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DIFFERENTIAL RESPONSE OF FIFTEEN PINTO BEAN CULTIVARS TO TWO NITROGEN RATES

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INTRODUCTION

Dry bean (*Phaseolus vulgaris* L.) is the main source of protein (20 to 25%) for most people in the world; protein from soybean is higher but is primarily use for livestock. Dry bean yield is often lower than 1000 kg ha^{-1} in most dry bean producing regions except the US. Besides drought, low soil fertility and ineffective nitrogen (N) management strategies are the most important yield-limiting factors for dry bean production worldwide (Fageria et al., 2013). Use of N-efficient dry bean genotypes, optimal timing of N application(s), and identifying a cost-effective N rate are good strategies to optimize dry bean profitability. Therefore, the aim of this study was to evaluate fifteen pinto bean cultivars grown in the greenhouse with two rates of nitrogen fertilizer for physiological/growth traits and their tolerance to low N.

MATERIAL AND METHODS

Seed of (Bill Z, Centennial, CO46348, COSD-25, COSD-35,Croissant, El Dorado, ISB1231-1, La Paz, Lariat, Long's Peak, ND307, Othello, Poncho, and UIP-40) were sown in 11.3 L pots (8 kg of soil) in the greenhouse (four pots per cultivars) on 20 September 2016 in Laramie WY (2200 m elevation). Seed were inoculated with a commercial inoculant at planting. The soil mix was 33% sand, 33% soil amendment, and 33% native soil. Seedlings were thinned to three per pot at two weeks. Aqueous fertilizer treatments (NH_4NO_3) were applied at (25, 32, 39, and 46 days after planting, dap) in two rates (0 and 67 kg N ha^{-1} seasonal equivalent). A randomized complete block design was used with two replicates. Leaf chlorophyll (CHYL) was measured on the third uppermost fully-expanded leaf by using a chlorophyll meter (SPAD-502) at (26, 33, 40, 47, and 54 dap). The height, root mass, and stalk mass was determined at maturity. Seed yield, pod harvest index (PHI), and nitrogen susceptibility index (NSI) were also determined at maturity. Pod harvest index equaled seed weight divided by the sum of pod wall plus seed weight; NSI was calculated as the cultivar's percentage reduction in yield due to zero N divided by the average yield reduction due to zero N.

RESULT AND DISCUSSION

Adding 67 kg N ha^{-1} increased most traits except for PHI which was reduced (Table 1). Adding N increased CHYL at 33 dap and at 40 dap (data not shown). The seed yield increase due to N was explained by increased number of pods per pot (12.9 vs. 10.3) whereas seed size and seed per pods did not explain any of the difference (data not shown). The only nitrogen-by-cultivar interaction we detected was on CHYL at 33 dap. This was due to several cultivars responding more intensely to N as opposed to others responding modestly (Table 2). Pod harvest index was greatest in Othello, CO-46348, and COSD-25 than the other twelve cultivars. The seed yield was not significantly different among cultivars due to unexplained variability within three cultivars. Nevertheless, we observed numerical differences in yield response to N and their associated NSI. High-N CHYL at 33 dap was positively correlated with seed yield at High-N ($r = 0.61$). We are repeating this experiment to validate or refute these observations.

Table 1. Influence of two nitrogen levels on leaf chlorophyll, growth, leaf traits, and yield of dry bean averaged across fifteen cultivars. The non-reproductive biomass and shoot:root ratio included root and shoot tissue only (no leaves were included because they had already senesced).

Treatment kg N ha^{-1}	Chlorophyll 33 dap	Plant Height cm	Total Non Repro Biomass	Shoot: Root Ratio	Specific Leaf Wt. mg cm^{-2}	Seed Yield g/pot	Pod Harvest Index
0	32	40.7	3.00	1.92	4.23	14.9	0.820
67	36	52.9	3.75	2.33	4.71	17.5	0.802
P-value	0.0001	0.0036	0.0080	0.0195	0.0090	0.0244	0.0001

Table 2. Leaf chlorophyll, root mass, pod harvest index, seed yield, and nitrogen susceptibility index (NSI) of fifteen dry bean cultivars grown at two N levels in the greenhouse.

Treatment	Zero-N Chlorophyll 33 dap	High-N Chlorophyll 33 dap	Root Mass g/pot	Pod Harvest Index	Zero-N Seed Yield g/pot	High-N Seed Yield g/pot	NSI
Bill Z	34	37	0.62	0.80	11.7	16.5	1.96
Centennial	37	40	0.92	0.78	12.1	13.8	0.81
CO-46348	27	33	0.66	0.84	13.6	25.3	3.11
COSD-25	36	38	0.92	0.83	12.5	16.7	1.69
COSD-35	34	37	1.02	0.82	16.7	18.7	0.68
Croissant	35	40	0.94	0.81	16.0	18.2	0.81
El Dorado	33	36	1.69	0.79	14.4	17.2	1.28
ISB1231-1	31	33	1.12	0.77	15.5	15.2	- 0.14
La Paz	33	36	0.98	0.81	16.2	15.3	- 0.41
Lariat	28	35	2.00	0.79	15.8	16.9	0.44
Long's Peak	28	36	1.05	0.82	12.6	16.3	1.55
ND307	30	35	1.69	0.79	21.8	16.8	- 2.03
Othello	32	38	0.85	0.86	13.2	21.5	2.64
Poncho	35	37	0.79	0.82	21.6	17.7	- 1.49
UIP-40	26	35	1.90	0.81	10.5	15.8	2.23
Mean	32	36	1.14	0.81	14.9	17.5	n/a
LSD (0.05)	3	3	0.64	0.02	N.S.	N.S	n/a

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