MODIFICATION OF WORKING ELEMENTS IN THE FIXED BATT SAW LINT CLEANER TO IMPROVE FIBER QUALITY AND TRASH REMOVAL

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Abstract

Previous investigations of lint cleaner working elements such as the grid bars, feed rollers and feed bar showed modification of these might significantly improve fiber quality, especially fiber length and trash content. Evidence from extensive laboratory-based trials was used to modify a 24D Continental lint cleaner in a high production gin. The main modifications included introduction of an additional set of draft rollers between the condenser doffing rollers and feed rollers, alteration of the drafting ratios between each set of rollers and introduction of a grid bar heel element. Trials showed these changes led to improved fiber length parameters and reduced levels of trash in cotton.

Introduction

Modern lint cleaning, in most cases, refers to the fixed or controlled-batt saw type lint cleaner. It is well documented these machines damage cotton, particularly longer, finer cotton exposed to more than one passage of lint cleaning. In previous work Gordon and Bagshaw (2007) and Gordon *et al.* (2011) showed the relative effects of the working elements of a fixed-batt saw lint cleaner, i.e. the feed bar, grid bars and brush, plus saw speed, batt density and combing ratio on three different cottons; a short & coarse cotton, a standard cotton and long & fine cotton. The results of these experiments showed the greatest amount of fiber damage, measured as decreases in fiber length and increases in short fiber content (SFC) and neps, occurred at the lint cleaner feed point or nip where fiber is transferred from the feed roller to the saw teeth. Longer, finer fiber was damaged more at this point than shorter, coarser fiber. Longer, finer fiber was also damaged more when batt density, combing ratio and saw speeds were higher.

In deference to these results changes were made to a 24D Continental Eagle Lint Cleaner in a commercial gin. This paper reports on the changes made to the lint cleaner and the subsequent effects on fiber quality. The main changes included implementing mechanisms to reduce the combing ratio and density of the fiber batt without loss of production. The tested hypothesis was that a lighter batt delivered at a lower combing ratio would not be damaged as much at the transfer point between the feed roller and saw, and that a lighter batt would offset the nominally reduced cleaning ability of the fiber at a lower combing ratio.

Methodology

Lint Cleaner Modifications

To produce a lighter batt and facilitate a lower combing ratio an additional draft zone was introduced between the condenser doffer rollers and feed rollers of a 24D Continental Eagle Lint Cleaner. This entailed the manufacture of a separate chassis to hold an additional set of draft rollers, which were fitted between the condenser and feed rollers. Figure 1 illustrates the position of the new chassis and rollers fitted to the lint cleaner; herein called the modified lint cleaner (MLC). To ensure production remained unaffected and to control combing ratios a separate variable speed motor drive for the rollers (from the doffing rollers to the final feed roller) was fitted. The condenser, saw and brush were driven by the existing lint cleaner motor.

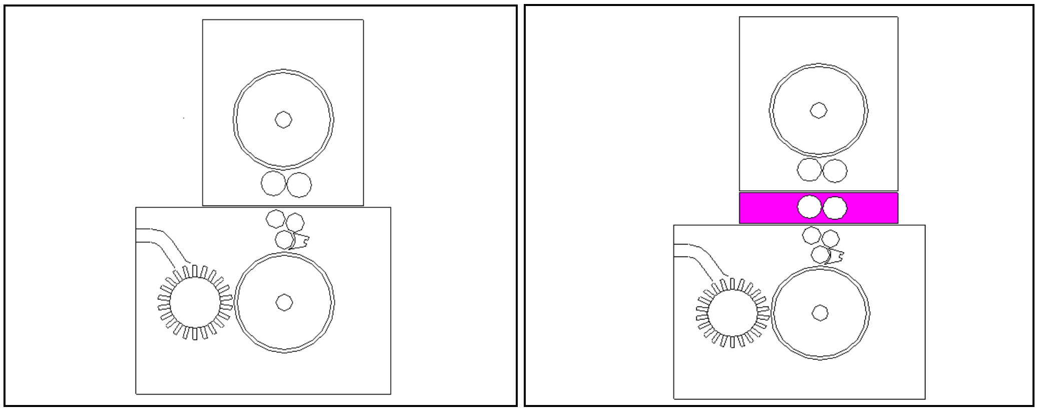


Figure 1 – Cross-sections of the 24D lint cleaner showing before (LHS) and after (RHS) installation of inter-feed draft rollers and chassis.

The addition of extra rollers allowed the total pre-draft before the final combing ratio to be increased from 1.3 to 2, which in turn allowed the combing ratio to be lowered, e.g. from 30 to 20. A series of trials were conducted to test the 'optimal' draft ratios and distances for the MLC. High initial draft ratios between the doffing rollers and new draft roller, e.g. 1.4 - 1.7, were reduced, along with the draft distance between roller nips, to minimize the batt being pulled apart and delivering 'clumps' of fiber onto the saw. These modifications were conducted over successive ginning seasons after extensive trials. Table 1 summarizes the range of modifications made to these settings to arrive at the final settings for the MLC, i.e. Modification 3, reported here.

Table 1 – Modified draft ratios and distances.

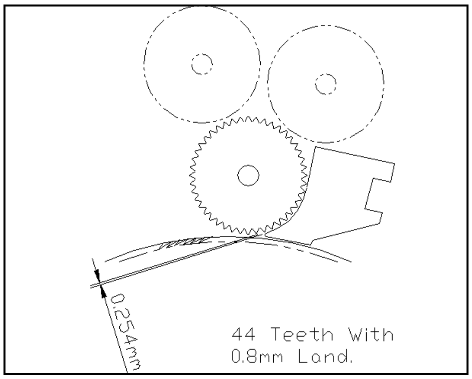
Lint cleaner	**Draft ratios**	**Draft distances roller nip-to-nip**
Standard		
doffer rollers:feed rollers	1.22	240 mm (150 to 100 mm rollers)
feed rollers:feed roller	1.06	fixed
feed roller:saw (CR)	30.93	
total draft	***40.00***	
Modification 1		
doffer rollers:inter-draft rollers	1.43	300 mm (150 to 150 mm rollers)
inter-draft roller:feed rollers	1.18	240 mm (150 to 100 mm rollers)
feed rollers:feed roller	1.12	fixed
feed roller:saw (CR)	21.16	
total draft	***40.00***	
Modification 2		
doffer rollers:inter-draft rollers	1.67	240 mm (150 to 150 mm rollers)
inter-draft roller:feed rollers	1.06	150 mm (150 to 100 mm rollers)
feed rollers:feed roller	1.04	fixed
feed roller:saw (CR)	21.72	
total draft	***40.00***	
Modification 3		
doffer rollers:inter-draft rollers	1.23	200 mm (150 to 100 mm rollers)
inter-draft roller:feed rollers	1.23	110 mm (100 to 100 mm rollers)
feed rollers:feed roller	1.32	fixed
feed roller:saw (CR)	20.03	
total draft	***40.00***	

While reducing the draft ratio and distance eliminated the problem of fiber clumping to a large extent, clumping was still evident in the fiber flow from the feed zone onto the saw. Investigation of the feed zone revealed that despite the close setting between the feed roller and feed bar (0.25 mm) the lighter batt appeared to be slipping from this nip point onto the saw, rather than being held and combed evenly. To improve control of the lighter batt in this zone a range of new feed roller profiles were investigated. Evaluations were conducted on the basis of observed feed, i.e. the consistency of the feed, and resulting fiber properties (length, SFC, length uniformity and neps). Table 2 lists the roller profiles investigated.

Table 2 – Feed roller profiles tested in investigation of behaviour from of feed from final roller to lint cleaner saw.

Roller	No. Teeth	Tooth depth (mm)	Tooth land (mm)	Contact area (mm)
R1 existing	44	6.4	0.8	35.2
R2	88	2.3	1.7	147.8
R3	44	6.7	1.7	73.9
R4	88	6.8	0.4	37.0
R5	44	8.2	0.4	18.5
R6 new	**44**	**4.2**	**2.5**	**110.0**

Figure 2 shows the existing and the best new roller profile, which required increased contact area rather than holding pressure. The tooth profile of the new roller was changed to have a greater land (tooth contact area) applied to the batt. Land area of the teeth was increased 300% from 44 teeth x 0.8 mm to 44 teeth x 2.5 mm.



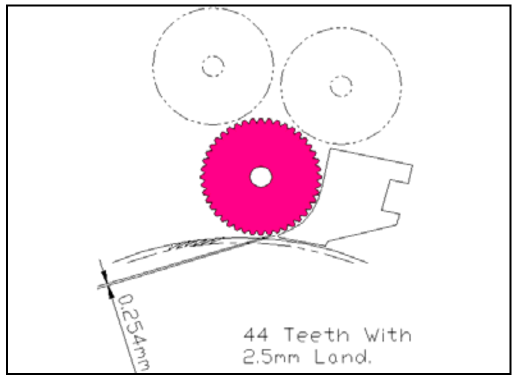


Figure 2 – Feed roller profiles showing original R1 (LHS) and modified feed rollers R6 (RHS). The modified version improved fiber properties (length parameters) and feed behaviour.

Reducing the draft ratio in the break part of the draft, the draft distance between rollers and utilising the new feed roller profile improved control of the lighter batt and allowed it to be more evenly drafted and combed onto the saw. The control mechanisms reduced clumping of the fiber, which in turn reduced the loss of fiber over the grid bars, and improved the cleaning ability of the MLC.

In addition to these modifications a new grid bar with a combing heel was used on the second grid bar position to deflect fiber into the saw teeth and break up any remaining clumps from the feed zone. Figure 3 shows the profile of the grid bar and its combing heel.

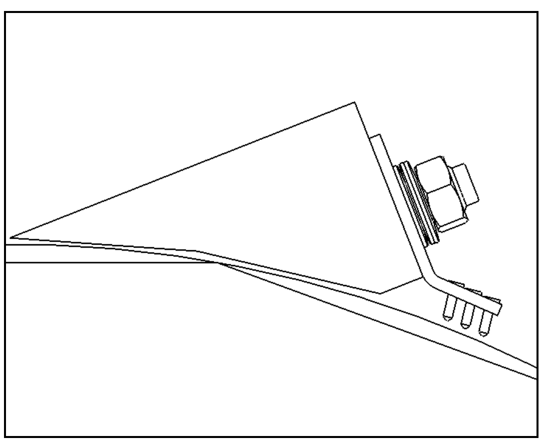


Figure 3 – Profile of toothed heel grid bars fitted to the second grid bar position on the MLC and SLC evaluated in this study.

Lint Cleaner Trials

Evaluation of the upgraded MLC was carried out over two days on two different irrigated cottons (var. Sicala 70BL and 71BRF) produced by two different growers. Field quality was kept constant throughout each evaluation day, i.e. gin and fiber comparisons were limited to one grower and one field.

Fiber quality comparisons were made between fiber ginned and sampled at the same time through the MLC and the adjacent standard lint cleaner (SLC), which like the MLC also had a toothed heel grid bar fitted to the second grid bar position.

A range of gin and lint cleaner settings were tested including cotton (two treatments), gin speed (two treatments) and combing ratio (three treatments). To keep dependency of trash removal only on lint cleaner action the Super-J trash exit points were closed on the two gin stands in front of the ML and SLCs. Gin production and seed fingers settings were also checked on both stands and adjusted so that they were the same. The combing ratio of the SLC was maintained at 27. Table 3 below lists the gin/lint cleaner production treatments checked during the MLC evaluation.

Table 3 – Evaluation of the MLC; treatments applied and sample nos.

Treatment	**Number and type of treatment applied**
Variety (day)	2 (days/varieties/growers) (2)
Lint Cleaner	2 (MLC vs. SLC) (4)
Gin (motor) speed	2 (140 A vs. 170 A) (8)
Lint cleaner combing ratio	3 (23, 27 and 30) (24)
Replicates/day	30 (720)
Total samples	**720**

Five fiber samples per hour were collected after each lint cleaner at the same time for periods of six hours. Fiber samples were then subject to standard HVI and AFIS PRO fiber tests.

Results and Discussion

Table 4 and Figures 4 to 8 illustrate the measured effects of the MLC and other gin treatments on the quality of cotton. Fiber length through the MLC was statistically longer and more uniform and the fiber was cleaner in terms of particle count and USDA leaf grade. Although combing ratio and gin speed also had significant effects on fiber quality, the MLC effects because of the reduced batt density were largest and most consistent. The MLC had no statistical affect on nep levels although as per previous work nep levels were slightly lower than the SLC, albeit still at a high level.

Table 4 – Grand average fibre property results (n = 60) from lint cleaner evaluations.

Property	**MLC (1)**	**SLC (2)**
UHML (inches)	1.155**	1.143
UNI (%)	80.72*	80.37
SFI (%)	8.92**	9.24
Leaf (USDA Grade)	2.23**	2.60
Neps (cnt/g)	421	429
Trash (cnt/g)	48**	75

** indicate statistical significance at $P \leq 0.001$

* indicate statistical significance at $P \leq 0.05$

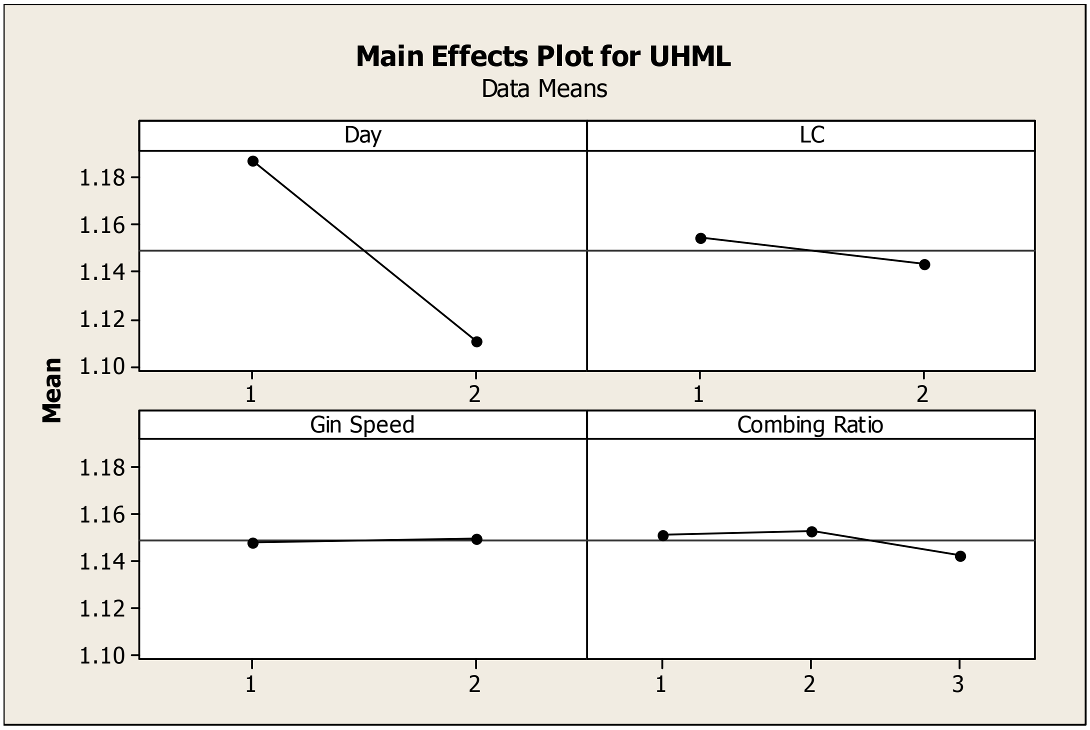


Figure 4 – UHML averages per treatment; Day 1 and Day 2; LC 1 = MLC, LC 2 = SLC; gin speed 1 = fast, gin speed 2 = slow; combing ratio 1 = 27 (standard), 2 = 23 (low), 3 = 30 (high).

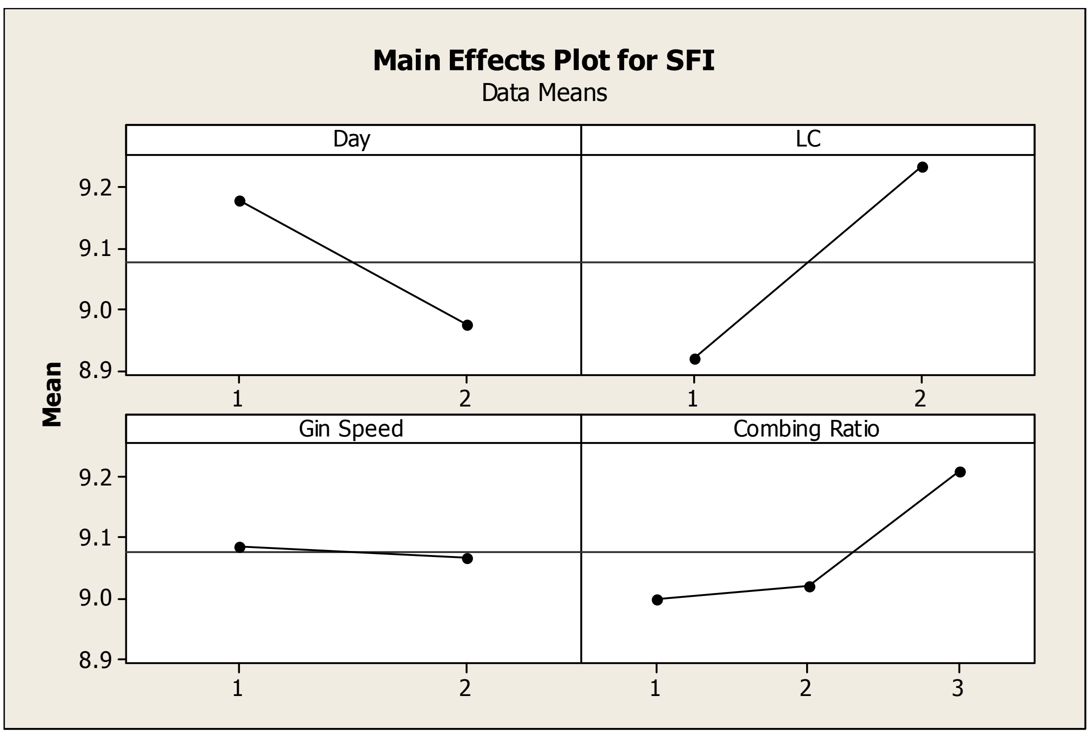


Figure 5 –Short Fiber Index (SFI) averages per treatment; Day 1 and Day 2; LC 1 = MLC, LC 2 = SLC; gin speed 1 = fast, gin speed 2 = slow; combing ratio 1 = 27 (standard), 2 = 23 (low), 3 = 30 (high).

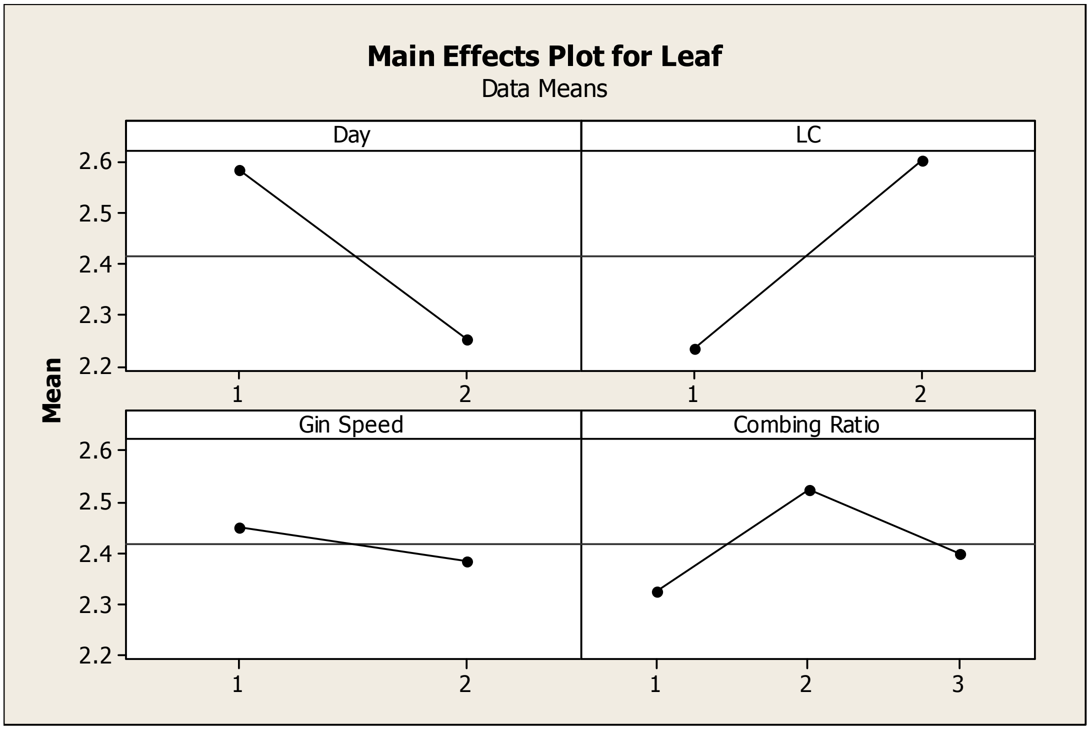


Figure 6 – HVI Leaf Grade averages per treatment; Day 1 and Day 2; LC 1 = MLC, LC 2 = SLC; gin speed 1 = fast, gin speed 2 = slow; combing ratio 1 = 27 (standard), 2 = 23 (low), 3 = 30 (high).

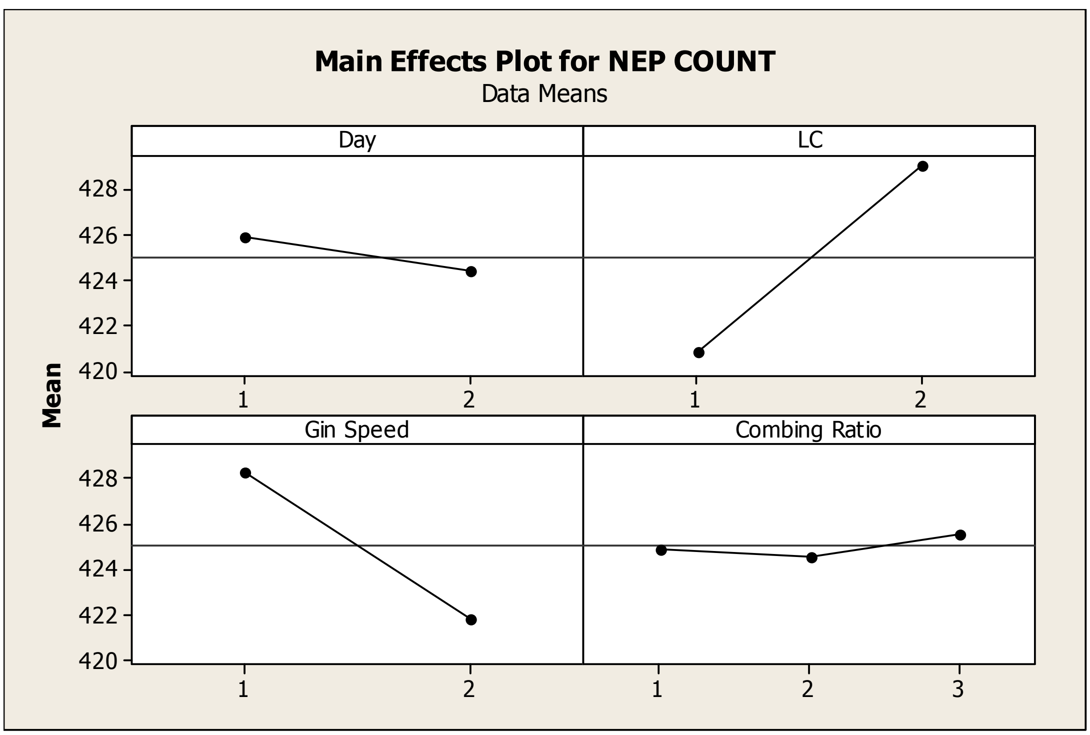


Figure 7 – AFIS PRO Nep count averages per treatment; Day 1 and Day 2; LC 1 = MLC, LC 2 = SLC; gin speed 1 = fast, gin speed 2 = slow; combing ratio 1 = 27 (standard), 2 = 23 (low), 3 = 30 (high).

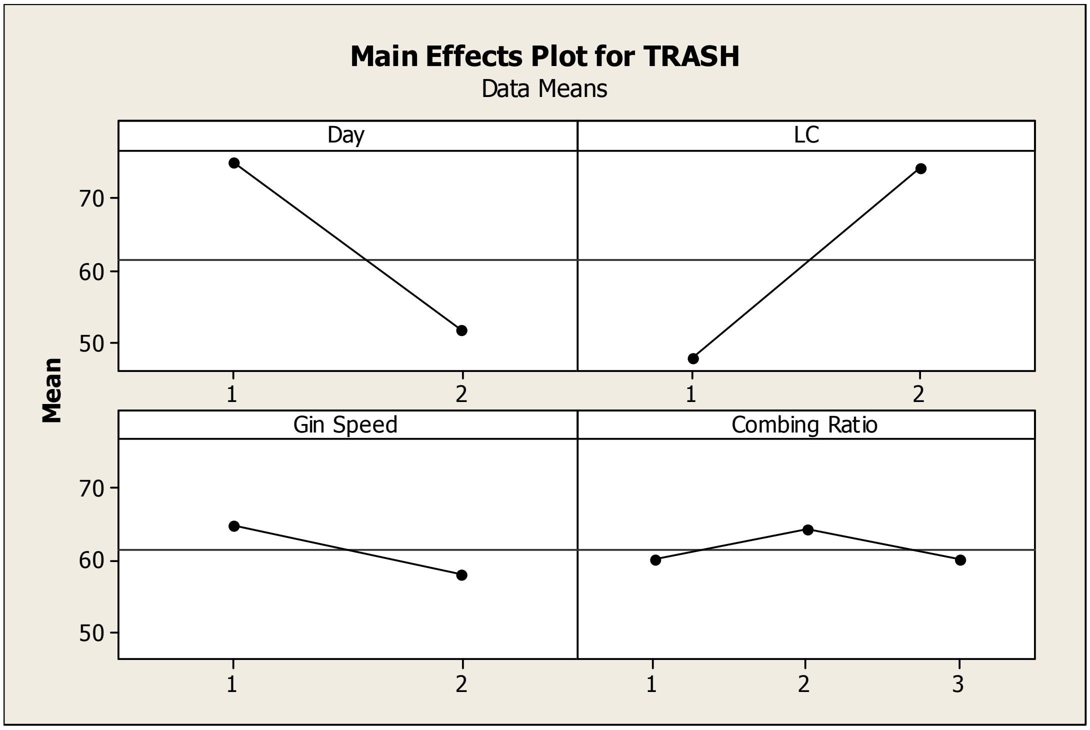


Figure 8 – AFIS PRO Trash count averages per treatment; Day 1 and Day 2; LC 1 = MLC, LC 2 = SLC; gin speed 1 = fast, gin speed 2 = slow; combing ratio 1 = 27 (standard), 2 = 23 (low), 3 = 30 (high).

Conclusion

Modifications to the drafting and feed zone of the fixed batt saw lint cleaner improved fiber length parameters and the cleaning ability of the lint cleaner. Modifications included the introduction of an additional roller drafting zone between the doffing rollers and existing feed rollers, changing the profile of final feed roller and fitting a combed heel grid bar to the second grid bar position.

The results indicated statistically significant improvements in fiber properties using the upgraded MLC for irrigated, spindle harvested cotton that ranged in length from 1.11 inches through to 1.19 inches. Length (UHML), SFC, leaf grade (by HVI) and neps and trash (by AFIS PRO) all improved when processed through the MLC.

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References

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