IRRIGATION ON THE OLD ROTATION

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Introduction

The Old Rotation (circa 1896) is the oldest, continuous cotton experiment in the world. Its 13 plots on one acre of land on the campus of Auburn University continue to document the long-term effects of crop rotations with and without winter legumes (e.g., crimson clover) as a source of N for cotton, corn, soybean, and wheat. Irrigation was installed on half of each plot in 2003 and both irrigated and non-irrigated yields have been monitored since then (Fig. 1). For more information on the history of the Old Rotation, visit the website at
http://www.ag.auburn.edu/agrn/cotton.htm

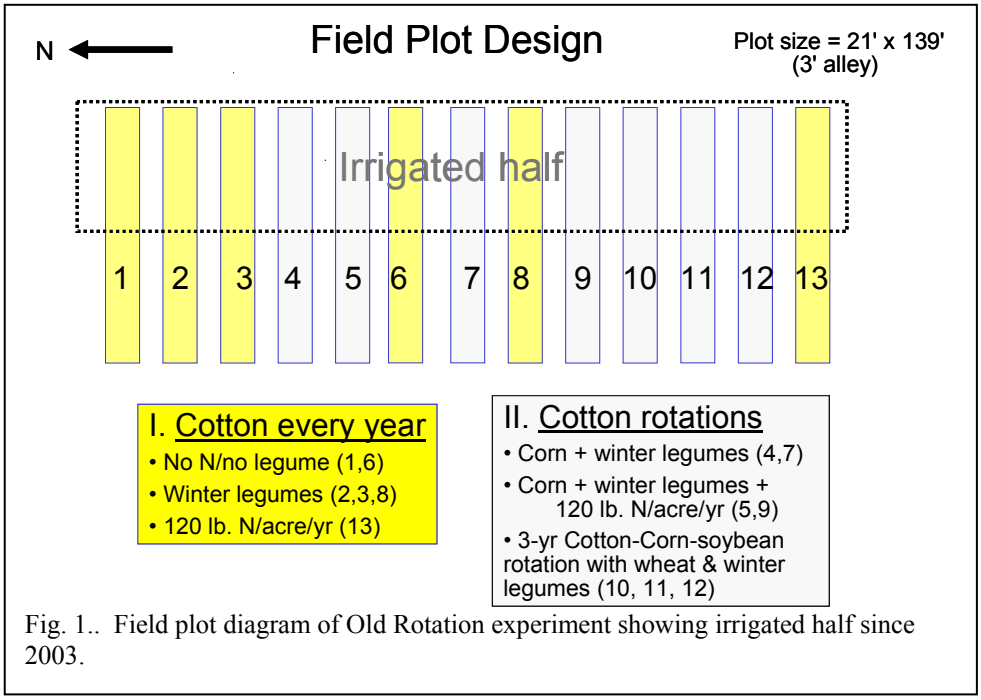

Fig. 1.. Field plot diagram of Old Rotation experiment showing irrigated half since 2003.

Methods

The eastern half of each of the 13 plots on the Old Rotation can be irrigated separately using a system of 8, 8-foot risers in each plot. Scheduling irrigation, on the other hand, is tricky. Ideally, irrigation should be based on soil moisture in the rooting depth plus the stage of growth of the crop. Because this system can be programmed to apply water on a regular schedule to each plot, we have chosen to simply estimate evapotranspiration and preset the system to apply supplemental water. If it rains, we have to manually cut the system off. We adjust the timing and rate of irrigation based upon the weather, crop, and stage of growth. In general, during tasseling of corn and peak boll fill of cotton, we apply between 1 and 2 inches of irrigation per week if no rain occurs. In most years, the irrigation system is not turned on until June so cotton and corn crops are established without irrigation. Because of the extreme drought of 2007, irrigation was necessary to assure a uniform stand of cotton and soybeans. In 2007,

irrigation began in mid May and continued to early September. Most of the cotton plots received a total of 20 to 25 inches of irrigation. This was twice the total amount applied in previous years. Winter wheat and winter legumes are not irrigated.

From its inception in 1896 through 1996, all crops on the Old Rotation were produced with conventional tillage, e.g., moldboard plowing, disking, harrowing, and cultivation. Since 1997, all crops have been produced using conservation tillage which leaves a maximum of crop residue on the soil surface. Prior to planting, all crops receive in-row subsoiling or para-tilling which is the only soil disturbance used. Since 1997 and the advent of genetically modified crops, the use of insecticides and herbicides have been dramatically reduced and overall crop yields have increased. Record yields of all crops grown on the Old Rotation have been produced since 1997 (Mitchell et al., 2003)

Results and Discussion

Cotton. There were no differences due to irrigation during the first 4 years after irrigation was installed, 2003-2006. Most of Alabama suffered under a severe drought in both 2006 and 2007. However, the site of the Old Rotation received some timely rains during 2006 which it did not get in 2007 (Fig. 2). In fact, 2007 was the worse drought in over 50 years for the Auburn, Alabama, area. Cotton that was planted on 17 May 2007 did not emerge until late June except where the plots were irrigated. Cotton on plots low in soil organic matter due to a lack of long-term rotations (e.g. plots 1, 6, and 13) never emerged because of soil crusting (Prieto et al., 2002). Previous research has shown that soil organic matter on these plots is less than 0.5% (Hubbs et al., 1998; Mitchell and Entry, 1998, Mitchell et al., 2000). Surface soil organic matter can be as high as 2.5% on plots with rotations, winter cover crops and high residue management. Irrigation in 2007 resulted in large yield differences and an all-time record cotton lint yield on plot 9 (2-yr cotton –corn rotation with legume plus 120 lb. N/acre) of 1940 lb. lint/acre. Potassium deficiency, which has not been observed on the Old Rotation by any of the authors, was observed on plots 7, 8, and 9 in 2007. This was attributed to the very high irrigated cotton yields.

Because of the dramatic yield increase due to irrigation in 2007, the 5-yr average yield increase due to irrigation was 22 percent.

Corn. High, non-irrigated corn grain yields in Central Alabama are very dependent on timely rainfall. As a result, irrigation has produced a highly significant yield increase every year on the Old Rotation. Grain yield averaged 47 percent higher with irrigation compared to the non-irrigated yields (Table 2).

Soybean and wheat. Soybean is double-cropped behind wheat for grain on plots 10, 11, and 12. Because rainfall can be critical for double-cropped soybean planted in early June behind wheat, irrigation has shown a 44% yield increase for soybean. Yield response to irrigation was observed in each of the five years with irrigated soybean averaging 56 bu/acre following a non-irrigated wheat grain yield of 51 bushels per acre over the 5 years (Table 2).

Table 2. Effect of irrigation on Old Rotation mean crop yields, 2003-2007.				
Treatment (plots)	Corn grain		Cotton lint	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated
	----------bu/acre----------		------pounds lint/acre------	
Cotton every year				
No N/no legume (plots 1 & 6)	--	--	470 d	300 d
Legume N only (plots 2, 3 & 8)	--	--	1020 c	1000 b
120 lb. N/acre (plot 13)	--	--	1330ab	940 bc
Cotton Rotations				
Cotton-Corn rotation, legume N only (plots 4&7)	69 c	54 c	1190 bc	1150 b
Cotton-Corn rotation, +legume, + 120 lb N/acre (plots 5&9)	166a	116a	1530 a	1380a
3-yr rotation, Cotton (winter legume)-Corn (wheat)-Soybean (plots 10, 11 , 12)	119 b	71 b	1210 bc	750 c
Soybean mean yield (irrigated) = 56 bu/acre Soybean mean yield (non-irrigated) = 39 bu/acre Wheat mean yield (non-irrigated) = 51 bu/acre				
Values followed by the same letter within a column are not significantly different at P<0.05.				

Summary

Irrigated cotton on the Old Rotation has resulted in a positive yield response in only one year out of five, and that was the severe drought year of 2007. Irrigated yields in 2007 were so dramatically higher than the non-irrigated cotton yields that over the 5-yr period, irrigation resulted in a 22 percent average yield increase over all plots. Irrigation with corn and soybean resulted in higher grain yields each year with average increases of 47 and 44 percent, respectively, over all treatments.

Acknowledgements

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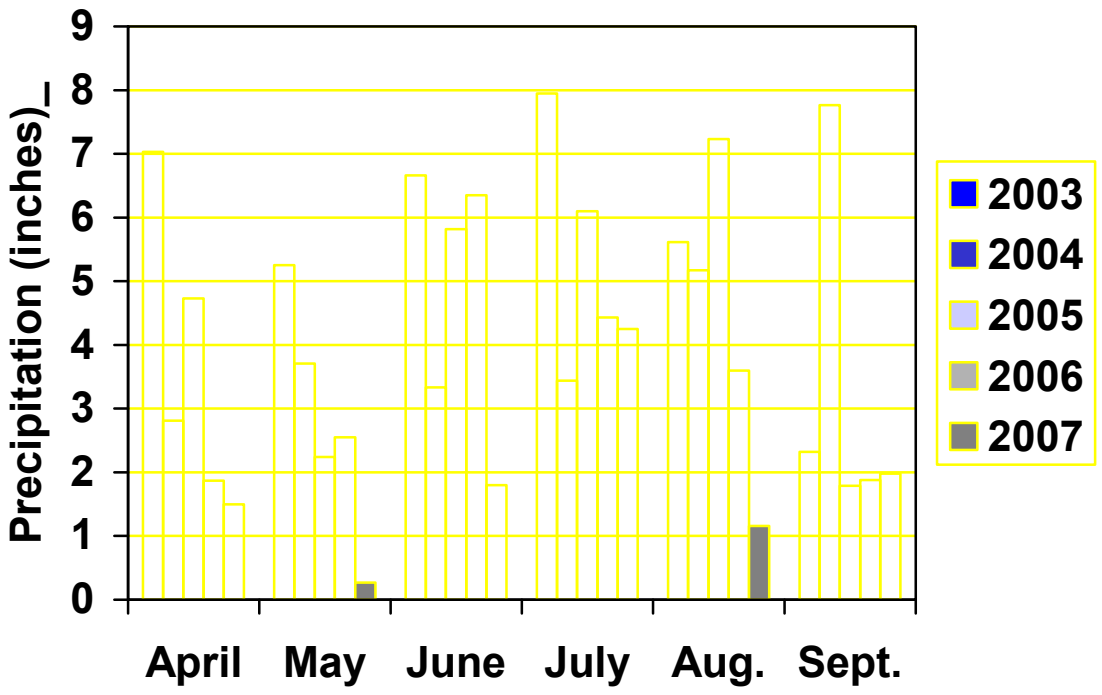

Fig. 2. Monthly precipitation during the growing season for the Old Rotation site, 2003-2007.

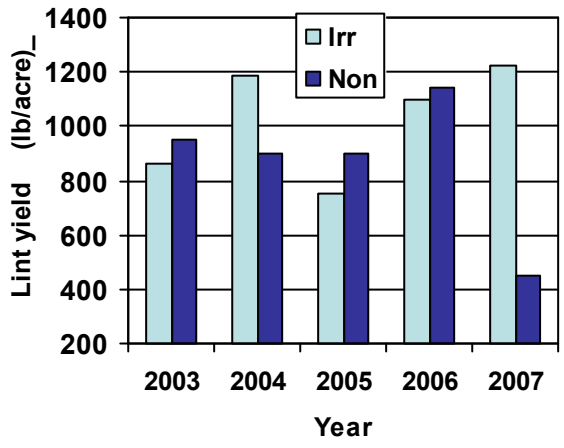

Figure 3. Mean cotton lint yields by year over all treatment/plots on the Old Rotation experiment as affected by irrigation (irr) and non-irrigation (non). $LSD_{P<0.05}$=400.