Technical Report TR09-06 September 2009

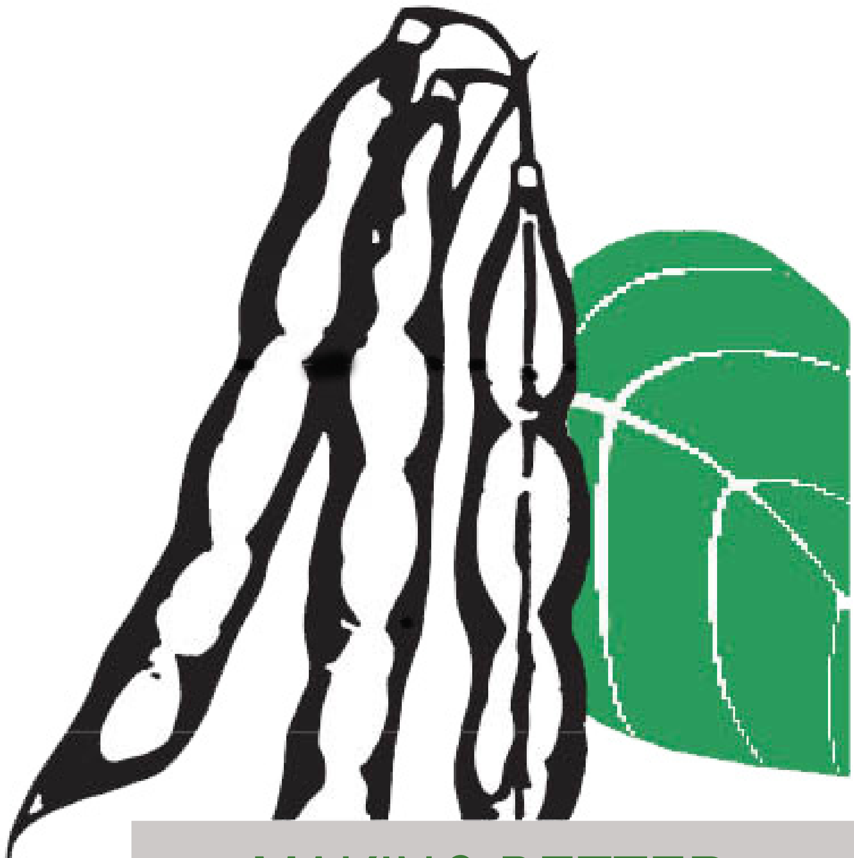
Agricultural Experiment Station

Colorado State University

College of Agricultural Sciences

Department of Soil and Crop Sciences

Extension



MAKING BETTER DECISIONS

2009 Dry Bean Variety Performance Trials

Acknowledgments

Colorado State University wishes to express its gratitude to the Colorado farmers who generously contributed the use of their land, equipment, and time to facilitate these trials for the benefit of all Colorado dry bean pro¬ducers and bean dealers: Yuma – Richard Wacker and Holyoke – Brent Adler. These trials would not be possible without the research support provided by The Colorado Dry Bean Administrative Committee, and publication of this report by The Colorado Bean Network. We are especially grateful to Bill Newth (Trinidad/Benham Bean Co. – Sterling, CO) for his assistance in identifying trial collaborators and hosting bean field days.

Trials conducted by Colorado State University Crops Testing, funded by the Colorado Dry Bean Administrative Committee and reported by the Colorado Bean Network

Disclaimer

Table of Contents

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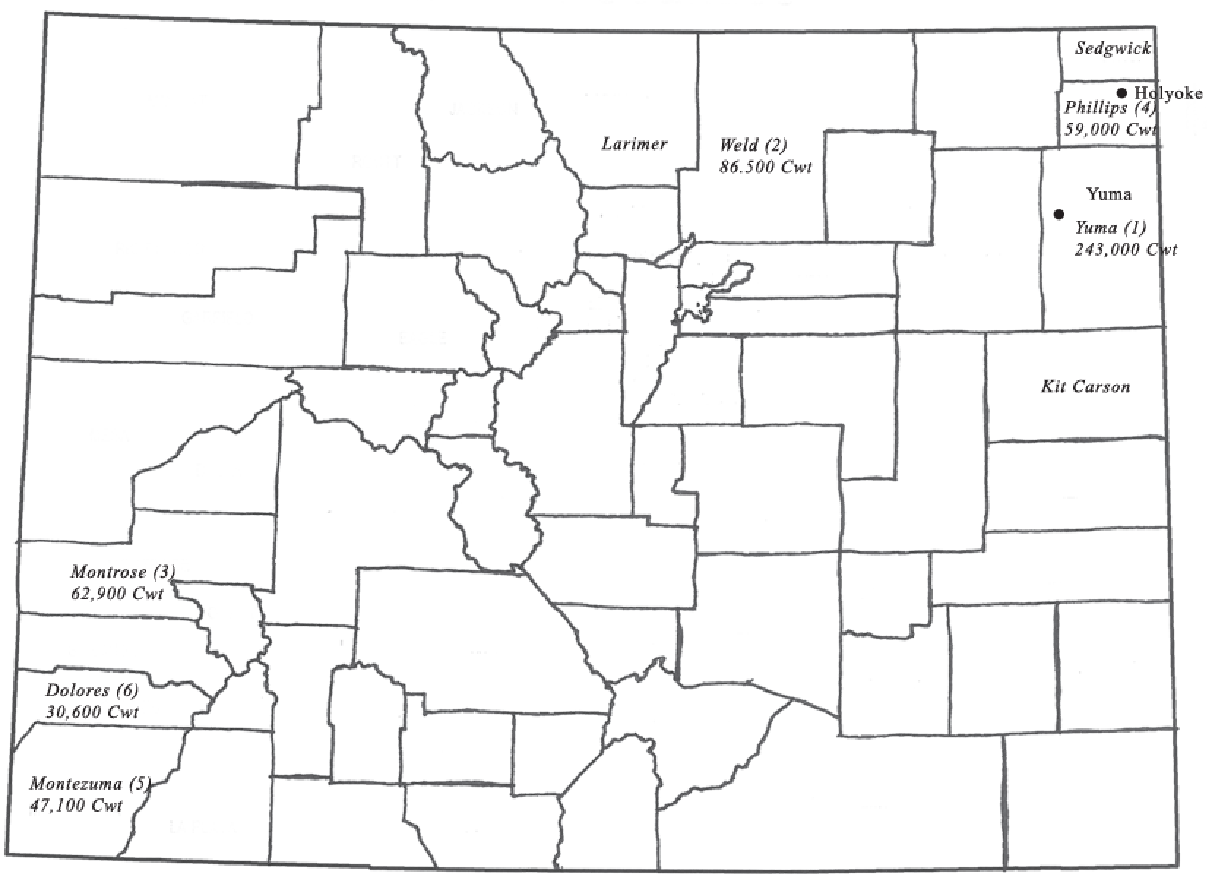
2009 Colorado Dry Bean Performance Trial

Introduction

Colorado producers annually spend millions of dollars on pinto bean seed. Variety decisions can have a big effect on yields. Colorado State University Crops Testing, the bean breeding program, and the bean pathology research program collaborate to conduct uniform variety trials annually to provide unbiased and reliable performance results to help Colorado dry bean producers make more informed variety decisions. The uniform variety trial serves a dual purpose of screening experimental lines from CSU's bean breeding program and to compare commercial variety performance for making variety recommendations to Colorado bean producers. The uniform variety trial is made possible by funding received from Colorado dry bean producers and handlers via the Colorado Dry Bean Administrative Committee. In 2009, two eastern Colorado trials were funded and planted at Yuma and Holyoke. Varieties tested in 2009 are described below. Seed yields, in pounds per acre, are adjusted to 14% moisture content.

2009 Colorado Dry Bean Trial Locations



2008 production (cwt) for the highest producing counties in Colorado.

Table 1. 2009 Pinto Bean Variety Performance Trial at Yuma.

Variety	Source	Yield	Moisture	Test Wt	Seeds/lb
		lb/ac	%	lb/bu	No.
Montrose	Colorado State University	3818	8.2	62.1	1213
Windbreaker	Seminis	3573	6.1	58.0	1300
Grand Mesa	Colorado State University	3449	7.7	59.6	1320
Medicine Hat	Seminis	3447	7.8	60.4	1220
Shoshone	University of Idaho	3409	5.2	59.1	1360
Bill Z	Colorado State University	3409	7.4	60.5	1330
6187	AmeriSeed	3345	6.7	59.6	1250
P239222	ADM Seedwest	3323	8.5	60.6	1217
99217	AmeriSeed	3296	6.7	59.2	1263
Durango	AmeriSeed	3250	6.3	59.7	1250
6203	AmeriSeed	3228	9.2	60.2	1253
CO 55646	Colorado State University	3198	7.1	58.5	1157
Lariat	North Dakota State University	3156	4.5	57.8	1290
P35161	ADM Seedwest	3146	6.7	59.7	1533
Croissant	Colorado State University	3070	5.7	57.8	1260
Mariah	Seminis	3055	6.9	60.9	1353
Stampede	North Dakota State University	3047	6.2	58.2	1443
CO 29258	Colorado State University	2994	5.3	58.2	1193
CO 55119	Colorado State University	2968	7.2	56.2	1170
CO 34142	Colorado State University	2887	4.2	56.4	1300
7221	AmeriSeed	2866	7.4	55.4	1247
5200	AmeriSeed	2827	5.9	57.3	1310
CO 24972	Colorado State University	2810	6.7	58.4	1240
Kimberley	University of Idaho	2721	6.6	59.2	1283
6189	AmeriSeed	2646	4.4	54.6	1350
CO 33875	Colorado State University	2560	8.7	56.5	1213
CO 55658	Colorado State University	2419	6.2	57.5	1100
CO 45308	Colorado State University	2410	6.6	57.5	1177
COB-2527-99	Gentec Inc	2331	7.4	59.5	1367
07220	AmeriSeed	2302	6.8	57.2	1273
ND-307	North Dakota State University	2299	6.2	56.2	1307
7218	AmeriSeed	2261	7.1	56.9	1373
GTS-904	Gentec Inc	2257	7.2	54.1	1300
6185	AmeriSeed	2156	7.4	57.0	1430
99195MR	AmeriSeed	1989	6.4	56.3	1470
La Paz	AmeriSeed	1784	6.4	55.8	1483
Average		**2881**	**6.7**	**58.1**	**1294**
LSD $_{(0.30)}$		424			

Experimental Design: randomized complete block with 3 replications

Field plot size: 10' x 31'. Harvested plot size 25 ft^2 (due to late planting and wet field conditions we had to hand harvest 10 linear ft of each plot, dry and thresh to obtain plot yields)

Site Information

Collaborator: Richard Wacker
Soil type: Platner loam
Previous crop: Corn
Planting date: 6/25/2009
Seeding rate: 85,000 seeds/ac
Irrigation: Sprinkler
Fertilization: N-P-K-S-Zn = 63-51-18-18-1 lb/ac
Herbicide: Dual, Outlook, and Select
Insecticide: Brigade for Western Bean Cutworm
Fungicide: Nu-Cop (2 times), Headline
Harvest date: 10/7/2009
Yields corrected to 14% moisture

Table 2. 2009 Pinto Bean Variety Performance Trial at Holyoke.

Variety	Source	Yield	Test Weight	Seeds per pound
		lb/ac	lb/bu	number
Montrose	Colorado State University	3320	61.9	1250
Shoshone	University of Idaho	3265	61.6	1227
Windbreaker	Seminis	3256	59.9	1243
ND-307	North Dakota State University	3171	59.0	1187
Kimberley	University of Idaho	3157	62.0	1310
Stampede	North Dakota State University	3153	60.1	1307
Bill Z	Colorado State University	3137	60.6	1267
6185	AmeriSeed	3024	62.5	1370
Durango	AmeriSeed	3022	61.9	1277
Mariah	Seminis	3010	62.1	1307
GTS-904	Gentec Inc	3010	60.7	1247
P239222	ADM Seedwest	3001	61.0	1285
7220	AmeriSeed	2982	63.3	1333
6203	AmeriSeed	2978	62.6	1313
P35161	ADM Seedwest	2927	60.0	1377
CO 34142	Colorado State University	2894	61.3	1260
COB-2527-99	Gentec Inc	2868	61.8	1233
Lariat	North Dakota State University	2865	61.6	1220
7221	AmeriSeed	2864	60.8	1255
CO 24972	Colorado State University	2850	60.5	1183
CO 55119	Colorado State University	2820	60.8	1223
Grand Mesa	Colorado State University	2815	60.7	1317
99195MR	AmeriSeed	2791	62.2	1367
CO 55646	Colorado State University	2748	61.1	1273
CO 55658	Colorado State University	2739	60.7	1093
5200	AmeriSeed	2727	61.9	1330
CO 45308	Colorado State University	2672	60.1	1143
Croissant	Colorado State University	2639	60.7	1290
CO 33875	Colorado State University	2594	58.7	1273
La Paz	AmeriSeed	2570	61.7	1467
6189	AmeriSeed	2519	61.8	1493
6187	AmeriSeed	2505	61.7	1265
CO 29258	Colorado State University	2400	58.9	1223
Medicine Hat	Seminis	2358	60.6	1310
7218	AmeriSeed	2313	62.2	1443
Average		**2856**	**61.1**	**1285**
LSD $_{0.30}$		144		

Experimental Design: randomized complete block, 3 replications
Plot size: 10' x 31

Site Information

Collaborator:	Brent Adler
Soil Type:	Balant sand
Previous Crop:	Corn
Planting Date:	6/1/2009 (6" rain followed planting)
Seeding Rate:	85000 seeds/ac
Irrigation:	Sprinkler
Fertilization:	N-P-K-5 (90-40-15-15)
Herbicide:	Sonalan, Dual, Eptam
Fungicide:	Nu-Cop
Harvest Date:	9/7/2009

Note: trial recovered from a strong hail storm 7/14/09

∞Table 3. 2-Year and 3-Year Summaries of Pinto Bean Variety Performance in Colorado Variety Trials

2-Year and 3-Year Summaries of Pinto Bean Variety Performance in Colorado Variety Trials

2-Yr Average [1]			
		2008-09	2008-09
Source	Variety[2]	Yield	Seeds/lb
		lb/ac	No.
Colorado State University	Montrose	3997	1179
AmeriSeed	99217*	3889	1151
Colorado State University	Bill Z	3819	1260
University of Idaho	Shoshone	3663	1250
AmeriSeed	Durrango	3576	1198
Colorado State University	Grand Mesa	3571	1282
ADM-Seedwest	P35161	3546	1366
North Dakota State University	Lariat	3498	1178
North Dakota State University	Stampede	3405	1278
University of Idaho	Kimberley	3392	1292
AmeriSeed	99195MR	3275	1351
Colorado State University	CO 34142	3261	1215
AmeriSeed	5200	3245	1272
AmeriSeed	6203	3230	1279
Colorado State University	Croissant	3137	1219
AmeriSeed	6189	3119	1357
AmeriSeed	6185	3070	1344
Gentec Inc	GTS-904	2927	1197
Colorado State University	CO 29258	2754	1178
AmeriSeed	La Paz	2719	1425
	Average	**3355**	**1264**

3-Yr Average [1]			
		2007-09	2007-09
Source	Variety[2]	Yield	Seeds/lb
		lb/ac	No.
Colorado State University	Montrose	3670	1233
Colorado State University	Bill Z	3410	1367
AmeriSeed	99217**	3147	1261
North Dakota State University	Lariat	3133	1268
Colorado State University	Grand Mesa	3114	1398
AmeriSeed	Durango	3102	1273
AmeriSeed	5200	3012	1355
North Dakota State University	Stampede	3011	1426
Gentec Inc	GTS-904	3003	1252
AmeriSeed	99195 MR	2968	1465
AmeriSeed	6185	2866	1402
Colorado State University	CO34142	2772	1357
AmeriSeed	La Paz	2666	1437
	Average	**3067**	**1346**

[1] 2-yr and 3-yr average yield and test weight are based on two 2009 trials, one 2008 trial, and two 2007 trials

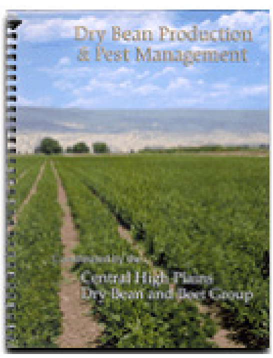
[2] Varieties ranked according to average 2-yr yield and according to average 3-yr yield.

*Data from Yuma 2008 and 2009

**Data from Yuma 2008 and 2009, Proctor 2007, Joes 2007

Summary of Pinto Bean Variety Performance in Colorado Variety Trials from 2000-2009

Every year CSU personnel conduct pinto bean variety performance trials in different locations. Both varieties and locations change from year to year so this table summarizes varieties that have been tested over the years. In the table, yield performance by variety has been averaged over locations within each of ten years. Entries reported are public and commercial named varieties common to all trials for a year. Experimental lines are not included in this summary. The number of locations per year varied from two to six. The trial average at bottom of each year's yield column is a simple average of the yields of reported varieties for that year. The second column is the yield for each reported variety expressed as a percent of the trial average for each year. Average yield over years and average percent of trial average are shown in the columns at the extreme right.



http: //www.csuag.com

Table 4. 10-Year Summary of Pinto Bean Variety Performance in Colorado Variety Trials from 2000-2009.

Variety	2000 Yield		2001 Yield		2002 Yield		2003 Yield		2004 Yield		2005 Yield		2006 Yield		2007 Yield		2008 Yield		2009 Yield		Long Term Yield	
	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave	lb/ac	% ave
99217													3080	96	2406	92	4482	104	3296	111	3316	111
99195 MR											2374	96	3437	108	2508	96	5046	117	2390	80	3151	106
Baja											2629	106	2963	93	2328	89	3730	86		0	2912	98
COB-2527-99																			2600	87	2600	87
Durango													3170	99	2390	92	4457	103	3136	105	3288	111
Bill Z	3212	104	2621	100	2613	110	2463	95	2253	105	2454	99	3689	115	2796	107	4910	114	3273	110	3028	102
Buckskin	2769	89			2184	92	2382	92	2090	97	2428	98	3090	97	2754	106	4024	93		0	2715	91
Buster	3087	100	2654	101					2185	101			3286	103						0	2803	94
Croissant																			2855	96	2855	96
Grand Mesa	2902	94	2458	93	2329	98	2283	88	1865	87	2265	92	2944	92	2429	93	4450	103	3132	105	2706	91
Kimberley																			2939	99	2939	99
La Paz											2490	101	3164	99	2586	99	3804	88	2177	73	2844	96
Mariah																			3033	102	3033	102
Medicine Hat																			2902	98	2902	98
Montrose	3213	104	2705	103	2586	109	2956	114	2562	119	2449	99	3466	108	2587	99	4854	112	3569	120	3095	104
ND-307																			2735	92	2735	92
Othello	3044	98							1936	90			3033	95						0	2671	90
Poncho	3332	108	2862	109	2371	100	2826	109	2398	111	2676	108	3033	95	3179	122	4432	102		0	3012	101
Rally			2312	88	2134	90			1935	90										0	2127	72
USPT-73	3230	104	2825	107	2374	100														0	2810	94
Lariat															2528	97	4472	103	3010	101	3337	112
GTS-904															3118	119	3513	81	2634	89	3088	104
Shoshone																			3337	112	3337	112
Stampede															2502	96	4015	93	3100	104	3206	108
Sonora															2421	93	4356	101		0	3389	114
Windbreaker																			3415	115	3415	115
Trial Average	**3099**		**2634**		**2370**		**2582**		**2153**		**2471**		**3196**		**2609**		**4325**		**2974**		**2974**	

*These varieties were each only tested for few years during the ten year period and are not included in this performance summary: 01242, 03250, 06185, 06206, 03261, 05200, 6I13, 6I15, 6I7, 6I9, Apache, Canyon, COB-2576-99, COB-2585-99, Frontier, GTS Cob 502-94, Maverick, ROG 214, ROG 261, UI 320, USPT 72, USPT 73, USPT 74, Winchester, P250215, P251215, P131423, P223217, GTS-905, GTS-906, 00218, 01223, Burke, Chase, Cisco, Elizabeth, Kodiak, and Vision.

Pinto Bean Variety Descriptions:

99195 MR An AmeriSeed Inc. variety from ProVita, Inc. with intermediate resistance to rust and *Bean common mosaic virus* (BCMV). It is a late maturing variety with a 2B plant type.

99217 An AmeriSeed Inc. variety from ProVita, Inc. with intermediate resistance to rust and BCMV. It is a late maturing variety with a 2B plant type.

Bill Z A medium maturity (95-96 days) pinto variety released by Colorado State University in 1985. It has a vine Type III growth habit with resistance to BCMV and moderate tolerance to bacterial brown spot. It is a very productive variety with good seed color. It is susceptible to white mold, common bacterial blight and strains of rust in the Hi-Plains region.

Croissant A new release from Colorado State University. It was formerly tested as CO23704 and Foundation seed was sold in 2008. It has semi-upright plant growth habit in most environments, bright pinto seed color, resistance to rust, field tolerance to common bacterial blight and resistance some strains of BCMV. Maturity is somewhat longer than Bill Z at 97-98 days.

Durango An AmeriSeed Inc. variety from ProVita, Inc. with intermediate resistance to rust and BCMV. It is a full season maturing variety with a 2B plant type.

Grand Mesa A medium maturity (94-96 day) pinto variety from Colorado State University released in 2001. Grand Mesa combines resistance to rust, BCMV, semi-upright Type II plant architecture and field tolerance to white mold, but is susceptible to common bacterial blight and bacterial brown spot. It has moderate yield potential and good seed color.

Kimberly Released in 2007 by the University of Idaho, Kimberly is a broadly adapted, and full-season pinto cultivar that has resistance or tolerance to BCMV, rust, *Beet curly top virus* (BCTV), and Fusarium root rot as well as tolerance to heat and drought. It has an indeter minate semi-prostrate Type III growth habit with medium to large vine. It is a full-season cultivar, 2 to 6 days longer maturity than Bill Z and 8 days longer maturity than Othello.

La Paz An AmeriSeed Inc. variety from ProVita, Inc. with intermediate resistance to rust and BCMV. It is a full season maturing variety with a 2B plant type.

Lariat A pinto line, tested as ND020069, was recently released by the North Dakota Agricultural Experiment Station in 2008. It has Type II upright, short vine, with good lodging resistance. In Colorado, it is a full season variety at approximately 99-100 days. It is resistant to rust and BCMV.

Mariah A variety released by Seminis. It is a full season (96- 98 day) pinto bean with an erect, short vine growth habit and resistance to BCMV.

Medicine Hat A variety released by Seminis. Medicine Hat is a medium to full season variety (94 – 96 day) with short-vine growth habit. It is resistant to BCMV.

Montrose A medium maturity (96-97 day) pinto variety released by Colorado State University in 1999. It has resistance to rust and BCMV. It has high yield potential and excellent seed quality. It is highly susceptible to white mold.

ND-307 Developed by North Dakota State University. It is a late season (>100 day) high yielding variety with upright short-vine growth habit and has resistance to rust, and BCMV.

Shoshone Released in 2007 by the University of Idaho, Shoshone is a broadly adapted, and medium maturing cultivar that has resistance or tolerance to BCMV, and rust. Shoshone is moderately tolerant to Fusarium root rot, BCTV, heat and drought. Shoshone has an indeterminate semi-prostrate growth habit Type III with small to medium length vine. Shoshone is a medium maturing cultivar, similar to Bill Z and about 4 days longer than Othello.

Stampede A pinto line, tested as ND0203 51, was recently released by the North Dakota Agricultural Experiment Station in 2008. It has full season maturity in the Hi-Plains (96-99 days), high yield capacity and excellent seed size, shape, and appearance. Stampede is an erect variety, with very good lodging resistance. It is resistant to rust and BCMV.

Windbreaker A variety released by Seminis. It is a full season (96 to 98 day) pinto bean with upright, short-vine growth habit and has resistance to BCMV.

Pinto Bean Experimental lines:

5200 An AmeriSeed Inc. experimental line from ProVita, Inc.
6185 An AmeriSeed Inc. experimental line from ProVita, Inc.
6187 An AmeriSeed Inc. experimental line from ProVita, Inc.
6189 An AmeriSeed Inc. experimental line from ProVita, Inc.
6203 An AmeriSeed Inc. experimental line from ProVita, Inc.
7218 An AmeriSeed Inc. experimental line from ProVita, Inc.
7220 An AmeriSeed Inc. experimental line from ProVita, Inc.
7221 An AmeriSeed Inc. experimental line from ProVita, Inc.
CO24972 An experimental pinto line from Colorado State University.
CO29258 An experimental pinto line from Colorado State University.
CO33875 An experimental pinto line from Colorado State University.
CO34142 An experimental pinto line from Colorado State University.
CO45308 An experimental pinto line from Colorado State University.
CO55119 An experimental pinto line from Colorado State University.
CO55646 An experimental pinto line from Colorado State University.
CO55658 An experimental pinto line from Colorado State University.
GTS-904 An experimental pinto line from Gentec, Inc.
COB-2527-99 An experimental pinto line from Gentec, Inc.
P239222 An experimental pinto line from ADM-Seedwest
P35161 n experimental pinto line from ADM-Seedwest

COAGMET Monthly Summaries from 2007-2009

Monthly Daily High Temperature (F)

	2007			2008			2009		
	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford
May	85.3	73.5	77.1	70.5	73.1	78.1	72.0	72.3	78.4
June	88.6	83.4	85.5	81.1	83.8	88.5	79.3	80.3	84.7
July	88.7	91.1	91.7	92.2	91.9	93.1	84.2	84.6	89.8
Aug	89.7	88.8	94.0	83.2	81.9	86.0	83.3	83.4	88.2
Sept	81.7	81.1	85.0	76.8	76.3	79.9	75.9	73.9	79.2
average	86.8	83.6	86.7	80.8	81.4	85.1	79.0	78.9	84.1

Number of Days Above 95 F

	2007			2008			2009		
	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford
May	0	0	0	0	0	0	0	0	1
June	4	3	2	0	3	7	0	1	3
July	5	8	8	10	11	14	1	1	10
Aug	6	5	16	4	4	5	0	1	4
Sept	0	0	1	0	0	0	0	0	0
total	15	16	27	14	18	26	1	3	18

Monthly Rainfall (inches)

	2007			2008			2009		
	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford	Holyoke	Burlington	Rocky Ford
May	0.2	1.6	1.4	2.3	0.9	0.5	3.1	3.2	1.1
June	0.2	0.9	3.0	3.2	1.7	0.4	5.0	3.3	1.3
July	2.9	3.0	0.3	1.6	2.6	0.6	4.4	5.6	2.6
Aug	1.4	4.4	1.9	4.9	8.0	4.4	4.2	3.0	0.5
Sept	1.2	0.5	0.5	1.4	1.5	0.0	1.6	2.8	0.6
total	5.9	10.4	7.1	13.3	14.7	5.9	18.3	18.0	6.2

Summary: 2009 had higher daily temperatures in southern Colorado during the season

Days above 95 F were lower in eastern Colorado, and could have delayed maturity for late-planted beans during 2009

Rainfall patterns were high in eastern Colorado in 2009, contributing to more bacterial disease and common rust // **CSU Veg Path Web Sites:**

http://www.colostate.edu/Orgs/VegNet/

http://legume.ipmpipe.org/cgi-bin/sbr/public.cgi

Effects of Weather on Dry Bean Irrigation Requirements

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The irrigation requirements of a crop are affected by weather variability. The amount and timing of precipitation (P) and evapotranspiration (ET) demand are the two main weather-related variables that determine irrigation requirements. The ET demand of a crop is a measure of how much water can be consumed via soil evaporation and plant transpiration assuming that plant-available water is adequate. The ET demand varies from day-to-day depending on crop growth stage and weather variables such as solar radiation, air temperature, humidity, and wind conditions. The daily ET demand of a crop can be estimated from daily measurements of the weather variables previously mentioned.

Assuming that all other growth factors are non-limiting – meaning conditions are such that these factors remain favorable to crop growth – a crop will attain its yield potential as long as its ET demand is satisfied throughout the growing season. Yield reductions occur when the ET demand is not satisfied, especially during critical growth stages (for example, reproductive and grain filling stages). The ET demand can be satisfied by precipitation, stored soil moisture in the root zone, and/or irrigation. Irrigation becomes necessary when natural precipitation and stored soil moisture are not adequate to satisfy all of the ET demand.

Examples of the seasonal variability of dry bean ET demand and precipitation are shown in Figures 1 and 2 for Yuma and Holyoke, respectively; both in north east Colorado. The dry bean ET demand and precipitation from June to September of each year was obtained from the Colorado Agricultural Meteorological Network (CoAgMet) crop ET access page (http://ccc.atmos.colostate.edu/cgi-bin/extended_etr_form.pl) for the available periods of record. Instructions for using this online tool are available on the main webpage given above. For these examples, dry bean ET demand was calculated assuming a May 31 planting date each year.

For the Yuma example (Figure 1), the average seasonal (June to September) dry bean ET demand was 25.6 inches while average precipitation for the same period was only 8.3 inches (only 32% of dry bean ET demand). This meant that the average shortfall (ET – P) was 17.3 inches, which would have had to be satisfied by stored soil moisture and/or irrigation. The quantity ET – P (that is, ET minus P) can also be used as a rough estimate of irrigation requirement. Actual stored soil moisture at planting must be subtracted from this quantity to get a better estimate of the seasonal irrigation requirement. It is also important to note that not all precipitation amounts are effectively available to the crop because of runoff and deep percolation losses from the root zone. Figures 1 and 2 show that ET demand, precipitation, and irrigation requirements can vary greatly from year-to-year. These figures show how the weather in each year (represented by ET and P) affects irrigation requirement (represented by ET – P). For example, the water shortfall at Yuma, Colorado was highest in 2003 (ET – P = 22.1 inches) and lowest in 1996 (ET – P = 6.0 inches).

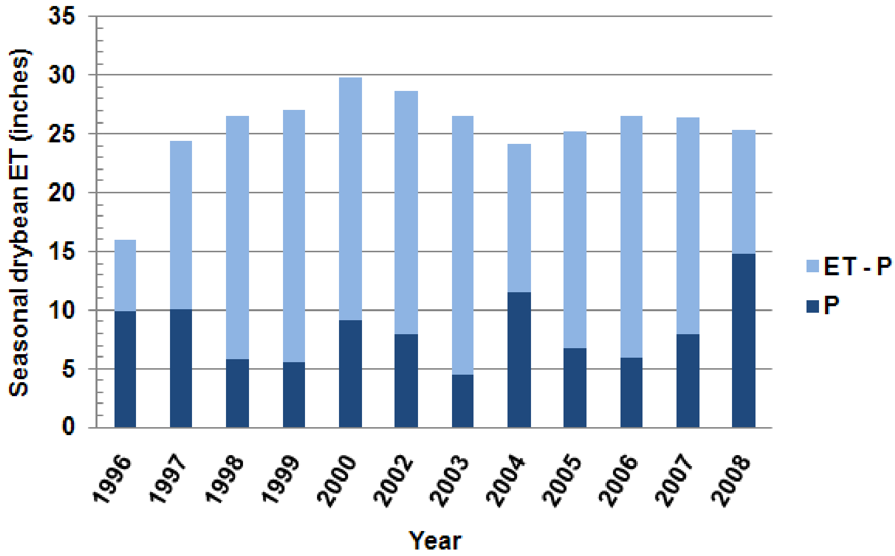

Figure 1. Total dry bean evapotranspiration (ET) demand per season (June to September) at Yuma, Colorado from 1996 to 2008. Part of the ET demand can be satisfied by precipitation (P) while the remainder (ET - P) must be satisfied by stored soil moisture or irrigation.

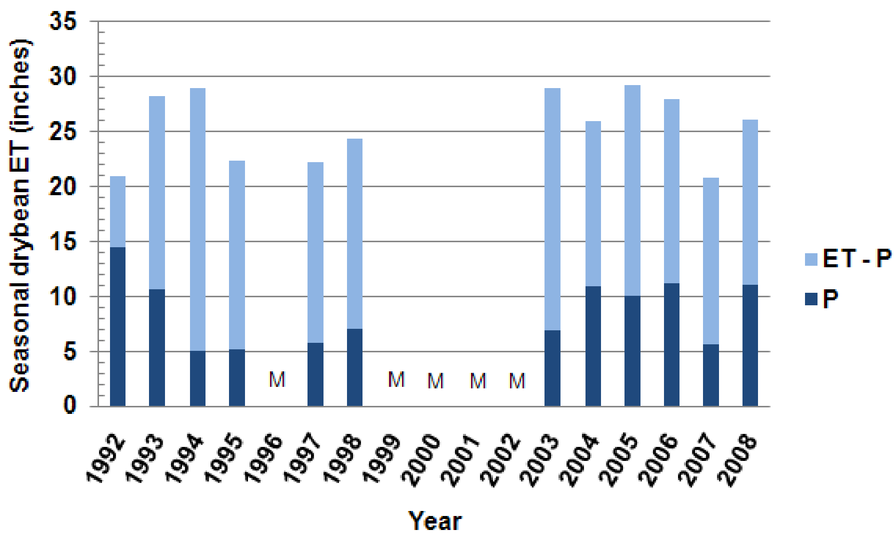

Figure 2. Total dry bean evapotranspiration (ET) demand per season (June to September) at Holyoke, Colorado from 1992 to 2008. Data for 1996; 1999 to 2002 were missing (M). Part of the ET demand can be satisfied by precipitation (P) while the remainder (ET - P) must be satisfied by stored soil moisture or irrigation.

Probable Irrigation Requirements

It is difficult to say with certainty what a crop's irrigation requirement will be for the coming season. This is because weather, specifically precipitation and ET demand, are difficult to predict. However, past records of P and ET can be used to estimate the probability (chance of occurrence) that certain amounts of P, ET, and corresponding shortfalls (P – ET) will occur at a location. Then, depending on the level of risk we are willing to take; we can select a level of probability (50% for example) and determine the corresponding crop ET demand that will likely occur. We can then plan ahead to ensure that we have enough water to supply the ET demand that will likely occur. Simple frequency analysis of P and ET can be performed to estimate the chances based on past weather records. For details on how to do simple frequency analysis, see CSU Extension fact sheet number 4.721 at http://www.ext.colostate.edu/pubs/crops/04721.html .

As an example, the dry bean ET, precipitation, and water shortfall (ET – P) for Yuma, Colorado (Figure 1) were each plotted versus their probabilities of exceedance. The probability of exceedance can be defined as the percentage of time that the value being considered will be exceeded.

Figure 3 shows that the relationship between dry bean ET demand and exceedance probability can be approximated by a straight line. The straight line accounts for about 67% of the variability of dry bean ET demand depending on exceedance probability ($r^2 = 0.67$). From the line, one can see that 50% of the time, seasonal dry bean ET demand was equal to or greater than 25 inches of water. Seasonal dry bean ET demand was at least 22.5 inches 80% of the time while it was at least 28.5 inches 20% of the time. From the graph, one can get an estimate of how often a certain value of dry bean ET demand at Yuma was equaled or exceeded. Notice that the line greatly over-estimates probable dry bean ET at 92% exceedance probability. The observed dry bean ET of 16 inches at 92% exceedance probability was a rare occurrence and did not follow the general trend. This shows one of the limitations of using a fitted line to describe actual observations, especially when the number of observations is limited.

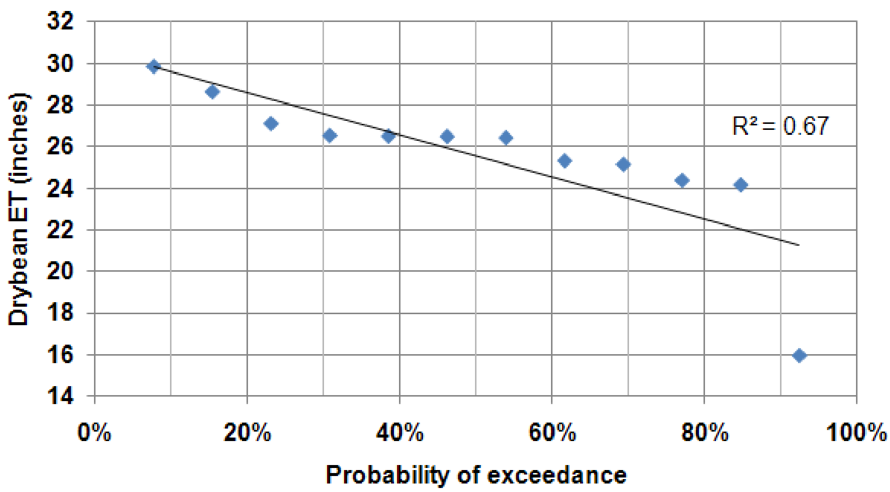

Figure 3. Probabilities (chances) of exceeding different values of seasonal dry bean ET (June to September) at Yuma, Colorado for the period 1996-2008.

As an example, if we want to be 80% sure that our water supply (stored soil moisture + irrigation water) will be enough to satisfy dry bean ET demand, then we should determine the seasonal dry bean ET that is exceeded only 20% of the time (Probability of exceedance = 100 – 80 = 20%). Dry bean ET with 20% exceedance probability means that it will not be exceeded 80% of the time. From Figure 3 at 20% probability of exceedance, the expected seasonal dry bean ET is 28.5 inches. Therefore, we should make plans to have a total of 28.5 inches of water available for the season (stored soil moisture and/or irrigation water). In this example, we are taking a 20% chance (risk) that our water supply will not be enough to satisfy dry bean ET demand. Producers who are willing to take more risks can select a higher probability of exceedance.

Likewise, seasonal precipitation (June to September) was plotted against probability (Figure 4). In this case, precipitation versus probability was not linear, so the horizontal axis was converted to a logarithmic scale (base 10 logarithmic scale in Microsoft Excel ®). This means that the probability changes rapidly as seasonal precipitation varies. In hydrology, a logarithmic scale is often used to make the probability graph appear linear. Sometimes, we are interested in unknown values between two adjacent observations. Interpolation is the process of estimating unknown values between actual observations based on observed trends. Converting data to their logarithmic values makes interpolation easier, since a straight trend line is much simpler than a curved trend line. From Figure 4, it can be estimated that seasonal (June to September) precipitation at Yuma was at least 7.5 inches 50% of the time. The line shows that seasonal precipitation was at least 5.5 inches 80% of the time while it was at least 11 inches 20% of the time.

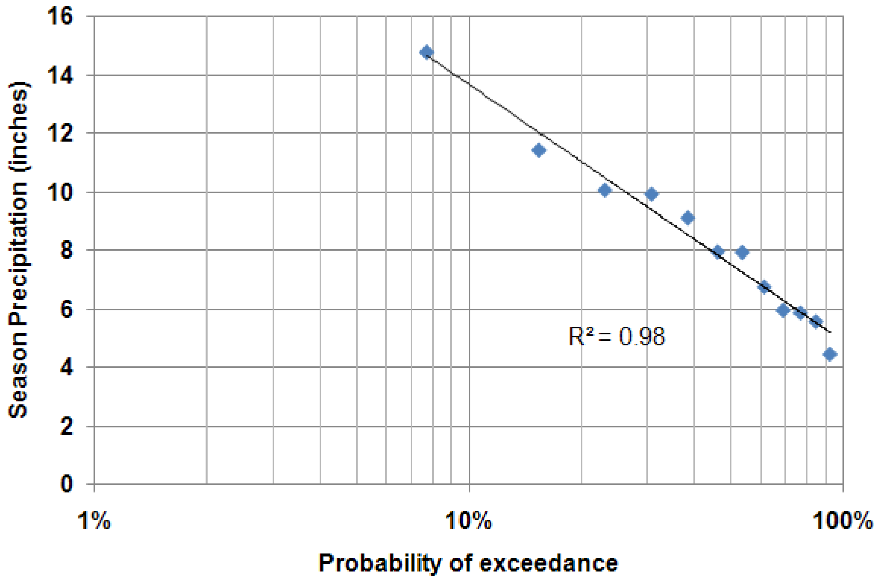

Figure 4. Probabilities (chances) of exceeding different values of seasonal precipitation (June to September) at Yuma, Colorado for the period 1996-2008.

As mentioned earlier, the water shortfall represented by (ET – P) can be a rough estimate of irrigation requirements. The probability graph of this requirement for dry bean at Yuma is approximately linear (Figure 5). Half of the time (50% probability), the water shortfall was at least 17.5 inches. The water shortfall was at least 12.5 inches, 80% of the time, while it was at least 22.5 inches 20% of the time.

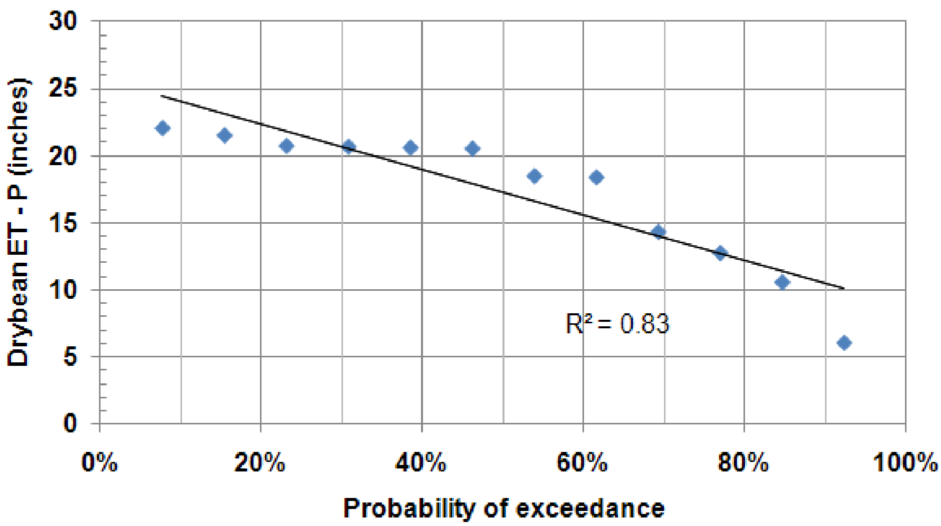

Figure 5. Probabilities (chances) of exceeding different values of seasonal (June to September) water shortfalls for dry beans at Yuma, Colorado for the period 1996-2008.

A set of probability graphs for Holyoke, Colorado is also given below (Figures 6, 7, 8). They can be used in the same way described above, to estimate probable ET, P, or ET – P amounts at selected probabilities of exceedance.

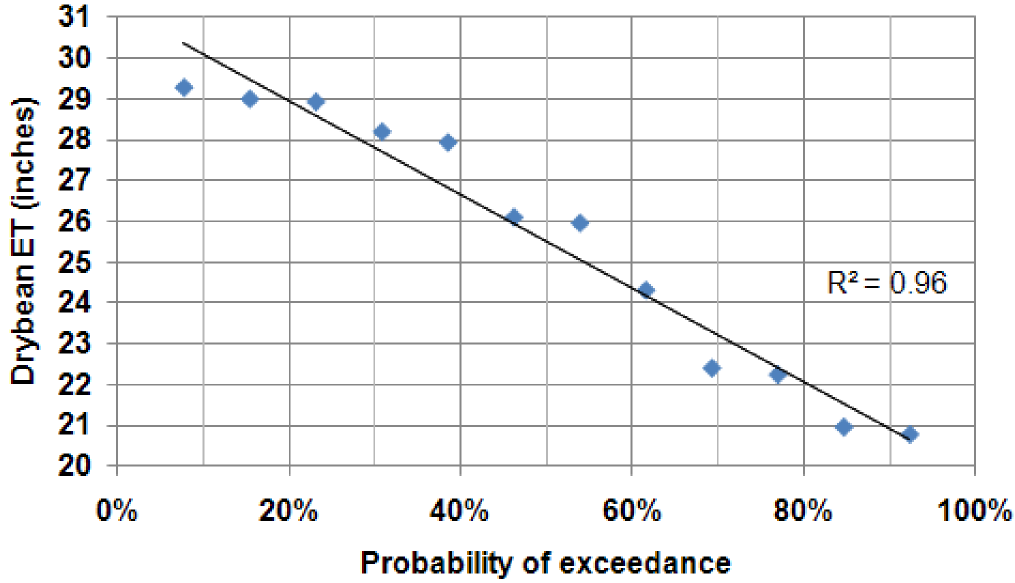

Figure 6. Probabilities (chances) of exceeding different values of seasonal dry bean ET (June to September) at Holyoke, Colorado for the period 1992-2008. The years 1996, 1999, 2000, 2001, and 2002 were missing from the record.

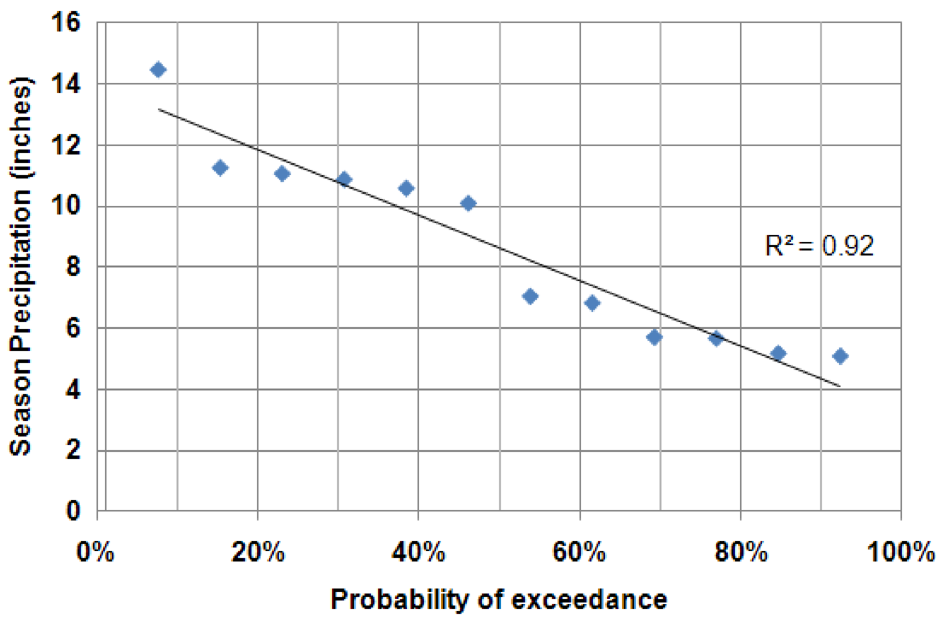

Figure 7. Probabilities (chances) of exceeding different values of seasonal precipitation (June to September) at Holyoke, Colorado for the period 1992-2008. The years 1996, 1999, 2000, 2001, and 2002 were missing from the record.

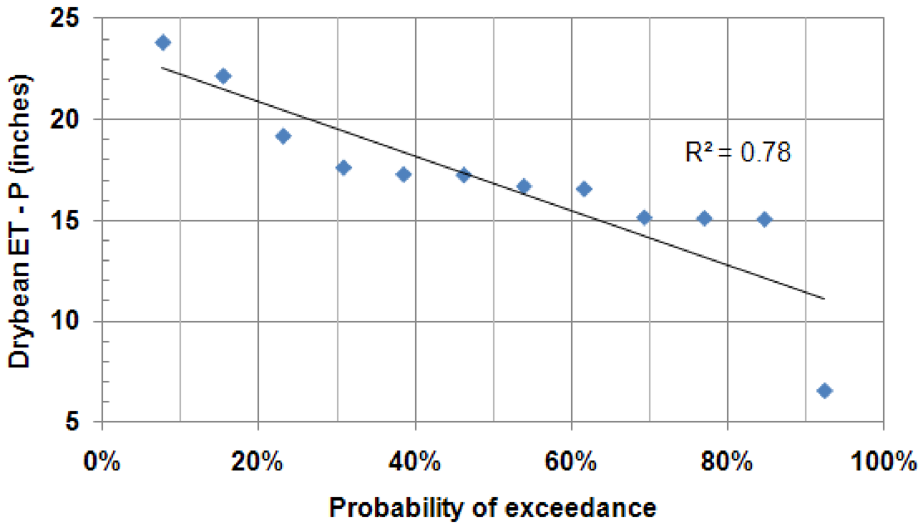

Figure 8. Probabilities (chances) of exceeding different values of seasonal (June to September) water shortfalls for dry beans at Holyoke, Colorado for the period 1992-2008. The years 1996, 1999, 2000, 2001, and 2002 were missing from the record.

From Figure 8 for Holyoke, half of the time (50% probability) the water shortfall for dry beans was at least 17.0 inches. The water shortfall was at least 15 inches, 80% of the time, while it was at least 21 inches 20% of the time.

Caution Needed in Interpreting Probabilities

Probability graphs, like the ones given above, are only as reliable as the individual data points used to make them. At times, there may be outliers – data points that are extremely high or low because of errors in data collection (a malfunctioning rain gauge, for example). Outliers may need to be excluded from the data series to get a more reliable probability plot. Also, having more data points in time gives more credibility to the probability graph. In the above examples, the years 1996, 1999, 2000, 2001, and 2002 were excluded from the Holyoke analyses because too many days of data were missing due to malfunctioning weather sensors. As more years are added to the historical record of ET and P at Yuma and Holyoke (and all other CoAgMet stations), these can be included in updated versions of the probability graphs.

There is a danger in estimating probabilities outside of the available data range (extrapolation). For example, estimating the probability of 20 inches of seasonal precipitation from Figure 4 would not be a good idea. Probability plots are most reliable in the middle of the data range, where more data have been recorded or observed. That is why longer periods of record are better, because more extreme (very high or very low) values would have been recorded.

Statisticians use statistical tests of the data to improve the reliability of probability plots and to fit appropriate lines through the data points. Only a simplistic approach is given here to illustrate how weather variability can affect irrigation water requirements.

2009 Common Bean Disease Scouting Summary

[Excerpts from the Legume ipmPIPE Report @ http://legume.ipmpipe.org/cgi-bin/sbr/public.cgi]

Rusts (soybean, common)
Common rust was noted in various fields of susceptible varieties in eastern Colorado during August to mid September. Some later fields sustained moderate infection before harvest.

Other Fungal Diseases (root rots, white mold)
Root rots were widespread during June and July, resulting in poor stands, reduced root vigor, and early maturity in some fields during August; as a result of the cool, wet spring conditions in many production areas. White mold has occurred in some fields with a history of the disease and in varieties with more dense plant canopies.

Bacterial Diseases (common blight, halo blight, brown spot, wilt)
The bacterial disease complex (primarily bacterial brown spot and common bacterial blight) was widespread in eastern Colorado as a result of the cool to moderate conditions with frequent storm activity.

Virus Diseases (AMV, BCTV, BCMV, BYMV, CMV, other)
Viruses like *Bean common mosaic virus* were widespread in susceptible varieties like yellow beans in eastern and southern Colorado.

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