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Export quality surgical cotton from NE India

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Pesticide free premium quality surgical cotton with a competitive price advantage is available in the north eastern states dominating with Meghalaya, Assam, Mizoram, Tripura, in *Jhum* cultivation (*Gossypium arboreum cernum)* and north coastal Andhra Pradesh states, India (*G. arboreum indicum*) which are the natural home. *G. arboreum Cvars* LD 230 and RG-8 will be useful to grow commercially in north eastern India under slash and burn system. In north coastal Andhra Pradesh ground nut/ green gram mixed cropping or sequential cropping with chilles with *G. arboreum indicum* requires adequate manuring (sheep penning, FYM) and topdressing of N: K_2O fertilizers 29:38 kg ha^{-1} besides sheep pennings as topdressing with September rains for both seed and Ratoon crop. Grey mildew is a serious problem in ratooning which needs protective spray of Copper fungicides with September rains. Surgical cotton processing centres can encourage commercial production under contract farming in north eastern India and north coastal Andhra Pradesh which can give a profitable returns of US$ 1000 ha^{-1}.

Key words: Absorbent cotton, Assam *Comilla* cotton, Bengal *desi* cotton, *Gossypium arboreum cernum, Gossypium arboreum indicum*, micronaire, pesticide free, premium quality, slash and burn system, surgical cotton.

INTRODUCTION

Increase in the corporate health care facilities internationally created high demand for pesticide residue free surgical cotton (MSME, 2010; Deshpande, 2011; Jayashree, 2013). Surgical cotton Indian export houses were continuously exporting to European union and China (Anon, 2008). However, they were recently facing shortage of raw materials (CCI, 2012). Bt hybrid cotton invasion was invisible on indigenous cottons in north eastern states and north coastal Andhra Pradesh. Absence of minimum support prices (MSP)/Bt trait and higher ginning out turn in *Gossypium arboreum cernum* cottons grown without pesticides (Guillaume and Yan, 2012), which were in favour of entrepreneurs who want to export EU countries where GMOs are not desirable. De-waxing and carboxilation are needed to get desirable absorbancy of 10 s absorbency and sinking time with water holding capacity > 23 g /g cotton (Mokate et al., 2011; MSME, 2010). ICAR-CIRCOT, Mumbai, India

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developed a chemical free surgical cotton protocol (Gayal et al., 2012).

Assam *Comilla* (7-8 micronaire) / *Bengal desi* (6.8 to 7.2 micronaire) cottons are only exported by leading international brands however, uses high micronaire, very coarse for surgical cotton production due to very few *neps* formed during processing (Cotton Inc, 2012). *Assam Comilla* cotton is traded much below the Minimum support price mainly because of absence of procurement centres of cotton by Cotton Corporation of India in north-eastern states (CCI, 2015). *Bengal desi* (*G. arboreum cernum*) cotton having big bolls produced in mixed cropping situations under pesticide free environment in north east dominating with Meghalaya, Assam, Mizoram and Tripura, in *Jhum* cultivation is unaffected by Bt hybrid cotton invasion. Now it is economical to procure and gin from north east and transport at lower price to destination by rail or shipping from Chittagong port in neighbouring Bangladesh. As the Govt of India policy to act east and spend 10% of its budget, Assam *Comilla* cotton cultivation can be encouraged with incentives which can lead to better employment generation and increase in farmers income.

Similarly, *Punasa* cotton (*G. arboreum indicum*) from north coastal Andhra Pradesh state, India, is also suitably available for export quality surgical cotton. However, commercial exploitation of these land races outside their home of production is subjected to the laws of the recently created National Biodiversity Authority of India (NBDAI). A possible way out is to procure cotton lint from the natural home of their production, ginning and crushing the seeds for oil onsite through one step by middle men which can reduce transportation cost by 65%. On farm trials were conducted by the authors under ICAR-world Bank funded National Agriculture Technology Project, Rainfed cotton Production System (RCPS-9) titled '*Development and evaluation of Technologies for Indigenous cottons"* in North east region. Agro economical study was conducted on *G. arboreum* cotton production sites which were extrapolated to current US $ prices for benefit of farmers, policy makers and young entrepreneurs to identify the optimum surgical cotton varieties, location and prices.

Experimental site character

G. arboreum cotton was commercially grown (2000-2004) on or before large scale expansion of Bt hybrid cotton were selected for this study.

Adilabad (AP), India

Experiments were conducted in *Gaorani* cotton tract at Agricultural Research station, Mudhol (18 58° 77 55° E) of Professor Jaishankar Telangana State Agricultural University, in Adilabad district of Telangana state, India. This site had both shallow red soils and medium deep gravelly *vertisols*. Normal annual rainfall of the district was 1045 mm.

Srikakulam (A.P)

On farm trials were also conducted at villages in *Ponduru*, *Amudalavalsa*, Srikakulam (18°-20' and 19°-10' N and 83°-50' and 84°-50' E) district in north coastal Andhra Pradesh of south eastern India with 900 and 150 mm SW and NE monsoon.

Diphu Assam

Onfarm trials were also conducted in *Karbi Anglong* district of Assam state, in north east India. The soils were sandy loams with steep slopes with 765 and 250 mm SW and NE monsoon.

MATERIALS AND METHODS

Seeds were planted at the experimental sites at 0.6 m x 0.30 m plant spacing in Adilabad and broadcasted in green gram on farm trials in *Jhum* cultivation at *Diphu* (Assam), India. *Punasa* cotton is often broadcasted as annual crop in the back yards of weavers along the coast line in red lateritic and coastal sandy loam soils without any fertilizers and manures. *Hill* / red cotton however, dibbled in groundnut / green gram mixed cropping at 1x1 m a part. Hill cotton is often ratooned with a higher yields and earliness besides drought mitigation at Srikakulam. Fertilizer dose of 60:30:30 kg ha^{-1} N: P_2O_5: K_2O were applied only at Adilabad. Topdressing of N: K_2O fertilizers 29:38 kg ha^{-1} with September rains after harvest of legume mixed crop at Srikakulam. There is no fertilizer/ pesticides supply in north eastern India, the crop was grown by default as organic under Jhum (slash and burn) cultivation at Diphu, Assam, India. Crop was harvested at the maturity weighed and calculated per unit area. Need based plant protection measures were followed in Adilabad and Srikakulam sites as per the requirement. Micronaire was analysed by HVI instrument at ICAR- Central Institute for Research on Cotton Technology (CIRCOT) Mumbai, Ginning Training Centre (GTC), Nagpur. Fish jaw combing is a local practice at Srikakulam for cleaning cotton, removing short fibres besides ginning by jerk on a wooden board with ruler and bow for opening cotton before chording.

RESULTS AND DISCUSSION

Ponduru cottons micronaire

They were suitable for surgical cotton in general and *Punasa* cotton in particular for premium quality range (Table 1) does not need any bleaching. Lower cost of production, absence of MSP/ competitive market forces besides cheaper labour availability for production, ginning and cleaning are ideal conditions for surgical cotton industry in north coastal Andhra Pradesh, India. Contract farming for lint supply is good offer for local farmers/ entrepreneurs through *Khadi* and village industries controlled local weaver co operative societies like *Andhra*

Table 1. Micronaire of Ponduru cottons at Srikakulam (A.P).

Cotton land races	Category	Micronaire(µg/inch)
Red cotton	Fish combed	6.7
Red cotton	No fish combed	6.2
Hill cotton	Fish combed	6.4
Hill cotton	No fish combed	6.2
Punasa cotton	Fish combed	6.4
Punasa cotton	No fish combed	6.4

Table 2. Punasa cotton in coastal sandy loam soils.

Variables	Seed cotton yield kg ha^{-1}	Gross returns US $ ha^{-1}
Punasa cotton seed crop	350	420
Punasa cotton seed crop with biofertilisers	519	623
Punasa cotton top dressed with 28 kg N ha^{-1}	950	1140

Fine khadi Karmika Sangham at Ponduru and *Srikakulam Fine khadi* at Srikakulam is organizing production and processing of these cottons since decades. Seeds after cleaning and ginning is used by local farmers as animal feed which had ready market and nutrients are recycled in local farms as farm yard manure.

Ponduru cotton production systems

Punasa cotton (Table 2) is predominantly cultivated only as pure crop in coastal sandy clay loam soils. This area is controlled by *Srikakulam Fine Khadi* Society located behind court complex with its retail outlets located in Srikakulam town and villages. Limited extent of red cotton is also grown by them under high rainfall area. The farmers economy is maintained with high plant density usually grown as back yard crop in red, sandy loams and black soils for ready to spin into yarn by rural women. *Punasa* cotton is suitable as direct introduction in to surgical cotton cultivation with minimal care. N fertilizers application of 58 kg $ha^{-1}$and advance payments will be more useful under contract farming. These soils also need N K fertilizer application at least as top dressing for reasonable profit of US $ 1000 $ha^{-1}$for *Punasa* seed cotton and red cotton ratoon (Tables 3 and 4).

Red soils

Red and hill cottons are predominantly cultivated as mixed crops and often ratooned to face the competition from mixed ground nut / sesame / green gram and black gram. Absence of basal fertilizer application, inter-cultures operations, rain water conservation harvesting and recycling as supplemental irrigations besides grey mildew control measures are constraints in cotton production. Small boll size (2 g) and large number of bolls (400 $plant^{-1}$) requires frequent pickings by family labour. Animal pennings for 3-4 days and application FYM are only avenues to maintain soil fertility, besides top dressing of 23:58:75 $N:P_2O_5:K_2O$ application after September rains or after harvest of mixed crop is a local practice due to fear of competition. Top dressing urea found to be very effective under poor N supply. Grey mildew damage is very severe after August rains for ratoon cotton besides occasional losses from boll worms. Ratoon crop matures earlier and produces more than seed crop which has to survive in severe summers. Beheading of cotton leaving one feet height was found superior instead of re sprouting the entire plant. Poor plant stand is also a yield constraint some times gaps filled with seeds. Very high expenditure on manual hoeing and hand weedings can pave way for post emergence herbicides reducing cost of production (Tables 5 and 6). Soils were deficient in potassium and responded well to NK topdressing in September after harvest of legume crop.

Medium black soils

Ratooning is producing more than seed crop. Plant stand of ratoon crop is sufficient but difficult to maintain under severe summer in the absence of irrigations. Lower moisture holding capacity of the soils, boll worms damage and grey mildew are limitations which need attention (Table 7).

Sandy loam soils

Ratoon is producing more than seed crop, therefore, wide spread rationing is followed which is leading to more

Table 3. Red cotton in coastal sandy loam soils.

Ampolu village	Seed cotton yield kg ha^{-1}	Gross returns US $ ha^{-1}
Pure crop no fertilisers	250	300
Pure crop with bio-fertilisers,	386	463
Mixed crop with *ragi* and bio-fertilisers	595	714
Mixed crop with black gram and bio-fertilisers	194	233
Biru singa puram village		
Ratoon crop top dressed with 28 kg N ha^{-1}	**1125**	**1350**
kishtappa peta village		
Red cotton seed crop	286	343

Table 4. INM in groundnut mixed crop in red soils at Nimmalavalasa, Sirkakulam Dist (A.P).

Variables	Fertilizers Kg ha^{-1} N: P_2O_5 :K_2O			Organic manures tonnes ha^{-1}	Sheep pennings days/ Year $^{-1}$	Seed cotton Yield Kg ha^{-1}	Gross returns US $ ha^{-1}
Red cotton	**12**	**29**	**50**	**15**	**6**	**1000**	**1200**
Hill cotton	40	29	0	11	3	600	720

Table 5. Onfarm trials in red soils at Nimmalavalasa, Sirkakulam Dist (A.P).

Treatments	SCY kg ha^{-1}	Mixed crop Ground nut yield kg ha^{-1}	Gross returns US $ ha^{-1}
Red cotton seed crop 40 kg N ha^{-1}	375	538	1363
Red cotton seed crop with no fertilizer	334	501	1236
Hill cotton ratoon crop 23:58:75 N:P_2O_5:K_2O	334	358	1093
Hill cotton seed crop with no fertiliser	250	501	1051
Hill cotton seed crop with 40:29:0 N:P_2O_5:K_2O	600		720
Hill cotton Ratoon crop with no fertiliser	167	250	617

Table 6. Red and Hill cottons in shallow black soils of Madhupam, Srikakulam.

Treatment	Seed cotton yield kg ha^{-1}	Gross returns US $ ha^{-1}
Red cotton ratoon crop without fertilizers	217	260
Red cotton ratoon crop -chillies on residual fertility	375	450
Hill cotton seed crop with biofertilisers and 28 kg N kg ha^{-1}	217	260
Hill cotton ratoon crop with 58 kg N 75 kg K_2O kg ha^{-1}	592	710

Table 7. Hill cotton in Sandy loam soils Narsapuram, Ponduru, Srikakulam Dist (A.P).

Treatment	Seed cotton yield kg ha^{-1}	Green gram kg ha^{-1}	Horse gram kg ha^{-1}	Gross returns US $ ha^{-1}
Hill cotton with green gram and biofertilisers.	63	56	34	142
Hill cotton with 5 tonnes FYM and 28 kg N ha^{-1} as basal dose with biofertilisers	750	1000	250	**1938**

Table 8. Kishtappa peta village, Ponduru (Srikakulam Dist) A.P.

Variables	Fertilizers applied Kg ha^{-1}			Organic manures	Sheep pennings	Seed cotton Yield Kg ha^{-1}	Gross returns US $ ha^{-1}
Crop	N	P	K	tonnes ha^{-1}	Days/ Year $^{-1}$		
Hill cotton	50	29	0	1.5	3	700	840

Table 9. *G. arboreum* cottons yield as mixed crop in green gram at Diphu, Assam (India).

Variables	Seed cotton yield kg ha^{-1}	Green gram kg ha^{-1}	Gross returns realized ha^{-1} US $			Micronaire (µg/inch)
			Farmer	Entrepreneur using local gin	Entrepreneur using factory gin	
LD 230	904	750	1647	134	167	
RG-8	823	750	1550	122	152	
Karbi local	**639**	750	1329	95	118	7.8
MDL 1875	578	750	1256	86	107	
AKH-5	560	750	1235	83	104	
AKA 8401	560	750	1235	83	104	
Lohit	540	750	1211	80	100	
Y1	504	750	1167	75	93	
K10	467	750	1123	69	86	

grey mildew and pink boll worm problem. Lower moisture holding capacity of the sandy loam soils is a severe limitation where mixed cropping is followed (Table 8). Hill cotton needs adequate manuring and topdressing of N, K fertilizers to get required economical yield and profitability (Table 8).

Assam *Comilla* cottons are 3rd in order of profit for both farmers and entrepreneurs under mixed farming situations of *Jhum* cultivation along with green gram with no external inputs being low yielders they were next only to LD 230 and RG-8 (Table 9). Premium quality pricing if paid can be expanded and second quality by LD 230 and RG-8 if NBDAI restricts its commercial cultivation. Although improvement of these cottons were initiated by breeders but maintaining higher boll weight and coarseness is difficult except under hybrid conditions as observed by at ARS, Mudhol (Laxman, 2009) which was notified as MDLABB-1 and CICR, Nagpur hit the head lines and attracted attention of cotton world on the cotton productivity (Anonymous, 2013). Pure line selections were made within local ecotypes at RARS, *Diphu*, *Karbi Anglong* district (Assam) and were tested in NATP project RCPS-9 but seeds could not be maintained by respective breeders.

Gaorani cotton tract is once the home of *desi* cottons covering two states of Telangana and Maharashtra states. This tract is now gets severe competition with Bt hybrid cottons although they may not give 1000 US $ but that is expected for a fairly good standard of living for farmers. This target can be achieved by premium quality LD 491 followed by Lohit and G-27. After this MDL 1875, K-10, LD-230 AKA-7 and AKA 8401 can be profitable in second quality for national requirement (Table 10). However, in the absence weighted premium for Bt trait and ginning out turn they cannot be competitive with Bt hybrid cotton.

Vidarbha and *Malwa* regions of Central India was once commercial production centres for *desi* cottons were totally replaced by Bt hybrid cotton (Table 11) due to boll worm susceptibility except pockets in Jalgaon of *Khandesh* region, *Melghat* of Amraoti and Murtizapur of Akola (MS) in *Vidarbha* region. Y-1, JLA-794, Jawahar Tapti, AKA-5 were used by local surgical industry for surgical cotton production. MPKV, Rahuri recently released *Phule Dhanwantary*, which produced higher seed cotton yield 1418 kg ha^{-1} over Y-1 1279 kg ha^{-1} and JLA-794 1292 kg ha^{-1}. It had absorbency of 1.9 s and sinking time 2.0 s. with water holding capacity 26.7 g /g of cotton as compared to Y-1 6.5 and 8.5 s and 25.0 g /g of cotton, respectively used for surgical cotton production for local requirement. G-27, RG-8, LD-491, Lohit, LD-230 and *Karbi* cotton were profitable with weighted premium to local farmers in medium deep soils.

Conclusion

Premium quality surgical cotton with a competitive price advantage is in the natural home of *G. arboreum cernum/ indicum* cottons. Processing centres can encourage LD 230 and RG-8 in north east India under *jhum* cultivation, adequate manuring and NK fertilizers are essential at

Table 10. Micronaire of *G. arboreum* cotton varieties at ARS, Mudhol, Adilabad (A.P).

Varieties	Yield kg ha^{-1}	Gross returns realized US $ ha^{-1}	Micronaire (µg/inch
G-27	1237	1031	6.1
Lohit	1119	933	6.3
MDL-1875	1022	852	5.5
K-10	1015	846	5.5
LD-230	991	826	5.5
AKA-5	982	818	5.5
LD-491	954	795	6.8
Hill cotton	850	708	6.2
RG-8	835	696	6.9
Red cotton	800	667	6.2
Punasa cotton	600	500	6.4
CD±5%	287	239	0.6

Table 11. Agronomical performance *G arboreum* cottons in medium deep black soils, Nagpur (M.S).

Year	Yield kg ha^{-1}	Gross returns US $ha^{-1}	Micro naire (µg/inch)
G-27	1162	968	6.1
Karbi	1139	949	5.1
Lohit	1056	880	5.8
LD-230	1013	844	5.5
RG-8	973	811	6.1
LD-491	953	794	6
CD±5%	346	288	0.5

least as topdressing to realize economic yield levels.

Conflict of Interest

The authors have not declared any conflict of interest.

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