# Mo' money now, or flexibility later – approaches to K fertilization

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# Thanks!

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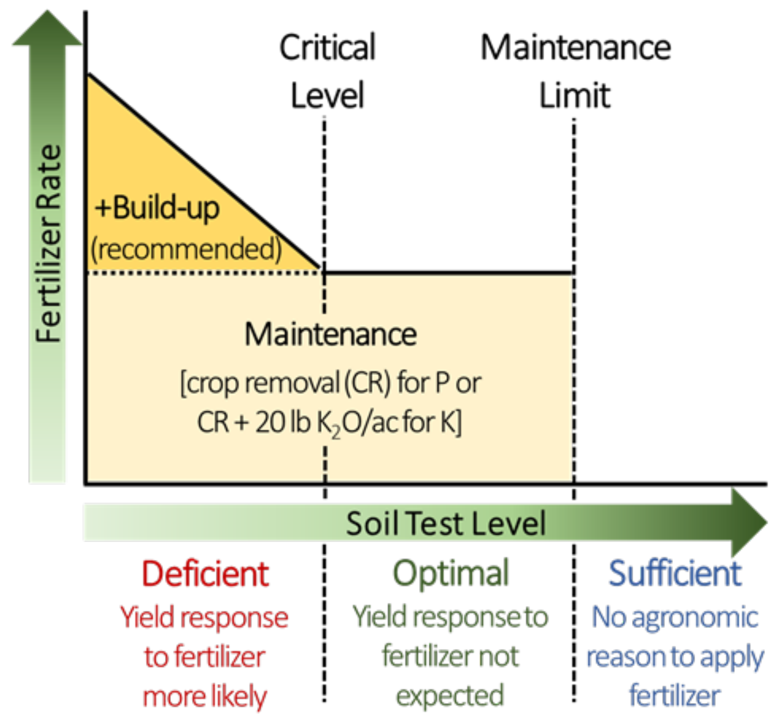
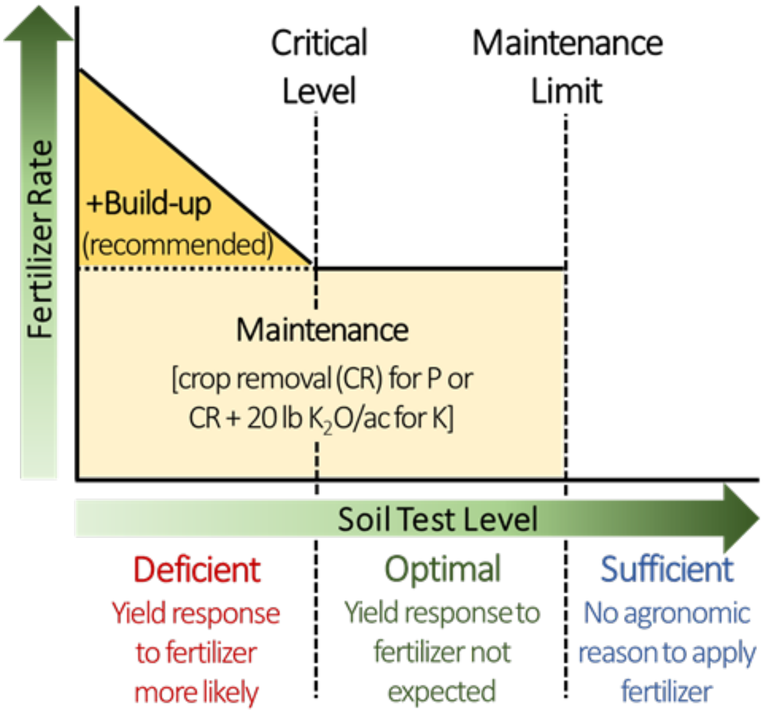
# Traditional approach to K fertilization in IN, OH, MI

- Build-up/maintain philosophy
- Fertilizer applied to soils with optimal soil test are designed to maintain soil test at optimal levels
- Adding fertilizer to soils below the critical level may increase yield
- The further below the critical level, the more likely and larger the response



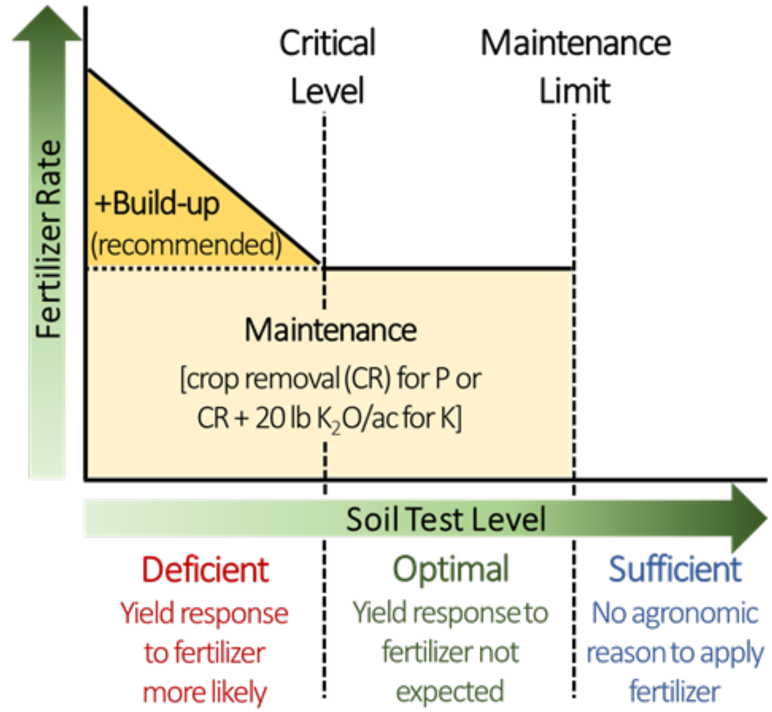
# Traditional approach to P and K fertilization in IN, OH, MI

- Maintenance fertilizer recommendations are crop removal +20 lb $K_2O$/acre
- When soil test is deficient, recommended rates also include additional $K_2O$ to build-up soil test K over a 4-year time frame



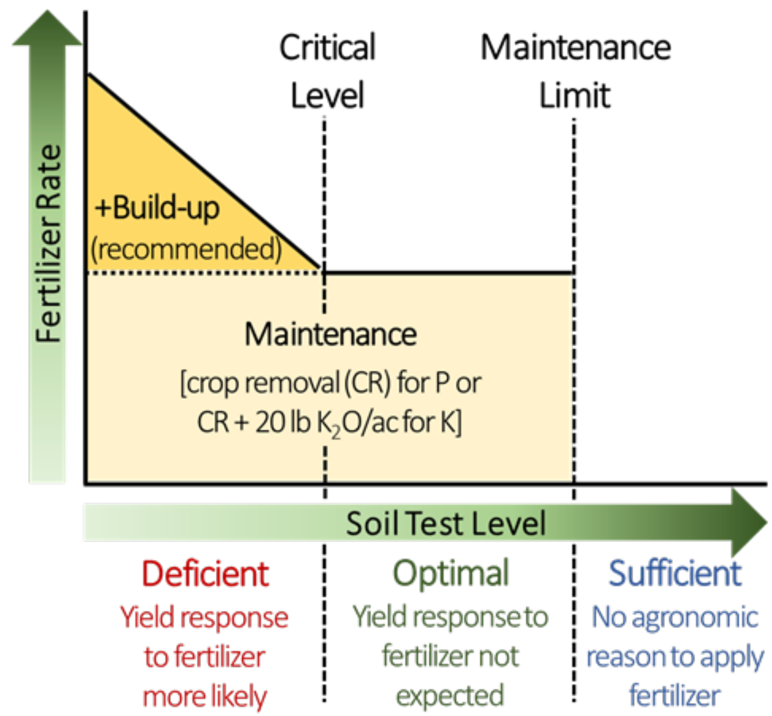
# Critical levels and maintenance limits for corn and soybean

| Mehlich-3 extract | Critical level | Maintenance limit |
|---|---|---|
| K, ppm CEC≤5 | **100** | **130** |
| K, ppm CEC>5 | **120** | **170** |

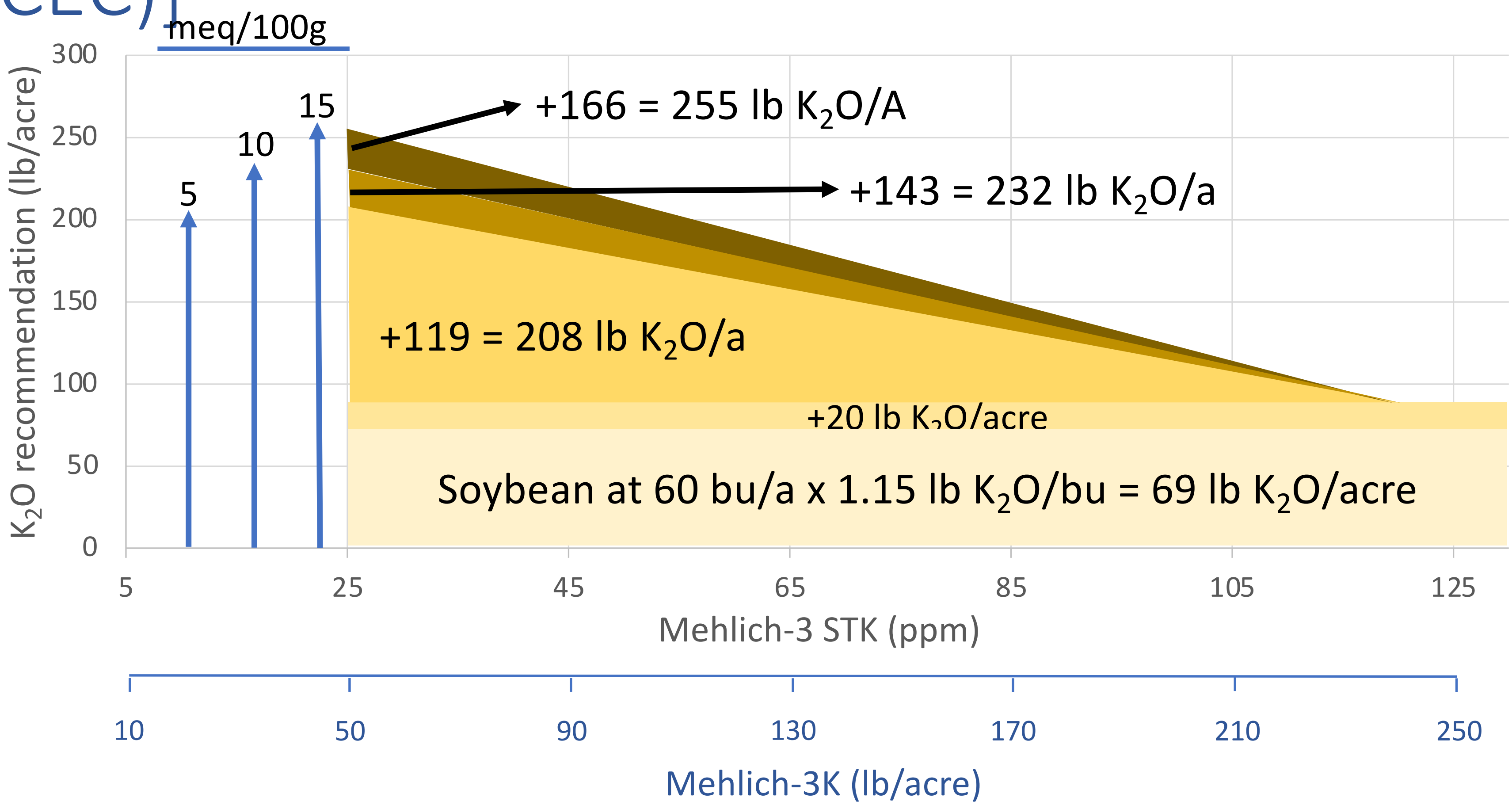


# Crop removal rates for corn and soybean

| Crop | lb $K_2O$/ bushel |
|---|---|
| Corn | **0.2** |
| Soybean | **1.15** |



# Extra K recommended depends on initial soil test and CEC [(STK-CL) x 1 + (0.05 x CEC)]

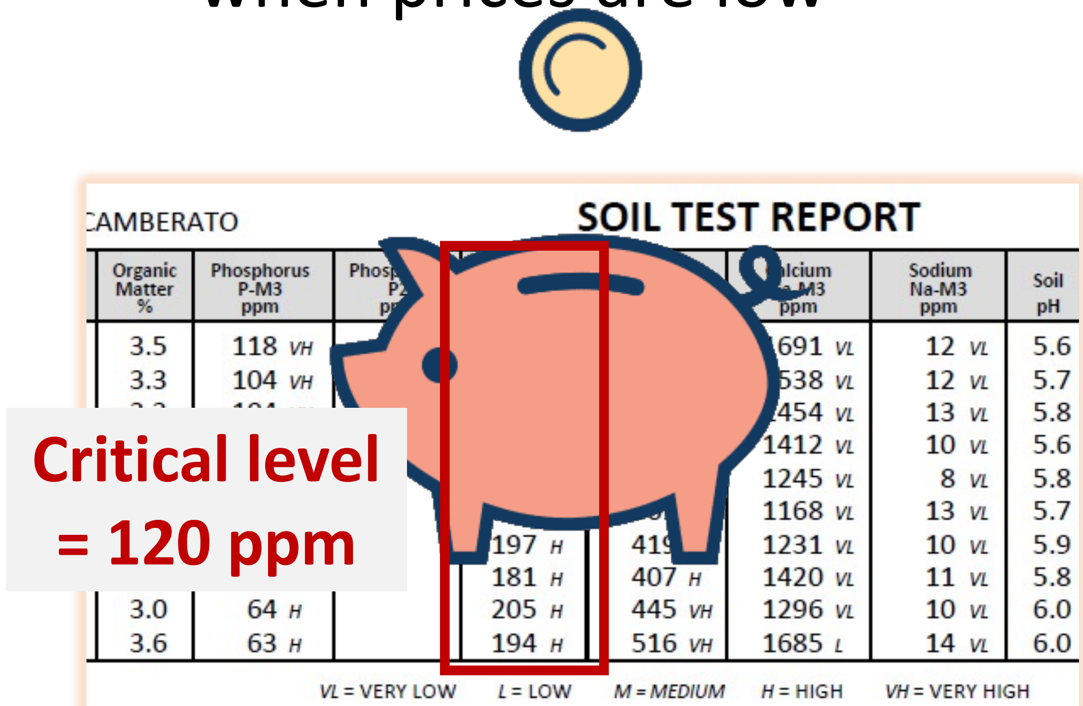


# Why recommend a build-up/maintain philosophy?

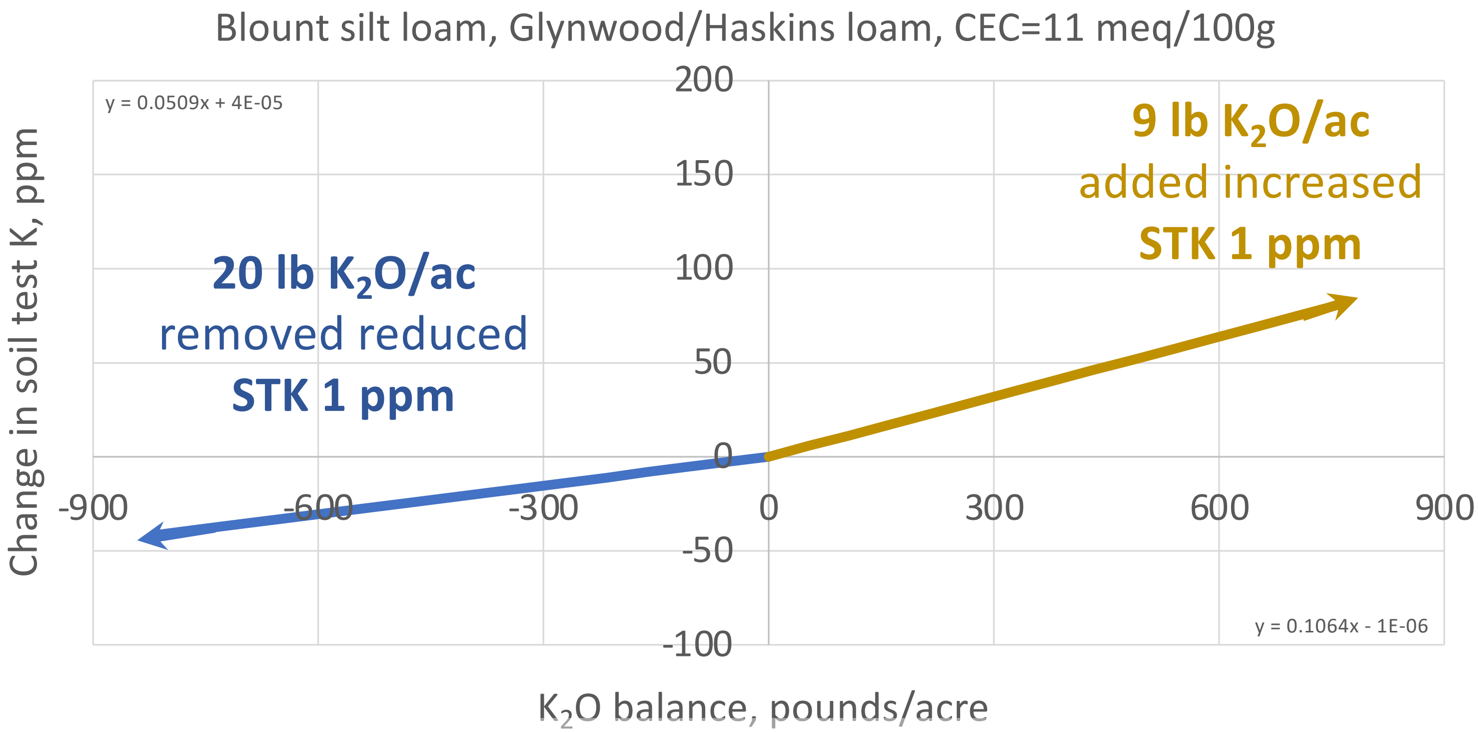
- Developed when farmers owned a higher % of the land they farmed and had more stable leases
- Flexibility to <u>not apply fertilizer</u> when soils weren't fit, fertilizer was scarce or expensive, commodity prices were low, etc.

# Why use this approach for K?

- K is retained in the soil so unused fertilizer is available in later years
- Decreases in soil test levels are small if fertilizer cannot be applied
- 'Bank' fertilizer in soil when prices are low



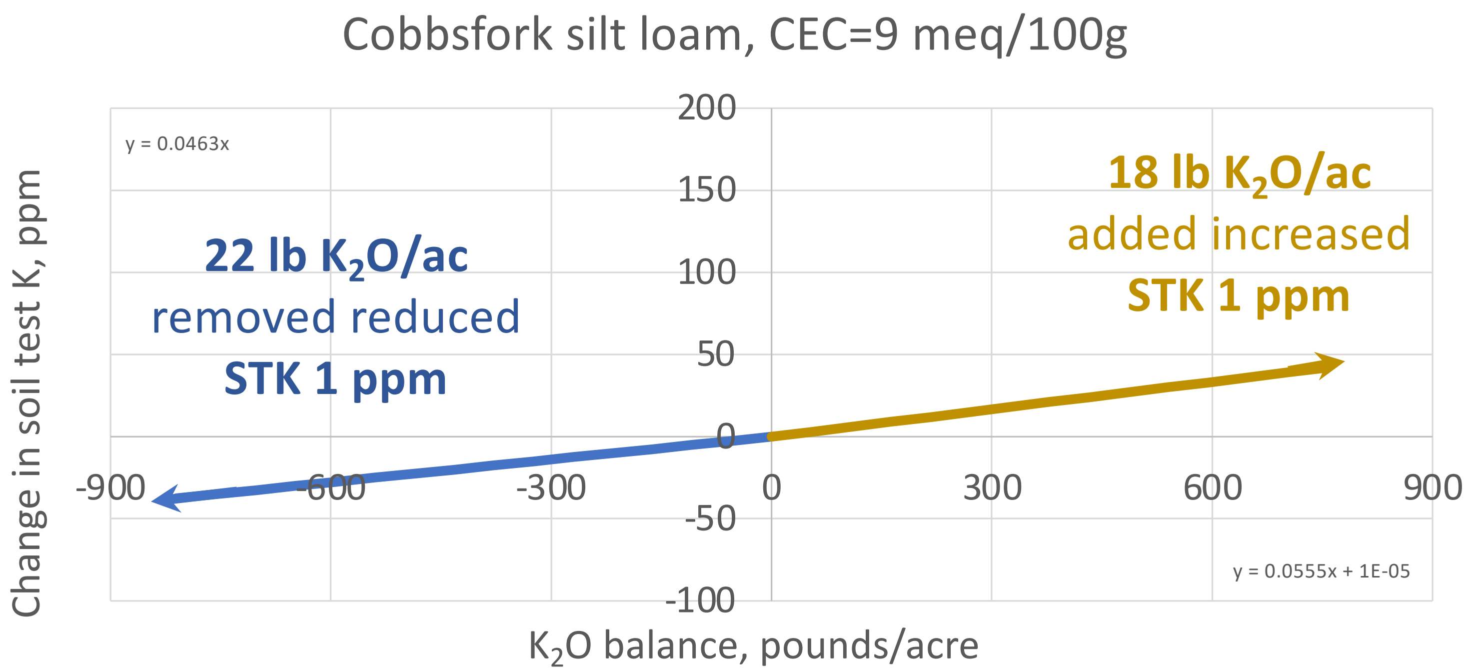
# Changes in STK require large changes in $K_2O$ balance (NEPAC)




60 bu/acre soybean would decrease STK <5 ppm

Navarette, 2013

# Changes in STK require large changes in $K_2O$ balance (SEPAC)




60 bu/acre soybean would decrease STK 3 ppm

Navarette, 2013

# What approach to apply when fertilizer is extraordinarily costly? Sufficiency Approach

**Table 1. Fertilizer Costs for Corn and Soybeans Using Fertilizer Prices in October 2020 and October 2021**

| | | Prices on 10/22/2020[2] | | Prices on 10/21/21 [3] | | |
|---|---|---|---|---|---|---|
| | Requirments[1] | Prices | Costs | Prices | Costs | Change |
| **Panel A. Corn[4]** | lbs/acre | $/ton | $/acre | $/ton | $/acre | $/acre |
| Anhydrous Ammonia | --[5] | 432 | 42 | 1,035 | 87 | 45 |
| DAP[6] | 177 | 428 | 38 | 814 | 72 | 34 |
| Potash[7] | 88 | 327 | 14 | 776 | 34 | 20 |
| **Total Fertilizer Costs** | | | **$94** | | **$193** | **$99** |
| **Panel B. Soybeans[8]** | lbs/acre | $/ton | $/acre | $/ton | $/acre | $/acre |
| DAP[9] | 111 | 428 | 24 | 814 | 45 | 21 |
| Potash[10] | 133 | 327 | 22 | 776 | 52 | 30 |
| **Total Fertilizer Costs** | | | **$46** | | **$97** | **$51** |

1 Fertilizer requirements are based on University of Illinois recommendations.
2 Taken from the October 22, 2020 *Illinois Production Cost Report*, Agricultural Marketing Service, USDA.
3 Taken from the October 21, 2021 *Illinois Production Cost Report*, Agricultural Marketing Service, USDA.
4 Based on an expected corn yield of 220 bushels per acre.
5 Based on Maximum Return to Nitrogen (MRTN) rates for central Illinois for corn-following-soybeans (see Corn Nitrogen Rate Calculator at http://cnrc.agron.iastate.edu). Given prevailing prices, the MRTN anhydrous ammonia rate is 234 pounds per acre on October 22, 2020 and 207 pounds per acre on October 21, 2021. For calculation of costs, the MRTN rates are reduced by 32 pounds to account for the nitrogen in DAP (DAP is 28% nitrogen, 32 = 177 pounds of DAP x .18).
6 Phosphate requirements are .37 pounds per bushel of expected corn yield. DAP is 46% phosphate.
7 $K_2O$ requirement is .24 pounds of expected corn yield. Potash's analysis is 0-0-60.
8 Based on an expected soybean yield of 68 bushels per acre.
9 Phosphate requirements are .24 pounds per bushel of expected corn yield. DAP is 46% phosphate.
10 $K_2O$ requirement is 1.17 of expected soybean yield. Potash analysis is 0-0-60.

11/2/21

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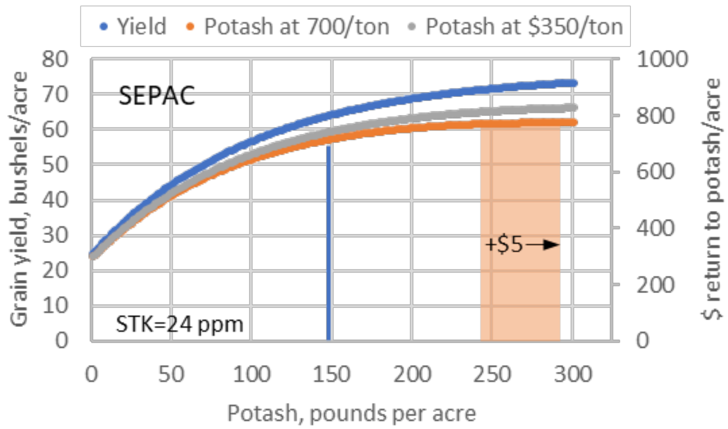
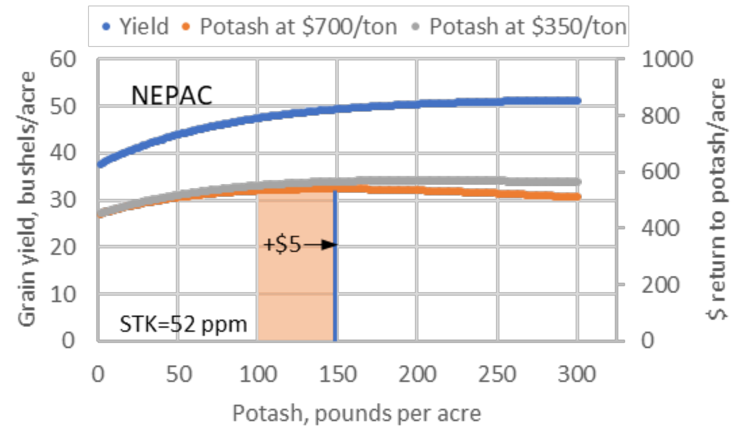
- Add enough $K_2O$ to maximize profit (not yield) at low soil test levels
  - Expensive fertilizer, low commodity prices
  - Limited availability of fertilizer
  - Cash rents

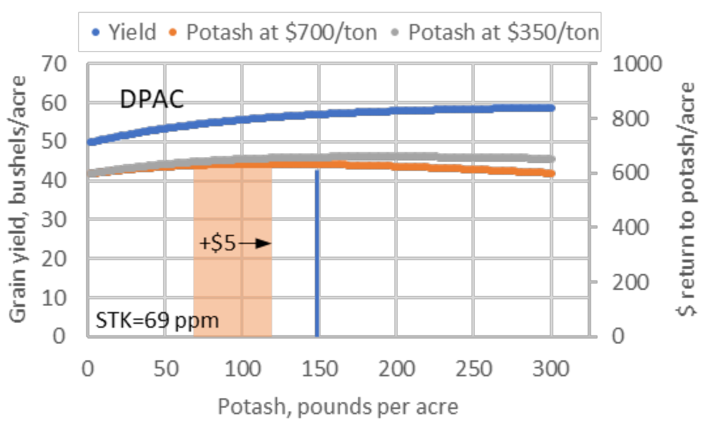
Schnitkey, Paulson, Swanson, Zulaf: https://farmdocdaily.illinois.edu/2021/11/planting-and-acreage-decisions-in-2022.html

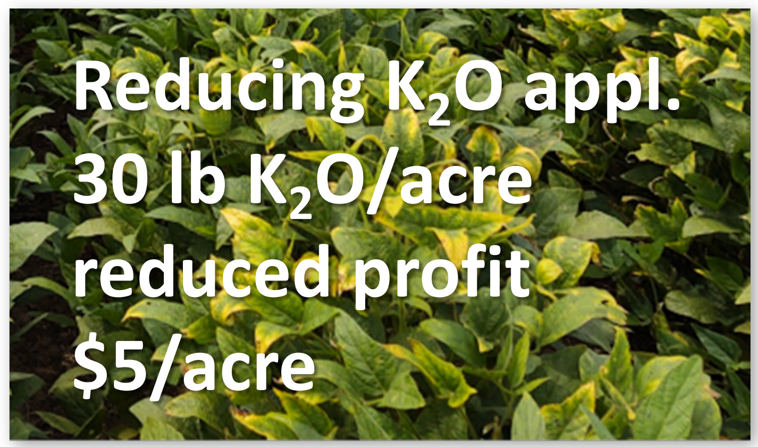

0 lb/ac Potash
Planted: May 14

# Soybean response to K fertilization

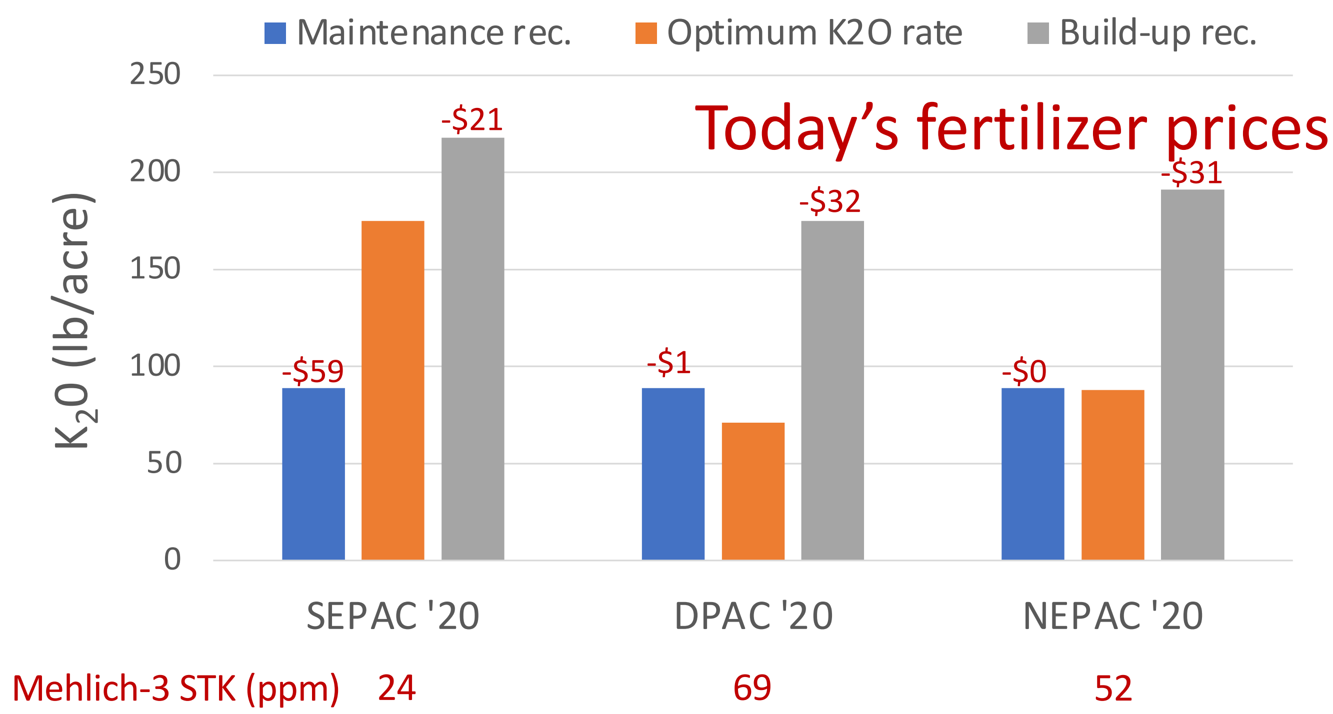


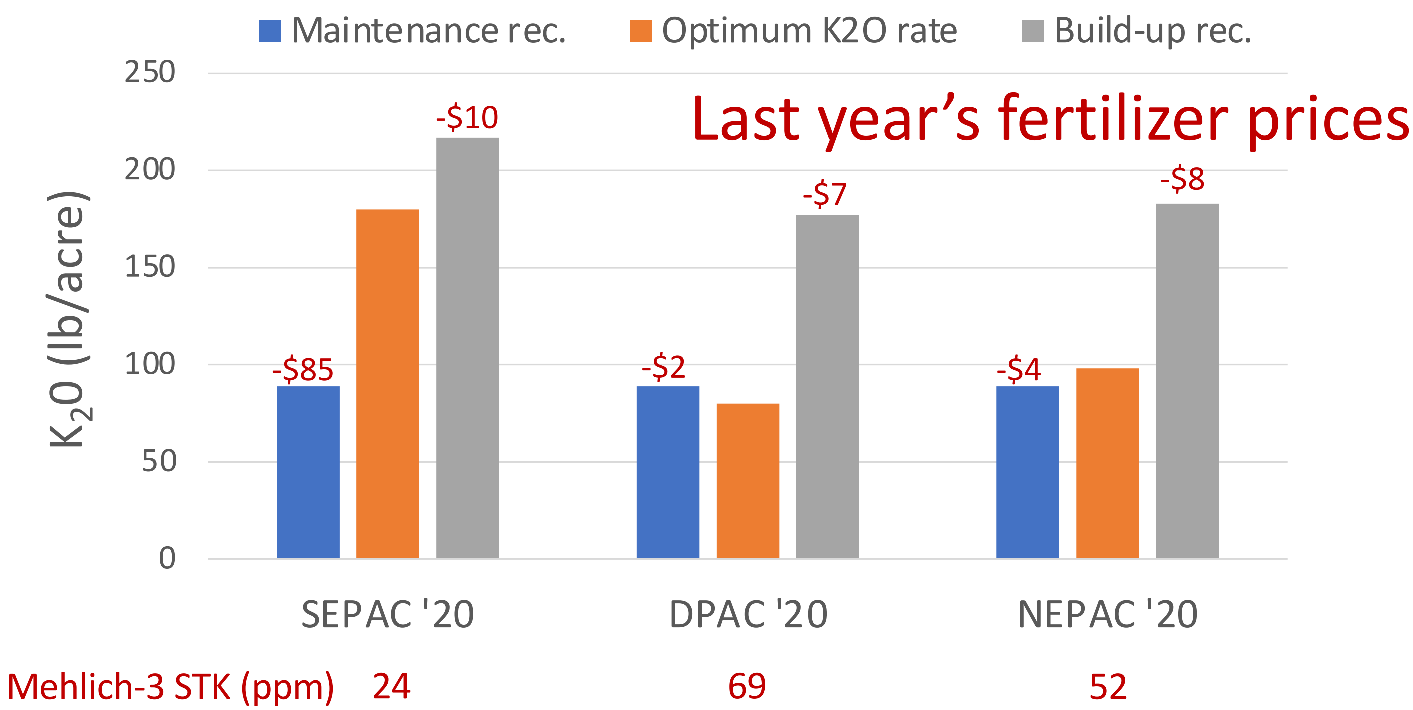



# Reduction in return to K with maintenance and build-up rec. compared to true optimum $K_2O$ rate for soybean - $700/ton 0-0-60, $12/bu soy.



# Reduction in return to K with maintenance and build-up rec. compared to true optimum $K_2O$ rate for soybean - $350/ton 0-0-60, $12/bu soy.



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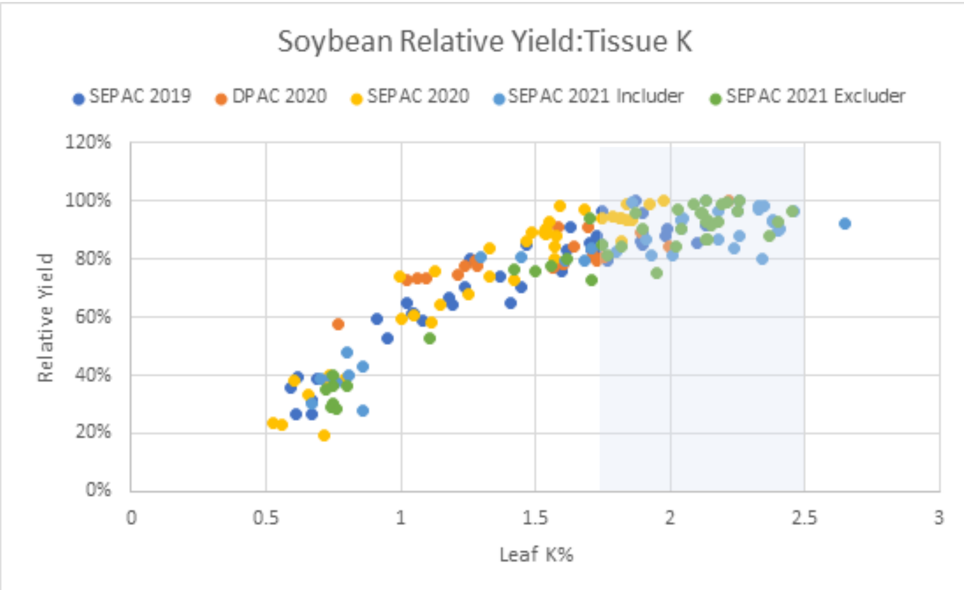
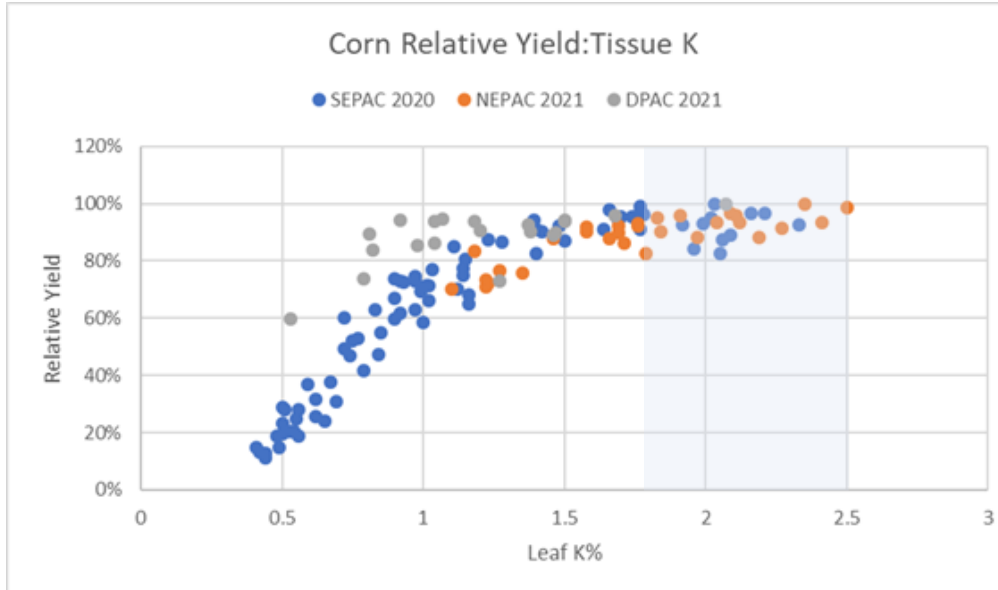
2020 SEPAC

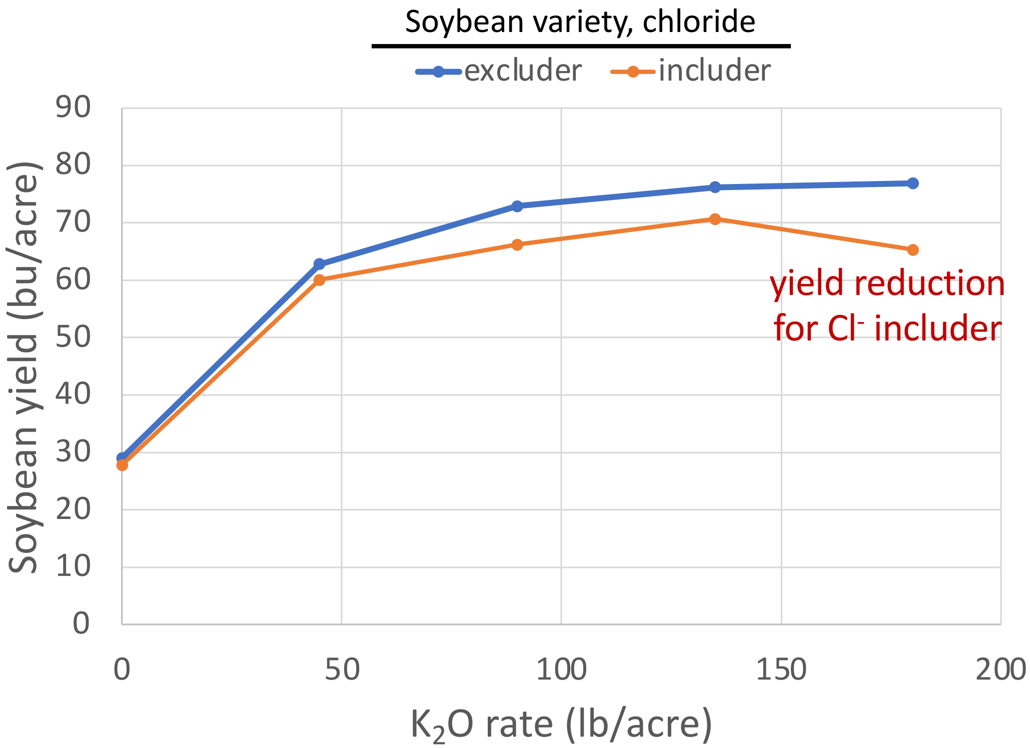
# Tissue testing guidelines




Current guidelines for corn and soybean 1.71-2.5% K

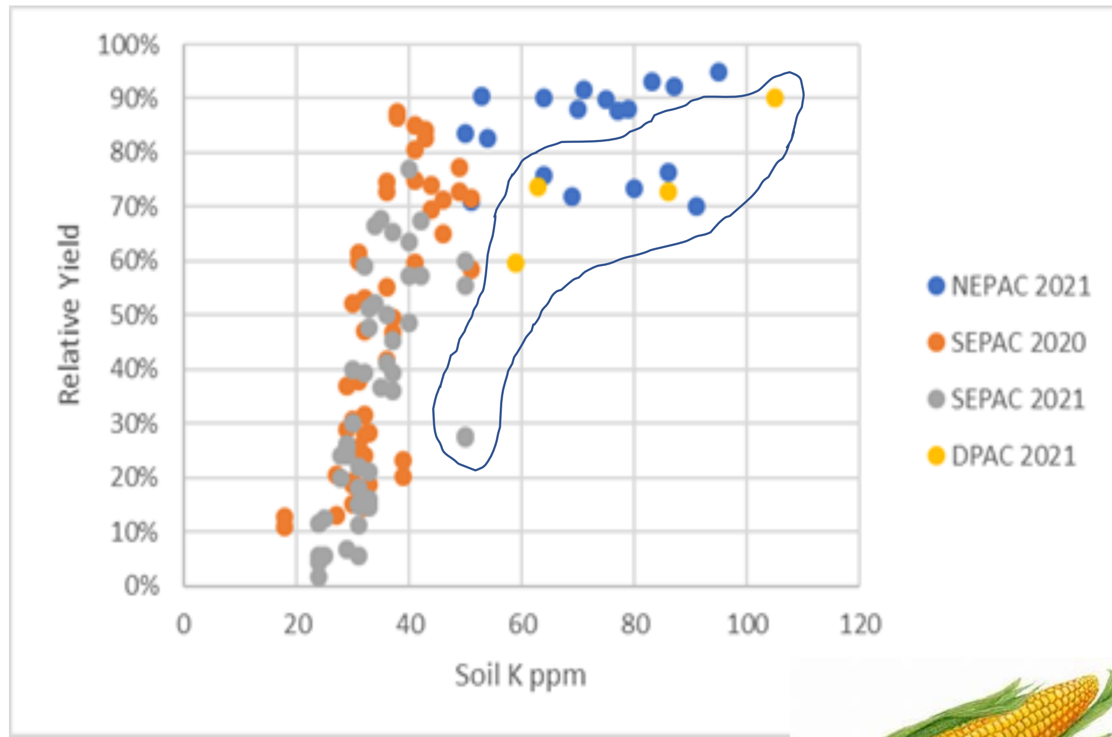
# Too much K in spring can hurt some soybeans sometimes

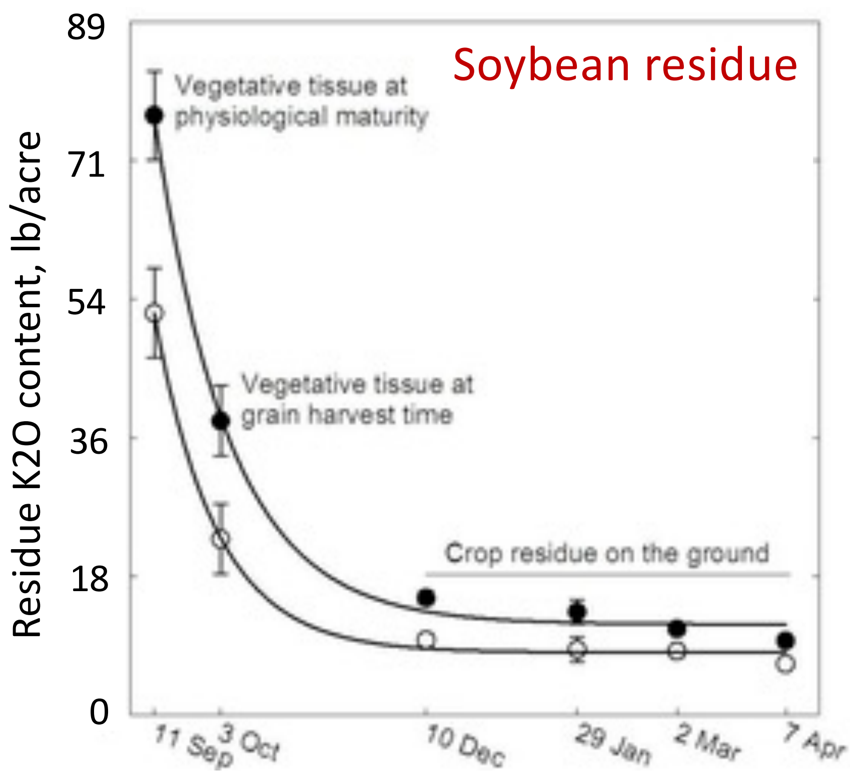

150 lb/ac Potash
Planted May 15
Potash applied Previous
Year Only

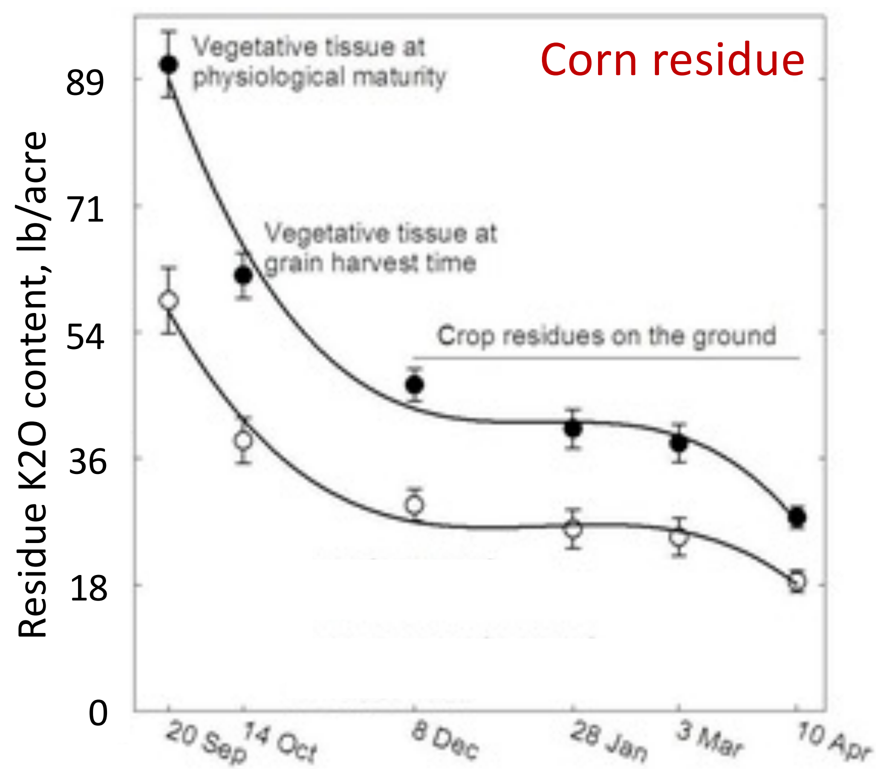
# Relative corn yield versus soil test

- Soil test K differences were due to K applied to soybean in previous year (residual)
- 90% of maximum yield achieved at 60 ppm STK



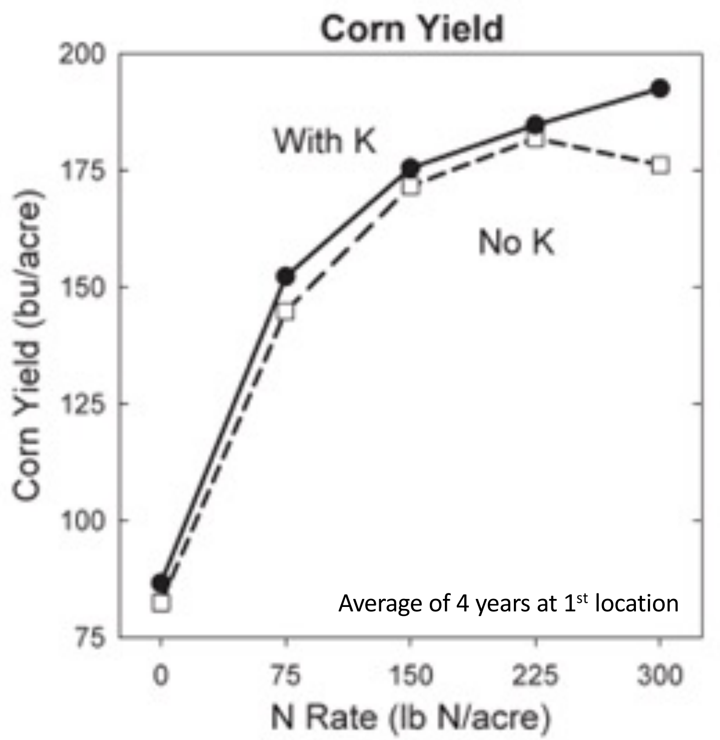

# Residues contain a lot of K that is returned to the soil

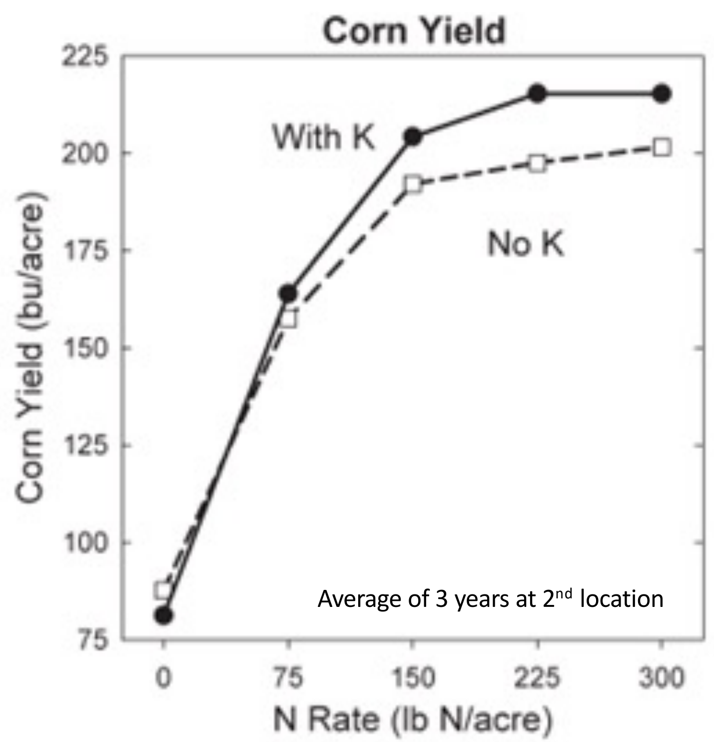



Oltmans and Mallarino, 2015

# Do not aim to economically optimize both N and K for corn?

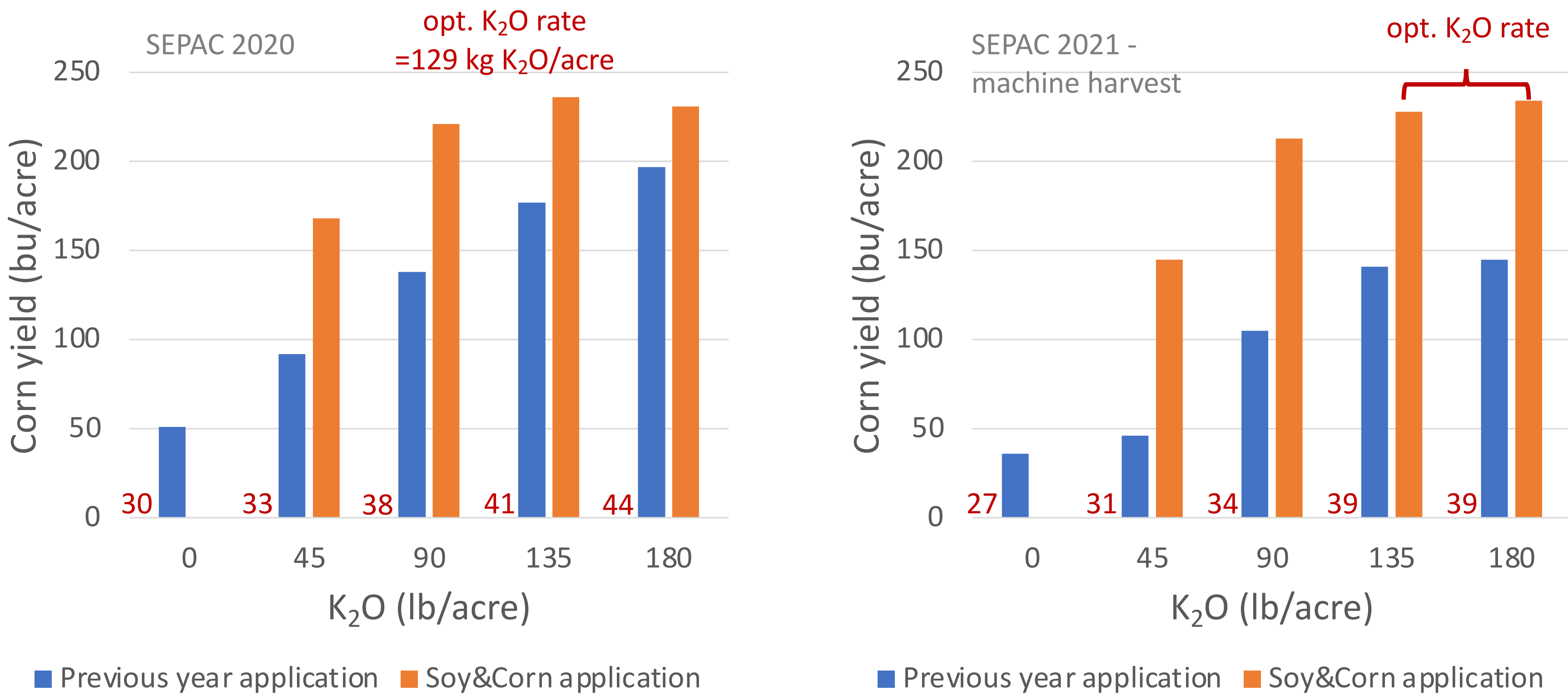



Mallarino, Iowa State Univ., 2017

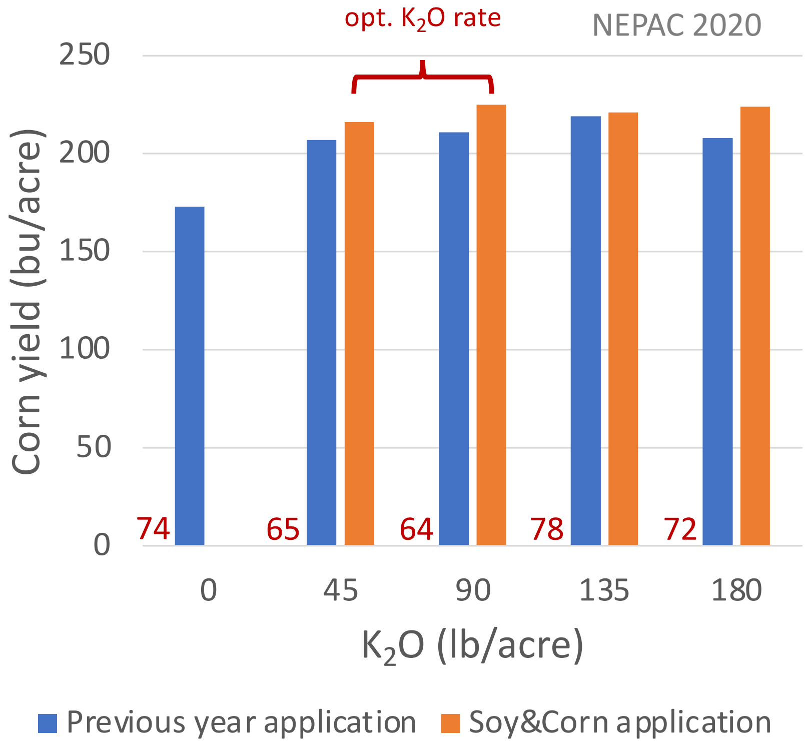
Yield response to N limited by K deficiency

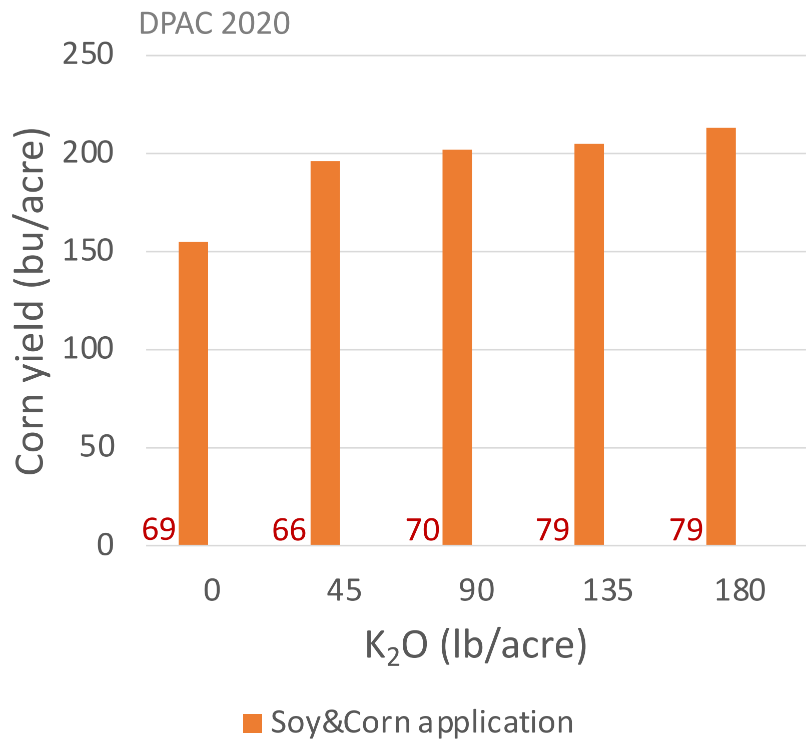
# Corn response to previous year and 2-year application on very low K soils




Mehlich-3 soil test K (ppm)

# Corn response to previous year and 2-year application on moderately low K soil



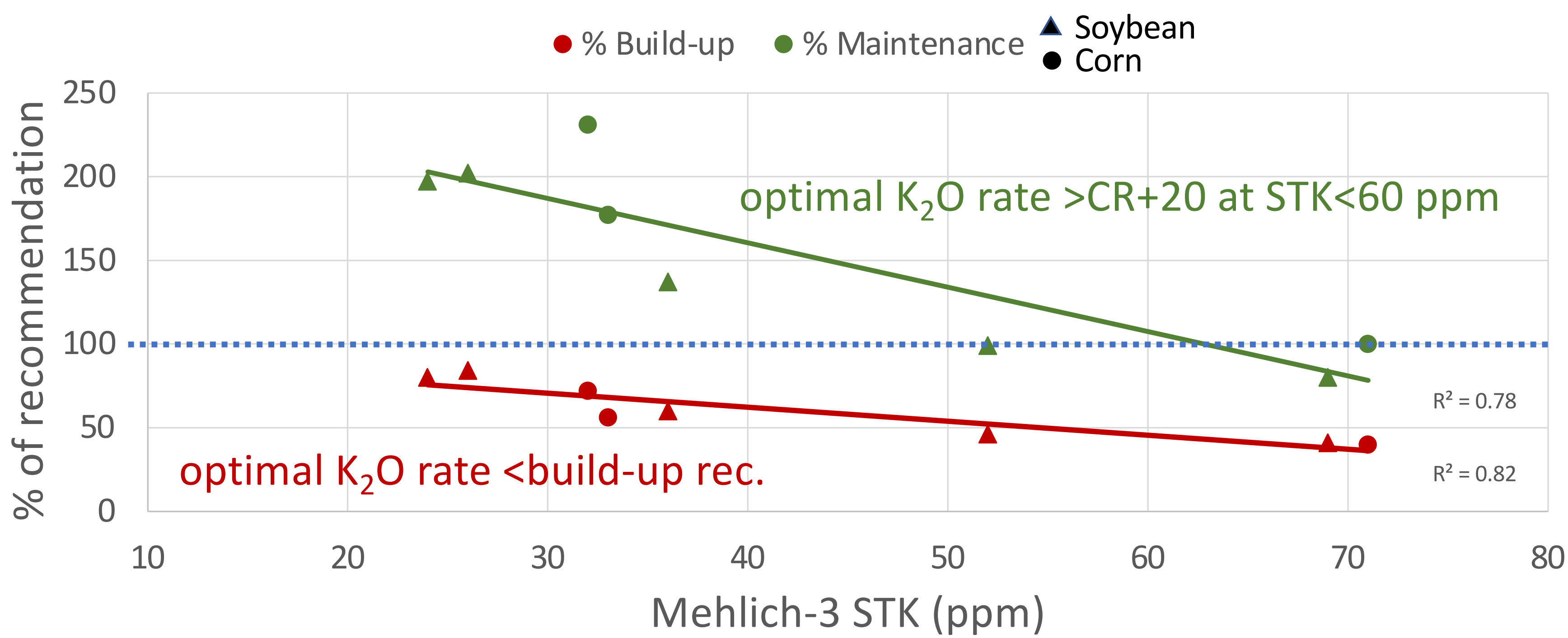




Mehlich-3 soil test K (ppm)

# Corn response to previous year and 2-year application on moderately low K soil

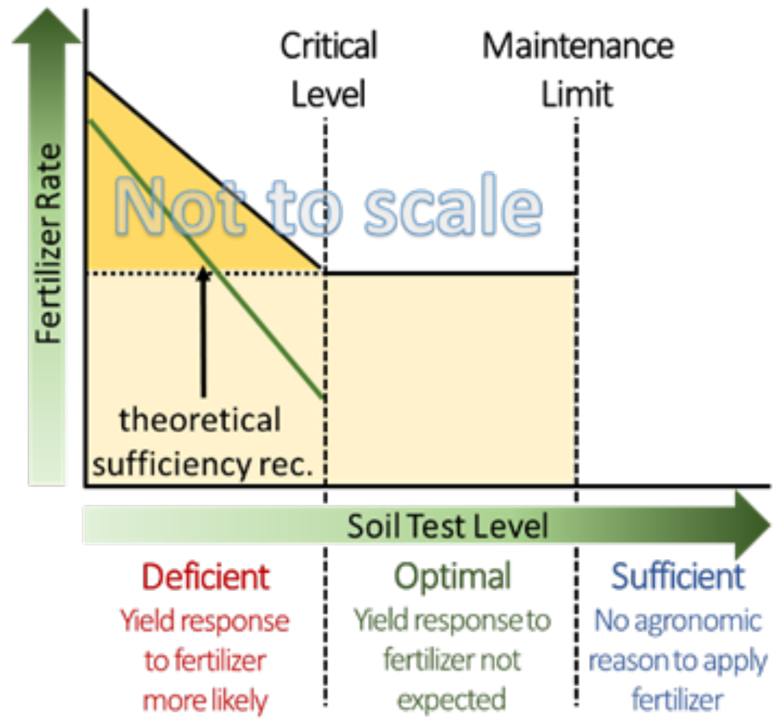
- Optimum rates range from about 75 to 150 lb $K_2O$/acre
- Maintenance recommendation for 225 bu/acre corn is 65 lb $K_2O$/acre (CR=45 + 20)
- Build-up recommendation approximately 225 lb $K_2O$/acre

# Optimal $K_2O$ rate as % of build-up and maintenance recommendations



# Conceptual sufficiency recommendation

- Optimal $K_2O$ rates will be less than the current build-up recommendation, with the difference getting smaller at lower STK
- Optimal $K_2O$ rates will be greater than the maintenance rec. at very low STK, but equal to or less than the maint. rec. as STK approaches the critical level



# Potassium management otherwise

- Results of previous Purdue research and this research suggest the current critical level for K is about right on these 3 soils
- Results of previous Purdue research and this research have found soil test K rises and falls (especially) more slowly than the general estimate, especially at SEPAC
- The nature of soil minerals (clay and other minerals) and their interaction with K and soil moisture make managing K difficult