N	P	K
Recommended	25	18.3	33.3
Past Years			
Manure	1	4.5	7.5
Fertilizer	16.8	6.2	1
Total Credits	**22.8**	**9.8**	**16**
Balance	**2.2**	**8.5**	**17.4**

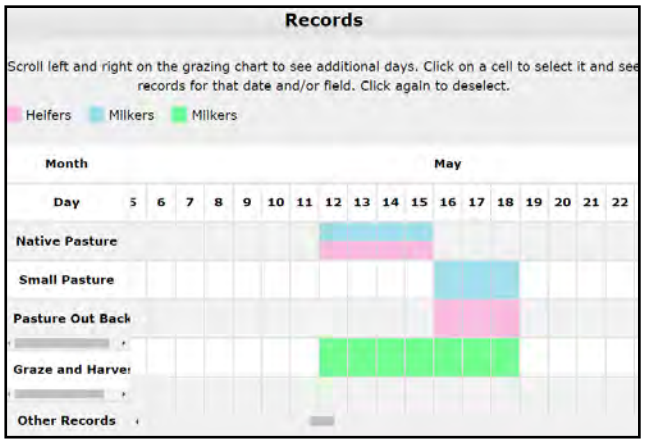
Figure 3. Table of nutrient balance for entire field.

Sign up for a **free 30-day trial** or purchase a subscription for $249.99 at www.goCrop.com

For more information contact:
Lindsey Ruhl, Agronomy Outreach Professional
UVM Extension
lruhl@uvm.edu; (802) 524-6501

There are several other features seamlessly integrated with goCrop™'s nutrient management functionality.

- The **goGraze planning tool** allows farmers to estimate acres available throughout the season, calculate percent DMI from pasture, and keep grazing records for each animal group.



Mass Nutrient Balance

Category	N	P	K
Imports		tons per year	
Feed	4.78	0.26	2.60
Fertilizer	8.87	0.14	0.00
Animals	0.00	0.00	0.00
Miscellaneous	0.04	0.02	0.04
Total Imports	13.70	0.42	2.64
Exports		tons per year	
Milk	2.22	0.38	0.68
Animals	0.19	0.05	0.01
Crops	0.00	0.00	0.00
Miscellaneous	0.00	0.00	0.00
Total Exports	2.41	0.43	0.69
Difference (Import - Export)	11.28	-0.00	1.95

- Based on a program from Cornell, the **Whole Farm Mass Nutrient Balance Calculator**, shows total import or export of nutrients based on crop production, farm purchases, and sales.

- Based on the NRCS tool, the **Cover Crop Economics Calculator** helps farmers quantify the short-term and long-term costs and benefits of cover cropping using seed costs, labor costs, and more.

Sign up for a **free 30-day trial** or purchase a subscription for $249.99 at www.goCrop.com

For more information contact:
Lindsey Ruhl, Agronomy Outreach Professional
UVM Extension
lruhl@uvm.edu; (802) 524-6501

UVM Cereal Grain Quality Evaluation
Sample Submission Form

THE UNIVERSITY OF VERMONT EXTENSION

FOR LAB USE ONLY
Intake date: _____
Paid? _____ **Check #**_____

Sample ID:

Cereal Grain Quality Laboratory
University of Vermont
James M. Jeffords Hall, Room 244
63 Carrigan Drive
Burlington, VT 05405-1737

Office: 802-656-5392
No fax available.
E-mail: uvmgrain@uvm.edu

Please submit **Payment** and one **Sample Submission Form** with each properly labeled sample to be analyzed.
Samples with incomplete forms and no payment included will not be accepted.
Turnaround time is 7-10 business days.

Farm/ Company Name: _____ Phone: _____
Contact:_____ Fax:_____
Address:_____ Email:_____
City, State: _____ Zip Code:_____

Are you a member of the Northern Grain Growers Association (NGGA)? YES or NO

Sample ID *(Variety)*:_____ **If wheat**: Hard or Soft
If barley: 2-Row or 6-Row

Sample Description (*check one*): □ Spring Wheat □ Winter Wheat □ Oats*

□ Barley □ Corn □ Rye □ Spelt (VOMITOXIN TEST ONLY)

**Oat analysis may take longer than 10 days.*

Analysis Requested *(Please check all that apply)*	**NGGA Member Cost per Sample (USD)**	**Non-Members Cost per Sample (USD)**
Standard Grain Analysis		
____Test Weight (lbs/bu):	$3.00	$5.00
____Grain Moisture (%):	$3.00	$5.00
____Whole Grain Protein by NIR (%):	$8.00	$10.00
____Falling Number (seconds) :	$15.00	$20.00
____All of the above 4 items:	$25.00	$37.00
____Seed Germination	$8.00	$12.00
____**Corn Analysis** *(% Moisture, % Crude Protein, % Crude Fiber, & % Starch)*	$15.00	$20.00
____ Vomitoxin "DON" (ppm):	$26.00	$36.00
Total:	$	$

Please make checks payable to *UVM* and **send with Submission Form**.

Please submit 1 quart of ***Clean*** and ***Dry*** (<14% Moisture) whole grain (do not send flour) for each sample submitted. Grain samples with stones and dirt will **NOT** be accepted. Remember, your results will only be as good as the sample submitted.

Questions? Please contact UVM Grain Lab at uvmgrain@uvm.edu, 802-656-5392 or Heather Darby at heather.darby@uvm.edu, 802-524-6501.

Consider becoming a NGGA member today! For more information go to www.northerngraingrowers.org

***Note**: Samples will be kept for 3 months from the date of receipt.*

UVM Hops Analysis Request

Sample Submission Form

UVM Grains and Hops Quality Testing Lab
University of Vermont
James M. Jeffords Hall, Room 244
63 Carrigan Drive
Burlington, VT 05405-1737

Office: 802-656-5392
No fax available.
E-mail: uvmgrain@uvm.edu

FOR LAB USE ONLY
Intake date: _____
Paid? _____ **Check #**_____

Farm/ Company Name:_____ Phone:_____
Contact:_____ Fax:_____
Address:_____ Email:_____
City, State:_____ Zip Code:_____

Payment **must** accompany request. Please write **HOPS** on outside of package for identification.
In order to minimize paper usage, reports will be sent via e-mail to the address above unless requested otherwise.

DATE SAMPLED	SAMPLE ID (Variety)	LAB ID (to be filled out in lab)

(Use additional forms as needed.)

Analysis Requested *(Only one available at this time)*	Cost per Sample (USD)
Brewing Values (BV's) Determines Alpha acids, Beta acids and Hop Storage Index (HSI). We follow the ASBC Hops-6a methodology to ensure accuracy for all values.	$30.00
Total number of samples _____ x $30 each	$

1. We require 100g (3.53 oz) of dried hops (at 8-10% moisture) for Brewing Values. Samples over 8-10% moisture will not be analyzed.
2. Turnaround time is 7 to 10 business days.
3. Dried hops should be frozen and/or packaged (ziploc or vacuum sealed) to avoid oxidation and shipped overnight if possible.
4. Any requests submitted after business hours, which are 8am to 4:30pm, or on Saturday or Sunday, will be processed the following business day. Do not ship samples on Friday as their quality will decrease over the weekend.
5. Please make checks payable to *UVM or University of Vermont* **and send along** with Submission Form.
6. Please write **HOPS** on outside of package for identification.

Remember, your results will only be as good as the sample submitted. **Questions?** Please contact UVM Grain Lab at uvmgrain@uvm.edu, 802-656-5392, or Heather Darby at heather.darby@uvm.edu, 802-524-6501.

UVM Cereal Grain Quality Evaluation
Malting Barley Sample Submission Form

THE UNIVERSITY OF VERMONT EXTENSION

FOR LAB USE ONLY
Intake date: _____
Paid? _____ **Check #**_____

Sample ID:

Cereal Grain Quality Laboratory
University of Vermont
James M. Jeffords Hall, Room 244
63 Carrigan Drive
Burlington, VT 05405-1737

Office: 802-656-5392
No fax available.
E-mail: uvmgrain@uvm.edu

Please submit **Payment** and one **Sample Submission Form** with each properly labeled sample to be analyzed.
Samples with incomplete forms and no payment included will not be accepted.
Turnaround time is 7-10 business days.

Farm/ Company Name: _____ Phone: _____
Contact: _____ Fax: _____
Address: _____ Email: _____
City, State: _____ Zip Code: _____

Are you a member of the Northern Grain Growers Association (NGGA)? YES or NO

Sample ID *(Variety)***:** _____

Barley Description (*check one*): □ 2-Row □ 6-Row

Analysis Requested *(Please check all that apply)*	**NGGA Member Cost per Sample (USD)**	**Non-Members Cost per Sample (USD)**
Standard Grain Analysis		
____Test Weight (lbs/bu):	$3.00	$5.00
____Grain Moisture (%):	$3.00	$5.00
____Dry Matter Protein by NIR (%):	$8.00	$10.00
____Falling Number (seconds) :	$15.00	$20.00
____All of the Above:	$25.00	$37.00
____Germination Energy (%):	$8.00	$12.00
____Germination Capacity (%):	$8.00	$12.00
____Plumpness by Sortimat (%):	$10.00	$15.00
____Vomitoxin "DON" (ppm):	$26.00	$36.00
Total:	$	$

Please make checks payable to *UVM* and **send with Submission Form**.

* Please submit 1 quart of ***Clean*** and ***Dry*** (<14% Moisture) whole grain (do not send flour) for each sample submitted. Grain samples with stones and dirt will **NOT** be accepted. Your results will only be as good as the sample submitted.
Questions? Please contact UVM Grain Lab at uvmgrain@uvm.edu, 802-656-5392, or Heather Darby at heather.darby@uvm.edu, 802-524-6501.
Consider becoming a NGGA member today! For more information go to www.northerngraingrowers.org

Note*: Samples will be kept for 3 months from the date of receipt.*

Additional Work Conducted by the Northwest Crops and Soils Program

In addition to our research trials, we also offer a number of services and educational opportunities for farmers and the agricultural service providers who work with them. Below are just a few of these efforts. View our website at www.uvm.edu/nwcrops for a listing of upcoming events as well as educational resources.

Nutrient Management Planning Courses

To complement our on-farm research and demonstrations on crop rotation, cover crops, soil amendments, reduced tillage, and soil aeration to protect water and soil quality resources, we assist farmers in developing their own nutrient management plans to minimize nutrient and soil losses to protect our state's water bodies. Since 2005, Heather has taught nutrient management planning courses for livestock farmers around the state. The courses use "Digging In: A Nutrient Management Course for Farmers," a manual we developed in 2006, and goCrop™ combined with in-class instruction over 6 weeks. As a result of these courses, over 300 farmers have successfully written their own nutrient management plans.

Through this work, farmers now better understand how their farming practices have an impact on water quality. Vermont farmers have reduced phosphorus additions on their farms by an average of 50% as a result of implementing nutrient management plans, based on a 2010 survey we conducted of Vermont dairy farms.

Our nutrient management planning work includes a companion user-friendly web-based application called goCrop™. goCrop™ was developed to help farmers keep track of inputs of manure and fertilizer and yields on the go, through a mobile application for their iPhone or iPad. In 2013, we made goCrop™ available to farmers throughout the U.S. and Canada—more than 160 farmers and service providers from 33 states and Canada are now using goCrop™ for their nutrient management planning. We have integrated several features including a companion app called, goGraze™ for pasture-based livestock operations, Whole Farm Mass Nutrient Balance Calculator showing total import or export of nutrients, and Cover Crop Economics Calculator to help farmers quantify the short- and long-term costs and benefits of cover cropping.

To assist certified organic producers throughout the U.S., our team plays a leading role in eOrganic, the organic production Community of Practice for eXtension.org, a national initiative among U.S. land grant universities to develop peer-reviewed online information. We lead eOrganic's dairy team—made up of more than 90 researchers, extension educators, farmers, and other professionals. Together, we've published more than 125 peer-review articles, 7 videos, and 30 webinars and conference broadcasts on a range of organic dairy topics to pasture management and soil fertility to herd health and economics. In addition, we offer two online, asynchronous courses on organic dairy production. Information on all is posted at eXtension.org/organic_production.

UVM Cereal Grain Testing Lab

The UVM Cereal Grain Testing Laboratory is for commercial grain, hop, and malting barley analysis. If you have samples you would like analyzed, please send in payment along with a completed submission form -- these **must** accompany all requests sent in. In order to get results that accurately reflect your product, be sure to employ good sampling techniques. Remember the results are only as good as the sample submitted! View our lab information online - https://www.uvm.edu/extension/nwcrops/cereal-grain-testing-lab

Social Media

In addition to our website, you can keep in touch with our activities through our social media channels:

https://www.facebook.com/uvmcropsoil

https://www.youtube.com/user/cropsoilsvteam

https://twitter.com/UVMExtcropsoil

Our blogs:
Out Croppings: http://blog.uvm.edu/outcropn/
What's Hoppening: http://blog.uvm.edu/hoppenin/

THE UNIVERSITY OF VERMONT AGRICULTURE & LIFE SCIENCES

Quick View of
USDA Risk Protection Programs
Available in Vermont

USDA U.S. Department of Agriculture Risk Management Agency

Program	Application Deadline	Program Description	Crops/Commodities
Multi-Peril Crop Insurance (MPCI)	March 15	MPCI policies must be purchased through a crop insurance agent prior to planting and cover loss of crop yields from all types of natural causes including drought, excessive moisture, freeze, and disease. Newer coverage options combine yield protection and price protection to guard farmers against potential loss in revenue, whether due to low yields or	March 15 is the application deadline for most insurable spring-planted crops, depending on county. In Vermont, crops covered include corn, forage seeding, sweet corn, soybeans, spring barley and spring wheat.
Whole Farm Revenue Protection (WFRP)	March 15	Provides a risk management safety net for all commodities on the farm under one insurance policy. Farms can get WFRP with only one commodity or with multiple commodities. T ailored for any farm with up to $8.5 million in insured revenue. Certified organic producers can use organic prices. Purchased through a crop insurance agent.	Conventional crops, specialty or organic commodities (crops and livestock), those who market to local, regional, farm-identity preserved, specialty, or direct markets, wholesale or regional.
Nursery crops	May 1	Multi-peril insurance for nursery crops. Purchased through a crop insurance agent.	Nursery crops
Pasture, Rangeland, Forage (PRF)	Nov 15	PRF (Pasture, Rangeland, Forage) program covers only one peril: lack of precipitation. Sales closing dates are established for each county. November 15 is sales closing date in all Vermont counties. Coverage is based on the rainfall index and the experience of the entire grid.	Losses of forage produced for grazing or harvested for hay, which result in increased costs for feed, destocking, depopulating, or other actions.
Dairy Revenue Protection (Dairy-RP)	Daily, when prices are posted	Insures against unexpected declines in the quarterly revenue from milk sales relative to a guaranteed coverage level. The expected revenue is based on futures prices for milk and dairy commodities and the amount of covered milk production elected by the dairy producer. Quarterly endorsements. Purchased through a crop insurance agent.	Milk
Apiculture (API)	Nov 15	API uses Rainfall Index to determine when low precipitation in your area triggers indemnity payments. Purchased through a crop insurance agent.	Coverage for honey, pollen collection, wax and breeding stock.
MPCI for Tree Fruits	Nov 20	Multi- peril coverage for tree fruit crops (depending on county). Purchased through a crop insurance agent.	Apples, peaches
Noninsured Crop Disaster Assistance Program (NAP)	Sales closing dates vary by crop (see MPCI dates above)	NAP is administered using MPCI crop deadlines and is designed to protect expected yields on non-insurable crops. NAP provides financial assistance when eligible crops are affected by natural weather causes resulting in lower yields or complete crop losses. Also includes prevented planting provisions. NAP is a yield-base protection offering CAT level yield and price coverage (50/55) for 2019. Organic market price elections are also available on some crops. Purchased through local Farm Service Agencies.	Eligible crops must be commercially produced agricultural commodities for which crop insurance is not available. Includes all crops like vegetables, small fruits, some tree fruits, maple sap, honey, hay, grains, other perennials Note: Maple sap and honey sales closing date is 1/1.

Program	Application Deadline	Program Description	Crops/Commodities
Cover Crop Termination	n/a	Cover Crop termination dates are based on NRCS recommendations. In Zone 4, terminate cover crops at planting or within 5 days after planting but before crop emergence.	Cover crops
Emergency Assistance – Honeybees (ELAP)	Nov. 1	Covers losses due to an eligible adverse weather or loss condition, including conditions such as Colony Collapse Disorder (CCD), blizzards, disease, water shortages and wildfires, as determined by the Secretary. Application period will end no later than Nov. 1 after the end of the program year in which the honeybee loss occurred. Purchased through local Farm Service Agencies.	Eligible honeybees include bees housed in a managed hive and used for honey production, pollination or honeybee breeding.
Emergency Assistance – Livestock (ELAP)	Nov. 1	Covers losses due to an eligible adverse weather or loss condition, Including blizzards, disease (including cattle tick fever), water shortages and wildfires, as determined by the Secretary. ELAP covers losses that are not covered under other disaster assistance programs such as LIP or LFP. Purchased through local Farm Service Agencies.	Livestock deaths, feed and grazing losses, transporting water.
Forage Seeding	Fall-seeded: Sales Closing Date July 31; Final Planting Date August 31	Protected against: Adverse weather conditions, including natural perils such as hail, frost, freeze, wind, drought, and excess precipitation; Failure of irrigation water supply, if caused by an insured peril during the insurance period; Fire, if caused by an insured peril during the insurance period; Insect damage and plant disease, except for insufficient or improper application of control measures; and Wildlife. Purchased through a crop insurance agent.	Forage seeding is insurable if it is alfalfa, or forage mixture containing at least 50 percent alfalfa, clover, birdsfoot trefoil, or any other locally recognized and approved forage legume species (by weight); OR It is planted during the current crop year to establish a normal stand of forage.
Livestock Gross Margin-Dairy (LGM-Dairy)	12 times per year, last business Friday of each mo.	Provides protection against loss of gross margin (market value of milk minus feed costs) on milk produced from dairy cows. LGM-Dairy uses the Chicago Mercantile Exchange Group futures prices for corn, soybean meal, and class III milk to determine the expected gross margin and the actual gross margin. Premium subsidy is available. Purchased through a crop insurance agent.	Milk
Livestock Gross Margin – Swine (LGM-Swine)	12 times per year, last business Friday of each mo.	Provides protection against the loss of gross margin (market value of livestock minus feed costs) on swine. LGM-Swine uses futures prices to determine the expected gross margin and the actual gross margin. Purchased through a crop insurance agent.	Swine. Operations covered: Farrow-to-Finish Operations; Feeder Pig-Finishing Operations; Segregated Early Weaned (SEW) Operations.
Livestock Indemnity Program (LIP)	When loss occurs	This FSA program is for livestock losses in excess of normal mortality caused by eligible loss conditions. Final dates to file notice of loss is 30 days after death is first apparent and final date to submit application for payment is 90 days after the calendar year in which the eligible loss condition occurred. Purchased through local Farm Service Agencies.	Livestock: cattle, sheep, swine

Program	Application Deadline	Program Description	Crops/Commodities
Dairy Margin Coverage Program (DMC)	Registration period TBA	DMC is a revenue protection program based on the difference between the price of milk and the cost of feed. The national dairy production margin is the difference between the all-milk price and average feed costs. Producers may purchase buy-up coverage that provides payments when margins are between $4.00 and $9.50 cwt. Purchased through local Farm Service Agencies.	Milk
Tree Assistance Program (TAP)	When loss occurs	This FSA disaster program provides financial assistance to eligible orchardists and nursery tree growers to replant or rehabilitate eligible trees, bushes, and vines lost by natural disasters. Final date to submit application and supporting documentation is the later of 90 calendar days of the disaster event OR the date when the loss is apparent. Purchased through local Farm Service Agencies,	Trees, bushes, and vines from which an annual crop is produced for commercial purposes. Nursery trees include ornamental, fruit, nut and Christmas trees produced for commercial sale.
For more information on these programs and other USDA services		University of Vermont Agricultural Risk Management Education Website: http://go.uvm.edu/ag-risk Contact Jake Jacobs, Crop Insurance Education Coordinator Email: jake.jacobs@uvm.edu Message phone number: 802-656-7356 RMA: https://www.rma.usda.gov/ FSA: https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/index	

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