Soil Fertility for Dry Edible Bean

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SF720 (Revised)

Fertilizing Pinto, Navy and Other Dry Edible Bean

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In the last 20 years, more than 30 site-years of trials have been conducted by various researchers in North Dakota and northwestern Minnesota.

North Dakota is the leading producer of dry edible bean in the U.S.. North Dakota has the greatest acreage of pinto bean of any state, and significant acres of navy, black and several other types of bean as well.

Beans are a warm-season crop that prefers fertile, well-drained soils. Adequate, but not excessive, moisture during the growing season and a dry harvest result in high-yielding, high-quality beans.

NITROGEN

Dryland production

Nitrogen (N) nutrition is important to dry bean production not only to sustain high yields, but also because of quality concerns. Excessive N can delay maturity and encourage excessive leaf canopy growth, which may lead to increased disease incidence and severity in some years. Maturity delays and increased disease may result in a reduced market price for growers due to reduced quality.

Dry bean growers usually do not go in and out of the business as do growers of other commodities in the state. For that reason, most growers know what N fertilization strategy works best for them in their area and their soils.

Growers have used four main N fertilization strategies effectively:

- No inoculation or supplemental N
- Inoculation using a nitrogen-fixing bacteria at seeding
- Inoculation and supplemental N
- Supplemental N only

Some soils with coarse to medium textures and higher organic matter levels (in excess of 3 percent) that have been in a dry bean rotation for many years do not require additional inoculation or supplemental N fertilization. These soils encourage natural inoculation by N-fixing bacteria from previous years' bean production.

The efficiency of the bacteria in this environment is so great that they are able to provide all the N requirements of the dry bean without additional assistance. In relation to the entire state dry bean acreage, these soils are in a minority, but for individual growers, they are important.

Inoculation is inexpensive, compared with supplemental N fertilizer. The inoculation for dry bean is *Rhizobium leguminosarum biovar phaseoli*. However, some soil and environmental conditions limit the effectiveness of the inoculants.

NDSU EXTENSION SERVICE
September 2017

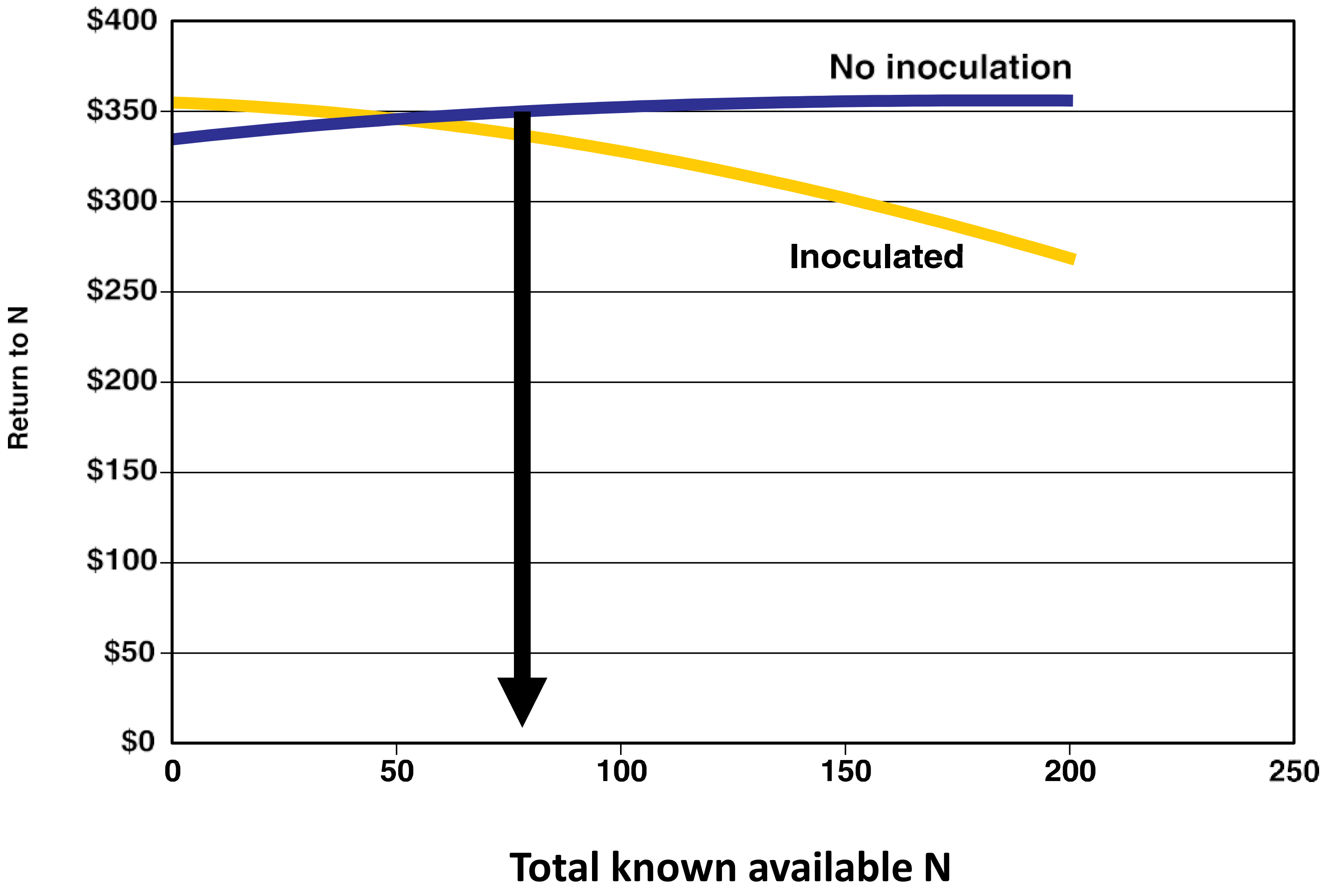
Net search:
'NDSU fertilizing bean'

Nitrogen nutrition of dry bean is very odd.

Can be inoculated with Rhizobia, but its effect is very inconsistent.

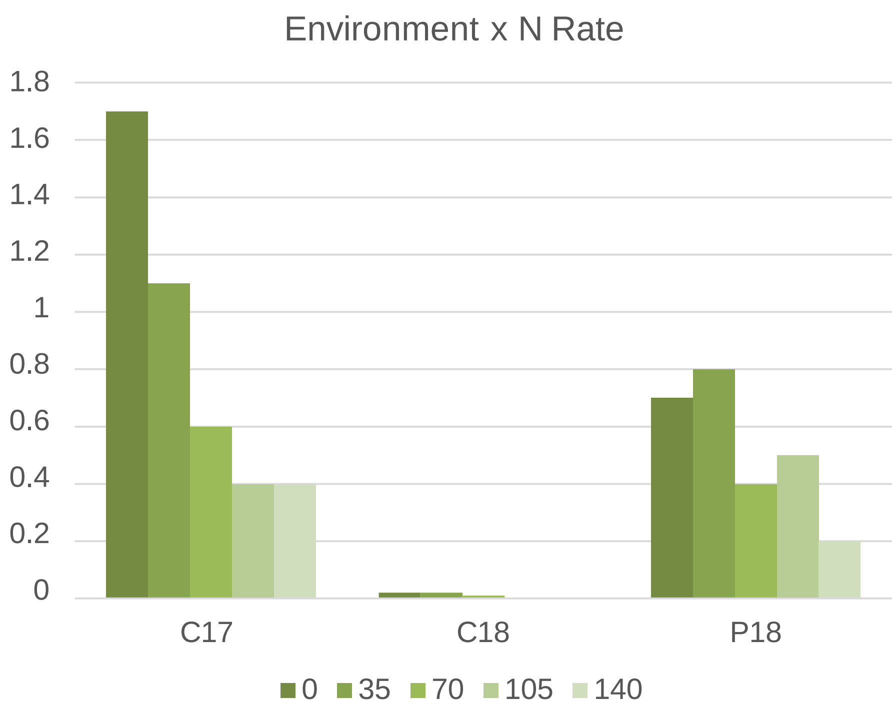
Wet soil
Dry soil
Too hot
Too cold
Soil salt

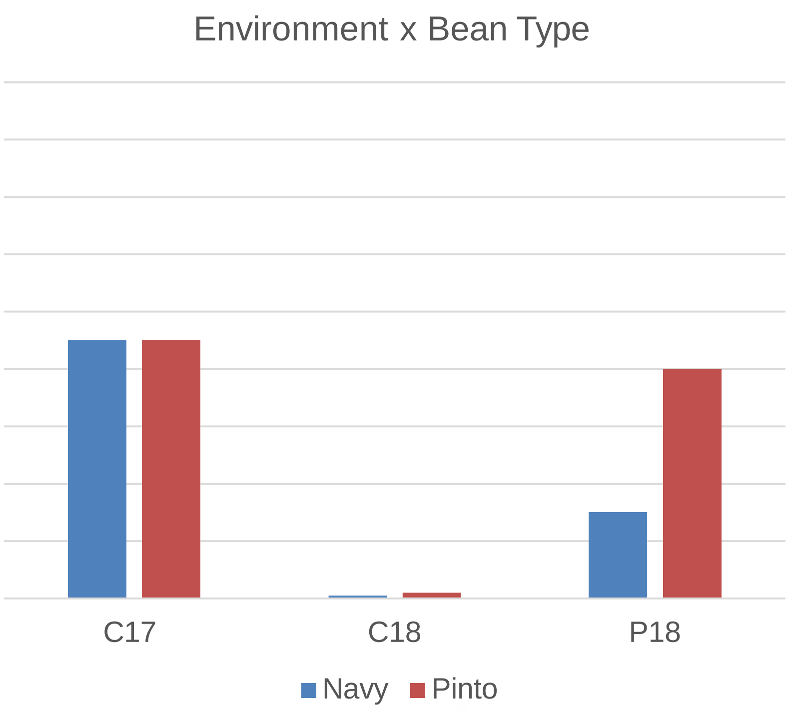
Franzen and others work on dry edible bean

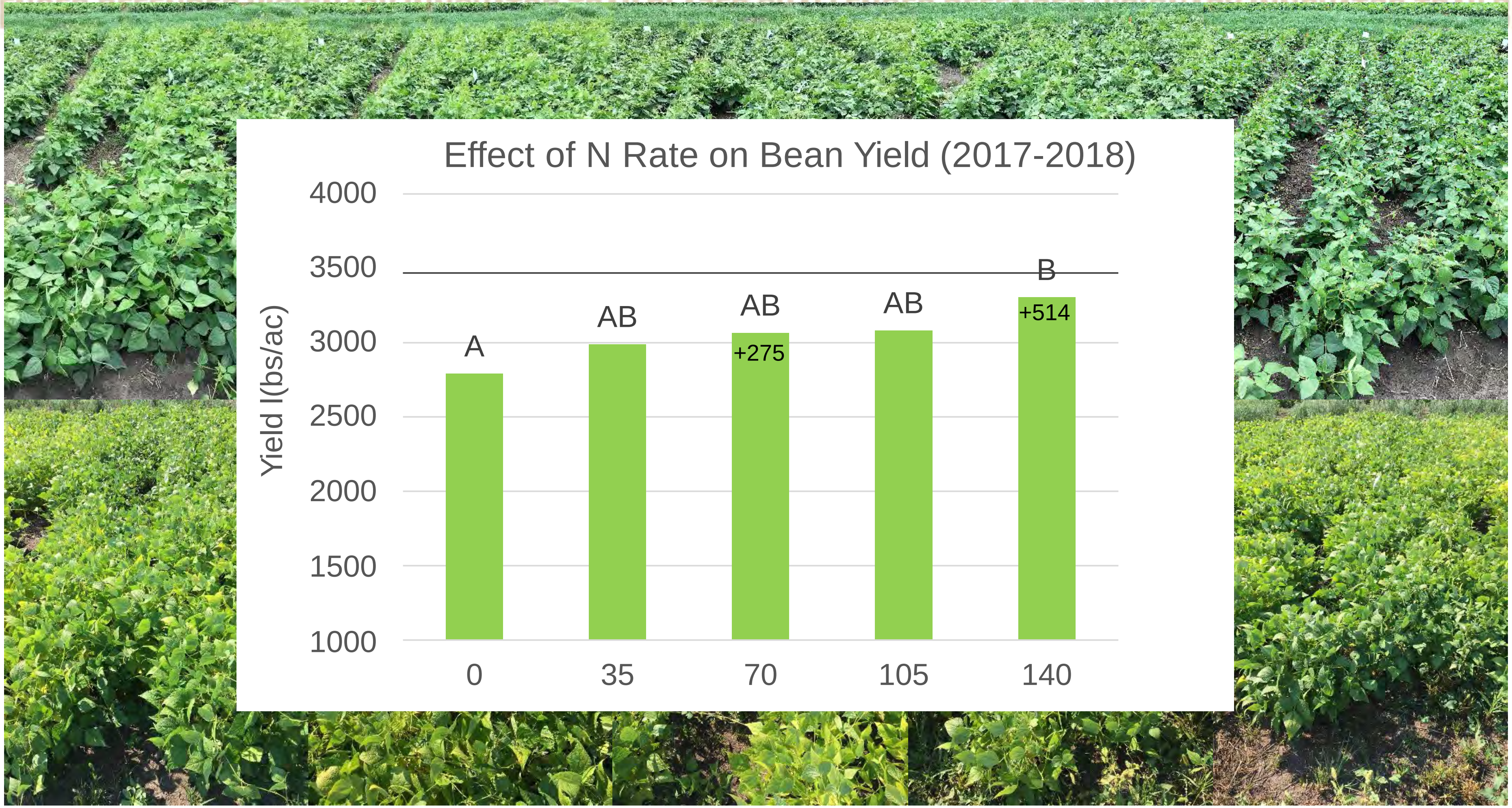


Nodulation (1-4 scale)

0 = no nodules
1 = <5 nodules $plant^{-1}$ (poor)
2 = 5-10 nodules $plant^{-1}$ (fair)
3 = 10-15 nodules $plant^{-1}$ (good)







Effect of N Rate on Bean Yield (2017-2018)
Yield l(bs/ac)
4000
3500
3000
2500
2000
1500
1000
0
35
70
105
140
A
AB
AB
AB
B
+275
+514

Manitoba work supports the earlier NDSU findings-

Response of dry bean to N and to nodulation is small

There are 3 possible N strategies-

1- **Do nothing**

2- **Inoculate**

3- **Fertilize with up to 70 lb N/acre (less soil test N and credits)**

Phosphate-

Not a great responder to P either

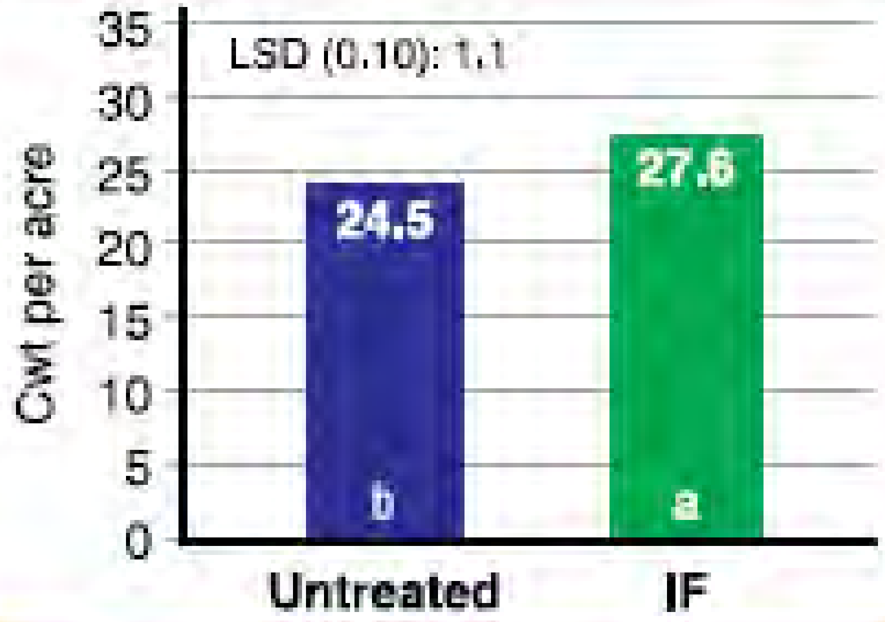
Olsen Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
45	30	20	10	0

Pinto bean fertilizer research, Carrington REC, 2009-19

- Loam soil
  - ✓ **Heimdal-Emrick** or Fram-Wyard
- 2.6-3.8% org matter
- 5.9-8.2 pH
- 3-8 ppm P
  - ✓ very low to med
- 0.2-0.8 ppm Zn
  - ✓ low

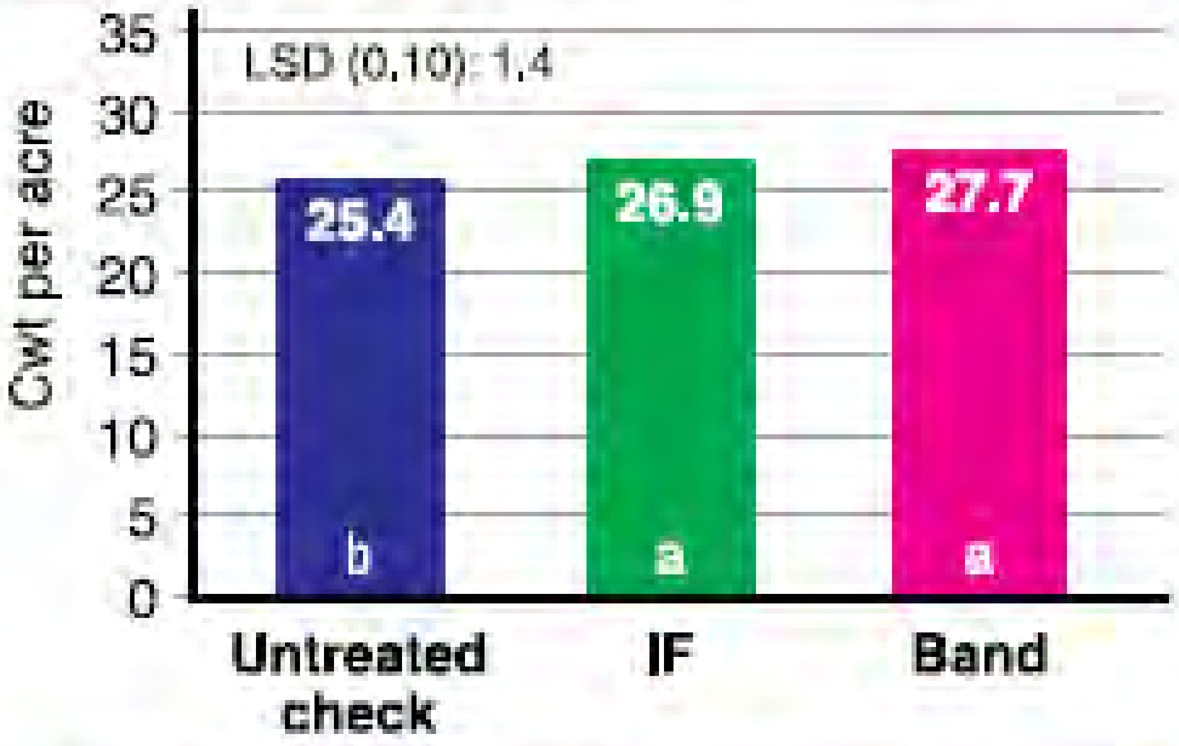
- 10-34-0
- 'Lariat' or 'ND Palomino' (2018-19)

Figure 1. Pinto bean yield with IF-applied 10-34-0, Carrington, 2012-17 (seven trials).*



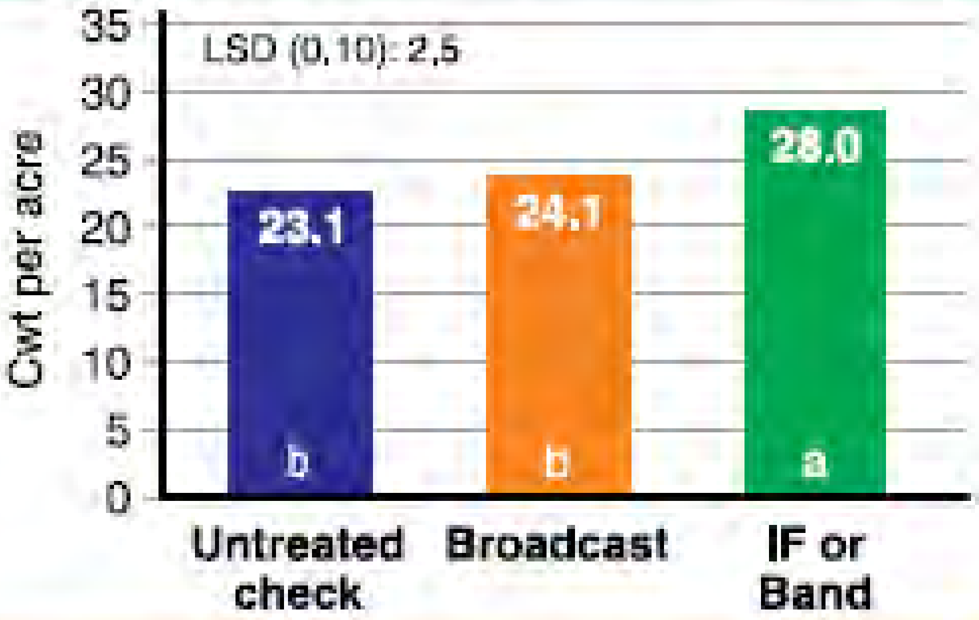
* Soil P: 5 to 8 ppm (low to medium).
10-34-0 rates: 2 to 3 gpa.

Figure 2. Pinto bean yield between IF- and band-applied 10-34-0, Carrington, 2009-13 and 2015-16 (seven trials).*



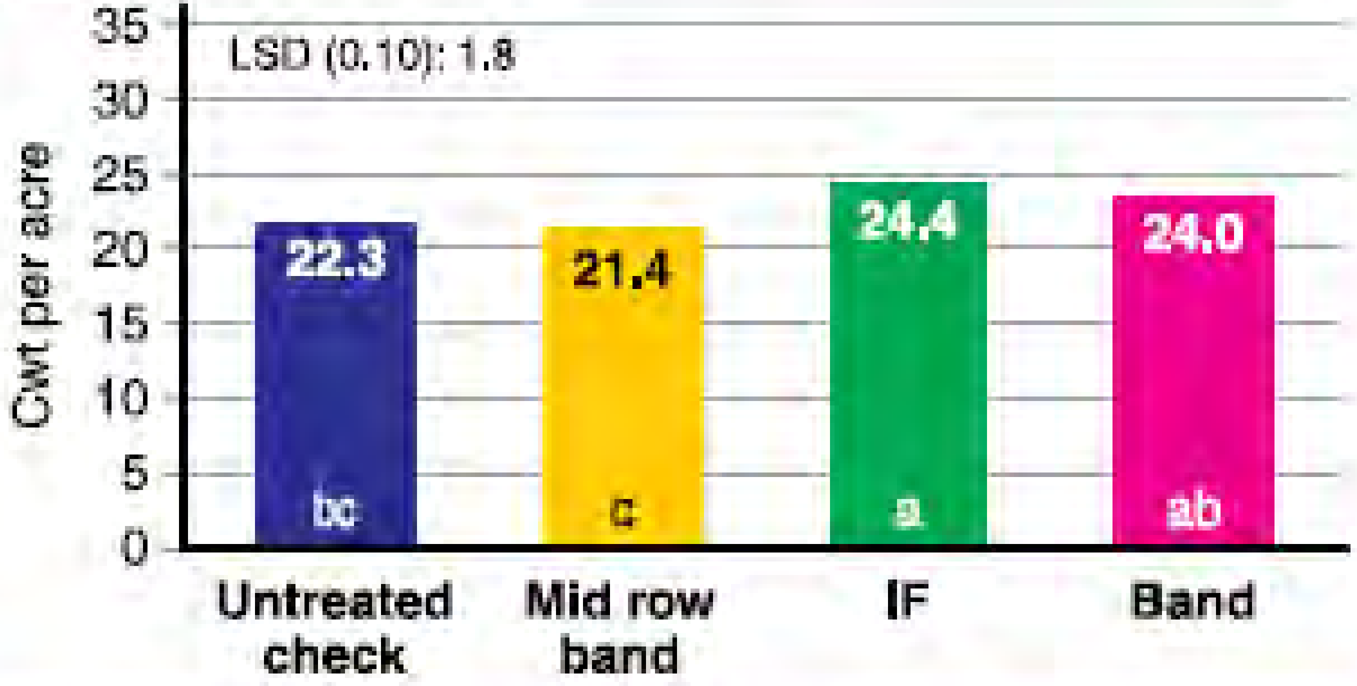
* Soil P: 5-10 ppm (low-med). 10-34-0 rates: 3 to 6 gpa.

Figure 3. Pinto bean yield between broadcast and IF- or band-applied 10-34-0, Carrington, 2013-15 (three trials).*



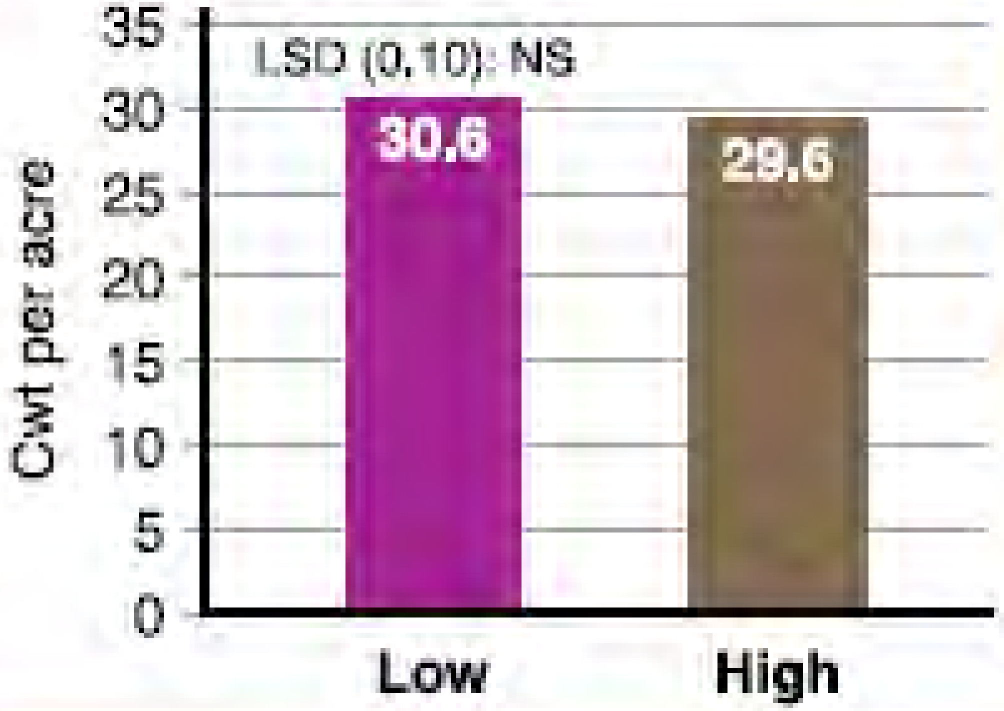
* Soil P: 5 ppm (low). 10-34-0 rates: 2013 = 8 gpa broadcast PRE (without mechanical incorporation) and 5 gpa IF and band; 2014 = 9 gpa broadcast PPI and 6 gpa IF; and 2015 = 4.5 gpa broadcast PPI and 3 gpa IF and band.

Figure 4. Pinto bean yield among midrow band, and IF- and band-applied 10-34-0, Carrington, 2009-11 (three trials).*



*Soil P: 7 to 10 ppm (low to medium). 10-34-0 rates: 4 or 6 gpa.

Figure 5. Pinto bean yield between rates of IF-applied 10-34-0, Carrington, 2012-14 (three trials).*



* Soil P: 5 to 6 ppm (low). 10-34-0 rates: low = 2.5 to 3 gpa; high = 5 to 6 gpa.

NDSU Extension Service EXTENDING KNOWLEDGE » CHANGING LIVES

Pinto Bean Response to Phosphorus Starter Fertilizer in East-central North Dakota

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North Dakota annually produces more than 500,000 acres of dry edible beans, primarily pinto beans. This publication provides a summary of pinto bean response to phosphorus (P)-based starter fertilizer from 10 trials NDSU conducted in east-central North Dakota from 2009 through 2017. The publication includes details on seed yield response primarily with liquid 10-34-0 using different application methods and rates.

Materials and Methods

Location and years: NDSU Carrington Research Extension Center, 2009-17

Experimental design: Randomized complete block with four replications

Soil: Heimdal-Emrick loam; 2.6 to 4 percent organic matter; 6.3 to 8.2 pH; 4 to 10 parts per million (ppm) P (Olsen test; most trial sites in the low range [P levels 4 to 7 ppm]); 0.06-1 mmho/cm salt

Standard treatments: 10-34-0 applied in-furrow (IF) with seed or in a 2- by 0-inch band (2 inches horizontally placed from planted seed)

General: The dryland trials were conducted using strip- or conventional-tillage systems. Lariat, a short, upright type of pinto bean, was planted in 22- or 30-inch rows. Low amounts of N (3 to 10 pounds per acre) were included as part of the starter fertilizer treatments. No additional fertilizer P was applied to supplement P in the starter treatments. Plant populations were measured two to four weeks after planting. Best management practices were used for dry bean production.

NDSU EXTENSION SERVICE
North Dakota State University
April 2018

Net search:
‘NDSU pinto P’

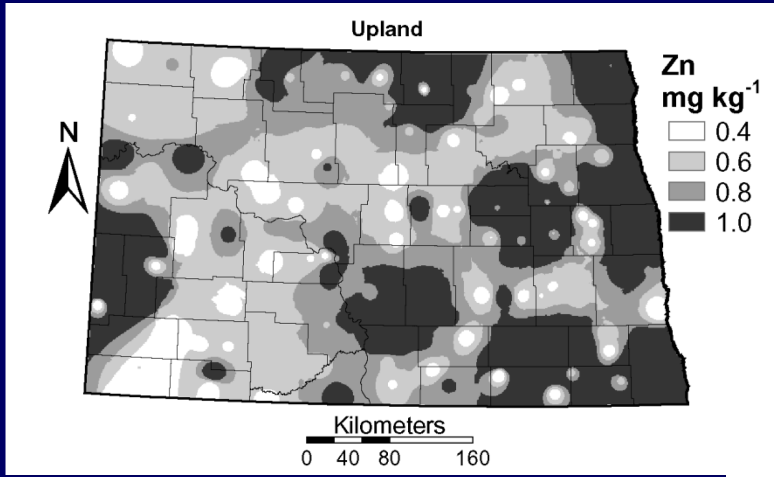
Potassium

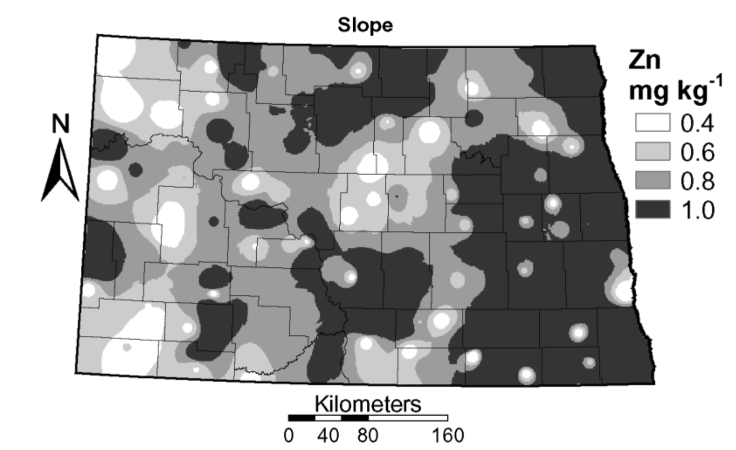
Not a big responder

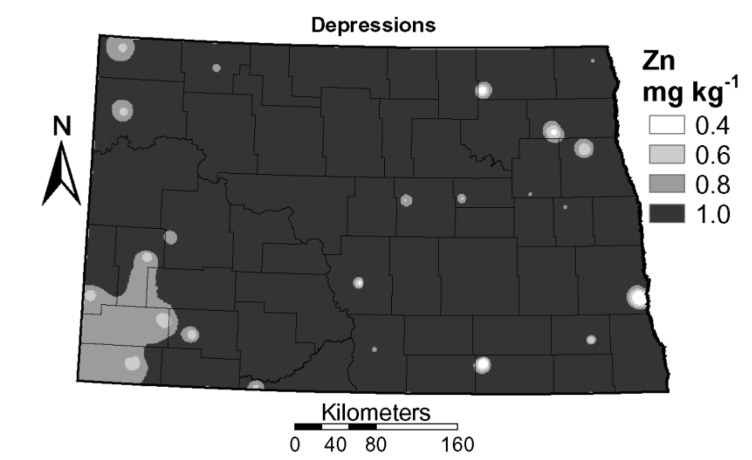
Soil test K > 80 ppm, OK
Soil tests 0-40 ppm, apply 50 lb K_2O
from 41-80 ppm, apply 20

Pinto bean response to fertilizer, 2015-19: **Zn, S and specialty fertilizers**

– Objectives
  - What is yield gain with in-furrow or foliar application of zinc on low-testing soils?
  - Will sulfur increase yield?
  - Are there yield and economic advantages with specialty fertilizers vs. 10-34-0 + Zn?


Upland
N
Zn
mg kg-1
0.4
0.6
0.8
1.0
Kilometers
0 40 80 160


Slope
N
Zn
mg kg-1
0.4
0.6
0.8
1.0
Kilometers
0 40 80 160

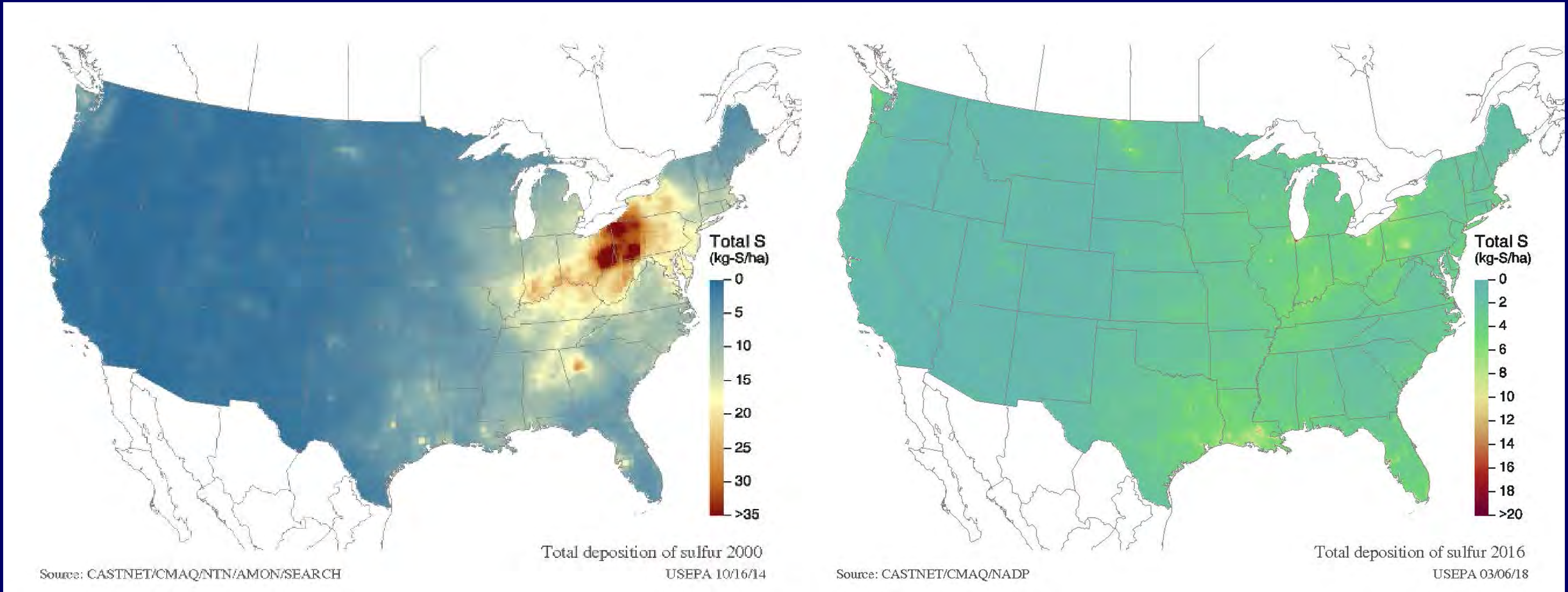

Depressions
N
Zn
mg kg-1
0.4
0.6
0.8
1.0
Kilometers
0 40 80 160

NDSU Zn recommendations-

Use soil test value (DTPA) on a 6 inch core composite (Field zone sampled)

If soil test is < 1 ppm, a small rate of Zn in starter band work alleviate any deficiency

Rates of chelated Zn 1pt to 1 qt are sufficient



2000 S deposition **2016 S deposition**

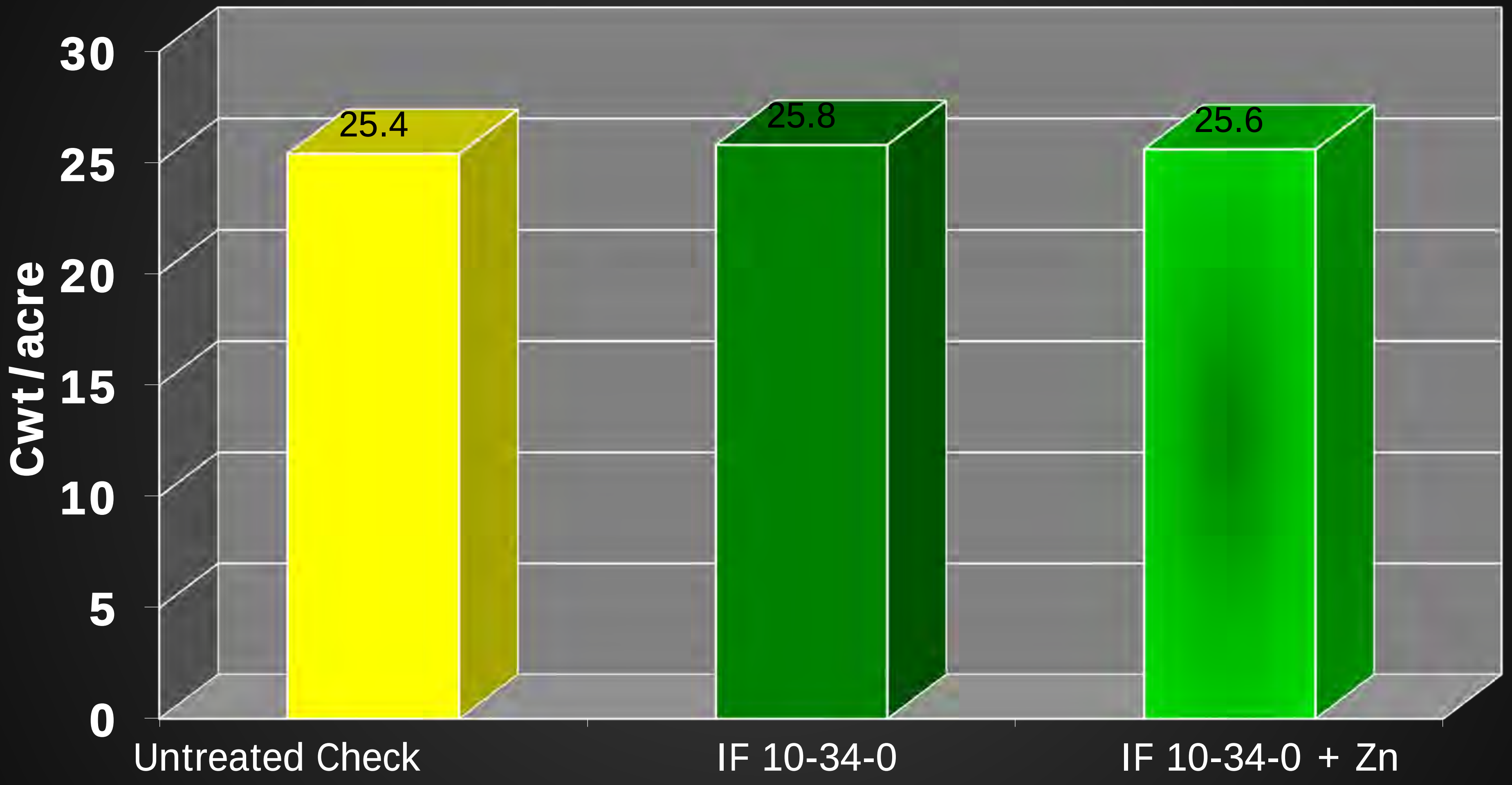
There are no firm S recommendations for dry bean

Soil test is garbage- don’t even bother

S responses most likely if weather in fall/early spring have been wet on sandy loam or coarser soils in upland positions (where there has been leaching)

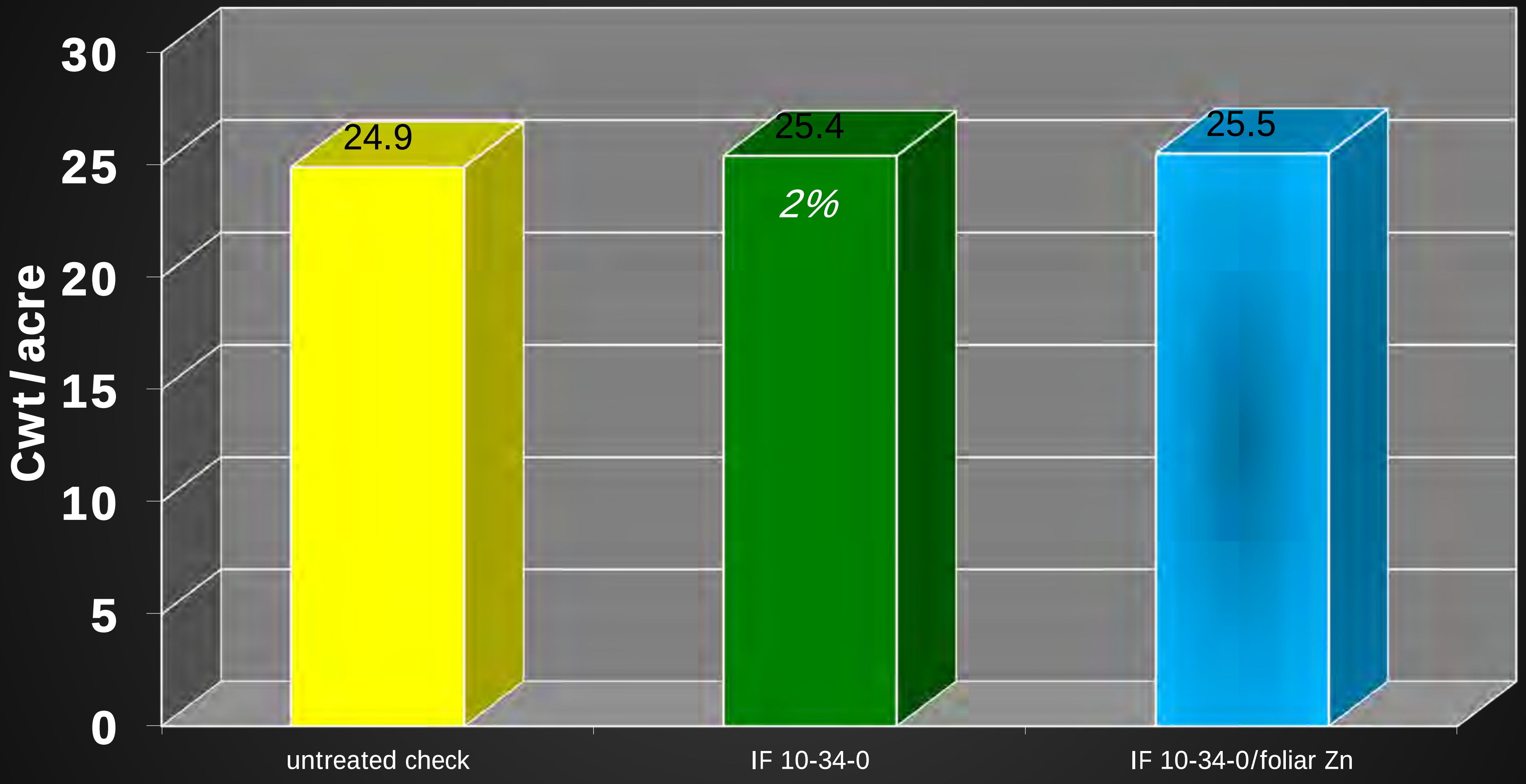
Elemental S is not an option
Use sulfate sources. Don’t put ATS with the seed!

Pinto bean yield with <u>in-furrow zinc</u>, Carrington, 2016-19 (4 years)*



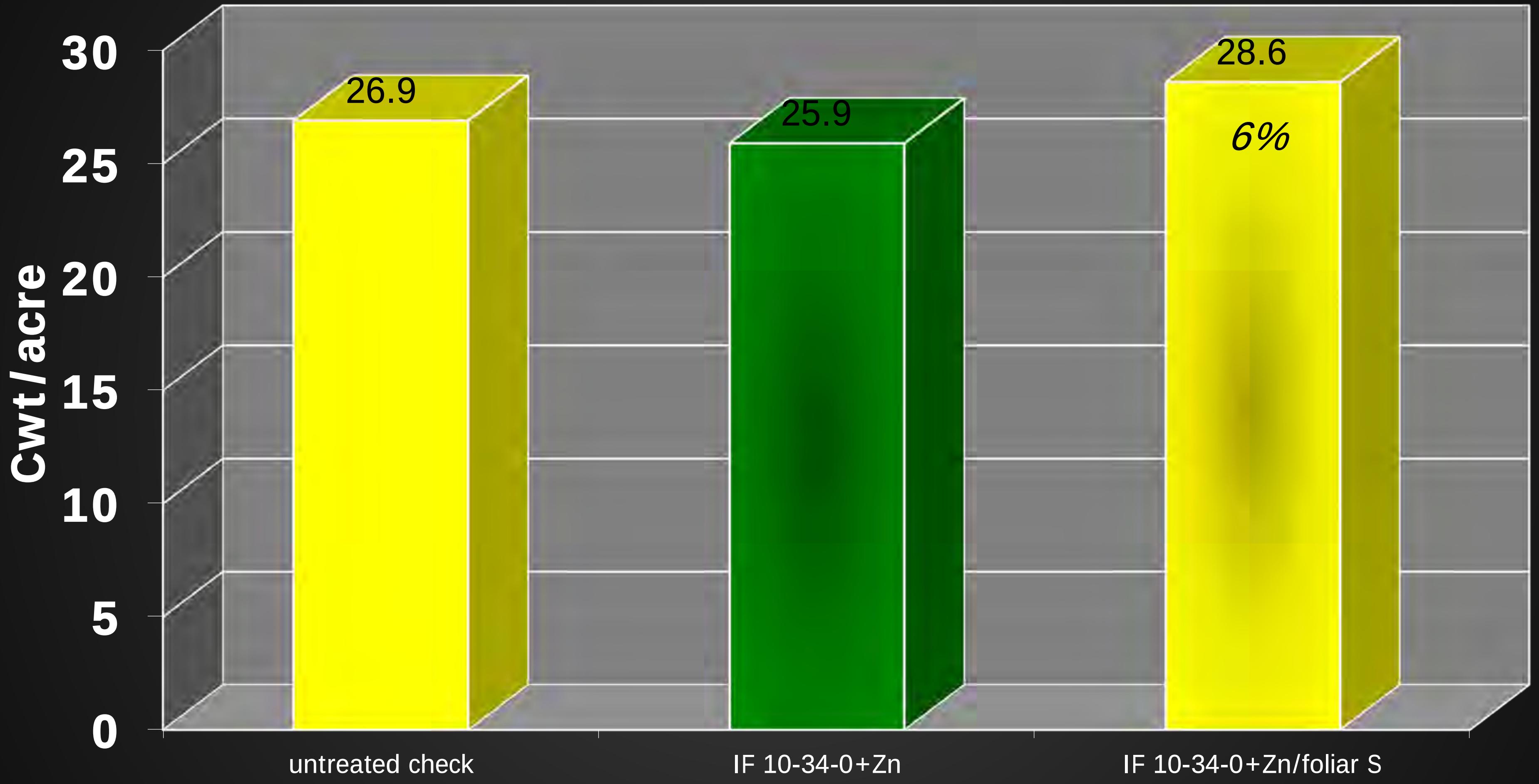
*In-furrow 10-34-0 at 2.75-3 gpa; Zn (2016-18=NWC Zn; 2019=Ammend) at 0.25 gpa.
LSD (0.10): 2016-19=NS.

Pinto bean yield with foliar zinc, Carrington, 2017-19 (3 years)*



*In-furrow 10-34-0 at 2.75-3 gpa; Foliar Zn (2017-18=NWC Zn; 2019=Ammend) at 0.25 gpa during R3-5.
LSD (0.10): 2017-19=NS.

Pinto bean yield with foliar S, Carrington, 2016 and 2018-19 (3 years)*

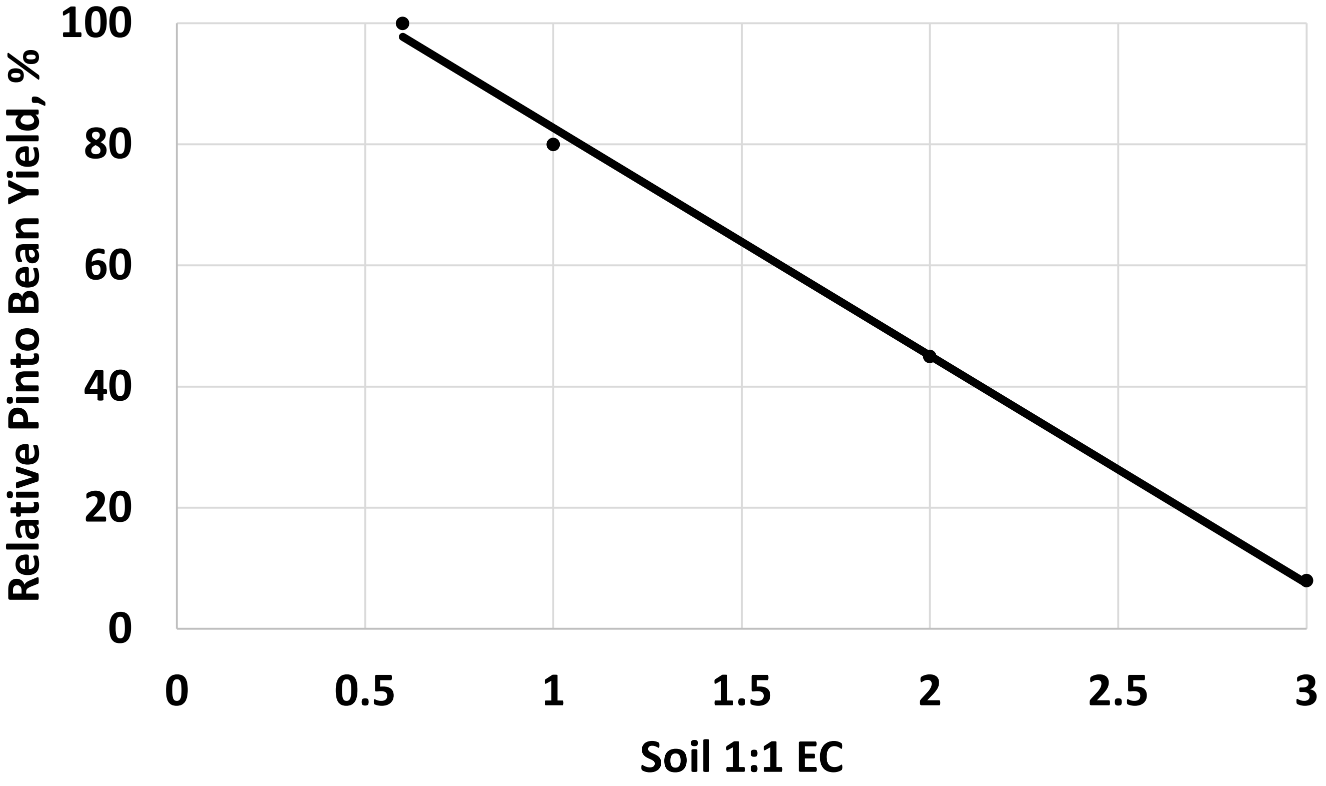


*In-furrow 10-34-0 at 3 gpa plus Zn (2016 and 2018=NWC Zn; 2019=Ammend) at 0.25 gpa.
Foliar S: MAX-IN S (0-0-19-13; Winfield) at 64 fl oz/A during R3-5 stages. LSD (0.10): 2016 and 2018=NS; 2019=*.

Fertilizer research database building progress, Carrington REC, 2015-19

Treatment	2015	2016	2017	2018	2019
IF Zn					
foliar Zn					
preplant Zn and S					
foliar S					
IF RizeR + Accomplish LM					
IF Redline					
foliar MAX-IN Ultra ZMB + Ascend					

Salinity tolerance is an issue
Field selection will help yields



From Colorado data, Davis, 1998

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