## Nitrogen management for diverse organic vegetable farms

Nick Andrews OSU Small Farms Extension Dan Sullivan OSU Soil Scientist



SARE

Oregon State

**Extension Service** 

#### A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

	Steps	Information source			
1	General crop nitrogen recommendation	University nutrient management guides			

# **Crop N requirement**

Table 1. Nitrogen requirement of vegetable crops based on seasonal nitrogen uptake

Low Total N Need <120 lb/acre	Medium Total N Need <120-200 lb/acre	High Total N Need >200 lb/acre				
Baby greens Carrot		Broccoli				
Beans	Corn, Sweet	Cabbage				
Cucumbers	Garlic	Cauliflower				
Radish	Lettuce	Celery				
Spinach	Melons	Potato				
Squashes	Onion					
	Peppers					
	Tomatoes					
— Gaskell et al. 2006, Soil Fertility Management for						

organic crops

#### A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

	Steps	Information source			
1	General crop nitrogen recommendation	University nutrient management guides			
2	Cover crop nitrogen contribution	OSU Organic Fertilizer & Cover Crop Calculator			

## Cover crop sampling







- 1. Mix sample to break up large plants and remove soil
- Record fresh weight of field sample (x.xlb)
- 3. Package to avoid wilting or molding



# Submit fresh sample to lab

# % dry matter total % N analysis

## Ask lab to dry and grind whole sample

## **Cover Crop PAN**

1	A	В	С	D	E	F	G	Н	I	J
1	ENTER YOUR CO	OVER (	CROP INFO	RMATIC	ON FRO	M THE	FIELD	AND TH	IE LAB	
2	Enter your information in yellow cells. Results are in green cells.									
3	OREGON TILLTH ® DISU Oregon State UNIVERSITY Extension Service	Area sampled (ft <sup>2</sup> )	Fraction of acre sampled	Fresh weight of field sample (x.x lb)	% N from lab (x.x%)	% dry matter from lab (xx.x%)	fresh weight (lbs/A)	Total dry weight (lb/A)	Total N (lb/A)	PAN (lb/A)
4	COVER CROPS									
5	Common vetch	16	0.000367	8.0	3.5	22.0	21780	4792	168	79
6	Rye vetch	16	0.000367	8.0	2.5	22.0	21780	4792	120	38
7	Common vetch (seed only)	16	0.000367	8.0	3.5	22.0	21780	4792	168	79
8	Comments to:	nick.and	rews@oregor	nstate.edu						
- + - )	Fertilizer Analysis Cover Crop Analysis Your Costs / Cost Comparisons / Nutrients Provided / 💭 🛛 🖛 📖									





#### A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

	Steps	Information source
1	General crop nitrogen recommendation	University nutrient management guides
2	Cover crop nitrogen contribution	OSU Organic Fertilizer & Cover Crop Calculator
3	Additional soil organic matter contribution	Estimate from previous soil building practices

## Cumulative PAN from an organic source



Courtesy of Dan Sullivan OSU Crop & Soil Science

# Does total soil organic matter correlate with N mineralized from soil OM?



# PAN from soil organic matter

- Make pre-plant estimate based on field/farm history, rotation, etc.
  - Ballpark estimate: after 3 years of organic management with increased organic inputs, PAN from soil organic matter will increase by at least 50 lb N/acre
  - Established organic growers can often credit much more than 50lb N/ac from soil N mineralization
- Monitor soil nitrate in growing season (PSNT timing) and crop performance
- Monitor postharvest soil nitrate
- Adjust N mineralization credit for future years

#### A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

	Steps	Information source
1	General crop nitrogen recommendation	University nutrient management guides
2	Cover crop nitrogen contribution	OSU Organic Fertilizer & Cover Crop Calculator
3	Additional soil organic matter contribution	Estimate from previous soil building practices
4	Site specific nitrogen recommendation	Line 1 – line 2 – line 3
5	Fertilizer PAN	OSU Organic Fertilizer & Cover Crop Calculator

## **Nutrients Provided**

4	A	В	С	D	E	F	G	Н
1	<b>COMPARE THE NUTR</b>	IENT VA	LUE C	F DIF	FERENI	FERTI	LIZER	lS, CO
2	Enter your information	in yellow	cells. R	esults a	re in gre	en cells.		
		APP'N			0			
3	MATERIAL	RATE				POUN	DS OF	EACH
4	OREGON TILTH Source State UNIVERSITY Extension Service	App'n rate "as-is" basis (lb/ac)	Total N applied (lb/ac)	Total dry matter applied (lb/ac)	Estimated PAN after 28 days (lb/ac)	Estimated PAN after full season (lb/ac)	P <sub>2</sub> O <sub>5</sub> (lb/ac)	K2O (lb/ac)
14	Sulfate of potash (0-0-50)		0	0	0	0	0	0
15	Sulfate of potash magnesia (0-0-22)		0	0	0	0	0	0
16	New fertilizer (5-3-3)		0	0	0	0	0	0
17	0		0	0	0	0	0	0
18	SYNTHETIC FERTILIZERS	2						
19	Triple super phosphate (0-40-0)		0	N/A	0	0	0	0
20	Urea (46-0-0)		0	N/A	0	0	0	0
21	0		0	N/A	0	0	0	0
22	0		0	N/A	0	0	0	0
23	COMPOST							
24	Composted manure (1.5-0.5-0.5)		0	0	0	0	0	0
25	0		0	0	0	0	0	0
26	0		0	0	0	0	0	0
27	COVER CROP FIELD			N 200		K		
28	Common vetch	21780	168	4792		79	)	
Comn	non vetch							
Rye v	etch		168	4792	0	79	0	0
Comn	non vetch (seed only)							
32	Fertilizer recommendation			1		100	50	50
33	Tertifizer recommendation					100	50	50
34	Balance		169	4702	0	21	50	50
25	Datadee		108	4792	0	-21	-30	-30
14 4 1	Fertilizer Analysis Cover Cro	p Analysis	Your Costs	Cost Con	nparisons N	utrients Prov	vided 🥂	]/

## **Nutrients Provided**

A	В	С	D	E	F	G	Н
<b>COMPARE THE NUTR</b>	IENT VA	LUE C	<b>OF DIF</b>	FERENT	FERTI	LIZER	<i>co, co</i>
Enter your information	in yellow	cells. R	esults a	re in gre	en cells.		
	APP'N						
MATERIAL	RATE				POUN	DS OF	EACH
OREGON     Oregon State       UNIVERSITY     Extension Service	App'n rate "as-is" basis (lb/ac)	Total N applied (lb/ac)	Total dry matter applied (lb/ac)	Estimated PAN after 28 days (lb/ac)	Estimated PAN after full season (lb/ac)	P2O5 (lb/ac)	K <sub>2</sub> O (lb/ac)
ORGANIC FERTILIZERS							
Blood meal (12.5-1.5-0.6)		0	0	0	0	0	0
Bone meal (3-20-0.5)		0	0	0	0	0	0
Chicken manure - dried (3.5-2-2)	2500	88	2125	28	41	50	50
Feather meal (granulated) (13-0-0)		0	0	0	0	0	0
Fish meal (10-6-2)		0	0	0	0	0	0
Meat and bone meal (7-8-0)		0	0	0	0	0	0
Muriate of potash (KCl) (0-0-60)		0	0	0	0	0	0
Soy meal (6.5-1.5-2.4)		0	0	0	0	0	0
Sulfate of potash (0-0-50)		0	0	0	0	0	0
Sulfate of potash magnesia (0-0-22)		0	0	0	0	0	0
New fertilizer (5-3-3)		0	0	0	0	0	0
0		0	0	0	0	0	0
COVER CROP FIELD						8	
Common vetch	21780	168	4792		79		
Total applied		255	6917	28	120	50	50
Fertilizer recommendation					100	50	50
Balance		255	6017	28	20	0	0
		255	0917	20	20	0	
Eertilizer Analysis	n Analysis	Cour Coste	Cost Cor	narisons N	utrients Prov	vided 🖉	17
	A COMPARE THE NUTR Enter your information is MATERIAL WATERIAL WOSSU OSSU DES	A   B     COMPARE THE NUTRIENT VA     Enter your information in yellow     MATERIAL   APP'N RATE     Image: Colspan="2">Image: Colspan="2">APP'N RATE     Image: Colspa	ABCCOMPARE THE NUTRIENT VA LUE OEnter your information in yellowcells. RMATERIALAPP'N RATEFormationImage: Colspan="2">Image: Colspan="2">Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan="2"Colspan	ABCDCOMPARE THE NUTRIENT VALUE OF DIFEnter your information ir yellowcells. Results aAPP'N RATEAPP'N RATETotal N applied (lb/ac)Total dry matter applied (lb/ac)MATERIALApp'n rate "as-is" basis (lb/ac)Total N applied (lb/ac)Total dry matter applied (lb/ac)ORGANIC FERTILIZERSImage: Colspan="2">Image: Colspan="2"ORGANIC FERTILIZERSImage: Colspan="2"Image: Colspan="2"Image: Colspan="2"Blood meal (12.5-1.5-0.6)000Bone meal (3-20-0.5)000Meat and bone meal (7-8-0)000Muriate of potash (KCl) (0-0-60)000Symmetry (13.0-0)000Symmetry (13.0-0)000Symmetry (16.5-1.5-2.4)00Symmetry (16.5-1.5-2.4)00Out00Symmetry (12.6-3.3)0<	ABCDECOMPARE THE NUTRIENT VALUE OF DIFFERENTEnter your information in yellowcells. Results are in greMATERIALAPP'N RATEFortal N app'n rate "as-is" basis (b/ac)Total N applied (b/ac)Total dry matter applied (b/ac)Estimated PAN after 28 days (b/ac)ORGANIC FERTILIZERSApp'n rate "as-is" basis (b/ac)Total N applied (b/ac)Total M applied (b/ac)Estimated PAN after 28 days (b/ac)ORGANIC FERTILIZERSO000Blood meal (12.5-1.5-0.6)0000Bone meal (3.20-0.5)0000Chicken maure - dried (3.5-2.2)250088212528Feather meal (granulated) (13-0.0)0000Nutriate of potash (KCI) (0-0.60)0000Soy meal (6.5-1.5-2.4)0000Sulfate of potash (0-0.50)0000Sulfate of potash magnesia (0-0.22)000New fertilizer (5-3-3)0000OCOVER CROP FIELD217801684792Common vetch217801684792Fertilizer recommendation255691728Fertilizer recommendation255691728HFertilizer AnalysisCover Crop AnalysisYour CostsCost Cover Cost cost cost cost cost cost cost cost c	ABCDEFCOMPARE THE NUTRIENT VALUE OF DIFFERENT FERITIEnter your information in yellowcells. Results are in green cells.MATERIALAPP'N RATEAPP'N appliedFotal ary matter applied (b/ac)Estimated PAN after full season (b/ac)MATERIALApp'n rate ras-is" basis (b/ac)Total N applied (b/ac)Total dry matter applied (b/ac)Estimated PAN after full season (b/ac)ORGANIC FERTILIZERSEBlood meal (12.5-15-0.6)00000Bone meal (3-20.0.5)00000Chicken manue - dried (3.5-2-2)25008821252841Feather meal (granulated) (13-0-0)00000Muriate of potash (CCI) (0-0-60)00000Sulfate of potash (0-0-50)000000Sulfate of potash (0-0-50)111111Growten of th	ABCDEFGCOMPARE THE NUTRIENT VALUE OF DIFFERENT FERTILIZEREnter your information in yellowcells. Results are in green cells.MATERIALAPP'N RATEFOUNDS OFImage: Colspan="4">Organization in yellowcells. Results are in green cells.Image: Colspan="4">POUNDS OFImage: Colspan="4">Organization in yellowColspan="4">Colspan="4">POUNDS OFImage: Colspan="4">Organization in yellowColspan="4">Colspan=

## Fertilizer N Mineralization



Specialty Products include						
Fish meals	Alfalfa meal	Fish bone meal				
Soybean meal	Blood meal	Meat & bone meal				
Corn gluten meal	Kelp meal	Bone meal				
Feather meal	Sol. Seaweed Extract	Seabird guano				

#### A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

	Steps	Information source
1	General crop nitrogen recommendation	University nutrient management guides
2	Cover crop nitrogen contribution	OSU Organic Fertilizer & Cover Crop Calculator
3	Additional soil organic matter contribution	Estimate from previous soil building practices
4	Site specific nitrogen recommendation	Line 1 – line 2 – line 3
5	Fertilizer PAN estimate and fertilizer application rate	OSU Organic Fertilizer & Cover Crop Calculator
6	Adjust nitrogen rates based on monitoring	Soil tests and observations of crop performance



David Brown, Mustard Seed Farms 80 ac organic fresh vegetables

"This project helps me evaluate my cover cropping program"

"This year I reduced my fertilizer bill about 60% by working with Nick and Dan and still got great yields"

Scott Latham, Sauvie Island Organics 20 ac organic fresh vegetables, 400 CSA members, 25 restaurants

"We didn't give our cover crops enough N-credit. The Calculator showed us we were getting twice the N we thought. Now, no N is applied to our head lettuce, we get the same yield and save \$275/ac on fertilizer."

"We invest our savings in additional N to our broccoli field and get higher broccoli yields."



## Cover crop PAN: PNW 636



Figure 4. Effect of kill date on typical plant-available N (PAN) release from cereal, legume, or mixed stands. Based on compilation of field data from Willamette Valley cover crop trials. Figure from PNW 636, Estimating Plant-available Nitrogen Release from Cover Crops (Sullivan and Andrews, 2012), ©Oregon State University. Used by permission.

## PAN from tops vs. roots

Legume cover crop	<b>C:N</b>	ratio	Total N addition (lb/ac)		
	Тор	Top Root		Root	
Austrian winter pea (1992)	14	28	76	13	
Austrian winter pea (1993)	10	24	35	13	
Hairy vetch (1992)	23	30	99	8	
Hairy vetch (1993)	10	29	120	8	

Adapted from: Kuo et al. (1997) SSSAJ 61:1392-1399.

Mineralization / immobilization tipping point  $\approx$  20-24 C/N