Managing corn in a high yielding system

"Hybrid selection is the first and most important decision made when increasing plant densities."

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Living up to potential

As corn yields continue to increase, it is important to look at how we manage our cropping systems. Some changes to an existing high yielding system could help to maintain current yields and increase yields to maximize your corn's true genetic potential.

In theory, a bag of corn has the potential to produce 470 bu/ac before it is opened (Tollenaar et al 2001). Once the bag is opened the yield reductions begin to occur based on environmental factors such as: poor fertility, poor planter maintenance, pests , poor soil health, and the list goes on and on.

In this article we will focus on the management of plant densities (seeding rates) in high yielding environments, and how the following two factors must be considered when deciding to increase plant densities:

- Hybrid Selection
- Fertility Increase Management (micronutrients).

According to Bender et al 2013, advances in plant breeding, biotechnology, and crop management have resulted in increased average corn yields. With these advancements in corn breeding, breeders have created hybrids that physically and agronomically respond to increased plant densities, and as populations are increased, both macronutrient (N, P, K, Ca, Mg) and micronutrient (Zn, Mn, Cu, B) intake increases (Ciampitti et al 2013).

Hybrid Selection:

Hybrid selection is the first and most important decision made when increasing plant densities. Fasoula et al 2004 stated that when selecting a hybrid for higher plant densities it should have two components: Tolerance to stress and the ability to exploit added inputs. If these two factors are not considered, then there is an increased risk of a negative yield response when planting densities are increased.

One more factor that should be considered is the ability for the cob to 'flex'. A hybrid with a flex cob does not respond to higher planting densities because its upper yield potential is gained by the cob's ability to flex longer under standard plant densities (32,000 plants/ac).

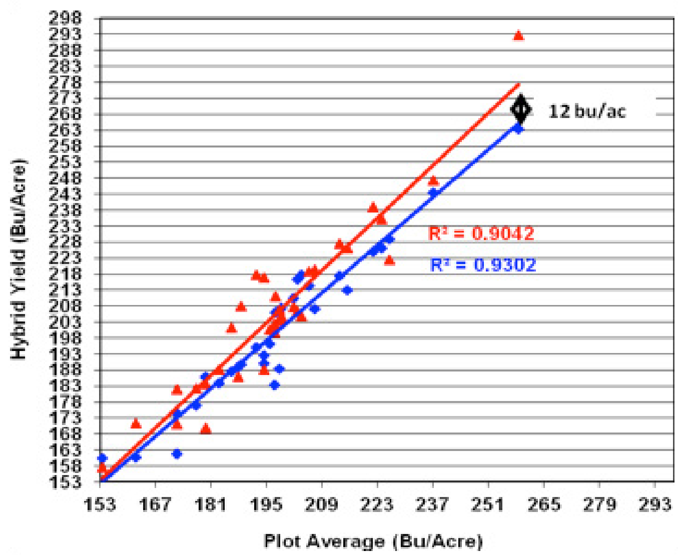
By contrast, a hybrid with a 'fixed' or 'semi-fle' cob; partnered with stress tolerance and the ability to exploit added inputs (strong roots) will respond to higher plant densities (34,000-36,000 plants/ac). The increased yield response can be attributed to the plant's ability to produce the same size of cob under low, medium and high planting densities.

The following is a comparison between two hybrids to help emphasize the importance of hybrid selection when increasing plant densities. As you can see in Table 1 the two selected hybrids are similar in maturity ratings, and stalk strength.

Table 1: Hybrid comparison

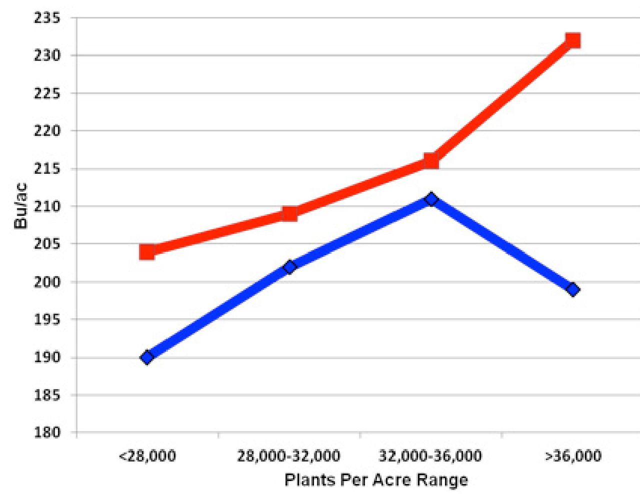
Hybrid	CRM	Root Strength (Catalog Rating)	Stalk Strength (Catalog Rating)	Traits	Response to Increased Planting Density
A	101	Very Good	Very Good	VT2Pro	Good
B	98	Excellent	Very Good	SSTX	Excellent

Below: When these two hybrids are taken to yield, there is a definite spread in the upper echelon of yield, but on the lower end they are statistically the same. Due to the 10-12 bu/ac yield spread between Hybrids A and B in the higher yielding environments, Hybrid B would be the selection of choice is a high yielding environment.



Above: A stability graph comparing Hybrid A to Hybrid B. A stability graph with enough data points is a powerful tool to understand how two different hybrids interact in different yield environments. This is done by plotting the hybrid's yield in a plot on the Y axis, and the average of that plot locations yield on the X axis. A linear slope is calculated based on each point for each plot location, and now you can compare how Hybrids A and B respond in different yield environments.

The next step that needs to be taken is to see how Hybrid B responds to higher plant densities. You can obtain this information from your seed provider, agronomist or consultants. Field scale trials can also be done on-farm to ensure accurate seeding rates for your farming environment. There is a lot of work involved in making the correct hybrid selection, but once you make the right educated hybrid selection it can pay back dividends on your farm. This statement resonates in the current example, as you can see in the following graph. Hybrid B continues to be the obvious choice for high fertility soils and increased plant densities. This process of hybrid selection will continue to be very important as the industry moves towards variable rate seeding. Positioning the right hybrid and population in the right management zone will be just as important as collecting accurate information to create said management zones.



Above: Yield comparison of Hybrid A vs Hybrid B in different plant density environments. Points are based on 40 plot locations across Ontario in ranges of population.

Fertility Increase Management:

As planting densities continue to increase, so do yields. With these increased yields increased fertility management is a very important factor that cannot be ignored. Soil fertility should simply be accounted for similar to a balance sheet: Soil Assets (fertility) – Crop Removal = Fertility Equity.

In other words as yields go up, more fertility is taken away from the soil and therefore fertility application needs to be seriously addressed. In fact, work done by Ciampitti et al 2013 and Bender et al 2013 shows that aggressive management strategies like: increases nitrogen rates & increased plant densities have changed the way nutrients are being taken up by the corn plant. In a Ciampitti et al 2013 article they stated that little is known in regards to management-induced changes to plant uptake and partitioning (allocation) of nutrients other than macronutrients.

In this section of the paper I will address how uptake and utilization of mirco nutrients are affected under increased nitrogen rates and plant densities. For an in-depth look at macronutrients please refer to the article written by PRIDE Seeds agronomist Aaron Bowman titled Feeding Today's High Yielding Hybrids: Macronutrients.

Justin Von Liebigs's Law of the minimums.

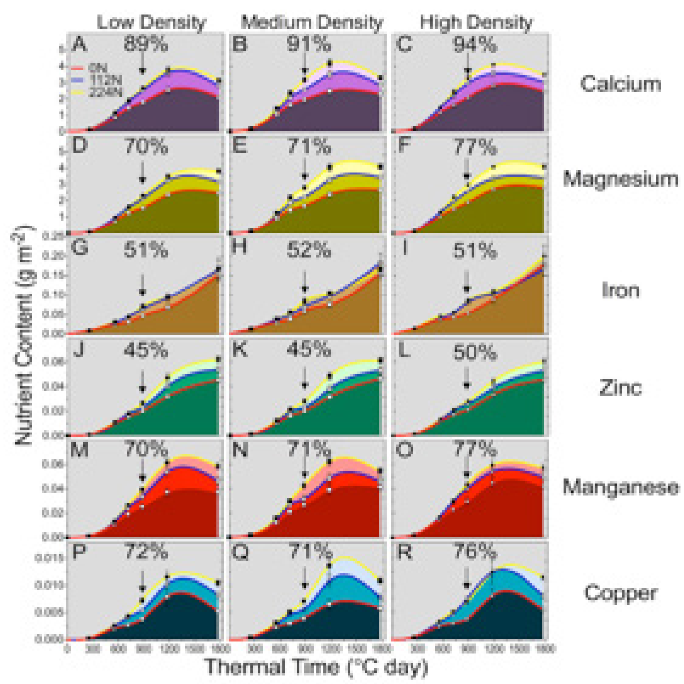
Justin Von Liebig's Law of the Minimum is a theory that has been readily accepted by modern agriculture. Liebig's law states that yield is proportional to the most limiting nutrient (Barak 2000). Liebig's Law has been associated with a wooden barrel (above) to give a visual representation; the water in the barrel represents yield and the lowest rung of the barrel represents the most limiting nutrient that limits yield until the next limiting factor is occurred.

Micronutrients are nutrients that can be overlooked when making cropping plans because they are used in excess, where micronutrients are used in smaller quantities. Ciampitti et al 2013 even stated that the likelihood of micronutrient deficiencies would only increase with the routine application of macronutrients.

Ciampitti et al 2013 wanted to understand how high yielding management systems affect the uptake and utilization of micronutrients (Fe, Zn, Mn, Cu) and two macronutrients (Ca, Mg). What Ciampitti et al 2013 found was very interesting. As you can see below, there was a plant response to increased plant densities and nitrogen rates. The corn plant actually changes how it takes up all of the observed nutrients. The two major factors that should be looked at are:

1. Percent nutrient concentration at flowering (VT)

2. How increased nitrogen rates affect the plant concentration of each observed nutrient



This illustration shows how nutrient concentration of Ca, Mg, Fe, Zn and Cu changes within the plant as nitrogen rates and plant densities are increased. The following colours represent the nitrogen rate (lb/ac): red line 0 N, blue line 112 N and the yellow line 224 N. The low, medium and high plant density values are as follows in ascending order: 22,000 plants/ac, 32,000 plants/ac, 42,000 plants/ac. The black arrow with a percentage value represents the percentage of nutrient concentration at tassel (VT). This graph was produced by Ciampitti et al 2013 . Agron. J. 105:3 783-795

Percent Nutrient Concentration at Flowering (VT):

Across all nutrients observed, except for iron (Fe), the percent nutrients concentration at flower increased dramatically with increased plant densities and nitrogen rates. This means that as said rates increase, the corn plant demands more nutrients (in this case Ca, Mg, Zn, Mn and Cu) from the soil. This means that as nitrogen rates and plant densities are increased, micronutrient supply needs to be seriously assessed and applied accordingly.

How increased nitrogen rates affect the plant concentration of each observed nutrient:

As nitrogen rates are increased, the whole plant concentration of all nutrient observed are increased (except for iron). Even at the low planting density (22,000 plants/ac), concentrations of all observed nutrients are almost doubled from the low rate (0 N) to the high rate (224 N). This means that even if nitrogen rates are increased to maximize the yield potential of corn, even without any change to population, the observed nutrients (Ca, Mg, Zn, Mn and Cu) should be assessed by soil test or tissue test. These tests will help to ensure you are truly maximizing the selected hybrid's genetic potential and the soil's nutrient available yield potential, thus controlling some of the controllable factors in high yielding corn management systems.

Summary:

As we continue to improve management strategies for high yielding corn we need to critically look at each new strategy before they are implemented into our systems.

This means being mindful of synergistic and inhibiting effects for each strategy and how they affect your whole management system.

In this article we discussed how hybrid selection, plant densities, and nitrogen rates can have a synergistic effect to create a high yielding corn environment. The inhibiting factor was the increased uptake of micro and macronutrients and if not addressed with added application could result in a yield plateau or a theoretical decrease in yield. This discussion also applies to the importance of partnering variable rate seeding and variable nutrients application so the right amount of nutrients are applied to maximize your selected hybrid's maximum yield potential in each management zone.

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