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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: K₂O 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

On farm 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, dilled 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: P₂O₅: K₂O were applied only at Adilabad. Topdressing of K₂O 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, intercultures 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\(_2\)O\(_5\):K\(_2\)O 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.

| 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\(_2\)O\(_5\):K\(_2\)O | 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\(_2\)O\(_5\):K\(_2\)O | 334                | 358        | 1093                            |                                |
| Hill cotton seed crop with no fertiliser | 250                | 501        | 1051                            |                                |
| Hill cotton seed crop with 40:29:0 N:P\(_2\)O\(_5\):K\(_2\)O | 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 ha\(^{-1}\) | 217                              | 260                            |
| Hill cotton ratoon crop with 58 kg N 75 kg K\(_2\)O kg ha\(^{-1}\) | 592                              | 710                            |

### Table 7. Hill cotton in Sandy loam soils Narsapuram, Ponduru, Sirkakulam 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                           |
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.

Vidarba 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.

### 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 50 P 29 K 0 1.5 3              | 700            | 840           |                               |                             |
| Hill cotton|

### 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) |
|-----------|---------------------------------|----------------|----------------------------------------|----------------------|
| LD 230    | 904                             | 750            | 1647 Farmer 134 Entrepreneur using local gin 167 Entrepreneur using factory gin 152 | 7.8                  |
| RG-8      | 823                             | 750            | 1550 Farmer 122 Entrepreneur using local gin 107 |                     |
| Karbi local| 639                             | 750            | 1329 Farmer 95 Entrepreneur using local gin 118 |                     |
| MDL 1875  | 578                             | 750            | 1256 Farmer 86 Entrepreneur using local gin 104 |                     |
| AKH-5     | 560                             | 750            | 1235 Farmer 83 Entrepreneur using local gin 104 |                     |
| AKA 8401  | 560                             | 750            | 1211 Farmer 80 Entrepreneur using local gin 100 |                     |
| Lohit     | 540                             | 750            | 1167 Farmer 75 Entrepreneur using local gin 93 |                     |
| Y1        | 504                             | 750            | 1123 Farmer 69 Entrepreneur using local gin 86 |                     |
| K10       | 467                             | 750            |                          |                     |

**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
least as topdressing to realize economic yield levels.

Conflict of Interest

The authors have not declared any conflict of interest.

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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\(^{-1}\) | Micronaire (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              |