INTERACTION OF NITROGEN AND POTASSIUM FERTILIZATION ON RENIFORM NEMATODE DYNAMICS IN A COTTON/CORN ROTATION SYSTEM

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Abstract

Nematode infestations continue to grow in the Mississippi Delta and are best address through crop rotations that involve non-host crops. Reniform nematodes (*Rotylenchulus reniformis*) have been an increasing problem where continuous cotton has been grown. Shifting to corn every other year or at least one year out of three has been shown to curtail reniform numbers. A long-term study, initiated at the Delta Research and Extension Center (DREC) and at the Tribbett Satellite Farm (TSF), to evaluate nitrogen (N) and potassium (K) nutrition for cotton and corn grown in rotation was adapted in 2007 to address nematode dynamics. A summary of long-term yields from cotton following corn compared to cotton following cotton has shown a 10% (TSF) to 18% (DREC) increase in yield for cotton following corn compared to cotton following cotton. Reniform nematode samples taken after planting, at mid-season, and post-harvest show no statistical relationship to nitrogen (N) or potassium (K) in either cotton or corn. Reniform numbers in most years started out higher in corn following two years of cotton but declined through the season. Where cotton followed corn, the reniform numbers were lower than either of the other two systems (cotton following cotton or corn following two years of cotton). In the second year of cotton, nematode numbers were much higher in the post-harvest samples compared to the other two systems. Rootknot nematodes (*Meloidogyne incognita*) were not found to be a problem at either study site. Both cotton and corn are hosts to the rootknot nematode and must be addressed through methods other than crop rotation.

Introduction

Long-term cotton/corn rotations were begun in 2000 at two locations in the Mississippi Delta. The first was established in a continuous cotton field at the Delta Research and Extension Center (DREC) on a Bosket very fine sandy loam (Mollic Hapludalfs) while the second was initiated at the Tribbett Satellite Farm (TSF) on a Dundee/Forestadale silty clay loam (Typic Endoaqualfs). The studies were initially designed to examine the rotational benefits and problems associated with crop rotation in the Mississippi Delta. Crop rotation dates back to the 1800's, but mono-culture production became popular in the mid- to late-1900's. The selected sites are characteristic of the soils in the region that are suited for both corn and cotton production. With the recent Farm Bills, producers have greater flexibility in their crop mix and recent increases in grain prices have made grain production a viable alternative to continuous cotton. Higher grain prices and lower cotton prices have eroded the cotton base while corn production has greatly increased in the last few years. Corn and soybean production are increasing while cotton declines. These studies were setup to evaluate the effects of rotation on crop yield and profit potential. By design, these studies also investigated cotton following corn verses cotton following cotton. The arrangements of the studies at each location are shown in Figure 1 (DREC) and Figure 2 (TSF). In 2007, a decision was made to examine nematode dynamics as a component of the long-term study and evaluate the effects of N and K rates along with crop rotation on nematode numbers. Reniform (*Rotylenchulus reniformis*) nematodes and rootknot (*Meloidogyne incognita*) nematodes have both been found in many Mid-south cotton and corn fields. The reniform nematode has been the most prevalent nematode in the study. The reniform nematodes are semiendoparasitic (partially inside the roots) species in which the female penetrates the root cortex to establish a permanent feeding site. The objectives of these studies were to 1) to determine the effects of nitrogen (N) and potassium (K) rates on cotton and grain yields; 2) to determine rotational effects of corn on cotton production and the implications of this rotation on whole-farm economics; 3) to evaluate the effects of N and K nutrition and crop rotation on nematode dynamics (reniform and rootknot) [*Objective added in 2007*]; and 4) to evaluate the long-term effects of the production systems. The results for crop rotations have been summarized for the entire duration of the studies while the nematode dynamics have been evaluated for the last three to four years. This research will continue if possible to continue to document the long-term effects of crop rotations.

Materials and Methods

Research sites were defined at each location that could be rotated over a 3-year period with corn followed by one or two years of cotton. At each location (DREC or TSF), each study area section had a factorial arrangement of N and K treatments (Table 1). The sections consisted of 4-row (40-in spacing) plots, 90 to 100 feet in length, with either four (TSF) or five (DREC) replications. Annual N rates were 60, 90, 120, 150, and 180 lb N/acre for cotton and 120, 160, 200, 240, and 280 lb N/acre for corn with the fertilizer N applied as urea-ammonium nitrate solution (32% N). Potassium rates for all rotations were 0, 40, 80, and 120 lb K/acre. Nitrogen was applied at a uniform rate (60 lb N/acre for cotton, 120 lb N/acre for corn) prior to or near planting with the different N rates established as a sidedress application at early square formation for cotton and at the 5- to 6-leaf stage of corn. Potassium applications were made after planting utilizing a 0-0-16 solution (1.3 lb K/gal) applied with the same equipment used for N applications. The K solution (muriate of potash, KCl) was chosen for ease of application with available equipment and does not imply that granular muriate of potash could not be used with incorporation. High-yield potential corn and cotton cultivars were planted at each location and maintained throughout the growing season and have been adjusted as new cultivars become available or as the cultivar of choice has been removed or replaced. Soil moisture sensors were installed to measure soil water relations and used to initiate, schedule, and terminate irrigations for both corn and cotton. The crops were harvested with commercial harvesters modified for plot harvest with cotton grab-samples taken for ginning and corn samples taken at harvest for determination of harvest moisture, bushel test weight, and seed weight. Seedcotton samples taken at harvest were ginned through a 10-saw micro-gin for calculation of the lint percentage. Data were summarized and statistically analyzed using SAS (Statistical Analysis Systems) with mean separations by Waller Duncan K-ratio t-tests and Fisher's Protected Least Significant Difference (LSD). Each plot was sampled after planting, at mid-season (10 to 12 weeks after planting), and post-harvest to determine nematode numbers. The samples were taken from the field and placed in cold storage until they could be processed. The remaining sample from the post-harvest sampling was used for to evaluate the soil nutrient status. The nematode samples were processed through the Nematology Laboratory at the Delta Research and Extension Center.

Results and Discussion

The agronomic and economic impact of crop rotation is a complicated issue as producers must make decisions on crop mix in a constantly changing market. In just the last four years, cotton acreage dropped from 1.2 million to under 300, 000 while corn acreage jumped from 340,000 to a high of 930,000. Corn has fallen to around 750,000 acres planted in 2010 but should continue at that level as long as prices stay high. Cotton acres have also rebounded and the highest prices ever recorded could bring some producers back to cotton. With these shifts in the annual crop mix, crop rotation has taken a forefront and producers continue to place their crops in specific situations that maximize production potential. In the last few years, fertilizer, planting seed, and fuel prices have reached levels never witnessed before. Prices, especially for grains, also reached new levels and remain high compared to previous years.

The summary information for the rotation project with respect to yields has been illustrated in Figures 3, 4, and 5. Figure 3 shows corn yields for both locations averaged across N rates and K rates (n = 100 observations for DREC and n = 80 observations for TSF). Corn yields have ranged from a low of 150 bu/acre at DREC in 2000 where herbicide injury was evident in the first year of corn behind continuous cotton to a high of 244 bu/acre in 2007. The overall corn yield at DREC has averaged 200 bu/acre (2000 not included). The TSF corn yields have ranged from a low of 141 in 2000 to 221 bu/acre in 2007. The overall yield at this location is 177 bu/acre which is 23 bu/acre lower than the sandier site at DREC. Cotton lint yields at DREC (Figure 4) for the same period have ranged from 631 to 1416 lb/acre and averaged 957 lb/acre where cotton followed corn. In the same area where cotton followed cotton (Figure 4), lint yields ranged from 510 to 1187 lb/acre and averaged 820 lb/acre. Thus the rotation response has averaged 138 lb/acre/year and ranged from –147 lb/acre to +334 lb lint/acre, an increase of 16.8%. Lint yields on the silty clay loam at TSF have actually exceeded those on the sandier soil at DREC. At TSF for cotton following corn (Figure 5), lint yields have ranged from 748 lb/acre to 1394 lb/acre with an average of 1064 lb/acre. For cotton following cotton (Figure 5) the yield ranged from 650 to 1276 lb/acre with an average of 977 lb/acre. This rotation response calculates to 87 lb/acre/year or an increase of 8.9% with the response ranging from –44 lb/acre to +341 lb/acre. At both locations, there have been years where cotton following cotton produced higher yields than cotton following corn. Usually this has happened when rainfall during July and August resulted in large plants and boll rot was present that reduced yield. The boll rot was worse in the bigger plants following corn.

Reniform and rootknot nematodes have both been observed in the Midsouth with most of the problems in cotton associated with the reniform nematode. This nematode is largely distributed in tropical, subtropical, and warm temperate zones in many areas of the world. At present no cotton cultivars are resistant to reniform nematodes but some tolerant lines have been developed and work continues in the development of resistance. Crop rotation with immune plant species is recommended to reduce nematode effects. Corn for grain offers the best possibility for the area. However, little information has been available as to the effect that nutrition may have on the plants ability to tolerate the nematode. With the long-term evaluations already underway, the logical step was to look at the impact of N and K nutrition on nematode populations. Multiple soil cores were composited from each plot for nematode determination just after planting, at mid-season, and post harvest. The samples were collected and refrigerated until analysis could be completed. The initial samples were taken in 2007 and the studies continued in 2008 through 2010. The data has been summarized in Figure 6 (DREC) and Figure 7 (TSF). There was no statistical relationship between the N and K treatments and nematode numbers for any to the systems, sampling dates, or years. Therefore the averages were used from each study, location, and year to evaluate the reniform nematode dynamics.

In 2008, total reniform numbers were much higher on the silty clay loam (TSF) soil but in subsequent years nematode numbers have increased on the sandy loam at DREC. In general, the reniform numbers just after planting were higher when two cotton crops had preceded the corn crop. However as the season progressed the numbers decreased since corn is not an alternate host for the reniform nematode. In the second year of cotton following corn, the post-harvest nematode numbers were many times higher than at planting or at mid-season. There has been some fluctuation between years but the patterns have been similar. In 2010, the post harvest numbers exceeded 8000 per pint where cotton was being grown for the second year. This was twice the level observed in the first year of cotton following corn. The pattern was similar at TSF but totals were about half of those observed at DREC.

The results to date have shown that N and K levels have not had any influence on reniform nematode numbers within the rotation system. There has been little response to repeated K applications and in some years little response to N applications with respect to cotton yields. These studies will continue as a part of the long-term rotation studies.

Table 1. Nitrogen and potassium application rates, timing of application, and fertilizer sources

COTTON/CORN ROTATIONS

Delta Research and Extension Center

Bosket very fine Sandy Loam

	Section 1 (South)	Section 2 (Middle)	Section 3 (North)
2006	Corn	Cotton	Cotton
2007	Cotton	Corn	Cotton
2008	Cotton	Cotton	Corn
2009	Corn	Cotton	Cotton
2010	Cotton	Corn	Cotton
2011	Cotton	Cotton	Corn

MATERIALS AND METHODS

Delta Research and Extension Center
Tribbett Satellite Farm

N Rates: Corn: 120, 160, 200, 240 & 280 lb N/A
Cotton: 60, 90, 120, 150 & 180 lb N/A

N Source: UAN Solution (32% N) [3.54 lb N/gal]
Preplant + Sidedress Application

K Rates: Corn: 0, 40, 80 & 120 lb K/A
Cotton: 0, 40, 80, & 120 lb K/A

K Source: K Solution (0-0-16 [1.3 lb K/gal]) applied as sidedress to both sides of row

Figure 1. Cotton/Corn Rotation Field Arrangement – Delta Research and Extension Center, Stoneville, MS

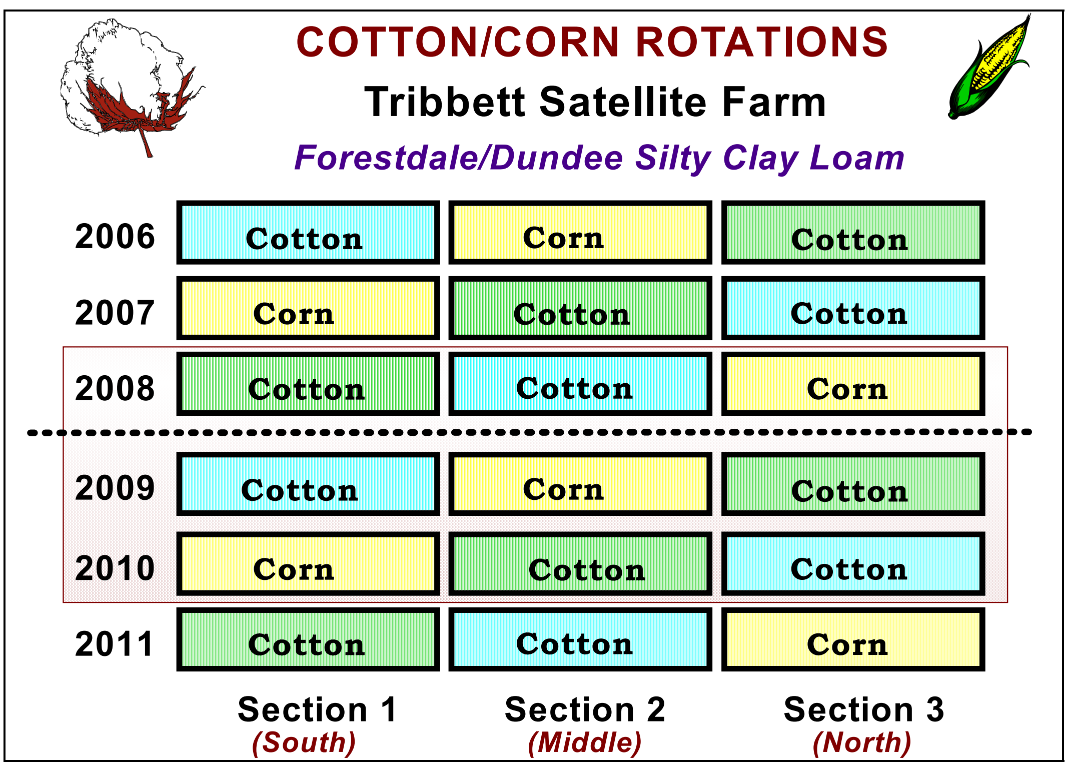

Figure 2. Cotton/Corn Rotation Field Arrangement – Tribbett Satellite Farm, Tribbett, MS

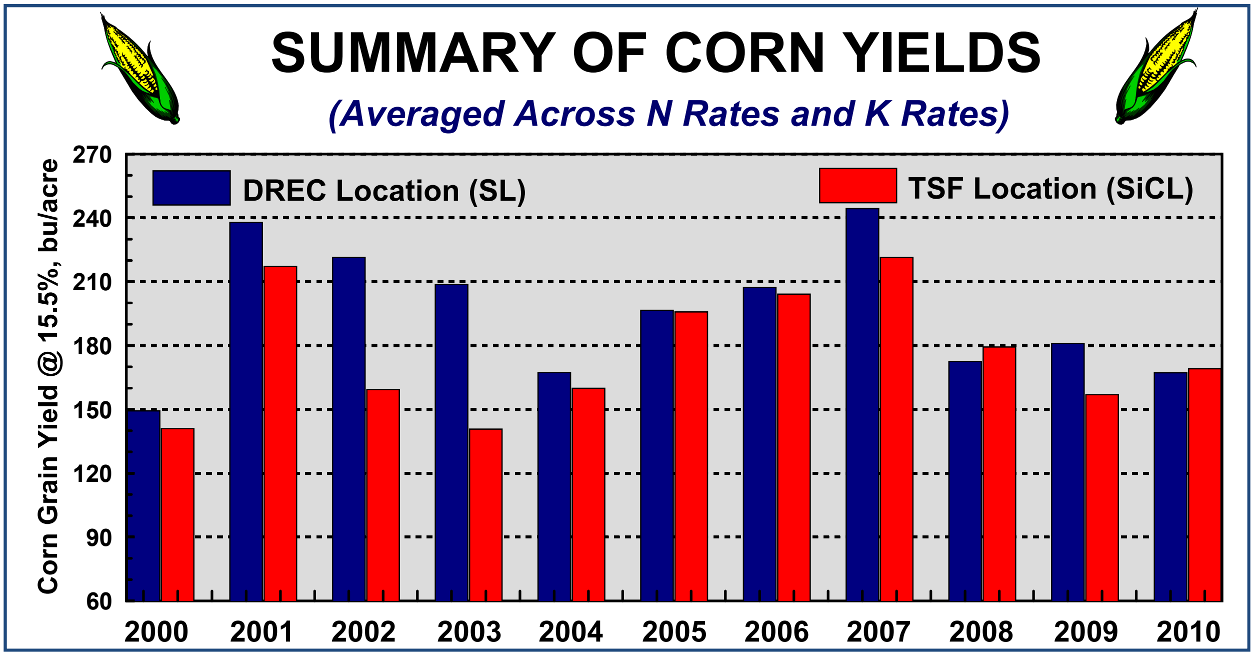

Figure 3. Summary of corn yields for cotton/corn rotations at the Delta Research and Extension Center, Stoneville, MS

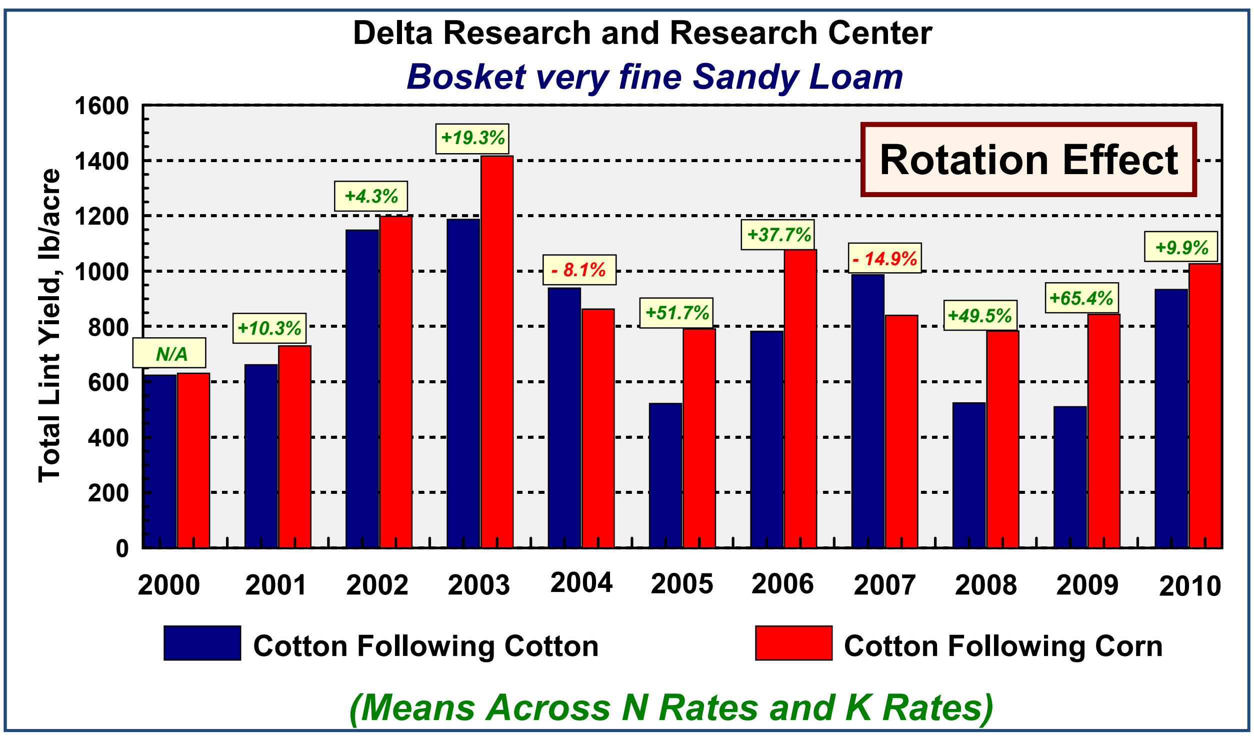

Figure 4. Summary of cotton lint yields for cotton following corn and cotton following cotton – Delta Research and Extension Center, Stoneville, MS

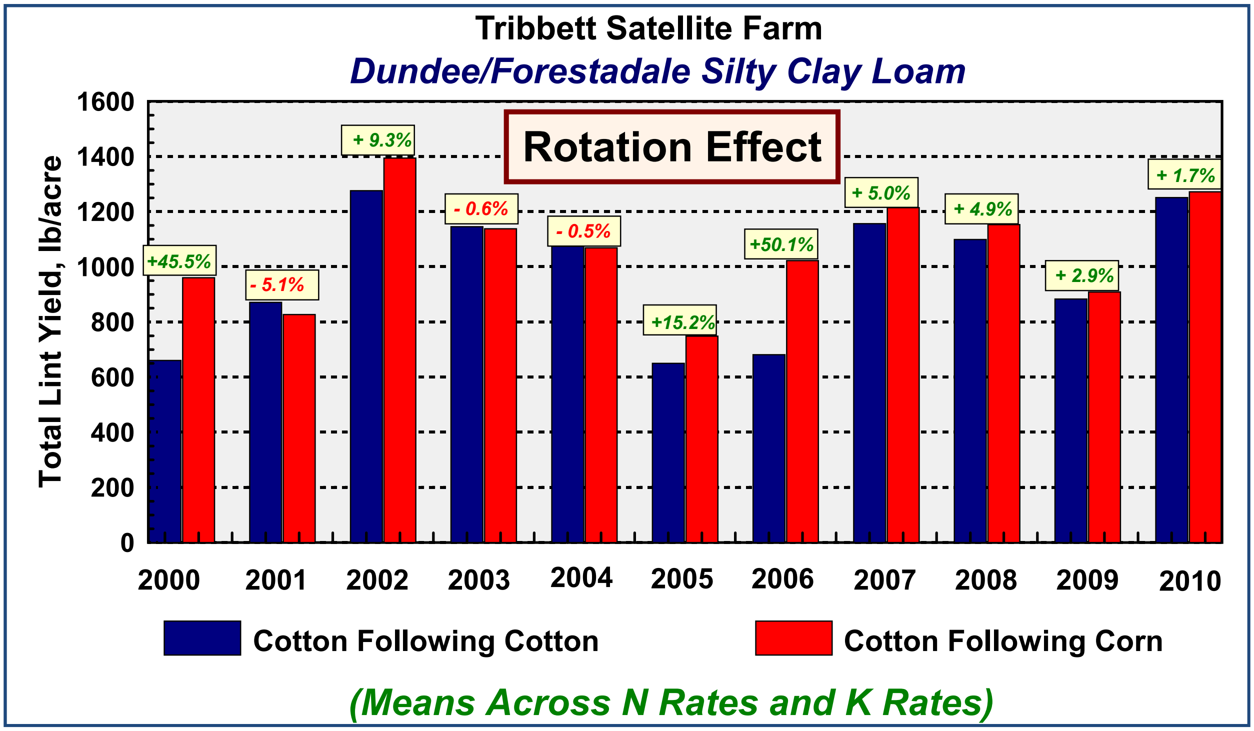

Figure 5. Summary of cotton yields for cotton following corn and cotton following cotton. Tribbett Satellite Farm, Tribbett, MS

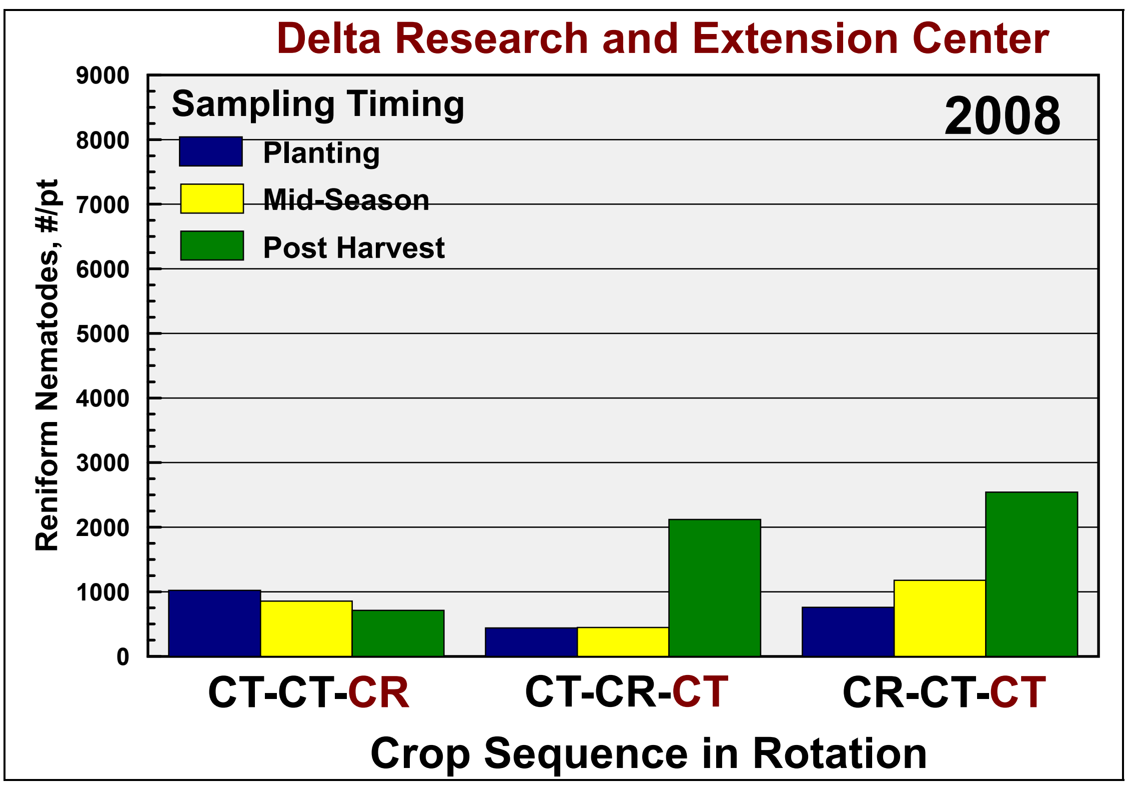

Figure 6a. Reniform nematode distribution in cotton/corn rotation system at the DREC - 2008

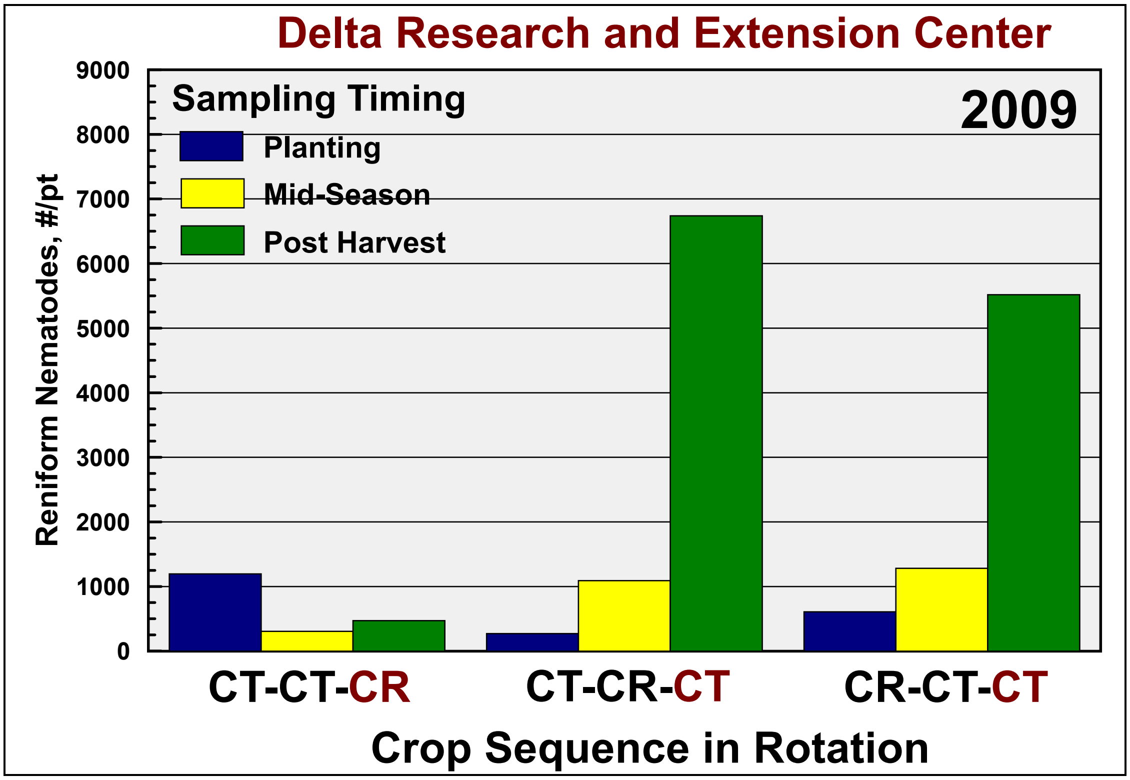

Figure 6b. Reniform nematode distribution in cotton/corn rotation system at the DREC – 2009

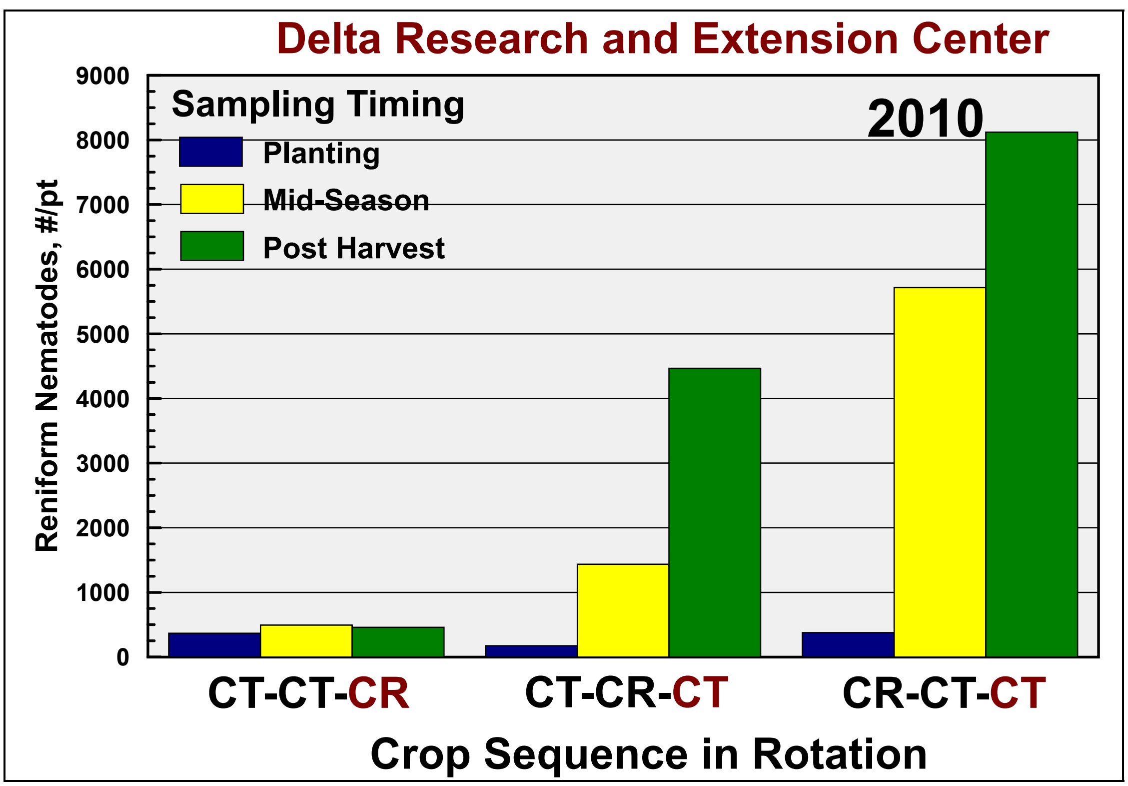

Figure 6c. Reniform nematode distribution in cotton/corn rotation system at the DREC – 2010

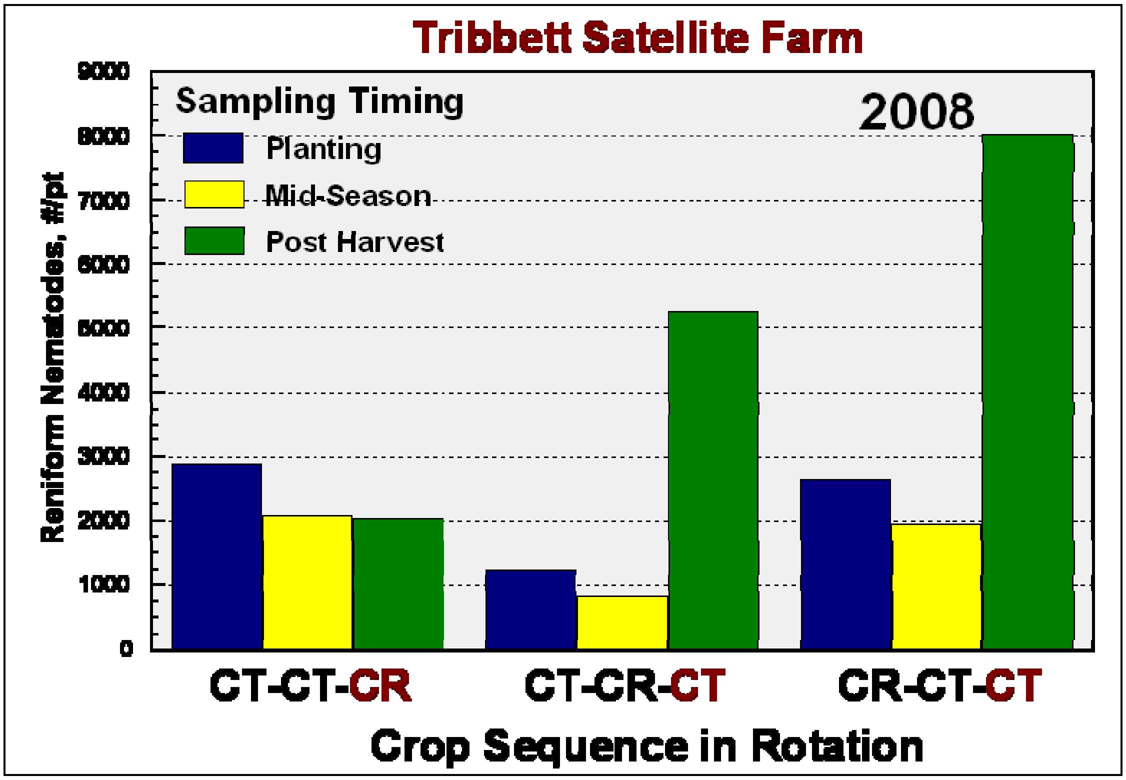

Figure 7a. Reniform nematode distribution in cotton/corn rotation system at the Tribbett Satellite Farm – 2008

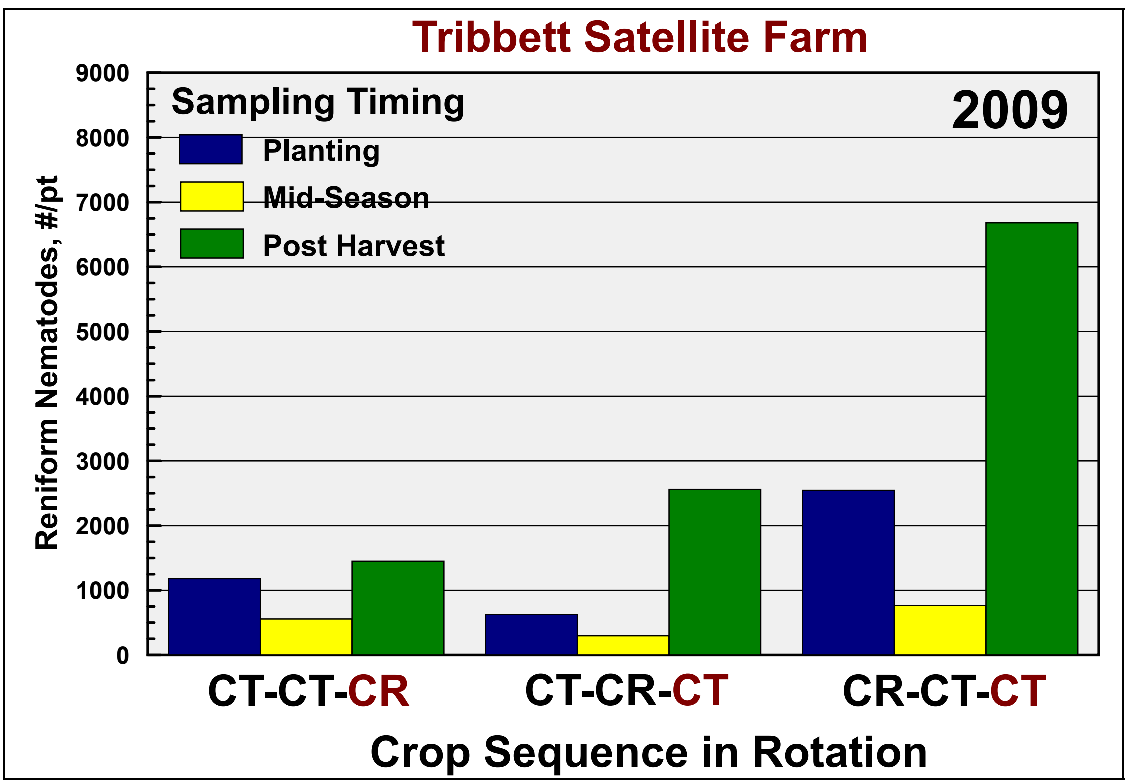

Figure 7b. Reniform nematode distribution in cotton/corn rotation system at the Tribbett Satellite Farm – 2009

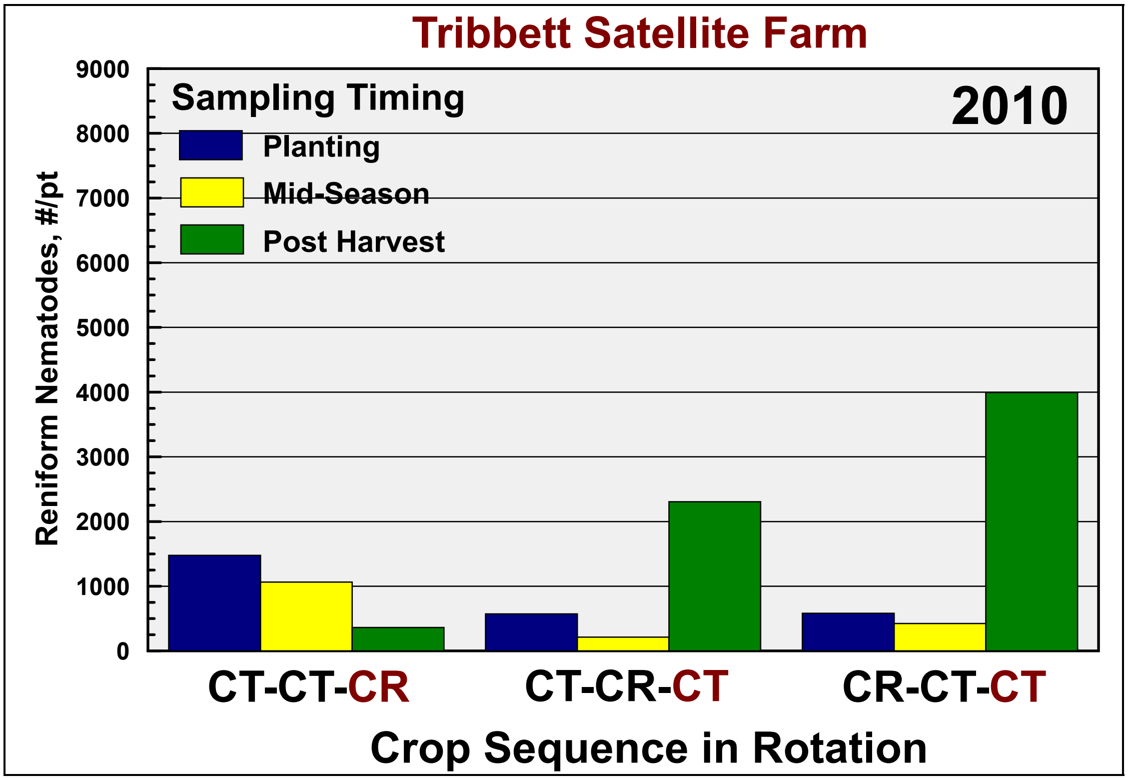

Figure 7c. Reniform nematode distribution in cotton/corn rotation system at the Tribbett Satellite Farm – 2010