COTTON YIELD RESPONSE TO N AND K APPLICATIONS IN A CONTINUOUS DRYLAND PRODUCTION SYSTEM

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Introduction

Most production system emphasis in the past decade has shifted from continuous monoculture cotton to rotation systems that include corn, grain sorghum, or soybean as a component crop in the production system. The rotation crops being used reach optimum production when supplied with some form of supplemental irrigation whether from overhead sprinkler systems or from various furrow irrigation systems. Irrigation has not been shown to consistently improve cotton yields especially where subsoil tillage is performed on an annual basis. Irrigation does offer the promise of yield increases and/or yield stability in dry years. Between 2000 and 2007, total annual rainfall at Stoneville, MS has ranged from a low of 39.82 inches (13.47 inches below normal) to a high of 71.25 inches (17.96 inches above normal). Record low rainfall in August was recorded in 2000 (0.00 inches) while record high rainfall was recorded in August 2001 (8.47 inches). Rainfall from April through September in the same years has ranged from 18.11 to 29.08 inches. The variation in rainfall amounts and patterns often lead to varied yields from dryland production systems.

Soil fertility influences cotton lint yields, especially nitrogen (N) and potassium (K) levels while other nutrients (phosphorus [P], magnesium [Mg], calcium [Ca], sulfur [S]) and soil pH can also affect cotton lint yields. On many Delta soils the most yield limiting nutrients are N and K, especially under high yielding environments with rapid-fruiting cotton cultivars. This study was designed to evaluate N and K applications for continuous mono-crop cotton grown under dryland (rain-fed) conditions in the Mississippi Delta and to determine cotton lint yield response to increasing N rates and K additions.

Materials and Methods

A multi-year study was established in 2000 on a Forestdale silty clay loam (fine, smectitic, thermic, Typic Endoaqualfs) at the Tribbett Satellite Farm near Tribbett, MS. The study had a 3x2 factorial arrangement of N rates (90, 120.and 150 lb N/acre) and K rates (0 and 60 lb K/acre) in a randomized complete block design with ten replications. Nitrogen was applied as urea-ammonium nitrate solution (32% N) and 'knifed' ten inches from both sides of the drill with 60 lb N/acre applied prior to planting and the remainder of each rate applied as a sidedress application near the pinhead square growth stage. Fertilizer K was applied as a 0-0-16 solution (1.3 lb K/gal) as a sidedress application at the time of the second N application. All cultural practices including weed control, insecticide applications, and defoliation were held constant across all treatments.

Defoliation occurred in early to mid-September with a second defoliation applied as needed. All plots were harvested in September or October with a commercial spindle picker adapted for plot harvest. Hand-grab samples of seedcotton were taken at harvest and ginned through a 10-saw micro-gin, without seedcotton or lint cleaning, to determine lint percent. Seedcotton yields were calculated based on the harvest from the two center rows of each 4-row plot. Lint yields were then calculated from lint percent determined from the micro-gin for each individual plot. All yield data and components including seedcotton and lint yields and the lint percentage, were analyzed statistically using the Statistical Analysis Systems (SAS) with Fisher's protected LSD for mean separations at the 5% level of significance. Main effects means were evaluated and presented when interactions were not significant at the 5% level.

Results and Discussion

The most significant factors influencing cotton lint yields under dryland (rain-fed) conditions are rainfall amounts and distribution along with subsoil tillage. Recent research from the same area has shown little economic benefit from combining subsoil tillage and supplemental irrigation for cotton production. The research area for this study received either in-row subsoil tillage or subsoil tillage at a 45° angle to the row annually throughout the duration of the study. Thus subsoil tillage was held uniform across the study. The summary of rainfall information has been included in Table

1 for the Tribbett Satellite Farm (TSF) and for the Delta Research and Extension Center (DREC) at Stoneville. The two areas are approximately eight miles apart. Rainfall data was collected daily at DREC for the entire year. At the TSF location, rainfall data was collected only during the growing season, thus total accumulation for the year was unavailable for this location.

Lint cotton yields are shown for all years and treatments in Figures 1 and 2. Of the seven years included in the study, a significant response to N and K treatments was found only in 2003 and 2004 (Fig. 1). Both years had good rainfall and distribution with adequate rainfall in May and June (Table 1). The highest cotton lint yields were harvested in 2002 with the yields ranging from 1766 to 1826 lb lint/acre; however, no response to N or K applications was measured. Rainfall was adequate in May and June and continued into July and August. Early maturing cotton in 2002 led to early harvest prior to extensive rains in late September that reduced harvestable yields as well as lint quality.

The lowest yields were measured in 2005 and 2006 (947 and 602 lb lint/acre, respectively) (Fig. 2). In 2005, May and June rainfall totaled around 0.5 inches each month that reduced the potential plant growth in the area (Table 1). July and August rainfall was at or above normal that did allow for some recovery. High winds and rainfall prior to harvest in 2005 that were related to Hurricanes Katrina and Rita significantly reduced lint yields compared to what was estimated to be on the plants prior to adverse weather conditions. In both 2005 and 2006 there was no response to increasing N rates or K additions. Rainfall total at TSF for April through September was just over 10 inches and the lowest rainfall total for any of the years of the study (Table 1). Rainfall totals for each month during the growing season were less than three inches for the month. The 2007 yields were in the 1350 to 1425 lb lint/acre range with adequate rainfall in April and May. June rainfall levels were below normal while July levels were above normal with more than 9 inches falling during the month. Excess rainfall during July did affect boll retention and some of the potential early crop was lost. Good growing conditions in August and September resulted in a large top crop but did delay maturity and harvest.

The summary of main effects for N and K are shown in Figures 3 and 4. There was no significant interaction between the two factors in any of the years of the study. The only significant response to K additions was observed in 2006 (Fig. 4) when lint cotton yields were the lowest. Significant responses to N rate increases were shown in 2003, 2004, and 2005. In each of these years the response to increasing N was positive with the highest yields measured with 150 lb N/acre. Even with the high rainfall and adverse weather conditions during the harvest season of 2005, there was still a positive response to N additions.

Upon close examination of data collected it was determined that rainfall (water) tends to be more limiting than N or K fertility in some years. During the seven years of the study, there was a near three-fold difference in lint yields between 2002 (1802 lb lint/acre) and 2006 (602 lb lint/acre). Rainfall totals for April to September in those years were 23.18 and 10.05 inches per acre for 2002 and 2006, respectively. However in neither 2002 nor 2006 was there a significant response to N or K applications.

In order to try and optimize production in continuous dryland systems, maintaining adequate soil nutrients is key. Heavy rainfall in the spring after planting can lead to N transformations in the soil that could hence lead to N loss prior to the time that the plants could utilize it. Since cotton is a perennial, undue stress from either too little or too much water, can lead to fruiting body shed. Pools of readily available N continue to change during the growing season and can provide adequate soil available N late in the growing season. When in doubt, always soil test and apply fertilizer N as close as possible to the time needed by the plant.

Table 1: Summary of rainfall data for Stoneville (DREC) and Tribbett (TSF) from 2001 through 2007. (Annual totals not available for TSF)

	2001	2002	2003	2004	2005	2006	2007
				inches			
STONEVILLE (DREC)							
APR	3.99	3.26	3.78	4.12	4.53	7.38	3.38
MAY	5.06	2.82	2.55	7.25	2.11	2.86	1.27
JUN	2.77	4.15	7.30	12.45	0.73	1.81	3.91
JUL	3.16	3.29	2.46	3.08	4.19	1.78	7.74
AUG	8.47	2.77	1.53	2.15	4.98	1.56	3.43
SEP	3.02	7.73	4.94	0.03	7.03	2.72	4.65
TOTAL (APR-SEP)	26.47	24.02	22.58	29.08	23.57	18.11	24.38
YEAR TOTAL	71.25	62.15	45.19	68.00	39.82	55.53	42.62
DEPARTURE	+17.96	+8.86	-8.10	+14.71	-13.47	+2.24	-10.67
TRIBBETT (TSF)							
APR	2.70	3.26	3.76	4.01	4.92	2.80	3.58
MAY	2.23	2.10	2.44	4.27	0.40	2.20	4.19
JUN	3.83	1.74	5.29	8.35	0.48	0.47	1.95
JUL	4.38	4.80	0.91	4.09	4.33	0.52	9.30
AUG	3.31	3.01	1.11	3.19	5.12	1.38	1.48
SEP	3.16	8.27	3.90	0.02	3.98	2.68	5.22
TOTAL (APR-SEP)	19.61	23.18	17.41	23.93	19.23	10.05	25.72

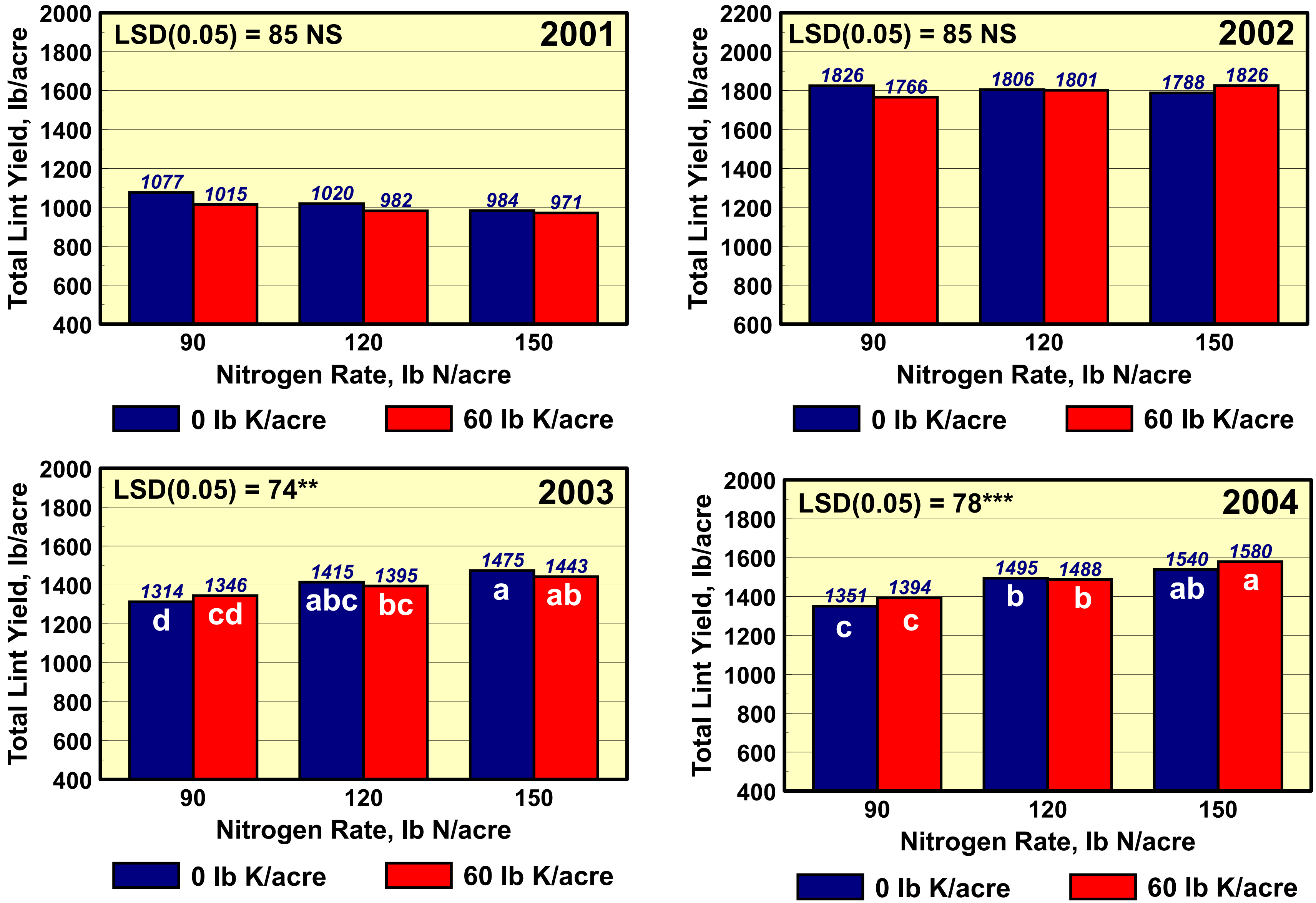

Figure 1: Cotton lint yield response to N and K application, 2001-2004

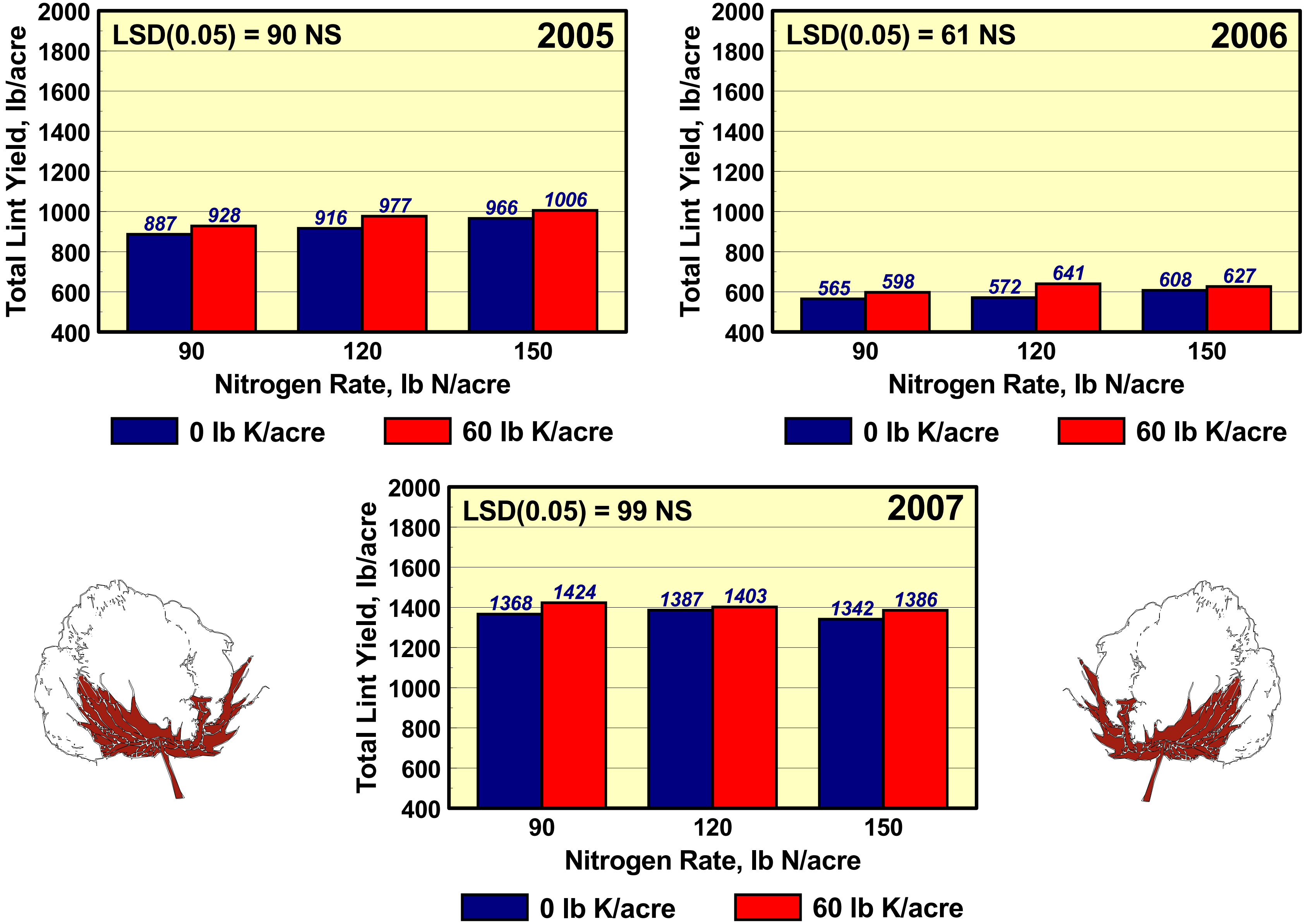

Figure 2: Cotton lint yield response to N and K application, 2005-2007

2008 Beltwide Cotton Conferences, Nashville, Tennessee, January 8-11, 2008

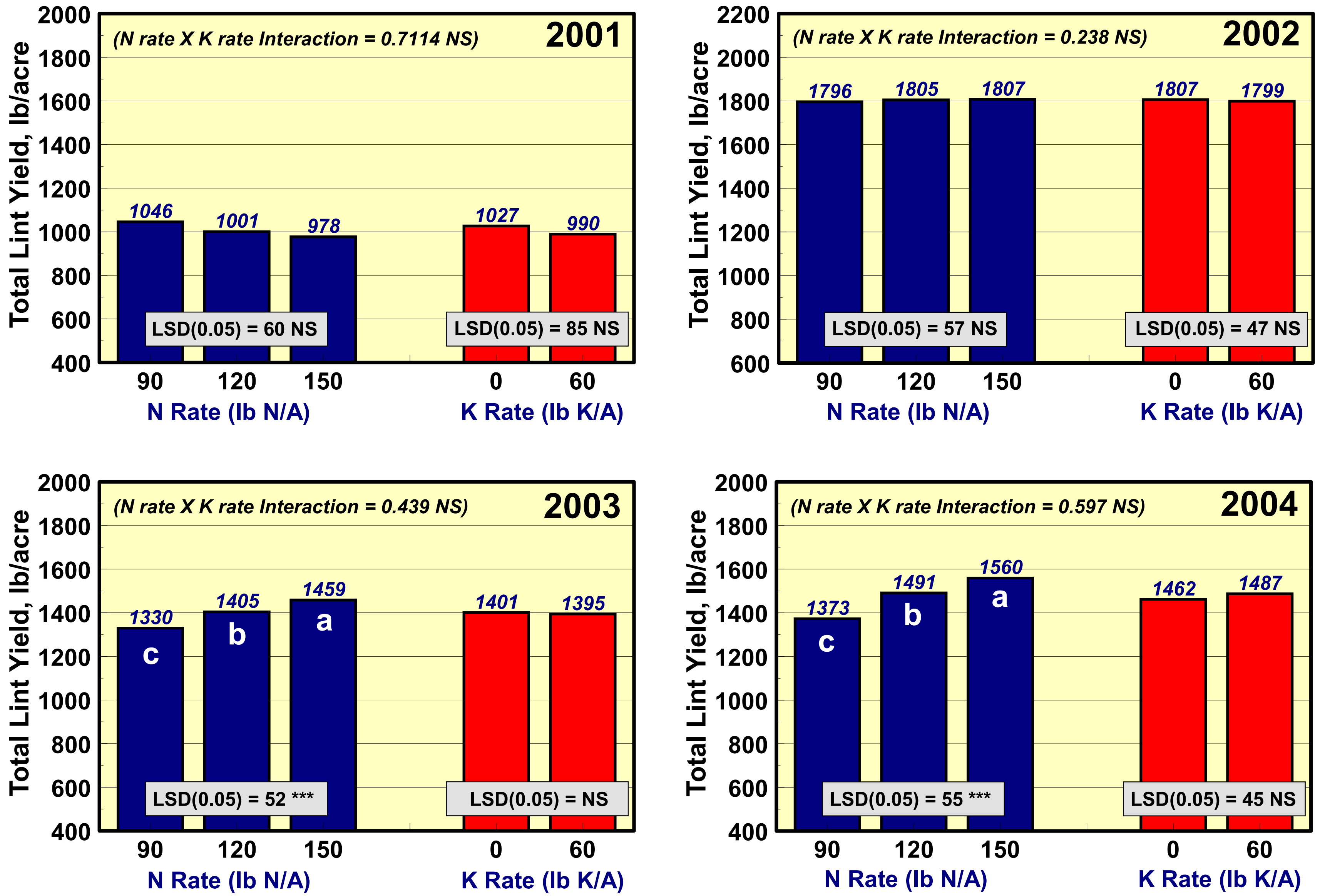

Figure 3: Main effects for lint yield response to N and K application, 2001-2004

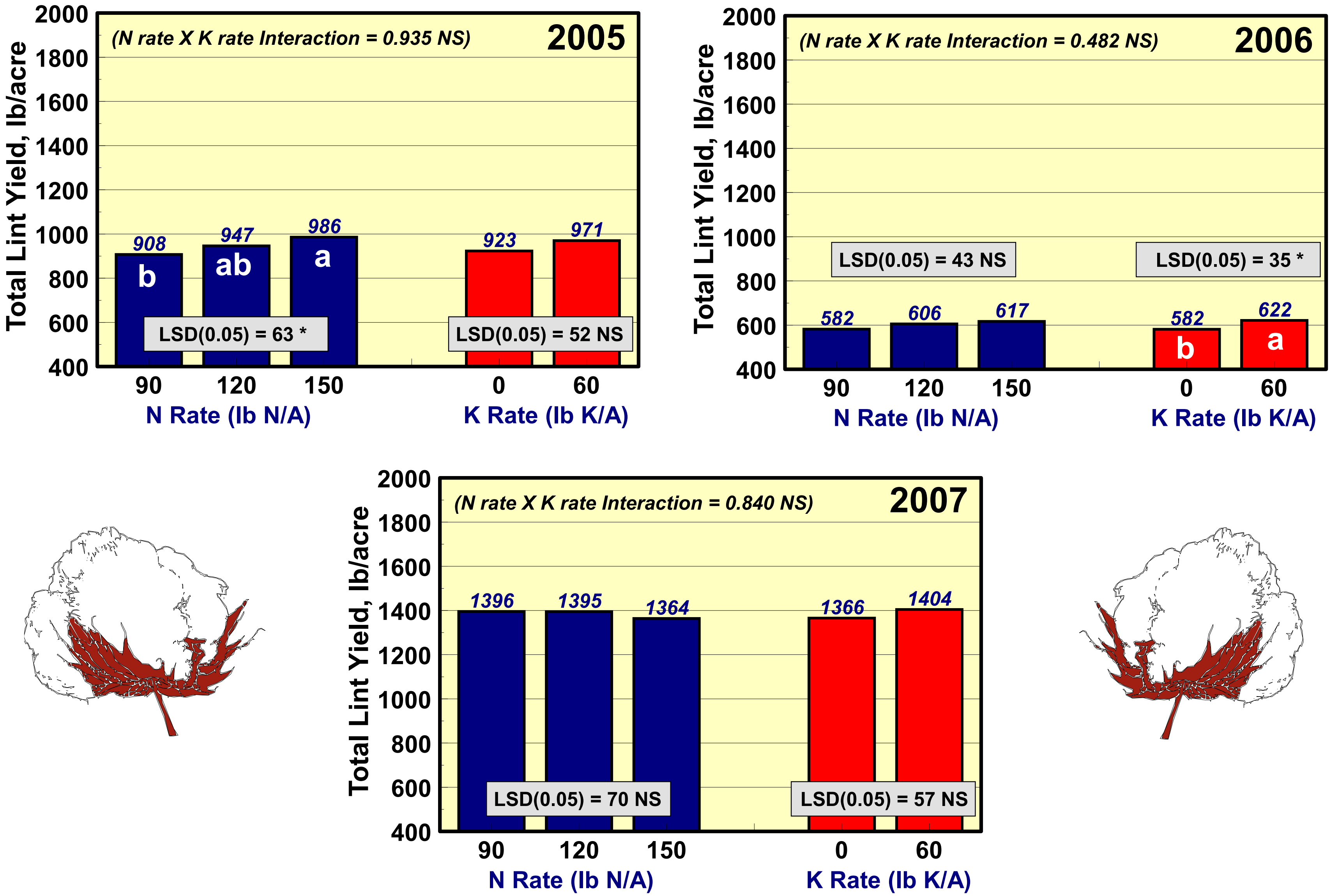

Figure 4: Main effects for lint yield response to N and K application, 2005-2007