

Enhancement of Quality of Indian Cottons through Optimization of Roller Gin Machine Parameters

Diyaj H. Kalathiya¹, Ashwin I. Thakkar², Dharmendra V. Bihola³, P. H. Shah⁴

¹ME Student (Textile Engineering), L. D. College of Engineering, Ahmedabad,

²Head of Department, Department of Textile Technology, L. D. College Engineering, Ahmedabad,

³Assistant Professor, Department of Textile Technology, L. D. College Engineering, Ahmedabad,

⁴Former Project Coordinator, ATIRA, Ahmedabad,

Abstract— Double Roller Ginning machines are commonly used in India for ginning of seed cotton where fibres are separated from the cotton seeds. The double roller gin plays the dominating role in the Indian ginning industry due to gentle handling of fibres. However, earlier studies revealed that frequent wear and tear of such gin machines affect the quality of Indian cotton particularly in terms of seed coat fragments, short fibres, neps etc. Because of high wear and tear of critical parts of the gin machine, various setting between parts get disturbed frequently and hence the quality of cotton gets deteriorated as well as productivity is decreased. There are certain critical parameters need to be optimized which are: Sharpness of moving and fixed knives, Condition of leather roller, Gin machine speed and Moisture Content present in raw material (Seed Cotton). A series of experiments using the above parameters has been conducted in order to identify their effect on cotton characteristics like Length, Short fibre content, Seed Coat Fragments, Fibrous neps etc. Ginned Cotton samples have been tested in appropriate instruments like HVI, Cotton Trash Analyzer and Moisture measuring system. With these studies appropriate optimization has been found to be possible and helpful to the ginning/spinning industries for minimising the deficiency present in the Indian cottons. Seed Cotton having standard moisture content (around 7.5 %) yields better ginning performance in all respect i.e. Fibre length, Fibre Strength, Trash Content, Gin productivity as well Cotton Realization. In addition to this, ginning machinery parameters/conditions like better condition of leather roller as well fixed and moving knives help in achieving higher gin productivity and Cotton realization having low trash content. However, lower gin machine speed minimises the trash content in cotton but at the cost of gin productivity.

Keywords— Cotton, Double Roller Ginning Machine, High Volume Instrument (HVI), Cotton trash Analyser, Moving Knife, Fixed Knife, Leather Roller

I. INTRODUCTION

Cotton is grown in the farm in the form of Seed Cotton in which fibres are attached to the seed. Ginning is the process to separate the cotton fibres from the seeds. Generally Roller Gins are suitable for longer length of fibres while Saw Gin is only suitable for coarse and short fibres. In India, 70 to 80 % Cotton Varieties are of Medium and Longer staple length and thereby Roller Ginning is most widely used. Roller Ginning is gentle mechanism and therefore the fibres are not ruptured/damaged while saw ginning has harsh treatment and thereby the fibres get ruptured during ginning. Normally fixed knife and moving knife gets worn out frequently as well leather roller diameter and its grooves are also worn out there by the quality of Indian cotton as well as Gin machine productivity also get affected up to a significant level. In such a situation, if ginning parameters are optimized then the chances of all critical parts are likely to be reduced and hence this dissertation has been planned to conduct in some of ginning units of Kadi region.

II. LITERATURE REVIEW

With the use of Pre-Ginning Cleaner, the quality of fibres is improved particularly in terms of Seed Coat Fragments and the purity of fibres. [1][2]

The effect of Pre-Ginning Cleaner on fibre property and trash content has been studied where, it is seen that immature balls get removed with the use of Pre-Ginning Cleaner. As a result, the fibre quality is improved in terms of Short Fibre Content, Maturity and Bundle Strength. Post-Ginning cleaner has been introduced in ginning units where the quality of Indian cotton is improved in terms of Trash Content. With the use of Automatic Cotton Conveying System, around 75 % labors are reduced and thereby the quality of Indian Cotton is likely to be improved particularly in terms of Contamination. Since labors are reduced the contaminants like human hair, tobacco pouches, pieces of cloth/yarn threads etc. were found to be minimized in the ginned cotton. [3]

The Post-Ginning Cleaner minimizes Seed Coat Content and Loose Trash Content by about 25 to 30 % in the ginned lint. At the same time fibre length properties remain same that means it is not affected with the use of Post-Ginning Cleaner. [2] [3]

The quality of yarn was found to be superior with the use of Pre and Post Ginning Cleaner in terms of imperfections and classimat A faults. (Short Thick) [4]

Newly Developed Pre and Post Ginning Cleaner having higher cleaning efficiency which affect opening of balls, Gin Productivity (Increased), Waste level (Decreased) and Cotton Prices (Increased) and Yarn quality. Indian cottons are heavy contaminated and also have higher microdust level. Such impurities can be removed/ eliminated by using Automatic Pneumatic Cotton Conveying System. [5]

Sources of Contaminants in Indian cotton varieties were determined. It was found that strings of Jute, leaf, feathers, oil, grease, seed coat fragments etc. are present in Indian cotton at serious level. These Contaminants can be reduced by proper handling of cotton and covering of cotton at ginning stage. [6]

Indian Hybrid cotton seems to be too much inferior to the Foreign Cotton in terms of Fibre Quality Parameters, Process Waste Level and Yarn Quality Parameters. Level of waste of Card & Comber is at very high when the Indian Hybrid Cotton was processed and hence, Poor Yarn Realization achieved. Quality parameters like Strength, Imperfections and Classimat faults get deteriorated substantially in the yarn spun from Indian Hybrid Cotton. Short Fibre content in foreign cottons is too much lower than that of the Indian hybrid cotton. [7]

It was found that the immature balls are poor in fibre quality in terms of Length and Strength. Lower mass of seed cotton was found to be inferior which should be used for producing coarse yarn. [8]

The mechanism of Double Roller Gin helps in producing cotton lint at very high rate as compared to single roller gins. As the roller speed increase, the gin productivity was found to be improved without affecting quality of cotton. After the introduction of Double Roller Gin machine in the ginning industry, machinery manufacturers have increased the width of machine from 42 inches to 54 inches. Thus increase in further production rate could be possible. [9]

Attempts were made to minimize grease and oil type contaminants in Indian cotton by developing prototype double roller gin machine. [10]

III. EXPERIMENTAL SETUP

A. Design of Experiment (DOE)

Design of Experiments done by using Minitab Software. Full Factorial Method is used for Design of Experiment. [11] Here, five Critical Parameters which are affecting Cotton Quality.

$$\text{No. of Parameters} = 5, \text{No. of Levels} = 2, \text{Total No. of Trials/Runs} = 32 (2^5)$$

B. Methodology

For conducting the experiments, different critical parts of Double Roller Gin machine having their Good Vs. Bad condition were collected. Those parts are:

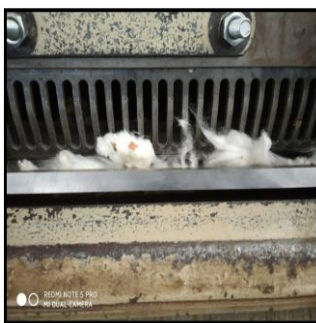


Fig. 1: Moving Knife (Sharp) Fig. 2: Moving Knife (Blunt) Fig. 3: Fixed Knife (Sharp) Fig. 4: Fixed Knife (Blunt)



Fig. 5: Leather Roller (Good Condition) Fig. 6: Leather Roller (Bad Condition) Fig. 7: Motor Pulley (5.75" and 6.0")

For comparison of the effect of speed of Double Roller Gin machine, different size of motor pulley was selected. Those Pulleys are 5.75" Vs. 6.0" where the speed of machine comes 940 Vs. 980 strokes/min.

$$\text{Machine Speed} = (\text{Motor Speed (RPM)} * \text{Motor Pulley Dia.}) / \text{Machine Pulley Dia.}$$

Table I: Gin Machine Speed Calculation

Sr. No.	Pulley Dia.	Calculated Speed	Actual Speed	Difference
1	5.75"	946.28 SPM	938.4 SPM	7.88
2	6"	987.42 SPM	981.1 SPM	6.32



Fig. 8: Machine Speed (938 SPM)



Fig. 9: Machine Speed (981 SPM)

For Experimental Trial, 1000 kg. of Raw Cotton (Kapas) having 8 % Moisture Content was Stored. Out of this quantity, half quantity (500 kg.) of raw Cotton material was kept in sunlight for 12 Hours in the open form and got the moisture content around 3 % in the Raw Cotton. Then 2 Set of Raw Cotton having 3 and 8 % Moisture Content is kept for Trials. Also chosen one Double Roller Gin Machine (Bajaj) which was working in good condition in one of the private ginning unit of Kadi region.

C. Standard Operating Procedure (SOP)

Gin Machine was made empty before conducting the trial and arranged to clean it appropriately. Stopwatch, Tachometer and all gauges were kept ready and used appropriately for each set of experiments.

Following Parameters was kept constant in each set of experiments:

- **Opening Gap:** 21 mm
- **Cut off Distance :** 9 mm
- **Height of Fix Knife:** 88 mm
- **Gap between both knives:** 1 mm

Raw material was weighed 25 kg in each trial and processed through the double roller gin machine. Total time was measured to finish the quantity of Raw Cotton. Lint fibres and Cotton Seeds were collected in each trial and the Machine Productivity and Ginning % were calculated on the basis of the weight of loose lint and seeds. Samples of loose lint material after completion of each trial were collected for testing purpose. Each Sample was tested on HVI (High Volume Instrument) and Cotton Trash Analyzer (CTA).

The results on Gin Productivity, Ginning % and Fibre properties including trash Content were tabulated and summarized.

D. Sample Testing

- ☐ HVI (High Volume Instrument)
 Model No.: Statex- HVI **ASTM Method:** ASTM D4604-95
- ☐ Cotton Trash Analyzer
 Company Made: Statex **ASTM Method:** ASTM D2812-07

IV. CONCLUSION

Table II: Comparison of Fibre Properties (Better Vs. Poor)

Parameters	All Better Parameters*	All Poor Parameters**
Production (kg/hr)	61.98	48.00
Ginning %	35.95	34.72
Trash %	2.22	3.71
UHML (mm)	30.2	29.2
ML (mm)	24.7	23.9
UI (%)	81.8	81.8
Mic (µg/inch)	4.03	3.68
Strength	29.9	27.9

* (Condition of Moving and Fixed Knives= Sharp, Condition of Leather Roller=Good, Machine Speed=938 SPM)

** (Condition of Moving and Fixed Knives= Blunt, Condition of Leather Roller=Bad, Machine Speed=981 SPM)

Fibre Length improves 0.2 to 0.5 mm having Standard Moisture Content in Seed Cotton. Fibre Strength improves around 1 to 2 gm/tex having Standard Moisture Content in Seed Cotton. Trash Content reduces marginally around 5 to 10 % having Standard Moisture Content in Seed Cotton. Ginning Productivity increases around 5 to 8 % having Standard Moisture Content in Seed Cotton. Ginning % improves around 0.2 to 0.4 % in absolute terms having Standard Moisture Content in Seed Cotton.

Better condition of leather roller gives higher gin productivity by about 10 to 15 %. Ginning % also improves by about 0.5 % in absolute terms. Trash Content reduces around 10 to 15 % with the use of good quality of leather roller. There is no significant change in fibre length property is seen with use of leather roller having better condition.

Gin Productivity increases by around 10 % when both new (sharp) knives were used. Ginning % improves by around 0.4 to 0.5 % in absolute terms. Trash Content reduces around 10 to 15 % with the use of sharp fixed and moving knives. The Sharpness of both knives does not affect the length quality parameters.

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