



Effect of Cleaning Methods on Trash Contents and Fibre Quality for Seed Cotton

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ABSTRACT

The present study was carried out at Department of Farm Machinery and Power Engineering, Punjab Agricultural University, Ludhiana, India during May to December, 2017 to evaluate the effect of mechanical cleaning methods on mechanically harvested cotton. The treatments consisted of three cotton cleaning methods *viz.* Boll Crusher cum Seed-Cotton Extractor, Pre-cleaner and On-board cleaner (field cleaner). The comparative performance of these methods was evaluated in terms of cotton fibre quality parameters *viz.* span length, uniformity ratio, elongation (%), micronaire (%), fibre strength (g tex⁻¹) and reflectance of cotton lint etc. The minimum trash content (seed cotton basis) was observed for boll crusher+pre-cleaner (5.17%) and maximum for on-board cleaner (21.4 %). The 2.5% span length for the manual was observed maximum (26.04 mm) and the minimum for boll crusher+pre-cleaner (23.83 mm). The uniformity ratio observed was minimum for manual (45.99) and maximum for boll crusher+pre-cleaner (47.29). The micronaire for the manual was observed as a minimum (3.97%) and maximum for boll crusher+pre-cleaner (3.57%). The fibre strength for manual (20.50 g tex⁻¹) was maximum whereas it was minimum for boll crusher+pre-cleaner (19.36 g tex⁻¹). The reflectance for manual (0.87) was observed as minimum and maximum for boll crusher+pre-cleaner (0.81). Based upon the fiber quality parameters of harvested cotton cleaned by boll crusher machine was of superior quality but it was inferior in quality for the boll crusher+pre-cleaner machine.

KEYWORDS: Cleaning methods, fibre quality, seed cotton, trash

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1. INTRODUCTION

Cotton is an important commercial crop of India, cultivated in an area of 12.81 mha constituting the largest in the world. Although India is the largest producer of cotton in the world the yield is much less [540 kg ha⁻¹] as compared to the world average yield [766 kg ha⁻¹] (Anonymous, 2014). The total constitution of fibres at present from various sources is 40.0, 50.0, 5.0 and 2.0 and 3.0% respectively from cotton, cellulosic, jute, and other natural fibres, wool and synthetics (Mishra et al., 2021a). The quality of the cotton fiber is best on the day of boll burst in field. Along with other factors, cleaning during the ginning process could have a significant impact on certain fibre quality parameters (Li et al., 2010).

Handpicking is the gentlest way of harvesting in most cotton growing countries. In advanced countries like USA, Australia, Brazil and Russia, cotton picking is carried out mechanically by cotton pickers (the most commonly used machines) or cotton strippers. The spindle picker works with a number of rotating spindles which tangle with the seed cotton in the open bolls, pulling it away from the husk. This type of machine is used for all good quality cotton. The cotton stripper is a non-selective harvester that removes not only the well-opened bolls but also the cracked and unopened bolls along with the burs and other foreign matter. The plant is literally brushed off and only the stem and some branches remain on the field. Stripping is a very efficient way of harvesting, cheaper and quicker than spindle picking (Mishra et al., 2017). However, it results in additional foreign matter in the cotton and causes a long chain of cleaning, subsequently. Even with elaborate cleaning equipment in the gin it produces a much poorer quality of lint (Mishra et al., 2021b).

Traditionally, the color of the cotton is a main factor for the price and the whiter the cotton the better is the price. Therefore, intensive cleaning seems to be essential. However, high level of cleaning results in greater fiber damage. Fibers break by mechanical treatment, especially if they are dry. This reduces length and creates short fibers. Which get entangled with each other and form little knots, called neps, which may cause thick and thin places in the yarn. It is difficult for the ginner to find the right compromise between trash removal and a minimum reduction in fiber quality. Bennett & Misra (1996) showed that a field cleaner should be used as a first step of cleaning to get the least cost cleaning configuration across the harvesting, ginning, and textile mill stages. They found that field cleaning did not affect the quality parameters measured in cotton classification.

The High-Volume Instrument (HVI) and Advanced Fiber Information System (AFIS) are very precise instruments to

measure the fiber properties (short fibers, neps or immature fibers etc). Cotton property measurements taken before and after cleaning showed that, in general, cleaning machinery reduced foreign matter content in lint. Further, cleaning machines tend to reduce fibre length and increase neps. Current lint cleaning practices improve the grade and increase lint value (Armijo et al., 2005, Mishra et al., 2018a, Usharani et al., 2015).

In the Indian scenario, no study was carried out with regard to fibre quality of mechanically harvested cotton especially by cotton strippers. Hence, keeping these points present study was carried out to document the performance of different cleaning methods of mechanically harvested seed cotton.

2. MATERIALS AND METHODS

2.1. Seed cotton cleaning/extraction machines

The study was conducted at the Department of Farm Machinery and Power Engineering, Punjab Agricultural University, Ludhiana during May to December, 2017 situated at the latitude and longitude 30.903618, 75.811429. Material harvested by cotton stripper having trash (leaves, sticks and cotton with outer burs) needs to be removed and separated to obtain clean seed-cotton. To separate the trash from the harvested material three types of machinery were employed *viz.* Boll Crusher cum Seed-Cotton Extractor, Pre-cleaner and On-board cleaner (field cleaner).

2.1.1. Boll crusher cum seed-cotton extractor

A boll crusher/seed-cotton extractor (Millennium Model), developed by a local manufacturer M/s Chetak Industries, Ahmadabad and operational at Bhuccho Mandi, Bathinda, Punjab, was used for cleaning. The harvested material was fed by hand to the boll crusher with the help of the air suction unit. The air suction blower created suction to convey the feeding material to serrated drum/cylinder. The working principle of boll crusher cum seed-cotton extractor is when cotton bolls come into the contact with the cylinder (drum) and concave assembly than the cotton burs are removed with the rubbing action between the cylinder and concave and cotton fibre sticks to the drum of having the serrated surface. The seed cotton wrapped on the drum was removed with the help of brush roller rotating in the opposite direction to the serrated drum with the speed of 1440 rpm (Sharma et al., 2015). The seed cotton separated from the shells and other foreign material was collected from the rear side of the machine known as seed cotton outlet. The foreign material included burs/shells, leaves, sticks, dust particles etc. was removed with the help of screw conveyor called trash outlet. The operational view and technical specification of boll crusher/seed-cotton extractor and its technical specifications are shown in Figure 1 and Table 1.





Figure 1: Operational view of boll crusher

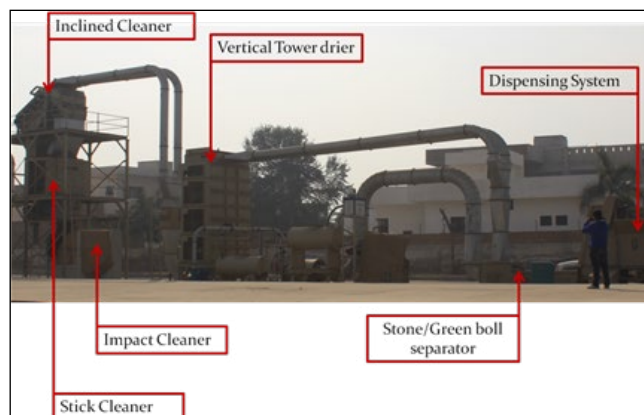


Figure 2: View of pre-cleaner installed at Grain Market, Malout, Punjab

Table 1: Technical specifications of boll crusher/seed-cotton extractor

S1. Parameters No.	Value
1. Total power requirement for boll crusher	15 hp (11.2 kW)
2. Blower power	5 hp (3.7 kW)
3. Blower rpm	1440
4. Drum type	Serrated (saw) drum
5. Speed of rotating drums (rpm)	Drum 1: 360 Drum 2: 360 Drum 3: 160
6. The speed of small/brush roller (rpm)	1440
7. The speed of rotating spikes (rpm)	600

The power requirement for the process of boll crusher is fifteen horsepower (11.2 kW). Two electrical motors of five horsepower (3.7 kW) each and an air-suction blower operated with 5 hp (3.7 kW) motor were used for the boll crusher operations. The saw drums (large drums) operated with installed motors rotate with 360 rpm (upper drums) and 160 rpm (lower drum) respectively (Mishra et al., 2018b). The parameters like lint turnout and trash content were calculated during the cotton extracting operation.

2.1.2. Pre-cleaner

A pre-cleaner, developed by Bajaj Steel Industries Ltd., Nagpur installed at Grain Market, Malout, Punjab, was used. The machine consisted of different types of system and steps for cleaning the harvested material to get clean seed cotton as depicted below (Figure 2). The component of pre-cleaner are Dispensing system (cotton feed control system), Green boll trapper cum stone separator, Vertical tower drier, Inclined cylinder cleaner, Stick removal machine and Impact cleaner (used for removal of small trash leaves).

2.1.2.1. Dispensing system (cotton feed control system)

The dispensing system is also known as a cotton feed control system. This is basically a stationary module feeding mechanism uses rotating spiked cylinders to pick the tightly packed module part and feed it to a conveyor for delivery to further process. The system controls the feed rate of seed cotton and creates a thin layer of the harvested seed cotton deposited on a conveyor belt.

2.1.2.2. Green boll remover cum stone trapper

The harvested material consisting of green, undeveloped bolls create cleaning troubles, such as blockage of the saw teeth, breakdown of the seed roll to turn, gathering of sticky material on the internal surface of the roll boxes and on the saws and infrequent blockage of other machines (Wakelyn et al., 1972). The green boll trapper is significant for separating green boll, rocks, and other weighty foreign substances from the seed cotton that is deposited on the conveyor belt in thin layer form with help of dispensing system. A suction pickup hood at the end of the belt lifts the open cotton while, the heavier green bolls, clods, rocks, and metal remain on the belt and are discharged over the end.

2.1.2.3. Vertical tower drier

The moisture content of seed cotton is the key point of the cleaning process. Seed cotton having excess moisture content will not clean in the right manner and will not easily separate but will form wads that may choke and damage cleaning machinery. For the drying seed cotton vertical tower drier are used. The source of heat for drying seed cotton is a fuel burner flame in the stream of drying air. Gaseous fuels (LPG) are used for efficient combustion. Efficient combustion allows more drying with less fuel and does not produce smoky flames, which discolours the seed cotton. The maximum temperature in the dried system should be kept below 170°C. The temperature control sensor should be located close enough to the mix point to respond

quickly to changes in burner output. Various numbers of shelves are arranged in such a manner that seed cotton must slow down while, making turns through Tower drier. The hot air stream conveys the seed cotton through the shelves.

2.1.2.4. Inclined cylinder cleaner

Inclined cylinder cleaner consists of 6 revolving spike cylinders which turns about 400 rpm with an inclination of a 30° angle. These spike cylinders convey the seed cotton over the series of grid bar (rods), agitate the seed cotton and allow to separate foreign material such as dry leaves, dirt and pin trash from seed cotton.

2.1.2.5. Stick removal machine

The foreign material taken from the plant by mechanical harvester was removed with the help of stick removal machine. Stick machine use the centrifugal force created by high-speed channel saw band cylinder to sling off foreign material while, cotton fibre gripped on the sawtooth. In the stick machine, a wire type rotating brush roller was provided for the doffing action. The seed cotton which was sling off with foreign material is picked by reclaimer saw band cylinder and put back into seed cotton stream. Reclaimer channel saw band cylinder similar to primary saw band cylinder but operated slow and having more grid bars.

2.1.2.6. Impact cleaner

Impact cleaner is used for removing small trash and leaves. The working principle of impact cleaner was similar to the stick machine. The flow of seed cotton is governed by the speed of 2 star-shaped feed rollers placed at the top of the feeder directly below the distributor hopper. These feed rollers are operated by variable-speed hydraulic or electric motors.

2.1.3. On-board cleaner

On-board cleaner, developed by M/s Bajaj Steel Industries Ltd., Nagpur was mounted on the tractor operated stripper. During harvesting, the feeder unit feeds the material into the on-board cleaner. The foreign material taken from the plant by mechanical harvester was removed with the help of this machine. On-board cleaner consists of beater high-speed channel saw band cylinder, reclaimer channel saw band cylinder, doffer bush roller and blower. The with its beating action detached with seed cotton. A centrifugal force created by high-speed channel saw band cylinder to sling off foreign material while cotton fibre gripped on the sawtooth. A wire type rotating brush roller was provided for the doffing action. The seed cotton which was sling off with foreign material is picked by reclaimer saw band cylinder and put back into seed cotton stream. Reclaimer channel saw band cylinder similar to primary saw band cylinder but operated slow and having more grid bars. After that clean seed cotton conveyed to a storage tank with the help of a

blower. A view of on-board cleaner is shown in (Figure 3). The width of the machine is 600 mm and weight are 800 kg. The throughput capacity of this machine was 2000 kg h⁻¹.



Figure 3: View of On-board cleaner

2.2. Measurement of seed cotton quality

Trash content and fibre quality are two main parameters to check the quality of seed cotton harvested mechanically.

2.2.1. Trash content

Tractor operated cotton header strips the cotton crop which includes opened/closed bolls, leaves, sticks and other trash contents (Figure 4). Materials like burs/bracts, sticks were removed with the help of boll crusher cum seed-cotton extractor during the cotton extracting operation. To remove the trash entangled with seed cotton extracted from the boll crusher, a commercially available trash analyser (Make: Texaco Engineering, Coimbatore) was used. Trash like entangled leaves with cotton, dust particles mixed with



Figure 4: View of trash content in seed cotton

cotton fibre was removed with the help of trash analyzer. Trash analyzer consists of the serrated drum, air-vacuum pump, heavy trash chamber, lint collector, macro and micro dust plates (Figure 5). To analyze the trash content in the seed cotton, the lint was removed from the seed. Then the weighted (known) sample was fed into the trash analyzer having articulated feeding claws and the weight of lint turnout and trash content were calculated individually to get the percentage of trash content from the sample throughout the machine operation (Sharma et al., 2015).



Figure 5: View of trash analyzer

Trash content was measured in two ways which are trash content on seed cotton basis and on a clean lint basis.

$$\text{Trash content percentage (Seed cotton basis)} = \frac{(W_t - (W_s + W_l))}{W_t} \times 100 \dots\dots\dots(1)$$

$$\text{Trash content percentage (Lint basis)} = \frac{(W_t - (W_s + W_l))}{W_l} \times 100 \dots\dots\dots(2)$$

Where

W_t = weight of seed cotton sample, g

W_s = weight of cotton seed, g

W_l = weight of clean lint, g

2.2.2. Fibre quality analysis

For fibre quality analysis, 1000 g sample of seed cotton was taken and ginned in the ginning machine. In ginning machine seed from seed cotton was removed and only lint samples were taken to use in cleaning machine. Lint samples were cleaned in trash analyser. 100 g of cleaned lint samples were analysed using High Volume Instrument (HVI). Various quality parameters (2.5% span length, 50% span length, uniformity ratio, fibre strength, micronaire, elongation and reflectance shown in Table 2) were measured by the instrument installed at Department of Plant Breeding and Genetics, PAU, Ludhiana. A view of High-Volume Instrument (HVI) as shown in Figure 6.

Table 2: Treatment details

Cleaning methods/ treatments	Fibre quality parameter	Unit	Remarks
M_1 =Manual	Trash	%	The measure of non-lint material in the cotton
M_2 =Boll crusher	Reflectance	Rd	Indicates how bright or dull a sample is.
M_3 =Pre-cleaner	Yellowness	+b	Indicates the degree of color pigmentation
M_4 =Boll crusher+Pre-cleaner	Color Grade		Three-digit code. Point of intersection of yellowness and reflectance in the Nickerson-Hunter color chart for Upland cotton
M_5 =On-board cleaner	Micronaire		The measure of air permeability through a constant mass of compressed cotton. Indication for fiber fineness and maturity.
	50% span length	mm	the longest 50% fibres held at one end by a clamp
	2.5% span length	mm	the longest 2.5% fibres held at one end by a clamp
	Length Uniformity Index	%	Ratio between mean length and upper half mean length of the fibers
	Strength	g tex ⁻¹	Force required to break a bundle of fibers
	Elongation	%	Indication of elasticity of the fiber. Ratio of increase in length before breakage and original length

3. RESULTS AND DISCUSSION

Trash content and quality parameters of cotton harvested by header and clean by different methods like boll crusher, pre-cleaner, boll crusher+pre-cleaner and on-board cleaner were measured and compared with the cotton harvested manually. ANOVA table of trash content and various fibre quality parameters is shown in Table 3. The effect of cleaning methods on cotton quality parameters was also calculated and shown in Table 4.

3.1. Trash content

The effect of various cleaning method on trash content (seed cotton and lint basis) is shown in Figure 7. There was a significant difference of cleaning method on the trash content (seed cotton basis) at 5% level of significance (p -value=0.0001). The trash content (seed cotton basis) for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and the on-board cleaner was observed to be 6.11, 15.67, 7.33, 5.17 and 21.4%, respectively. In a post-hoc test of cleaning methods, the manual (M_1) is significantly different



Figure 6: View of High Volume Instrument (HVI)

from Boll crusher (M₂), Pre-cleaner (M₃) and On-board cleaner (M₅) but significantly at par with Boll crusher+Pre-cleaner (M₄).

There was a significant difference of trash content (lint basis) observed among the cleaning method at 5% level of significance (*p*-value= 0.0001). In general, cleaning

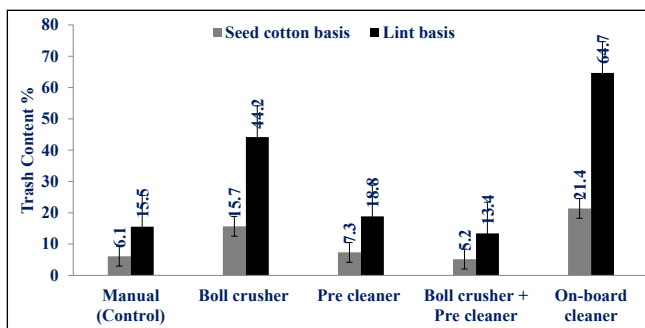


Figure 7: Effect of different cleaning methods on trash content

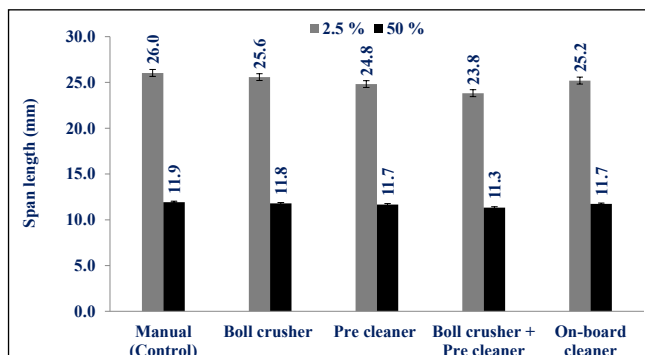


Figure 8: Effect of different cleaning methods on span length (mm) of cotton lint

Table 3: ANOVA table for trash content and fibre quality parameter

Tests of between-subjects effects					
Source	Dependent variable	df	Mean Square	F	p-value
Picking	SL	4	3.321	16.834	<.0001
	SL1	4	0.239	14.216	<.0001
	UR	4	1.838	4.246	0.012
	Elong	4	0.032	1.897	0.150
	Strength	4	1.783	1.956	0.140
	Mic	4	0.160	22.997	<0.0001
	MR	4	0.003	2.340	0.090
	T ₁	4	243.714	220.597	<0.0001
	T ₂	4	2530.631	291.132	<0.0001

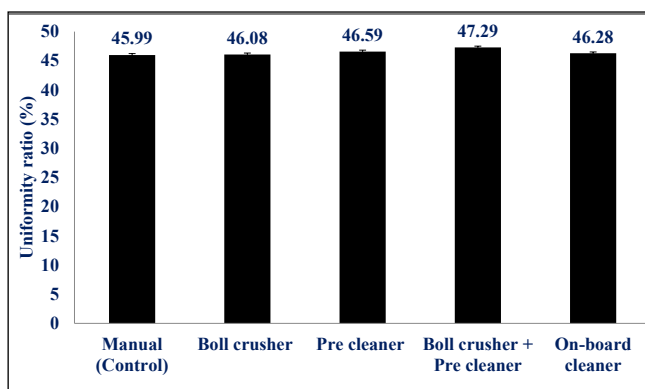


Figure 9: Effect of different cleaning method on uniformity ratio (%) of cotton lint

Table 4: Effect of cleaning methods on cotton quality parameters

Methods	SL	SL1	UR	Elong	Strength	Mic	MR	T ₁	T ₂
M ₁	26.03 ^a	11.92 ^a	45.99 ^a	4.93 ^a	20.5 ^a	3.97 ^a	0.86 ^a	6.11 ^{ab}	15.54 ^{ab}
M ₂	25.58 ^{ab}	11.78 ^{ab}	46.08 ^a	4.81 ^{ab}	19.75 ^{ab}	3.72 ^b	0.84 ^{ab}	15.67 ^c	44.17 ^c
M ₃	24.81 ^c	11.67 ^b	46.58 ^{ab}	4.71 ^{ab}	19.55 ^{ab}	3.64 ^b	0.83 ^{ab}	7.33 ^b	18.82 ^b
M ₄	23.82 ^d	11.32 ^c	47.28 ^b	4.57 ^b	19.35 ^b	3.54 ^c	0.81 ^b	5.17 ^a	13.38 ^a
M ₅	25.17 ^{bc}	11.73 ^{ab}	46.28 ^a	4.75 ^{ab}	19.63 ^{ab}	3.7 ^{bc}	0.85 ^a	21.4 ^d	64.7 ^d
<i>p</i> -value	<0.0001	<0.0001	0.012	0.15	0.14	<0.0001	0.09	<0.0001	<0.0001

Note: SL-2.5% span length, SL1-50% span length, UR-uniformity ratio, Elong: elongation ratio, Strength-Fibre strength, Mic-micronaire, MR-reflectance %, T₁: trace content seed cotton basis and T₂: trace content lint basis

machinery reduced foreign matter content in lint (Armijo et al., 2005). The trash content (lint basis) for boll crusher+pre-cleaner is minimum (13.38%) as compared to other cleaning methods i.e. manual (15.54%), boll crusher (44.17%), pre-cleaner (18.82%) and on-board cleaner (64.70%). So increasing the number of seed cotton cleaners reduced trash content in the seed cotton (Armijo et al., 2009).

In a post-hoc test of cleaning methods, the manual (M_1) is significantly different from Boll crusher (M_2), Pre-cleaner (M_3) and On-board cleaner (M_5) but significantly at par with Boll crusher+Pre-cleaner (M_4).

Trash content either on seed cotton or lint basis was minimum for boll crusher+pre-cleaner method of cleaning which was lesser than the trash content for cotton picked manually. Trash content for the cotton clean by on-board cleaner was maximum among all the methods. It was clearly evident that, more trash was removed from the cotton harvested without on board cleaner than from those harvested with on board cleaner and the difference was levelled out.

3.2. Quality parameters of cotton lint

Cotton fibre quality parameters like 2.5% span length (mm), 50% span length (mm), uniformity ratio (%), elongation (%), micronaire (%), strength ($g\ tex^{-1}$) and reflectance (%) for different cleaning methods are explained below;

3.2.1. Effect of different cleaning methods on span length (mm) of cotton lint

The effect of various cleaning methods on span length is shown in Figure 8. There was significant (p value= 0.0001) effect of cleaning methods on the 2.5% span length at 5% level of significance.

There was no significant difference in span length for M_1 , M_2 and M_5 but M_1 , M_3 and M_4 significantly differed from each other for span length at 5% of the level of significance. The 2.5% span length is minimum for boll crusher+pre-cleaner (23.83) as compared to pre-cleaner (24.82), on-board cleaner (25.20), boll crusher (25.59), and manual cleaning method (26.04) (Table 3). It is clear that higher combination of mechanical cleaning reduces span length (Tian et al., 2018).

The 50% span length for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and the on-board cleaner was observed 11.92, 11.78, 11.67, 11.32 and 11.73 mm respectively (Table 3). Cotton having more span length (mm) is considered to be of better quality hence, cotton cleaned by ball crusher was of better quality but cotton clean by ball crusher+pre-cleaner was of poorer quality based upon span length.

3.2.2. Effect of different cleaning methods on uniformity ratio (%) of cotton lint

The effect of various cleaning method on uniformity ratio is

depicted in Figure 9. There was significant (p -value=0.012) effect of cleaning methods on the uniformity ratio at 5% level of significance.

There was no significant difference in uniformity ratio among M_1 , M_2 , M_3 , M_5 and M_3 , M_4 but M_1 , M_2 , M_5 and M_4 significantly differed from each other for span length at 5% of the level of significance. The uniformity ratio for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and the on-board cleaner was observed at 45.99, 46.08, 46.59, 47.29 and 46.28 % observed respectively (Table 3). Cotton having less uniformity ratio (%) is considered better quality hence cotton cleaned by ball crusher was of better quality but, cotton clean by ball crusher+pre-cleaner was of poorer quality based upon uniformity ratio. Similar findings were observed by Armijo et al., 2019.

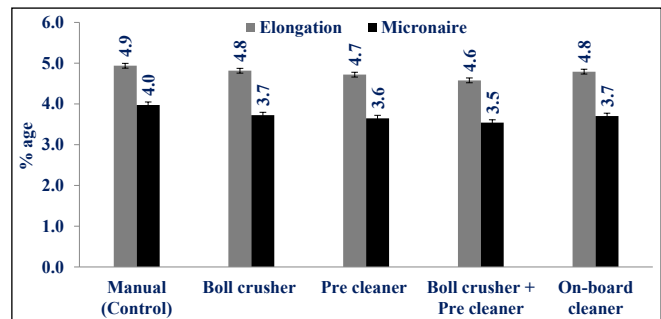


Figure 10: Effect of different cleaning methods on elongation (%) and micronaire (%) of cotton lint

3.2.3. Effect of different cleaning method on elongation (%) and micronaire (%) cotton lint

The effect of various cleaning methods on elongation (%) and micronaire (%) is depicted in Figure 10. There was significant (p -value=0.15) effect of cleaning method on the elongation (%) at 5% level of significance. The elongation (%) for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and the on-board cleaner was observed 4.94, 4.81, 4.72, 4.58 and 4.79%, respectively. There was significant (p -value=0.0001) effect of cleaning method on the micronaire at 5% level of significance. There was no significant difference in micronaire (%) for M_2 , M_3 and M_4 , M_5 but M_1 , M_2 , M_4 and M_3 , M_5 significantly differed from each other for span length at 5% of the level of significance. The micronaire for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and on-board was observed 3.97, 3.72, 3.69, 3.57 and 3.7 % respectively (Table 3). Cotton having more elongation (%) and micronaire (%) is considered better quality hence cotton cleaned by ball crusher was of better quality but cotton clean by ball crusher+pre-cleaner was of poorer quality based upon elongation and micronaire.

3.2.4. Effect of different cleaning methods on fibre strength ($g\ tex^{-1}$) of cotton lint

The effect of various cleaning methods on fibre strength (g tex^{-1}) is depicted in Figure 11. There was significant (p -value=0.0014) effect of cleaning methods on the fibre strength at 5% level of significance. There was no significant difference in uniformity ratio for M_1, M_2, M_3, M_5 and M_2, M_3, M_4, M_5 but M_1 and M_4 significantly differed from each other for fibre strength at 5% of the level of significance.

The fibre strength for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and on-board cleaner was observed 20.50, 19.75, 19.55, 19.35 and 19.63 g tex^{-1} respectively (Table 3). Cotton having more fibre strength (g tex^{-1}) is considered better quality hence cotton cleaned by ball crusher was of better quality but, cotton cleaned by ball crusher+pre-cleaner was of poorer quality based upon fibre strength.

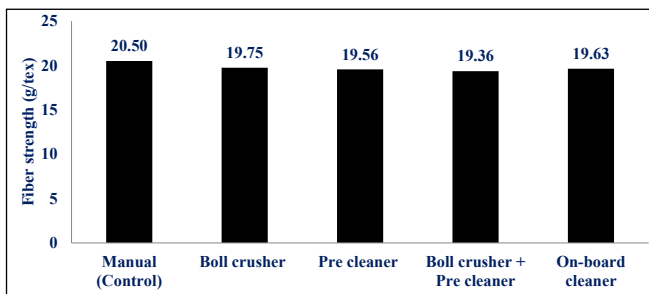


Figure 11: Effect of different cleaning methods on fibre strength (g tex^{-1}) of cotton lint

3.2.5. Effect of different cleaning methods on the reflectance of cotton lint

The effect of various cleaning methods on reflectance is depicted in Figure 12. There is a significant effect of cleaning methods on the reflectance at 5% level of significance. There was no significant difference in reflectance for M_1, M_2, M_3, M_5 and M_2, M_3, M_4 but M_1, M_3 and M_5 significantly differed from each other for the reflectance at 5% of the level of significance.

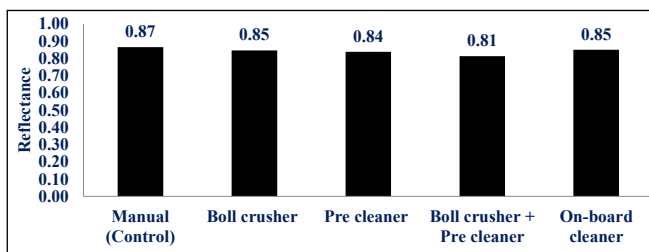


Figure 12: Effect of different cleaning methods on reflectance (%) of cotton lint

The reflectance for manual, boll crusher, pre-cleaner, boll crusher+pre-cleaner and on-board was observed 0.87, 0.85, 0.84, 0.81 and 0.85 respectively (Table 3). Cotton having more reflectance is considered better quality hence cotton

cleaned by ball crusher was of better quality but cotton clean by ball crusher+pre-cleaner was of poorer quality based upon reflectance. Improvement in fiber color parameters is not unique to this study as Seed cotton cleaning rate had no influence on reflectance or yellowness after either lint cleaner.

The fibre quality parameters like 2.5% span length (mm), 50% span length (mm), uniformity ratio (%), elongation (%), strength (g tex^{-1}), micronaire ($\mu\text{g inch}^{-1}$) and reflectance observed 23.83, 11.3, 47.29, 4.58, 19.36, 3.57 and 0.81 respectively were poor for boll crusher+pre-cleaner machine. The good fibre quality parameters 2.5% span length (mm), 50% span length (mm), uniformity ratio (%), elongation (%), strength (g tex^{-1}), micronaire ($\mu\text{g inch}^{-1}$) and reflectance observed 25.17, 11.73, 46.28, 4.57, 19.63, 3.7 and 0.85, respectively were best for boll crusher machine. Fiber quality differences by cleaning method were observed for all cases. Boll crusher machined clean cotton exhibited a higher Fiber quality than combination of boll crusher+pre-cleaner machined cotton in each case.). This is due to the difference in mechanical treatment by cleaning method affected through the selective cleaning action of the boll crusher machine. Cotton fibre quality can be affected by various factors, such as multiple cleaning process, mechanical treatment during especially if they are dry etc. Similar results were reported by Wanjura et al. (2011).

4. CONCLUSION

Trash content either on seed cotton or lint basis was minimum for the boll crusher+pre-cleaner method of cleaning which was even lesser than the trash content for cotton picked manually. Trash content for the cotton cleaned by on-board cleaner was maximum among all the methods of cleaning. Based upon the fiber quality parameters of harvested cotton cleaned by boll crusher machine was of superior quality but it was inferior in quality for the boll crusher+pre-cleaner machine.

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