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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.

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

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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 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.

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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

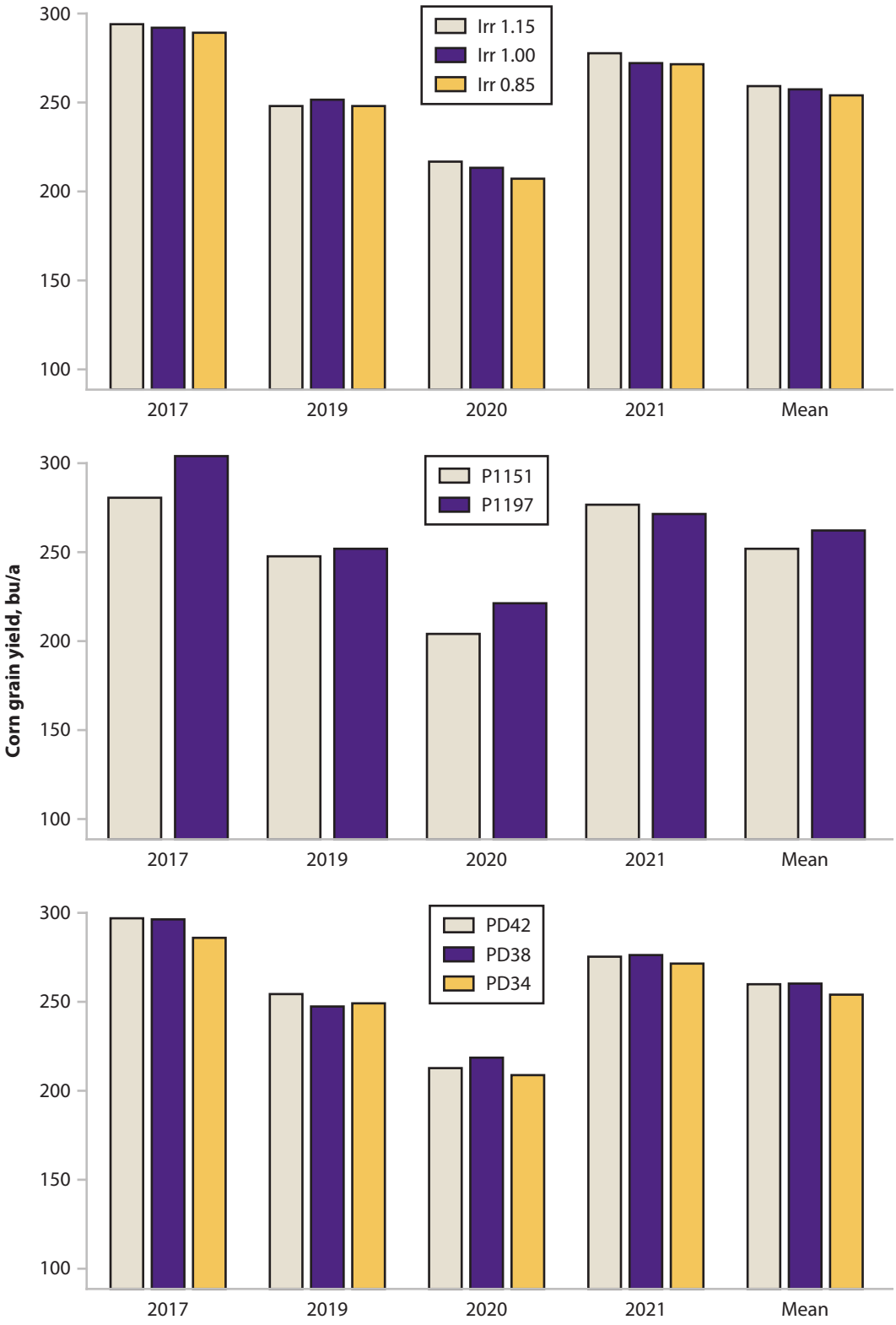

Figure 1. Corn grain yields (2017, 2019–2021) for a subsurface drip irrigation (SDI) crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus rain. 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.

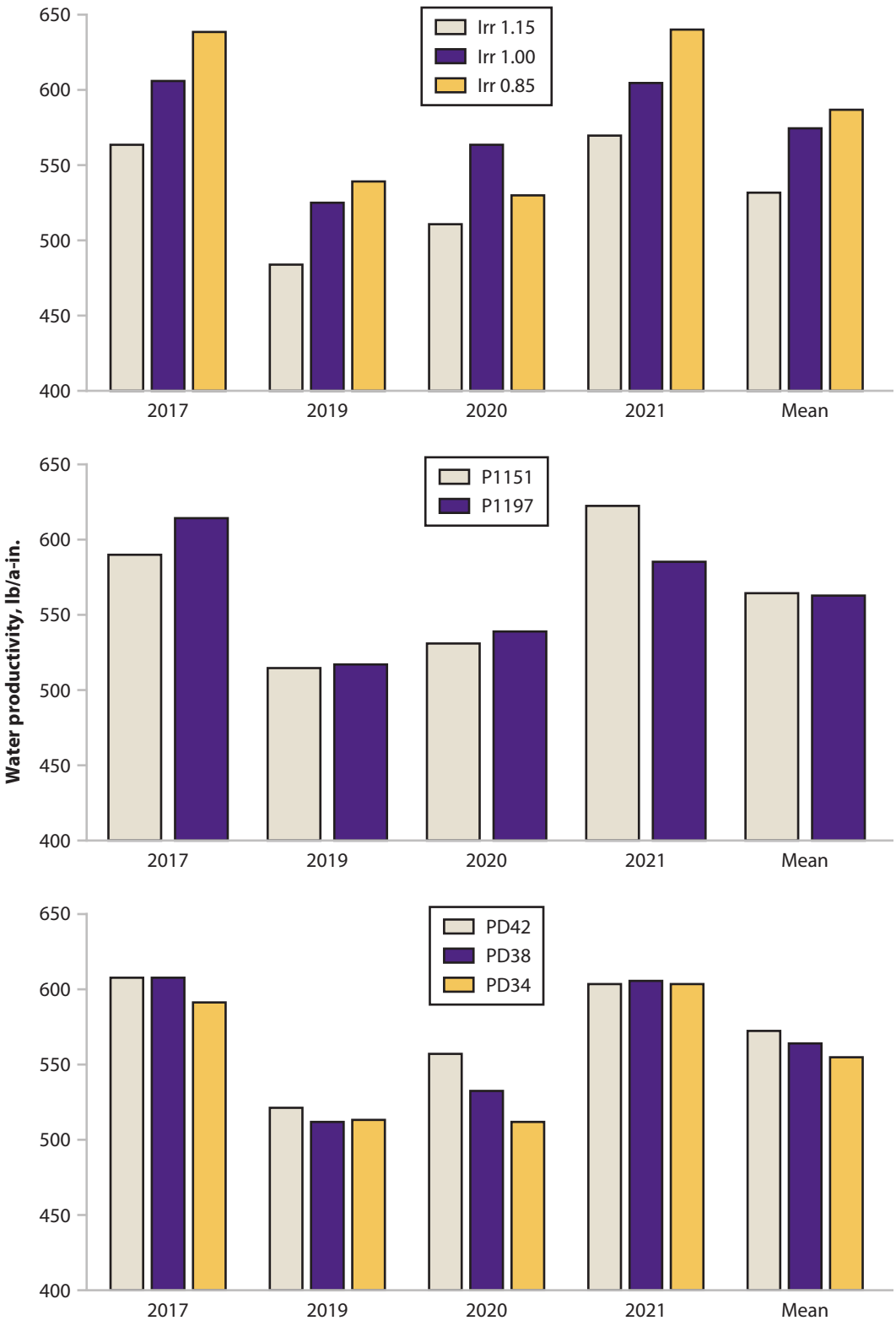

Figure 2. Crop water productivity (2017, 2019–2021) for a subsurface drip irrigation (SDI) crop intensification study at Kansas State University Northwest Research-Extension Center, Colby, KS. Upper panel is for the three irrigation levels designed to match 115, 100, or 85% of well-watered corn ET minus 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.