Station report for Corteva Agriscience™ Agriculture Division of DowDuPont™

Johnston, Iowa Members: Jonathan Frantz and Brian Krug

Facilities and equipment

The Johnston, IA site has about 4.5 acres of research greenhouses and is supported by a little over 2 acres of support buildings in which we operate and maintain many dozens of growth chambers in a variety of sizes and capabilities (Figure 1). The Hayward, CA site is considerably smaller with about 8,500 sq ft of greenhouse space supported by a roughly equal headhouse and growth chamber space.

Figure 1. Aerial view of the Corteva greenhouses in Johnston, IA

Unique plant responses

Over the last year, we have focused on two plant responses related to growing corn consistently in greenhouses year round: 1) poorly developed tassels and 2) "fusing" disorder in seedlings and rapidly growing vegetative plants.

Tassel development

Observations of poorly developed tassels are more common in late January through March in our Johnston, IA greenhouse location (Figure 2). The annual and periodic nature led us to believe it was light related, but the shift in appearance later than the winter solstice when light was most limiting confused the root cause analysis. Additionally, not all germplasm displayed the symptoms at the same time, leading us to wonder if there were multiple factors at play. However, corn tassel development occurs in vegetative phases, and that development can be much earlier (by weeks) than the initial appearance of the tassel. In a series of experiments, we grew different corn genotypes in sufficient light (25 mol m^{-2} d^{-1}) and placed them into low light (10 mol m^{-2} d^{-1}) for a week before returning them to sufficient light conditions. We targeted different vegetative stages and staggered the treatments in their development from the 4-leaf stage through to tassel emergence.

Figure 2. Poor-quality tassel

We found, depending on the genotype, that low light negatively impacted tassel development between the 6 and 8 leaf stages, but had no effect in any other time in development. This led us to alter how we arrange and organize plant growth areas to improve light supply at critical developmental stages. This work and the resulting actions were submitted to IP.com; the final publication was anonymous, but Libby Trecker, Chris Currey, and Brian Krug were key contributors to this work.

Plant "fusing"

Similar to the observations on tassel development, we have seen an increase in "fusing" symptoms, especially in young plants, during winter months (Figure 3). Also known as buggy whipping, bull whip, rat tailing, rapid growth syndrome, root-cause analysis was challenging because this persistent problem seems to be triggered by a variety of cultural and environmental conditions. For example, over- and under-watering, low light, specific genotypes, high humidity, low humidity, heavy substrate, and water delivery method have all been blamed on this disorder.

It basically presents as a Ca disorder, and can therefore be looked at like lettuce tipburn. In lettuce, conditions leading to rapid growth rates trigger the Ca disorder (e.g. excess light above 17 mol m-2 d-1) and if other environmental factors are not in balance to support such rapid growth rates, crop loss can occur. Applying the same model to corn resulted in finding conditions that support rapid growth rates, are easily controlled at scale, and do not compromise short cycle times needed for high-throughput product pipeline support. High humidity (80% RH), high light (at least 15 mol m-2 d-1 for seedlings and at least 20 for vegetative phase), and full wet-dry cycles in irrigation lead to reduced fusing. There are clear genotype differences in fusing susceptibility, but in a well-managed or automated system, all can be grown successfully with no fusing.

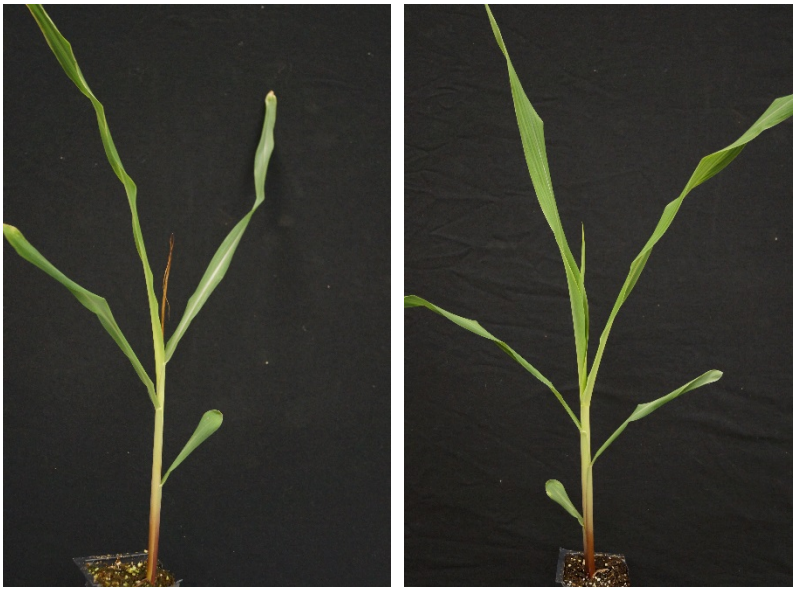

Figure 3. Fusing shown on meristem of young seedling on left compared to healthy non-fused seedling on right.

Other relevant activities

In late 2017, the merger between Dow and DuPont was completed. In the agriculture portions of each company, this merger of equals combined the histories of Dow Agrosciences, Pioneer Hi-Bred Int'l, and DuPont crop protection. Immediately, we began to aim for an eventual “spin” of 3 separate companies including one pure-play agriculture company. The headquarters for the new company is in Wilmington, DE, but research activities are focused in Indianapolis, IN and Johnston, IA.

The combined company still has a lot of work ahead to become independent, but from a controlled environment standpoint, we immediately have internal greenhouse and growth chamber focus colleagues. Relatively large research greenhouse operations in Indianapolis and Johnston provide different perspectives and opportunities on operations, plant responses, automation approaches, and talent pools.

We have welcomed in 2017 far more visitors into the Johnston greenhouses than previous years, and we began to do more outreach to universities. We have given seminars at Michigan State, Iowa State, U of Maryland, U of Tennessee, and NC State, as well as made site visits to Purdue, and U of Nebraska-Lincoln. And in 2017, the company launched an open innovation portal for funding of targeted topics.

Listed publications

Trecker, Elizabeth. 2016. Transient low-light stress and the effects on tassel quality in maize. IP.com IPCOM000237464D