1. New Facilities and Equipment

In May 2013, Syngenta inaugurated the Advanced Crop Lab in the Research Triangle Park innovation center. The objective of this new site is to improve controlled environment capabilities to conduct high-precision and high-throughput plant phenotyping.

At the 2014 NCERA-10 Annual Conference, we presented two posters that describe two technologies contributing to these enhanced capabilities: (i) a precision irrigation based Whole Plant Phenotyping System (WPPS) (Figure 1) and (ii) a sealed precision chamber system (Figure 2). The WPPS was developed in collaboration with Argus Controls, Advances Control Solutions (?), and Marc van Iersel (University of Georgia). The Precision Chamber technology was developed in collaboration with Mike Stasiak and Mike Dixon (University of Guelph).

2. Unique Plant Responses

3. Accomplishment Summaries

4. Impact Statements

5. Published Written Works
Background & Objectives

The precise control of plant irrigation is a technology developed by the horticulture industry to provide (i) optimized plant health (ii) water input management solutions.

Precision irrigation technology relies on the programed water supply triggered by a water status sensor acting as a feedback-control.

We present here applications of this technology for the industrial phenotyping of crop plants. Specifically, this work describes how we are able to measure (i) plant transpiration, (ii) total water use, and (iii) fresh biomass gain.

This system provides an advanced whole-plant phenotyping system that will be implemented in our new controlled environment facilities.

Implementation for industrial plant phenotyping

Figure 1. Syngenta poster presented to the NCERA-101 2014 conference describing the development of a new whole-plant phenotyping system that combine load cell, moisture sensor, and feedback controlled irrigation technologies for detailed studies on plant water use.
Closed-chamber technology for whole plant characterization

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This technology makes precise measurements of subtle changes in plant response to an environment in a non-invasive manner. These programmable environments continuously monitor photosynthesis of a plant population in real time. Detection of differences in plant growth characteristics is possible in significantly less time compared to conventional methodologies.

Enabling instantaneous measurements of physiological responses to the environment

Using rate calculations to generate daily comparative data during early in maize development (V3-V6)

Figure 1: Argus data feed showing CO₂ concentration in ppm (red and yellow) in two chambers and CO₂ volume (green) adjusted to maintain a steady-state environment (purple and blue) over one-week period.

Figure 2: Argus data feed showing atmospheric O₂ (green), nitrogen (orange) and CO₂ (ppm, white) during a venting cycle. Oxygen is vented during a three-hour period at night when levels exceed a set point; in this case 20%.

Figure 3: Data from a single day showing CO₂ changes as a result of plant respiration (increasing), re-assimilation (decreasing) and steady-state photosynthesis under two different set points (flat lines at 400 ppm and 900 ppm).

Figure 4: Data from a single day showing CO₂ variations required to maintain a set concentration within a chamber. At 400 minutes of photosynthesis, the set point is adjusted from 400 ppm to 600 ppm, altering the injection rate of CO₂.

Figure 5: Data from a single day showing cumulative transpiration in mL.Values are corrected for evaporation. Note the rate changes between dark hours (6:00-9:00) and light hours (9:00-15:00).

Figure 6: Photosynthesis rate comparisons between two chambers over the course of an experiment. Note the higher rate and accelerating trend in chamber 4 compared to chamber 5.

Figure 7: Water use efficiency of a daily basis. Note the opposing trends in chamber 4 and chamber 5.

Figure 8: Daily biomass accumulation calculated from CO₂ consumption, also with equal results; biomass measurements taken at the end of the experiment.