Kansas Agricultural Experiment Station Research Reports

Volume 8
Issue 8 *Western Kansas Agricultural Research*

Article 5

2022

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Recommended Citation

Lamm, F. R. (2022) "Intensification of Sprinkler-Irrigated Corn Production," *Kansas Agricultural Experiment Station Research Reports*: Vol. 8: Iss. 8. https://doi.org/10.4148/2378-5977.8333

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Abstract

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.

Keywords

crop intensification, irrigated corn, sprinkler irrigation, water productivity

Cover Page Footnote

Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022. Special appreciation to Jonathan Aguilar for reviewing this report for final publication. This research project received support from the U.S. Department of Agriculture Agricultural Research Service Ogallala Aquifer Program.

K-STATE Research and Extension

2022 WESTERN KANSAS AGRICULTURAL RESEARCH

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.

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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 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 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.

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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

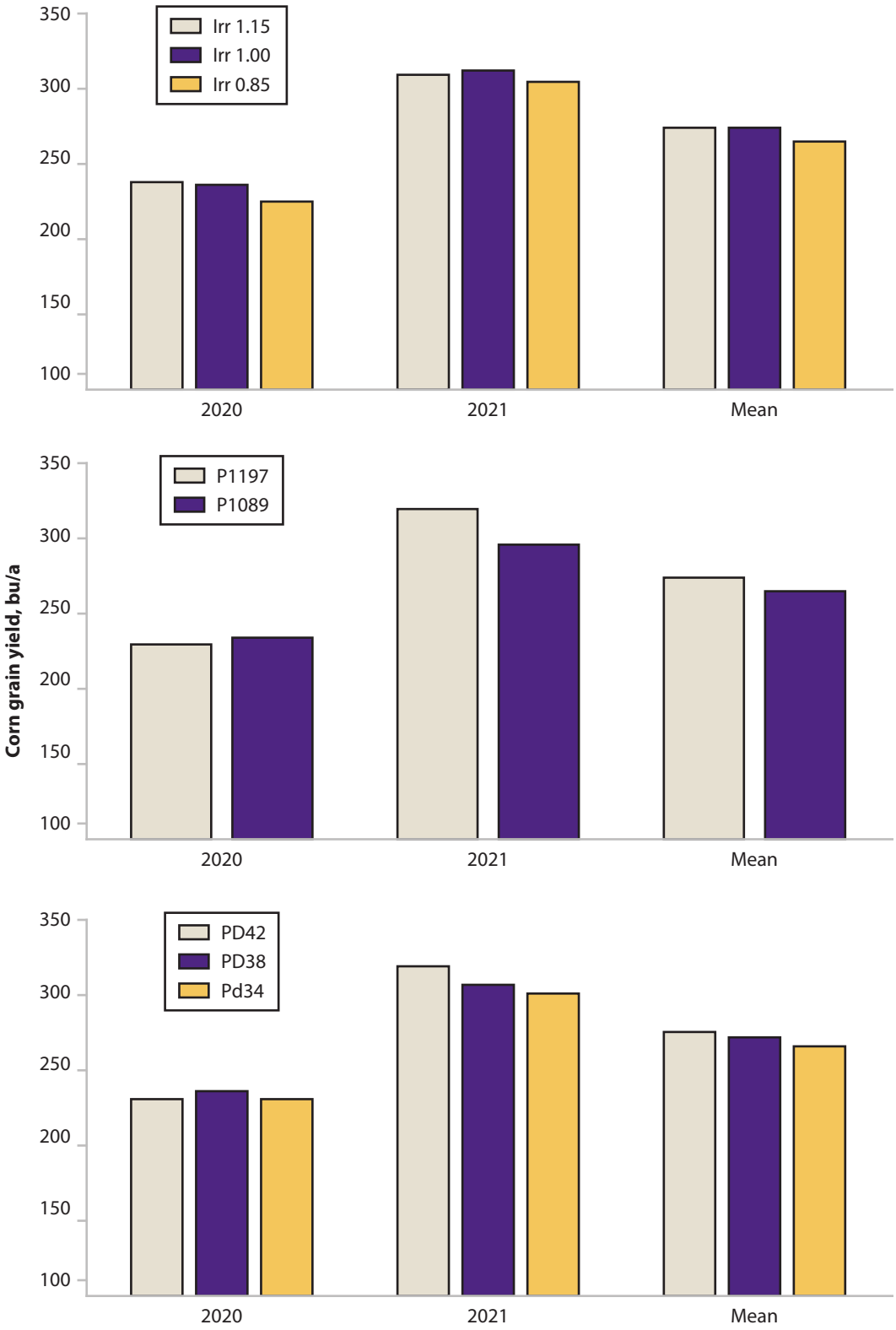

Figure 1. Corn grain yields (2020–2021) for a sprinkler-irrigated crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel is 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.

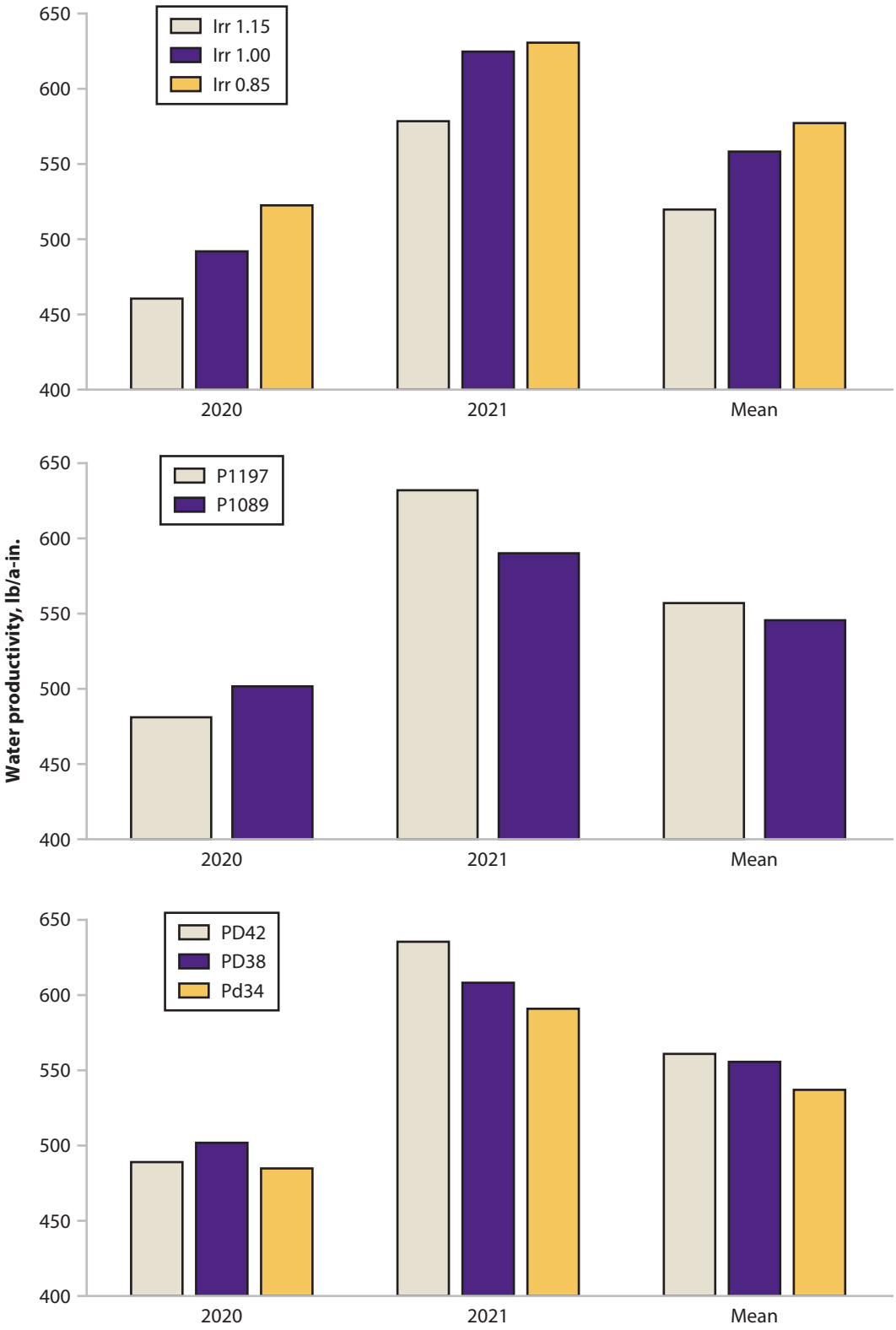

Figure 2. Crop water productivity (2020–2021) for a sprinkler-irrigated crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. Middle panel 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.