Pinto bean response following winter rye cover crop, Carrington, 2019.
(Greg Endres and Mike Ostlie)

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 prior 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 4.0% organic matter, 6.5 pH, 0.41 mmho/cm salt, 70 lb/A N, 16 ppm P, 319 ppm K, and 1.5 ppm Zn. 'ND Dylan' rye was direct seeded into barley stubble in 7-inch rows at 60 lb/A on September 18, 2018. Rye plants emerged October 1 and reached the 2-leaf stage on November 15. 'ND Palomino' pinto bean was planted into tilled soil or rye residue in 21-inch rows on June 3, 2019. NDAWN monthly rain (inches): May=1.46; June=3.00; July=3.64; August=3.08; September=8.26; and 5-month total=19.4.

Rye treatments were designated by termination method and timing:

1. Conventional production check: Tillage (2x roto-till) on October 1 (13 days after seeding rye); followed by preplant (PP) Roundup PowerMax (glyphosate; 28.4 fl oz/A) plus NIS+AMS (Class Act NG; 2.5% v/v) on May 2 [31 days before bean planting (DBP)] and preemergence (PRE) Roundup PowerMax plus NIS+AMS and Spartan Elite (sulfentrazone+S-metolachlor; 20 fl oz/A) on June 5 [3 days after bean planting (DAP); 0.64 inches of rain was received during June 5-16].
2. PP Roundup PowerMax plus NIS+AMS on May 2 (tillering rye at 2- to 3-inch height).
3. PP Roundup PowerMax plus NIS+AMS on May 2 followed by PRE Roundup PowerMax plus NIS+AMS and Spartan Elite on June 5 (boot-stage rye).
4. PP Roundup PowerMax plus NIS+AMS on May 14 (20 DBP; tillering rye at 4- to 5-inch height).
5. PP Roundup PowerMax plus NIS+AMS on May 29 (5 DBP; 2-joint rye at 12-inch height).
6. PRE Roundup PowerMax plus NIS+AMS on June 10 (7 DAP; boot-stage to headed rye).

Herbicide treatments were applied with a hand-boom sprayer delivering 10 gpa through TJ 80015 flat-fan nozzles at 35 psi. Raptor (3 fl oz/A) plus SelectMax (16 fl oz/A) and Destiny HC (20 fl oz/A) were post-emergence applied at 14 gpa through TJ AIXR 110015 nozzles at 40 psi to all trial plots for general weed control on July 5.

Bean plants were hand-pulled for field drying on September 25. Seed harvested with a plot combine: treatments 1-4=September 27; treatments 5-6=October 7.

Delaying rye termination until near or after pinto bean planting extended bean plant development (emergence, flowering, and maturity) 8-14 days compared to the conventional production check and earlier rye termination treatments (Table 1). Plant stand was similar among treatments though there was a trend for the check having the highest plant density. Plant stand across treatments averaged 62,300 plants/acre, which was 67% of the 93,300 pure live seeds/A planting rate. Bean canopy closure also was reduced with the delay in rye termination (trts 5 and 6). Bean yield was similar among treatments, though there was a trend for higher yield with trts 1-4. Test weight was highest with trts 5 and 6.

Table 1. Pinto bean response to rye cover crop, Carrington, 2019.

Trt no.	Plant[a]						Seed	
	Emergence	Stand (3-Jul)	Flower (R1)	Canopy closure (%) 29-Jul		Maturity (R9)	Yield	Test weight
	DOY	plt/A	DOY	visual	canopeo	DOY	lb/A	lb/bu
1	163	72,100	196	89	90	256	2981	59.8
2	162	59,300	196	83	82	257	3387	60.6
3	162	63,900	196	87	87	256	3078	59.7
4	163	58,800	196	82	82	257	3204	60.1
5	174	59,300	206	66	61	264	2805	61.5
6	176	65,000	208	71	64	266	2885	61.3
Mean	167	62,300	200	80	78	259	3057	60.5
CV (%)	1.1	16.6	0.6	5.7	6.3	0.5	10.2	0.8
LSD (0.10)	2	NS	2	6	6	2	NS	0.6

[a]DOY (day of year): 167=June 16; 200=July 19; 236=Sept 17. Plant stage at stand count = V3.

Rye ground cover when measured after bean planting generally was greatest with delay of rye termination (trts 5 and 6) (Table 2). However, early season soil moisture (May 29 and June 10 measurements) was slightly higher with trts 1-4 compared to the late rye termination trts.

Table 2. Ground cover, soil moisture, and weed control with a rye cover crop for pinto bean, Carrington, 2019.

Trt no.	Ground cover (%)		Soil moisture[a]				Weed control[b]	
	5-Jun	6-Jun	29-May	10-Jun	8-Jul	9-Aug	3-Jul	9-Aug
	Canopeo	Line transect	%				%	
1	12	1	18.9	17.8	20.8	12.0	68	91
2	40	1	18.0	17.5	20.9	13.9	61	74
3	34	1	18.5	18.2	21.5	14.0	64	85
4	42	2	17.8	17.9	21.4	15.3	65	84
5	86	4	15.8	15.4	18.9	17.2	86	83
6	78	49	16.1	10.3	19.9	14.6	96	96
Mean	49	10	17.5	16.2	20.6	14.5	73	85
CV (%)	23.2	75.3	7.6	9	9.5	14.7	17.7	8.1
LSD (0.10)	14	9	1.6	1.8	NS	2.6	16	9

[a]Measured with Extech Instruments MO750 soil moisture meter at 4-inch soil depth.

[b]Visual evaluation of grass weeds including green and yellow foxtail, volunteer rye, and stinkgrass.

The trial contained a low density grassy weeds: green and yellow foxtail, rye (escapes), and stinkgrass. Grass control visually evaluated on July 3 (before Raptor plus SelectMax application across the trial) was good to excellent (86-96%) with the delay in rye termination until near or after bean planting (trts 5 and 6) compared to control with other treatments (61-68%). Grass control generally was good to excellent (83-91%) with all treatments on August 9 except with trt 2 (early glyphosate application without PRE herbicide). In summary, the delay in termination of rye with trts 5 and 6 provided greater (July 3 evaluation) or similar (August 9 evaluation) grass weed control compared to the check. Trial data indicates rye can be a substitute for a PRE herbicide.

In summary, lack of adequate spring rainfall and stored soil moisture during pinto bean plant establishment and delay in rye termination until near or after bean planting negatively impacted bean plant development and canopy closure but not seed yield. The delay in rye termination provided the benefits of additional ground cover and a substitute for PRE herbicide for weed control.