FALL BEDDING FOR IMPROVED HARVESTING EFFICIENCY AND YIELD OF STRIP-TILL PEANUT ON FINE-TEXTURED SOILS

by

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(Under the Direction of John P. Beasley, Jr.)

ABSTRACT

Most peanut (*Arahcis hypogeae* L.) production occurs under conventional tillage. Reducing tillage trips can reduce production costs. Growers switching to strip-tillage peanut can experience a decrease in yield on certain soil types. This study compared strip-till utilizing fall prepared raised beds and rip and beds to standard flat strip-till on a sandy soil at Tifton, GA and a clay soil at Plains, GA. At Plains, the rip and bed and raised bed reduced digging losses by 62 and 47 %, respectively. Soil compaction decreased by 3.3 and 4.7 times for the raised bed and rip and bed, respectively. The rip and bed increased yield by 465 kg/ha over flat bed. At Tifton, no differences in yield or digging losses were found. Soil compaction decreased by only 1.9 and 2.5 times for raised bed and rip and bed, respectively. Results suggest bedding can minimize yield loss on finer textured soils.

INDEX WORDS: Peanut, *Arachis hypogaea* L., strip-till, conventional tillage, bedding, fall beds, bed type, flat bed, rip and bed, raised bed, reduced tillage, minimum tillage, conservation tillage, harvest efficiency, digging efficiency, digging losses, soil compaction, yield potential, net returns, marginal returns, economics, nutrient content, soil moisture

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DEDICATION

I would like to dedicate this thesis to my granddad Edgar Breedlove "Bud" Jackson who passed away in 2002. He is the person who taught me the values of hard work, self-respect, and responsibility. Working on the farm as a child and teenager it was not always so easy to see he was shaping me into an adult capable of surviving in an ever changing world. Growing up in the Great Depression and fighting in WWII he learned how to do just that, survive. He also learned values like the importance of saving, respect, honesty, integrity, and principle. His word and handshake with someone was better than any written contract or binding agreement. At times, it could seem humorous, because if he said he was going to meet someone only five miles from his house, he would leave 30 minutes early just so he wouldn't be late. He would say something like you always have to be prepared for unexpected interruptions in life.

He was a very simple man, but he lived his everyday life based on the principles and wisdom instilled in him along the way. He was the kind of man who would give you the shirt off his back if you asked for it, but who would disown you for trying to steal from him. Some would describe him as contrary and difficult, but those were simply side-effect traits that came with his desire to treat everyone equally and fairly. Since his death, a day hasn't gone by that he hasn't crossed my mind. Trying to measure up to the legacy he left behind is what has motivated me to go further in school and be successful doing it. At times when I thought it was too difficult to continue, I have referred to conversations with him in my memory about the enduring times he survived, and those conversations made me realize that with hard work anything can be accomplished. Thanks Grandpa! This one is for you.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Review of Literature

Peanut (*Arachis hypogaea* L.) is a row crop common to Georgia and much of the Southeast. Currently, about 44% of the U.S. peanut production takes place in Georgia (NASS, 2008) with the balance occurring in neighboring states, the Southwest (Texas, Oklahoma, New Mexico), and the Virginia-Carolina (South Carolina, North Carolina, Virginia) region. Most of this production occurs under conventional tillage practices that involve vigorous tillage of the soil. This includes deep turning of the soil with a moldboard plow, multiple passes over the field, high capital investments, high energy inputs, increased wear on machinery, and the possibility of high moisture losses, erosion problems, and high carbon dioxide (CO^2) emissions. However, these full-tillage systems do generally include preparation of a friable, residue free, flat or slightly raised seedbed (Sholar *et al.*, 1995; Grichar, 1998) to accommodate plant growth and efficient harvesting. In Georgia, a majority of growers produce some type of raised seedbed to accommodate easier harvesting. With equipment and energy prices at record highs, there is more interest than ever from growers to find ways to reduce production costs in peanut without sacrificing yield.

One way to achieve this goal of lowering production costs will be through reduced tillage. At the production level, this will allow a reduction in overhead costs due to smaller equipment inventories, a decrease in time and labor resources for tillage operations, a reduction in wear and tear on machinery, and a reduction in energy investments, which will essentially reduce production costs. In addition, reduced trips over a field means growers will be able to enter and prepare a field for planting in a timelier manner with less risk of weather delays. Producers will also have the option of multiple cropping as a possible incentive where cover crops are used. Environmentally, reduced tillage also results in decreased runoff and erosion, increased water infiltration and retention, and improved soil quality (Durham, 2003). In return, this also means that less sediment, nutrients, and chemicals are being deposited into streams and watersheds. On an even larger scale, benefits of reducing tillage include reduced soil respiration (Bauer *et al.*, 2004), which results in a decrease of agricultural contributions to increasing atmospheric CO^2 levels that may enhance the threat of global warming. When the soil is not being constantly tilled, it allows carbon to be stored in the soil as organic matter rather than being released into the atmosphere as a pollutant. As the number of tillage trips is reduced, the amount of fossil fuel being consumed and CO^2 produced is reduced.

Reduced tillage in other row crops has occurred primarily as no-till where planting occurs directly into residue with minimal surface disturbance, or as strip-till where tillage bands occur under each row resulting in 30 percent or less of the soil surface being disturbed (ASAE, 1990). Other definitions by ASAE for reduced tillage include (a) performing the least manipulation necessary for crop production or for meeting tillage requirements under existing soil conditions, and (b) planting in a system that consists of fewer or less energy intensive operations compared to conventional tillage. Reduced tillage is widely used in producing corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), soybean (*Glycine max* L.), and grain sorghum (*Sorghum* *bicolor*), and has demonstrated reduced runoff, erosion, and production costs while maintaining comparable yields with conventional tillage (Sanford *et al.*, 1973; Fink and Wesley, 1974; Musick *et al.*, 1975; Melville and Rabb, 1976; Nelson *et al.*, 1977). It should be noted that the grains or fiber of these crops are produced and harvested above ground. Problems do arise when reducing tillage in peanut, because pegging and pod formation processes occur at and beneath the soil surface, usually spanning the width of the above ground portion of the plant. In addition, the crop must be harvested from the soil, so many producers familiar with conventional tillage express skepticism for the ability to harvest peanut in reduced tillage situations (Grichar and Boswell, 1987; Wright and Porter, 1991; Jordan *et al.*, 2001; Faircloth *et al.*, 2005).

Some studies have documented significantly lower yields (Grichar and Boswell, 1987; Brandenburg *et al.*, 1998), root and pod formation (Khan, 1984a, b), and harvesting problems (Grichar, 2006) when initially switching from conventional tillage to reduced tillage in peanut, especially with no-till. Long-term research of this phenomenon has shown deterioration of these initial problems does occur with time (Grichar, 1998) as soil aggregation and tilth improve as a result of increasing organic matter, water holding potential, microbial biomass, and soil quality. In this ten year study comparing no-till, conventional tillage, and reduced tillage, even no-till produced comparable yields with conventional tillage towards the end of the study as soil properties improved over time. It can take several years for soils to undergo these beneficial improvements, and the amount of time needed, and extent to which improvements occur, is highly variable and heavily dependent upon soil type (Dick and Van Doren Jr., 1985). Most producers interested in reduced tillage peanut simply do not have the time to wait for these fragile processes to occur in their fields, and data that show suppression of initial yields resulting from reduced tillage is discouraging. For these reasons, most producers and researchers agree that tillage is necessary in some form or another to achieve optimum yields in peanut (Buchanan and Houser, 1980; Colvin *et al.*, 1988; Grichar, 1998), and no-till is simply not an option in most fields where conversion from conventional tillage is occurring. These soils are generally low in organic matter and are more easily compacted than soils where reduced tillage has been in place for several years. The exact degree of tillage necessary is still widely debated.

The system of reduced tillage that is most popular in peanut production has been strip-till (Johnson *et al.*, 2001). The term strip-till is used very liberally, but for the most part applies to tillage of the soil in a narrow strip or band within the row either with or without the use of in-row sub-soiling. The objective is to produce a friable area for pegging and pod formation to occur while at the same time leaving a majority of the soil surface undisturbed for residue accumulation. Initial studies comparing strip-till in peanut have been inconsistent with yields ranging from significantly lower (Wright and Porter, 1991, 1995; Brandenburg *et al.*, 1998; Grichar, 2006), equal to (Colvin and Brecke, 1988; Colvin *et al.*, 1988; Johnson *et al.*, 2001; Faircloth *et al.*, 2005; Tubbs and Gallaher, 2005), to significantly higher (Baldwin *et al.*, 1999; Jordan and Johnson, 2006) than those with conventional tillage. Upon reviewing these inconsistencies, the outcomes seem to be more related to varying yearly weather patterns and differing soil types than to tillage itself. Additionally, one Real-Time Kinematic (RTK) study indicated conservational tillage (strip-till) was more sensitive to the digger not being exactly on the row due to operator error (Balkcom, 2008). Yield losses in conventional tillage were much lower with the same amount of operator error at digging. In light of these inconsistent results, strip-till does tend to produce more suitable yields in comparison with no-till (Grichar and Boswell, 1987; Naderman, 1998; Baldwin *et al.*, 1999; Dowler *et al.*, 1999), and, if coupled with the use of fall-raised beds, there is evidence that some of the risks associated with lower yields in strip-till can be eliminated (Jordan *et al.*, 2001; Jordan *et al.*, 2004a; Jordan *et al.*, 2004b; Jordan and Johnson, 2006). Strip-till has also demonstrated reductions in pests and diseases in several instances (Porter and Wright, 1991; Brandenburg *et al.*, 1998; Baldwin *et al.*, 1999; Baldwin, 2001; Chapin *et al.*, 2001; Jordan *et al.*, 2004b; Monfort *et al.*, 2004; Cantonwine *et al.*, 2007) which also makes it an attractive option in integrated pest management systems.

Previous researchers have demonstrated higher yields and lower soil resistance measurements with the use of bedding in conventional tillage (Wright and Porter, 1980), and this seems to hold true in strip-till as indicated by studies from North Carolina researchers. Jordan et al. (2004b) go even further to indicate that bedding may have increased benefits on finer textured soils compared to coarser textured soils when followed by strip-till. This is also evident by the fact that on coarser soils there seems to be a trend for higher or equal yields with strip-till while on finer soils the trend seems to favor conventional tillage (Jordan and Johnson, 2006). These ideas are consistent with growers' thoughts as they are more apt to attempt reduced tillage on sandy soils, but more hesitant when it comes to finer, clay soil types.

Objectives

According to Henning et al. (1982), one of the main objectives in conventional tillage is to establish a slightly raised seedbed. This factor has been recognized as a problem in strip-till, because the practice is generally conducted on flat ground which is less conducive to harvesting (Grichar and Boswell, 1987; Wright and Porter, 1991; Jordan *et al.*, 2001; Grichar, 2006). No studies have taken place in Georgia to assess the assumption of using beds in conjunction with strip-till. The objective of this work was to determine if utilizing fall-raised beds could in fact improve harvesting efficiency and yield of strip-till peanut on Georgia soils. In addition, the previous studies were focused on yield and never accounted for digging losses. It could only be assumed that lower harvest efficiency led to reduced yields for the non-bedded plots in those studies. The idea of bedding procedures affecting soil and agronomic factors leading to increased yield potential which possibly resulted in higher yields in bedded plots was left open to debate. This study accounted for harvest efficiency as well, by measuring the amount of pod loss at digging. This study also attempted to determine if any other agronomic factors were affected by the bedding procedures by taking plant tissue samples for nutrient analysis and monitoring soil conditions. In addition, an economic analysis was composed to determine if the extra tillage could be justified by the value of any additional yield gained from bedding. Therefore, data collected focused on yield and grade, digging losses, soil compaction, economics, plant tissue nutrient contents, soil moisture, and peanut growth characteristics

Trial Description

Experiments were conducted at two locations to evaluate the effect of fall-bedding in strip-till peanut on different soil types over a two year period beginning in 2006 and ending in 2008. Beds were established in the fall of 2006 and 2007, and peanut crops were grown in the 2007 and 2008 growing seasons. The first location was at the

University of Georgia's Southwest Georgia Research and Education Center in Plains, GA on a Greenville sandy loam (Fine, kaolinitic, thermic Rhodic Kandiudults) (USDA-NRCS, 2009). This soil's sand, silt, and clay concentrations were 69, 15, and 16%, respectively. The second location was at the University of Georgia's Coastal Plain Experiment Station's Lang Farm in Tifton, GA on a Tifton loamy sand (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults) (USDA-NRCS, 2009). This soil's sand, silt, and clay concentrations were 94, 4, and 2%, respectively. Three bed types, with and without wheat (*Triticum aestivum* L.) cover were evaluated. The following three bed types were implemented in the fall (Nov.) of each year: (a) flat bed (no further tillage after disking in fall serving as control), (b) rip and bed (single beds for each peanut row spaced 91 cm apart being approximately 28 cm high and 40 cm wide), and (c) raised bed (one wide bed to accommodate two peanut rows spaced 91 cm apart being approximately 18 cm high and 180 cm wide).

Hypotheses

1. Soil type at Plains will likely result in higher digging losses due to its finer texture and higher clay content than the sandier soil at Tifton.
2. Bedding should reduce soil compaction and digging losses as the degree of bedding increases from none to greatest (Flat bed, raised bed, rip and bed). Bedding benefits should be more pronounced at Plains.
3. Decreased digging losses should result in higher yields for bedding at Plains.
4. Bedding should not impact nutrient availability.
5. Bedding and cover crop are likely to influence soil moisture.

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CHAPTER 2

FALL-BEDDING FOR REDUCED DIGGING LOSSES AND IMPROVED YIELD IN STRIP-TILL PEANUT[1]

[1] Jackson, J.L., J.P. Beasley, Jr., R.S. Tubbs, R.D. Lee and T.L. Grey. To be submitted to *Peanut Science.*

Abstract

Most peanut (*Arahcis hypogaea* L.) production occurs under highly intensive conventional tillage systems. With recent volatility in input prices, reducing tillage trips is a viable way of reducing production costs. However, growers can experience yield loss when switching from conventional tillage to strip-tillage in peanut on certain soil types due to the lack of an elevated bed at harvest time. Studies were conducted to compare strip-till in conjunction with raised beds and rip and beds prepared in the fall to standard flat strip-till on a coarse textured soil at Tifton, GA and a fine textured soil at Plains, GA. The three bed types, with or without a cover, were evaluated over two years at both locations. No effects of wheat cover or interactions with bed type were present. At Plains, the rip and bed and raised bed reduced digging losses by 62 and 47 %, respectively. Soil compaction within the harvest depth was reduced by 3.3 and 4.7 times by the raised bed and rip and bed, respectively. The rip and bed increased peanut yield by 465 kg/ha over flat bed. At Tifton, no significant differences in yield or digging losses occurred between tillage methods. Soil compaction in the harvest depth was reduced by 1.9 and 2.5 times by raised bed and rip and bed, respectively on this soil type. Results suggest bedding is more important on finer textured soils.

Key Words

Arachis hypogaea L., conventional tillage, bed type, flat bed, rip and bed, raised bed, reduced tillage, harvest efficiency, digging efficiency, digging losses, soil compaction, yield potential.

Introduction

Peanut (*Arachis hypogaea* L.) is a popular row crop in the Southeast, most especially in Georgia. In 2007 and 2008, the state accounted for approximately 43 and 44% , respectively, of the entire U.S. peanut production (NASS, 2008). The majority of this acreage was produced under conventional tillage practices involving deep tillage and turning of the soil along with multiple trips over the field for seedbed formation prior to planting. These practices are highly intensive in terms of energy, labor, and equipment maintenance and replacement. The trips generally must occur in rapid succession during a short period in the spring of each year and can be delayed by unfavorable weather conditions. With the recent volatility in production costs, coupled with shortages of skilled farm labor, there has been increased interest from growers in finding ways to reduce inputs without sacrificing yield. One way of achieving this goal is through reduced tillage. Along with reducing labor, fuel, and equipment cost, reduced tillage adds the benefits of conserving soil and water along with improving soil quality (Durham, 2003). Reducing tillage trips would also allow farmers to enter and prepare a field in a timelier manner.

There are numerous variations to conservation tillage, but the reduced tillage system that is most popular in peanut is strip tillage (Johnson *et al.*, 2001). However, even with all the adversities currently facing growers, there is still skepticism among them about the efficacy of this tillage system for peanut production. The skepticism is even more pronounced when growers consider fields with finer texture and higher clay content. According to Sholar *et al*. (1995), despite the potential benefits of reducing erosion and production inputs, conservation tillage does not consistently produce yields equal to conventional tillage.

One of the biggest challenges facing farmers using strip-till is getting a good peanut stand at planting (Campbell *et al.*, 2002). Growers using full tillage peanut production systems generally include the preparation of a friable, residue-free, flat or slightly raised seedbed (Sholar *et al.*, 1995; Grichar, 1998). This insures adequate seed-to-soil contact for proper moisture absorption (Porter and Wright, 1991), low levels of competition from diseases and weeds (Buchanan and Houser, 1980), and aids the harvest process by producing a raised seedbed which provides the digger's blades a place to penetrate the soil surface at a point beneath the crop. More recent innovations in precision tillage and planting equipment have all but eliminated the stand issue associated with accurate seed placement in strip-tillage peanut. Newer herbicides and fungicides are also more effective at controlling weeds and diseases than those that were available when conventional tillage was the only recommendation available for peanut. Therefore, adoption of strip-till has lagged compared with other crops, due mainly to producer reluctance and concern for digging problems (Faircloth *et al.*, 2005) with the lack of an elevated bed (Grichar and Boswell, 1987; Wright and Porter, 1991; Jordan *et al.*, 2001; Grichar, 2006).

Much of the concern growers express is related to greater soil resistance and residue buildup in strip-till compared to conventional tillage that can cause increased difficulty at the time of digging. Previous research in a conventional tillage study demonstrated that a ripper-bedder bed type lowered soil compaction by 5.5 times that for other bed types and flat tillage (Wright and Porter, 1980). In this 3-yr study, peanut yields were 1.9% to 3.6% higher for disk-bedder and ripper-bedder plots than those from plots prepared flat. Due to higher costs with bedding, it was concluded that additional costs of production equipment to lower soil resistance to root penetration must be considered on an individual basis among farming operations. More recently, studies in North Carolina indicated that use of preformed beds in conjunction with strip-till can improve yields compared to those of strip-till conducted on a flat soil surface and approach those of conventional tillage (Jordan *et al.*, 2001; Jordan *et al.*, 2004b; Jordan and Johnson, 2006). These studies stated lower yields in flat strip-till plots were most likely related to increased pod loss at digging. However, the results could not be officially confirmed, because pod loss was not substantiated. They acknowledged the possibility that other agronomic and soil fertility factors could have been affected by the bedding operation, which could have possibly led to the higher yields.

In North Carolina, an advisory index for growers transitioning to reduced tillage (Jordan *et al.*, 2004a) was created that attributed the following risk values to tillage intensity: (a) no tillage into flat ground = 40, (b) strip tillage into flat ground = 20, and (c) strip tillage into stale seedbeds = 0. Other components of the risk index include peanut cultivar (market type), irrigation availability, soil series, cover crop, and history of tomato spotted wilt virus (Bunyaviridae: *Tospovirus*). The risk levels of each of the components are then summed to give the producer's total risk (low, moderate, or high) of yield being lower than that of conventional tillage. Higher values indicate a grower is more likely to experience yield loss in a transition from conventional tillage to reduced tillage while low values indicate there is little risk of yield loss involved.

These theories have never been tested in Georgia. Therefore, the objective of this study was to determine if yield in strip-till peanut could be enhanced by utilizing fall prepared beds on fine and coarse textured soil types, and whether or not yield enhancement could be attributed to digging losses.

Materials and Methods

Experimental Design

Experiments were conducted at two locations to evaluate the effect of fall-bedding in strip-till peanut on different soil types over a two-year period beginning in 2006 and ending in 2008. Beds were established in the fall of 2006 and 2007, and peanut crops were grown in the 2007 and 2008 growing seasons. The first location was at the University of Georgia's Southwest Georgia Research and Education Center in Plains, GA on a Greenville sandy loam (Fine, kaolinitic, thermic Rhodic Kandiudults) (USDA-NRCS, 2009), with sand, silt, and clay of 69, 15, and 16%, respectively. The second location was at the University of Georgia's Coastal Plain Experiment Station's Lang Farm in Tifton, GA on a Tifton loamy sand (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults) (USDA-NRCS, 2009), with sand, silt, and clay of 94, 4, and 2%, respectively. Each year, plots at both locations were fall established following either two diskings or a disking and field cultivation.

At Tifton, a two-way factorial based on three bed types, with and without a winter cover crop was used in both years to determine treatments. Plots were arranged in a randomized complete block design (RCB). Six-row plots 15.2 m long were used in both years to reduce any border effects. There were eight replications in 2007 and four replications in 2008, due to reduced land availability in 2008. Reduction in the number of reps was favored over a reduction in plot size. The study followed a rotation of cotton *(Gossypium hirsutum* L.)-corn (*Zea mays* L.)-peanut in both years, and was located under a lateral irrigation system. This system was responsible for supplying water to a broad array of crops and research trials, and therefore, irrigation was received on an availability basis.

At Plains, a three-way factorial design based on three bed types, with and without a winter cover crop, and a row pattern of twin or single row peanut was used to determine treatments in 2007. In 2008, a two-way factorial design was utilized with the peanut row pattern factor omitted. In both years, a RCB was used to arrange plots. Six-row plots 15.2 m long and six replications were present both years. The study followed the same cotton-corn-peanut rotation system as the Tifton location. This location was also located under a lateral irrigation system and irrigation based on availability.

Fall Bed Types

Three tillage systems were implemented in the fall (Nov.) of each year: (a) flat bed (no further tillage after fall disking serving as control), (b) rip and bed (single beds for each peanut row spaced 91 cm apart being approximately 28 cm high and 40 cm wide), and (c) raised bed (one wide bed to accommodate two peanut rows spaced 91 cm apart being approximately 18 cm high and 180 cm wide). Flat bed plots did not receive any further tillage until the spring. The rip and bed plots were established in the fall using a two-row KMC Ripper-Bedder (Kelly Manufacturing Co., Tifton, GA). This process included in-row subsoiling to a depth of approximately 25 cm, followed by disks located behind the shank on each side of the furrow that pulled soil toward the furrow forming a bed directly over the center of each row. The raised bed plots were established using the same implement, but for this bed type the ripper-bedder was equipped with a drag attachment and 18-cm bed shapers in the wheel middles. This setup allowed the two individual beds to be leveled enough to form one single wide bed. All bed types were followed by spring strip-tillage.

Wheat Cover

Immediately following the bedding procedures exactly half of the plots were sown with wheat (*Triticum aestivum* L.) as a cover crop in 17.8 cm rows at a seeding rate of 101 kg/ha based on the experimental design. If necessary, winter weeds were controlled in all plots using an application of a herbicide premix of dicamba and 2, 4-D at 0.28 and 0.80 kg ai/ha, respectively (Culpepper *et al.*, 2007). Primary winter weeds were henbit (*Lamium amplexicaule* L.) and wild radish (*Raphanus raphanistrum* L.). Henbit tended to be the main problem in plots with no cover, while wild radish tended to be more pronounced in plots with cover. Controlling these weeds was of significant importance to prevent a false cover effect in plots without cover, and to prevent discrepancies in biomass samplings of plots with cover. Herbicides were applied in February each year if needed. Termination of the cover crop occurred in early-mid April each year with a single application of glyphosate at 1.12 kg ai/ha to all plots. Early termination was aimed at preventing viable wheat seed from being produced and to prevent excessive moisture extraction by the cover crop. The early termination was also more conducive to strip-tillage, because the cover crop was given sufficient time to begin decomposition.

Strip-tillage and Planting

Strip-tillage occurred in early May each year using a strip-till implement (Kelly Manufacturing Co., Tifton, GA). The implement utilized a coulter mounted in front of an in-row subsoiler followed by fluted coulters and a rolling crumble basket to prepare a seedbed approximately 30-40 cm wide. In-row subsoiling occurred to a depth of 25-30 cm.

The peanut cultivar was planted at a rate of 18-20 seeds/m in each row of the single row pattern (rows spaced 91 cm apart) and at 9-10 seeds/m in each row of the twin row pattern (pairs of rows spaced 18 cm apart with outside rows 91 cm apart) after strip-tillage each year. Planting occurred with both single and twin-row vacuum planters (Monosem Inc., Edwardsville, KS) for precise and accurate seed placement. The cultivar 'Georgia-02C' was chosen due to its higher level of resistance to Cylindrocladium black rot (*Cylindrocladium parasiticum* Crous). This disease had a known history of prevalence at the Plains location, and producers in the area typically use a cultivar with higher levels of resistance to lessen the disease's impact. The in-furrow insecticide phorate was applied at planting at 1.12 kg ai/ha in both site years. Following planting, preemergence herbicides including glyphosate, pendimethalin, flumioxazin, and diclosulam were applied to all sites at 1.12, 0.92, 0.107, and 0.026 kg ai/ha, respectively. The applications were accompanied by an irrigation of approximately 12.7 mm of water for incorporation of herbicides within 24 hours. All plots were managed the same at each location based on year for weed, insect, and disease control according to agronomic recommendations in the University of Georgia Cooperative Extension 2007 Peanut

Update (Prostko, 2007). Harvesting was based on the Hull-Scrape Maturity Profile method (Williams and Drexler, 1981).

2007

At Tifton, peanut was planted on 14 May. Rainfall totaled 398 mm for the season. Irrigation applied in 12 events totaled 215 mm. Water available totaled 613 mm, which was adequate to produce normal yields (Figure 2.1). On 21 June, clethodim was applied at 0.14 kg ai/ha for control of Texas panicum (*Panicum texanum* Buckl.). Bentazon was applied at 1.12 kg ai/ha for control of yellow nutsedge (*Cyperus esculentus* L.) on 9 July. For control of early (*Cercospora arachidicola* Hori) and late [*Cercosporidium personatum* (Berk. and Curt.) Dieghton] leaf spot, pyraclostrobin was applied at 0.17 kg ai/ha on 16 July. On 6 Aug., a premix of tebuconazole and prothioconazole was applied at 0.15 and 0.07 kg ai/ha, respectively, for control of early and late leaf spot and white mold (*Sclerotium rolfsii* Sacc.). At the same time, boron and lambda cyhalothrin were included to promote flower development and control fall armyworm [*Spodoptera frugiperada* (J. E. Smith)] (Lepidoptera: Noctuidae) at 0.46 kg B/ha and 0.02 kg ai/ha, respectively. On 22 Aug. and 24 Sept., tebuconazole and prothioconazole was applied again, at rates mentioned previously, for control of late leaf spot and white mold. Peanut digging occurred on 15 Oct. Rainfall delayed combine harvesting until 25 Oct.

At Plains, peanut was planted on 15 May. Rainfall totaled 503 mm during the season. Irrigation applied in eight events totaled 174 mm. An irrigation of 18 mm was applied prior to strip-till, and one application of 13 mm was applied prior to digging to soften the soil. The remainder of the irrigation was applied during the growing season.

The total water received over the growing season was 676 mm and was sufficient for producing adequate yields (Figure 2.2). On 18 June, clethodim at 0.14 kg ai/ha was applied for control of Texas panicum. Chlorothalonil at 1.26 kg ai/ha was applied on 19 June for control of early and late leaf spot. Chlorpyrifos at 2.18 kg ai/ha was applied on 13 July for control of Southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber). On 23 July, tebuconazole and prothioconazole was applied for control of Cylindrocladium black rot, white mold, and leaf spot at 0.23 and 0.11 kg ai/ha, respectively. For control of corn earworm (*Helicoverpa zea* Boddie), methomyl was applied at 0.34 kg ai/ha on 27 July. The tebuconazole and prothioconazole mentioned previously was applied at the same rates on 6 and 20 Aug. for leaf spot and soilborne disease control. On 21 Aug., a spider mite (*Tetranychus urticae* Koch) infestation resulted in the application of the miticide fenpropathrin at 0.34 kg ai/ha. Digging occurred on 16 Oct., but recurring rainfall delayed combine harvest until 31 Oct. Yield was not significantly affected by the delay in harvest, because little to no drying occurred before rain began.

2008

At Tifton, peanut was planted on 8 May. Rainfall during the growing season totaled 445 mm. Tropical systems deposited 286 mm in the month of August alone. Irrigation applied in 10 events totaled 168 mm. An irrigation of 23 mm was made prior to strip tilling to soften the soil. This made the total water received 612 mm (Figure 2.3). Again, this amount was considered adequate for achieving normal yields. The herbicide 2, 4-DB was applied on 19 June at 0.25 kg ai/ha for control of sicklepod (*Cassia obtusifolius* L.) and burgherkin (*Cucumis anguria* L.). On 25 June, the pyraclostrobin and boron was applied at 0.18 kg ai/ha and 0.46 kg B/ha, respectively. Pyraclostrobin was applied again at the same rate on 11 July. For control of Texas panicum, clethodim at 0.25 kg ai/ha was applied on 16 July. A mixture of tebuconazole and prothioconazole was applied at 0.23 and 0.11 kg ai/ha, respectively, on 22 July for control of leaf spot and white mold. The same mixture was applied on 5 Aug. at 0.17 and 0.09 kg ai/ha for tebuconazole and prothioconazole, respectively. On 3 Sept., chlorothalonil was applied at 1.26 kg ai/ha for control of late leaf spot. Peanut was dug on 15 Oct. and combine harvested on 20 Oct.

At Plains, peanut was planted on 14 May. Rainfall for the season totaled 541 mm. Tropical systems deposited 299 mm in the month of August alone. Irrigation applications were made seven times during the season totaling 150 mm. Total water for the season was 690 mm (Figure 2.4). This amount was in excess of the required amount, but does not account for runoff during the heavy rain events from tropical storms. On 18 June, pyraclostrobin was applied at 0.22 kg ai/ha for control of leaf spot. A mixture of tebuconazole and prothioconazole at 0.17 and 0.09 kg ai/ha, respectively, was applied for control of white mold and Cylindrocladium black rot on 21 July. The same mixture was applied on 4 and 18 Aug. at the same rates. On 29 July, chlorpyrifos was applied at 2.18 kg ai/ha for control of Southern corn rootworm. Chlorothalonil was applied at 1.26 kg ai/ha on 1 Sept. for controlling leaf spot. Digging occurred on 22 Oct., and combine harvesting took place on 28 Oct.

Digging Losses

Following digging and inversion each year, harvesting efficiency was determined by sampling a random section of soil from each plot. Sampling after digging rather than after combine harvest prevented the incorporation of threshing losses into the digging losses analysis. An area of two square meters was cleared by moving the inverted windrow out of the area to be sampled. The soil in this area was then excavated with shovels to a depth of 25 cm, and sieved to collect any pods remaining in the soil. A tractor-driven power take-off (PTO) platform soil screening implement (National Peanut Research Laboratory, Dawson, GA) was used to sieve the soil and collect lost pods. Pods were washed and viewed under a dissecting microscope. Healthy pods were kept, but diseased, over mature, and immature pods were excluded. This was aimed at measuring only the marketable pods lost due to mechanical and soil resistance related causes. Loss of diseased and over mature pods is unavoidable under the most favorable digging conditions, and immature pods are usually lost in the curing and combining processes of harvest. The remaining pods were dried and weighed to determine the approximate amount of pod loss on a kg/ha basis.

Soil Compaction

Soil compaction measurements were taken at approximately 50 days after planting (DAP) following a rainfall event that brought soil moisture to field capacity. Measurements were recorded at 10 locations within each plot with an SC 900 Soil Compaction Meter (Spectrum Technologies, Inc., Plainfield IL). Samples were taken 18 cm to the outside of each row (harvest zone) which was representative of where the digger’s blades would come in contact with the soil surface at harvest. Sampling in this fashion also prevented the low resistance encountered when sampling directly in the row center where deep tillage occurred and the much higher resistance encountered when sampling directly in the row middle where no tillage and increased compaction occurred due to the wheel track. Resistance was recorded at 2.5 cm intervals from 0-20 cm in depth. The top 10 cm were viewed as the most critical in terms of the digging process at harvest, because most pods were located within this depth. Soil compaction was measured only in 2008.

Yield and Grade

Yield was determined from the pods combine harvested from the center two rows of each plot. Plots were harvested individually, so pods could be collected separately. The pods were first cleaned, then dried (when needed) and weighed. Random moisture samples were taken at the time of weighing. An average moisture percentage was assigned to each location. Weights were then adjusted to a 7% moisture standard. While weighing, random 500-g grab samples were also taken from each of the original yield samples for grading. Grading was performed by the Federal State Inspection Service in Tifton, Georgia. Total Sound Mature Kernels (TSMK) and Other Kernels (OK) were the grade factors used for comparison. The percentage TSMK is the total of sound mature kernels and sound splits as a percentage of farmer stock peanut. The percentage OK is the percentage of kernels in farmer stock that is slightly less mature, but still marketable and capable of being graded.

Statistical Analysis

The statistical analysis was performed using Proc Mixed (SAS Institute Inc., Cary NC). When F tests identified significant main effects and interactions, means were tested for differences using Fisher's protected LSD at $P = 0.10$. When applicable, probability levels of 0.05 and 0.01 were also considered. Data for the same location were combined over years.

Results and Discussion

The row pattern effect was not significant in 2007 at the Plains location and only single rows were planted in 2008. Therefore, twin row data was excluded from the analysis, so that data from the two years could be combined at Plains. Locations were not combined due to significant interactions and random effects. Only general assumptions and hypotheses are made pertaining to the differences between locations.

Digging Losses

The digging losses analysis is presented in Table 2.1. Digging losses were significant only at the Plains location. At Plains, the main effect of bed type was significant at P = 0.01. No effects of cover crop or bed type by cover crop interactions occurred for any significance level. The flat bed plots exhibited significantly higher digging losses of 1549 kg/ha compared to raised bed and rip and bed plots with 825 and 586, respectively (Table 2.2). Raised beds and rip and beds reduced digging losses by 47 and 62%, respectively, compared to the flat beds. Digging losses decreased in the order of increasing degree of bedding intensity (Flat bed, raised bed, rip and bed), but differences between the raised bed and rip and bed were not significant. The significant differences between the bedded plots and flat plots illustrate the importance of having elevated beds for harvesting efficiency in strip-till peanut on the soil type at this location.

Digging losses were not significant at the Tifton location (Table 2.1). Also, no clear trend existed with the degree of bedding intensity (Table 2.2). Overall, digging losses at Tifton were relatively lower across all bed types compared to Plains. Averaged over bed types, digging losses were roughly 70% less at Tifton than at Plains. The differences between locations cannot be considered significant from a statistical standpoint, because locations were not replicated within any given year. However, it is hypothesized that lower digging losses and lack of a bed type effect at Tifton are most likely related to differences in soil type between the two locations. Other uncontrollable variables may have contributed to the differences as well, but it is plausible to mention that the soil at Tifton was a much coarser textured soil with a higher sand content while the soil at Plains was finer textured with higher clay content. Peanut on the sandier soil was much easier to dig than peanut on the higher clay soil. Soil compaction data illustrate why the soil at Tifton was more conducive to digging. Therefore, the soil type certainly contributed to these results to some extent. These findings also agree with previous research that suggested elevated beds in strip-till peanut were more important on finer textured soils than on coarser soil types (Jordan *et al.*, 2004b).

Soil Compaction

Soil compaction is a good indicator of the ease of the digging process at harvest. Previous researchers have demonstrated higher yields and lower soil resistance measurements with the use of bedding in conventional tillage (Wright and Porter, 1980), and this seems to hold true in strip-till as indicated by initial studies. North Carolina researchers went even further to indicate that bedding may have increased benefits on finer textured soils compared to coarser textured soils when followed by strip-till (Jordan *et al.*, 2004b).

At Plains, soil compaction was also affected by bed type in 2008 (Table 2.3). No effects of cover crop or bed type by cover crop interactions were present at any significance level. The main effect of bed type was significant on soil compaction in the harvest zone at P = 0.01 for depths of 2.5, 12.5, 15, 17.5, and 20 cm. Bed type was also significant for depths of 7.5 and 10 cm at P = 0.05, and it was significant for the depth of 0 and 5 cm at P = 0.10. As related to harvesting efficiency, the depth of 0-10 cm was considered most important. This was the depth to which harvesting generally occurred. When averaged over the 0-10 cm depth, bedding in the form of raised bed and rip and bed reduced soil compaction by 3.3 and 4.7 times, respectively, compared to flat bed plots (Table 2.4). These findings agree with a previous study that indicated rip and beds reduced soil compaction by 5.5 times compared to plots prepared flat (Wright and Porter, 1980). When averaged over the below harvest depth interval (12.5-20 cm), compaction was collectively reduced by approximately 1.7 and 3.8 times for raised bed and rip and bed plots, respectively, when compared to flat bed plots (Table 2.5). Trends in compaction were similar to digging loss trends mentioned previously.

Soil compaction differences between bed types in both the harvest depth and below harvest depth intervals at Plains are illustrated in Figure 2.5. On this soil type, there is a rapid separation between compaction for the flat bed and compaction for the raised bed and rip and bed. By a depth of 5 cm, the flat bed compaction was 1265 kPa, while the raised bed and rip and bed compaction was 364 and 231, respectively. At 10 cm, soil compaction was 2067, 644, and 489 kPa for flat bed, raised bed, and rip and bed, respectively. The increased compaction in the flat bed contributed to the increased digging losses in the flat bed plots mentioned previously at this location.

At Tifton, main effect of bed type was also significant for compaction (Table 2.6). No effects of cover crop or bed type by cover interactions occurred at any significance level. The main effect of bed type was significant on soil compaction at P = 0.01 at the depth of 15 cm. At P = 0.05, main effect of bed type was significant at depths of 7.5, 10, 12.5, 17.5, and 20 cm, and compaction was significant for the depth of 2.5 cm at P = 0.10. No significant differences in compaction occurred at depths of 0 and 5 cm. When averaged over the 0-10 cm depth, raised bed and rip and bed plots reduced compaction by 1.9 and 2.5 times, respectively, compared to flat bed plots (Table 2.7). These reductions in soil compaction from bedding were approximately half those that occurred in Plains. When averaged over the 12.5-20 cm interval, bedding reduced soil compaction compared to flat beds by 1.7 and 4 times for raised bed and rip and bed, respectively (Table 2.8). At this depth, the reduction in soil compaction for bedding was similar to the Plains location. However, at these depths it was unlikely that compaction influenced digging losses.

Soil compaction differences for bed types in both the harvest depth and below harvest depth intervals at Tifton are illustrated in Figure 2.6. Unlike the Plains location, the separation of compaction for the flat bed from the bedded plots is slow to develop in the harvest depth interval. When separation does occur, the differences between bed types were reduced for this soil type. Flat bed exhibited soil compaction of 357 kPa at a depth of 5 cm, and compaction for raised bed and rip and bed was 180 and 181, respectively. Soil compaction at 10 cm is 1043, 568, and 346 kPa for flat bed, raised bed, and rip and bed, respectively. Though there were significant differences between bed types at Tifton, the differences between flat bed plots and bedded plots were much smaller and soil compaction was lower in general compared to Plains. The degrees of differences for soil compaction between the two locations based on bed types partially explain why peanut was easier to dig at Tifton and why digging losses were significant at Plains.

Yield and Grade

At Plains, main effect of bed type was significant for yield (Table 2.9). There was no significant cover crop or bed type by cover crop interaction for yield for any significance level. No significant differences were found for TSMK or OK. This indicates that the crop matured consistently regardless of the tillage or cover crop. These findings are consistent with previous studies that have indicated peanut matures equally under most production systems regardless of the various reduced tillage methods utilized (Grichar and Boswell, 1987; Grichar, 2006). Yield was significantly higher at P = 0.05 for the rip and bed with 4961 kg/ha compared to the flat bed with 4496 (Table 2.10). The raised bed yield was 4707 kg/ha and was not significantly different from the flat bed or rip and bed. Rip and bed plots increased yield over the flat bed plots by 465 kg/ha or 10.3 %. For this finer textured soil, yield increased following the trend of increasing degree of bedding intensity much like decreased digging losses and soil compaction followed the trend of increasing bedding intensity.

At Tifton, no significant effects or interactions occurred for yield or grade factors (Table 2.11). Means for bed type and cover crop effects are presented in Table 2.12. No difference in grade is indicative of the peanut crop maturing consistently across tillage and cover crop regimes. The lack of a bed type effect on yield at Tifton was related to the sandier soil being less compacted and more compatible with peanut digging. These same factors are partially responsible for the lower digging losses at this location.

Yield potential for bed type at Plains can be compared by summing the digging losses and yield means for each of the bed types to determine total marketable yield if no digging losses occurred. Yield potentials for flat bed, raised bed, and rip and bed were

6045, 5532, and 5547 kg/ha, respectively (Table 2.13). In terms of yield potential, flat bed had the highest yield, but as a percentage of the actual yield harvesting efficiency was only about 74 % for this bed type. The remaining 26 % of marketable pods produced were left in the soil. For the raised bed, harvesting efficiency was approximately 85 % with about 15 % of the marketable pods being left in the field. Harvesting efficiency was highest for the rip and bed at approximately 89 % with only 11% of marketable pods remaining in the soil. Noting that yield potential for rip and bed is lower than flat bed and only 15 kg/ha higher than raised bed prevents assumptions from being made that bedding may have improved agronomic and soil environment factors which could have led to the higher yield as a result of increased yield potential. Rip and bed resulted in the lowest digging losses, the lowest soil compaction, the lowest yield potential, and the highest actual yield. Beds on this soil type hold their size and shape for a longer period of time during the growing season. It is hypothesized that lower yield potential is a result of the elevated nature of the plant preventing all pegs from reaching and penetrating the soil surface to form pods in the valleys between beds. This is logical, because peanut that exhibits the runner growth habit relies heavily on the maturation of a nut crop on the outer limb portion of the canopy for yield generation (Colvin and Brecke, 1988). Rip and bed procedures did not improve peanut yield potential, it simply improved the percentage of marketable yield that was recoverable on the finer textured soil at Plains.

Yield potential at Tifton was unaffected by bedding procedures. From highest to lowest, there was only a difference of 55 kg/ha (Table 2.14). All bed types were approximately 94-95 % effective at recovering the total marketable pods with only 5-6 % of the pods being left in the soil. These data agree with the small differences found in soil compaction, no differences in digging losses, and no differences in yield on this soil type. These data indicate that the lack of differences on this soil type is due to its coarse more friable texture. It is hypothesized that lack of difference in yield potential by bed type is a result of beds weathering away more quickly during the winter and growing season on this soil type, thus, allowing the plant more consistent access to the soil surface for pegging and pod formation.

Summary and Conclusions

Fall bedding used in conjunction with strip-till peanut can be effective in Georgia for finer textured soils like those at Plains. For these soil types, bedding reduced digging losses, lowered soil compaction, and increased yield. The rip and bed exhibited the greatest improvements in all of these areas. Bedding reduced yield potential (actual yield plus digging losses) at this location, and therefore it was assumed that the resulting increase in yield on the rip and bed was related to greater harvesting efficiency rather than improvements of agronomic factors from bedding. Raised bed was effective at reducing digging losses and soil compaction as well, but it did not significantly improve yield over plots prepared flat. Therefore, the added cost of this tillage makes justifying the use of the raised bed type hard when no enhancement in yield is expected. Rip and bed tends to be the most productive option on this soil type.

For coarser soil types like those at Tifton, bedding was not beneficial to the extent that was evident at Plains on the finer soil type. On this soil type, bedding reduced soil compaction to a smaller extent, but had no effect on digging losses, yield, or grade. As a result, no incentive exists to recommend bedding on these coarser textured soils. Grades were unaffected by bed type or cover crop, and there were no significant cover crop effects or bed type by cover crop interactions for any of the data presented at either location. These results suggest that peanut matures consistently regardless of bed type and that short term benefits of a cover crop might be negligible. This does not consider the long term benefits of a cover crop like increasing soil organic matter, decreasing erosion, and increasing water holding capacity.

Future considerations should be in comparing reduced tillage in the form of rip and bed strip-tillage to conventional tillage on finer textured soils like those at Plains under irrigated and dryland scenarios. The inability to apply moisture for reducing soil compaction at time of digging will most likely prove to be an important component affecting harvesting efficiency. Another possible comparison would be to apply a taller style of raised bed that would allow for the improvements in harvest efficiency like the rip and bed, while providing the peanut plant a larger area of access to soil for pegging and pod formation processes like the flat bed in hopes of improving yield potential.

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CHAPTER 3

ECONOMICS AND DISEASE INFLUENCE OF FALL-BEDDING USED IN CONJUNCTION WITH STRIP-TILL PEANUT [1]

[1] Jackson, J.L., J.P. Beasley, Jr., R.S. Tubbs, R.D. Lee, T.L. Grey, N.B. Smith and A.R. Smith. To be submitted to *Peanut Science.*

Abstract

Peanut grown in reduced tillage can result in decreased yield on certain soil types. Rip and beds and raised beds along with a flat bed control were used in conjunction with strip-tillage in order to evaluate the effects of bedding on disease, yield, and net return in reduced tillage. Plots were prepared with and without a wheat cover. Studies were conducted on a fine textured soil at Plains, GA and a coarse textured soil at Tifton. GA. No effects on disease occurred at either location. At Plains, rip and bed resulted in a 10.3 and 9.8% increase in yield and net return, respectively, over flat bed. Wheat cover had no effect on yield, but it resulted in a 5.1% decrease in net return compared to none. For Tifton, there were no differences for bed type or cover crop. Results indicated bedding in the form of rip and bed was economical on the finer textured soil at Plains, and cover crop was disadvantageous. On the coarser soil at Tifton, there was no incentive for bedding.

Key Words

Arachis hypogaea L., conventional tillage, bed type, flat bed, rip and bed, raised bed, reduced tillage, harvest efficiency, digging losses, soil compaction, net return, marginal return.

Introduction

Peanut (*Arachis hypogaea* L.) is an economically important crop in Georgia with the 2006 and 2007 value at approximately $280 and $325 million, respectively (NASS, 2009). During the same time period, U.S. agricultural production input costs increased substantially. The largest increases were with fertilizer, lime and soil conditioners up 26%; fuels, up 14%; agricultural chemicals, up 11%; tractors and self propelled equipment, up 11%; and farm services, up 8% (NASS, 2008). Therefore, maintaining peanut production levels will depend on minimizing input costs without sacrificing yield. With a majority of GA producers using very intensive conventional tillage practices, one way of reducing input costs could be through reduced tillage. At the production level, this will allow a reduction in overhead costs due to smaller equipment inventories, a decrease in time and labor resources for tillage operations, a reduction in wear and tear on machinery, and a reduction in energy investments, which will essentially reduce production costs.

The system of reduced tillage that is most popular in peanut production has been strip-tillage or strip-till (Johnson *et al.*, 2001). However, initial studies comparing strip-till have been inconsistent with yields ranging from lower (Wright and Porter, 1991, 1995; Brandenburg *et al.*, 1998; Grichar, 2006), equal to (Colvin and Brecke, 1988; Colvin *et al.*, 1988; Johnson *et al.*, 2001; Faircloth *et al.*, 2005; Tubbs and Gallaher, 2005), or greater (Baldwin *et al.*, 1999; Jordan and Johnson, 2006) than those with conventional tillage. The outcomes of these studies seem to be more related to varying yearly weather patterns and differing soil types than to tillage itself. Generally, when soil type is fine-textured, yields favor conventional tillage over strip-till, but when soil is coarse-textured, yields are comparable with conventional which favors strip-till (Jordan *et al.*, 2004b). North Carolina research demonstrated that the risk of yield loss associated with strip-till can be minimized by strip-till into raised seedbeds rather than into a flat soil surface (Jordan *et al.*, 2001; Jordan *et al.*, 2004a). This was agreeable with previous research that confirmed bedding reduces soil compaction (Wright and Porter, 1980). However, due to higher costs with bedding, it was concluded that additional costs of production equipment to lower soil resistance to root penetration must be considered on an individual basis among farming operations. Research of this nature has never been applied to strip-till in Georgia.

The objective of this research was to determine if bedding could be utilized to improve yield in strip-till compared to that of standard flat strip-till. Three bed types were tested on two soil types, a fine textured and a coarse textured soil. The study was designed to determine if bedding could improve yield, and if improvements in yield existed, determine if the value of that increased yield could justify the added cost of the extra tillage. A partial budget analysis was established to determine if differences in net return existed and if extra tillage was economical. In addition, disease ratings for two major peanut diseases were included to assess the impact of tillage on their occurrence.

Materials and Methods

Experimental Design

Experiments were conducted at two locations to evaluate the effect of fall-bedding in strip-till peanut on different soil types over a two-year period beginning in 2006 and ending in 2008. Beds were established in the fall of 2006 and 2007, and peanut crops were grown in the 2007 and 2008 growing seasons. The first location was at the University of Georgia’s Southwest Georgia Research and Education Center in Plains, GA on a Greenville sandy loam (Fine, kaolinitic, thermic Rhodic Kandiudults) (USDA-NRCS, 2009), with sand, silt, and clay of 69, 15, and 16%, respectively. The second location was at the University of Georgia’s Coastal Plain Experiment Station’s Lang Farm in Tifton, GA on a Tifton loamy sand (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults) (USDA-NRCS, 2009), with sand, silt, and clay of 94, 4, and 2%, respectively. Each year, plots at both locations were fall established following either two diskings or a disking and field cultivation.

At Tifton, a two-way factorial based on three bed types, with and without a winter cover crop was used in both years to determine treatments. Plots were arranged in a randomized complete block design (RCB). Six-row plots 15.2 m long were used in both years to reduce any border effects. There were eight replications in 2007 and four replications in 2008, due to reduced land availability in 2008. Reduction in the number of reps was favored over a reduction in plot size. The study followed a rotation of cotton *(Gossypium hirsutum* L.)-corn (*Zea mays* L.)-peanut in both years, and was located under a lateral irrigation system. This system was responsible for supplying water to a broad array of crops and research trials, and therefore, irrigation was received on an availability basis.

At Plains, a three-way factorial design based on three bed types, with and without a winter cover crop, and a row pattern of twin or single row peanut was used to determine treatments in 2007. In 2008, a two-way factorial design was utilized with the peanut row pattern factor omitted. In both years, a RCB was used to arrange plots. Six-row plots 15.2 m long and six replications were present both years. The study followed the same cotton-corn-peanut rotation system as the Tifton location. This location was also located under a lateral irrigation system and irrigation based on availability.

Fall Bed Types

Three tillage systems were implemented in the fall (Nov.) of each year: (a) flat bed (no further tillage after fall disking serving as control), (b) rip and bed (single beds for each peanut row spaced 91 cm apart being approximately 28 cm high and 40 cm wide), and (c) raised bed (one wide bed to accommodate two peanut rows spaced 91 cm apart being approximately 18 cm high and 180 cm wide). Flat bed plots did not receive any further tillage until the spring. The rip and bed plots were established in the fall using a two-row KMC Ripper-Bedder (Kelly Manufacturing Co., Tifton, GA). This process included in-row subsoiling to a depth of approximately 25 cm, followed by disks located behind the shank on each side of the furrow that pulled soil toward the furrow forming a bed directly over the center of each row. The raised bed plots were established using the same implement, but for this bed type the ripper-bedder was equipped with a drag attachment and 18-cm bed shapers in the wheel middles. This setup allowed the two individual beds to be leveled enough to form one single wide bed. All bed types were followed by spring strip-tillage.

Wheat Cover

Immediately following the bedding procedures exactly half of the plots were sown with wheat (*Triticum aestivum* L.) as a cover crop in 17.8 cm rows at a seeding rate of 101 kg/ha based on the experimental design. If necessary, winter weeds were controlled in all plots using an application of a herbicide premix of dicamba and 2, 4-D at 0.28 and 0.80 kg ai/ha, respectively (Culpepper *et al.*, 2007). Primary winter weeds were henbit (*Lamium amplexicaule* L.) and wild radish (*Raphanus raphanistrum* L.). Henbit tended to be the main problem in plots with no cover, while wild radish tended to be more pronounced in plots with cover. Controlling these weeds was of significant importance to prevent a false cover effect in plots without cover, and to prevent discrepancies in biomass samplings of plots with cover. Herbicides were applied in February each year if needed. Termination of the cover crop occurred in early-mid April each year with a single application of glyphosate at 1.12 kg ai/ha to all plots. Early termination was aimed at preventing viable wheat seed from being produced and to prevent excessive moisture extraction by the cover crop. The early termination was also more conducive to strip-tillage, because the cover crop was given sufficient time to begin decomposition.

Strip-tillage and Planting

Strip-tillage occurred in early May each year using a strip-till implement (Kelly Manufacturing Co., Tifton, GA). This implement utilized a coulter mounted in front of an in-row subsoiler followed by fluted coulters and a rolling crumble basket to prepare a seedbed approximately 30-40 cm wide. In-row subsoiling occurred to a depth of 25-30 cm in all plots.

The peanut cultivar was planted at a rate of 18-20 seeds/m in each row of the single row pattern (rows spaced 91 cm apart) and at 9-10 seeds/m in each row of the twin row pattern (pairs of rows spaced 18 cm apart with outside rows 91 cm apart) after strip-tillage each year. Planting occurred with both single and twin-row vacuum planters (Monosem Inc., Edwardsville, KS) for precise and accurate seed placement. The cultivar 'Georgia-02C' was chosen due to its higher level of resistance to Cylindrocladium black rot (*Cylindrocladium parasiticum* Crous). This disease had a known history of prevalence at the Plains location, and producers in the area typically use a cultivar with higher levels of resistance to lessen the disease's impact. The in-furrow insecticide phorate was applied at planting at 1.12 kg ai/ha in both site years. Following planting, preemergence herbicides including glyphosate, pendimethalin, flumioxazin, and diclosulam were applied to all sites at 1.12, 0.92, 0.107, and 0.026 kg ai/ha, respectively.

The applications were accompanied by an irrigation of approximately 12.7 mm of water for incorporation of herbicides within 24 hours. All plots were managed the same at each location based on year for weed, insect, and disease control according to agronomic recommendations in the University of Georgia Cooperative Extension 2007 Peanut Update (Prostko, 2007). Harvesting was based on the Hull-Scrape Maturity Profile method (Williams and Drexler, 1981).

2007

At Tifton, peanut was planted on 14 May. Rainfall totaled 398 mm for the season. Irrigation applied in 12 events totaled 215 mm. Water available totaled 613 mm, which was adequate to produce normal yields (Figure 2.1). On 21 June, clethodim was applied at 0.14 kg ai/ha for control of Texas panicum (*Panicum texanum* Buckl.). Bentazon was applied at 1.12 kg ai/ha for control of yellow nutsedge (*Cyperus esculentus* L.) on 9 July. For control of early (*Cercospora arachidicola* Hori) and late [*Cercosporidium personatum* (Berk. and Curt.) Dieghton] leaf spot, pyraclostrobin was applied at 0.17 kg ai/ha on 16 July. On 6 Aug., a premix of tebuconazole and prothioconazole was applied at 0.15 and 0.07 kg ai/ha, respectively, for control of early and late leaf spot and white mold (*Sclerotium rolfsii* Sacc.). At the same time, boron and lambda cyhalothrin were included to promote flower development and control fall armyworm [*Spodoptera frugiperada* (J. E. Smith)] (Lepidoptera: Noctuidae) at 0.46 kg B/ha and 0.02 kg ai/ha, respectively. On 22 Aug. and 24 Sept., tebuconazole and prothioconazole was applied again, at rates mentioned previously, for control of late leaf spot and white mold. Peanut digging occurred on 15 Oct. Rainfall delayed combine harvesting until 25 Oct.

At Plains, peanut was planted on 15 May. Rainfall totaled 503 mm during the season. Irrigation applied in eight events totaled 174 mm. An irrigation of 18 mm was applied prior to strip-till, and one application of 13 mm was applied prior to digging to soften the soil. The remainder of the irrigation was applied during the growing season. The total water received over the growing season totaled 676 mm and was sufficient for producing adequate yields (Figure 2.2). On 18 June, clethodim at 0.14 kg ai/ha was applied for control of Texas panicum. Chlorothalonil at 1.26 kg ai/ha was applied on 19 June for control of early and late leaf spot. Chlorpyrifos at 2.18 kg ai/ha was applied on 13 July for control of Southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber). On 23 July, tebuconazole and prothioconazole was applied for control of Cylindrocladium black rot, white mold, and leaf spot at 0.23 and 0.11 kg ai/ha, respectively. For control of corn earworm (*Helicoverpa zea* Boddie), methomyl was applied at 0.34 kg ai/ha on 27 July. The tebuconazole and prothioconazole mentioned previously was applied at the same rates on 6 and 20 Aug. for leaf spot and soilborne disease control. On 21 Aug., a spider mite (*Tetranychus urticae* Koch) infestation resulted in the application of the miticide fenpropathrin at 0.34 kg ai/ha. Digging occurred on 16 Oct., but recurring rainfall delayed combine harvest until 31 Oct. Yield was not significantly affected by the delay in harvest, because little or no drying occurred before rainfall began.

2008

At Tifton, peanut was planted on 8 May. Rainfall during the growing season totaled 445 mm. Tropical systems deposited 286 mm in the month of August alone. Irrigation applied in 10 events totaled 168 mm. An irrigation of 23 mm was made prior to strip tilling to soften the soil. This made the total water received 612 mm (Figure 2.3). Again, this amount was considered adequate for achieving normal yields. The herbicide 2, 4-DB was applied on 19 June at 0.25 kg ai/ha for control of sicklepod (*Cassia obtusifolius* L.) and burgherkin (*Cucumis anguria* L.). On 25 June, the pyraclostrobin and boron was applied at 0.18 kg ai/ha and 0.46 kg B/ha, respectively. Pyraclostrobin was applied again at the same rate on 11 July. For control of Texas panicum, clethodim at 0.25 kg ai/ha was applied on 16 July. A mixture of tebuconazole and prothioconazole was applied at 0.23 and 0.11 kg ai/ha, respectively, on 22 July for control of leaf spot and white mold. The same mixture was applied on 5 Aug. at 0.17 and 0.09 kg ai/ha for tebuconazole and prothioconazole, respectively. On 3 Sept., chlorothalonil was applied at 1.26 kg ai/ha for control of late leaf spot. Peanut was dug on 15 Oct. and combine harvested on 20 Oct.

At Plains, peanut was planted on 14 May. Rainfall for the season totaled 541 mm. Tropical systems deposited 299 mm in the month of August alone. Irrigation applications were made seven times during the season totaling 150 mm. Total water for the season was 690 mm (Figure 2.4). This amount was in excess of the required amount, but does not account for runoff during the heavy rain events from tropical storms. On 18 June, pyraclostrobin was applied at 0.22 kg ai/ha for control of leaf spot. A mixture of tebuconazole and prothioconazole at 0.17 and 0.09 kg ai/ha, respectively, was applied for control of white mold and Cylindrocladium black rot on 21 July. The same mixture was applied on 4 and 18 Aug. at the same rates. On 29 July, chlorpyrifos was applied at 2.18 kg ai/ha for control of Southern corn rootworm. Chlorothalonil was applied at 1.26 kg ai/ha on 1 Sept. for controlling leaf spot. Digging occurred on 22 Oct., and combine harvesting took place on 28 Oct.

Disease Ratings

To determine the impact of bedding and, or cover crop on disease incidence, tomato spotted wilt virus or TSWV (Bunyaviridae: *Tospovirus*) ratings were recorded within two weeks prior to digging each year. Ratings consisted counting the number of 0.3-m incidences of the disease in 30.4 meters-of-row. Data was transformed to the percentage of spotted wilt disease per plot. At the Plains location, Cylindrocladium black rot (CBR) ratings were also taken each year. These ratings were taken in the same fashion as TSWV ratings, except they were recorded immediately after digging and inversion. This allowed the disease to be easily recognized by the presence of small, reddish-orange, perithecia of the fungus in clusters on stems, pegs and pods just above and, or below the soil surface. Ratings were not taken at Tifton, because there was no CBR at that location.

Yield and Grade

Yield was determined from the pods combine harvested from the center two rows of each plot. Plots were harvested individually, so pods could be collected separately. The pods were first cleaned, then dried (when needed) and weighed. Random moisture samples were taken at the time of weighing. An average moisture percentage was assigned to each location. Weights were then adjusted to a 7% moisture standard. While weighing, random 500-g grab samples were also taken from each of the original yield samples for grading. Grading was performed by the Federal State Inspection Service in Tifton, Georgia. Total Sound Mature Kernels (TSMK) and Other Kernels (OK) were the grade factors used for comparison. The percentage TSMK is the total of sound mature kernels and sound splits as a percentage of farmer stock peanut, and OK is the percentage of kernels in farmer stock that is slightly less mature, but still marketable and capable of being graded.

Economic Analysis

A partial budget analysis was used to evaluate the economics of each of the treatments. This was preferred over a complete budget due to highly fluctuating prices and complex array of chemicals used. Chemicals and rates applied can vary greatly on a year by year and field by field basis. Therefore, management costs outside of bed type formation, cover establishment, and row pattern costs were not used for the analysis. In this study, all treatments received the same management based on year and location after the initial bedding and cover establishment procedures in the fall, except for the row pattern factor in the spring.

For this reason, the partial budget utilized the flat bed, no cover treatment as the control. This treatment received the bare minimum tillage and was therefore used as the comparison receiving no dockage from the gross return value. In addition to this same bare minimum tillage, all other treatments received additional tillage in the form of bed establishment and, or cover establishment. The cost of additional tillage and, or cover establishment was therefore deducted from the gross return value of each of these treatments to give an estimate of net return over those costs. Where a twin row peanut pattern was present, the additional row cost for twin rows over single rows was deducted from the gross return of those treatments. Economic data are presented in the form of net return (gross return minus bedding, cover, and, or row pattern costs) and marginal return to tillage. For marginal return, the net return of the flat bed, no cover treatment within each replication was subtracted from the net return of all other treatments in that replication. When twin rows were present, the flat bed, no cover and twin row treatment's net return was subtracted from all other treatments with twin rows in that particular replication. This allowed for comparison of tillage by attributing an average marginal return value of $0.00/ha to the flat bed, no cover treatments. In all other treatments, advantages in marginal return will appear as positive values while disadvantages will appear as negative values.

The goal was to make the budget applicable at the farm scale level. For this reason, several broad assumptions were made. First, it was assumed that each of these treatments was being made at a farm scale size of approximately 40 hectares for the calculation of per hectare repairs and maintenance costs. Secondly, it was assumed that the farm was using equipment in the 6-row size category which is average for most Georgia farms. It was also assumed that fuel and labor costs were approximately $0.79/L ($3.00/gal) and $10/hr, respectively. Finally, it was assumed that the farm already owned the equipment being utilized. Georgia producers who grow cotton, corn, or soybeans in rotation with peanut generally own bedding equipment necessary for producing these bed types. Therefore, the costs considered were strictly variable costs. For determining gross return, the peanut loan rate of $391/Mg and grade factors were used to determine the value of yield.

The cost of cover establishment was based on the cost of seed, fuel, labor, and repairs and maintenance. Seed cost was established based on the seeding rate of 101 kg/ha at a cost of $0.403/kg or $40.76/ha. It was assumed a 2-wheel drive, 190 horsepower tractor and a 5.5 m wide grain drill was used to plant the wheat cover. This combination consumed approximately 5.7 L/ha of fuel for $4.52/ha. The time allowed for each hectare was 0.185 hrs at $1.85/ha in labor. Typical repairs and maintenance cost for this equipment combination were set at $4.62/ha. The total variable cost associated with cover establishment was $51.75/ha. This value was subtracted from the gross return of all plots with cover.

Rip and bed costs were based on fuel, labor, and repairs and maintenance. It was assumed that a 4-wheel drive, 190 horsepower tractor with a 6-row ripper-bedder was used for creating this particular bed type. Based on this equipment combination, fuel consumed was determined to be 9.57 L/ha at $7.56/ha. Labor was calculated at 0.309 hr/ha for $3.09/ha. Repairs and maintenance for this combination totaled $3.75/ha. Total variable costs estimated for this bed type were $14.40/ha. These costs were subtracted from the gross return of all rip and bed plots. Rip and bed plots with cover also received the deduction of $51.75/ha from gross return for cover establishment making the total deductions $66.15/ha.

Raised bed costs were very similar to rip and bed costs. Remembering the raised bed was created with the same equipment as the rip and bed helps to illustrate these costs. The same tractor and equipment configuration was used with the addition of a drag attachment and bed shapers to the ripper-bedder for bed formation. No extra fuel consumption or labor was estimated with this combination, but extra repairs and maintenance costs were assessed. Maintaining the drag accessory would cost an additional $0.17/ha over the cost of the ripper-bedder alone. Total variable costs for the raised bed was $14.57/ha. This amount was subtracted from the gross return of all raised bed plots. When cover was present on raised bed plots, the total deduction from gross return was $66.32/ha.

Row pattern of peanut also influenced costs. Single row costs, used as the control standard, were estimated using a 2-wheel drive 190 horsepower tractor and a 6-row vacuum planter combination. Fuel consumption for this combination was 6.85 L/ha at $5.41/ha. The labor cost was based 0.34 hr/ha totaling $3.40/ha. Repairs and maintenance for this setup was $4.22/ha. This amounts to total variable costs of $13.03/ha for single row. Twin row had a doubling affect on variable cost. The number of planter units utilized is doubled and twice the amount of restraint is placed on the tractor. For this reason, fuel, labor, and repairs and maintenance cost doubled for twin row peanut. The total variable cost for twin rows was $26.06/ha. Therefore twin rows added approximately $13.03/ha over planting single rows. This additional cost was subtracted from the gross return of all twin row treatments. When cover was present, an additional $51.75/ha was subtracted, thus the total deduction from gross return was $64.78/ha for twin rows with a cover crop. In addition, the cost of the appropriate bed type was also subtracted in twin row plots.

Statistical Analysis

The statistical analysis was performed using Proc Mixed (SAS Institute Inc., Cary NC). When F tests identified significant main effects and interactions, means were tested for differences using Fisher's protected LSD at P = 0.10. When applicable, probability levels of 0.05 and 0.01 were also considered. Data for the same location were combined over years. Locations were not combined due to significant interactions and random effects. Only general assumptions and hypotheses are made pertaining to the differences between locations.

Results and Discussion

The row pattern effect was not significant in 2007 at the Plains location and only single rows were planted in 2008. Therefore, twin row data was excluded from the analysis, so that data from the two years could be combined at Plains.

Disease Ratings

Based on the analysis of TSWV and CBR ratings, no effects or interactions of bed type or cover crop were present at either location (Table 3.1). Data for TSWV and CBR ratings are presented in Table 3.2. Tomato spotted wilt virus was low overall, and this indicates that pressure from thrips (*Frankliniella fusca* Hinds and *F. occidentalis* Perg.) transmitting the virus was relatively low in both growing seasons. In years with higher thrips pressure, outcomes may be slightly different. It may be that elevated plants on the bedded surfaces in the absence of a dense cover crop are easier for thrips to find than plants on non-bedded surfaces, thus increasing TSWV infection rate in bedded plots. However, this occurrence was not found in this study. Incidence of CBR was not significantly affected by bed type or cover crop at the Plains location even though the location had a known history of problems with the disease. Either management practices did not affect the disease's occurrence, or the cultivar's level of resistance to CBR masked any effects on the disease. This was the goal of using a resistant cultivar, because we were strictly focused on digging efficiency and yield of bed types on this particular soil type in the absence of the disease. With CBR, it could be possible that bedding procedures result in a more highly concentrated inoculum load in the row center, because all soil near the surface is pulled toward that region during bed formation. This has been the case for other diseases where underrow ripping and bedding appeared to increase the incidence of pod breakdown caused by *Pythium myriotylum* Drechs and *Rhizoctonia solani* Kuhn (Sholar *et al.*, 1995). However, these outcomes were associated with bedding immediately prior to planting. This occurrence was not confirmed in this study, and given the amount of time between bed formation and planting of peanut, this should not be a problem. The impact of fall prepared beds on the incidence of TSWV and CBR are areas that need to be researched in years with higher pressure from these diseases and with cultivars of lower resistance levels to reach conclusive results about the effects of bedding on these diseases.

Yield and Grade

At Plains, main effect of bed type was significant for yield (Table 2.9). There was no significant cover crop or bed type by cover crop interaction witnessed for yield at any significance level. No significant differences were found in TSMK or OK. This indicates that the crop matured consistently regardless of the tillage or cover crop. These findings are consistent with previous studies that have indicated peanut matures equally under most production systems regardless of the various reduced tillage methods utilized (Grichar and Boswell, 1987; Grichar, 2006). Yield was significantly higher at $P = 0.05$ for the rip and bed with 4961 kg/ha compared to the flat bed with 4496 (Table 2.10). The raised bed with 4707 kg/ha was not found to be significantly different from the flat bed or rip and bed. Rip and bed plots increased yield over the flat bed plots by 465 kg/ha or 10.3 %. The raised bed plots increased yield over flat bed plots by 211 kg/ha or 4.7 %, but the difference was not considered significant. For this finer textured soil, yield increased following the trend of increasing degree of bedding intensity (flat bed, raised bed, rip and bed).

At Tifton, no significant effects or interactions were present at any level of significance for yield or grade factors (Table 2.11). Means for bed type and cover crop effects are presented in Table 2.12. No difference in grade is indicative of the peanut crop maturing consistently across tillage and cover crop regimes. The lack of a bed type effect on yield at Tifton is likely related to the sandier soil being less compacted and more compatible with peanut digging. These findings also agree with previous research that suggested elevated beds in strip-till peanut were more important on finer textured soils than on coarser soil types (Jordan *et al.*, 2004b). Bedding procedures were more effective at reducing digging losses and soil compaction on the higher clay content soil at Plains than on the sandier soil at Tifton, which led to increased harvesting efficiency (data not shown) and yield from bedded plots at Plains.

Economic Analysis

At Plains, there were significant main effects of both bed type and cover crop on net return and marginal return (Table 3.3). There were no interactions of bed type x cover crop at any level of significance. For main effect of bed type at P = 0.01, rip and bed had a significantly higher net return of $1964.40/ha compared to $1791.20 with flat bed (Table 3.4). Raised bed was not found to be significantly different from flat bed or rip and bed with a net return of $1858.70/ha. Rip and bed improved net return over flat bed by $173.20/ha or 9.8 %. This agrees with the 10.3 % increase in yield by rip and bed over flat bed. The same differences for bed type are exhibited in marginal return where flat bed, raised bed, and rip and bed have marginal returns to tillage of $56.50, $123.90, and \$229.60/ha, respectively at P = 0.05. The rip and bed was the only bed type to significantly improve marginal return over flat bed enough to justify the bedding procedure. The raised bed type provided no advantage over the flat bed type. These results were very similar to the effects of bed type on yield for this soil type (Table 2.10). Higher yield on the rip and bed resulted in greater return. It was concluded that rip and bed is an economically viable option when used in conjunction with strip-till on this soil type.

Main effect of cover crop at Plains was also significant on net return at P = 0.05 (Table 3.3). Where wheat was grown as a cover crop, net return was \$1822.90/ha compared to \$1920.00 with none (Table 3.4). Therefore, wheat resulted in a decrease of 5.1% for net return. Wheat had a negative impact on net return, due mainly to the higher cost of establishment and lack of an effect on yield. Peanut yields were lower for wheat cover, but not significantly different from none (Table 2.12). This trend is also evident in marginal return where wheat led to a reduction of \$97.10/ha compared to none at P = 0.10 (Table 3.4). Therefore, planting a wheat cover crop could be negligible, because it was not justified in net or marginal return on this soil type. However, this does not consider long term benefits to the soil of using a cover crop. Over an extended period of time, enhancements to soil organic matter and tilth may outweigh the short term disadvantages of using a cover crop.

At Tifton, no effects or interactions of bed type and cover crop were discovered at any level of significance. The analysis is presented in Table 3.3 and means are displayed in Table 3.4. For this location, bedding in any form resulted in a trend for lower net return than the flat bed. This is also illustrated by the negative values in marginal return which demonstrate bedding can be disadvantageous on this soil type. These trends are a direct result of flat bed, although not significant, having a higher yield (Table 2.12). There was also a trend for higher return with wheat cover compared to none (Table 3.4) which also agrees with the trend for yield as related to cover crop at this location (Table 2.12). Based on these results, there is no incentive to recommend bedding on this soil type, but trends indicate that a cover crop may be a viable option. On this coarser, light-colored soil type, cover crop most likely plays a bigger role in shading the soil and retaining moisture than on the finer, darker-colored soil type at Plains.

The results from bedding in this study are consistent with a previous study that stated due to cost associated with bed formation, use of bedding would need to be applied on an individual farming operation basis (Wright and Porter, 1980). For farms with sandier soil, bedding is not shown to be beneficial when used with strip-till, but on farms with higher clay soils bedding can result in higher yield and net return. Therefore, bedding should only be recommended on soil types similar to those at Plains with higher clay content and finer texture. On sandier soils with coarser texture, results indicate that strip-till on flat ground is comparable or superior to strip-till with beds in terms of both yield and return, and therefore bedding should not be recommended on soil types similar to those at Tifton. This agrees with research by Jordan *et al.* which stated when soil type is fine textured, yields favor conventional tillage over strip-till, but when soil is coarse textured, yields are comparable with conventional or favor strip-till (2004b). On fine textured soils like those at Plains, use of bedding should allow strip-till to be a more consistent and competitive alternative to conventional tillage.

Summary and Conclusions

The incidence of TSWV and CBR was unaffected by bed type or wheat cover crop. This was most likely a result of overall low pressure from TSWV and the use of a cultivar with a high level of resistance to CBR in both years. At Plains, yield was significantly influenced by the degree of bedding. The rip and bed improved yield over flat bed which also translated into significant increases in net return and marginal return over flat bed. The use of bedding in the form of rip and bed was justified by the increase in return. The raised bed type was not found to offer a significant advantage over the flat bed. Wheat cover led to a significant decrease in net return, and use of a cover crop could not be justified by short-term return on this soil type. At Tifton, there were no significant effects on yield, net return or marginal return. However, trends showed decreased net return from bedding and increased return from the use of a wheat cover crop. Bedding could not be justified on this soil type, but wheat cover showed the potential for increasing net return.

Results show that the rip and bed used in conjunction with strip-till can be a viable option for growers switching to reduced tillage on finer textured, higher clay content soils like those at Plains. The recommendation to use bedding on that soil type was confirmed by higher net returns and marginal returns than strip-till on flat ground. For sandier soils like those at Tifton, no form of bedding improved net return or marginal return over flat strip-till. Therefore, no incentive to recommend any bed type exists for that soil type when using strip-till. For future considerations, the standard conventional tillage practices in the Plains area should be included for comparison. Additionally, dryland and irrigated scenarios should be evaluated simultaneously, because differences between bedded plots and flat plots are likely to be more pronounced when it is not possible to apply moisture to soften the soil prior to digging.

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CHAPTER 4

EFFECTS OF FALL BEDDING ON NUTRIENT UPTAKE, SOIL MOISTURE, AND GROWTH CHARACTERISTICS OF STRIP-TILL PEANUT[1]

[1] Jackson, J.L., J.P. Beasley, Jr., R.S. Tubbs, R.D. Lee and T.L. Grey. To be submitted to *Agronomy Journal*.

Abstract

Peanut (*Arachis hypogaea* L.) grown under reduced tillage practices can result in lower yields. Use of fall bedding with strip-tillage has been shown to produce yields comparable with conventional tillage. The objective of this study was to determine if bedding influenced nutrient uptake, soil moisture content, and growth characteristics of peanut planted in strip-tillage, or if bedding simply improved harvesting efficiency. Trials were established at Plains, GA on a fine textured soil and at Tifton, GA on a coarse textured soil in 2007 and 2008 using three types of fall bedding. Multiple parameters measured suggested differences in agronomic factors either failed to exist, existed and could not be linked to bedding procedures, or they exhibited no correlation with yield potential. It was concluded that increased yield in bedded plots was more a result of decreased digging losses than a result of increased yield potential from agronomic factors influenced by bedding.

Key Words

Arachis hypogaea L., yield potential, bed types, rip and bed, raised bed, flat bed, cover crop, wheat, biomass, nutrient uptake, nutrient content, tissue samples, soil moisture.

Introduction

Peanut (*Arachis hypogaea* L.) is a row crop common to Georgia and much of the Southeast. Production generally consists of conventional tillage, including moldboard plowing, followed by multiple tillage operations to create a slightly raised seedbed, bury crop residues that may harbor disease, and bury weed seeds to inhibit their germination (Colvin and Brecke, 1988; Hartzog and Adams, 1989; Sholar *et al.*, 1995). Since the crop is harvested from the soil, producing an elevated seedbed generally facilitates easier harvesting by allowing the digger's blades access to the soil surface on the side of the bed at a point beneath where the crop is proliferating. Producers pursuing reduced tillage to lower input costs in peanut generally do not have the option of preparing a raised seedbed. Therefore, grower skepticism, increased harvesting difficulty and, or decreased yield in reduced tillage due to the lack of an elevated bed has been recognized as an issue in several studies (Grichar and Boswell, 1987; Wright and Porter, 1991; Jordan *et al.*, 2001; Grichar, 2006). Strip-till has been recognized as the most popular method of reduced tillage in peanut (Johnson *et al.*, 2001), but on certain Georgia soil types it is possible that lack of a raised seedbed could be a major contributor to yield reduction with this method compared to conventional tillage. This problem is generally more pronounced on soils with higher clay contents and finer texture.

Studies in North Carolina have shown that use of preformed beds in conjunction with strip-till can improve yields compared to those of strip-till conducted on flat ground and approach those of conventional tillage (Jordan *et al.*, 2001; Jordan *et al.*, 2004; Jordan and Johnson, 2006). These studies stated lower yields in flat strip-till plots were most likely related to increased pod loss at digging. However, the results could not be officially confirmed, because pod loss was not substantiated. They also acknowledged the possibility that other agronomic and soil fertility factors could have been affected by the bedding operation which could have possibly led to the higher yields. The objective of this study was to determine if other agronomic factors were affected by bedding procedures, and if so, to determine to what extent they could be linked to differences in yield potential or yield. This was accomplished by measuring soil moisture, plant nutrient contents, and multiple plant growth components in the cover crop and strip-till peanut produced on three bed types.

Materials and Methods

Experimental Design

Experiments were established at the University of Georgia's Southwest Georgia Research and Education Center in Plains, GA on a Greenville sandy loam (Fine, kaolinitic, thermic Rhodic Kandiudults) and the Coastal Plain Experiment Station's Lang Farm in Tifton, GA on a Tifton loamy sand (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults) in 2007 and 2008. The Plains soil's sand, silt, and clay concentrations were 69, 15, and 16%, respectively. The Tifton soil's sand, silt, and clay concentrations were 94, 4, and 2%, respectively. Bed formation occurred in the fall prior to the crop being planted the following spring. Treatments were determined based on a two-way factorial of three bed types, with and without a wheat (*Triticum aestivum* L.) cover crop. The plots were then arranged in a randomized complete block design (RCB). Plot size was 15.2 m long by 5.5 m (six rows 0.91 m apart) wide. Six-row plots were aimed at preventing any border effects from tillage. Six replications were present at Plains in both years. At Tifton, eight replications were present in 2007 and four replications were present in 2008. The three following bed types were implemented in November of each year: (a) flat bed type (no further tillage after disking in fall), (b) rip and bed (single beds for each row being approximately 27 cm high and 40 cm wide), and (c) raised bed (one wide bed to accommodate two rows spaced 91 cm apart being approximately 18 cm high and 180 cm wide). All bed types were followed by spring strip-till and peanut planting.

Each year, plot area was established following either two diskings or a disking and field cultivation in the fall. Flat bed plots received no further tillage until the spring. The rip and bed plots were established using a two-row KMC Ripper-Bedder (Kelly Manufacturing Co., Tifton, GA). This process included in-row subsoiling to a depth of approximately 25 cm, followed by angled disks located behind the shank on each side of the furrow that pulled soil toward the furrow forming a bed directly over the center of each row. The raised bed plots were established using the same implement, but for this bed type the ripper-bedder was equipped with a drag attachment and 18-cm bed shapers in the wheel middles. This setup allowed the two individual beds to be leveled enough to form one single wide bed. Immediately following the bedding procedures exactly half of the plots were drilled with wheat as a cover crop at a seeding rate of 101 kg/ha based on the RCB.

Cover crop termination occurred in early-mid April each year. Strip-till and planting of the peanut cultivar ‘Georgia-02C’ occurred in early May each year. Strip-till occurred using a wide-strip system (Kelly Manufacturing Co., Tifton, GA) that utilized a coulter mounted in front of an in-row subsoiler followed by fluted coulters and a rolling crumble basket to prepare a seedbed approximately 30-40 cm wide. In-row subsoiling occurred to a depth of 25-30 cm. Peanut was planted at a rate of 18-20 seed/m in single rows spaced 91cm apart using vacuum planters (Monosem Inc., Edwardsville, KS). In 2007, peanut was planted 14 May at Tifton and 15 May at Plains. In Tifton and Plains, peanut was dug 15 and 16 Oct., respectively. Combine harvest at Tifton and Plains occurred 25 and 31 Oct., respectively. In 2008, planting was 8 May at Tifton and 14 May at Plains. Peanut was dug 15 and 22 Oct. at Tifton and Plains, respectively. Combine harvest at Tifton and Plains occurred 20 and 28 Oct., respectively. All plots were managed the same at each location based on year for weed, insect, and disease control according to agronomic recommendations in the University of Georgia Cooperative Extension 2007 Peanut Update. Harvesting was based on the Hull-Scrape Maturity Profile method. In this method, the exocarp of the pod was removed to expose the mesocarp's color which is a good indicator of maturity (Williams and Drexler, 1981).

Cover Crop Sampling

The cover crop was subjected to several measurements to determine consistency of stand establishment, biomass accumulation, and uniform nutrient uptake across bed types. Prior to the study there was concern for the ability to obtain a stand of wheat when planting on beds with a grain drill. Therefore, wheat stand counts were taken at approximately 30-40 days after planting (DAP) to determine emergence. This was achieved by counting the number of emerged plants in a square meter within each plot. Prior to wheat termination in the spring, biomass samples were taken by harvesting all above ground plant material from a 0.25 square meter area within each plot with a wheat cover. Samples were collected in the first week of April each year during the flag leaf stage between 130 and 140 DAP. Non-cover plots were free of plant material. Samples were then dried at 66 C and weighed to determine total biomass accumulation on a kg/ha basis. Following weighing, samples were ground and sent to the University of Georgia's Agricultural and Environmental Services Laboratory for nutrient analysis. Nutrients analyzed included the macronutrients calcium (Ca), potassium (K), magnesium (Mg), nitrogen (N), phosphorus (P), and sulfur (S), and the micro-nutrients boron (B), copper (Cu), iron (Fe), Manganese (Mn), molybdenum (Mo), and zinc (Zn). Nutrients were analyzed on a concentration basis, but are reported in this study on a content basis (concentration x biomass in kg/ha) to determine the total amount of plant uptake per hectare. All measurements mentioned previously were taken in both years of the study.

Peanut Tissue Samples

Similarities in cover crop nutrient content in 2007 prompted the question of whether peanut nutrient uptake was similar among different bed types. Therefore, peanut leaf samples were taken in 2008 to determine the nutrient status of the peanut crop. This was monitored to test assumptions that nutrient availability to the peanut crop may be affected by bedding and, or cover crop. Samples were taken at approximately 40 DAP or at bloom stage by randomly collecting 40-50 leaves from each plot. Recently mature leaves were taken from the main stem and cotyledon lateral branches or the shoulder of the plant canopy. After drying in an oven at 66 C, leaves were ground and sent to the laboratory for analysis of the same nutrients mentioned in the biomass nutrient analysis. Concentrations of these nutrients were reported as percentages for macronutrients or in parts per million (ppm) for micronutrients. Comparisons of nutrient concentrations were made following the sufficiency ranges listed for peanut in the Plant Analysis Handbook for Georgia (Plank and Kissel, 2009).

Soil Moisture

Soil moisture was monitored and recorded with WatchDog Model 450 Data Loggers (Spectrum Technologies, Inc., Plainfield, IL) connected to soil watermark sensors. Soil watermark sensors were installed vertically in the center of each row and measured soil tension in a range from 5-13 cm in depth. In 2007, soil moisture measurements were recorded from one replication at each location. In 2008, soil moisture was recorded from two replications at each location. During each year, soil moisture was recorded at 15-min intervals. One study found this interval to be sufficient for determining differences in soil moisture for peanut (Balkcom *et al.*, 2005). Data was downloaded every 10-15 days to prevent large losses of data and correct potential problems with sensors. Mice were very aggressive at chewing and unplugging sensor cables. This was prevented in 2008 by using braided metal tubing to insulate the sensor cables. Once downloaded, software was used to generate reports from the data containing daily values for mean soil moisture based on the average daily soil tension in kPa.

Peanut Stand Counts

Peanut stand counts were taken at 10, 20, and 30 DAP each year to determine if differences in emergence existed. Measurements were taken from two locations in each plot by randomly throwing down a meter-stick and counting the emerged seedling plants within that section of row. The emergence rates at these intervals are indicative of the environment surrounding the seed in each treatment at that particular time. Differences in soil moisture and temperature along with the presence of seedling diseases can all affect emergence rates. In addition to emergence counts, stand counts were also taken at the end of the season after digging by counting the number of inverted tap roots in a row. These measurements were also taken by randomly throwing down a meter stick in two locations within each plot. Digging stand counts were taken to make sure all plots had similar plant numbers prior to harvest. Multiple factors could affect plots during a growing season to reduce plant density. This measurement was taken to ensure consistency and prevent any possible bias in yield as a result of unforeseen reduction in plant stands over the growing season that were unrelated to treatment type.

Peanut Heights and Widths

Peanut height and width was measured in centimeters each year to address any differences in growth rate. Measurements were taken at 48 and 62 DAP from six locations in each plot. Main stem height was measured from the center of the crown at the soil surface to the tallest erect leaflet in the canopy. Width was measured across the row to the tips of leaflets on opposite lateral branches at the soil surface.

Statistical Analysis

The statistical analysis was performed using Proc Mixed (SAS Institute Inc., Cary NC). When F tests identified significant main effects and interactions, means were tested for differences using Fisher's protected LSD at $P = 0.10$. When applicable, probability levels of 0.05 and 0.01 were also considered. Data for the same location were combined over years for analysis of cover crop sampling, peanut stand counts, and peanut heights and widths. Locations were not combined due to significant interactions and random effects. Only general assumptions and hypotheses are made pertaining to the differences between locations. Data for peanut tissue samples were collected only in 2008 and were analyzed by location. Soil moisture data were analyzed independently of both year and location. Due to lack of replication, results for soil moisture are presented as seasonal averages based on bed type and cover crop. Daily values were used as replication, so differences based on date were not addressed. Overall, soil moisture data sets typically had less than 5% missing data. Multiple-imputation was used to produce estimates for missing data and to avoid any possible bias. Results for complete and imputed data were equivalent, and imputed data results are reported.

Results and Discussion

Cover Crop Sampling

No differences were detected at any significance level in wheat stand counts or biomass accumulation based on effect of bed type at Plains or Tifton (Table 4.1). This indicates similar stands of cover can be achieved when drilling seed regardless of bed type, and dismisses the assumption of not being able to plant wheat on rip and beds with a grain drill. Stand counts and biomass accumulations were obviously significant for wheat cover compared to none. Since total biomass accumulation was similar between bed types, it appears that wheat cover crop progresses consistently regardless of the degree of bedding. This helps to contradict assumptions that bedding would alter agronomic factors affecting growth for the cover crop. Biomass accumulation tended to be greater in Plains compared to Tifton. Many random factors could have led to this occurrence, but soil type most likely contributed to some extent. The Plains' soil type was finer textured with higher clay content capable of holding more nutrients and moisture than the coarse textured higher sand content soil at Tifton. This is a plausible explanation to greater biomass accumulation at Plains.

Results of statistical analysis were the same for nutrient concentration and content, so content was reported in this study. Analysis of the nutrient content of the cover crop biomass revealed no differences in macronutrients or micronutrients based on the bed type effect at either location (Tables 4.2-4.5). Again the effect of cover crop was highly significant on all nutrients for wheat compared to none. This was the direct result of no biomass harvested from plots without cover. Based on the outcomes, it appears the wheat cover crop had similar uptake of nutrients regardless of fall tillage. It can be hypothesized that the availability of nutrients to the wheat crop was unaffected by bedding procedures. Overall, nutrient contents tended to be slightly lower for the Tifton location compared to the Plains location. The soil at Plains is finer textured and capable of holding larger volumes of nutrients and moisture than the soil at Tifton. It is also likely that management practices in previous crops differed between locations resulting in differences in the availability of nutrients to the wheat cover. This most likely allowed greater biomass accumulation and higher plant concentrations of nutrients at the Plains location. Since nutrient content is the product of biomass weight and plant nutrient concentration, the result was a higher per hectare nutrient content value when these factors were combined at Plains.

Peanut Tissue Samples

At Plains, bed type had no effect on macronutrient concentrations in leaf tissue (Table 4.6). However, cover crop did affect concentrations for K, Mg, and S. Higher concentrations of K and S were present where a cover crop was present. There was a lower concentration of Mg when cover crop was present. However, concentrations for both wheat cover and none for K and Mg were well within their sufficiency ranges of 0.70-3.0 % and 0.30-0.80 %, respectively. (Plank and Kissel, Unknown). Even though differences were detected in concentrations for these elements, no corrective measure was recommended based on sufficiency ranges. This suggested that plant uptake and plant performance should be similar regardless of presence or absence of cover. The sufficiency range for sulfur was 0.20-0.35 % (Plank and Kissel, Unknown). The presence of wheat cover caused concentrations to be slightly higher than the sufficiency range with a concentration of 0.37 % S in the leaf tissue. This was not found to be problematic as the N:S ratio for peanut tissue in plots with wheat cover and none were found to be very similar at 11.46 and 11.77, respectively. One study indicated that the N:S ratio in corn should never exceed 18:1 (Reneau, 1983). Another study indicated that N:S ratios above 16:1 limit protein formation (Stewart and Porter, 1969). N:S ratios for peanut in plots with wheat cover and none were well below these upper limits and did not suggest deficiency in either case. This suggested crop uptake and performance with respect to S should be similar. All other macronutrient concentrations were within their suggested sufficiency ranges regardless of bed type or cover crop.

Micronutrient concentrations in leaf tissue at Plains were unaffected by bed type, but Mn and Cu concentrations were affected by cover crop (Table 4.7). Mn was present at a significantly higher concentration of 94.4 ppm where wheat cover was present compared to 75.8 with none. However, manganese in peanut has a broad sufficiency range of 20-350 ppm (Plank and Kissel, Unknown). Deficiency usually does not occur unless concentrations are less than 15 ppm. This suggests that uptake and growth of peanut plants with respect to Mn was similar with cover crop or none. Cu was present at a higher concentration of 4.91 ppm where cover was present compared to 2.98 with none. Both of these concentrations were lower than the suggested sufficiency range of 5-20 ppm (Plank and Kissel, Unknown). This occurrence could not be explained. Copper deficiency is not common, and no visual symptoms of deficiency were displayed in plots with or without cover. Since values were lower than the sufficiency range in all cases, differences in plant performance were not expected between treatments. All other micronutrient concentrations were within their sufficiency ranges with the exception of Fe. Iron tended to be slightly higher than the level indicated by the sufficiency range, but this was most likely a result of unwashed leaves. Accurate iron levels can only be achieved with washed leaves, and high Fe usually indicates soil or dust contamination (Plank and Kissel, Unknown).

At Tifton, macronutrient concentrations of K were affected by bed type, and concentrations of Mg were affected by cover crop (Table 4.8). Concentration of K decreased following the pattern of increased bedding intensity (flat bed, raised bed, and rip and bed). All concentrations were within the sufficiency range of 1.70-3.0 % for K (Plank and Kissel, Unknown). From highest to lowest concentration, values for K varied by only 0.18 %. It was assumed that the minute differences found were unlikely to affect plant performance. For Mg, concentrations were higher at 0.47 % with no cover compared to 0.43 with cover. These differences were unlikely to have affected crop performance, because they were within the sufficiency range of 0.30-0.80 % (Plank and Kissel, Unknown). All other macronutrients were within their sufficiency levels.

Micronutrient concentrations in leaf tissue at Tifton were unaffected by bed type. However, the main effect of cover crop was significant on concentrations of Zn (Table 4.9). Zinc was more highly concentrated in peanut leaves from wheat cover plots at 27.6 ppm compared to 24.4 in plots without cover. Zinc deficiency is unlikely to occur, and the sufficiency range is 20-60 ppm for peanut (Plank and Kissel, Unknown). Both values were within the sufficiency level. Again the significant but relatively small differences did not suggest the occurrence of differences in plant performance. All other micronutrients, with the exception of Cu were within their sufficiency ranges. Like

Plains, Cu levels at Tifton were lower in all cases than the recommended 5-20 ppm. Again this occurrence could not be explained, because no symptoms of copper deficiency were evident. As a result, differences in plant performance were not expected.

Soil Moisture

Significant interactions of bed type x cover crop existed in all cases for soil moisture at P = 0.05 (Figure 4.1-4.4). Soil moisture was the only data containing significant interactions. No clear trends existed between years at a particular location or across locations within a particular year. However, in most cases, raised bed did tend to have more available moisture than other bed types when wheat was present as a cover crop compared to when none was present. In all cases, flat bed had more available water when no cover crop was present compared to wheat being present. At Plains, rip and bed had more water available when a wheat cover crop was present than when cover crop was absent. To a smaller degree, results were reversed for rip and bed at Tifton. The results suggest that the effect of cover crop is dependent on bed type and soil type. Overall cover tends to provide the most benefit on bedded surfaces. This is most likely due to the elevated nature of the beds being more directly exposed to the sun for drying and evaporation processes. When cover was present, these processes were suppressed. It could also be hypothesized that cover helped slow the flow of water off the sides of bedded surfaces increasing moisture infiltration and retention near the sensor in the row center. On flat surfaces, the strip-till furrow provided a slight depression which could have increased moisture infiltration and retention in the row center where the moisture sensor was located. Cover was not as critical in this situation for retaining soil moisture. It could not be explained why the wheat cover on the flat surface led to decreased moisture availability. However, it could be hypothesized that cover elevated the surrounding areas and prevented water from naturally channeling from the row middles into the strip-till depressions on flat beds where sensors were located. Trends in yield and yield potential (data not shown) could not be matched to trends in availability of soil moisture. This suggests that soil moisture was influenced by fall tillage, but it was not the critical factor influencing differences in yield (harvested pods) and yield potential (harvested pods + digging losses) between bed types (data not shown).

Peanut Stand Counts

At Plains, there were significant main effects of either bed type or cover crop for peanut stand counts at all sample times (Table 4.10). No interactions of bed type x cover crop were found at any level of significance. At 10 DAP, wheat cover had significantly lower peanut emergence with 6.5 plants/m compared to 7.7 with none at P = 0.05. Wheat residue was very dense at Plains, so higher emergence with no cover was most likely the result of greater seed-to-soil contact in these plots. At 20 DAP, no cover crop effect existed, but main effect of bed type was significant at P = 0.10. Rip and bed had higher peanut emergence than flat bed at this sample interval. Raised bed was amid the two and could not be differentiated from them. By 20 DAP, the crop had received sufficient moisture in the form of rainfall and irrigation, so the effect of cover crop on seed-to-soil contact was most likely masked by this time. Even seeds with poor seed-to-soil contact had received enough moisture to germinate. At 30 DAP, the same trend for bed type present at 20 DAP was significant on peanut stands at P = 0.05. These occurrences suggest that conditions for emergence were more favorable as the degree of bedding intensity increased. Early in the season, warmer temperatures on the elevated surfaces most likely facilitated the higher rates of emergence on the rip and bed. Digging stand counts showed no significant outliers in plant density among plots, therefore yield was not expected to be biased by unforeseen reductions in stand. However, main effect of bed type was significant at P = 0.10 on this stand count. Raised bed had a higher plant density with 14.9 plants/m compared to 13.3 plants with rip and bed. Flat bed was not found to be different from either. Trends in yield (harvested pods) agreed with trends in emergence at 20 and 30 DAP, but not with stand counts at digging. Yield potential (harvested pods + digging losses) failed to agree with any of the trends in plant densities. Data for yield and yield potential is not shown, but results suggest that small differences in plant densities had little or no effect on overall yield or yield potential.

At Tifton, main effect of bed type was significant on peanut stand counts at 10 and 30 DAP at P = 0.05 (Table 4.11). Main effect of cover crop and bed type x cover crop interactions were not found at any level of significance for stand counts. Cover crop density was lower at Tifton, so seed-to-soil contact was not an issue at this location. The ability of wheat to retain moisture for quicker emergence was most likely masked by irrigations following planting. At 10 DAP, rip and bed was found to have higher emergence with 12.5 plants/m compared to 10.3 plants/m with flat bed. Raised bed was not significantly different from either. Flat bed, raised bed, and rip and bed were all significantly different at 30 DAP with 12.3, 13.2, and 14.4 plants/m, respectively. Like Plains, these trends indicate that conditions for emergence tended to be more favorable as the degree of bedding intensity increased. The differences in peanut emergence did, however, tend to be more pronounced at Tifton. This was most likely related to warmer soil temperatures on the elevated beds early in the season. However, trends for peanut emergence did not match trends for yield or yield potential (data not shown). This also illustrates yield was most likely not influenced by emergence rates.

Peanut Heights and Widths

At Plains, no main effects of bed type, cover crop, or bed type by cover crop interactions were witnessed at any level of significance on peanut heights and widths (Table 4.12). This is indicative of plant performance being similar across bed types and agrees with peanut tissue sample results for nutrient uptake. This suggests bedding did not influence vegetative growth of the peanut crop at this location. The vegetative growth did not agree with results in yield potential. Yield potential favored flat plots over bedded plots at this location, but no differences were found in vegetative growth. Additionally, actual harvested yield favored bedded plots over flat bed plots. Therefore, it is assumed that height and width measurements are a poor indicator of differences in yield potential and actual yield. It also suggests that another factor such as digging losses (data not shown) was a more influential culprit of the lower harvested yield from flat plots compared to bedded plots at this location, since flat plots had the highest yield potential. It is believed that the finer textured soil at this location directly influenced digging losses.

At Tifton, main effect of bed type was significant for height and width at 48 DAP and for width at 62 DAP (Table 4.13). For 48 DAP height, rip and bed peanut was significantly taller at 31.9 cm compared to 29.3 cm for flat bed peanut at $P = 0.10$. Raised bed height was not significant from flat bed or rip and bed. The same trend was seen for bed type at 48 DAP width at $P = 0.10$. Rip and bed peanut was wider at 69.4 cm compared to flat bed at 62.4 cm. No differences were found in height at 62 DAP. This suggests that peanut had reached its height potential in all plots by this point. For width at 62 DAP, main effect of bed type was significant at P = 0.01. Rip and bed peanut was significantly wider than both raised bed and flat bed. Rip and bed, raised bed, and flat bed had widths of 92.8, 88.4, and 85.9 cm, respectively, at 62 DAP. Results at this location suggest that plant performance and vegetative growth were influenced by bedding procedures. Soil moisture data and plant tissue nutrient analysis did not suggest the occurrence of differences in peanut growth. For Tifton, the only data that follows remotely similar trends to height and width are peanut stand counts. Quicker emergence and more dense populations could have possibly led to the taller, wider canopies for bedded plots compared to flat plots. However, vegetative growth did not agree with results for yield potential or actual yield. Yield potential and yield were similar among all bed types at this location even though differences were found in vegetative growth. This also suggests that yield differences cannot be predicted based on height and width measurements. Additionally, no differences were found in digging losses between bed types on this coarser textured soil (data not shown). This further confirms the idea of digging losses being a more influential factor in yield differences between bed types than the agronomic factors that were measured.

Summary and Conclusions

Results indicated that several agronomic factors were affected, or at least influenced by bedding procedures. At Tifton, K concentrations in peanut leaf tissue were reduced in rip and bed plots. This effect did not correspond with any other measurements recorded. Also, concentrations for all bed types were within the sufficiency range for this nutrient, and the differences, although significant, were very miniscule. Soil moisture was influenced by bed type x cover crop interactions at both locations in each year. No consistent trends in soil moisture could be identified between years or locations based on bed type or cover crop even though trends in all other measurements were similar between years at each location. It was concluded that the highly random interactions in soil moisture were not likely to be the sole contributors of the very consistent yield potentials witnessed over years at each location. Peanut stand counts tended to be higher for bedded plots than flat plots at both locations, but differences were more pronounced at Tifton. It was hypothesized that elevated surfaces of bedded plots warmed more quickly in the early part of the season creating an environment more conducive to rapid peanut emergence. Bed type also influenced heights and widths of peanut at Tifton. Bedded plots tended to have wider and taller plants than flat plots. This occurrence was attributed to the quicker emergence and more dense canopies in these plots. This increased growth at Tifton did not translate into increased yield as yield potential for all bed types was similar at this location.

Several agronomic factors were unaffected by bedding procedures at both locations. These included cover crop establishment, biomass accumulation, and biomass nutrient content. This was evidence that nutrient availability, nutrient uptake, and cover crop performance were not influenced by bedding procedures. At Plains, peanut leaf tissue concentrations and heights and widths were not influenced by bedding procedures. Leaf tissue concentrations illustrated similar uptake of nutrients regardless of bed type, so no differences in yield potential were expected based on fertility factors. The lack of difference in heights and widths at Plains was attributed to the smaller difference in stand counts and emergence at this location compared to Tifton. Yield potential was higher for flat plots compared to bedded plots at Plains even though no differences in vegetative growth were found. Therefore, it was concluded that these factors were not related to the increased harvested yield of bedded plots at Plains.

After analysis of data, no measurements recorded could conclusively confirm the ability of bedding procedures to influence agronomic factors in a positive or negative way as related to yield potential. Differences in agronomic factors either failed to exist, existed and could not be linked to bedding procedures, or they exhibited no correlation or similarity with yield potential and other agronomic factors which indicated their differences were irrelevant and, or random. Based on results at both locations, it was also concluded that differences in vegetative growth of peanut were poor indicators of yield potential. When no differences in vegetative growth existed at Plains, differences in yield potential were found, and when differences in growth existed at Tifton, no differences in yield potential were found. The differences in yield potential at Plains favored flat bed plots over bedded plots which was opposite of actual harvested yield at that location. Therefore, it is believed that the differences witnessed in harvested yield at Plains are largely a result of increases in harvesting efficiency and lower digging losses as the degree of bedding increased rather than a result of increased yield potential from bedding. In order to determine the exact agronomic factors influenced to give flat plots higher yield potential at Plains, more detailed data collection will be needed.

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CHAPTER 5

CONCLUSIONS

Yield, Digging Losses, and Soil Compaction

Fall bedding used in conjunction with strip-till peanut can be effective in Georgia on our finer textured soils like those at Plains. On these soil types, bedding reduced digging losses, lowered soil compaction, and increased yield. The rip and bed exhibited the greatest improvements in all of these areas. Bedding reducec yield potential (actual yield plus digging losses) at this location, and therefore it was assumed that the resulting increase in yield on the rip and bed was related to greater harvesting efficiency rather than improvements of agronomic factors from bedding. Raised bed was effective at reducing digging losses and soil compaction as well, but it did not significantly improve yield over plots prepared flat. Therefore, the added cost of this tillage makes justifying the use of the raised bed type hard when no enhancement in yield is expected. Rip and bed was a more viable option on this soil type.

For coarser soil types like those at Tifton, bedding did not appear to have beneficial characteristics to the extent of those that were evident at Plains on the finer soil type. For this soil type, bedding reduced soil compaction to a smaller extent, but had no effect on digging losses, yield, or grade. As a result, no incentive exists to recommend bedding on these coarser textured soils. Grades were unaffected by bed type or cover crop, and there were no significant cover crop effects or bed type x cover crop interactions for any of the data presented at either location. These results suggest that peanut matures consistently regardless of bed type and that short term benefits of a cover crop might be negligible. This does not consider the long term benefits of a cover crop like increasing soil organic matter, decreasing erosion, and increasing water holding capacity.

Economic Analysis

At Plains, the rip and bed improved yield over flat bed which also translated into significant increases in net return and marginal return over flat bed. The use of bedding in the form of rip and bed was justified by the increase in return. The raised bed type was not found to offer a significant advantage over the flat bed. Wheat cover led to a significant decrease in net return, and use of a cover crop could not be justified by short-term return on this soil type. At Tifton, there were no significant effects on yield, net return or marginal return. However, trends showed decreased net return from bedding and increased return from the use of a wheat cover crop. Bedding could not be justified on this soil type, but wheat cover showed the potential for increasing net return.

Results show that the rip and bed used in conjunction with strip-till can be a viable option for growers switching to reduced tillage on finer textured, higher clay content soils like those at Plains. The recommendation to use bedding on that soil type was confirmed by higher net returns and marginal returns than strip-till on flat ground. For sandier soils like those at Tifton, no form of bedding improved net return or marginal return over flat strip-till. Therefore, no incentive to recommend any bed type exists for that soil type when using strip-till.

Bedding Influence on Agronomic Factors

Results indicated that several agronomic factors were affected, or at least influenced by bedding procedures. At Tifton, potassium concentrations in peanut leaf tissue were reduced in rip and bed plots. This affect did not correspond with any other measurements recorded. Also, K concentrations for all bed types were within the sufficiency range for this nutrient, and the differences, although significant, were very miniscule. Soil moisture was influenced by bed type by cover crop interactions at both locations in each year. No consistent trends in soil moisture could be identified between years or locations based on bed type or cover crop even though trends in all other measurements were similar between years at each location. It was concluded that the highly random interactions in soil moisture were not likely to be the sole contributors of the very consistent yield potentials witnessed over years at each location. Peanut stand counts tended to be higher for bedded plots than flat plots at both locations, but differences were more pronounced at Tifton. It was hypothesized that elevated surfaces of bedded plots warmed more quickly in the early part of the season creating an environment more conducive to rapid peanut emergence. Bed type also influenced heights and widths of peanut at Tifton. Bedded plots tended to have wider and taller plants than flat plots. This occurrence was attributed to the quicker emergence and more dense canopies in these plots. This increased growth at Tifton did not translate into increased yield as yield potential for all bed types was similar at this location.

Several agronomic factors were unaffected by bedding procedures at both locations. These included cover crop establishment, biomass accumulation, and biomass nutrient content. This was evidence that nutrient availability, nutrient uptake, and cover crop performance were not influenced by bedding procedures. At Plains, peanut leaf tissue concentrations and heights and widths were not influenced by bedding procedures. Leaf tissue concentrations illustrated similar uptake of nutrients regardless of bed type, so no differences in yield potential were expected based on fertility factors. The lack of difference in heights and widths at Plains was attributed to the smaller difference in stand counts and emergence at this location compared to Tifton. Yield potential was higher for flat plots compared to bedded plots at Plains even though no differences in vegetative growth were found. Therefore, it was concluded that these factors were not related to the increased harvested yield of bedded plots at Plains.

After analysis of data, no measurements recorded could conclusively confirm the ability of bedding procedures to influence agronomic factors in a positive or negative way as related to yield potential. Differences in agronomic factors either failed to exist, existed and could not be linked to bedding procedures, or they exhibited no correlation or similarity with yield potential and other agronomic factors which indicated their differences were irrelevant and, or random. Based on results at both locations, it was also concluded that differences in vegetative growth of peanut were poor indicators of yield potential. When no differences in vegetative growth existed at Plains, differences in yield potential were found, and when differences in growth existed at Tifton, no differences in yield potential were found. The differences in yield potential at Plains favored flat bed plots over bedded plots which was opposite of actual harvested yield at that location. Therefore, it is believed that the differences witnessed in harvested yield at Plains are largely a result of increases in harvesting efficiency and lower digging losses as the degree of bedding increased rather than a result of increased yield potential from bedding.

APPENDICES

Table 2.1: Peanut Digging Losses Analysis pooled over years, Plains and Tifton.

Effect	**Digging Losses**[a]					
	Plains			**Tifton**		
	-------------kg/ha------------			------------kg/ha-----------		
	SE	df	Prob.[b]	SE	df	Prob.
Bed Type (BT)	108.06	43.0	***	39.07	68.0	NS
Cover Crop (CC)	88.23	43.0	NS[c]	31.90	68.0	NS
BT x CC	---	---	NS	---	---	NS

*** Significant at the 0.01 probability level.

[a] Digging losses = pods screened from soil following digging process.

[b] Probability level.

[c] NS = not significant.

Table 2.2: Actual Peanut Digging Losses pooled over years, Plains and Tifton.

Characteristic	**Plains**	**Tifton**
Bed Type	--------------------kg/ha--------------------	
Flat Bed	1548.67 a[a]	265.48 a
Raised Bed	824.92 b	319.79 a
Rip and Bed	585.55 b	311.62 a
LSD (0.01)	411.87	---
LSD (0.10)	---	NS
Cover Crop		
Wheat	991.28 a	305.53 a
None	981.48 a	292.39 a
LSD (0.10)	NS[b]	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 2.3: Analysis of Soil Compaction, Plains 2008.

Effect	**Soil Compaction[a]**								
	Depth (cm)								
	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0
	kPa								
Bed Type (BT)	*	***	*	**	**	***	***	***	***
SE	38.21	74.1	192.1	162.9	185.3	181.8	155.01	158.6	146.5
df	2	22	2	2	2	26	26	26	26
Cover Crop (CC)	NS[b]	NS	NS	NS	NS	NS	NS	NS	NS
SE	31.2	60.5	156.9	133	151.3	148.4	126.6	129.5	119.6
df	20	22	2	2	2	26	26	26	26
BT x CC	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE	---	---	---	---	---	---	---	---	---
df	---	---	---	---	---	---	---	---	---

*** Significant at 0.01 probability level.

** Significant at the 0.05 probability level.

* Significant at the 0.10 probability level.

[a] Soil Compaction was measured 18 cm to outside of the peanut row to a depth of 20 cm at 2.5 cm intervals in 2008. Analysis was performed on soil compaction at each depth.

[b] NS = not significant.

Table 2.4: Harvest Depth Soil Compaction, Plains 2008.

Characteristic	**Soil Compaction**					
	----------Depth (cm)----------					
	0.0	2.5	5.0	7.5	10.0	0.0-10.0
	----------kPa----------					
Bed Type						Avg.
Flat Bed	220.4 a[a]	557.3 a	1265 a	1843.4 a	2067.3 a	1190.7
Raised Bed	97.6 ab	195.8 b	364.3 b	488.3 b	644.6 b	358.1
Rip and Bed	53.7 b	104.5 b	231.5 b	387.8 b	489.5 b	253.4
LSD (0.01)	---	295.4	---	---	---	
LSD (0.05)	---	---	---	991.4	1127.6	
LSD (0.10)	157.8		793.3	---	---	
Cover Crop						
Wheat	147.7 a	344.6 a	757.5 a	1065.2 a	1200.1 a	703.0
None	100.1 a	227.1 a	483.0 a	747.8 a	934.2 a	498.4
LSD (0.10)	NS[b]	NS	NS	NS	NS	

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 2.5: Below Harvest Depth Soil Compaction, Plains 2008.

Characteristic	**Soil Compaction**				
	----------Depth (cm)----------				
	12.5	15.0	17.5	20.0	12.5-20.0
	----------kPa----------				
Bed Type					Avg.
Flat Bed	2242.8 a[a]	2154 a	2214.8 a	2314.7 a	2231.6
Raised Bed	950.4 b	1203.1 b	1414.1 b	1787.8 a	1338.9
Rip and Bed	570.8 b	564.3 c	588.9 c	597.1 b	580.3
LSD (0.01)	714.2	609.2	623.4	575.6	
Cover Crop					
Wheat	1321.7 a	1331.1 a	1436 a	1589.9 a	1419.7
None	1187.6 a	1283.1 a	1375.9 a	1543.1 a	1347.4
LSD (0.10)	NS[b]	NS	NS	NS	

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 2.6: Analysis of Soil Compaction, Tifton 2008.

Effect	**Soil Compaction[a]**								
	Depth (cm)								
	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0
	kPa								
Bed Type (BT)	NS[b]	*	NS	**	**	**	***	**	**
SE	17.4	28.8	67.6	91	182.3	353.8	254.3	227.5	363.6
df	7	8	8	8	8	8	7	2	2
Cover Crop (CC)	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE	14.18	23.5	55.2	74.3	148.8	288.9	207.6	185.7	296.9
df	7	8	8	8	8	8	7	2	2
BT x CC	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE	---	---	---	---	---	---	---	---	---
df	---	---	---	---	---	---	---	---	---

*** Significant at 0.01 probability level.
** Significant at the 0.05 probability level.
* Significant at the 0.10 probability level.
[a] Soil Compaction was measured 18 cm to outside of the peanut row to a depth of 20 cm at 2.5 cm intervals in 2008. Analysis was performed on soil compaction at each depth.
[b] NS = not significant.

Table 2.7: Harvest Depth Soil Compaction, Tifton 2008.

Characteristic	**Soil Compaction**					
	Depth (cm)					
	0.0	2.5	5.0	7.5	10.0	0.0-10.0
	kPa					
Bed Type						Avg.
Flat Bed	76.7 a[a]	189.3 a	357.7 a	615.9 a	1043.7 a	456.7
Raised Bed	62.1 a	101.1 b	180.4 a	299.4 b	568.8 ab	242.4
Rip and Bed	41.7 a	77.9 b	181.0 a	260.0 b	346.6 b	181.4
LSD (0.05)	---	---	---	296.6	594.4	
LSD (0.10)	NS[b]	75.7	NS	---	---	
Cover Crop						
Wheat	56.5 a	122.8 a	269.9 a	426.1 a	677.2 a	310.5
None	63.8 a	122.8 a	209.5 a	357.4 a	640.8 a	278.9
LSD (0.10)	NS	NS	NS	NS	NS	

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 2.8: Below Harvest Depth Soil Compaction, Tifton 2008.

Characteristic	**Soil Compaction**				
	Depth (cm)				
	12.5	15.0	17.5	20.0	12.5-20.0
	kPa				
Bed Type					Avg.
Flat Bed	1993.2 a[a]	2767.1 a	3923.1 a	4145.8 a	3207.3
Raised Bed	842 ab	1447 b	2256.3 b	2938.6 ab	1871
Rip and Bed	501 b	674 b	936 b	1067.3 b	794.6
LSD (0.01)	---	1258.4	---	---	
LSD (0.05)	1153.9	---	1384.2	2212.6	
Cover Crop					
Wheat	1016 a	1546.7 a	2359 a	2639.7 a	1890.4
None	1208.1 a	1712 a	2384.6 a	2794.7 a	2024.9
LSD (0.10)	NS[b]	NS	NS	NS	

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 2.9: Analysis of Peanut Yield and Grade Factors pooled over years, Plains.

Effect	**Yield**	**-------------Grade------------**	
	kg/ha	% TSMK[a]	% OK[b]
Bed Type (BT)	**	NS	NS
SE	92.9	0.41	0.18
df	63.7	7.3	65.5
Cover Crop (CC)	NS[c]	NS	NS
SE	75.8	0.33	0.14
df	63.7	7.3	65.5
BT x CC	NS	NS	NS
SE	---	---	---
df	---	---	---

** Significant at the 0.05 probability level.
[a] % TSMK = Percent Total Sound Mature Kernels.
[b] % OK = Percent Other Kernels.
[c] NS = not significant.

Table 2.10: Peanut Yield and Grade Factors pooled over years, Plains.

Characteristic	Yield	-------------Grade------------	
	kg/ha	% TSMK[a]	% OK[b]
Bed Type			
Flat Bed	4496 b[c]	74.4 a	4.0 a
Raised Bed	4707 ab	74.3 a	4.1 a
Rip and Bed	4961 a	74.2 a	4.3 a
LSD (0.05)	262.5	---	---
LSD (0.10)	---	NS	NS
Cover Crop			
Wheat	4671 a	74.3 a	4.1 a
None	4772 a	74.3 a	4.2 a
LSD (0.10)	NS[d]	NS	NS

[a] % TSMK = Percent Total Sound Mature Kernels.
[b] % OK = Percent Other Kernels.
[c] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[d] NS = not significant.

Table 2.11: Analysis of Peanut Yield and Grade Factors pooled over years, Tifton.

Effect	**Yield**	-------------**Grade**------------	
	kg/ha	% TSMK[a]	% OK[b]
Bed Type (BT)	NS[c]	NS	NS
SE	113.2	0.37	0.27
df	6.2	68.0	2.0
Cover Crop (CC)	NS	NS	NS
SE	108.6	0.30	0.22
df	6.2	68.0	2.0
BT x CC	NS	NS	NS
SE	---	---	---
df	---	---	---

[a] % TSMK = Percent Total Sound Mature Kernels.
[b] % OK = Percent Other Kernels.
[c] NS = not significant.

Table 2.12: Peanut Yield and Grade Factors pooled over years, Tifton.

Characteristic	**Yield**	------------**Grade**------------	
	kg/ha	% TSMK[a]	% OK[b]
Bed Type			
Flat Bed	5016 a[c]	75.3 a	3.3 a
Raised Bed	4912 a	75.1 a	2.2 a
Rip and Bed	4914 a	74.8 a	2.9 a
LSD (0.10)	NS[d]	NS	NS
Cover Crop			
Wheat	5072 a	75.4 a	3.1 a
None	4823 a	74.7 a	3.2 a
LSD (0.10)	NS	NS	NS

[a] % TSMK = Percent Total Sound Mature Kernels.
[b] % OK = Percent Other Kernels.
[c] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[d] NS = not significant.

Table 2.13: Peanut Yield Potential pooled over years, Plains.

Bed Type	Yield	Digging Losses	Yield Potential[a]
	------------------------------kg/ha-------------------------		
Flat Bed	4496 b[b] (74)[c]	1548.67 a (26)	6045
Raised Bed	4707 ab (85)	824.92 b (15)	5532
Rip and Bed	4961 a (89)	585.55 b (11)	5547

[a] Yield potential in terms of total marketable pods as a sum of Yield and Digging Losses for Bed Type. No statistical analysis was run for yield potential. This data was calculated for general discussion purposes concerning harvesting efficiency.
[b] Means in a column followed by the same letter are not significantly different.
[c] ( ) = Yield or digging losses as a percentage of yield potential.

Table 2.14: Peanut Yield Potential pooled over years, Tifton.

Bed Type	**Yield**	**Digging Losses**	**Yield Potential**[a]
	------------------------------	kg/ha	-------------------------
Flat Bed	5016 a[b] (95)[c]	265.48 a (5)	5281
Raised Bed	4912 a (94)	319.79 a (6)	5232
Rip and Bed	4914 a (94)	311.62 a (6)	5226

[a] Yield potential in terms of total marketable pods as a sum of Yield and Digging Losses for Bed Type. No statistical analysis was run for yield potential. This data was calculated for general discussion purposes concerning harvesting efficiency.
[b] Means in a column followed by the same letter are not significantly different.
[c] ( ) = Yield or digging losses as a percentage of yield potential.

Table 3.1: Analysis of Diseases pooled over years, Plains and Tifton.

Effect	**-----------Plains----------**		**-----------Tifton[a]----------**	
	TSWV[b]	CBR[c]	TSWV	CBR
	------------------------------------%------------------------------------			
Bed Type (BT)	NS[d]	NS	NS	---
SE	0.80	1.59	0.70	---
df	2.0	7.1	5.9	---
Cover Crop (CC)	NS	NS	NS	---
SE	0.66	1.30	0.57	---
df	2.0	7.1	5.9	---
BT x CC	NS	NS	NS	---
SE	---	---	---	---
df	---	---	---	---

[a] No CBR ratings were made at Tifton.
[b] TSWV = Tomato spotted wilt virus.
[c] CBR = Cylindrocladium black rot.
[d] NS = not significant.

Table 3.2: Disease Means pooled over years, Plains and Tifton.

Characteristic	**-----------Plains----------**		**-----------Tifton[a]----------**	
	TSWV[b]	CBR[c]	TSWV	CBR
	-----------------------------------	-%	-----------------------------------	
Bed Type				
Flat Bed	2.89 a[d]	12.7 a	3.04 a	---
Raised Bed	4.14 a	14.9 a	3.42 a	---
Rip and Bed	4.21 a	14.7 a	4.93 a	---
LSD (0.10)	NS[e]	NS	NS	---
Cover Crop				
Wheat	3.29 a	14.2 a	3.14 a	---
None	4.21 a	14.0 a	4.46 a	---
LSD (0.10)	NS	NS	NS	---

[a] No CBR ratings were made at Tifton.
[b] TSWV = Tomato spotted wilt virus.
[c] CBR = Cylindrocladium black rot.
[d] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[e] NS = not significant.

Table 3.3: Analysis of Net Return and Marginal Return Analysis pooled over years, Plains and Tifton.

Effect	**-----------Plains----------**		**-----------Tifton----------**	
	Net Return[a]	Marginal Return[b]	Net Return	Marginal Return
	----------------------------------$/ha----------------------------------			
Bed Type (BT)	***	**	NS	NS
SE	39.76	47.75	62.36	62.5
df	63.1	58.3	6.3	6.5
Cover Crop (CC)	**	*	NS	NS
SE	32.47	38.99	50.91	51.24
df	63.1	58.3	6.3	6.5
BT x CC	NS[c]	NS	NS	NS
SE	---	---	---	---
df	---	---	---	---

*** Significant at the 0.01 probability level.
** Significant at the 0.05 probability level.
* Significant at the 0.10 probability level.
[a] Net Return after bedding and cover costs are deducted.
[b] Marginal Return when net return for flat bet no cover treatment is deducted from all treatments.
[c] NS = not significant.

Table 3.4: Net Return and Marginal Return pooled over years, Plains and Tifton.

Characteristic	**-----------Plains----------**		**-----------Tifton----------**	
	Net Return[a]	Marginal Return[b]	Net Return	Marginal Return
	----------------------------------$/ha----------------------------------			
Bed Type				
Flat Bed	1791.20 b[c]	56.50 b	2020.20 a	43.10 a
Raised Bed	1858.70 ab	123.90 ab	1954.10 a	-26.40 a
Rip and Bed	1964.40 a	229.60 a	1944.50 a	-37.60 a
LSD (0.01)	149.37	---	---	---
LSD (0.05)	---	135.17	---	---
LSD (0.10)	---	---	NS[d]	NS
Cover Crop				
Wheat	1822.90 b	88.10 b	2005.90 a	27.60 a
None	1920.00 a	185.20 a	1939.90 a	-41.50 a
LSD (0.05)	91.76	---	---	---
LSD (0.10)	---	92.17	NS	NS

[a] Net Return after bedding and cover costs are deducted.
[b] Marginal Return when net return for flat bet no cover treatment is deducted from all treatments.
[c] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[d] NS = not significant.

Table 4.1: Wheat Stand Counts and Biomass pooled over years, Plains and Tifton.

Characteristic	---------------**Plains**------------		--------------**Tifton**------------	
	Plants/ sq. m	Biomass kg/ha	Plants/ sq. m	Biomass kg/ha
Bed Type				
Flat Bed	101.8 a[a]	3245.8 a	105.3 a	1488.6 a
Raised Bed	99.4 a	3841.7 a	104.6 a	1312.2 a
Rip and Bed	98.8 a	3966.7 a	107.7 a	1516.1 a
LSD (0.10)	NS[b]	NS	NS	NS
Cover Crop				
Wheat	203.8 a	7369.4 a	214.3 a	2930.9 a
None	0.0 b	0.0 b	0.0 b	0.0 b
LSD (0.01)	8.4	6881.1	17.5	1363.0

[a] Means within a column followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.2: Biomass Macronutrient Content Analysis pooled over years, Plains.

Characteristic	**Nutrient**					
	N	P	K	Ca	Mg	S
	-----------------------------------kg/ha-----------------------------------					
Bed Type						
Flat Bed	71.0 a[a]	7.4 a	79.6 a	6.2 a	3.5 a	15.3 a
Raised Bed	83.6 a	8.2 a	93.6 a	6.9 a	4.1 a	19.4 a
Rip and Bed	78.3 a	8.5 a	93.9 a	7.1 a	4.1 a	16.7 a
LSD (0.10)	NS[b]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	156.1 a	16.0 a	184.1 a	15.0 a	8.2 a	34.3 a
None	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
LSD(0.05)	111.9	11.9	139.2	10.5	5.9	26.8

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[b] NS = not significant.

Table 4.3: Biomass Micronutrient Content Analysis pooled over years, Plains.

Characteristic	**Nutrient**					
	B	Cu	Fe	Mn	Mo	Zn
	--------------------------------------g/ha--------------------------------------					
Bed Type						
Flat Bed	16.6 a[a]	10.7 a	1224.1 a	230.1 a	5.0 a	83.7 a
Raised Bed	19.3 a	9.9 a	975. 6 a	318.8 a	6.3 a	102 a
Rip and Bed	21.9 a	12.0 a	1254.0 a	334.9 a	7.0 a	98.2 a
LSD (0.10)	NS[b]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	38.6 a	21.7 a	2182.1 a	609.1 a	11.5 a	202.6 a
None	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
LSD(0.01)	30.21	15.9	649.5	600.7	7.5	188.6

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[b] NS = not significant.

Table 4.4: Biomass Macronutrient Content Analysis pooled over years, Tifton.

Characteristic	**Nutrient**					
	N	P	K	Ca	Mg	S
	--------------------------------------kg/ha--------------------------------------					
Bed Type						
Flat Bed	24.9 a[a]	4.0 a	28.5 a	4.1 a	1.6 a	3.0 a
Raised Bed	17.3 a	3.2 a	21.1 a	3.1 a	1.3 a	1.7 a
Rip and Bed	19.6 a	3.6 a	22.1 a	3.4 a	1.4 a	2.0 a
LSD (0.10)	NS[b]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	50.8 a	7.1 a	62.5 a	7.0 a	2.9 a	7.3 a
None	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
LSD(0.01)	39.6	4.9	51.4	2.9	1.8	6.2

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.5: Biomass Micronutrient Content Analysis pooled over years, Tifton.

Characteristic	**Nutrient**					
	B	Cu	Fe	Mn	Mo	Zn
	--g/ha--					
Bed Type						
Flat Bed	6.1 a[a]	26.4 a	641.5 a	59.6 a	3.6 a	40.5 a
Raised Bed	6.1 a	12.5 a	1075.6 a	48.7 a	2.6 a	32.7 a
Rip and Bed	5.6 a	17.4 a	1572.3 a	46.7 a	5.8 a	35.4 a
LSD (0.10)	NS[b]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	11.9 a	76.1 a	1965.2 a	101.9 a	8.0 a	71.9 a
None	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
LSD (0.01)	4.0	---	---	68.9	---	46.9
LSD (0.05)	---	67.2	---	---	---	---
LSD (0.10)	---	---	1790.7	---	5.6	---

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[b] NS = not significant.

Table 4.6: Peanut Tissue Sample Macronutrient Concentrations, Plains 2008.

Characteristic	**Nutrient**					
	N	P	K	Ca	Mg	S
	----------------------	----------------------	----------------------	%	----------------------	----------------------
Bed Type						
Flat Bed	4.18 a[a]	0.27 a	2.38 a	1.55 a	0.57 a	0.36 a
Raised Bed	4.18 a	0.26 a	2.37 a	1.57 a	0.56 a	0.37 a
Rip and Bed	4.17 a	0.26 a	2.44 a	1.52 a	0.55 a	0.36 a
LSD (0.10)	NS[b]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	4.24 a	0.27 a	2.47 a	1.58 a	0.51 b	0.37 a
None	4.12 a	0.26 a	2.33 b	1.52 a	0.61 a	0.35 b
LSD(0.05)	---	---	0.124	---	0.07	---
LSD (0.10)	NS	NS	---	NS	---	0.01

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.7: Peanut Tissue Sample Micronutrient Concentrations, Plains 2008.

Characteristic	**Nutrient**					
	B	Cu	Fe	Mn	Mo	Zn
	--ppm[a]--					
Bed Type						
Flat Bed	43.0 a[b]	3.48 a	97.5 a	81.9 a	1.07 a	33.3 a
Raised Bed	41.7 a	4.28 a	547.3 a	90.9 a	1.30 a	89.2 a
Rip and Bed	41.4 a	4.08 a	100.3 a	82.5 a	1.30 a	33.4 a
LSD (0.10)	NS[c]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	44.6 a	4.91 a	398.9 a	94.4 a	1.31 a	73.7 a
None	39.4 a	2.98 b	97.8 a	75.8 b	1.14 a	30.2 a
LSD (0.01)	---	---	---	12.25	---	---
LSD (0.10)	NS	1.85	NS	---	NS	NS

[a] ppm = parts per million.
[b] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[c] NS = not significant.

Table 4.8: Peanut Tissue Sample Macronutrient Concentrations, Tifton 2008.

Characteristic	**Nutrient**					
	N	P	K	Ca	Mg	S
	--	--	-------%	--	--	--
Bed Type						
Flat Bed	3.97 a[a]	0.23 a	2.26 a	1.47 a	0.46 a	0.37 a
Raised Bed	3.89 a	0.23 a	2.15 ab	1.45 a	0.45 a	0.37 a
Rip and Bed	3.93 a	0.23 a	2.08 b	1.49 a	0.45 a	0.35 a
LSD (0.05)	---	---	0.12	---	---	---
LSD (0.10)	NS[b]	NS	---	NS	NS	NS
Cover Crop						
Wheat	3.91 a	0.23 a	2.19 a	1.47 a	0.43 b	0.36 a
None	3.95 a	0.23 a	2.14 a	1.47 a	0.47 a	0.36 a
LSD (0.10)	NS	NS	NS	NS	0.03	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.9: Peanut Tissue Sample Micronutrient Concentrations, Tifton 2008.

Characteristic	**Nutrient**					
	B	Cu	Fe	Mn	Mo	Zn
	ppm[a]					
Bed Type						
Flat Bed	37.6 a[b]	3.13 a	84.5 a	47.6 a	1.05 a	25.9 a
Raised Bed	46.5 a	2.45 a	89.9 a	49.2 a	1.09 a	26.2 a
Rip and Bed	38.8 a	3.46 a	105.8 a	49.8 a	1.00 a	26.0 a
LSD (0.10)	NS[c]	NS	NS	NS	NS	NS
Cover Crop						
Wheat	37.8 a	3.30 a	99.3 a	50.5 a	1.00 a	27.6 a
None	44.2 a	2.72 a	87.5 a	47.3 a	1.09 a	24.4 b
LSD(0.05)	---	---	---	---	---	2.39
LSD (0.10)	NS	NS	NS	NS	NS	---

[a] ppm = parts per million.
[b] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[c] NS = not significant.

Table 4.10: Peanut Stand Counts pooled over years, Plains.

Characteristic	**Stand Counts**			
	10 DAP	20 DAP	30 DAP	At Digging
	----------------------------Plants/m---------------------------			
Bed Type				
Flat Bed	6.6 a[a]	12.3 b	12.8 b	13.8 ab
Raised Bed	7.4 a	12.8 ab	13.4 ab	14.9 a
Rip and Bed	7.2 a	13.6 a	14.2 a	13.3 b
LSD (0.05)	---	---	0.95	---
LSD (0.10)	NS[b]	1.09	---	1.25
Cover Crop				
Wheat	6.5 b	12.6 a	13.5 a	13.7 a
None	7.7 a	13.2 a	13.4 a	14.3 a
LSD (0.05)	0.96	---	---	---
LSD (0.10)	---	NS	NS	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.11: Peanut Stand Counts pooled over years, Tifton.

Characteristic	**Stand Counts**			
	10 DAP	20 DAP	30 DAP	At Digging
	----------------------------Plants/m--------------------------			
Bed Type				
Flat Bed	10.3 b[a]	12.9 a	12.3 c	13.7 a
Raised Bed	11.7 ab	13.3 a	13.2 b	14.4 a
Rip and Bed	12.5 a	13.6 a	14.4 a	14.3 a
LSD (0.05)	1.79	---	0.86	---
LSD (0.10)	---	NS	---	NS
Cover Crop				
Wheat	11.6 a	13.0 a	13.4 a	14.0 a
None	11.5 a	13.6 a	13.1 a	14.3 a
LSD (0.10)	NS[b]	NS	NS	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.

[b] NS = not significant.

Table 4.12: Peanut Heights and Widths pooled over years, Plains.

Characteristic	**Heights and Widths**			
	48 DAP Height	48 DAP Width	62 DAP Height	62 DAP Width
	---------------------------------------cm-----------------------------------			
Bed Type				
Flat Bed	30.2 a[a]	64.6 a	44.9 a	97.4 a
Raised Bed	32.1 a	69.5 a	45.7 a	97.7 a
Rip and Bed	31.6 a	69.2 a	45.7 a	96.6 a
LSD (0.10)	NS[b]	NS	NS	NS
Cover Crop				
Wheat	31.2 a	66.7 a	45.6 a	96.7 a
None	31.3 a	68.9 a	45.2 a	97.8 a
LSD (0.10)	NS	NS	NS	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[b] NS = not significant.

Table 4.13: Peanut Heights and Widths pooled over years, Tifton.

Characteristic	**Heights and Widths**			
	48 DAP Height	48 DAP Width	62 DAP Height	62 DAP Width
	----------------------	------cm------	----------------------	----------------------
Bed Type				
Flat Bed	29.3 b[a]	62.4 b	38.8 a	85.9 b
Raised Bed	31.1 ab	65.9 ab	39.6 a	88.4 b
Rip and Bed	31.9 a	69.4 a	41.1 a	92.8 a
LSD (0.01)	---	---	---	2.72
LSD (0.05)	---	4.57	---	---
LSD (0.10)	2.12	---	NS	---
Cover Crop				
Wheat	31.7 a	67.0 a	40.2 a	89.2 a
None	29.9 a	64.8 a	39.5 a	88.8 a
LSD (0.10)	NS[b]	NS	NS	NS

[a] Means within a column and effect followed by the same letter are not significantly different. Within an effect (Bed Type or Cover Crop), significance lettering is determined by the LSD presented for that effect.
[b] NS = not significant.

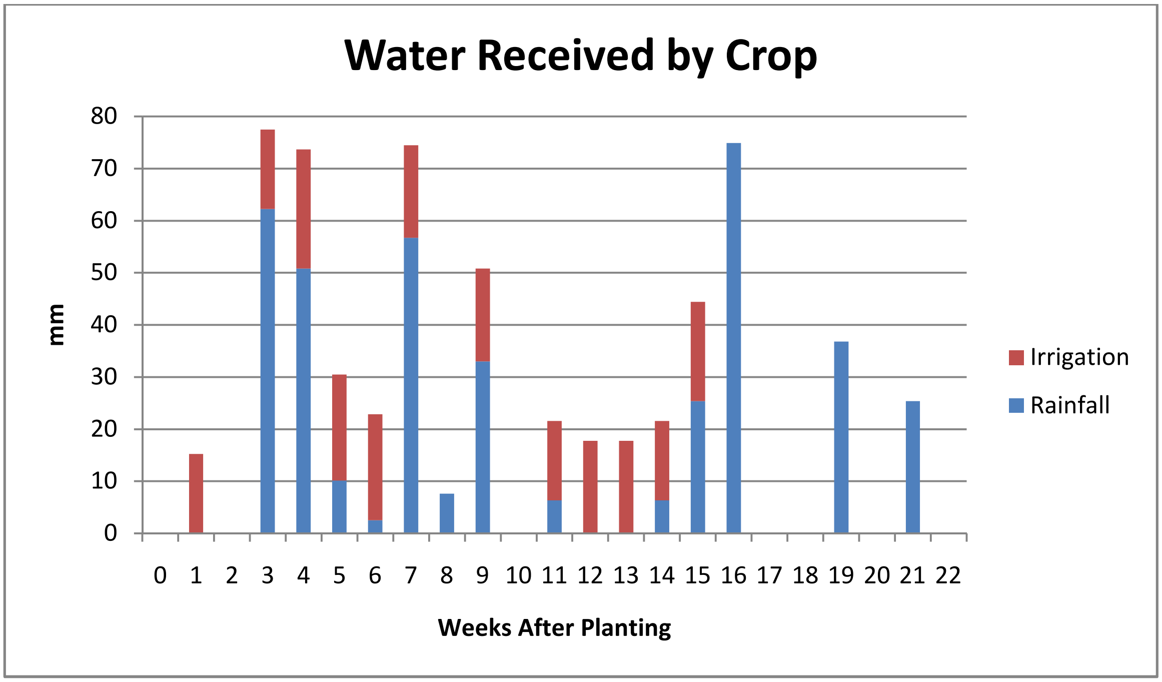


Figure 2.1: Total Water Received by Peanut, Tifton 2007. Week 0 refers to the week prior to planting. Week 1 begins the day peanut was planted. The last week represented in the graph was the week in which digging occurred.

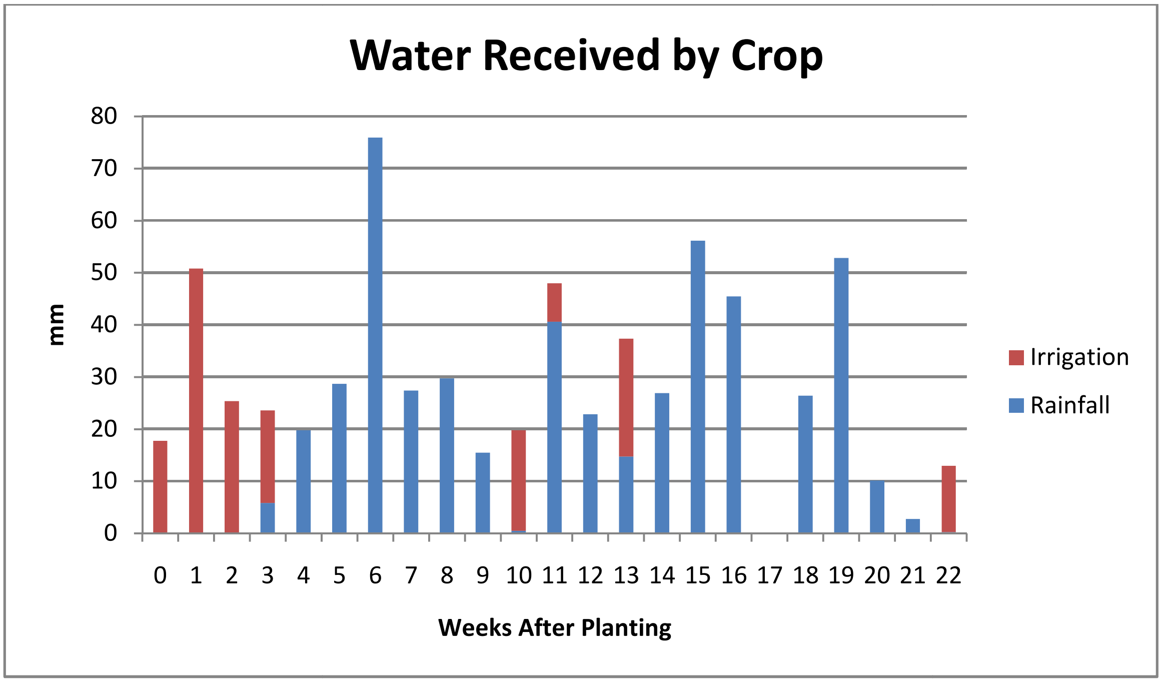


Figure 2.2: Total Water Received by Peanut, Plains 2007. Week 0 refers to the week prior to planting. Week 1 begins the day peanut was planted. The last week represented in the graph was the week in which digging occurred.

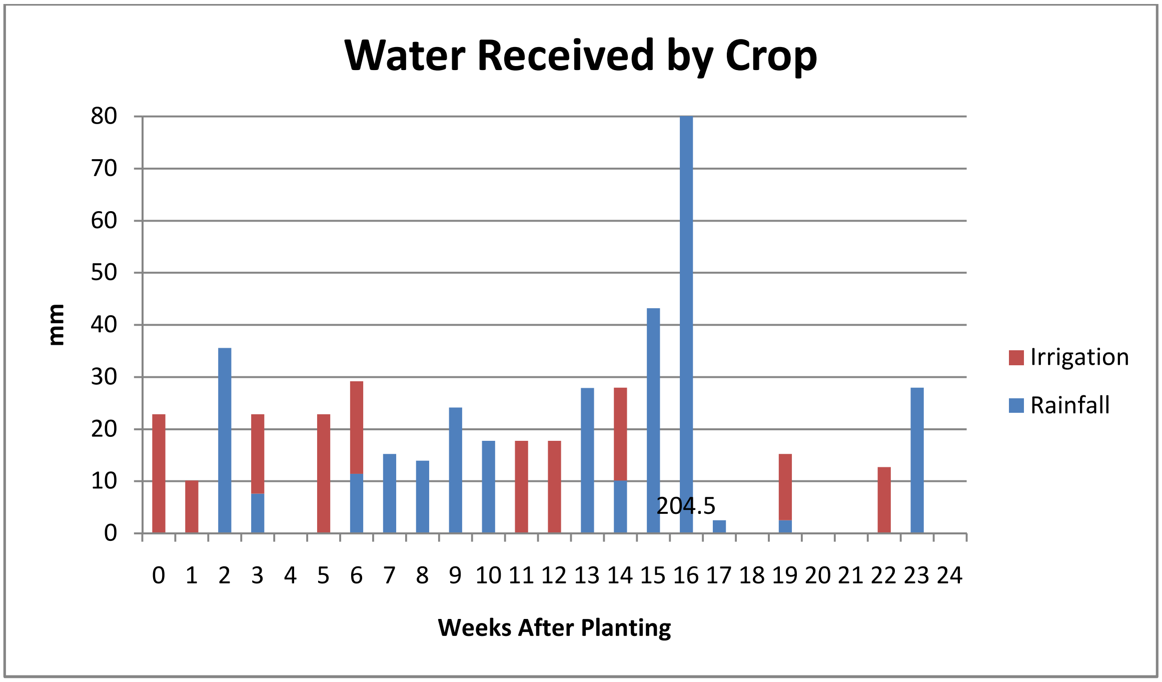


Figure 2.3: Total Water Received by Peanut, Tifton 2008. Week 0 refers to the week prior to planting. Week 1 begins the day peanut was planted. During week 16, Hurricane Fay deposited 204.5 mm of rainfall. The last week represented in the graph was the week in which digging occurred.

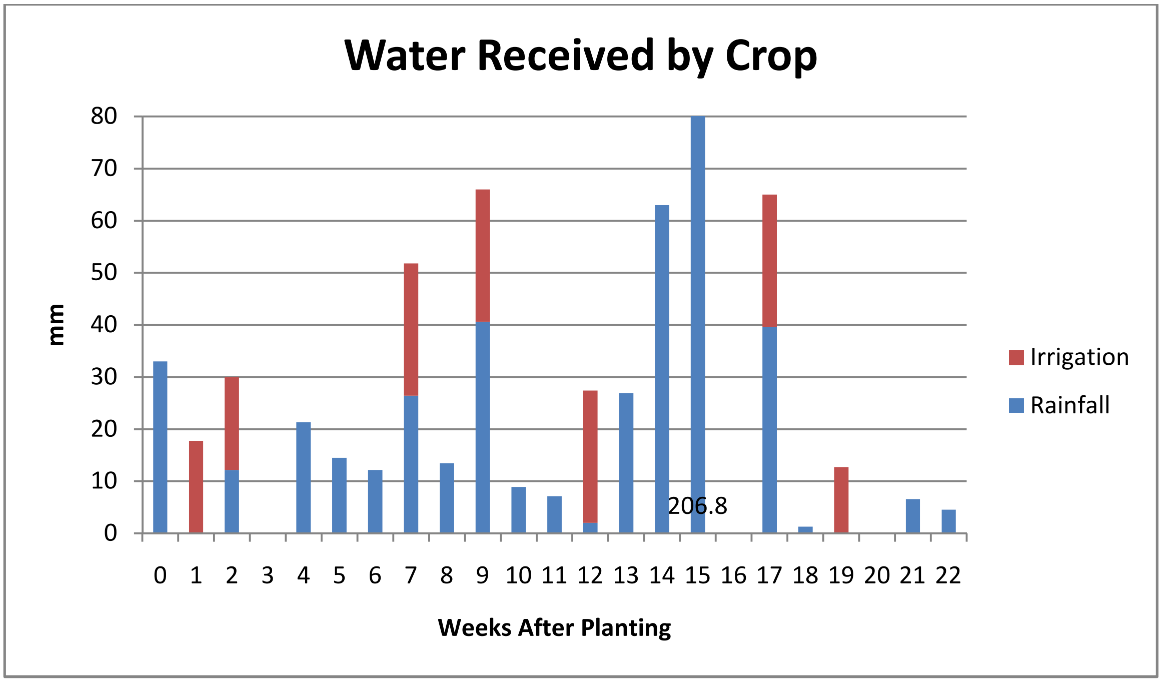


Figure 2.4: Total Water Received by Peanut, Plains 2008. Week 0 refers to the week prior to planting. Week 1 begins the day peanut was planted. During week 15, Hurricane Fay deposited 206.8 mm of rainfall. The last week represented in the graph was the week in which digging occurred.

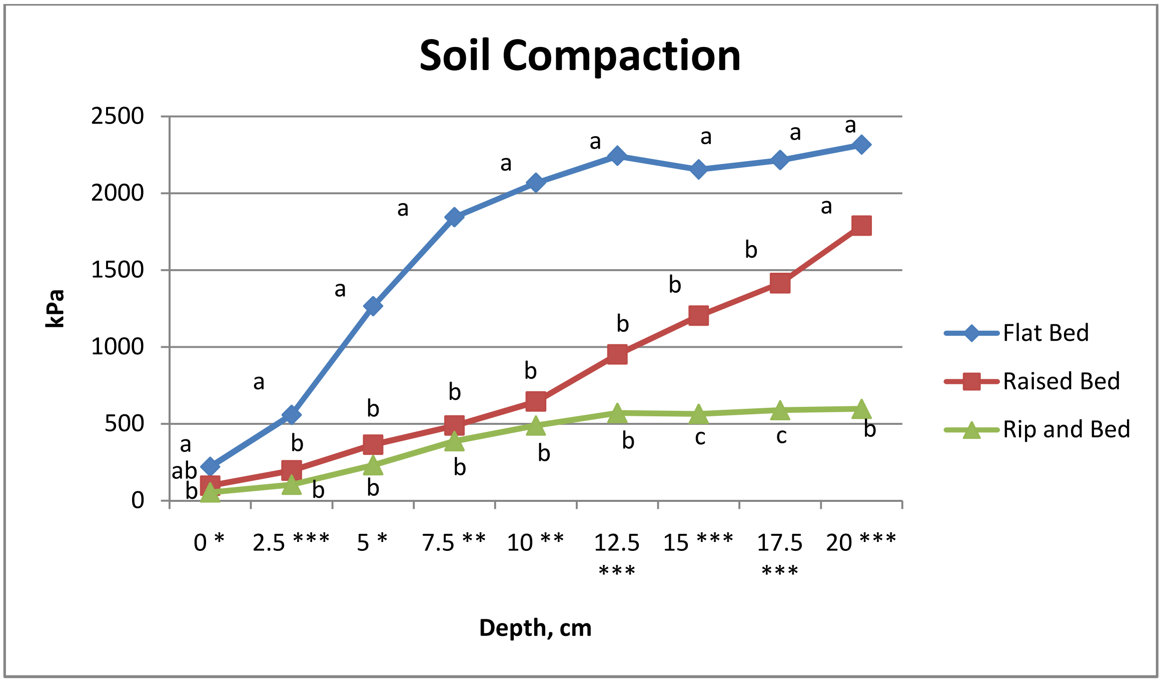


Figure 2.5: Soil Compaction, Plains 2008. This figure illustrates the main effect of bed type on soil compaction. At a given depth, data points with the same letter label are not significantly different. The significance level at each depth is represented by *, **, and *** which equals 0.10, 0.05, and 0.01, respectively.

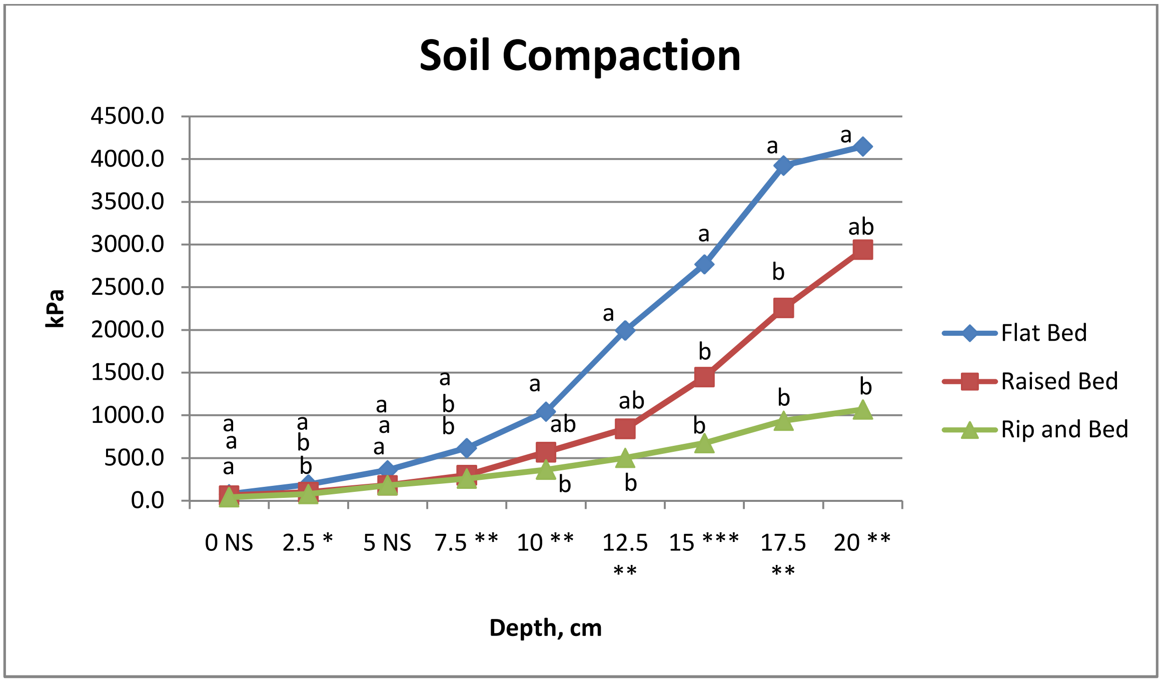


Figure 2.6: Soil Compaction, Tifton 2008. This figure illustrates the main effect of bed type on soil compaction. At a given depth, data points with the same letter label are not significantly different. The significance level at each depth is represented by NS, *, **, and *** which equals not significant, 0.10, 0.05, and 0.01, respectively.

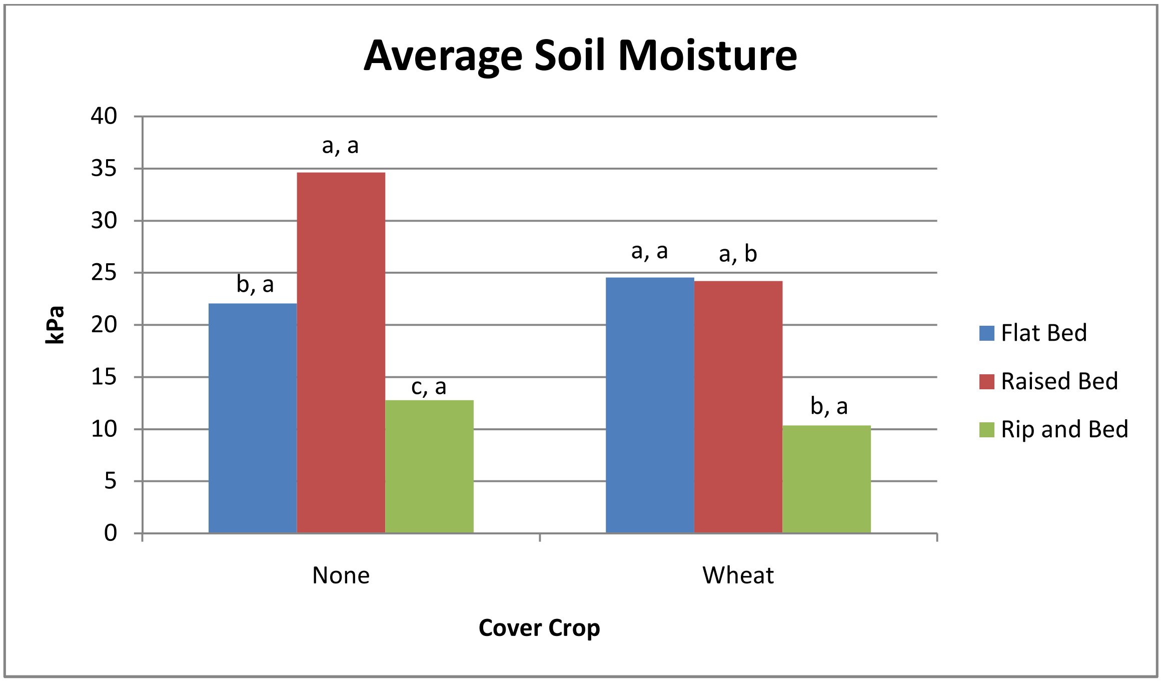
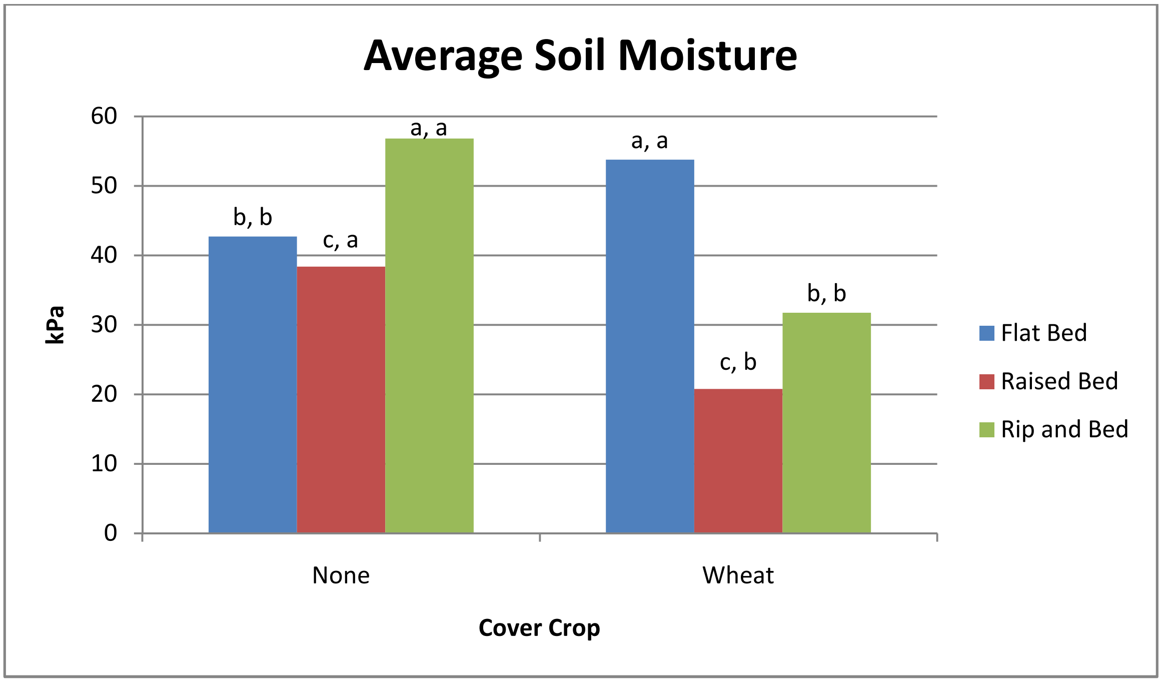


Figure 4.1: Average Soil Moisture, Plains 2007. Tension is measured in kPa on the y-axis. As soil tension increases, less soil moisture is available to the crop. Columns, bed types, within a cover crop category labeled with the same letter before the comma are not significantly different at P = 0.05. Columns for the same bed type labeled with the same letter after the comma are not significantly different with or without wheat at P = 0.05.



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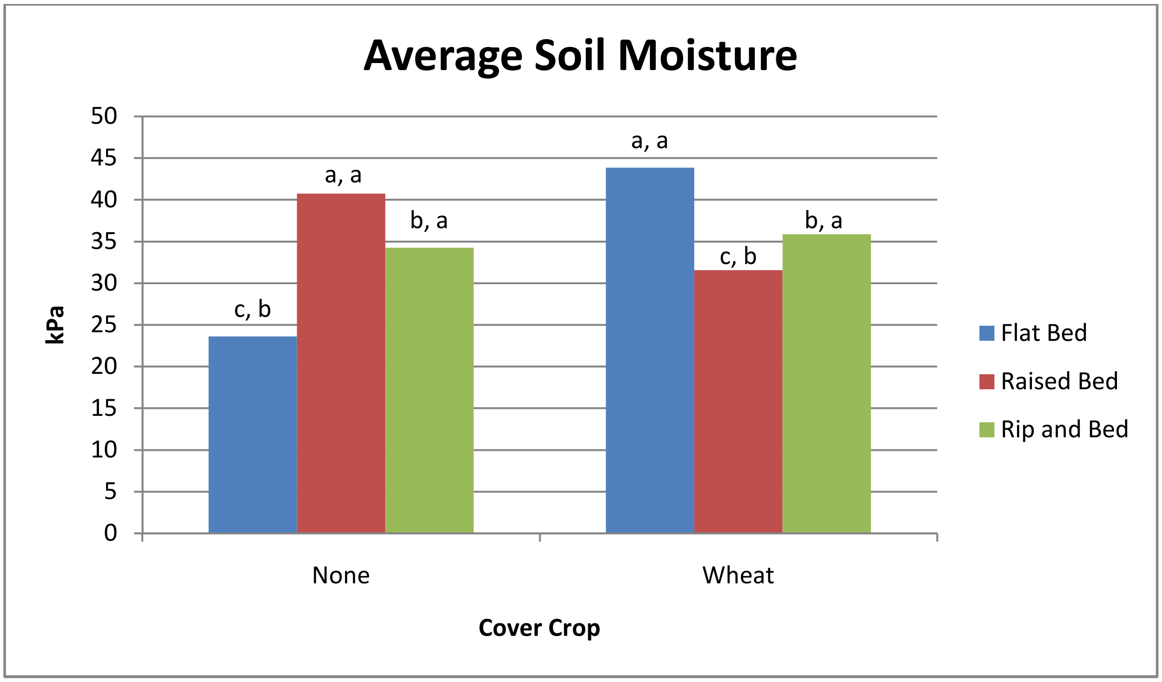

Figure 4.3: Average Soil Moisture, Tifton 2007. Tension is measured in kPa on the y-axis. As soil tension increases, less soil moisture is available to the crop. Columns, bed types, within a cover crop category labeled with the same letter before the comma are not significantly different at P = 0.05. Columns for the same bed type labeled with the same letter after the comma are not significantly different with or without wheat at P = 0.05.

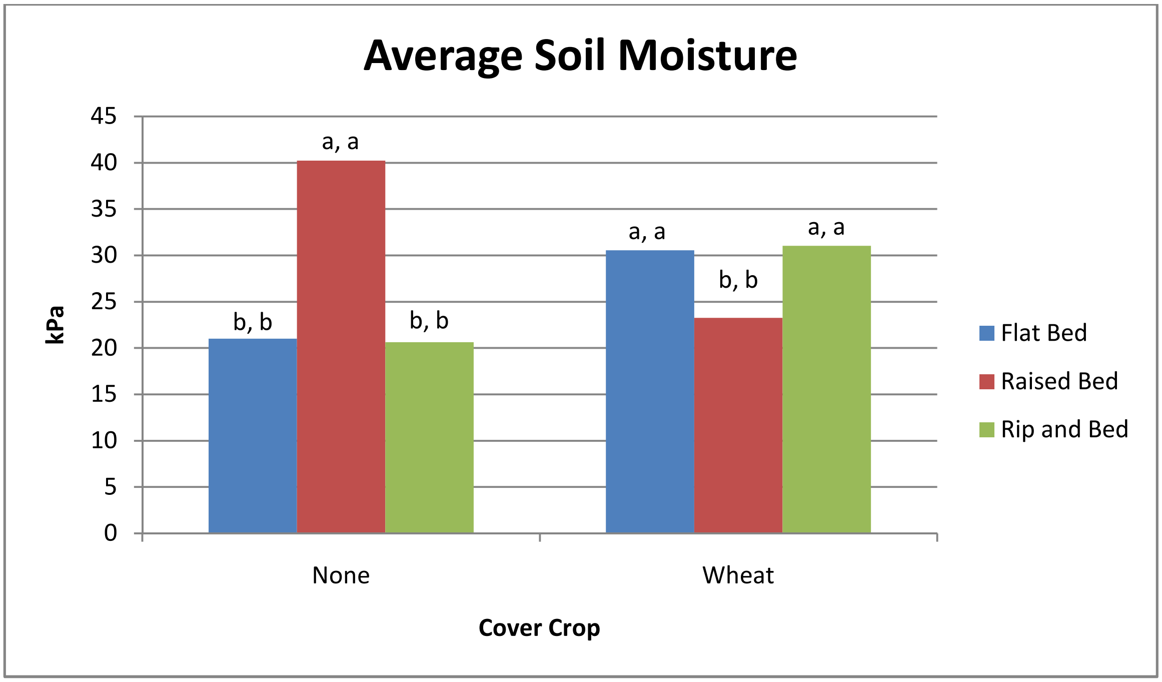

Figure 4.4: Average Soil Moisture, Tifton 2008. Tension is measured in kPa on the y-axis. As soil tension increases, less soil moisture is available to the crop. Columns, bed types, within a cover crop category labeled with the same letter before the comma are not significantly different at P = 0.05. Columns for the same bed type labeled with the same letter after the comma are not significantly different with or without wheat at P = 0.05.