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Assessment of strength of attachment of cotton fibre to seed

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ABSTRACT: Strength of attachment of fibre to seed was assessed for extra-long, long and short staple Indian cotton varieties with a pendulum-type SDL2 tester. Strength of attachment in terms of energy (J/g) was determined. Fibre to seed attachment force was observed higher in case of extra-long staple cotton as compared to long and short staple cotton. It was found to be least for Assam Comilla variety and highest for Suvin amongst the tested varieties. It was found more at Micropyle end followed by Chalazal and Middle portion of seed for long staple and short staple cotton but no trend was seen for extra-long staple cotton. Breeding cottons for low strength of attachment of fibre to seed would be beneficial to ginners for improving ginning efficiency in terms of reduction in energy and fibre breakage.

***Keywords*:** cotton, strength, attachment, fibre to seed

Cotton processing costs are increasing rapidly year by year. Energy consumption is the prominent factor contributing to high processing costs. Ginning is an energy intensive process. Since ginning is highly energy intensive, identifying areas of improved energy efficiency will offer considerable opportunities for cost savings. To remain profitable cotton gins must reduce costs that can be reduced by increasing ginning rate. Electrical costs can be reduced by ginning cotton that requires less energy from gin machinery such as the gin stand.

Total ginning energy has two components : idle and net, each of which might respond differently to seed lines. Total ginning energy is the power consumption of the gin stand integrated over the time required to gin. Idle energy is the power consumption of the gin stand without the presence of cotton integrated over the time, and net energy is the difference in the total and idle energy. Net energy required for ginning a particular variety mainly depends on the strength of attachment of fibre to seed. Generally, cotton varieties with low attachment strengths require less force to pull the fiber from the seed. The resulting separation requires less energy and expected to be faster than cotton with a high strength attachment. Varieties with high attachment strength tend to reduce gin productivity by increasing power requirements, slowing the system and increasing fiber damage as measured by short fiber content (SFC) and neps. Fiber breakage during ginning will be minimum if the fiber-seed attachment strength are lower.

Improving ginning efficiency is the foremost target. The key factor for reducing energy and increasing overall ginning efficiency is to decrease the time required to gin a bale. Gins, today, are looking for every opportunity to improve the ginning efficiency by increasing capacity and reducing ginning energy while preserving fiber.

The fibre seed strength of attachment of *Gossypium barbadense* L., *G. hirsutum*, *G. herbaceum*, *G. arboreum*L was reported as 0.26, 0.41, 0.76, and 0.98 g/fiber, respectively. Separation force of individual fibers for less fuzzy seeds was 17 per cent lower than the fuzzy controland ginned 23 per cent faster. The energy required to gin a bale (500 lb lint) was significantly lower for the semi-naked seed strain resulting in 31 per cent energy reduction for fiber seed separation.

The force required to break an individual fiber equals 1.8 times the force required to remove it from the seed. Most fibers tend to be ginned from the seed without additional breakage due to a weakened area in the fiber at the surface of the seed. However, the gin stand is known to break some fibers in multiple places or with fragments of fiber left on the seed, and this leads to reduced fiber length and increased short fiber content. Increased neps, seed coat neps and seed fragments are also attributed to the gin stand. So it is important to avoid excessive breakage and other damage caused by the gin stand.Cotton varieties are well known to differ in yield and fiber quality. Varieties also differ in how strongly fibers are attached to seed.

The gin stand energy consumption and ginning rate may differ among varieties with differences presumably related to fiber-seed attachment force. One way to reduce energy for ginning and unwanted fiber breakage would be to select cotton varieties with strong fibers loosely attached to the seed. Varieties with reduced fiber-seed attachment force have the potential to be ginned faster with less energyand less fiberand seed damage given that all other properties are the same.

The overall objective of this study was to investigate the strength of attachment of fibre to seed for Indian cottons which is a key factor in determining the ginning efficiency in terms of energy consumption, ginning capacity and fibre quality. The data generated would be useful to understand the reasons for variations in ginning efficiency of different staple groups of cottons. It may provide an opportunity for the breeders to develop cotton breeding programmes to reduce the energy while ginning.

MATERIALS AND METHODS

The strength of attachment of fibre to seed was measured with a SDL2 (Shirley Developments Limited) Cotton Fibre Seed Attachment Tester (Fig. 1). It is a pendulum-type tester. Fibre seed attachment strength was measured for single locule with tufts of fiber on each side of the seed oriented towards the Chalazal (rounded) end, Micropyle (pointed) end and on Middle portion of the locule.

Eight different varieties belonging to different staple groups viz., extra long (2), long (3) and short (3) were selected for the study. Suvin and DCH-32 from extra-long staple, Ankur-652, Mallika and First class from long staple and Assam Comila, HD-123 and G Cot-15 from short staple cotton were selected.Three replications were taken for each end *i.e.* Chalazal, Micropyle and Middle portion for each variety. Samples for testing were prepared as

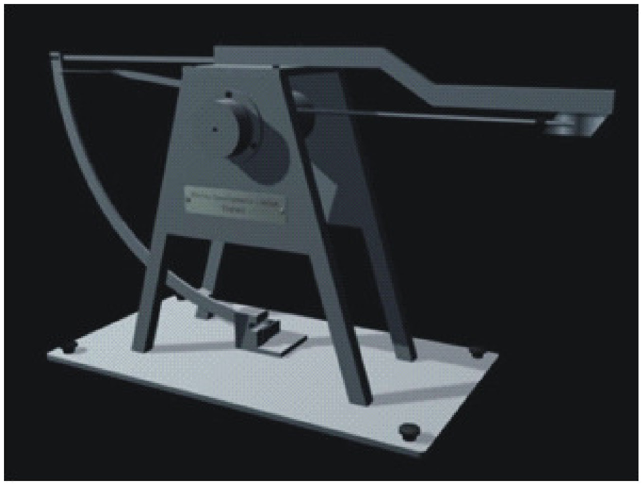

Fig 1. Cotton fibre seed attachment tester

shown in Figure 2 by orienting the tuft of fibres at each end of the locule.

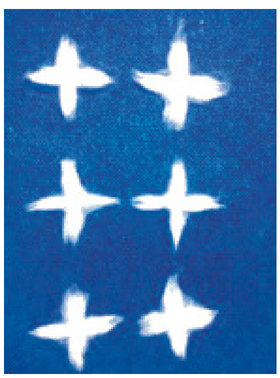

Fig 2. Sample preparation

To measure fibre seed strength of attachment, a pendulum of cotton fibre seed attachment tester was raised and locked into position with a known amount of potential energy of the pendulum. The tuft of fibers was held in the path of pendulum by a clamp on one side. The seed end was kept free on other side of pendulum. The pendulum was released to pass through the fiber bundle between the seed and fiber clamp, thus shearing the tuft of fiber from the seed.The pendulum swing angle was measured after shearing of the fibres. The

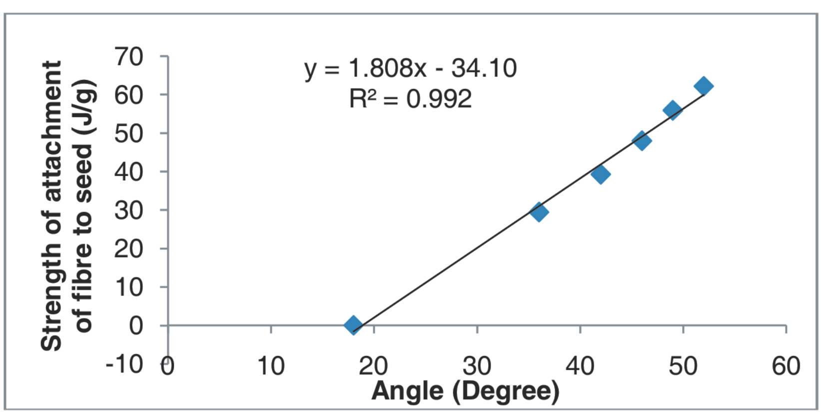

Fig 3. Calibration of SDL 2 fibre seed strength of attachment tester

instrument was calibrated for determining strength of attachment.The tuft weight after trimming (Figure 4) to uniform length was measured. The energy required to shear the fiber bundle from the seed was determined from the calibration curve (Figure 3).

Fig 4. Tuft of cotton fibres after test

For testing, a single lock of cotton was taken from a sample.Three seeds were tested for three replications. Each side (Micropyle, Chalazal and Middle) of seed was tested as described above. Then, the entire procedure was repeated in the same way for each variety. Data were collected and analysed by finding out the mean, standard deviation and coefficient of variation. Fibre seed strength of attachment was compared among the varieties, between the different ends of the same seed and between the staple groups.

RESULTS AND DISCUSSION

Fig. 5, 6 and 7 respectively show the strength of attachment of fibre to seed for different varieties belonging to extra-long, long and short staple cotton. The strength of attachment was compared within the variety for Chalazal end, Micropyle end and for Middle portion of the seed for cottons of different staple groups. It was found to be higher at Micropyle end followed by Chalazal end and Middle portion of seed for long staple and short staple cotton but no definite trend was seen for extra-long staple

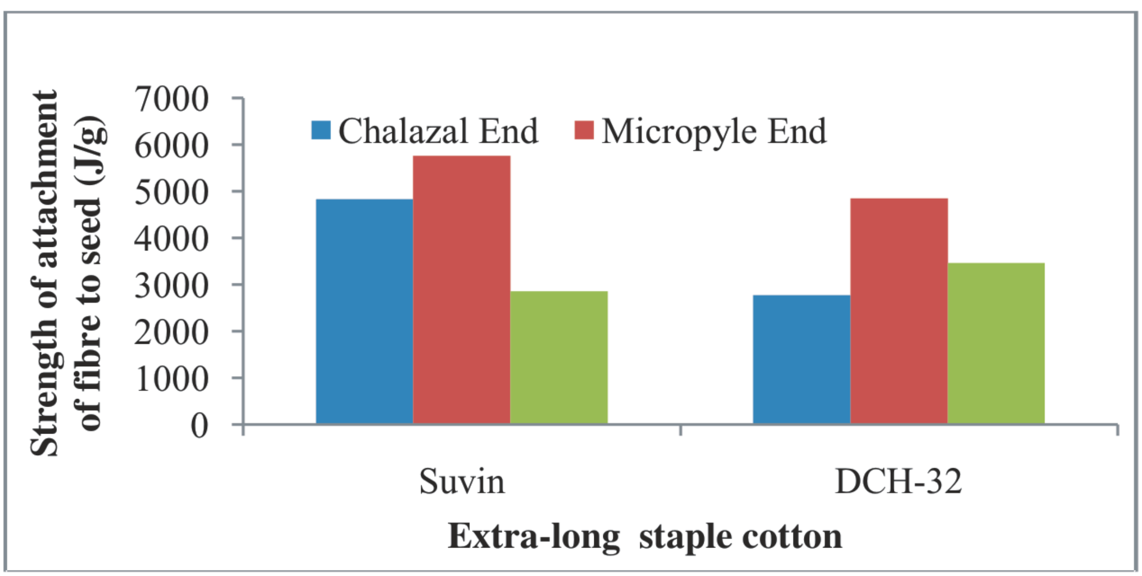

Fig 5. Strength of attachment of fibre to seed for extra-long staple cotton

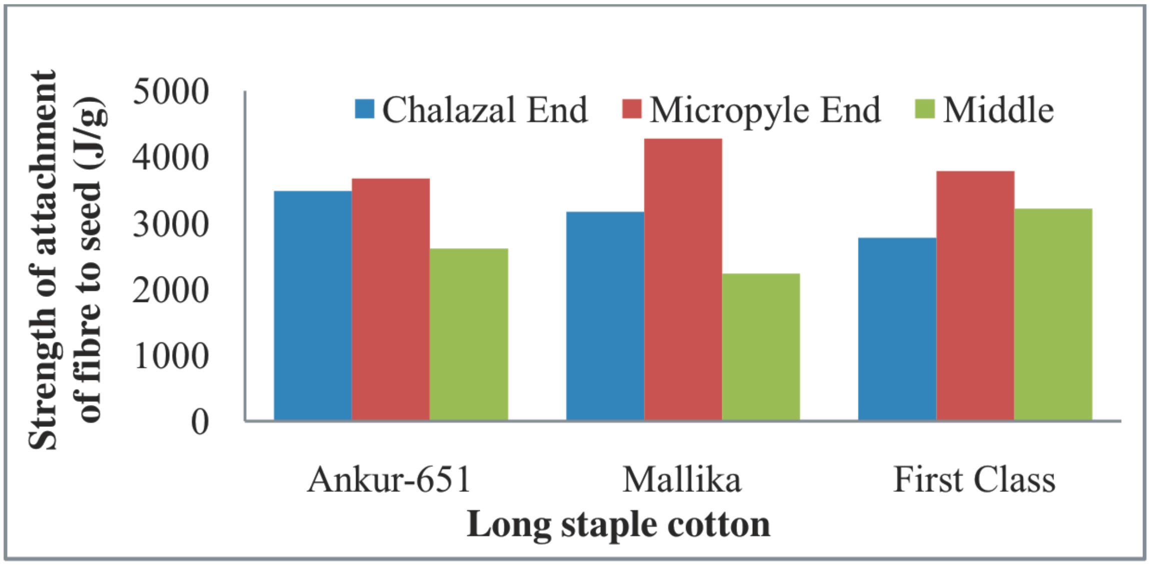

Fig6.Strength of attachment of fibre to seed for long staple cotton

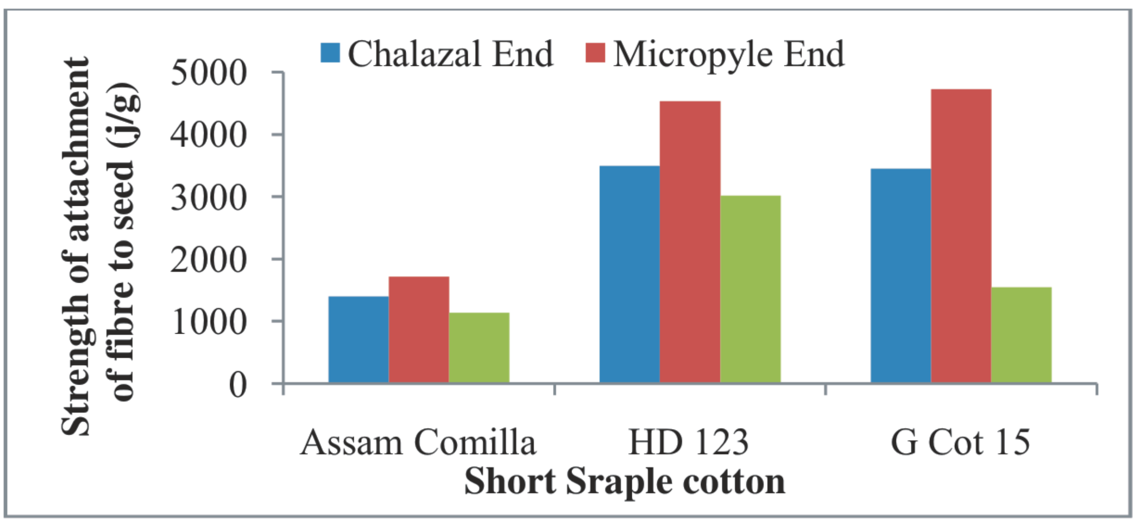

Fig 7.Strength of attachment of fibre to seed for short staple cotton

cotton.

Table 1 shows the strength of attachment of seed to fibre for different Indian cotton. The mean value of strength of attachment for extra-long staple cotton was found to be 4481.7 and 3691.8 J/g of fibre for Suvin and DCH-32 varieties with CV values of 0.32 and 0.28, respectively. The mean value of strength of attachment for long staple cotton was found to be 3254.5, 3296.6 and 3126.7 J/g of fibre for Ankur-651, Mallika and First class varieties with CV values of 0.17, 0.22 and 0.28 respectively. The mean value of strength of attachment for short staple cotton was found to be 1417.7, 3682.3 and 3240.5 J/g of fibre for Assam Comilla, HD-123 and G Got-15 varieties of cotton with CV values of 0.30, 0.23 and 0.47, respectively. Strength of attachment of fibre to seed was compared for all varieties by taking the means of each variety for Chalazal end, Micropyle end and for Middle portion of the locule. The CV values for all varieties were found to vary from 0.10 to 0.30. Assam Comilla variety has the least strength of attachment and Suvin the highest among the varieties tested.

Fig. 8 and 9 shows the effect of staple length on strength of attachment of fibre to seed. Strength of attachment was found to be higher in case of extra-long staple cotton as compared to long and short staple cotton at different ends of the cottonseed.Strength of attachment at Chalazal, Micropyle and Middle portion on the seed was found to decrease with the decrease in the staple length.

Strength of attachment for fibre to seed was found to vary with varieties. It was observed that cotton varieties with low attachment strengths required less force to pull the fiber from the seed. The resulting separation required less energy and expected to be faster than cotton with a high strength attachment.Similar results were reported by various researchers stating that cotton varieties with reduced fiber-seed

Table 1. Strength of attachment of fibre to seed (J/g) for Indian cotton

Staple	Variety		Chalazal	Micropyle	Middle	**Mean**	STD	CV
Long	Ankur-651	Mean	3571.8	3663.0	2528.7	**3254.5**	630.23	0.19
		STD	269.5	163.2	93.3			
		CV	0.07	0.04	0.03			
	Mallika	Mean	3560.3	3920.6	2581.0	**3296.6**	789.5	0.23
		STD	373.1	421.6	822.2			
		CV	0.10	0.10	0.31			
	First Class	Mean	2272.1	3925.0	3181.8	**3216.3**	827.8	0.25
		STD	603.8	226.6	868.5			
		CV	0.26	0.05	0.27			
Extra-long	Suvin	Mean	4830.4	5763.4	2851.1	**4481.7**	1487.1	0.33
		STD	1095.8	767.9	494.7			
		CV	0.22	0.13	0.17			
	DCH-32	Mean	2766.4	4845.1	3464.0	**3691.9**	1057.9	0.28
		STD	479.1	781.7	441.7			
		CV	0.22	0.13	0.12			
Short	Assam Comilla	Mean	1396.8	1719.4	1136.5	**1417.5**	291.9	0.20
		STD	436.0	522.3	109.95			
		CV	0.31	0.30	0.09			
	HD- 123	Mean	3493.6	4535.0	3018.2	**3682.3**	1600.4	0.49
		STD	430.0	773.6	678.3			
		CV	0.12	0.17	0.22			
	G Cot- 15	Mean	3449.1	4726.6	1546.0	**3240.6**	775.8	0.21
		STD	819.3	1073.5	67.6			
		CV	0.23	0.22	0.04			
		CV	0.29	0.11	0.21			

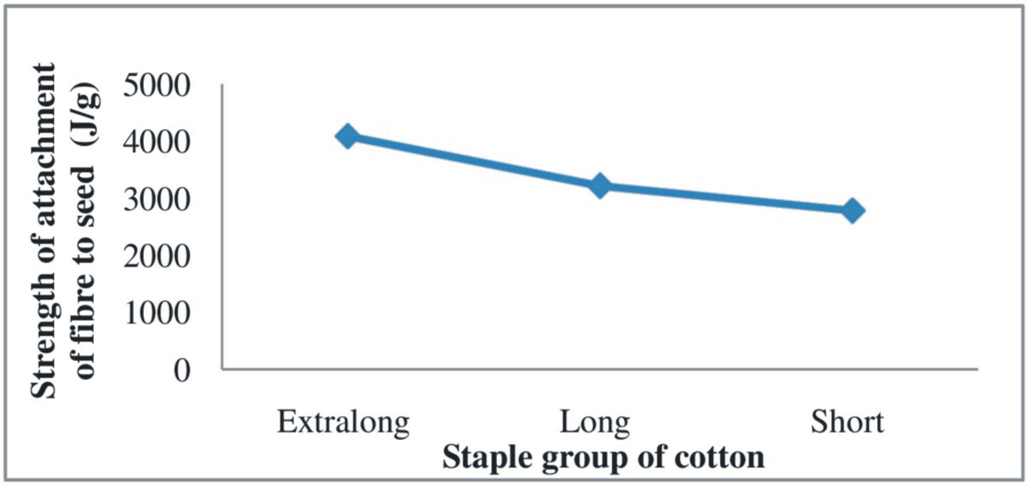

Fig 8. Effect of staple length on strength of attachment of fibre to seed

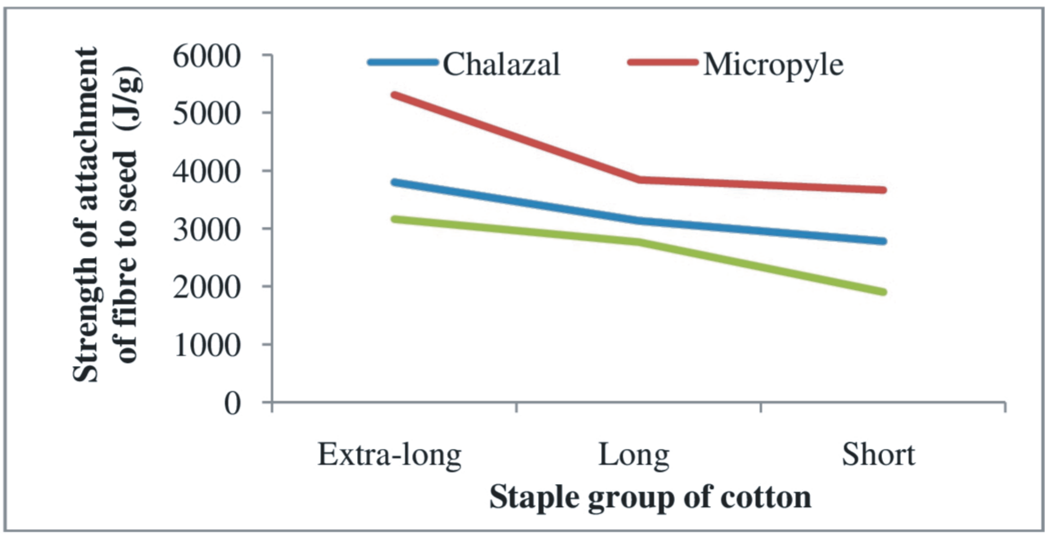

Fig 9. Strength of attachment of fibre to seed for different staple groups

attachment force had the potential to be ginned faster with less energy and fiber damage.Increased fiber-seed attachment strength and increased fiber length both together increased net gin stand energy. These findings were important as energy required for ginning could be determined from fiber-seed attachment strength. Since ginning is highly energy intensive, one way to reduce energy for ginning and unwanted fiber breakage would be to select cotton varieties with strong fibers loosely attached to the seed and to process the varieties with reduced fiber-seed attachment force which has the potential to be ginned faster with less energy and less fiber and seed damage given that all other properties are the same. The low fiber-to-seed strength of attachment of cottons would be beneficial to ginners as the rate of ginning might be increased and the energy required for ginning would be reduced through breeding for low fiber-seed strength of attachment.

CONCLUSIONS

1. Indian cotton varieties were found to differ in how strongly fibers are attached to seed.
2. Fibre to seed strength of attachment was observed higher in case of extra-long staple cotton as compared to long and short staple cotton.The mean values of strength of attachment for fibre to seed for extra-long, long and short staple Indian cottons were observed to be 4086.8, 3255.8 and 2780.1 J/g, respectively.
3. Fibre seed attachment force was found more at Micropyle end followed by Chalazal and Middle portion of seed for long staple and short staple cotton but no trend was seen for extra-long staple cotton.
4. Fibre to seed strength of attachment was found to be least for Assam Comilla variety and highest for Suvin amongst the tested varieties.
5. Breeding cottons for low strength of attachment of fibre to seed would be beneficial to ginners for improving ginning efficiency.

DISCLAIMER

Mention of a trade names in the publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the authors

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