2006 Report to the Oregon Processed Vegetable Commission

Title: Impacts of high biomass cover crop management on soil factors and corn root rot and productivity.

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Objective: to evaluate the impacts of N availability, microbial activity, and root health on corn productivity and yield in high biomass cover crop systems

Summary:

- ✓ Root rot severity was reduced by approximately 20% in corn grown after a winter oat "Saia" cover crop than when grown after winter fallow.
- ✓ The severity of leaf firing, an aboveground symptom of corn root rot, was lower (by 23%) in corn grown after the oat cover crop than after the winter fallow.
- ✓ The oat cover crop immobilized nitrogen and reduced corn N uptake in the short term in comparison to the fallow
- ✓ Yield was 12% (one ton) higher in the oat than in the fallow treatment

Materials and methods:

Site description

An oat cover crop field experiment was conducted at the Oregon State University Vegetable Research Farm east of Corvallis, Oregon. The soil at the study field is classified as a Chehalis silt clay loam. The study field has been in continuous corn for over 10 years and is known to have high root rot potential.

Cropping history:

The previous cropping history for the study field was continuous corn for more than 10 years with the exception of 2005, when it was fallowed, and 2003, when it was planted to buckwheat. A winter cover crop (cereal rye and common vetch mixture) was planted in winter 2004 to March 2005. In the previous winter, the field was planted to a diversity of cover crops.

Experimental design

The field dimensions are 300' by 50', comprised of four blocks of 12 plots (25' x 20'). The main treatments were oats or fallow, in a randomized block design with 4 replications. Each plot was then split and one half of the plot was treated with 50 pounds urea and the other half with 150 lbs urea in a split-plot design.

Source of seeds

Oat 'Saia' was obtained in 2004 from Kenagy Family Farm (Albany, OR). Sweet corn 'Reward' (Syngenta Seed) was obtained in 2003. This cultivar is early-maturing and root rot intolerant.

Treatments

Oat 'Saia' was planted by drilling on November 6, 2005. Fallow plots were sprayed out by applying Round Up on March 27, 2006.

Above-ground cover crop biomass was collected on April 25, 2006 immediately before spring incorporation. Aboveground biomass was evaluated by collecting aboveground plant material from one quadrat (2' x 2') per plot. Samples were air-dried for 40 days at 33 C°. All cover crops

were flailed, manually spread to evenly distribute the flailed residues, and immediately rotovated to approximately 5 inches.

Sweet corn 'Reward' was planted on June 20, 2006 with starter fertilizer (54 lb acre^{-1} N, 130 lb acre^{-1} P, and 45 lb acre^{-1} K; 450 lb acre^{-1}, N-P-K:12-29-10). Sweet corn seeds treated with Captan were planted approximately 1.5 in deep and 8 in apart in rows on 30 in centers on June 20, 2006. .

Urea was sidedressed to each plot at approximately 47 days after planting sweet corn 'Reward' (at the 6-leaf stage) at one of two application rates: 23 lb acre^{-1} of N or 69 lb acre^{-1} of N (urea 50 lb acre^{-1} or 150 lb acre^{-1}).

Soil sampling

Approximately 30 and 80 days after cover crop incorporation, soils were sampled for greenhouse bioassays and extractable NO_3-N analysis.

For the greenhouse bioassays, ten soil wedges (approximately 5.5 in x 2 in x 6 in) were randomly sampled from each treatment plot. The wedges were passed through a 1 in screen, mixed thoroughly, and potted into cone tubes.

For soil NO_3-N analysis, ten soil cores (approximately 6 in depth and 1 in diameter) were sampled from each plot. Each soil core was sieved through a 0.19 in sieve, mixed thoroughly, and stored in a Ziploc bag at 22 C°.

For the soil incubations, soil was sampled from an adjacent field trial that was fallowed for the summer. Many soil cores (approximately 6 in depth and 1 in diameter) were sampled, sieved through a 0.19 in sieve and mixed thoroughly.

Greenhouse root rot bioassays

Field soils were sampled as described above and processed and potted into 550 mL cone-shaped tubes with 5 cone tubes per plot. Cone-tubes were gently tapped to settle the soil into the cone-tubes.

Two seeds of sweet corn 'Golden Jubilee' treated with Captan were planted about 1 inch deep and thinned to one plant after emergence. Cone tubes were irrigated daily to maintain soil moisture near field capacity. Cone tube was fertilized weekly with liquid fertilizer (0.058 g N, 0.038 g P, and 0.049 g K cone tube $^{-1}$ week^{-1}; Schultz Co., St. Louis, MO). When the corn plants reached the six-leaf stage, plants were harvested. Roots were washed and evaluated by visual assessment for percent necrosis of radicle and nodal roots. Root rot severity was evaluated on an eight-point scale: 0 = healthy, 1 = 1 to 10 % necrotic, 2 = 11 to 20 % necrotic, 3 = 21 to 40 % necrotic, 4 = 41 to 60 % necrotic, 5 = 61 to 80 % necrotic, 6 = 81 to 90 % necrotic, 7 = 91 to 99 % necrotic, and 8 = 100 % necrotic.

In-field assessments of aboveground biomass and root rot severity

On September 14, 2006, sweet corn 'Reward' was harvested. Ears were taken from one 10 ft section from each of two rows in the center of each plot. All ears with less than 6 inches of fully developed kernels were discarded. Three complete corn plants per plot were removed for aboveground biomass and in-field root rot assessments. Radicle and nodal root rot were evaluated using the eight-point scale as mentioned above. Aboveground biomass was dried at 37.7 C° and weighed.

Firing of field-grown corn leaves

Ten plants were evaluated for number of leaves fired from one center row per plot at harvest.

Soil N availability measurements

Field soils were sampled for N availability as described above. A 15 g sample was removed from each aggregated sample and placed into a 125 mL Erlenmeyer flask. Fifty ml of 2 M KCl was added

to each flask. Flasks were shaken at 178 rpm for 1 hr and the resulting solution was filtered with Whatman No. 42 filter paper. The filtrate was refrigerated in capped plastic cuvettes and analyzed for NO_3-N by colorimetric analysis by cadmium reduction (Keeney and Nelson, 1982) by the OSU Central Analytical Laboratory.

Soil incubations

Field soils were sampled for N availability as described above. The sampled soil, from a field adjacent to the field experiment, was moistened to approximately 25% gravimetric moisture by adding distilled water with a spray bottle; approximately 625 g of moist soil was mixed and stored in a ziploc incubation bag. A plastic straw was inserted into the bag to permit air circulation and the bags were placed into a 30 L plastic tub. A moistened foam pad (approximately 2.5 cm depth) was placed at the bottom of the incubation tub and was re-moistened approximately every 7 days to maintain moisture. The incubation bags were maintained at 22° C for approximately 63 days.

Incubated soils were sampled at 0, 21, 42, and 63 days after field sampling and evaluated for extractable nitrate and ammonium. After taking the day 0 sample, approximately 1 g (wet weight) of freshly diced oat residue was added to the oat treatment soils in the bags and mixed well. The bags were then replaced in the tubs and incubated at 22° C. A 15 g soil sample was taken from each incubation bag and placed into a 125 mL Erlenmeyer flask. Fifty ml of 2 M KCl was added into each flask, and the sampled soil with flasks was shaken at 178 rpm for 1 hr. The colloidal solution was filtered with a Whatman no. 42 filter paper and the filtrate was collected in cuvettes, refrigerated overnight, and analyzed by the OSU Central Analytical Laboratory for inorganic N by colorimetric analysis with the cadmium reduction for NO_3-N (Keeney and Nelson, 1982).

Gravimetric soil water content was determined for each sample by taking approximately 10 g of incubated soil from the plastic bag and drying at 105 °C for 24 hr. Gravimetric moisture was used to calculate soil N concentration on a dry weight basis.

Leaf chlorophyll content

A chlorophyll meter (Minolta SPAD-502, Minolta Camera Co., Osaka, Japan) was used to determine the concentration of leaf chlorophyll. SPAD readings were taken just before side-dressing with urea and also at one, two, three, and four weeks after urea application. One SPAD reading was taken from 10 randomly selected plants from the three center rows from each plot; readings were averaged to generate one mean SPAD reading per plot. Readings were taken from the newest fully expanded leaf with the leaf collar exposed; the height of the sampled leaf was similar (±2.5 cm) among plants. The reading was taken between the leaf margin and midrib on the surface of the leaf, midway between the base and tip of the leaf.

Additional soil measurements

Soils were also evaluated for microbial activity (rate of hydrolysis of fluorescein diacetate); methods will be described in the final report to the commission.

Additional field experiment:

A second field trial (winter cover crop) was established at the OSU vegetable research farm in fall of 2005 (6 blocks, 4 treatments, randomized complete block design, 40’ x 20’ plots). The treatments were: 1) fallow (no cover crop), 2) rape “Dwarf Essex”, 3) oats “Saia”, and 4) mustard mixture “Caliente”. Cover crops were sown on September 25. The only cover crop that survived the winter was rape “Dwarf Essex”. No information on this experiment is reported here but will be reported in the final report to the commission.

Results:

Cover crop biomass:

The aboveground biomass for oat "Saia" averaged 5.2 dry tons per acre.

Root rot severity and firing:

Radicle and nodal root rot severity were significantly lower (22.5 and 19.5%, respectively) in corn plants grown to the 6 leaf stage in the oats treatment when compared to the fallow treatment in both greenhouse bioassays at day 35 (Fig. 1a), but there was no difference between the treatments at day 80 (Fig. 1b) after incorporation. Radicle and nodal root rot severity were lower (24% and 20%, respectively) at harvest in the field-grown corn grown in the oats treatment (Fig 2). Number of leaves fired was 23% lower in field-grown corn grown in the oats treatment than in the fallow treatment at harvest (Fig. 3).

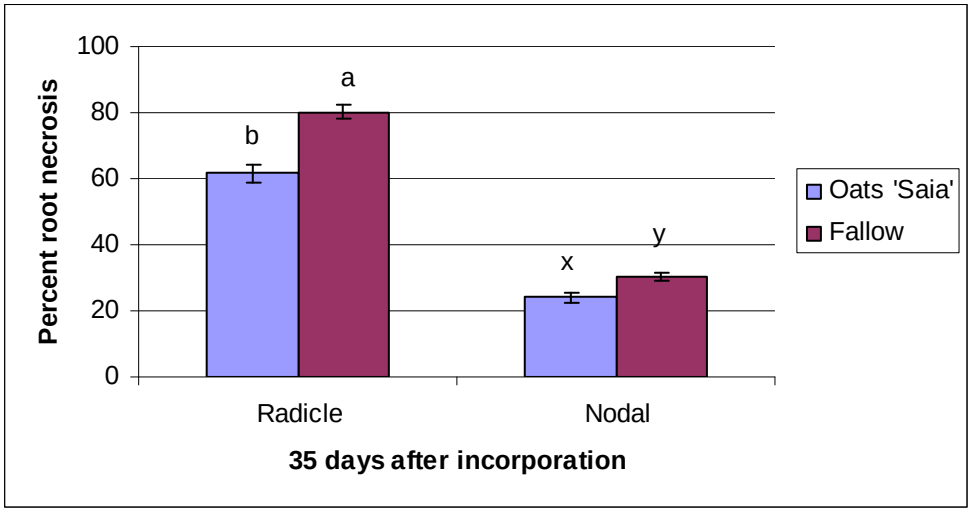

Fig. 1a. Root rot severity in corn grown in greenhouse bioassays (35 days)

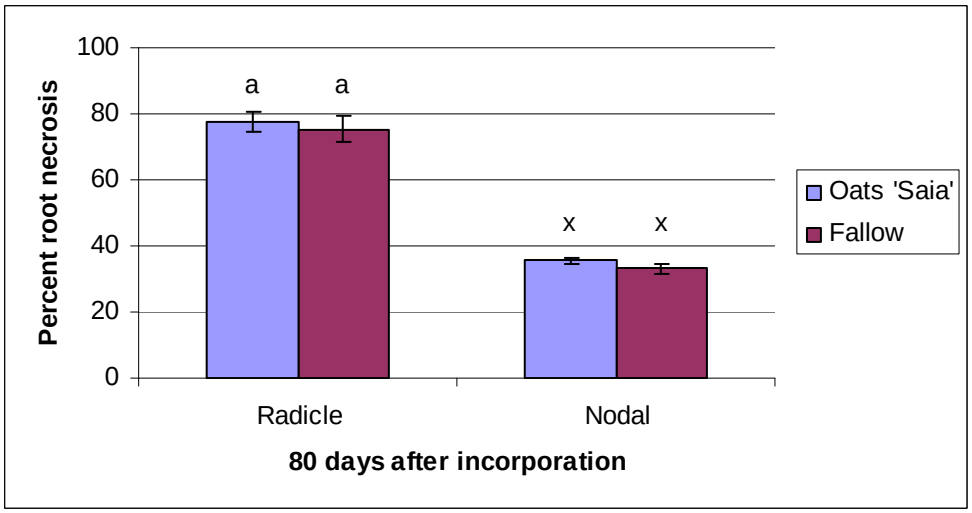

Fig. 1b. Root rot severity in corn grown in greenhouse bioassays (80 days)

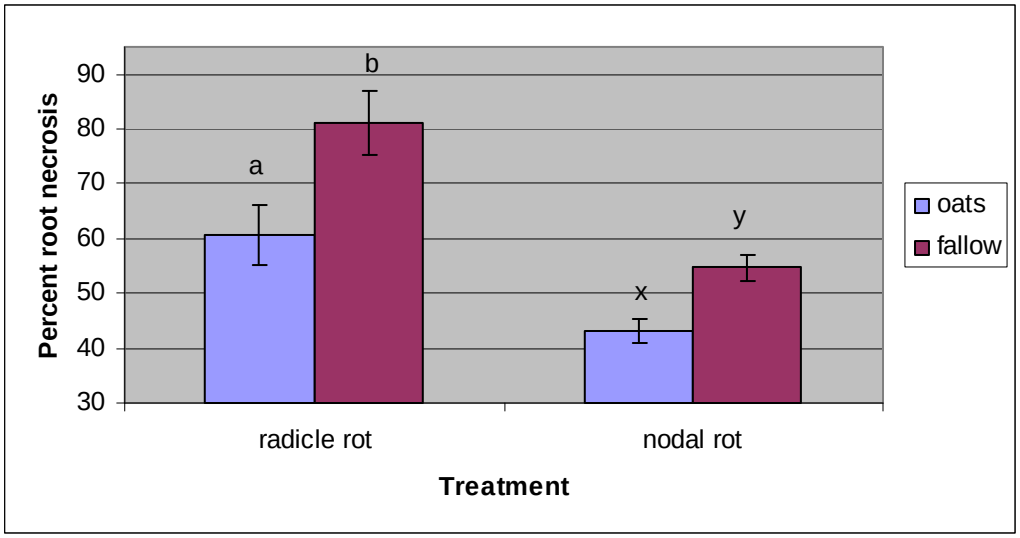

Fig. 2. Root rot severity in field-grown corn at harvest

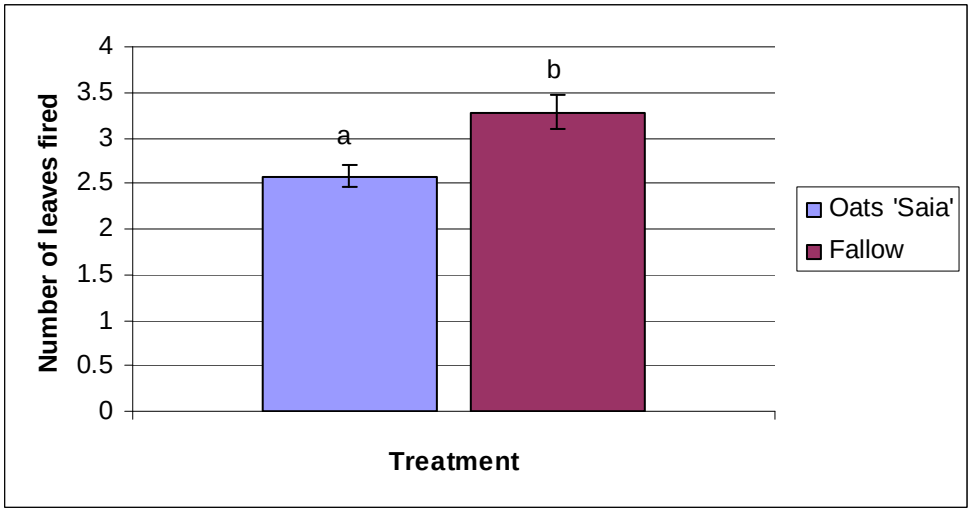

Fig. 3. Number of leaves fired in field-grown corn at harvest

Soil and corn nitrogen status:
Extractable soil NO_3-N content was 74% lower in the oat than in the fallow treatment soils at 35 days after incorporation (Fig. 4), a difference of approximately 40 lbs available N per acre. There was no difference in extractable nitrogen at day 80 (Fig. 4). Cumulative extractable NO_3-N was significantly lower in soil incubated with chopped oat stems than in soil incubated alone (Fig. 5). Field-grown corn planted in the oat treatment was of lower N status (as determined by foliar SPAD readings) than corn grown in the fallow treatment (Fig. 6).

Corn yield:
Yield was 11.6% higher in corn grown in the oat treatment than corn grown in the fallow treatment (Fig. 7).

Additional soil measurements
Soils were also evaluated for microbial activity (rate of hydrolysis of fluorescein diacetate). In addition, plots were split and splits were side-dressed with either 23 or 69 lb acre^{-1} of N (urea 50 lb acre^{-1} or 150 lb acre^{-1}). The microbial activity and split-plot N data are currently being analyzed; results and discussion of these data will appear in subsequent reports.

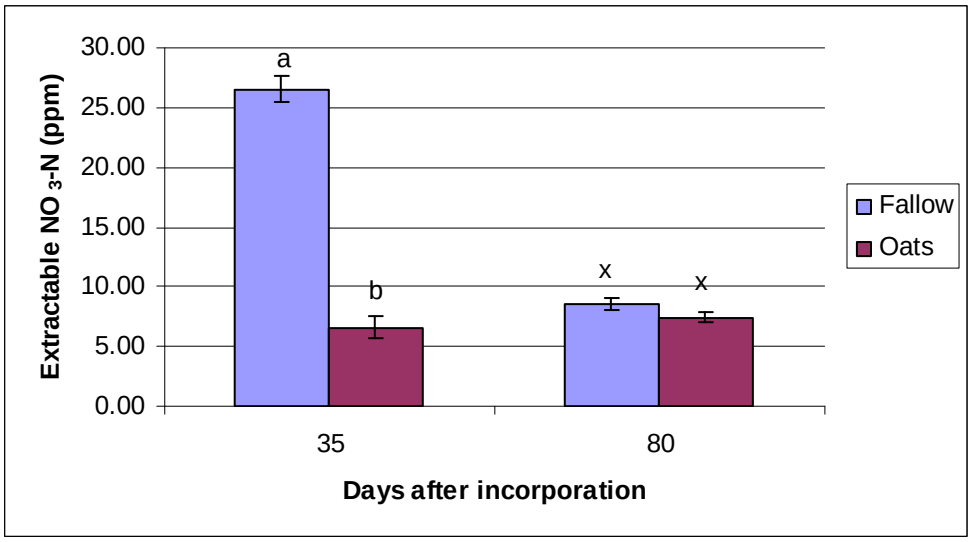

Fig. 4. Extractable soil NO_3-N at 35 and 80 days after incorporation

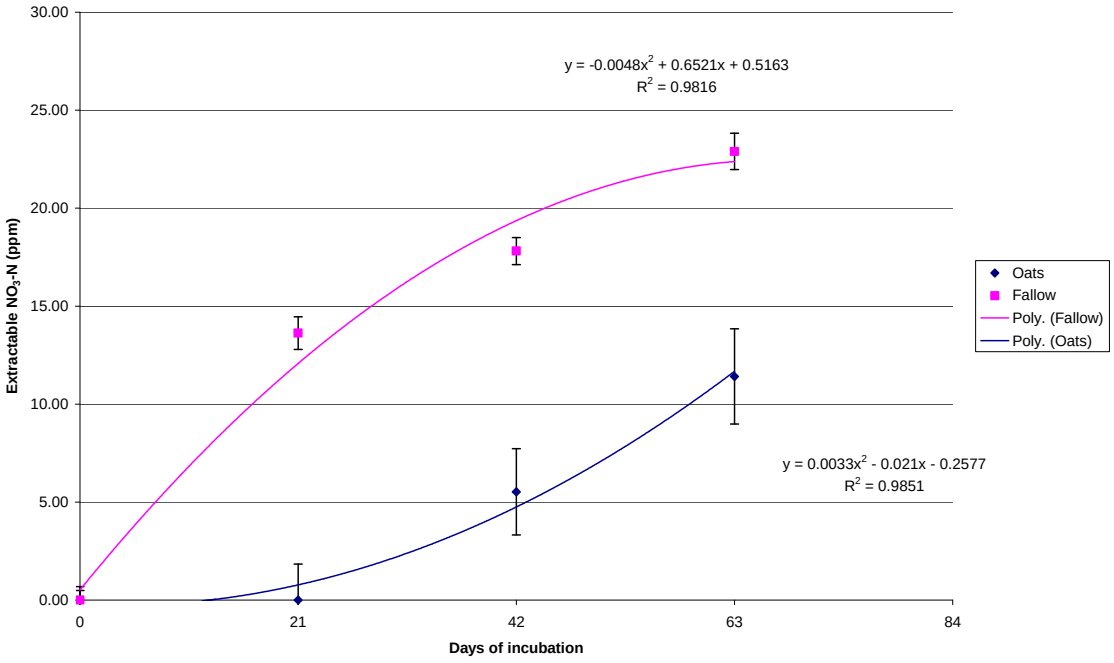

Fig. 5. Cumulative extractable soil NO_3-N in incubated soil

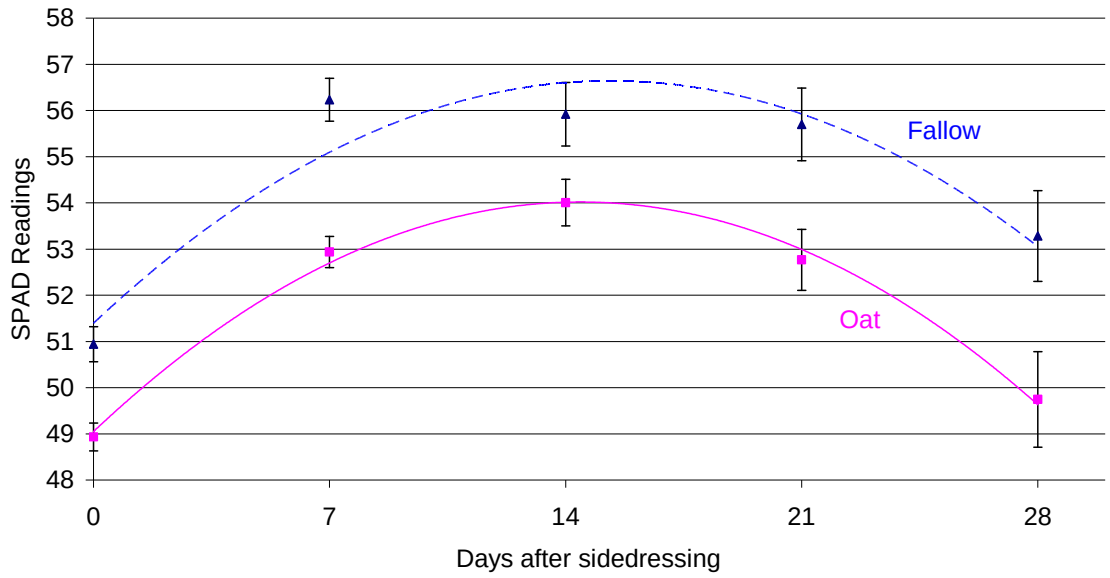

Fig. 6. Corn nitrogen status (foliar SPAD measurements)

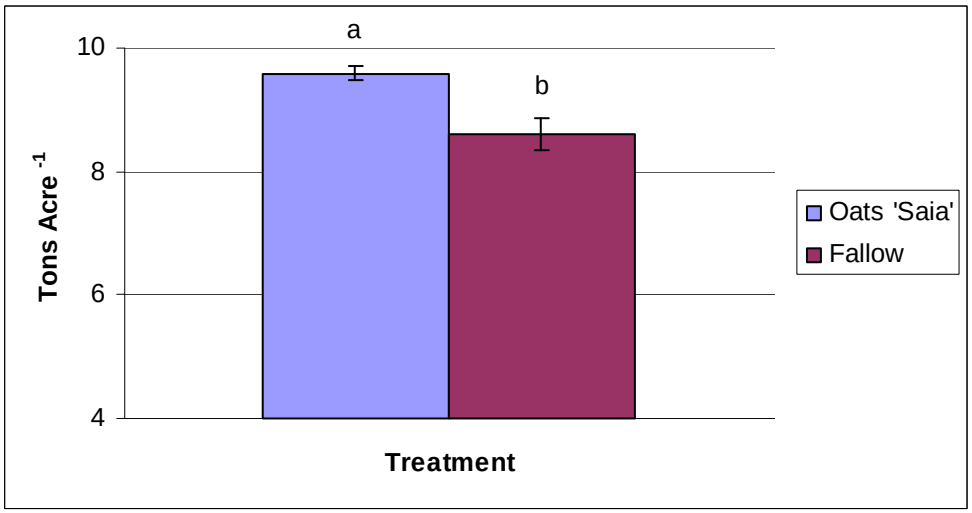

Fig. 7. Yield of field-grown corn at harvest

Summary and discussion:

A winter oat "Saia" cover crop reduced root rot severity in sweet corn "Reward" in the field and in sweet corn "Golden Jubilee" in greenhouse bioassays. In general, root rot was reduced by approximately 20% in the oat treatment compared to the fallow treatment. Firing of corn leaves, an aboveground symptom of corn root rot, was also lower (by 23%) in the oat treatment.

The oat treatment immobilized nitrogen and reduced corn N uptake in the short term as was shown by reduced soil N availability at 35 days after incorporation and lower foliar SPAD readings. Nonetheless, yield was one ton (11.6%) higher in the oat than in the fallow treatment.

Cover crops have multiple impacts on cropping system components; because of this, the impact of a cover crop on the yield of subsequent crops may not be predictable or consistent from year to year or

farm to farm. In this experiment, oat “Saia” reduced root rot severity by approximately 20%. As root rot is negatively associated with yield, a yield increase would be expected if this was the only yield-determining effect of the cover crop. However, oat also immobilized soil N. Nitrogen immobilization by the cover crop in the short term could reduce yield if the timing and magnitude of the immobilization reduces corn N uptake below critical levels during yield-determining periods of corn growth. The soil microbial activity and split plot N data are now being analyzed to better understand the impact of soil factors on corn yield in this experiment. Results and discussion of these analyses will be described in a final report. Results and discussion of the rape “Dwarf Essex” experiment will also be described in a final report.