2022 WESTERN KANSAS AGRICULTURAL RESEARCH REPORT

K·STATE
Research and Extension

KANSAS STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE

2022 WESTERN KANSAS AGRICULTURAL RESEARCH

Contents

Forage Report

Cover photo by Bruce Niere

A Tribute to Freddie R. Lamm

Professor and Research Irrigation Engineer, Ph.D., P.E.
Northwest Research-Extension Center, Colby, KS
Kansas State University

Freddie Lamm, who positively impacted many through his life and career, passed away on May 26, 2022.

Kansas State University and the agricultural irrigation research community lost a great contributor to their field. Lamm was the research irrigation engineer at the Northwest Research-Extension Center in Colby, Kansas. He passed away sooner than his family, friends, and colleagues were ready for—before his planned retirement from his remarkable career.

Mourning his passing include his wife Donna of Colby; children Elaine, Brooklyn, New York; Henry Silas IV, Naperville, Illinois; Rachel (Chelston Ketting), stationed at Hurlburt Field, Florida; and Sarah, Lawrence, Kansas; siblings; nieces and nephews; and many friends, which include many colleagues throughout Kansas, the US, and other countries.

According to his obituary, "One of Freddie's proudest moments of 2022, would be completing his 43rd year working at the Kansas State University Northwest Research-Extension Center."

"Freddie came to northwest Kansas in 1979 to begin his career as a K-State instructor and research engineer at the Colby Branch Experiment Station, now the Northwest Research-Extension Center, armed with agricultural engineering degrees from the

University of Missouri," said Danny Rogers, a K-State Professor Emeritus and Extension Agricultural Engineer. "He was raised on a farm in central Missouri. During his tenure, Freddie became a licensed Professional Engineer (PE) in 1987 and completed a Ph.D. from K-State in 1990, both accomplished while maintaining an active research program. At the time of his death, he had at least 10 active irrigation related research projects underway. His dedication to detail continued from his hospital room with checking on project progress and sending instructions."

Lamm was a pioneer in irrigation research and contributed to internationally-recognized technologies such as subsurface drip irrigation. His accomplishments were also commended through his Irrigation Association Man of the Year award and being named a Fellow of the American Society of Agricultural and Biological Engineers (ASABE).

Terry Howell, a retired research leader for the USDA-Agricultural Research Service in Bushland, Texas, continues, "Freddie Lamm's early promotion of precise, highly controlled subsurface drip irrigation is a hallmark for K-State's Northwest Research-Extension Center that caught not only research colleagues' attention, but it quickly gained notoriety with producers facing increasing pressures to use less irrigation water and to still maintain profitable crop productivity. His experiments aided other researchers across the US Central Plains well into Texas, where producers were facing even less available groundwater for irrigation."

"Freddie will be missed for his integrity and the great person he was," said Bill Kranz, an Emeritus Professor in Biological Systems Engineering at the University of Nebraska-Lincoln. "While research was his career, I was very appreciative that he crossed over to participate in and become a founding member of the Central Plains Irrigation Association. The association's annual conference is one of the longest running of its kind due to his and his wife Donna's unwavering support."

Jonathan Aguilar, an Associate Professor and Water Resource Engineer at K-State's Southwest Research-Extension Center, who worked with Lamm, also recalls, "As a relatively junior irrigation engineer, I have utmost respect to Freddie who guided me through the tenure process, particularly in conducting field research and in navigating through scientific publications. A couple of things that I could definitely attribute to him is the proper hand harvesting/sampling of plots and for guiding me to become an effective associate editor of the ASABE journal. I will definitely miss his words of wisdom and guidance."

Lamm was a valuable asset to his department and a helping hand to many. He will be greatly missed. Beyond his career, Lamm was a man who loved to help others.

2022 Western Kansas Research Report Book Author List

Jonathan Aguilar, Associate Professor, Water Resources Engineer, Southwest Research-Extension Center, Garden City

Rob M. Aiken, Professor, Research Crop Specialist, Northwest Research-Extension Center, Colby

Dewayne Bond, Assistant Scientist, Southwest Research-Extension Center, Tribune

Randall Currie, Associate Professor, Weed Scientist, Southwest Research-Extension Center, Garden City

Scott Dooley, Assistant Scientist, Department of Agronomy, North Central Experiment Field, Courtland

Patrick W. Geier, Assistant Scientist, Southwest Research-Extension Center, Garden City

Keith R. Harmoney, Professor, Range Specialist, Agricultural Research Center, Hays

John Holman, Professor, Cropping Systems Agronomist, Southwest Research-Extension Center, Garden City

Freddie R. Lamm, Professor, Irrigation Engineer, Northwest Research-Extension Center, Colby

Augustine K. Obour, Associate Professor, Soil Scientist, Agricultural Research Center, Hays

Daniel M. O'Brien, Professor, Agricultural Economist, Northwest Research-Extension Center, Colby

Rocio Reyes-Esteves, Postdoctoral Research Fellow, Northwest Research-Extension Center, Colby

Tom Roberts, Assistant Scientist, Southwest Research-Extension Center, Garden City

Erin Russell, Farm Manager, Southwest Research-Extension Center, Garden City

Jeff Slattery, Agricultural Technician II Research, Southwest Research-Extension Center, Garden City

Anthony Zukoff, Extension Associate, Entomology, Southwest Research-Extension Center, Garden City

All are affiliated with Kansas State University unless otherwise noted.

Faculty and Specialists of the Western Kansas Research-Extension Centers

Jonathan Aguilar – Extension Specialist, Water Resources Engineer, Garden City
Rob Aiken – Research Crop Specialist, Colby
Spencer Casey – Assistant Director II, Hays
Rachel Clews – Extension Specialist, Family and Consumer Sciences, Garden City
Randall Currie – Weed Scientist, Garden City
Jeanne Falk Jones – Multi-County Specialist, Agronomy, Colby
Daniel Foster – Farm Manager, Colby
Lucas Haag – Extension Specialist/Interim Agronomist-in-Charge, Colby/Tribune
Keith Harmony – Range Specialist, Hays
John Holman – Cropping Systems Agronomist, Garden City
John Jaeger – Beef Cattle Specialist, Hays
Sandy Johnson – Extension Specialist, Livestock Production, Colby
Vipan Kumar – Weed Scientist, Hays
Freddie Lamm – Irrigation Engineer, Colby
J.P. Michaud – Entomologist, Hays
Augustine Obour – Soil Scientist, Hays
Daniel O'Brien – Agricultural Economist, Colby
Chandra Plate – Extension Specialist, 4-H Youth Development, Colby
Ramasamy Rerumal – Sorghum/Miller Breeder, Hays
Erin Russell – Farm Manager, Garden City
Amy Sollock – Southwest Area 4-H Specialist, Garden City
Ashley Svaty – Extension Specialist, Family and Consumer Sciences, Garden City
Justin Waggoner – Extension Specialist, Beef Systems, Garden City
Bob Weaber – Acting Department Head, Western Kansas Research and Extension Centers
Guorong Zhang – Wheat Breeder, Hays
Anthony Zukoff – Extension Associate, Entomology, Garden City

Staff of the Western Kansas Research-Extension Centers

Jeff Ackerman – Research Assistant, Hays
Yared Assefa Mulisa – Postdoctoral Research Fellow, Garden City
Dewayne Bond – Assistant Scientist, Tribune
Vicki Brown – Office Specialist II, Colby
Amanda Burnett – Agricultural Technician II Research, Tribune
Matt Cheney – Agricultural Technician II Research, Colby
Shelli Dowd – Accountant I, Hays
Ray Duffey – Agricultural Technician II Research, Colby
Forough Fazel – Scholar, Garden City
Angie Gaede – Office Specialist II, Colby
Pat Geier – Assistant Scientist, Garden City
Tom Geist – Maintenance Supervisor, Hays
Curt Gottschalk – Farm Manager, Hays
Jacob Hadle – Agricultural Technician II Research, Hays
Heather Hicks – Accountant I, Hays
Sara Juenemann – Office Specialist IV, Colby
Joe Kimzey – Agricultural Technician II Research, Hays
Taylor Lambert – Agricultural Technician II, Hays
Taylor Lang – Agricultural Technician II Research, Hays
Justice Lear – Agricultural Technician II Research, Colby
Rui "Tabby" Liu – Assistant Scientist, Hays
Raenette Martin – Agricultural Technician II Research, Colby
Joanna Meier – Accountant II, Garden City
Farzam Moghbel – Scholar, Garden City
Bruce Niere – Agricultural Technician II Research, Garden City
Cody Norton – Agricultural Technician II Research, Hays
Michelle Reinfschneider – Accounting Specialist, Hays
Rocio Reyes Esteves – Postdoctoral Research Fellow, Colby
Tom Roberts – Assistant Scientist, Garden City
Wayne Schmidtberger – Animal Technician II, Hays
Jeff Slattery – Agricultural Technician II Research, Tribune
Jake Thompson – Irrigation Extension Assistant, Garden City
Jacob Thorell – Agricultural Technician II Research, Hays
Dennis Tomsicek – Agricultural Technician II Research, Garden City
Rich Windholz – Agricultural Technician II Research, Hays
Ashlee Wood – Office Specialist II, Garden City
Matt Woydziak – Animal Technician II, Hays
Rodney Zimmerman – Landscape Technician II, Colby

Weather Information for Tribune, 2021

D. Bond and J. Slattery

In 2021, annual precipitation of 22.12 in. was recorded, which is 3.68 in. above normal. Only four months had above-normal precipitation. May (9.44 in.) was the wettest month and historically the wettest May, breaking the record set in 1915 (8.20 in.). This also ranked as the third wettest month on record after June of 1932 (11.48 in.) and June of 1951 (10.55 in.). The largest single amount of precipitation was 5.66 in. on May 16. Historically, this was the second largest recorded amount in a 24-hour period, surpassed only by June 4, 1932 (6.46 in.). December, the driest month, recorded no precipitation. In addition, November only recorded 0.09 in. of precipitation.

Snowfall for the year totaled 16.7 in. (5.5 in. below normal); January, February, March, and April had 6.5, 3.7, 3.3, and 3.2 in., respectively. There was a total of 22 days of snow cover, which is three days below normal. The longest consecutive period of snow cover, 12 days, occurred February 8 through February 19.

Record-high temperatures were recorded on 4 days: April 5 (88°F), September 11 (99°F), November 16 (80°F), and December 3 (74°F). Historical record-high temperatures were tied on 4 days: April 6 (88°F), September 12 (101°F) and 13 (100°F), and October 27 (85°F). Record-low temperatures were recorded on 3 days: February 14 (-9°F), 15 (-25°F) and 16 (-15°F). A historical record-low temperature was tied on April 20 (18°F). August was the warmest month with a mean temperature of 75.2°F. The hottest day of the year (101°F) occurred on September 12. The coldest day of the year (-25°F) occurred on February 15. This reading has only been recorded one other time in the station's history on January 18, 1984! February was the coldest month with a mean temperature of 21.9°F.

Mean air temperature was below normal for 7 months. December set a record of 55.6°F for average maximum temperature, which broke the historical record of 55.4°F set in 1980. December had the greatest departure above normal (6.1°F), and February had the greatest departure below normal (-11.1°F). Temperatures were 100°F or higher on 7 days, which is 5 days below normal. Temperatures were 90°F or higher on 55 days, which is 10 days below normal. The latest spring freeze was May 12, which is 8 days later than normal; the earliest fall freeze fell on October 13, which is 6 days later than normal. This produced a frost-free period of 154 days, which is 2 days less than the normal of 156 days.

Open-pan evaporation from April through September totaled 63.48 in., which is 6.79 in. below normal. Wind speed for this period averaged 4.1 mph, which is 0.9 mph less than normal.

The 2021 weather information for Tribune is summarized in Table 1.

Table 1. Climatic data, Southwest Research-Extension Center, Tribune, KS

	Precipitation (in.)		Monthly average temperatures (°F)						Wind (MPH)		Evaporation (in.)	
			2021		Normal		2021 extreme					
Month	2021	Normal	Max	Min	Max	Min	Max	Min	2021	Normal	2021	Normal
January	0.51	0.43	45.3	14.0	44.2	16.1	67	-10	---	---	---	---
February	0.28	0.54	35.2	8.6	47.2	18.7	72	-25	---	---	---	---
March	3.24	0.99	56.1	25.2	56.9	26.5	86	11	---	---	---	---
April	0.68	1.66	64.0	30.3	64.9	34.6	89	18	4.3	5.6	8.19	8.06
May	9.44	2.23	71.2	45.2	74.6	46.0	87	31	4.9	5.2	9.06	11.73
June	0.97	2.77	85.4	56.8	86.2	56.6	100	43	3.6	5.2	11.66	14.27
July	2.76	3.14	88.0	59.0	91.4	61.7	100	52	3.7	4.8	11.69	15.11
August	0.95	2.87	92.0	58.5	88.2	59.8	100	52	4.3	4.3	12.04	11.67
September	2.12	1.13	88.2	51.8	81.4	50.8	101	35	3.7	4.7	10.84	9.43
October	1.08	1.59	71.7	36.2	68.3	36.7	86	24	3.1*	4.2*	6.40*	6.01*
November	0.09	0.53	61.5	26.7	54.7	25.6	83	11	---	---	---	---
December	0.00	0.56	55.6	18.6	44.8	17.2	74	4	---	---	---	---
ANNUAL	22.12	18.44	67.9	35.9	66.9	37.5	101	-25	4.1	5.0	63.48	70.27

Normal latest freeze (32°F) in spring: May 4. In 2021: May 12.
Normal earliest freeze (32°F) in fall: October 7. In 2021: October 13.
Normal frost-free (>32°F) period: 156 days. In 2021: 154 days.
Normal for precipitation and temperature is 30-year average (1991–2020) from National Weather Service.
Normal for latest freeze, earliest freeze, wind, and evaporation is 30-year average (1991–2020) from Tribune weather data.
* Normal for October wind and evaporation is 20-year average (2001–2020) from Tribune weather data; October not included in annual totals.

Weather Information for Garden City, 2021

E. Russell

Precipitation in Garden City, KS, for 2021 totaled 16.34 inches. This was 2.9 inches below the 30-year average of 19.24 inches. From January through the end of June, the station received 11.03 inches, which was 0.87 inches above normal for that point in the year, resulting in ideal spring planting conditions. No significant hail was witnessed in 2021. The largest precipitation amounts were 6.29 inches recorded in May, 1.37 inches in June, and 2.54 inches in September. Although good moisture was recorded during these months, the second half of the year was significantly below the 30-year average precipitation, resulting in a 4.57-inch deficit. The spacing of the rains through the summer months, however, helped in watering the fall crops.

Measurable snowfall for the year totaled 7.70 inches; January, February, and April had 3.80, 1.40, and 2.50, respectively. There was a total of eleven days of snow cover. The longest consecutive period of snow cover, five days, occurred February 7 through February 11.

Average daily windspeed was 4.94 mph compared to the 30-year average of 4.20 mph. Open pan evaporation was measured daily from April through October and totaled 84.80 inches. This was 14.54 inches above the 30-year mean of 70.26 inches.

Our mean annual temperature was 55.5°F compared to the 30-year average of 53.7°F. Triple-digit temperatures were experienced in June, July, August and September. The longest consecutive run of triple-digit days was observed from June 17 through June 21 with an average temperature being 104.4°F. August 25 exhibited the highest temperature of 108°F. Sub-zero temperatures were observed in both January and February with -6°F and -20°F respectively.

Table 1. 30-year averages are for the period 1981-2010

	Precipitation		Temperatures						Wind, mph		Evaporation, inches	
			2021 Average				2021 Extremes					
Month	2021	Average 81-10	Max	Min	Mean	Average 81-10	Max	Min	2021	Average 81-10	2021	Average 81-10
January	0.25	0.46	48.4	18.1	33.3	30.4	70	-6	4.41	4.5	n/a	n/a
February	0.08	0.55	38.9	11.0	24.9	33.9	75	-20	3.90	5.24	n/a	n/a
March	2.44	1.31	60.0	29.8	44.9	42.9	88	10	6.74	6.31	n/a	n/a
April	0.60	1.74	66.6	34.0	50.3	52.3	90	22	6.01	6.42	8.89	8.21
May	6.29	2.98	74.7	49.7	59.9	62.8	91	35	5.90	5.76	10.00	10.04
June	1.37	3.12	90.8	60.6	75.7	72.6	106	50	4.41	5.37	12.82	11.96
July	0.80	2.8	93.1	64.1	78.6	77.9	101	54	4.68	4.59	14.91	13.22
August	0.77	2.51	95.9	64.4	80.1	76.3	108	56	5.93	4.11	16.43	11.28
September	2.54	1.42	90.5	57.2	73.9	67.7	104	39	5.82	4.73	13.27	9.22
October	0.98	1.21	75.1	41.0	58.0	54.9	91	28	4.91	4.89	8.48	6.33
November	0.22	0.55	62.6	31.2	46.9	41.6	86	15	4.55	4.8	n/a	n/a
December	0.00	0.59	58.0	21.2	39.6	31.4	80	8	4.94	4.45	n/a	n/a
Annual	16.34	19.24	71.2	40.2	55.5	53.7	108	-20	5.18	5.10	84.80	70.26

	Average	2021
Latest spring freeze	April 29	April 22
Earliest fall freeze	October 12	October 16
Frost free period	165 days	160 days

Forage Crop Water Use and Production Under Dryland Conditions

R. Aiken and F. Lamm[1]

Introduction

Forage crops contribute diversity and buffer agronomic risk in water-limited cropping systems. Knowledge of growth responses to uncertain water supply can help guide crop selection and management—including timing of harvest. Our research objective was to determine water use and growth responses of forage winter triticale and forage sorghum under rainfed conditions.

Experimental Procedures

Forage winter triticale (FWT, NE 422T) and forage sorghum (FS, Sorghum Partners 405) were grown in alternate years of a two-year crop sequence, beginning in 2008. The study site, located at the Kansas State University Northwest Research-Extension Center (39.4 N, 100.1 W), was established on a Keith silt loam soil. Typically, FWT was drilled (Great Plains 2000 drill, 7.5-in. row spacing, 75 lb/a) in late September; FS was planted (John Deere 7300 planter, 30-in. row spacing, 50,000 seed/a) in early June. Soil fertility was supplemented with 60 lb N/a and 30 lb P_2O_5/a prior to planting for both FWT and FS. A pre-emergent herbicide (*S*-metolachlor) was applied after FS planting; weeds emerging after planting were controlled by a post-emergent herbicide such as Starane (Fluroxypyr) for both FS and FWT; contact herbicides (glyphosate, 2,4-D) controlled weeds after FWT harvest. Experimental plots (40 × 80 ft) were included in a larger cropping sequence study with randomized treatment assignment to each of three replicate blocks. Both FWT and FS phases were present each year.

Harvest was generally taken at boot, milk, and soft-dough stages by hand sampling. Fresh weight was adjusted to dry weight basis using samples taken for water content determination (dried to constant weight). Effective water use was calculated from precipitation and soil water depletion (early vegetative growth to harvest, by neutron thermalization to 8-ft depth). Heat stress degree days were calculated from daily maximum temperatures greater than 90°F. Linear regression was used to determine the relationship of above-ground biomass production with water use and interpreted as an indicator of crop water productivity.

Results and Discussion

Growing conditions at the NWREC study site were generally representative of the conditions observed at Colby for the 30-year normal[2] (1981–2010, Table 1). Effective water use differed among years and increased for harvest with later development stages for both FWT and FS. Above-ground biomass increased with effective water use for both FWT (Figure 1) and FS (Figure 2). The water productivity of FS exceeded that of FWT, based on the greater slope in the relationship of biomass productivity with water

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

[2] 30-year normal conditions taken from https://www.usclimatedata.com/climate/colby/kansas/united-states/usks0120.

use. Heat stress decreased forage productivity of FWT and FS by 257 lb/a and 466 lb/a, respectively, for each 10°F in cumulative heat stress degree days (temperatures exceeded 90°F; data not shown). Farmers in the region can refer to these figures to estimate productivity, given a range of anticipated water supply and weather conditions.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Quarterly precipitation and growing season maximum temperature for forage winter triticale and forage sorghum during the 2008–2020 period, in comparison with the 1981–2010 normal, for Colby, KS

	Average precipitation (in.)				Average maximum temperature (°F)				
	Jan-Mar	Apr-June	July-Sept	Oct -Dec	May	June	July	Aug	Sept
2008 – 2020	1.88	8.13	7.67	2.46	74	88*	91	88	82
1981 – 2010	2.01	7.86	8.00	2.78	74	85	91	89	80

* The June average maximum temperature during the study period was significantly greater than that of the 30-year normal (P = 0.10).

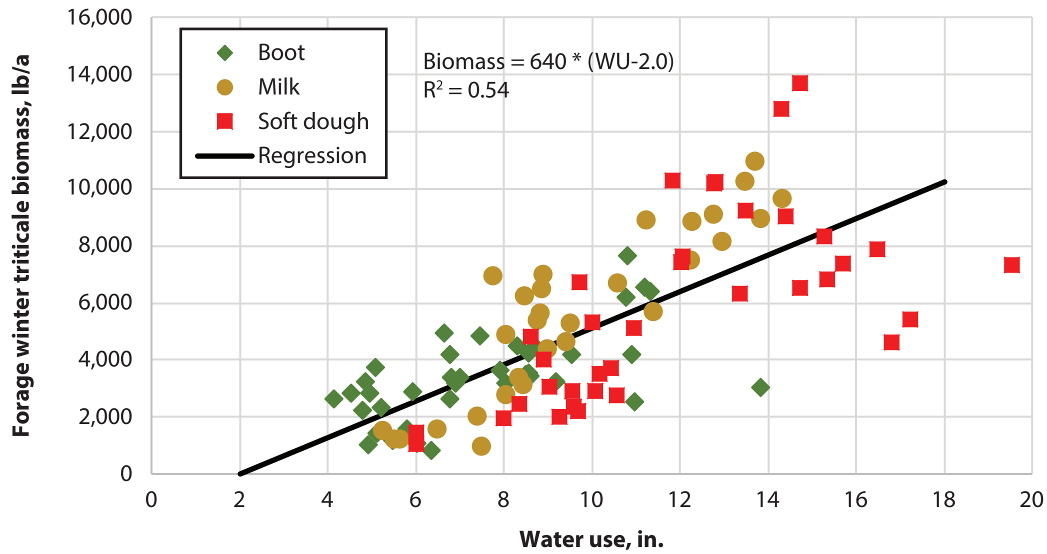


Figure 1. Above-ground biomass (dry matter) of forage winter triticale in relation to seasonal water use for crop harvested at boot, milk, or soft dough stages. Crops were grown in rotation with forage sorghum at Colby, KS, during 2008 through 2020 growing seasons. Each symbol represents values obtained for individual plots in the various years.

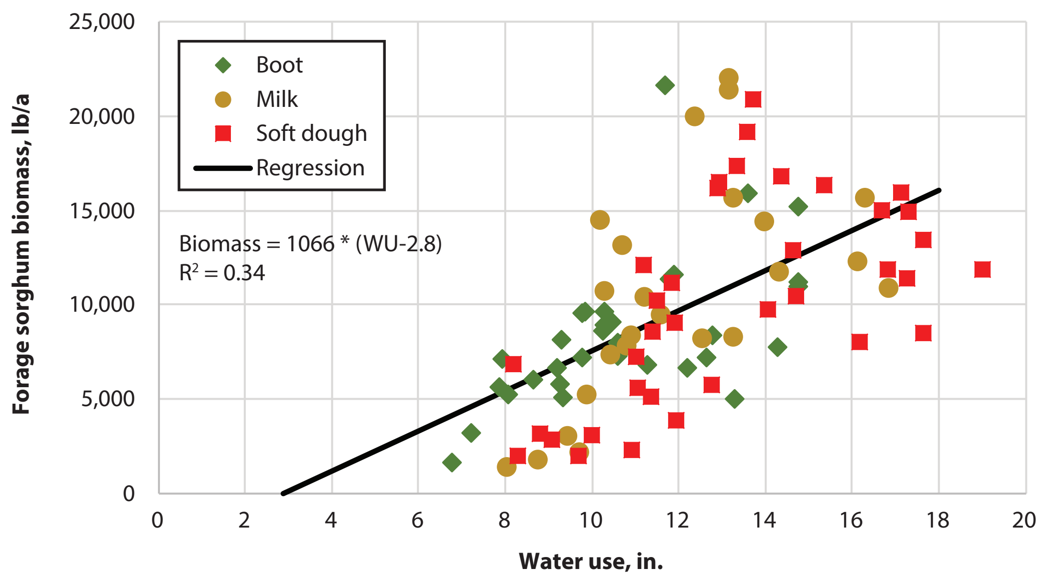


Figure 2. Above-ground biomass (dry matter) of forage sorghum in relation to seasonal water use for crop harvested at boot, milk, or soft dough stages. Crops were grown in rotation with forage winter triticale at Colby, KS, during 2008 through 2020 growing seasons. Each symbol represents values obtained for individual plots in the various years.

Efficacy of Miticides Applied at Tassel Stage for the Control of Spider Mites in Corn, 2020

A. Zukoff

Summary
Spider mite populations peaked during the week of August 19 and declined rapidly by August 26. Mite populations were made up entirely of two-spotted spider mites (*Tetranychus urticae*). The Portal with Exponent, Oberon, and Zeal treatments provided the best season-long control in this trial while Portal, Onager, and Mitomax II provided the most control 14 to 21 days after treatment. The lowest overall reduction in predatory mites during the season, when compared to control plots, occurred in the Portal and Onager treatments.

Experimental Procedures
A center pivot irrigated field near Garden City, KS, in Finney County was planted to Mycogen MY10Z28R8 corn hybrid on May 29, 2020, at a rate of 35,000 seeds per acre. Agronomic practices for irrigation, fertilizer, and herbicide were standard for corn production in the southwest Kansas region. Average maximum air temperature between onset of tasseling and the end of the trial was 89.8°F and 6.99 inches of precipitation was recorded. The trial was arranged in a randomized complete block design with 8 treatments (includes untreated check) replicated four times. Plots were 4 rows wide (30-in. center) by 30-ft long. Replications were separated by 4 rows of buffer corn while individual plots within replications were separated by 10-ft alleyways. All treatments were applied on August 5 at 15.0 gpa with an air pressurized (30 psi) 10-foot-wide high-clearance spray boom. All applications were mixed with a .25% v/v rate of non-ionic surfactant (except for the Mitomax II treatment). The boom was equipped with 8 (XR TeeJet 8002VS) nozzles on 18-inch centers. At application the temperature was 78°F (64% RH) with a wind speed of 10 mph from the south.

Samples were taken 1 day before the miticide applications and at 7, 14, and 21 days thereafter. On each sample date, half the leaves were taken from each of two plants randomly selected from the middle two rows of the plot. Leaves were bagged within the plot and transferred to the laboratory and placed in 5-gallon Berlese funnels equipped with 60-watt incandescent light bulbs for 3 days. Mites exiting the leaves fell into 50-mL centrifuge tubes filled with 70% methanol. Mites were separated from the methanol using a vacuum aspirator and counted under a stereoscope. Insect data were log transformed (Log (x + 1.0)) and analyzed using PROCMIX (SAS 9.4) and then back-transformed to mites per plant for presentation. All "percent reduction" calculations were made using Henderson-Tilton's formula. Grain yield data were not collected because mite infestation never reached economic levels.

Results and Discussion

In untreated plots, two-spotted spider mite populations peaked at 24.8 mites per plant on August 19 and rapidly fell to 1.8 per plant by August 26 (Table 1). On September 2, active mite colonies were no longer present and evidence of the entomopathogenic fungus *Neozygites sp.* was widespread throughout the plots. Natural enemy populations were present during each week of sampling before and after treatments and predatory mites (*Neoseiulus sp.*) were abundant (Table 2). Overall, spider mite pressure during this trial was low, but the number of mites per plant prior to treatments were not significantly different (Table 1).

Portal with Exponent, Zeal, and Oberon all provided the highest season long control with up to 98%, 100%, and 97%, respectively, and all three provided a significant reduction of spider mites 7 DAT (Tables 1 and 3). Oberon's control began to wane after two weeks, while Portal with Exponent along with Zeal held up for 3 weeks (Tables 1 and 3). Onager provided limited control 7 days after treatment (DAT) but increased significantly to 70% 14 DAT and offered no additional control 21 DAT (Table 3). Significant control with Mitomax II was not achieved until 14 DAT (Table 3). Control by Portal alone was modest 7 DAT but steadily increased to a peak of 59% 21 DAT (Table 3). Initial control by Portal with Zeal was better (51%) but declined steadily and offered no additional control 21 DAT (Table 3). Predatory mites were present in all plots both before and after treatment and their population peaked and declined in step with the spider mite population (Table 2). A significant reduction in predatory mites 7 DAT when compared to untreated plots occurred in the Portal with Exponent (60%), Portal with Zeal (77%), Zeal (74%) and Oberon (75%) treatments (Table 4). Predatory mite reductions steadily continued through 21 DAT in the Portal alone, Onager, and Mitomax II treatments (Table 4). Average overall reduction in predatory mites through the season was lowest in the Portal alone and Onager treatments (21% and 26%, respectively) while the highest overall reduction in predatory mites through the season occurred in the treatments containing Zeal, up to 68% (Table 4).

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Average number of spider mites per plant (± SE)

Treatment	Rate, oz/a	1 DPT	7 DAT	14 DAT	21 DAT
UTC	.	20.5±8.1Aba	24.8±7.7Aa	9.8±5.5Ba	1.8±1.4Ba
Portal	32	27.5±8.9Aa	24.0±10.2Aa	5.8±2.3Ba	1.0±1.0Ba
Portal+Exponent	32 + 8	43.8±19.1Aa	11.8±9.1Ba	0.5±0.3Ca	0.8±0.3Ca
Portal+Zeal SC	32 +4	22.3±5.8Aa	13.3±7.7Aba	5.8±2.8Ba	2.0±1.7Ba
Zeal SC	4	41.3±18.0Aa	12.0±6.7Ba	3.5±2.1BCa	0.0±0.0Ca
Oberon 4SC	6	54.3±22.1Aa	11.0±8.4Ba	0.8±0.8Ca	2.3±1.3BCa
Onager	12	24.3±13.6Aa	28.8±16.6Aa	3.5±2.3Ba	3.3±1.6Ba
Mitomax II	54	31.3±9.3Aa	21.5±9.3Aa	2.8±1.1Ba	1.3±0.6Ba

Different uppercase letters indicate significant differences within a treatment over sampling times. Different lowercase letters indicate significant differences between treatments within a given sampling time.
DPT = days pretreatment. DAT = days after treatment. UTC = Untreated control.

Table 2. Average number of predatory mites per plant (± SE)

Treatment	Rate, oz/a	1 DPT	7 DAT	14 DAT	21 DAT
UTC	.	22.5±4.6Ba	64.3±10.3Aa	34.8±6.2ABa	20.0±4.0Ba
Portal	32	20.5±4.3Aa	55.0±21.1Aab	33.3±7.9Aa	7.8±5.1Bb
Portal+Exponent	32 + 8	19.3±1.7Aa	22.3±6.2Ab	33.8±11.0Aa	6.5±3.4Bb
Portal+ZealSC	32 + 4	27.8±7.4Aa	18.5±6.1Ab	23.3±4.8Aa	5.0±1.8Bb
Zeal SC	4	27.0±10.5Aa	20.0±12.4Ab	22.0±9.2Aa	5.0±2.0Bb
Oberon 4SC	6	20.3±3.0Aa	14.3±5.0Ab	24.3±3.0Aa	12.0±3.4Ab
Onager	12	18.8±2.9Ba	47.0±12.9Aab	21.0±1.4ABa	10.5±1.7Bb
Mitomax II	54	29.0±6.4Ba	61.8±11.1Aa	30.5±6.9Ba	9.5±2.5Cb

Different uppercase letters indicate significant differences within a treatment over sampling times. Different lowercase letters indicate significant differences between treatments within a given sampling time.
DPT = days pretreatment. DAT = days after treatment. UTC = Untreated control.

Table 3. Percent reduction in spider mites compared to untreated plots

Treatment	Rate, oz/a	1 DPT	7 DAT	14 DAT	21 DAT	Season average
UTC	.	20.5	24.8	9.8	1.8	
Portal	32		28	56	59	48
Portal+Exponent	32 + 8		64	98	79	80
Portal+ZealSC	32 + 4		51	46	0	32
Zeal SC	4		76	82	100	86
Oberon 4SC	6		83	97	52	77
Onager	12		2	70	0	24
Miteomax II	54		43	81	53	59

Highlighted cells are the mite counts from untreated plots used in calculations.
DPT = days pretreatment. DAT = days after treatment. UTC = Untreated control.

Table 4. Percent reduction in predatory mites compared to untreated plots

Treatment	Rate, oz/a	1 DPT	7 DAT	14 DAT	21 DAT	Season average
UTC	.	22.5	64.3	34.8	20.0	
Portal	32		6	0	57	21
Portal+Exponent	32 + 8		60	0	62	41
Portal+ZealSC	32 + 4		77	46	80	68
Zeal SC	4		74	47	79	67
Oberon 4SC	6		75	23	34	44
Onager	12		13	28	37	26
Miteomax II	54		25	32	63	40

Highlighted cells are the mite counts from untreated plots used in calculations.
DPT = days pretreatment. DAT = days after treatment. UTC = Untreated control.

Deficit Irrigation Strategies for Subsurface Drip-Irrigated Alfalfa

F.R. Lamm,[1] R. Reyes-Esteves, and K.R. Harmoney

Summary
This subsurface drip-irrigated study was conducted from 2020 to 2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS, to evaluate five deficit irrigation strategies for alfalfa. All strategies were irrigated similarly (100% of Evapotranspiration (ET) minus Rain) through the first seasonal cutting. Following the first cutting, treatments were 1) Irrigate to replace 85% ET minus Rain; 2) Irrigate to replace 50% ET minus Rain between Cutting 2 and 3, then 85% ET-Rain; 3) Irrigate to replace 50% ET minus Rain between Cutting 2 and 4, then 85% ET-Rain; 4) Irrigate to replace 70% ET minus Rain between Cutting 2 and 4, then 85% ET-Rain; and 5) Irrigate to replace 25% ET minus Rain between Cutting 2 and 3, then 85% ET-Rain. Average alfalfa forage dry matter yields varied less than 5% across treatments (9.52 vs. 9.94 ton/a) while irrigation requirements varied 20% (17.50 vs. 22.03 inches). Overall, the best treatments appeared to be treatments 2 and 3, obtaining both good yields and greater water productivity.

Introduction
Alfalfa is an important irrigated crop in the United States and it is often the most economically profitable irrigated agricultural crop, excluding horticultural crops. Although many are not aware, it is also an extremely drought-tolerant crop due to its deep and extensive root system and through its ability to go dormant and wait for water. The first harvest (late May or early June in the Central Great Plains) is usually the greatest and can be 30 to 40% of the annual yield. Some irrigation management strategies intentionally allow water deficits for alfalfa during the summer slump period when forage yields and water productivity are greatly reduced.

Results (2005–2007) from a subsurface drip irrigation field study of alfalfa at the K-State Northwest Research-Extension Center near Colby, KS, indicated that yields were not greatly affected by irrigation levels ranging from replacement of 70 to 100% of calculated evapotranspiration (ET) minus precipitation, and that improvements in alfalfa quality partially compensate for lower yields when deficit irrigated. It was concluded that a subsurface drip irrigation (SDI) regime of 85% ET minus precipitation appears reasonable on deep silt loam soils in the Central Great Plains region. Further work was initiated in 2019 to evaluate strategies for in-seasonal deficit irrigation adjustments that might reduce irrigation during the summer slump period.

Experimental Procedures
Alfalfa (Pioneer 54VR70) was planted on May 6, 2019, at a seeding rate of approximately 18 lb/a. Due to an insufficient and irregular stand, a second planting was interseeded on July 1, 2019 at the same seeding rate. After the second seeding, hand-set sprinkler lines were used to periodically apply small irrigation events (≈0.25 to 0.5

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

inches) over an approximately two-week period to help assure good establishment. For the remainder of 2019, the alfalfa was uniformly irrigated as needed with SDI and was harvested when it reached the 10% bloom stage and immediately prior to fall freeze-up. No study yields were measured during this establishment year. Phosphorus fertilizer (APP 10-34-0) was applied at a rate of 90 lb P_2O_5/a prior to planting in 2019. Soil water was monitored periodically to an 8-ft depth in 1-ft increments with neutron moderation techniques. Forage yields were determined from cutting samples at 10% bloom, weighing the entire wet sample, drying a subsample to determine the forage moisture content, and converting the measured wet yield to dry matter yield. Crop water use was determined as the sum of the seasonal soil water change, irrigation, and rainfall. Crop water productivity was calculated as alfalfa dry matter yield/crop water use.

Subsurface driplines at a depth of approximately 15 inches were spaced 5 ft apart with 4 driplines for each plot. All five strategies received 100% of calculated evapotranspiration (ET) minus rain from spring green-up through the first cutting. Then the strategies differed and were:

1. 85% of ET - Rain.
2. 50% ET - Rain for 2^{nd} through 3^{rd} cutting and then 85% of ET - Rain thereafter.
3. 50% ET - Rain for 2^{nd} through 4^{th} cutting and then 85% of ET - Rain thereafter.
4. 70% ET - Rain for 2^{nd} through 4^{th} cutting and then 85% of ET - Rain thereafter.
5. 25% ET - Rain for 2^{nd} through 3^{rd} cutting and then 85% of ET - Rain thereafter.

An additional 2.5 inches of irrigation was applied in November each year to conduct some pressure and flow testing for the SDI system and to wet the soil profile prior to freezing.

Results and Discussion

Growing conditions were favorable for alfalfa production in both years of the study. Precipitation during the April through October growing period was 10.87 and 13.27 inches for 2020 and 2021, respectively, and was drier than normal (16.00 inches, long-term average). Irrigation requirements varied between years, but the requirement was greatest for 2020 (Table 1).

Average alfalfa forage yields were 9.73 ton/a during the study (Table 1) but varied between years (Figure 1). Yield differences between the irrigated strategies were very small with treatment 2 having the greatest yield (9.94 ton/a) and treatment 5 having the lowest yield (9.52 ton/a). Crop water productivity was greatest for treatments 3 and 5 (Table 1 and Figure 1), and, because overall yield differences were small for all treatments, treatments 2, 3, and 5 appear to be the best balance between yield and water productivity.

The study will be continued in 2022 and the stands are being monitored for losses due to insufficient water and due to winterkill.

Acknowledgments

This research project received support from the U.S. Department of Agriculture Agricultural Research Service through a special grant.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Irrigation amounts, annual alfalfa forage yields, total crop water use, and water productivity in a subsurface drip-irrigated study, Kansas State University Northwest Research-Extension Center, Colby, KS

Irrigation treatment	Irrigation amount (inches)	Dry matter yield (ton/a)	Water use (inches)	Water productivity (ton/acre-in.)
2020 crop year				
1	22.50	10.09	40.19	0.251
2	20.40	10.05	38.83	0.259
3	18.95	9.81	37.19	0.264
4	21.00	9.66	39.07	0.247
5	18.55	9.68	37.18	0.260
Mean	20.28	9.86	38.49	0.256
2021 crop year				
1	21.55	9.70	40.60	0.2390
2	18.80	9.84	36.87	0.2668
3	16.95	9.51	34.25	0.2778
4	19.60	9.60	37.67	0.2550
5	16.45	9.36	34.09	0.2749
Mean	18.67	9.60	36.70	0.2627
Mean 2020 to 2021				
1	22.03	9.89	40.39	0.2450
2	19.60	9.94	37.85	0.2628
3	17.95	9.66	35.72	0.2708
4	20.30	9.63	38.37	0.2512
5	17.50	9.52	35.63	0.2676
Mean	19.48	9.73	37.59	0.2595

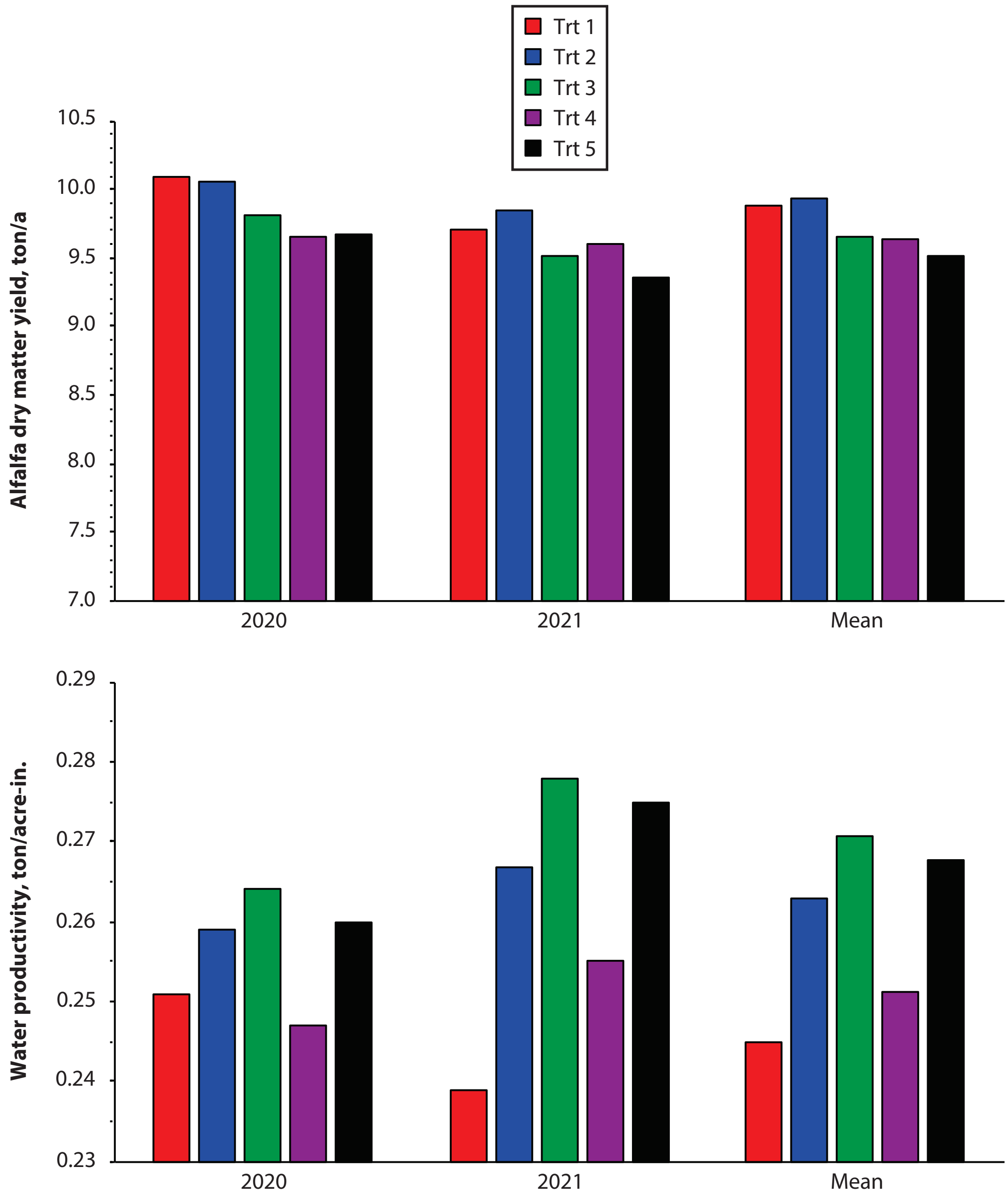


Figure 1. Alfalfa yields (upper panel) and water productivity (lower panel) for 2020 and 2021 in a subsurface drip-irrigated study examining five different irrigation strategies, Kansas State University Northwest Research-Extension Center, Colby, KS.

Crop Assurance Strategies for Irrigated Grain Sorghum Production

F.R. Lamm[1,2]

Summary
This sprinkler-irrigated study was conducted from 2018 to 2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS, to evaluate four different water management strategies that could provide assurance of adequate-yielding grain sorghum. The grain sorghum was grown on sites with good initial soil water at planting (>70% of field capacity within the 8-ft deep silt loam profile). Strategies were 1) No seasonal irrigation; 2) Irrigation of 100% of ET minus Rain after the boot stage through remainder of season; 3) Irrigation of 100% of ET minus Rain up to a limit of 6 inches; and 4) Irrigation of 100% of ET minus Rain up to a limit of 3 inches. Cropping season rainfall ranged from 5.48 inches to 13.98 inches and irrigation ranged from 0 to 11 inches across strategies for the 4 years of the study. Yield increases due to irrigation varied across years, ranging from -3.6 bu/a to 21.2 bu/a, but averaged only 7.2 bu/a over the non-irrigated treatment. Average yields were 138, 143, 144, and 145 bu/a for the four respective water management strategies. Soil water extraction by the grain sorghum was greater in the drier years and increased with less applied irrigation. These results indicate that adequately-yielding grain sorghum can be produced on sites with good soil water profiles at planting with little (≈ 3 inches) or even no in-season irrigation.

Introduction
Grain sorghum is tolerant of crop water stress and can be an excellent crop when irrigation is restricted both in total amount and temporally within the season. Many Central Great Plains producers prefer to grow corn under fully irrigated conditions, but those opportunities are decreasing as time progresses. Some producers are already beginning to remediate deficit irrigation capacities (i.e., gpm/a) by splitting center pivot sprinkler land areas annually into multiple crops. Although grain sorghum is reasonably tolerant of crop water stress, it does need sufficient water to yield well, and sometimes irrigation is needed to assure an adequate crop that is profitable. A sprinkler-irrigated grain sorghum study was conducted from 2018 to 2021 at the K-State Northwest Research-Extension Center at Colby, KS, to evaluate four water management strategies ranging from non-irrigated in-season to full irrigation.

Experimental Procedures
Grain sorghum (Pioneer 86P20) was planted in late May or early June in all years at a seeding rate of approximately 140,000 seeds/a. Nitrogen fertilizer (UAN 32-0-0) was applied at a rate of 175 lb N/a in 2018 and 2019 and at a rate of 240 lb N/a in 2020 and 2021. Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to an 8-ft depth in 1-ft increments with neutron moderation techniques. Grain sorghum yield and yield components were determined by hand

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

[2] Special appreciation to Jonathan Aguilar for reviewing this report for final publication.

harvesting at physiological maturity. Crop water use was determined as the sum of the seasonal soil water change, irrigation, and rainfall. Crop water productivity was calculated as yield/crop water use. The water management strategies were:

1. No in-season irrigation
2. Irrigation only after boot stage to replace 100% ET – Rain
3. Irrigation only after boot stage to replace 100% ET – Rain, but capped at 6 inches
4. Irrigation only after boot stage to replace 100% ET – Rain, but capped at 3 inches.

Irrigation was scheduled only as needed as determined by the weather-based water budgets. Irrigation amounts were generally 1 inch per application.

Results and Discussion

Growing conditions were favorable for good grain sorghum production in all four years of the study. Precipitation during the grain sorghum growing period was 11.77, 13.98, 6.13, and 5.48 inches for 2018, 2019, 2020, and 2021, respectively. Irrigation requirements varied between years, but were greatest for 2021 (Table 1). The drier years (i.e., less precipitation) of 2020 and 2021 provided a more thorough testing of the water strategies.

Average grain sorghum yields were 143 bu/a during the study (Table 1) but varied between years (Figure 1). Yield differences between the irrigated strategies were very small with Treatment 4, where total irrigation was limited to 3 inches, having the greatest average yield. Irrigation appreciably increased yields over the non-irrigated treatment in only two of the four years (2018 and 2021). Crop water productivity was greatest for the non-irrigated treatment and decreased further with increased irrigation (Table 1 and Figure 1).

The study sites in each year had ample soil water at planting, averaging greater than 70% of field capacity for the 8-ft deep silt loam soil profile (Figure 2) and this later helped to buffer seasonal drought periods when they occurred. In all four years there were not appreciable differences in available soil water among treatments until approximately August 20 (i.e., Day of Year 232). These results suggest that starting the season with ample soil water within these deep silt loam profiles can minimize the need for in-season irrigation.

Acknowledgments

This research project received support from the U.S. Department of Agriculture Agricultural Research Service Ogallala Aquifer Program.

Table 1. Irrigation amounts, grain sorghum yields, total crop water use, water productivity (WP) and available soil water (ASW) at planting and harvest in a sprinkler-irrigated study

Irrigation treatment	Irrigation	Yield	Water use	WP	ASW at planting	ASW at harvest
	inches	bu/a	inches	lb/acre-in.	------- inches/8 ft -------	
2018 crop year						
No irrigation	0.00	144.3	20.14	402	14.91	6.54
100% ET	8.00	153.7	24.37	354	16.07	11.48
100% ET to 6 in.	6.00	149.0	23.12	361	15.49	10.14
100% ET to 3 in.	3.00	152.3	21.68	394	15.45	8.54
Mean	4.25	149.8	22.33	378	15.48	9.17
2019 crop year						
No irrigation	1.00	144.2	19.69	410	16.89	12.18
100% ET	6.00	144.1	24.26	337	16.43	12.15
100% ET to 6 in.	6.00	147.8	23.18	358	16.68	13.49
100% ET to 3 in.	4.00	148.4	21.75	382	16.83	13.06
Mean	4.25	146.1	22.22	372	16.71	12.72
2020 crop year						
No irrigation	0.00	133.3	13.05	573	12.33	5.40
100% ET	8.00	124.5	16.54	423	13.76	11.35
100% ET to 6 in.	6.00	129.7	16.03	456	13.47	9.57
100% ET to 3 in.	3.00	129.8	14.96	487	13.76	7.93
Mean	4.25	129.3	15.15	485	13.33	8.56
2021 crop year						
No irrigation	0.00	131.2	15.46	476	16.16	6.18
100% ET	11.00	148.9	20.94	398	16.36	11.90
100% ET to 6 in.	6.00	152.4	18.33	466	16.35	9.50
100% ET to 3 in.	3.00	151.3	17.20	493	16.55	7.83
Mean	5.00	145.9	17.98	458	16.35	8.85
All four years						
No irrigation	0.25	138.3	17.09	465	15.07	7.57
100% ET	8.25	142.8	21.53	378	15.65	11.72
100% ET to 6 in.	6.00	144.7	20.16	410	15.50	10.67
100% ET to 3 in.	3.25	145.4	18.90	439	15.65	9.34
Mean	4.44	142.8	19.42	423	15.47	9.83

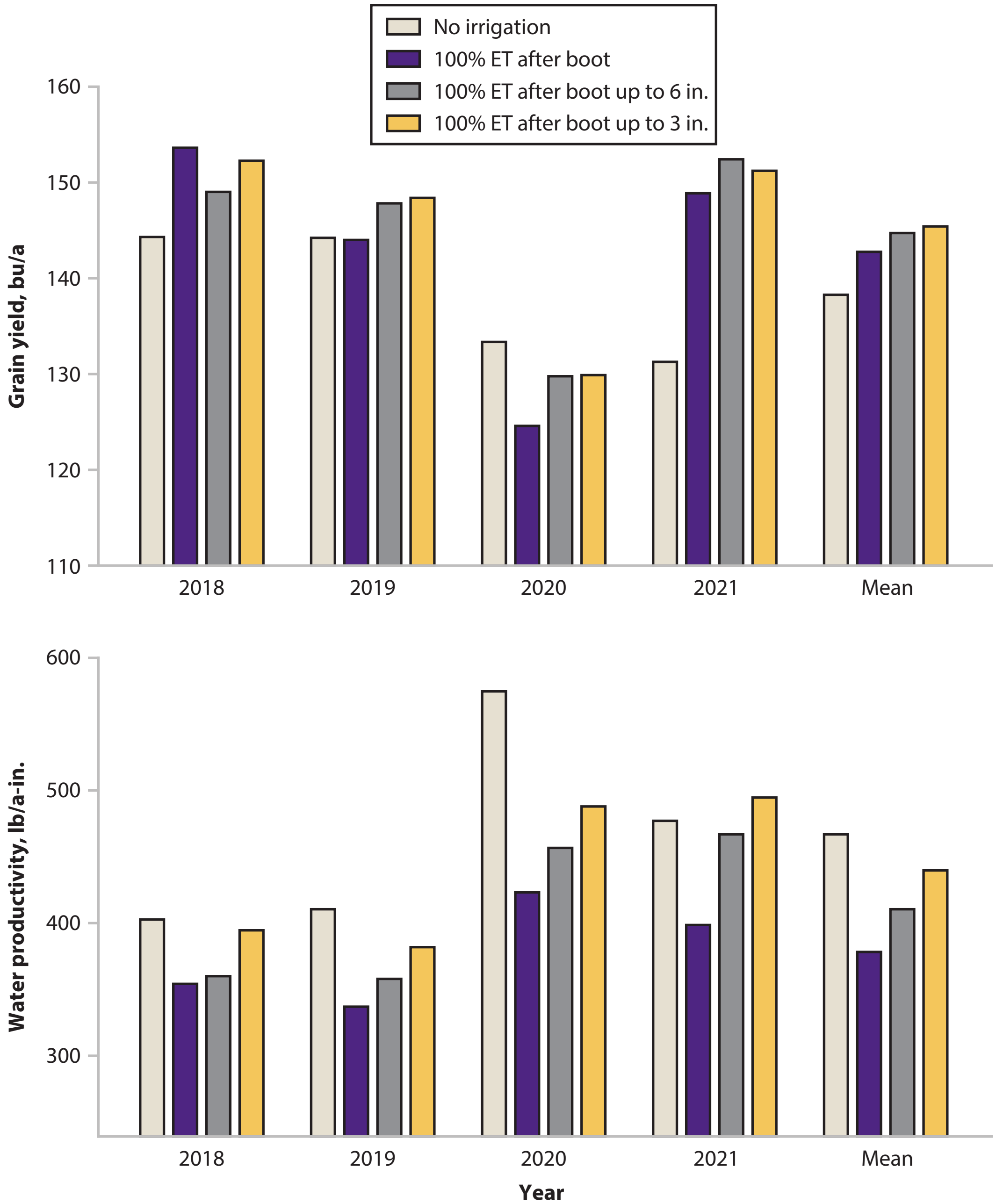


Figure 1. Grain sorghum yields (upper panel) and water productivity (lower panel) for 2018 through 2021 in a sprinkler-irrigated study examining four different water management strategies, Kansas State University Northwest Research-Extension Center, Colby, KS.

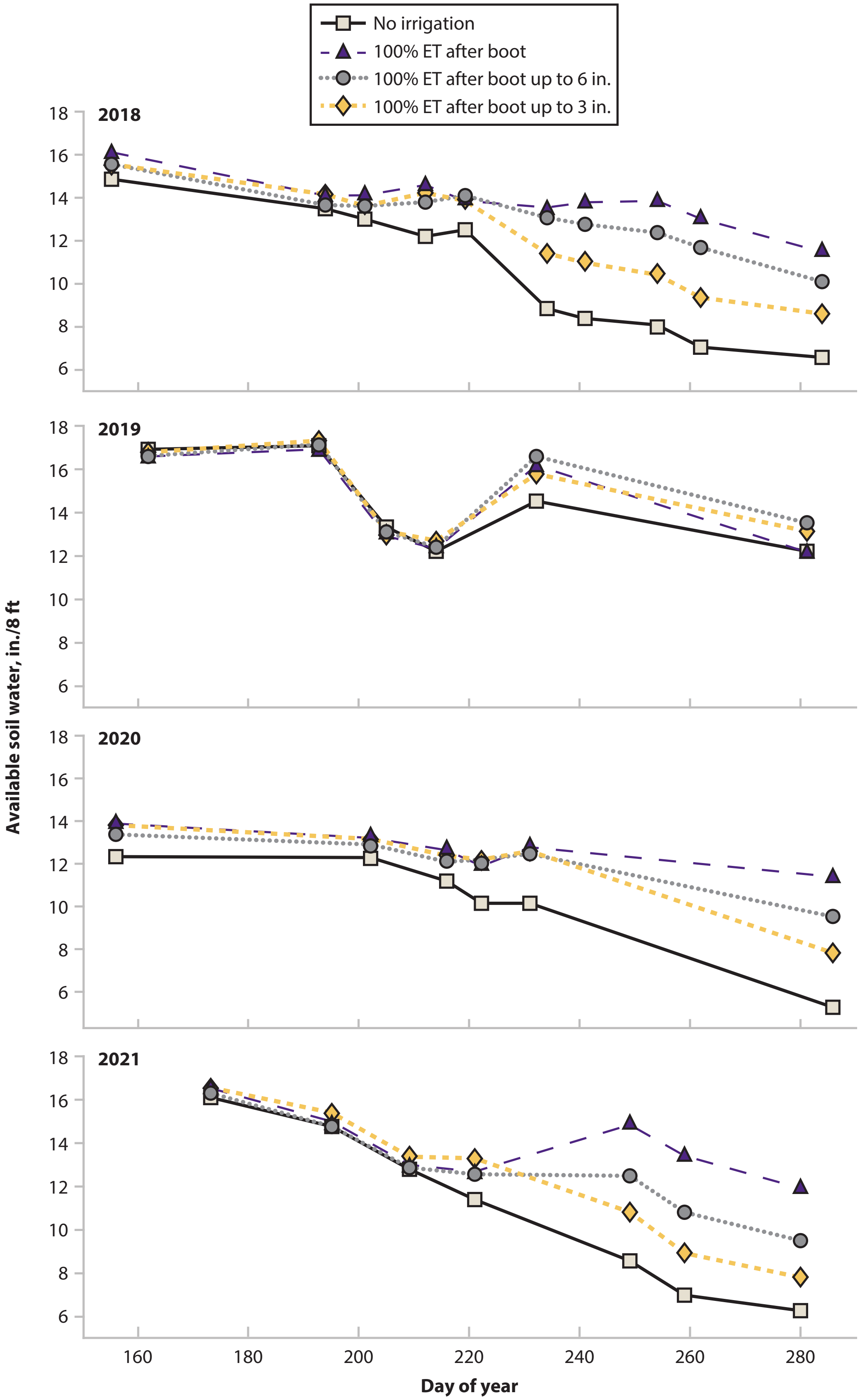


Figure 2. Seasonal progression of available soil water for four crop years as affected by water management strategy in a sprinkler-irrigated grain sorghum study, Kansas State University Northwest Research-Extension Center, Colby, KS.

Intensification of Sprinkler-Irrigated Corn Production

F.R. Lamm[1,2]

Summary
This corn intensification study was conducted under sprinkler irrigation from 2020 to 2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS. Two corn hybrids (Pioneer 1197 and Pioneer 1089) were grown with advanced fertilization at three plant densities (42,000, 38,000, and 34,000 plants/a) using three irrigation levels (115, 100, or 85% of calculated well-watered ET minus rain). As anticipated, there was no additional need for irrigation above normal amounts (100% of ET - Rain), giving further evidence that crop intensification is possible without negatively affecting water resource use. Yields were excellent in both years, averaging 227 bu/a in 2020 and 306 bu/a in 2021. Both corn hybrids yielded well and overall the greater plant density gave slightly greater yields. Crop water productivity was maximized at an irrigation level of 85% of ET - Rain, with the Pioneer 1197 hybrid, and with a plant density of 42,000 plants/a.

Introduction
Crop water productivity (WP) is defined as the crop grain yield divided by the total crop water use. Optimization of irrigation water resource usage is often guided by WP. This term is often used to guide sound use of water resources. Attempts to increase WP are often concentrated on decreasing the denominator (water use), though this can be problematic in that decreased water use can negatively impact crop yield and subsequently farm profitability. In fact, a traditional definition of deficit irrigation is a level of irrigation that is anticipated to reduce crop evapotranspiration (ETc) to less than the full potential amount. Since crop yield and ETc are typically linearly related, a reduction in ETc means a reduction in crop yield. In this study, a crop intensification effort was made to increase the numerator (corn grain yield) of WP without a commensurate increase in corn irrigation amounts. Crop intensification has existed since the first farmer planted a seed. In a general sense, crop intensification is practiced to increase crop or economic productivity, but can also help to make wiser use of the crop inputs and natural resources. A study was conducted in 2020 and 2021 at the K-State Northwest Research-Extension Center at Colby, KS, to intensify corn production through hybrid selection, increased plant density (aka plant population), and advanced fertilization.

Experimental Procedures
Corn was planted on April 24 in both 2020 and 2021 at seeding rates of approximately 42,000, 38,000, and 34,000 seeds/a. Selected corn hybrids were Pioneer 1197 and Pioneer 1089. Advanced fertilization procedures varied between years and are listed in Table 1. Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to an 8-ft depth in 1-ft increments with neutron modera-

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

[2] Special appreciation to Jonathan Aguilar for reviewing this report for final publication.

tion techniques. Corn yield and yield components were determined by hand harvesting at physiological maturity. Crop water use was determined as the sum of the seasonal soil water change, irrigation, and rainfall. Crop water productivity was calculated as grain yield/crop water use. Irrigation was scheduled only as needed to match 115, 100, or 85% of the previous period's ET – Rain. Irrigation amounts were generally 1 inch.

Results and Discussion

Growing conditions were favorable for good corn production in both years of the study, but a wind storm during the overnight period of July 1–2, 2020, definitely limited yields in that year. The wind, coupled with a small amount of small hail, reduced leaf area by 10–25% when the corn was approximately 6-ft tall. The corn reached anthesis on July 19 in 2020 and on July 15 in 2021. In both summers, the latter half of July and most of August were very dry at Colby.

Irrigation amounts in 2020 were 18.20, 15.20, and 11.20 inches for the 115, 100, and 85% ET - Rain treatments, respectively. Irrigation amounts in 2021 were 19.20, 16.20, and 14.20 inches for the 115, 100, and 85% ET - Rain treatments, respectively.

Average corn yields were good during the study (Table 2) but were excellent in 2021 (Figure 1). As discussed previously, the early July wind and hail storm in 2020 definitely reduced yield potential in that year. In 2020, corn yields were 233, 231, and 218 bu/a for the 115, 100, and 85% ET - Rain treatments, respectively. In 2021, corn yields were 307, 310, and 302 bu/a for the 115, 100, and 85% ET - Rain treatments, respectively. Crop water productivity was also high for this study, averaging 520, 558, and 577 lb/a-in. for the 115, 100, and 85% ET - Rain treatments, respectively. Increasing plant density was generally beneficial. These high yields and high water productivity indicate that intensification of corn is a realistic cropping scenario for the region.

Acknowledgments

This research project received support from the U.S. Department of Agriculture Agricultural Research Service Ogallala Aquifer Program.

Table 1. Advanced fertilization procedures used in the sprinkler-irrigated corn intensification study in 2020 and 2021

Application type	Date	Product	Amount
2020 Crop season			
Strip tillage	11-15-19	UAN 32-0-0 and APP 10-34-0	80 lb N/a and 45 lb P_2O_5/a
Preplant broadcast	4-18-20	UAN 32-0-0	95 lb N/a
Fertigation	6-23-20	UAN 32-0-0	50 lb N/a
Foliar	6-30-20	NACHURS Crop Watch	0.5 gal/a
Fertigation	7-01-20	UAN 32-0-0 and boron	50 lb N/a and 0.4 gal/a
Additional fertigation	7-01-20	NACHURS Aquatech 7-20-4 and K-Fuel	4 gal/a and 2 gal/a
2021 Crop season			
Strip tillage	11-16-20	UAN 32-0-0 and APP 10-34-0	80 lb N/a and 45 lb P_2O_5/a
Preplant broadcast	4-7-21	UAN 32-0-0	160 lb N/a
Planting in-furrow	4-24-21	NACHURS Impulse and zinc 9%	6 gal/a and 1 qt/a
Fertigation at V5 toV8	6-18-21	UAN 32-0-0, NACHURS K-Flex Max, and NACHURS Sideswipe	35 lb N/a, 1 gal/a, and 1 qt/a
Foliar at V5 toV8	6-30-20	NACHURS FinishLine and K-Fuel	1 qt/a and 1 gal/a
Fertigation at V5 toV8	6-25-21	UAN 32-0-0, NACHURS K-Flex Max, and NACHURS Sideswipe	35 lb N/a, 1 gal/a, and 1 qt/a
Fertigation at V8 to VT	6-29-21	Aquatech 7-20-4	4 gal/a

Table 2. Average (2020 to 2021) corn grain yields, harvest plant density, total crop water use, and crop water productivity (WP) in a corn in the sprinkler-irrigated corn intensification study in 2020 and 2021

Irrigation treatment	Hybrid	Plant density treatment	Yield	Plant density	Water use	WP
			bu/a	plants/a	inches	lb/acre-in.
1.15 ET 18.7 in.	P 1197	42K	277	41273	29.36	527
		38K	280	38333	29.01	539
		34K	273	33759	29.00	525
		Mean	277	37788	29.12	530
	P 1089	42K	268	41491	28.63	523
		38 K	268	38224	29.27	513
		34K	253	33977	28.79	492
		Mean	263	37897	28.90	509
	Mean		270	37843	29.01	520
1.00 ET 15.70 in.	P 1197	42K	274	41382	26.44	578
		38 K	282	37679	27.24	578
		34K	271	33759	27.80	543
		Mean	276	37607	27.16	566
	P 1089	42K	274	41600	26.96	570
		38 K	260	37679	26.91	540
		34K	261	33759	27.10	538
		Mean	265	37679	26.99	549
	Mean		270	37643	27.07	558
0.85 ET 12.70 in.	P 1197	42K	268	40620	25.98	573
		38 K	260	38006	24.56	588
		34K	261	33759	25.97	560
		Mean	263	37462	25.51	573
	P 1089	42K	266	42035	24.77	597
		38 K	256	38006	24.94	574
		34K	251	33650	24.77	568
		Mean	258	37897	24.83	580
	Mean		260	37679	25.17	577
Grand Mean			267	37722	27.08	551

continued

Table 2. Average (2020 to 2021) corn grain yields, harvest plant density, total crop water use, and crop water productivity (WP) in a corn in the sprinkler-irrigated corn intensification study in 2020 and 2021

Irrigation treatment	Hybrid	Plant density treatment	Yield	Plant density	Water use	WP
			bu/a	plants/a	inches	lb/acre-in.
Mean by Category						
1.15 ET			269.9	37843	29.01	520
1.00 ET			270.3	37643	27.07	558
0.85 ET			260.3	37679	25.17	577
	P1197		271.7	37619	27.26	557
	P1089		261.9	37825	26.90	546
		42K	271.2	41400	27.02	561
		38K	267.6	37988	26.99	555
		34K	261.7	33777	27.24	537

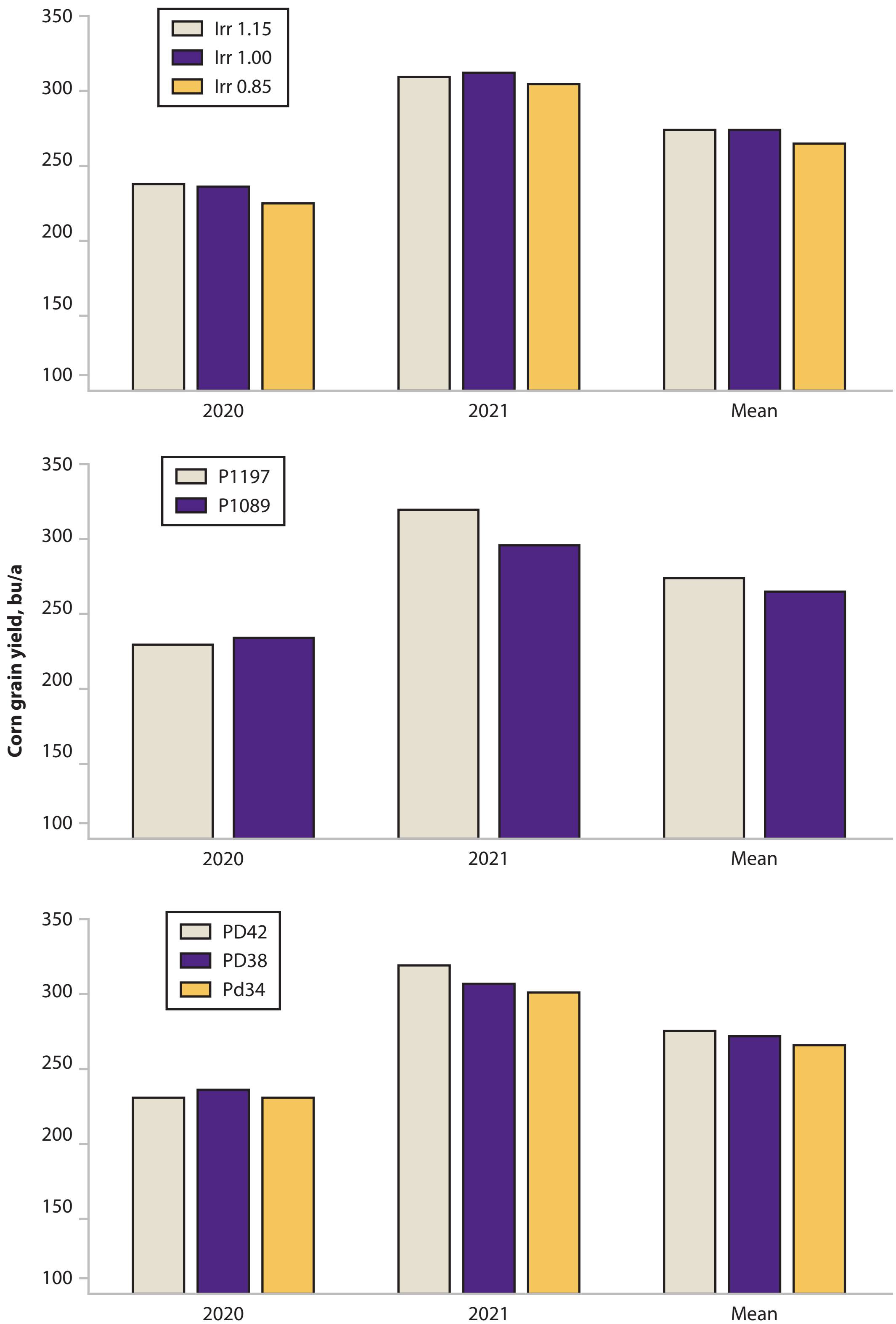


Figure 1. Corn grain yields (2020–2021) for a sprinkler-irrigated crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel is for the two corn hybrids Pioneer 1197 and Pioneer 1089. Bottom panel is for the three plant densities, 42,000, 38,000, or 34,000 plants/a.

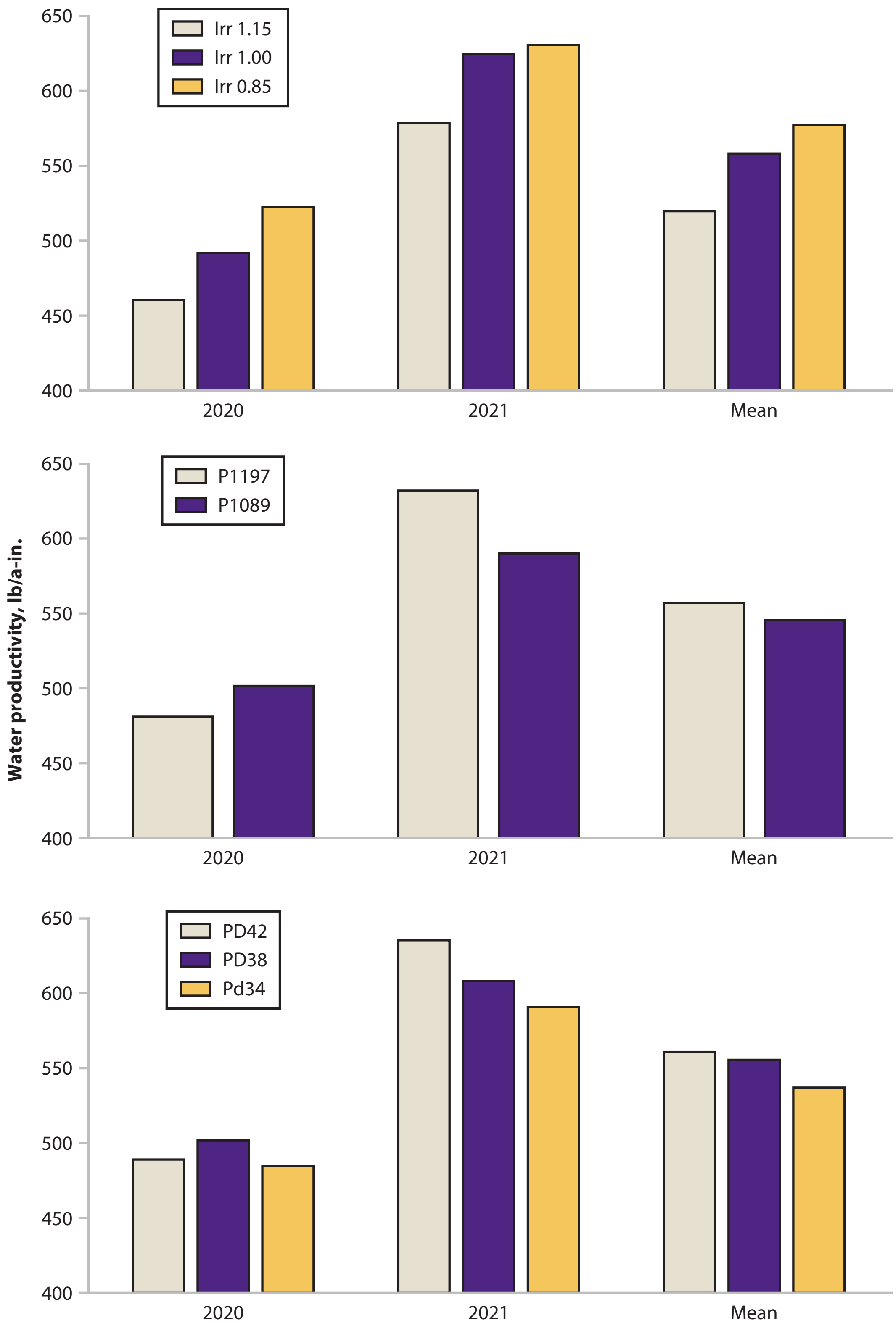


Figure 2. Crop water productivity (2020–2021) for a sprinkler-irrigated crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel is for the two corn hybrids Pioneer 1197 and Pioneer 1089. Bottom panel is for the three plant densities, 42,000, 38,000, or 34,000 plants/a.

Efficient Irrigation Technologies for Corn—A Comparison

F.R. Lamm[1] and D.M. O'Brien

Summary

This study was conducted from 2016–2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS. Two irrigation systems, subsurface drip irrigation (SDI) and mobile drip irrigation (MDI) were compared for two irrigation capacities equivalent to 0.25 in./day and 0.167 in./day. Irrigation amounts were similar for the two systems when comparing the equivalent capacities, averaging 13.3 and 11.4 inches per acre. When averaged over the six-year period, SDI and MDI corn grain yields were 242.5 and 239.2 bu/a, respectively. Although irrigation amounts for the two systems at an equivalent irrigation capacity were similar, total crop water use was less for SDI than for MDI. There was greater soil water depletion with MDI than with SDI. Crop water productivity was greater with SDI than with MDI. Both of these advanced irrigation systems are acceptable for corn production in the Central Great Plains.

Introduction

Western Kansas producers are under pressure from both hydrologic and institutional constraints to reduce withdrawals from the declining Ogallala aquifer. By far, the predominant irrigation system in western Kansas is the center pivot sprinkler irrigation system, but some subsurface drip irrigation (SDI) systems are being installed and operated for row crop production. A major disadvantage of SDI systems is their high initial cost but there are some scenarios where the economics can compare favorably with center pivot sprinklers (Lamm et al., 2020). A newer technology attempting to obtain some of the benefits of SDI is mobile drip irrigation (MDI), where pressure-compensating driplines are installed on the center pivot irrigation system instead of the conventional irrigation sprinkler system package. The cost of MDI is considerably less than for SDI. The MDI driplines are pressure compensating which means that the emitter discharge (flowrate) is constant independent of length or distance from the inlet within operational parameters. This pressure-compensating feature allows for MDI to be simulated within an existing SDI research field for cropping comparisons of the two systems. From 2016 to 2021, a study was conducted at the K-State Northwest Research-Extension Center at Colby, KS, to compare SDI and MDI for corn production under two different irrigation capacities equivalent to 0.025 or 0.167 in./day.

Experimental Procedures

Corn was planted annually in late April or early May at a seeding rate of approximately 35,000 seeds/a. Initial fertilizer amounts of 125 lb N/a and 45 lb P_2O_5/a were preplant broadcast applied. Later at the first irrigation event, an additional 100 lb N/a was applied through the irrigation system (i.e., both the MDI and SDI system plots). Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to a 8-ft depth in 1-ft increments with neutron moderation techniques. Corn yield and yield components were determined by hand harvesting at

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

physiological maturity. Crop water use was determined as the sum of the seasonal soil water change, irrigation, and rainfall. Crop water productivity was calculated as grain yield/crop water use. Mobile drip irrigation and SDI typically have some operational differences. Mobile drip irrigation typically applies a fixed amount of water, and the irrigation capacity determines the frequency of events. This fixed amount is usually in the range of 0.75 to 1.25 in. and this helps to minimize water evaporation losses from the soil. Subsurface drip irrigation, being subsurface, is less subject to soil water evaporation, so it can apply variable amounts of water on a shorter fixed frequency of events. In this study, irrigation was scheduled with a weather-based water budget only as needed. Thus irrigation treatments shown below were limited to the indicated criteria:

1. MDI with irrigation limited to 1 in./4 days
2. MDI with irrigation limited to 1 in./6 days
3. SDI with irrigation limited to 0.25 in./day
4. SDI with irrigation limited to 0.17 in./day

Results and Discussion

Growing conditions were favorable for good corn production in all 6 years (2016 to 2021). The greater irrigation capacity (treatments 1 and 3) averaged receiving 13.3 in. and the lesser irrigation capacity (treatments 2 and 4) averaged receiving 11.4 in. Irrigation requirements were greatest in 2021 (16 in. for greatest irrigation capacity) and least in 2019 (≈11.6 in. for greatest irrigation capacity). There were little to no differences in applied irrigation between MDI and SDI among years.

In five of the six years, corn grain yields were greater with SDI than for MDI (Figure 1). However in 2021, MDI yields were 16 to 25 bu/a greater than SDI for equivalent irrigation capacities. When averaged over both capacities and the entire six years, SDI had greater yields by only 3.3 bu/a, so both systems provided acceptable yields.

Although irrigation amounts were similar between equivalent irrigation capacities for the two irrigation systems, crop water use was always less for the SDI system (Figure 2), probably reflecting a slight reduction in evaporative losses when irrigation is applied subsurface.

Anecdotally, it was observed that crop senescence was slightly advanced in the MDI plots compared to the SDI plots in every year, but it was apparently never too early or too severe to greatly affect grain yield. Similarly, available soil water at harvest was less for the MDI plots compared to the SDI plots in every year (Figure 3).

Similar to corn grain yield, crop water productivity was greater for SDI in five of the six years and also for the overall period (Figure 4).

Acknowledgments

This research project received support from the Kansas Corn Commission.

References

Lamm, F. R., D. M. O'Brien, and D. H. Rogers. 2020. Using the K-State center pivot sprinkler and SDI economic comparison spreadsheet - 2020. In: Proc. 32nd annual Central Plains Irrigation Conference, Feb. 18-19, 2020, Burlington, Colorado. Available from CPIA, 760 N. Thompson, Colby, Kansas. pp. 135-143. *https://www.ksre.k-state.edu/sdi/reports/2020/LammUsingCPSDI20.pdf*

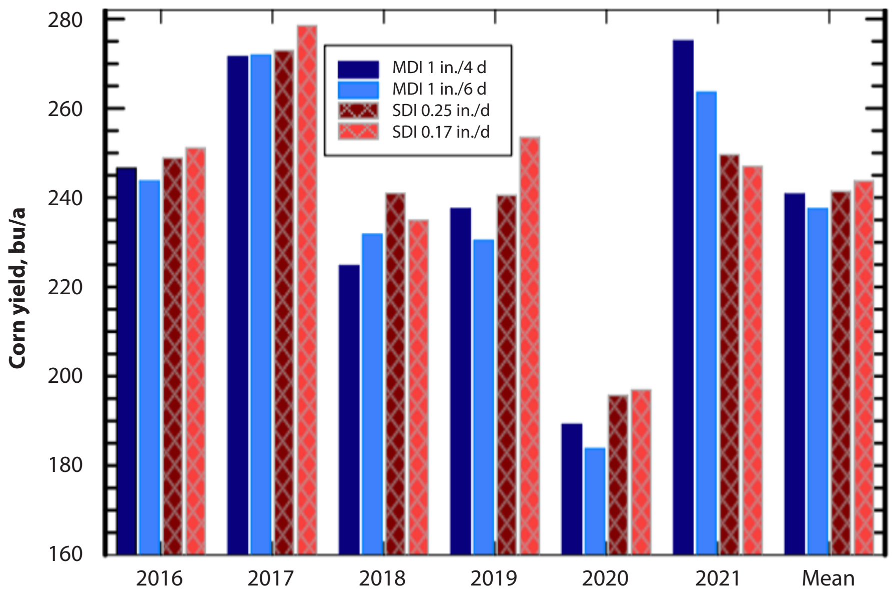


Figure 1. Corn grain yields (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

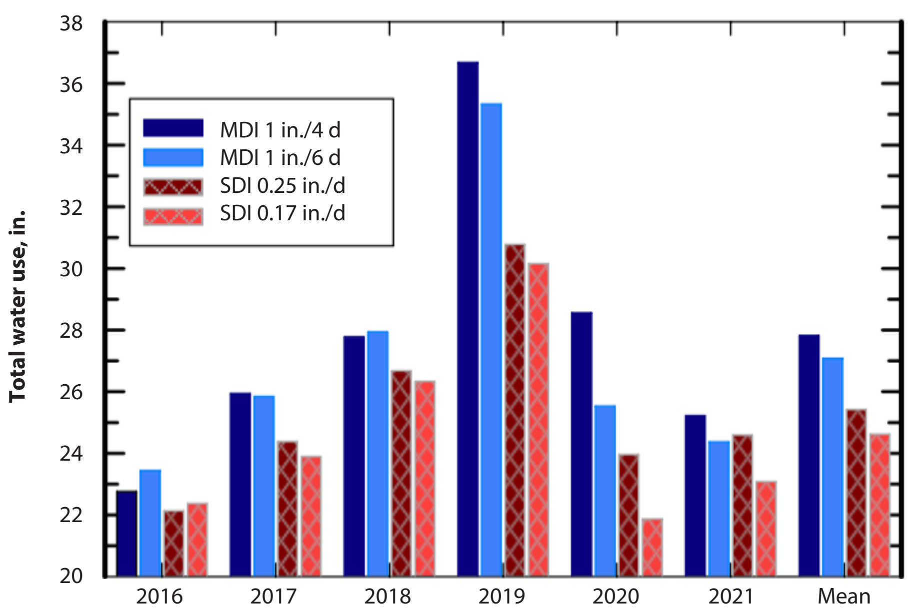


Figure 2. Crop water use for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

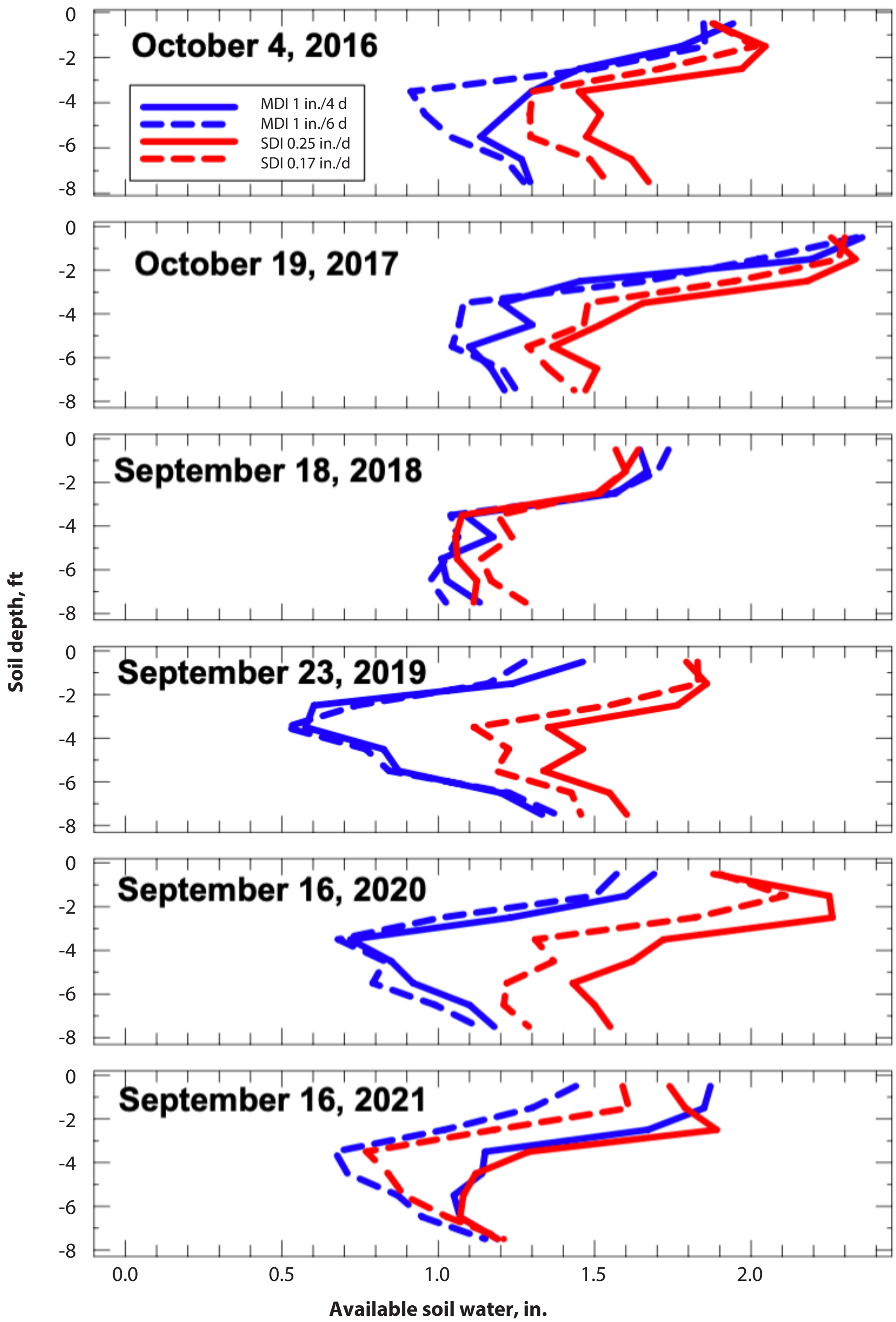


Figure 3. Available soil water within the 8-ft profiles for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

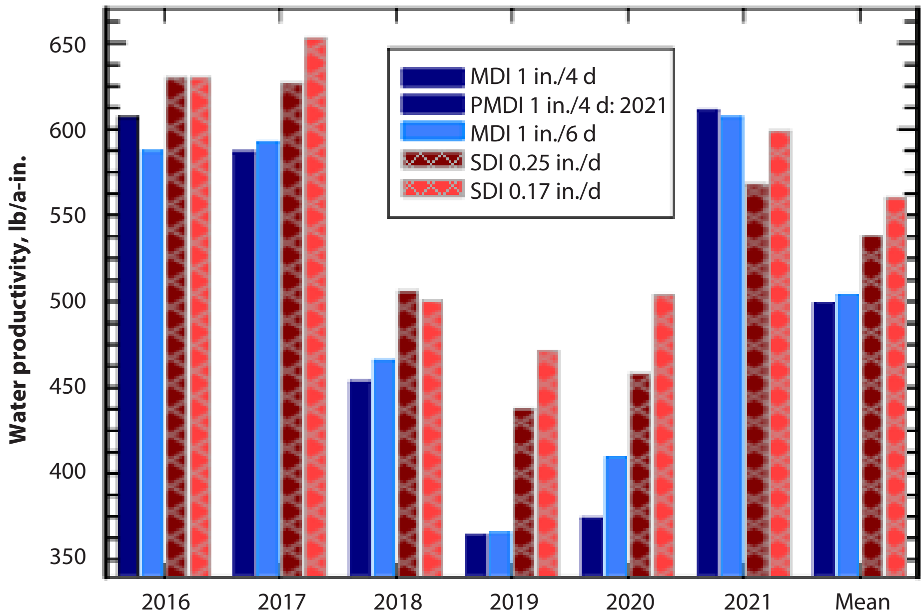


Figure 4. Crop water productivity for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

High Yielding Corn Production with Subsurface Drip Irrigation

F.R. Lamm[1,2]

Summary

This corn intensification study was conducted under subsurface drip irrigation (SDI) from 2017 to 2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS. Two corn hybrids (Pioneer 1151 and Pioneer 11197) were grown with advanced fertilization at three plant densities (42,000, 38,000, and 34,000 plants/a) using three irrigation levels (115, 100, or 85% of calculated well-watered ET minus rain). Average yields were 259, 257, and 254 bu/a for the 115, 100, and 85% ET - Rain irrigation levels respectively, indicating that irrigation does not have to increase with crop intensification when using SDI. Both corn hybrids yielded well, and plant densities that were greater than 34,000 plants/a attained slightly greater yields.

Introduction

Crop production intensification is a key factor for addressing one of the greatest challenges of this century: feeding 9.5 billion people by the year 2050. Inherent in this challenge are the limitations of arable land as well as a shortage of fresh water sources. Ecologically, crop intensification can protect marginal lands from further development and save water resources. Intensification on a smaller land area also has potential to reduce inputs required for crop production and crop protection. These include seed, fertilizer, herbicides, pesticides, crop scouting, crop insurance, harvesting costs and any other input cost that has a fixed cost per land area basis. Crop water productivity (WP) is defined as the crop grain yield divided by the total crop water use. Optimization of irrigation water resource usage is often guided by WP. This term is often used to guide sound use of water resources. In this study, efforts concentrated on increasing the numerator of WP (i.e., corn grain yield), while not adversely increasing the denominator (i.e., crop water use). A subsurface drip-irrigated corn study was conducted from 2017 to 2021 at the K-State Northwest Research-Extension Center at Colby, KS, to intensify corn production through hybrid selection, increased plant density (aka plant population) and through advanced fertilization. A wind storm heavily damaged the crop in 2018 and it was abandoned for research and will not be further discussed in this summary.

Experimental Procedures

Corn was planted in late April or early May in all years at seeding rates of approximately 42,000, 38,000 and 34,000 seeds/a. Selected corn hybrids were Pioneer 1151 and Pioneer 1197. Advanced fertilization procedures varied between years and are listed in Table 1. Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to an 8-ft depth in 1-ft increments with neutron moderation techniques. Corn yield and yield components were determined by hand harvesting at physiological maturity. Crop water use was determined as the sum of the seasonal

[1] Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022.

[2] Special appreciation to Jonathan Aguilar for reviewing this report for final publication.

soil water change, irrigation, and rainfall. Crop water productivity was calculated as grain yield/crop water use. Irrigation was scheduled only as needed to match 115, 100, or 85% of the previous period's ET - Rain. Irrigation amounts per event were generally 1 inch.

Results and Discussion

Growing conditions were favorable for good corn production in all 4 years of the study (2017, 2019-2021), but a wind storm during the overnight period of July 1–2, 2020, definitely limited yields in that year. The wind, coupled with a small amount of small hail, reduced leaf area by 10–20 % when the corn was approximately 5 ft tall. When averaged over the 4 crop years, irrigation amounts were 16.99, 14.65, and 12.30 inches for the 115, 100, and 85% ET - Rain treatments respectively.

Average corn yields were 257 bu/a during the study (Table 2) but varied between years (Figure 1). Yield differences between irrigation levels were very small indicating that replacing irrigation at 85% of ET - Rain would be an acceptable irrigation strategy. Both hybrids yielded well, with Pioneer 1197 yielding better in 3 of the 4 years. There was a 6 bu/a yield benefit of increasing plant density above 34,000 plants/a. Crop water productivity was also high for this study, averaging 520, 558, and 577 lb/acre-in. for the 115, 100, and 85% ET - Rain treatments, respectively (Figure 2). These high yields and high water productivity indicate that intensification of corn is a realistic cropping scenario for the region.

Acknowledgments

This research project received support from the U.S. Department of Agriculture Agricultural Research Service Ogallala Aquifer Program.

Table 1. Advanced fertilization procedures used in the sprinkler-irrigated corn intensification study in 2017, and 2019 to 2021

Application type	Date	Product	Amount
2017 Crop season			
Preplant broadcast	5-08-17	UAN 32-0-0 and NACHURS 9-20-3	44 lb N/a and 11.4 gal/a
Planting in-furrow	5-09-17	Zinc 9%	2 qt/a
Fertigation	6-20-17 6-26-17 7-06-17 7-10-17	UAN 32-0-0 and NACHURS Aquatech 7-20-4	66 lb N/a and 1.875 gal/a total applied in the 4 equal events
Fertigation	7-14-17 7-18-17 7-21-17 7-24-17	UAN 32-0-0 and NACHURS Aquatech 7-20-4	66 lb N/a and 3.75 gal/a total applied in the 4 equal events
Fertigation	7-31-17	NACHURS RhyzoLink LF and NACHURS K-Fuel	28 oz/a and 2 gal/a
Fertigation	7-31-17 8-4-17	UAN 32-0-0, NACHURS Aquatech 7-20-4 and NACHURS 2-6-16	44 lb N/a, 1 gal/a, and 3 gal/a total applied in the 2 equal events
2019 Crop season			
Preplant broadcast	4-29-19	UAN 32-0-0 and NACHURS 10-18-4	44 lb N/a and 12.6 gal/a
Planting in-furrow	4-29-19	Zinc 9%	1 qt/a
Fertigation	6-14-19 6-20-19 6-25-19 6-29-19	UAN 32-0-0 and NACHURS Aquatech 7-20-4	66 lb N/a and 1.875 gal/a total applied in the 3 equal events
Fertigation	7-02-19 7-11-19 7-18-19	UAN 32-0-0 and NACHURS Aquatech 7-20-4	66 lb N/a and 3.75 gal/a total applied in the 4 equal events
Fertigation	7-18-19	NACHURS RhyzoLink LF and NACHURS K-Fuel	28 oz/a and 2 gal/a
Fertigation	7-26-19 7-31-19	UAN 32-0-0, NACHURS Aquatech 7-20-4 and NACHURS 2-6-16	44 lb N/a, 1 gal/a, and 3 gal/a total applied in the 2 equal events
2020 Crop season			
Preplant broadcast	5-05-20	UAN 32-0-0 and NACHURS 10-18-4	44 lb N/a and 12.6 gal/a
Planting in-furrow	5-05-20	Zinc 9%	1 qt/a
Fertigation	6-18-20 6-22-20 6-25-20 6-30-20	UAN 32-0-0 and NACHURS Aquatech 7-20-4	198 lb N/a and 1.875 gal/a total applied in the 3 equal events
Fertigation	7-07-20 7-14-20 7-17-20	NACHURS Aquatech 7-20-4	3.75 gal/a total applied in the 4 equal events
Fertigation	7-17-20	NACHURS RhyzoLink LF and NACHURS K-Fuel	28 oz/a and 2 gal/a
Fertigation	7-23-20 7-31-20	NACHURS Aquatech 7-20-4 and NACHURS 2-6-16	1 gal/a and 3 gal/a total applied in the 2 equal events

continued

Table 1. Advanced fertilization procedures used in the sprinkler-irrigated corn intensification study in 2017, and 2019 to 2021

Application type	Date	Product	Amount
2021 Crop season			
Preplant broadcast	5-05-20	UAN 32-0-0	44 lb N/a
Planting in-furrow	5-05-20	NACHURS ImPulse and NACHURS Crop Watch	6 gal/a and 1 qt/a
Fertigation	6-16-21 6-25-21 6-30-21	UAN 32-0-0, NACHURS Aquatech 7-20-4, NACHURS K-Flex Max and NACHURS Sideswipe	64 lb N/a, 1.875 gal/a, 1 gal/a, and 1 qt/a, total applied in the 3 equal events
Foliar	6-11-21	NACHURS FinishLine and NACHURS K-Fuel	1 qt/a and 1 gal/a
Fertigation	7-02-21 7-09-21	UAN 32-0-0, NACHURS Aquatech 7-20-4, NACHURS K-Flex Max and NACHURS Sideswipe	63 lb N/a, 3.75 gal/a, 1 gal/a, and 1 qt/a, total applied in the 2 equal events
Fertigation	7-20-21 7-25-21	UAN 32-0-0, NACHURS Aquatech 7-20-4, NACHURS K-Flex and NACHURS Sideswipe	45 lb N/a, 3 gal/a, 1 gal/a and 1 qt/a in the 2 equal events

Table 2. Average (2020 to 2021) corn yields, harvest plant density, total crop water use, and water productivity (WP) in a subsurface drip-irrigated corn intensification study

Irrigation treatment	Hybrid	Plant density treatment	Yield	Plant density	Water use	WP
			bu/a	plants/a	inches	lb/acre-in.
1.15 ET 16.99 in.	P 1151	42K	255	41055	27.05	527
		38 K	261	37189	26.99	541
		34K	248	33323	26.98	514
		Mean	255	37189	27.01	527
	P 1197	42K	268	41382	27.48	545
		38 K	265	37135	28.10	528
		34K	257	33215	27.13	532
		Mean	263	37244	27.57	535
	Mean		259	37217	27.29	531
1.00 ET 14.65 in.	P 1151	42K	247	41164	24.51	611
		38 K	254	37788	25.32	562
		34K	254	33487	25.29	562
		Mean	252	37480	25.04	578
	P 1197	42K	265	41110	26.15	567
		38 K	262	37353	25.49	576
		34K	261	33487	26.07	564
		Mean	263	37316	25.90	569
	Mean		257	37398	25.47	574
0.85 ET 12.30 in.	P 1151	42K	252	40729	24.22	585
		38 K	251	37516	23.64	597
		34K	241	33541	23.43	578
		Mean	248	37262	23.76	587
	P 1197	42K	265	40892	24.86	599
		38 K	258	37462	24.86	581
		34K	256	33215	24.88	578
		Mean	260	37189	24.87	586
	Mean		254	37226	24.32	586
Grand mean			257	37280	25.69	564

continued

Table 2. Average (2020 to 2021) corn yields, harvest plant density, total crop water use, and water productivity (WP) in a subsurface drip-irrigated corn intensification study

Irrigation treatment	Hybrid	Plant density treatment	Yield	Plant density	Water use	WP
			bu/a	plants/a	inches	lb/acre-in.
Mean by category						
1.15 ET			259	37217	27.29	531
1.00 ET			257	37398	25.47	574
0.85 ET			254	37226	24.32	586
	P1151		251	37310	25.27	564
	P1197		262	37250	26.11	563
		42K	259	41055	25.71	572
		38K	259	37407	25.73	564
		34K	253	33378	25.63	555

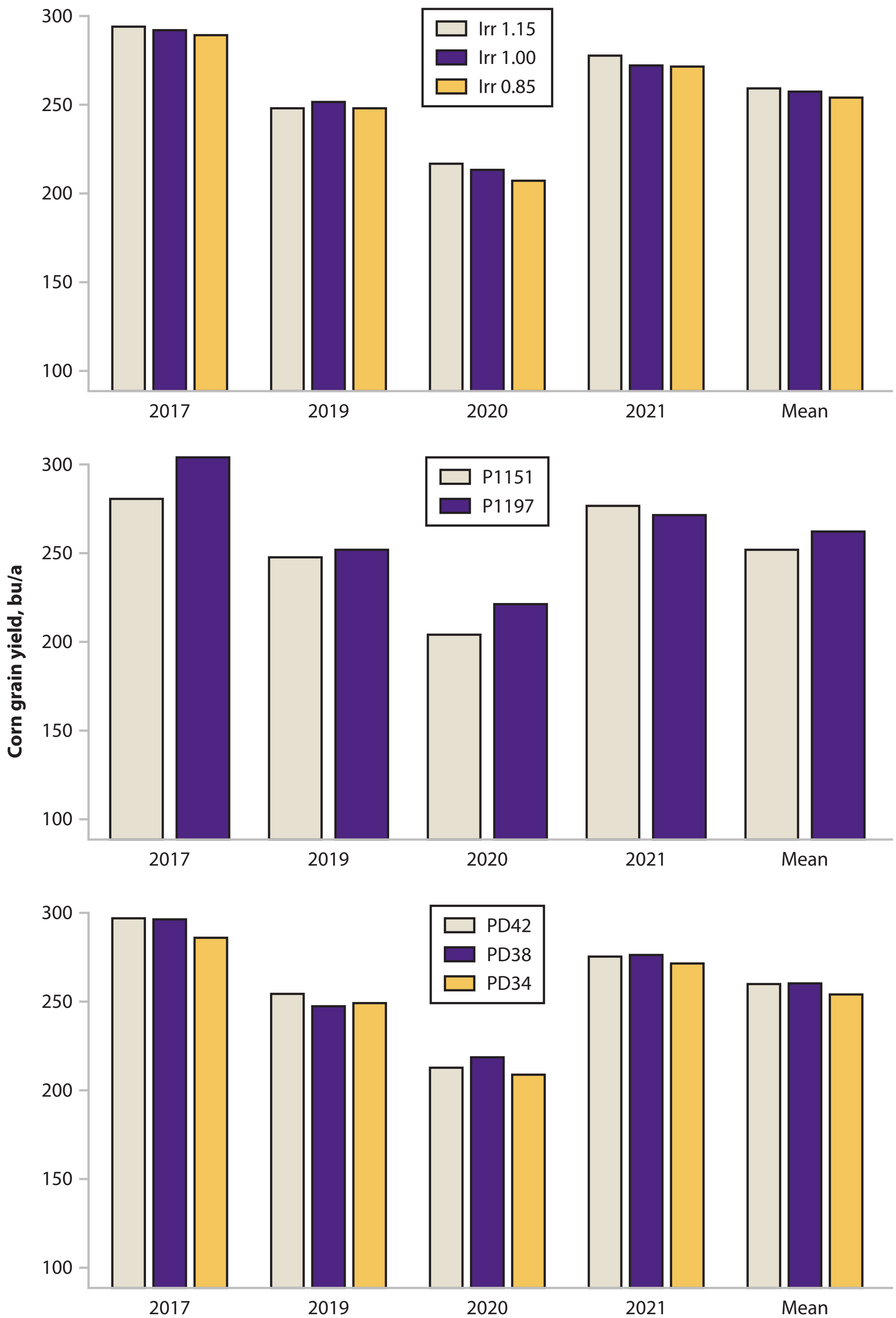


Figure 1. Corn grain yields (2017, 2019–2021) for a subsurface drip irrigation (SDI) crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel is for the two corn hybrids Pioneer 1151 and Pioneer 1197. Bottom panel is for the three plant densities, 42,000, 38,000, or 34,000 plants/a.

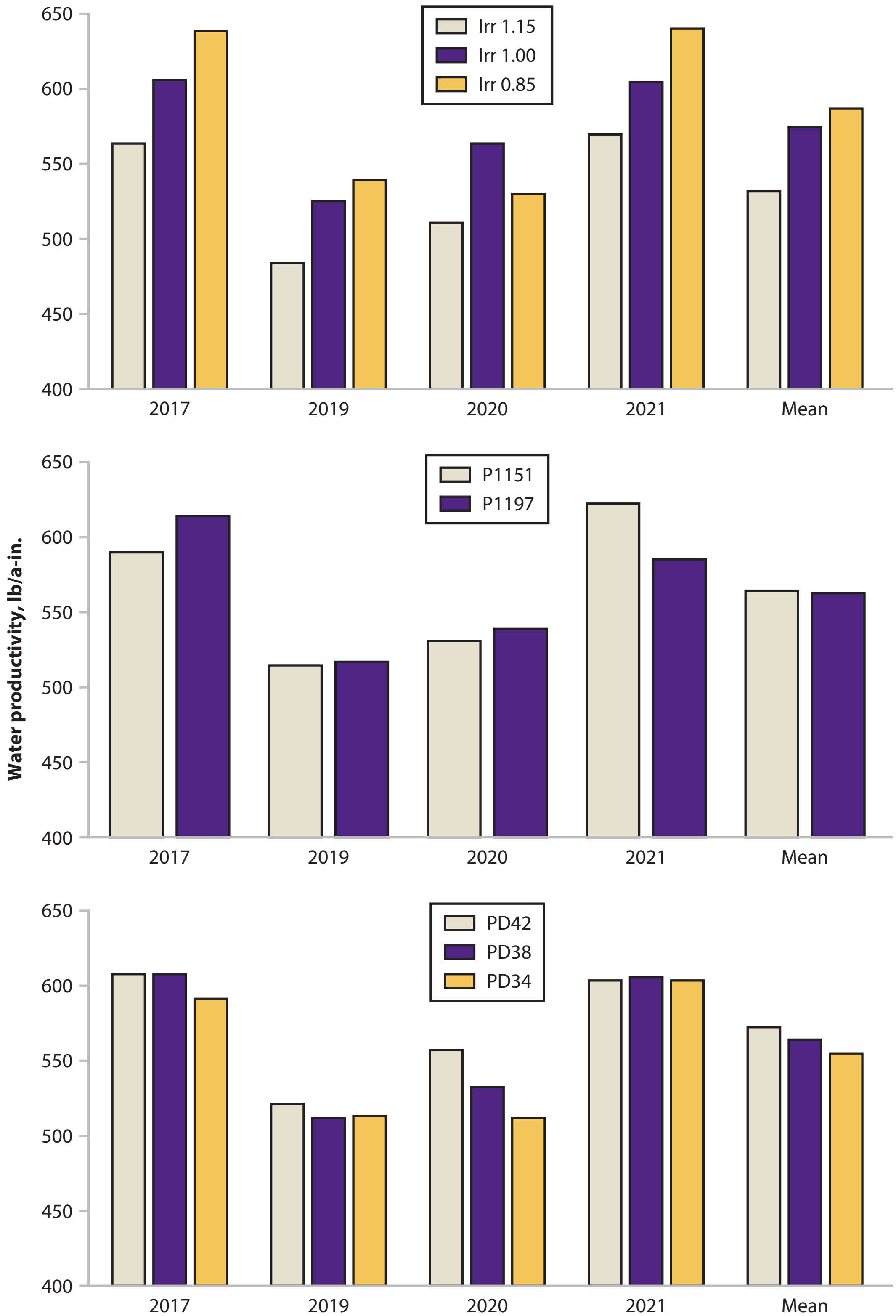


Figure 2. Crop water productivity (2017, 2019–2021) for a subsurface drip irrigation (SDI) crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel is for the two corn hybrids Pioneer 1151 and Pioneer 1197. Bottom panel is for the three plant densities, 42,000, 38,000, or 34,000 plants/a.

Industrial Weed Control with Plainview, Esplanade, and Method Application Timings

R.S. Currie and P.W. Geier

Summary

The objective of this trial was to compare Plainview, Esplanade, and Method at three applications for season-long weed control in noncropland. Glyphosate alone provided no residual weed control. Plainview (indaziflam/aminocyclopyrachlor/imazapyr) at 64 oz/a applied in the early or late fall controlled kochia similarly to Krovar (bromacil/diuron) late in the season. Either rate of Plainview, as well as the tank mixture of Esplanade (aminocyclopyrachlor) plus Method (indaziflam), provided complete woollyleaf bursage control regardless of application timing. No treatment of Krovar controlled woollyleaf bursage more than 60%.

Introduction

Industrial sites such as railroads, electrical utilities, and pipelines often use nonselective, persistent herbicides to maintain total vegetative control. Some of the key benefits of total vegetative control include improved site appearance, minimizing fire hazards, and facilitating visual inspection of equipment. The objective of this trial was to compare Plainview, Esplanade, and Method at three applications for season-long weed control in noncropland.

Experimental Procedures

An experiment was conducted to evaluate nonselective herbicides at three application timings for noncropland weed control. All herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on May 12, August 13, and October 11, 2021. These dates were approximately 2, 5, and 7 months after the early spring applications (MA-C).

Results and Discussion

Glyphosate provided no residual kochia or woollyleaf bursage control regardless of application time (Table 2). All other herbicides controlled kochia 100% at 2 MA-C. Kochia control at 5 MA-C remained high when Plainview was applied in early fall or late fall, and with Krovar at any application timing. These same treatments controlled kochia 84% or more at 7 MA-C. Woollyleaf bursage control was complete with Plainview or Esplanade plus Method regardless of application timing or rating date. Conversely, no treatment of Krovar provided more than 60% woollyleaf bursage control.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Application, environmental, and weed data for the industrial weed control study

Application timing	Early fall	Late fall	Early spring
Application date	October 8, 2020	December 9, 2020	March 11, 2021
Air temperature (°F)	79	71	55
Relative humidity	28	14	30
Soil temperature (°F)	64	38	53
Wind speed (mph)	1 to 4	0 to 3	4 to 8
Wind direction	South	North-northwest	East-northeast
Soil moisture	Dry	Dry	Dry
Kochia			
Height (inches)	---	---	0.5
Density (plants/ft^2)	0	0	1
Woollyleaf bursage			
Height (inches)	3 to 6	2 to 4	---
Density (plants/ft^2)	1	1	0

Table 2. Efficacy in the industrial weed control study

Treatment	Rate, oz/a	Timing	Kochia			Woollyleaf bursage		
			2 MA-C[1]	5 MA-C	7 MA-C	2 MA-C	5 MA-C	7 MA-C
Glyphosate	64	Early Fall	0	0	0	0	0	0
NIS	0.25%	Early Fall						
Plainview SC	48	Early Fall	100	90	84	100	100	100
Glyphosate	64	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Plainview SC	64	Early Fall	100	90	88	100	100	100
Glyphosate	64	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Krovar DF	128	Early Fall	100	100	100	53	60	57
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Esplanade	5	Early Fall	100	84	79	100	100	100
Method 240 SL	12	Early Fall						
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Glyphosate	2.5	Late Fall	0	0	0	0	0	0
Nonionic surfactant	0.25%	Late Fall						
Plainview SC	48	Late Fall	100	85	81	100	100	100
Glyphosate	64	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Plainview SC	64	Late Fall	100	91	90	100	100	100
Glyphosate	64	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Krovar DF	128	Late Fall	100	100	100	50	60	60
Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Esplanade	5	Late Fall	100	68	63	100	100	100
Method 240 SL	12	Late Fall						
Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						

continued

Table 2. Efficacy in the industrial weed control study

			Kochia			Woollyleaf bursage		
Treatment	**Rate, oz/a**	**Timing**	**2 MA-C[1]**	**5 MA-C**	**7 MA-C**	**2 MA-C**	**5 MA-C**	**7 MA-C**
Glyphosate	2.5	Early Spring	0	0	0	0	0	0
Nonionic surfactant	0.25%	Early Spring						
Plainview SC	48	Early Spring	98	68	63	100	100	100
Glyphosate	64	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Plainview SC	64	Early Spring	100	78	70	100	100	100
Glyphosate	64	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Krovar DF	128	Early Spring	100	100	100	53	58	55
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Esplanade	5	Early Spring	100	63	55	100	100	100
Method 240 SL	12	Early Spring						
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
LSD (0.05)			2	12	14	6	4	3

[1] MA-C = months after the early spring applications.

ImiFlex Rates for Efficacy in Imidazolinone-Tolerant Grain Sorghum

R.S. Currie and P.W. Geier

Summary
The objective of this study was to compare ImiFlex rates and timings for efficacy and crop response in imidazolinone-tolerant grain sorghum. Volunteer corn and Johnsongrass control was generally best when ImiFlex (imazamox) was applied postemergence (POST), except when tank mixed with Huskie (bromoxynil/pyrasulfotole). Likewise, Palmer amaranth control was most consistent when ImiFlex was applied POST. Though all herbicides increased grain yields relative to the weedy controls, yields increased the most when Moccasin II Plus (metolachlor) plus Motif (mesotrione) preemergence (PRE) was followed by ImiFlex POST or Moccasin II Plus and Sharpen (saflufenacil) PRE was followed by ImiFlex plus atrazine POST.

Introduction
Historically, producers have had limited options for postemergence grass control in grain sorghum. Troublesome grass weeds that escaped a preemergence herbicide treatment can negatively impact yields. Several herbicide-tolerant sorghum technologies have recently been developed to address this need. Imidazolinone-tolerant (Igrowth) sorghum is one such technology. The objective of this study was to compare ImiFlex rates and timings for efficacy and crop response in imidazolinone-tolerant grain sorghum.

Experimental Procedures
An experiment compared ImiFlex rates and timings for efficacy and crop response in imidazolinone-tolerant grain sorghum. All herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on July 14 and August 23, 2021. These dates were 2 and 42 days after the late postemergence treatments (DA-B), respectively. Yields were determined on November 23, 2021, by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Results and Discussion
ImiFlex at 9.0 oz/a applied PRE controlled the volunteer corn 63 to 88% regardless of the tank mix partner early in the season (Table 2). By 42 DA-B, volunteer corn control exceeded 90% with ImiFlex PRE alone, or with Moccasin II Plus and Motif PRE, followed by atrazine postemergence (POST), and with Moccasin II Plus with Motif or Sharpen PRE followed by ImiFlex at 6.0 oz/a POST. Late-season Johnsongrass control was best (95 to 99%) when ImiFlex was applied POST. However, tank mixing Huskie with ImiFlex POST provided only 85% Johnsongrass control. ImiFlex applied POST controlled Palmer amaranth 86 to 96% at 42 DA-B, and was similar to ImiFlex plus

Motif PRE followed by atrazine POST. Grain yields from herbicide-treated sorghum were 29 to 66 bu/a greater than the untreated controls. Yields were best when Moccasin II Plus and Motif PRE were applied followed by ImiFlex POST or Moccasin II Plus and Sharpen PRE were followed by ImiFlex plus atrazine POST.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Application, environmental, and weed data for the ImiFlex sorghum trial

Application timing	Preemergence	Postemergence
Application date	June 16, 2021	July 12, 2021
Air temperature (°F)	87	78
Relative humidity	43	42
Soil temperature (°F)	77	72
Wind speed (mph)	4 to 11	3 to 7
Wind direction	South	South
Soil moisture	Good	Good
Grain sorghum		
Height (inches)	---	12 to 15
Leaves (no.)	0	5 to 7
Palmer amaranth		
Height (inches)	---	2 to 6
Density (plants/ft^2)	0	1
Volunteer corn		
Height (inches)	---	10 to 15
Density (plants/ft^2)	0	0.3
Johnsongrass		
Height (inches)	---	3 to 7
Density (plants/ft^2)	0	0.5

Table 2. Weed control and grain yield in the ImiFlex sorghum study

Treatment[1]	Rate	Timing[2]	Volunteer corn 2 DA-B[3]	Volunteer corn 42 DA-B	Johnsongrass 2 DA-B	Johnsongrass 42 DA-B	Palmer amaranth 2 DA-B	Palmer amaranth 42 DA-B	Sorghum yield
	oz/a		% Visual						bu/a
Untreated	---	---	---	---	---	---	---	---	29.9
ImiFlex	9.0	PRE	70	88	73	73	75	78	83.3
Atrazine	32	PRE							
2,4-D amine	8.0	POST							
ImiFlex	9.0	PRE	75	83	90	83	94	91	90.4
Motif	6.0	PRE							
Atrazine	32	POST							
COC	1%	POST							
ImiFlex	9.0	PRE	83	85	75	75	80	73	74.2
Sharpen	1.0	PRE							
Atrazine	32	POST							
COC	1%	POST							
ImiFlex	9.0	PRE	78	88	84	73	85	81	77.6
Moccasin II Plus	21	PRE							
Atrazine	32	POST							
COC	1%	POST							
ImiFlex	9.0	PRE	63	98	80	83	78	65	59.3
Atrazine	32	POST							
COC	1%	POST							
UAN	2.5%	POST							
ImiFlex	9.0	PRE	88	91	90	83	94	85	93.3
Moccasin II Plus	21	PRE							
Motif	6.0	PRE							
Atrazine	32	POST							
COC	1%	POST							
Moccasin II Plus	21	PRE	0	99	88	99	95	91	95.8
Motif	6.0	PRE							
ImiFlex	6.0	POST							
COC	1%	POST							
UAN	2.5%	POST							
Moccasin II Plus	21	PRE	0	99	80	95	81	86	95.1
Sharpen	1.0	PRE							
ImiFlex	6.0	POST							
Atrazine	32	POST							
COC	1%	POST							
UAN	2.5%	POST							
Moccasin II Plus	21	PRE	0	100	78	98	91	96	93.7
Motif	6.0	PRE							
ImiFlex	6.0	POST							
Atrazine	32	POST							
COC	1%	POST							
UAN	2.5%	POST							

Table 2. Weed control and grain yield in the ImiFlex sorghum study

Treatment[1]	Rate	Timing[2]	Volunteer corn		Johnsongrass		Palmer amaranth		Sorghum yield
			2 DA-B[3]	42 DA-B	2 DA-B	42 DA-B	2 DA-B	42 DA-B	
	oz/a		------------------------------------- % Visual -------------------------------------						bu/a
Moccasin II Plus	21	PRE	0	0	70	0	83	75	60.9
Atrazine	32	PRE							
Huskie	14	POST							
AMS	1.0	POST							
Moccasin II Plus	21	PRE	0	86	70	85	85	93	82.5
Atrazine	32	PRE							
ImiFlex	6.0	POST							
Huskie	14	POST							
LSD (0.05)			8	10	15	12	12	10	20.7

[1] COC = crop oil concentrate. UAN = 28% urea-ammonium nitrate. AMS = ammonium sulfate.
[2] PRE = preemergence. POST = postemergence.
[3] DA-B = days after the postemergence treatments.

Single and Split Herbicide Applications for Efficacy in Corn

R.S. Currie and P.W. Geier

Summary
The objective of this study was to compare season-long weed control from single and sequential herbicide applications in corn. Control of all weed species was generally good (90% or more) early in the season regardless of preemergence (PRE) herbicide. However, Russian thistle and Palmer amaranth control was best later in the season when a PRE herbicide was followed by a postemergence (POST) treatment. While all herbicide treatments increased yields compared to the untreated control, yields were greatest when Lumax EZ PRE (atrazine/mesotrione/metolachlor) was followed by Acuron (atrazine/ bicyclopyrone/mesotrione/metolachlor) and glyphosate POST.

Introduction
Early season weed control is important to reduce competition during crop establishment. Typically, this is accomplished with burndown herbicides or tillage prior to planting and application of residual herbicides near planting time. Delaying a portion of the residual herbicide until after the crop emerges can extend the weed-free period later into the growing season. The objective of this study was to compare single application preemergence herbicides with split applications for season-long efficacy in corn.

Experimental Procedures
An experiment was conducted to compare residual herbicides applied in single or split applications for efficacy in corn. All herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on May 28 and July 19, 2021. These dates were 28 days after the preemergence treatments (28 DA-A), and 46 days after the postemergence treatments (46 DA-B), respectively. Corn chlorosis was evaluated on June 6 and June 18, 2021, which was 3 and 15 days after the postemergence treatments (DA-B). Yields were determined on October 5, 2021, by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Results and Discussion
Sunflower control was 90% or more regardless of herbicide or application timing, and did not differ (data not shown). Kochia and Russian thistle control were similar among all preemergence (PRE) herbicide treatments at 26 DA-A (Table 2). By 46 DA-B, control of each of these weed species was complete with all PRE followed by postemergence (POST) herbicides. Similarly, Palmer amaranth control with all sequential treatments was 95 to 98% at 46 DA-B. Although minor corn chlorosis was evident with most POST herbicides at 3 DA-B, visual injury did not persist (Table 3). All herbicides increased grain yields 71 to 104 bu/a compared to the untreated control. Lumax EZ

PRE followed by Acuron plus glyphosate resulted in the highest yields, and was better than any herbicide treatment applied PRE alone.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Application, environmental, and weed data for the single and split application study

Application timing	Preemergence	Postemergence
Application date	April 30, 2021	June 3, 2021
Air temperature (°F)	63	86
Relative humidity	37	32
Soil temperature (°F)	52	70
Wind speed (mph)	2 to 5	0 to 2
Wind direction	West	South
Soil moisture	Good	Good
Corn		
Height (inches)	---	6 to 9
Leaves (no.)	0	3 to 4
Kochia		
Height (inches)	---	1 to 2
Density (plants/ft^2)	0	0.5
Russian thistle		
Height (inches)	---	1 to 3
Density (plants/ft^2)	0	1
Palmer amaranth		
Height (inches)	---	1 to 3
Density (plants/ft^2)	0	1
Common sunflower		
Height (inches)	---	3 to 5
Density (plants/ft^2)	0	0.5

Table 2. Weed control with single and split herbicide applications in corn

			Kochia		Russian thistle		Palmer amaranth	
Treatment[1]	**Rate**	**Timing[2]**	**28 DA-A[3]**	**46 DA-B[3]**	**28 DA-A**	**46 DA-B**	**28 DA-A**	**46 DA-B**
	qt/a		% Visual					
Lumax EZ	2.7	PRE	100	85	96	80	100	75
Acuron	3.0	PRE	100	100	100	90	100	85
Atrazine	0.5	PRE						
Lumax EZ	1.35	PRE	100	100	98	100	98	96
Acuron	1.5	POST						
Glyphosate	0.84	POST						
AMS	1%	POST						
Bicep Lite II Magnum	1.5	PRE	100	100	90	100	93	98
Halex GT	1.8	POST						
Atrazine	0.5	POST						
Glyphosate	0.84	POST						
NIS	0.25%	POST						
AMS	1%	POST						
Bicep Lite II Magnum	1.1	PRE	99	100	90	100	85	95
Bicep Lite II Magnum	1.5	POST						
Glyphosate	0.84	POST						
AMS	1%	POST						
Acuron	1.5	PRE	98	100	98	100	98	96
Acuron	1.5	POST						
Glyphosate	0.84	POST						
AMS	1%	POST						
Resicore	1.25	PRE	96	100	93	100	95	98
Resicore	1.25	POST						
Glyphosate	0.84	POST						
AMS	1%	POST						
LSD (0.05)			NS	6	NS	5	7	7

[1] AMS = ammonium sulfate. NIS = nonionic surfactant.
[2] PRE = preemergence. POST = postemergence.
[3] 28 DA-A = 28 days after the preemergence applications. 46 DA-B = 46 days after the postemergence treatments.

Table 3. Crop response to the single and split herbicide applications in corn

Treatment[1]	Rate	Timing[2]	Chlorosis 3 DA-B[3]	Chlorosis 15 DA-B[3]	Yield
	qt/a		---------- % Visual ----------		bu/a
Nontreated control			0	0	6.8
Lumax EZ	2.7	PRE	0	0	78.1
Acuron	3.0	PRE	0	0	91.1
Atrazine	0.5	PRE			
Lumax EZ	1.35	PRE	4	0	111.6
Acuron	1.5	POST			
Glyphosate	0.84	POST			
AMS	1%	POST			
Bicep Lite II Magnum	1.5	PRE	4	0	98.6
Halex GT	1.8	POST			
Atrazine	0.5	POST			
Glyphosate	0.84	POST			
NIS	0.25%	POST			
AMS	1%	POST			
Bicep Lite II Magnum	1.1	PRE	8	0	102.3
Bicep Lite II Magnum	1.5	POST			
Glyphosate	0.84	POST			
AMS	1%	POST			
Acuron	1.5	PRE	5	0	96.2
Acuron	1.5	POST			
Glyphosate	0.84	POST			
AMS	1%	POST			
Resicore	1.25	PRE	1	0	96.8
Resicore	1.25	POST			
Glyphosate	0.84	POST			
AMS	1%	POST			
LSD (0.05)			3	NS	20.4

[1] AMS = ammonium sulfate. NIS = nonionic surfactant.
[2] PRE = preemergence. POST = postemergence.
[3] DA-B = days after the postemergence treatments.

Assure II Alone and with Tacoma and Classic for Efficacy in Fallow

R.S. Currie and P.W. Geier

Summary
The objective of this trial was to compare Assure II (quizalofop) at two rates with or without tank mix partners for grass control in fallow. Assure II at either rate alone provided similar control of volunteer corn and barley. Corn control was 90% or more regardless of rating date with all herbicides except Assure II at 8.0 oz/a plus Classic (chlorimuron) at 42 days after treatment (DAT). Tacoma (fenoxaprop) at 3.5 or 5.4 oz/a added to Assure II at 8.0 oz/a improved barley control later in the season.

Introduction
Weed control, including volunteer crops, is important during the fallow period between crops. With the advent of herbicide-resistant crops such as corn, traditional herbicides such as glyphosate may not be effective. The objective of this study was to evaluate Assure II alone or with tank mixtures for grass control in fallow.

Experimental Procedures
An experiment was conducted to compare Assure II alone and in tank mixtures for grass control in fallow. All herbicides were applied postemergence using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on June 11, June 25, and July 9, 2021. These dates were 14, 28, and 42 DAT.

Results and Discussion
Volunteer corn and volunteer barley were the only grass weeds emerged at the time of herbicide application and the only weeds evaluated. Increasing the rate of Assure II from 6.0 to 8.0 oz/a did not improve volunteer corn or barley at any rating date (Table 2). The addition of Tacoma or Tacoma plus Classic at the higher rates improved volunteer corn control compared to Assure II alone at 14 DAT. By 42 DAT, only the treatment of Assure II plus Classic provided less than 90% corn control. All herbicides provided 90% or more volunteer barley control. The addition of Tacoma, at any rate, increased barley control compared to Assure II at 8.0 oz/a alone at 14 DAT. The addition of Tacoma at 3.5 and 5.4 oz/a also increased barley control at 28 and 42 DAT.

Table 1. Application, environmental, and weed data for the quizalofop, fenoxaprop, and chlorimuron fallow study

Application date	May 28, 2021
Air temperature (°F)	55
Relative humidity	66
Soil temperature (°F)	60
Wind speed (mph)	1 to 4
Wind direction	East
Soil moisture	Good
Volunteer corn	
Height (inches)	1 to 3
Density (plants/ft^2)	2
Volunteer barley	
Height (inches)	2 to 5
Density (plants/ft^2)	20

Table 2. Grass weed control with quizalofop alone and in mixtures in fallow

		Volunteer corn			Volunteer barley		
Treatment[1]	Rate	14 DAT[2]	28 DAT	42 DAT	14 DAT	28 DAT	42 DAT
	oz/a	--- % Visual ---					
Assure II COC	6.0 1.0%	86	98	98	95	95	94
Assure II Tacoma COC	6.0 2.6 1.0%	92	98	96	98	99	98
Assure II Tacoma COC	6.0 3.3 1.0%	93	99	98	100	98	96
Assure II Tacoma COC	6.0 4.0 1.0%	94	98	99	100	99	98
Assure II COC	8.0 1.0%	91	96	91	91	95	90
Assure II Tacoma COC	8.0 3.5 1.0%	97	98	95	100	100	99
Assure II Tacoma COC	8.0 4.4 1.0%	97	100	100	100	98	96
Assure II Tacoma COC	8.0 5.4 1.0%	98	98	98	100	100	99
Assure II Classic COC	8.0 0.5 1.0%	83	88	85	98	100	100
Assure II Tacoma Classic COC	8.0 3.5 0.5 1.0%	88	92	90	100	100	100
Assure II Tacoma Classic COC	8.0 4.4 0.5 1.0%	95	95	94	100	100	100
Assure II Tacoma Classic COC	8.0 5.4 0.5 1.0%	93	93	90	100	99	98
LSD (0.05)		6	6	7	5	4	6

[1] COC = crop oil concentrate.
[2] DAT = days after treatment.

Katagon at Two Timings Compared to Standards in Corn

R.S. Currie and P.W. Geier

Summary
The objective of this trial was to compare Katagon (tolpyralate/nicosulfuron) to standard treatments for weed control in corn. Katagon plus atrazine applied early postemergence was as effective as any herbicide tested on the weeds present. When application timing was delayed to late postemergence, most herbicides were less effective. Early season corn injury was minor and did not persist. Although most herbicide treatments increased yields relative to the non-treated control, yields were generally best when any treatment was applied early postemergence.

Introduction
Katagon is a relatively new herbicide that combines two chemistries, tolpyralate and nicosulfuron, for weed control in corn. Tolpyralate is an HPPD-inhibiting herbicide which may have utility in controlling weeds resistant to other herbicide modes of action. Nicosulfuron is an ALS-inhibiting herbicide that has long been used for grass control in corn. The objective of this study was to compare Katagon at two application timings to standard herbicides for efficacy in corn.

Experimental Procedures
An experiment was conducted to compare Katagon applied at two application timings to competitive standard practices for efficacy in corn. All herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on June 18 and July 2, 2021. These dates were 6 and 20 days after the late postemergence treatments (DA-B), respectively. Corn chlorosis was evaluated on June 6 and June 18, 2021, which was 2 days after the early postemergence treatments (2 DA-A), and 6 DA-B, respectively. Yields were determined on October 6, 2021, by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Results and Discussion
Katagon plus atrazine applied early postemergence (EPOST) controlled all weed species with results similar to Capreno (tembotrione/thiencarbazone), Armezon Pro (dimethenamid/topramezone), or Coyote (metolachlor/mesotrione), each with atrazine, applied EPOST (Tables 2 and 3). Late- postemergence (LPOST) applications of these herbicides without atrazine were less effective on all species except common lambsquarters (97 to 100% control), and when Coyote was applied to green foxtail (33 to 35% control) late in the season. Less corn chlorosis was observed with Katagon applied EPOST than with Armezon Pro or Coyote at 2 DA-A (Table 3). However, injury did not persist. All herbicides increased grain yields 59 to 165 bu/a relative to the untreated

control except Coyote LPOST. Yields were greatest when any of the herbicides evaluated was applied EPOST and when Status (dicamba/diflufenzopyr) plus glyphosate was applied LPOST. Delaying herbicide treatment to LPOST resulted in yields 61 to 124 bu/a less than with the same treatments applied EPOST.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Application, environmental, and weed data for Katagon study

Application timing	Early postemergence	Late postemergence
Application date	June 4, 2021	June 12, 2021
Air temperature (°F)	77	75
Relative humidity	60	64
Soil temperature (°F)	68	76
Wind speed (mph)	2 to 5	2 to 6
Wind direction	South	East
Soil moisture	Good	Good
Corn		
Height (inches)	5 to 7	9 to 12
Leaves (no.)	2 to 3	4 to 6
Kochia		
Height (inches)	1 to 3	3 to 5
Density (plants/ft^2)	0.5	0.5
Russian thistle		
Height (inches)	2 to 4	4 to 6
Density (plants/ft^2)	1	0.5
Palmer amaranth		
Height (inches)	1 to 4	4 to 10
Density (plants/ft^2)	3	2
Common lambsquarters		
Height (inches)	1 to 2	2 to 6
Density (plants/ft^2)	0.5	0.5
Green foxtail		
Height (inches)	1 to 2	2 to 6
Density (plants/ft^2)	0.5	0.5

Table 2. Weed control in the Katagon study

Treatment[1]	Rate	Timing[2]	Palmer amaranth		Common lambs-quarters		Russian thistle	
			6 DA-B[3]	20 DA-B	6 DA-B	20 DA-B	6 DA-B	20 DA-B
	oz/a		% Visual					
Katagon	3.2	EPOST	95	89	100	100	100	100
Atrazine	32	EPOST						
HSOC	1%	EPOST						
Katagon	3.2	LPOST	45	60	48	97	40	60
HSOC	1%	LPOST						
Capreno	3.0	EPOST	96	86	100	100	100	100
Atrazine	32	EPOST						
COC	1%	EPOST						
AMS	1%	EPOST						
Capreno	3.0	LPOST	50	53	55	100	53	55
COC	1%	LPOST						
AMS	1%	LPOST						
Armezon Pro	20	EPOST	94	88	100	100	100	100
Atrazine	32	EPOST						
COC	1%	EPOST						
AMS	1%	EPOST						
Armezon Pro	20	LPOST	55	53	48	98	48	55
COC	1%	LPOST						
AMS	1%	LPOST						
Coyote	64	EPOST	94	88	100	100	100	100
Atrazine	1.0	EPOST						
COC	1%	EPOST						
AMS	1%	EPOST						
Coyote	64	LPOST	35	23	48	100	40	43
COC	1%	LPOST						
AMS	1%	LPOST						
Status	5.0	LPOST	96	96	100	100	100	100
Glyphosate	22	LPOST						
NIS	0.25%	LPOST						
AMS	1%	LPOST						
LSD (0.05)			6	9	9	NS	6	8

[1] HSOC = high surfactant oil concentrate. COC = crop oil concentrate. AMS = ammonium sulfate. NIS = nonionic surfactant.
[2] EPOST = early postemergence. LPOST = late postemergence.
[3] DA-B = days after the late postemergence treatments.

Table 3. Weed control and crop response in the Katagon study

Treatment[1]	Rate	Timing[2]	Kochia 6 DA-B[3]	Kochia 20 DA-B	Green foxtail 6 DA-B	Green foxtail 20 DA-B	Corn chlorosis 2 DA-A[4]	Corn chlorosis 6 DA-B	Corn yield
	lb/a		% Visual						bu/a
Nontreated	---	---	---	---	---	---	0	0	15.4
Katagon	3.2	EPOST	99	99	99	99	5	0	175.3
Atrazine	32	EPOST							
HSOC	1%	EPOST							
Katagon	3.2	LPOST	45	45	30	70	---	0	114.2
HSOC	1%	LPOST							
Capreno	3.0	EPOST	100	100	100	96	1	0	180.6
Atrazine	32	EPOST							
COC	1%	EPOST							
AMS	1%	EPOST							
Capreno	3.0	LPOST	58	58	35	68	---	0	74.9
COC	1%	LPOST							
AMS	1%	LPOST							
Armezon Pro	20	EPOST	100	100	100	100	11	0	173.6
Atrazine	32	EPOST							
COC	1%	EPOST							
AMS	1%	EPOST							
Armezon Pro	20	LPOST	100	100	45	65	---	0	75.6
COC	1%	LPOST							
AMS	1%	LPOST							
Coyote	64	EPOST	48	48	73	35	18	0	154.3
Atrazine	1.0	EPOST							
COC	1%	EPOST							
AMS	1%	EPOST							
Coyote	64	LPOST	99	99	23	33	---	0	30.1
COC	1%	LPOST							
AMS	1%	LPOST							
Status	5.0	LPOST	100	100	95	100	---	0	180.4
Glyphosate	22	LPOST							
NIS	0.25%	LPOST							
AMS	1%	LPOST							
LSD (0.05)			45	45	8	11	3	NS	26.6

[1] HSOC = high surfactant oil concentrate. COC = crop oil concentrate. AMS = ammonium sulfate. NIS = nonionic surfactant.
[2] EPOST = early postemergence. LPOST = late postemergence.
[3] DA-B = days after the late postemergence treatments.
[4] DA-A = days after the early postemergence treatments.

FirstAct for Efficacy in ACCase-Tolerant Grain Sorghum

R.S. Currie and P.W. Geier

Summary
The objective of this study was to compare FirstAct with several tank mix partners for efficacy in herbicide-tolerant grain sorghum. FirstAct (quizalofop) alone or in tank mixtures controlled Johnsongrass 94% or more. However, tank mixing FirstAct with any broadleaf herbicide was generally antagonistic to Palmer amaranth control. Minor sorghum injury was 5% or less by four weeks after postemergence treatment. Sorghum yields increased with all postemergence treatments except with atrazine alone.

Introduction
Postemergence grass control in grain sorghum is currently limited to very few herbicides. Consequently, grass weeds that escape a preemergence herbicide can cause severe yield reductions. FirstAct is a grass herbicide that is studied for use in ACCase-tolerant (Double Team) grain sorghum. The objective of this study was to compare FirstAct with several tank mix partners for efficacy in herbicide-tolerant grain sorghum.

Experimental Procedures
An experiment was conducted to compare FirstAct with various tank mix partners for weed control in acetyl CoA carboxylase (ACCase)-tolerant grain sorghum. All herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on July 27 and August 24, 2021. These dates were 14 and 42 days after the postemergence treatments (DA-B), respectively. Sorghum injury response was visually estimated on July 27, August 10, and August 24, 2021 (14, 28, and 42 DA-B). Yields were determined on November 23, 2021 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Results and Discussion
FirstAct applied at 10 oz/a applied postemergence controlled Johnsongrass 94% or more regardless of tank mix partner or rating date (Table 2). Conversely, Palmer amaranth control was generally lower with FirstAct tank mixtures compared to Huskie (bromoxynil/pyrasulfotole) plus atrazine or Kochiavore (2,4-D/bromoxynil/fluroxypyr) alone postemergence. Minor sorghum necrosis and sprawling occurred with FirstAct plus 2,4-D amine or dicamba, and with Kochiavore at 14 DA-B (Table 3). Visual sorghum injury declined to 5% or less by 42 DA-B. Grain yields increased 34 to 64 bu/a with all postemergence treatments except atrazine alone. The highest yields occurred when FirstAct alone or FirstAct plus dicamba were applied postemergence.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Application, environmental, and weed data for the ACCase-tolerant sorghum trial in Kansas

Application timing	Preemergence	Postemergence
Application date	June 17, 2021	July 13, 2021
Air temperature (°F)	73	75
Relative humidity	47	61
Soil temperature (°F)	76	73
Wind speed (mph)	2 to 5	1 to 4
Wind direction	South	South
Soil moisture	Good	Good
Grain sorghum		
Height (inches)	---	12 to 18
Leaves (no.)	0	8 to 9
Palmer amaranth		
Height (inches)	---	6 to 10
Density (plants/ft^2)	0	0.3
Johnsongrass		
Height (inches)	---	6 to 15
Density (plants/ft^2)	0	0.5

Table 2. Weed control in the FirstAct sorghum study

Treatment[1]	Rate	Timing[2]	Johnsongrass		Palmer amaranth	
			14 DA-B[3]	42 DA-B	14 DA-B	42 DA-B
	oz/a		% Visual			
Parallel Plus	32	PRE	99	100	0	0
FirstAct	10	POST				
COC	1%	POST				
Parallel Plus	32	PRE	99	98	68	73
FirstAct	10	POST				
Huskie	16	POST				
COC	1%	POST				
Parallel Plus	32	PRE	98	94	68	74
FirstAct	10	POST				
2,4-D amine	16	POST				
COC	1%	POST				
Parallel Plus	32	PRE	99	100	60	87
FirstAct	10	POST				
Dicamba	8	POST				
COC	1%	POST				
Parallel Plus	32	PRE	99	98	75	78
FirstAct	10	POST				
Bromoxynil	16	POST				
COC	1%	POST				
Parallel Plus	32	PRE	0	0	85	95
Huskie	16	POST				
Atrazine	16	POST				
NIS	0.25%	POST				
Parallel Plus	32	PRE	0	0	95	93
Kochiavore	24	POST				
Parallel Plus	32	PRE	0	0	71	72
Atrazine	16	POST				
COC	1%	POST				
Coyote	64	PRE	0	29	98	100
Atrazine	16	POST				
COC	1%	POST				
LSD (0.05)			4	10	17	13

[1] COC = crop oil concentrate. NIS = nonionic surfactant.
[2] PRE = preemergence. POST = postemergence.
[3] DA-B = days after the postemergence treatments.

Table 3. Crop response to FirstAct in the ACCase-tolerant sorghum study

			Necrosis		Sprawl		Sorghum
Treatment[1]	Rate	Timing[2]	14 DA-B[3]	28 DA-B	14 DA-B	28 DA-B	yield
	lb/a		% Visual				bu/a
Parallel Plus	32	PRE	0	0	0	0	44.9
Parallel Plus	32	PRE	0	0	0	0	107.9
FirstAct	10	POST					
COC	1%	POST					
Parallel Plus	32	PRE	0	1	3	0	93.0
FirstAct	10	POST					
Huskie	16	POST					
COC	1%	POST					
Parallel Plus	32	PRE	13	0	11	0	94.5
FirstAct	10	POST					
2,4-D amine	16	POST					
COC	1%	POST					
Parallel Plus	32	PRE	6	0	6	0	109.0
FirstAct	10	POST					
Dicamba	8	POST					
COC	1%	POST					
Parallel Plus	32	PRE	0	0	0	0	91.6
FirstAct	10	POST					
Bromoxynil	16	POST					
COC	1%	POST					
Parallel Plus	32	PRE	0	3	0	0	93.7
Huskie	16	POST					
Atrazine	16	POST					
NIS	0.25%	POST					
Parallel Plus	32	PRE	15	1	10	5	78.6
Kochiavore	24	POST					
Parallel Plus	32	PRE	0	0	0	0	65.4
Atrazine	16	POST					
COC	1%	POST					
Coyote	64	PRE	0	0	0	0	91.2
Atrazine	16	POST					
COC	1%	POST					
LSD (0.05)			2	3	5	2	25.1

[1] COC = crop oil concentrate. NIS = nonionic surfactant.
[2] PRE = preemergence. POST = postemergence.
[3] DA-B = days after the postemergence treatments.

Pyraflufen Tank Mixtures for Efficacy in Fallow

R.S. Currie and P.W. Geier

Summary

The objective of this study was to compare Vida (pyraflufen) tank mixtures for glyphosate-resistant kochia control in fallow. Early-season kochia control was best with tank mixtures that included Sharpen (saflufenacil), but tank mixtures including dicamba provided the best control later in the season. No herbicide controlled kochia more than 80% late in the season. All herbicides controlled downy brome more than 90% within 14 days after treatment, and 100% by 21 days after application.

Introduction

Kochia is one of the most common and troublesome weeds in western Kansas. Resistance to multiple herbicide modes of action has developed in kochia, including herbicides such as dicamba and glyphosate. Therefore, the need for novel herbicides for its control is essential. The objective of this trial was to compare Vida with various tank mix partners for kochia control in fallow.

Experimental Procedures

An experiment was conducted to compare Vida tank mixtures for weed control in fallow. All herbicides were applied postemergence using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on May 13, May 20, and May 27, 2021. These dates were 7, 14, and 21 days after herbicide treatment (DAT).

Results and Discussion

Kochia control at 7 and 14 DAT was greatest (80 to 85%) when Sharpen was included in the herbicide mixture (Table 2). However, by 21 DAT, only those treatments containing dicamba controlled kochia more than 75%. Kochia control with all herbicide treatments peaked at 21 DAT, and began to decline later in the season (data not shown). Vida plus Sharpen, glyphosate and 2,4-D controlled downy brome best at 7 DAT (65%). At 14 DAT, downy brome control was greater than 95% with all treatments except glyphosate with 2,4-D or dicamba. Downy brome control was complete regardless of herbicide treatment by 21 DAT.

Table 1. Application, environmental, and weed data for the pyraflufen tank mixture study

Application date	May 6, 2021
Air temperature (°F)	72
Relative humidity	43
Soil temperature (°F)	72
Wind speed (mph)	2 to 6
Wind direction	Northeast
Soil moisture	Good
Kochia	
Height (inches)	1 to 3
Density (plants/ft^2)	100
Downy brome	
Height (inches)	10 to 25
Density (plants/ft^2)	15

Table 2. Weed control with pyraflufen tank mixtures in fallow

		Kochia			Downy brome		
Treatment[1]	Rate	7 DAT[2]	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
	oz/a	% Visual					
Vida	2.0	63	50	45	48	96	100
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
Glyphosate	24	20	43	58	43	91	100
2,4-D	8.0						
AMS	3.0 lb						
Vida	2.0	63	58	50	58	97	100
Glyphosate	24						
2,4-D	8.0						
COC	1.0%						
AMS	3.0 lb						
Vida	2.0	80	84	70	60	99	100
Sharpen	2.0						
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
Sharpen	2.0	81	80	60	63	98	100
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
Vida	2.0	84	85	73	65	97	100
Sharpen	2.0						
2,4-D	8.0						
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
Dicamba	8.0	30	55	79	43	93	100
Glyphosate	24						
AMS	3.0 lb						
Vida	2.0	68	68	80	55	97	100
Dicamba	8.0						
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
Vida	2.0	81	85	78	55	97	100
Dicamba	8.0						
Sharpen	2.0						
Glyphosate	24						
COC	1.0%						
AMS	3.0 lb						
LSD (0.05)		6	8	7	5	3	NS

[1] COC = crop oil concentrate. AMS = ammonium sulfate. 2,4-D was the amine formulation.

[2] DAT = days after herbicide treatment.

2021 Kansas Summer Annual Forage Hay and Silage Variety Trial

J. Holman, A. Obour, S. Dooley, and T. Roberts

Summary
In 2021, summer annual forage variety trials were conducted across Kansas near Garden City, Hays, and Scandia. All sites evaluated hay and silage entries. Companies were able to enter varieties into any possible combinations of research sites, so not all sites had all varieties. Across the sites, a total of 104 hay varieties and 55 sorghum silage varieties were evaluated.

Introduction
Annually, there are approximately 35,000,000 acres of hay and haylage harvested in the U.S. for a total of 96,000,000 dry matter tons of production. Yields in Kansas averaged 2.77 tons of dry matter per acre. Of this total, about 13,600,000 acres were alfalfa, which averaged 3.76 dry matter tons per acre, and all other crops averaged 2.13 dry matter tons/a.

In Kansas, there were 2,400,000 acres of hay and haylage harvested with an average yield of 2.24 dry matter tons per acre. Of this total, 650,000 acres were alfalfa with an average yield of 3.72 dry matter tons per acre, and 1,770,000 acres were crops other than alfalfa with an average yield of 1.69 dry matter tons/a. Kansas ranked 6th in the U.S. for hay and haylage production. This largely supports the state dairy (ranked 19th in the U.S. and valued at $483,000,000) and cattle (feedlot, background, and cow/calf) industries (ranked second in the U.S. and valued at $10,200,000,000) (USDA, NASS). Dairy and beef cattle represented 58% of the total agricultural product of Kansas. Hay and grain commodities that support these two industries are critical for the state.

Study Objectives
The objectives of the Kansas Summer Annual Forage Variety Trial are to evaluate the performance of released and experimental varieties, determine where these varieties are best adapted, and increase the visibility of summer annual forages in Kansas. Breeders, marketers, and producers use data collected from the trials to make informed variety selections. The Summer Annual Forage Trial is planted at locations across Kansas based on the interest of those entering varieties into the test.

Procedures
The Summer Annual Forage Variety Test was conducted near Garden City, Hays, and Scandia, KS. All of the sites evaluated hay and silage entries. Companies were able to enter varieties into any possible combinations of research sites, so not all sites had all varieties. In the hay test, there were 35 entries at Garden City, 35 at Hays, and 34 at Scandia. In the silage test, there were 32 sorghum entries at Garden City and 23 sorghum entries at Scandia (Table 1). Information on the varieties is shown in Tables 2 and 3.

Management guidelines were provided to cooperators; however, previous growing experience influenced final management decisions. All trials were planted in small research plots (approximately 225 ft^2) with three replications. Cultural practices (Table 5), growing season temperature, and precipitation (Figures 1, 2, and 3) are provided for each site. Results are listed alphabetically by seed supplier. Forage samples were dried, ground, and analyzed for nutrient contents using NIR (near infrared reflectance) by Sevitech Laboratories in Dodge City, KS. Nutrient contents measured were crude protein (CP), adjusted crude protein (Adj_CP), nitrogen free neutral detergent fiber (NDFn), acid detergent fiber (ADF), neutral detergent fiber organic matter basis (aNDFom), lignin, undigested aNDFom remaining after in vitro digestion at 240 hr (uNDFom240), neutral detergent fiber-digestible at 240 hr (NDFD240), water soluble carbohydrates (WSC), starch, total fatty acids (TFA), ash, calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), sulfur (S), non-fiber carbohydrates (NFC), total digestible nutrients using Ohio Agricultural Research and Development Center (OARDC) calculation (TDN_OARDC), net energy for lactation 3x intake using OARDC (NEL3x_OARDC), net energy for gain using OARDC (NEG_OARDC), net energy for maintenance using OARD (NEM_OARDC), and relative feed value (RFV).

2021 Growing Conditions

Temperature and precipitation (Figures 1, 2, and 3) for each site is shown. Thick black lines on the temperature graphs represent long-term average high and low temperatures (°F) for the location. The upper thin line represents actual daily high temperatures, and the lower thin line represents actual daily low temperatures. On the precipitation graph, the line labeled “normal” represents long-term average precipitation (1980–2020), and the line labeled “2020” represents actual precipitation.

In general, the 2021 growing season saw near normal temperatures across all locations. Precipitation was near normal at Garden City and Hays, but very dry (50%) at Scandia. However, Garden City was irrigated so moisture was not limiting.

Results and Discussion

Since all entries were not evaluated across all sites, data were analyzed by location. All locations had a control entry of Rox Orange (Waconia) and Early Sumac for the hay test, and a control entry of Kansas Orange for the silage test.

Hay Test

Top performing varieties varied by cutting and when comparing a single cutting compared to total yield. These results indicate performance evaluation needs to consider single or multiple cuttings, and the regrowth potential of varieties.

At Garden City, Danny Boy II BMR, Fullgraze II, Fullgraze II BMR, Excel II, 18180, 19102, and 19186 were in the top LSD (least significant difference at $P \leq 0.05$) group in the first cutting (Table 5). In the second cutting, more separation occurred between entries; Cadan 99 B WMR, Sweet Sioux BMR, Sweet Sioux WMR, Sweetleaf, Dynagraze II, Dynagraze II BMR, PearlMil, Super Sweet 10, Early Sumac, Sordan 79, SP4555, Grazex AT, 20270, Tifleaf III, and Integra 31F65 were in the highest yielding

LSD group. Combined across cuttings, all varieties except PearlMil, Early Sumac, Rox Orange, Bruiser, 19011, and 20268 were in the top LSD group.

At Hays, Nutri-Cane, Danny Boy II BMR, Fullgraze II, Fullgraze II BMR, Super Sweet 10, Bruiser, Excel II, 18180, and 19102 had the greatest yield in the top LSD group in the first cutting (Table 6). There was no second cutting due to little regrowth and frost in early October.

At Scandia, Fullgraze II BMR and 19102 were in the top LSD group in the first cutting (Table 7). There was no second cutting due to little regrowth and frost in early October.

Sorghum Silage Test

At Garden City, ADVF7424, ADV8322, ADVS6504, ADVS6520, ADVXF4501G, ADVXS005, AF7401, 5 Star, F72FS05, F74FS72 BMR, Super Sile 20, Super Sile 30, Buffalo Sugar Sweet AT, Brutis, 19042, 19156, and Integra 34F95 were in the top LSD group for silage (Table 8).

At Scandia, Nutri-Choice, Nutri-Chomp, 5 Star, F70FS91 BMR, F72FS05, F74FS72 BMR, Super Sile 20, Super Sile 30, KS Orange, Brutis, Packer, 19040, 19042, 19156, Integra 33F70, and Integra 38F80 were in the top LSD group for silage (Table 9).

Recommendation

Inestimable differences in soil type, weather, and environmental conditions play a part in increasing experimental error, therefore one should use more than one location and year to make an informed variety selection decision. Please refer to previous years' forage reports to see how a variety performed across years (*https://www.agronomy.k-state.edu/outreach-and-services/kaes-research-reports/forage.html*).

Acknowledgments

This work was funded in part by the Kansas Agricultural Experiment Station and seed suppliers. Sincere appreciation is expressed to all participating researchers and seed suppliers who have a vested interest in expanding and promoting annual forage production in the U.S.

Table 1. Number of hay and silage entries for each location

Location	Hay	Silage
Garden City	35	32
Hays	35	-[a]
Scandia	34	23
Total	104	55

[a]Hays silage test was abandoned.

Table 2. 2021 Hay entries

Company	Variety/Entry	Type	BMR	Dwarf	Male Sterile	Dry Stalk	Photoperiod Sensitive	Aphid Resistance	Maturity
Dyna-Gro Seed	PearlMil	MT	N	N	N	N	N	N	EM
Ward Seed	Tifleaf III	MT	NS	Y	NS	NS	NS	NS	M
Channel Seed	Nutri-Cane	FS	N	N	Y	N	N	NS	M
Dyna-Gro Seed	Sweet Ton MS	FS	N	N	Y	N	N	N	M
KSU (check)	Early Sumac	FS	N	N	N	N	N	N	M
KSU (check)	Rox Orange	FS	N	N	N	N	N	N	M
Star Seed	Magnum Ultra BMR	FS	Y	N	Y	N	N	NS	L
S & W Seed Co	SP4105	SS	Y	N	N	N	Y	NS	NA
Browning Seed	CADAN 99 B WMR	SS	N	N	N	y	NS	NS	ML
Browning Seed	HEADLESS WONDER	SS	Y	N	N	N	Y	NS	PPS
Browning Seed	SWEET SIOUX BMR	SS	Y	N	N	N	N	NS	M
Browning Seed	SWEET SIOUX WMR	SS	N	N	N	N	N	NS	M
Channel Seed	Qualimax	SS	N	N	N	N	N	NS	ML
Channel Seed	Sweetleaf	SS	N	N	Y	N	N	N	M
Dyna-Gro Seed	Danny Boy II BMR	SS	Y	N	N	N	Y	N	M
Dyna-Gro Seed	Dynagraze II	SS	N	N	N	N	N	N	EM
Dyna-Gro Seed	Dynagraze II BMR	SS	N	N	N	N	N	N	ML
Dyna-Gro Seed	Fullgraze II	SS	N	N	N	N	N	N	ML
Dyna-Gro Seed	Fullgraze II BMR	SS	Y	N	N	N	N	N	ML
Dyna-Gro Seed	Super Sweet 10	SS	N	N	N	N	N	N	EM
S & W Seed Co	Sordan 79	SS	N	N	N	N	N	NS	M
S & W Seed Co	SP4555	SS	Y	N	N	N	N	NS	M
Sharp Brothers	Grazex AT	SS	N	N	N	N	N	Y	ME
Star Seed	Bruiser	SS	Y	Y	N	N	N	NS	ME
Star Seed	Excel II	SS	N	N	N	N	N	NS	L
Star Seed	Nutrimaxx BMR	SS	Y	N	N	N	N	NS	L
Ward Seed	18180	SS	NS	NS	NS	NS	NS	NS	L
Ward Seed	18182	SS	Y	NS	NS	Y	NS	NS	M
Ward Seed	19011	SS	Y	Y	NS	Y	NS	NS	ML
Ward Seed	19102	SS	NS	NS	NS	NS	Y	NS	L
Ward Seed	19186	SS	Y	NS	NS	NS	Y	NS	L
Ward Seed	20268	SS	Y	NS	NS	Y	NS	NS	ML
Ward Seed	20270	SS	Y	NS	NS	NS	NS	NS	ML
Ward Seed	19011 harvested +25 day	SS	Y	Y	NS	Y	NS	NS	L
Wilbur Ellis	Integra 31F65	SS	Y	Y	N	N	N	NS	ML
Wilbur Ellis	Integra Ranch Hand	SS	Y	N	N	N	N	NS	M
S & W Seed Co	SWSB8801	SS	Y	N	N	N	N	NS	M

Hybrid information was provided by seed companies.
Abbreviations: Millet (MT), Forage sorghum (FS), sorghum sudan (SS), sorghum (S), dual-purpose (DP), brown mid-rib (BMR), photoperiod sensitive (PS), not applicable (NA).
Maturity groups: Early (E), medium early (ME), medium (M), medium late (ML), late (L), and full (F).

Table 3. 2021 Silage Entries

Company	Variety/Entry	Type	BMR	Dwarf	Male Sterile	Dry Stalk	Photo-period Sensitive	Greenbug	Sugarcane Aphid Tolerance	Maturity	Grams /1000 seeds
Alta Seeds	ADVF7424	FS	Y	Y	N	N	N	NS	NS	ML	24.15
Alta Seeds	ADVF8322	FS	N	N	N	N	N	NS	Y	M	38.67
Alta Seeds	ADVS6504	SS	Y	N	N	N	Y	NS	NS	L	30.42
Alta Seeds	ADVS6520	SS	Y	N	N	N	Y	NS	Y	L	27.2
Alta Seeds	ADVXF450IG	FS	N	Y	N	N	N	NS	NS	M	29.12
Alta Seeds	ADVXS005	SS	Y	N	N	N	Y	NS	Y	L	28.84
Alta Seeds	AF7401	FS	Y	Y	N	N	N	NS	NS	ML	25.41
Channel Seed	Nutri-Choice	FS	N	N	N	N	N	NS	NS	ML	37.12
Channel Seed	Nutri-Chomp	FS	Y	N	Y	N	N	NS	NS	ML	32.05
Dyna-Gro Seed	5 Star	FS	N	N	N	N	N	N	NS	M	26.56
Dyna-Gro Seed	F70FS91 BMR	FS	Y	N	N	Y	N	N	NS	E	37.57
Dyna-Gro Seed	F71FS72 BMR	FS	Y	N	N	Y	N	N	NS	E	23.38
Dyna-Gro Seed	F72FS05	FS	N	N	N	N	N	N	Y	EM	31.54
Dyna-Gro Seed	F74FS23 BMR	FS	Y	N	N	N	N	N	NS	M	33.13
Dyna-Gro Seed	F74FS72 BMR	FS	Y	Y	N	Y	N	N	NS	M	26.44
Dyna-Gro Seed	Super Sile 20	FS	N	N	N	N	N	N	NS	ML	23.11
Dyna-Gro Seed	Super Sile 30	FS	N	N	N	N	N	N	NS	M	26.70
Dyna-Gro Seed	Sweet Ton MS	FS	N	N	Y	N	N	N	NS	L	24.96
KSU (check)	KS Orange	FS	N	N	N	N	N	N	NS	M	20.54

continued

Table 3. 2021 Silage Entries

Company	Variety/Entry	Type	BMR	Dwarf	Male Sterile	Dry Stalk	Photo-period Sensitive	Greenbug	Sugarcane Aphid Tolerance	Maturity	Grams /1000 seeds
MOJO Seed	Opal	FS	N	Y	N	Semi	N	N	Y	ML	35.07
MOJO Seed	Pearl	FS	N	Y	N	Semi	N	N	Y	ML	31.20
Sharp Brothers	Buffalo Sugar Sweet AT	FS	N	N	N	N	N	NS	Y	ML	31.76
Sharp Brothers	SBW7706W	FS	N	N	N	N	N	C, E	NS	M	32.55
Star Seed	Brutis	FS	Y	Y	N	N	N	N	NS	L	26.25
Star Seed	Packer	FS	N	N	N	N	N	N	NS	ML	32.67
Ward Seed	19040	FS	NS	NS	NS	NS	NS	NS	NS	ML	28.67
Ward Seed	19042	FS	NS	NS	NS	NS	NS	NS	NS	ML	33.85
Ward Seed	19156	FS	NS	NS	NS	NS	NS	NS	NS	M	32.50
Ward Seed	19181	FS	NS	NS	NS	NS	NS	NS	NS	ML	31.77
Wilbur Ellis	Integra 33F70	FS	Y	Y	N	N	N	N	NS	ML	33.73
Wilbur Ellis	Integra 34F95	FS	Y	N	Y	N	N	N	NS	M	31.74
Wilbur Ellis	Integra 38F80	FS	N	N	N	N	N	SCA	NS	ML	29.4

Hybrid information was provided by seed companies.
Abbreviations: Forage sorghum (FS), sorghum sudan (SS), sorghum (S), dual-purpose (DP), brown mid-rib (BMR), photoperiod sensitive (PS), not applicable (NA).
Maturity groups: Early (E), medium early (ME), medium (M), medium late (ML), late (L), and full (F).

Table 4. Irrigation, plant, harvest, and fertilizer details for hay and silage variety tests near Garden City, Hays, and Scandia, KS, in 2021

Location	Irrigation (inch)	Planting Date	1st Harvest Date	2nd Harvest Date	Seeding Rate	Harvest Area (ft^2)	N Fertilizer (lb N/a)	P Fertilizer (lb P_2O_5/a)
Hay Test								
Garden City	14	15-Jun	23-Aug 30-Aug 7-Sep 21-Sep	9-Nov	20 (lb/acre)	360/150	160	0
Hays	---	11-Jun	25-Aug 16-Sep	---	15 (lb/acre)	78/66	50	0
Scandia	---	7-Jun	4-Aug 11-Aug 19-Aug 25-Aug 1-Sep 15-Sep	---	20 (lb/acre)	60	55	0
Silage Test								
Garden City	14	22-Jun	28-Sep 5-Oct 19-Oct	---	80000 (seeds/acre)	225	160	0
Scandia	---	8-Jun	7-Sep 15-Sep 22-Sep	---	50000 (seeds/acre)	50	55	0

Table 5. Hay performance test near Garden City

		First Cutting				Second Cutting				Total Yield
Company	**Variety**	**Days to cutting**	**Height (inches)**	**DM lb/acre**	**% Moisture**	**Days to cutting**	**Height (inches)**	**DM lb/acre**	**% Moisture**	**DM lb/acre**
Browning Seed	CADAN 99 B WMR	71	107	8817	0.76	74	44	**3158**	0.53	**11974**
Browning Seed	HEADLESS WONDER	74	103	8931	0.77	72	34	2333	0.43	**11264**
Browning Seed	SWEET SIOUX BMR	74	91	7839	0.79	72	38	**2915**	0.46	**10754**
Browning Seed	SWEET SIOUX WMR	69	110	7976	0.77	76	45	**3237**	0.51	**11213**
Channel Seed	Nutri-Cane	74	92	9133	0.79	72	24	1839	0.66	**10972**
Channel Seed	Qualimax	84	112	9779	0.78	61	15	1179	0.58	**10959**
Channel Seed	Sweetleaf	69	99	8603	0.74	76	42	**3436**	0.50	**12039**
Dyna-Gro Seed	Danny Boy II BMR	98	107	**10893**	0.79	47	0	0	0.00	**10893**
Dyna-Gro Seed	Dynagraze II	69	95	7515	0.77	76	48	**3432**	0.57	**10947**
Dyna-Gro Seed	Dynagraze II BMR	69	91	7262	0.79	76	42	**2662**	0.51	**9924**
Dyna-Gro Seed	Fullgraze II	84	115	**12031**	0.76	61	0	0	0.00	**12031**
Dyna-Gro Seed	Fullgraze II BMR	98	108	**11894**	0.76	47	0	0	0.00	**11894**
Dyna-Gro Seed	PearlMil	69	59	6148	0.79	76	27	**3506**	0.42	9654
Dyna-Gro Seed	Super Sweet 10	69	91	7871	0.78	76	51	**3454**	0.60	**11326**
Dyna-Gro Seed	Sweet Ton MS	71	87	8054	0.79	74	29	2225	0.41	**10280**
KSU (check)	Early Sumac	69	84	7059	0.81	76	32	**2720**	0.52	9779
KSU (check)	Rox Orange	69	83	6685	0.82	76	21	2210	0.41	8895
S & W Seed Co	Sordan 79	69	94	8196	0.82	76	48	**3543**	0.57	**11739**
S & W Seed Co	SP4555	69	84	7162	0.80	76	46	**2733**	0.61	**9895**
Sharp Brothers	Grazex AT	69	102	8016	0.77	76	46	**3322**	0.49	**11339**

continued

Table 5. Hay performance test near Garden City

		First Cutting				Second Cutting				Total Yield
Company	Variety	Days to cutting	Height (inches)	DM lb/acre	% Moisture	Days to cutting	Height (inches)	DM lb/acre	% Moisture	DM lb/acre
Star Seed	Bruiser	93	83	8642	0.76	52	7	538	0.82	9180
Star Seed	Excel II	86	101	**10433**	0.77	59	20	1754	0.64	**12187**
Star Seed	Magnum Ultra BMR	71	82	7880	0.80	74	29	2131	0.44	**10011**
Star Seed	Nutrimaxx BMR	93	103	10015	0.79	52	0	0	0.00	**10015**
Ward Seed	18180	86	111	**11401**	0.76	59	15	770	0.88	**12171**
Ward Seed	18182	69	87	8373	0.79	76	36	2441	0.51	**10813**
Ward Seed	19011	86	77	8021	0.77	59	11	554	0.89	8576
Ward Seed	19102	98	109	**11035**	0.80	47	0	0	0.00	**11035**
Ward Seed	19186	98	98	**12244**	0.76	47	0	0	0.00	**12244**
Ward Seed	20268	81	84	7676	0.78	64	17	1304	0.68	8980
Ward Seed	20270	69	85	7555	0.78	76	44	**3951**	0.50	**11506**
Ward Seed	19011 harvested +25 day	98	78	9960	0.72	47	0	0	0.00	**9960**
Ward Seed	Tifleaf III	69	59	8077	0.79	76	27	**3450**	0.41	**11527**
Wilbur Ellis	Integra 31F65	71	78	6862	0.80	74	42	**3316**	0.50	**10179**
Wilbur Ellis	Integra Ranch Hand	89	105	9957	0.78	57	6	435	0.78	**10391**
LSD			*8*	*2005*	*0.02*		*14*	*1343*	*0.29*	*2444*

Values in bold are in the top LSD group.

Abbreviations for this table and following tables: Crude protein (CP), adjusted crude protein (Adj_CP), nitrogen free neutral detergent fiber (NDFn), acid detergent fiber (ADF), neutral detergent fiber organic matter basis (aNDFom), lignin, undigested aNDFom remaining after in vitro digestion at 240 hr (uNDFom240), neutral detergent fiber-digestible at 240 hr (NDFD240), water soluble carbohydrates (WSC), starch, total fatty acids (TFA), ash, non-fiber carbohydrates (NFC), total digestible nutrients (TDN), net energy for lactation (NEL), net energy for gain (NEG), net energy for maintenance (NEM), and relative feed value (RFV).

Table 5b. 2021 Garden City, Kansas Hay Performance Test, Finney County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Browning Seed	CADAN 99 B WMR	8.74	39.24	61.71	4.30	17.34	4.77	2.42	0.87
Browning Seed	HEADLESS WONDER	7.75	40.25	61.99	4.35	17.96	4.36	2.31	0.78
Browning Seed	SWEET SIOUX BMR	8.55	36.46	56.91	3.24	15.54	4.41	2.61	0.94
Browning Seed	SWEET SIOUX WMR	9.16	39.12	60.74	4.06	16.12	4.84	2.53	0.93
Channel Seed	Nutri-Cane	8.75	35.92	55.29	3.66	16.76	4.48	2.74	0.99
Channel Seed	Qualimax	8.23	37.06	56.40	3.78	16.52	5.39	2.44	0.99
Channel Seed	Sweetleaf	8.03	41.23	63.83	4.65	18.60	4.77	2.28	0.75
Dyna Gro Seed	Danny Boy II BMR	7.37	39.25	58.68	3.72	17.77	4.07	2.29	0.74
Dyna Gro Seed	Dynagraze II	9.42	37.49	57.60	4.06	17.00	4.86	2.52	1.00
Dyna Gro Seed	Dynagraze II BMR	8.35	37.37	59.01	3.46	15.03	4.15	2.61	0.91
Dyna Gro Seed	Fullgraze II	8.18	38.88	62.18	4.25	19.17	4.67	2.47	0.81
Dyna Gro Seed	Fullgraze II BMR	7.49	37.39	58.93	3.61	18.18	4.50	2.37	0.76
Dyna Gro Seed	PearlMil	12.28	37.04	59.47	4.01	14.27	4.33	2.50	1.10
Dyna Gro Seed	Super Sweet 10	9.34	37.94	59.09	4.32	16.76	4.97	2.48	0.97
Dyna Gro Seed	Sweet Ton MS	9.25	35.09	55.50	3.50	15.59	4.77	2.60	0.99
KSU check	Early Sumac	8.52	35.72	56.50	3.52	14.78	4.27	2.68	1.01
KSU check	Rox Orange	8.95	36.44	59.18	3.69	16.08	3.78	2.62	0.89
S & W Seed Co	Sordan 79	8.31	41.57	62.95	4.61	18.65	4.70	2.09	0.71
S & W Seed Co	Rox Orange	9.38	36.71	57.62	3.40	15.23	4.58	2.63	0.97
Sharp Brothers	Grazex AT	7.96	39.84	61.51	4.38	18.40	5.80	2.18	0.84

continued

Table 5b. 2021 Garden City, Kansas Hay Performance Test, Finney County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Star Seed	Bruiser	8.39	38.87	59.09	3.67	16.93	4.15	2.55	0.88
Star Seed	Excel II	8.08	38.21	57.54	4.10	17.09	4.82	2.42	0.93
Star Seed	Magnum Ultra BMR	8.47	37.31	58.67	3.73	16.43	4.81	2.55	0.95
Star Seed	Nutrimaxx BMR	7.41	37.21	59.76	3.41	16.08	4.29	2.44	0.91
Ward Seed	18180	7.43	38.37	58.98	4.16	18.22	5.02	2.35	0.86
Ward Seed	18182	8.48	38.33	58.90	3.46	15.93	4.93	2.47	0.87
Ward Seed	19011	9.08	36.50	56.01	3.35	15.53	5.14	2.63	0.97
Ward Seed	19102	6.38	41.41	62.38	4.61	19.18	4.25	2.03	0.68
Ward Seed	19186	7.19	35.11	56.42	3.10	15.08	6.00	2.50	0.96
Ward Seed	20268	9.18	36.63	55.84	3.42	15.84	4.38	2.69	0.95
Ward Seed	20270	9.11	37.85	56.81	3.54	15.72	4.77	2.47	0.86
Ward Seed	19011 harvested +25 day	7.91	35.40	53.56	3.32	16.51	6.69	2.72	1.00
Ward Seed	Tifleaf III	13.41	35.75	58.50	3.92	13.94	4.72	2.55	1.14
Wilbur Ellis	Integra 31F65	10.01	37.10	58.63	3.83	15.86	3.98	2.62	0.94
Wilbur Ellis	Integra Ranch Hand	8.19	37.99	58.70	3.69	17.41	4.90	2.43	0.78
Average		8.65	37.77	58.71	3.83	16.61	4.72	2.48	0.90

Table 5b. 2021 Garden City, Kansas Hay Performance Test, Finney County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Browning Seed	CADAN 99 B WMR	8.31	8.01	21.38	12.78	85.01	58.50	0.57	0.32	0.60
Browning Seed	HEADLESS WONDER	8.50	7.38	21.91	11.74	83.13	57.60	0.56	0.30	0.59
Browning Seed	SWEET SIOUX BMR	9.06	11.45	25.95	15.86	96.16	61.80	0.62	0.36	0.63
Browning Seed	SWEET SIOUX WMR	8.59	8.49	21.62	13.33	86.10	58.80	0.58	0.32	0.60
Channel Seed	Nutri-Cane	8.20	11.59	28.19	16.07	98.07	62.40	0.63	0.37	0.64
Channel Seed	Qualimax	8.71	11.56	26.80	16.95	95.61	60.90	0.61	0.35	0.62
Channel Seed	Sweetleaf	8.01	7.31	20.22	12.08	79.87	56.10	0.54	0.28	0.57
Dyna Gro Seed	Danny Boy II BMR	10.01	9.06	24.51	13.13	89.84	58.80	0.58	0.32	0.60
Dyna Gro Seed	Dynagraze II	8.54	9.99	24.53	14.85	92.60	60.60	0.60	0.35	0.62
Dyna Gro Seed	Dynagraze II BMR	8.67	9.35	24.41	13.50	91.36	60.90	0.61	0.35	0.62
Dyna Gro Seed	Fullgraze II	7.84	8.77	21.95	13.44	85.26	58.80	0.58	0.32	0.60
Dyna Gro Seed	Fullgraze II BMR	8.43	10.49	25.52	14.99	91.70	60.90	0.61	0.35	0.62
Dyna Gro Seed	PearlMil	10.15	7.98	18.66	12.31	91.55	61.20	0.61	0.35	0.63
Dyna Gro Seed	Super Sweet 10	8.04	9.55	23.78	14.52	90.03	60.00	0.59	0.33	0.61
Dyna Gro Seed	Sweet Ton MS	8.47	12.13	27.10	16.89	98.79	63.30	0.64	0.38	0.65
KSU check	Early Sumac	7.25	11.84	28.24	16.10	96.61	62.70	0.64	0.37	0.64
KSU check	Rox Orange	7.48	10.47	24.83	14.25	91.95	62.10	0.63	0.37	0.64
S & W Seed Co	Sordan 79	9.15	6.52	19.71	11.22	80.47	56.10	0.54	0.28	0.57
S & W Seed Co	Rox Orange	9.21	9.85	24.05	14.43	93.96	61.80	0.62	0.36	0.63
Sharp Brothers	Grazex AT	7.78	9.34	22.82	15.13	84.67	57.90	0.56	0.31	0.59

continued

Table 5b. 2021 Garden City, Kansas Hay Performance Test, Finney County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Star Seed	Bruiser	10.05	8.22	22.99	12.37	89.43	59.10	0.58	0.32	0.60
Star Seed	Excel II	8.65	10.69	25.85	15.51	92.30	59.70	0.59	0.33	0.61
Star Seed	Magnum Ultra BMR	8.01	11.17	24.90	15.98	92.25	60.90	0.61	0.35	0.62
Star Seed	Nutrimaxx BMR	8.09	10.20	25.33	14.49	90.73	61.20	0.61	0.35	0.63
Ward Seed	18180	8.24	10.37	25.64	15.39	90.14	59.40	0.59	0.33	0.61
Ward Seed	18182	10.04	8.82	22.77	13.75	89.73	59.70	0.59	0.33	0.61
Ward Seed	19011	9.88	10.38	25.24	15.52	96.25	61.80	0.62	0.36	0.63
Ward Seed	19102	8.85	8.32	22.68	12.57	81.70	56.10	0.53	0.28	0.57
Ward Seed	19186	7.61	12.79	29.26	18.79	98.78	63.30	0.64	0.38	0.65
Ward Seed	20268	9.85	10.20	25.63	14.58	97.19	61.50	0.62	0.36	0.63
Ward Seed	20270	10.68	8.61	23.86	13.39	93.35	60.00	0.60	0.34	0.61
Ward Seed	19011 harvested +25 day	9.08	10.72	29.96	17.42	102.36	63.00	0.64	0.38	0.65
Ward Seed	Tifleaf III	10.38	8.50	18.42	13.21	94.34	62.40	0.63	0.37	0.64
Wilbur Ellis	Integra 31F65	9.73	7.93	22.09	11.92	91.18	60.90	0.61	0.35	0.62
Wilbur Ellis	Integra Ranch Hand	9.80	8.55	23.90	13.44	90.92	60.00	0.59	0.34	0.61
Average		8.84	9.62	24.13	14.34	91.24	60.29	0.60	0.34	0.62

Table 6. Hay performance test near Hays

		First Cutting				Total Yield
Company	Variety	Days to cutting	Height (inches)	DM lb/acre	% Moisture	DM lb/acre
Browning Seed	CADAN 99 B WMR	75	103	9290	0.63	9290
Browning Seed	HEADLESS WONDER	75	95	9779	0.67	9779
Browning Seed	SWEET SIOUX BMR	75	86	8314	0.72	8314
Browning Seed	SWEET SIOUX WMR	75	97	8815	0.65	8815
Channel Seed	Nutri-Cane	75	77	**11594**	0.70	**11594**
Channel Seed	Qualimax	97	108	10658	0.65	10658
Channel Seed	Sweetleaf	75	99	9034	0.67	9034
Dyna-Gro Seed	Danny Boy II BMR	97	101	**11959**	0.69	**11959**
Dyna-Gro Seed	Dynagraze II	75	82	8992	0.68	8992
Dyna-Gro Seed	Dynagraze II BMR	75	82	7639	0.66	7639
Dyna-Gro Seed	Fullgraze II	97	101	**11389**	0.61	**11389**
Dyna-Gro Seed	Fullgraze II BMR	97	100	**11474**	0.64	**11474**
Dyna-Gro Seed	PearlMil	75	58	5876	0.67	5876
Dyna-Gro Seed	Super Sweet 10	75	77	**11372**	0.66	**11372**
Dyna-Gro Seed	Sweet Ton MS	75	77	9804	0.69	9804
KSU (check)	Early Sumac	75	73	8752	0.71	8752
KSU (check)	Rox Orange	75	66	6927	0.73	6927
S & W Seed Co	Sordan 79	75	89	9780	0.71	9780
S & W Seed Co	SP4105	97	89	9787	0.68	9787
S & W Seed Co	SP4555	75	78	7969	0.71	7969
S & W Seed Co	SWSB8801	75	63	7770	0.67	7770
Sharp Brothers	Grazex AT	75	94	9209	0.62	9209
Star Seed	Bruiser	97	83	**13160**	0.61	**13160**
Star Seed	Excel II	97	115	**12072**	0.63	**12072**
Star Seed	Magnum Ultra BMR	75	81	10590	0.63	10590
Star Seed	Nutrimaxx BMR	97	95	8750	0.69	8750
Ward Seed	18180	97	108	**11744**	0.65	**11744**
Ward Seed	18182	75	80	10671	0.67	10671
Ward Seed	19011	75	67	10206	0.67	10206
Ward Seed	19011	75	70	10412	0.66	10412
Ward Seed	19102	97	110	**12704**	0.69	**12704**
Ward Seed	19186	97	100	9657	0.66	9657
Ward Seed	20268	75	69	9465	0.66	9465
Ward Seed	20270	75	76	9744	0.66	9744
Ward Seed	Tifleaf III	75	50	6482	0.65	6482
LSD[1]			*9*	*2396*	*0.05*	*2396*

[1]Values in bold are in the top LSD group.
There was no second cutting for Hays, KS.

Table 6b. 2021 Hays, Kansas Forage Hay Performance Test, Ellis County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Browning Seed	CADAN 99 B WMR	9.31	36.80	59.04	3.76	16.46	3.81	2.68	0.92
Browning Seed	HEADLESS WONDER	8.99	38.30	61.34	4.01	16.43	3.83	2.40	0.87
Browning Seed	SWEET SIOUX BMR	8.78	36.99	57.06	3.38	14.43	3.76	2.45	0.83
Browning Seed	SWEET SIOUX WMR	9.29	37.44	60.51	3.69	15.81	3.78	2.60	0.90
Channel Seed	Nutri-Cane	7.23	34.88	55.46	3.49	16.22	4.37	2.58	0.95
Channel Seed	Qualimax	5.24	39.90	58.99	4.28	18.60	3.49	2.32	0.73
Channel Seed	Sweetleaf	8.32	40.03	62.14	4.36	18.39	4.70	2.43	0.79
Dyna Gro Seed	Danny Boy II BMR	6.59	38.70	58.65	3.56	16.26	3.00	2.38	0.72
Dyna Gro Seed	Dynagraze II	10.24	35.36	59.19	3.13	14.09	3.34	2.70	1.01
Dyna Gro Seed	Dynagraze II BMR	9.17	36.15	57.70	3.77	15.75	4.25	2.60	0.96
Dyna Gro Seed	Fullgraze II	6.78	37.96	62.04	3.98	18.85	3.97	2.42	0.77
Dyna Gro Seed	Fullgraze II BMR	7.21	37.55	59.44	3.51	16.39	2.72	2.44	0.70
Dyna Gro Seed	PearlMil	12.00	36.22	57.72	3.76	12.21	2.64	2.67	1.27
Dyna Gro Seed	Super Sweet 10	7.31	39.31	59.99	4.31	18.84	4.70	2.31	0.75
Dyna Gro Seed	Sweet Ton MS	8.87	35.98	57.75	3.41	14.40	3.60	2.64	0.98
KSU check	Early Sumac	9.05	33.55	54.44	3.20	14.02	3.64	2.73	1.06
KSU check	Rox Orange	9.58	34.90	56.67	3.21	15.31	3.10	2.54	0.91

continued

Table 6b. 2021 Hays, Kansas Forage Hay Performance Test, Ellis County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
S & W Seed Co	Sordan 79	8.66	37.98	59.43	4.09	16.69	3.47	2.30	0.77
S & W Seed Co	SP4105	9.14	37.06	58.31	3.44	14.79	2.27	2.58	0.86
S & W Seed Co	SP4555	9.66	35.04	55.13	3.17	14.09	3.94	2.59	0.93
S & W Seed Co	SWSB8801	9.21	34.52	51.18	2.95	14.52	4.73	2.70	0.94
Sharp Brothers	Grazex AT	8.81	37.90	60.06	4.12	16.89	4.83	2.35	0.93
Star Seed	Bruiser	7.91	37.96	58.67	3.11	15.92	3.93	2.75	0.79
Star Seed	Excel II	5.50	37.79	58.12	4.01	17.56	4.83	2.35	0.80
Star Seed	Magnum Ultra BMR	7.22	36.94	56.98	3.75	16.40	4.32	2.48	0.83
Star Seed	Nutrimaxx BMR	6.31	37.98	58.39	3.47	14.98	3.67	2.42	0.74
Ward Seed	18180	4.72	40.05	59.52	4.15	17.87	4.15	2.40	0.69
Ward Seed	18182	8.77	36.95	57.93	3.19	14.66	4.37	2.49	0.81
Ward Seed	19011	8.07	35.71	55.67	2.92	14.49	4.65	2.79	0.98
Ward Seed	19011	11.32	33.82	54.69	2.93	13.50	3.13	2.89	1.07
Ward Seed	19102	6.01	39.25	60.41	4.14	16.84	3.17	2.36	0.73
Ward Seed	19186	6.65	36.33	56.83	3.17	14.14	3.74	2.66	0.82
Ward Seed	20268	7.82	36.79	55.25	3.15	14.21	3.78	2.64	0.79
Ward Seed	20270	7.56	37.19	56.74	3.30	15.41	4.15	2.46	0.82
Ward Seed	Tifleaf III	10.86	36.12	59.58	3.72	13.09	2.99	2.61	1.18
Average		8.23	37.01	58.03	3.59	15.67	3.79	2.53	0.87

Table 6b. 2021 Hays, Kansas Forage Hay Performance Test, Ellis County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Browning Seed	CADAN 99 B WMR	8.70	7.31	23.19	11.11	91.51	61.20	0.61	0.35	0.63
Browning Seed	HEADLESS WONDER	8.26	7.03	21.61	10.86	86.10	59.70	0.59	0.33	0.61
Browning Seed	SWEET SIOUX BMR	9.95	8.90	24.85	12.66	93.98	61.20	0.61	0.35	0.63
Browning Seed	SWEET SIOUX WMR	8.90	7.73	21.51	11.51	88.29	60.60	0.60	0.34	0.62
Channel Seed	Nutri-Cane	6.87	13.37	30.82	17.73	100.35	63.60	0.65	0.38	0.65
Channel Seed	Qualimax	8.10	9.66	28.41	13.15	88.52	58.20	0.57	0.31	0.59
Channel Seed	Sweetleaf	8.42	6.03	21.40	10.73	83.16	57.60	0.56	0.30	0.59
Dyna Gro Seed	Danny Boy II BMR	9.58	8.00	25.85	11.00	90.23	59.10	0.58	0.32	0.60
Dyna Gro Seed	Dynagraze II	9.29	7.47	21.93	10.80	92.94	63.00	0.64	0.38	0.65
Dyna Gro Seed	Dynagraze II BMR	8.81	8.47	24.72	12.72	93.97	62.10	0.62	0.36	0.64
Dyna Gro Seed	Fullgraze II	6.81	9.56	24.66	13.53	86.47	60.30	0.60	0.34	0.62
Dyna Gro Seed	Fullgraze II BMR	8.76	8.13	25.23	10.85	90.12	60.90	0.61	0.35	0.62
Dyna Gro Seed	PearlMil	11.02	8.71	19.52	11.35	95.70	62.10	0.62	0.36	0.64
Dyna Gro Seed	Super Sweet 10	8.04	8.30	25.14	13.00	86.92	58.50	0.57	0.31	0.60
Dyna Gro Seed	Sweet Ton MS	8.43	9.77	25.30	13.37	94.54	62.10	0.63	0.36	0.64
KSU check	Early Sumac	7.47	12.65	29.59	16.28	102.99	64.80	0.67	0.40	0.67
KSU check	Rox Orange	7.98	10.86	26.45	13.96	96.81	63.60	0.65	0.38	0.65

continued

Table 6b. 2021 Hays, Kansas Forage Hay Performance Test, Ellis County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
S & W Seed Co	Sordan 79	8.89	7.09	23.55	10.56	89.40	60.00	0.59	0.34	0.61
S & W Seed Co	SP4105	11.58	6.04	21.76	8.32	92.64	60.90	0.61	0.35	0.62
S & W Seed Co	SP4555	10.20	8.44	25.51	12.38	97.89	63.00	0.64	0.37	0.65
S & W Seed Co	SWSB8801	10.55	10.01	29.77	14.74	106.62	63.90	0.65	0.39	0.66
Sharp Brothers	Grazex AT	8.20	8.01	23.08	12.84	87.92	60.00	0.59	0.33	0.61
Star Seed	Bruiser	10.31	7.83	23.84	11.76	90.76	60.00	0.59	0.33	0.61
Star Seed	Excel II	7.66	10.28	29.14	15.11	92.03	60.30	0.60	0.34	0.62
Star Seed	Magnum Ultra BMR	8.03	10.58	28.19	14.91	94.49	61.20	0.61	0.35	0.63
Star Seed	Nutrimaxx BMR	9.32	7.37	26.86	11.04	89.22	60.00	0.60	0.34	0.61
Ward Seed	18180	8.44	8.99	27.86	13.14	86.83	57.90	0.57	0.31	0.59
Ward Seed	18182	10.14	8.20	23.68	12.57	93.85	61.20	0.61	0.35	0.63
Ward Seed	19011	9.63	9.40	26.96	14.05	98.68	62.70	0.63	0.37	0.64
Ward Seed	19011	10.28	8.53	24.37	11.66	101.84	64.80	0.67	0.40	0.67
Ward Seed	19102	8.50	7.80	25.45	10.97	86.51	58.80	0.58	0.32	0.60
Ward Seed	19186	8.98	8.51	28.24	12.25	94.01	61.80	0.62	0.36	0.63
Ward Seed	20268	10.83	8.04	26.78	11.81	96.19	61.20	0.61	0.35	0.63
Ward Seed	20270	9.72	9.38	26.43	13.53	93.69	60.90	0.61	0.35	0.62
Ward Seed	Tifleaf III	9.91	8.95	19.95	11.94	92.54	62.10	0.62	0.36	0.64
Average		9.04	8.73	25.19	12.52	92.79	61.12	0.61	0.35	0.63

Table 7. Hay performance test near Scandia

		First Cutting				Total Yield
Company	**Variety**	**Days to cutting**	**Height (inches)**	**DM lb/acre**	**% Moisture**	**DM lb/acre**
Browning Seed	CADAN 99 B WMR	65	119	7253	0.78	7253
Browning Seed	HEADLESS WONDER	73	119	9863	0.75	9863
Browning Seed	SWEET SIOUX BMR	73	109	7827	0.78	7827
Browning Seed	SWEET SIOUX WMR	65	115	8595	0.76	8595
Channel Seed	Nutri-Cane	73	102	9198	0.79	9198
Channel Seed	Qualimax	79	111	9138	0.75	9138
Channel Seed	Sweetleaf	58	102	6043	0.79	6043
Dyna-Gro Seed	Danny Boy II BMR	88	107	9309	0.77	9309
Dyna-Gro Seed	Dynagraze II	58	89	4371	0.80	4371
Dyna-Gro Seed	Dynagraze II BMR	65	95	6724	0.78	6724
Dyna-Gro Seed	Fullgraze II	79	128	10204	0.73	10204
Dyna-Gro Seed	Fullgraze II BMR	100	120	**15867**	0.70	**15867**
Dyna-Gro Seed	PearlMil	65	63	5578	0.82	5578
Dyna-Gro Seed	Super Sweet 10	58	86	4570	0.82	4570
Dyna-Gro Seed	Sweet Ton MS	73	101	7909	0.80	7909
KSU (check)	Early Sumac	65	85	5728	0.84	5728
KSU (check)	Rox Orange	65	83	6460	0.84	6460
S & W Seed Co	Sordan 79	65	104	8958	0.80	8958
S & W Seed Co	SP4555	65	101	5416	0.82	5416
Star Seed	Bruiser	92	97	8211	0.75	8211
Star Seed	Excel II	79	110	7926	0.76	7926
Star Seed	Magnum Ultra BMR	73	93	7392	0.79	7392
Star Seed	Nutrimaxx BMR	92	105	8685	0.76	8685
Ward Seed	18180	79	113	9574	0.75	9574
Ward Seed	18182	65	99	7532	0.80	7532
Ward Seed	19011	73	84	6930	0.80	6930
Ward Seed	19102	100	127	**14617**	0.79	**14617**
Ward Seed	19186	100	114	9773	0.71	9773
Ward Seed	20268	73	87	8067	0.80	8067
Ward Seed	20270	77	101	6894	0.77	6894
Ward Seed	19011 harvested +25 day	92	85	9414	0.72	9414
Ward Seed	Tifleaf III	65	65	5795	0.81	5795
Wilbur Ellis	Integra 31F65	73	95	6657	0.81	6657
Wilbur Ellis	Integra Ranch Hand	79	117	9161	0.78	9161
LSD[1]			*10*	*3170*	*0.03*	*3170*

[1]Values in bold are in the top LSD group.
There was no second cutting for Scandia, KS.

Table 7b. 2021 Scandia, Kansas Forage Hay Performance Test, Republic County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Browning Seed	CADAN 99 B WMR	9.80	36.75	59.31	3.79	15.65	4.15	2.64	0.98
Browning Seed	HEADLESS WONDER	5.83	40.25	63.43	4.55	18.29	5.66	2.04	0.73
Browning Seed	SWEET SIOUX BMR	8.76	33.55	53.73	3.06	13.61	5.80	2.52	1.00
Browning Seed	SWEET SIOUX WMR	8.96	37.91	62.10	4.02	17.09	5.19	2.33	0.84
Channel Seed	Nutri-Cane	8.62	32.03	53.23	3.11	14.45	5.84	2.62	1.06
Channel Seed	Qualimax	8.81	36.18	58.00	3.87	15.40	4.48	2.55	1.02
Channel Seed	Sweetleaf	11.12	35.17	60.54	3.65	15.43	4.78	2.80	1.08
Dyna Gro Seed	Danny Boy II BMR	8.87	35.36	56.46	3.32	14.97	4.58	2.53	0.86
Dyna Gro Seed	Dynagraze II	13.02	32.49	54.85	3.34	12.78	3.95	2.88	1.28
Dyna Gro Seed	Dynagraze II BMR	9.61	35.24	59.05	3.16	13.45	4.60	2.52	0.95
Dyna Gro Seed	Fullgraze II	7.65	39.92	65.31	4.51	20.03	4.59	2.32	0.72
Dyna Gro Seed	Fullgraze II BMR	5.08	38.18	59.99	3.78	19.01	5.35	2.08	0.57
Dyna Gro Seed	PearlMil	13.79	36.00	59.01	3.79	11.53	2.69	2.91	1.40
Dyna Gro Seed	Super Sweet 10	11.74	34.42	56.03	3.69	14.29	4.00	2.85	1.18
Dyna Gro Seed	Sweet Ton MS	8.84	32.31	52.82	3.19	13.48	5.80	2.60	1.11
KSU check	Early Sumac	10.79	36.35	59.12	3.56	14.70	3.45	2.71	1.01
KSU check	Rox Orange	10.57	34.64	57.92	3.43	14.73	3.87	2.65	0.91
S & W Seed Co	Sordan 79	8.96	37.00	59.83	4.11	16.08	4.59	2.42	0.81
S & W Seed Co	SP4555	9.61	34.51	54.48	3.22	14.29	4.56	2.58	0.93

continued

Table 7b. 2021 Scandia, Kansas Forage Hay Performance Test, Republic County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Star Seed	Bruiser	8.33	34.03	54.04	3.05	14.73	5.06	2.60	0.94
Star Seed	Excel II	7.51	37.93	59.60	4.21	16.96	5.45	2.16	0.84
Star Seed	Magnum Ultra BMR	9.95	33.04	53.45	3.27	13.93	5.60	2.71	1.14
Star Seed	Nutrimaxx BMR	6.49	34.67	56.80	3.16	14.47	5.67	2.23	0.86
Ward Seed	18180	6.67	36.97	57.05	4.20	17.43	6.29	2.11	0.84
Ward Seed	18182	8.51	36.62	60.58	3.23	14.53	4.63	2.39	0.82
Ward Seed	19011	11.29	34.33	55.16	2.86	12.29	4.05	2.87	1.07
Ward Seed	19102	8.32	38.51	60.64	4.24	17.29	3.77	2.40	0.84
Ward Seed	19186	5.44	35.16	57.01	3.30	15.14	6.98	2.17	0.78
Ward Seed	20268	9.66	34.96	56.69	2.90	12.45	4.19	2.75	1.01
Ward Seed	20270	9.49	36.01	56.87	3.24	14.19	4.64	2.42	0.85
Ward Seed	19011 harvested +25 day	7.69	32.34	48.87	2.76	14.01	7.79	2.71	1.10
Ward Seed	Tifleaf III	12.47	36.55	60.69	3.70	12.24	3.59	2.71	1.34
Wilbur Ellis	Integra 31F65	9.15	35.96	57.34	3.50	13.95	4.25	2.53	0.97
Wilbur Ellis	Integra Ranch Hand	9.34	36.25	58.31	3.31	14.91	3.96	2.52	0.89
Average		9.14	35.64	57.60	3.53	14.93	4.82	2.52	0.96

Table 7b. 2021 Scandia, Kansas Forage Hay Performance Test, Republic County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Browning Seed	CADAN 99 B WMR	8.05	8.29	23.06	12.44	91.47	61.50	0.62	0.36	0.63
Browning Seed	HEADLESS WONDER	6.14	10.95	24.75	16.60	82.02	57.60	0.56	0.30	0.59
Browning Seed	SWEET SIOUX BMR	8.04	14.17	29.86	19.97	103.79	65.10	0.67	0.40	0.67
Browning Seed	SWEET SIOUX WMR	7.81	8.03	21.31	13.22	85.44	60.30	0.60	0.34	0.62
Channel Seed	Nutri-Cane	6.39	16.02	32.04	21.86	107.35	66.60	0.69	0.42	0.69
Channel Seed	Qualimax	7.75	10.53	25.69	15.00	92.90	62.40	0.63	0.37	0.64
Channel Seed	Sweetleaf	7.43	9.06	21.11	13.84	91.42	63.30	0.64	0.38	0.65
Dyna Gro Seed	Danny Boy II BMR	9.00	10.36	26.12	14.94	97.36	63.30	0.64	0.38	0.65
Dyna Gro Seed	Dynagraze II	7.95	10.55	24.68	14.50	103.03	66.30	0.69	0.42	0.68
Dyna Gro Seed	Dynagraze II BMR	8.18	10.27	23.68	14.87	92.30	63.30	0.64	0.38	0.65
Dyna Gro Seed	Fullgraze II	6.61	7.69	20.61	12.27	79.63	57.90	0.56	0.30	0.59
Dyna Gro Seed	Fullgraze II BMR	6.80	12.16	28.56	17.51	88.53	59.70	0.59	0.33	0.61
Dyna Gro Seed	PearlMil	10.80	6.65	16.58	9.34	92.94	62.40	0.63	0.37	0.64
Dyna Gro Seed	Super Sweet 10	8.40	9.47	24.27	13.47	98.37	63.90	0.65	0.39	0.66
Dyna Gro Seed	Sweet Ton MS	6.52	15.34	32.08	21.14	107.76	66.60	0.69	0.42	0.69
KSU check	Early Sumac	8.10	8.50	22.49	11.95	91.81	61.80	0.62	0.36	0.63
KSU check	Rox Orange	8.06	8.78	24.16	12.65	94.57	63.60	0.65	0.38	0.65
S & W Seed Co	Sordan 79	7.94	8.28	23.62	12.87	89.30	60.90	0.61	0.35	0.62
S & W Seed Co	SP4555	9.10	10.51	27.31	15.06	99.21	63.60	0.65	0.38	0.65

continued

Table 7b. 2021 Scandia, Kansas Forage Hay Performance Test, Republic County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Star Seed	Bruiser	8.58	12.23	29.58	17.29	103.71	64.20	0.66	0.39	0.66
Star Seed	Excel II	7.33	11.28	25.80	16.73	89.15	60.00	0.59	0.34	0.61
Star Seed	Magnum Ultra BMR	7.09	13.22	29.77	18.82	105.11	65.70	0.68	0.41	0.68
Star Seed	Nutrimaxx BMR	6.73	14.04	30.58	19.71	97.09	63.90	0.65	0.39	0.66
Ward Seed	18180	6.83	13.65	29.73	19.94	94.11	61.20	0.61	0.35	0.63
Ward Seed	18182	9.03	9.39	22.29	14.03	89.85	61.50	0.62	0.36	0.63
Ward Seed	19011	10.04	9.43	23.99	13.48	98.93	64.20	0.66	0.39	0.66
Ward Seed	19102	8.36	7.94	23.05	11.71	86.69	59.40	0.58	0.33	0.61
Ward Seed	19186	6.19	13.46	31.88	20.44	96.34	63.30	0.64	0.38	0.65
Ward Seed	20268	9.54	9.88	24.56	14.07	97.59	63.30	0.64	0.38	0.65
Ward Seed	20270	9.25	10.06	24.96	14.70	94.64	62.40	0.63	0.37	0.64
Ward Seed	19011 harvested +25 day	8.09	15.05	35.59	22.83	115.90	66.30	0.69	0.42	0.68
Ward Seed	Tifleaf III	9.64	8.48	17.35	12.08	90.10	61.80	0.62	0.36	0.63
Wilbur Ellis	Integra 31F65	8.76	9.47	25.21	13.72	94.25	62.40	0.63	0.37	0.64
Wilbur Ellis	Integra Ranch Hand	9.27	9.11	23.42	13.07	93.17	62.10	0.63	0.36	0.64
Average		8.05	10.66	25.58	15.47	95.17	62.70	0.63	0.37	0.64

Table 8. Silage performance test near Garden City

		Stand Assessment			First Cutting			
Company	**Variety**	**Stand**	**Vigor**	**Lodging %**	**Days to harvest**	**Height (inches)**	**DM lb/acre**	**Moisture**
Alta Seeds	ADVF7424	10	10	0	119	71	**14240**	0.66
Alta Seeds	ADVF8322	9	10	0	119	71	**14989**	0.64
Alta Seeds	ADVS6504	10	9	0	119	108	**14107**	0.72
Alta Seeds	ADVS6520	10	10	0	119	104	**14497**	0.69
Alta Seeds	ADVXF450IG	10	10	0	119	67	**15629**	0.66
Alta Seeds	ADVXS005	10	10	0	119	106	**14830**	0.69
Alta Seeds	AF7401	10	10	0	119	65	**15009**	0.66
Channel Seed	Nutri-Choice	9	10	0	119	74	13157	0.67
Channel Seed	Nutri-Chomp	10	10	0	119	93	12714	0.69
Dyna-Gro Seed	5 Star	10	10	0	98	94	**13766**	0.70
Dyna-Gro Seed	F70FS91 BMR	9	9	0	105	80	10913	0.67
Dyna-Gro Seed	F71FS72 BMR	10	9	0	98	67	11472	0.70
Dyna-Gro Seed	F72FS05	10	10	0	119	69	**15821**	0.66
Dyna-Gro Seed	F74FS23 BMR	10	10	0	98	83	12534	0.74
Dyna-Gro Seed	F74FS72 BMR	10	10	0	119	65	**13761**	0.64
Dyna-Gro Seed	Super Sile 20	9	9	0	119	94	**13977**	0.67
Dyna-Gro Seed	Super Sile 30	10	9	0	119	89	**14805**	0.69
Dyna-Gro Seed	Sweet Ton MS	10	9	0	98	89	11643	0.70

continued

Table 8. Silage performance test near Garden City

		Stand Assessment			First Cutting			
Company	**Variety**	**Stand**	**Vigor**	**Lodging %**	**Days to harvest**	**Height (inches)**	**DM lb/acre**	**Moisture**
KSU (check)	KS Orange	10	9	0	105	99	12537	0.68
MOJO Seed	Opal	10	10	0	105	69	11247	0.71
MOJO Seed	Pearl	10	10	0	98	70	10660	0.70
Sharp Brothers	Buffalo Sugar Sweet AT	10	10	0	119	86	**13446**	0.70
Sharp Brothers	SBW7706W	10	10	0	98	66	12987	0.69
Star Seed	Brutis	10	10	0	119	65	**13305**	0.65
Star Seed	Packer	10	10	0	105	73	11054	0.71
Ward Seed	19040	10	10	0	119	61	10894	0.67
Ward Seed	19042	10	10	0	119	79	**15090**	0.69
Ward Seed	19156	10	9	0	98	96	**13739**	0.67
Ward Seed	19181	10	10	0	119	73	12625	0.66
Wilbur Ellis	Integra 33F70	9	10	0	119	63	11050	0.68
Wilbur Ellis	Integra 34F95	9	10	0	105	87	**13214**	0.69
Wilbur Ellis	Integra 38F80	10	10	0	119	82	12211	0.71
LSD[1]						*8*	*2632*	*0.05*

[1]Values in bold are in the top LSD group.

Table 8b. 2021 Garden City, Kansas Silage Performance Test, Finney County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Alta Seeds	ADVF7424	7.01	30.40	49.39	2.40	16.20	8.86	2.75	1.13
Alta Seeds	ADVF8322	7.19	31.99	51.35	3.73	17.16	10.97	2.57	1.09
Alta Seeds	ADVS6504	6.82	33.80	51.79	2.51	16.19	2.53	2.47	0.93
Alta Seeds	ADVS6520	6.37	33.64	51.86	2.49	16.08	3.63	2.40	0.91
Alta Seeds	ADVXF450IG	7.21	33.52	54.49	3.73	18.94	8.24	2.31	0.96
Alta Seeds	ADVXS005	6.91	33.44	51.88	3.12	16.41	3.64	2.49	0.91
Alta Seeds	AF7401	7.97	31.15	48.68	3.17	15.85	10.93	2.69	1.09
Channel Seed	Nutri-Choice	7.43	31.82	49.97	3.56	16.25	11.34	2.41	1.05
Channel Seed	Nutri-Chomp	7.06	31.63	51.93	2.79	14.52	3.43	2.49	0.99
Dyna Gro Seed	5 Star	7.60	30.04	46.10	3.50	14.83	13.62	2.81	1.18
Dyna Gro Seed	F70FS91 BMR	8.31	31.03	46.18	3.41	14.57	13.09	3.01	1.22
Dyna Gro Seed	F71FS72 BMR	7.76	29.87	44.45	3.26	14.79	15.94	3.14	1.29
Dyna Gro Seed	F72FS05	7.64	31.24	48.89	3.20	15.33	9.98	2.65	1.07
Dyna Gro Seed	F74FS23 BMR	7.55	30.61	47.75	2.79	14.61	9.25	2.72	1.13
Dyna Gro Seed	F74FS72 BMR	7.15	31.82	49.87	2.79	16.13	9.28	2.67	1.07
Dyna Gro Seed	Super Sile 20	6.79	33.02	52.69	3.67	17.97	7.52	2.32	0.95
Dyna Gro Seed	Super Sile 30	7.34	33.46	51.70	4.06	17.08	9.38	2.42	0.91
Dyna Gro Seed	Sweet Ton MS	7.54	28.39	43.33	3.05	14.57	12.71	2.93	1.18
KSU check	KS Orange	7.17	31.04	48.46	3.62	17.17	10.86	2.80	1.01
MOJO Seed	Opal	7.97	31.41	48.19	3.46	16.27	11.07	2.62	1.12
MOJO Seed	Pearl	7.73	31.30	48.55	3.43	16.22	13.34	2.79	1.21
Sharp Brothers	Buffalo Sugar Sweet AT	7.43	32.85	50.26	3.92	16.82	8.95	2.47	1.00
Sharp Brothers	SBW7706W	8.15	30.98	46.46	3.76	15.44	17.52	2.95	1.28
Star Seed	Brutis	7.22	31.35	49.31	2.76	15.08	9.14	2.68	1.05
Star Seed	Packer	7.57	32.17	49.75	3.65	16.02	11.03	2.57	1.09
Ward Seed	19040	8.34	32.03	51.10	3.29	16.51	5.69	2.57	1.05
Ward Seed	19042	7.69	33.34	53.87	3.35	17.12	2.91	2.45	0.96
Ward Seed	19156	6.76	32.50	48.61	4.00	16.07	13.08	2.58	1.09
Ward Seed	19181	7.76	29.16	46.69	2.18	14.99	8.66	2.83	1.18
Wilbur Ellis	Integra 33F70	7.53	32.17	50.51	3.49	15.65	13.10	2.52	1.11
Wilbur Ellis	Integra 34F95	8.19	28.01	42.00	2.85	13.46	12.09	3.27	1.19
Wilbur Ellis	Integra 38F80	7.94	32.97	52.83	3.86	16.62	9.04	2.42	1.04
Average		7.47	31.63	49.34	3.28	15.97	9.71	2.65	1.08

Table 8b. 2021 Garden City, Kansas Silage Performance Test, Finney County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Alta Seeds	ADVF7424	10.80	14.23	32.71	23.09	119.02	68.67	0.72	0.45	0.71
Alta Seeds	ADVF8322	9.81	10.53	31.53	21.50	112.10	66.60	0.69	0.43	0.69
Alta Seeds	ADVS6504	12.67	17.79	28.92	20.33	108.50	64.80	0.66	0.40	0.67
Alta Seeds	ADVS6520	11.68	17.52	29.98	21.15	108.58	65.10	0.67	0.41	0.67
Alta Seeds	ADVXF450IG	9.93	11.93	28.57	20.18	103.52	65.10	0.67	0.40	0.67
Alta Seeds	ADVXS005	10.88	18.38	30.33	22.02	108.84	65.10	0.67	0.40	0.67
Alta Seeds	AF7401	10.23	11.35	33.18	22.28	119.27	67.80	0.71	0.44	0.70
Channel Seed	Nutri-Choice	10.35	11.11	32.31	22.45	114.63	66.90	0.70	0.43	0.69
Channel Seed	Nutri-Chomp	10.00	18.15	31.12	21.57	111.27	67.20	0.70	0.43	0.69
Dyna Gro Seed	5 Star	9.90	12.82	36.31	26.44	125.42	69.00	0.73	0.45	0.71
Dyna Gro Seed	F70FS91 BMR	10.80	10.13	34.53	23.22	123.95	67.50	0.71	0.44	0.70
Dyna Gro Seed	F71FS72 BMR	10.86	9.79	36.68	25.73	131.01	68.97	0.73	0.45	0.71
Dyna Gro Seed	F72FS05	11.01	11.90	32.50	21.88	117.48	67.80	0.71	0.44	0.70
Dyna Gro Seed	F74FS23 BMR	11.70	14.60	33.00	23.85	120.71	68.10	0.71	0.44	0.70
Dyna Gro Seed	F74FS72 BMR	11.34	11.99	31.74	21.27	113.99	67.20	0.70	0.43	0.69
Dyna Gro Seed	Super Sile 20	9.54	14.30	30.91	21.81	108.23	65.70	0.68	0.41	0.68
Dyna Gro Seed	Super Sile 30	9.66	12.93	31.38	22.32	108.78	65.10	0.67	0.40	0.67
Dyna Gro Seed	Sweet Ton MS	9.08	16.77	39.74	29.49	136.43	70.73	0.75	0.48	0.73
KSU check	KS Orange	9.11	15.18	35.27	26.04	119.61	67.80	0.71	0.44	0.70
MOJO Seed	Opal	10.60	12.70	33.27	23.77	118.55	67.20	0.70	0.43	0.69
MOJO Seed	Pearl	10.81	10.52	32.72	23.86	117.21	67.50	0.71	0.44	0.70
Sharp Brothers	Buffalo Sugar Sweet AT	10.34	13.22	31.96	22.17	111.75	66.00	0.68	0.42	0.68
Sharp Brothers	SBW7706W	10.13	6.45	34.91	23.97	124.51	67.80	0.71	0.44	0.70
Star Seed	Brutis	10.41	12.23	32.99	21.37	117.41	67.20	0.70	0.43	0.69
Star Seed	Packer	10.96	11.92	31.72	22.94	114.15	66.60	0.69	0.43	0.69
Ward Seed	19040	10.80	15.35	29.90	21.04	111.71	66.60	0.69	0.43	0.69
Ward Seed	19042	10.35	15.57	28.26	18.48	105.24	65.40	0.67	0.41	0.67
Ward Seed	19156	10.04	11.42	34.44	24.50	115.82	66.30	0.69	0.42	0.68
Ward Seed	19181	10.91	14.98	34.49	23.63	127.43	70.17	0.75	0.47	0.73
Wilbur Ellis	Integra 33F70	11.10	8.08	30.85	21.18	113.54	66.60	0.69	0.42	0.69
Wilbur Ellis	Integra 34F95	9.56	16.76	39.97	28.85	142.70	71.30	0.76	0.48	0.74
Wilbur Ellis	Integra 38F80	10.67	11.23	28.64	20.28	108.33	65.70	0.68	0.41	0.68
Average		10.50	13.18	32.65	22.90	116.87	67.17	0.70	0.43	0.69

Table 9. Silage performance test near Scandia

Company	Variety	Stand Assessment			First Cutting			
		Stand	Vigor	Lodging %	Days to harvest	Height (inches)	DM lb/acre	Moisture
Channel Seed	Nutri-Choice	9	3	7	99	88	**10073**	0.74
Channel Seed	Nutri-Chomp	9	2	17	106	121	**10271**	0.75
Dyna-Gro Seed	5 Star	9	3	7	91	115	**9839**	0.75
Dyna-Gro Seed	F70FS91 BMR	9	7	13	91	112	**11372**	0.71
Dyna-Gro Seed	F71FS72 BMR	8	1	0	91	89	7329	0.77
Dyna-Gro Seed	F72FS05	9	0	3	99	85	**11832**	0.73
Dyna-Gro Seed	F74FS23 BMR	9	8	67	99	99	5360	0.79
Dyna-Gro Seed	F74FS72 BMR	9	0	0	106	73	**10736**	0.74
Dyna-Gro Seed	Super Sile 20	7	1	0	106	114	**9741**	0.73
Dyna-Gro Seed	Super Sile 30	8	1	13	99	102	**10648**	0.75
Dyna-Gro Seed	Sweet Ton MS	9	7	7	91	112	6652	0.75
KSU (check)	KS Orange	7	4	3	99	116	**8938**	0.70
MOJO Seed	Opal	8	1	0	99	89	8549	0.74
MOJO Seed	Pearl	10	4	13	91	95	7493	0.78
Star Seed	Brutis	9	1	0	99	78	**11490**	0.73
Star Seed	Packer	10	1	0	91	93	**10153**	0.76
Ward Seed	19040	8	1	0	106	77	**10571**	0.73
Ward Seed	19042	9	1	0	106	97	**9072**	0.74
Ward Seed	19156	9	9	53	91	117	**10776**	0.72
Ward Seed	19181	9	0	0	99	87	6779	0.77
Wilbur Ellis	Integra 33F70	10	1	0	91	71	**10736**	0.76
Wilbur Ellis	Integra 34F95	9	5	0	91	113	7702	0.74
Wilbur Ellis	Integra 38F80	9	0	0	99	91	**9369**	0.74
LSD[1]						*5*	*3265*	*0.04*

[1]Values in bold are in the top LSD group.

Table 9b. 2021 Scandia, Kansas Silage Performance Test, Republic County

Company	Variety	CP	ADF	aNDFom	Lignin	uNDFom240	Starch	EE	TFA
Channel Seed	Nutri-Choice	6.72	37.38	58.73	4.23	17.08	3.60	2.32	0.83
Channel Seed	Nutri-Chomp	6.48	30.30	48.55	2.59	11.66	3.33	2.67	0.91
Dyna Gro Seed	5 Star	7.53	32.88	51.40	3.36	15.79	3.63	2.42	1.03
Dyna Gro Seed	F70FS91 BMR	8.73	31.64	50.12	3.27	14.09	8.10	2.97	1.27
Dyna Gro Seed	F71FS72 BMR	7.98	30.31	47.08	2.99	13.65	10.32	2.79	1.26
Dyna Gro Seed	F72FS05	7.05	37.91	60.82	4.95	17.44	4.54	2.34	0.92
Dyna Gro Seed	F74FS23 BMR	8.94	35.76	56.47	3.23	15.44	0.98	2.55	1.05
Dyna Gro Seed	F74FS72 BMR	7.86	33.19	52.61	3.16	14.70	7.05	2.76	1.16
Dyna Gro Seed	Super Sile 20	6.77	31.68	50.09	3.37	15.08	6.48	2.37	1.00
Dyna Gro Seed	Super Sile 30	6.88	36.06	56.46	4.15	17.28	3.03	2.21	0.91
Dyna Gro Seed	Sweet Ton MS	8.39	29.14	46.65	2.75	13.82	5.96	2.80	1.17
KSU check	KS Orange	7.10	32.49	51.75	3.61	16.88	5.18	2.59	0.86
MOJO Seed	Opal	6.38	32.39	51.78	3.04	15.58	3.43	2.62	0.93
MOJO Seed	Pearl	7.65	36.81	58.38	4.31	16.91	3.26	2.40	0.97
Star Seed	Brutis	8.97	32.42	51.97	3.27	14.63	7.50	2.76	1.13
Star Seed	Packer	7.14	36.24	57.64	4.44	16.17	3.38	2.36	0.99
Ward Seed	19040	7.50	31.10	48.48	3.05	14.10	4.98	2.74	1.09
Ward Seed	19042	7.28	32.60	52.45	3.17	14.64	2.31	2.53	1.08
Ward Seed	19156	6.77	38.87	59.90	4.44	18.69	1.53	2.14	0.85
Ward Seed	19181	6.75	32.79	52.59	2.49	15.46	1.97	2.71	1.01
Wilbur Ellis	Integra 33F70	7.91	33.90	54.09	3.31	14.38	6.37	2.51	1.14
Wilbur Ellis	Integra 34F95	7.82	28.85	47.02	2.41	13.30	5.53	2.90	1.19
Wilbur Ellis	Integra 38F80	5.62	34.79	56.13	3.72	15.97	4.57	2.21	0.92
Average		7.40	33.46	53.10	3.45	15.34	4.65	2.55	1.03

Table 9b. 2021 Scandia, Kansas Silage Performance Test, Republic County

Company	Variety	Ash	WSC	NFC	NSC	RFV	TDN	NEM	NEG	NEL
Channel Seed	Nutri-Choice	9.87	12.14	25.21	15.74	91.21	60.90	0.61	0.35	0.62
Channel Seed	Nutri-Chomp	9.13	23.04	35.93	26.37	119.04	68.67	0.72	0.45	0.71
Dyna Gro Seed	5 Star	9.79	18.79	31.74	22.43	108.96	66.00	0.68	0.42	0.68
Dyna Gro Seed	F70FS91 BMR	10.30	12.22	30.96	20.32	115.75	66.90	0.70	0.43	0.69
Dyna Gro Seed	F71FS72 BMR	10.64	14.00	34.56	24.32	122.76	68.67	0.72	0.45	0.71
Dyna Gro Seed	F72FS05	9.44	9.02	23.18	13.55	88.90	60.30	0.60	0.34	0.62
Dyna Gro Seed	F74FS23 BMR	12.81	11.46	22.42	12.44	96.78	62.40	0.63	0.37	0.64
Dyna Gro Seed	F74FS72 BMR	11.33	11.49	28.41	18.54	109.26	65.37	0.67	0.40	0.67
Dyna Gro Seed	Super Sile 20	9.91	19.55	33.24	26.03	113.69	66.87	0.70	0.43	0.69
Dyna Gro Seed	Super Sile 30	9.88	15.34	27.24	18.36	96.26	62.10	0.63	0.36	0.64
Dyna Gro Seed	Sweet Ton MS	9.46	19.32	35.60	25.29	124.72	69.87	0.74	0.46	0.72
KSU check	KS Orange	8.68	18.51	32.99	23.69	109.64	66.00	0.68	0.42	0.68
MOJO Seed	Opal	9.08	19.41	33.04	22.84	109.99	66.27	0.69	0.42	0.68
MOJO Seed	Pearl	10.21	12.51	24.26	15.77	92.62	61.50	0.62	0.36	0.63
Star Seed	Brutis	10.76	11.30	28.66	18.80	109.50	66.30	0.69	0.42	0.68
Star Seed	Packer	10.00	13.11	25.67	16.50	93.58	61.80	0.62	0.36	0.63
Ward Seed	19040	10.19	18.94	33.89	23.92	117.83	67.50	0.71	0.44	0.70
Ward Seed	19042	9.89	18.67	30.70	20.98	106.67	66.00	0.68	0.42	0.68
Ward Seed	19156	10.13	12.94	23.77	14.47	87.28	59.40	0.58	0.33	0.61
Ward Seed	19181	10.61	18.11	30.43	20.08	107.42	65.70	0.68	0.41	0.68
Wilbur Ellis	Integra 33F70	11.69	10.31	26.64	16.68	102.39	64.50	0.66	0.39	0.66
Wilbur Ellis	Integra 34F95	9.83	20.20	35.38	25.74	125.31	70.13	0.75	0.47	0.73
Wilbur Ellis	Integra 38F80	8.82	17.20	29.64	21.77	100.36	63.60	0.65	0.38	0.65
Average		10.11	15.55	29.72	20.20	106.52	65.08	0.67	0.40	0.67

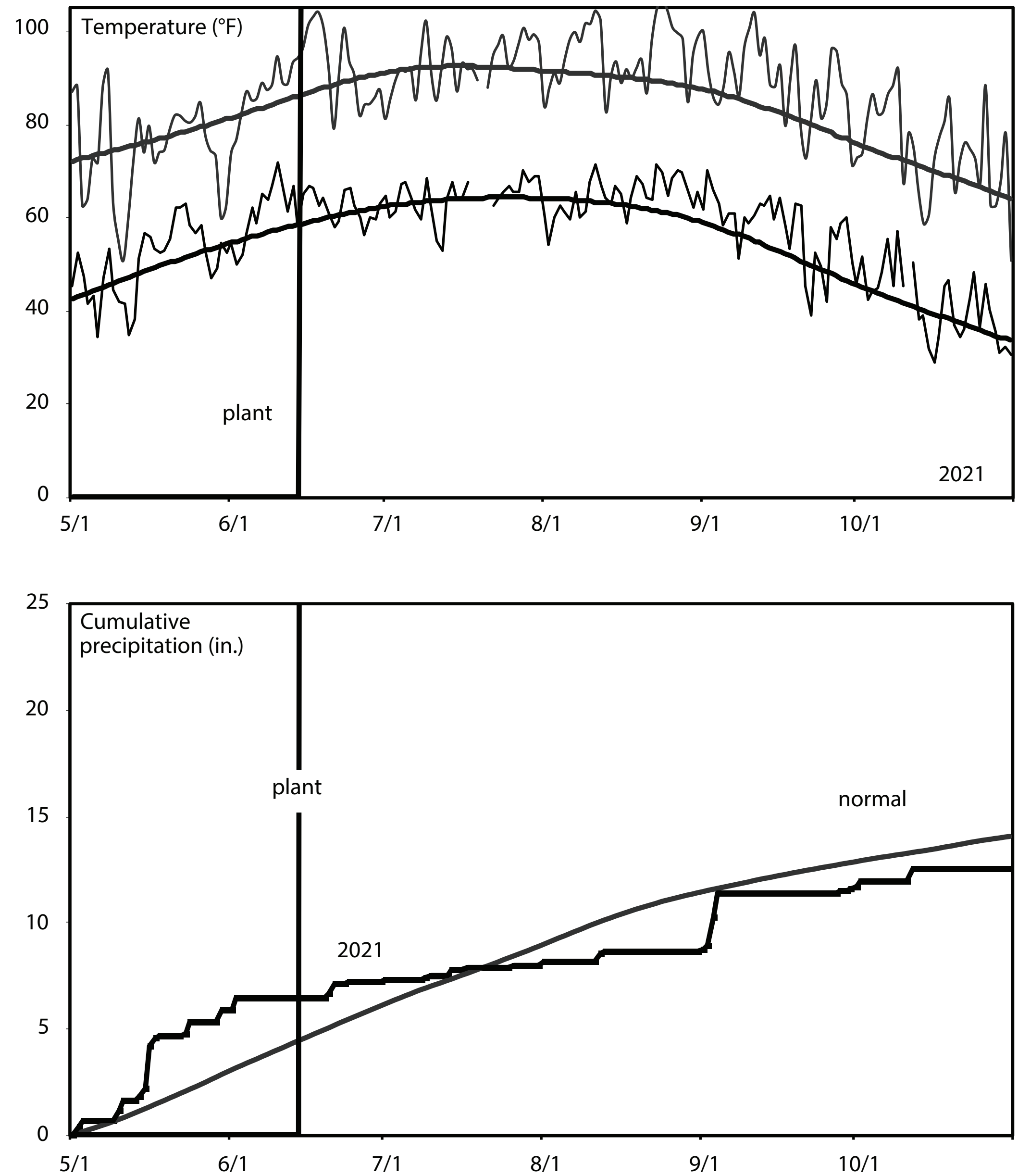
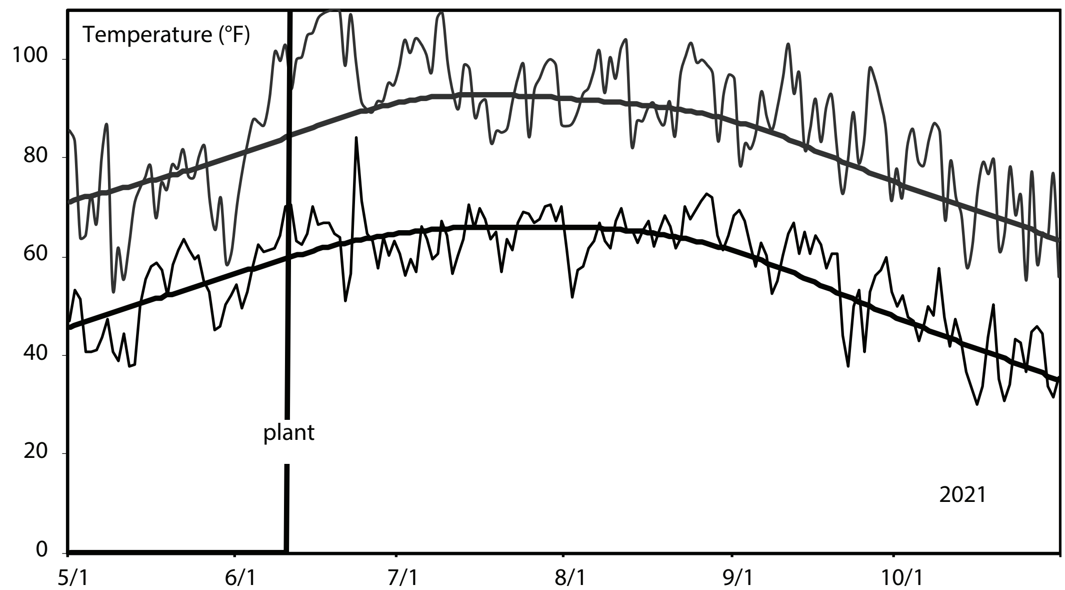


Figure 1. Precipitation and temperature during the 2021 growing season near Garden City, KS. Top pane: daily and mean (1981 to 2010) high and low temperature. Bottom pane: daily and mean (1981 to 2010) cumulative precipitation.



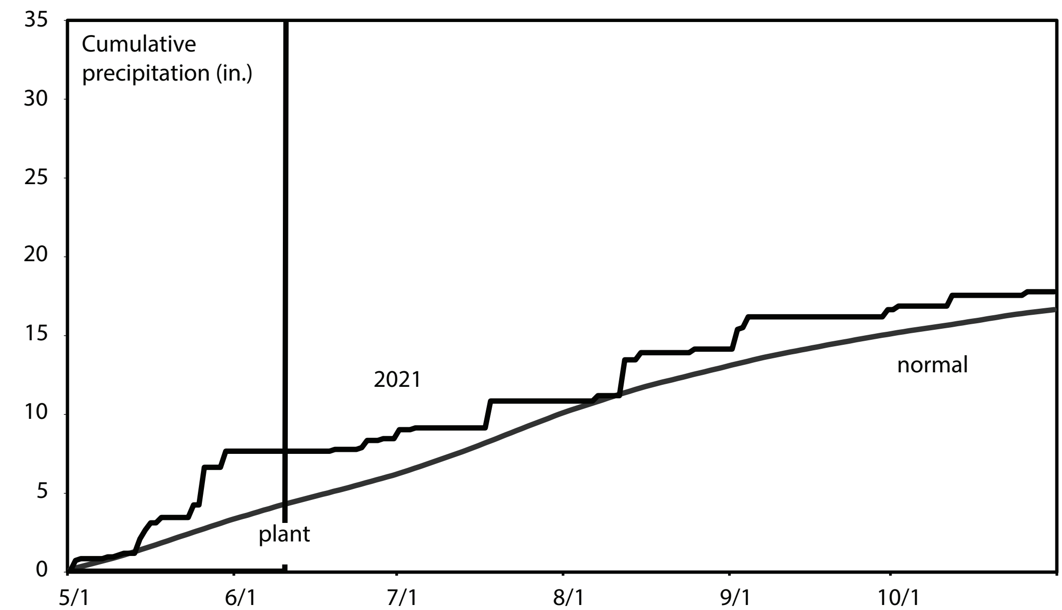


Figure 2. Precipitation and temperature during the 2021 growing season near Hays, KS. Top pane: daily and mean (1981 to 2010) high and low temperature. Bottom pane: daily and mean (1981 to 2010) cumulative precipitation.

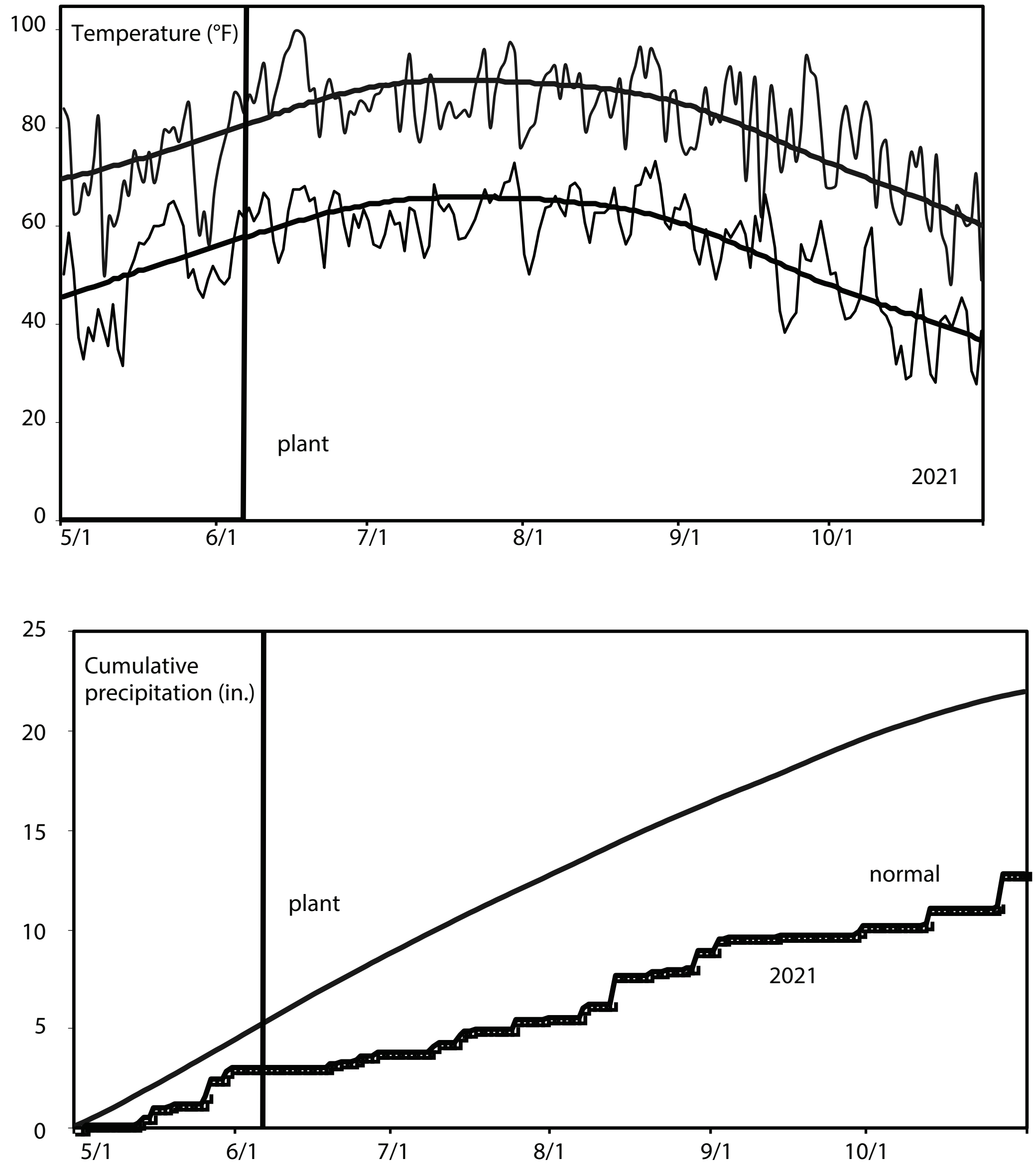


Figure 3. Precipitation and temperature during the 2021 growing season near Scandia, KS. Top pane: daily and mean (1981 to 2010) high and low temperature. Bottom pane: daily and mean (1981 to 2010) cumulative precipitation.

Acknowledgments

The staffs of the Western Kansas Research-Extension Centers and Kansas State University appreciate and acknowledge the following companies, foundations, and individuals for their support of the research that has been conducted in the past year.

Donations

Bayer Crop Science
Central Plains Equipment LLC
Commerce Bank
Crop Quest
Dragon-Line
Ehmke Seed
Great Plains Canola Association
Hydro Resources - Midcontinent, Inc
KanEquip, Inc
Kansas Corn Commission
Kansas Forage and Grassland Council
Lang Diesel, Inc
Pioneer Hi-Bred
Pioneer Seed
Sharp Brothers Seed
UPL NA Inc.
Western State Bank

Grant Support

ADAMA Agricultural Solutions
AMVAC Chemical Corporation
Bayer CropScience
Great Plains Canola Association
Helm Ag
International Plant Nutrition Institute
Kansas Department of Agriculture
Kansas Wheat Commission
United Sorghum Checkoff Program
U.S. Canola Association
USDA Agricultural Research Service
USDA Canola Project
USDA National Institute of Food and Agriculture
USDA National Resources Conservation Service CIG
USDA Ogallala Aquifer Project
USDA Risk Management Agency

Cooperators/Collaborators

Colorado State University
Dodge City Community College
Kansas State University Research Foundation
Oklahoma State University
USDA Agricultural Research Service, Bushland, TX

Performance Tests

AgriLead
Alta Seeds
Browning Seed
Channel Seed
CHS Seed Resources
Coffey Seeds Inc.
Dyna-Gro Seed
Ehmke Seed
Wilber Ellis
Fontanelle
Gayland Ward Seed
KSW Cereals
Limagrain
Mojo Seed
Richardson Seed
S & W Seed
Scott Seed
Sharp Brothers Seed
Sorghum Partners
Star Seed
Texas A&M AgriLife Foundation Seed
Walter Moss Seed
Ward Seed
Watley Seed
Wilber Ellis
Winfield United

2022 WESTERN KANSAS AGRICULTURAL RESEARCH

Contribution no. 23-022-S from the Kansas Agricultural Experiment Station.

Chemical Disclaimer

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Experiments with pesticides on nonlabeled crops or target species do not imply endorsement or recommendation of nonlabeled use of pesticides by Kansas State University. All pesticides must be used consistent with current label directions. Current information on weed control in Kansas is available in *2022 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland*, Report of Progress 1169, available from the KSRE Bookstore, 24 Umberger Hall, Kansas State University, or at: ***www.bookstore.ksre.ksu.edu/*** (type Chemical Weed Control in search box).

These and other articles are available at the Kansas Agricultural Experiment Station Research Reports site at: ***http://newprairiepress.org/kaesrr***

Publications from Kansas State University are available at: ***www.ksre.ksu.edu***

Open the camera app on your phone or tablet to scan the QR code and be directed to this report on the Kansas Agricultural Experiment Station Research Report website (newprairiepress.org/kaesrr/vol8/iss8/).

KANSAS STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE

K-State Research and Extension is an equal opportunity provider and employer.

August 2022