

Pinto bean response following winter rye cover crop, Carrington, 2020.
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The study is being conducted at the NDSU Carrington Research Extension Center with support from Northarvest Dry Bean Growers Association to examine soil cover and moisture, weed management, and pinto bean performance 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 3.7% organic matter, 6.9 pH, 0.34 dS/m soluble salt (0-6-inch depth), 17 ppm P, 331 ppm K, and 0.87 ppm Zn. 'ND Dylan' rye was direct seeded into soybean stubble in 7-inch rows at targeted rate of 60 lb/A on October 8, 2019. Estimated growth stage based on Haun wheat scale on November 8 was 0.3 leaf (NDAWN). 'ND Palomino' pinto bean was planted into tilled soil, rye residue or living rye in 30-inch rows with a JD Flex planter on June 4, 2020. NDAWN monthly rain (inches): May=1.18; June=1.23; July=5.00; August=1.06; September=0.13; and 5-month total=8.6.

Rye treatments (trts) were designated by termination method and timing:

1. Conventional production system check: Tillage (2x roto-till) on October 28, 2019 (20 days after seeding rye [DBBP]); followed by preemergence (PRE) Roundup PowerMax (glyphosate; 28.4 fl oz/A) plus NIS+AMS (Class Act NG; 2.5% v/v) plus Spartan Elite (sulfentrazone+S-metolachlor; 20 fl oz/A) on June 5, 2020 (1 day after bean planting [DABP]; boot- to early headed rye; 0.27 inches of rain received during June 6-7).
2. Preplant PP Roundup PowerMax plus NIS+AMS on April 29 (36 DBBP; 2- to 3-leaf rye).
3. PP Roundup PowerMax plus NIS+AMS on April 29 followed by PRE Roundup PowerMax plus NIS+AMS plus Spartan Elite on June 5.
4. PP Roundup PowerMax plus NIS+AMS on May 15 (20 DBBP; tillering stage rye [3- to 5-inch height]).
5. PRE Roundup PowerMax plus NIS+AMS on June 5.
6. PRE Roundup PowerMax plus NIS+AMS (Blue Diamond at 0.5% v/v) on June 15 (11 DABP; flowering 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. Beyond (4 fl oz/A) plus SelectMax (16 fl oz/A) plus Destiny HC (24 fl oz/A) were post-emergence to all trial plots for general weed control with pinto bean at V1 growth stage on June 25.

Killing frosts occurred on September 8 (low of 29 degrees F; NDAWN) and September 9 (27 degrees). Trts 1-4 bean plants had mature seed and were hand-pulled for field drying on September 9, while trts 5 and 6 plants generally had immature seed and were hand-pulled on September 14. Seed harvested with a plot combine: trts 1-4=September 11; trts 5-6=September 17.

Delaying rye termination until near or after pinto bean planting (trts 5 and 6) delayed bean plant emergence about three weeks compared plant development with the conventional production check and earlier rye termination trts (Table 1). Topsoil moisture was depleted by the extended growth of the rye and delay in adequate rainfall to replenish soil moisture (0.3 inches June 6-8 and 1.3 inches June 29-July 2 [NDAWN]). In addition, plant flowering and maturity were delayed 9-14 days with extended delay in rye termination. Initial trts 5 and 6 plant stands were greatly reduced when measured June 24 but were adequate on July 9 (73,800-74,200 plants/A) after the late June rain. Bean canopy closure also was reduced with the extended delay in rye termination. In addition, potential yield loss with direct harvest increased slightly with trts 5 and 6.

Table 1. Pinto bean response to rye cover crop, Carrington, 2020.

Trt no.	Plant ^a							Seed			
	Emergence	Stand (24-Jun; V1) ^b	Flower (R1)	Canopy closure (%) 10-Aug		Maturity (R9)	Direct harvest ^c	Yield	Test weight	Count	Protein
	DOY	plt/A	DOY	visual	canopeo	DOY	%	lb/A	lb/bu	no./lb	%
1	164	93,692	204	82	86	243	94	2,309	60.0	1,473	22.8
2	163	93,692	204	83	84	244	94	2,204	60.4	1,479	22.4
3	163	90,524	203	83	85	243	94	2,405	60.3	1,464	22.5
4	163	94,145	203	85	89	244	95	2,259	60.2	1,548	22.2
5	185	25,347	213	49	66	253	91	1,014	55.9	1,463	22.7
6	185	6,789	217	43	58	254	89	569	54.2	1,637	22.6
Mean	171	67,365	207	71	78	247	93	1,793	58.7	1,511	22.5
CV (%)	0.2	14.2	0.4	10.2	8.0	1.0	2.9	15.5	0.5	4.2	2.6
LSD (0.10)	1	11,835	1	9	8	2	3	345	0.3	79	NS

^aDOY (day of year): 171=June 19; 207=July 25; 247=Sept 3.

^bPlant stand on July 9: trt 5=73,777 plt/A; trt 6=74,229 plt/A.

^cA relative score to estimate the percent of beans that would successfully be direct/straight harvested.

Bean seed yield among early rye termination trts (2-4) ranged from 2,200 to 2,400 lb/A and were similar to yield with the conventional check. Yield was reduced 56% and 75%, respectively, with trts 5 and 6 compared to yield with the conventional check. Late plant establishment and development with trts 5 and 6 resulted in immature seed damaged by the September 8-9 frosts. Test weight also was reduced with trts 5 and 6, and smaller seed occurred with trt 6.

Rye ground cover measured at bean planting and mid-season indicated significantly greater amounts with delay of rye termination (trts 5 and 6) (Table 2). However, early season topsoil moisture (June 5 and 25 measurements) was greater with trts 1-4 compared to the late rye termination trts.

Table 2. Ground cover, soil moisture, and weed control with rye cover crop for pinto bean, Carrington, 2020.

Trt no.	Rye ground cover (%)			Soil moisture ^a				Weed control ^b				
	Line transect	Canopeo	Residue					Vol rye	Fota	Colq	Fota	Colq
	5-Jun		24-Jul	5-Jun	25-Jun	17-Jul	17-Aug	25-Jun			9-Jul	
	%											
1	13	5	0	19.9	19.2	19.4	11.4	99	95	85	96	83
2	43	3	4	21.3	22.0	19.4	13.4	78	81	66	75	68
3	38	2	1	19.6	21.1	19.8	13.1	99	97	95	98	95
4	40	1	1	20.4	21.6	21.2	12.8	99	75	81	71	81
5	78	55	41	15.1	11.0	21.2	17.8	98	99	97	99	91
6	68	57	50	12.9	11.0	20.3	19.2	97	99	97	99	91
Mean	46	20	16	18.1	17.6	20.2	14.6	95	91	87	90	84
CV (%)	43.4	25.2	50.9	6.6	8.9	7.8	17.4	2.8	5.5	12.2	5.5	13.5
LSD (0.10)	25	6	10	1.5	1.9	NS	3.2	3	6	13	6	14

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

^bVisual evaluation: Vol rye=volunteer rye; Fota=green and yellow foxtail; Colq=common lambsquarters.

Rye control visually evaluated on June 25 (before POST herbicide application across the trial) was excellent (97-99%) except with trt 2. Foxtail and common lambsquarters control on June 25 and July 9 was good to excellent (83-99%) with glyphosate plus PRE herbicide (trts 1 and 3) or the delay in rye termination with glyphosate until near or after

bean planting (trts 5 and 6). Weed control generally was reduced with trts 2 and 4 (68-81%) due to the early rye termination with glyphosate that reduced impact on weeds during early bean establishment.

In summary, pinto bean seed yield with selected rye cover crop trts was similar to yield with the conventional check. Delay in terminating rye until near or after dry bean planting ('planting green') allowed the rye to deplete topsoil moisture that was needed to timely establish bean plants, and negatively impacted bean plant development, canopy closure, yield and test weight. The delay in rye termination did provide benefits of increase ground cover during the crop season and weed control similar to a PRE herbicide.