

PURDUE

Agronomic Practices for Irrigated Corn Production

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What is the greatest single obstacle to consistently achieving higher corn yields?



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“Normal” growing seasons!

- “Normal” growing seasons are those that involve an unpredictable number of unpredictable **extreme** weather events, each occurring unpredictably, with unpredictable severity.

The frequency of extreme weather events is becoming more prevalent.



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Consequently, our greatest agronomic challenge today is to stress-proof our crops against unpredictable, extreme weather events.

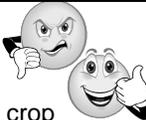


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Bad news & Good news

- The effects of weather stress on crop growth and yield are compounded by the presence of other yield-limiting factors.
 - Soil compaction, nutrient deficiencies, disease damage, insect injury, weed competition, poorly drained soils, or any of the other gazillion yield-limiting factors that influence crop growth & yield.
 - That's the bad news.



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Also good news because...

- If you can identify and manage other yield-limiting factors, this will help you “stress-proof” your cropping system against the vagaries of Mother Nature.



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Yield influencing factors (YIFs)

- Can be positive or negative.
 - Pay attention to both.
- Some occur every year.....some do not.
- Often interact with each other.
- Often influence different crops differently.
- Almost always interact with the weather.



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How to identify YIFs?

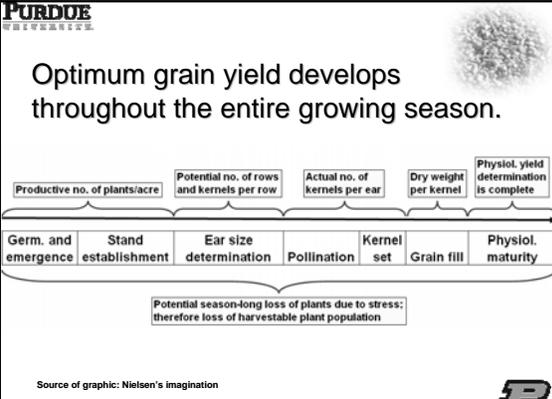
- Spend time with your crops.
- Educate yourself.
- Consult folks w/ experience.
- Document everything.
- Spend time with your crops.
- Attention to detail.
- Identify problems early.
- Diagnose every problem.
- Spend time with your crops.



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Optimum grain yield develops throughout the entire growing season.



Source of graphic: Nielsen's imagination

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Optimum grain yield begins with...

- Establishing a healthy, vigorous stand of corn by the time the crop has reached about V6 (knee-high).
 - Choice or luck with planting dates.
 - Seedbed & initial growing conditions.
 - Speed & uniformity of germination / emergence.
 - Initial population vs. seeding rate.
 - Success of initial root development.

Image: RL Nielsen

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Optimum yield continues with...

- Maintaining the health of the root system and crop canopy throughout the entire growing season.
 - Soil fertility / plant nutrition
 - Plant health (diseases)
 - Plant health (insects)
 - Soil tilth, health, quality factors

Image: RL Nielsen

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How to raise the "yield bar"...

- I do not have all the answers.
- But, then, neither does anyone else.
- Let me share with you some of the key factors that I believe to be important for raising the "yield bar" for corn in the eastern Corn Belt.
 - Maybe some of these agronomic factors will resonate with you also.

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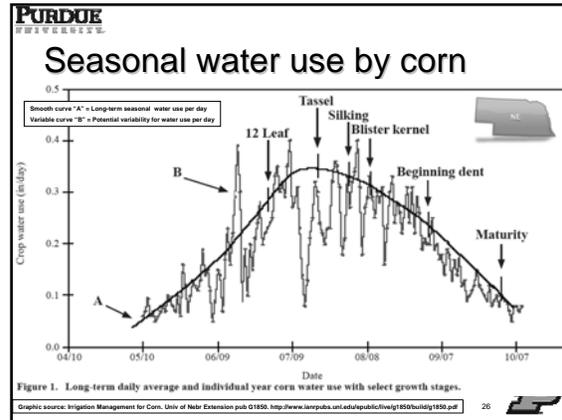
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Evapo-transpiration (ET) by corn

- Early in the season, ET is primarily driven by soil moisture evaporation.
- As plants develop, ET is driven primarily by transpiration by the plants, but declines as plants mature during grain fill.
- Thus, seasonal ET for a corn crop looks like a typical “bell” curve...



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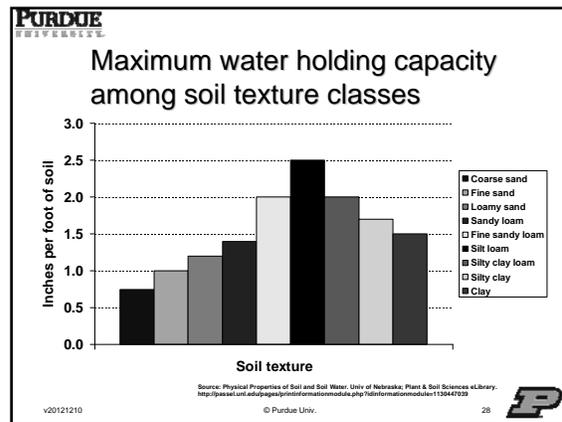
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Water requirements for corn

- From 20 to 25 inches total (soil reserves + rainfall + irrigation).
 - For you trivia fans, an acre-inch of water equals 27,154 gallons; so an acre of corn requires as much as 678,850 gallons of water in a growing season.
 - Depending on soil texture and depth, soil moisture capacity may be as great as 10 to 12 inches.



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Improved irrigation management

- Make more informed decisions on when to irrigate and how much water to apply.
 - Capacity of irrigation water supply
 - Well, reservoir, river, drainage ditch
 - Pump capacity (gal/min)
 - Efficiency (accuracy) of irrigation system
 - Soil water holding capacity & current status
 - Water needs (ET) of the crop
 - Anticipated rainfall



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NebGuide
University of Nebraska—Lincoln Extension, Institute of Agriculture and Natural Resources
Know how. Know now.

G1859

Irrigation Management for Corn

William L. Kranz, Irrigation Specialist, Northeast Research and Extension Center
Suat Irmak, Agricultural Water Management Specialist, Biological Systems Engineering
Simon J. van Duik, Water Resources Engineer, West Central Research and Extension Center
C. Dana Young, Irrigation Engineer, Panhandle Research and Extension Center
Derrel L. Martin, Professor, Biological Systems Engineering

<http://www.ianrpubs.unl.edu/epublic/live/g1859/build/g1859.pdf>

Also, this one from Michigan State Univ:
http://msue.anr.msu.edu/news/drought_irrigation_management

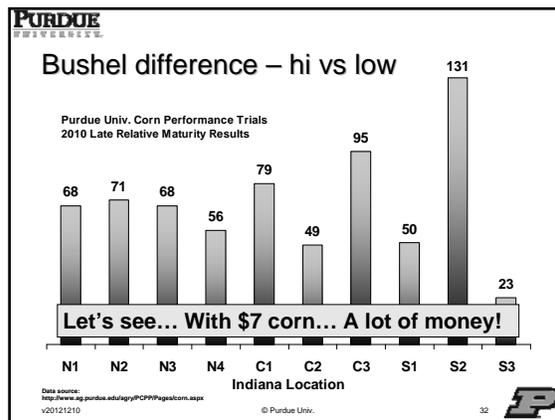
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Hybrid selection

- There is a lot of money to be made or lost with this one decision.
 - As much or more than any other crop input decision corn growers make every year.
- Just look at the bushel differences between the highest to lowest yielding hybrids in any public variety trial.
 - Assuming companies do not enter crappy™ hybrids in variety trials!

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Yield potential AND consistency

- In the absence of stress, hybrids yield differently simply due to differences in genetic yield potential.
- **CONSISTENCY** of yield performance over years and across locations is based on how well hybrids tolerate unforeseen and unpredictable stresses.

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So, your challenge is to...



- Identify hybrids that tolerate a wide range of growing conditions.
 - Evaluate variety trial results from a lot of locations (i.e., growing conditions) and look for hybrids whose yields are at least 90% that of the highest yielding hybrid in almost every variety trial you can find.
 - Do not relegate this decision solely to your seed dealer. Be a participant in the process!

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Drought tolerant hybrids?

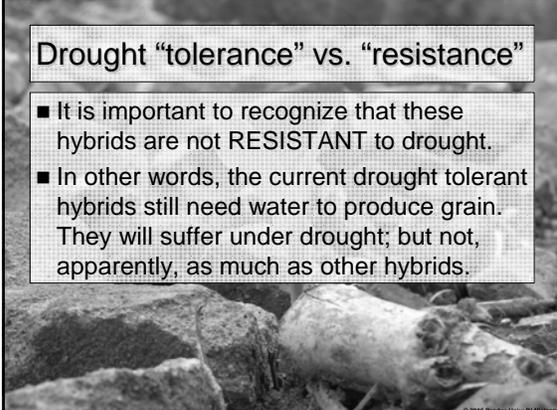
- There is no single common trait among hybrids currently labeled "drought tolerant"
 - Simply have shown the ability to yield better than others under water-limited conditions.
- If you can find the evidence that supports their superiority for yield and consistency of yield across a wide range of growing conditions, go for it.

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Drought "tolerance" vs. "resistance"

- It is important to recognize that these hybrids are not **RESISTANT** to drought.
- In other words, the current drought tolerant hybrids still need water to produce grain. They will suffer under drought; but not, apparently, as much as other hybrids.



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Drought “tolerance”; not “resistance”

- E.g., Pioneer AQUAmax™ 2012 reports*:
 - Across 3,606 water-limited environments, out-yielded “competitive” hybrids 69% of the time by an average of 8.9% or about 8.5 bu/ac.
- Let’s do the math:
8.5 bu = 8.9% better than competitors
Therefore, competitors’ avg yield = ??

- Competitors’ avg yld = 8.5 divided by 0.089 = 95.5 bu/ac
- So, the avg AQUAmax yield was 95.5 + 8.5 = 104 bu/ac

* Online at <https://www.pioneer.com/home/site/us/products/corn/seed-traits-technologies/seed-traits/yield-data-early-look>
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Soil tilth, “health”, or “quality”

- Minimize the risk of soil compaction caused by tillage or other equipment.
- Minimize tillage traffic or adopt outright no-till where appropriate.
- Minimize grain cart traffic and other heavy equipment on your fields.
- Include fall or winter cover crops where appropriate.

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Crop rotation...

- Avoid continuous corn, especially no-till corn after corn... Too many challenges.
 - Surface corn stover delays soil drying / warming and can interfere with planter operation.
 - Decomposing corn stover immobilizes soil N.
 - Corn stover harbors disease inoculum.
 - Continuous cropping puts “all the eggs into one basket” in terms of weather stresses.

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Relative Crop Yield Loss 2012 Indiana

Crop	Percent departure from trend
Corn	-38.1%
Soybean	-9.3%
Wheat	-6.60%

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Starter fertilizer...

- Adopt a robust 2x2 starter fertilizer program; especially in terms of starter N.
 - In challenging conditions, starter N aids young corn plants (V3 – V5) as they “wean” themselves from the kernel reserves to dependence on nodal roots.
 - Consider starter N rates no less than 30 lbs actual N /ac, and maybe higher for no-till continuous corn or corn into cover crops.

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Nitrogen management...

- Implement nitrogen management practices that minimize risk of N loss and maximize N use efficiency by the corn crop.
 - Avoid fall N applications (risk of N loss).
 - Avoid early spring N applications (N loss)
 - Avoid surface-applied urea-based fertilizers without incorporation (risk of N loss).
 - Sidedress or split-apply N where practical.

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Risk of N loss with irrigation...

- Is inherently greater than many rain-fed situations elsewhere, primarily because of sandier soils that cannot “hang on” to nitrate-nitrogen.
- Thus, greater value to...
 - Sidedressing or fertigation
 - Ammonia vs. UAN; especially pre-plant
 - Nitrification or urease inhibitors; esp. pre-plant

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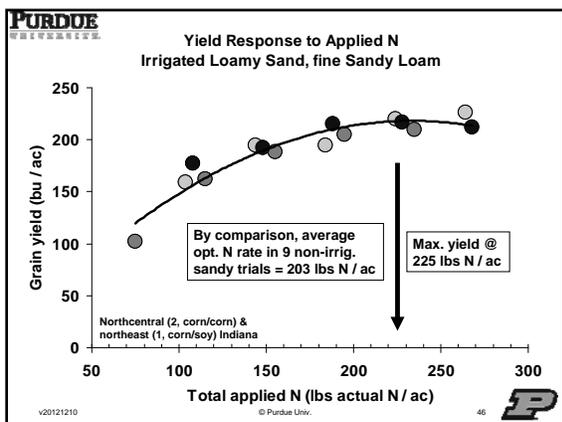
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Thoughts on N fertilizer rates

- Optimum N fertilizer rate is not correlated with yield potential!
 - Corn generally requires about 275 TOTAL lbs of actual N per acre (soil + fertilizer).
- Rotation corn N guidelines (lbs of actual N applied per acre)
 - Low risk of N loss: 180 – 190 lbs
 - High risk of N loss: 210 – 220 lbs
- Continuous corn about 40 lbs higher

Based on nearly 200 field-scale research trials conducted since 2006

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We're looking for collaborators...

- To participate in on-farm trials evaluating N fertilizer rates under irrigated and non-irrigation conditions.
- Variable rate, Rx-driven controller simplifies logistics.
- Auto-steer may be beneficial.
- GPS-enabled grain yield monitor simplifies harvest.



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On-farm corn N rate trials

- Typically, five to six N rates.
 - Range of rates negotiable, but low to high
- Replicated 3 to 6 times.
 - Field length plots, ~ twice combine width
- Option to include seeding rates.
- Option to include 2 hybrids (split-planter).

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Disease management...

- Yield losses from foliar diseases can easily lower corn yields by 20% or more.
- Implement sound disease management strategies that include...
 - Hybrid selection for disease resistance
 - Crop rotation
 - Tillage (where appropriate)
 - Foliar fungicides (if needed).

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Surface “trash” in no-till...

- Manage surface “trash” in no-till to hasten drying / warming of soil, facilitate effective planter operation, and improve crop emergence & stand establishment.
 - Kill winter annual weeds and / or cover crops before their growth becomes unmanageable.
 - Use row-cleaners on the planter row units.
 - Minimize the risk of furrow sidewall or surface compaction by avoiding planting when soil moisture is “on the wet side”.

Seeding Rates

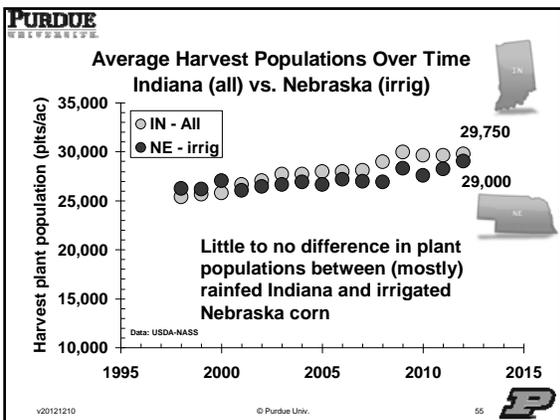


Balancing act for corn...

- More plants per unit area equals more ears per unit area. (that’s good)
- But, ear size per plant decreases with increasing plant density. (that’s not good)
- The optimum final stand is that which best balances the decrease in ear size per plant with the gain in ears per unit area.
- Furthermore, stalk health & integrity at higher populations sometimes falters.

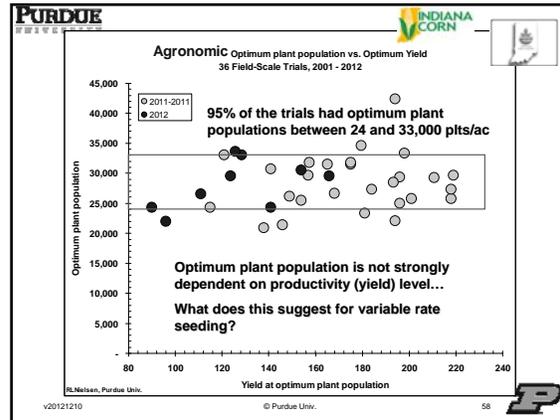
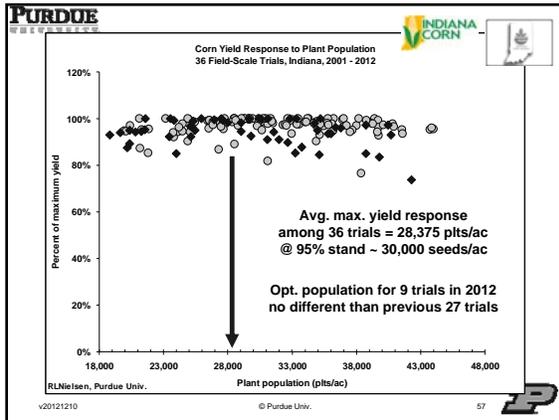
General observations

- Little difference for optimum harvest population at yield levels ranging from low 100’s to low 200’s.
- Few differences between well-rainfed and irrigated corn.
- Few differences among hybrids.
- Little evidence that higher seeding rates require more N fertilizer.



On-farm corn seeding rate trials

- Since 2010, I have been involved with 27 field-scale or on-farm seeding rate trials around the state.
 - Other field-scale trials back in the early 2000’s bring the total number up to 37 trials.



Variable seeding rates...

- In all honesty, there is probably a maximum of two meaningful seeding rates that might be used in any given field....
 - A rate on the lower end for challenging soils.
 - Approximately 130 bpa or lower.
 - Seeding rates ~ 25,000 spa
 - A rate on the higher end for everything else.
 - Seeding rates ~ 32,000 spa

Image and opinion: RL Nielsen © Purdue Univ. 59

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Remember, it ain't rocket science!

- The key factor is to identify those yield limiting factors that are most important for your specific farming operation.
- Together with your crop advisor(s), identify & implement good agronomic management practices to target those yield limiting factors.

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