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Fibre Attributes, Their Measurement and Impact

GUEST COLUMN

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The classification of cotton as well as its ranking, for commercial use, is done mainly based on its four important fibre properties such as length, fineness, maturity and strength. The conventional methods to measure these parameters are very tedious and time-consuming but give accurate results. In order to measure various fibre properties simultaneously and quickly, an advanced instrument like High Volume Instrument (HVI) has been developed. This instrument is mainly used for testing large number of samples in a short span of time with comparable results. Another instrument called Advanced Fibre Information System (AFIS) is also available for testing fibre properties particularly for small size sample. All these instruments have their own merit and use in the field of cotton evaluation.

An attempt is made in this paper to describe in brief the various methods in vogue to evaluate cotton quality and the impact of each fibre attributes on processing of cotton into yarn.

1. Conventional Instruments/Methods

a. **Length Measurement:** Length of the cotton fibre is generally expressed as 2.5% span length or mean length or staple length. The following instruments are used for measuring length parameters.

   i. **Comb Sorter:** In this method, all the fibres of a given sample tuft are laid out side by side in the order of their length beginning with longest and finished with the shortest. The diagram, so obtained, represents distribution of fibres in the order of length.

   ii. **Digital Fibrograph:** The Fibrograph[1] is an optical instrument. A beard of cotton fibres is scanned through light and the length frequency curve known as Fibrogram is drawn. With this Fibrogram some simple geometrical constructions are carried out to determine various parameters like mean length and upper half mean length. The distance travelled by comb and light absorbed by fibres is recorded as 'length' and 'amount' on the counter. The Fibrogram is obtained by plotting length vs. amount.

b. **Fibre Fineness Measurement:** Fibre fineness is more commonly expressed as linear density or weight per unit length and popularly known as Micronaire.

   i. **Gravimetric Method:** In this method, fibre weight is determined by weighing a known number of fibres either as a whole or as cut to 1 cm length. For this purpose, from a representative fibre tuft, 100 fibres are counted and made into 10 bundles totalling to 1000 fibres. Each bundle is weighed on a microbalance and then weight per unit length is determined.

   ii. **Indirect Methods:** Indirect methods are often used for quick measurement of fibre fineness. In this method, the resistance to air flow through fibre plug is measured. A fixed weight (3.24g) of cotton fibres are placed in the cylindrical chamber of the instrument and then air at constant pressure (4.3 psi) is passed through the sample. The resistance to air flow is measured with a float in terms of microgram per inch. The value obtained is called Micronaire Value.

   iii. **Caustic Soda Swelling Method:** This method involves the swelling of the fibres with 18% caustic soda and their examination under the microscope with suitable magnification. Depending upon the relative dimensions of cell wall and lumen, the fibres are classified in maturity group viz. mature and immature. The percentage of mature and immature are calculated over the total number of fibres evaluated.

c. **Fibre Strength:** Fibre strength is a very important parameter and generally expressed as tenacity. The breaking strength denotes the maximum tension the fibre is able to sustain before break. Dividing the breaking load by the fibre weight per unit length is termed as tenacity. Fibre strength is determined for single fibre or bundle of fibres.

   i. **Single Fibre Strength:** The most commonly used equipment for this purpose is Instron Tensile Tester, where single fibre is fixed between two plastic/ metal tabs with an adhesive. The fibre is clamped between two jaws of the instrument. The moveable jaw then pulls the fibre and the breaking load is recorded.

   ii. **Bundle Strength:** Two instruments viz. Pressley Strength Tester and Stelometer

are generally used for bundle strength determination. A parallelised fibre bundle is held between a pair of clamps and the protruding fibres are cut. After mounting the fibre bundle in clamp, it is put in the slot and the pendulum beam is released to move through an arc of a circle. The force is exerted on one part of the clamp and when it reaches breaking strength, the pendulum stops and the force is recorded on the scale in kg. The fibres in the clamp are then weighed and the tenacity is calculated. The tenacity is expressed in terms of gm/tex. Stelometer also gives elongation at break in terms of percentage.

iii. **Weak Link Effect:** The strength and extensibility of yarn/ fabric ultimately depends upon those of fibres. Strength and extension of fibres rely on two groups of factors namely, (i) constitution, fine structure and morphology of the fibre and (ii) testing conditions such as ambient atmospheric conditions, rate of loading, method of application of load and test length. The theoretical strength of any material estimated on the basis of rupture strength of chemical bonds is never realised in practice. An upper limit to the tensile strength of cellulose has been calculated by Mark[2] and by De Boer[3]. From known molecular data for perfectly oriented and perfectly crystalline cellulose, and assuming that all the chain molecules rupture simultaneously, they estimated the breaking stress of crystalline cellulose to be about 11 x 10^2 g/t. This value is many times of actually observed strength. Griffith[4] attributed the difference between calculated and practically obtained values to the presence of flaws that leads to localisation of stress in excess of theoretical strength, whereby the rupture process is initiated. The presence of a distribution of flaws of varying magnitude along the length, coupled with the fact that the probability of encountering a flaw increases with test length, result in the reduction in the magnitude or tensile characteristics such as breaking load, elongation, specific work of rupture etc. as gauge length is advanced. This phenomenon of decrease in tensile parameters with increase in specimen length is known as "Weak Link Effect."

All textile fibres exhibit weak link effect. However, the relative loss in strength with increasing specimen length is very high for cotton compared to any other textile fibre. As gauge length is increased from 1 mm to 10 mm, loss of strength is as low as 10% for wool and some other natural fibres, whereas it is as high as 50% for cotton fibres.

2. Other Fibre Characteristics:

The length, fineness, maturity and strength are the four major physical properties of cotton fibres. However, cotton fibres are also associated with other characteristics like Neps, lustre, colour and trash, which are very important in deciding the quality of cotton. Nep is the fibre entanglement and forms a knot like structure in fibres. Trash or contamination is the foreign materials present in the lint. Both these characters viz. Neps and Trash disturb spinning performance and effect yarn quality. Lustre and colour of cotton are also important particularly for price fixing in the market.

3. Classification of cotton on the basis of Fibre Properties

Length		Length Uniformity	
Range of 2.5% span length	Category	Range of UR%	Category
20.0 mm and below	Short	Below 42	Poor
20.5 mm - 24.5 mm	Medium	42 - 43	Fair
25.0 mm - 27.0 mm	Medium Long	44 - 45	Average
27.5 mm – 32.0 mm	Long	46 - 47	Good
32.5 mm and above	Extra long	Above 47	Excellent

Micronaire		Strength	
Range of Micronaire	Category	Range of Fibre Bundle Strength (g/t) at 3.2 mm gauge	Category
Below 3.0	Very fine	16 and below	Very low
3.0 - 3.9	Fine	17 - 20	Low
4.0 - 4.9	Average	21 - 24	Average
5.0 - 5.9	Coarse	25 - 28	Good
6.0 and above	Very coarse	29 and above	Very good

4. Developments in Measurement of Fibre Attributes

a. High Volume Instrument (HVI)

Conventional instruments used for measuring cotton fibre properties need considerable efforts and time to get complete fibre-test results. Research and developments spread over several decades at different laboratories have led to designing instruments capable of measuring various fibre properties simultaneously and quickly.

High Volume Instrument popularly known as 'HVI' is one such instrument. It measures seven physical characteristics of cotton fibres viz. length, length uniformity, strength at 3.2 mm gauge, elongation, fineness, colour and trash percent[5]. In HVI various conventional instruments are integrated into a single electronic instrument. The instrument is highly sophisticated, easy in operation and offers precise and reliable results. As a large number of samples can be tested in short span of time, the instrument is very useful in bale management studies and spinning process.

b. Application of HVI: Cotton Purchase - Bale Management

Bale Management is a concept, a system and a control mechanism practiced by every spinning mill. In a modern spinning mill, each incoming cotton bale is tested for fibre parameters on HVI. Presently software systems, such as BIAS-bale inventory analysis system, designed for special requirements of the spinning mills are available. In this software the HVI data is used to automatically prepare the daily mixes in a mill. A typical bale management system performs evaluation of fibre properties, inventory/ware houses control and bale selection for preparation of daily mix consumption. As HVI gives quick results bale management becomes easier with the help of suitable software.

For sale or purchase transaction in cotton market the estimation of fibre properties are usually done by visual judgement by experts. Now a days HVI system is widely used and known for quick measurement. It can be used for measurement of fibre of cottons kept in market for sale or purchase. As little quantity of lint is required, a large number of samples can be tested on a daily basis, HVI system is useful to either purchaser or seller of cotton for evaluation of fibre properties.

c. Advanced Fibre Information System (AFIS)

Advance Fibre Information System commonly known as (AFIS) is important and useful test equipment particularly for small lint sample (4.0 gm) and it gives several fibre quality parameters. The system is made by Zellweger Uster Inc., USA.

The measurements are done on single fibre and their distribution. The instrument consists of three modules viz. length and maturity (L & M Module), micro-dust and trash module (T module) and neps module (N-Module). The basic unit is common for all the modules whereas the data boards are different for different modules.

AFIS is mainly used for monitoring of fibre properties of in process materials collected from various stages of processing. L & M module gives length parameters such as average length, upper quartile length, short fibre index, length of longest 2.5% and 5% fibre by number, fibre fineness and fibre maturity. T-module measures Trash %, micro dust and as total visible foreign matter in the lint, while N-module identifies and classified neps.

References:

1. *Hertel KL, A Method of Fiber Length Analysis Using the Fibrogram. Textile Research Journal 10: 510 – 524., 1940*
2. *Mark,E, Cellulose and cellulose derivatives, Ed.E, Otty Interscience Puhlishers Inc., Newyork, 1943*
3. *De Boer, J.H., Trans. Faraday Soc., 32, 10, 1936*
4. *Griffith, A.A., Philos, Trans. Royal Sco., London Ser., A221, 163, 1921*
5. *ASTM D4604, Standard Test Method for Measurement of Cotton Fibres by High Volume Instruments (HVI)*

(To be continued...)

(The views expressed in this column are of the author and not that of Cotton Association of India)

All India Weather Summary and Forecast

Significant Weather Features

The low pressure area over northeast Madhya Pradesh & neighbourhood is very likely to move northwestwards and merge with the monsoon trough during next 48 hours.

♦ The monsoon trough is in its near normal position with the above low pressure area embedded in it.

♦ Also, an east-west shear zone passes across central India in the mid-tropospheric levels tilting southwards with height.

♦ A fresh low pressure area is likely to form over Northwest Bay of Bengal & neighbourhood around 13th August.

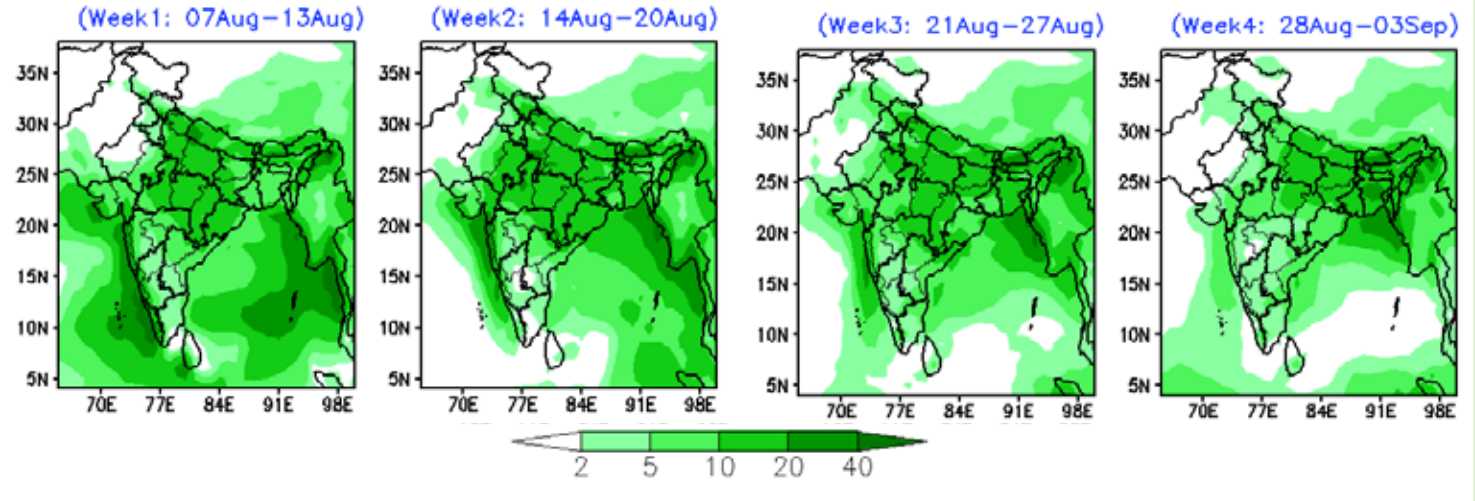
♦ Under the above scenario.

(i) Fairly widespread to widespread rainfall with heavy to very heavy rainfall at isolated places very likely over major parts of northwest India (Western Himalayan region, Punjab, Haryana, Chandigarh & Delhi, Uttar Pradesh and East Rajasthan) during 10th-12th August.

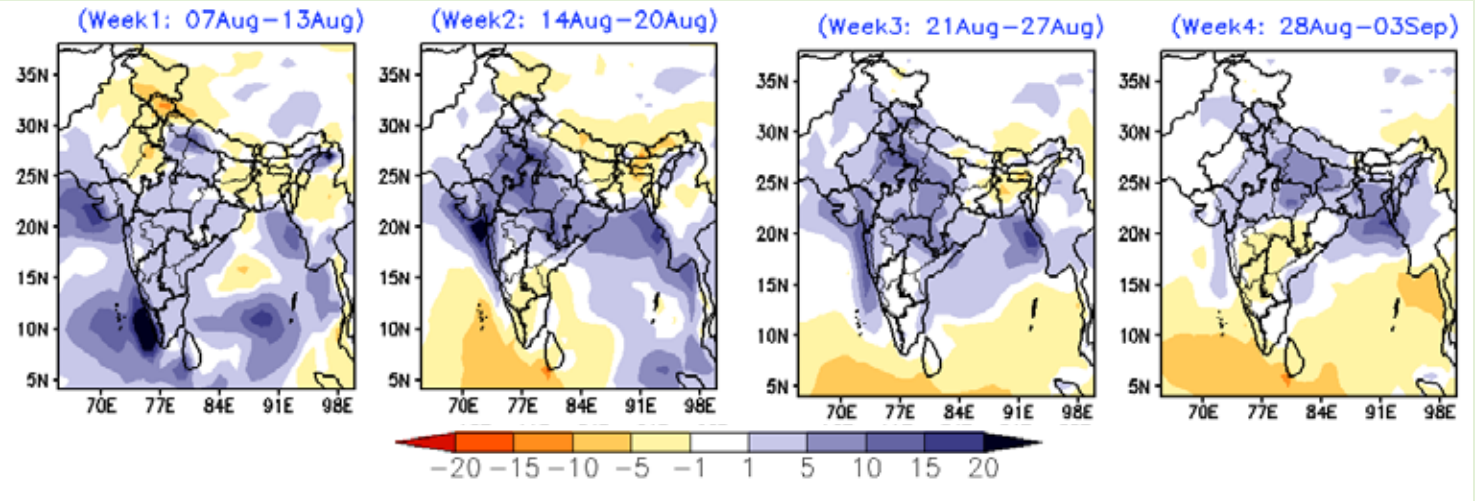
(ii) Fairly widespread to widespread rainfall with heavy to very heavy rainfall at isolated places are also very likely over parts of Madhya Pradesh and Gujarat region during 10th-14th August with likely further enhancement of rainfall intensity over north Gujarat and southwest Madhya Pradesh on 13th & 14th August.

♦ Strength of monsoon westerlies over southern parts of Arabian Sea has reduced since 09th August and is likely to reduce further during

Extended range Model Guidance
Forecast Rainfall (mm/day)



Forecast Rainfall Anomaly (mm/day)



next 5 days. Unde this scenario, rainfall activity is very likey to reduce further over Kerala and Karnataka during next 5 days.

♦ Moderate to severe thunderstorm accompanied with lightning very likely at isolated places over northeast Rajasthan and western parts of Uttar Pradesh

Main Weather Observations

♦Rain/Thundershowers observed (from 0830 hrs of yesterday to 0830 hrs IST of today) at most places over Jammu & Kashmir, Ladakh, Uttarakhand, Himachal Pradesh, Gujarat region, East Madhya Pradesh, Chatisgarh, Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram, Tripura, Konkan and Goa, Vidarbha, Telangana, Karnataka, Coastal Andhra Pradesh, Rayalseema, Kerala, Andaman & Nikobar Islands and Lakshadeep at many places over Haryana, Chandigarh & Delhi, East Rajasthan, Saurashtra and Kutch, West Madhya Pradesh, Bihar, Jharkhand, West Bengal & Sikkim, Odisha, Madhya Maharashtra, Marathwada and Tamilnadu, Pondicherry & Karaikal; at a few places over Uttar Pradesh over West Rajasthan.

♦ Rainfall recorded (from 0830 hrs of yesterday to 0830 hrs IST of today) (7 cm or more) Balod-23, Dhamtari-20, Shirali-17, Chhota Udaipur, Honavar & Gondia-15 each. Agumbe-14; Idukki, Vadodra and Baroda-12; Mount Abu, Kudulu & Cherrapunji-11 each; Manglore, Cannur, Jaipur, Jabalpur and North Lakhimpur-10 each; Valprai, Karnal, Nizamabad-9 each, Anandpur Sahib, Rajgarh, Sawai Madhopur, Hanamkonda-8; Cochin, Ambikapur-7 each.

♦ Extremely heavy rainfall observed at isolated places over Chhattisgarh; heavy to very rainfall at isolated places over Coastal Karnataka, Vidarbha and Gujarat region and heavy rainfall at isolated places over Rajasthan, Assam & Meghalaya, Kerala, East Madhya Pradesh, Punjab, Haryana, Tamilnadu and Telangana.

♦ Thunderstorm observed (0530 hrs IST to 1430 hrs IST of today): Jammu & Kashmir, Ladakh, Gilgit-Baltistan, Muzaffarabad, Uttarakhand, Punjab, West Uttar Pradesh, West Madhya Pradesh, Bihar and Gujarat region.

Update on Cotton Acreage (As on 06.08.2020)

(Area in Lakh Ha)

Sr. No.	State	Normal Area (DES)*	Normal Area as on Date (2015-2019)	Area Covered (SDA)					
				2020-21	2019-20	2018-19	2017-18	2016-17	2015-16
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Andhra Pradesh	6.56	6.450	4.759	4.180	4.020	4.430	3.390	4.030
2	Telangana	17.01	17.262	22.770	17.240	17.065	17.770	11.940	16.290
3	Gujarat	26.04	26.322	22.480	24.696	26.587	26.490	22.815	26.110
4	Haryana	6.07	6.412	7.370	6.760	6.650	6.560	4.980	5.810
5	Karnataka	6.47	6.584	4.818	4.468	3.760	4.300	4.310	4.400
6	Madhya Pradesh	5.65	5.852	6.371	6.100	5.240	5.760	5.990	5.420
7	Maharashtra	41.48	41.532	41.375	42.815	39.699	41.130	37.735	37.220
8	Odisha	1.31	1.380	1.666	1.690	1.560	1.444	1.260	1.250
9	Punjab	3.56	3.206	5.010	4.020	2.840	3.850	2.560	4.400
10	Rajasthan	4.77	5.238	6.735	6.445	4.961	5.031	3.830	3.490
11	Tamil Nadu	1.61	1.574	0.067	0.048	0.050	0.059	0.048	0.040
12	Others	0.43	0.462	0.216	0.271	0.172	0.286	0.170	0.210
All India		**120.97**	**122.274**	**123.637**	**118.732**	**112.604**	**117.110**	**99.028**	**108.670**

** Directorate of Economics & Statistics, Ministry of Agriculture and Farmers Welfare, Krishi Bhavan, New Delhi*
Source : Directorate of Cotton Development, Nagpur

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	Spot Rate (Upcountry) 2019-20 Crop August 2020 3rd	4th	5th	6th	7th	8th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15	10208 (36300)	10151 (36100)	10151 (36100)	10151 (36100)	10151 (36100)	10151 (36100)
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	10376 (36900)	10320 (36700)	10320 (36700)	10320 (36700)	10320 (36700)	10320 (36700)
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20	5736 (20400)	5736 (20400)	5765 (20500)	5793 (20600)	5821 (20700)	5849 (20800)
4	KAR	ICS-103	Fine	23mm	4.0 – 5.5	4.5%	21	6946 (24700)	6889 (24500)	6889 (24500)	6917 (24600)	6946 (24700)	6974 (24800)
5	M/M (P)	ICS-104	Fine	24mm	4.0 – 5.5	4%	23	8267 (29400)	8352 (29700)	8436 (30000)	8492 (30200)	8548 (30400)	8577 (30500)
6	P/H/ R (U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26	9476 (33700)	9561 (34000)	9589 (34100)	9645 (34300)	9645 (34300)	9589 (34100)
7	M/M(P)/ SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25	7227 (25700)	7255 (25800)	7255 (25800)	7283 (25900)	7283 (25900)	7283 (25900)
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	9617 (34200)	9701 (34500)	9729 (34600)	9786 (34800)	9786 (34800)	9729 (34600)
9	M/M(P)/ SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25	7592 (27000)	7620 (27100)	7620 (27100)	7649 (27200)	7649 (27200)	7649 (27200)
10	M/M(P)/ SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26	8717 (31000)	8717 (31000)	8717 (31000)	8773 (31200)	8802 (31300)	8802 (31300)
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	9673 (34400)	9758 (34700)	9786 (34800)	9842 (35000)	9842 (35000)	9786 (34800)
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	9476 (33700)	9505 (33800)	9505 (33800)	9533 (33900)	9533 (33900)	9533 (33900)
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	9589 (34100)	9617 (34200)	9617 (34200)	9645 (34300)	9645 (34300)	9645 (34300)
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	9533 (33900)	9561 (34000)	9561 (34000)	9589 (34100)	9589 (34100)	9589 (34100)
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	9729 (34600)	9814 (34900)	9842 (35000)	9898 (35200)	9898 (35200)	9870 (35100)
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	9786 (34800)	9814 (34900)	9814 (34900)	9842 (35000)	9842 (35000)	9842 (35000)
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	9842 35000	9870 35100	9870 35100	9898 35200	9898 35200	9898 35200
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	9814 (34900)	9842 (35000)	9842 (35000)	9870 (35100)	9870 (35100)	9870 (35100)
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3.5%	29	9983 (35500)	10011 (35600)	10011 (35600)	10039 (35700)	10039 (35700)	10039 (35700)
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	10067 (35800)	10095 (35900)	10095 (35900)	10123 (36000)	10123 (36000)	10123 (36000)
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	10208 (36300)	10208 (36300)	10208 (36300)	10236 (36400)	10236 (36400)	10236 (36400)
22	SA/TL/ K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	10236 (36400)	10236 (36400)	10236 (36400)	10264 (36500)	10264 (36500)	10264 (36500)
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31	10517 (37400)	10517 (37400)	10545 (37500)	10545 (37500)	10545 (37500)	10545 (37500)
24	M/M(P)	ICS-107	Fine	34mm	3.0 - 3.8	4%	33	14763 (52500)	14763 (52500)	14763 (52500)	14763 (52500)	14763 (52500)	14763 (52500)
25	K/TN	ICS-107	Fine	34mm	3.0 - 3.8	3.5%	34	15100 (53700)	15044 (53500)	15044 (53500)	15044 (53500)	15044 (53500)	15044 (53500)

(Note: Figures in bracket indicate prices in Rs./Candy)