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Assessment of boll opener for processing of *kawdi* cotton in Indian ginneries

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ABSTRACT: Seed cotton coming from farm contains up to 5-10 per cent *kawdi* depending on the extent of insect infestation, crop damage, improper agronomic practices and harvesting stage. *Kawdi* cotton poses problems in normal ginning operation due to its closely packed fibres and is separated from seed cotton in various pre-cleaning sections prior to ginning. Though, *kawdi* cotton is generally ignored by ginners considering it as waste material, it can be processed and good quality lint can be recovered from it that can provide additional income to ginners. To make it ginnable, closely packed fibres of *kawdi* cotton have to be opened well and cleaned using specialized machines. In this study, a boll opener machine used in Indian ginneries was assessed for cleaning and opening performance of *kawdi* cotton so as to make it ginnable. Performance trials revealed that about 40 per cent of *kawdi* cotton could be recovered for ginning and good quality lint could be obtained from the opened kawdi cotton, giving additional economic benefit to ginners.

Key words: Boll opener, ginning, *kawdi* cotton, lint, seed cotton

India is the leading cotton producing country in the world with the production of more than 350 lakh bales from about 180 lakh tonnes of seed cotton harvested in the country every year (Anonymous, 2019). Harvested seed cotton, along with dust particles and leafy trash, may also contain immature and unopened cotton bolls, which are locally called as *kawdi* cotton in Maharashtra. *Kawdi* cotton results due to improper production technology or infestation by insect/pests like the pink boll worm attack (CICR, 2015). According to the grading of cotton by The Maharashtra State Cotton Cooperative Growers Marketing Federation (MSCCGMF), the lowest grade cotton is termed as *kawdi* cotton, which is normally rejected at the procurement centres (The World Bank, 2000). In India, instances of pink boll worm infestation have increased in recent past leading to increased percent of *kawdi* in seed cotton received at ginneries. Up to about 5-10 per cent *kawdi* is generally present in seed cotton arriving at ginneries.

When raw seed cotton is taken to ginneries, it is passed through many cleaning systems like hot-box dispenser and pre-cleaner where dust particles, leaves and *kawdi* cotton are removed (Sreenivasan and Venkatakrishnan, 2007). During ginning and further processing the remaining *kawdi* is removed through the auto feeder. Because fibres in *kawdi* cotton are not fluffy enough and are snuggly held to the seed, they are not easily picked up by ginning rollers or saw teeth. Therefore, *kawdi* cotton poses problems in ginning and is generally rejected as waste material by ginners. However, if properly processed by cleaning and opening, good quality lint could be recovered from *kawdi* yielding additional benefit to ginners. A number of machines are available in the market for processing of *kawdi* cotton by beating and rubbing action for opening up of fibres and cleaning. Mostly, these machines are custom made for small traders and there is a lack of standardisation in design principles. Ginning industry is looking for a better and efficient solution to process this material so as to make it

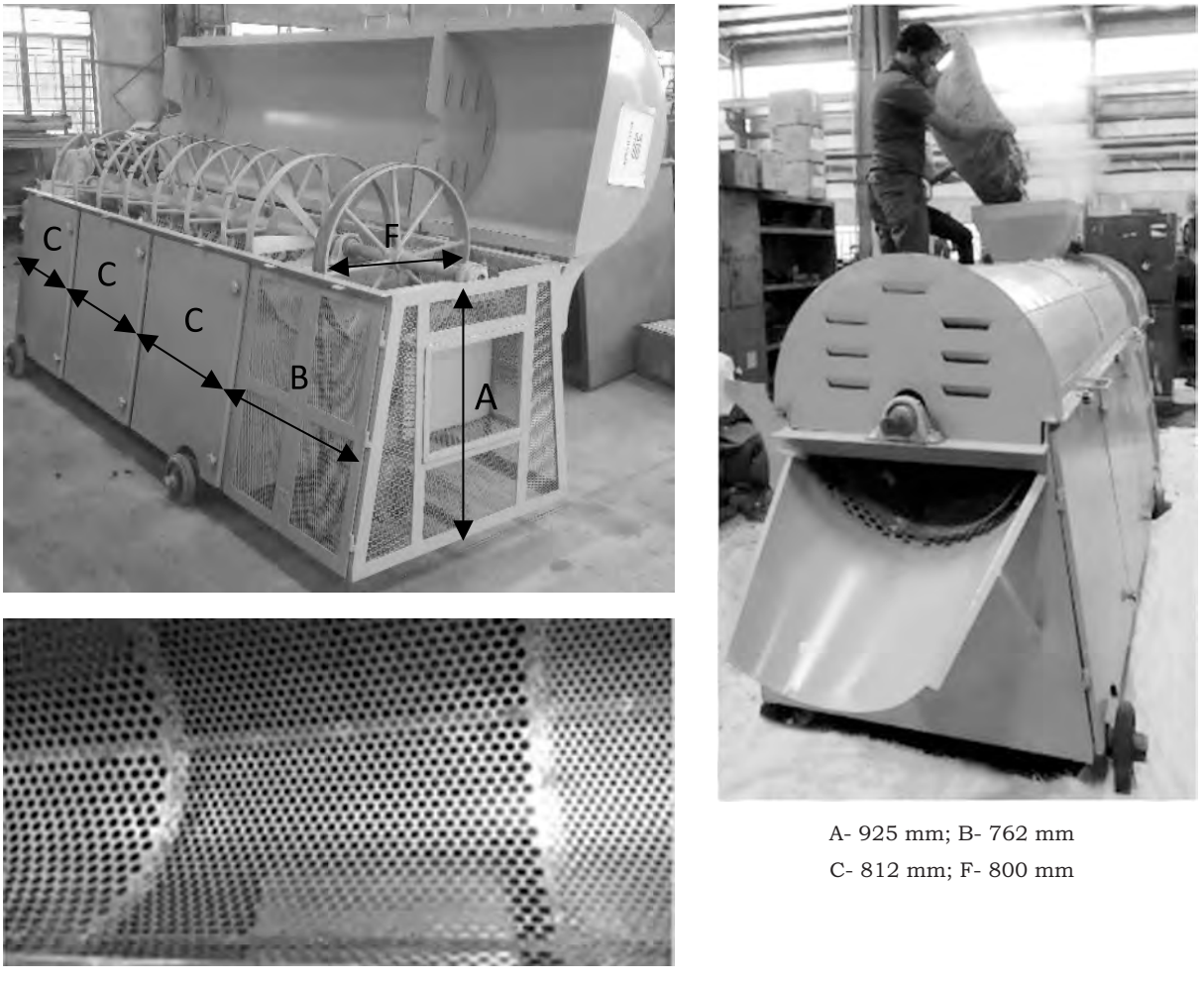
ginnable and good quality lint could be obtained from it.

The present investigation was carried out for evaluating the performance of the 'Boll Opener' machine manufactured by M/s Bajaj Steel Industries Ltd., Nagpur in terms of cleaning and opening of *kawdi* cotton so as to make it ginnable using Double Roller (DR) or Saw Gins and assessing the quality of lint obtained from the opened *kawdi* cotton.

MATERIALS AND METHODS

The existing *kawdi* cotton openers available in the market were reviewed for its performance evaluation. Most of the boll openers available in the market consist of a series of perforated screens with a spiral beater assembly, which also acts as conveyor. The rubbing action between screens and beater assembly opens the *kawdi* cotton and separates out trashes.

In the present study, most commonly used boll opener machine manufactured and marketed by M/s Bajaj Steel Industries Ltd. (BSIL), Nagpur was selected for evaluating the performance for opening and cleaning of kawdi cotton. The machine consists of a rotating helical beater shaft cylinder assembly mounted on a frame with 12-, 20- and 25-mm perforated screens arranged underneath in series for trash separation (Fig. 1). The length, width and height of the machine are 3.2, 1.0 and 1.3 m, respectively. Beater diameter is 800 mm and its rotational speed is 250 RPM. The width of each



A- 925 mm; B- 762 mm
C- 812 mm; F- 800 mm

Fig. 1. Boll opener machine and screen grids (12, 20 and 25 mm) used in this study

perforated screen section is 812 mm. A 1440-RPM, 5-HP electric motor is used as prime mover to drive the beater assembly using V-belt transmission system.

The test trials of the boll opener machine were conducted at ICAR-CIRCOT-GTC Nagpur. Raw *kawdi* cotton used in this study was a mixture of kawdi cotton obtained from different cleaning sections like hot-box dispenser, pre-cleaner chamber and auto feeder in ginning factory. Three lots of such *kawdi* cotton (A, B, C) for this study were obtained from three different ginneries nearby Nagpur. The experimental design consisted of three treatments replicated three times, thus making a total of nine lots for conducting trials. The boll opener machine was run for 15 min every time for each replication. *Kawdi* cotton was fed into the hopper manually ensuring uniform feeding.

The performance of the machine was evaluated in terms of *kawdi* cotton handling capacity (kg/h), recovery (%) of ginnable seed

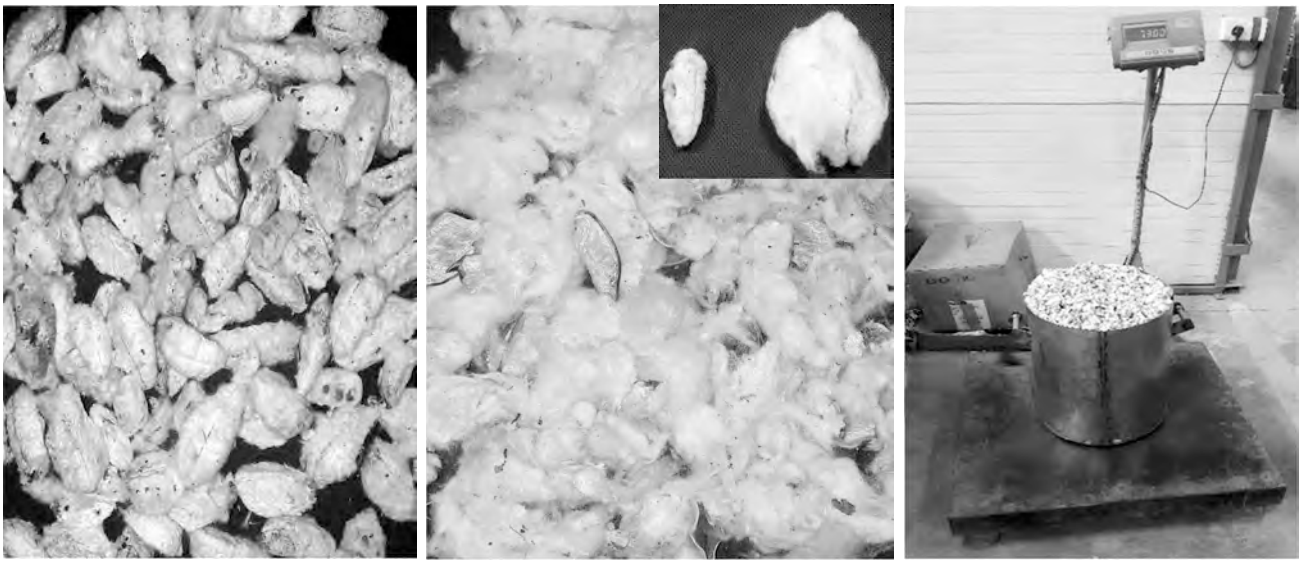


Fig. 2. Raw (left) and Opened (Centre) kawdi cotton and specific volume measurement

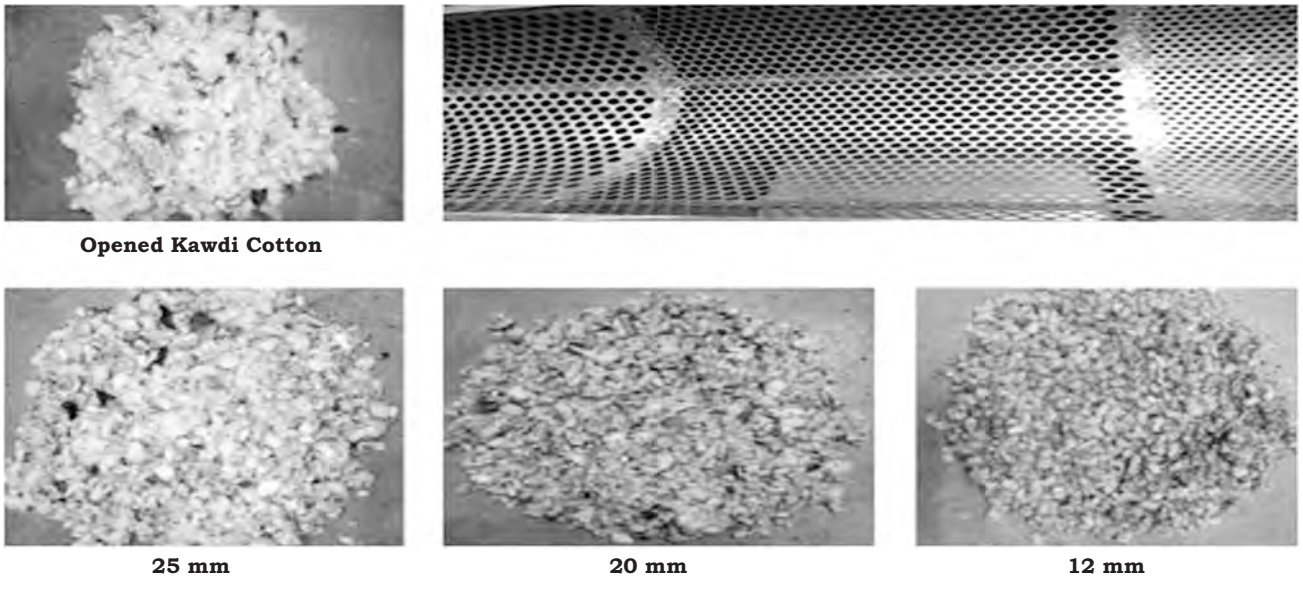


Fig. 3. Opened kawdi cotton and output from different screens of boll opener

cotton from raw *kawdi* cotton and increase in specific volume (%) of *kawdi* cotton. The recovery of ginnable seed cotton was calculated as weight percent of opened *kawdi* cotton obtained at opener outlet to the input weight of raw *kawdi* cotton while the extent of opening was determined in terms of percent increase in specific volume of *kawdi* cotton. The specific volume of *kawdi* cotton was calculated by noting the weight of cotton required to fill the specially designed measuring cylinder of 56150 cm^3 volume (Fig. 2). Opened kawdi cotton, trash, dust and cottonseed removal through different screens (12, 20 and 25 mm) were determined as weight percentages based on the weight of input kawdi cotton (Fig. 3).

The opened kawdi cotton was ginned using Bajaj 170 mm roller diameter 1370 mm roller length Double Roller (DR) gin and Murray 406 mm diameter 90-Saw Gin (SG) stands. Both ginning machines were operated under normal settings. Lint samples of appropriate weights were collected from lint slides and were analysed at ICAR-CIRCOT-GTC, Nagpur laboratory for quality attributes using High Volume Instrument (HVI). The average values of three replications of the boll opener performance tests and the fibre properties of lint obtained from saw and roller gin are presented in this work.

RESULTS AND DISCUSSION

The results of the performance trials conducted on Bajaj boll opener machine are presented in Table 1. It can be seen that about 40 per cent *Kawdi* cotton could be recovered for ginning and further processing, the rest going out as losses through 12-, 20- and 25- mm screens and as dust loss. About 9 per cent input material, which is thrown out as feeder splash-out can be fed-in again to increase the recovery up to about 50 per cent. The recovery could be further improved by adding in some of the ginnable *kawdi* removed through 25-mm screen. Machine vibrations due to rotation cause about 3-4 percent dust flyout losses. Some dust, cottonseeds and unopened *kawdi* are removed through 12- and 20- mm screens.

The extent of opening up of fibres in *kawdi* cotton can be assessed by the increase in specific volume of raw *kawdi* cotton. It was found that specific volume of raw *kawdi* cotton which was around 7-8 cc/g nearly doubled to 13-14 cc/g on passing through Boll Opener machine, thus indicating loosening of fibres making them ginnable.

The maximum capacity of the boll opener machine for processing *kawdi* cotton was found to be 850 kg/h, which varied greatly due to uncontrolled manual feeding. The opened *kawdi* cotton was ginned using DR as well as Saw gins. There was no significant difference observed in the lint outturn both these methods. However, the Upper Half Mean Length (UHML) of fibre was consistently lower in case of saw gin as compared to that of DR gin. This finding is in line with previously reported results on comparative performance of saw and roller gins (Funk and Gamble, 2009; Marinus and Sluijs, 2015). The HVI test results of other fibre parameters including Colour Grades (CG) showed no significant differences in both the methods (Table 2).

Some of the general observations during the test trials include fan blockage, where k*awdi* gets blocked in between the peripheral support flat of the fan and the screen underneath with a possibility of fire hazard due to friction and outlet chute safety- there is a risk of operator hand injury in the rotating beater element close to the chute outlet. The location of the feed hopper on top of the machine is observed to be faulty making it inconvenient and difficult for the operator. *Kawdi* has to be manually fed into the hopper using baskets/bags for which two labourers are required, one for filling and delivering the basket to the other standing on the raised platform in order to reach the hopper. In view of this, some design modifications in the

Table 1. Performance of boll opener machine for processing of *kawdi* cotton

Kawdi	Feeder splash-out (%)	Trash removal (%)			Dust flyout (%)	Recovery (%)	Capacity (kg/h)	Specific volume (cc/g)		
		12 mm*	20 mm#	25 mm$				Raw *kawdi*	Opened *kawdi*	Per cent Increase
A	8.8	8.0	20.1	18.2	4.1	40.8	850	7.46	13.70	83.6
B	8.3	8.5	20.6	18.6	3.8	40.2	830	7.25	13.33	83.8
C	9.1	8.3	20.3	18.4	4.3	39.6	835	7.36	13.51	83.6

*dust and cottonseeds #dust, seeds and unopened kawdi $unopened and some ginnable kawdi

Table 2. Average fibre properties of lint obtained from the opened *kawdi* cotton

Kawdi	Gin Machine	Lint out-turn (%)	UHML (mm)	UI (%) (µg/inch)	MIC (g/tex)	Tenacity 3.2 mm (%)	EL	Rd (%)	+b	CG
A	DR	31.3	28.3	82	3.1	25.1	5.7	56.4	14.0	54-3
	Saw	32.0	27.9	83	3.0	24.8	5.6	56.5	14.1	54-3
B	DR	32.1	27.6	83	3.0	24.7	5.4	57.4	13.8	54-3
	Saw	31.7	27.2	82	2.9	24.3	5.3	56.9	13.6	54-3
C	DR	32.3	28.0	82	3.1	25.3	5.6	57.2	14.6	54-3
	Saw	32.1	27.5	82	3.0	24.6	5.8	56.5	14.5	54-3

machine especially for arresting the losses and proper feeding may help in improving its performance for increased recovery.

CONCLUSIONS

Kawdi cotton- the immature and unopened cotton bolls rejected in ginneries, if properly processed can yield some ginnable seed cotton earning additional profit to ginners. The available systems for processing of *kawdi* cotton seem to be inefficient and there is a need to develop an efficient system to effectively clean and open *kawdi* cotton as well as to maximize the output of the machine so that the economic profits of ginneries can be increased. An improvement in the existing boll opener machines may lead to development of new system with improved efficiency and also a suitable technology to gin kawdi cotton to improve its grade.

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