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AGRONOMY AND SOILS

Evaluation of Wheat Stubble Management and Seeding Rates for Cotton Grown Following Wheat Production

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ABSTRACT

Growers desiring to maximize productivity of farm land have driven interest in double-cropping cotton (*Gossypium hirsutum* L.) following wheat (*Triticum aestivum* L.) production. However, the optimum approach for wheat stubble management and cotton seeding rates to achieve optimum cotton yield following wheat production yields is not completely defined. The objective of this study was to evaluate wheat stubble management practices and cotton seeding rates following wheat production. Field research was conducted in 2012 and 2013 at the R.R. Foil Plant Science Research Center in Starkville, MS and at the Black Belt Branch Experiment Station near Brooksville, MS. Wheat stubble management techniques included: no-till planting of cotton seed into undisturbed wheat stubble (None); double-disking wheat stubble followed by re-forming beds with a one-pass bedding implement (Re-bed); and burning wheat stubble and planting cotton seed without additional tillage (Burn). Delta and Pineland 0912 B2RF cotton seed was seeded at the following rates (planted seeds ha^{-1}): 49,000; 86,500; 123,500; and 160,500. Generally, as cotton seeding rates increased, percent cotton emergence decreased. Burning wheat stubble prior to planting cotton seed resulted in greater cotton emergence when compared to other wheat stubble management techniques. Cotton height at the end of the season was unaffected by wheat stubble management technique or cotton seeding rate. Cotton yields were highest when wheat stubble was burned and cotton was seeded at 160,500 seeds ha^{-1}. These data suggest that increasing cotton seeding rate and planting cotton seed into burned wheat stubble could increase the success rate of double cropping cotton following wheat.

As a whole, one of the foremost concerns in a double-crop system is the shortened growing season for the second crop (Baker, 1987). With respect to cotton (*Gossypium hirsutum* L.) grown in a double-crop system following wheat (*Triticum aestivum* L.), the length of fruiting period and adequate temperature accumulation for boll maturation are reduced (Baker, 1987). However, the development of earlier maturing cotton varieties may improve probability for success (Baker, 1987). A primary decision when planting a crop following wheat production is determining how to manage wheat stubble after harvest. Management of wheat stubble can influence soil loss (Hairston et al., 1987; Mutchler and Greer, 1984), planting conditions, nutrient availability, and allelopathic effects from decomposing wheat straw (Hairston et al., 1987; Hicks et al., 1989). Burning, mowing, disking, and leaving wheat straw at harvest height are options producers commonly utilize for managing wheat stubble. Planting directly into existing wheat stubble or no-tilling, has been suggested as the optimum method of wheat stubble management when double-cropping cotton following wheat production (Bagwell et al., 2007). No-till production increases surface residues and organic matter as well as preserves soil moisture needed to establish a subsequent crop (Bond and Willis, 1971). Previous research has shown that wheat stubble height after harvest has no influence on cotton lint yield (Ferguson et al., 2008). However, cotton was significantly shorter at the end of the season when cotton seed were planted into 15 and 30 cm tall wheat stubble compared to stale seed beds or fields in which

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wheat stubble was burned prior to cotton planting (Ferguson et al., 2008). Furthermore, a combine with a properly adjusted straw chopper/shredder has been shown to improve double-cropped soybean (*Glycine max* L.) establishment (Wesley, 1999). In addition, weed control may be problematic when soybeans are planted into wheat straw (Sanford et al., 1973). Wheat straw intercepts herbicides, in turn decreasing efficacy as well as impairing cultivation equipment. As a result, growers tend to burn wheat straw prior to seeding a subsequent crop (Kapusta, 1979; Sanford, 1982; Sanford et al., 1973; Wesley and Cooke, 1988). Wesley and Cooke (1988) indicated that planting soybean no-till after burning wheat straw enhances net returns in the Mid-South. Furthermore, burning wheat straw may not result in long term net positive or negative effects on soil properties (Kelley and Sweeney, 1998).

Cotton seeding rates following wheat production must also be considered when double-cropping cotton following wheat production. Additional costs associated with transgenic crops such as technology fees have increased input costs, and in turn, producers have reduced seeding rates in order to optimize yield and increase profit (Pettigrew and Johnson, 2005). Double-cropped cotton following wheat production is planted under less than optimal conditions adding complexity to the decision of whether to increase or decrease seeding rates to achieve an adequate stand of cotton (Ferguson et al., 2008; Pettigrew, 2002). In addition, Hicks et al. (1989), demonstrated that cotton varieties differ with respect to tolerance to allelopathic products produced by wheat residue. Ferguson et al. (2008) observed that a greater number of cotton plants emerged from the soil in stale seedbeds compared to double crop planting.

Low cotton plant populations can result in delayed maturity (Siebert et al., 2006). Cotton growers in Mississippi typically plant cotton seeds at 99,000 to 111,000 seeds ha^{-1} (Bridge et al., 1973). Bagwell et al. (2007), suggested increasing cotton seeding rates by 20% when planting into wheat stubble compared to cotton seeding rates used when not double-cropping. Increased seeding rates may facilitate adequate stand establishment and decrease the chance of delayed maturity. Also, due to the truncated growing season associated with double-cropped cotton following wheat production, it is important to maximize the number of first position fruiting structures due to the lack of heat units which are needed to mature second and third position fruiting structures, hence higher recommended seeding rates (Bednarz et al., 2000). Jenkins et al. (1990), determined that 90% of cotton lint yield was derived from first and second position fruit on sympodial branches which supports higher seeding rates based on increasing first position fruiting structures. Bednarz et al. (2000), observed that at high plant densities, fruit production from first position fruit on sympodial branches increased; however, at lower plant densities fruit production from third position fruit and monopodial branches increased. Additional studies have shown that lower seeding rates in early planted cotton should be avoided due to concerns of seed survival and uniform stand establishment (Pettigrew and Johnson, 2005).

Limited data is available regarding cotton yield grown in double-crop systems following wheat production. Smith and Varvil (1982) observed that yield of double-cropped cotton following wheat production was reduced 35 to 50% for early maturing varieties and 50 to 65% for full season varieties. Additionally, Smith and Varvil (1982) cite data from Georgia which indicated that double-cropped cotton produced nearly 80% of total yield compared to mono-cropped cotton. Baker (1987), observed similar results in double-cropped cotton following wheat yielded 28% less than that of mono-cropped cotton. Baker (1987), observed similar yields where cotton seed was planted into undisturbed soil where wheat stubble had been burned and where cotton seed was planted into soil that was re-bedded prior to cotton planting. Ferguson et al. (2008) found that wheat stubble management practice had no impact on cotton lint yield. Baker (1987) and Smith and Varvil (1982), found no detrimental effects on double-cropping cotton following wheat production on cotton fiber properties.

While limited data on double cropping cotton following wheat production is available, these data are more than 25 years old and do not represent modern cotton cultivars. Field observations indicate that cotton matures up to ten days earlier today compared to 25 years ago (Bednarz and Nichols 2005; Jenkins et al., 1990; McClelland, 1916). In addition, data is lacking on the interaction between wheat stubble management and cotton seeding rates with respect to cotton growth, development, and yield for cotton grown following wheat production. Therefore, this research was conducted to evaluate the interactive effects of wheat stubble management and cotton seeding rates on cotton growth, development, and yield in a double-crop system.

MATERIALS AND METHODS

Studies were conducted at the R.R. Foil Plant Science Research Center in Starkville, MS and at the Black Belt Branch Experiment Station near Brooksville, MS in 2012 and 2013 to determine the effect of wheat stubble management and cotton seeding rates on cotton growth, development, and yield when double cropped following wheat production. Wheat was planted uniformly at 67 kg ha^{-1} using conventional tillage onto beds during November 2011 and 2012 at all locations. Nitrogen was applied to wheat at 78 kg ha^{-1} as urea (46% N) in March of each year. Wheat was harvested at the following dates: 21 May 2012 and 18 June 2013 in Brooksville and 01 June 2012 and 12 June 2013 in Starkville using a John Deere 9900 combine equipped with a straw chopper/spreader.

Cotton plots consisted of four-97 cm rows that were 12.2 m in length at all locations and treatments were replicated four times. Wheat stubble management techniques included: no-till planting into undisturbed wheat stubble (None); double-disking wheat followed by re-forming beds with a one-pass bedding implement (Re-bed); and burning wheat stubble and planting cotton seed without additional tillage (Burn). Delta and Pineland 0912 B2RF (Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, MO 63167) was seeded at the following rates (planted seed ha^{-1}): 49,500; 86,500; 123,500; and 160,500 on 25 May 2012 and 21 June 2013 at Brooksvill,e and 04 June 2012 and 14 June 2013 at Starkville. All cotton was planted using a John Deere MaxEmerge XP vacuum planter manually calibrated for each respective seeding rate. The planter was equipped with floating trash cleaners (Martin Industries, P.O. Box 428, Elkton, KY 42220), 25 wave coulters (John Deere, One John Deere Place, Moline, IL 61625), and in-furrow seed firmers (Precision Planting, 23207 Townline Road, Tremont, IL 61658). Cotton seed was treated with Acceleron N (thiamethoxam + pyraclostrobin + ipconazole + abamectin). Fertilizer nitrogen (N) was injected in the soil 10 cm deep at a rate of 134 kg N ha^{-1} as 32% urea-ammonium nitrate (UAN) with a knife applicator on 21 June 2012 and 29 July 2013 at Brooksville, and 23 July 2012 and 29 July 2013 at Starkville; with both locations having an effective bloom date from mid to late August. Fertilizer in the form of P_2O_5 and K_2O was applied at each location based on soil test recommendations for cotton at each respective location. Each plot was scouted using appropriate methodology on a weekly basis for weed and/or insect pests with all pesticide and harvest aid applications applied based on Mississippi State University Extension Service recommendations. The Starkville location was furrow irrigated (~3.1 ha cm^{-1} per irrigation) as needed whereas the Brooksville location was grown under dry land conditions. Rainfall data for each location is given in Table 1. Soil at Starkville was classified as a Leeper silty clay loam (Fine, smectitic, nonacid, thermic Vertic Epiaquepts) and as a Brooksville silty clay (Fine, smectitic, thermic Aquic Hapluderts) in Brooksville. Cotton was defoliated using a blanket application when the latest maturing treatments reached 60 % open. Cotton at the Brooksville location was not harvested in 2012 due to excessive rainfall at that location that persisted into the spring of 2013. However, all other data with the exception of lint yield and fiber quality were collected throughout the growing season and was utilized in data analysis. Cotton was harvested on the following dates: 29 October 2013 in Brooksville, 28 November 2012, and 07 November 2013 in Starkville.

Table 1. Rainfall (cm) at each experimental location in 2012 and 2013

Month	Location			
	Starkville 2012	Brooksville 2012	Starkville 2013	Brooksville 2013
June	3.3	4.9	9.9	8.1
July	14.8	27.6	12.5	8.9
August	2.4	12.8	6.5	1.3
September	7.2	22.8	10.4	12.3
October	11.7	4.0	10.4	2.8
November	5.4	6.9	7.9	6.7

Data collection from the beginning to the middle of the season consisted of: cotton stand counts; cotton height, total nodes and nodes above white flower (NAWF) at first bloom. Data collection at the end of the season consisted of cotton height, total nodes, and nodes above cracked boll (NACB); data was collected immediately prior to harvest aid application. With the exception of stand counts, all data were collected from five plants per plot. Stand counts were taken by counting every plant in each row within a single plot. Yield and fiber quality data were also collected. The center two rows of each plot were harvested with a cotton picker modified to harvest small plots. Fiber quality was determined from 25 boll samples collected by hand immediately prior to machine harvest. Fiber quality was determined by high volume instrumentation (HVI) at the Louisiana State University (LSU) AgCenter fiber testing laboratory (Sasser, 1981). Lint yield was calculated from lint percent determined from ginning samples from each individual plot.

Experiments were conducted using a split-plot arrangement of treatments within a randomized complete block design. Wheat stubble management technique was the main plot and cotton seeding rate was the subplot. All data were analyzed using the Proc GLIMMIX procedure in SAS v. 9.3. Means were separated using Fisher's protected LSD at α=0.05. Each site-year was treated as a random effect and data were pooled across experimental locations to allow for inferences regarding treatments across a range of environments (Carmer et al., 1989). A number of previously published manuscripts across a wide array of disciplines have utilized this approach including Bond et al., (2008); Hager et al., (2003) and Jenkins et al., (1990).

RESULTS AND DISCUSSION

No interaction between cotton seeding rate and wheat stubble management techniques were present regarding observed effects on stand counts. Wheat stubble management technique only significantly affected percent cotton emergence at 11 to 12 days after planting (DAP) and 17 to 19 DAP (Table 2). Cotton emergence averaged 44% regardless of wheat stubble management technique at nine to ten DAP (Table 3). Percent cotton emergence was influenced by wheat stubble management technique at 11-12 DAP and ranged from 37-50% (Table 3). Cotton seed planted no-till into standing wheat stubble or fallow beds where wheat stubble was burned prior to cotton planting emerged at a rate of 45 and 50%, respectively, at 11-12 DAP. A significant reduction in cotton emergence was observed 11 to 12 DAP where land was double-disked and re-bedded prior to cotton planting (37%). Cotton emergence averaged 61%, regardless of wheat stubble management technique at 13 to 14 DAP (Table 3). Cotton seed planted into burned wheat stubble had significantly greater emergence (58%) compared to emergence of cotton seed that was planted into land re-bedded (50%) prior to cotton planting at 17 to 19 DAP (Table 3).

Cotton seeding rate significantly affected percent cotton emergence for all dates where stand counts were recorded (Table 2). Percent cotton emergence was greatest at all evaluation dates when 49,500 seed ha^{-1} was planted. Cotton emergence ranged from 35 to 60% at nine to ten DAP depending on seeding rate (Table 3). Cotton seeded at 49,500 seed ha^{-1} resulted in significantly greater plant emergence (60%) nine to 1ten DAP compared to percent emergence following all other seeding rates which ranged from 35-40% (Table 3). Cotton emergence ranged from 38 to 60% at 11 to 12 DAP depending on seeding rate. Cotton seeded at 49,500 seed ha^{-1} resulted in 60% emergence whereas 38-40% emergence was observed when cotton was seeded at rates greater than 49,500 seeds ha^{-1} (Table 3). At 13 to 14 DAP, cotton seeded at 49,500 seed ha^{-1} had significantly greater emergence (77%) compared to all other seeding rates (Table 3). Emergence of cotton seeded at 86,500 seeds ha^{-1} and greater ranged from 54-56% at 13 to 14 DAP. Cotton emergence at 17 to 19 DAP ranged from 47-70% depending on seeding rate. Cotton seeded at 49,500 seed ha^{-1} had an emergence rate of 70% at 17 to 19 DAP compared to 47-49% emergence at seeding rates greater than 86,500 seed ha^{-1}.

Table 2. Analysis of variance p-values for cotton growth, development, and yield parameters for cotton grown following wheat production

Source	Degrees of Freedom	Stand Counts 9 to 10 DAP[x]	Stand Counts 11 to 12 DAP[x]	Stand Counts 13 to 14 DAP[x]	Stand Counts 17 to 19 DAP[x]	First Bloom Heights	First Bloom Nodes	First Bloom NAWF[y]	Final Height	Final Nodes	NACB[z]	Lint Yield	Fiber Length	Fiber Uniformity	Fiber Strength	Micronaire
Wheat Stubble Management	2	0.2647	0.0012	0.6246	0.0226	0.2346	0.3230	0.0233	0.4174	0.2660	0.0219	0.0364	0.2281	0.0256	0.0215	0.5300
Cotton Seeding Rate	3	0.0046	<.0001	<.0001	<.0001	0.9673	0.3153	0.3500	0.8483	0.0306	0.0274	0.0075	0.4202	0.0718	0.0310	0.1640
Stubble Management x Seeding Rate	6	0.9521	0.8836	0.1206	0.8952	0.5348	0.6050	0.8513	0.9357	0.9401	0.9986	0.7656	0.8026	0.2280	0.7080	0.8596

[z] Nodes above cracked boll.

[y] Nodes above white flower.

[x] Days after planting.

Table 3. Percent cotton emergence as affected by wheat stubble management technique and cotton seeding rate[zy]

Wheat Stubble Management Technique	Cotton Seeding Rate	Days After Planting 9 to 10	11 to 12	13 to 14	17 to 19
	seed ha^{-1}	% Emergence			
Burn	--	**46 a**	**50 a**	**62 a**	**58 a**
None	--	**47 a**	**45 a**	**60 a**	**53 ab**
Re-bed	--	**39 a**	**37 b**	**60 a**	**50 b**
--	**49500**	**60 a**	**60 a**	**77 a**	**70 a**
--	**86500**	**40 b**	**40 b**	**56 b**	**49 b**
--	**123500**	**40 b**	**38 b**	**54 b**	**48 b**
--	**160500**	**35 b**	**38 b**	**54 b**	**47 b**

[z] **Data were pooled across experimental locations and years.**

[y] **Means within a column followed by the same letter are not significantly different based on Fisher's protected LSD at $p \leq 0.05$.**

Cotton emergence was lower in this study compared to cotton grown in a mono-crop situation. Reduced cotton emergence compared to cotton not planted following wheat production may be attributed to allelopathy from decomposing wheat stubble as suggested by Hicks et al., (1989) and Wu et al., (2001). In addition, less than optimal soil conditions at planting including cloddy soil where re-bedding occurred as well as heavy residue in the no-till treatments resulted in poor seed to soil contact in some instances. In addition, soil moisture was lacking where land was double disked and re-bedded prior to planting cotton seed. Although row cleaner attachments were utilized in this study, instances where poor seed to soil contact occurred due to the presence of heavy wheat stubble and straw. This made optimizing seed to soil contact difficult. Hicks et al., (1989), suggests that cotton tolerance to allelopathic effects are variety dependent. The cultivar utilized could have reduced tolerance to allelopathic chemicals produced by wheat residue and roots. In instances where wheat straw and wheat stubble were burned the level of trash was greatly decreased however, the burning of residue also caused the soil to become increasingly hard. In 2013 furrow irrigation was implemented one week after planting in an attempt to aid cotton emergence. Previous research indicates up to a 21% reduction in cotton emergence may occur when cotton was planted following wheat production (Hicks et al., 1989). Furthermore, with increasing cotton seeding rates, a reduction in cotton emergence may be due to increased plant competition, less than optimum planting conditions, and environmental conditions (L.T. Barber, Personal Communication).

No interaction between cotton seeding rate and wheat stubble management techniques were present regarding observed effects on cotton height at first bloom or total mainstem nodes at first bloom. Cotton height and total nodes at first bloom were unaffected by wheat stubble management technique alone or cotton seeding rate alone (Table 2). Cotton height at first bloom ranged from 66 to 68 cm with plants having 15 nodes regardless of wheat stubble management technique or cotton seeding rate (Table 4). Wheat stubble management significantly affected NAWF at first bloom (Table 4). Cotton grown on land that was re-bedded prior to planting had 6.7 NAWF at first bloom whereas cotton grown where no wheat stubble management was performed had 6.4 NAWF (Table 4). Wheat stubble that was burned prior to cotton planting resulted in cotton with 6.6 NAWF at first bloom which was not significantly different than NAWF of cotton grown where no wheat stubble management was performed or where land was re-bedded prior to cotton planting (Table 4). Although significant differences did exist with respect to cotton NAWF at first bloom, these differences were minor. Cotton grown under normal conditions typically has at least nine NAWF at first flower, any less is an indication of early-season stress (Silvertooth, 1994).

Cotton height at the end of the season was unaffected by wheat stubble management technique or seeding rate and ranged from 88 to 91 cm (Tables 2 and 5). Total nodes at the end of the season were also unaffected by wheat stubble management practice; however, total nodes at the end of the season were affected by cotton seeding rate (Table 2). Total cotton nodes at the end of the season ranged from 19 to 20. Cotton seeded at 49,500 seed ha^{-1} had 20 nodes at the end of the year whereas cotton seeded at 123,500 seed ha^{-1} and greater had 19 nodes at the end of the season. Total cotton nodes at the end of the season where cotton was seeded at 86,500 seed ha^{-1} were similar to total nodes produced from cotton seeded at all other seeding rates (Table 5). Total nodes at the end of the season increased as seeding rates decreased; however, differences were minimal. Similar observations were made by Siebert et al. (2006). Nodes above cracked boll at the end of the season were affected by wheat stubble management technique and cotton seeding rate. Wheat stubble management affected NACB and counts ranged from 6.9 where cotton was seeded into burned wheat stubble to 7.5 where cotton was seeded into land re-bedded prior to planting and 7.6 NACB where no wheat stubble management was performed (Table 5). Cotton seed planted into burned wheat stubble had significantly lower NACB at the end of the season than cotton seeded into standing wheat stubble or land that had been re-bedded prior to planting (Table 5). The lack of differences in NACB associated with the standing wheat stubble treatments and the re-bedding treatments disagree with findings by Stevens et al., (1992), who observed maturity delays when cotton was planted into terminated wheat when compared to when land was prepped prior to planting. Nodes above cracked boll ranged from 6.9 when cotton was seeded at 123,500 seed ha^{-1} to 7.6 when cotton was seeded at 49,500 and 86,500 seed ha^{-1} (Table 5). Cotton seeding rates of 123,500 seed ha^{-1} resulted in the least amount of NACB; however, NACB counts following this seeding rate were not significantly different than NACB counts following cotton seeding rates of 160,500 seed ha^{-1} (Table 5). Seeding rates of 49,500 seed ha^{-1} and 86,500 seed ha^{-1} resulted in the largest delay in maturity; however, NACB counts following these seeding rates were not significantly different from NACB counts following seeding rates of 160,500 seed ha^{-1} which is in agreement with previous research (Bagwell et al. 2007) (Table 5).

Cotton lint yield was affected by wheat stubble management technique and cotton seeding rate (Table 1). Cotton lint yields ranged from 766 to 892 kg ha^{-1} with cotton seeded into burned wheat stubble having significantly greater yields than cotton seeded into standing wheat stubble (Table 5). Lint yield from cotton seed planted into standing wheat stubble was not significantly different from that of cotton seed planted into land that had been re-bedded prior to planting (Table 5). Cotton lint yields ranged from 750 to 944 kg ha^{-1} depending on seeding rate (Table 5). Differences in yields could be attributed to delays in maturity that were observed (Table 5). In addition, the lack of growing degree days to mature bolls also likely influenced cotton lint yields. Cotton seeding rates of 160,500 seed ha^{-1} resulted in significantly greater lint yields (944 kg ha^{-1}) than cotton planted at all other seeding rates (Table 5). Similar results have been observed by Bagwell et al. (2007); Bednarz et al., (2000); Franklin et al., (2000); Pettigrew and Johnson (2005); and Siebert et al., (2006) with respect to increased cotton lint yields following increased seeding rates.

Table 4. Cotton height, total nodes, and nodes above white flower at first bloom as affected by wheat stubble management technique and cotton seeding rate[zy]

Wheat Stubble Management Technique	Cotton Seeding Rate	Cotton Height	Total Nodes	NAWF[x]
	seed ha^{-1}	cm	#	
Burn	--------	68 a	15 a	6.6 ab
None	--------	67 a	15 a	6.4 b
Re-bed	--------	66 a	15 a	6.7 a
--	49500	67 a	15 a	6.6 a
--	86500	67 a	15 a	6.6 a
--	123500	67 a	15 a	6.5 a
--	160500	68 a	15 a	6.4 a

[z] Data were pooled across experimental locations and years.

[y] Means within a column followed by the same letter are not significantly different based on Fisher's Protected LSD at $p \leq 0.05$.

[x] Nodes above white flower

Table 5. End of season cotton height, nodes, nodes above cracked boll, lint yield, and fiber quality based on wheat stubble management technique and cotton seeding rate[zy]

Wheat Stubble Management Technique	Cotton Seeding Rate	Cotton Height	Total Nodes[x]	NACB[w]	Lint Yield	Fiber Length	Fiber Uniformity	Fiber Strength	Micronaire
	seed ha^{-1}	cm	#		kg ha^{-1}	cm	%	g tex^{-1}	
Burn	**--**	**88 a**	**20 a**	**6.9 b**	**892 a**	**2.82 a**	**83.4 b**	**31.6 b**	**4.8 a**
None	**--**	**91 a**	**20 a**	**7.5 a**	**766 b**	**2.82 a**	**83.5 ab**	**32.2 a**	**4.8 a**
Re-bed	**--**	**91 a**	**20 a**	**7.6 a**	**824 ab**	**2.84 a**	**83.8 a**	**32.1 a**	**4.9 a**
--	**49500**	**91 a**	**20 a**	**7.6 a**	**785 b**	**2.84 a**	**83.8 a**	**32.1 a**	**4.8 a**
--	**86500**	**90 a**	**20 ab**	**7.6 a**	**750 b**	**2.82 a**	**83.5 a**	**31.6 b**	**4.8 a**
--	**123500**	**89 a**	**19 b**	**6.9 b**	**831 b**	**2.84 a**	**83.6 a**	**32.3 a**	**4.9 a**
--	**160500**	**89 a**	**19 b**	**7.1 ab**	**944 a**	**2.82 a**	**83.4 a**	**31.6 ab**	**4.9 a**

[z] **Data were pooled across experimental locations and years.**

[y] **Means within a column grouped with similar treatments (wheat stubble management or cotton seeding rate) followed by the same letter are not significantly different based on Fisher's protected LSD at p≤0.05.**

[x] **Statistical differences were present in total nodes due to cotton seeding rate were present; however, due to rounding, these differences are not overly apparent.**

[w] **Nodes above cracked boll**

Fiber length was unaffected by cotton seeding rate or wheat stubble management practice and ranged from 2.82 to 2.84 cm which would not warrant price deductions or premium based on the CCC cotton loan chart (NCC, 2014) (Tables 2 & 5). Cotton seeding rates of 49,500 and 123,500 seed ha^{-1} resulted in significantly greater fiber strength than fiber strength from cotton seeded at 86,500 seed ha^{-1}. Cotton fiber strength was similar for cotton seeded at 49,500, 123,500, and 160,500 seed ha^{-1} (Table 5). Although cotton fiber strength was affected by both stubble management and seeding rate, these differences were minor and all wheat stubble management techniques and cotton seeding rates would have increased premiums up to 45 points based on the CCC loan chart (NCC, 2014). Micronaire was unaffected by cotton seeding rate or wheat stubble management practice and ranged from 4.8 to 4.9 which would not warrant price deductions based on the 2014 CCC cotton loan chart (Table 5). Fiber quality data agree with Smith and Varvil (1982), who found that double-cropped cotton had no detrimental effects on fiber quality.

Fiber uniformity was significantly affected by wheat stubble management technique but not by cotton seeding rate (Table 2). These results are contrary to the findings of Baker (1987), who found cotton seed planted into land that was re-bedded prior to planting had significantly greater fiber uniformity at 83.8% than fiber uniformity from cotton seeded into burned wheat stubble (83.4%) (Table 5). Although significant differences in fiber uniformity did exist, cotton grown under all wheat stubble management techniques resulted in high levels of fiber uniformity (83.4-83.8%) which would have increased premiums up to 20 points based on the CCC loan chart (NCC, 2014). Cotton seeding rate had no effect on fiber uniformity. Cotton seed planted into standing wheat stubble as well as land that was re-bedded prior to planting resulted in significantly greater fiber strength compared to fiber strength from cotton seed planted into burned wheat stubble (Table 5).

In conclusion, as cotton seeding rates increased, percent emergence decreased. Additionally, cotton seed planted into burned wheat stubble had greater emergence compared to cotton seed planted into land that was re-bedded prior to planting. Cotton height at first bloom or at the end of the season was unaffected by either wheat stubble management or cotton seeding rate. Growers should increase seeding rates when planting DP 0912 B2RF following wheat by at least 20% compared to mono-cropped cotton when double-cropping cotton following wheat production. Based on these findings, burning wheat stubble prior to planting cotton following wheat production is another measure that should be taken in Mississippi in an attempt to maximize yield. Observations by Rasmussen et al., (1980), have shown sharp declines in the carbon and nitrogen levels when wheat stubble is burned in the fall or the spring. However, this study was developed using methods already commonly practiced by growers who are double cropping acres behind wheat production. When comparing the fixed costs associated with stubble management treatments, the total for preparing and re-bedding a production field would be \$63.20 ha^{-1} (Falconer et al., 2015). Whereas the total for burning the stubble or leaving the stubble is zero considering there is no need for additional equipment to be used. Disking the wheat stubble and re-bedding prior to cotton planting is not recommended due increased input costs and risk of soil moisture loss.

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