Final Report – 2021 (for Wyoming Bean Commission)

Row Spacing, Seeding Rate, and Cultivar Effects on Yield and Direct Harvest Recovery

Jim Heitholt, Samual George, Cody Hurford, and Chloe Winkler

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Introduction

Across much of the eastern US Dry Bean Belt, the harvest routine involves a one-step process (often called direct cut). For the Intermountain West, dry beans are harvested by two methods, undercutting/windrowing/threshing or direct cut. Producers have found success with both methods.

Due to an increasing interest in direct cut for Intermountain West dry bean production, our research group has been studying the effects of different planting configurations and cultivar on canopy architecture and other factors. These effects need to be quantified better so that producers will know whether or not direct harvest is a possible management practice for their own farm.

In addition to the direct cut question, costs associated with different planting configurations are also a concern. As far as seeding rate per acre, it is obvious that planting a 50K seed per acre is cheaper than planting at 100K seed per acre. But costs for planting with 7-inch vs. 15-inch vs. 22-inch row spacing are a little more complicated to separate due to other producer-driven factors such as equipment, weed management, and irrigation strategy.

In 2020, we were able to characterize the canopy architecture and yield performance of two cultivars grown in three different row spacings, different seeding rates, and different irrigations. For each of the 180 plots grown that year, we also were able to obtain a comparison of direct harvest yield to conventional harvest (undercut/thresh) yield data.

With that background, we decided to establish a 2021 study similar to the 2020 study but with four dry bean cultivars.

Objective

The main goal of this project is to determine if planting configurations other than our tried-and-true 22-inch rows and 100K seeds per acre can improve yield and/or profitability. A secondary objective is to quantify yield loss upon direct harvest of different row spacings and cultivars to confirm that the differences we have observed in previous years are indeed consistent.

Methods

The project employed all combinations of the following treatments. Four cultivars (early and late, prostrate and upright), three row spacings (7-inch, 15-inch, 22-inch), two seeding rates (40K and 80K per acre), and three irrigation rates (full irrigation, 80% ET, and 60% ET with each irrigation rate will be its own separate study). Four cultivars were included: Blackfoot (early-upright); Monterrey (late-upright); Poncho (early-prostrate); Windbreaker (mid-maturity, semi-upright). Plot size was 11-feet by 20-feet. With three replicates, the study consisted of 216 plots. The test was grown under sprinkler irrigation. Typically, the 100% irrigation received 1.0 inch per week whereas the 80% ET and 60% ET sections received 0.8 inch and 0.6 inch, respectively.

Before planting, 80 units N, 130 units P, 80 units K, 70 units S, and 8 units Zn were applied and incorporated. Additionally, Sonalan and Outlook were preplant incorporated. The study was sown on 4 and 5 June. Raptor/Basagran was applied before bloom. Throughout the latter part of the season, maturity notes were collected. Canopy temperature was collected on 11-12 August 2021. Leaf area index (LICOR LAI-2200C) and light interception (ACCUPAR LP-80) was collected on 6, 7, and 8 August 2021 (one replicate each day). The ACCUPAR unit records LAI as well although it uses a different principle than the LAI-2200C. Photos of the devices used to measure canopy temperature, LAI, and light interception are shown in Figures 1 and 2.

At maturity, each plot was be divided into two parts, one part destined for conventional harvest and one for direct harvest (Fig. 3). Each of the two subplots were end-trimmed on all four sides in order to eliminate edge effects. Before harvesting, the exact size of the remaining plot area was measured and the exact number of plants present was counted. This allowed us to determine the final plant density. Also at maturity, we visually determined the percentage of pods that were above 10 cm (4-inch).

Due to the experimental design with only one field section per irrigation rate, we could not legitimately compare (statistically that is) the irrigation rates. Thus, each irrigation section was treated as its own experiment. However, we do provide some side-by-side comparisons of the different irrigations throughout this report for the reader's convenience.

Example of midday canopy temperature being recorded with a MI-2H0 Apogee unit. Values are collected from the two center rows of a fully bordered six-row plot. Photo here is just an example, values are never taken from field edges.

Figure 1. Infrared thermometer used to measure canopy temperature.

Figure 2. The Licor LAI 2200C and the Accupar LP-80 devices. The LAI 2200C measures leaf area index (LAI) using gap fraction and the Accupar LP-80 measure both LAI and light interception. LAI was collected two hours prior to dusk and light interception was collected within two hours of solar noon.

Figure 3. Photo of indirect harvest (top) and direct harvest (below).

Results

For mid-season (early August) leaf area index (LAI) within the 100% ET irrigation, we found that the increased seeding rate increased LAI (Table 1). The increased seeding rate also increased light interception. This observation of increased LAI and light interception was expected but we wanted to quantify the difference. As for row spacing and cultivar effects on LAI and light interception, there were significant interactions. Thus, the combination of those factors are presented in Table 2 for these two variables. The narrowest row spacing had the lowest LAI. Although this seems counter-intuitive, this observation was associated with, and can be explained by, a poor stand with the 7-inch spacing. In general, Monterrey and Poncho had the higher LAI at the two narrower row spacings. At the 22-inch row spacing, LAI of Blackfoot was substantially lower than the other three cultivars. Light interception followed a parallel trend as LAI. The row spacing-by-cultivar interaction for both traits was partly due to low values for Windbreaker in the two narrow row spacings (7-inch and 15-inch) whereas Windbreaker had values similar to Monterrey and Poncho at 22-inch.

For mid-season LAI and light interception within the 80% ET irrigation, the higher seeding rate also increased LAI and light interception (Table 3). The increase was observed across all three row spacings (Table 4). Poncho and Monterrey tended to have higher LAI and light interception than the other two cultivars (Table 5).

For mid-season LAI and light interception within the 60% ET irrigation, the only consistent effect was that of cultivar. However, LAI was greater for the 80K seeding rate vs. the 40K rate (Table 6). Additionally, there were no interactions; thus, only the main effects are shown. LAI tended to be greater in the 15-inch rows than the 22-inch and 7-inch rows but the difference was not statistically significant (Table 7). Monterrey had higher LAI and light interception than Blackfoot and Windbreaker (Table 8).

Table 1. Effect of seeding rate on leaf area index and light interception of dry bean grown at Powell on 7 Aug (actually 6, 7, 8 Aug) 2021 under 100% ET irrigation. Data value are average across cultivars and row spacings; thus each data value represents 36 plots.

Seeding Rate (per acre)	LAI-Licor	LAI- Accupar	Light Interception (%)
40K	4.0	3.7	77
80K	4.7	4.3	84
P-value	0.0006	0.0008	0.003

Table 2. Effect of row spacing and cultivar on LAI and light interception on 7 Aug 2021 at Powell under 100% ET irrigation.

Row Spacing	Cultivar	LAI-Licor	Light Interception (%)
7-inch	Blackfoot	2.2	52
	Monterrey	3.8	75
	Poncho	4.5	83
	Windbreaker	2.0	57
15-inch	Blackfoot	3.1	76
	Monterrey	5.9	92
	Poncho	5.5	90
	Windbreaker	4.8	87
22-inch	Blackfoot	3.8	79
	Monterrey	5.6	93
	Poncho	5.6	91
	Windbreaker	5.6	88
P-value (RS-by-Cult)		0.0105	0.0093

Table 3. Effect of seeding rate on seeding rate on leaf area index and light interception of dry bean grown at Powell on 7 Aug (actually 6, 7, 8 Aug) 2021 under 80% ET irrigation. Data value are average across cultivars and row spacings; thus each data value represents 36 plots.

Seeding Rate (per acre)	LAI-Licor	LAI- Accupar	Light Interception (%)
40K	3.8	3.2	74
80K	4.8	3.9	84
P-value	0.0001	0.0007	0.0001

Table 4. Effect of row spacing and seeding rate on leaf area index and light interception under 80% ET irrigation.

Row Spacing	Seeding Rate (per acre)	LAI-Licor	Light Interception (%)
7-inch	40K	2.5	59
	80K	4.0	79
15-inch	40K	4.8	82
	80K	5.5	90
22-inch	40K	4.0	82
	80K	4.9	85
P-value		0.3524	0.0034

Table 5. Effect of row spacing and cultivar on LAI and light interception on 7 Aug 2021 at Powell under 80% ET irrigation.

Row Spacing	**Cultivar**	**LAI-Licor**	**Light Interception (%)**
7-inch	Blackfoot	1.9	58
	Monterrey	3.8	75
	Poncho	4.4	77
	Windbreaker	3.0	66
15-inch	Blackfoot	4.1	81
	Monterrey	5.7	90
	Poncho	5.4	88
	Windbreaker	5.5	87
22-inch	Blackfoot	4.2	76
	Monterrey	5.1	89
	Poncho	4.5	80
	Windbreaker	3.9	79
LSD (0.05)		1.1	9
P-value (RS-by-Cult)		0.1130	0.2346

Table 6. Effect of seeding rate on seeding rate on leaf area index and light interception of dry bean grown at Powell on 7 Aug (actually 6, 7, 8 Aug) 2021 under 60% ET irrigation. Data value are average across cultivars and row spacings; thus each data value represents 36 plots.

Seeding Rate (per acre)	LAI-Licor	LAI- Accupar	Light Interception (%)
40K	2.6	2.3	62
80K	3.1	2.5	66
P-value	0.0090	0.1777	0.0850

Table 7. Effect of row spacing on leaf area index and light interception of dry bean grown at Powell on 7 Aug (actually 6, 7, 8 Aug) 2021 under 60% ET irrigation. Data value are average across cultivars and seeding rate; thus each data value represents 24 plots.

Seeding Rate (per acre)	LAI-Licor	LAI- Accupar	Light Interception (%)
7-inch	2.3	2.0	58
15-inch	3.6	2.8	71
22-inch	2.8	2.2	63
P-value	0.0980	0.2314	0.0648

Table 8. Effect of cultivar on leaf area index and light interception of dry bean grown at Powell on 7 Aug (actually 6, 7, 8 Aug) 2021 under 60% ET irrigation. Data value are average across row spacings and seeding rates; thus each data value represents 18 plots.

Cultivar	LAI-Licor	LAI- Accupar	Light Interception (%)
Blackfoot	2.3	2.0	58
Monterrey	3.4	2.9	72
Poncho	3.1	2.3	65
Windbreaker	2.6	2.2	62
LSD (0.05)	0.6	0.4	6
P-value	0.0008	0.0002	0.0003

For convenience to the reader, we have provided a table for indirect yield, direct yield, LAI, and light interception for each irrigation rate when averaged across all plots within a given irrigation (Table 9). For all of these variables, the major difference was between the 60% and 80% whereas the values for 80% and the 100% were much closer. There was a trend for the percent loss due to direct harvest to be worse for the deficit irrigation. Canopy temperatures (shown only in this paragraph and not in a separate table) were 86°F, 81°F, and 79°F for the 60% ET, 80% ET, and 100% ET irrigations, respectively. This translates to 30.1°C, 26.9°C, and 26.2°C. Temperatures were similar between the 80% ET and 100% ET, an observation we sometime see.

Table 9. Effect of irrigation rate on yield (indirect and direct harvest) and light interception. Values are averaged across all factors, row spacing, seeding rate, and cultivar (72 plots for each value). †

Irrigation Rate	Yield Indirect (lbs/a)	Yield Direct (lbs/a)	LAI - Licor	LAI - Accupar	Light Interception (%)
60% ET	1561	986	2.9	2.3	64
80% ET	2426	1699	4.3	3.6	79
100% ET	2647	1911	4.4	4.1	80

† The percent loss due to direct harvest was 37%, 30%, and 28%, for 60%ET, 80% ET, and 100% ET, respectively.

In addition to the summary Table 9, yields within each irrigation when broken down by the two seeding rates indicated that the higher seeding rate improved direct harvest efficiency which also means that the loss to direct harvest was reduced (Table 10). The thicker seeding rate also increased the percentage of pods located above 4-inch across all three irrigations (Table 11).

When comparing the effect of row spacing we observed a general trend for the 15-inch rows to outyield the 7-inch and 22-inch rows (Table 12). For the 60% ET irrigation (both direct and indirect harvest), the 22-inch rows had lower yield than the two narrower row spacings but the differences were not statistically significant. For the 80% ET irrigation, again for both harvest methods, the 15-inch spacing outyielded the 7-inch and 22-inch rows and this difference was statistically significant. For the 100% ET irrigation, the 15-inch rows outyielded the 7-inch and 22-inch spacing although the difference was only significant for the direct harvest. As far as the percent loss due to direct harvest under the two deficit irrigations, there was a trend for the 22-inch rows to have reduced loss, that is, more efficient recovery. However, under full 100% ET irrigation, the 15-inch rows showed the most efficient recovery upon direct harvest at least as compared to the 7-inch and 22-inch rows. There was a consistent trend for the canopies from wider rows to place a higher percentage of pods above 4-inch (Table 13). This row-spacing trend of more pods above 4-inch for 22-inch rows was not as consistent with direct harvest recovery percentage as we expected.

Cultivar differences were also found for direct harvest efficiency (Tables 14 and 15). Under 60% ET, Poncho had the highest yield but Monterrey was the best cultivar as far as direct harvest recovery losing only 30% of the seed. Under 80% ET, the yield among cultivars was quite similar for indirect harvest but for direct harvest, Monterrey outyielded the other three cultivars. Likewise, under 100% ET, the yields were similar among cultivars for indirect harvest but Monterrey yielded highest for direct harvest. The superior response of Monterrey under full 100% ET irrigation was partially related to the percentage of pods that stood above 4-inch (Table 16). Monterrey had an average of 87% of its pods

above 4-inch whereas the other cultivars tended to position their pods much lower in the canopy (Table 16).

Table 10. Comparison of indirect and direct harvest yields for each of the three irrigations.

Irrigation	Seeding Rate	Yield Indirect (lbs/a)	Yield Direct (lbs/a)	Percent Loss/Gain
60% ET	40K	1680	1014	40
	80K	1442	958	34
80% ET	40K	2417	1598	34
	80K	2435	1801	26
100% ET	40K	2676	1828	28
	80K	2617	1934	26

Table 11. Effect of seeding rate on the percentage of pods above 4-inch. Each value is the average of 36 plots.

Seeding Rate	60% ET	80% ET	100% ET	Average
40K	65	63	60	63
80K	71	68	67	69
LSD (0.05)	4	3	4	na
P-value	0.103	0.013	0.001	na

Table 12. Comparison of indirect and direct harvest yields as affected by row spacing in Powell in 2021. Data are provide for each of the three irrigation rates. Each value is the average of 24 plots. Values are averaged across

Irrigation	Row Spacing	Indirect	Direct	Percent Loss (%)
60% ET	7-inch	1778	1067	40
	15-inch	1734	1109	36
	22-inch	1169	782	33
	P-value	0.293	0.478	0.969
80% ET	7-inch	2318	1624	30
	15-inch	2825	1980	30
	22-inch	2135	1495	30
	P-value	0.037	0.030	0.987
100% ET	7-inch	2559	1664	35
	15-inch	2837	2293	19
	22-inch	2544	1777	30
	P-value	0.451	0.026	0.054

Table 13. Effect of row spacing on the percentage of pods above 4-inch in 2021. Values are the average of 24 plots each.

Row Spacing	60% ET	80% ET	100% ET	Average
7-inch	62	59	52	58
15-inch	67	65	66	66
22-inch	72	72	71	72
LSD (0.05)	4	8	5	na
P-value	0.001	0.065	0.003	na

Table 14. Yield of the four cultivars under the three irrigation rates at Powell in 2021. Values represent the average of 18 plots. Values average across seeding rate and row spacings.

Irrigation	Cultivar	Indirect	Direct	Percent Loss
60% ET	Blackfoot	1579	913	42
	Monterrey	1440	1006	30
	Poncho	1802	1165	35
	Windbreaker	1423	859	40
LSD (0.05)		325	196	21
P-value		0.088	0.018	0.220
80% ET	Blackfoot	2140	1349	37
	Monterrey	2453	2038	17
	Poncho	2531	1691	33
	Windbreaker	2580	1720	33
LSD (0.05)		380	340	13
P-value		0.106	0.003	0.029
100% ET	Blackfoot	2421	1621	33
	Monterrey	2457	2360	4
	Poncho	2762	1783	35
	Windbreaker	2947	1880	36
LSD (0.05)		309	286	13
P-value		0.003	0.001	0.001

Table 15. Percent loss due to direct harvest by cultivar under three different irrigations in 2021. Values are the average 18 observations and were averaged across row spacings and seeding rates. The values in this table do not exactly match the values in Table 14. The values in Table 14 were calculated by using the average indirect and direct yield values whereas the values in this table were calculated using only the percentage loss values. Both values paralleled each other, however.

Cultivar	60% ET	80% ET	100% ET	Average
Blackfoot	34	35	31	33
Monterrey	16	16	1	11
Poncho	33	31	35	33
Windbreaker	37	33	33	34
LSD (0.05)	21	13	13	na
P-value	0.2202	0.0288	0.0001	na

Table 16. Percent of pods above 4-inch for the four cultivars and three irrigation rates in 2021.

Cultivar	60% ET	80% ET	100% ET	Average
Blackfoot	67	65	62	65
Monterrey	89	87	84	87
Poncho	50	44	45	46
Windbreaker	67	66	61	65
LSD (0.05)	5	6	5	na
P-value	0.0001	0.0001	0.0001	na

As for maturity dates as affected by the treatments at 100% ET, the patterns were mostly as expected. Blackfoot and Poncho matured earlier than Monterrey and Windbreaker although, for some reason, Poncho at the low seeding rate had delayed maturity (Table 17). There was another interaction (RS-by-Cultivar) for 100% with Windbreaker maturing earlier than expected in 22-inch rows than in the narrower row spacings (Table 18).

Table 17. The effect of cultivar and seeding rate on maturity of dry bean grown at 100% ET in 2021. The values are the means of 9 plots.

Cultivar	Seeding Rate	Maturity
		days after planting
Blackfoot	40K	81
	80K	80
Monterrey	40K	98
	80K	95
Poncho	40K	87
	80K	78
Windbreaker	40K	94
	80K	94
LSD (0.05)		3
P-value (Cult-by-SR)		0.0001

Table 18. Effect of row spacing and cultivar on maturity at 100% ET in 2021. The values are the mean of 6 plots.

Row Spacing	**Cultivar**	**Maturity**
		dap
7-inch	Blackfoot	83
	Monterrey	98
	Poncho	86
	Windbreaker	98
15-inch	Blackfoot	82
	Monterrey	97
	Poncho	83
	Windbreaker	97
22-inch	Blackfoot	78
	Monterrey	95
	Poncho	79
	Windbreaker	87
LSD (0.05)		4
P-value (RS-by-Cult)		0.0272

As for maturity under 80% ET, there was a row spacing-by-cultivar interaction and a seeding rate effect. The row spacing-by-cultivar interaction was caused by Windbreaker maturing earlier than expect in the 15-inch spacing (Table 19). The higher seeding rate hastened maturity by two days (Table 20).

As for maturity under the 60% irrigation, the only conspicuous effects were associated with cultivar. As expected, Blackfoot and Poncho matured earlier than Monterrey and Windbreaker (Table 21). Also as expected and averaged across the 72 plots per irrigation treatment, the 60% ET matured earlier (84 dap) than the 80% ET (87 dap) and the 100% ET (89 dap).

Table 19. Effect of row spacing and cultivar on maturity at 80% ET irrigation. Values are the mean of six plots.

Row Spacing	**Cultivar**	**Maturity**
		dap
7-inch	Blackfoot	82
	Monterrey	94
	Poncho	82
	Windbreaker	92
15-inch	Blackfoot	76
	Monterrey	95
	Poncho	80
	Windbreaker	85
22-inch	Blackfoot	82
	Monterrey	98
	Poncho	82
	Windbreaker	97
LSD (0.05)		4
P-value (RS-by-Cult)		0.0061

Table 20. Effect of seeding rate on maturity at 80% ET. The values are the average of 36 plots.

Seeding Rate	**Maturity**
	days after planting
40K	88
80K	86
LSD (0.05)	1.5
P-value	0.0063

Table 21. Effect of cultivar on maturity of the four cultivars grown under 60% ET at Powell in 2021. Values represent the means across 18 plots.

Cultivar	**Maturity**
	days after planting
Blackfoot	81
Monterrey	97
Poncho	82
Windbreaker	94
LSD (0.05)	2
P-value	0.0001

As for upright stature under 100% ET, a significant row space-by-cultivar interaction and a significant cultivar-by-seeding rate interaction was observed. The row spacing-by-cultivar interaction was attributed to Poncho having a very prostrate architecture under 22-inch rows (Table 22). The cultivar-by-seeding rate interaction was caused by the tall/late-maturing cultivars improving their upright stature at the high seeding rates whereas the short/early-maturing cultivar became more prostrate at the higher seeding rates (Table 23).

Table 22. Effect of row spacing and cultivar on upright stature under 100% ET.

Row Spacing	**Cultivar**	**Upright Stature**
7-inch	Blackfoot	7.8
	Monterrey	8.3
	Poncho	5.2
	Windbreaker	7.5
15-inch	Blackfoot	7.3
	Monterrey	7.3
	Poncho	5.0
	Windbreaker	7.3
22-inch	Blackfoot	6.5
	Monterrey	8.8
	Poncho	3.7
	Windbreaker	7.7
LSD (0.05)		1.2
P-value (RS-by-Cult)		0.0204

Table 23. Effect of cultivar and seeding rate on upright stature under 100% ET. Values represent the mean of six plots.

Cultivar	Seeding Rate	Upright Stature
Blackfoot	40K	7.7
	80K	6.8
Monterrey	40K	7.9
	80K	8.4
Poncho	40K	4.8
	80K	4.4
Windbreaker	40K	7.1
	80K	7.9
LSD (0.05)		1.0
P-value (Cult-by-SR)		0.0539

Under 80% ET, there was a cultivar-by-seeding rate interaction effect on upright stature but no other effects. The interaction was attributed to Monterrey improving its stature when grown at the higher seeding rate (Table 24).

At 60% ET, the only effect observed on upright stature was cultivar with Poncho having a prostrate growth habit (Table 25). When examining all three irrigations, upright stature was highest as 60% ET at 8.0 compared to 7.1 for 80% ET and 6.9 for 100% ET. The more prostrate growth for the heavier irrigations are expected because the fully irrigated plots yield more and thus, weight down the plant and canopy.

Table 24. Effect of cultivar and seeding rate on upright stature under 80% ET. Values represent the mean of six plots.

Cultivar	Seeding Rate	Upright Stature
Blackfoot	40K	7.4
	80K	7.4
Monterrey	40K	7.8
	80K	8.8
Poncho	40K	5.2
	80K	4.7
Windbreaker	40K	7.7
	80K	8.0
LSD (0.05)		0.8
P-value (Cult-by-SR)		0.0314

Table 25. Effect of cultivar on upright stature under 60% ET in 2021 at Powell.

Cultivar	Upright Stature
Blackfoot	8.3
Monterrey	9.3
Poncho	5.2
Windbreaker	8.7
LSD (0.05)	0.5
P-value	0.0001

Discussion and Summary

This study incorporated four factors and for the most part their effects were distinct and we have chosen to summarize each factor separately.

Irrigation – For irrigation, we did not compare the three irrigations statistically because they were separate experiments. Nevertheless, full 100% ET irrigation increased LAI and light interception above the 60% ET irrigation. Canopy temperatures were cooler under full irrigation as expected. Grain yield was highest in the full irrigation and lowest under 60% ET. The percentage harvest loss due to direct harvest was greater for the 60% ET irrigation compared to full irrigation. The percentage of pods above 4-inch was similar across the three irrigations. In general, our observations for 2021 and for previous years suggest that full irrigation is clearly the safest management. However, given the yield results, we are able to speculate that irrigation at 80% ET may carry minimal risk and it would be interesting to see if it could be employed late in the season for early-maturing cultivars. The 100% ET irrigation resulted in later maturity and more prostrate growth habit.

Row Spacing – The wider row spacing tended to have greater LAI and light interception than 7-inch rows probably due to poor stands in the 7-inch spacing. Grain yield was generally the highest in the 15-inch spacing as compared to the 7-inch or 22-inch except in the 60% ET. The percent loss due to direct harvest was not consistently affected by row spacing but there was clear trend for the wider row spacings to have a higher percentage of pods above 4-inch. Row spacing did not have profound effect on maturity but within the 80% ET, 22-inch delayed maturity slightly. Row spacing had minimal effect on upright stature.

Seeding Rate – The thicker seeding rate had consistently higher LAI and light interception than the thinner seeding rate. This was true across the three irrigation rates. Surprisingly, the 40K seeding rate and 80K seeding rate produced similar indirect harvest yields. For the 80% ET with direct harvest, the 80K rate outyielded the 40K rate. This was partly explained by the 80K seeding rate having a greater percentage of pods above 4-inch than the 40K rate. Although indirect harvest yield did not show a response when seeding rate increased from 40K to 80K, it appears that the 80K rate would definitely be warranted for direct harvest situations. Seeding rate had minimal effect on maturity except for the anomaly with Poncho under 100% ET and for hastening maturity at 80K vs. 40K under 80% ET. As for upright stature under 100% ET and 80% ET, the later-maturing cultivars were more prostrate under 40K than for 80K but the opposite was true for Poncho and Blackfoot.

Cultivar - Monterrey and Poncho generally produced greater LAI and had greater light interception that Windbreaker and Blackfoot at least under deficit irrigation. Blackfoot is a sprite cultivar and although it is upright did not appear to have good canopy development or yield potential in

this study. Windbreaker produced more LAI and had higher light interception in the 22-inch spacing compared to its values in the two narrower-row spacings. Windbreaker also seemed to struggle with the 60% ET deficit irrigation but yielded quite well under the 80% ET and 100% ET especially with indirect harvest. For maturity, Monterrey as the latest maturing followed by Windbreaker. Poncho and Blackfoot were the earliest. This pattern was true across the three irrigations. Upright stature paralleled maturity with Monterrey being high and Poncho being low.

Overall – We have the following take-home lessons from this study:

(1) Loss of grain yield due to direct harvest was at least 28% and greater than for 2020.
(2) Loss of grain yield due to direct harvest was lower at the higher seeding rate.
(3) Loss of grain yield due to direct harvest was lowest for Monterrey.
(4) The higher seeding rate (80K per acre vs. 40K) increased the percentage of pods above 4-inch.
(5) The percentage of pods that were held higher than 4-inches was greater for Monterrey.
(6) The higher seeding rate increased leaf area index (LAI) and light interception.
(7) The 15-inch row spacing produced the highest and most consistent yields.
(8) Maturity was not greatly affected by planting configuration but cultivar differences were consistent.
(9) Upright stature was also not greatly affected by planting configuration although were slight trends for 22-inch rows to be more prostrate and a mixed response to seeding rate. Clearly, Monterrey had the highest upright stature and Poncho the lowest.

Assuming the producer is paid $40 per bag at harvest, it would take a yield of only 83 pounds more per acre to pay for 100K seeding rate vs. a 50K seeding rate. It would take a yield of only 67 pounds more per acre to pay for 80K seeding rate vs. a 40K seeding rate.