**Why Yield Potential and Nitrogen Response are Independent**

**Abstract**

Recent work has highlighted the importance of yield potential (YP0) and nitrogen response or the response index (RI) as being independent.

This work documents the controlling variables that explain why YP0 and RI are independent. Furthermore, this manuscript delineates the need for estimates of both to arrive at reliable mid-season fertilizer N rates.

**Introduction**

Each year, residual N in the soil following harvest is different. Yield levels change radically from year to year, a product of an ever changing and unpredictable environment. Residual N that is left behind ends up being random.

Work by Bundy and Malone (1988) demonstrated that soil profile NO3-N influenced maize response to applied N. They further noted that adjustment of N recommendations for profile NO3-N should be made especially when substantial overwinter carryover of profile NO3-N occurs. Recorded profile NO3-N was highly variable over years and locations sampled (Bundy and Malone, 1988).

Over an eight-year period (1991 to 1998), Herron et al. (1999) showed that total rainfall at North Platte, NE ranged from 477 to 723 mm, with the low and high falling in consecutive years (1995, 1996).

Dhital and Raun (2017) showed that optimum N rates for maize fluctuated from year to year at all locations. This work encumbered 213 years of field trials coming from Colorado, Iowa, Kansas, Kentucky, Maryland, Minnesota, Missouri, Nebraska, Texas, and Wisconsin. Published data included in this work spanned the years of 1958 to 2010. This study further showed that optimum N rates were not correlated with either the high-N rate yield or the 0-N check plot yield.

Delta yield concept here, please check.

Precipitation and mineralization of soil organic matter have a tremendous effect on nitrate losses and N loading in subsurface drainage water (Randall and Mulla, 2001). Row crops leak substantially greater amounts of nitrate compared with perennial crops. Improving N management by applying the correct rate of N at the optimum time and giving proper credits to prior-year management and residual N will lead to reduced nitrate losses (Randall and Mulla, 2001).

One of the reasons that yield potential and N response are independent is because residual N from the previous year is always different (random due to last year’s environment).  The contribution of residual N for the ensuing year then impacts ensuing years’ RI, randomly, but that doesn’t necessarily impact yield level, unless it was a great year (no moisture stress).

This concept is expressed in results from Dhital and Raun (2017) that documented highly variable optimum N rates from year to year and location to location, across the entire Great Plains states. This was also tied to the unpredictable nature of the environment on N demand.

If the ensuing year was a bad year, and I had all this residual N hanging around, things line up, and the RI is low and yields are low.  What makes sense is the random nature of yield level, and the random nature of RI.  But, each is theoretically influenced by different years (yield by the current year, and RI by the previous year).  Because each is random, this makes sense as to why YP0 and RI would seldom be related (over time).  OSU long term experiments allow for the actual testing of this concept. Although all wheat, the theory should be the same for most cereal crops.

previous year yield, versus current yield

previous year yield, previous year N yield increase versus current yield

previous year RI, versus current yield

previous year delta yield. versus current RI

From Raun yp0-ri#1

Because yield and response to N were consistently independent of one another, and as both affect the demand for fertilizer N, estimates of both should be combined to calculate realistic in-season N rates

From Raun, ypo-ri#2

The biological reasons that would explain why yield potential and N responsiveness are independent of one another include knowing that there are wetter than normal years when yield levels are high, but where limited N response to fertilizer has been reported (Raun et al., 2009; Raun and Johnson, 1999). Similarly, finding large increases in yield from applied N in mild/ dry years is not unusual (Girma et al., 2007a). The unpredictable nature of the environment was evident at Arlington, WI, where the check plot yielded 5.6 Mg ha–1 in 1995. Considering that no N had been applied for 37 yr, it was somewhat surprising to find a yield level almost 60% of the highest yield observed in 1995 (9.5 Mg ha–1) (Fig. 5). Without exception, near maximum yields were randomly observed in check plots having received no fertilizer N for many years, at all sites (Fig. 1–8). The influence of environment on N demand is variable and unpredictable. A consequence of unpredictable weather effects on crop requirements has been to use reference plots (high N rates) and crop sensing before in-season N application (Tremblay and Belec, 2006). This is then bound to the understanding that weather (particularly rainfall in dryland crop producing areas) is the primary driver of both plant growth and soil nutrient availability, and that weather changes dramatically year to year. This was in turn reflected in unusually high check plot yields that were randomly observed over time in all seven long-term trials evaluated. Specifically for this work, this was further expressed in the random nature of N response (estimated using RI) over time and that was observed in each long-term experiment (Fig. 1–8).

What does NOT impact YP0

What does NOT impact RI

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