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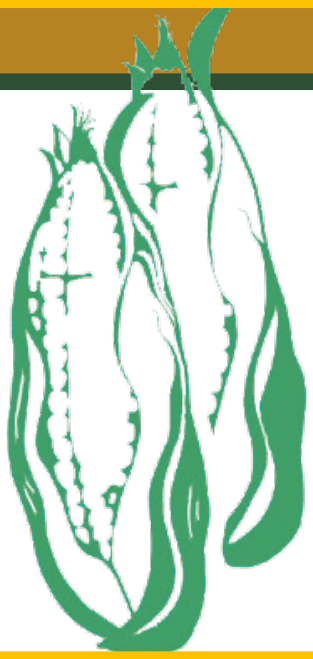

2016 Colorado Corn Variety Performance Trials

Crops Testing

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2016 Colorado Corn Hybrid Performance Trials

Jerry Johnson, Sally Jones, and Kirk Broders

Colorado State University conducts hybrid corn performance trials to provide research-based, unbiased and reliable information to Colorado corn producers so they can select the best hybrids for their farms. In addition, we have collaborative trials with the Colorado Corn Administrative Committee (drought tolerant hybrids) and Valent Biosciences (beneficial microorganisms) to test different technologies that may be adopted by farmers. The corn trials are made possible by funding received from company entry fees, the CSU Agricultural Experiment Station and the Colorado Corn Administrative Committee.

In 2016, Bacterial leaf streak (BLS), caused by the bacterial pathogen *Xanthomonus vasicola* pv *vasculorum* (Xvv), was officially reported from corn in the United States. However, reports from growers, crop consultants, and extension specialists indicate the disease has been around since at least 2014 and perhaps earlier. In 2015 the most severe disease pressure was observed in southwestern Nebraska and northeastern Colorado. The disease has continued to expand in 2016 reaching epidemic levels in regions of Colorado, Kansas and Nebraska with several fields reporting disease incidence levels above 90%. Results from a statewide survey found the presence of the disease in seven counties (Sedgwick, Phillips, Logan, Yuma, Kit Carson, Cheyenne, and Washington) in Colorado. The disease was also recently identified from grain corn fields in Iowa, Illinois, Minnesota, Oklahoma, South Dakota, and Texas.

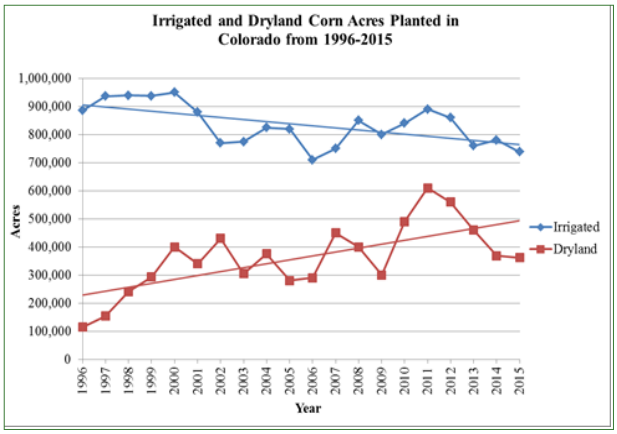


Figure 1: Irrigated and Dryland Corn Acres Planted in Colorado from 1996-2015

Colorado produced over 160 million bushels of corn on 1,170,000 harvested acres in 2016 according to the USDA National Ag. Statistics Service. The total value of production was over 499 million dollars in 2015 (most recent year available). Figure 1 shows the dryland and irrigated corn acres planted in Colorado from 1996 through 2015. In general, there is a substantial increase in dryland acreage over the last 20 years, starting from 107,000 acres in 1995 and increasing to a high of 610,000 dryland acres in 2011. No – till systems and herbicide resistant corn have played a large part in increasing acreage. Higher corn prices in some years have led to increased corn acreage. Dryland corn acreage has decreased in recent years. The rapid decrease in corn value, drought from 2011-2014, and stubbornly high prices for corn inputs have combined to make corn less desirable, resulting in reduced corn acreage in the last few years.

Figure 2 shows the yearly average yield for irrigated and dryland corn in Colorado from 1996 through 2015. There is a steady linear increase in irrigated corn yield from 121 bu/ac in 1995 to 191 bu/ac in 2014. Note that in 2006 and 2010 average yields were 200 bu/ac or better! Improved genetics and more precise farming practices may account for the increasing general trend in average irrigated yield. The high average yields in 2006 and 2010 were most likely due to higher than average growing season heat units (longer growing season).

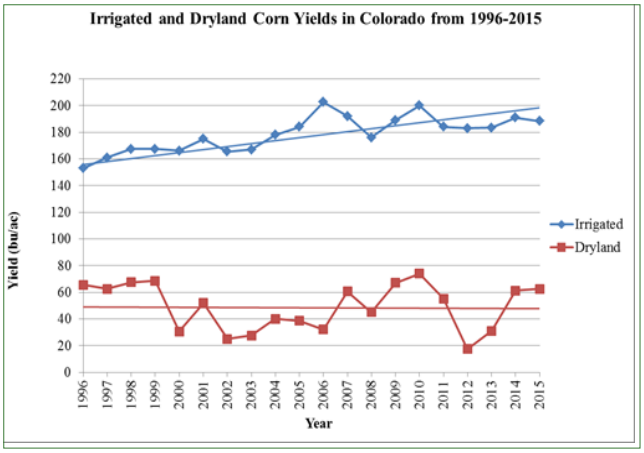
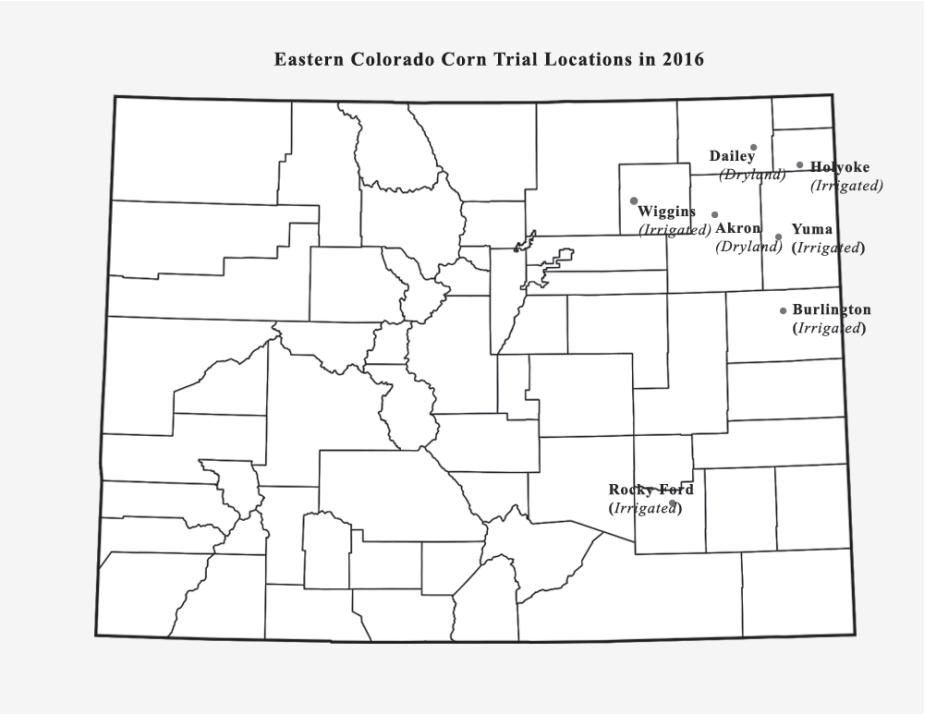


Figure 2: Irrigated and Dryland Corn Yields in Colorado from 1996-2015

The dryland corn yields are highly dependent on weather conditions during the growing season. The amount and timing of rainfall received can make-or-break dryland corn yields. This was true in the drought years from 2002 through 2006, and again in 2012 and 2013 when there was not enough rainfall during the growing season and the dryland yield fell below 50 bu/ac. It is hoped that new drought tolerance genetics, applied to hybrids suitable to Colorado conditions, will change the downward trend of dryland corn yields.

Colorado State University personnel planted five irrigated and two dryland corn trials in eastern Colorado. Irrigated trial locations were Burlington, Holyoke, Rocky Ford, Wiggins, and Yuma. The dryland trials were located at Akron and Dailey. Our irrigated trial at Wiggins did not give viable harvest results due to a severe hailstorm in August. Thirty-eight hybrids with diverse origins, maturities, and value-added traits were tested in our different irrigated and dryland trial locations based on company entries. Plot sizes were 150 ft^2 in the irrigated trials and 300 ft^2 in the dryland trials. All trials were replicated four times. All irrigated trials were planted at 34,000 seeds per acre and the dryland trials were over-planted and thinned to the desired plant populations based on the population treatments. Seed yields for all trial varieties are reported in the tables. Yields are adjusted to 15.5% seed moisture content. Each table is intended to be stand-alone, containing all of the available information for that trial. Due to significant levels of bacterial leaf streak in the variety trial at Yuma, accessions were rated for resistance/susceptibility to *Xanthomonus vasicola* pv *vasculorum* (Xvv). Disease severity was rated as the percent of leaf tissue affected. Each plot was given a single disease severity score. Disease severity scores for each variety were averaged across replicates.



2016 Irrigated Corn Hybrid Performance Trial at Holyoke

Brand	Hybrid	Insect and Herbicide Technology Traits[a]	Yield[b]	Relative Maturity[c]	Moisture	Test Weight	Plant Height	Population	Greensnap
			bu/ac		percent	lb/bu	in	plants/ac	percent
NuTech/G2 Genetics	5F-906	AM, RR2, LL	218.1	106	14.7	59.9	108	32,249	2.2
NuTech/G2 Genetics	5F-713	AM, RR2, LL	202.0	113	16.3	59.4	114	34,036	8.5
NuTech/G2 Genetics	5F-510	AM, RR2, LL	196.9	110	15.3	60.3	107	33,243	7.9
NuTech/G2 Genetics	5F-709	AM, RR2, LL	190.9	109	15.5	60.1	98	34,848	6.0
LG Seeds	LG5618STXRIB	STXRIB, RR2, LL	190.4	112	17.2	60.0	98	33,457	7.8
LG Seeds	LG5548STXRIB	STXRIB, RR2, LL	182.4	109	13.9	60.2	102	32,910	2.2
Phoenix	6948A3	3000GT, GT, LL	182.0	114	16.4	59.3	110	32,432	0.9
Phoenix	5552A4	3111, GT, LL	179.3	110	14.4	58.3	98	33,364	0.8
LG Seeds	LG2602VT3PRIB	VT3PRIB, RR2	178.0	112	14.1	57.8	104	33,759	4.9
Phoenix	6342A4	3111, GT, LL	177.9	113	14.2	56.8	86	33,167	2.2
Phoenix	6518GTA	GT	174.5	116	16.1	59.0	106	33,759	0.4
LG Seeds	LG5565STXRIB	STXRIB, RR2, LL	173.6	108	13.6	61.6	95	33,033	1.5
Average			**187.1**	**111**	**15.1**	**59.4**	**102**	**33,355**	**3.8**
[d]LSD (P<0.30)			8.1						

[a]Technology trait designations: 3000GT=Agrisure 3000GT; 3111=Agrisure Viptera 3111; AM=Optimum AcreMax; GT=Glyphosate Tolerant; LL=LibertyLink; RR2=Roundup Ready 2; STXRIB=Genuity SmartStax Refuge in the Bag Complete; VT3PRIB=Genuity VecTran Triple Protection Refuge in the Bag Complete.

[b]Yields corrected to 15.5% moisture.

[c]Relative maturity is provided by the respective companies and is the approximate time from planting to harvest maturity. The method of calculation of the relative maturity ratings may vary among companies.

[d]If the difference between two hybrid yields equals or exceeds the LSD value, there is a 70% chance the difference is significant.

Plot size: 5' x 31'

Site Information

Collaborator:	Brent Adler
Planting Date:	May 6, 2016
Harvest Date:	October 27, 2016
Fertilizer:	N at 208, P at 70, S at 35, and Z at 1.5 lb/ac
Herbicide:	Post-emergence (early): Atrazine at 0.75 lb/ac, Status at 3.5 oz/ac, and Roundup at 32 oz/ac Post-emergence (30 days after planting): Status at 2 oz/ac, Roundup at 32 oz/ac, Dual at 22 oz/ac
Soil Type:	Valent sand
Irrigation Type:	Center-pivot
Comments:	Trial was hailed on June 27, which caused some greensnap in the trial.

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2016 Irrigated Corn Hybrid Performance Trial at Rocky Ford

Brand	Hybrid	Insect and Herbicide Technology Traits[a]	Yield[b]	Relative Maturity[c]	Moisture	Test Weight	Plant Height	Population
			bu/ac		percent	lb/bu	in	plants/ac
Pioneer	P1751 AMT	AMT, RR2, LL	294.0	117	18.9	57.4	115	32,888
Producers Hybrids	7493VT2RIB	VT2PRIB, RR2	274.9	114	16.5	58.7	112	31,073
Phoenix	6342A4	3111, GT, LL	267.3	113	17.9	54.8	112	30,928
Producers Hybrids	7268STXRIB	STXRIB, RR2, LL	266.8	112	16.9	58.2	106	32,815
Phoenix	6518GTA	GT	264.6	116	18.6	56.6	112	32,597
Producers Hybrids	7574VT3PRIB	VT3PRIB, RR2	252.6	115	16.0	57.0	111	31,508
Dekalb	DKC65-20 RIB	VT2PRIB, RR2	244.9	120	16.8	60.1	109	30,928
Phoenix	6948A3	3000GT, GT, LL	233.6	114	18.0	56.8	115	30,347
Producers Hybrids	7358STXRIB	STXRIB, RR2, LL	232.9	113	14.8	58.6	106	31,218
Phoenix	5552A4	3111, GT, LL	231.2	110	15.1	56.0	99	32,234
Average			**256.3**	**114**	**16.9**	**57.4**	**110**	**31,654**
[d]LSD (P<0.30)			14.0					

[a]Technology trait designations: 3000GT=Agrisure 3000GT; 3111=Agrisure Viptera 3111; AMT=Optimum AcreMax TRIsect; GT=Glyphosate Tolerant; LL=LibertyLink; RR2=Roundup Ready 2; STXRIB=Genuity SmartStax Refuge in the Bag Complete; VT2PRIB=Genuity VecTran Double Protection Refuge in the Bag Complete; VT3PRIB=Genuity VecTran Triple Protection Refuge in the Bag Complete.

[b]Yields corrected to 15.5% moisture.

[c]Relative maturity is provided by the respective companies and is the approximate time from planting to harvest maturity. The method of calculation of the relative maturity ratings may vary among companies.

[d]If the difference between two hybrid yields equals or exceeds the LSD value, there is a 70% chance the difference is significant.

Plot size: 5' x 31'

Site Information

Collaborator:	Arkansas Valley Research Center
Planting Date:	May 9, 2016
Harvest Date:	October 24, 2016
Fertilizer:	N at 27 and P at 69 lb/ac during early-season
	Second application of N applied at 148 lb/ac
Herbicide:	Status at 5 oz/ac and Tomahawk at 1 qt/ac applied on May 25
Soil Type:	Rocky Ford silty clay loam
Irrigation Type:	Furrow

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2016 Irrigated Corn Hybrid Performance Trial at Burlington

Brand	Hybrid	Insect and Herbicide Technology Traits[a]	Yield[b]	Relative Maturity[c]	Moisture	Test Weight	Plant Height	Population
			bu/ac		percent	lb/bu	in	plants/ac
NuTech/G2 Genetics	5F-510	AM, RR2, LL	183.9	110	13.1	60.5	101	34,340
NuTech/G2 Genetics	5F-308	AM, RR2, LL	173.5	108	12.6	59.5	99	33,954
NuTech/G2 Genetics	5F-713	AM, RR2, LL	172.4	113	13.6	59.0	102	33,320
Phoenix	6948A3	3000GT, GT, LL	170.4	114	14.6	59.0	101	32,221
NuTech/G2 Genetics	5F-906	AM, RR2, LL	166.2	106	12.5	59.0	98	33,456
Phoenix	6518GTA	GT	163.4	116	14.0	58.4	104	32,865
NuTech/G2 Genetics	5F-709	AM, RR2, LL	157.9	109	13.2	59.8	95	33,013
LG Seeds	LG2602VT3PRIB	VT3PRIB, RR2	155.8	112	12.3	57.0	97	33,396
LG Seeds	LG5548STXRIB	STXRIB, RR2, LL	153.0	109	12.1	58.5	95	33,251
Phoenix	6342A4	3111, GT, LL	150.1	113	13.1	56.5	98	32,452
LG Seeds	LG5565STXRIB	STXRIB, RR2, LL	147.6	108	12.6	60.1	95	34,340
Phoenix	5552A4	3111, GT, LL	141.3	110	12.2	56.9	92	32,810
Average			**161.3**	**111**	**13.0**	**58.7**	**98**	**33,285**
[d]LSD (P<0.30)			9.9					

[a]Technology trait designations: 3000GT=Agrisure 3000GT; 3111=Agrisure Viptera 3111; AM=Optimum AcreMax; GT=Glyphosate Tolerant; LL=LibertyLink; RR2=Roundup Ready 2; STXRIB=Genuity SmartStax Refuge in the Bag Complete; VT3PRIB=Genuity VecTran Triple Protection Refuge in the Bag Complete.

[b]Yields corrected to 15.5% moisture.

[c]Relative maturity is provided by the respective companies and is the approximate time from planting to harvest maturity. The method of calculation of the relative maturity ratings may vary among companies.

[d]If the difference between two hybrid yields equals or exceeds the LSD value, there is a 70% chance the difference is significant.

Plot size: 5' x 31'

Site Information

Collaborator:	Tim Stahlecker
Planting Date:	May 6, 2016
Harvest Date:	October 24, 2016
Fertilizer:	N at 218, P at 60, S at 10, and Zn at 1.5 lb/ac
Herbicide:	Post-emergence (early): Atrazine at 1 pt/ac, Laudis at 2.5 oz/ac, and Roundup at 32 oz/ac Post-emergence (mid-season): Halex GT at 3.6 pt/ac (includes Touchdown at 24 oz/ac, Dual at 15.6 oz/ac, and Callisto at 3 oz/ac)
Soil Type:	Kuma-Keith silt loam
Irrigation Type:	Center-pivot

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2016 Irrigated Corn Hybrid Performance Trial at Yuma

Brand	Hybrid	Insect and Herbicide Technology Traits[a]	Yield[b]	Relative Maturity[c]	Moisture	Test Weight	Plant Height	Population	Bacterial Leaf Streak
			bu/ac		percent	lb/bu	in	plants/ac	score (1-5)[d]
LG Seeds	LG5643STX	STX, RR2, LL	217.9	114	17.0	57.8	110	31,726	2
B-H Genetics	BH 8399VT2P	VT2Pro, RR2	213.5	113	15.1	58.9	111	32,597	2
NuTech/G2 Genetics	5F-709	AM, RR2, LL	210.6	109	15.9	59.4	108	30,430	3
NuTech/G2 Genetics	5F-906	AM, RR2, LL	210.5	106	13.8	59.5	111	31,218	3
Phoenix	6518GTA	GT	210.4	116	18.0	57.1	110	30,563	3
LG Seeds	LG5548STXRIB	STXRIB, RR2, LL	207.7	109	14.6	58.6	111	31,871	3
B-H Genetics	BH 8550SS	STX, RR2, LL	205.9	113	14.6	61.2	111	32,402	5
NuTech/G2 Genetics	5F-308	AM, RR2, LL	204.1	108	14.4	59.4	109	31,436	2
Phoenix	6948A3	3000GT, GT, LL	204.1	114	17.0	58.3	115	31,753	2
LG Seeds	LG2602VT3PRIB	VT3PRIB, RR2	201.7	112	14.1	57.2	111	33,255	2
NuTech/G2 Genetics	5F-510	AM, RR2, LL	201.2	110	15.1	60.2	114	31,700	2
Phoenix	6342A4	3111, GT, LL	201.0	113	16.3	55.7	111	31,354	3
Phoenix	5552A4	3111, GT, LL	184.7	110	15.3	57.8	102	31,218	3
LG Seeds	LG5565STXRIB	STXRIB, RR2, LL	174.9	108	14.6	59.9	107	31,363	3
B-H Genetics	BH 7646VT2P	VT2Pro, RR2	172.7	107	13.3	59.1	107	30,975	4
Average			**201.4**	**111**	**15.3**	**58.7**	**110**	**31,591**	
[e]LSD (P<0.30)			10.3						

[a]Technology trait designations: 3000GT=Agrisure 3000GT; 3111=Agrisure Viptera 3111; AM=Optimum AcreMax; GT=Glyphosate Tolerant; LL=LibertyLink; RR2=Roundup Ready 2; STX=Genuity SmartStax; STXRIB=Genuity SmartStax Refuge in the Bag Complete; VT2Pro=Genuity VecTran Double Protection; VT3PRIB=Genuity VecTran Triple Protection Refuge in the Bag Complete.

[b]Yields corrected to 15.5% moisture.

[c]Relative maturity is provided by the respective companies and is the approximate time from planting to harvest maturity. The method of calculation of the relative maturity ratings may vary among companies.

[d]Bacterial Leaf Streak (*Xanthamonas vasicola* pv. *vasculorum*) Score: 1 equals no leaf streak disease present and 5 equals severe disease presence.

[e]If the difference between two hybrid yields equals or exceeds the LSD value, there is a 70% chance the difference is significant.
Plot size: 5' x 30'

Site Information

Collaborator:	Joe Newton
Planting Date:	May 12, 2016
Harvest Date:	October 25, 2016
Fertilizer:	Manure applied at 10 ton/ac
	Early-season: N at 60 lb/ac through pivot and 160 lb/ac side-dressed, P at 40 lb/ac
	Mid to Late-season: N at 20 lb/ac thru pivot at tasseling, N at 20 lb/ac thru pivot at brown silk stage
Herbicide:	Early post-emergence: Clarity at 8 oz/ac, atrazine at 1 pt/ac, Roundup at 1 qt/ac
	Mid-season: Clarity at 4 oz/ac, Laudis at 3 oz/ac, Dual Magnum at 1.3 pt/ac, Roundup at 1 qt/ac
Fungicide:	Quadris at 9 oz/ac at tasseling
Soil Type:	Julesburg loamy sand
Irrigation Type:	Center-pivot

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2016 Dryland Corn Results at Akron and Dailey:
Drought Tolerant Corn Performance at Three Plant Densities

Summary:

Well-timed precipitation and mild temperatures during the 2016 growing season created good growing conditions for dryland corn. Average rainfall during the summer led to a yield of 67.6 bushels per acre at Akron and 114.3 bu/ac at Dailey. There was a significant difference between the drought and traditional, non-drought tolerant hybrid groups at Akron, with the traditional hybrid group yielding higher than the drought tolerant group. There was not a difference between the drought and traditional groups at Dailey, although the same trend was observed as at Akron. There was a large difference in yield among the 12 hybrids in the trials at both locations. There was not a difference in yield among the three plant densities at either Akron or Dailey. Test weight was the same regardless of the plant density at Dailey but they were significantly different at Akron with the 17,000 plants/ac density having a much lower weight than the lower plant densities. Test weight was significantly different among the 12 hybrids at both locations.

Introduction:

Akron and Dailey Colorado tend to have warm and dry weather during the summer with poorly timed rainfall, restricting the yield potential of dryland corn. There are often true drought conditions at these trial locations. Drought tolerant corn hybrids that are adapted to the region are needed to help increase yield potential and to help reduce yield losses due to drought.

The purpose of our study was to:

1. Assess the performance of drought tolerant corn hybrids relative to traditional hybrids under dryland conditions.
2. Assess the response of drought tolerant hybrids to different plant densities compared to traditional hybrids under dryland conditions.

Approach:

We tested three hybrids from each of four companies: NuTech, Dekalb, Golden Harvest, and Channel. At least one traditional, non-drought tolerant hybrid and one drought tolerant hybrid were tested from each company, for a total of twelve hybrids (NuTech: 5X698, 5F200, and 5F399; Dekalb: DKC51-20, DKC50-84, and DKC50-64; Golden Harvest: G01P52, G98L17, and G01Q76; Channel: 198-00, 200-48, and 197-68). The hybrids represented three different drought tolerance technologies, with Channel and Dekalb using DroughtGard, NuTech using AQUAmax, and Golden Harvest using Agrisure Artesian. The hybrids were thinned to achieve three different plant densities (11, 14, and 17 thousand plants/ac) at both Akron and Dailey. All hybrids were within the 97-101 CRM range and are adapted for production in the western United States. Trials were planted using a four-row cone planter with 30-inch row spacing. Plots were 10 feet wide by 30 feet long. All treatments were replicated four times at each location. The plots were over-seeded and then thinned to achieve the respective plant density for the treatments at the V-4 growth stage. Stand counts were taken during early growth (V-4). Ear-heights were taken at harvest. Grain yield was adjusted to 15.5% grain moisture content. Statistical analyses and comparisons were performed using a mixed model with hybrid, seeding rate, and their interaction

as the main effects. Replicate and replicate by seeding rate were random effects. Differences were determined based on an alpha level of 0.05.

Dailey, CO

The rainfed study was planted on a Haxtun sandy loam soil one mile west of Dailey. The soil pH was 7.0 and the organic matter content was 2.2%. The average annual precipitation amount is 17.5 inches. The previous crop was winter wheat and the site was managed as a dryland minimum-till cropping system. The trial was planted on May 20, 2016. A starter fertilizer was applied at planting at a rate of 20, 10, and 1.5 lb/ac each of nitrogen, phosphorus, and zinc. Composted manure was applied to the site prior to planting at an approximate rate of 1.5 tons/ac. Glyphosate, DiFlexx, and atrazine herbicides were applied early in the growing season for weed control. The trial was harvested on October 4, 2016 using a modified Case IH plot combine equipped with a Harvest Master grain weighing system to collect grain weight, moisture content, and test weight data.

Akron, CO

The study was planted on an Ascalon sandy loam soil at the USDA Central Great Plains Research Station at Akron. The soil has an average pH of 7.1 and an organic matter content of 1.0%. The average annual precipitation amount is 16.5 inches. The previous crop was winter wheat and the site is managed as a dryland no-till cropping system. The trial was planted on June 1, 2016. Nitrogen and phosphorus were applied at planting at a rate of 5 and 6 lb/ac, respectively. Nitrogen was applied as 32-0-0 after planting (June 9) at a rate of 50 lb/ac. Cornerstone Plus, Lumax, and atrazine herbicides were applied on June 9 at a rate of 48 oz/ac, 1.75 pt/ac and 1 pt/ac, respectively. The trial was harvested on October 10, 2016 using a modified Case IH plot combine equipped with a Harvest Master grain weighing system to collect grain weight, moisture content, and test weight data.

Results and Discussion:

Weather conditions

The overall yield level was much higher in 2016 for both locations (114 bu/ac at Dailey and 68 bu/ac at Akron) than the long-term average yield (73 bu/ac at Dailey and 44 bu/ac at Akron) due to the timely rainfall, especially in July, and mild temperatures this year. There was only one day when the daily high temperature was over 100°F from the planting to harvest at Dailey (Haxtun is the nearest COAgMet station) and two days at Akron this year, whereas there are normally many days over 100°F. The total rainfall during the growing season (planting to harvest) was 9.3 inches at Akron and 8 inches at Dailey. We narrowly missed a hail storm that went through in June at Akron, and both trials had consistent and very good stands.

Akron Yield Results

Table 1 shows the average yield results for the 12 hybrids within the two hybrid groupings– drought tolerant and traditional hybrids at Akron. There was a difference in yield between drought tolerant and the traditional hybrid groups ($p=0.023$). The drought tolerant hybrid group yielded significantly lower (65.4 bu/ac) than the traditional hybrid group (69.2 bu/ac). In 2014 at Akron (trial was hailed-out in 2015), the overall trial yield was much higher (115 bu/ac) but there was no statistical difference between the drought tolerant and traditional hybrids, although we tested fewer and some different hybrids. There was not a difference between the drought tolerant and traditional hybrids within each company except for Golden Harvest, where the traditional hybrids yielded higher than the drought

tolerant hybrid (p=0.002). There was a difference in yield among the 12 hybrids (p<0.001). The highest yielding hybrid was G98L17, a traditional hybrid that yielded 75.6 bu/ac. The lowest yielding hybrid was 5F200, a drought tolerant hybrid that yielded 59.4 bu/ac.

Different plant populations did not affect the grain yield when averaged across all twelve hybrids (p=0.87) nor within the drought and traditional groups. The general trend for yield across the three plant densities was the hybrids yielded the highest in the 14,000 plants/ac treatment (69.5 bu/ac) and the lowest in the 11,000 plants/ac treatment (65 bu/ac). The planting density didn't have a significant effect on any one particular hybrid.

Dailey Yield Results

Table 2 shows the average yield results for the 12 hybrids within the two hybrid groupings– drought tolerant and traditional hybrids at Dailey. There was not a difference between drought tolerant and the traditional hybrid groups (p=0.059). The drought tolerant hybrid group yielded lower (112.4 bu/ac) than the traditional hybrid group (115.6 bu/ac), which is the same trend that we observed at Akron this year. There was not a difference between the drought tolerant and traditional hybrids within each company except for Golden Harvest, where the traditional hybrids yielded higher than the drought tolerant hybrid (p=0.006), which is what we observed at Akron this year as well. There was a significant difference among the 12 individual hybrids (p=0.003) with the highest yielding hybrid being G98L17, a traditional hybrid that yielded 124.7 bu/ac. The lowest yielding hybrid was G01P52, a drought tolerant hybrid that yielded 106.2 bu/ac.

The plant density treatments did not affect the grain yield when averaged across all twelve hybrids (p=0.085) but it did significantly affect yield within the drought tolerant group (p=0.032). The general trend for yield across the three plant densities and for all hybrids was that the hybrids yielded the highest in the 14,000 plants/ac treatment (119.7 bu/ac) and the lowest in the 17,000 plants/ac treatment (109.9 bu/ac). The planting density had a significant effect on one hybrid, 5F200, which had the same trend as the hybrids as a group (14,000 plants/ac was highest yield and 17,000 plants/ac was lowest yield). These results are similar to what we saw at Akron this year, with the 14,000 plants/ac treatment having the highest overall yield of the three plant densities.

Akron Test Weight Results

Table 1 shows the average test weight of the 12 hybrids at three plant densities in the Akron trial. The planting density had a large effect on the test weight (p=0.009), with the 17,000 plants/ac treatment having a much lower test weight (55.7 lb/bu) than both the 14 and 11 thousand plants/ac treatments (56.1 and 56.2 lb/bu, respectively). We did not observe a planting density effect on test weight in 2014 at Akron. The traditional and drought tolerant hybrid groups did not differ significantly in test weight (p=0.30) and the plant density did not have an effect on the drought or traditional hybrid groups, which is what was noted in 2014 at Akron as well. There was a significant difference among the 12 hybrid test weights (p<0.001), with DKC50-64 having the highest test weight and G98L17 having the lowest (57.4 and 54.2 lb/bu, respectively).

Dailey Test Weight Results

Table 2 shows the average test weight of the 12 hybrids among the three plant densities at Dailey. The planting density did not have an effect on the test weight (p=0.94) (all plant density treatments had an average test weight of 56.9 lb/bu) like we observed at Akron this year. The traditional and drought tolerant hybrid groups did not differ significantly in test weight (p=0.69) and the plant density did not have an effect on the drought or traditional hybrid groups. There was a significant difference among the

12 hybrid test weights ($p<0.001$), with DKC50-64 having the highest test weight and 5F399 having the lowest (58.2 and 54.8 lb/bu, respectively).

Conclusions:

There was a significant difference in yield between the drought and traditional hybrid groups at Akron, with the traditional hybrid group yielding higher. The difference wasn't significant at Dailey. This was possibly due to the timely rains received at both locations, especially during flowering, which allowed for higher than normal yield and less-pronounced drought conditions than we experience some years. There was a large difference in yield among the 12 hybrids in the trials with G98L17 yielding the highest at both locations. There was not a difference in yield among the three plant densities at either Akron or Dailey, possibly due to the small range of plant densities (only a difference of 6,000 plants/ac). Test weight were the same regardless of the plant density at Dailey but they were significantly different at Akron with the 17,000 plants/ac density having a much lower weight, which is not surprising given the lower yield we experienced at Akron compared to Dailey. Test weight were significantly different among the 12 hybrids at both locations with DKC50-64 having the highest weight at both locations.

Table 1. 2016 average grain yield and test weight across the hybrid and plant density treatments at Akron, CO.

		Yield				Test Weight			
		Plant Density (plants/acre)				Plant Density (plants/acre)			
Company	Hybrid[a]	11,000	14,000	17,000	**Average**	11,000	14,000	17,000	**Average**
		bu/ac				lb/bu			
	Drought Tolerant	**62.8**	**66.7**	**66.6**	**65.4**	**56.3**	**55.7**	**55.6**	**55.9**
NuTech	5X698	71.8	73.0	70.6	**71.8**	56.0	55.6	55.9	**55.8**
Dekalb	DKC51-20	68.2	74.3	70.8	**71.1**	56.2	55.5	54.8	**55.5**
Channel	198-00	62.0	62.7	69.4	**64.7**	56.7	56.8	55.8	**56.4**
Golden Harvest	G01P52	59.2	63.7	56.9	**60.0**	56.5	55.9	56.0	**56.1**
NuTech	5F200	52.7	60.1	65.4	**59.4**	56.0	55.0	55.5	**55.5**
	Traditional	**66.5**	**71.4**	**69.7**	**69.2**	**56.2**	**56.3**	**55.8**	**56.1**
Golden Harvest	G98L17	73.9	70.7	82.3	**75.6**	54.1	54.5	53.9	**54.2**
Channel	200-48	71.1	71.8	71.1	**71.3**	56.3	56.5	56.0	**56.3**
Dekalb	DKC50-84	62.5	81.6	69.2	**71.1**	57.0	56.5	55.8	**56.4**
Dekalb	DKC50-64	64.3	69.7	73.9	**69.3**	57.3	57.9	56.9	**57.4**
Channel	197-68	62.2	68.3	68.0	**66.2**	57.0	56.9	56.1	**56.7**
Golden Harvest	G01Q76	68.2	69.8	60.2	**66.0**	56.3	56.3	57.1	**56.6**
NuTech	5F399	63.2	68.1	63.1	**64.8**	55.3	55.3	54.7	**55.1**
	Average	**65.0**	**69.5**	**68.4**	**67.6**	**56.2**	**56.0**	**55.7**	**56.0**

[a]Hybrids ranked from highest to lowest average yield across the three plant densities within each drought tolerance group. Relevant p-values for the data presented are included in the results section of the text.

Table 2. 2016 average grain yield and test weight across the hybrid and plant density treatments at Dailey, CO.

		Yield				Test Weight			
		Plant Density (plants/acre)				Plant Density (plants/acre)			
Company	Hybrid[a]	11,000	14,000	17,000	**Average**	11,000	14,000	17,000	**Average**
		bu/ac				lb/bu			
	Drought Tolerant	**110.5**	**119.8**	**106.9**	**112.4**	**56.9**	**56.9**	**56.8**	**56.9**
Dekalb	DKC51-20	114.6	123.9	117.8	**118.8**	57.1	57.1	56.8	**57.0**
NuTech	5X698	115.0	119.2	105.6	**113.2**	56.2	56.8	56.8	**56.6**
Channel	198-00	110.8	123.3	105.1	**113.1**	57.5	57.3	57.0	**57.2**
NuTech	5F200	108.0	122.9	101.4	**110.8**	56.6	56.5	56.1	**56.4**
Golden Harvest	G01P52	104.3	109.6	104.8	**106.2**	57.1	56.8	57.4	**57.1**
	Traditional	**115.2**	**119.6**	**112.0**	**115.6**	**56.9**	**56.9**	**57.0**	**56.9**
Golden Harvest	G98L17	134.6	123.6	115.8	**124.7**	55.9	55.9	56.1	**56.0**
Dekalb	DKC50-84	114.4	126.6	110.6	**117.2**	57.2	57.0	57.2	**57.1**
NuTech	5F399	116.2	124.2	108.8	**116.4**	54.5	55.1	54.8	**54.8**
Channel	197-68	108.4	120.6	116.0	**115.0**	58.0	57.7	57.8	**57.8**
Channel	200-48	115.0	121.0	108.7	**114.9**	57.8	57.1	57.8	**57.5**
Dekalb	DKC50-64	106.9	114.5	116.2	**112.5**	58.1	58.3	58.2	**58.2**
Golden Harvest	G01Q76	111.1	106.9	107.9	**108.6**	56.7	56.9	57.2	**56.9**
	Average	**113.3**	**119.7**	**109.9**	**114.3**	**56.9**	**56.9**	**56.9**	**56.9**

[a]Hybrids ranked from highest to lowest average yield across the three plant densities within each drought tolerance group. Relevant p-values for the data presented are included in the results section of the text.

Bacterial Leaf Streak of Corn

Dr. Kirk Broders

Pathogen

Bacterial leaf streak, caused by Xanthomonas vasicola pv. vasculorum (syn X. campestris pv zeae), was confirmed for the first time in the United States in 2016, and the disease has been confirmed in Colorado. The disease has only been reported on corn previously in South Africa, although the pathogen has been reported as causing a gumming disease on sugar cane in other countries. The species has undergone several name changes and is recognized by other synonyms including X. axonopodis pv. vasculorum and X. campestris pv. zeae.

Fig. 1. Orange-brown lesions with wavy margins of bacterial leaf streak caused by *X. vasicola* pv. *vasculorum* (K. Broders)

Fig 2. Narrow elongated lesions of bacterial leaf streak on corn (K. Broders)

Symptoms

Symptoms of this disease on corn plants are narrow, wavy-edged lesions that range in length from less than an inch to several inches long (Fig 1-2). They may be tan, brown or orange in color and occur between the veins of the leaf on the leaves of corn. When backlit, light passes through the translucent lesions. Disease symptoms have been observed as early as growth stage V7 with lesions appearing on lower leaves first (Fig. 3). Lesions can expand over time to cover larger areas and spread to the upper leaves.

Fig 3. Lesions of bacterial leaf streak are usually first observed on lower leaves early in the season, and then can spread upward to new leaves.

Disease Cycle and Epidemiology

There is currently limited information about this disease and what impacts it may have on corn production. There is also little known about the epidemiology of the pathogen. It is presumed that *X. vasicola* pv. *vasculorum* over seasons in infected crop debris and is splash dispersed to leaves of healthy plants during early stages of growth. Research has not been conducted on whether or not it is

seedborne. As with other bacterial diseases such as Goss's bacterial blight, weeds adjacent to corn fields may serve as alternate hosts. It does not appear that wounding is required for entry into the plant by the bacterium. It most likely enters through stomata and then moves through intercellular spaces. Irrigation during hot weather appears to increase the disease incidence and, under these conditions, disease severity attributable to bacterial leaf streak can approach 30%. The bacterium is also likely spread via rain splash and wind dispersal, but it is unclear how far the bacterium may be able to travel.

Disease Diagnosis

Several other corn diseases can cause similar symptoms which can complicate diagnosis. Lesions caused by *X. vasicola* pv. *vasculorum* look very similar to gray leaf spot (GLS), except that they have wavy margins compared to gray leaf spot lesions that have very straight sides and are more rectangular in shape (Fig 4a & b). When GLS lesions are backlit (Fig 4b), light does not easily pass through the lesion and they are more opaque compared to the translucent lesions (Fig. 5) caused by *X. vasicola* pv. *vasculorum*.

Fig. 4a. Rectangular symptoms of Grey Leaf Spot on corn (A. Robertson)

Fig. 4b. Back lit Grey leaf spot lesions with more rectangular and opaque lesion (A. Robertson)

Fig. 5. Translucent lesions of bacterial leaf streak lesions when back lit (A. Robertson)

Management

Currently there is limited research on management strategies for this disease. Field observations suggest that there are differences in susceptibility among corn hybrids. Once hybrids can be screened for resistance, use of resistant or more tolerant hybrids will be the way to manage the disease. Like other bacterial diseases such as Goss's blight, no effective chemical controls currently exist. Until more research has been conducted to determine the most effective management strategies for this disease, corn producers are advised to use standard management practices for bacterial disease. This will include using sanitation practices to remove any infected debris from equipment between fields in order to slow the spread of the pathogen and the use of crop rotation or tillage to reduce the amount of infected corn debris and reduce the survival of the bacteria

the **Handy Bt Trait Table** for U.S. Corn Production

Updated January 2017

Posted at www.msuent.com
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Most corn hybrids planted in the U.S. contain one or more transgenic traits for weed or insect management. These traits can increase flexibility and profitability for producers, but sometimes cause confusion about their spectrum of control or refuge requirements. The Handy Bt Trait Table provides a helpful list of trait names (below) and details of trait packages (next page) to make it easier to read company seed guides, sales materials, and bag tags. Note that there are two versions of the table (north/Midwest vs. south/cotton belt) which differ only in refuge percentages.

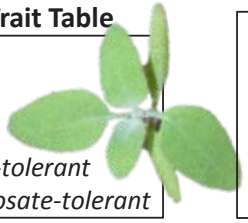
Important clarifications or changes to the Trait Table for 2017

- ✓ An insect is listed in the CONTROL SPECTRUM column if seed providers claim protection or efficacy for a given Bt package; insect species which are 'suppressed' are no longer listed. Actual field-level performance of hybrids on lepidopteran and rootworm larvae may differ if there are local or regional insect populations which are less susceptible or resistant to Bt proteins.
- ✓ To address local or regional performance issues, a new column ('May be Ineffective On') was added to highlight insect x Bt combinations with documented field-failures, confirmed resistance, or cross-resistance. An insect is listed in this column only if ALL of the Bt proteins which should control it in a product are 'ineffective' somewhere in the US or Canada. Ineffective ratings are based on published lab assays &/or field research from field corn, sweet corn, and cotton. University extension specialists or local educators can assist in determining if you are in an area where reduced effectiveness was reported. On a broader scale, this column is intended to alert growers and consultants to potential management problems, influence seed selection, and encourage field scouting.
- ✓ The refuge column was simplified to include only the % and an indication if the refuge is in the bag.

Field corn 'events' (transformations of one or more genes) and their Trade Names

Trade name for trait	Event	Protein(s) expressed	Insect Target or *Herbicide Activity*
Agrisure CB/LL	Bt11	Cry1Ab + *PAT*	corn borer + *glufosinate tolerance*
Agrisure Duracade	5307	eCry3.1Ab	rootworm
Agrisure GT	GA21	*EPSPS*	*glyphosate tolerance*
Agrisure RW	MIR604	mCry3A	rootworm
Agrisure Viptera	MIR162	Vip3A	broad lep control (but not corn borer)
Herculex 1 or CB	TC1507	Cry1Fa2 + *PAT*	corn borer + *glufosinate tolerance*
Herculex RW	DAS-59122-7	Cry34Ab1/Cry35Ab1 + *PAT*	rootworm + *glufosinate tolerance*
Roundup Ready 2	NK603	*EPSPS*	*glyphosate tolerance*
Yieldgard Corn Borer	MON810	Cry1Ab	corn borer
Yieldgard Rootworm	MON863	Cry3Bb1	rootworm
Yieldgard VT Pro	MON89034	Cry1A.105 + Cry2Ab2	broader lep control
Yieldgard VT Rootworm RR	MON88017	Cry3Bb1 + *EPSPS*	rootworm + *glyphosate tolerance*

Abbreviations used in the Trait Table



Herbicide activity

D *2-4 D tolerant*
GT *glyphosate tolerant*
LL Liberty Link - *glufosinate-tolerant*
RR2 Roundup Ready 2, *glyphosate-tolerant*

Insect targets

BCW	black cutworm	SB	stalk borer
CEW	corn earworm	SCB	sugarcane borer
ECB	European corn borer	SWCB	southwestern corn borer
FAW	fall armyworm	TAW	true armyworm
RW	corn rootworm	WBC	western bean cutworm

Bt corn trait packages with their Bt proteins, spectrum of control, & % refuge (Updated January 2017)

TRAIT FAMILY Specific Product	Bt protein(s)	CONTROL SPECTRUM Marketed for control of: above-ground----------in soil		May be locally or regionally ineffective on:	Herbicide tolerance	Refuge - Midwest/ North
AGRISURE						
Agrisure 3010, 3010A	Cry1Ab	ECB SCB SWCB	---	SCB	GT LL	20%
Agrisure 3000GT, 3011A	Cry1Ab mCry3A	ECB SCB SWCB	RW	SCB RW	GT LL	20%
Agrisure Viptera 3110	Cry1Ab Vip3A	BCW CEW ECB FAW SB SCB SWCB TAW WBC	---		GT LL	20%
Agrisure Viptera 3111	Cry1Ab Vip3A mCry3A	BCW CEW ECB FAW SB SCB SWCB TAW WBC	RW	RW	GT LL	20%
Agrisure 3122 E-Z Refuge	Cry1Ab Cry1F mCry3A Cry34/35Ab1	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, WBC RW	GT	5% in bag
Agrisure Viptera 3220 E-Z Refuge	Cry1Ab Cry1F Vip3A	BCW CEW ECB FAW SB SCB SWCB TAW WBC	---		GT	5% in bag
Agrisure Duracade 5122 E-Z Refuge	Cry1Ab Cry1F mCry3A eCry3.1Ab	BCW ECB FAW SB SWCB WBC	RW	FAW, WBC RW	GT	5% in bag
Agrisure Duracade 5222 E-Z Refuge	Cry1Ab Cry1F Vip3A mCry3A eCry3.1Ab	BCW CEW ECB FAW SB SCB SWCB TAW WBC	RW	RW	GT	5% in bag
HERCULEX						
Herculex 1 (HX1)	Cry1F	BCW ECB FAW SB SCB SWCB WBC	---	FAW, SWCB, WBC	LL	20%
Herculex RW (HXRW)	Cry34/35Ab1	---	RW	RW	RR2	20%
Herculex XTRA (HXX)	Cry1F Cry34/35Ab1	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, SWCB, WBC RW	(most)	20%
OPTIMUM						
Intrasect (YHR)	Cry1Ab Cry1F	BCW ECB FAW SB SCB SWCB WBC	---	FAW, WBC	LL RR2	5%
AcreMax (AM)	Cry1Ab Cry1F	BCW ECB FAW SB SCB SWCB WBC	---	FAW, WBC	LL RR2	5% in bag
Leptra (VYHR)[a] AcreMax Leptra (AML)[b]	Cry1Ab Cry1F Vip3A	BCW CEW ECB FAW SB SCB SWCB TAW WBC	---		LL RR2	[a]5% ½ mile [b]5% in bag
AcreMax RW (AMRW)	Cry34/35Ab1	---	RW	RW	LL RR2	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, SWCB, WBC RW	LL RR2	10% in bag 20% ECB
TRIsect (CHR)	Cry1F mCry3A	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, SWCB, WBC RW	LL RR2	20%
Intrasect TRIsect (CYHR)[a] AcreMax TRIsect (AMT)[b]	Cry1Ab Cry1F mCry3A	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, WBC RW	LL RR2	[a]20% [b]10% in bag
Intrasect Xtra (YXR)[a] AcreMax Xtra (AMX)[b]	Cry1Ab Cry1F Cry34/35Ab1	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, WBC RW	LL RR2	[a] 20% [b]10% in bag
Intrasect Xtreme (CYXR)[a] AcreMax XTreme (AMXT)[b]	Cry1Ab Cry1F mCry3A Cry34/35Ab1	BCW ECB FAW SB SCB SWCB WBC	RW	FAW, WBC RW	LL RR2	[a]5% [b]5% in bag
YIELDGARD or GENUITY						
YieldGard CB (YGCB)	Cry1Ab	ECB SCB SWCB	---	SCB	RR2	20%
YieldGard VT Rootworm	Cry3Bb1	---	RW	RW	RR2	20%
YieldGard VT Triple	Cry1Ab Cry3Bb1	ECB SCB SWCB	RW	SCB RW	RR2	20%
Genuity VT Double PRO[a] or RIB complete[b]	Cry1A.105 Cry2Ab2	CEW ECB FAW SB SCB SWCB	---	CEW	RR2	[a]5% [b]5% in bag
Genuity VT Triple PRO[a] or RIB complete[b]	Cry1A.105 Cry2Ab2 Cry3Bb1	CEW ECB FAW SB SCB SWCB	RW	CEW RW	RR2	[a]20% [b]10% in bag
Genuity SmartStax[a] or RIB Complete[b]	Cry1A.105 Cry2Ab2 Cry1F Cry3Bb1 Cry34/35Ab1	BCW CEW ECB FAW SB SCB SWCB WBC	RW	CEW, WBC RW	LL RR2	[a]5% [b]5% in bag
OTHER						
Powercore[a] Powercore Refuge Adv.[b]	Cry1A.105 Cry2Ab2 Cry1F	BCW CEW ECB FAW SB SCB SWCB WBC	---	CEW, WBC	LL RR2	[a]5% [b]5% in bag
Smartstax[a] Smartstax Refuge Adv.[b]	Cry1A.105 Cry2Ab2 Cry1F Cry3Bb1 Cry34/35Ab1	BCW CEW ECB FAW SB SCB SWCB WBC	RW	CEW, WBC RW	LL RR2	[a]5% [b]5% in bag

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Crops Testing

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