WSARE Project FW09-328 Appendix 2

Figures and Tables

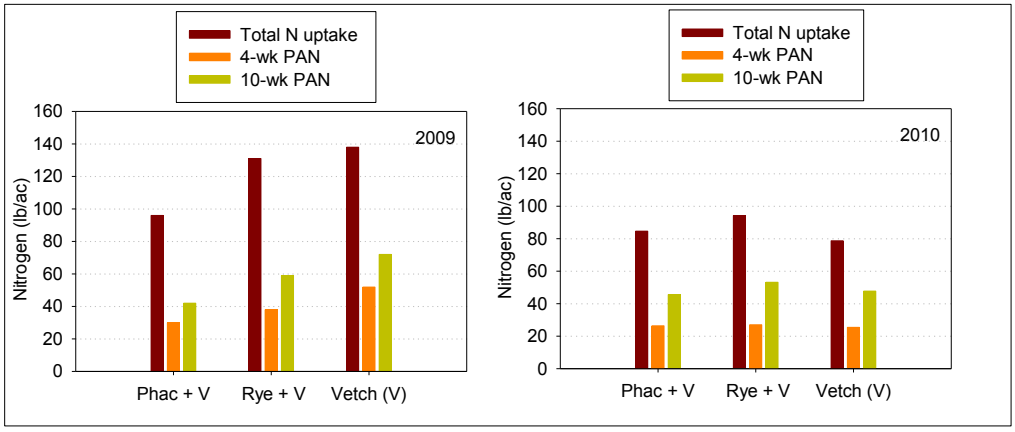

Figure 1. 2009 and 2010 cover crop N uptake ranged from 80 to 140 lb N/acre when vetch-dominated cover crop mixtures were killed at vegetative growth stage in mid-April in the N. Willamette Valley (left). Plant-available N (PAN) ranged from 40 to 70 lb/acre (right). Values shown are the average of 4 field experiments in 2009 and 3 experiments in 2010.

2009 Figures and Tables

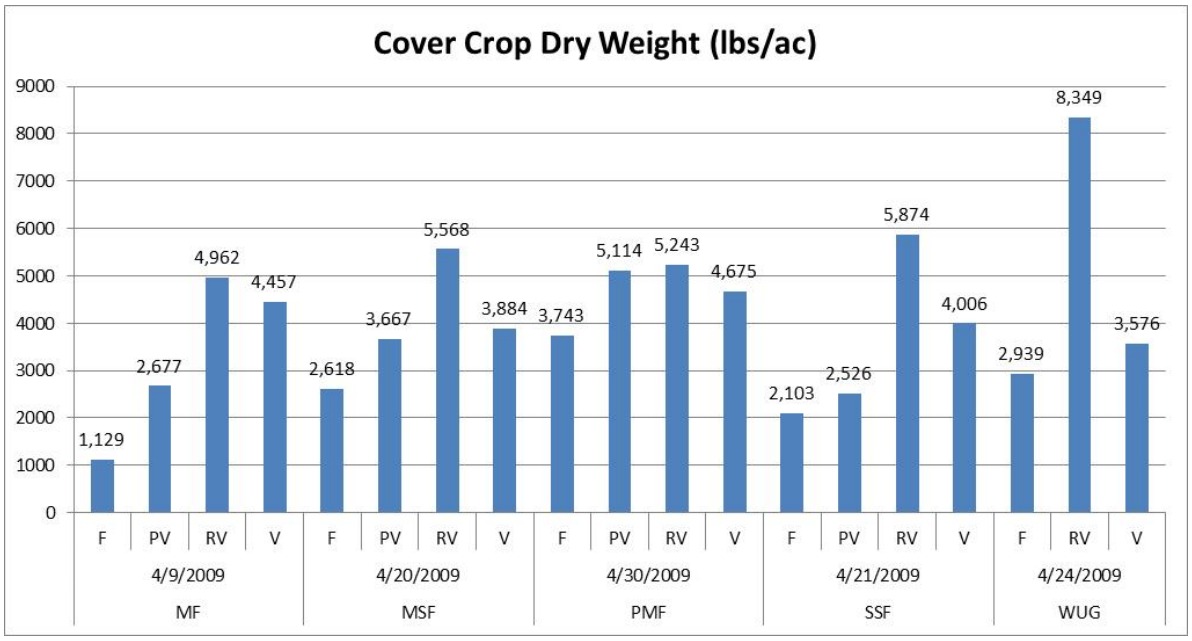

Figure 2. 2009 cover crop dry weight was higher in cover crop plots than fallow plots (F), with rye-vetch (RV) plots normally having the most biomass, followed by vetch (V), then phacelia-vetch (PV).

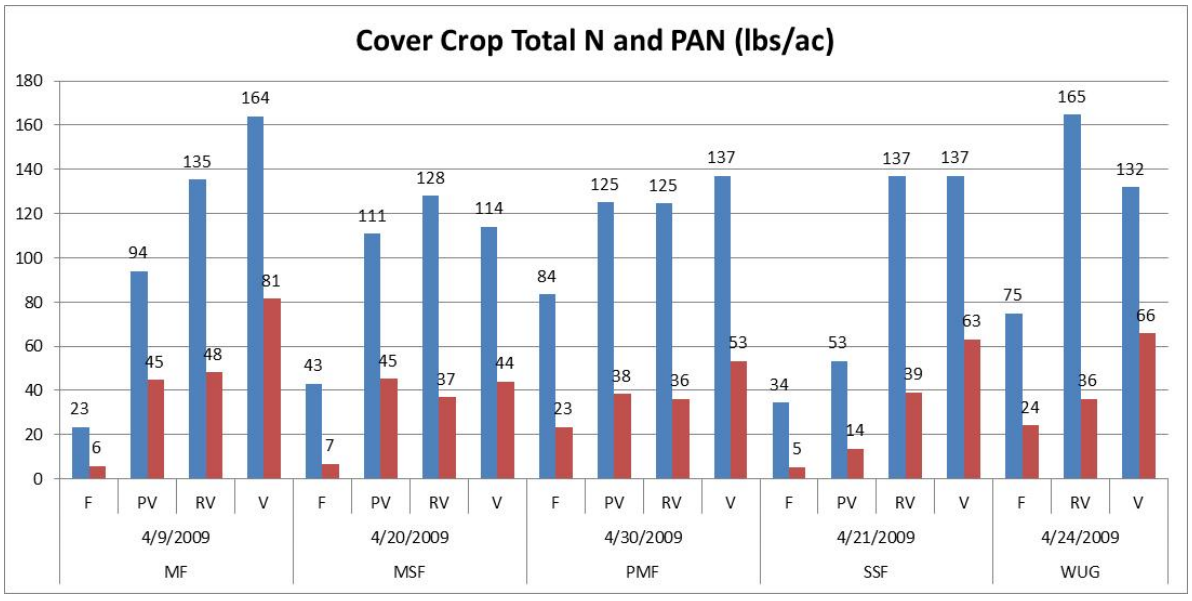

Figure 3. 2009 cover crop total N and estimated PAN (using Vigil & Kissel equation) was higher in cover crop plots than fallow plots (F). At most sites vetch (V) and rye-vetch (RV) had the highest total N, and vetch normally had the highest PAN. Phacelia-vetch (PV) performed well when it didn't winter kill (i.e. MSF and PMF).

2009 Figures and Tables

Table 1. Cover crop biomass, percent N and total N uptake with standard error.

Farm	Cover Crop ID	Cover Crop Biomass		Cover crop N		Cover crop N uptake	
		lb/acre	SE	% N	SE	lb/acre	SE
MF	PV	2671	(389)	3.6	(0.18)	94	(12)
	RV	4951	(574)	2.7	(0.15)	135	(23)
	V	4447	(474)	3.7	(0.06)	164	(20)
MSF	PV	3658	(479)	2.9	(0.26)	111	(24)
	RV	5556	(361)	2.3	(0.24)	128	(18)
	V	3875	(381)	2.9	(0.11)	114	(12)
PMF	PV	5103	(405)	2.4	(0.09)	125	(11)
	RV	5231	(504)	2.3	(0.10)	124	(17)
	V	4664	(378)	2.9	(0.15)	137	(16)
SSF	PV	2520	(346)	2.0	(0.23)	53	(13)
	RV	5861	(286)	2.3	(0.09)	137	(7)
	V	3996	(305)	3.4	(0.13)	137	(13)
WUG	RV	8330	(487)	2.0	(0.03)	164	(9)
	V	3568	(152)	3.7	(0.13)	132	(10)

Table 2. Cover crop laboratory % PAN and lb/ac PAN estimates from 70 day laboratory incubations, and the Vigil Kissel equation (used in the OSU calculator) with standard error.

Farm	Cover Crop ID	70-day lab incubation PAN %		Lab based PAN estimate		VK Eqn based PAN		VK Eqn based PAN estimate	
		% total N	SE	lb PAN/acre	SE	% total N	SE	lb PAN/acre	SE
MF	PV	58	(1)	54	(7)	48	(3)	45	(6)
	RV	51	(3)	71	(15)	34	(2)	48	(12)
	V	52	(3)	87	(14)	49	(1)	81	(11)
MSF	PV	50	(6)	59	(19)	38	(4)	45	(14)
	RV	36	(7)	49	(15)	27	(4)	37	(10)
	V	41	(4)	47	(7)	38	(2)	44	(6)
PMF	PV	33	(3)	40	(3)	31	(2)	38	(4)
	RV	41	(7)	53	(15)	29	(2)	36	(7)
	V	53	(7)	74	(16)	38	(2)	53	(9)
SSF	PV	27	(5)	15	(4)	23	(4)	14	(6)
	RV	44	(3)	61	(0)	29	(1)	39	(3)
	V	58	(8)	81	(16)	46	(2)	63	(8)
WUG	RV	22	(2)	37	(5)	22	(1)	36	(2)
	V	32	(2)	42	(7)	49	(2)	66	(7)

2009 Figures and Tables

Table 3. Percent biomass of cover crop species and weeds in 2009 cover crop plots. Clover weeds from PMF were weighed separately because of their N fixing potential.

		Species mixture (% of cover crop dry mass)				
Farm	Treatment ID	Rye	Phacelia	Vetch	Weeds	Clover weeds (PMF)
MF	PV		0.01	0.90	0.09	
	RV	0.56		0.44	0.01	
	V			0.95	0.05	
MSF	PV		0.07	0.62	0.31	
	RV	0.46		0.40	0.14	
	V			0.59	0.41	
PMF	F				0.64	0.36
	PV		0.34	0.14	0.34	0.19
	RV	0.33		0.09	0.31	0.27
	V			0.22	0.39	0.39
SSF	PV		0.02	0.12	0.85	
	RV	0.66		0.11	0.23	
	V			0.62	0.38	
WUG	RV	0.90		0.05	0.05	
	V			0.56	0.44	

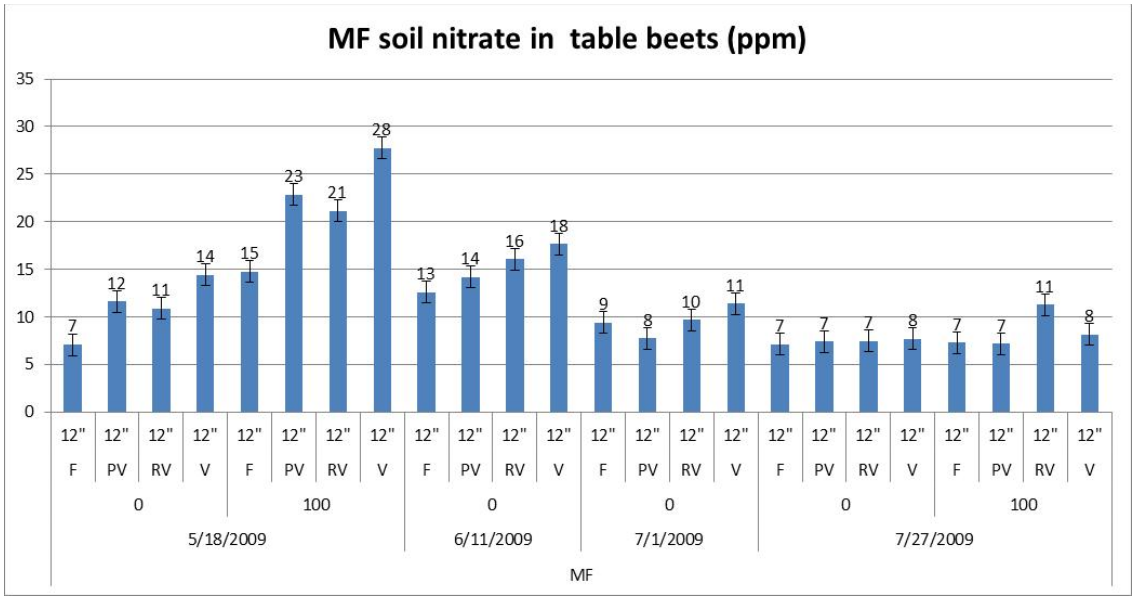

Figure 4. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Background soil nitrate in unfertilized fallow plots was low at MF and PAN released from cover crops appear to have been rapidly taken up by the table beets. The only plots that showed much early season difference between fallow and cover crop soil nitrate levels were the plots fertilized with 100lbs/ac estimated PAN from feather meal (100). Error bars show standard error.

2009 Figures and Tables

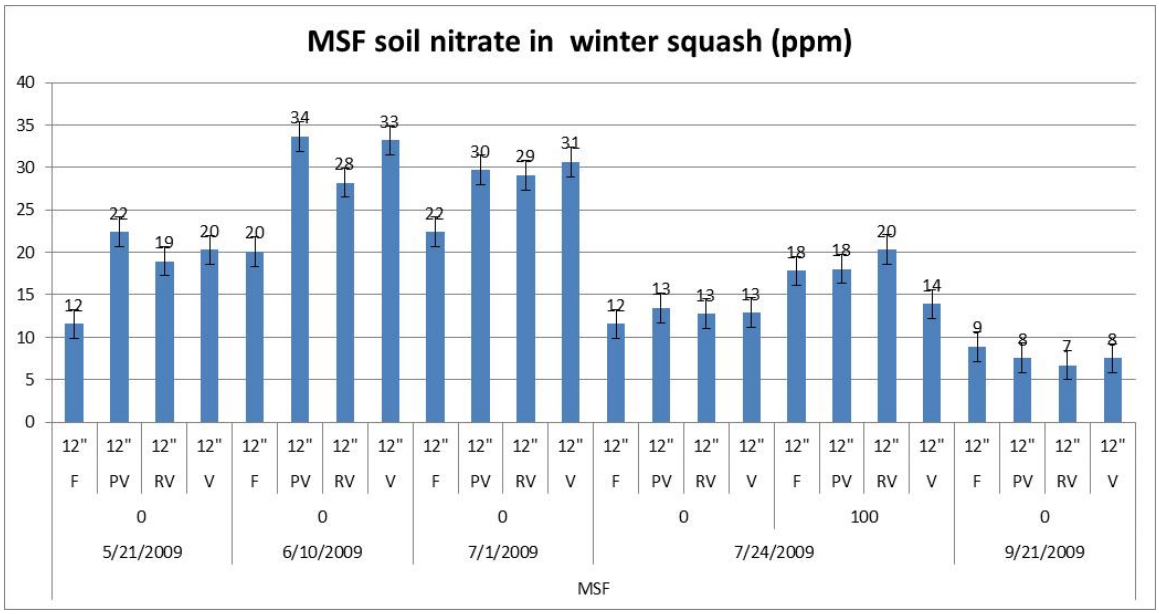

Figure 5. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Unfertilized fallow plots had moderate soil nitrate levels at MSF. Early in the season cover crop plots had higher soil nitrate levels than fallow plots (F). Error bars show standard error.

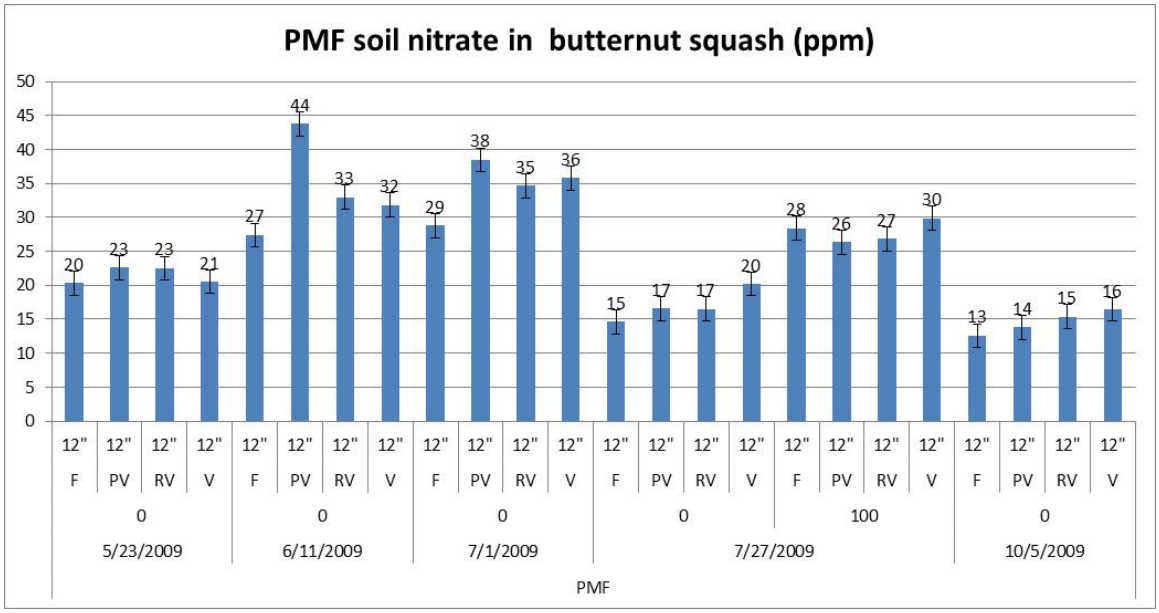

Figure 6. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Fallow soil nitrate levels were modest to high at PMF, but fallow plots (F) had large amounts of volunteer clover. Some differences in soil nitrate levels were apparent early in the season, but not as large as at MSF and SSF where fallow plots supplied little PAN. Error bars show standard error.

2009 Figures and Tables

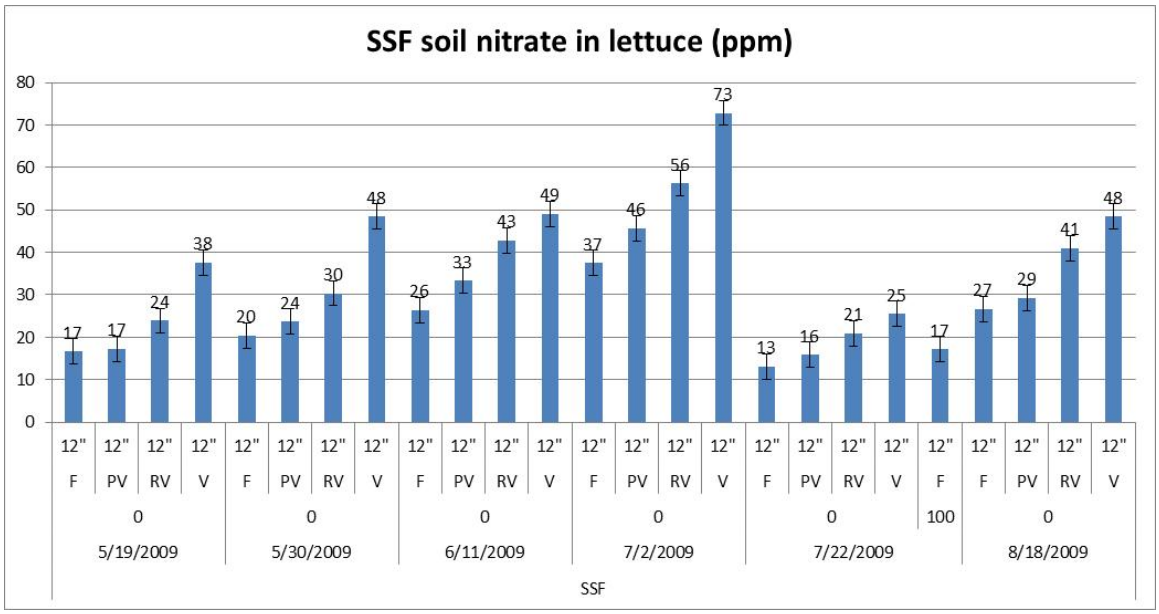

Figure 7. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Soil nitrate levels were modest to high in unfertilized fallow plots at SSF, and phacelia-vetch (PV) performed poorly because P was winterkilled and smothered the vetch. Fallow plots had sufficient N for crop growth, and soil nitrate levels were significantly higher in the plots treated with the other cover crops. These differences lasted all season. Error bars show standard error.

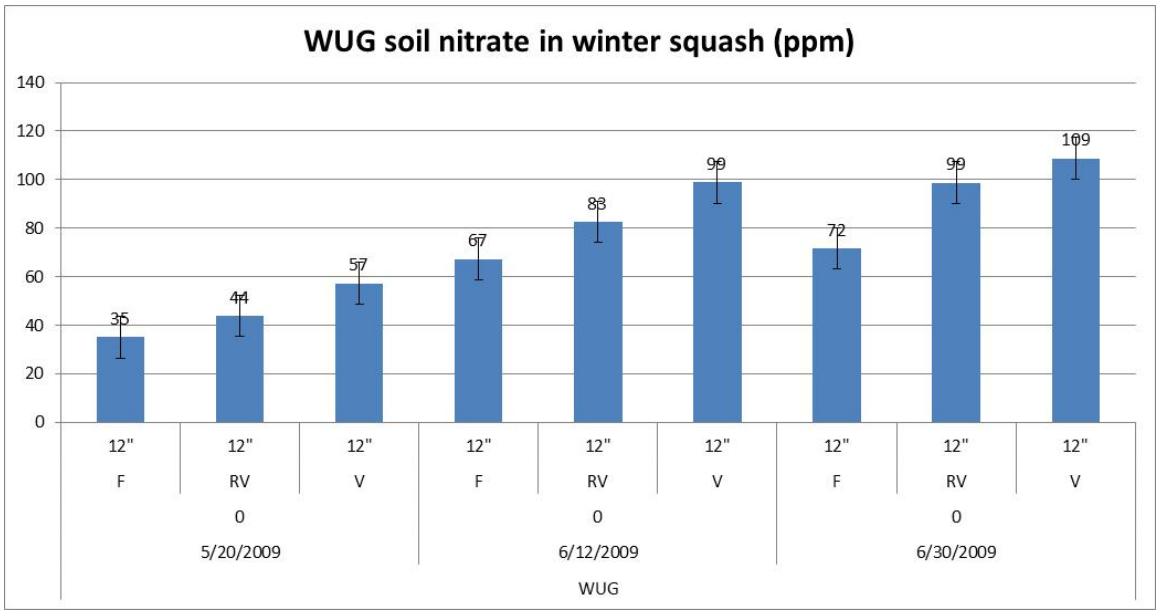

Figure 8. Soil nitrate was very high in unfertilized fallow plots at WUG. Rye-vetch (RV) and vetch (V) cover cropped plots had higher soil nitrate levels. Error bars show standard error.

2009 Figures and Tables

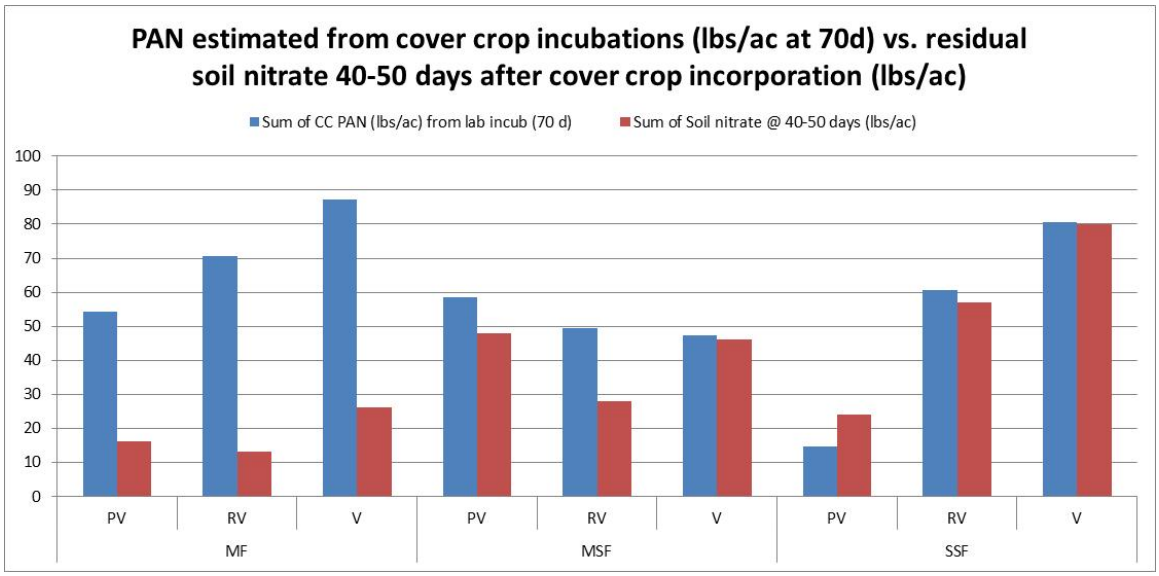

Figure 9. PAN (lbs/ac) from 70 day cover crop laboratory incubations vs. residual soil nitrate 40-50 days after cover crop incorporation. Estimated PAN from plants in the fallow plots was subtracted from the estimated PAN from cover crop plots, and soil nitrate from the fallow plots was subtracted from soil nitrate in the cover crop plots. Soil nitrate in lbs/ac was estimated multiplying ppm x 3.5.

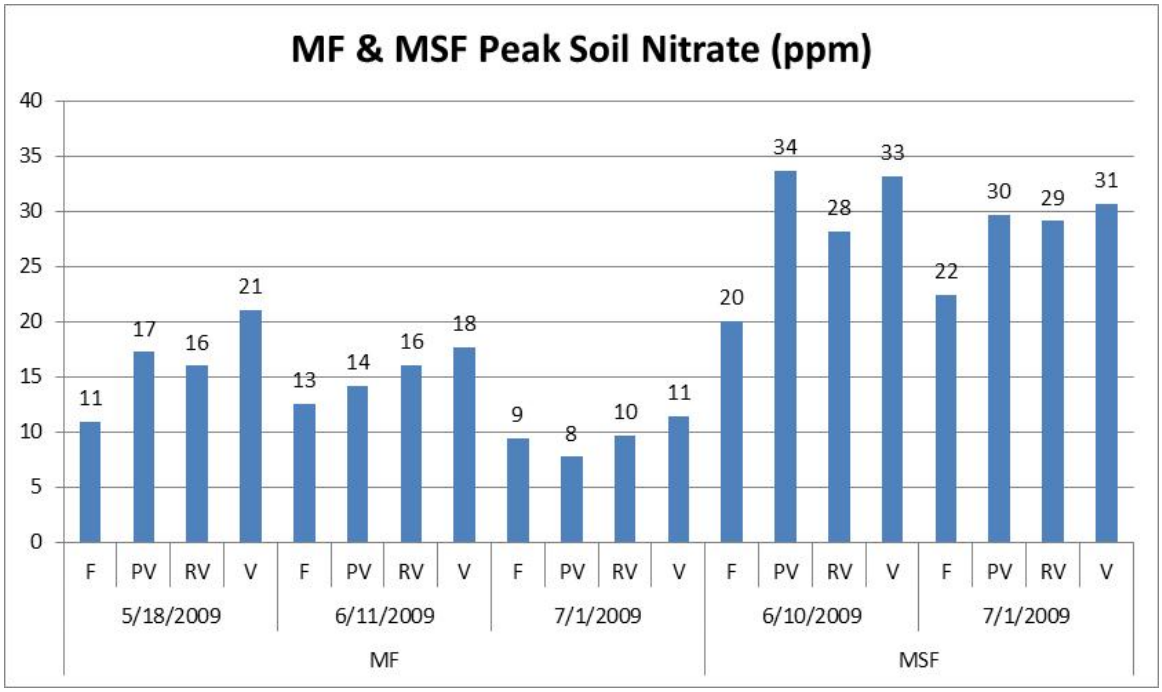

Figure 10. Soil nitrate levels at MF and MSF were the highest during the early summer and these sampling times showed the greatest differences between fallow and cover cropped plots.

2009 Figures and Tables

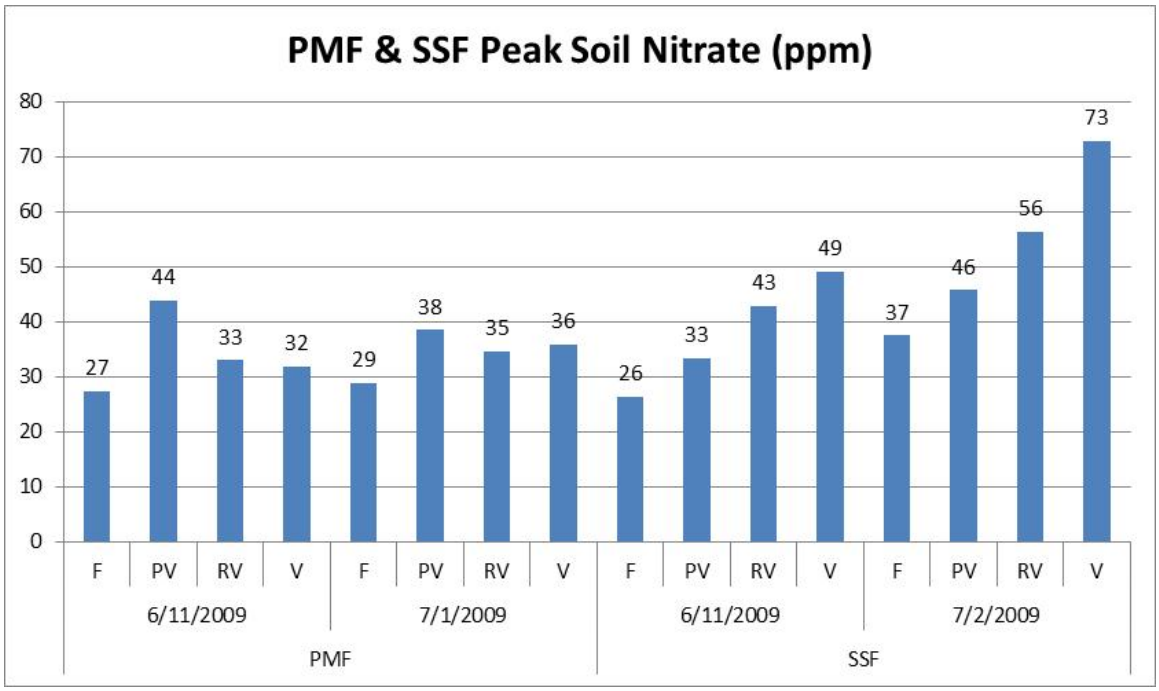

Figure 11. Soil nitrate levels at PMF and SSF were the highest during the early summer and these sampling times showed the greatest differences between fallow and cover cropped plots.

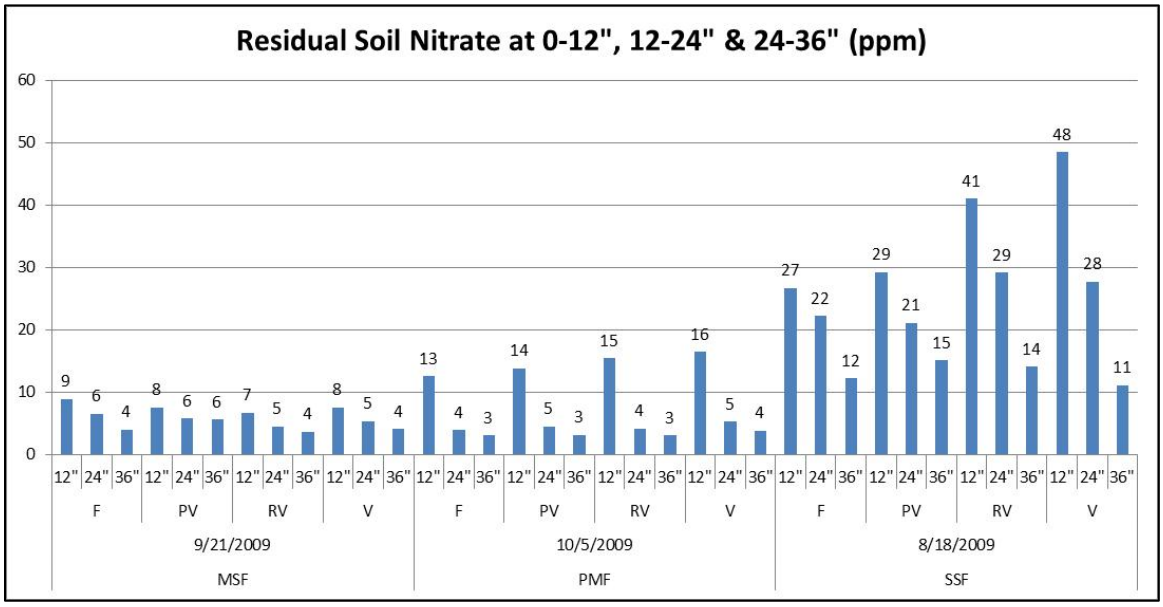

Figure 12. End of season deep soil samples from three farms.

2009 Figures and Tables

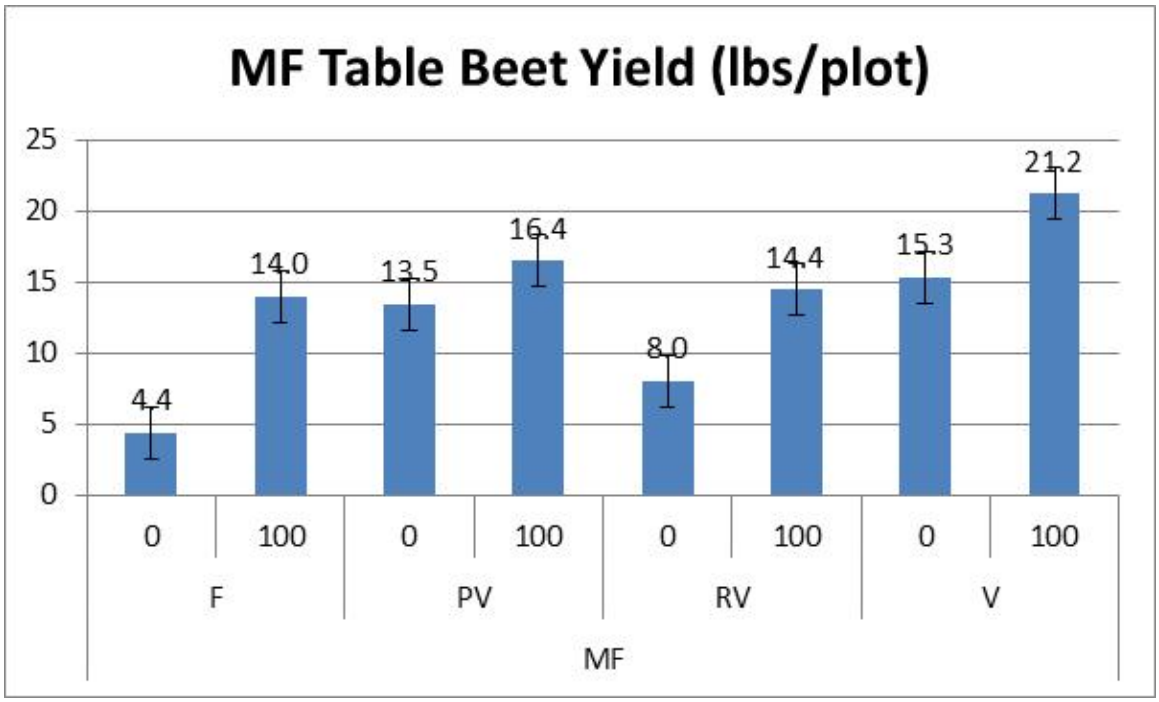

Figure 13. Table beet yield at MF was highest in cover cropped plots that were fertilized with feather meal (100lbs/ac estimated PAN). Error bars show standard error.

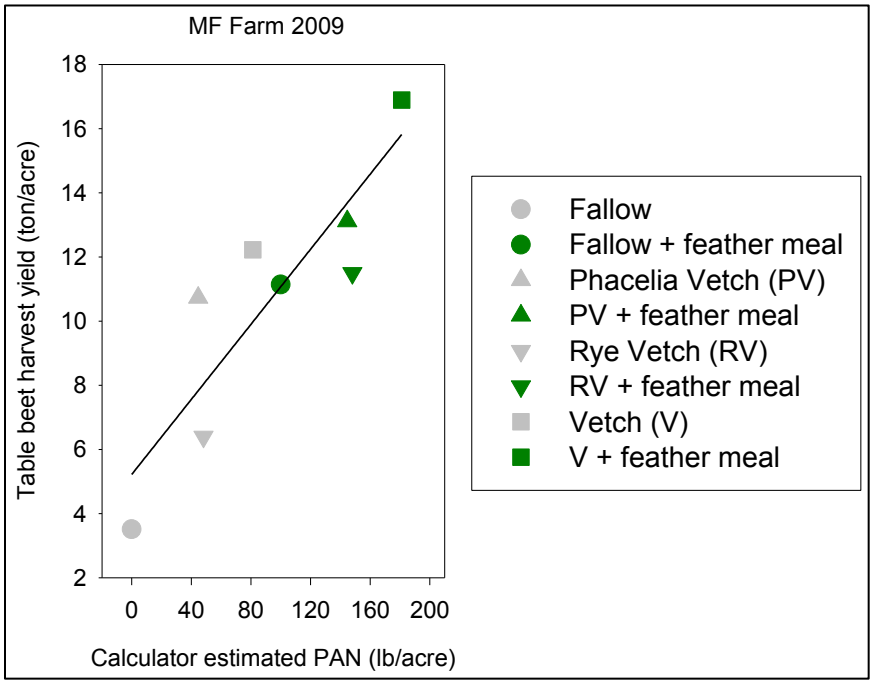

Figure 14. The x-axis shows cumulative estimated PAN from cover crops and feather meal. Unfertilized vetch plots had similar yields to fallow plots fertilized with 100 lbs/ac estimated PAN from feather meal.

2009 Figures and Tables

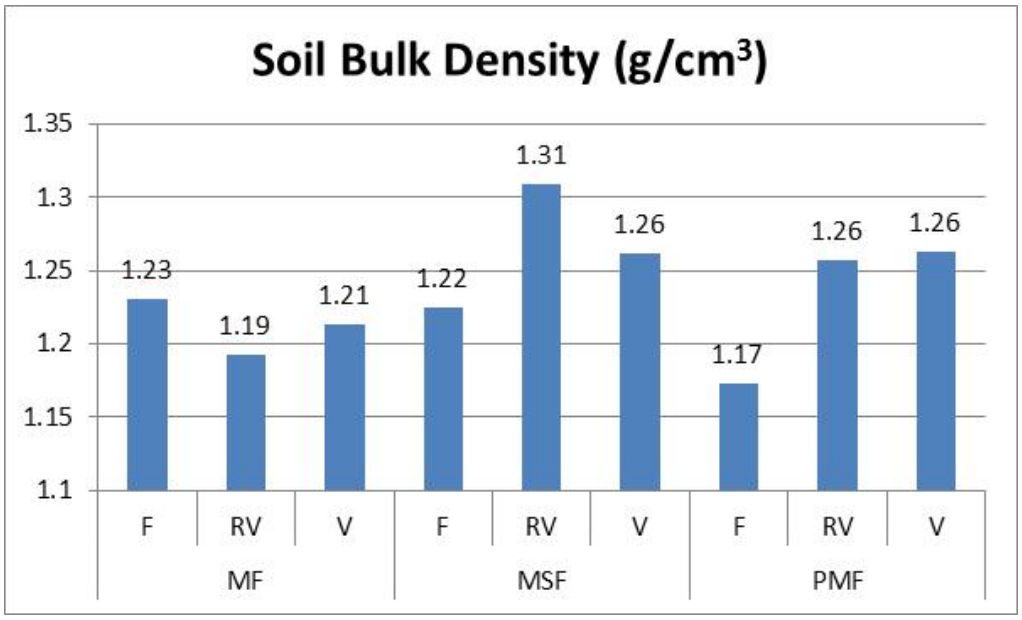

Figure 15. Soil bulk density results were variable and unexpected. Sandy loam soils (MF) were expected to have higher bulk density that silt loam soils (MSF and PMF). Organic matter supplied by cover crops was expected to reduce rather than increase bulk density.

2010 Figures and Tables

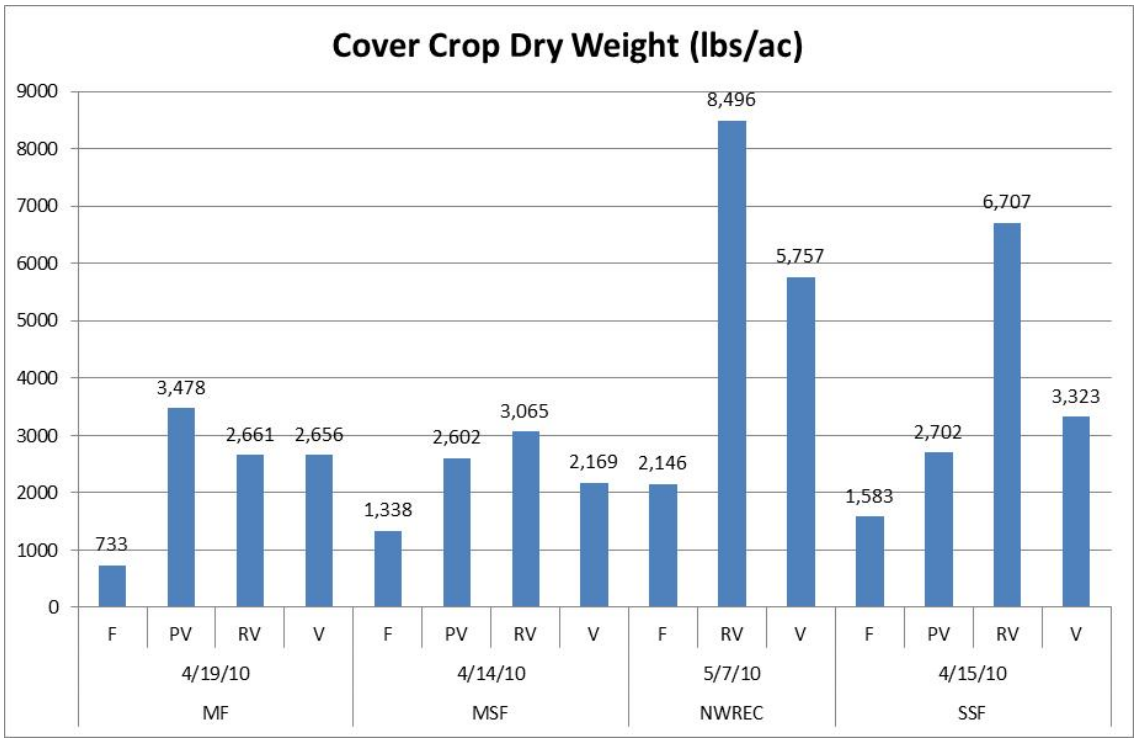

Figure 16. Cover crop dry weight was higher in cover crop plots than fallow plots (F), with rye-vetch (RV) plots having the most biomass, followed by vetch (V) and phacelia-vetch (PV). Cover crop biomass was lower at on-farm plots (MSF, SSF, MF) than in 2009 because fall planting was delayed by late harvests.

Table 4. Statistical analysis of cover crop dry matter (kg/ha) at four farms.

Effect of Cover Crop Treatments on Dry Matter and Nitrogen at Four Locations in 2010					
Cover Crop & Contrasts	Farm				
	MF	MSF	SSF	NWREC	Three loc avg.
	Cover Crop Biomass (kg/ha)				
Fallow	821	1500	1774	2405	1365
Phacelia + Vetch	3897	2916	3027	-	3280
Cereal Rye + Vetch	2982	3434	7516	9520	4644
Common Vetch	2977	2431	3724	6452	3044
LSD (0.05)	745	910	805		
	Significance				
F vs All Cover Crops	**	**	**	**	
V vs RV	NS	*	**	**	
V vs PV	*	NS	NS		
RV vs PV	*	NS	**		

* P < 0.05, ** P < 0.01.

2010 Figures and Tables

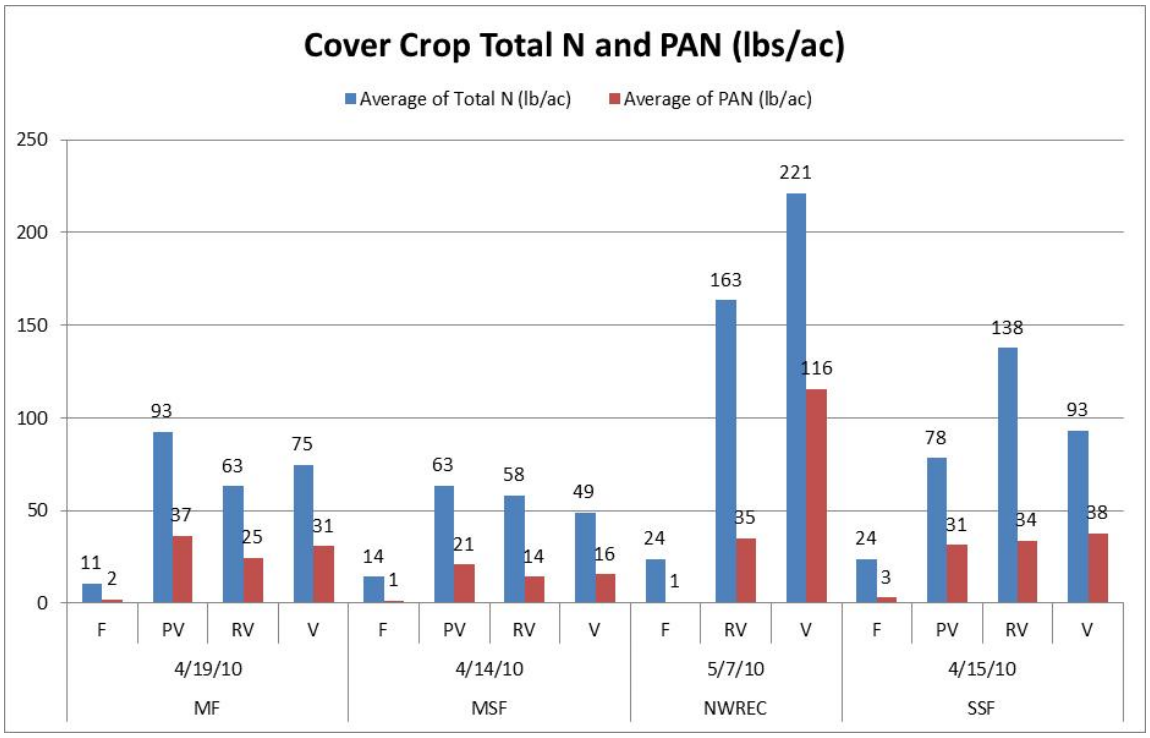

Figure 17. Cover crop total N and estimated PAN (using Vigil & Kissel equation) was higher in cover crop plots than fallow plots (F). At the on-farm sites (MSF, SSF and MF) the cover crops performed similarly, and were generally lower than in 2009 because of late fall planting dates. At the North Willamette Research & Extension Center (NWREC) vetch (V) contained more total N and estimated PAN was higher than rye-vetch (RV).

Table 5. Statistical analysis of cover crop nitrogen content (g/kg) at four farms.

Effect of Cover Crop Treatments on Dry Matter and Nitrogen at Four Locations in 2010					
Cover Crop & Contrasts	Farm				
	MF	MSF	SSF	NWREC	Three loc avg.
	Cover Crop Total N (g/kg)				
Fallow	19	14	15	11	16
Phacelia + Vetch	30	26	30	-	29
Cereal Rye + Vetch	29	21	21	19	24
Common Vetch	31	24	31	38	28
LSD (0.05)	4.7	5.3	2.6	5.1	
	Significance				
F vs All Cover Crops	**	**	**	**	
V vs RV	NS	NS	**	**	
V vs PV	NS	NS	NS		
RV vs PV	NS	NS	**		

* P < 0.05, ** P < 0.01

2010 Figures and Tables

Table 6. Statistical analysis of cover crop nitrogen uptake (kg/ha) at four farms.

Effect of Cover Crop Treatments on Dry Matter and Nitrogen at Four Locations in 2010					
Cover Crop & Contrasts	**Farm**				
	MF	**MSF**	**SSF**	**NWREC**	**Three loc avg.**
	Cover Crop N Uptake (kg/ha)				
Fallow	15	21	27	27	21
Phacelia + Vetch	116	76	92	-	95
Cereal Rye + Vetch	86	72	159	183	106
Common Vetch	92	59	114	248	88
LSD (0.05)	23	21	23		
	Significance				
F vs All Cover Crops	**	**	**	**	
V vs RV	NS	NS	**	*	
V vs PV	*	NS	NS		
RV vs PV	*	NS	**		

* P < 0.05, ** P < 0.01

Table 7. Statistical analysis of cover crop percent PAN at four farms. Results are from laboratory incubations.

Laboratory Incubations of Cover Crop Samples in Soil to Determine PAN in 2010					
Cover Crop & Contrasts	**Farm**				
	MF	**MSF**	**SSF**	**NWREC**	**Three loc avg.**
	PAN (fraction of total N) after 70 days				
Fallow	0.41	0.23	0.17	0.29	0.27
Phacelia + Vetch	0.54	0.64	0.47	-	0.55
Cereal Rye + Vetch	0.59	0.51	0.58	0.51	0.56
Common Vetch	0.62	0.44	0.65	0.47	0.57
LSD (0.05)	0.13	0.20	0.16		
	Significance				
F vs All Cover Crops	*	**	**	*	
V vs RV	NS	NS	NS	NS	
V vs PV	NS	*	*		
RV vs PV	NS	NS	NS		

* P < 0.05, ** P < 0.01

2010 Figures and Tables

Table 8. Statistical analysis of cover crop PAN contribution (kg/ha) at four farms. Results are from laboratory incubations.

Laboratory Incubations of Cover Crop Samples in Soil to Determine PAN in 2010					
Cover Crop & Contrasts	**Farm**				
	MF	**MSF**	**SSF**	**NWREC**	**Three loc avg.**
	Estimated Cover Crop PAN Contribution (kg/ha)*				
Fallow	6	5	4	7	5
Phacelia + Vetch	62	48	43	-	51
Cereal Rye + Vetch	50	37	92	93	60
Common Vetch	57	26	78	119	53
LSD (0.05)	10	14	29		
	Significance				
F vs All Cover Crops	**	**	**	***	
V vs RV	NS	NS	NS	NS	
V vs PV	NS	**	*		
RV vs PV	*	NS	**		
* Calculated as: 70 day PAN x Cover Crop Biomass					

* P < 0.05, ** P < 0.01

Table 9. Percent biomass of cover crop species and weeds in 2010 cover crop plots.

		Species Mixture (% of dry CC biomass)			
Farm	Treatment ID	Rye	Phacelia	Vetch	Weeds
MF	PV	0.34	0.27	0.56	0.17
MF	RV			0.44	0.22
MF	V			0.69	0.31
MSF	PV	0.31	0.13	0.62	0.24
MSF	RV			0.50	0.19
MSF	V			0.52	0.48
NWREC	RV		0.67	0.26	0.07
NWREC	V			0.75	0.25
SSF	PV			0.69	0.31
SSF	RV		0.61	0.20	0.20
SSF	V			0.66	0.34

2010 Figures and Tables

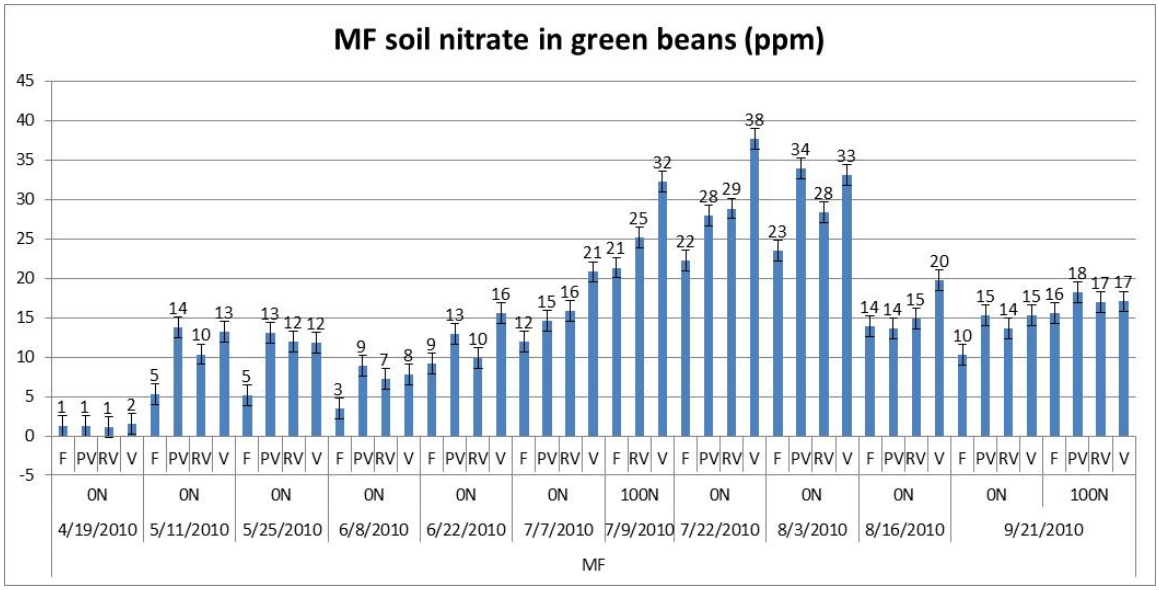

Figure 18. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Soil nitrate levels were higher in cover crop plots than fallow plots. These differences were apparent until harvest in mid-August. Error bars show standard error.

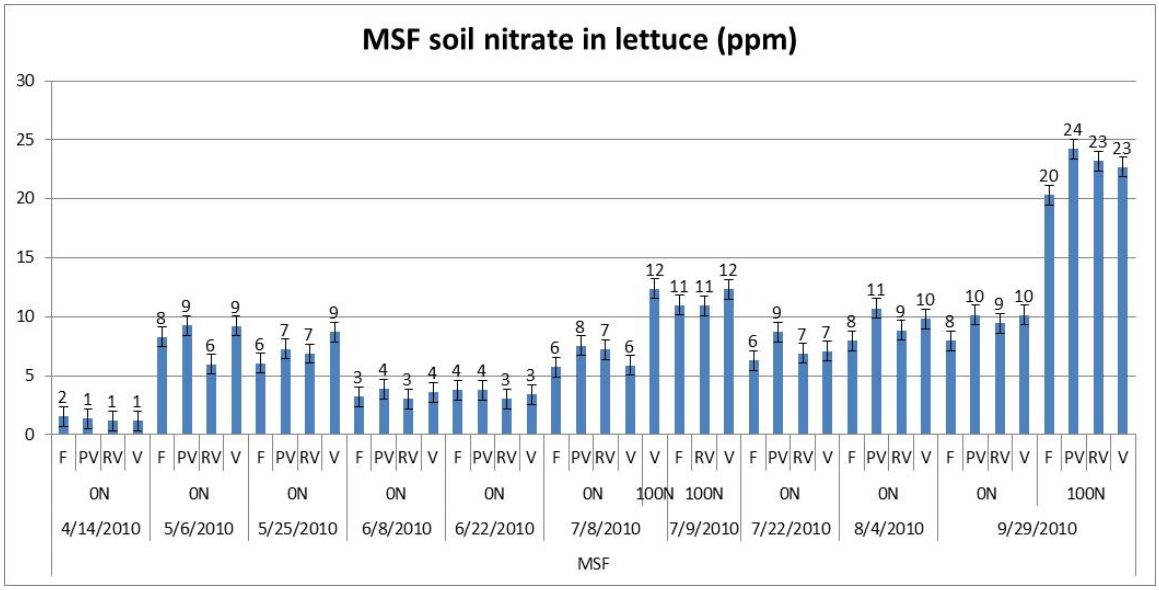

Figure 19. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Cover crop biomasss and N-contributions at MSF were small in 2010. Soil nitrate levels were also low in all plots with no consistent difference between fallow and cover cropped plots. The lettuce appeared to take up N as soon as it was mineralized from cover crop residues. Error bars show standard error.

2010 Figures and Tables

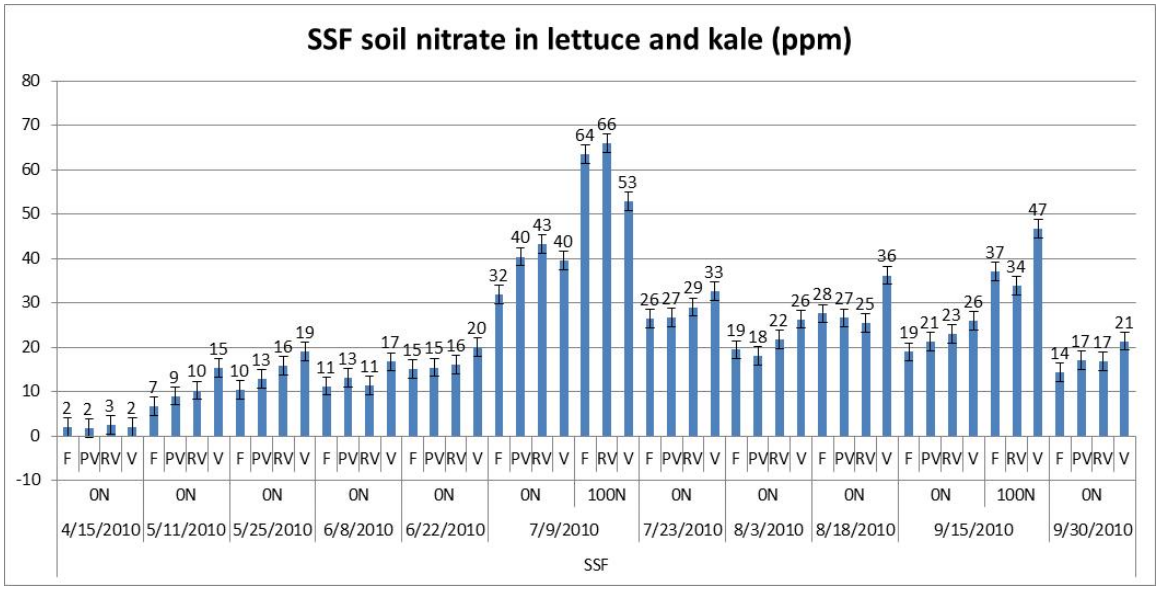

Figure 20. Soil nitrate levels in cover cropped plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). This field was double cropped to lettuce then kale. There were little to no differences in soil nitrate levels between cover crop treatments at most sampling dates except 7/9/10. Error bars show standard error.

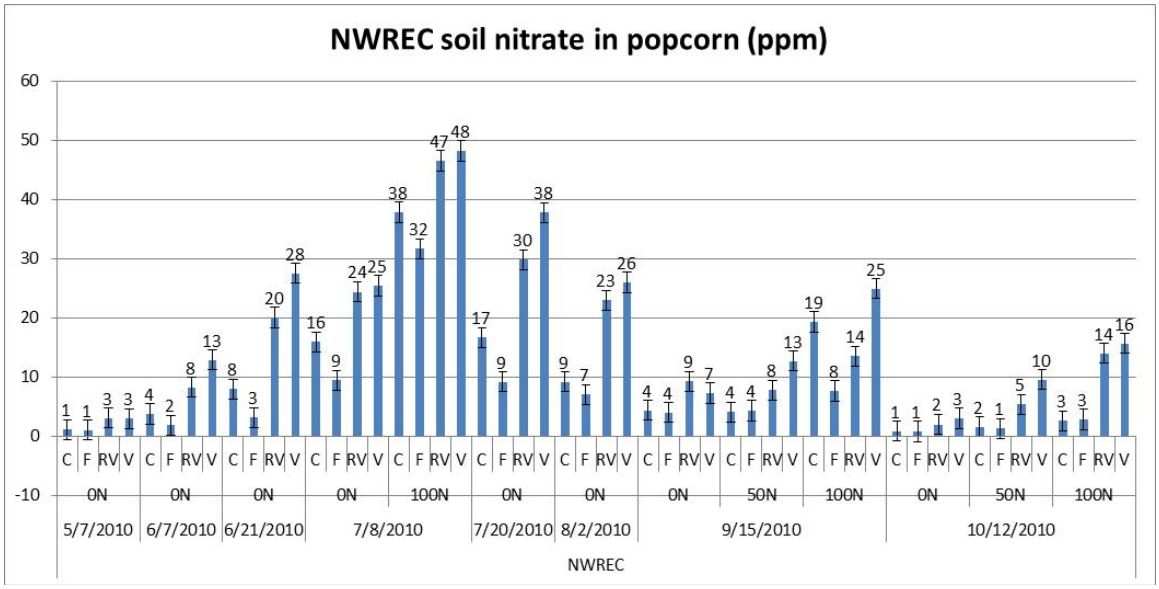

Figure 21. Soil nitrate levels in cover crop and compost plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). In this trial the phacelia-vetch cover crop was replaced by compost (C) with no cover crop. Soil nitrate levels in compost treated plots were higher than in fallow plots until early August. The cover cropped plots had higher soil nitrate than the compost plots, with higher nitrate levels at the V plots than the RV plots at most sampling dates. Error bars show standard error.

2010 Figures and Tables

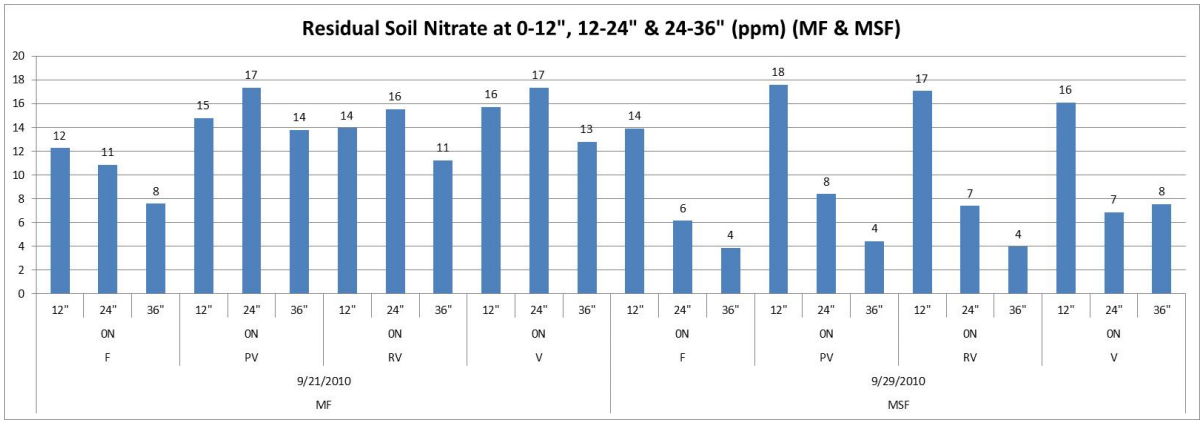

Figure 22. End of season deep soil samples from MF and MSF.

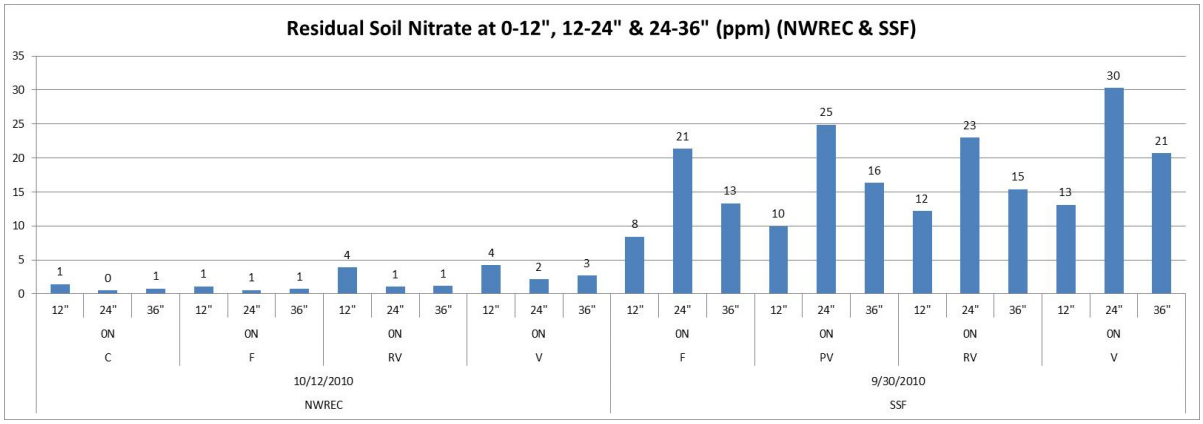

Figure 23. End of season deep soil samples from NWREC and SSF.

2010 Figures and Tables

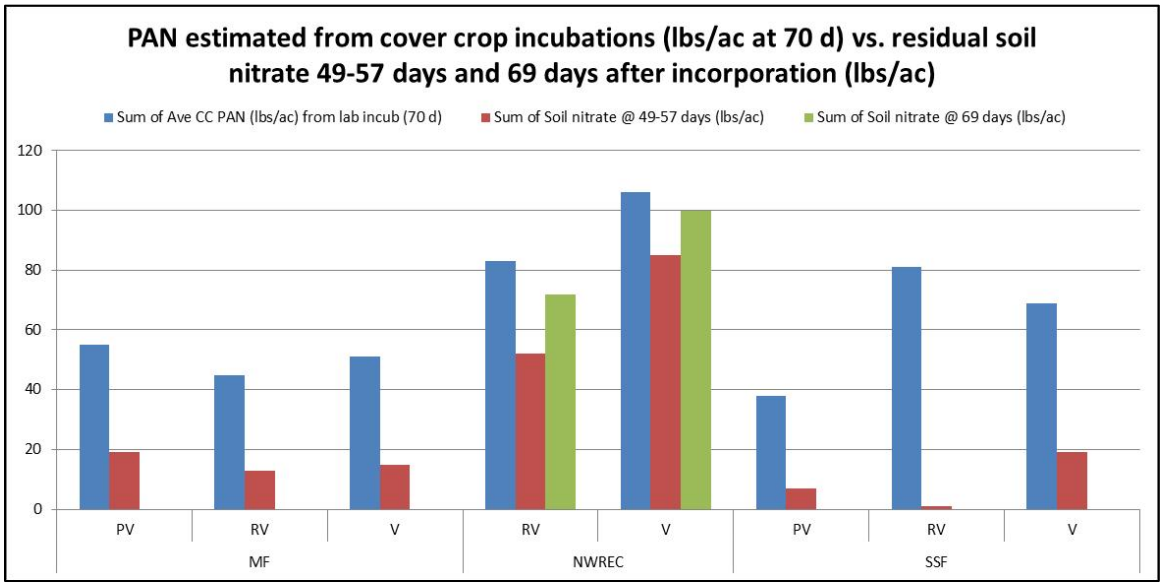

Figure 24. PAN (lbs/ac) from 70 day cover crop laboratory incubations vs. residual soil nitrate 49-57 days (and 69 days at NWREC) after cover crop incorporation. Estimated PAN from plants in the fallow plots was subtracted from the estimated PAN from cover crop plots, and soil nitrate from the fallow plots was subtracted from soil nitrate in the cover crop plots. Soil nitrate in lbs/ac was estimated multiplying ppm x 3.5.

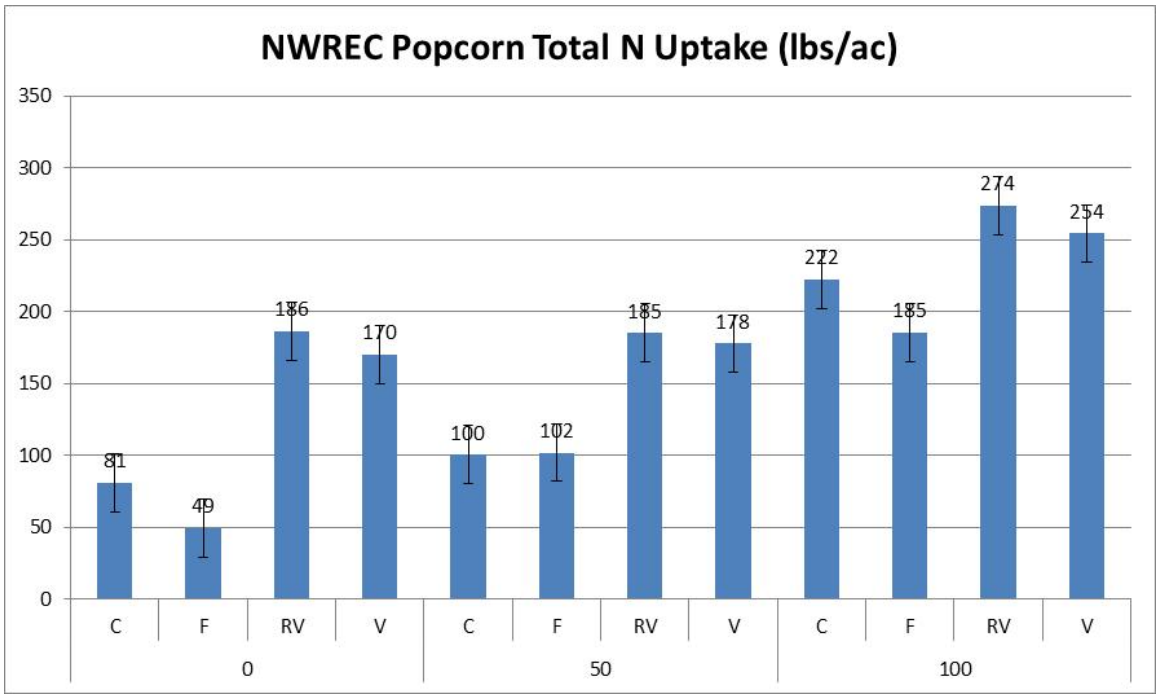

Figure 25. Crop N uptake by the popcorn at NWREC. RV and V treatments with no fertilizer had similar yields to the fallow treatment with 100lbs PAN (applied as feather meal). Error bars show standard error. This is consistent with results from the laboratory incubations.

2010 Figures and Tables

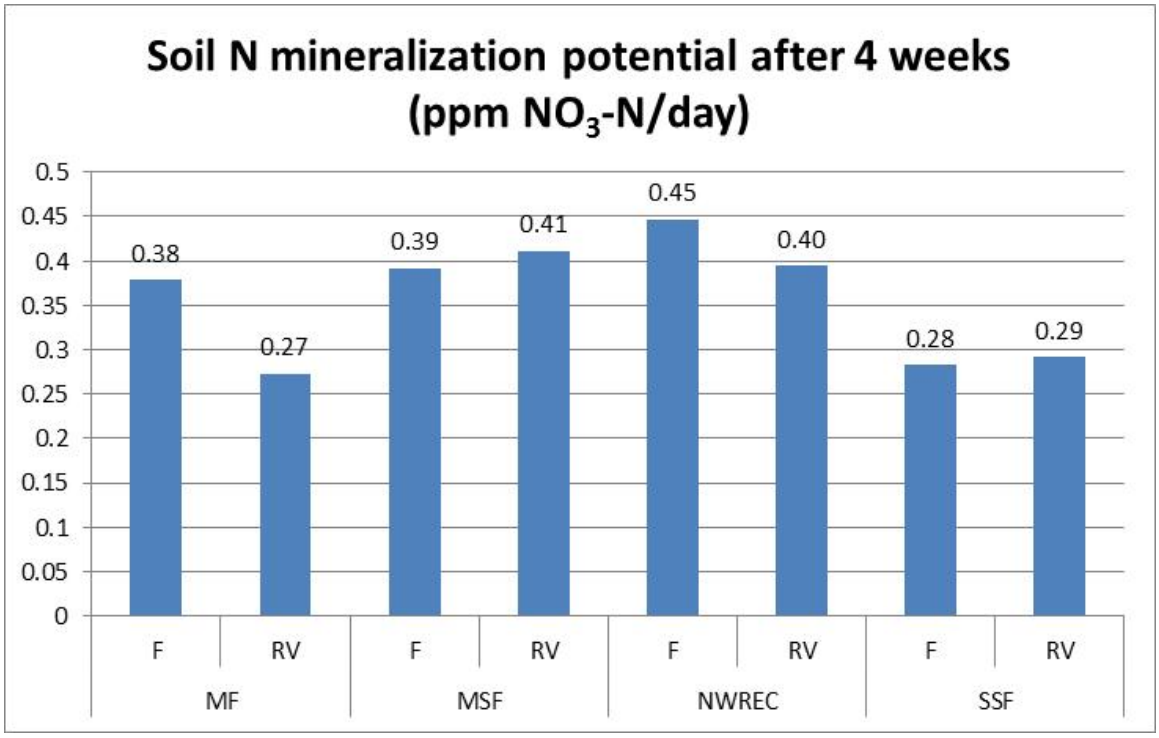

Figure 26. N mineralization potential of fallow and RV cover crop plots at four farms, determined by 28 day incubations in field soil.

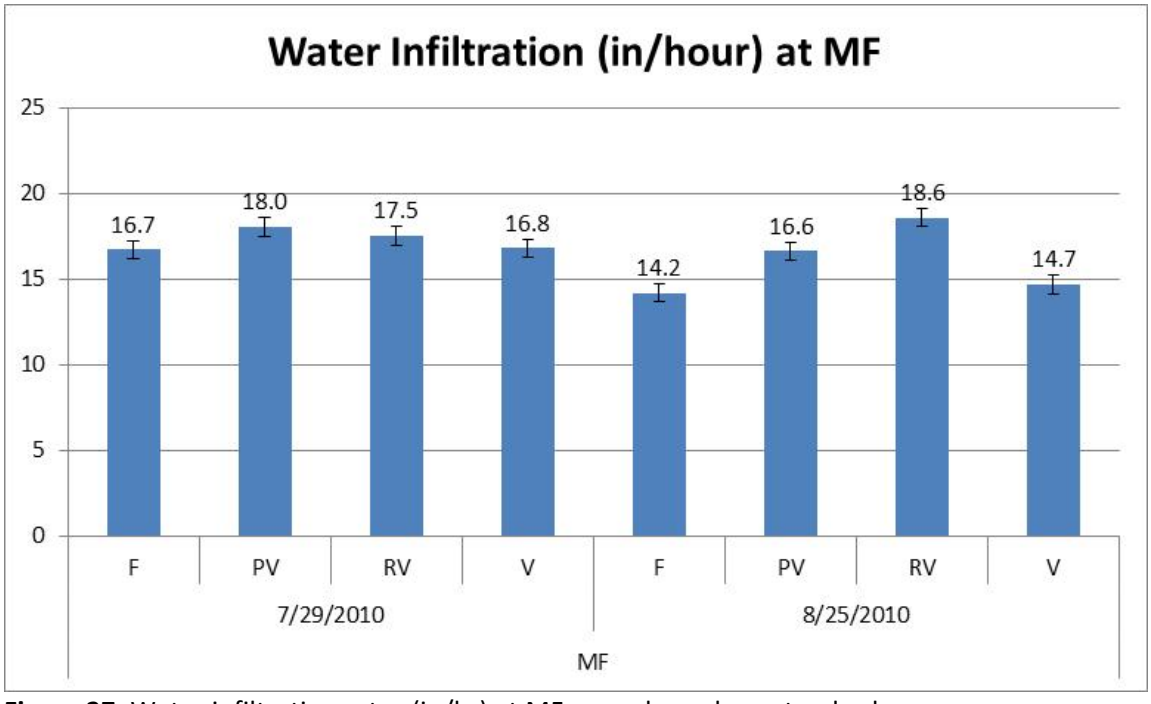

Figure 27. Water infiltration rates (in/hr) at MF, error bars show standard error.

2010 Figures and Tables

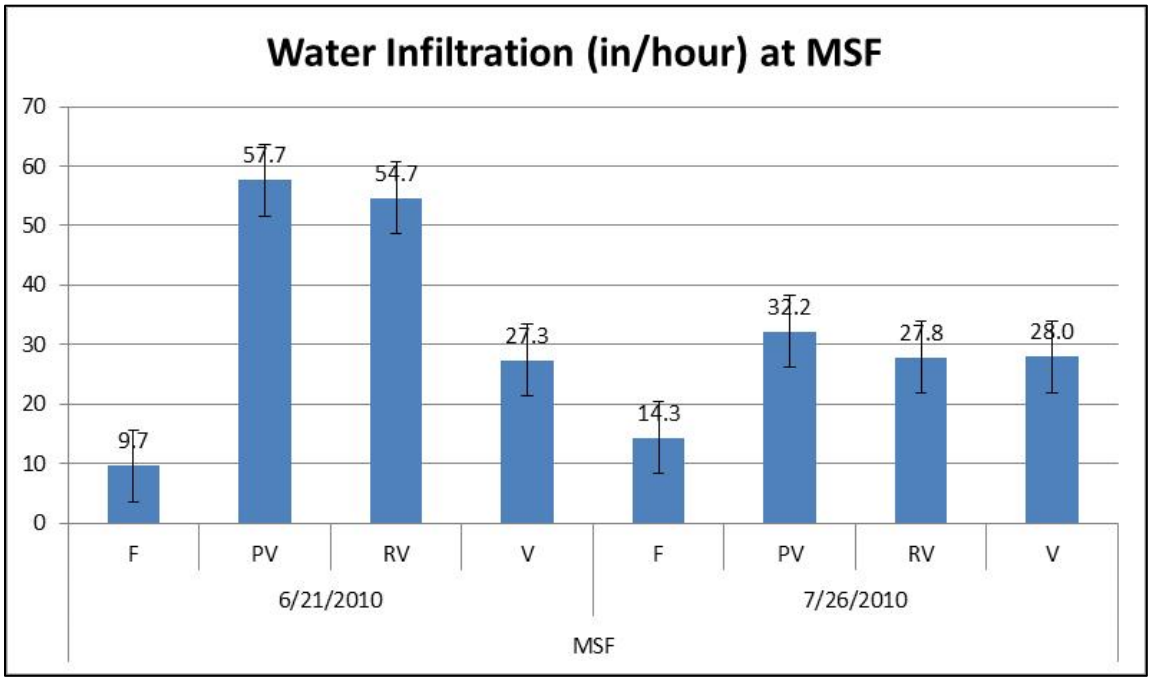

Figure 28. Water infiltration rates (in/hr) at MSF, error bars show standard error.

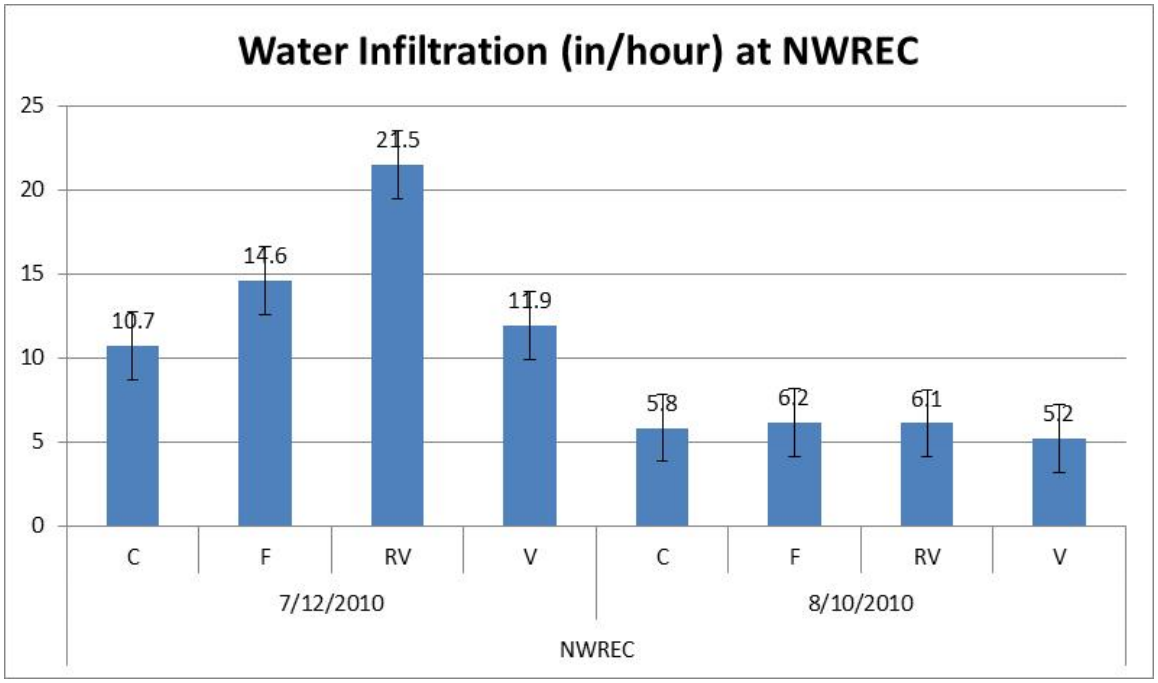

Figure 29. Water infiltration rates (in/hr) at NWREC, error bars show standard error.

2010 Figures and Tables

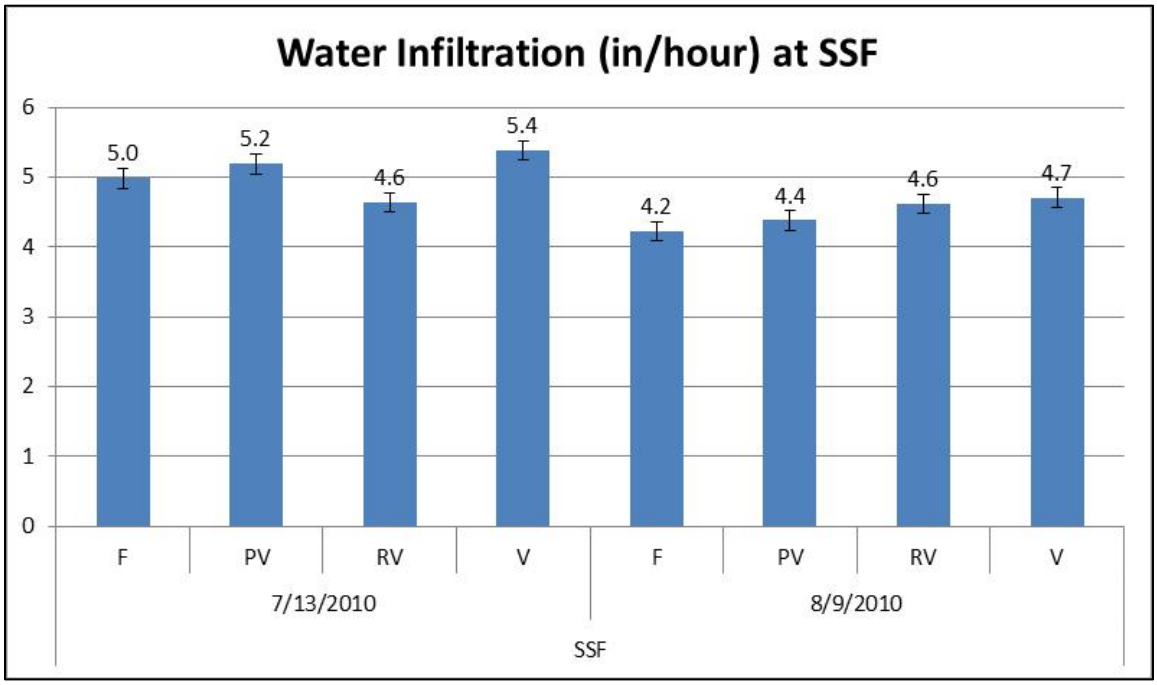

Figure 30. Water infiltration rates (in/hr) at SSF, error bars show standard error.

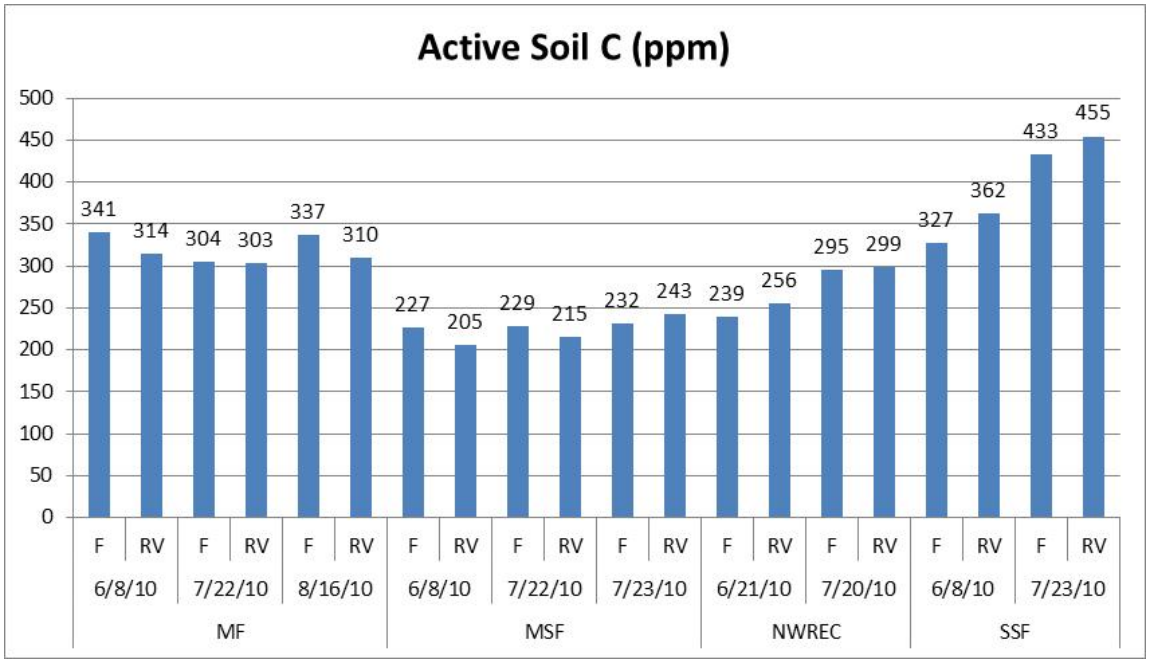

Figure 31. Active soil carbon (ppm) at four farms in fallow and rye-vetch plots.

2011 Figures

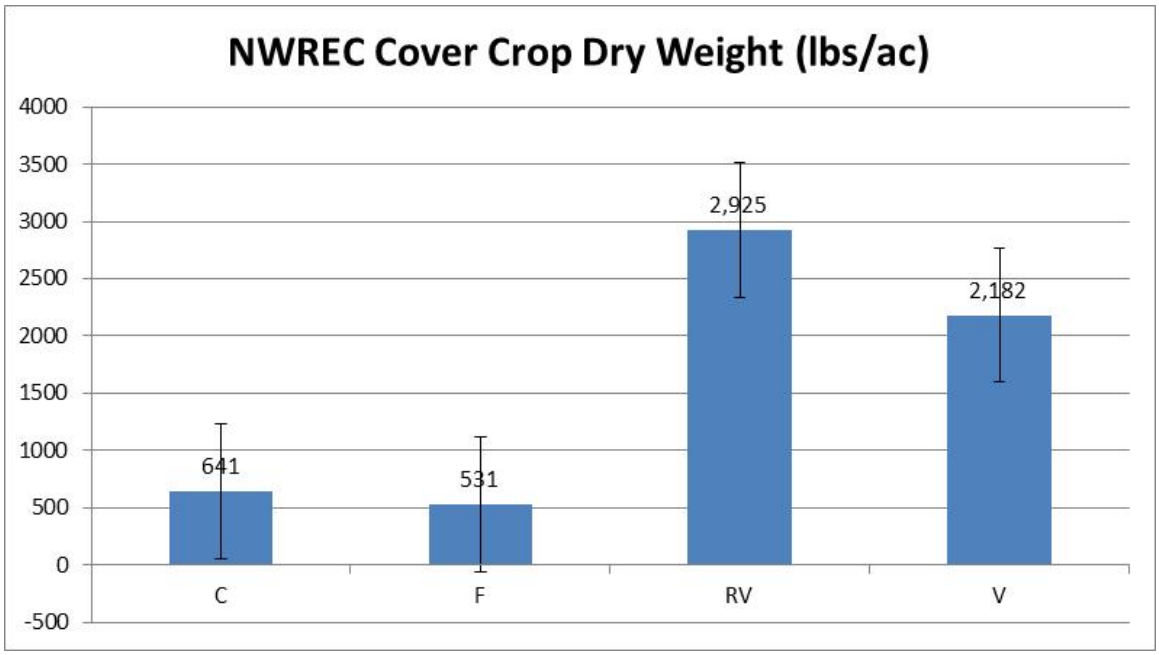

Figure 32. Cover crop dry weight (lbs/ac). Error bars indicate standard error.

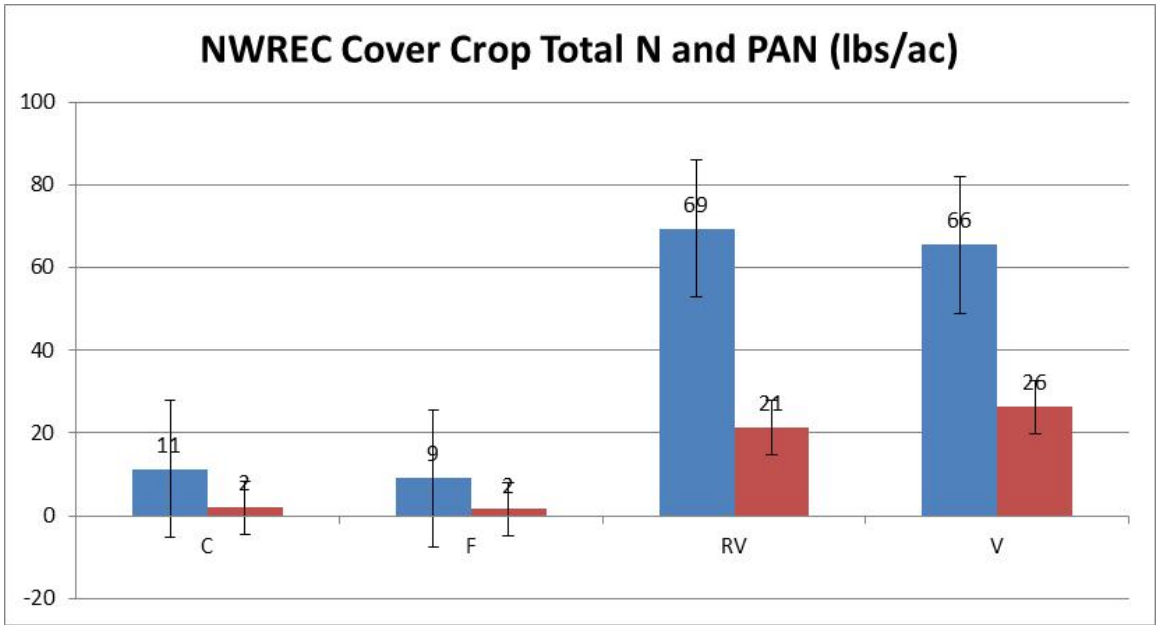

Figure 33. Cover crop total N uptake and estimated PAN release (using Vigil & Kissel equation). Error bars indicate standard error.

2011 Figures

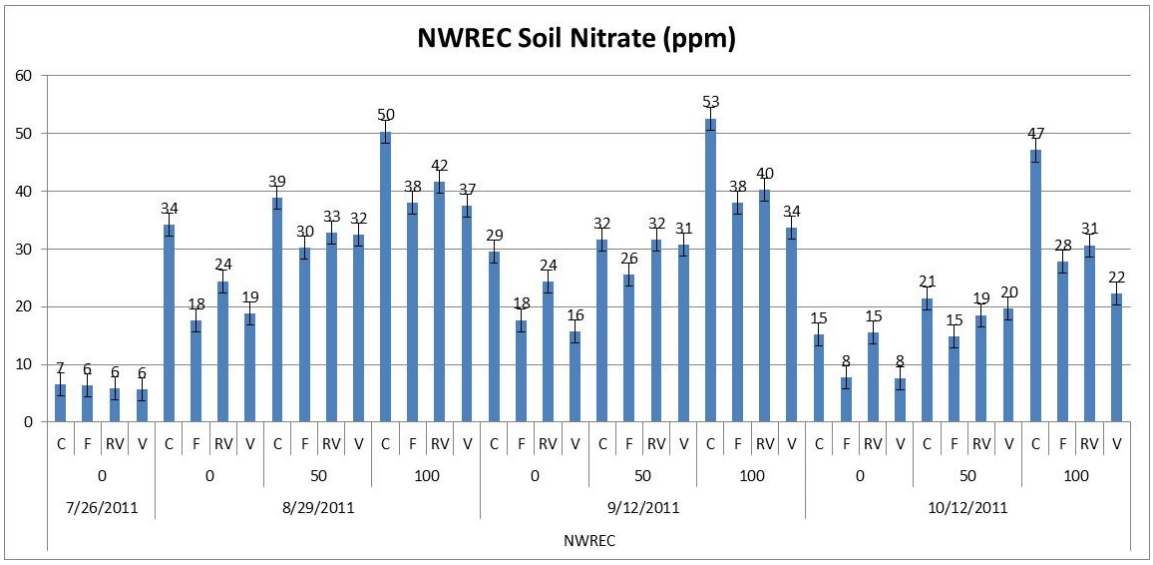

Figure 34. Soil nitrate levels in cover crop and compost plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Error bars indicate standard error.

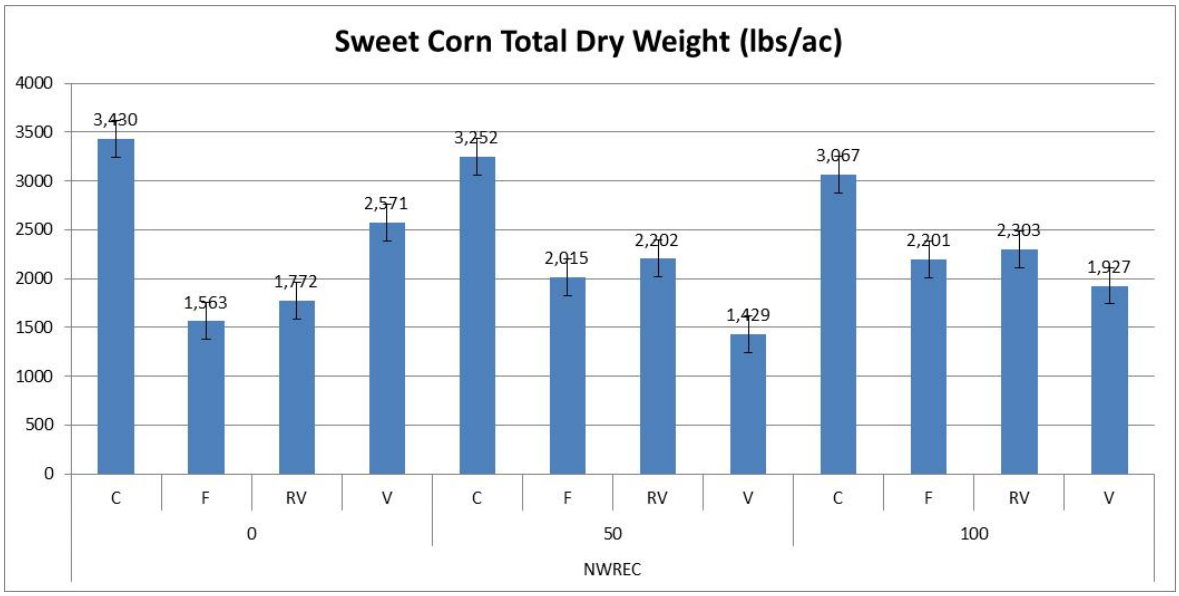

Figure 35. Sweet corn dry weight in cover crop and compost plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Error bars indicate standard error.

2011 Figures

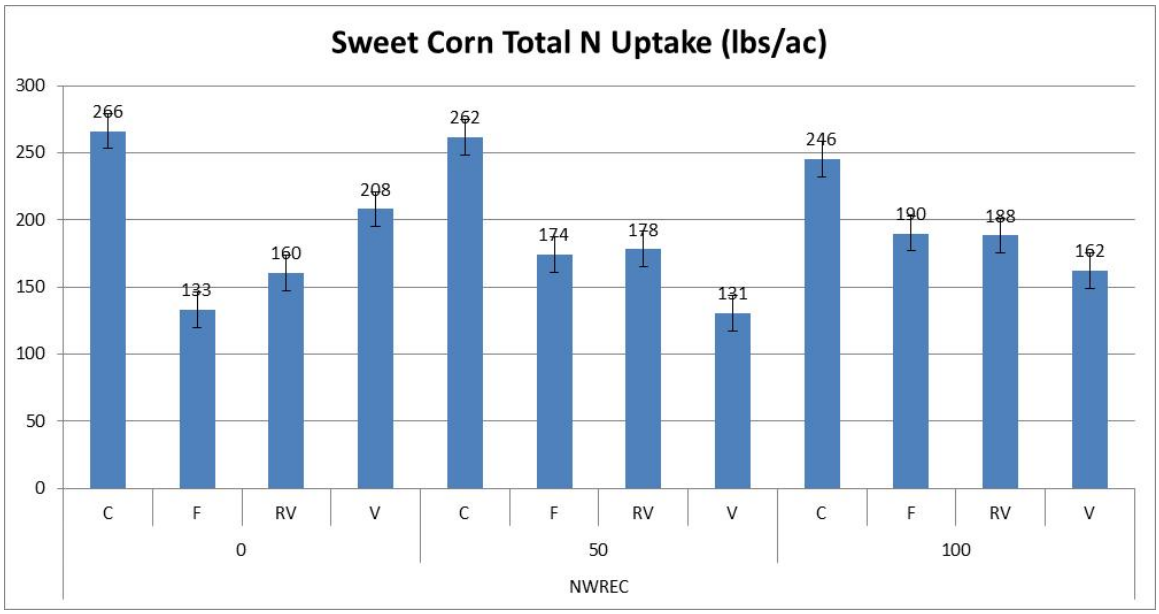

Figure 36. Sweet corn total N uptake in cover crop and compost plots and fertilized sub-plots (numbers indicate lbs of estimated PAN applied as feather meal). Error bars indicate standard error.

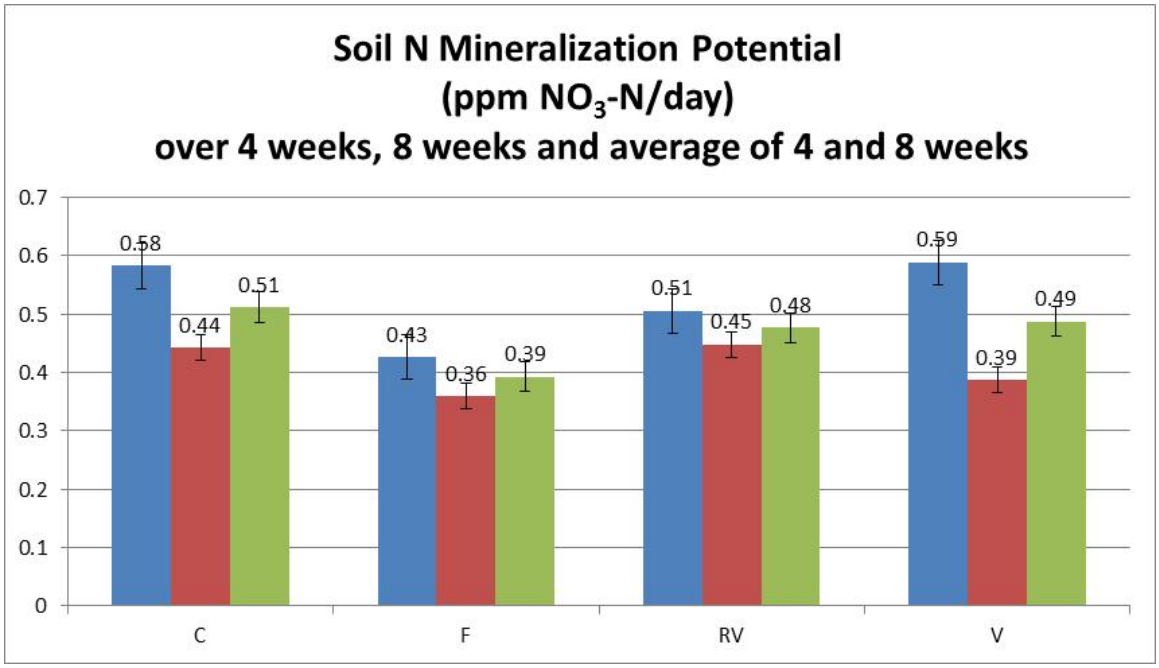

Figure 37. Incubations were run in a basement with relatively even temperatures. Using a base temperature of 50F, the 4 week incubations accumulated 743 degree-days and the 8 week incubations accumulated 1462 degree-days. At NWREC 1227 degree-days accumulated while the sweet corn was growing (7/29/11 - 10/13/11). Error bars indicate standard error.