WSARE Project FW09-328 Appendix 3

Outcomes and Impacts
A more detailed discussion of results from each year is provided below.

2009 trial results:
Cover crops harvested in April 2009 produced between 2,600 and 8,300 lbs of dry matter per acre compared to 1,100 – 3,700 lbs per acre in the fallow plots. The RV stands consistently produced the highest dry matter with the V and PV cover crops producing about the same amount of dry matter (figure 2). Total weed biomass in the fallow plots varied widely from farm to farm (table 3). The fallow plots produced less dry matter at all locations, but at one site (SSF) PV winter killed and smothered the vetch, and then produced only slightly more biomass than the fallow plots. At two sites the phacelia died over the winter, but the vetch continued to grow and produce considerable biomass (table 3). Within each farm, weed biomass was lowest in the cover crops with the highest biomass. In 2009 this was in the rye-vetch plots (table 3). At PMF volunteer red clover in the fallow plots produced almost as much biomass as the other cover crop treatments.

Cover crop total N content and PAN contributions as estimated by the OSU Organic Fertilizer and Cover Crop Calculator are shown in figure 3. At most sites rye-vetch and vetch produced similar amounts of total N (114-165 lbs N/ac), and more than the phacelia-vetch (53-123 lbs N/ac). Cover crop total %N was usually the highest in the vetch (2.9-3.7%N), and lower in the rye-vetch (2.3-2.7%N). Total % N was variable in the phacelia-vetch (2.0-3.6%N) depending in large part on how well the phacelia established and survived the winter.

Estimated PAN contributions were highest from the vetch (table 1). Total %N in the vetch was highest and biomass production was fairly high, explaining why PAN contributions from vetch were generally higher (42-87 lbs PAN/ac). Rye-vetch produced more biomass but with a lower total %N, PAN contributions were slightly lower than vetch on each farm (37-71 lbs PAN/ac). PV biomass and % N were variable so PAN contributions were also variable (15-49 lbs PAN/ac), and at most sites were lower than vetch and rye-vetch cover crops. PMF grows red clover and crimson clover for seed so the fallow plots had a large portion of clovers. Cover crop treatments still provided more total N and PAN, but the differences weren't as large as at other sites.

Soil nitrate levels were monitored in the subsequent vegetable crops (figures 4-8). At most sites the soil nitrate levels were higher following cover crops. These differences were less apparent at MF when the crop rapidly took up all available soil N (figure 4), and at PMF where the clovers in the fallow plots provided nearly as much PAN as the cover crops (figure 6). The trials at WUG were discontinued when the winter squash was accidentally over-sprayed with herbicide.

PAN estimates from the cover crop laboratory incubations were similar to crop yield or soil nitrate levels depending on field conditions. Figure 9 compares the cover crop PAN estimated by laboratory incubations with peak soil nitrate levels before significant crop N uptake. PAN estimates from the resident vegetation in the fallow were subtracted from the PAN estimate from the cover crops. Soil nitrate levels from the fallow plots were also subtracted from the soil nitrate levels in the cover crop plots. At MSF and SSF, PAN mineralized during laboratory incubations correlated very closely with soil nitrate levels after the sole vetch cover crop and provided useful predictions of soil nitrate levels after the RV and PV cover crops. Background soil nitrate levels in unfertilized fallow plots were around 20-30ppm and soil nitrate levels in cover cropped plots were over 30ppm in both of these fields during June and early July (peak N mineralization and crop N-uptake). These levels provided enough N for crop growth, so nitrate from cover crop mineralization was able to accumulate in the soil. At MF, background (unfertilized fallow) soil nitrate levels were 7-15 ppm and soil nitrate in cover cropped plots with no fertilizer were 8-18 ppm during June and July. The table beets rapidly took up most of the available soil nitrate before it could accumulate in the soil. Figures 13 and 14 show that table beet yields responded well to cover crop and organic fertilizer N, and was in the range of what was expected from the laboratory incubations.

2010 trial results:
In 2010 a new trial was started at the North Willamette Research & Extension Center with the following main plot treatments: fallow (F), compost with fallow (C), cereal rye and common vetch (RV) and common vetch (V). Trials were discontinued at PMF because the farmer rotated the field to a perennial red clover cover crop, and at WUG after the winter squash was killed by herbicide. The 2010 cover crop data was statistically analyzed in metric units using SAS.

Most of the cover crops harvested in 2010 had less biomass than in 2009. At all farms biomass from all the cover crops was higher than the fallow ($P<0.01$) (figure 16 and table 4). The overall trend was similar to 2009, with rye-vetch usually producing the most biomass. At MF, the phacelia-vetch produced more biomass than rye-vetch ($P<0.05$). Rye-vetch produced the most biomass at the other sites and the differences were statistically significant in all but two comparisons. However in 2010 the phacelia-vetch performed better than in 2009 at some sites due to less freeze damage. Phacelia-vetch biomass was similar to the solo vetch at two sites and higher than vetch at one site ($P<0.05$). Total weed biomass varied widely from farm to farm (table 9) again in 2010. Within each farm, weed biomass was lowest in the cover crops with the highest biomass. At MF the phacelia-vetch had the lowest weed biomass and at all other sites the rye-vetch had the lowest weed biomass. At two sites weed biomass was higher in the vetch than in the phacelia-vetch plots, at SSF vetch and phacelia-vetch had about the same weed biomass.

All of the cover crops had a higher N content than fallow plants and contributed more total N and PAN per area (table xx, xx and xx). Vetch ($P<0.05$), rye-vetch ($P<0.01$) and phacelia-vetch ($P<0.05$) contained the most total N at one farm each, with vetch and phacelia-vetch being about the same at MSF. In 2010, the cover crop providing the most PAN varied from farm to farm based on the laboratory incubations. Vetch, rye-vetch and phacelia-vetch each released the most PAN in different trials. The differences between cover crop PAN contributions were usually not statistically significant within one farm.

Soil nitrate results showed differences between fallow treatments at MF and NWREC (figures 18 and 21). At NWREC, soil nitrate in the popcorn was high in the vetch and rye-vetch treated plots (38 and 30 ppm respectively at peak levels in unfertilized plots). The compost treated plots with no fertilizer reached 17 ppm and the fallow plots reached 9 ppm. Soil nitrate levels at NWREC were similar to what was predicted from the laboratory incubations when fallow cover crop and soil nitrate levels were subtracted from treatment levels (figure 24). At MF background soil nitrate levels were relatively low and when the green beans started to put on vegetative growth in June, the crop began to use the soil nitrate. The treatment minus fallow comparison showed similar trends, but were lower in the field trials than lab incubations where there was no crop N uptake. At MSF cover crop N contributions were small in 2010 and soil nitrate levels were also low (figure 19). The lettuce appeared to take up all available nitrate, preventing nitrate from accumulating in the soil. At SSF cover crop N contributions predicted by the incubations were fairly high (43-92 lbs/ac), but soil nitrate levels did not accumulate as much (figure 20).

2011 trial results:
In 2011 we continued the cover crop trials at NWREC. The relay seeded cover crop failed and the field was reseeded in Feb 11, 2011, then allowed to accumulate biomass until June 17. The first sweet corn planting failed due to a seeding error on July 14, and was replanted on August 2.

Cover crop dry matter was low and variable in the rye-vetch and vetch plots (figure 32), but considerably higher than in the fallow and compost-fallow plots. Total N and PAN contributions were higher in the cover cropped plots, but were low compared to previous cover crop treatments (figure 33). Estimated PAN contributions were 21 lbs/ac in the rye-vetch plots and 26 lbs/ac in the vetch plots. Soil nitrate levels in cover cropped plots were not consistently higher than the fallow plots, but the compost plots had somewhat higher nitrate levels than the fallow and cover crop plots, especially in the high fertilizer sub-plots (100 lbs/ac estimated PAN).

Total sweet corn dry matter and N-uptake was higher in the compost plots than in the cover crop and fallow plots (figures 35 and 36). The cover crop plots also saw greater sweet corn dry matter and N uptake in the unfertilized plots, but not the fertilized plots. Due to late planting the crop was not fully mature at sampling. Soil mineralization potential appeared slightly higher in the compost and cover cropped plots than in the fallow plots (figure 37). The incubated samples were taken 28 days after cover crop incorporation and three days after compost application.