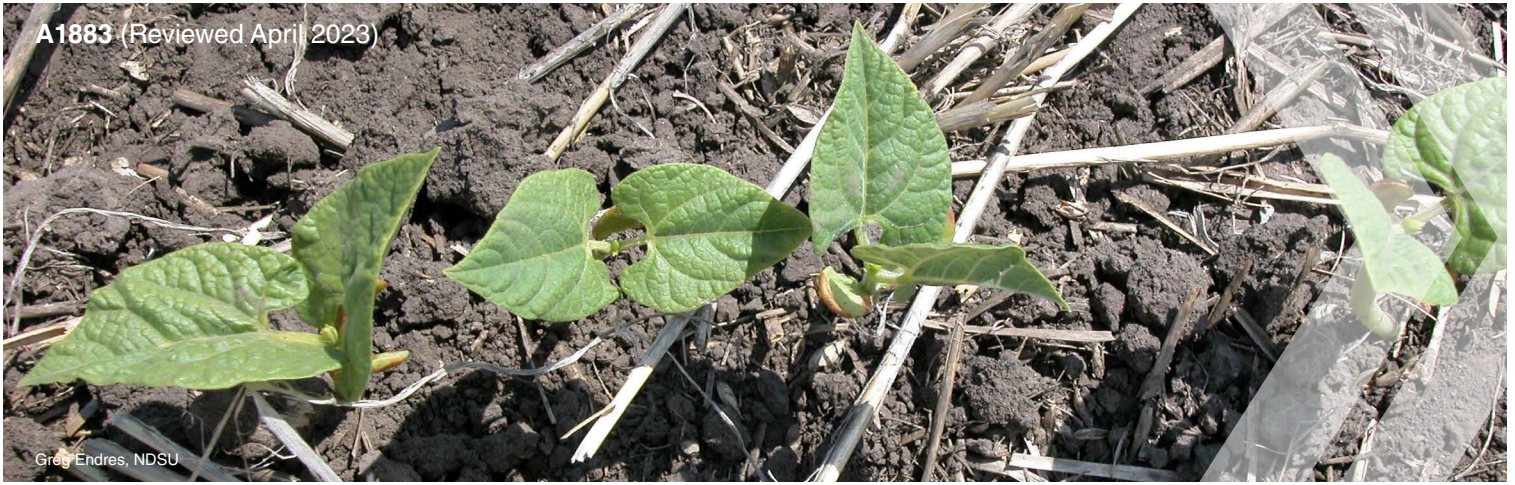


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Pinto Bean Response to Phosphorus Starter Fertilizer in East-central North Dakota

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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.

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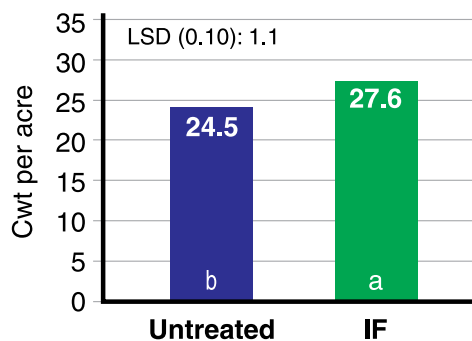
Results and Discussion

In individual trials, pinto bean seed yield response did not always occur among fertilizer treatments.

Seed yield averaged across seven trials increased 3.1 hundredweight (cwt) per acre (11 percent), compared with the untreated check (Figure 1).

Averaged across six trials, IF-applied 10-34-0 at 2 to 3 gallons per acre (gpa) reduced the pinto bean plant population by 4 percent, compared with the untreated check (Table 1). Given the reduction in plant population due to IF application, a separated seed to fertilizer band might be most beneficial.

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.

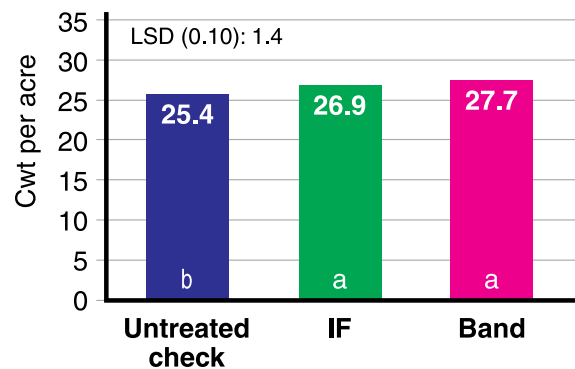
Table 1. Pinto bean plant population with IF-applied 10-34-0, Carrington, 2012-17 (six trials).*

Method	Rate (gpa)	Plants per acre
Untreated check		68,860 a
IF	2 to 3	65,835 b
LSD (0.10)		2,070

* Soil P: 5 to 8 ppm (low to medium).

Pinto bean yield between IF- and band-applied 10-34-0 at 3 to 6 gpa was statistically similar averaged among seven trials (Figure 2). However, the plant population was reduced an average of 13 percent with IF-applied 10-34-0, compared with band-applied 10-34-0 and the untreated check (Table 2). The banded fertilizer application provides soil separation between fertilizer and bean seed that reduces the risk of seed damage from fertilizer salts and ammonium-N (Franzen, 2017).

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.

Table 2. Pinto bean plant population with IF- and band-applied 10-34-0, Carrington, 2009-16 (seven trials).*

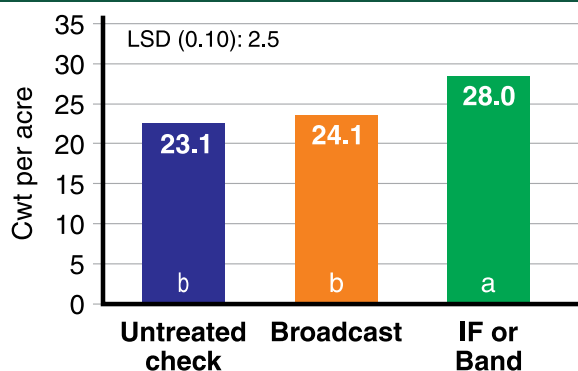
Method	Rate (gpa)	Plants per acre
Untreated check		57,160 a
IF	3 to 6	50,650 b
Band	3 to 6	59,730 a
LSD (0.10)		2,990

* Soil P: 5 to 10 ppm (low to medium).

Averaged across three trials, pinto bean yield was similar between broadcast-applied 10-34-0 and the untreated check, while yield increased 4.9 cwt per acre with IF- or band-applied 10-34-0, compared with the untreated check (Figure 3).

Broadcast 10-34-0 at 8 gpa was applied immediately after planting (PRE) without mechanical incorporation in 2013, and was preplant applied and incorporated (PPI) at 9 gpa in 2014 and 4.5 gpa in 2015. IF- and band-applied fertilizer rates were one-third less, compared with the broadcast rate in the trials.

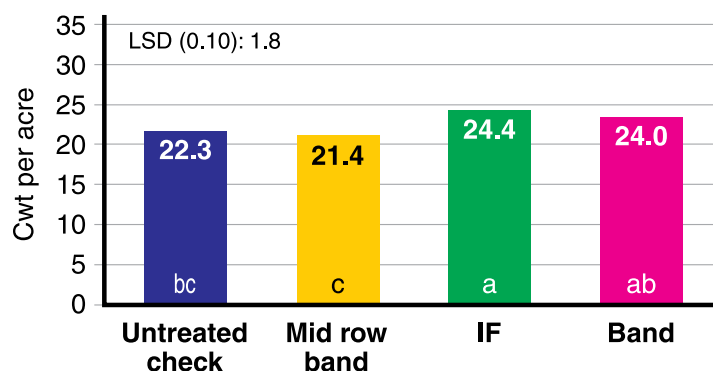
Figure 3. Pinto bean yield between broadcast and IF- or band-applied 10-34-0, Carrington, 2013-15 (three trials).*



* 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.

Averaged across three trials, pinto bean yield did not increase with midrow band application (centered between 22- or 30-inch rows) at 4 or 6 gpa of 10-34-0 at planting, compared with the untreated check. Also, midrow band application of 10-34-0 averaged 12 percent less yield than with similar fertilizer rates of IF- or band-applied (Figure 4).

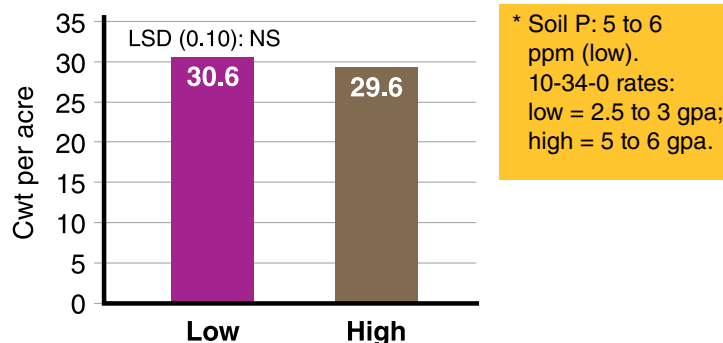
Figure 4. Pinto bean yield among midrow band, and IF- and band-applied 10-34-0, Carrington, 2009-11 (three trials).*



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

Pinto bean yield, averaged across three trials, was similar with low (2.5 to 3 gpa) and high (5 to 6 gpa) rates of IF-applied 10-34-0 (Figure 5). The plant population was statistically similar between the untreated check and low fertilizer rates, while high fertilizer rates decreased the population by 13 percent, compared with the untreated check (Table 3).

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.

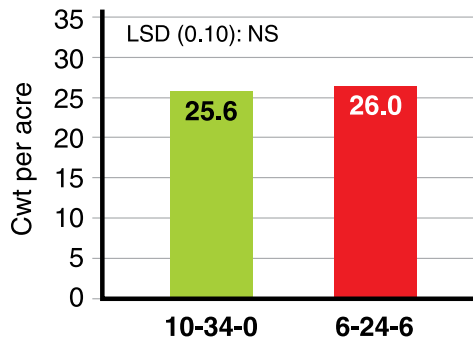
Table 3. Pinto bean plant population with low and high rates of IF-applied 10-34-0, Carrington, 2012-14 (three trials).*

Method	Rate (gpa)	Plants per acre
Untreated check		68,830 a
IF	2.5 to 3	65,050 a
IF	5 to 6	59,800 b
LSD (0.10)		4,720

* Soil P: 5 to 6 ppm (low).

At similar rates of IF-applied P, pinto bean yield averaged across three trials with 10-34-0 was similar to yields from the low-salt fertilizer 6-24-6 application (Figure 6). Also, the plant population was statistically similar between the two fertilizers; however, the plant population was lower, compared with the untreated check (Table 4). K soil levels in the trials were high to very high.

Figure 6. Pinto bean yield between IF-applied 10-34-0 and 6-24-6 fertilizer, Carrington, 2014-16 (three trials).*



* Soil P: 5 to 7 ppm (low). Fertilizer rates: 2014-15 = 10-34-0 at 3 gpa and 6-24-6 at 4.5 gpa; 2016 = 10-34-0 at 2.75 gpa and 6-24-6 at 4.25 gpa.

Table 4. Pinto bean plant population with IF-applied 10-34-0 and 6-24-6, Carrington, 2014-16 (three trials).*

Fertilizer

Type	Rate (gpa)	Plants per acre
Untreated check		67,510 a
10-34-0	2.75 to 3	61,540 b
6-24-6	4.25 to 4.5	62,630 b
LSD (0.10)		2,990

* Soil P: 5 to 7 ppm (low).

Summary

- Pinto bean seed yield increased more than 3 cwt per acre with IF-applied 10-34-0 at 2 to 3 gpa, compared with the untreated check.
- Yield was similar with IF- and band-applied 10-34-0 at 3 to 6 gpa, although the plant population was reduced with IF application.
- Broadcast or midrow band-applied 10-34-0 did not increase yield.
- Yield was similar between low (2.5 to 3 gpa) and high (5 to 6 gpa) rates of IF-applied 10-34-0. The high fertilizer rate reduced the plant population.
- The plant population and yield were similar between IF-applied 10-34-0 and the low-salt fertilizer 6-24-6.

Reference

Franzen, D.W. 2017. Fertilizing pinto, navy and other dry edible bean. NDSU Extension Service publication SF720 (Revised).

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