Cooperative Extension
Colorado State University

JULY 2002
VOLUME 22
ISSUE 3

FROM THE GROUND UP
Agronomy News

Dryland Corn Newsletter

INSIDE THIS ISSUE

Dryland Corn Acreage Increasing in Colorado

Intensive cropping systems have higher precipitation use efficiency, thus increasing yield per inch of rain.

Dryland producers in Colorado have been adopting more intensive cropping systems, including dryland corn in rotation with wheat, at an increasing rate since 1990 (Figure 1). Area planted to dryland corn in northeastern Colorado (Adams, Kit Carson, Logan, Morgan, Phillips, Sedgwick, Washington, and Yuma counties) increased from about 20,000 acres per year in years previous to 1990 to 220,000 acres in 1999. Total dryland corn acreage in Colorado increased from 23,700 historically to 340,000 in 2000.

Corn acreage is expanding into areas once thought to be too dry for corn production, as exemplified in Lincoln County, where corn acreage increased from 1500 in 1996, to 4000 in 1997, 8000 in 1998, 18,000 in 1999, and 23,000 in 2000. Producers wishing to get started in dryland rotation farming may consult bulletins published in previous years (www.colostate.edu/Depts/AES/) and/or the CSU Cooperative Extension dryland cropping systems factsheet (no 0.516) by Croissant et al. (1992).

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Colorado State University
Knowledge to Go Places

Dryland Corn Acreage Increasing in Colorado (cont.)

Currently, all of Colorado is experiencing a severe drought. Soil moisture is 60-100 mm (2.4-3.9 inches) below average. Streamflow is running less than half of average flows in almost the entire state. While forecasters project above normal rainfall over much of Colorado, the extra rain will do little to improve drought conditions, because the rainfall amounts will not be adequate to erase the water deficit. States in the West are likely to experience above normal temperatures, as well. In general, western Colorado is undergoing serious drought impacts with some spotty improvement, while eastern Colorado is seeing some improvement, in spite of the ongoing drought.

The current drought conditions are a serious challenge to dryland crop producers, regardless of the crop grown. However, research has repeatedly shown that intensive cropping systems have higher precipitation use efficiency (yield per inch of water received) than the wheat-fallow system. Data from eastern Colorado show that corn grain yield is more dependent on July and August rainfall than on stored soil water at planting. Therefore, it is possible to have average or better corn yields, even when spring stored water is below average. Including corn in dryland rotations increases the potential for productivity year after year, in spite of fluctuations in weather conditions.

Jessica Davis and Gary Peterson
Extension Soil Specialist and Professors

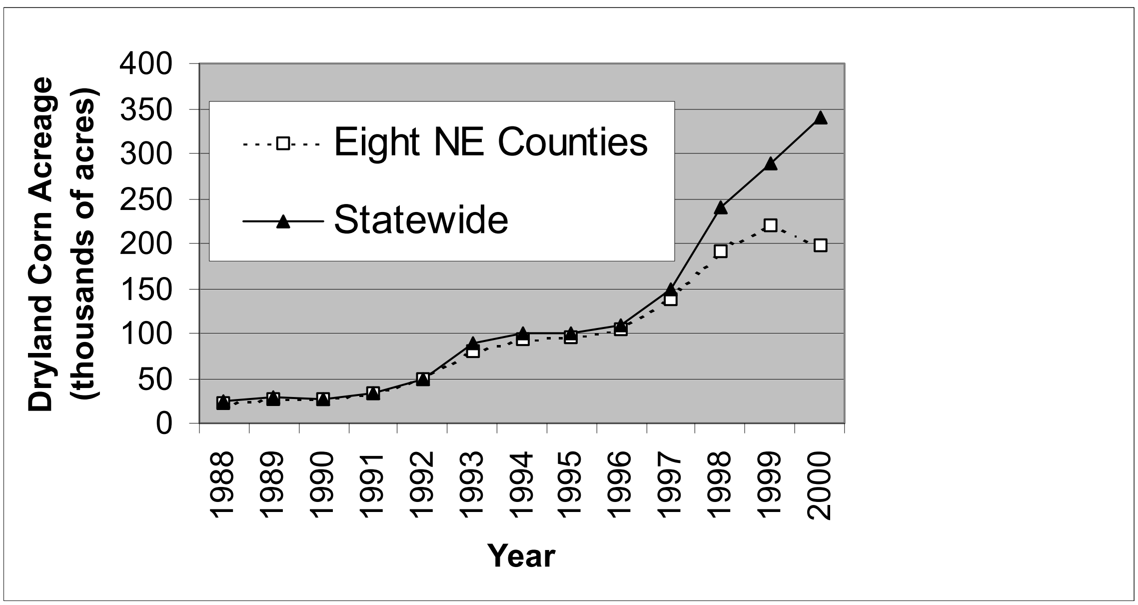

Figure 1. Dryland corn acreage in Colorado from 1988 to 2000.

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agronomy news is a monthly publication of Cooperative Extension, Department of Soil & Crop Sciences, Colorado State University, Fort Collins, Colorado.

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Corn Water Use and Yield
Under Dryland Rotations and Limited Irrigation

Variation in yield is correlated to rainfall from July 15 to August 25.

Dryland corn production in Colorado has increased steadily over the past decade with the adoption of reduced tillage, good residue management, and more intensive crop rotations. Irrigated corn production continues strong in the area as well, although there are concerns relative to the continued long-term availability of sufficient water supplies to accommodate fully irrigated corn production. In order to make wise choices regarding the production of dryland corn and the application of limited irrigation, an understanding of corn's response to amount and timing of precipitation and irrigation is important.

When water supplies to growing corn are not severely limited during any one growth stage, yield generally increases linearly with more available water and crop water use. The relationship that has been found applicable for northeastern Colorado is:

yield in bu/acre = 10.4 x (water use in inches - 9.1)

where water use (inches) is the sum of rainfall during the growing season and water extracted by the corn crop from the soil profile. The relationship can be interpreted to mean that yield increases 10.4 bu/acre for every inch of water that is used after about 9 inches of water is used to grow the plant. Growing season rainfall ranges from 5.5 to 19.5 inches (average 11.5 inches) at Akron, CO, and soil water extraction ranges from 0.8 to 10.3 inches (average 4.9 inches). Table 1 shows dryland corn water use from 1993 to 2001 at Akron, CO ranging from 10.9 to 17.3 inches for corn grown in a wheat-corn-fallow rotation under no-till management. Corn yields over that same period ranged from 10 to 84 bu/acre and generally follow the relationship given above, although the relationship does not predict corn yield well when precipitation distribution is skewed.

Table 1. Dryland corn water use and yield at Akron, CO, from 1993-2001.

Year	Water Use (in)	Yield (bu/acre)	--------Rainfall (in)------		Soil Water Extracted (in)
			4/30-7/14	7/15-8/25	
1993	13.4	39	3.9	4.5	4.4
1994	10.9	30	2.5	2.3	5.5
1995	17.2	33	12.0	1.1	10.3
1996	17.3	83	9.0	3.2	0.8
1997	14.5	27	5.5	4.5	2.9
1998	11.2	53	3.3	1.4	4.1
1999	16.4	84	6.0	7.0	2.3
2000	12.0	10	2.6	3.5	5.4
2001	16.1	72	6.5	3.7	8.2

Corn Water Use and Yield Under Dryland Rotations and Limited Irrigation (cont.)

Corn is very sensitive to water deficits and water stress during tasseling, silking, and early grain-filling. Precipitation during the 6-week period from July 15 to August 25 is highly correlated with corn yield. Previous investigations have shown that 70% of the yield variability of dryland corn production in eastern Colorado was attributed to rainfall during this critical 6-week period. This is illustrated well by the data in Table 1, where very favorable precipitation conditions during vegetative development (April 30 to July 14) in 1995 did not result in high yields, due to very low precipitation during the critical 6-week period. We have found that corn yields vary with precipitation according to the following relationship:

$$\text{yield in bu/acre} = 33.9 + 7.49 * \text{precipitation}$$

where precipitation (inches) is the amount of rainfall occurring from July 15 to August 25.

In situations where irrigation water is limited or there are restrictions on the volume of water allowed to be pumped, a good strategy may be to add water only during the reproductive (tasseling, silking, pollination) and grain-filling growth stages. By irrigating only during these growth stages, the producer can remove water stress during this critical, highly sensitive period, and maintain high yields while reducing the amount of water used. As seen in Table 2, the elimination of vegetative stage irrigation in Akron resulted in a 33% smaller plant, but no yield decrease, with a savings of 6.5 inches in irrigation water.

David Nielsen, Joseph Benjamin, and Joel Schneekloth
Agronomist, Soil Scientist, USDA-ARS; and Eastern Region Extension Water Resource Specialist; Akron, CO

Table 2. Limited irrigation contrasted with full irrigation.

Irrigation Treatment	-----4/30-7/31-------		-------8/1-9/1--------		Total Water	Corn stover at harvest	Corn grain at harvest
	rainfall	irrigation	rainfall	irrigation			
	--------------------------inches----------------------------					lb/acre	bu/acre
full irrigation	6.5	6.5	3.7	7.0	23.7	8020	168
partial irrigation	6.5	0.0	3.7	7.0	17.2	5370	168

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Dryland Corn Population Decisions

Choose seeding rate based on average, local rainfall.

Dryland corn growers are faced with the question, "How many seeds should I plant per acre?" Plant population choice is a critical decision because it affects eventual grain yield potential, and because corn seed costs are a relatively large component of the overall production budget.

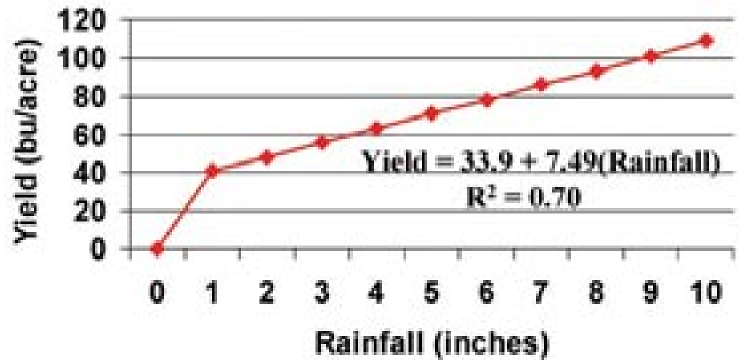


Figure 2. Corn yield as a function of 15 July - 25 August rainfall.

Corn yield potential is primarily a function of July and August rainfall (Fig. 2). Each 1" of rainfall received between 15 July and 25 August increases corn yield by 7.5 bu/A (Nielsen et al., 1996). Stored soil water is a "bank" the corn crop draws from to keep growing between rainfall events. The "water bank" remains important throughout the critical reproductive stage that occurs in July and August, but stored soil water is never sufficient to produce a crop. The critical 15 July - 25 August rainfall determines yield potential. Each grower can estimate their long-term yield potential by using the rainfall records from the weather station nearest their farm (Click on Data Access on the Colorado Climate Center webpage found at **http://climate.atmos.colostate.edu/**). Yield potential will influence the corn population decision.

Data in Figure 3 indicate that 12,000 to 16,000 plants/acre maximized corn grain yield across a wide range of growing season rainfall levels in eastern Colorado (Fithian, 1992). These data provide insight as to what will happen if the grower plants a high population, say 16,000 plants/acre, and the growing season rainfall is dryer than expected. Note that, in the growing season, with only 6 inches of rainfall, the plant populations above 12,000 plants/acre did not affect yields either positively or negatively. This indicates that the grower can plant populations adequate for their expected yield potential and not be penalized if less than average rainfall is received. To maximize long-term profits it is important to plant populations that are adequate for the expected average year, and not for the possible low rainfall year. Dryland farmers maximize their profits by planting a plant population that can take advantage of the higher rainfall years when they occur.

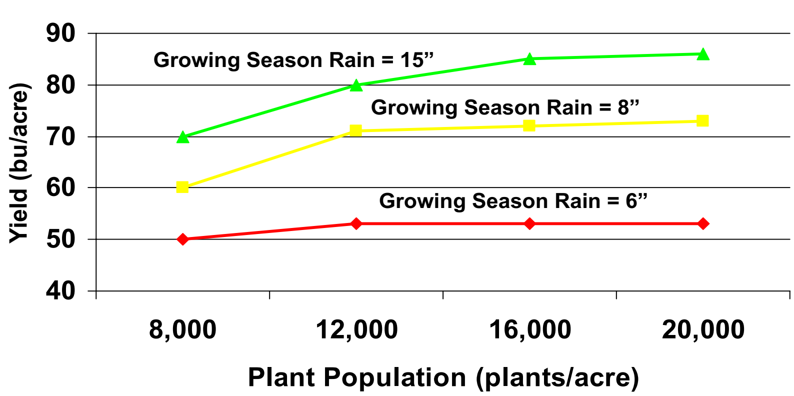


Figure 3. Corn yield as a function of population (Haxtun, Colorado).

References:

Fithian, W. 1992. Dryland yield book. Pioneer Hi-bred International Inc. Plains Sales Area.

Nielsen, D., G. Peterson, R. Anderson, V. Ferreira, W. Shawcroft, and K. Remington. 1996. Estimating corn yields from precipitation records. Cons. Tillage Fact Sheet #2-96. USDA-ARS. Akron, CO.

Gary Peterson, Professor,
Soil and Crop Sciences

Meet Gary "Pete" Peterson

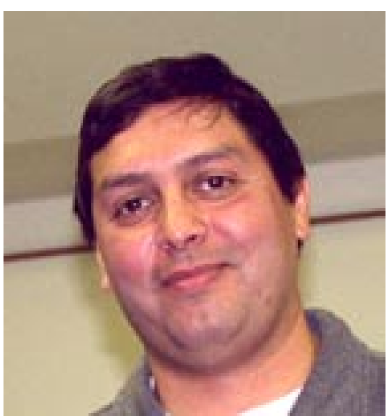
Pete was born at Holdrege, Nebraska, and grew up on a small irrigated corn farm. His formative education was in a one room, one teacher school in Phelps County. Pete is a graduate of Holdrege High, "The Dusters", in 1958. He earned his B.S. in Technical Agronomy and M.S. in Soil Fertility at the University of Nebraska and his Ph.D. in Soil Fertility at Iowa State University in 1967.

The first 17 years of Dr. Peterson's career were spent at the University of Nebraska teaching Introductory Soil Science, Soil Management, and Soil Chemistry Methods. His research there was on soil fertility problems of wheat and sugar beet. Pete's interest in no-till, water conservation, and soil organic matter was sparked by interactions with Prof. C.A. Fenster of Scottsbluff.

Pete moved to CSU in the summer of 1984. Now he team teaches Crop and Soil Management with Jack Fenwick. His research effort is in Dryland Soil Management, which is in cooperation with Dwayne Westfall. Their Dryland Agroecosystem Project was initiated in fall 1985, and its research goals are to: 1) increase overall precipitation use efficiency; 2) decrease soil erosion; and 3) reverse the long term organic matter loss pattern that has accompanied conventional cropping practices in dryland areas. Pete has served as major professor for 20 M.S. and 18 Ph.D. students.

Pete married Jackie in 1965, and they have two daughters, Kerstin and Ingrid. Kerstin and her husband, Russ, live in Chico, California, and they have three children. Ingrid and her husband, Dave, live in Fort Collins. Pete's favorite activity is teaching adult education at Faith Evangelical Free Church. Pete enjoys his work so much, that Jackie would say his profession is his hobby! He also enjoys hiking and skiing.

Meet Merle Vigil



Merle was born and raised in Thornton, CO, but his family farmed in the San Luis Valley. It was during summer visits to the valley, that Merle became interested in agriculture. He went to CSU to get his B.S. in agronomy (1980) and his M.S. in soil fertility in 1983. Dwayne Westfall was his graduate advisor at CSU, but we don't hold that against him! Merle was a county agent in Logan County for one year, and then went back to school to get his Ph.D. in soil fertility/chemistry from Kansas State University in 1989.

After all that schooling, Dr. Vigil got a post-doc position with the USDA-Agricultural Research Service in Lincoln, Nebraska. He moved to Akron in 1991 to accept a position at the Central Great Plains Research Station as a soil scientist. Merle's research focus is on nitrogen transformations in agricultural soils and on nitrogen fertilizer use efficiency. He uses simulation modeling of these processes to expand the application of his research results. Dr. Vigil was promoted to Research Leader for the Akron station in 2000.

Merle is married to Desiree, and they have five children and one grandchild. Merle spends most of his free time following his kids around to sporting events, but he also enjoys hunting, fishing, camping, and backpacking. He also plays guitar, runs, and bikes to work whenever possible. Merle has taught the Jr. High Sunday School class at St. Joseph's Catholic Church ever since the Vigils moved to Akron. With all those hobbies (and kids!), it's amazing how hard he works to support the farmers in Washington County and the Great Plains.

2001 Dryland Grain Corn Performance Data

New trial aims to identify public varieties capable of yielding 80-100% of hybrids.

We initiated two new dryland corn tests in 2001. David Baltensperger, University of Nebraska plant breeder working out of Scottsbluff, provided us with 10 synthetic corn varieties that were tested at Akron and Julesburg. The objective is to identify public corn varieties capable of yielding 80-100% of hybrids and whose seed could be saved by dryland corn producers and used in subsequent years. These varieties performed admirably against modern corn hybrids. Synthetic varieties will be tested for at least three years.

In addition, the Maximum Economic Yield Club (a group of Colorado dryland farmers organized through the Akron USDA-ARS Experiment Station) sponsored an enhanced dryland corn hybrid trial at the Akron location. Club members, desiring performance results for the hybrids they plant in their own fields, entered a large number of hybrids in the Akron dryland corn performance trial. They plan to maintain the same hybrids in the trial for a minimum of three years. Hybrid seed company entries and MEY Club entries were compared in a single trial.

Jerry Johnson
Extension Crop Production

Table 3: Dryland corn performance at Akron[1] in 2001

Hybrid[2]	Yield	Grain Moisture	Test Wt
	bu/ac	%	lb/bu
DEKALB DKC48-83	111	13.3	55.9
Pioneer brand 3655	99	14.7	56.5
Triumph 9066(RR)	99	13.4	57.8
Seedex SX5701	97	12.2	54.9
DEKALB DK440(RR/YG)	97	12.2	55.0
DEKALB DK520(RR/YG)	95	13.2	54.4
Novartis N43-C4	93	12.6	55.3
DEKALB DKC53-32(YG)	92	14.0	54.1
DEKALB DK46-28(RR)	90	13.7	56.7
Pioneer brand 37M81	90	13.3	55.9
DEKALB DK493(RR)	90	12.9	55.7
Novartis N3030(Bt/YG/LL)	90	14.1	57.1
Triumph 2370RR	90	13.9	56.3
Garst 8686(IT/IMI)	88	17.1	58.2
Pioneer brand 35R57	87	13.4	56.2
Pioneer brand 37M34	87	13.6	56.9
Novartis NK Brand 4424	87	14.1	57.1
Novartis N4242	87	13.5	57.8
DEKALB DKC46-26	87	13.0	56.9
Pioneer brand 3752	87	14.2	58.3
Novartis N4242(Bt/YG/LL)	87	13.9	57.8
Pioneer brand 38K06	86	13.5	58.0
Cropland 481(RR)	86	14.9	55.6
Seeds 2000 X3132	85	13.8	57.2
NC+ 2021(RR)	85	12.3	53.5
DEKALB DKC51-88	85	15.3	57.6
Triumph 9907(RR)	85	12.5	54.5
Triumph 1321(RR)	84	16.8	57.3
Cropland 441	84	14.3	56.2
Garst 8590(IT/IMI)	83	14.8	57.1
Triumph 4542(Bt)	82	17.5	56.1
Triumph 1120(Bt/RR)	82	20.8	56.0
Novartis N45T5	81	12.5	54.7
NC+ 2300	80	13.9	55.6
Garst 8756(RR)	78	12.1	53.6
Pioneer brand 34G81	76	16.4	56.6
AgriPro 9313	71	13.3	55.5
AgriPro 9340	67	13.9	55.5
Average	**87**	**14.1**	**56.2**
$LSD_{(0.30)}$	9.2		

[1]Trial conducted on the Central Great Plains Research Center; seeded 5/18 and harvested 10/20. No significant lodge or ear drop.
[2]Abbreviations used with corn hybrids: Bt = transgenic corn borer protection, IR, IMI, IMT, PT = Imidazolinone Resistant (Pursuit, Resolve, Contour), LL = Liberty Link/Glufosinate herbicide tolerance, RR = Roundup Ready/roundup herbicide tolerance, YG = YieldGard/Cry1Ab corn borer resistance.

2001 Dryland Grain Corn Performance Data (cont.)

Table 4: Two-year average dryland corn performance at Akron, 2000-01.

Hybrid	Yield	Grain Moisture	Test Wt
	bu/ac	%	lb/bu
DEKALB DKC48-83	87	13.5	55.2
DEKALB DKC53-32	85	14.0	54.0
Seedex SX5701	82	12.6	54.7
Garst 8756(RR)	81	12.5	53.8
Novartis N43-C4(Bt)	79	13.3	55.1
Garst 8590	71	17.4	56.7
AgriPro 9313	65	13.4	55.2
Average	**79**	**13.8**	**54.9**

Table 5: Dryland synthetic varieties performance at Akron[1] in 2001.

Hybrid	Yield	Grain Moisture	Test Wt
	bu/ac	%	lb/bu
HPAL C-8	78	14.6	57.6
HPAL C-7	77	14.5	58.0
HPAL C-10	76	15.5	57.8
HPAL C-1	73	14.2	57.1
HPAL C-9	71	15.6	57.5
HPAL C-5	71	15.2	57.1
HPAL C-4	71	14.7	57.0
HPAL C-2	71	15.1	58.1
HPAL C-6	70	15.2	57.4
HPAL C-3	68	14.8	57.6
Average	**73**	**15.0**	**57.5**
$LSD_{(0.30)}$	6		

[1]Trial conducted on the Central Great Plains Research Center; seeded 5/18 and harvested 10/21.

Table 7: Two-year average dryland corn performance at Julesburg, 2000-01.

Hybrid	Yield	Grain Moisture	Test Wt
	lb/ac	%	lb/bu
DEKALB DKC53-32	51	21.6	52.4
Grand Valley SX1264	51	19.9	55.9
Seedex SX5701	50	15.9	54.3
DEKALB DK507	48	16.4	57.1
Grand Valley SX1229	46	15.2	55.0
Garst 8590	46	22.2	55.2
Garst 8756(RR)	46	16.3	52.3
AgriPro 9313	43	17.7	55.2
Average	**48**	**18.2**	**54.7**

Table 6: Dryland corn performance at Julesburg[1] in 2001.

Hybrid[2]	Yield	Grain Moisture	Test Wt
	bu/ac	%	lb/bu
Seeds 2000 X3132	51	17.0	50.6
Grand Valley GVX2050	48	16.7	55.0
Triumph 2370RR	47	16.5	55.1
DEKALB DKC53-32(YG)	47	16.5	53.1
Grand Valley SX1264	45	15.8	56.4
Grand Valley SX1211	44	16.8	54.0
DEKALB DK507	44	16.0	57.1
DEKALB DKC51-88	43	16.0	55.5
Garst 8590(IT/IMI)	43	15.2	55.9
Garst 8686(IT/IMI)	42	15.2	58.0
DEKALB DKC46-26	42	17.2	50.2
Seedex SX5701	41	16.4	54.3
Farmer Check*	39	16.4	52.2
Grand Valley GVX8959	38	16.0	55.6
Kaystar KX-630	37	16.3	54.4
ASGROW RX601(RR/YG)	36	15.6	55.4
AgriPro 9340	35	16.2	54.5
Grand Valley SX1229	33	15.8	55.4
AgriPro 9313	31	16.2	56.0
Garst 8756(RR)	31	16.9	51.4
Grand Valley GVX4651	31	16.5	54.5
Grand Valley GVX7259	28	15.6	55.4
NC+ 3820	23	15.3	59.9
Average	**39**	**16.2**	**54.8**
$LSD_{(0.30)}$	5		

[1]Trial conducted on Josh Lechman farm; seeded 5/15; harvested 10/22.
[2]Abbreviations used with corn hybrids: Bt = transgenic corn borer protection, IR, IMI, IMT, PT = Imidazolinone Resistant (Pursuit, Resolve, Contour), LL = Liberty Link/Glufosinate herbicide tolerance, RR = Roundup Ready/roundup herbicide tolerance, YG = YieldGard/Cry1Ab corn borer resistance.
*Farmer check was DEKALB 520.

Table 8: Dryland synthetic varieties performance at Julesburg[1] in 2001.

Hybrid	Yield	Grain Moisture	Test Wt
	bu/ac	%	lb/bu
HPAL C-8	42	16.5	55.7
HPAL C-1	40	16.3	56.4
HPAL C-7	36	16.4	56.4
HPAL C-2	36	16.4	55.2
HPAL C-5	35	16.5	55.3
HPAL C-6	35	16.7	54.6
HPAL C-4	34	16.5	55.1
HPAL C-3	33	16.6	54.9
HPAL C-9	31	16.4	56.4
HPAL C-10	28	16.5	56.2
Average	**35**	**16.5**	**55.6**
$LSD_{(0.30)}$	5		

[1]Trial conducted on the Josh Lechman farm; seeded 5/15 and harvested 10/22.

Managing Nitrogen to Maximize Water Use Efficiency for Dryland Corn

Nitrogen deficiency reduces water use efficiency and yield.

Under the current drought conditions, it is critical to spend your fertilizer dollar wisely. If water is the primary limiting factor for corn growth, applying fertilizer will achieve minimal results. However, if the late summer rains do come, you won't want your corn crop to be limited due to inadequate nitrogen.

Most fertilizer decisions have already been made for this season's crops, but remember that soil testing is really the only sound basis for determining fertilizer application rates. Use Table 9 to interpret your soil test results and determine how much N to apply (lbs N/acre). This table is based on an expected yield of 80 bushels/acre. Add or subtract 1 lb N/acre for every bushel you expect above or below 80, based on previous yield history and probability of rainfall.

Anhydrous ammonia is still the cheapest fertilizer per pound of N, and ammonium nitrate is still the most expensive, with UAN and urea in between these extremes. Assuming proper fertilizer placement, there is no difference in the effectiveness of different N sources. Base your decision on availability of the fertilizer type and equipment to apply it properly, in addition to the cost.

Be sure to place your fertilizer appropriately in order to reduce N volatilization losses to the air. Drought conditions increase volatilization potential. Anhydrous ammonia should be placed 4-6 inches deep. Volatilization risk is high when surface applying UAN and urea during hot, dry weather. Banding will reduce N loss, and subsurface banding will conserve even more N for use by the crop, thus increasing fertilizer and water use efficiency.

Some N may be band-applied in combination with starter fertilizers, but the rate should be less than 20 lbs N/acre (based on a 2 inch beside and 2 inch below the seed application) in order to avoid burning the crop. Apply only 10 lbs N/acre maximum if using pop-up placed directly with the seed.

The peak demand for N for corn is from 6-leaf stage through silking. The closer you can apply the N to this period of peak demand, the better the fertilizer efficiency will be. The most efficient time to apply N to corn is just prior to the rapid growth period, when plants have about 6 leaves. Fall application of N is not recommended for corn due to losses and inefficiency.

Apply fertilizer on fields with the greatest probability of response. In general, the lower the soil nitrate level and soil organic matter content, the greater your chances of getting a yield response to N application. However, if something else is limiting yield, like drought, pests, hail, or poor soil quality, applying N will not overcome those limitations.

Due to the ongoing drought, farmers' sidedressing decisions are all about gambling on the weather. If you have a decent stand and are expecting (hoping for?) good rainfall from July 15 to August 25, then sidedress now and don't let a lack of N reduce corn yield or water use efficiency.

Jessica Davis, Extension Soil Specialist and Professor

Table 9. Nitrogen fertilizer recommendations (lbs N/acre) for dryland corn based on soil test results.

	Soil Organic Matter		
Soil NO_3-N (ppm)	**≤1.0 %**	**1.1-2.0 %**	**>2.0 %**
0-6	100	90	80
7-12	50	40	30
>12	0	0	0

What's in a Liquid Phosphorus Fertilizer?

Both ortho-P and poly-P are found in nearly all P fertilizers. Poly-P converts to ortho-P before plants can use it or soils can bind it.

A friend asked me the other day about phosphorus fertilizer (starter fertilizers). He was concerned about what source to use. His questions were specifically about the liquid sources, 10-34-0 or 9-18-9 or 9-24-3...... the list goes on. After visiting with him a bit, his real questions were: "What is the difference in the actual makeup of the various materials?" and "Does that difference in chemical makeup change the availability of the key ingredients (nitrogen (N), phosphorus (P) and potassium (K)) to my corn and wheat?" A third (and probably more important) implication of these questions is: Does the chemical makeup of one liquid fertilizer give it an advantage over another? Is there enhanced nutrient availability, because of inherent chemical makeup? His reasons for asking the question were because the costs of the various products (per actual pound of nutrient) were very different.

If you visit with a fertilizer dealer, he might indicate "this product is 70% orthophosphate (ortho-P) and 30% polyphosphate (poly-P)" (some call it pyrophosphate). Another dealer may indicate "this product is 35% ortho-P and 65% poly-P". **Well what is ortho-P? What is poly-P?** And what difference does it make to plants growing in soil that is P deficient versus plants growing in soil that is not P deficient?

It is easy to answer the last part of this question. If the soil is not P deficient, then spending your dollars on P fertilizer is not going to provide you with a return on your investment. Those dollars could have been spent on a family vacation or on putting child number three through college. Differences in liquid-P fertilizers takes a little more explanation.

Ortho-P in its purist form, is phosphoric acid (H_3PO_4). Strong acids are corrosive, nasty stuff to work with, but strong acids are neutralized by strong bases. And so, fertilizer companies use ammonia, which in water forms a strong base, ammonium hydroxide (NH_4OH which is also highly corrosive), to neutralize this acidity. When the acid and the base are mixed together, they neutralize each other, and the final result is a safe, salty liquid. Don't try this at home! The actual mixing of the acid and the base usually causes a violent reaction and produces a lot of heat. When ammonium hydroxide is mixed with phosphoric acid (ortho-P), ammonium phosphate is formed, and water and heat are given off. It is the ammonium (NH_4) from the injected ammonia, that gives us the 10 (10% N) in 10-34-0 and the 9 (9% N) in 9-18-9 or 9-24-3.

We measured the salt content of batches of 10-34-0 and 9-24-3 in 200:1 dilutions using an electrical conductivity (EC) meter. The ECs of the two products were similar. We measured an EC of 37 mmhos/cm in the 9-24-3 and an EC of 41 in the 10-34-0. You might expect a lower EC in the 9-24-3 because it has 10% less N and 30% lower P than the 10-34-0. Electrical conductivity values decrease as you increase the water content of a liquid fertilizer. One could dilute 10-34-0 with water to make a 7-24-0, add KCl and a little ammonia to get the N concentration back up to 9%, and you would have a 9-24-3 product. The pH of the 10-34-0 and the 9-24-3 were both about 6.2, indicating their corrosive characteristics due to pH (a pH of 6.2 is just slightly acidic) should be similar.

And so, after mixing with ammonia, and at the concentrations we work with, liquid P fertilizer materials are essentially harmless, but very salty, liquids. Salty liquids are naturally very corrosive to metal, and both of the products we evaluated would be expected to corrode steel toolbars and metal fertilizer applicators in about the same way.

Poly-P is made by heating phosphoric acid (ortho-P) to remove water. The result of this reaction is $H_5P_3O_{10}$ (tri-poly P). **Why do we need poly-P?** It turns out that poly-P's are more soluble in water and are easier to maintain at a near neutral pH in solution than ortho-P types of fertilizer. Therefore, poly-P fertilizers stay dissolved in solution and don't "salt out" as easily as other forms of P. In storage, some of the poly-P will split to form ortho-P (phosphoric acid, which drops the pH of the solution and is more

What's in a Liquid Phosphorus Fertilizer? (cont.)

corrosive). And so ammonia (which forms NH_4OH in water) is added to neutralize that pH drop and to improve the nutrient status of the fertilizer. The result is ammonium-poly-P (10-34-0, 9-24-3, 9-18-9, 7-21-7 are mixtures of poly-P and ortho-P and ammonia). The amounts of poly-P versus ortho-P in each liquid fertilizer might be different, but the chemistry is essentially the same. Of course, the 9-24-3, 9-18-9 and 7-21-7 have K added, probably as potassium chloride. But remember that K is deficient in less than 1% of the soils in our four state region, and you don't need fertilizer K if you are farming soils that are already high in available K. In general, sandy and low organic matter soils are more often low in K, but most of our silt loams are very high in K.

Do corn and wheat plants really care? Corn, wheat, millet, sunflowers, barley, grain sorghum.....and most other crops that have been researched all take P up through their roots in the HPO_4^{2-} or $H_2PO_4^-$ forms (ortho-P ion forms). And so, poly-P fertilizers first have to break down (hydrolyze) into ortho-P, and the ortho-P has to dissociate into an ion form for uptake by plant roots. The ortho-P in a liquid starter, is essentially 100% available for plant uptake. The poly-P is initially not available for uptake, but it hydrolyzes fairly quickly (in about 7-14 days depending on temperature and moisture) and is essentially 100% available in the time span that the plant is going to need it, even if it is applied at planting. Remember, germination takes 3-10 days (depending on moisture and temperature) and the seedling doesn't really do a whole lot of nutrient accumulation for the first few days after emergence.

The flip side of rapid availability with ortho-P is rapid fixation of P into less available forms. In our neutral to high pH, calcareous soils, P fertilizers will form dicalcium and octacalcium phosphate minerals which are much less soluble in the soil and therefore less available for plant uptake than the original fertilizer P. The poly-P form maintains fertilizer solubility for a few days longer than pure ortho-P because it has to hydrolyze into ortho-P before it can be either taken up by plants or fixed into a less soluble mineral. And so poly-P might be thought of as a somewhat "slower release" fertilizer than pure ortho-P fertilizer. Typical batches of 10-34-0 are about 65% poly-P and 35% ortho-P, or 35% immediately available, and 65% "slowly available but available fairly soon after application."

The bottom line

Crop plants need P in ortho-P ion forms before plant uptake will occur. Both ortho-P and poly-P fertilizers will provide the needed nutrition if applied at recommended rates to P deficient soils. Both ortho-P and poly-P are found in nearly all typical liquid P fertilizers. Poly-P provides some delay in fixation of P into less plant available forms. Buy your fertilizer based on price per pound of nutrient and based on how well the company/dealer handles the product. A good clean batch of 10-34-0, or 9-24-3 coming from a clean storage tank is as good a fertilizer product as a good clean batch of 9-18-9 or 7-21-7. If the dealer has dirty tanks then you will get a dirty batch of any of these products. The nutrient availability for the crop is essentially the same for all of these products. Differences in how well the dealer keeps the products clean of dirt and other impurities is an issue. Dirty batches plug applicator nozzles and are a real pain to deal with.

Merle Vigil
Soil Scientist and Research Leader,
USDA-ARS Central Great Plains
Research Station

Site-Specific Management Zones for Efficient Nitrogen Management

Variable N application based on yield potential increases N use efficiency.

Traditionally, application of nitrogen (N) fertilizer for corn production has been at uniform rates across an entire field. Determination of the amount of N to be applied has been a function of expected yield and N credits based on composite soil sampling. While this technique has proven effective for overall grain production, it does not take into account the amount of soil variability (because composite soil sampling requires too few samples and provides an average number for the entire field). The traditional technique of uniform N application may result in under and over application of N in various parts of the field. This has two implications: (i) under application of N leads to a crop's inability to maximize its growth potential (ii) over application of N in certain areas of the field leads to potential nitrate leaching below the root zone.

With the development of global positioning systems, and geographic information systems, it is now possible to vary the rate of N applied to certain areas of a field. Also, a field can now be separated into areas or zones that have similar characteristics, and these areas can be managed variably. We call these areas with similar characteristics “site specific management zones” (SSMZ). Currently, these SSMZ are delineated using aerial imagery, topography, and the farmer’s experience of the field. These SSMZ are then differentiated into categories of high, medium, and low yield potential. For the high, medium, and low productivity zones, the amount of N applied is varied such that the plants receive optimum amounts of N needed to maximize growth in each zone, while minimizing potential nitrate leaching.

An ongoing study on two sites near Greeley, CO (Site I), and Wiggins, CO (Site II) is testing the management zone concept compared to traditional N application methods. Site I is under furrow irrigation, and Site II is under sprinkler irrigation (Figure 4). The N management treatments and their corresponding N application rates for the two sites are presented in Table 10. Corn grain yields within each N application treatment across each zone are examined to determine which N management treatment performed best for yield and apparent nitrogen fertilizer use efficiency.

Yield results at the furrow irrigated study site I, showed that the SSMZ – HNHZ and the grid sample based N application produced the highest grain yield with an average of 215 and 204 bu/ac, respectively (Table 11). Both treatments, (SSMZ-HNHZ and grid sampling) account for spatial variability in soils. However, economically speaking delineating management zones on a field is much less expensive than performing grid sampling. Besides, management zones are stable and can be used for managing N for a number of years. Also, the Apparent Nitrogen Use Efficiency (ANUE, Table 11) was the highest for the SSMZ – HNHZ treatment.

Yield results at the sprinkler-irrigated study site II are somewhat similar. The SSMZ – HNHZ treatment produced the highest grain yield and ANUE (Table 11). While Site II did not show the separation in yields among treatments that we had hoped for, it does again demonstrate that by using SSMZ we can achieve yields as good as traditional methods with relatively less input.

To date, this study has shown that by using SSMZ we can achieve yields as good as, or better than, any other current method of N application management. The SSMZ – HNHZ method of N management results in high yields, and potentially less environmental degradation, both of which are important for the future of irrigated corn production.

Raj Khosla and Tim Shaver
Assistant Professor and Extension Specialist, and Research Associate, Precision Ag Program

Site-Specific Management Zones for Efficient Nitrogen Management (cont.)

Table 10

Nitrogen management treatment and application rates at two study sites in Northeastern Colorado.

Site	N management[1] Treatments	Zone[2]	Rate -- lb N ac^{-1} --
Study Site I (Furrow irrigated)	Uniform	High	164
		Medium	164
		Low	164
	Grid Sampling	High	171 - 230
		Medium	210 - 246
		Low	203 - 235
	SSMZ-LNHZ	High	167
		Medium	177
		Low	187
	SSMZ-HNHZ	High	164
		Medium	142
		Low	122
Study Site II (Sprinkler irrigated)	Recommended–50	High	113
		Medium	113
		Low	113
	Recommended+50	High	213
		Medium	213
		Low	213
	Grid Sampling	High	160 - 185
		Medium	160 - 185
		Low	160 - 185
	SSMZ-LNHZ	High	133
		Medium	163
		Low	193
	SSMZ-HNHZ	High	182
		Medium	159
		Low	126

[1] The N application treatments were based on uniform application, grid sampling, control (zero N), recommended uniform application plus or minus 50 lb N ac^{-1}, and site specific management zones (SSMZ). The HNHZ received high and low N rates for the high and low productive zones, respectively. The LNHZ received low and high N applications to the high and low productive zones, respectively.

[2] Level of soil productivity.

Site-Specific Management Zones for Efficient Nitrogen Management (cont.)

Table 11

Nitrogen treatment, corresponding mean N application rates, grain yield, and apparent nitrogen use efficiency for the two study sites.

Site	N Management treatment[1]	Mean N Application lb N ac^{-1}	Grain Yield bu ac^{-1}	ANUE[2]
Study Site I				
(Furrow irrigated)	Uniform	164	200 b	1.22 b
	Grid Sampling	216	204 ab	0.94 d
	SSMZ-LNHZ	177	185 c	1.04 c
	SSMZ-HNHZ	143	215 a	1.50 a
Study Site II	Control	0	164 c	N/A
(Sprinkler irrigated)	Recommended–50[3]	113	181 bc	1.60 a
	Recommended+50[3]	213	200 ab	0.93 e
	Grid Sampling	173	194 bc	1.12 d
	SSMZ-LNHZ	163	202 a	1.23 c
	SSMZ-HNHZ	156	205 a	1.31 b

[1] The N application treatments were based on uniform application, grid sampling, control (zero N), recommended uniform application plus or minus 50 lb N ac^{-1}, and site specific management zones (SSMZ). The HNHZ received high and low N rates for the high and low productive zones, respectively. The LNHZ received low and high N applications to the high and low productive zones, respectively.

[2] The Apparent Nitrogen Use Efficiency (ANUE) refers to bushels of grain produced for every lb of N fertilizer applied ANUE = (Grain Yield (bu/ac) / Mean N fertilizer applied (lbs/acre).

[3] Uniformly applied at the recommended rate minus 50 lbs N and recommended rate plus 50 lbs of N. The recommended rate was based on the N algorithm in the CSU corn fertilizer suggestions factsheet by Mortvedt et al. (1996).

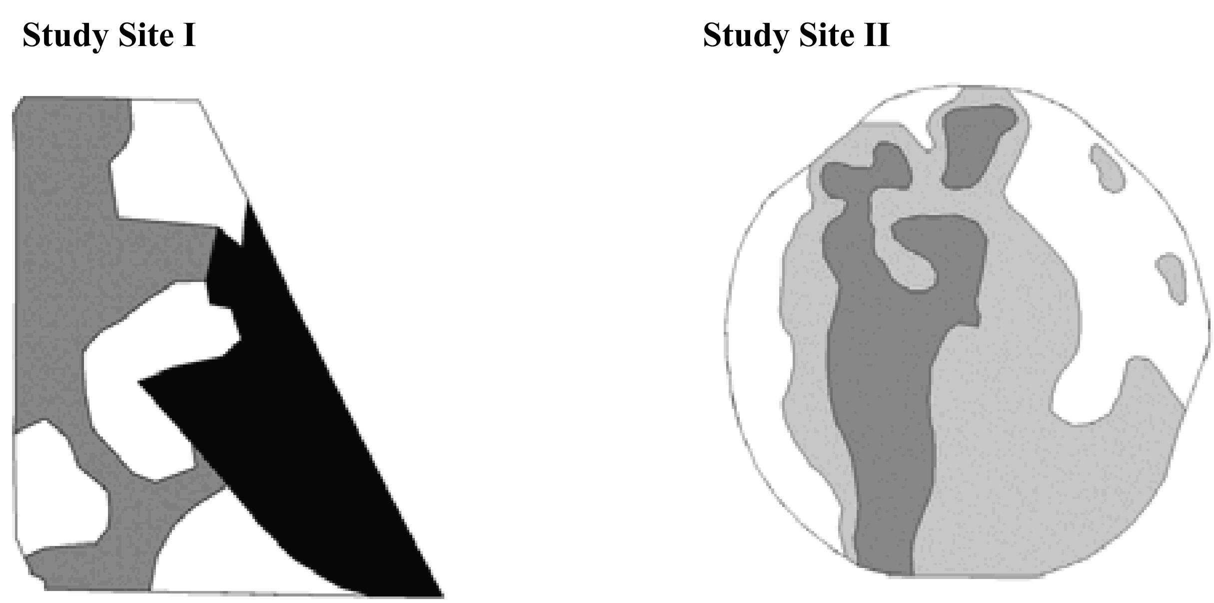


Figure 4. Furrow irrigated study site I and Sprinkler irrigated study site II, showing high (black), medium (gray), and low (white) productivity management zones.

Herbicide Choices for Weed Control in Dryland Corn

Late flushes of weeds are a challenge, due to high herbicide costs.

The above photo shows control of a heavy sandbur infestation in dryland corn following a Roundup application.

Dryland corn production in the Central Great Plains is always dicey. Most growers shoot for 50 bushel corn at a minimum and don't budget more than $15.00 per acre for herbicides. The majority of farmers with multi-crop rotations in dryland agriculture practice no-till or minimum-till farming to conserve the moisture necessary to sustain consecutive crops. Less tillage typically puts more emphasis on herbicidal weed control.

Growers often apply glyphosate (Round Up, Touchdown, and others) preplant or preemergent to the corn and control early emerging weeds. Later occurring flushes of sandbur, crabgrass, witchgrass, kochia, pigweed species and Russian thistle are often quite a problem in dryland corn. Herbicides exist that will effectively control these species of weeds, but often they are not cost effective. The most commonly used herbicide in dryland corn is atrazine, which is inexpensive and provides residual activity. Unfortunately, the above mentioned grass species are tolerant to atrazine, and at least 50% of Colorado kochia and pigweed populations have developed resistance to atrazine.

The herbicide treatments listed in Table 12 were applied June 21 on dryland corn plots located at the Akron Central Great Plains Research Station. The list does not include all herbicides available for dryland corn production, nor is it intended to endorse any specific products. The treatments were selected because of cost efficiency and/or recent registration being of interest to the agricultural community. Hopefully, when touring these plots in August, discussion will take place comparing these products to similar ones in terms of relative effectiveness.

Roundup Ready corn is a good choice for combating weeds in dryland corn. Glyphosate products such as Roundup Ultra Max and Touchdown IQ hmmcan only be applied over Roundup Ready corn. A tech fee of $17.00/bag of corn is assessed, and, when spread over approximately 5 acres, comes to $3.00 - $4.00 per acre. Glyphosate products are becoming less expensive and provide excellent broad spectrum weed control with no rotational restrictions. The advantages of glyphosate for weed control are: no rotational restrictions from residual soil activity, broad spectrum weed control, and relatively low cost. The above treatments include Dual II Magnum for residual control of subsequent weed flushes.

Herbicide Choices for Weed Control in Dryland Corn (cont.)

Distinct, a premix of dicamba (Banvel, Clarity) and diflufenzopyr provides excellent broadleaf weed control and suppression, though not control, of grass species. There is a four month plantback restriction to all crops, following application of Distinct.

The tank mix of 2,4-D + atrazine is the least expensive treatment and, depending on the weed spectrum present, may provide adequate weed control.

Option is a new sulfonylurea herbicide from Bayer (formerly Aventis). Option provides good to excellent grass control and fair to good broadleaf weed control on sulfonylurea susceptible weed species. Methylated seed oil must be used with Option (not NIS or COC) for effectiveness. Option has a 90 day plantback interval to any crop.

Aim is a contact herbicide from FMC that provides good to excellent broadleaf weed control. Weed size and surfactant quality are critical for maximum effectiveness. Aim has no soil residual activity nor plantback restrictions to dryland crops.

Callisto is a new herbicide from Syngenta that controls most broadleaf weeds and has good activity on wild proso millet and crabgrass. Callisto has best activity when applied with atrazine. This product has plantback restrictions. Refer to the label for details.

Marksman is a pre-mix of dicamba and atrazine that provides excellent control of most broadleaf weeds but misses grass species that are tolerant to atrazine.

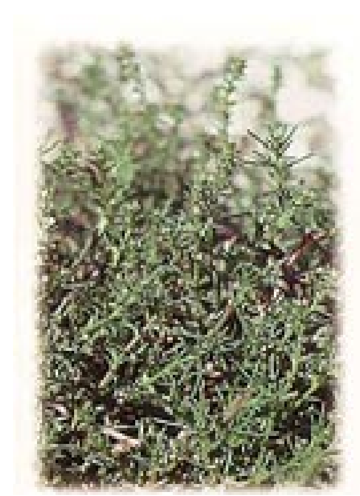
Basis Gold is a pre-mix of nicosulfuron, rimsulfuron, and atrazine. This product provides excellent grass control and good to excellent broadleaf weed control. Plantback restrictions exist.

Tim D'Amato, Phil Westra, Mark Collins
Research Associate, Professor, and Research Associate

Table 12
Treatments applied to dryland corn in Akron on June 21, 2002.

Treatment	Application Rate (product/acre)	Approximate Product Cost ($/acre)
Roundup Ultra Max	26 oz	10.00
Roundup Ultra Max Dual II Magnum	26 oz 12 oz	10.00 10.00
Touchdown IQ	32 oz	10.00
Touchdown IQ Dual II Magnum	32 oz 12 oz	10.00 10.00
Distinct UAN & NIS	6 oz 1 qt & .25% v/v	12.00
2,4-D Ester Atrazine	1 pint 0.5 lb	1.75 1.40
Option Aim UAN & MSO	1.5 oz .33 oz 1 qt & 1.5 pint	15.00 2.60
Callisto Atrazine UAN & COC	3 oz 0.25 lb 1 qt & 1 qt	12.00 .70
Marksman UAN & NIS	2.5 pint 1 qt & .25% v/v	8.50
Basis Gold UAN & NIS	14 oz 1 qt & 1 qt	17.00

UAN – urea ammonium nitrate COC – crop oil concentrate
NIS – non-ionic surfactant MSO – methylated seed oil



Russian Thistle

Root and Seedling Insect Pests

Crop rotation is the most consistent and economical means of controlling western corn rootworm.

Several insect species including wirewoms, white grubs, chinch bugs, cutworms, and corn root aphids can cause damage to seedlings. Pale western cutworm appears to have the greatest economic impact on dryland corn in Colorado. Injury to corn roots can be caused by white grubs, corn rootworm larvae, and several other pests. Western corn rootworm is among the major insect problems.

Pale Western Cutworm

Pale western cutworms cut off small seedlings below ground. As corn plants get larger, they enter the plant and kill the growing point. It is a subterranean, soft-bodied caterpillar, grayish-white in color, unmarked by spots or stripes, with two distinct vertical brown bars on the front of the head capsule. A fully developed larva is about 25 millimeters (one inch) in length. Eggs are deposited in loose soil and usually hatch within two weeks. Hatch may be delayed for up to several months if moisture and temperature conditions are unfavorable. Larvae prefer loose, sandy or dusty soil and are found most easily in the driest parts of the field such as hilltops.

Outbreaks are associated with dry conditions in the previous spring. If the preceding May and June had fewer than 10 days with ¼ inch or more of rainfall, then pale western cutworm populations can be expected to be high. If the preceding May and June had more than 15 such days, the cutworm will almost totally disappear.

Because of the sporadic nature of pale western cutworm outbreaks, management options are limited to the use of insecticides. Pale western cutworms seem to feed more under dry conditions, so yield relationships are difficult to define. Consider insecticide treatment if one plant in 20 is injured, and cutworms are present.

Western Corn Rootworm (WCR)

The WCR larvae feed on the underground root systems of corn plants. Western corn rootworm (WCR) larvae are white and slender with brown heads and a dark plate on the top side of the terminal body segment. Mature rootworm larvae are about 12 millimeters (1/2 inch) long. Peak feeding usually occurs from late June to mid-July. Lodging (goose necking) of corn plants due to larval root feeding is a typical symptom of damage. Adults often feed on corn silks, and severe silk pruning may result in yield reduction due to poor pollination. However, most damage is due to larval root feeding.

Crop rotation is the most consistent and economical means of controlling WCR populations. There are no commercial rootworm resistant corn varieties, but rootworm resistant Bt hybrids are being tested for commercial use.

Fields that have completed pollen shed are not very attractive to rootworm beetles. Early planted fields can be through with pollination before the majority of the adults have emerged, and, therefore, have less egg laying activity. Early fields also will have relatively larger root systems when rootworm feeding starts. This makes them somewhat more tolerant to rootworm damage. Chemical application to first year corn is not recommended. Incorporation of soil insecticides into the soil protects wildlife. If corn is planted prior to May 15, post-emergent treatments are preferable. Under Colorado conditions, post-emergent treatments are generally more reliable than planting-time treatments.

The granular formulations (except Fortress and Aztec) can be applied

Root and Seedling Insect Pests (cont.)

at the same rates, as a band on either side of the row, by cultivator shoes and disc hillers at cultivation. Liquids for cultivation applications include Dyfonate 4EC[R] and Furadan 4F[R] (may also be broadcast with ground or aerial equipment). Application at cultivation is usually more reliable than at planting. **Apply only before June 15.**

Control of rootworm adults is intended either to protect silks during pollination or to prevent egg laying and damage to roots in next year's crop. Adults rarely become numerous enough to interfere with pollination. Control may be justifiable if there are more than 10 beetles per ear zone during the wet silk stage (R1).

If treatments are intended to prevent egg laying, then treatment is recommended when beetle counts exceed 18,000 beetles per acre. Adult treatments applied too early, that is, before 10 percent of the females are carrying fertile eggs, may not have much effect on egg laying. Determining the percentage of females with fertile eggs can be difficult, but generally the proper time for the application of adult treatments occurs two to three weeks after the first adult emerges.

A second adult treatment should be considered if beetle densities rebound to above 12,000 per acre. The products registered for control of western bean cutworm are Furadan 4F[R], malathion, Penncap-M[R], and Slam; use them at label rates to control adult corn rootworms.

Assefa Gebre-Amlak
Golden Plains Area Extension
Entomologist

Colorado Dry Bean Field Days - August 21 and 22

Eastern Colorado Dry Bean Field Days will be held August 21 and 22. On August 21, the field day programs will start at 9:00 AM on the Ryan Weaver farm southeast of Burlington, CO. The Field Days will continue on to the Platte River site located on the Bob Duncan farm northeast of Crook, CO. Participants will see the newest dry bean varieties; tour research plots and hear the most up-to-date information on agronomic, disease and pest control practices. Area Extension Agronomists and dry bean Extension Specialists from CSU will present brief updates on breeding, pathology, weed science and agronomy. Both of these Field Days will take place at test sites of the Colorado State University Dry Bean Crops Testing Program located in producers' fields. On August 22, the Field Days move to the Agricultural Research Development and Education Center (ARDEC), the principal research station for the Colorado Agricultural Experiment Station in Fort Collins. It is located north of Fort Collins adjacent to I-25. The program at ARDEC will start at 10 AM and include variety test plots and research plots for plant pathology, weed science, soil compaction, plant breeding and more. A complimentary lunch will be provided by the Colorado Bean Network after the tour at ARDEC.

Location Time / Date	Grower	Local Extension Contact	Directions to the Site
Burlington, CO 8:00 AM August 21	Ryan Weaver 719-346-7779	Ron Meyer 719-346-5571	From Burlington, go 10 mi. S. on Hwy 385 to Rd K, 7 ¼ mi. E. to trial on south side of road K
Proctor, CO 5:00 PM August 21	Bob Duncan	Bruce Bosley 970-522-3200	From Proctor, go 3 mi. E. on Hwy 138, 3 mi. N on Rd 71, 1 mi E. on Rd 60 to plots on south side of the road
Fort Collins, CO 10:00 AM August 22	Ag. Exp. Station, ARDEC	Jerry Alldredge 970-356-4000 Extension 4474	From Fort Collins, go 3 mi. N. of Anheuser Busch Brewery on east side of I-25 Frontage Road

Please refer to the table for the dates, times, locations, growers/collaborators, local Extension contacts, and directions to each site. Mark your calendars now for this important event. The Colorado Dry Bean Field Days are sponsored by Colorado State University Cooperative Extension, Colorado Agricultural Experiment Station and the Colorado Dry Bean Administrative Committee through your market order check-off dollars.

For more information contact your local Extension Agent or one of the following Extension Specialists:

Jerry Johnson, 970-491-1454 jjj@lamar.colostate.edu
Howard Schwartz, 970-491-6987 hfspp@lamar.colostate.edu
Mark Brick, 970-498-4215 mbrick@lamar.colostate.edu

Insects Attacking Ears of Dryland Corn!

Western bean cutworm causes enough damage to warrant chemical control in dryland corn.

Several insects can be found attacking the ears of dryland corn. Most of these are not economically significant, although corn earworm and western bean cutworm can cause substantial losses. Use the following guide to identify the problem.

Caterpillars feeding in ear tips, obvious stripes and quite variable in color. May be found quite late in the season on dry grain. Under magnification, the skin appears to be covered with rows of tiny hairs (microspines). See below for details. **Corn earworm**

Caterpillars feeding in tips or elsewhere on ear. Not found on dry grain. Uniform coloration with indistinct stripes and no microspines. Three dark brown bars can be seen just behind head capsule. See below for details. **Western bean cutworm**

Caterpillars feeding in tips or elsewhere on ear late in season. Not found feeding on dry grain. Distinct stripes, variable coloration and no microspines. Not considered to be a major corn pest in Colorado. **Fall armyworm**

Cream-colored caterpillars with light brown spots feeding between rows of kernels, or tunneling in corn or shank. Rare in dryland corn. **European corn borer**

Small, elongate black beetles feeding on silks or exposed ear tips. Wing covers with variable yellow and black coloration. Not considered a problem in first year corn, usually managed through crop rotation. **Western corn rootworm adult**

Small, elongate black beetles with yellow spots on wing covers feeding on grain. Usually enter ear through holes in husks made by birds or other insects. Little is known about the significance of this problem in dryland field corn. **Sap beetles**

Corn earworm

Adult moths migrate north from the southern states in the spring. Female moths lay a single off-white colored egg. First generation earworms often feed in corn whorls, producing "shot holes" and damaging developing tassels. Second generation moths seek out green corn silks on which to deposit their eggs.

The eggs hatch into young larvae in two to 10 days and begin feeding on the corn silk, sometimes clipping it off. Later, the larvae bore through the silk channel to the ear tip and begin feeding on the kernels, usually starting at the ear tip. Fecal pellets (frass) accumulate along feeding channels. Not only do larvae cause direct loss by feeding on kernels but also provide openings in the husks for entry of disease organisms and birds. Larger larvae are cannibalistic, so usually only one larva reaches maturity in an ear of corn.

Mature earworm larvae crawl down the stalk, burrow into the ground and pupate in an earthen cell. Adult moths emerge from the pupal cells 10 to 25 days later; the last generation overwinters as a pupa, if conditions are favorable.

Control of corn earworms in field corn is usually neither practical nor economical. Some control can be achieved with Bt corn hybrids. Neither insecticide treatments nor Bt corn hybrids have been proven effective against late season infestations.

Western bean cutworm

Western bean cutworms complete a single generation each year. Fully-grown larvae (pre-pupae) overwinter in the soil. In May and early June they change to pupae. The moths emerge between mid-July and early August. They are active at night and are attracted to lights. Eggs are laid shortly after the moths emerge. The eggs are deposited in clusters of four to 200 on the top surface of upper leaves. When first laid, the

Insects Attacking Ears of Dryland Corn! (Cont.)

eggs are white with a thin red ring around the top. As they age, they change to brown, then immediately prior to hatching, they are purple to black in color. The eggs hatch in five to seven days. The majority of the western bean cutworms feed until mid-September. When mature, they enter the soil and change to the pre-pupal stage to overwinter.

Following hatch, young western bean cutworms move to one of two places on the corn plant, depending on the stage of development of the corn. If corn has not tasseled, larvae feed on pollen in the developing tassel. If corn has tasseled, larvae feed on silk in the ear; this type of silk feeding may cause pollination to be poor. Once the ear has formed, larvae feed on developing kernels. Destruction of the kernels may reduce corn yields by as much as 30 to 40 percent.

Fields should be scouted closely, because good control is difficult once the larvae move into the ear. Chemical control in irrigated systems has proven economical if eight percent or more of the plants have egg masses or small larvae in the tassels, and the crop is at least 95% tasseled. The percent infested plants needed to justify a treatment in dryland corn production has not been determined, but 15% is probably reasonable. This number should be adjusted upward if July precipitation has been low. If tasseling is much less than 95%, the percentage of infested plants should be raised, as fewer larvae are likely to reach the ears. There are a number of effective products registered in corn for control of western bean cutworm (see **www.highplainsipm.org**).

Pyrethroid insecticides have performed well in Colorado State University tests. Control is not expected with currently available Bt corn hybrids.

Frank Peairs
Professor and Extension Entomologist

Dryland Corn Field School

Colorado State University Cooperative Extension is hosting a dryland corn field school that will address dryland corn production issues. The outdoor classroom will be held on August 15, 2002 beginning at 7:00 a.m. at the Akron USDA/ARS Station (4 miles east of Akron on Hwy 34) and ending with lunch at 1:00 p.m.

Topics include planting decisions, water use in dry land rotations and limited irrigation, soil fertility and management zones, insects and diseases, weed management, and economics of dryland corn production. Continuing education credits will be offered for certified crop advisors (CCA CEUs: 2 CP, 2 PM, 1 SW, and 1NM). Pre-registration is required due to limited space, although there is no registration fee.

For registration questions, call Karen at (719) 346-5571. REGISTRATION Deadline – July 26

Detach and mail this registration form to:

Corn Field School
Attention: Karen
Kit Carson County Extension
251-16th Street, Suite 101
Burlington, CO 80807

Or fax to: 719-346-5660
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Update on Prevalent Colorado Corn Diseases

Proper variety selection, seed treatment, and rotations can prevent most serious disease problems.

Corn diseases are not normally a problem under Colorado corn growing systems. In recent years the occurrence of gray leaf spot (*Cercospora zeae-maydis*) has increased in eastern Nebraska and eastern Kansas and is being monitored. As of now, this disease poses no problem for Colorado growers. Other foliar diseases are not a problem, and, if found, usually appear so late in the season that, for all practical purposes, they cause no significant loss of yield or quality.

In the past, virus and virus-like diseases have rarely been found. In the case of the new High Plains Disease, little to no threat to field corn production is posed. If it does occur, it is easily managed with variety selection and other cultural management tactics.

There are three groups of problems that on occasion can cause concern and some damage in corn in Colorado. These are: plant emergence failure (damping-off), stalk rots, and smuts.

In some years, poor stands have resulted from failure of plants to emerge or seedling death. While frequently diagnosed as damping-off, such problems are not always a problem caused by damping-off fungi. Both soil moisture and temperature can be involved, as well as compaction and/or soil surface crusting. Damping-off fungi can have an effect if seed is planted early, and exceptionally wet and cool weather develops. Usually the water mold type fungi, *Pythium* species, and/or *Fusarium* fungi are associated with seed rot and damping-off. Some of this can be prevented with appropriate seed treatments. But a seed treatment is not the only solution. Proper seedbed preparation, moisture and time of planting are critical. Planting into a dry seedbed and then trying to irrigate the corn up can also cause problems with crusting and, in some parts of fields, rotting due to excessive water and or poor drainage.

There are actually several stalk rot fungi and at least one bacterial stalk rot found in Colorado. In some instances, any one of these can cause severe damage and yield loss. The most important stalk rot diseases and their causal agents are:

Fusarium stalk rot
[Fusarium moniliforme, Fusarium subglutinans]

Gibberella stalk rot
[*Gibberella zea (Fusarium graminearum)]*

Charcoal stalk rot
[*Macrophomina phaseolina]*

Bacterial stalk rot
[*Erwinia* spp]

Goss's wilt
[*Clavibacter michiganense* subsp. *nebraskense* (syn. *Corynebacterium nebraskense*)]

While resistant varieties are available for most of the stalk rots, there are times when a particular situation gives raise to a stalk rot problem that was not expected.

Fusarium stalk rots are always found to some degree. Usually the amount of damage is associated as much with cultural practices as with varieties. Crop stress is a critical factor in predisposing corn to damage from the Fusarium stalk rot fungi. In many instances, corn can support a certain level of Fusarium invasion without showing a significant loss of yield or quality.

Gibberella stalk rot is potentially the most damaging under Colorado conditions. Fortunately, it does not consistently develop and, therefore, is not an annual problem. While proper rotations, variety selection and stress management will minimize damage, current corn growing practices do not utilize rotations as effectively as possible.

Charcoal stalk rot is generally found only in the southern part of the state, but, in some years, it has been found in dryland corn on the plains. It is a heat and stress driven disease, and appropriate stress management practices will help to minimize damage.

Bacterial stalk rot is only found when temperatures are high during the night and fields are heavily fertilized or heavy manure applications have been made. This

Update on Prevalent Colorado Corn Diseases (cont.)

disease has only been found in a few fields a couple of times over the last 15 years and is not a major problem over a wide area.

Goss's wilt is always associated with highly susceptible varieties, lack of rotation and low to minimum tillage. In the last couple of growing seasons, this disease is being reported on the increase and, in some instances, in varieties that historically have been considered resistant to the pathogen.

Stalk rot management depends on variety selection, rotation and stress management. No pesticides are currently labeled for this problem.

There are two smut diseases of corn in Colorado. These are **common smut** caused by *Ustilago maydis*, and **head smut** caused by *Sphacelotheca reiliana.*

The two smut diseases are very different, both in the way they attack the plant, and in the way the plant is affected. Common smut infections come from wind borne spores and infect the plant locally through wounds. Common smut is not systemic or seed borne. Head smut infections in contrast, come from soil borne spores and develop systemically through the seedling into the mature plant.

Common smut infects any part of the plant, while head smut shows only in the tassels and the ears. Head smut, if infection occurs early, will also cause considerable stunting of the plant.

Smut management generally depends on resistant varieties. Certain cultural practices will help to minimize damage but are not always successful.

In 1997, a unique fungus stalk rot disease was found in the southeast part of the state. Pyrenochaeta stalk rot, caused by *Pyrenochaeta terrestris*, causes shallow, dark brown, blotchy lesions that blend with reddish areas as the plant matures. These lesions commonly are found at the base of the stalk and frequently below the soil line. Mature lesions will have very small dark pepper-grain-sized fungal bodies. The disease is considered of little importance, and no specific management tactics are recommended.

Corn diseases under Colorado conditions are readily managed with rotations, variety selection, clean seed selection, seed treatment, tillage, and stress management.

In most instances, conservation tillage poses no major disease problem to corn production under Colorado conditions. Proper variety selection, seed treatment and rotations can prevent most potentially serious problems.

Bill Brown and Tamla Blunt, Professor of Plant Pathology & IPM Coordinator and Graduate Student

Fusarium stalk rot (above)

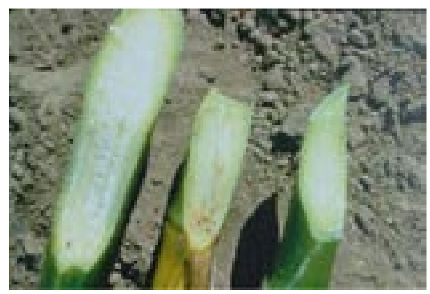
Gibberella stalk rot (above)

Update on Prevalent Colorado Corn Diseases (cont.)

Charcoal stalk rot (above)

Common smut (above)

Goss's wilt (above)



Goss's wilt (above)

Head smut (above)

Webpages

King Corn
The objective of the *KingCorn.org* website is to offer a web-based encyclopedia of knowledge about the production, marketing and usage of corn in North America. *KingCorn.org* includes the latest technology and information from major agricultural universities, governmental agencies, corn grower organizations and agricultural industries across Canada and the United States. This website contains hundreds of links to on-line publications that address nearly every agronomic aspect of producing a corn crop and is searchable by keyword. Visit at: **http://www.kingcorn.org**

National Weather Service Climate Prediction Center
This website provides weekly drought updates, soil moisture forecasts, and crop moisture index maps. Go to: **http://www.cpc.noaa.gov/index.html**

Weekly Weather and Crop Bulletin
Every Tuesday this website is updated with the latest crop moisture maps, precipitation maps, soil temperature maps, and growing degree day maps. **http://www.usda.gov/oce/waob/jawf/wwcb.html**

Central Great Plains Research Station
The USDA-ARS research station in Akron, Colorado serves the farmers of the Central Great Plains. The website includes annual reports, factsheets, and research information on dryland corn and other crops and cropping systems. **http://www.akron.ars.usda.gov/**

Colorado State University Dryland Agroecosystem Project
The 2001 technical bulletin summarizing data from this dryland crop rotation project from 1985 to the present is available here: **http://www.colostate.edu/Depts/AES/Pubs/tb01-2.pdf**

Colorado State University Cooperative Extension factsheets
Available factsheets include 0.516 Dryland Cropping Systems (R.L. Croissant, G.A. Peterson, and D.G. Westfall) and 0.538 Fertilizing Corn (J.J. Mortvedt, D.G. Westfall, and R.L. Croissant).
http://www.ext.colostate.edu/pubs/crops/pubcrop.html#prod

Colorado State University Crops Testing Program
Results are available here for irrigated, dryland, and silage hybrid testing results for corn trials in Colorado from 1996-2001. Results for other crops are available here, as well.
http://www.colostate.edu/Depts/SoilCrop/extension/CropVar/index.html

High Plains Integrated Pest Management Guide
This website is a cooperative effort of four land-grant universities and covers Colorado, Western Nebraska, Wyoming, and Montana. General IPM principles are covered, in addition to details about specific insects and diseases. Learn more at: **http://www.highplainsipm.org/**