
G. Endres, NDSU

A2050 (March 2022)

Winter Rye as a Preceding Cover Crop for Pinto Bean Production in North Dakota

Gregory Endres, Extension Cropping Systems Specialist, Carrington Research Extension Center (REC)

Hans Kandel, Extension Agronomist, Plant Sciences Department, Fargo

Mike Ostlie, Research Agronomist, Carrington REC

Historic dry bean production in North Dakota has primarily involved conventional tillage. Conventional-tilled soils are susceptible to soil erosion before a bean crop is established and after harvest. Also, long-term soil productivity likely declines with conventional tillage. However, dry bean production with reduced tillage is slowly increasing. A 2020 dry bean grower survey (Knodel et al., 2021) indicated 65% of North Dakota acres were grown using conventional tillage compared to 35% with minimum tillage, no-till or strip-till systems.

Use of cover crops plus reduced tillage will reduce soil erosion and increase long-term soil productivity. The 2020 dry bean grower survey indicates 17% of North Dakota dry bean acres included a cover crop, primarily intended for soil and moisture conservation, weed management and to improve soil health.

Winter (cereal) rye is a common cover crop used in North Dakota and has many advantages when properly managed (Ransom et al., 2021). Expected advantages with winter rye, established prior to pinto bean production and with timely termination, include reduction in soil erosion, supplement weed management, utilize excess soil moisture and improved efficiency with direct harvest of bean seed (e.g., timely harvest and clean seed).

A study commenced at the Carrington REC during fall 2017 with seeding winter rye to provide living ground cover in the fall and spring prior to pinto bean production, providing benefits including protection from soil erosion and aid in weed management. Objectives included determining optimum time for terminating rye based on bean planting date, assessing weed suppression and measuring productivity of the bean crop. The study was completed in 2021, providing a four-year database on the production strategy.

Materials and Methods

ND Dylan winter rye was seeded with a no-till drill in 7-inch rows into small grain or soybean residue at 60-65 lb per acre during Sep. 17 to Oct. 8, 2017-20. Late-fall rye growth stages ranged from plants not emerged to 2-leaf. Early spring rye plant populations were 432,000 plants per acre in 2020 and 354,000 plants per acre in 2021 (data not available for 2018-19). Lariat or ND Palomino pinto bean was seeded with a no-till planter in 21- or 30-inch rows into no residue (tilled plots), rye residue or living rye (”green planted”) during May 31 to June 4, 2018-21 at rates targeted to establish 70,000 pinto bean plants per acre.

Standard treatments (trts) based on rye termination and pinto bean planting dates (and rye growth stages among years):

1. Conventional production system check—fall and/or spring tillage followed by preplant (PP) or pre-emergence (PRE) glyphosate (Roundup Powermax at 28.4 fl oz per acre plus adjuvant) and PRE Spartan Charge (5 fl oz per acre) or Spartan Elite (20 fl oz per acre).
2. PP glyphosate 29-36 days before bean planting (DBBP) (1-leaf to tiller).
3. PP glyphosate 29-36 DBBP plus PRE herbicide (1-leaf to tiller).
4. PP glyphosate 16-20 DBBP (tiller).
5. PP or PRE glyphosate 5 DBBP to 1 day after bean planting (DABP) (2-joint to boot).
6. PRE glyphosate 7-11 DABP (flag to flower).

After visual evaluation of weed control associated with trts, post-emergence herbicides were applied across each trial for general weed control. At bean seed maturity, plants were hand-pulled for field drying and threshed via combine.

Results and Discussion

Average pinto bean plant population was 50,600, 62,300 and 22,100 plants per acre during 2018, 2019 and 2021 (drought season), respectively. The early season plant densities were 11-68% less than the targeted stand of 70,000 plants per acre. With reduced plant populations in three of four trials trials (2020 average stand was 67,400 plants per acre) compared to the recommended stand, farmers should carefully consider planting rates and procedures when using this production system. In each of the trials, plant stands among trts generally were similar to the conventional system check.

Averaged over four years (2018-21), pinto bean seed yield with rye terminated 29-36 DBBP (trts 2-3) ranged from 1,795-1,855 lb per acre and were statistically similar to the conventional check (trt 1) with 1,750 lb per acre (Table 1). In addition, yield was similar to trt 1 with delaying rye termination 16-20 DBBP (trt 4). These data indicate that yield can be maintained with this production system compared to a conventional system. Yield averaged 1,390 lb per acre with delaying rye termination until near bean planting (trt 5), reducing yield 24% compared to the average yield of trts 2-3. Averaged over three years, delaying rye termination 7-11 DABP (trt 6) reduced yield 36% and 11% compared to yield with trts 2-3 and 5, respectively.

Table 1. Pinto bean seed yield with rye cover crop termination treatments, Carrington, 2018-21.

Treatment[1]		3-year average (2019-21)	4-year average
No.	Description	lb per acre	
1	Conventional production check	1945	1750
2	PP glyt 29-36 DBBP	2025	1795
3	PP glyt 29-36 DBBP/PRE Spartan Charge or Elite	2060	1855
4	PP glyt 16-20 DBBP	1965	1705
5	Near planting glyt 5 DBBP to 1 DABP	1475	1390
6	PRE glyt 7-11 DABP	1315	—
LSD 0.05		355	261

[1]PP=preplant. Glyt=glyphosate. DBBP=days before bean planting. PRE=pre-emergence. DABP=Days after bean planting.

Averaged over four years, ground cover, measured by the line-transect method one to two DABP, generally was greater with delay of rye termination near or after planting compared to the conventional check and PP termination of rye (Figure 1 and Table 2).

Figure 1. Trt 2 (left) and trt 6 (right) plots at early pinto bean plant emergence (mid-June 2019).

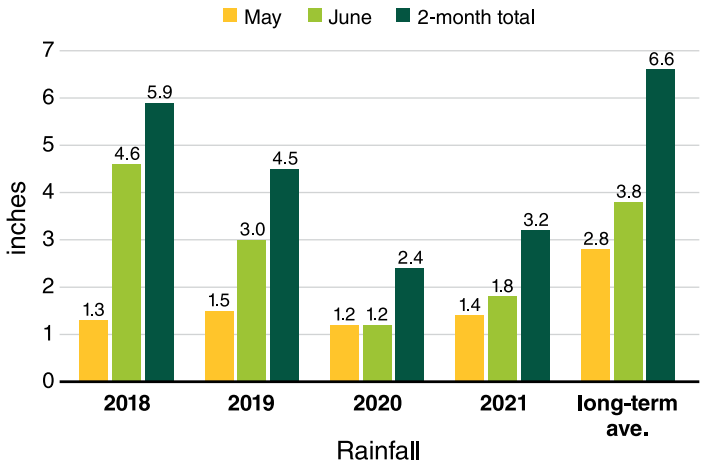
Table 2. Ground cover and topsoil moisture with rye cover crop termination treatments, Carrington, 2018-21.

Treatment[1]		Ground cover[2]	Topsoil moisture[3]
No.	Description	%	
1	Conventional production check	18	17.5
2	PP glyt 29-36 DBBP	32	18.0
3	PP glyt 29-36 DBBP/PRE Spartan Charge or Elite	29	18.7
4	PP glyt 16-20 DBBP	34	18.7
5	Near planting glyt 5 DBBP to 1 DABP	50	15.7
6	PRE glyt 7-11 DABP	59	—
LSD 0.05		24	2.1

[1]PP=preplant. Glyt=glyphosate. DBBP=days before bean planting. PRE=pre-emergence. DABP=Days after bean planting.
[2]Measured previous crop residue and rye using line-transect method 1-2 DABP (2019-21).
[3]Measured with Extech Instruments MO750 soil moisture meter at 4-inch depth 0-7 DABP.

During each year of pinto bean production, topsoil moisture in the trials was reduced by delaying rye termination until near bean planting (trt 5). In addition, rainfall to replenish soil moisture was less than normal (Figure 2) and not timely. Averaged over four years, topsoil moisture, measured within a week of bean planting, generally was greater with the conventional check (trt 1) and PP termination of rye (trts 2-4) compared to rye termination near bean planting (trt 5) (Table 2). Pinto bean plant development (emergence, flowering and maturity) was extended three to 10 days with trt 5 (Table 3). In addition, bean plant canopy closure was reduced 12-20% with trt 5 compared to other trts.

Figure 2. May and June rainfall, Carrington 2018-21 (NDAWN).[1]



[1]NDAWN=North Dakota Agricultural Weather Network

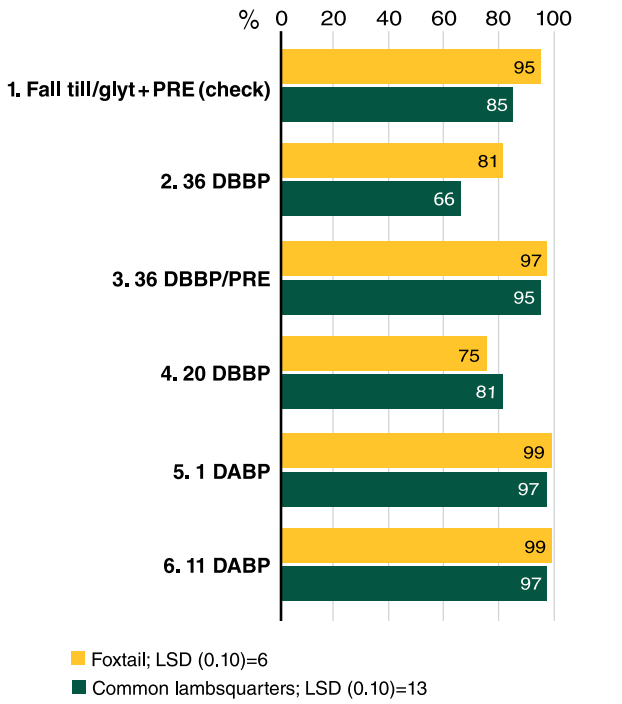
Table 3. Pinto bean plant development and canopy cover with rye cover crop termination treatments, Carrington, 2018-21.

Treatment[1]		Plant development			Canopy[2]
		Emergence	Flower	Maturity	
No.	Description	Day of year[3]			%
1	Conventional production check	164	200	254	74
2	PP glyt 29-36 DBBP	164	200	254	69
3	PP glyt 29-36 DBBP/ PRE Spartan Charge or Elite	163	200	250	75
4	PP glyt 16-20 DBBP	164	200	255	68
5	Near planting glyt 5 DBBP to 1 DABP	173	208	258	60
LSD 0.05		7	5	6	10

[1]PP=preplant. Glyt=glyphosate. DBBP=days before bean planting. PRE=pre-emergence. DABP=Days after bean planting.
[2]Day of the year 163 is June 12, 200 is July 19 and 250 is Sept. 7.
[3]Pinto bean canopy cover measured using Canopeo app during late July-August.

A uniform stand of winter rye will suppress annual weeds through a combination of allelopathy and competition (Ransom et al., 2021). Grass and broadleaf weeds present in this study generally had similar control with the use of PRE herbicides and when rye termination was delayed until or after bean planting, when visually evaluated three to four weeks following planting. For example, in the 2020 trial (Figure 3), green and yellow foxtail control ranged from 95-99% and common lambsquarters control was 85-97% with PRE herbicide (trts 1 and 3) or when rye was allowed to grow until 1-11 DABP (trts 5-6). Rye terminated 20 or 36 DBBP (trts 2 and 4) resulted in 75-81% control of foxtail and 66-81% control of common lambsquarters. Averaged across three years (2018 and 2020-21), foxtail control averaged 87-89% with trts 1, 3 and 5 compared to foxtail control of 71-72% with trts 2 and 4. Weed control generally was reduced with early rye termination (without PRE herbicide) as the lack of live rye and residue allowed weed presence earlier in the growing season.

Figure 3. Weed control in pinto bean among rye termination treatments with glyphosate, Carrington, 2020.[1]



[1]Visual evaluation 3 weeks after bean planting (prior to POST herbicide applied across trial for general weed control). DBBP = days before bean planting; DABP = days after bean planting. Glyphosate = Roundup Powermax at 28.4 fl oz/A; PRE = Spartan Elite at 20 fl oz/A. 'ND Palomino' direct planted in 30" rows on June 4.

Summary

Pinto bean seed yield with preplant terminated rye was similar to yield with the conventional check. Delay in terminating rye until near or after dry bean planting allowed the rye to deplete topsoil moisture that was needed to timely establish bean plants, and negatively impacted bean plant development, canopy closure and seed yield. Dry topsoil conditions during early bean plant establishment throughout the years of the study indicate rye termination at least two weeks before bean planting is suggested with similar environmental conditions as experienced in Carrington. The delay in rye termination did provide benefits of increased ground cover during the crop season and weed control similar as achieved with PRE herbicides. Weed suppression with rye can be considered another management tool to supplement herbicides and other cultural control methods.

Adequate topsoil moisture during bean planting and plant establishment would allow extended benefits of the live rye cover crop at planting while maintaining seed yield potential. Soil moisture status and precipitation forecast should be taken into consideration when determining the best time to terminate rye at a particular location. A site-specific termination approach could be considered when some areas of a field would benefit from extended cover crop presence (i.e., saline soils) or conversely may be at greater risk of dry bean establishment issues (i.e., hilltops).

References

Knodel, J.J., P.B. Beauzay, M. Ebert, G.J. Endres, D.W. Franzen, J.T. Ikley, H.J. Kandel, S.G. Markell and J.M. Osorno. 2020 Dry bean grower survey of production, pest problems and pesticide use in Minnesota and North Dakota. NDSU Extension publication E2014. March 2021. www.ndsu.edu/agriculture/ag-hub/publications/2020-dry-bean-grower-survey-production-pest-problems-and-pesticide-use

Ransom, J., M. Berti, G. Endres, D. Franzen, A. Friskop, J. Ikley, H. Kandel and M. Ostlie. Growing rye as a cover crop in North Dakota. NDSU Extension publication A2010. March 2021. www.ndsu.edu/agriculture/ag-hub/publications/growing-rye-cover-crop-north-dakota

Expected advantages with winter rye, established prior to pinto bean production and with timely termination, include reduction in soil erosion, supplement weed management, utilize excess soil moisture and improved efficiency with direct harvest of bean seed (e.g., timely harvest and clean seed).

Northarvest Bean Growers Association provided financial support for this study.