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# GRAIN SORGHUM YIELD AND SUSCEPTIBILITY TO INSECTS AS AFFECTED BY EARLY SEASON GROWTH

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## Abstract

**Vigorous and uniform seedling emergence and growth are considered essential for profitable crop production. The objective of this note is to document the effect of nonuniform growth, apparently caused by differences in planting depth, on the susceptibility of grain sorghum [*Sorghum bicolor*, (L.) Moench] to *Heliothis zea* (Boddie) in a production environment. Observations were made within an 8-ha field near Florence, SC, where differences in productivity among 17 soil map units representing seven soil series classified as Ultisols were being determined. The center two rows of each six-row planting configuration grew more slowly than and reached the boot and bloom growth stage approximately 7 to 10 d after the outside rows. During early grainfill this delayed growth and development resulted in more than 90% infestation of the center rows by *Heliothis zea* compared with less than 10% infestation in the outside rows. Differential growth and subsequent *Heliothis* damage to the crop were similar across all soil map units. Average grain yield was reduced from 3110 to 1640 kg ha$^{-1}$, apparently because deeper seed placement slowed plant growth and development enough that there was subsequent synchronization between a third generation *Heliothis* flight and flowering. This demonstrates that nonuniform plant growth and seasonal insect populations can reduce yield by nearly 50% in the Southeastern Coastal Plains.**

Achieving uniform seedling emergence and vigorous crop growth were identified as major problems when conservation tillage practices were initially evaluated on Coastal Plain soils (Campbell et al., 1984a,b). For corn (*Zea mays* L.), late-emerging and ultimately barren plants acted as "weeds" by extracting water and nutrients without producing grain (Karlen and Sojka, 1985). Fortunately, many stand establishment and early plant growth problems have been subsequently eliminated by improvements in conservation tillage equipment, fertilizer placement, and planter design (Karlen and Sojka, 1985; Karlen and Zublena, 1986).

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One effect of nonuniform growth receiving inadequate attention is the interaction between seedling development and seasonal insect cycles. This interaction is important in the Southeastern Coastal Plain because multiple generations of several insects can be identified each year (Roach, 1975; Roach, 1976; Roach and Whisnant, 1986). The potential impact of multiple insect generations must be considered when implementing practices such as conservation tillage, alternative crops, or multiple cropping. One example is double-crop production of grain sorghum after wheat (*Triticum aestivum* L.), which is increasing because of the demand for grain sorghum in swine and poultry rations.

The objective of this note is to document the observed interaction between plant emergence and growth, and a third generation infestation of *Heliothis zea* for double-crop grain sorghum in the Southeastern Coastal Plains.

## Materials and Methods

Grain sorghum ('Savannah-5') was planted into burned wheat stubble in an 8-ha field using a six-row KMC[1] (Kelley Manufacturing Co., Tifton, GA) in-row tillage system equipped with Series 800 Early-Riser planters (Case-IH, Racine, WI) on 30 June 1987. Starter N was applied at a rate of 33 kg N ha$^{-1}$ approximately 5 cm below the seed using urea-ammonium nitrate (UAN) solution. On 10 July, at the three-leaf stage, 1.5 kg a.i. ha$^{-1}$ of atrazine (6-chloro-N-ethyl-N′-(1-methylethyl)-1,3,5-triazine-2,4-diamine) plus surfactant was broadcast over the top for weed control. Surviving weeds were controlled by applying 0.7 kg a.i. ha$^{-1}$ paraquat (1,1′-dimethyl-4,4-bipyridinium ion) with a shielded sprayer on 20 July. Sidedress N was applied at a rate of 67 kg ha$^{-1}$ using UAN on 28 July. On 10 September panicles in normal and slow-growing rows were evaluated throughout the field to determine what insect had infested the slow-growing rows. On 6 November grain yield was measured from 13 adjacent normal and slow-growing plots using an Almaco (G.W.C. Inc., Nevada, IA) SP-25 combine. Grain moisture was determined using a Steinlite model SS250 meter (Fred Stein Lab., Inc., Atchison, KS) so that grain yield could be adjusted to a constant water content of 150 g kg$^{-1}$ (15%). Data were analyzed using a paired *t*-test.

## Results and Discussion

Nonuniform seedling growth was observed 20 d after planting when paraquat was applied with the shielded sprayer. The center two rows of each six-row planting configuration were slightly shorter than the

[1] Mention of trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

outside rows. Frequent visual observations were made thereafter to determine a possible cause for the nonuniform growth pattern. The primary purpose of growing the crop was to evaluate productivity differences among 17 soil map units representing seven soil series at the site, but regardless of soil type, the center two rows were growing more slowly. Samples were collected from normal and slow-growing rows to determine if soil acidity, either naturally-occurring or starter-N-induced, caused the problem. Soil pH averaged 5.9 in the top 15 cm for both plant growth conditions, and showed no differences within or between rows. The differential rate of growth and development was especially evident by the boot and bloom growth stages because the slow-growing center rows reached those stages 7 to 10 d after the normal rows. Composite flag leaf samples were collected from each plant growth condition to determine if there were any plant nutritional differences. Tissue analyses showed little difference averaging 22, 3, 17, 3.8, 3.2, 1.1, 0.008, 0.007, 0.04, and 0.02 g kg$^{-1}$ for N, P, K, Ca, Mg, S, B, Cu, Mn, and Zn, respectively.

Prior to anthesis differential growth was primarily an experimental curiosity or, at worst, a nuisance for operations such as directed spraying or side-dress fertilization. However, the economic impact of slow plant growth and development rapidly became evident. Instead of setting seed, many florets were destroyed by a *Heliothis zea* infestation. The slow-growing rows across all soil types were more than 90% infested by *Heliothis zea* and seed production per panicle was significantly lower than in the normal rows, which had less than 10% infestation. We hypothesize that slow plant growth contributed to differential *Heliothis* infestation because those plants were less mature and more attractive to ovipositing females of *Heliothis zea* (Todd and Pitre, 1979). Slower plant growth and development may have also resulted in more open panicles which further increased the attractiveness of those plants (Teetes and Wiseman, 1979). Yield was significantly different ($P < 0.0001$) for the two plant growth conditions, averaging 3110 kg ha$^{-1}$ for the normal rows and 1640 kg ha$^{-1}$ for the slow-growing rows. The lower yield for the slow-growing center rows presumably reflected differences in maturity, plant available soil water, and rooting, as well as the third generation *Heliothis* infestation. The net result of nonuniform growth and development, and synchronization with a *Heliothis* flight was a yield reduction of almost 50%.

The magnitude of yield loss was such that each component of the tillage/planting operation was subsequently evaluated in an attempt to identify why the center two rows grew more slowly. Rates of starter N were found to be uniform for all rows and all seed were identified as being from the same lot. All management practices after planting were the same for each row, therefore we hypothesize that the center two rows were planted slightly deeper than the outside rows. This apparently occurred because, with 0.75 m row spacing and a six-row planting configuration, rows 1, 2, 5, and 6 were almost always within the 1.4 m wide area compacted by either the front or rear set of dual wheels on each side of the tractor. Only the center two rows were planted in noncompacted soil. When the planting system was set up all six planters were bolted at similar angles to the same planter bar, planting depth was set as suggested in the manuals for grain sorghum, and checked in the field prior to planting. Planting depth was apparently not checked again, although it would not have been unusual to change the angle and adjustment of individual planters to ensure a uniform planting depth. If seedbed water content and soil temperature are optimum small differences in planting depth may not noticeably affect plant emergence. However, achieving a uniform planting depth can be very critical in some years, and failure to plant uniformly can delay emergence of complete rows for several days because of variable soil temperature and differences in water content.

In summary, long-term seasonal insect population data (Roach, 1975; Roach, 1976; Roach and Whisnant, 1986) and field observations show that substantial damage to slowly developing plants was caused by a third generation *Heliothis* flight. An insecticide application could have been used to reduce the damage if the magnitude of potential loss was known beforehand, but an interaction between plant growth and development with insects was not anticipated. This information should make agronomists more aware of the potential economic impact of delayed emergence and slow plant growth when interactions with insect cycles are considered.

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