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Balanced Nutrition and Crop Production Practices for Closing Grain Sorghum Yield Gaps

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Abstract

A field experiment was conducted at the East Central Kansas Experiment Field near Ottawa, KS, and at the Kansas River Valley Experiment Field near Rossville, KS, in the summer of 2014 to evaluate diverse cropping systems approaches on closing sorghum yield gaps. Yield gaps can be understood as the difference between maximum yield and attainable on-farm yields. The factors that were tested include narrow row spacing; plant population; balanced nutrition practices, including various timings of nitrogen, phosphorus, and potassium (NPK) and micronutrient applications; crop protection with fungicide and insecticide applications; plant growth regulator effects; and the use of precision ag technology for maximizing yields, including a GreenSeeker meter (Trimble Navigation, Westminster, CO) for more precisely determining fertilizer nitrogen needs for sorghum. In addition, this project seeks to quantify the comparison between corn and grain sorghum grown side by side at two production input levels (low vs. high). Only sorghum grain yields are presented in this report. Grain sorghum yields were 115 to 135 bu/a in Rossville (under irrigation) and 60 to 80 bu/a in Ottawa (dryland). Rainfall was limited in Ottawa during the flowering and reproductive stages of growth, which drastically limited yield potential.

Keywords

sorghum, production practices, nutrients, yield

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Summary

A field experiment was conducted at the East Central Kansas Experiment Field near Ottawa, KS, and at the Kansas River Valley Experiment Field near Rossville, KS, in the summer of 2014 to evaluate diverse cropping systems approaches on closing sorghum yield gaps. Yield gaps can be understood as the difference between maximum yield and attainable on-farm yields. The factors that were tested include narrow row spacing; plant population; balanced nutrition practices, including various timings of nitrogen, phosphorus, and potassium (NPK) and micronutrient applications; crop protection with fungicide and insecticide applications; plant growth regulator effects; and the use of precision ag technology for maximizing yields, including a GreenSeeker meter (Trimble Navigation, Westminster, CO) for more precisely determining fertilizer nitrogen needs for sorghum. In addition, this project seeks to quantify the comparison between corn and grain sorghum grown side by side at two production input levels (low vs. high). Only sorghum grain yields are presented in this report. Grain sorghum yields were 115 to 135 bu/a in Rossville (under irrigation) and 60 to 80 bu/a in Ottawa (dryland). Rainfall was limited in Ottawa during the flowering and reproductive stages of growth, which drastically limited yield potential.

Introduction

Kansas sorghum producers face the problem of low attainable yield. Grain sorghum is one of the major crops grown in the state of Kansas, and addressing this problem will improve short-term yield and crop productivity. Using better genotypes and best management practices are essential to closing grain sorghum yield gaps. This project is unique in that it takes into account the multitude of factors that influence farmers' decisions in an effort to quantify the diverse interactions that can maximize yields.

Procedures

At the two locations, Ottawa, KS (dryland), and Rossville, KS (irrigated), the plots were set up with 5 replications with 11 treatments in each replication for the sorghum phase (Table 1). A randomized complete block design was used for the grain sorghum treatments, and side-by-side corn comparison plots were grown on each side of the sorghum replications (2 extra treatments, low vs. high production input for corn). The plots were

10 ft × 50 ft, or 0.01 acres. The hybrids used were Sorghum Partners NK7633 for sorghum and Pioneer 1151 for corn. Measurements for plant characterization were taken at the V5 growth stage, flowering, mid-reproductive stage, and at harvest. The measurements taken included: plant population stand counts, leaf area index (LAI) at V5 and flowering, chlorophyll (SPAD) readings at V5 and flowering, canopy temperature at flowering, aboveground biomass and nutrient concentrations at diverse growth stages, and grain yield and its components (grain number/head and seed weight).

Results

Grain sorghum yields were 60 to 80 bu/a in Ottawa (dryland), with lower yield potential related to the limited precipitation experienced during the reproductive period (Figure 1). At Rossville, grain sorghum yields were 115 to 135 bu/a, with higher yield potential related to the irrigation scheduling system (irrigated site) (Figure 2). At Ottawa, the cropping system approach did not influence sorghum grain yields, which may be related to the low yield potential explored in this location (reproductive-stage drought stress). At Rossville, the maximum yield gap documented between the highest-yielding treatment ("kitchen sink," or all inputs are applied but without chloride, treatment 9) and the lowest-yielding scenario (check, treatment 10) was close to 20 bu/a (135 vs. 114 bu/a, respectively). The diverse systems evaluated did not differ in sorghum grain yield, with a statistically significant yield difference from all treatments versus the check, a common-practice approach (treatment 10).

Table 1. Description of sorghum treatments implemented in this study

	Treatments										
	1	2	3	4	5	6	7	8	9	10	11
Seeding rate	Optimum	Normal	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Normal	Optimum
Row spacing	15 in.	15 in.	30 in.	15 in.	15 in.	15 in.	15 in.	15 in.	15 in.	30 in.	15 in.
N program	GS	GS	GS	Standard	GS	GS	GS	GS	GS	Standard	GS
Fungicide/insecticide	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Micronutrients	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn
PGR	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Starter fertilizer	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NP	NPKSZn	NP	NPKSZn
Chloride	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
GreenSeeker + N	No	No	No	No	No	No	No	No	No	No	Yes

Optimum seeding rate = 80,000 plants/a; Normal = 50,000 plants/a; 15 in. = narrow row spacing; 30 in. = wide row spacing; GS = GreenSeeker meter (Trimble Navigation, Westminster, CO); Standard = conventional N application (without precision ag technology); Fe = Iron; Zn = Zinc; PGR = plant growth regulator; N = nitrogen; P = phosphorus; K = potassium; S = sulfur.

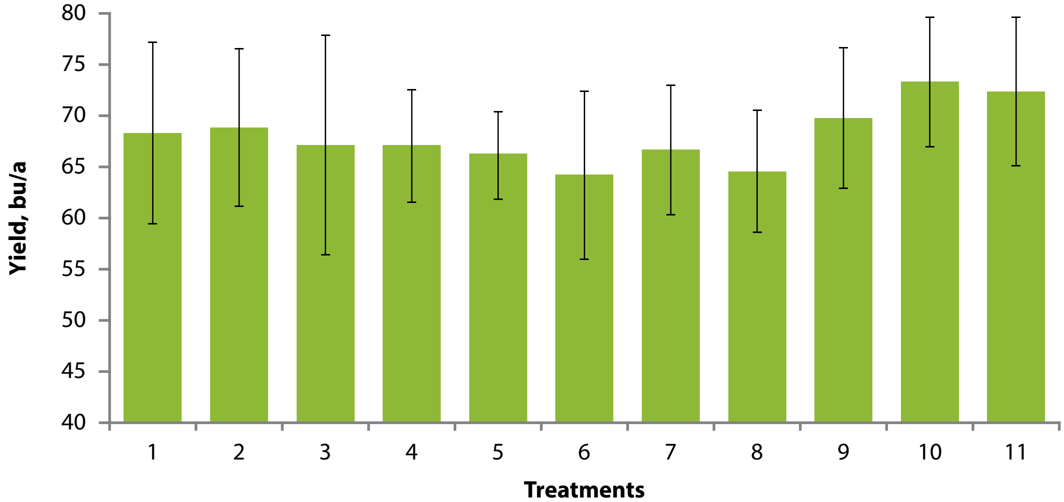

Figure 1. Sorghum grain yield under diverse cropping systems approaches at the Ottawa Unit of the East Central Kansas Experiment Field. See Table 1 for treatment details.

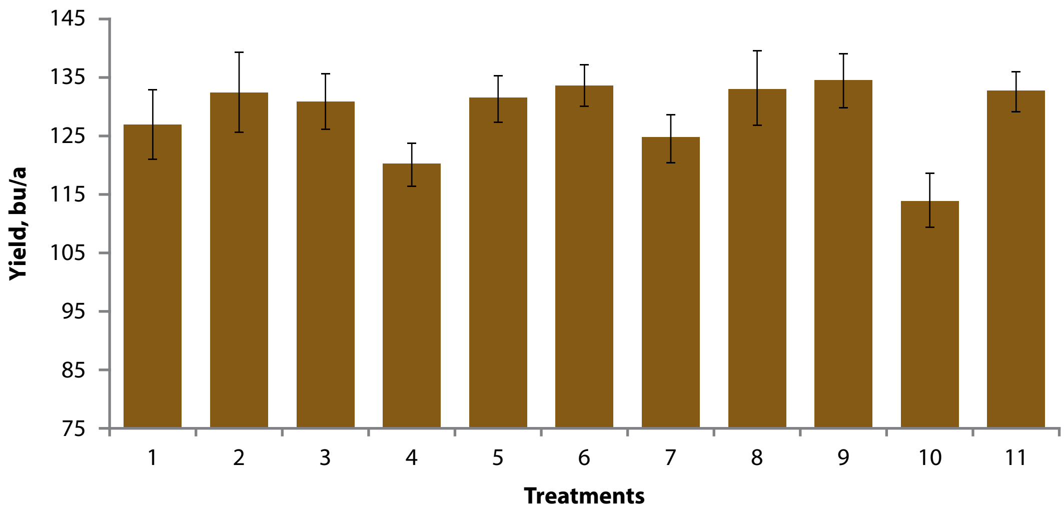

Figure 2. Sorghum grain yield under diverse cropping systems approaches at the Rossville Unit of the Kansas River Valley Experiment Field. See Table 1 for treatment details.