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Corn Yield Response to Water Availability

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Corn Yield Response to Water Availability

Abstract

Drought-tolerant technologies have become popular in hybrids for low-yielding corn environments across central and western Kansas and are marketed for their ability to produce higher grain yields with less water. The objective of this study was to compare water use, yield, and water use efficiency (WUE) of two types of drought-tolerant (DT) corn hybrids and a high-yielding non-DT hybrid. Water use and yield of two DT and one non-DT, high-yielding hybrid were compared in both dryland and irrigated situations. The average yield for the irrigated corn was 217 bu/a, and the average was 127 bu/a in dryland, representing a yield increase of 90 bu/a. The irrigated corn received a total of 10 in. more water than the dryland corn over the course of the growing season, resulting in 9 bu for each additional inch of water use averaged across the three hybrids. The irrigated corn used a mean of 20.85 in. of water, and the dryland corn used a mean of 11.66 in. of water. The WUE was 10.71 bu/in. and 10.43 bu/in. for dryland and irrigated corn, respectively. Although hybrid yields differed in the irrigated environment, water use and WUE were similar for all hybrids in both dryland and irrigated environments. One DT hybrid exhibited more stable yields across dryland and irrigated environments compared with the other DT hybrid and the non-DT hybrid.

Keywords

corn, water use, yield, water use efficiency, drought tolerance

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Summary

Drought-tolerant technologies have become popular in hybrids for low-yielding corn environments across central and western Kansas and are marketed for their ability to produce higher grain yields with less water. The objective of this study was to compare water use, yield, and water use efficiency (WUE) of two types of drought-tolerant (DT) corn hybrids and a high-yielding non-DT hybrid. Water use and yield of two DT and one non-DT, high-yielding hybrid were compared in both dryland and irrigated situations. The average yield for the irrigated corn was 217 bu/a, and the average was 127 bu/a in dryland, representing a yield increase of 90 bu/a. The irrigated corn received a total of 10 in. more water than the dryland corn over the course of the growing season, resulting in 9 bu for each additional inch of water use averaged across the three hybrids. The irrigated corn used a mean of 20.85 in. of water, and the dryland corn used a mean of 11.66 in. of water. The WUE was 10.71 bu/in. and 10.43 bu/in. for dryland and irrigated corn, respectively. Although hybrid yields differed in the irrigated environment, water use and WUE were similar for all hybrids in both dryland and irrigated environments. One DT hybrid exhibited more stable yields across dryland and irrigated environments compared with the other DT hybrid and the non-DT hybrid.

Introduction

Because irrigation water in central and western Kansas has decreased and water restrictions have increased, producers are looking for a more economical way to use available irrigation water and maximize dryland corn yields. Drought-tolerant hybrids such as Monsanto's DroughtGard (Monsanto, St. Louis, MO) and Pioneer's AQUAmax (Pioneer Hi-Bred, Johnston, IA) have been marketed as providing hybrids with superior drought and heat tolerance that result in the ability to produce in low-yielding environments. The objective of this study is to compare water use, yield, and water use efficiency of two types of DT corn hybrids and a high-yielding non-DT hybrid.

Procedures

Three corn hybrids were planted into both dryland and fully irrigated blocks in a randomized complete block design with four replications. Each block contained four replications of three hybrids: Pioneer 1151 AQUAmax (native traits, water-optimized hybrid), Croplan 6000 DroughtGard (WinField Solutions, Shoreview, MN; native traits plus transgenic trait, water-optimized hybrid), and Croplan 6274 (high yield potential in well-watered conditions). The plot size was 10 ft × 45 ft, and corn was planted

into 30-in. rows (four rows per plot). The center two rows were hand-harvested (20 ft) to determine the final yield and yield components.

Soil water content was measured at various growth stages using a neutron moisture meter (NMM). After emergence, 6-ft aluminum tubes were installed in the row between corn plants in one of the two center rows of each plot. These tubes were used to take NMM water readings at depths of 6, 18, 30, 42, and 54 in. Soil moisture readings were taken at emergence; at mid-vegetative, flowering, and mid-reproductive stages; at harvest; and 30 days postharvest.

Seeding rates and fertilizer applications were based on yield goals of 110 bu/a dryland and 190 bu/a irrigated. The corn was planted May 2 with a seeding rate based on a goal of 28,000 plants/a dryland and 34,000 plants/a irrigated. Nitrogen (N) was applied preplant at 100 lb/a on both dryland and irrigated and was supplemented (at V4) with 130 lb/a N and 35 lb/a P_2O_5 in the irrigated block and only 30 lb/a P_2O_5 in the dryland block. Means were calculated, and mean separations were conducted using SAS 9.3 PROC GLIMMIX ($\alpha = 0.10$).

Results

Treatment differences were observed for grain moisture, test weight, and irrigated grain yield (Table 1). In both dryland and irrigated environments, the non-DT hybrid had the greatest grain moisture. This could be because many of the current hybrids adapted for irrigated conditions have an extended grain-fill period and a longer stay-green period. Croplan 6000DG had the driest grain at harvest in both environments, but it did not differ from Pioneer 1151AM in the dryland environment. The only difference in test weight was that Pioneer 1151AM was greater than the other two hybrids in the dryland environment. In the irrigated environment, Pioneer 1151AM had the greatest yield, Croplan 6000DG the least, and Croplan 6274 was intermediate (Table 1).

Figure 1 illustrates the yield response to estimated water use for each plot. The nearly parallel lines for Croplan 6274 and Pioneer 1151AM imply that these two hybrids responded similarly for yield as water input increased, which represents the capacity of both hybrids to increase grain production efficiently as more water is introduced to the growing environment. Although Croplan 6000DG did not have the top yield in well-watered conditions, the smaller slope of the yield-water use curve (Figure 1) indicates that yield of this hybrid may be more stable in environments with less available water.

Table 1. Means per hybrid/environment of water use, yield, yield components, and water use efficiency (WUE)

	Means				
	Water use, in.	Grain moisture, %	Test weight, lb/bu	Yield, bu/a	WUE, bu/in.
Dryland					
Pioneer 1151AM	11.84 a ¹	14.60 b	59.18 a	129.38 a	10.93 a
Croplan 6000DG	11.75 a	14.30 b	56.80 b	133.80 a	11.40 a
Croplan 6274	12.00 a	19.50 a	57.08 b	118.04 a	9.80 a
Irrigated					
Pioneer 1151AM	21.05 a	14.35 b	62.75 a	228.81 a	10.87 a
Croplan 6000DG	20.66 a	13.95 c	62.08 a	205.28 b	9.93 a
Croplan 6274	20.84 a	14.90 a	62.43 a	218.10 ab	10.50 a

¹ Values within column and a water environment followed by the same letter are not different, $\alpha = 0.10$.

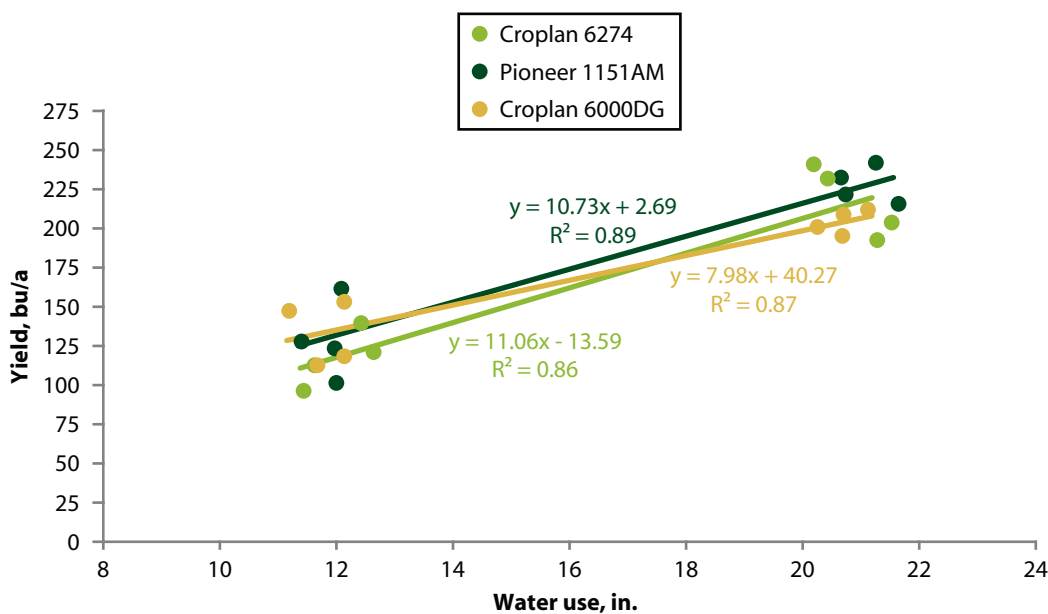


Figure 1. Corn grain yield response to estimated water use at Scandia in 2014.