

Surface Application of Fertilizers: Can We Make It Work?

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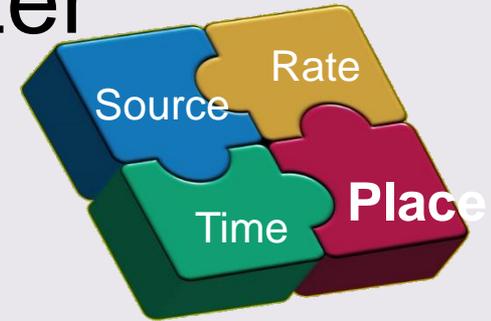
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A good rule of thumb for fertilizer management:

GET IT IN THE GROUND!



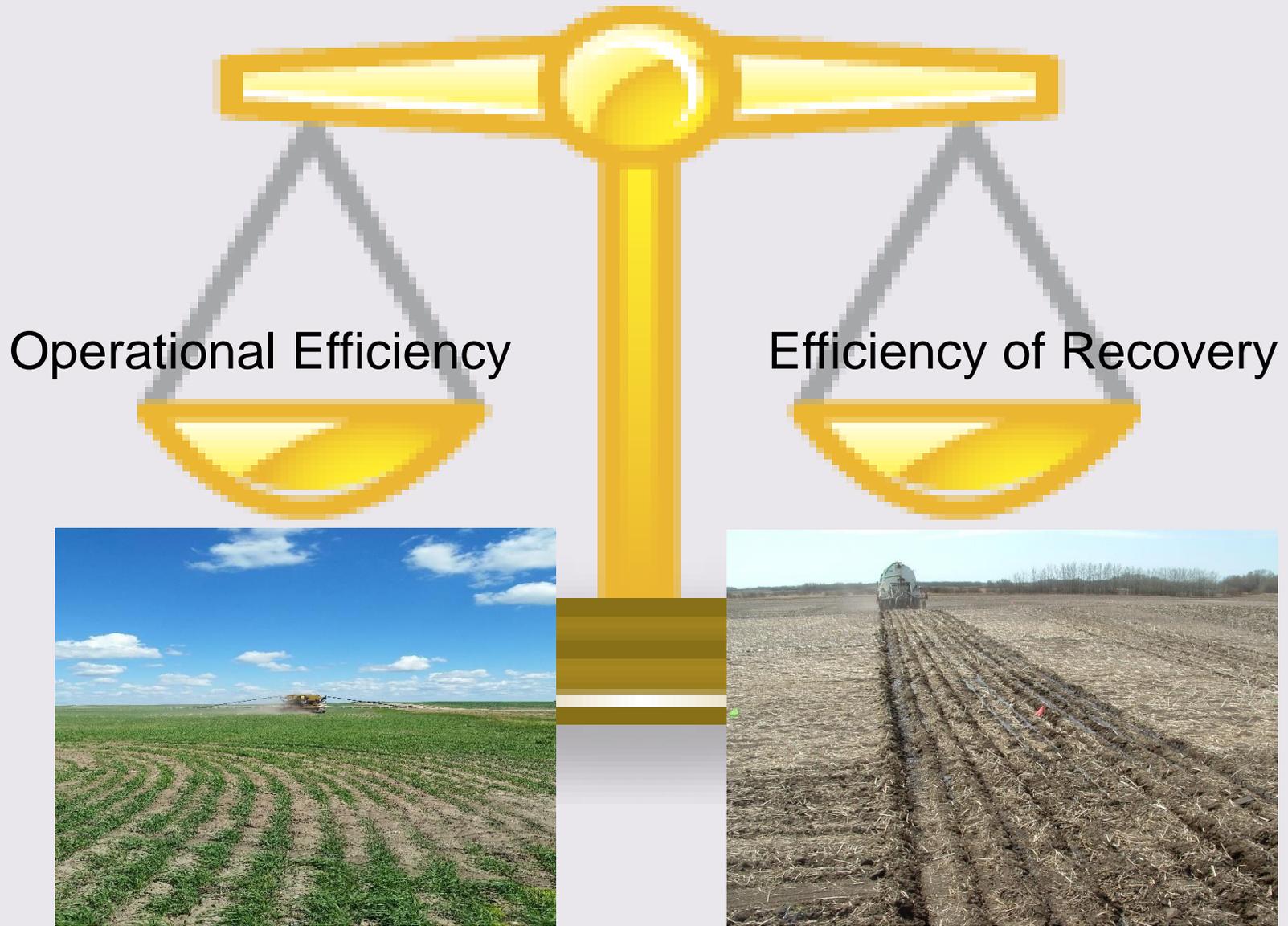
Many reasons why we don't want fertilizer nutrient hanging around on the soil surface:

- Increased gaseous (ammonia) losses of N, especially 46-0-0. *Urea hydrolyzes rapidly to ammonia*
- Increased immobilization (tie-up) of nutrients. *Fertilizer used by microbes in decomposing surface straw*
- Increased transport of nutrient off-site in surface run-off water. *Especially in spring snowmelt run-off*
- Reduced root access, especially for nutrients like P and K that don't move in soil. *Only move a few mm*

Separation of fertilizer from surface thatch:



- 1. Reduces tie-up (immobilization) of fertilizer N,P,S during straw decomposition.**
- 2. Reduces volatile gassing off of nitrogen.**
- 3. Reduces competition from shallow rooted weeds.**
- 4. Improves root access by placing fertilizer in moisture.**



Agronomic and Environmental Quality Considerations

Surface Application of Nitrogen Without Incorporation

Dissolution..... Enzyme Hydrolysis.....Reaction with soil water and particles

Urea -----> ammonia gas -----> retained ammonium

On soil surface, reaction with water & soil is reduced, ammonia gases off

- Broadcast urea on warm, moist soils with lots of surface trash = high volatile ammonia losses b/c urease enzyme very active! High pH aggravates loss because favors free ammonia gas.
- Up to 20% of surface applied urea lost in one North Dakota soil over 10 days at 30°C (Franzen, NSDU) (Losses higher at higher pH e.g. > 33% loss when soil pH > 7.5).

Strategies

Urea ~~----->~~ ammonia gas -----> retained ammonium

- Urease inhibitors (e.g. Agrotain™, Limus™) give a window of a couple of weeks for rain to move the urea into the soil. Once in soil, ammonia produced from hydrolysis of urea will be retained by conversion to ammonium.
- Coatings can help by slowing release of urea.
- Nitrification inhibitors less effective for reducing gaseous losses associated with putting N fertilizer on surface, more effective for reducing leaching, denitrification losses.
- Dribble banding of UAN (28-0-0) on surface of soil can work well, especially for forage crops (Lkhagvasuren et al., 2011 Grass and Forage Science).

Surface application of urea to frozen soils?



- Urea will not move downward if snow, soil stays frozen. Susceptible to loss in rapid runoff or blown away. Can get urea hydrolysis even in winter.
- Significantly lower recovery of urea applied to snow covered soil in late fall compared to bare soil because snow containing fertilizer was blown off (Selles et al., 1989 Can.J.Soil Sci.).

Application of Urea to Frozen Soils Preceding Spring Wheat		
Application timing	Yield, bu/a	Protein, %
Fall applied, incorporated	45.4	14.5
Soil frosted, not deeply frozen, November	45.8	13.8
Soil deeply frozen, December	27.6	12.7
Soil deeply frozen, March	33.3	13.0
Applied prior to seeding, April incorporated	49.6	14.6
Least Significant Difference, 5%	5.0	0.5

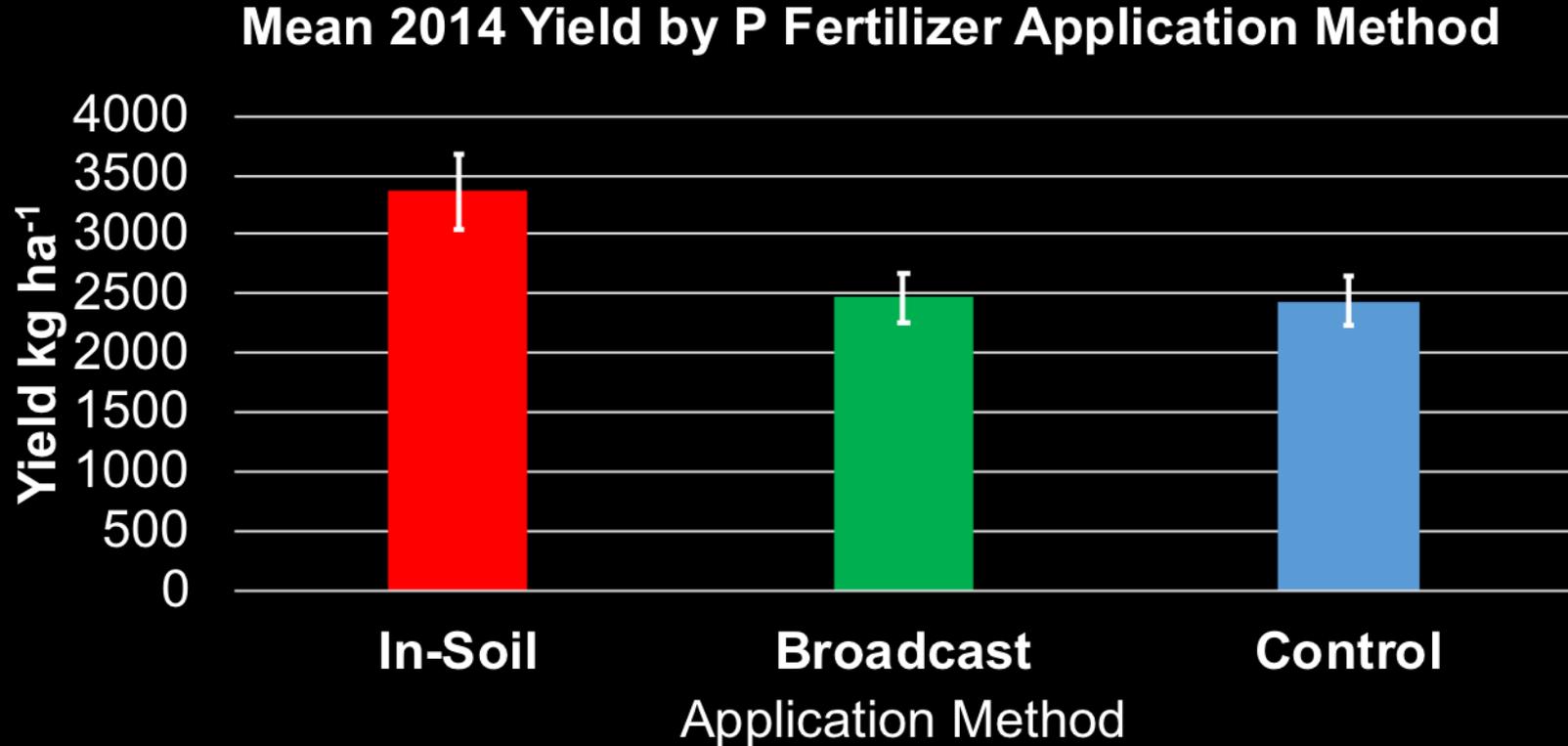
Based on research by Greg Endres, Blaine Schatz and David Franzen, winter of 1995-1996 at NDSU Carrington Research Extension Center.

Surface Application of Phosphorus (P)

“Broadcasting P fertilizer, especially in conservation tillage systems, is agronomically inefficient and leaves water soluble P on the soil surface ... prone to runoff ... especially if applied in fall”

(D. Flaten, Soil Science Professor, University of Manitoba)

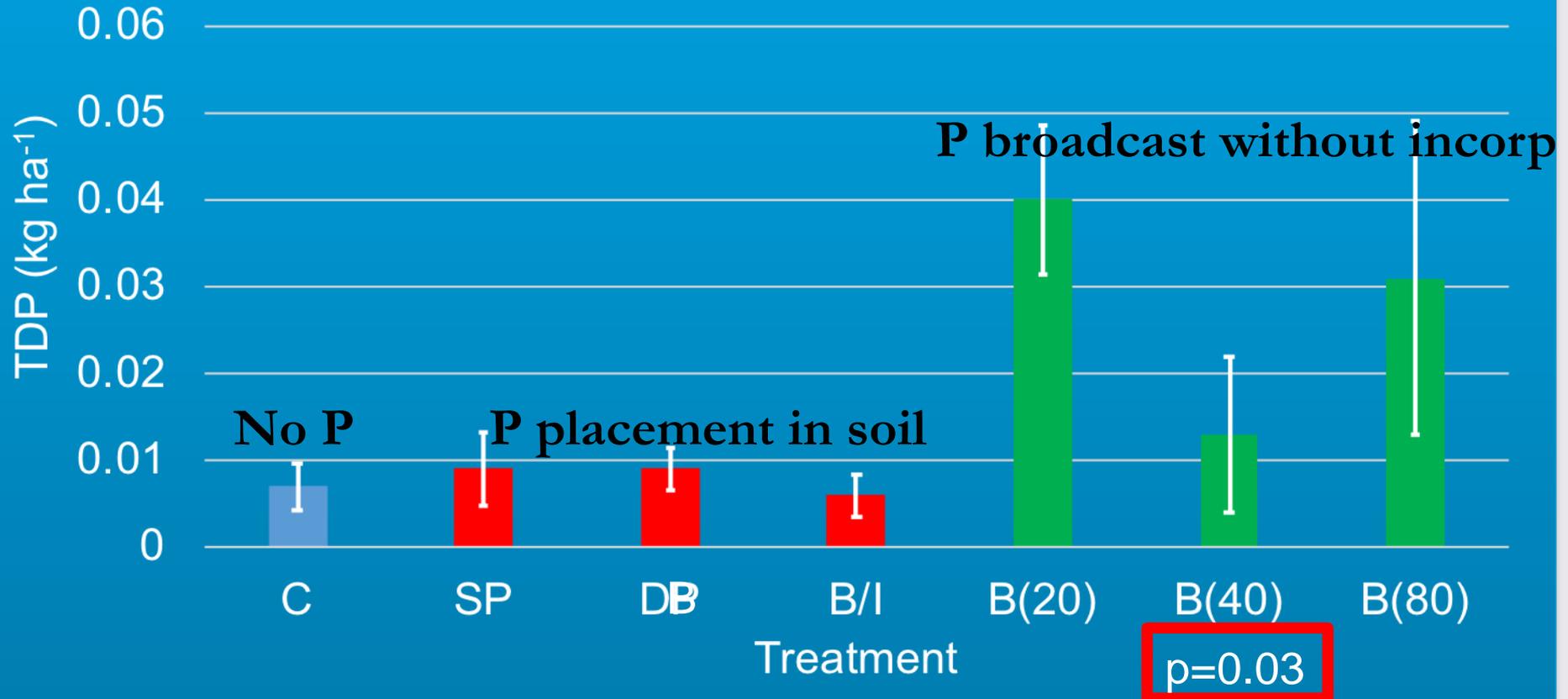
Weiseth et al 2014 SK study with soybean



In-soil placement of P (11-52-0) agronomically superior to broadcast.

Placement of 11-52-0 into soil in seed-row, band or through incorporation reduced dissolved P loss in runoff compared to leaving on surface Wiens et al., 2019 J. Env. Qual.

Mean Total Dissolved P Loss in Snowmelt by Treatment



Surface Placement of Potassium (K)



- Potash (KCl) 0-0-60 most common source of K.
- Like phosphorus, potassium can only move a few mm or cm in the soil. Surface placement can result in K "hung up" in dry surface.
- Old rule of thumb: To account for reduced efficiency of surface placed K, increase rate by 50% to achieve same response from K placed in soil in year of application.
- Losses of K, even surface placed, generally small and not of environmental concern.
- Chloride component of potash is mobile, will readily move into soil with precipitation. Cereals may respond to Cl in soils with very low Cl levels.

Surface Application of Sulfur (S)



- Ammonium sulfate (21-0-0-24) can work in broadcast to non-calcareous soils
 - Gaseous N losses ↓ than surface urea.
 - No gaseous losses for sulfate, sulfate is mobile, precipitation will move sulfate into soil for root access.

- Elemental S (e.g. 0-0-0-90) forms are insoluble. Require dispersion into small particles, followed by microbial oxidation, to be turned into plant available sulfate. Takes time, need lead time.
- Elemental S forms often best when broadcast on surface and left to weather, helps in dispersion and release of micron sized particles from granule.

Soil Fertility Class Experiment with Canola in Pots

Treatment



Plant S Uptake (mg)

no S

4.3

Elemental S in Band

8.0

Elemental S Mixed With Soil

15.5

Surface Application of Micronutrients

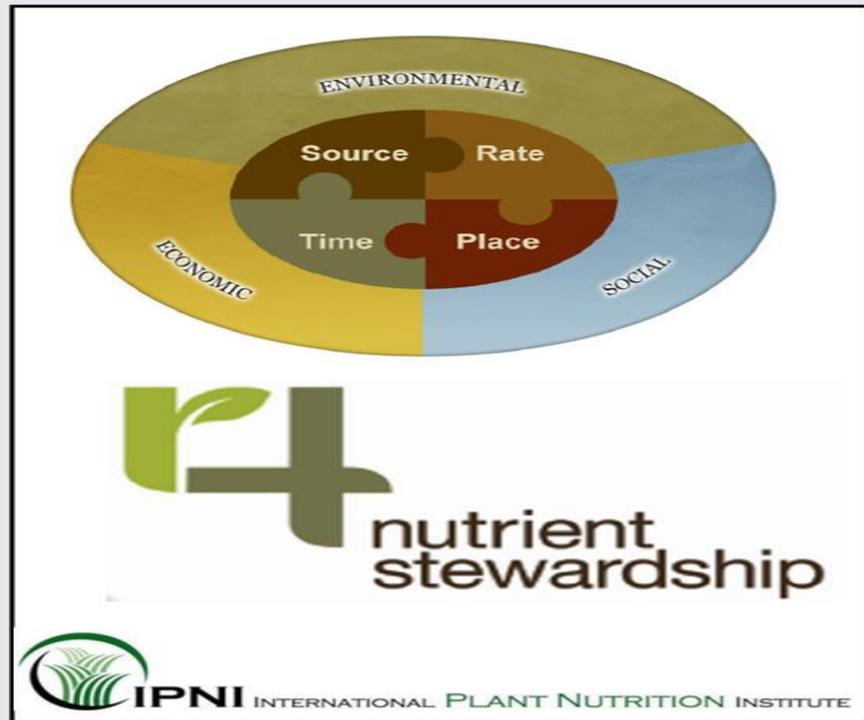
- Cu and Zn applied to soil as sulfate salts
 - Cu and Zn become readily bound to soil particles, precipitated, therefore can get stranded at surface.
 - Incorporate or band to increase root access.



- B applied as borate, Cl as chloride, both are mobile & will wash into soil.
- No significant gaseous losses for micronutrients.

OVERALL

Need to consider **interactions** among form, placement, rate, and timing when deciding what is required to make that nutrient work best!



Thanks for your attention!

QUESTIONS?

