Organic World Congress 2020 | FRANCE

SEPTEMBER 21ST TO 27TH, 2020 IN RENNES
AT THE COUVENT DES JACOBINS • RENNES MÉTROPOLE CONFERENCE CENTRE
www.owc.ifoam.bio/2020

OWC 2020 Paper Submission - Science Forum

Topic 1 - Ecological approaches to systems' health

OWC2020-SCI-1090

RESCUING NON-GM ORGANIC COTTON SEED THROUGH PARTICIPATORY BREEDING APPROACH

Amritbir S. Riar[*1], Tanay Joshi[1], Shivraj Raguwanshi[2], Surendra Deshmukh[3], Ramprasad Sana[4], Rajeev Verma[5], Deepak Yadav[6], Ashok Mahavadi[7], Devendra Shrivastava[8], Monika Messmer [1]

[1]Research institute of Organic Agriculture , Frick , Switzerland, [2]Pratibha Syntex Ltd, Indore , [3]Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola , [4]Centre for Sustainable Agriculture, Secunderabad, [5]CottonConnect, Gurgaon, [6]Action for Social Advancement, Bhopal, [7]Chetna Organic, Hyderabad, [8]Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, India

Preferred Presentation Method: Oral or poster presentation

Full Paper Publication: Yes

Abstract: Introduction of Bt-cotton and its fast adoption in India posed a major threat to availability of non-GM cotton seed for organic production. With the continuous growth of the organic market it is important to maintain non-GM germplasm, to enlarge the offer of organic cultivars with a better performance that meet the demand of the market, and to rebuild the seed sovereignty of organic smallholder cotton farmers. This study aims to examine relative yield performance and fibre length of commercially cultivated American *Gossypium hirsutum* (HV) and Desi cotton *G. arboreum* (AV) varieties in comparison with the advance (F6-F8) HV and AV lines developed under Seeding the Green Future (SGF) program at different sites. Analysis revealed wide range in seed cotton yield across different locations in both, heavy and light soils resulting from the unpredictable weather conditions, an extended period of drought during sowing followed by flash flooding during the 2018-19 cotton-growing season. However, both advance (F6-F8) HV and AV lines gave promising results and were at par with the performance of commercial HV and AV cultivars. Analysis of data on fibre quality revealed encouraging results with mean fibre length of >28 mm observed in Bandapari and Akola, especially with advance (F6-F8) AV lines, which is minimum industrial standard. While desi cotton *G. arboretum* has inherent ability to adapt under adverse climatic condition and is well known for tolerance to sucking pests and drought if coupled with such important quality parameter can help in securing the availability of non-GM seed. This is of special importance as desi cotton does not cross-pollinate with Bt-cotton and shows clearly distinguished leaf morphology. In the current scenario, where the integrity of Indian organic cotton under the spotlight due to GM contamination, there is a need to reorient research efforts to ensure that the existing wealth of genetic diversity of traditional Desi cotton can be capitalized in organic production and industrial processing.

Introduction: Small farmers of the organic cotton sector in India face an acute shortage of non-GM cottonseed (free of genetic engineering) due to the widespread dissemination and adoption of genetically modified Bt-cotton hybrids,

producing a toxin of *Bacillus thuringensis* (Bt) to combat bollworm attack. Local seed traders no longer offer any non-GM cottonseed. Some older cultivars are still available by a few seed companies on pre-payment basis, but they have not been tested for their suitability for organic farming conditions. India has a wealth of cotton germplasm of tetraploid (*Gossypium hirsutum, G. barbadense*) and traditional diploid species (*G. arboreum, G. herbaceum*), so called Desi cotton and many elite cultivars developed by public universities and research institutes. However, since the introduction of genetically modified Bt-cotton in 2002, private breeding companies started to dominate the seed market with focus on tetraploid *G. hirsutum* developing Bt-hybrids with high fibre quality and high yield potential under high input farming conditions. Although, the traditional diploid cotton species *G. arboreum* and *G. herbaceum* have several advantages with regard to biotic and abiotic stress resistance, they largely remained neglected after the introduction of Bt-cotton and their cultivation dropped within 10 years from 20% to less than 5%. However, these cotton species have been shown to be specially suited for low external input conditions under organic farming, are morphologically distinct from present Bt-*hirsutum* hybrids and do not cross-pollinate with them. Without secure supply of non-GM cotton seed, the organic cotton production in India and consequently the income of small holder farmers in the major cotton belts is severely threatened. In view of the foregoing, a participatory organic cotton breeding initiative with the aim to securing supply and integrity of organic cotton throughout the supply chain was started in 2011. We hypothesized that traditional diploid cotton can achive the similar yield and quality as *G. hirsutum* in organic cropping systems.

Material and methods: This program is implemented in India in close collaboration with Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior (RSKVV), Pratibha Syntex Ltd. (PSL), Action for Social Advancement (ASA), and CottonConnect (CC) in Madhya Pradesh (MP), Chetna Organic (FFID) in Odisha, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV) in Maharashtra (MH) and Centre for Sustainable Agriculture (CSA) in Andhra Pradesh. In 2018, four cultivar evaluation trials on different soil types and different agro-climatic zones were conducted in India. Nine promising hirsutum and Six arboretum lines developed under Seeding the Green Future program (SGF) were screened together with five commercial hirstum cultivars and three commercial arboreum cultivars at the four sites in the season 2018/19. Performance on seed cotton yield, phenotypic characters and fibre quality was assessed for comparisons. Primarily, all the planting material was subject to test for GM contamination and only those seed lots were integrated into the trials that were free of contamination. The trials were sown in June/July 2018 with drip irrigation on heavy and medium soils and sowing in light soil was delayed to July dependent on the onset of monsoon rains. Trials were established under certified organic conditions and no synthetic chemicals were used for nutrient, pest and disease management. Instead, farmyard manure (FYM) and vermicompost were applied to the cotton crop. Cultivars were arranged in randomized complete block design and replicated thrice.

Results: Seed cotton yield across different location and soil types ranged from 149 kg/ha at PDKV, Akola (Figure 1a) under heavy soil conditions to 2106 kg/ha at Pratibha under medium soil conditions and irrigation (Figure 1d). The median yield recorded at Odisha was 654 kg/ha for Mading (heavy soil, Figure 1c) and 390 kg/ha at Bandapari (light soil, Figure 1b). *Hirsutum* varietal lines (HV) performed well across different trial sites. In general, performance of *arboreum* varieties (Figure 2a,b,c,d) was comparable to HV lines (Figure 1a,b,c,d). Advanced (F6-F8) HV and AV lines developed under SGF program performed at par with commercial lines (Com) at all locations and most of them showed superior fibre length (Figure 1 & 2). Median fibre length was observed to be at par with the industrial requirement at Bandapari (28.4 mm), and PDKV, Akola (28.3 mm) in light soil conditions (Figure 1&2). Maximum fibre length was recorded at Mading, Odisha in heavy soil while the minimum (23.9 mm) was reported in medium soil at Pratibha. In all the locations, average mean fibre

length values of majority of AV and HV lines were acceptable according to industry-standard (>28 mm), most of these lines are being forward for second year testing in the upcoming cultivar evaluation trials.

Figure 1: Performance of Gossypium hirsutum commercial (Com) and SGF lines on seed cotton yield and fibre length quality at different locations a) PDKV, Akola; b) Bandapari, Chetna; C) Mading, Chetna and d) Pipalgone, Pratibha.

Figure 2: Performance of Gossypium arboreum commercial (Com) and SGF lines on seed cotton yield and fibre length quality at different locations a) PDKV, Akola; b) Bandapari, Chetna; C) Mading, Chetna and d) Pipalgone, Pratibha.

Discussion: Cotton in India is grown in various soils, climates, and agricultural practices under irrigated and rainfed situations. Approximately 65% of India's cotton is produced under rainfed conditions (Gutierrez et al. 2015). Higher yield in medium soil in Pipaglone can be attributed to early summer sowing and fertile soil, while delayed monsoon sowing resulted in flash floods that caused waterlogging at PDKV, Akola-Maharastra and in Mading, Chetna-Odisha. At Bandapari, Odisha in light soils poor yield was recorded due to poor germination and high weed pressure. Although, trials underperformed at most of the locations, still, comparative performance of new lines vs commercial lines was at par for seed cotton yield. Whereas, a superior fibre length of advanced (F6-F8) lines from SGF was observed at all sites. It is well known that fibre length of cotton is a highly heritable trait and does not vary much with agronomic management or seasonal conditions (Blaise 2006). *Gossypium arboreum* is often attributed to short or medium fibre length. The best available commercial *arboreum cultivars* under Indian conditions were grown in these experiments and yielded good results. However, the comparatively striking performance of advance (F6-F8) SGF *arboreum* lines in the trial at all the locations raise a possibility to have better fibre length of *arboreum* without compromising on the seed cotton yield. For long, textile industry has been demanding for non-GM quality cotton suitable for the recent spinning systems. As fiber length, beside micronair, is one of the most important parameters determining yarn quality for ring spinning, further advancement of these promising lines under SGF can contribute overcoming the trade-off between the yield and fibre length under organic cultivation. Overall the performance of the arboretum lines was very promising and therefore, due consideration should be given to traditional cotton cultivars for development of locally adaptive cultivars.

References: Blaise, D. (2006) Yield, boll distribution and fibre quality of hybrid cotton (Gossypium hirsitum L.) as influenced by organic and modern methods of cultivation. Journal of Agronomy and Crop Science 192: 248-256.

Gutierrez, Andrew Paul, et al. "Deconstructing Indian cotton: weather, yields, and suicides." Environmental Sciences Europe 27.1 (2015): 12.

Image:

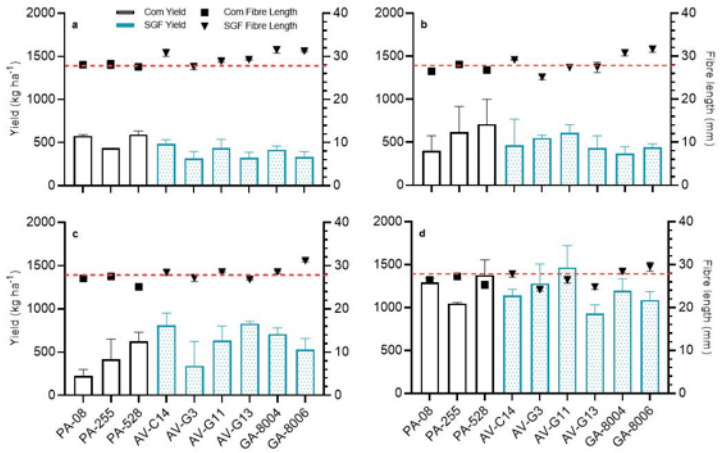
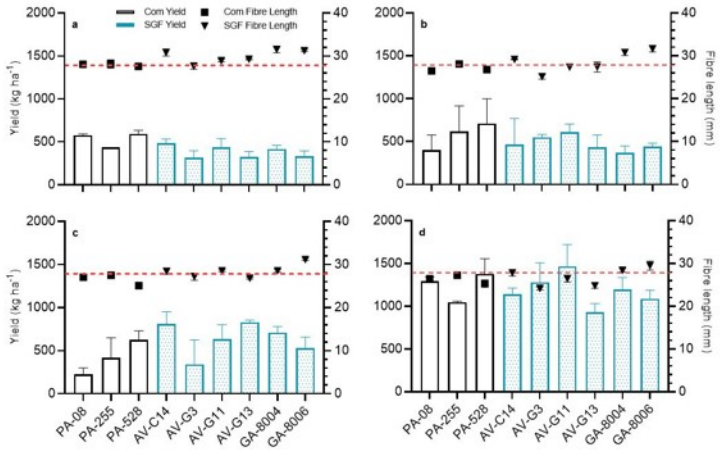


Image 2:



Disclosure of Interest: None Declared

Keywords: Organic cotton, participatory breeding, seed,