Optimizing Corn Plant Density

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Our experiments in Illinois

- We conducted hybrid x density trials at 5 to 7 sites per year from 2012 through 2016
- We used a precision planter to drop seeds in 4-row plots (0.76 m rows) about 23 ft. (7 m) long
- Plant stands have been very close to dropped populations; we'll consider them the same
- We fitted an appropriate line to the data, and calculated optimum densities based on corn at $3.75/bushel ($148/t) and seed at $3.00 per thousand, for a ratio of 3/3.75 = 0.8 or 3/148 = 0.0203

\[ y = -0.1631x^2 + 10.736x + 9.7383 \]
\[ R^2 = 0.9956 \]

Yield, bu/acre
Plant density, 000/acre

Quadratic response

Max  ▲ Opt

Yield = 92.4 + 7.37P – 0.098P^2

Quadratic + plateau response

Max  ▲ Opt

Response by site, 2012 (dry)

Response by site, 2013
Response by site, 2014

Response by site, 2015

Response by site, 2016

Density responses by year

A "return to seed" approach

RTS by site-year, n=32
The results of our “VRT” exercise:

- The average of the 32 different optimum plant densities was 33,399 plants/acre (82,496/ha)
  - That’s 62 fewer plants per acre (153/ha) than the 33,461 needed for the overall MRTS
- The average MRTS from using VRS (32 different densities) was $742.89/acre ($1,834.94/ha)
  - That’s $2.80/acre ($6.92/ha) more than the $740.09/acre RTS at the (uniform) MRTS density
- Of the $2.80/acre, $0.19/acre was from lower seed cost (62 seeds) and $2.61 was from higher yield (0.7 bu/acre) with “VRS”

Now suppose...

- That we had a field with 32 blocks, and we knew (somehow) that the plant density response in each block would be the same as at one of the 32 site-years in our study
- This allows us to calculate the return to seed at the “perfect” density for each zone, and to compare the average over zones to the overall “MRTS” number (average of all 32 RTS lines at the MRTS density)
Summary and conclusions

- Optimum plant densities over a range of growing conditions in productive fields mostly range from 30,000 to 40,000 per acre (75,000 to 100,000/ha)
- We found an economic optimum across sites of 33,400 plants/acre (82,500/ha)
- Optimum density was positively but rather weakly correlated with yield at optimum density
- Over 32 site-years, simulated variable-rate seeding produced slightly higher net return to seed than uniform seeding
  - VRS "works" but may provide little return in many fields
- Penalties for over- and under-seeding for the conditions may be less than we have thought

THANK YOU