

Pinto bean response following winter rye cover crop, Carrington, 2021.

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The final (fifth) year of the study was conducted at the NDSU Carrington Research Extension Center with support from Northarvest Bean Growers Association to examine soil cover and moisture, weed management, and pinto bean production with winter rye grown as a preplant cover crop. Experimental design was a randomized complete block with four replications. The dryland trial was established on a conventionally tilled Heimdal-Emrick loam soil with 3.9% organic matter, 6.8 buffer pH, 0.22 dS/m soluble salt (0-6-inch depth), 24 ppm P, 400 ppm K, and 0.99 ppm Zn. 'ND Dylan' rye was direct seeded in 7-inch rows at targeted rate of 65 lb/A (98% germination and 19,100 seeds/lb=1,216,700 PLS/A) on September 17, 2020. Rye was not emerged at soil freeze-up due to dry topsoil during fall. Rye stand averaged 354,000 plants/A across the trial on April 17, 2021. 'ND Palomino' pinto bean was planted at 94,000 seeds/A in 30-inch rows with a JD Flex planter into tilled soil, rye residue or living rye in moderately dry topsoil on June 2. NDAWN monthly rain (inches): May=1.4; June=1.8; July=0.1; August=2.6; September=2.0; October=3.7; and 6-month total=11.6.

Rye treatments (trts) were designated by termination method and timing based on crop planting date:

1. Conventional production system check: Preplant (PP) Roundup PowerMax (glyphosate; 28.4 fl oz/A) plus adjuvant on May 4, 2021 (29 days before bean planting [DBBP]; 2- to 3-leaf [3- to 4-inch height] rye). Tillage (field cultivator plus harrow) on May 5. Preemergence (PRE) Spartan Elite (sulfentrazone+S-metolachlor; 20 fl oz/A) on June 2 (0.39 inch of rain received during June 8-11 and 0.55 inch on June 20).
2. PP Roundup PowerMax on May 4.
3. PP Roundup PowerMax on May 4 followed by PRE Spartan Elite on June 2.
4. PP Roundup PowerMax on May 17 (16 DBBP; 3-leaf [tillering; 3- to 8-inch height] rye).
5. PRE Roundup PowerMax on June 2 (day of bean planting; flag-stage [\leq 18-inch height] rye).
6. PRE Roundup PowerMax on June 2 followed by ground rolling on June 3.
7. PRE Roundup PowerMax on June 11 (9 days after bean planting [DABP]; flag- to flower-stage [$<$ 30-inch height] rye).
8. Non-terminated rye.

Herbicide trts were applied with a CO₂-pressurized hand-boom sprayer delivering 14 gpa through TJ Turbo 02 flat-fan nozzles at 35 psi. Raptor (imazamox) plus Trizenta (clethodim) plus MSO was post-emergence (POST) applied on June 28 at V1-2 bean growth stages, and Trizenta plus MSO was applied on July 19 at prebloom to R2 bean stages for general weed control. A killing frost occurred on October 20 (low of 25 degrees F; NDAWN). Plants were hand-pulled for field drying on November 4 and seed harvested with a plot combine on November 8.

Delaying rye termination until or after bean planting (trts 5-7) delayed bean plant emergence 4-6 days; flowering 12-19 days; and maturity 0-20 days compared to the conventional production check and earlier rye termination trts (Table 1). Topsoil moisture (measured 1 DABP) needed for bean plant establishment was depleted by the extended rye growth in trts 5-8 and delay in adequate rainfall to replenish soil moisture (0.39 inch June 6-11 and 1.38 inches June 20-25; NDAWN). Bean plant stands generally were greater when rye was terminated with glyphosate about one month before planting (trts 2-3) compared to other treatments (Table 1). However, the trial stand was poor, averaging 22,000 plants/A, versus the target of establishing at least 70,000 plants/A. Plant canopy closure was greatest with trts 1 and 3, and greatly reduced with trt 8. Late-season rain (Aug 20 to Oct 20=7.86 inches) stimulated new plant growth and extended time to reach plant maturity. Bean seed yield was poor, averaging 550 lb/A, due to dry soil and high temperatures during the first half of the growing season. Seed yield was greatest with early rye termination and PRE herbicide (trt 3). Yield generally was similar among other trts including with late-terminated rye except with the non-terminated rye (no yield). Test weight was greatest with trts 4-7.

Table 1. Pinto bean response to rye cover crop, Carrington, 2021.

Trt no.	Plant ^a						Seed			
	Emergence	Stand (2-Jul; V2-4)	Chlorosis ^b	Flower (R1)	Canopy closure (30-Aug)	Maturity (R9)	Yield	Test weight	Count	Protein
	DOY	plt/A	0-9	DOY	%	DOY	lb/A	lb/bu	no./lb	%
1	164	21,910	2	200	38	280	546	55.2	1,225	21.8
2	165	24,570	2	199	32	276	480	55.6	1,230	21.5
3	164	29,880	2	201	39	266	726	54.6	1,224	21.7
4	165	22,580	3	202	30	281	434	56.1	1,270	20.9
5	170	20,590	2	215	31	280	585	56.2	1,166	20.9
6	169	22,580	1	218	30	286	531	56.9	1,186	21.0
7	169	19,260	1	214	32	276	543	56.6	1,171	21.0
8	170	15,270	2	225	7	293	0	x	x	x
Mean	167	22,080	2	209	30	279	549	55.9	1,210	21.3
CV (%)	0.6	16.8	26.4	2.0	12.1	3.0	21.0	1.4	3.9	2.2
LSD (0.10)	1	4,510	1	5	4	10	141	1.0	57	0.6

^aDOY (day of year): 167=June 16; 209=July 28; 279=Oct 6.

^b0=green and 9=yellow.

Table 2. Ground cover, soil moisture, and weed control with rye cover crop for pinto bean, Carrington, 2021.

Trt no.	Ground cover (%) ^a		Topsoil moisture ^b		Weed Control ^c		
	Line transect	Canopeo			Fota	Piwe	Rye
	3-Jun		3-Jun	2-Jul	25-Jun		
%							
1	39	1	14.1	17.5	71	81	99
2	52	1	15.7	18.6	65	59	98
3	49	1	17.1	20.4	77	78	99
4	60	1	16.1	19.7	70	54	99
5	69	19	12.7	20.0	74	73	72
6	66	25	13.6	19.1	70	63	73
7	61	19	13.7	20.1	76	73	99
8	62	17	14.3	14.2	76	75	0
Mean	57	10	14.6	18.7	72	69	80
CV (%)	25.0	50.8	12.9	6.7	11.0	13.1	2.1
LSD (0.10)	NS	6	2.3	1.5	NS	11	2

^aLine transect measured plant residue and live plants (primarily rye). Canopeo measured green plant material.

^bMeasured with Extech Instruments MO750 soil moisture meter at 4-inch soil depth.

^cVisual evaluation: Fota=green and yellow foxtail; Piwe=redroot and prostrate pigweed.

Ground cover ranged from 39-69% after bean planting (Table 2). Rye ground cover was greatest with trts 5-8. Foxtail control visually evaluated on June 25 (before POST herbicide application across the trial) was similar among trts, ranging from 65-77%. Pigweed control (73-81%) was greatest with PRE herbicide and generally with late termination of rye. Ground rolling following PRE glyphosate (trt 6) generally provided similar trial results as trt 5.

In summary, the adverse soil and weather conditions starting fall 2020 and continuing until late August 2021 resulted in low rye and pinto bean plant densities, and poor bean seed yield. As in previous years of the study, delaying rye termination until or after bean planting generally extended bean plant development due to rye depleting topsoil soil moisture that was needed for establishment of bean plants. However, bean seed yield generally was similar among trts, except if rye was not terminated. Also, as in past years of the study, delaying rye termination until or after bean planting generally provided similar weed suppression as the PRE herbicide.