PURDUE UNIVERSITY

Stand Establishment Issues & Concerns for No-Till Corn

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A Common No-Till Lament….

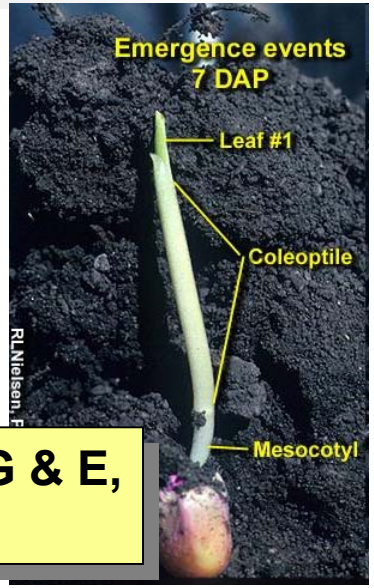
- "Stand establishment with no-till soybeans is easy, but…
- **Stand establishment with no-till corn can be a royal pain in the rear!"**

Key points…

- Fast/uniform germination, emergence, and early development
  - Why these are important.
  - Discuss key factors required to achieve these.
- "Trashy" nature of early season no-till environment
  - Soil temperature & moisture
  - Planter challenges
  - Disease & insect pressure
- Agronomic & equipment decisions
  - Hybrid sel'n
  - Planting date
  - Seeding rate
  - Starter fert
  - Planter gadgets
  - Strip tillage

Stand establishment phase

- Germination & emergence (G & E)
  - Ideal conditions:
    Occurs less than 7 days after planting
  - Your experience says .....?



Stand Establishment does not end with successful G & E, it also includes…

- Establishment of nodal roots by leaf stage V6
  - Ideal conditions:
    V6 occurs 25 to 35 days after emergence
  - Your experience says .....?

Stand Establishment:

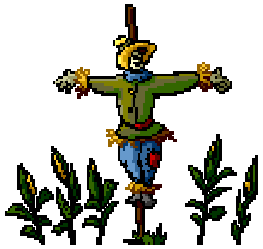
Why is "fast" desirable?

- Shorter exposure time to damaging soil-borne pathogens, insects or pesticides prior to full stand establishment.
  - Plus overall improved crop tolerance to stresses.
- Faster root development…
  - Hastens their encounter with soil nutrients.
- Increases the effective length of the available growing season.
  - Crop development remains on schedule.

Stand Establishment:

Why is "uniform" desirable?

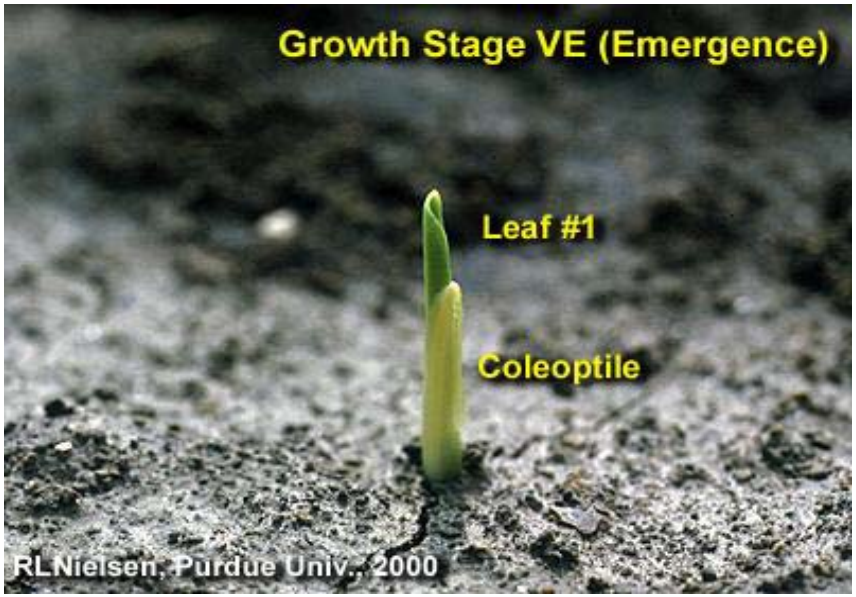
- Stragglers in uneven stands are out-competed by healthier plants.
  - Yield less or not at all.
  - Effective plant population is reduced.



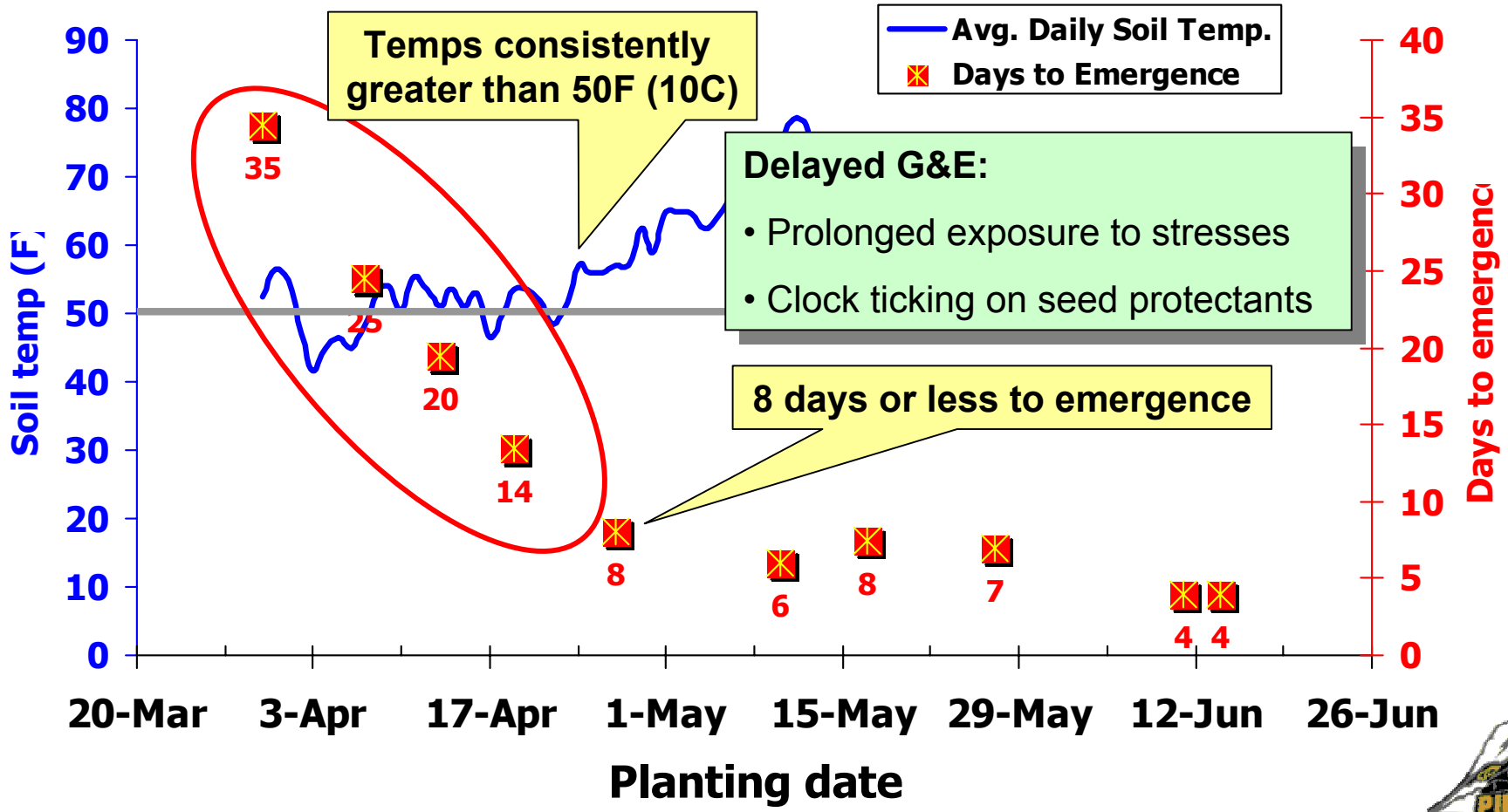
Germination & Emergence:

Fast & uniform G&E requires:

- Adequately warm soils
  - Consistently higher than 50° F (10° C)
  - Uniform temperature within the seed zone
    - Especially when soil temperatures are hovering around 50° F to begin with.



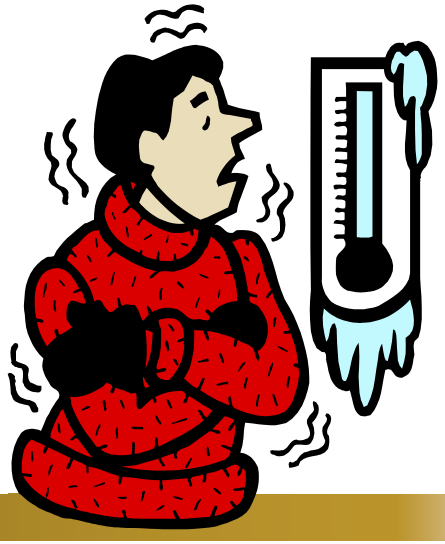
Soil temperature & corn emergence



Variable seedbed temperature…

- Variable soil color, texture, & drainage
- Variable seeding depths
- Variable distribution of surface trash

- Especially important when soil temps. are hovering around 50F (10C).



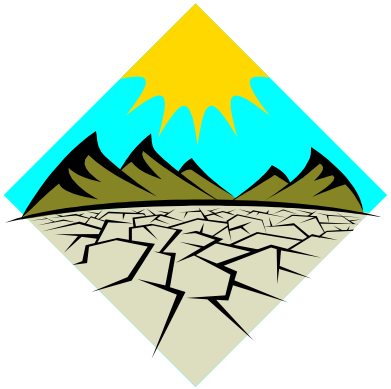
Germination & Emergence:

Fast & uniform G&E requires:

- Adequately & uniformly moist soils
  - Too wet >> Drowning or death by disease
  - Too dry >> Inert seed (like in the bag)
  - Uneven >> Uneven germination

Variable seedbed moisture…

- Soil variability for texture and natural or artificial drainage
- Uneven seeding depths
- Uneven distribution of surface trash
- Soil drying patterns due to tillage traffic



Germination & Emergence:

Fast & uniform G&E requires:

- Adequate & uniform seed-to-soil contact
  - Imbibition of moisture req'd to begin germination
- Poor substitutes…
  - Seed-to-trash!
  - Seed-to-rock!
  - Seed-to-clod!

Variable seed-to-soil contact...

- Rough, cloddy seedbeds
- Uneven distribution of surface trash
- Coulters running too deep (air pockets)
- Incorrect furrow opener adjustment
- Incorrect closing wheels adjustment

Germination & Emergence:

Fast & uniform G&E requires:

- Pest-free conditions
  - Grubs, wireworms, seedcorn maggots
  - Seed rots and seedling blights
  - Prying agronomists!

Germination & Emergence:

Fast & uniform G&E requires:

- Surface soil free of crust or compaction that would interfere with the emergence of the coleoptile (spike)

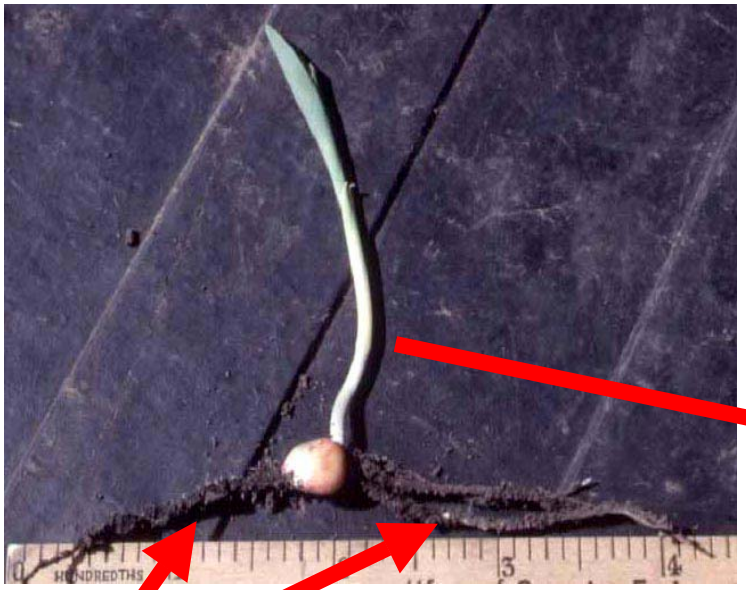
When good fields turn bad

- Successful emergence (fast & uniform) does not guarantee successful stand establishment.
  - The next crucial phase is the establishment of a vigorous nodal root system, from about 2-leaf to 6-leaf stages of development.

Nodal root system

- Nodal roots originate from stalk nodes
  - One set of roots develops from every below-ground node plus 1 or more above ground nodes.
    - Nodal root sets develop sequentially over time.
  - Begin elongation shortly after seedling emergence.
    - First set is noticeable by 2-leaf collar stage
  - By 6-leaf collar stage, will be the main roots of plant if development has occurred normally.

Growth stage VE (Emergence)

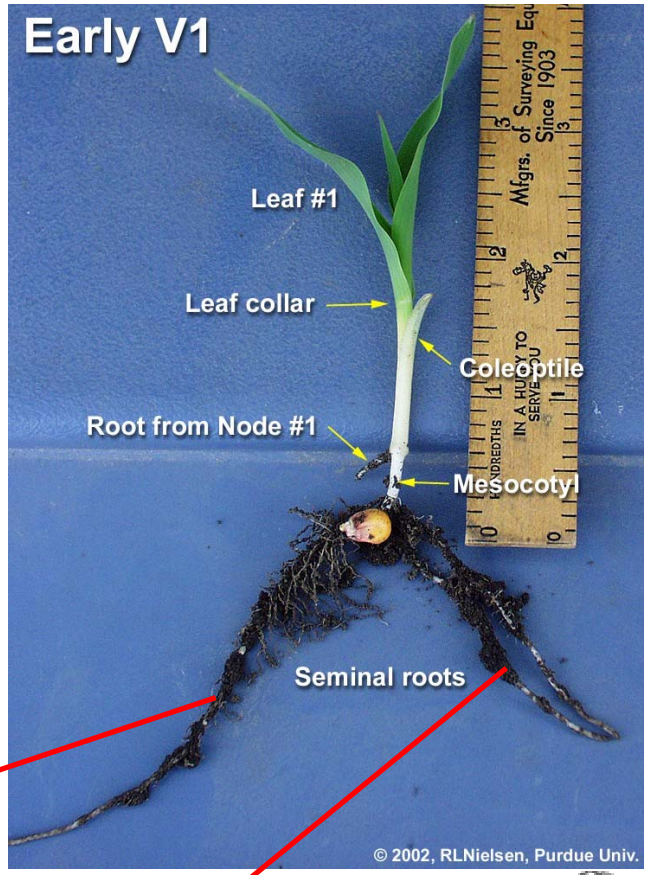


Seminal (seed) roots

Swelling of 1st nodal roots

Seminal (seed) roots…

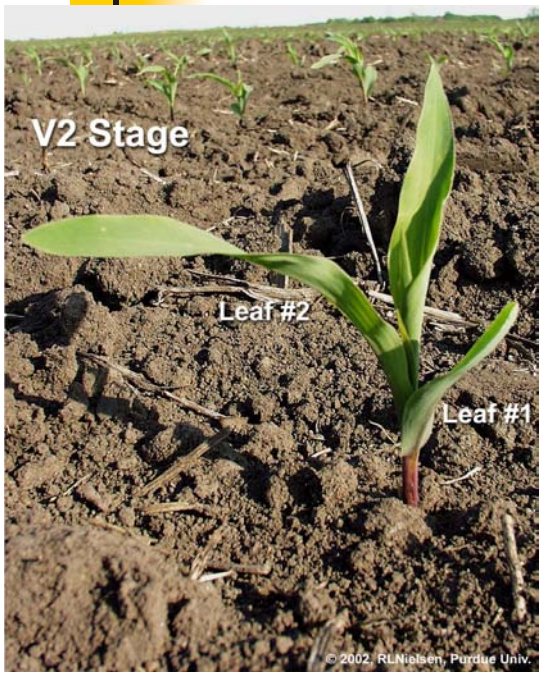
- Originate from the node located within the seed embryo.
  - Composed of the radicle root and lateral seminal roots.
  - Serve mainly to anchor seedling.
  - Take up minimal amounts of water & nutrients.
  - Cease new growth shortly after seedling emergence.



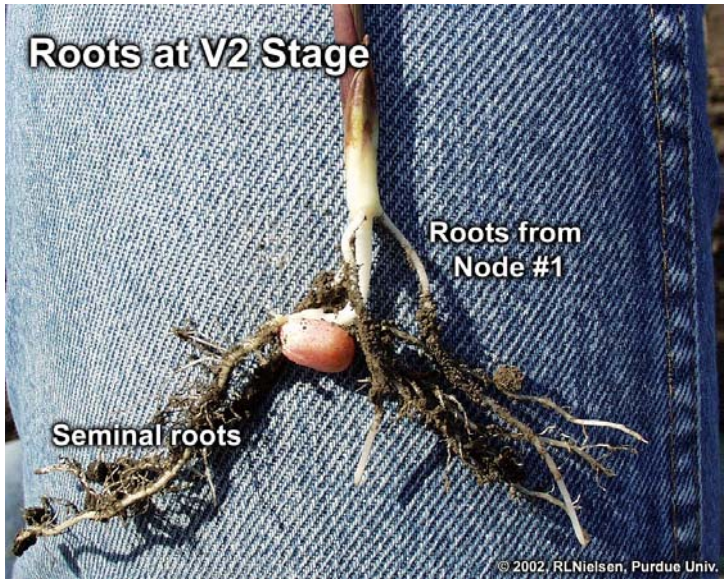
Radicle

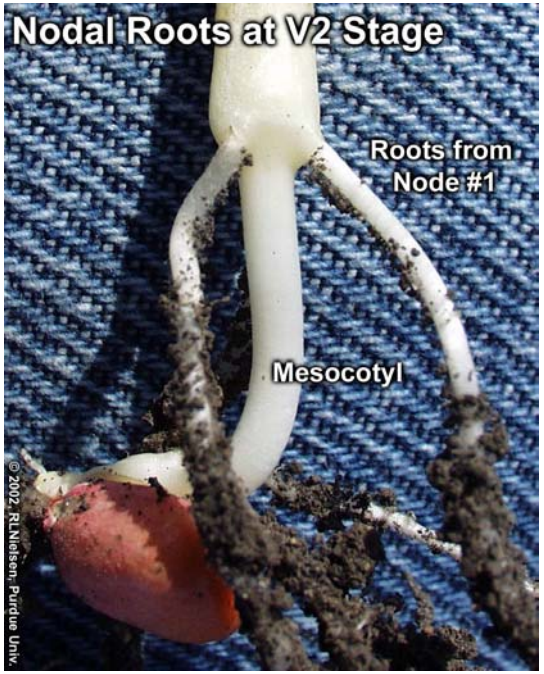
Lateral seminal

Nodal roots at V2…

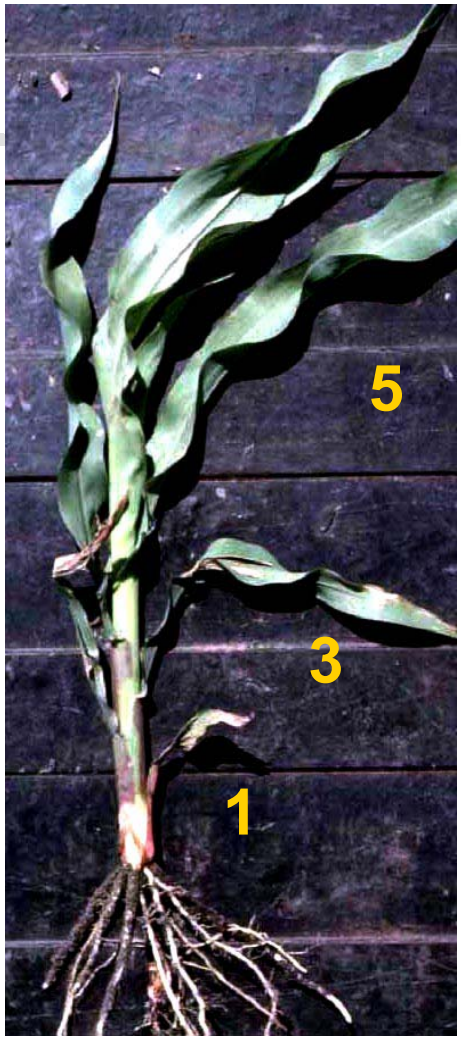


Lowermost two leaves with visible leaf collars.

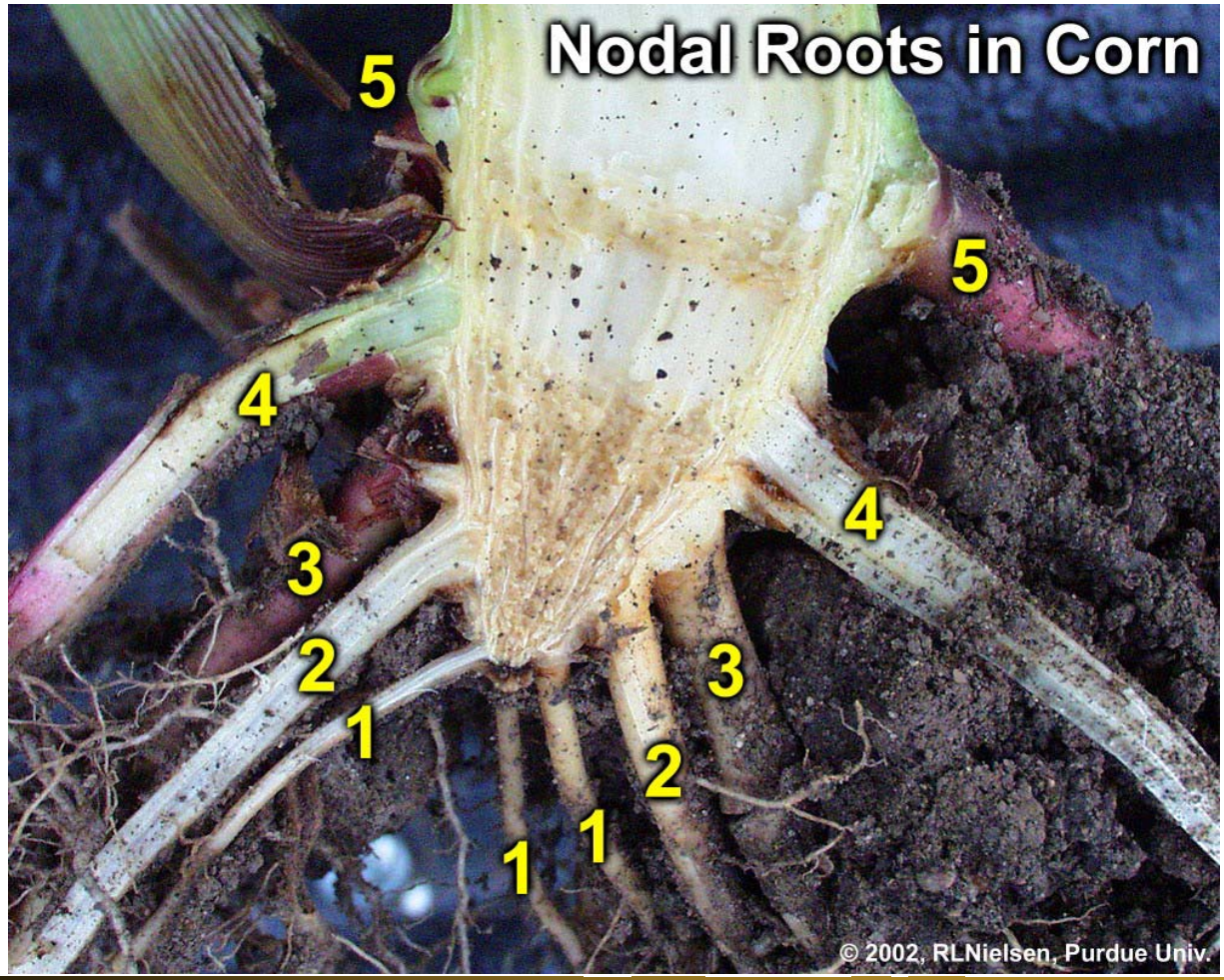




Nodal roots at V5



Nodal root morphology…

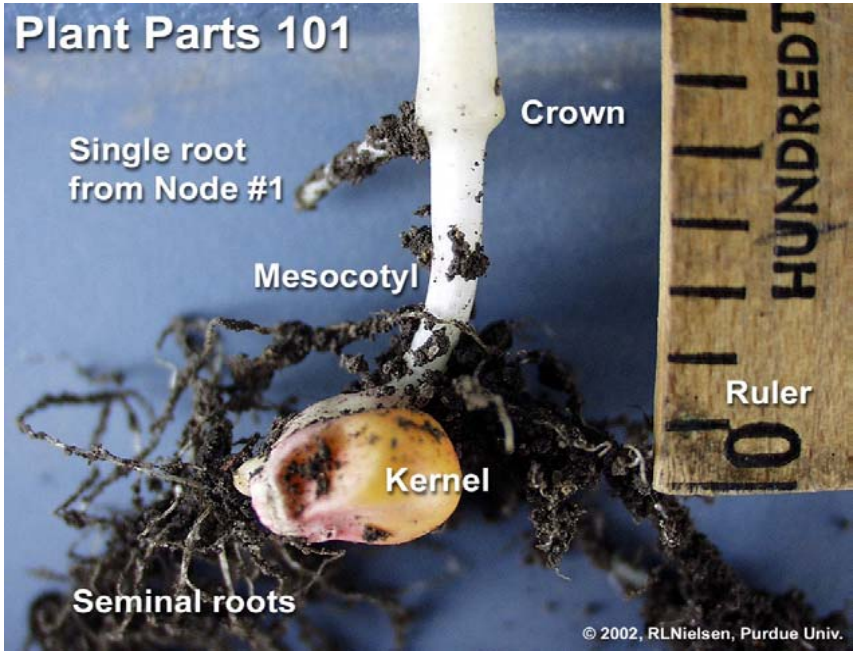


Until nodal roots are established…

- Seedlings depend primarily on the energy reserves of the kernel…
  - Translocated from the kernel through the connecting mesocotyl "pipeline" to the young stalk and leaf tissues.

Mesocotyl?

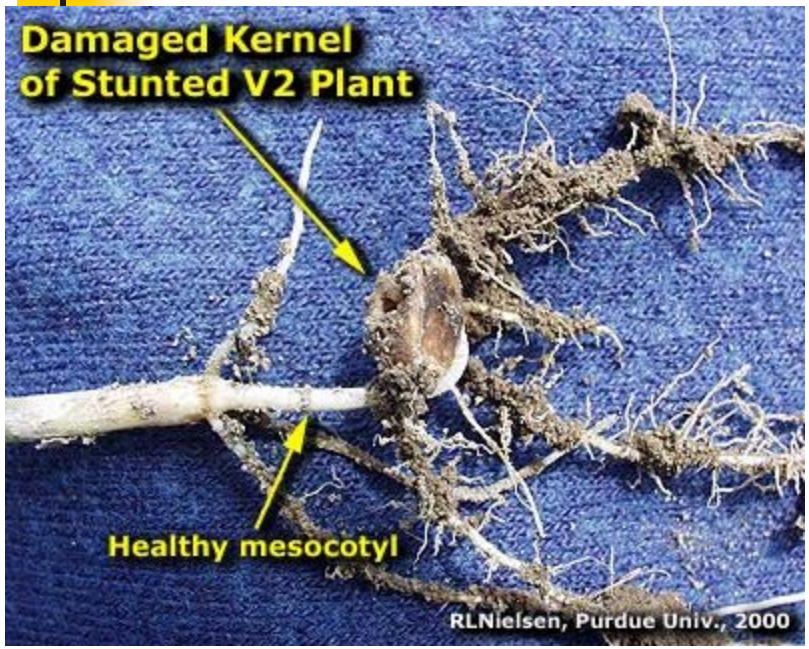
- Tubular, white, stemlike tissue that connects the kernel and base of coleoptile (the "crown").
  - Mesocotyl cell elongation elevates coleoptile to soil surface during emergence.



From emergence to knee-high…

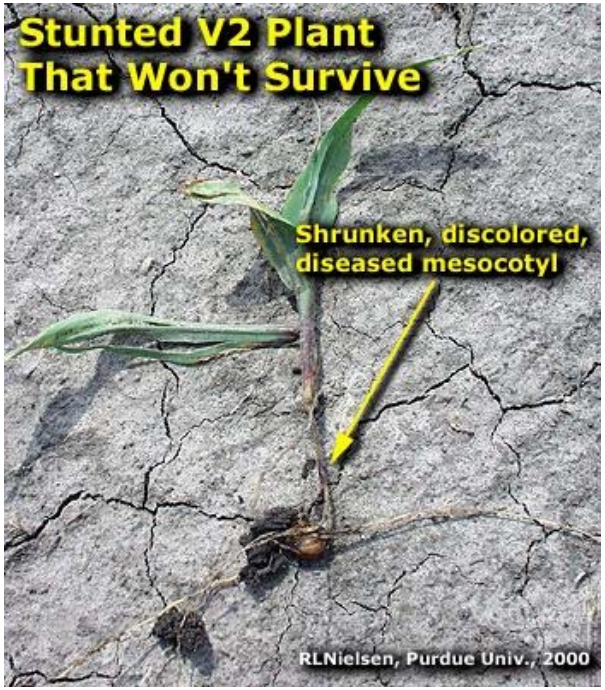
- Damage to the **kernel or mesocotyl** prior to establishment of nodal root system will stunt or kill the seedling
  - Most sensitive from emergence to about 3-leaf collar stage of development
  - Stresses include fertilizer salt injury, seedling diseases, insect feeding damage, excessively wet or dry soils

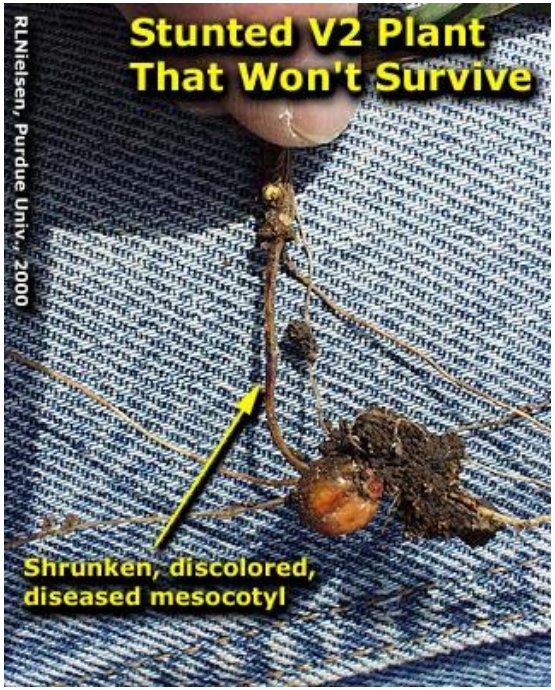
Insect injury to kernel…



Injured plant technically alive, but severely stunted.

Seedling blight…





From emergence to knee-high

- Damage or stress to the 1st few sets of **nodal roots** can severely stunt or delay a corn plant's development.
  - Most sensitive from emergence to about 6-leaf collar stage of development
  - Fertilizer salt injury, seedling diseases, herbicide injury, insect feeding damage, excessively wet or dry soils, soil compaction (tillage or planter)

Bottom Line...

- Regardless of tillage, uneven stand establishment in corn reduces yield potential early in the ballgame.
  - Yield losses can easily approach 7 to 15 bu./ac.
  - This yield loss cannot be recovered.
- No-till environments are often less friendly to stand establishment than conventional tillage.

So, why less friendly?

Trash, trash, and more trash!

- **TRASH:** Stover, stubble, and other plant materials left from previous crops or weeds that directly or indirectly interferes with corn germination, emergence, & seedling growth.
- **RESIDUE:** Stover, stubble and other plant materials left from previous crops or weeds that conserve soil moisture and improve soil tilth.

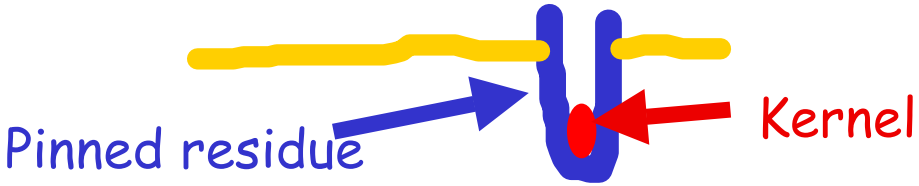
Surface trash…

- Delays soil drying and warmup, which then…
  - Delays or causes uneven germination.
  - Delays early root & shoot growth.
- Harbors disease inoculum that can cause...
  - Seedling blights
  - Leaf diseases
  - Root, stalk, & ear rots

- Favors bothersome pests…
  - Slugs
  - Seedcorn maggot
  - Brown stinkbug
  - Stalk borer
- Hinders planter operation, especially when coupled with wet soils.
  - Depth control
  - Seed-soil contact

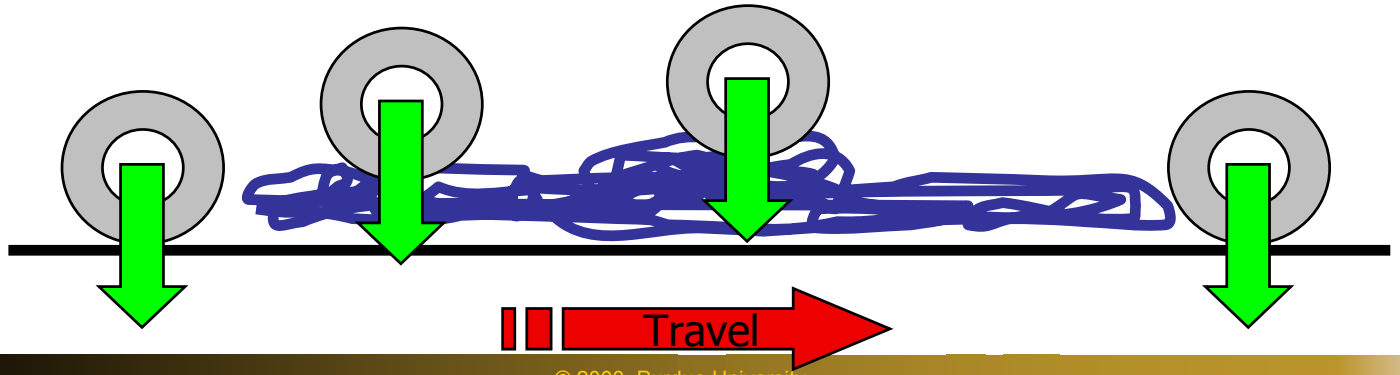
Planter challenges…

- Hairpinning of wet trash into seed furrow
  - Wet trash is difficult for coulters to slice.
  - Wet, soft soil acts like a sponge-like cutting board.
  - Dull coulters do not help!



Planter challenges …

- Uneven seed depth in seedbed…
  - Caused by uneven distribution of surface trash and/or excessive planting speeds
  - Depth gauge wheels technically work properly, but relative to surface they are riding over (which may not be soil surface).

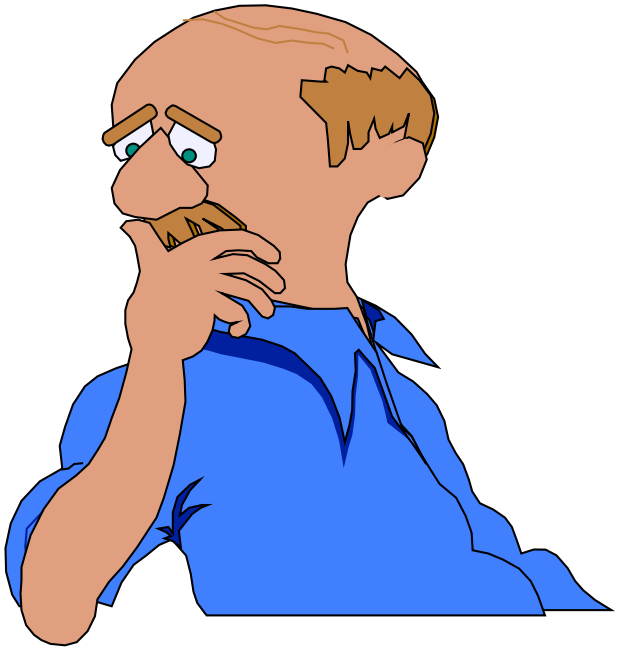


Planter challenges …

- Optimizing closing wheel pressure can be more challenging in no-till environments, especially if seed bed conditions are extremely variable.
  - Insufficient down pressure = Open planter slots
  - Excessive down pressure = Compacted furrow

Assist stand establishment…

- Manage planting dates wisely
- Choose hybrids wisely
- Use pre-applied seed treatments wisely
- Use starter fertilizer wisely
- Invest wisely in planter gadgets
- Consider fall/spring strip tillage



Planting date management…

- How many no-till corn growers plant as early or earlier than in conventional tillage?

After all, no-till ground supports equipment better than conventional till!

No-till corn planting dates?

- Maybe..... we should be planting a little later?
  - Let the soil dry some.
  - Let the soil warm some.
- Maybe..... we should plant no-till soybeans before no-till corn?
  - Soybean establishment seems to be easier.

Unfortunately, corn yield drops off sooner w/ delayed planting than soybean.

Hybrid selection for no-till…

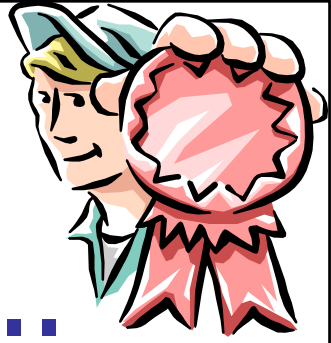
- Identify consistently superior yielding hybrids, regardless of tillage system.
  - Good hybrids in conventional tend to also be good in no-till.
  - Emphasize multiple location or year performance data.
    - Look for consistency across environments.
    - Performance on "My" farm should NOT be given the highest priority!

Purdue crop variety trials:
www.agry.purdue.edu/ext

Hybrid traits for no-till…

- Within that group of superior hybrids, select those with characteristics important for no-till…
  - Cold tolerance for germination/emergence
  - Strong seedling vigor or early growth habits
  - Disease tolerance or resistance

This information available from seed company literature or sales folk.



Seed quality is important...

- Seed quality has greater potential impact in no-till than in conventional tillage because of no-till's generally "crappier" stand establishment environment.
  - The best hybrid in the world may fall apart in no-till if its seed quality is mediocre!
  - Seed quality can vary from year to year, seed lot to seed lot, company to company.

Seed quality indicators…

- Warm germination ratings…
  - Listed on seed tag by law.
  - Recognize that most hybrids sold are rated 95% germination or greater.
  - Nonetheless, target seed lots w/ superior warm germ. ratings for earlier planting.
    - Good warm germination scores tend to be related to good seedling vigor.

Seed quality indicators…

- Cold germination ratings…
  - Cold germination test simulates ability of a seed lot to germinate under "crappy" cold, wet soil conditions.
  - Cold germination ratings are not listed on the seed tag, but are often performed by the seed company for their own information.
    - Seed lots less than 85% typically not sold.

Cold germination tests…

Ask for "extended" cold germination test ratings.

- Standard cold test
  - ~50F for 7 days, then
  - ~77F for 4 - 6 days
- Extended cold test
  - High soil moisture
  - ~50F for 14 days
  - ~68 for 7 days

Note: There is no single standardized cold germination test procedure, so hybrid ratings should only be compared within an individual seed company's lineup.

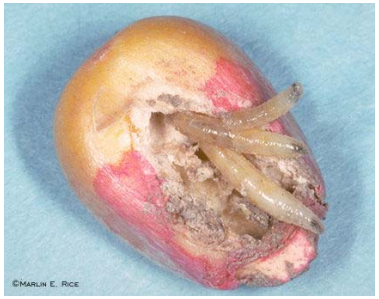
Use cold germ. ratings…

- Plant better cold germ. seed lots (90% or higher) where conditions are most severe…
  - High trash levels
  - Earlier plantings
  - Anticipated cold and wet conditions after planting.

- Plant mediocre cold germ. seed lots (less than 90%) where conditions are less severe…
  - Low trash levels
  - Later plantings
  - Drier & warmer soils.

Pre-applied seed treatments

- Insecticidal treatments applied during seed processing and targeted at secondary insect pests.
  - Wireworms, seedcorn maggots, white grubs, flea beetles, and black cutworms



- Primarily Cruiser™ and Poncho™
  - Offer systemic seedling protection.
  - Cost ranges from $4 to $6 per acre.

Images from http://www.ent.iastate.edu/imagegal/

Mixed thoughts…

- University entomologists are uncertain in their support for these products.
  - Claim insufficient data on efficacy to date.
  - Pests are not a problem in every field, so "blanket" use of product runs counter to IPM concepts.
  - Fields with historical pest problem will likely benefit most from the use of these products.
- YieldGard™ Rootworm hybrids will be marketed with one or the other of these products by default.

Image from http://www.ent.iastate.edu/imagegal/

Starter fertilizer …

- Success with starter fertilizer means…
  - Maximizing the probability of getting a response and
  - Maximizing the potential size of the response if it occurs.
- Probability of response often greater for no-till (colder, wetter) versus conventional till corn.
- Aim for the biggest bang for your fertilizer dollar.

Starter fertilizer decisions …

- High soil P & K + warm seedbed

- Probability of yield response to starter is low and…
- Size of expected response is low, so…
- Little yield risk if you decide to forego the use of starter.

Starter fertilizer decisions …

- High soil P & K, but cold, crappy conditions for germination and seedling growth

- Probability of yield response to starter P & K is low but…
- Probability of yield response to starter N is high, so…
- Use starter N and aim for no less than 20 lbs N per acre.

Starter fertilizer decisions …

- Low soil P + cold, crappy conditions for germination and seedling growth

- Probability of yield response to starter P and N is high, so…
- Apply N-P mix but still aim for no less than 20 lbs starter N per acre.
  - 50:50 UAN + 10-34-0

2 x 2 versus "pop-up" …

- Rates of starter fert. placed in-furrow (aka "pop-up") are limited because of the risk of "salt" injury to the seed or seedling…
  - Rates of "pop-up" considered "safe" are no more than 5 to 8 lbs per acre of actual N + K.
- Higher "safe" rates allowed with 2 x 2 increases probability of yield response.

In-furrow or "pop-up" starter fertilizer placement is attractive because of low rates & simple planter attachments.

Planter gadgets…

- May help manage trash and wet, cold soils.
- Some move trash from the planter row area.
  - May warm & dry row zone
  - May aid planter operation

- Some cheat & do a little row zone tillage.
  - Before or during planting
  - May warm & dry row zone
  - May aid planter operation
- Some give the closing wheels some help.
  - Firming knives or blades
  - In-furrow firming wheels
  - Furrow sidewall shavers
  - Furrow finger fluffers

Trash removal or zone tillage…

- Beneficial for…
  - Early planting (cold soils)
  - Poorly drained soils
  - High trash loads
    - Continuous corn
    - Winter cover crops
    - Unevenly distributed soy stubble
  - Cooler climates (e.g., northern Corn Belt)

Seed firming contraptions…

- Trap & firm seeds in furrow.
- Useful for situations where seed-to-soil contact is inadequate due to poor slot closure.
  - One could sarcastically argue that some of these situations are wet seedbeds where you have no business being with the planter anyway!

Seed firmer image source: http://www.martinandcompany.com/keeton.htm

So, planter gadgets…

- May improve seed placement uniformity.
  - Planter sees "conventional" seedbed.
- May improve germination success.
  - Improved seed-to-soil contact.
  - Warmer, drier seed zone.
- May improve early root development.
  - Warmer rooting zone.

The "Nu-Till" system: A collection of gadgets…

- Concept promoted by Ag Spectrum (Dewitt, IA)
- The system is composed of:
  - Case IH depth gauge wheels
  - Martin row cleaners
  - Martin spading closing wheels
  - Drag chains to break clods
  - Liquid N banded 4 – 6 inches from seed furrow
  - Keeton seed firmer w/ starter fert applicator tubes
    - Application of proprietary phosphorus starter fertilizer & micronutrient "enhancement" formulation

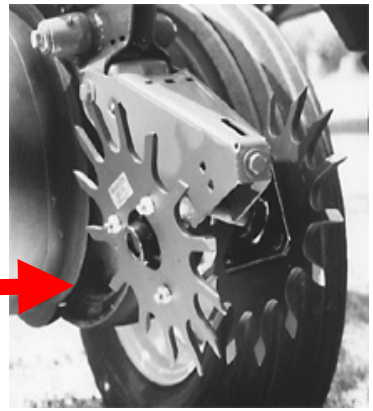


Image source: http://www.martinandcompany.com/SCW70/72.htm

Strip tillage as alternative…

- Narrow-width tilled strips, fall or spring, often coupled with in-row application of dry P & K fertilizers and/or anhydrous ammonia.
  - Approx. 6 inch wide strips
  - Tilled 4 to 8 inches deep
  - Slightly raised "berm"
  - 15 – 20 hp required per row

Images source: http://www.extension.iastate.edu/Publications/PM1901C.pdf

Strip tillage benefits…

- Fewer tillage trips.
  - Less compaction?
- Lower potential for erosion & runoff than conventional tillage.
- Residue-free "berms" encourage faster drying of seedbed which allows for earlier planting.

Strip tillage benefits…

- Residue-free "berms" encourage warmer seedbeds that facilitates faster corn germination, emergence, and initial seedling development.
- Allows for deep banding of P and K that may mitigate nutrient stratification concerns in no-till.

Strip tillage challenges…

- Weather and soil conditions after harvest may limit your ability to complete strip till operation in the fall with suitable soil moisture conditions.
  - Risk of soil compaction and/or clod formation if soils are wet.
- Labor availability may be limited during fall harvest.
- Not suitable for HEL fields w/ steep slopes because of erosion potential in tilled strips.

Strip tillage challenges…

- Fall-applied anhydrous not recommended in southern half of Indiana.
- Accurately matching up planter row units to strips can be challenging.
  - Opportunity for GPS autosteer systems.
- Yield advantage (C/B) over conventional or no-till **NOT** consistent year to year.
  - But, usually yields no less than no-till.

A Parting Thought…

"Farming is a kind of continual miracle, wrought by the hand of God."

-- Benjamin Franklin