# Improving Conservation Tillage Practices for Pearl Millet

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## Introduction

Conservation tillage practices should reduce pearl millet production costs by saving time, fuel, and fertilizer, but there is little information available concerning recommendations. In this paper we summarize recent research, developments, and experiences in developing no-till practices and identifying improved varieties for more cost-effective production.

***Stand Establishment***

Stand establishment is the most critical stage for production. Planting depth control and soil contact are the greatest challenges to getting a good stand. Because of the small size of pearl millet seed (about 1/3 the size of sorghum), planting depth should be ½ to ¾ inches. Crop residue can cause the planter's depth wheels to ride up making it difficult to get the seed placed into the furrow. It is important to plant into soils with moisture sufficient for seed germination.

With conventional tillage, seeding rates of 4 lbs/ac in 21 inch rows are recommended (Lee et al, 2004). Rates ranging from 8 to 13 lbs/ac are necessary to assure adequate stands in no-till. Cost of hybrid seed can be prohibitive for using these higher seeding rates, but new varieties such as "2304" that allow seed to be saved should have lower seed costs.

Row spacing of 7.5, 15, and 22.5 inches were evaluated at Watkinsville GA in a split plot design, with tillage as main plots and legacy fertility treatment as sub-plots. Tillage treatments were conventional tillage vs. no-till. Legacy fertility treatments were prior fertilization with poultry litter vs. anhydrous N. Tifgrain 102 and 2304 were sown 18 Jul 2006 in 3 replications with 6 lbs seed/ac with a pre-emergence application of Callisto (3 oz/ac). Fertilizer was applied at 80 lbs N/ac. Grain was combine-harvested, and yields were corrected to 15.5% moisture.

Neither variety nor fertility effects were significant for stand or yield ($P \geq 0.31$). Stands and yields were greater in plots with conventional tillage ($P=0.03$, Fig. 1). In no-till plots, stands and yields were greater in 7.5 inch rows compared to the wider inch row spacings ($P<0.05$).

Although better stands were obtained with closer row spacing, plants in close rows may be more prone to lodging. Variety 2304 was planted 7 Jul 2007 in 7.5 and 15 inch rows at 8 lbs seed/ac on a farm in Tifton GA. Due to scheduling difficulties, harvest was delayed until after plants had begun to lodge. At harvest on 25 Oct 2007, numbers of erect and lodged stems were counted in five random 10 ft x 7 ft sections for both row spacings. Lodging in the 7.5 inch rows (39.9% of stems) differed (*P*=0.03) from lodging in the 15 inch rows (20.3%). Lodging may be reduced by timely harvest.

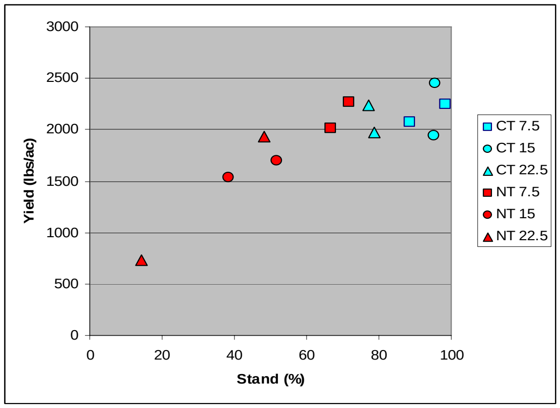


**Figure 1. Stand establishment and yield of pearl millet in conventional tillage (CT) and no-till (NT) at three row spacings at Watkinsville, GA in 2006. Two data points for each treatment represent different varieties.**

### *Weed Management*

It is important to control annual grass weeds for a successful crop. Until recently, the only pre-plant or pre-emergence herbicide options were glyphosate or paraquat to control existing weeds. Callisto (mesotrione) was registered for use on pearl millet in 2008. Callisto applied at-plant at 3 oz/ac provides season-long control of crabgrass (*Digitaria* spp.), Texas panicum (*Panicum texanum*), and many broadleaf weeds. As with other pre-emergence herbicides, soil moisture from rain or irrigation is necessary to activate Callisto for best results.

Atrazine is an effective post-emergence herbicide when applied at the 2 to 3 leaf stage (Wright et al, 1995), but it has not been possible to get registration for pearl millet. The only herbicide registered for post-emergence broadleaf weed control in pearl millet is 2,4-D. Apply to emerged weeds at 3 to 4 weeks after emergence or when the crop is 8 to 12 inches tall. The broadcast rate for 2,4-D is 1 pint/ac of a 4-pound formulation or 0.5 lbs/ac active ingredient.

### *Hybrid Evaluations*

Experimental pearl millets were evaluated for yield and grain composition at Watkinsville GA in a split plot design, with tillage as main plots and legacy fertility treatment as sub-plots. Tillage treatments were conventional tillage vs. no-till. Legacy fertility treatments were prior fertilization with poultry litter or anhydrous N. Varieties were sown 18 Jul 2006 in 3 replications with 6 lbs seed/acre in 15 inch rows with a pre-emergence application of Callisto (3 oz/acre). Fertilizer was applied at 80 lbs N/ac. Grain was combine-harvested, and yields were corrected to 15.5% moisture. Grain was evaluated for 100 grain weight, protein, fat, and starch.

Experimental hybrid (506 x 2304) was among the top yielding entries in each treatment (Table 1). Across all treatments, (506 x 2304) had 38% greater yield than Tifgrain 102. Hybrid (606 x 2304) had 30% greater yield than Tifgrain 102. Over all entries, yields were greatest with conventional tillage (Table 2), primarily due to poorer stand establishment in no-till (data not shown). Prior fertility treatment had no effect on yield. Grain from no-till plots had greater 100 grain weight and protein content, and less starch. Prior fertility treatment had a minor effect on grain quality. Grain from poultry litter plots had higher protein and lower starch.

Despite the greater yield potential of some experimental hybrids, management will play a key role in achieving that potential. Stand establishment is critical to a successful crop. No-till planting with in-row subsoiling increased yield 16% over conventional tillage (Wright et al, 1995). Poultry litter can be a beneficial fertilizer up to 2 tons/ac (Gascho et al, 2001). Fertilizer costs might be reduced if warranted by site-specific conditions.

**Table 1. Yield of experimental pearl millets in tillage and fertilizer trials in Watkinsville, GA in 2006.**

| Entry | Grain yield (lbs/ac) | | | | |
|---|---|---|---|---|---|
| | Overall mean | No-till poultry | No-till anhydrous | Conventional poultry | Conventional anhydrous |
| 106 x 2304 | 2191 cd | 2082 ab | 2216 ab | 2337 bcd | 2127 cd |
| 206 x 2304 | 2377 bc | 2203 ab | 1834 abc | 2789 b | 2681 abc |
| 306 x 2304 | 1998 de | 1910 ab | 1741 abc | 2231 cd | 2110 cd |
| 406 x 2304 | 2585 ab | 2456 a | 2406 a | 2662 bc | 2816 ab |
| 506 x 2304 | 2750 a | 2578 a | 2041 abc | 3465 a | 2917 ab |
| 606 x 2304 | 2595 ab | 1992 ab | 1502 c | 3647 a | 3240 a |
| 99 x 2304 | 2434 abc | 2457 a | 2095 abc | 2432 bc | 2752 abc |
| 2304 | 1820 e | 1681 ab | 1709 bc | 1913 d | 1978 d |
| Tifgrain 102 | 1991 de | 1460 a | 1609 bc | 2586 bc | 2307 bcd |
| lsd (*P*=0.05) | 355 | 964 | 688 | 502 | 677 |

**Table 2. Tillage and fertilizer treatment effects on pearl millet in Watkinsville, GA in 2006**

| Management main effect | Yield (lbs/ac) | 100 Grain weight (g) | Protein (%) | Fat (%) | Starch (%) |
|---|---|---|---|---|---|
| Conventional | 2610 a | 0.63 b | 11.1 b | 5.0 | 63.9 a |
| No-till | 1999 b | 0.80 a | 11.6 a | 5.1 | 63.1 b |
| lsd (*P*=0.05) | 168 | 0.02 | 0.1 | NS | 0.1 |
| | | | | | |
| Poultry litter | 2382 | 0.71 | 11.6 a | 5.1 | 63.1 b |
| Anhydrous N | 2227 | 0.71 | 11.1 b | 5.0 | 63.9 a |
| lsd (*P*=0.05) | NS | NS | 0.1 | NS | 0.1 |

### *Changes in Soil Carbon and Nitrogen*

Pearl millet was no-till planted into rye residue on plot land previously in a cotton-cotton-peanut rotation at the University of Georgia Tifton. Tifgrain 102 and 2304 were planted 2 May 2005 and

15 June 2006 at 6 lbs seed/ac in 15 inch rows, with a post-emergence application of Atrazine 4L (1.5 pints/ac) + Agri-oil (1 pint/ac). Soil was sampled (0-2 cm) and evaluated for total soil carbon and nitrogen content in oven dried and ball-milled samples using a Carlo-Erba Model NA 1500 series II carbon-nitrogen analyzer.

Soil carbon and nitrogen increased with no-till pearl millet (Fig. 2). Spikes in both elements corresponded to the cropping period of pearl millet. In Brazil, soybean/pearl millet rotations are becoming increasingly popular for nematode control and soil conservation. Assessing the long-term effects of cropping systems, field data and computer simulations determined that soil carbon in no-till soybean/pearl millet rotations remain comparable to native savannah conditions, while soil nitrogen would increase compared to alternative systems (Corbeels et al, 2004).

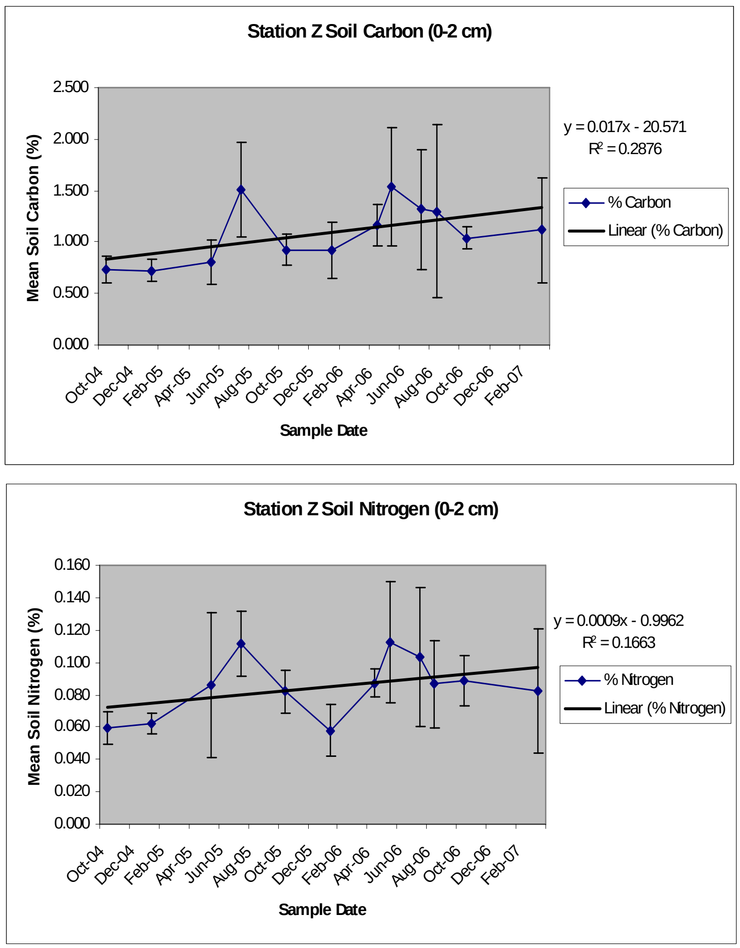


**Figure 2. Changes in soil carbon and nitrogen from no-till rye/pearl millet at Tifton, GA in 2005 and 2006.**

### *Double Cropping*

In some circumstances a grass rotation is beneficial. In traditional conservation tillage, the rye cover must be killed before planting corn. In contrast, rye and pearl millet can be double cropped. From 2002-2005, rye yield in Georgia averaged 20.8 bu/ac and sold for $4.50/bu (IPM Center, 2006). Double cropping with rye would increase gross revenue $94/ac compared to spraying the rye cover with herbicide. Both rye and pearl millet can be grown on dryland with limited fertilizer, and planted and harvested with the same equipment.

Double cropping with wheat may be an acceptable alternative, but observations suggest that chinch bug (*Blissus leucopterus*) is greater in pearl millet following wheat, particularly in the Piedmont. Pearl millet does not affect wheat yields in Georgia (Buntin et al, 2007). Sorghum can have allelopathic effects and reduce subsequent no-till wheat yield compared to no-till wheat following pearl millet (Roth et al, 2000).

## Conclusion

Stand establishment is critical for successful cultivation of pearl millet using conservation tillage practices. Close row spacing can improve yield, but may increase the potential for lodging. Callisto is now registered for use on pearl millet, providing an effective weed management option. New experimental varieties are being identified for their suitability in no-till systems. When pearl millet is included as a grass rotation, soil carbon and nitrogen levels can increase. Profitability can be improved by double cropping with rye instead of burning down the biomass cover.

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