Iowa State University's Agricultural Drainage Water Research Site: Site Characterization and Past and Present Research

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INTRODUCTION

Currently, a portion of Iowa State University's Agricultural Drainage Water Research Site is being utilized for research in the CSCAP project, and measurements are being taken to investigate corn and soybean grain yield, biomass, and carbon and nitrogen content, rye cover crop biomass and carbon and nitrogen content, soil moisture, soil carbon and nitrogen, tile drainage volume and nitrogen concentration, and weather conditions. Plots in the research area are planted to one of three treatments, all in corn/soybean rotation with each crop present in each year: (i) conventional tillage, (ii) no till, and (iii) no till with rye cover crop.

SITE HISTORY/DESCRIPTION

The research site was established in 1989 to study the effect of different tillage systems and fertilizer application rates on NO_3-N concentrations in subsurface tile drainage under agricultural fields. This research is of particular interest in Iowa, where subsurface drainage tile quickly diverts water with high concentrations of NO_3-N into streams. This movement of nitrogen is a major factor in nonpoint-source pollution of surface waters, which creates potentially unsafe drinking water and contributes to the hypoxic zone in the Gulf of Mexico (Mitsch et al., 2001; Rabalais et al.,1996).

The total research area is 4.5 ha, of which 3.8 ha are used as experimental plots; the remainder is border and buffer. There are 78 0.05 ha plots (15 x 38 m long); 24 of these plots are being used for the CSCAP project (Fig. 1).

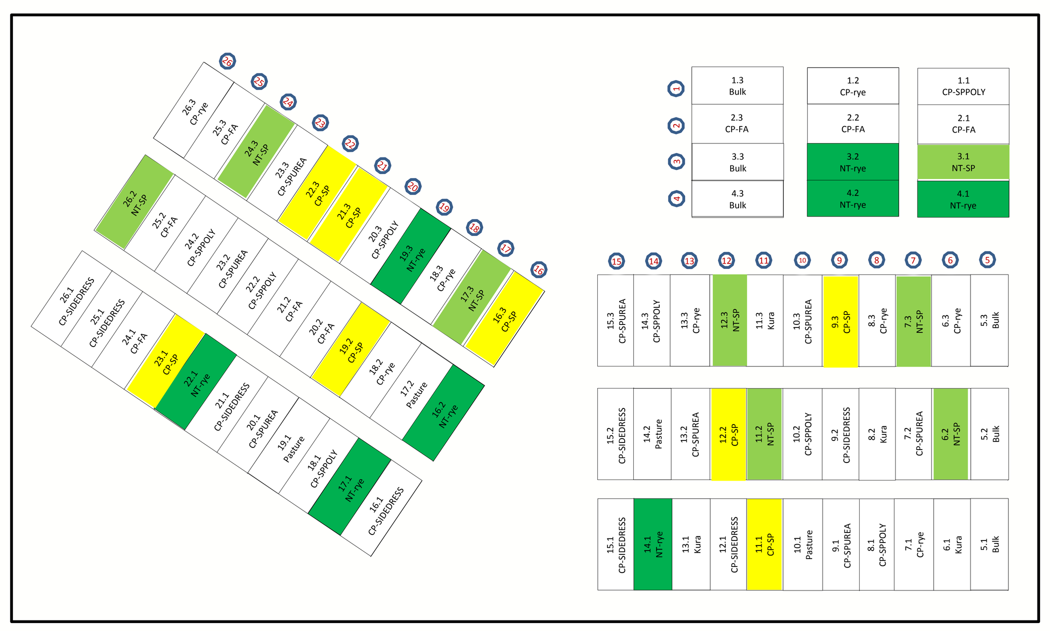

Fig. 1. Plots within the research area. Yellow indicates a plot under conventional tillage, light green a plot with no till, and dark green is no till with rye cover crop. Drainage sumps are indicated by numbered circles located at the end of plots.

In 1989, subsurface drainage lines were installed parallel to the long dimension through the center of each plot and on the borders between plots. Only center drainage lines are monitored for drainage volume and NO_3-N concentration. Three center drainage lines drain into an aluminum culvert containing three separate sumps and sampling/monitoring systems (Fig. 2). Back pressure diverts a small fraction of all drainage to a 20 L glass sampling bottle allowing for continuously monitored flow volume measurement and flow-integrated sampling of subsurface drainage.

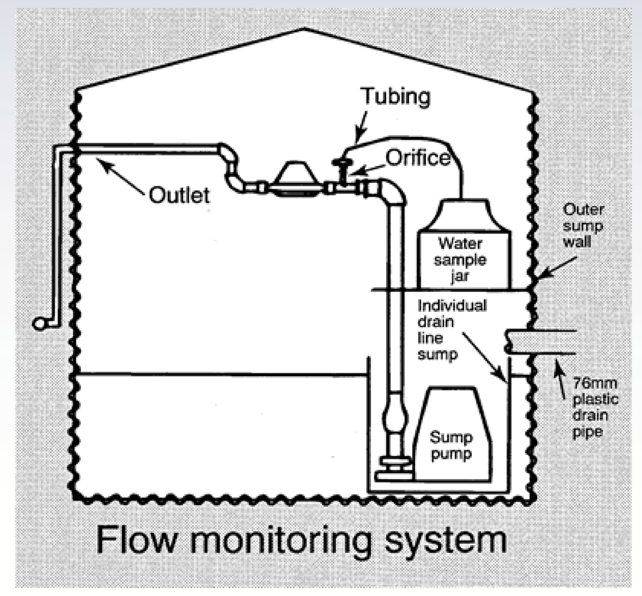

Fig. 2. Drainage monitoring sump configuration (three individual drain line sumps in each flow monitoring sump).

Average annual precipitation (1989-2010) at the site is 763 mm. Approximately 63% of precipitation occurs during the growing season (May-Sept) and 90% occurs during the drainage season (Mar-Nov) (NCDC). An average of 281 mm, or 37%, of annual precipitation from 1989-2010 flowed through subsurface tile drainage (Fig. 3).

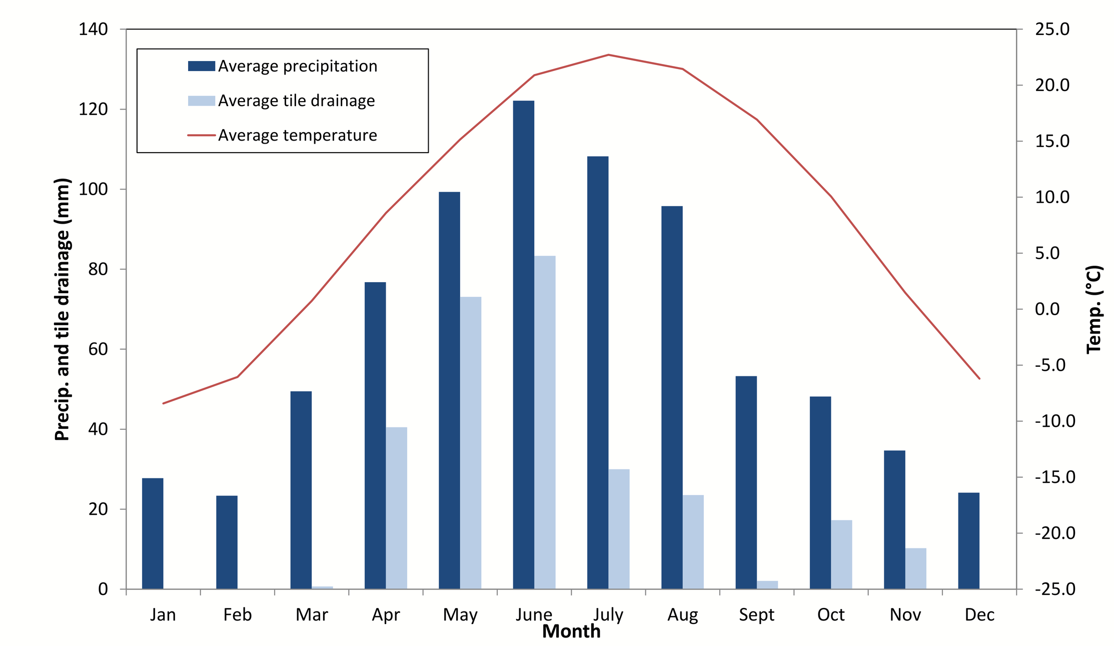

Fig. 3. Averages based on 22 years of data (1989-2010). Precipitation and temperature data retrieved from National Climate Data Center station in Pocahontas, IA; tile drainage from site measurements.

The research site has been utilized for many studies, but major findings from two large studies are included. Lawlor *et al.* (2008) compared grain yields and NO_3-N concentrations in subsurface drainage among different N fertilizer application rates (using liquid UAN and aqueous ammonia-N). Results indicated:

- Corn yield showed a strong correlation between N rate and yield within a certain range.
- Concentrations of NO_3-N generally increased with N rate.
- At the site, to achieve average NO_3-N concentrations less than 10 mg L^{-1} (USEPA drinking water standard), N application rate would need to be below the lower end of the currently recommended rate of 112 kg N ha^{-1}.

Lawlor *et al.* (2011) compared subsurface drainage NO_3-N concentrations among different nitrogen application types (liquid swine manure and aqueous ammonia-N) and timing. Results indicated:

- Rate, and to a lesser extent, timing affect N concentration and losses
- Concentration and losses can vary highly depending on precipitation patterns, N mineralization/denitrification processes, and crop utilization in a given season.

CURRENT MEASUREMENTS

Data collection for CSCAP beginning in 2011 includes agronomic, soil, IPM, climate, and water quality and volume variables (Table 1).

Table 1. Data being collected at the site for the CSCAP project.

Population: Corn final plants
Biomass: Corn plant at R6, soybean plant at R8, and rye in spring
Biomass N and C: Corn at R6, soybean at R8, and rye in fall and spring
Grain moisture: Corn and soybean for plot and subsample
Grain N and C: Corn and soybean
Corn stalk nitrate
Soil: soil description, CEC, SOC, total N, soil nitrate, soil fertility for P, K, and pH, soil moisture
IPM: field log, foliar disease incidence and severity, soil plant pathogens, soil insect population, soybean aphids, insect population and percent ground cover
Climate and weather (on site weather station)**:** precip., air temp., soil temp., solar radiation, wind speed, humidity
Water: Tile drainage volume and N concentrations

PRELIMINARY INFORMATION FROM 2011

- Average dry weight for rye biomass was 321.8 kg ha^{-1} when grown before corn and 563.6 kg ha^{-1} when grown before soybean.
- Soil nitrate testing:

Table 2. Early spring nitrate (mg kg^{-1}) for 3 treatments. Sample dates: 4/28/2001 and 5/9/2011.

	NT	NT+rye	CT
Corn (0-30 cm)	3.40	3.75	2.93
Corn (30-60 cm)	4.45	3.63	4.20
Soybean (0-30 cm)	4.70	3.00	4.60
Soybean (30-60 cm)	5.85	4.95	5.65

Table 3. Late spring nitrate (mg kg^{-1}) for 3 treatments. Sample date: 6/13/2011.

	NT	NT+rye	CT
Corn (0-30 cm)	6.36	7.71	9.11
Corn (30-60 cm)	5.07	5.11	7.69

- Grain yields:

Table 4. Grain yields for 3 treatments (kg ha^{-1}).

	NT	NT+rye	CT
Corn	9974	9641	11299
Soybean	2310	2310	2668

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