The *Journal of Cotton Science 14:212–220 (2010)*
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# ENGINEERING AND GINNING

## Effects of Different Roller/Crimper Designs and Rolling Speed on Rye Cover Crop Termination and Seedcotton Yield in a No-Till System

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### ABSTRACT

**Rollers/crimpers have been utilized in no-till systems to mechanically terminate cover crops as a substitute for chemical termination; however, excessive vibration generated by the original straight bar roller adopted from Brazil has delayed its adoption in the U.S. To reduce excessive vibration, producers must decrease roller speed, which increases the time for rolling cover crops. The effect of speed on cereal rye (*Secale cereale* L.) termination rate, vibration, and seedcotton yield was tested and evaluated on two roller designs during the 2004-2005 growing season. A three-section 4.1-m wide roller with straight bars (original straight bar roller) and a new design smooth roller with oscillating crimping bar (smooth roller/crimper) were evaluated at speeds of 3.2 and 6.4 km h$^{-1}$. In 2004, higher rye termination rates resulted from the straight bar roller (96%) in comparison to the smooth roller/crimper (94%). Three weeks after rolling, both rollers had effectively terminated rye without the use of herbicides. In both seasons, the smooth roller with crimping bar transferred lower vibration levels to the tractor's frame (at both speeds) than the straight bar roller, while maintaining rye termination rates comparable with the original design. The average seedcotton yield differed between years: 2,150 kg ha$^{-1}$ and 2,462 kg ha$^{-1}$ in 2004 and 2005, respectively. In 2004 and 2005, no differences in seedcotton yield existed among roller types, speeds, and Roundup$^{TM}$ (glyphosate). In both growing seasons applying glyphosate with rolling operation did not affect seedcotton yield. Using rollers only without herbicide was effective in maintaining seedcotton yield while reducing cost of herbicide.**

Cover crops are an essential part of conservation agriculture, but they must be managed properly to obtain their full benefit (Brady and Weil, 1999). Several studies have identified soil benefits such as increased water infiltration, reduced runoff, reduced soil erosion, and reduced negative effects of soil compaction (Kern and Johnson, 1993; McGregor and Mutchler, 1992; Raper et al., 2000a, 2000b; Reeves, 1994).

Between 1990 and 2004, southern U.S. cropland acres planted in conservation systems without inversion tillage increased from 5.7 million ha to 7.3 million ha (CTIC, 2004). This important increase can be credited to many benefits of winter cover crops such as rye.

In the southern U.S., cover crops must be terminated at least 2 w prior to planting the cash crop to prevent the cover crop from depleting soil moisture that could be used by the cash crop; this interval is recommended by most agricultural extension services. Hargrove and Fry (1987) confirmed that a termination date at least 14 d before planting the cash crop enabled soil water recharge by planting time. Ashford and Reeves (2003) recommended that in conservation systems, cover crops should be terminated 3 w prior to planting the cash crop as a standard practice.

Traditionally, terminating cover crops has been achieved by applying herbicides because spraying is fast, effective, and economical. However, for a cover crop such as rye that is relatively tall and might lodge in multiple directions, planting efficiency can be reduced due to frequent stops needed to clean accumulated cover crop residue from planting units. In addition, non-rolled residue may cause hair-pinning, a condition where residue prevents adequate seed-soil contact.

According to Derpsch et al. (1991), flattening and crimping cover crops by mechanical rollers is widely used in South America, especially in Brazil, to successfully terminate cover crops without herbicides. Because of potential environmental and monetary benefits, this technology is now receiving increased interest in the U.S. Rollers histori-

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cally consisted of round drums with equally spaced straight blunt bars (across the roller width) around the drum's circumference. The function of the bars is to crimp or crush the cover crop stems without cutting through; otherwise, cover crops can re-sprout. Ashford and Reeves (2003) investigated the benefits of rolling cover crops in the southeastern U.S. by comparing cover crop termination rates during a 28-d period using a roller alone and a roller with different herbicides and application rates. They indicated that when rolling was conducted at the appropriate plant growth stage (i.e., soft dough), the roller was equally effective at terminating the cover crop (94%) as chemical herbicides. In addition, Ashford and Reeves (2003) found no significant differences in kill rates between chemical and mechanical termination by the roller between 14 and 28 d prior to planting, and rye mortality above 90% was sufficient to begin planting of the cash crop due to accelerated cover crop senescence. Another important aspect of rolling cover crops is that a flat residue mat is created that lies in the direction of travel, allowing farmers to use planters for cash crop operating parallel to the rolled cover crop direction, which has been successful in obtaining proper plant establishment.

Some U.S. farmers have reported vibration problems with roller/crimper implements on-farm (Kornecki et al., 2006, 2009a; Raper et al., 2004). The main concern has been the excessive vibration generated by the original roller design at higher operating speeds. Where a roller's mass is subjected to vibration, forces are generated and these forces can cause mechanical damage to an implement and/or injury to an operator. Research shows that vibrations generated by agricultural equipment have harmful effects on operator's health including increased heart rate, headache, stomach pain, lower back pain, and spinal degeneration with long exposure to vibrations (Bovenzi, 1996; Muzammil et al., 2004; Toren et al., 2002). The International Standard Office (ISO, 1997) has developed a scale for vibrations that are dangerous to the human body. Vibration levels from 1.25 to 2.0 m $sec^{-2}$ are classified as "very uncomfortable" and vibrations above 2.0 m $sec^{-2}$ are considered "extremely uncomfortable". Australian Standards developed limits for 8-h human exposure to vibrations; for comfort limit, fatigue limit, and health limit (detrimental effect) vibration limit levels are 0.1 m $sec^{-2}$, 0.315 m $sec^{-2}$, and 0.63 m $sec^{-2}$, respectively (Mabbott et al., 2001).

The most effective method of alleviating roller/crimper vibration has been to reduce travel speed, but this is neither desirable nor economical. Most farmers find reducing speed to be an unacceptable solution due to the much higher operating speeds utilized for spraying herbicides onto cover crops. Therefore, the objectives of this study were to determine: (1) the effectiveness of two roller designs in terminating cover crops as compared to chemical termination, (2) the effect of operating speed on termination rates for two roller types, (3) vibration levels generated by different roller designs at different operating speeds, and (4) operating speed and roller type effects on seedcotton yield.

## MATERIALS AND METHODS

In 2004 and 2005, field experiments were conducted at the Alabama Agricultural Experiment Station's E.V. Smith Research Station near Shorter, AL on a Compass loamy sand soil (thermic Plinthic Paleudults). Cereal rye cover crop (*Secale cereale* L., Elbon variety) with row spacing of 19 cm was planted 27 October 2003 and 2 November 2004 at a rate of 100 kg $ha^{-1}$ using a Great Plains grain drill** (Great Plains Mfg., Inc., Salina, KS). Rolling treatments were applied 12 April 2004, and 2 May 2005 when rye was at the soft dough growth stage, which was a desirable growth stage for mechanical rye termination (Nelson et al., 1995).

**Rolling Treatments.** In spring 2004, two roller designs, having a width of 4.1 m and weight of 1,400 kg, were utilized: (1) straight bar roller and (2) smooth roller with crimper. Both rollers were tested at operating speeds of 3.2 and 6.4 km $h^{-1}$; the 6.4 km $h^{-1}$ speed was chosen to match speeds commonly used by tractors in field chemical applications. Termination rates by rollers were compared to rolling + glyphosate treatment sprayed at the rate of 1.12 kg $ha^{-1}$ (active ingredient), on the same day as the rolling operation.

The first roller was a three-section assembly (Fig. 1) constructed by Bigham Brothers, Inc.** (Lubbock, TX). Each section of the straight bar roller contained a 36-cm DIA steel drum mounted to the roller's frame by two flange bearings. Seven steel crimping bars equally spaced around the perimeter were attached to the drum. Each crimping bar measured 76 mm in height and 6 mm in thickness. The second roller was a three-piece assembly prototype of the smooth roller/crimper developed and fabricated at the USDA-ARS-NSDL (Fig. 2). The smooth roller crimper comprised of a 61-cm DIA smooth drum with double cam mechanisms concentrically located inside the vertical walls of the drum and connected with crimping bar assembly via rollers. The crimping bar assembly was preloaded with two springs on each side of the drum (Fig. 2), which were responsible for the oscillation of the crimping bar around its pivot point. The springs released energy against the cams to create a downward (crimping) force on rolled cover crop residue (Kornecki and Raper, 2010).


**Figure 1. Three-section straight bar roller.**

**Figure 2. Three-section smooth roller with crimping bar assembly.**

Before treatment application, the height and the biomass of rye were measured. The height was measured at 10 randomly chosen locations throughout the plot using a custom-made scale rod and averaged for each plot. The biomass was collected from two locations in each plot using a 0.25 m$^2$ area (0.5 m x 0.5 m square) frame. The collected rye biomass was oven dried for 72 h at 55$^o$C using an electric oven (Model No. SC-350; Grieve Corporation**, Round Lake, IL). Rolling direction was parallel to both rye rows and cotton planting direction. Rye senescence, based on visual desiccation, was estimated on a scale of 0 (no injury symptoms) to 100 (complete desiccation of all plants), a method commonly used in weed science (Frans et al., 1986), and was evaluated at 1, 2, and 3 w after rolling treatments. Visual rye desiccation is based on relative greenness comparing plots to the non-treated and glyphosate treatments and is a proven method to assess senescence in various winter cover crops (Ashford and Reeves, 2003; Kornecki et al., 2006, 2009a, 2009b; Price et al., 2009). Accelerometers from Crossbow Technology Inc.** (San Jose, CA) were mounted on the tractor's frame to measure vibration levels to which the driver was subjected (Fig. 3a) and on the roller's frame to measure vibration due to roller motion (Fig. 3b). Vibration data from accelerometers was recorded continuously on 15 m distance (for full length of the plot) during the rolling operation utilizing a custom data acquisition system and a laptop computer. From each run (four runs per treatment), an average vibration value (RMS) was calculated by the acquisition system for each plot.

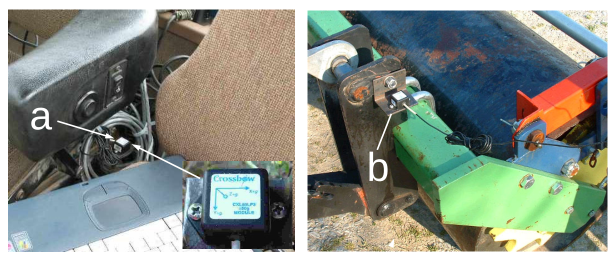


**Figure 3. Placement of one-dimensional (z-axis) accelerometer from Crossbow Technology: (a) tractor's frame, and (b) roller's frame.**

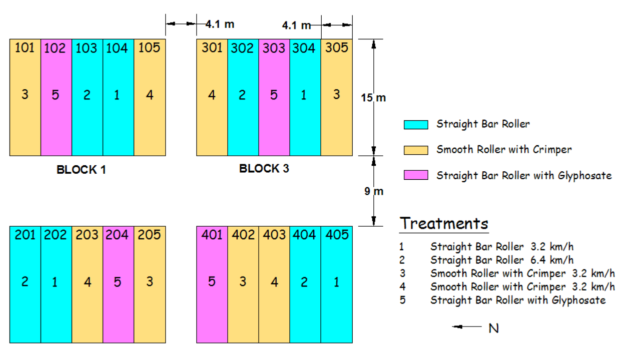


**Figure 4. Experiment layout: randomized complete block design with four blocks (replications).**

The cotton variety planted in both 2004 and 2005 was Stoneville 5242BR. Cotton was planted using a four-row John Deere Vacuum Max planter**, manufactured by Deere & Company, Moline, IL (with row spacing of 101 cm) after rye was terminated and with soil moisture condition adequate to plant cotton seeds. On 17 May 2004, after planting cotton, a starter granular nitrogen fertilizer (21-10-00-with S, Zn, and B supplements) was applied at 47 kg ha$^{-1}$, followed by a granular potassium application (0-0-60) at 90 kg ha$^{-1}$, and completed with a second nitrogen (32-0-0) liquid injected into soil at 67 kg ha$^{-1}$ on 16 June 2004. In 2004 no irrigation water was applied. In the 2005 growing season on 25 May cotton received 45 kg ha$^{-1}$ potassium granular fertilizer (0-0-60), and 22 kg ha$^{-1}$ of nitrogen granular fertilizer (16-16-16). A liquid nitrogen fertilizer (32-0-0) at a rate of 67 kg ha$^{-1}$ was injected into furrows on 6 June 2005. Cotton was irrigated once on 24 June 2005, in the amount of 18 mm. No irrigation applied in 2004. A two-row John Deere 9920 cotton picker** (Deere & Company, Moline IL) was used for field harvesting the cotton. The two middle rows from each four-row plot were harvested and bagged in the field. Bags were then weighed to determine the cotton yield. The cotton yield in this experiment is referred to the harvested seedcotton, i.e., locks of cotton containing the seed and the fiber still attached.

**Experimental Design.** As depicted in Fig. 4, the experiment was a randomized complete block (RCB) design with four blocks (replications). Each block contained five equal size experimental units (plots) seeded with the rye cover crop. The RBC design was chosen for this study due to the gradual slope of the experimental area, which could result in varying soil moisture conditions. The ground surface had minor depressions (up to 50 mm) formed either from previous fall harvest or cover crop planting and fertilizer application where higher soil moisture made soil more susceptible for equipment tires to create depressions. Such field conditions were considered normal for typical farming operations in Alabama. The study was installed in a blocked design (CRB) to minimize variation within each block (i.e., soil moisture, soil surface depressions) and to maximize variation among the blocks. Five different rolling treatments were randomly assigned to each block. A total of 20 plots (experimental units) were utilized. Each plot was 15 m long and 4.1 m wide allowing four rows of cotton to be planted in one run (Fig. 4). Data were analyzed by using the analysis of variance (ANOVA), General Linear Model (GLM) procedure. To separate treatment effects, Fisher's protected least significant difference (LSD) test was employed at the 10%probability level ($\alpha = 0.10$). Percentages of rye termination were transformed using an arcsine square-root transformation method (Steel and Torrie, 1980). This transformation did not result in a change in the analysis of variance, thus, nontransformed means are presented. For vibration analysis, original vibration data (RMS values) were used. Where interactions between treatments by weeks by years occurred, data were analyzed separately, and where no interactions were present, data were combined using SAS (2001) ANOVA Analyst's linear model. Treatments were considered fixed effects and year was considered a random effect (Gomez and Gomez, 1984). Also, to determine a difference between two specific treatment means, a preplanned single degree of freedom contrast procedure as described in Steel and Torrie (1980) was performed to detect these differences at the 10% probability level ($\alpha = 0.10$) (Table 1).

**Table 1. Preplanned single degree of freedom contrast comparisons for rolling treatments during 2004-2005 growing seasons.**

| Contrast | Treatment Comparisons |
|---|---|
| **3.2 km h$^{-1}$ vs 6.4 km h$^{-1}$** | **Straight bar roller at 3.2 km h$^{-1}$, smooth roller crimper at 3.2 km h$^{-1}$ vs straight bar roller at 6.4 km h$^{-1}$, smooth roller crimper at 6.4 km h$^{-1}$** |
| **Straight bar roller vs smooth roller crimper** | **Straight bar roller at 3.2 km h$^{-1}$, straight bar roller at 6.4 km h$^{-1}$ vs smooth roller crimper at 3.2 km h$^{-1}$, smooth roller crimper at 6.4 km h$^{-1}$** |
| **Straight bar roller vs rolling with glyphosate** | **Straight bar roller at 3.2 km h$^{-1}$, straight bar roller at 6.4 km h$^{-1}$ vs rolling/crimping with glyphosate** |
| **Smooth roller crimper vs rolling with glyphosate** | **Smooth roller crimper at 3.2 km h$^{-1}$, smooth roller crimper at 6.4 km h$^{-1}$ vs rolling/crimping with glyphosate** |

## RESULTS AND DISCUSSION

Statistical results from ANOVA analysis for rye biomass and seedcotton yield are presented in Table 2. There were significant differences between 2004 and 2005 in rye biomass production (Pr = 0.0032) and seedcotton yield (Pr = 0.0011). In addition there was a significant difference among the blocks with respect to the amount of rye biomass (Pr = 0.0134) and seedcotton yield (Pr = 0.0130) indicating that the choice of a RCB was an appropriate experimental design.

**Rye Biomass and Height.** There were no interactions between years and roller treatments for rye biomass and plant height. However, a significant difference was observed in rye height ($P > F = 0.0001$) between 2004 and 2005. In 2004 rye height measured 170 cm and in 2005 the height was only 129 cm. Similarly, there was a significant difference between production of biomass in 2004 and 2005 ($P > F = 0.0032$). Rye dry biomass in 2004 was 6,444 kg ha$^{-1}$, whereas in 2005 the amount was only 4,602 kg ha$^{-1}$. Rye growth was most likely inhibited due to the cold and unusually wet weather in the spring. Comparing rainfall amounts in March of 2004 and 2005, there was 281 mm of rain in 2005, whereas in the same period of 2004 the rain was only 21 mm. In addition, on 30 March 2005, hail fell on the experimental area, which had an adverse effect on rye growth. The wet spring continued between March and May of 2005 and the total rainfall recorded was 533 mm, whereas for the same period of 2004, the rainfall amount was only 201 mm.

**Rye Termination.** Interactions between years/weeks and rolling treatments were detected for rye termination ($P > F = 0.0001$), therefore years were analyzed separately by each week. In 2004, 1 w after rolling, no differences in termination rate were found between the 3.2 and 6.4 km h$^{-1}$ roller speeds (Table 3). A significantly higher rye termination rate of 95% was produced by the straight bar roller and glyphosate treatment compared to the straight bar roller alone (26%) and the smooth bar roller (24%) ($P > F = 0.0001$). Two weeks after rolling, higher rye termination was reported for the straight bar roller and glyphosate application (99.8%) compared to the straight bar roller at both speeds (32.5%), smooth roller crimper (30%) at 6.4 km h$^{-1}$ and the smooth roller (26.3%) at 3.2 km h$^{-1}$. Three weeks after rolling, there were significant differences ($P > F = 0.0001$; LSD = 1.2) in rye termination among glyphosate with straight bar roller treatment (100%) straight bar roller (96.5% at 3.2 km h$^{-1}$; 96% at 6.4 km h$^{-1}$), and smooth roller with crimping bar (94.5% at 3.2 km h$^{-1}$; 94% at 6.4 km h$^{-1}$). Changing operating speed for each roller type did not affect rye termination. Despite these differences, both rollers effectively terminated the cover crop (≥ 94%) without the need for chemical application. Studies conducted by Ashford and Reeves (2003) showed similar termination rates, produced by a roller alone, 3 w after rolling. The slightly lower termination rates produced by the smooth roller/crimper might be related to incomplete contact of the oscillating bar

**Table 2. Analysis of variance from 2004 and 2005 showing degrees of freedom (df), *F*-values and *P*- values for rye biomass and seedcotton yield.**

| Source of variation | df | Rye biomass | | Seedcotton yield | |
|---|---|---|---|---|---|
| | | F-value | P-value | F-value | P-value |
| YEAR (Y) = 2 | 1 | 13.45 | 0.0032* | 18.15 | 0.0011* |
| BLOCK (B) = 4 | 3 | 5.46 | 0.0134* | 5.50 | 0.0130* |
| Treatment (T) = 5 | 4 | 0.33 | 0.8540 | 0.81 | 0.5449 |
| Year x Treatment | 4 | 0.54 | 0.7108 | 1.00 | 0.4453 |

*significant at the 0.10 level of probability

**Table 3. Speed effects on rye mortality (%) for three-section roller type and different weeks after rolling/crimping in 2004.**

| Time after rolling | Roller type and speed (treatment) | | | | | |
|---|---|---|---|---|---|---|
| | Straight bar roller (3.2 km h$^{-1}$) | Smooth roller/ crimper (3.2 km h$^{-1}$) | Straight bar roller (6.4 km h$^{-1}$) | Smooth roller/ crimper (6.4 km h$^{-1}$) | Straight bar roller +glyphosate | LSD (0.1) |
| Week 1 | 25.0b* | 23.8b | 26.3b | 23.8b | 95.0a | 5.8 |
| Week 2 | 32.5b | 26.3c | 32.5b | 30.0b | 99.8a | 3.4 |
| Week 3 | 96.0b | 94.5c | 96.5b | 94.0c | 100.0a | 1.2 |

*Values of the means within rows with the same letters are not significantly different at the 10% level.

with the rolled rye due to uneven ground and lower crimping pressure settings. In contrast, the straight bar roller might generate higher crimping pressure, resulting in deeper bar penetrations into the rye, thus nearly eliminating empty pockets between soil depressions and the crimping bars.

As noted in the discussion regarding rye height and biomass, spring of 2005 was unusually wet compared to 2004. Because of poor weather, rye growth was inhibited, thus rolling treatments were applied 3 w later (2 May) compared to 2004, as a proper rye termination date is based on its growth stage (between early milk and soft dough). Rye termination rates for spring 2005 are presented in Table 4. In 2005, no differences in rye termination rates were found between operating speeds for each roller type after any week. A consistently higher rye termination rate was found with straight bar roller + glyphosate in comparison with the rollers alone for each week after rolling (85% after the first week and 100% after the second and the third week). After the first week, rye termination rate for rollers alone was higher (from 76.7% to 81.7%) than reported in 2004 and was most likely related both to roller crimping action and natural rye senescence due to late rolling treatment application. The first week after rolling the straight bar roller at 6.4 km $h^{-1}$ produced significantly higher rye termination of 81.7% compared to 76.7% by the smooth roller crimper at 6.4 km $h^{-1}$. After second week no differences in rye termination were present among roller types and speeds and rye termination rates were from 89.7% to 91.3%. Three weeks after rolling, all rollers effectively terminated the cover crop (from 95.7% to 97%) without the need for the supplemental herbicide application.

**Vibrations.** In 2004, vibration levels produced by the two rollers measured on the roller's frame, were not different at the same operating speed (Table 5). At 3.2 km $h^{-1}$, the straight bar roller generated 6.47 m $sec^{-2}$, whereas the smooth roller/crimper generated 4.65 m $sec^{-2}$. With increased operating speed of 6.4 km $h^{-1}$, vibration levels increased for both rollers: 14.41 m $sec^{-2}$ for the straight bar roller and 15.86 m $sec^{-2}$ for smooth roller/crimper (Table 5).

The smooth roller/crimper transferred lower vibration levels to tractor's frame at both speeds in comparison with straight bar roller (Table 5). The roller with crimping bar transferred most of its energy to the cover crop, thus minimizing vibration transferred to the tractor. Vibration levels at both operating speeds were not different for each roller type. However, there were differences between roller types at both speeds (Table 5). Vibration levels generated by the two rollers

**Table 4. Speed effects on rye termination (%) for three-section roller type and different weeks after rolling/crimping in 2005.**

| Time after rolling | Roller type and speed (treatment) | | | | | |
|---|---|---|---|---|---|---|
| | Straight bar roller (3.2 km $h^{-1}$) | Smooth roller/crimper (3.2 km $h^{-1}$) | Straight bar roller (6.4 km $h^{-1}$) | Smooth roller/ crimper (6.4 km $h^{-1}$) | Straight bar roller + glyphosate | LSD (0.1) |
| Week 1 | 78.3bc | 80.0bc | 81.7ab | 76.7c | 85.0a | 4.70 |
| Week 2 | 90.7bc | 90.0bc | 90.3bc | 89.7c | 100.0a | 1.30 |
| Week 3 | 95.7b | 96.7b | 97.0b | 96.3b | 100.0a | 1.68 |

*Values of the means within rows having with the same letters are not significantly different at the 10% level.

**Table 5. Speed effects on vibration levels measured on roller and tractor frames for a three-section straight bar roller and smooth roller/crimper in 2004 and 2005.**

| Roller type | Roller speed (km $h^{-1}$) | Year | | | |
|---|---|---|---|---|---|
| | | 2004 | | 2005 | |
| | | Vibration source (m $sec^{-2}$) | | | |
| | | Roller frame | Tractor frame | Roller frame | Tractor frame |
| Straight bar roller | 3.2 | 6.47b | 0.88b | 6.31b | 1.03c |
| Smooth roller crimper | | 4.65b | 0.50b | 4.31b | 1.21c |
| Straight bar roller | 6.4 | 14.41a | 1.93a | 11.63a | 2.98a |
| Smooth roller | | 15.86a | 1.89a | 10.47a | 1.67b |
| LSD at α =0.1 | | 3.21 | 0.60 | 2.8 | 0.31 |

*Values of the means within columns with the same letters are not significantly different at the 10% level.

on the tractor frame were above ISO (1997) and Australian limits (Mabbott et al., 2001). However, the smooth roller/crimper generated lower vibration levels: 0.50 m sec$^{-2}$ and 0.88 m sec$^{-2}$ at 3.2 and 6.4 km h$^{-1}$, respectively, which are below the "very uncomfortable limit" as determined by ISO (1997). In contrast, the straight bar roller generated vibration levels of 1.93 m sec$^{-2}$ and 1.89 m sec$^{-2}$ at 3.2 and 6.4 km h$^{-1}$, respectively, which were within "very uncomfortable limit" and could cause discomfort to the operator. In 2005 vibration levels generated by the rollers both at roller and tractor frame were comparable with levels generated in the 2004 test. In 2005, at 3.2 km h$^{-1}$ no significant differences were detected between the two roller types; although straight bar roller generated higher numerical vibration level on roller's frame (6.31 m sec$^{-2}$) in comparison with the smooth roller crimper. Increasing operating speed to 6.4 km h$^{-1}$ significantly increased vibration for the two roller types, and as with lower speed, there were no significant differences in vibration generated between the two rollers; but again slightly higher numerical vibration level was generated by straight bar roller (11.63 m sec$^{-2}$, Table 5). In 2005, there were no significant differences on tractor frame vibrations between two roller types at 3.2 km h$^{-1}$. Compared to lower speed, with increasing speed to 6.4 km h$^{-1}$, there was significant increase in vibration on the tractor frame for two roller types. Also within the higher speed there was a significant difference in vibration level generated by each roller. The straight bar roller generated higher vibration levels (2.98 m sec$^{-2}$), which were above "extremely uncomfortable limit" (ISO, 1997). The lower vibration on tractor frame were generated by the smooth roller crimper (1.67 m sec$^{-2}$), and were below the "very uncomfortable limit" as determined by ISO (1997).

**Seedcotton Yield.** There was a significant difference in seedcotton yield between 2004 and 2005 growing seasons ($P > F = 0.0011$, Table 2). In 2004 seedcotton yield was collected at the beginning of November and the average yield was 2,150 kg ha$^{-1}$. Results obtained from contrast procedure showed that there were no significant differences in seedcotton yield between two operating speeds and among straight bar roller, smooth roller with crimping bar and straight bar roller with glyphosate ($P > F = 0.357$) (Fig. 5). In 2004 adding glyphosate to rolling operation did not increase seedcotton yield.

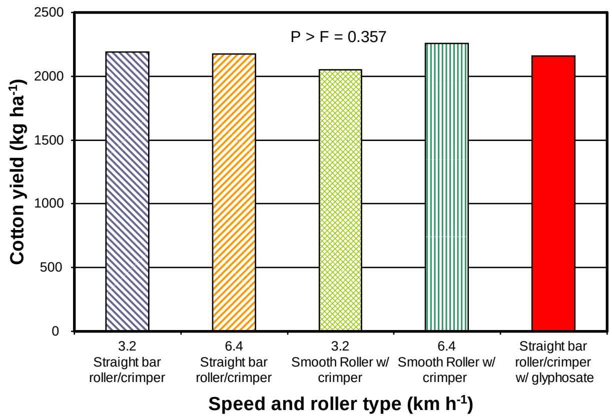


**Figure 5. Operating speed and roller type effect on seedcotton yield in 2004 growing season.**

In 2005, seedcotton yield was collected at the end of October and the average yield was 2,462 kg ha$^{-1}$. From contrast comparisons no significant differences in seedcotton yield was recorded among two roller types, and rolling with glyphosate application. Rollers operating speed for both roller designs did not affect seedcotton yield. No significant differences in seedcotton yield was found between the straight bar roller, and the smooth bar roller with crimping bar ($P > F = 0.439$) (Fig. 6). In both growing seasons applying glyphosate with rolling operation did not affect seedcotton yield. Based on the results, utilizing rollers only without glyphosate application can be effective in maintaining seedcotton yield while reducing cost of herbicide.

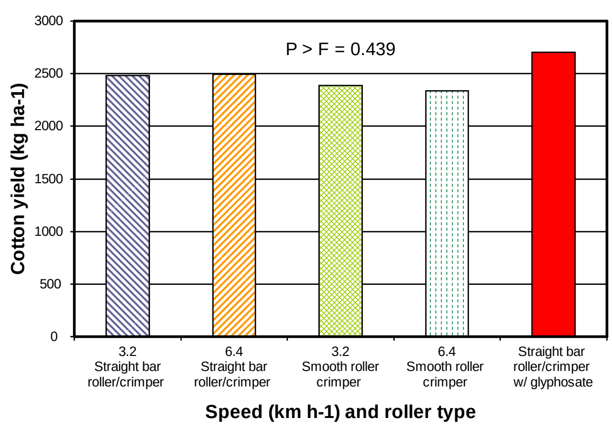


**Figure 6. Operating speed and roller type effect on seedcotton yield in 2005 growing season.**

## CONCLUSIONS

In the 2004 experiment, both roller designs effectively terminated the cover crop (> 94%) 3 wk after rolling, without the need of herbicide. Similarly in 2005, after 3 wk, both rollers effectively terminated the cover crop (97%). In 2004, an increase in operating speed had no effect on termination rates. In 2005, an increase in operating speed did not affect termination rate for either roller type, except the first week after rolling. In both years, increased operating speed significantly increased vibration levels that were measured on the roller's frame for all roller types. However, in 2004, no differences in vibration levels on the roller's frame were observed between the two rollers within the same operating speed. The smooth roller/crimper transferred lower vibration levels to the tractor's frame than the straight bar roller, and these levels are below the "very uncomfortable limit" as determined by ISO (1997). In 2005, differences in vibration levels at the tractor frame were reported for the three rollers at both speeds. The lowest vibration at tractor frame was generated by the smooth roller crimper that was below ISO limits and was half the vibration generated by the straight bar roller. In both years, no differences in cotton yield were observed among roller types, operating speeds, or chemical treatment (glyphosate). Applying glyphosate with rolling rye did not affect cotton yield. Based on results from two growing seasons, rolling/crimping of cover crops without supplemental glyphosate application was effective in maintaining cotton yield while reducing cost of glyphosate. Different weather conditions in each year significantly influenced cotton yield.

## DISCLAIMER

** The use of trade or company names does not imply endorsement by the USDA-ARS.

## ACKNOWLEDGMENT

The authors wish to thank Eric Schwab, Dexter LaGrand and Morris Welch for their invaluable assistance with conducting field experiments, instrumentation, and data collection and preparation.

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