OPVC CONTINUING PROJECT REPORT: 2016 **PROJECT YEAR**: 1

Project Title: Providing organic nutrient management guidance to processed vegetable growers

PI: Dan M. Sullivan, Dept. Crop & Soil Science
Co-PI: Aaron Heinrich, Dept. of Horticulture

Organization: Oregon State University
Telephone: 541-737-5715 (Sullivan)
Email: Dan.Sullivan@oregonstate.edu
Address: 3017 Ag & Life Sciences Bldg.
City/State/Zip: Corvallis, OR 97331

Cooperators: Ernie Pearmine (Pearmine Farms), Jason Bradford (Green Spring Farms), Matt Cook (Cook Family Farms), Denny Hopper (Hopper Bros.), Thomas Barnett, and Ryan Koch.

Total Project Request (all years): Year 1: $24,011 Year 2: TBA

Other funding sources*:* None at this time

2. EXECUTIVE SUMMARY

The market for organic vegetables is increasing. As conventional farmers transition fields to organics to meet this demand, there is a need for better organic nutrient management guidance, especially for nitrogen (N). Organic N management is more challenging than conventional N management due to a higher level of uncertainty surrounding the N supplying capacity of an organically managed soil as well as the constraints of organic fertilizers (supply, application timing and placement, and uncertainty of release rate and amount). As a result, conventional nutrient management strategies may not be appropriate for organically managed systems. With organic N management there is often a higher risk of excessive nitrate-N loss and higher risk of not achieving economic yield targets.

Results of the first year of this project demonstrate the nutrient management challenges that organic producers face, as well as potential solutions. Of the seven fields sampled in this study, soil test P was elevated in five (>90 ppm Bray 1P). Although the probability of a P fertilizer response is very low for these high soil test P fields for all vegetable crops, an average of 178 lb P2O5/acre was applied. This was the result of applying low N:P ratio fertilizers (mostly pelleted and raw chicken litter) to meet N demands. There is little incentive to switch to N only fertilizers such as feather meal (FM) due to its high cost (approximately $5-6 vs. $7-8 per lb of plant available nitrogen (PAN) from pelleted chicken manure and FM, respectively). PAN from leguminous cover crops is often the least expensive source of organic N, however, cover crops are not always compatible with every farming system.

Using an in-field aerobic soil incubation technique at constant moisture, average "background" soil N mineralization at 12-wks from six organic and one transitional field was 103 lb N/acre-8 inches (range 60 to 161). This represented a rate of 1.2 lb N/acre-8 inches/day (range 0.9 to 1.9), and 2.1% of total soil N (range 1.1 to 3.3). Based on N mineralization results and in-field monitoring of five sites growing organic sweet corn, three had adequate N nutrient management programs, and two exceeded crop N needs. The fields with high N had a history of raw chicken litter applications.

Due to the high variability among fields, adjusting preplant organic fertilizer rates based on N mineralization estimates may result in excessive or deficient N applications. To reduce the uncertainty associated with estimating mineralization, and to better match fertilizer rates with crop needs, the sweet corn pre-sidedress nitrate test (PSNT) should be evaluated and recommendations modified for use in organic systems. For the PSNT to be effective, research is needed to determine the best organic fertilizer strategy (rate, timing, placement, and source) that would meet crop needs at the lowest cost. There is the potential to fine-tune nutrient management programs, which may result in significant cost savings for some fields.

3. FULL REPORT

3a. Background

Nationwide, the demand for organically produced vegetables is increasing. If Oregon's processed vegetable growers are to meet this demand, more fields must be transitioned to organics. One of the challenges that current and future organic producers face is a lack of organic nutrient management guidance. Most nutrient management guides for processed vegetable crops have been created for conventionally managed systems using conventional fertilizers.

Organic N management is more challenging than conventional N management due to a higher level of uncertainty surrounding the N supplying capacity of an organically managed soil as well as the constraints of organic fertilizers (supply, application timing and placement, and uncertainty of release rate and amount). Conventional N fertilizers (urea, ammonium sulfate, UAN solutions) typically contain 100% immediately plant available N and are water soluble. This gives conventional growers flexibility in application timing and the confidence that the plants are supplied with the right N rate at the right time. In contrast, organic fertilizers contain mostly plant unavailable, organically bound N that is not water soluble. Through the process of mineralization, the organic N is converted to plant available ammonium-N, which is water soluble. As a result, most organic fertilizers are applied preplant and incorporated, and there are not many economical options to deal with a mid-season N deficiency. With this front-loading of fertilizer, a grower must be able to estimate the N supplying capacity of a soil so that the field is adequately fertilized. This is critical for economic success due to the higher cost of organic fertilizers per unit of nitrogen, which is often twice that of conventional fertilizers.

Estimating the N supply capacity of an organically managed field can be challenging. The goal of an organically managed field is to increase a soil's N supplying capacity by building up the soil organic matter (SOM) using cover crops, and organic amendment and fertilizers.

Conventionally managed fields in the Willamette Valley routinely supply 100 lb N/acre over a growing season, but organically managed fields may supply twice that amount depending on their crop rotation and management history. Without knowing how much N the soil will supply over a growing season makes it difficult to estimate how much organic fertilizer should be applied at planting.

This project will address the challenges mentioned above with the overall goal of helping farmers growing processed vegetables with their organic nutrient management program so that costs and environmental losses are minimized, and yield and product quality are maximized.

3b. Objectives

The overall project goal is to assist growers in matching N supply from soil organic matter and organic fertilizers with crop uptake with the goal of achieving yield targets. To do so involves the following objectives:

a. Quantify the soil N supply (i.e., soil organic matter mineralization) of organically managed fields.
b. Assess farmer organic nutrient management programs through targeted soil sampling over the growing season.
c. Provide tools and guidance to farmers and ag professionals on how to determine the fertilizer source and rate to minimize organic fertilizer costs and environmental losses, and maximize yield and product quality.

3c. Significant findings

<u>Research farm and laboratory incubations</u>

- N mineralization from soil incubated at constant moisture and temperature in the lab (72F) was very close to that measured from the same soil incubated in the field at the same constant moisture but under fluctuating temperature. However, the average soil temperature in the field (0-12 inches) over 12-wks was 69F, which was close to the lab temperature.
- Average net N mineralization was 103 lb N/acre-8 inches (range 60 to 161). This represented a rate of 1.2 lb N/acre-8 inches/day (range 0.9 to 1.9), and 2.1% of total soil N (range 1.1 to 3.3).
- By increasing the incubation temperature from 72F to 95F, net N mineralization increased by 240%.
- The pattern of N mineralization (slope), indicate that the soils will continue to mineralize N even after the crop is harvested, though decreasing soil temperatures will slow the process.

<u>Soil test P and K</u>

- Of the seven fields sampled in this study, soil test P was elevated in five (>90 ppm Bray 1P). Although the probability of a P fertilizer response is very low for these high soil test

P fields when growing sweet corn, an average of 178 lb P2O5/acre was applied. This was the result of applying low N:P ratio fertilizers (mostly processed and raw chicken manure/litter) to meet N demands.

On-farm N mineralization and soil nitrate monitoring

Soil from five fields growing organic sweet corn was collected at growth stage V4-V5 (when crop N demand begins to increase rapidly) and incubated in the grower's field. N mineralization from these samples represents N supply from soil organic matter, applied fertilizers, and spring incorporated plant biomass (from winter cover crops, volunteer weeds, or pasture).

- At 9-wks (several weeks before harvest), there was an average of 233 lb N/acre (range 144 to 381) in the field incubated soil. This indicates that there was sufficient N at all sites to meet crop demands.
- The two fields with the highest N (261 and 381 lb N/ acre) had applied 6 and 4 tons/acre of raw chicken litter, respectively, and also had high soil N mineralization rates (122 and 161 lb N/acre, respectively). Both of these sites also had high soil test P and K, and fertilizer rates could have been significantly reduced.
    - For these two fields, the presidedress nitrate test (PSNT) was 52 and 55 ppm, indicating that more than sufficient N was available to meet crop N needs.
    - A pre-harvest nitrate test indicated that there was between 38 to 69 lb N/acre of residual N in the soil that was not used by the crop.

Overall

Due to the high variability among fields, adjusting preplant organic fertilizer rates based on N mineralization estimates may result in excessive or deficient N applications. To reduce uncertainty associated with estimating mineralization, and to better match fertilizer rates with crop needs, the sweet corn PSNT should be evaluated for use in organic systems. For the PSNT to be effective, research is needed to determine the best organic fertilizer strategy (rate, timing, placement, and source) that would meet crop needs at the lowest cost. There is the potential to fine-tune nutrient management programs, which may result in significant cost savings for some fields.

3d. Methods

Research farm in-field incubation

Soil was randomly collected (0-8") from six fields that are organically certified and one field that is in organic transition. The collection was done in early spring before organic fertilizer had been applied and when the soil was moist (i.e., often collected several days after a rain to be as close to field capacity as possible). The soil was stored at 40°F for 5 to 8 weeks (depending on the collection date). On June 14, the soil was sieved through a 9.8 mm screen, which was then placed in 4-mm low density polyethylene (LDPE; Wagner Packaging Solution, Salt lake City, UT) tube shaped bags. One end of the bag was tied and the sieved soil was added in ~3" increments, packed with rapid vertical shaking, and repeated until the bag contained 12" of packed soil. The bags were then tied shut to prevent moisture exchange and flagging was attached. Subsamples of the sieved soil were collected and analyzed for moisture, initial mineral N concentration, pH, total C and N, and nutrients (Table 1).

Table 1. Soil characteristics of seven organically managed fields used for processed vegetable production. Soil sampled in early spring before fertilizer additions.

Site	Location	Soil mapping and texture[1]	pH	OM[2] (%)	N (%)	C/N Ratio	P[3] (ppm)	K[4] (ppm)
1	Gervais	Chehalis sicl	6.6	2.1	0.13	9.6	101	224
2	Dever-Conner[5]	Chehalis sicl	6.3	3.2	0.22	8.6	102	432
3	S. Corvallis	Verboort sicl	6.6	3.6	0.21	10.2	41	244
4	Hubbard	McBee/Cove sicl	6.5	5.0	0.32	9.2	120	319
5	Woodburn	McBee/Cove sicl	5.6	4.5	0.24	10.9	16	48
6	Mollala	Salem sil/Malabon sicl	5.5	4.9	0.18	15.9	87	259
7	Aurora	Amity sil	6.4	4.6	0.21	12.8	270	423

1- sil= silt loam and sicl= silty clay loam; 2- 1.7*total carbon by combustion; 3- Bray 1P; 4- Mehlich III; 5- this farm is in its 2nd year of organic transition

At OSU's vegetable research farm (Corvallis), the bags were buried in a sweet corn field, which allowed us to incubate the soil under field temperature conditions, but at constant moisture (Table 2). Using a 1.75" mud auger (AMS, Inc. American Falls, ID), 12" holes were hand dug in the seedline of recently emerged corn and the bags were placed in each hole (Fig. 1). The bags fit snuggly and required no backfilling with soil; however, the top of the bag was covered with soil with only the flagging visible to mark their location. The "tail" at the top of the bag was folded over when placed in the soil to prevent water from collecting and potentially seeping into the bag. The bags were placed in the field in a randomized complete block design with 4 replicates for each of the 4 sampling intervals (16 bags total, 4 in each block). At 3, 6, 9, and 12 weeks one bag from each block and from each farm was removed, thoroughly mixed, and a subsample taken for moisture and mineral N extraction using a 2M KCl solution.

To monitor soil temperature, Hobo pendant dataloggers were placed at 3, 6, 9, and 12 inches, and the temperature recorded every four hours. The temperature was then averaged over the total depth and for each 3-wk collection interval.

Figure 1. Buried bag before installation (left) and installed into an auger hole before backfilling (right)

Laboratory Incubation

Approximately 500 g of the sieved soil used in the research farm incubation was added to plastic bags equipped with a straw for aeration. For each soil, 6 bags were made-up. Three bags were incubated at room temperature (72^{o}F = 22 ^{o}C) and three in an incubator at 95^{o}F (35 ^{o}C), both in the dark. The bags were checked weekly for moisture loss and additional water added as needed. At 3, 6, 9, and 12 weeks the bags were mixed and approximately 15 g was removed and extracted with 2M KCl for mineral N concentration.

Table 2. Incubation soil moisture (gravimetric; % water of oven dry soil).

Site	Research farm and lab	On-farm
	------ % moisture -----	
1	19	NA
2	30	NA
3	32	22
4	36	34
5	32	30
6	27	24
7	27	21

On-farm Study

Of the seven fields from which soil was collected for the research farm incubations, five sites were growing sweet corn and were used for an on-farm incubation. Soil nitrate was monitored three times from planting until harvest; preplant, V4 to V5, and preharvest (1 to 2 wks before harvest).

For the in-field incubation, a composite soil sample was collected from 3 locations in the field to a depth of 12" and sieved through a 9.8 mm screen. These are true replicates as opposed to the research farm incubation where only one large composite sample was collected from a field and each replicate was actually a subsample. Also, the soil collected had received fertilizer applications and the nitrogen mineralization reflects N mineralization of both soil organic matter and organic fertilizers. Using the same methods given above, three soil bags per sampling location were created and installed between plants in a corn row at V4 to V5 depending on the fieldsite. At 3, 6, and 9 one bag from each rep was removed, mixed, and a subsample taken for moisture and extraction for mineral N using a 2M KCl solution.

To monitor soil temperature, Hobo pendant dataloggers were placed at 4 and 10 inches, and the temperature recorded every four hours. The temperature was then averaged over the total depth and for each 3-wk collection interval.

Table 3. Nutrients applied to sweet corn during the 2016 growing season.

Site	Total N	PAN[1]	P2O5	K2O	Fertilizers and application timing[2]
	---------------- lb/acre ----------------				
3	96	48	72	48	CM (PPI+Band+Top)
4	280	140	200	200	CL (PPI) + SF (Top)
5	133	75	110	65	CM (PPI) + liquid (F)
6	113	65	95	55	CM (PPI) + liquid (F)
7	368	184	240	240	CL (PPI) + CM (Band)

1- Plant available nitrogen calculated using OSU's Organic fertilizer calculator using a moisture content of 10% and 30% for the CM and CL, respectively. CL was not analyzed for nutrients, and we are using a best guess based on past nutrient analysis from the farmers.
2- CM= Stutzman pelleted or granular chicken manure (4-3-2), CL= raw chicken litter (est. 3-2-2), SF = specialty fertilizer (4-4-4), liquid= liquid fertilizer derived from fish and chicken manure, PPI= preplant incorporated, Band= banded at planting, Top= topdress midseason typically followed by cultivation to incorporate into soil, F= foliar followed by irrigation

Farm descriptions

Site 1- Gervais: 7 years organic. Previous cash crop: cauliflower.

Site 2- Dever-Conner: 0 years organic, 2nd year in transition. Cash crop since starting transition: Einkorn wheat. The only fertilizer applied in the last 2 years has been mint "compost" (likely just stockpiled and not actively managed).

Site 3- S. Corvallis: ? years organic. Using Google Earth imagery, the field was in grass seed in 2012. Prior to study initiation, the field had been in pasture (1 to 2 yrs).

Site 4- Hubbard: This farm has been organically managed for 25 years, possible longer. The only fertilizer applied over this time has been chicken litter.

Site 5- Woodburn: 10-12 years organic. This field has been in native grasses for at least the past 3 years, with hay taken 3 years ago. The field has been fallowed for the past 2 (left in native grasses) and has received no fertilizer. As a result, a dense sod had built up. The primary fertilizer used has been Stutzman chicken manure, though in 2016, liquid fish was foliar applied and washed into soil with irrigation.

Site 6-Mollala: 5-6 years organic. Previous cash crop: snap beans. This field has had a winter cover crop every year since it has been organic (typically a mix of cereals and legumes). The primary fertilizer used is Stutzman chicken manure, though in 2016, liquid fish was foliar applied and washed into soil with irrigation.

Site 7- Aurora: 10 years organic. Previous crop: squash- in 2015 25 t/a squash was left to rot in field, in spring of 2016 lime was applied and squash residue and weeds disced under. The primary fertilizer used has been raw chicken litter and Stutzman chicken manure. Some feather meal, organic K-mag, and cover cropping used in past. They apply chicken litter based on availability even when it may not be needed because they are often uncertain if and when they will have access to the fertilizer.

3e. Results & Discussion

Phosphorus and potassium

Based on OSU's sweet corn fertility guide, there is a low likelihood of a yield response to P and K fertilizer when soil test P and K is 50 and 200 ppm, respectively. Based on the soil test values in Table 1, soil test P and K are high for most sites. Only sites 3 and 5 required P, and only site 5 required K. For the sites that required no P and K, an average of 178 lb P2O5 and 136 lb K2O was applied, respectively. This is the result of using manure based fertilizers that contain N:P and N:K ratios of between 1 to 2. None of the fertilizers applied will contribute significantly to soil organic matter (SOM) building because of the high N mineralization potential (≥50% over a growing season), which results in the decomposition of applied carbon.

Using a combination of high N analysis fertilizers (i.e., feather meal) and N fixing cover crops (legumes), crop N needs could be met without applying P and K while building the long-term fertility of the soil (i.e., SOM building). However, meeting N needs with high N analysis fertilizers and/or cover crops can be challenging for the following reasons: 1) the supply of specialty fertilizers such as FM may not be sufficient to meet demand, 2) weather constraints may make cover crop establishment difficult in the fall, 3) dealing with cover crop biomass in the spring (e.g., flailing and incorporation) may not be compatible with farm operations and/ or planting dates, and 4) the cost plant available N (PAN) from specialty fertilizers are often more expensive than chicken manure ($5.2 vs. $8.3 per lb of PAN from pelleted chicken manure and FM, respectively). The cost per pound of PAN from cover crops is usually the least expensive ($1 to 3) option of supplying N without adding P and K.

Some growers use chicken litter, which is an economical source of N, but the disadvantages include difficulty applying evenly at an agronomic rate, and P and K are applied well in excess for crop removal. Also, there is a limited local supply that is already being utilized, and may not be a reliable source of fertilizer.

N mineralization: Field (research farm "buried bag") and lab incubations

The soil temperature averaged over 4 sampling depths (3, 6, 9, and 12 inches) is given in Fig. 2. Over the entire 12-wk incubation, the average soil temperature was 69.0^{o}F, with the highest temperatures occurring late June through the end of July. Daily variations in temperature were greatest in the first 3-wks after installing the bags when the corn was small, which allowed light penetration to increase the soil temperature during the day. The soil temperature in the laboratory incubation was only 3 degrees F warmer than the field incubation, but the temperature in the lab was constant whereas in the field there were daily fluctuations.

Despite the different temperature conditions, net N mineralization was similar between the lab and field incubations (Table 4). The absolute difference between the two methods was 9% (range 1 to 32%), with N mineralization in the field incubation being slightly lower for all sites except site 1. This suggests that when average soil temperatures are close to that of the laboratory (i.e., room temp), there is no benefit to conducting in-field incubations. By increasing the incubation temperature from 72 to 95F, the rate of mineralization increased by 240%.

Based on the in-field incubation, average soil Nmin was 103 lb N/acre-8 inches (range 60-161; Table 4). Site 7 had the highest Nmin potential, possibly because in 2015, 25 t/acre of squash was left unharvested in the field, which may have contributed significantly to N mineralization. Also, this site has a history of large manure applications (chicken litter) and use of winter cover crop, both of which may have increased SOM. The average N mineralization rate was 1.2 lb N/d/acre-8 inches (Table 5).

Average N mineralization in the lab and field incubations was approximately 2.2% of total soil N, however, the range was 1.1 to 3.3, making this a poor predictor of N mineralization.

Figure 3 shows mineralization over 12 wks. The shape of the graph indicates that the soils will continue to mineralize even after 12 wks.

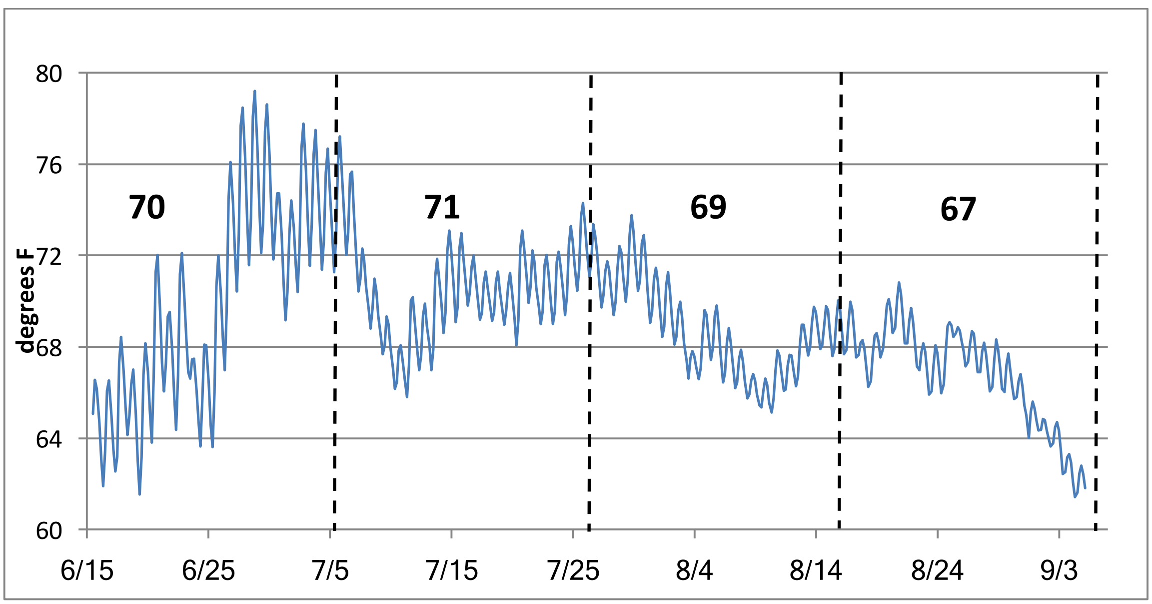

Figure 2. Average soil temperature of 4 depths: 3, 6, 9, and 12 inches measured at 4 hr intervals. The vertical line indicates sample date and the number is the interval average.

Table 4. Soil nitrogen mineralization (0 to 8 inches) incubated in the field and laboratory.

Site- Location	Initial soil NO3-N	Soil total N (0-8" @BD of 1.3 g/cm3)	Lab incubation Nmin @ 72F	Lab incubation Nmin @ 95F	Field incubation Nmin	Increase in Nmin w/increase from 72 to 95F
	ppm	-------------------------- lb N/acre- 8 inches ------------------------				Nmin(@72/@95)
1-Gervais	15	3,035	75	175	79	2.3
2-Dever-Conner	8	5,136	122	226	90	1.8
3-S. Corvallis	1	4,902	135	272	126	2.0
4-Hubbard	2	7,470	134	326	122	2.4
5-Woodburn	0	5,603	64	249	60	3.9
6-Mollala	2	4,202	80	184	80	2.3
7-Aurora	4	4,902	172	339	161	2.0
Average		5,036	112	253	103	2.4
Conventional soils		3,483	NA	NA	NA	2.8

Table 5. Soil nitrogen mineralization (0 to 8 inches) incubated in the field and laboratory.

Location	Soil total N	Lab incubation Nmin @ 22C	Lab incubation Nmin @ 35C	Field incubation Nmin	Field incubation Nmin rate
	%	--------- % of total soil N ----------			lb N/a/d
1-Gervais	0.13	2.5	5.8	2.6	0.9
2-Dever-Conner	0.22	2.4	4.4	1.8	1.1
3-S. Corvallis	0.21	2.8	5.5	2.6	1.5
4-Hubbard	0.32	1.8	4.4	1.6	1.5
5-Woodburn	0.24	1.1	4.4	1.1	0.7
6-Mollala	0.18	1.9	4.4	1.9	0.9
7-Aurora	0.21	3.5	6.9	3.3	1.9
Average	0.2	2.3	5.1	2.1	1.2

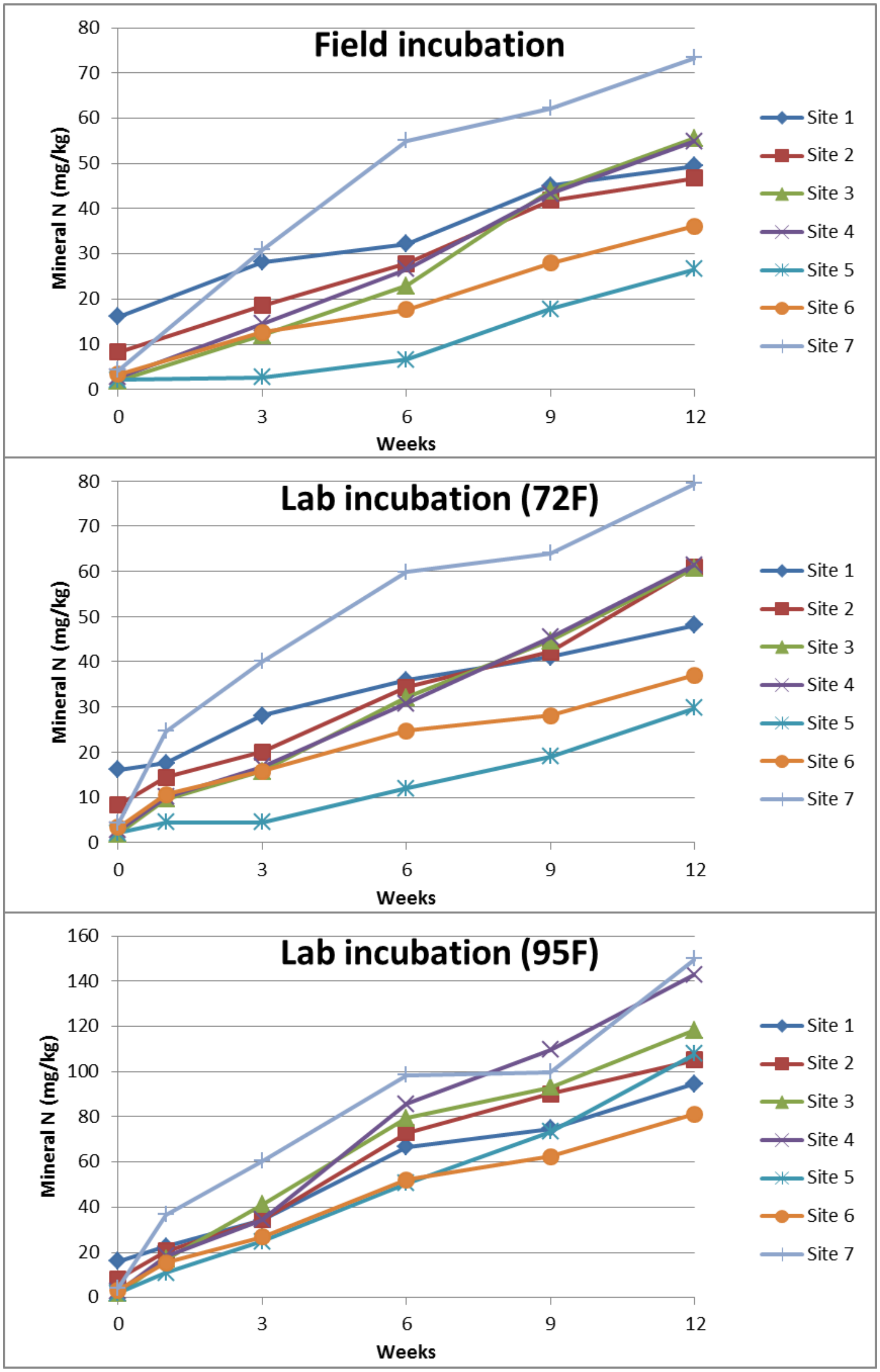

Figure 3. Changes in soil mineral N concentration (NH4-N + NO3-N) during a 12 wk aerobic incubation conducted in the field and the lab. Each point represents the average of 3 or 4 subsamples (not true replicates) for the field and laboratory incubations, respectively.

On-farm Study

Average soil temperatures for the on-farm incubation study are given in Table 6. The average temperature across sites ranged from 69 to 72°F. Temperature was measured at fewer depths than in the research farm incubation and we cannot make comparisons between the two trials.

N mineralization from soil collected at growth stage V4-5 is given in Fig. 4. Unlike in the research farm incubation were mineralization was from soil organic matter only, mineralization in this study is also from spring incorporated vegetation (cover crops and/or weeds) and applied fertilizers. For sites 3, 4, and 5, N was not overly excessive if we assume that N uptake from a sweet corn crop is approximately 140 lb N/acre. Soil nitrate sampling at harvest supports this as there was only 2 to 4 ppm NO3-N present (equivalent to 7 to 14 lb N/acre).

The sites with excessive N were those that applied raw chicken litter preplant incorporated (4 and 6 ton/acre for sites 4 and 7, respectively). At PSNT, there was already more than ample mineral N available to achieve maximum yields. As a result, there was more residual soil N at harvest (Table 7) compared to the other sites. N mineralization data for site 7 suggests that no fertilizer would have been required at this site to achieve maximum yield and product quality (Table 4).

A mass balance approach was used to compared the on-farm field incubation results (wk 9) with estimates of N mineralization from applied fertilizers and cover crops (Table 3) and the field incubation at wk 12 (Table 4). Results of this mass balance are given in table 8. They are surprisingly close given the assumptions used to estimate plant available N (PAN) from applied fertilizers. The largest differences were for the sites 4 and 7 that applied chicken litter. This may be the result of assumptions of moisture and nutrient content, which may not reflect the true content and thus resulted in poor estimates of PAN from the applied fertilizer.

Table 6. Soil temperature (average of 2 depths- 4 and 10") averaged over each collection interval. Temperature was recorded every 3 hrs.

Start date	19-Jul	14-Jul	22-Jul	22-Jul	14-Jul
Interval	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**
week	--------------- degrees F ---------------				
Average (0-9)	71	71	70	69	72
0-3	75	75	74	74	76
3-6	72	72	70	70	73
6-9	64	67	64	63	66

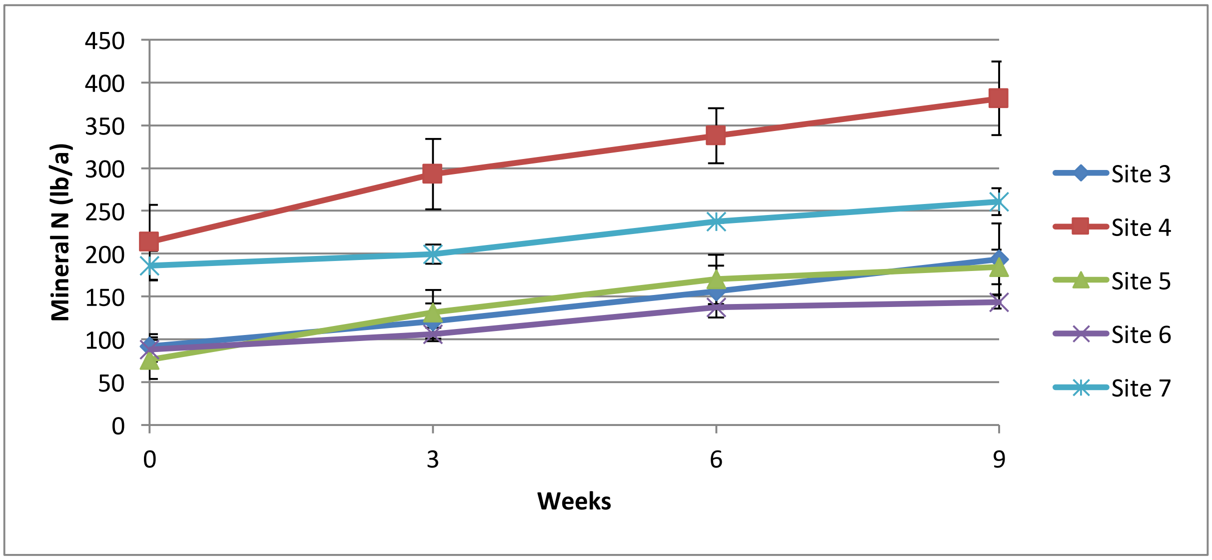

Figure 4. N mineralization from soil collected (0-12”) at V4-5 and incubated in the field. In this study, mineralization is from soil organic matter, spring incorporated cover crops and/or weeds, and applied fertilizer. Error bars represent the SE (n=3).

Table 7. Soil nitrate

Site-location	Early spring	At-planting	PSNT (V4-5)	Pre-harvest
	------------	NO3-N (mg/kg)	-----------	
3-S. Corvallis	1	4	23	4
4-Hubbard	2	47	55	11
5-Woodburn	0	7	18	2
6-Mollala	2	4	23	4
7-Aurora	4	55	52	20

Table 8. Mass balance of potentially plant available nitrogen (PAN) based on soil incubations and estimates of N release from sampled cover crops and applied fertilizer compared to measured PAN from on-farm soil incubation.

Site-location	Soil Nmin (0-8")[1]	Fertilizer PAN[2]	Cover crop PAN[3]	Estimated total PAN	Measured PAN (0-12")[4]
	--------------------------		lb N/acre		-----------------------
3-S. Corvallis	126	48	NM	174	194
4-Hubbard	122	140	NA	262	381
5-Woodburn	60	75	3	138	185
6-Mollala	80	65	15	160	144
7-Aurora	161	184	NA	345	261

1- from table 4; 2- from table 3; 3- estimated based on cover crop sampling and OSU's Cover Crop calculator; 4- from Fig. 4 wk 9.

4. BUDGET DETAILS

Expenses		Year 1
Salary:	OSU Faculty (Dan Sullivan)	2746
Benefits:	OPE (49%)	1263
Salary:	Faculty research assistant	8000
Benefits:	OPE (61.6%)	5280
Wage:	Graduate research assistant ($12/hr for 320 hrs)	3840
Benefits:	OPE (8%)	141
Equipment:		0
Supplies:	Nitrate test strips, bags, lab supplies	500
Travel:	To and from field sites	600
Other:	Complete soil analysis (10*$25/sample)	250
	Nitrate and ammonium analysis (200*$7/sample)	1400
	Total:	**$24,020**