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College of Agricultural Sciences

Department of Soil & Crop Sciences

Extension

Making Better Decisions



2021 Colorado Dry Bean Variety Performance Trials



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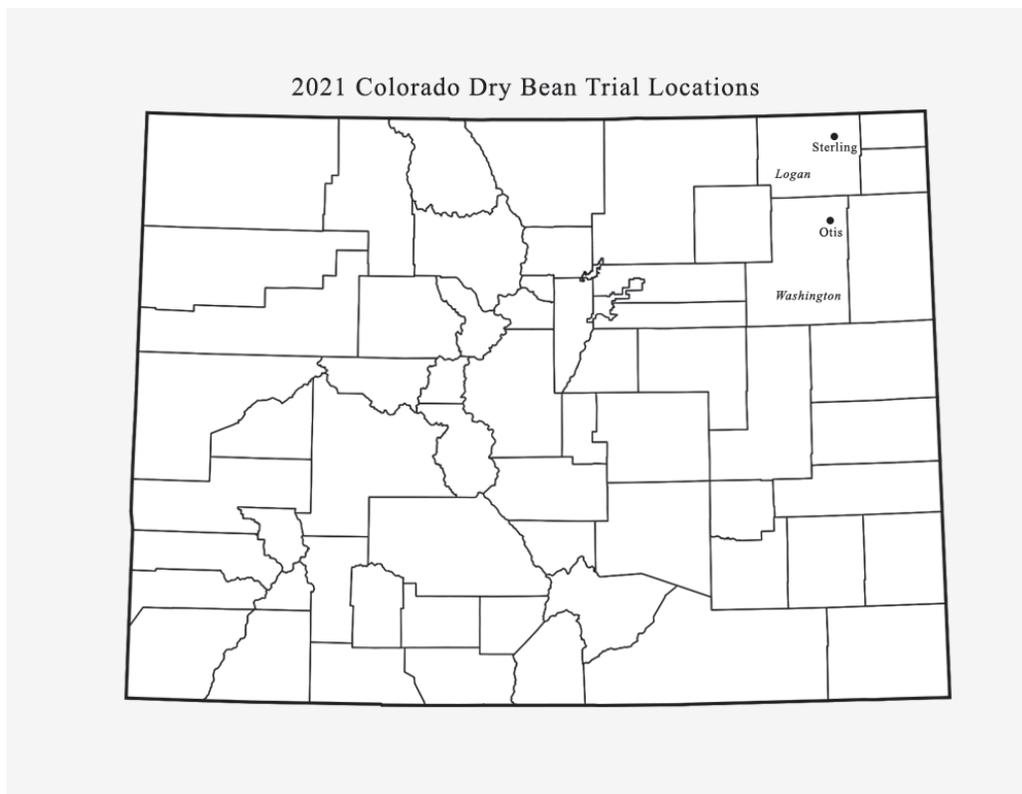
Acknowledgments

The Colorado State University dry bean improvement team wishes to express their gratitude to our 2021 collaborating farmers, Corman Farms at Otis, and Bob Duncan at Sterling. These collaborators voluntarily and generously contributed the use of their land, equipment, and time to facilitate the dry bean variety trial. These trials are evidence of bean check off dollars at work. Our dry bean variety tests would not be possible without research funding and support provided by the Colorado Dry Bean Administrative Committee and Colorado State University. The cowpea trial was funded by Trinidad-Benham and would not have been possible without their help.

2021 Colorado Dry Bean Performance Trials

The Colorado State University Crops Testing Program provides unbiased, current, and reliable variety performance results and information to help Colorado dry bean producers make better planting decisions. Our dry bean variety trials serve to test public varieties alongside commercially available varieties. Colorado State University promotes crop variety testing as a service to crop producers and seed companies who depend on us for crop variety performance information.

Two eastern Colorado pinto bean strip trials were planted under irrigation at Otis and Sterling in 2021. A report on those trials is included on the following pages, followed by a detailed description of each of the six varieties tested in those trials. A pertinent article on white mold of dry bean is included with information on the disease and management options. Lastly, a short report on cowpea research conducted at Akron, CO this year is also included, as this shows promise as a new crop for Colorado farmers.



Dry Bean Variety Strip Tests at Otis and Sterling in 2021

Introduction

Dry bean strip tests were conducted at two irrigated sites in Northeast Colorado in 2021. Both sites tested the same six varieties that were selected by the members of the Dry Bean Administrative Committee. The varieties tested were Windbreaker, SV6139GR, Rough Rider, StayBright, NE2-17-37, and NE4-17-6. Data collected and summarized included soil test results, weather (precipitation and temperature), field management, variety maturity, plant lodging, variety yield, seed size, grain moisture, and grain test weight.

Approach

Strip trials were planted on farmer fields at Sterling and Otis under center-pivot irrigation. Six varieties were selected based on current popularity/production acres in Colorado and/or because they showed promise as newly adapted varieties for Colorado. Each trial location had two replications of the six varieties, planted in 4-row strips that were 10' wide by at least 150' long. Strips were planted using 30" row spacing, and all varieties were seeded at a rate of 87,100 seeds/acre. No starter fertilizer was applied. Trials were planted the same day as the rest of the field. Trials were desiccated to allow for direct harvest using a modified Case IH plot combine equipped with a flex head. Plot seed weight, moisture, and test weight were collected using a Harvest Master H2 grain weighing system on the combine. Seed yields were adjusted to 14% moisture content. Soil samples were pulled at planting (0-12" and 12-24" depth) and were analyzed at American Agricultural Laboratory.

Results

The strip trial at Otis averaged 2,397 lb/ac and the trial at Sterling averaged 2,620 lb/ac. The varieties at the Otis site took an average of 97 days to reach physiological maturity compared to 79 days at Sterling. The difference in maturity is likely due to a later planting date at Otis, in addition to the site being higher elevation (4,340' compared to 3,707' at Sterling) and accumulating fewer heat units during the growing season. We noted during direct harvesting that the StayBright variety was the easiest to combine due to the taller plants/upright architecture, and pods that mostly stayed off the ground compared to other varieties. The NE4-17-6 experimental variety was the most difficult (but still possible) to direct harvest due to the plant architecture. Results tables for each site along with specific site information and management notes are on the following page.

The least significant difference (LSD) is provided at the bottom of the results tables. The LSD is used to help determine whether the difference in variety yields is statistically significant. If two entries being compared have a difference in yield that is less than the LSD value, those two entries are to be considered equal yielding. Variety yields in bold are in the top LSD group. Varieties in the table are sorted from highest-to-lowest yield. Variety selection may be based on more than yield performance. Other factors to consider when selecting a variety may include maturity, disease resistance, plant stature, and seed quality.

2021 Otis Dry Bean Strip Trial Results

Variety	Source	Traits	Yield ^a	Test		Physiological		Seeds/Pound
				Weight	Moisture	Maturity		
			lb/ac	lb/bu	percent	days after planting		
Windbreaker	Seminis	-	2562	60	9	99	1008	
NE4-17-6	University of Nebraska	Slow Dark	2505	61	10	95	913	
NE2-17-37	University of Nebraska	Slow Dark	2503	62	10	96	1141	
StayBright	Trinidad-Benham	Slow Dark	2448	63	22	101	1164	
SV6139GR	Seminis	-	2377	60	11	98	1096	
Rough Rider	Trinidad-Benham	-	1990	63	9	92	1045	
Average			2397	61	12	97	1061	
			^b LSD (0.30)	224				

^aYields corrected to 14% moisture.

^bFarmers selecting a variety based on yield should use the LSD (0.30) to protect from false negative decisions. Variety yields in bold are in the top LSD group.

Site Information

Collaborator: Corman Farms
 Planting Date: June 15, 2021
 Harvest Date: October 7, 2021
 Fertilizer: Pre-plant: N at 14 and P at 48 lb/ac; In-season: N at 30 lb/ac
 Soil Type: Weld silt loam
 Herbicides: Pre-emerge: Prowl at 16 oz/ac, Brawl at 16 oz/ac, Valor at 1 oz/ac, RT3 at 24 oz/ac;
 In-season: 1.5 pt/ac Eptam in July, and another 1 pt/ac in early Aug.
 Insecticide: Bifenthrin for western bean cutworm control
 Fungicide: Copper sulfate for white mold
 Trial Comments: Planted late due to heavy spring rains. Good plant stands and excellent weed control throughout the season. Desiccant herbicide sprayed on trial on Sept. 24th to allow for direct harvest.

2021 Sterling Dry Bean Strip Trial Results

Variety	Source	Traits	Yield ^a	Test		Physiological		Seeds/Pound
				Weight	Moisture	Maturity		
			lb/ac	lb/bu	percent	days after planting		
SV6139GR	Seminis	-	3035	64	9	79	1362	
Windbreaker	Seminis	-	2684	61	7	81	1168	
NE4-17-6	University of Nebraska	Slow Dark	2597	61	10	80	1175	
Rough Rider	Trinidad-Benham	-	2578	62	10	74	1324	
NE2-17-37	University of Nebraska	Slow Dark	2437	61	11	80	1336	
StayBright	Trinidad-Benham	Slow Dark	2390	64	14	83	1265	
Average			2620	62	10	79	1272	
			^b LSD (0.30)	165				

^aYields corrected to 14% moisture.

^bFarmers selecting a variety based on yield should use the LSD (0.30) to protect from false negative decisions. Variety yields in bold are in the top LSD group.

Site Information

Collaborator: Bob Duncan
 Planting Date: June 7, 2021
 Harvest Date: September 13, 2021
 Fertilizer: N at 65 lb/ac
 Soil Type: Norka-Ulysses loams
 Herbicides: Pre-emerge: Prowl at 3 pt/ac, Brawl at 1 pt/ac; In-season: Outlook at 18 oz/ac on June 26
 Fungicide: July 26: Nu-CopXLR sprayed for white mold
 Trial Comments: Excellent plant stands and good weed control throughout the season. Desiccant sprayed on Sept. 2nd.

These tables may be reproduced only in their entirety.

Soil test results for each location appear after the yield results, followed by temperature and precipitation graphs from weather station data. Note that the Otis weather station was in the trial field and therefore recorded irrigation water in addition to rainfall, whereas the Sterling station was located next to the pivot field and recorded natural rainfall only.

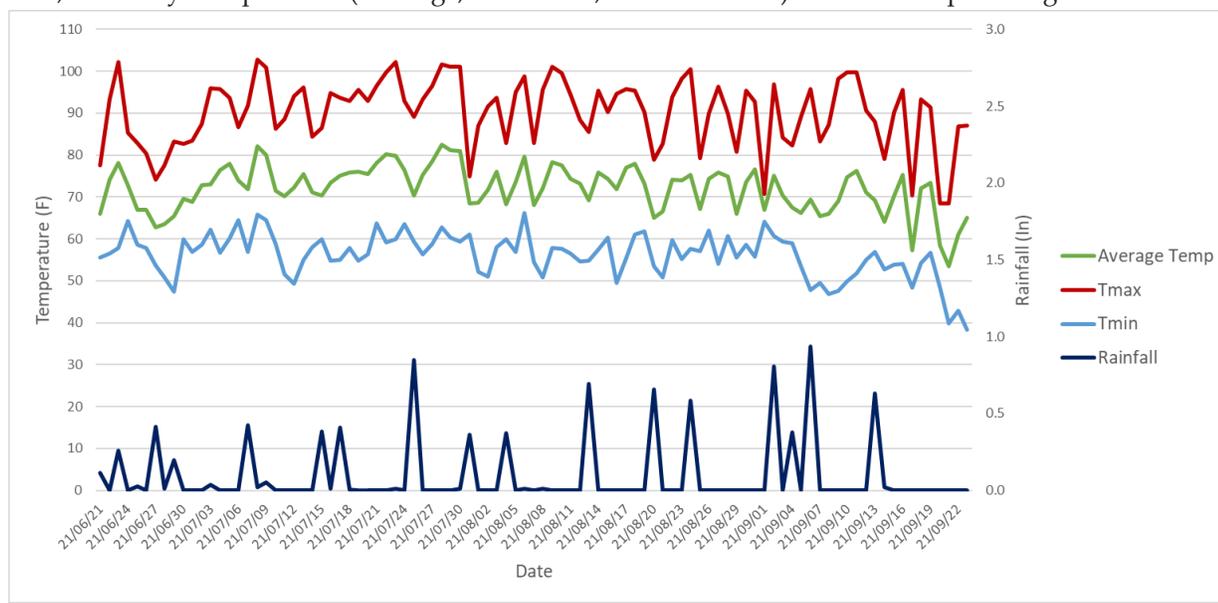
Otis and Sterling Soil Test Results (Pre-Season)

Location	Organic	Total N ₀₃	Soil pH	Phosphorus	Potassium	Sulfur		Magnesium	Sodium	Zinc	Iron	Manganese	Copper
	Matter	Available				(SO ₄)	Calcium						
	percent	lb/acre				parts per million							
Otis	1.6	96	7.4	7	605	9	2020	472	84	0.9	11.1	3.8	0.6
Sterling	2.7	134	8	3	767	95	2860	436	252	0.2	3.4	1.5	0.4

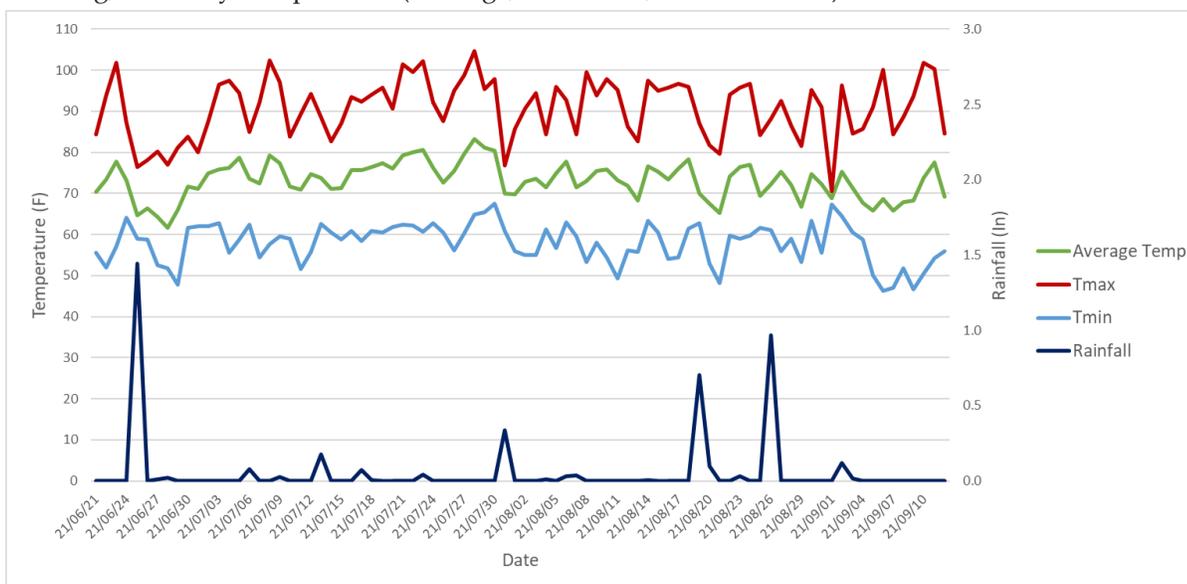
*Samples were pulled down to 24-inches, nitrate is total for 24" depth. Other results are based on top 12" of soil profile.

Weather Information

Otis, CO Daily Temperature (Average, Maximum, and Minimum) and Rainfall plus Irrigation



Sterling, CO Daily Temperature (Average, Maximum, and Minimum) and Rainfall



2021 Pinto Bean Strip Trial Variety Descriptions

Rough Rider (SV6533GR) is an early semi-determinate pinto variety developed by Seminis and marketed by Trinidad-Benham. It is an upright plant type and has good yield potential. The variety has superior lodging resistance and similar seed size to Windbreaker with very good pod placement and improved quality. It has disease resistance to bean common mosaic virus and bean rust.

StayBright is a slow-darkening pinto variety released by Colorado State University and marketed by Trinidad-Benham. The slow darkening allele was derived from the germplasm line SDIP-1 by the University of Idaho in 2006. It is resistant to endemic strains of foliar rust in the High Plains and all strains of BCMV. It has semi-upright architecture. Harvest maturity is 96 to 99 days in the High Plains region.

SV6139GR is a variety released by Seminis with an upright, semi-determinate plant growth habit and good pod position making it suitable for direct combining. It has good yield potential and improved lodging resistance with a broad adaptation and possesses disease resistance to bean common mosaic virus and bean rust.

Windbreaker is a variety released by Seminis and currently marketed by Jack's Bean. It is an indeterminate mid-season (94 to 98 day) pinto bean with upright, short-vine growth habit. It has resistance to BCMV and rust.

Experimentals

NE2-17-37 and NE4-17-6 are slow darkening pinto lines from the University of Nebraska that are being considered for release. They have resistance to BCMV and common rust and intermediate resistance to CBB. They exhibit broader adaptation. Both have an upright plant architecture (Type 2b) and medium maturity.

White Mold of Dry Bean

Olivia LoGrasso and Dr. Robyn Roberts

White mold disease and symptoms

White mold, caused by the *Sclerotinia sclerotium* fungus, is one of the most destructive diseases of dry bean in Colorado, with yield losses averaging 20% but causing up to 65% loss. The white mold fungus causes disease in over 370 plant species, including canola, soybean, many legume species, and multiple weed species frequently found in dry bean fields such as redroot pigweed, common lambsquarters, and Canada thistle.

Symptoms of white mold disease include wilting and rotting lesions on the foliage, blossoms, stems, and pods (Figure 1). A key identifying symptom of white mold infection is bleaching of stems and pods, giving them a dried appearance. Additional signs include fluffy, white mold growth on rotting plant parts, a 'cottony' appearance on flowers, visible fungal growth (mycelia), and irregularly-shaped and darkly-colored fungal structures (called sclerotia, Figure 2) both on and within the plant, which form late in the season. Harvested bean seeds will be reduced in size.



Figure 1. White mold disease symptoms demonstrating lesions, rot, and stem bleaching. Photo: Howard F. Schwartz, Colorado State University, Bugwood.org

Infection and pathogen survival

Weather and irrigation practices significantly influence the prevalence and severity of white mold infections, which are perpetuated by cool, wet conditions. Because of this, the most impactful infections occur near the end of the growing season during periods of cooler temperatures and rainfall. Temperatures of 68°F–77°F are most conducive for disease development. Petals on older, senescent (aging, weakening) flowers are especially susceptible to white mold.

S. sclerotiorum overwinters in fungal 'survival structures' (sclerotia) in the soil or in crop residue (Figure 2). Sclerotia are composed of compact, hardened masses of hyphae (thread-like filaments), with a dark, pigmented 'rind' on the outside. Sclerotia can remain dormant and infectious for at least 3 years and are produced abundantly by the white mold fungus. At or following flowering, sclerotia will typically germinate mushroom-like structures called apothecia. These apothecia produce spores (ascospores) that land on the plant, germinate, and infect the plant. Infections are typically localized within a field, but sometimes spores can be carried greater distances through wind, leading to more widespread infections in fields.



Figure 2. Fungal 'survival structures' (sclerotia, red arrows) on pods. Photo: Howard F. Schwartz, Colorado State University, Bugwood.org

Management

Integrated pest management approaches are the most effective methods to manage white mold. Because sclerotia can persist in the soil for at least three years, implementing a minimum of three-year crop rotations of non-hosts (such as corn) while avoiding alternate hosts (such as sunflower)

are important. However, because sclerotia can persist in the soil for up to 10 years under the optimal conditions, crop rotation is not effective on its own. Effective weed management is also essential to avoid inoculum build-up within and around fields, including management of common lambsquarters and redroot pigweed. Avoid planting dry beans next to or within fields that had been affected by white mold in the previous three years. Increasing air flow around the canopy by using wide row spacings of at least 30 inches and appropriately using fertilizer applications can make the environment less conducive to disease development by reducing the canopy density and allowing the foliage and soil to dry more quickly after irrigation.

When possible, white mold disease-resistant varieties should be used, but there remains a hurdle with the positive correlation between high yield and high occurrence of white mold. Using bean varieties with a more open canopy will further help to promote air flow through the canopy and mitigate spread of the disease. Biological controls such as *Bacillus amyloliquefaciens* strain F727 are potentially effective in combatting white mold. Fungicide applications have been shown to be effective and are recommended in fields where white mold has occurred in the past. For best results, apply fungicides when all plants have at least one open flower, before symptoms have developed. Applications should target plant structures close to the ground, rather than focusing on foliage, but adequate coverage of the canopy is necessary. Always follow label directions when applying fungicides.

Additional resource:

Crop Protection Network Fungicide Efficacy Table for Control of Soybean Foliar Diseases: <https://crop-protection-network.s3.amazonaws.com/publications/fungicide-efficacy-for-control-of-soybean-foliar-diseases-filename-2019-03-25-121546.pdf>

Photos (used with permission):

Schwartz, H.F., Colorado State University, and Bugwood.org. 2008a. Sclerotinia timber rot (*Sclerotinia sclerotiorum*). IPM Images. <https://www.ipmimages.org/browse/detail.cfm?imgnum=5363979>.

Schwartz, H.F., Colorado State University, and Bugwood.org. 2008b. Sclerotinia timber rot (*Sclerotinia sclerotiorum*). IPM Images. <https://www.ipmimages.org/browse/detail.cfm?imgnum=5361385>.

Irrigation Management of Cowpea for NE Colorado

Joel P. Schneekloth, Derek Witkze, and Maria Muñoz-Amatriain

Cowpea, a relatively new dry bean crop for northeastern Colorado, is well known for its adaptation to drought, heat and poor soils. The response of cowpea to full irrigation may differ from the response of dry beans typically grown in northeastern Colorado, such as pinto beans and kidney beans.

A study at the Central Great Plains Research Station near Akron, CO, in 2021 examined the response of cowpea to dryland conditions, two levels of partial irrigation, and full irrigation. A rainout shelter was used to ensure that naturally occurring precipitation events did not interfere with the planned levels of water availability in the experimental protocol. When precipitation occurs, as measured by a tipping bucket precipitation gauge, the rainout shelter closes over the crop and opens after the event is over.

The four irrigation levels used in this study were dryland, 4 inches of irrigation, 8 inches of irrigation, and full irrigation. All plots received the equivalent of the average weekly precipitation through a drip irrigation system. Irrigation for the 4" and 8" treatments was delivered in 2" applications during the reproductive growth stages either twice-weekly (8" treatment) or every other week (4" treatment). The final treatment was full irrigation which was defined as maintaining plant available soil moisture between 50 and 80% during the growing season which required a total of 11" of irrigation for the growing season.



The rainout shelter shown in the picture runs on a track system to cover the plots when rainfall occurs. The system is set to shut when 0.01" of moisture has been recorded and will reopen when moisture has not been recorded for the last hour.

Results:

Compared to the dryland treatment, irrigation up to 8" increased yield, but increasing irrigation past the 8" allocation did not further increase yield (Table 1). Yields increased from 968 to 2,484 lb/ac from dryland to 8" of applied irrigation. Irrigation beyond 8" increased evapotranspiration (ET) but not yield. Most crops generally have a yield response of increasing yield as ET increases.

One of the factors to look at is how irrigation impacted yield components such as pods per plant, seeds per pod, and seed size. Irrigation did not significantly increase seeds per pod. The number of seeds per pod ranged from about 5 to 5.9 for dryland and irrigated treatments, respectively.

The two major impacts due to irrigation were pods per plant and seed size (seeds per lb). Irrigation at 4" seasonally did not increase pods per plant, but did significantly increase seed size. The number of seeds per lb was reduced by approximately 20%. Approximately the same number of seeds were produced per acre as in the dryland treatment but it required fewer seeds to produce one pound of yield.

As irrigation increased to 8", pods per plant increased to generate the increased yield per acre. Full irrigation did not increase pods per plant, seeds per pod, or seed size compared to the 8" allocation.

Harvest index is the amount of seed produced compared to the total plant biomass production on a dry weight basis. This is an indication of the efficiency of the plant to produce seed as compared to total biomass. As with yield, the harvest index increased with irrigation up to the 8" allocation. Irrigation above 8" increased biomass production but did not increase seed production, resulting in a slightly lower harvest index. Increased biomass production typically results in greater crop water use or ET. The measured increase in ET for full irrigation compared to the 8" allocation was slightly greater than 3" of water use. This shows the potential savings in irrigation for cowpea with limited irrigation.

The dryland cowpea treatment produced 968 lbs per acre. This has the potential to either replace fallow or become another crop within the rotation for dryland producers. For irrigated producers, the potential of this crop for water savings with either limited water supplies or low capacity wells could prove beneficial in a cropping system to spread limited water. Overall, 14.5" of ET maximized yield of cowpea. An estimate of ET for a dry bean crop such as pinto is 19.5" according to CoAgMet calculations. Cowpea would offer an approximate 5" savings of water overall in the system.

Table 1. Yield components, yield and ET of cowpea under 4 irrigation management strategies.

Water Treatment	Pods/Plant	Seed/Pod	Seed Size seeds/lb	Yield lb/ac	Harvest Index yield/biomass	ET inches
Dryland	4.0	4.9	2185	968	0.36	7.8
4"	4.3	5.9	1753	1507	0.42	10.5
8"	7.3	5.5	1941	2484	0.46	14.5
Full	6.8	5.9	1935	2384	0.41	17.8



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