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Artificial Intelligence and Area Wide Approaches in Tackling the Dreaded Pest of Cotton

EXPERT's Column

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Traditional insect pest monitoring relies on the subject matter expert manually identifying pests, a process that is labour-intensive for area-wider applications. With the proliferation of sensors and embedded devices equipped with cameras and internet connectivity, computer vision technology offers a transformative solution for automated pest monitoring over a larger area in modern agriculture. This innovation significantly enhances monitoring efficiency by enabling real-time, automated systems, which empower farmers to make informed, timely decisions and implement swift interventions, ultimately managing the pests efficiently, reducing costs and labour, and minimising adverse environmental impact. Artificial intelligence (AI) is increasingly being leveraged for critical tasks, including pest identification, counting, and predicting pest

Pink bollworm larva

Rosetted flower symptom due to pink boll worm attack

Open boll damage due to pink bollworm

spread across key crop ecosystems like cotton, paving the way for smarter and more sustainable agricultural practices.

The pink bollworm (PBW) (Pectinophora gossypiella Saunders), the dreaded pest of cotton became a menace in India causing more than 35% damage to the crop in late season as it developed resistance to Bt-cotton. The cryptic behaviour and hidden lifecycle of the PBW make it challenging to monitor the pest infestation and manage using conventional pest control methods such as insecticides and biocontrol agents. After hatching, the larvae bore into cotton bolls, feed inside the bolls and pupate beneath the soil surface, leaving only a narrow window for effective intervention through traditional strategies. Sex pheromone traps are pivotal for monitoring PBW adult populations, and these traps enable early detection and provide crucial insights for timely and targeted pest management interventions. The decision of insecticidal spray for the management of PBW is arrived at using the moth catches in the traps. If the PBW male moth catches exceed eight per pheromone trap for three consecutive days, it is considered as having crossed the economic threshold level (ETL) and an insecticidal spray is recommended.

Nevertheless, the conventional trap technologies have inherent limitations. The collection of trap data consists of repeated field surveys, where visual observation of traps is performed by a human operator to record the number of captured insects. The process is laborious, time consuming, costly and prone to human error. The manual data only gives the trap catch i.e, insect trapped between two consecutive surveys, usually between 7-15 days. Timely application of insecticide spray is difficult due to the poor temporal observations and the dynamics of pest population density in the field cannot be accurately monitored. Multi location trap data cannot be synchronised to measure the target pest population in a wider area.

For a pest of national importance like PBW, a real time monitoring over a larger area in inevitable in devising a timely and cost-effective management strategy. AI tools are effectively being tried in insect pest identification; pest

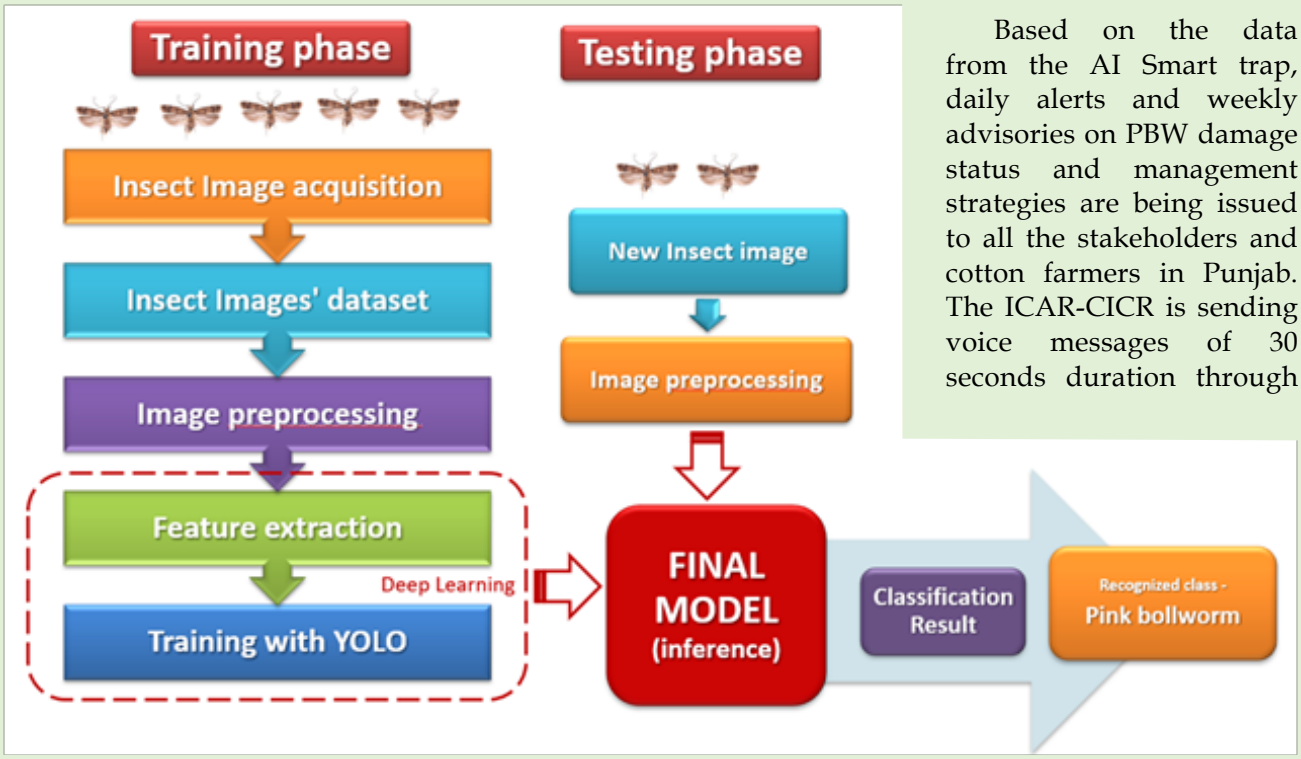
AI Smart Trap

counting and pest-spread prediction in important crop ecosystems. Several machine learning algorithms and methods are being used for the classification and detection of pests and diseases through computer vision using feature extraction and image processing. Image processing is the analysis and manipulation of graphical images from sources such as photographs and videos.

There are three main steps in image processing; first, is the conversion of captured images into binary values that a computer can process; second, is the image enhancement and data compression; and the third is the output step that consists of the display or printing of the processed image. The colour, texture, and edges are extracted from the images of the diseased leaf or insect pest samples. The segmented images are fed into the machine learning classification algorithms such as Support Vector Machine (SVM), Convolutional Neural Networks (CNN), Artificial Neural Networks (ANN), You Only Look Once (YOLO) etc.

The Internet of Things (IoT) and Information and Communications Technology (ICT) tools can be employed for collecting image data of insect pests over a wider area, including sex-pheromone traps, yellow sticky traps, light traps and mobile phones. Images from these devices are uploaded to the remote servers and processed using computer vision techniques and machine learning (ML) algorithms. Eventually, insect recognition and detection are analysed to estimate pest density, thus serving to make informed decisions on timing of management actions, including precision pesticide spraying, which is useful to reduce the pest damage and yield loss.

The AI Smart trap has been deployed for the real-time monitoring of PBW in Punjab state with the financial assistance from the Department of Agriculture & Farmers Welfare, Government of India. The smart traps are installed at 18 locations in three major cotton growing districts of Punjab viz., Mansa, Bathinda and Sri Muktsar Sahib at the identified farmers' fields at the rate of 6 units per district. At all the locations conventional pheromone traps were also installed @ 3 per village and the weekly trap catch data are being observed for comparison. A dedicated web portal https://cicr.indianmark.com/ is developed for the real-time information of PBW trap catch and corresponding weather data. Log-in credentials for the web portal were circulated to all the stakeholders in the state for data access. The web portal can be used the access the live trap information with the image, count of insects and weather data. Additional reports on the hourly trap catch, daily count report, ETL report and historical report can be generated by the end user. The information can be viewed and downloaded as Excel file for the required time period.



Development of ML algorithm in PBW detection

Based on the data from the AI Smart trap, daily alerts and weekly advisories on PBW damage status and management strategies are being issued to all the stakeholders and cotton farmers in Punjab. The ICAR-CICR is sending voice messages of 30 seconds duration through

Deployment of AI Smart Trap for the real-time monitoring of PBW in Punjab

the GSM network at weekly intervals to a total of 28,190 cotton growers in state. Brief information on the pest status and management strategies in vernacular language is being sent. Alert voice messages are also being sent to individual district farmers whenever the particular a district records trap catch above ETL. Mass Media and Social Media channels are also being used to send alert messages and control measures for the pink bollworm. Pest alerts are also sent via personal phone calls to farmers, group massages and announcements in village Gurudwara Sahibs on regular basis. With the area wide monitoring and issue of timely alerts, the infestation of PBW has been brough down significantly during the current season. The pest infestation ranged from 30-65% in Punjab during the last few years and due to the focused efforts of ICAR-CICR, the PBW occurrence is being brought down to below 10% levels in the project implemented areas.

Artificial Intelligence (AI) and the Internet of Things (IoT) in cotton cultivation hold significant potential to address critical challenges faced by farmers today. These technologies reduce reliance on manual labour for pest monitoring and management, enable the judicious use of agro-inputs such as pesticides and enhance crop productivity while promoting environmental sustainability and maintaining soil health. However, the adoption of IoT and AI comes with certain challenges. AI systems require extensive spatial and temporal data to train models and generate accurate predictions. Developing location-specific machine learning algorithms demands substantial initial investment, focused research and development, and ongoing operational and maintenance costs. Additionally, limited internet connectivity and bandwidth in remote agricultural areas can hinder the implementation and scalability of these technologies. Despite these hurdles, technological advancements in AI and IoT are progressing rapidly. Numerous agricultural enterprises are integrating AI solutions into plant health management systems, providing innovative tools to support progressive farmers and facilitate precision farming practices. Successful AI based monitoring of PBW in cotton in Punjab has demonstrated the potential and scope for establishment of a county-wide grid network of AI traps for spatial monitoring and timely management of this key pest in cotton.

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

Sneh Sammelan at CAI

In keeping with our rich tradition, a "Sneh Sammelan" was organised by CAI in association with the Bombay Cotton Merchants and Muccadums Association on Wednesday, the 6th November 2024 at 1.00 p.m. in the Survey Room of the Association, Cotton Exchange Building, Cotton Green, Mumbai, on the occasion of New Year.

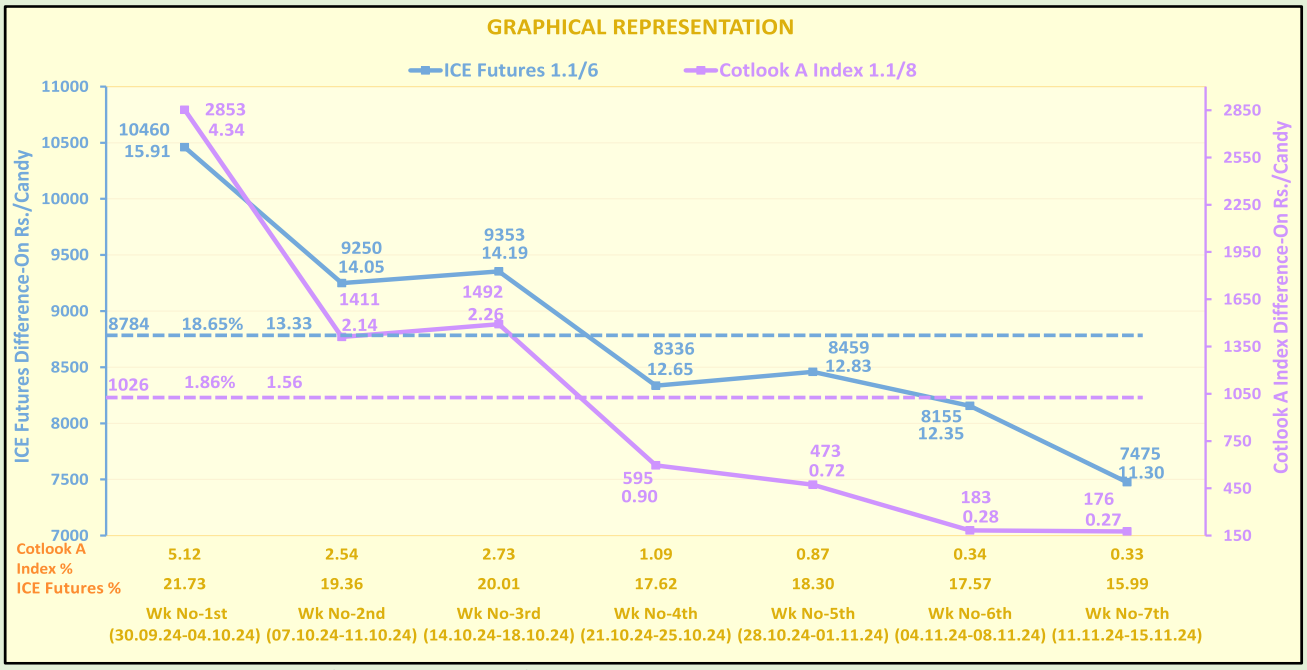
As per our custom, bhog was offered to deities in Shree Ramchandraji's Temple at Cotton Green between 12.00 noon to 1.00 p.m. on the same day i.e. Wednesday, the 6th November 2024.

Our members graced the occasion in large numbers to receive Lord Ramchandraji's Prasad.

Basis Comparison of ICS 105 with ICE Futures and Cotlook A Index -16th November 2024

SEASON 2024-2025
Comparison M/M(P) ICS-105, Grade Fine, Staple 29mm, Mic. 3.7-4.5, Trash 3.5%, Str./GPT 28 with ICE Futures & Cotlook A Index

Date 2024	1 US $ = Rs.	CAI Rates Rs./c.	Indian Ctn in USc/lb.	ICE Settlement Futures 1.1/6 Mar.'24 USc/lb.	Difference-ON/OFF ICE Futures		%	Cotlook A Index M-1.1/8	Difference-ON/OFF Cotlook A Index		%
					USc/lb.	Rs./c			USc/lb.	Rs./c	
A	B	C	D	E	F	G	H	I	J	K	L
Cotton Year Week No-07th											
11th Nov	84.39	54700	82.68	72.20	10.48	6934	14.52	83.25	-0.57	-377	-0.68
12th Nov	84.39	54500	82.37	71.07	11.30	7476	15.90	82.25	0.12	79	0.15
13th Nov	84.38	54200	81.93	71.10	10.83	7164	15.23	81.30	0.63	417	0.77
14th Nov	84.41	54100	81.75	70.56	11.19	7405	15.86	81.35	0.40	265	0.49
15th Nov	84.41	54000	81.60	68.91	12.69	8398	18.42	80.85	0.75	496	0.93
Weekly Avg.	**84.40**	**54300**	**82.07**	**70.77**	**11.30**	**7475**	**15.99**	**81.80**	**0.27**	**176**	**0.33**
Cotton Year Week No-06th											
04th Nov	84.11	54600	82.80	69.93	12.87	8487	18.40	82.20	0.60	396	0.73
05th Nov	84.12	54600	82.79	69.95	12.84	8468	18.36	82.20	0.59	389	0.72
06th Nov	84.24	54600	82.67	69.69	12.98	8573	18.63	82.20	0.47	310	0.57
07th Nov	84.36	54600	82.55	71.05	11.50	7606	16.19	82.00	0.55	364	0.67
08th Nov	84.38	54600	82.53	70.98	11.55	7641	16.27	83.35	-0.82	-542	-0.98
Weekly Avg.	**84.24**	**54600**	**82.67**	**70.32 Dec.'24**	**12.35**	**8155**	**17.57**	**82.39**	**0.28**	**183**	**0.34**
Cotton Year Week No-05th (28th Oct 2024-01st Nov 2024)											
Weekly Avg.	**84.08**	**54680**	**82.95**	**70.12 Dec.'24**	**12.83**	**8459**	**18.30**	**82.23**	**0.72**	**473**	**0.87**
Cotton Year Week No-04th (21st Oct 2024-25th Oct 2024)											
Weekly Avg.	**84.07**	**55660**	**84.44**	**71.80 Dec.'24**	**12.65**	**8336**	**17.62**	**83.54**	**0.90**	**595**	**1.09**
Cotton Year Week No-03rd (14th Oct 2024-18th Oct 2024)											
Weekly Avg.	**84.06**	**56100**	**85.12**	**70.93 Dec.'24**	**14.19**	**9353**	**20.01**	**82.86**	**2.26**	**1492**	**2.73**
Cotton Year Week No-02nd (7th Oct 2024-11th Oct 2024)											
Weekly Avg.	**83.98**	**57040**	**86.63**	**72.58 Dec.'24**	**14.05**	**9250**	**19.36**	**84.49**	**2.14**	**1411**	**2.54**
Cotton Year Week No-01st (30th Sep 2024-04th Oct 2024)											
Weekly Avg.	**83.86**	**58600**	**89.13**	**73.22 Dec.'24**	**15.91**	**10460**	**21.73**	**84.79**	**4.34**	**2853**	**5.12**
Total Avg.	**84.10**	**55854**	**84.72**	**71.39**	**13.33**	**8784**	**18.65**	**83.16**	**1.56**	**1026**	**1.86**



Note:- Weeks taken as per Cotton Year (October To September).

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Standard Descriptions with Basic Grade & Staple in Millimetres based on Upper Half Mean Length As per CAI By- laws								Spot Rate (Upcountry) 2023-24 Crop November 2024					
Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	11th	12th	13th	14th	15th	16th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15	- -	- -	- -	- -	- -	- -
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	- -	- -	- -	- -	- -	- -
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20	11951 (42500)	11979 (42600)	11979 (42600)	11979 (42600)	11951 (42500)	11951 (42500)
4	KAR	ICS-103	Fine	22mm	4.5 – 6.0	6%	21	12851 (45700)	12513 (44500)	12513 (44500)	12513 (44500)	12485 (44400)	12485 (44400)
5	M/M (P)	ICS-104	Fine	23mm	4.5 – 7.0	4%	22	14904 (53000)	14482 (51500)	14397 (51200)	14397 (51200)	14369 (51100)	14369 (51100)
6	P/H/R (U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26	- -	- -	- -	- -	- -	- -
7	M/M(P)/ SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	- -	- -	- -	- -	- -	- -
9	M/M(P)/ SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25	13526 (48100)	13498 (48000)	13216 (47000)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
10	M/M(P)/ SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26	14650 (52100)	14622 (52000)	14454 (51400)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	- -	- -	- -	- -	- -	- -
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15269 (54300)	- -	- -	- -	- -	- -
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15325 (54500)	- -	- -	- -	- -	- -
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	15382 (54700)	- -	- -	- -	- -	- -
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	- -	- -	- -	- -	- -	- -
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	- -	- -	- -	- -	- -	- -
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	- -	- -	- -	- -	- -	- -
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	- -	- -	- -	- -	- -	- -
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	- -	- -	- -	- -	- -	- -
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	- -	- -	- -	- -	- -	- -
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	- -	- -	- -	- -	- -	- -
22	SA/TL/ K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	- -	- -	- -	- -	- -	- -
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
24	M/M(P)	ICS-107	Fine	34mm	2.8 - 3.7	4%	33	25308 (90000)	24746 (88000)	24746 (88000)	24746 (88000)	24746 (88000)	24605 (87500)
25	K/TN	ICS-107	Fine	34mm	2.8 - 3.7	3.5%	34	25870 (92000)	25308 (90000)	25308 (90000)	25308 (90000)	25308 (90000)	25167 (89500)
26	M/M(P)	ICS-107	Fine	35mm	2.8 - 3.7	4%	35	26152 (93000)	- -	- -	- -	- -	- -
27	K/TN	ICS-107	Fine	35mm	2.8 - 3.7	3.5%	35	- -	- -	- -	- -	- -	- -

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

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Standard Descriptions with Basic Grade & Staple in Millimetres based on Upper Half Mean Length As per CAI By- laws								Spot Rate (Upcountry) 2024-25 Crop November 2024					
Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	11th	12th	13th	14th	15th	16th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15	14510 (51600)	14679 (52200)	14679 (52200)	14763 (52500)	14735 (52400)	14650 (52100)
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	14679 (52200)	14847 (52800)	14847 (52800)	14932 (53100)	14904 (53000)	14819 (52700)
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20	- -	- -	- -	- -	- -	- -
4	KAR	ICS-103	Fine	22mm	4.5 – 6.0	6%	21	- -	- -	- -	- -	- -	- -
5	M/M (P)	ICS-104	Fine	23mm	4.5 – 7.0	4%	22	- -	- -	- -	- -	- -	- -
6	P/H/R (U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26	15157 (53900)	15072 (53600)	14932 (53100)	14932 (53100)	14904 (53000)	14847 (52800)
7	M/M(P)/ SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25	- -	- -	- -	- -	- -	- -
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	15325 (54500)	15241 (54200)	15100 (53700)	15100 (53700)	15072 (53600)	15016 (53400)
9	M/M(P)/ SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25	- -	- -	- -	- -	- -	- -
10	M/M(P)/ SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26	- -	- -	- -	- -	- -	- -
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	15382 (54700)	15297 (54400)	15157 (53900)	15157 (53900)	15129 (53800)	15072 (53600)
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	- -	15016 (53400)	14847 (52800)	14819 (52700)	14791 (52600)	14791 (52600)
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	- -	15044 (53500)	14763 (52500)	14735 (52400)	14707 (52300)	14707 (52300)
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	- -	15325 (54500)	15185 (54000)	15157 (53900)	15129 (53800)	15072 (53600)
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15550 (55300)	15466 (55000)	15269 (54300)	15213 (54100)	15213 (54100)	15185 (54000)
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15382 (54700)	15325 (54500)	15241 (54200)	15213 (54100)	15185 (54000)	15129 (53800)
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15438 (54900)	15382 (54700)	15297 (54400)	15269 (54300)	15241 (54200)	15072 (53600)
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15550 (55300)	15494 (55100)	15410 (54800)	15382 (54700)	15353 (54600)	15297 (54400)
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	15578 (55400)	15522 (55200)	15466 (55000)	15438 (54900)	15410 (54800)	15353 (54600)
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	15607 (55500)	15550 (55300)	15494 (55100)	15466 (55000)	15438 (54900)	15269 (54300)
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	15803 (56200)	15747 (56000)	15747 (56000)	15719 (55900)	15691 (55800)	15635 (55600)
22	SA/TL/ K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	15832 (56300)	15775 (56100)	15775 (56100)	15747 (56000)	15719 (55900)	15663 (55700)
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31	- -	- -	- -	- -	- -	- -
24	M/M(P)	ICS-107	Fine	34mm	2.8 - 3.7	4%	33	- -	- -	- -	- -	- -	- -
25	K/TN	ICS-107	Fine	34mm	2.8 - 3.7	3.5%	34	- -	- -	- -	- -	- -	- -
26	M/M(P)	ICS-107	Fine	35mm	2.8 - 3.7	4%	35	- -	25308 (90000)	25308 (90000)	25308 (90000)	25308 (90000)	25167 (89500)
27	K/TN	ICS-107	Fine	35mm	2.8 - 3.7	3.5%	35	26714 (95000)	26152 (93000)	26152 (93000)	26152 (93000)	26152 (93000)	26011 (92500)

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