Research Report:

Use of Pre-sidedress Nitrogen Tests (PSNTs) to Understand Nitrogen Availability after Incorporation of Cover Crops on Vegetable Farms

November 29, 2016

Thanks to funding from the VVGBA, the New England Vegetable and Berry Growers Association (NEVBGA), and UVM Extension, Vern Grubinger and Becky Maden of UVM Extension initiated a project in the spring of 2016 to better understand nitrogen management from legume cover crops on vegetable farms.

For the 2016 growing season, eleven commercial Vermont vegetable farms agreed to sample legume cover crops that were planted as part of their regular farming operation by taking monthly Pre-Sidedress Nitrate Tests (PSNT) beginning one week after cover crop incorporation. All farms took a pre-incorporation sample, then began regular sampling one week after incorporation.

Cover crop species on participating farms varied based on what the farmers had planned as part of their usual rotation. Seeding rates, seeding dates, incorporation dates, and tillage practices also varied. Farmers were encouraged to maintain their usual farming practices, including fertilizing, cultivating, and planting cash crops. Records of soil amendments and crops planted were collected for this project.

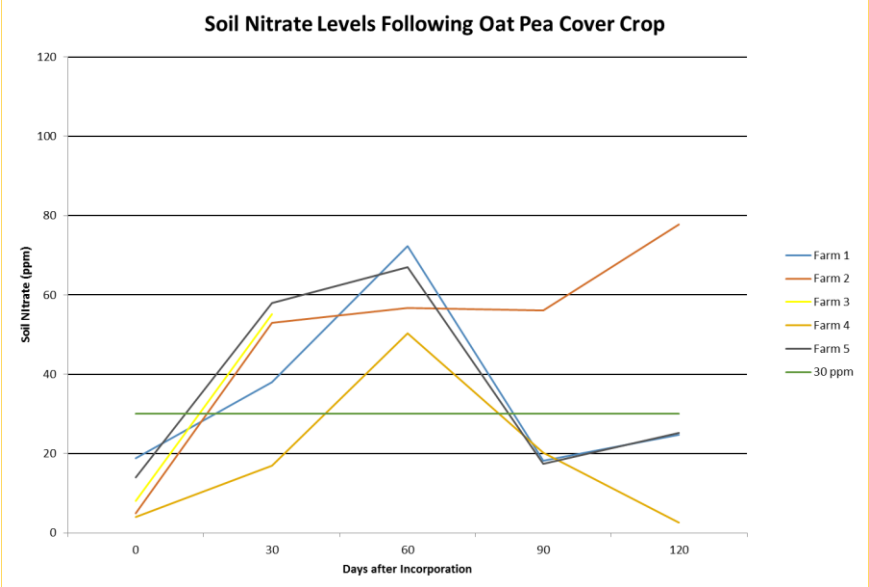
Cover crop species sampled:

- Spring planted Oat-Pea (five farms)
- Fall planted Rye-Vetch (four farms)
- Single trials of each of the following:
    - Spring planted triticale (not a legume but sampled as a comparison with a legume crop on the same farm)
    - Spring planted Field pea
    - Fall planted Oat Vetch
    - Fall planted Red clover/ Timothy
    - Spring planted mixed grasses/ Timothy (not a legume but sampled as a comparison with a legume crop on the same farm)
    - Fall planted Yellow clover/ Winter rye

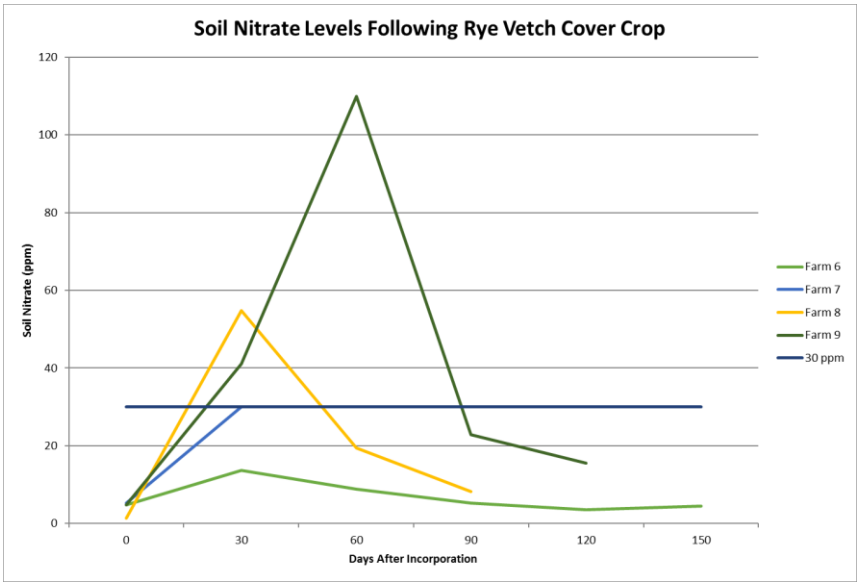
Results/ Discussion:

Although the data for this study was “crowd sourced” and sampling was done in an active, on-farm setting, several trends are nonetheless worthy of attention despite the huge variability in agronomic practices.

Oat/ Peas: The collected data suggests that under this season’s weather conditions, spring planted oat pea blends have a peak release between 45 and 70 ppm of nitrate approximately 60 days after incorporation, regardless of when they are seeded and incorporated.



Rye/ Vetch: Widely varying results. One farm mowed the cover crop in the spring, and didn't incorporate it until the fall of 2016, when it was lightly disked for a subsequent cover crop seeding. Two other farms added fertilizer prior to sweet corn planting. Peak nitrate release rates ranged from 13.7 ppm (on the farm that did not incorporate in spring) to 110 ppm on one of the farms that added fertilizer. Peak release dates range from 30 days after incorporation to 60 days after incorporation.



Straight Legumes: Fall planted oat vetch cover crop (with a heavy rate of vetch and winter killed oats) had the highest peak levels of soil nitrate (122 ppm) in the whole study; however, this field was also fertilized with 100 lbs of nitrogen (Kreher's 5-3-4) around the time of cover crop incorporation. It is likely that the sharp spike in nitrate release and subsequent steep decline was due in part to the fertilization and in part to the lack of an accompanying grain species, which would increase the overall C:N ratio of the cover crop and thus moderate the rate of nitrate release. In contrast to the nitrate rich oat pea

cover crops, the single species spring planted field pea released just 40 ppm of nitrate about three weeks after incorporation and hovered around that level until it began to decline around 60 days after incorporation.

Hay/ mulch cover crops: The three cover crops used in hay mulch production (red clover/ Timothy; Timothy/ mixed grasses; Yellow clover/ rye) all demonstrated a later and somewhat lower release of nitrate than the more traditionally grown annual cover crops, likely due to the fact that these fields have a higher percentage of grasses (thus a higher C:N ratio) and the slow growing clovers would continue to fix nitrogen throughout their two-year duration in the soil.

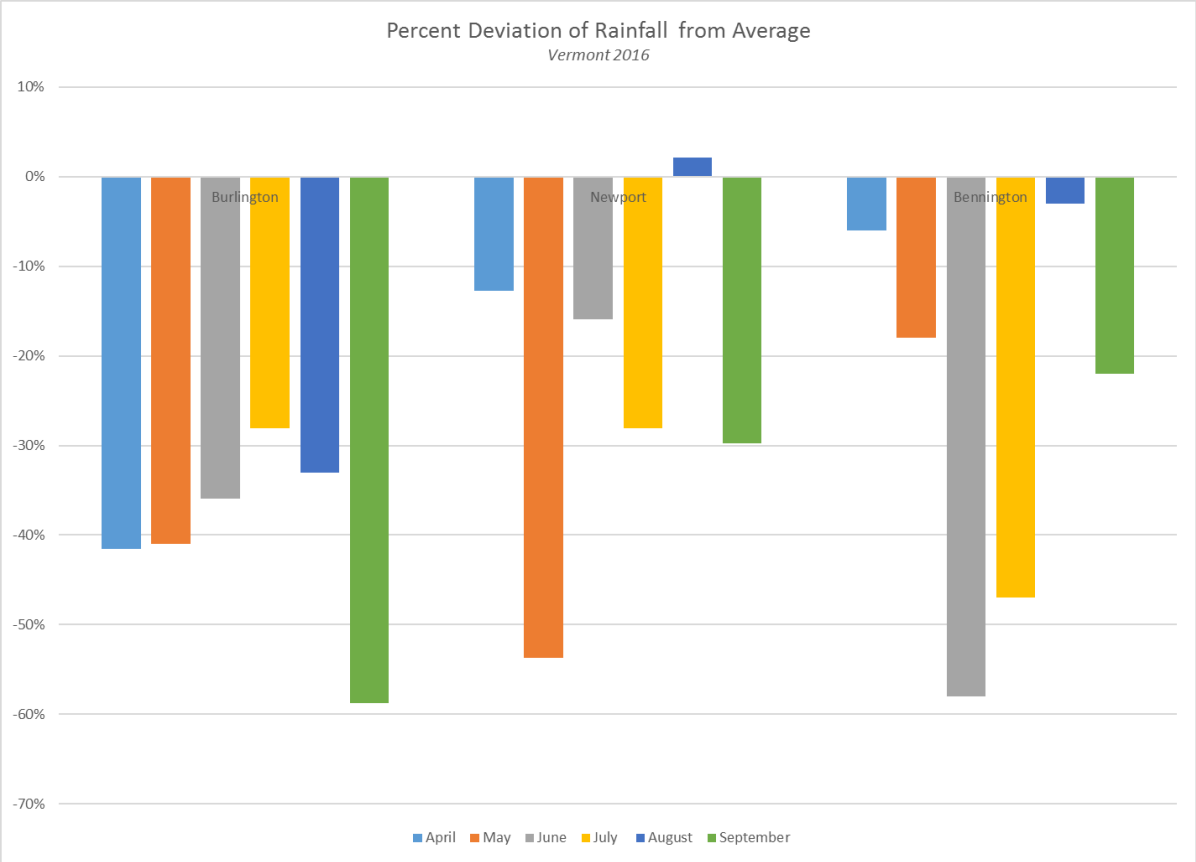
Year to year variability of **climate and rainfall** play a significant role in the timing of nitrate release from legume cover crops. 2016 was unusually dry, which may account for sustained levels of nitrate on some of the trail fields. If rainfall were closer to average, nitrate would be more likely to leach, particularly on sandier soils.

Vermont Rainfall (in Inches)*

	April	May	June	July	Aug	Sept
Burlington						
Avg**	3.08	4.17	4.76	4.24	3.36	3.37
2016	1.8	2.46	3.05	3.05	2.25	1.39
% Deviation	-42%	-41%	-36%	-28%	-33%	-59%
Newport						
Avg	3.38	3.95	4.95	4.67	5.59	3.69
2016	2.95	1.83	4.16	3.36	5.71	2.59
% Deviation	-13%	-54%	-16%	-28%	2%	-30%
Bennington						
Avg	2.47	3.55	4.13	4.54	4.01	3.86
2016	2.63	2.92	1.74	2.39	4.13	3.03
% Deviation	6%	-18%	-58%	-47%	3%	-22%

*Source: National Weather Service

**Averages are based on 2000-2016 data



Conclusions:

This study helps narrow down the choice of cover crops to focus future research on. Fall planted rye vetch and spring planted pea oats are two of the most popular grain/ legume mixes used on vegetable farms because they fit well into vegetable farm crop rotations, they reliably provide nitrogen to cash crops, and they offer substantial organic matter contributions. This project confirms that these are excellent choices for vegetable farmers from a nitrogen perspective since available nitrate from these two cover crops aligns well with most vegetable cash crop needs. It is also clear that planting legumes in combination with grains offers a substantial and sustained release of nitrate available to cash crops, rather than the quick burst of N typically released by pure stands of legumes or a very slow and lower level release from a pure stand of grass.

This project also highlights the complexity of cover crop timing on vegetable farms. Understanding the general timeframe of nitrate release from commonly grown cover crops is just one small piece of the puzzle; matching these release rates with cash crop needs is another piece. Furthermore, managing crop rotations to allow for cover crop seeding and incorporation at the ideal times is difficult for many growers with limited and valuable land bases. Finally, weather conditions are hugely variable and unpredictable. Thus, regardless of how much research is done in this arena, farmers remain the best judge of what practice works for their systems with in-field implementation on a year by year basis.

Some of the trials demonstrated that there were still significant levels of nitrate remaining in the soil through October. Nitrate from cover crops behaves no differently in the soil than fertilizer nitrate, and is therefore susceptible to leaching. Some of these sample sites are entering the winter with over 70 ppm nitrate available in the soil, which suggests that the farmer could capture the nitrate and make it available for next season with a fall planted cover crop like winter rye. Without a cover crop on the soil, the nitrate could leach and ultimately contribute to watershed contamination.

A final objective was to familiarize vegetable growers with the Pre-sidedress nitrate test and to gain an understanding of when optimal timing is for sampling after cover crop incorporation. The past summer's research suggests that for pea oat and rye vetch cover crops, taking a sample 30 days after cover crop incorporation would reveal how much nitrate the cover crop had released until that point, and that the nitrate levels should be well above 30 ppm. The timing of this test could allow the farmer to save time and money by avoiding unnecessary fertilizer applications.

Becky and Vern were awarded a Specialty Crop Block Grant to build on this year's work. In 2017 and 2018, they will conduct a two-year research project on four vegetable farms sampling plots of rye vetch and oat pea to determine optimal timing of incorporation and when peak nitrate release is for cash crop use. They are also collaborating with Katie Campbell-Nelson of UMASS Extension to share data from a similar study she is conducting in Massachusetts in 2017.

A huge thank you to the following farms for participating—and for faithfully taking soil samples:

Cedar Circle Farm, Clearbrook Farm, Diggers Mirth Collective Farm, Elmer Farm, Intervale Community Farm, Killdeer Farm, Lewis Creek Farm, New Leaf Organics, Pete's Greens, River Berry Farm, and Singing Cedars Farmstead.