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Stress Does Not Exist in a Vacuum

By: Raechel Baumgartner

No two growing seasons are exactly alike. This is even true in Puerto Rico, despite the relative consistency in the weather forecast! Another true fact of life: very rarely do stresses occur singly. Drought is often accompanied by heat (or is it the other way around?). Excess rain and heat bring on lovely conditions for disease. Spider mites often flare when conditions are hot and dry. Corn root-worm and disease pressure increase in continuous corn situations. Every growing season is composed of a unique combination of stresses.

Since stresses almost never occur singly, what I cannot figure out is why so much emphasis is placed on "breeding for x trait". It's not "breeding for x, y, and z" anytime there is a news article, a conference, or even a plant breeding class (at least in anything I've come across. If you have, please pass it on!). Instead, this group of people is focusing on drought tolerance; that group is focusing on nutrient use efficiency, and that group over yonder is working on tolerance to salinity. Maybe that makes sense from a genetic study standpoint (it certainly makes it easier), but it certainly does not make sense from a plant breeding standpoint. Why? Because all of these are issues in growing crops, and they are all hot topics under a fairly common management practice: irrigation. A lot of irrigation also happens in places where it's hot, so we can also add "heat tolerance" to the list of characteristics important under an irrigated production system

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Breeding School Lessons

By Ed Baumgartner

I had the opportunity to attend the Illinois Corn Breeder's School this year. They had several topics that were relevant to the Durayield work that we are doing, and that prompted me to attend. I am in no way an expert on any of the various topics, and in all honesty the speakers can get well over my head in a short time. However, like all schools if you can learn something, it was a worthwhile investment to attend. Dr. Stephen Moose presented a discussion on epigenetics. I wish Raechel had been there because this topic is her favorite in the world of plant breeding. In short, epigenetics (http://en.wikipedia.org/wiki/Epigenetics) is the study of cellular and physiological trait variations that are not caused by changes in the DNA (deoxyribonucleic acid) sequence. What this means is that the same DNA sequence can have variations of expression. This makes corn breeding even more interesting! Depending on the environment that the breeding selections are made in, you can have different outcomes of plant phenotypes and responses to various levels of stress with the same DNA sequence. RNA (ribonucleic acid) causes these differences in expression even though the DNA is the same. Even less is known about RNA than DNA. So how does this apply to Durayield development? It reinforces our concept of breeding under very diverse conditions looking with our eyes at multiple agronomic traits at the same time. We can use molecular markers to move the genes or QTLs (Quantitative Trait Loci) from our source materials to our new inbreds under development, but we would be selecting randomly the RNA that moves along with the genes we identified through the DNA molecular markers. This means it would not transfer accurately the desired outcome we are looking for without using field selection under the targeted conditions. The take home message from this presentation to me was that that we need field selection more than we need technology in day-to-day plant breeding programs and understand what that field selection can do for us, especially under managed stress conditions. Scientists like Dr. Moose need to keep studying RNA and its relationship to DNA to help us in the future. Our job is to figure out how to use what they learn in the most practical way possible to efficiently and effectively develop better products to meet the needs of the customer.

Dr. Donald Ort led the next talk, and it was on Limitations on Yields in the Corn Belt. He focused his discussion on elevated carbon dioxide concentrations in the atmosphere, the resulting elevated temperatures that follow the increased carbon dioxide levels, and its effects on corn yield. He made several interesting statements during the presentation. "Absolute corn yields have increased under drought from 1995-2012 but sensitivity to drought has increased." "This correlates with increased planting density." "Water Use Efficiency (WEU) goes down as temperature goes up." "Breeding for drought tolerance does not improve WEU." I agree with Dr. Ort's comments based on my observations, and I'll attempt to explain why. We as an industry have been breeding at higher and higher populations since we started plant breeding. We have the assumption that the corn plant will produce only a certain amount of grain, so lets pack as many plants in an acre as possible to increase yield per acre. This has been a very good strategy.

Using higher plant populations during the development process will remove plants that will go barren; plants will become better at extracting water from the soil under competition; plants will become more disease tolerant since crowding always brings health issues; plants will fix the ear at a constant size and the number of ears produced per plant will be one, but consistently one will be produced consistently. This methodology will bring more yield. We really have done a good thing so far in the history of corn breeding by making more reliable hybrids and higher producing hybrids in average to above average growing conditions for corn producers. However, we are asking how to get to the next level of corn production due to higher demand in the future with uncertain weather patterns. According to Dr. Ort, current hybrids produce about 20 bushels of corn per acre per inch of water assuming 70% of rainfall is available to the corn plant. He claims that this is a constant production level across all hybrids he has tested because corn's water use efficiency is the same when measuring water vapor deficit. He states that different hybrids can extract water from the soil better than others due to breeding, but how the plant uses that water is the same in all the varieties that he has measured. I asked him after the talk why he didn't think that we could make progress in water use efficiency by corn breeding. His answer was basically that the soils where we are breeding are too good. They hold too much water and allow plants that extract water best to be selected. I take that to mean the plants that are more efficient, if they exist, are not identified in current breeding methodologies so we need to figure out how to find efficient plants along with good water extracting plants. I believe this is how we will reach the next yield level in corn. You can say we are in good shape since we just achieved 503 bu per acre in 2014. (link to article). If you read into the article, Mr. Dowdy had over 30 inches of rain during the first 3 months of the growing season. That translates into 420 bushels of possible yield based on Dr. Ort's formula. (30 inches x 70% available x 20 bu. per inch) It would be easy to assume that he had 6" more rain in the final two months of the growing season make up the remaining 83 bushels he produced. We all know there is more involved in a record-breaking crop than water. This farmer discusses doing everything he can to reduce stress on the growing corn crop. Why not breed with all the imaginable stresses possible to increase the corn yield no matter what Mother Nature throws at you?

I had three different plant breeders walk up to me after these two talks that are familiar with our "crazy" approach to corn breeding and say, "Keep doing what you're doing. We are going to need it in the future." We can actually bring you some of the future now with our products.

Consumer Perception & Alternatives

by Erin Rodríguez

As the person who does the food shopping in my household, I am responsible for the nutrition of my family. I am like many other wives and mothers who take this responsibility seriously. This weekly excursion is not only an opportunity to buy delicious food, but also an opportunity to socialize. I often talk to other women as I browse the supermarket aisles. Sometimes a fellow shopper will direct me to an especially beautiful piece of produce or a good deal on a product. We share information about nutrition, recipes and current events. The supermarket is like a small microcosm of the larger community in which I live. Lately as I walk through the market, I hear more and more conversations about GMO food products. Are they safe? Is it worth it to pay a little extra for organic or non-GMO products? It has become evident to me that shoppers are apprehensive about these GMO products.

There are a number of studies being conducted on the subject of consumer perception of GMO food products. What is consistent in these studies is that Americans are skeptical about the safety and viability of GMO products. The Pew Research Foundation did a study in February of 2015 studying how different demographic groups think about scientific issues. One of the measurements was how participants perceive GMO foods. It states that 57% of the respondents believe that GMO foods are unsafe to eat (link to article). A study published by Rutgers University has found that support for GMO foods slipped between the years 2001 to 2003 (link to article). Another study conducted by the University of Vermont found that the majority of Vermont residents are concerned about GMO foods and were willing to pay extra for organic or non-GMO products (link to article). Finally, a study by Murray State University in Kentucky found that Millennials (those born between 1980-2000, current 15-35 year olds) are the most skeptical about these products (link to article). Three of the above mentioned studies showed that women are more skeptical than men. Regardless of which side of the GMO argument you are on, the perception of the consumer is increasingly negative and cannot be ignored.

As someone who works in agriculture, I cannot help but wonder: how does this affect our industry? Are we addressing the concerns of our end users? From a business perspective it would be a mistake to ignore this demographic. We are still subject to the laws of supply and demand. As demand for non-GMO products increase, so do the opportunities to capitalize on this market. I do not want to give the impression that I am opposed to GMO's. I believe it is important to give consumers alternatives that fit their lifestyles. That is what we do at 3MG: we provide genetic alternatives to our customers.

HARD FACTS ABOUT GMO

57% of people believe GMO foods are unsafe to eat

Public approval of GMO foods has dropped 11% from last year

People are engaging in conversations about GMO foods more than ever before.

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Drought, nutrient usage, salinity, heat.

The scientist part of my brain completely understands why you would look at each of these characteristics separately. We want to get down to the nitty gritty: what effects are attributable to this set of conditions? What effects are attributable to that set? What happens to my crop when it's hot? What happens when it's dry? This all goes into building really cool models that predict crop yields under certain conditions or help us decide what to do when we are hit with a certain set of environmental conditions. Are there limitations to this? Oh yes—the major one being that in the field we can never totally separate these conditions out, so how good are the models? I don't know. They are still pretty cool, though.

The practical part of my brain has Major Issues when plant breeders start thinking the same way. When we don't think we are combining resistances but rather confounding them, we are heading down the completely wrong path. We have a job: stabilize and increase crop production with finite land and resources. I think single-stress selection is the wrong way to go about doing that. After all, if selection works, won't selection under tough, multi-stress conditions assure that we still have yield under Mother Nature's tough conditions?

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Founded in 2012, 3MG R&D has been involved in the creation of innovative products that we hope will be in the forefront of the seed market. Guided by our principle that we can develop food crops that combat environmental pressures naturally and economically, we continuously research new solutions using a mix of millennia-old breeding techniques with high-end modern genetic technologies.