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Cotton Productivity Scenario in North Zone - Can We Break the Present Logjam?

EXPERT's Column

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Introduction

India has the largest area under cotton and is also the largest producer of cotton. However, it is ranked 37th in the world in terms of productivity. The area under cotton reached a record high of 133.73 lakh ha in 2019-20. The highest production (398 lakh bales with each bale of 170 kg.) and productivity (566 kg. lint/ha) was recorded during 2013-14 (cotcorp.org.in). In general, there has been a stagnation in productivity during the last decade and half. Even reduction in yields over the previous high has been observed during some years. Bt cotton technology, acclaimed to be a game-changer for increasing cotton productivity, is now being debated. The contribution of increased area has been a major contributor to the overall increased production in Bt era compared to increase in productivity per-se.

The Northern cotton zone is completely irrigated and higher yields were always expected from this zone but this has not been the case. During the 1990s, 40% of the country's cotton was produced from only 20% of area from the North zone. The scenario has changed drastically now. At present around 14% of total cotton area comes under this zone, with a contribution of 17% towards total production in 2019-20. This has mainly been due to increased area and production in other states, notably Gujarat, Maharashtra and Telangana. In this article, we intend to analyse the cotton scenario in the North zone and also offer some suggestions for breaking the productivity logjam in this zone.

Cotton Scenario

A cursory analysis of the cotton cultivation in the North zone during a decade of pre-Bt era (1995-96 to 2004-05) and the recent past decade of Bt cotton (2010-11 to 2019-20) throws out some interesting facts (Table 1). The area under cotton during the pre-Bt phase ranged from 13.22 lakh ha in 2003-04 to 20.45 lakh ha in 1996-97. The area during the past decade under Bt cotton was between 13.57 in 2010-11 to 18.76 lakh ha in 2019-20. The average of 10 years during the pre Bt era was 16.79 lakh ha and it was slightly higher than that during the last decade (15.12 lakh ha). Thus, unlike in the other parts of the country, the introduction of Bt cotton did not increase the area

Table 1: Area, production and productivity of cotton in the north zone during the pre Bt (1995-96-2004-05) period and the recent past decade of Bt cotton (2010-11 to 2019-20)

Year	Area lakh ha	Production lakh bales	Yield kg lint/ha
1995-96	20.02	39.40	335
1996-97	20.45	43.50	362
1997-98	20.10	28.00	230
1998-99	17.89	23.50	223
99-2000	16.04	31.55	334
2000-01	15.39	30.30	334
2001-02	15.57	21.75	237
2002-03	13.54	21.25	267
2003-04	13.22	31.00	399
2004-05	15.68	43.00	466
Mean	**16.79**	**31.33**	**317**

Year	Area lakh ha	Production lakh bales	Yield kg lint/ha
2010-11	13.57	45.60	571
2011-12	16.71	62.00	631
2012-13	15.44	64.00	705
2013-14	13.75	59.00	729
1014-15	15.55	53.00	579
2015-16	14.02	35.75	434
2016-17	11.96	47.00	668
2017-18	15.40	56.50	624
2018-19	16.05	59.00	625
2019-20	18.76	65.00	589
	15.12	**54.69**	**614**

under cotton in this zone. The production during pre-Bt period ranged between 21.25 lakh bales in 2002-03 to 43.5 lakh bales in 1996-97. In the last decade of Bt cotton, it ranged between 35.75 lakh bales in 2015-16 to 65.0 lakh bales in 2019-20. Similarly, the productivity for the above two periods ranged from 223 to 466 kg lint/ha and from 434 to 729 kg lint per ha respectively. The highest productivity of 729 kg lint/ha obtained during 2013-14 was quite close to 766 kg lint per ha of world productivity average that year.

The trends in area were almost similar during both the periods and the annual fluctuations were mainly due to biotic stresses (bollworms and cotton leaf curl virus disease-CLCuD in pre-Bt phase and sucking pests and CLCuD in Bt phase), prevailing market prices and certain policy issues. In case of production, there was a mean increase of 23.4 lakh bales indicating the gains from Bt cultivation. Similarly, there was a mean net increase in productivity by 297 kg/ha during the last decade under Bt cotton over the pre Bt phase.

Productivity Constraints

Poor soil organic carbon level and salinity/ sodicity problems

The organic carbon in soils under cotton cultivation of Haryana has varied from low (less than 0.50) to medium (0.50 to 0.75). It was noted to be around 0.5% in Punjab also, indicating poor fertility status of soils. An intensive double cropping system is practiced in this zone and almost the entire area is sown with wheat after the cotton crop. The cotton stalks would be removed from the fields after picking and used for fuel purpose earlier and now partly in brick kilns. Burning of straw, from the subsequent rabi wheat crop, is also a regular practice. The recommendation of intercropping of legumes in cotton has also not found much favour among the farmers due to poor and unstable yields and operational difficulties. The application of FYM has also reduced due to its non- availability and if available is of poor quality. All these have contributed to a decline in soil organic matter content and emergence of multiple nutrient deficiencies.

Around 6.18 lakh ha of the soils in the states of Haryana, Punjab and Rajasthan are degraded due to the problem of salinity and sodicity and considerable area under cotton is under these soils. Plant growth is also adversely affected by saline ground water used for irrigation primarily through excessive salts raising osmotic pressure of the soil solution resulting in reduced water availability and poor germination.

Plant Stand Issues

Establishing an optimum plant stand is the primary requirement for high productivity. Maintenance of proper plant stand has always been challenging in the North zone. There is around 100mm rainfall during the pre-monsoon months of May and June and if there is rainfall within 24-48 hours after sowing, a crust is formed on the soil surface that hampers the emergence of the germinating seedlings. Often, re-sowing has to be done under such situations. Usually there are cyclic high temperature peaks during

the sowing period or shortly thereafter when the air temperature crosses 45 0C. The seedlings emerging during this period show severe burning symptoms as the temperature of soil touching the emerging seedlings would be higher by another 1-2 0C. The technologies for preventing crust formation (apart from improving soil organic carbon content) or imparting temperature tolerance in emerging seedlings are yet to be evolved. The technology for gap filling to make up for the missing seedlings through nursery raising and transplanting of seedlings have been developed (Meena et. al., 2014) but this needs to be popularised among the farmers.

Productivity Stagnation

Breaking the yield stagnation barrier is a major challenge in the North zone. On one hand, there are annual yield fluctuations due to biotic and abiotic factors. On the other hand, the genetic yield potential in cotton hybrids and varieties has not increased during the last decade. A maximum of 180 days period for cotton crop is available in the double cropping system from May to October, if the yield of subsequent wheat crop is not to be compromised by delayed sowing of wheat. So the cultivars which complete their productivity cycle in 160-180 days, appear to be best suited for this zone. Short duration varieties and hybrids that fully mature in less than 150 days have proved to be of low productivity at current planting densities. High yielding (40-50 quintals/ha) desi cottons varieties and hybrids were released in the recent past by the State Agricultural Universities and ICAR-CICR, but the area under desi cotton declined to a negligible level after the introduction of Bt hybrids. The demonstrations to test quality desi cotton varieties under higher density to boost quality and productivity were not consistently successful in the zone due to issues of canopy management under high planting densities.

However, desi cottons have fetched much higher market price ranging from Rs. 500-1000/- in most of the years. Desi cotton (G arboreum) is also known for its adaptability to harsh conditions, better tolerance to biotic and abiotic stresses and they are known to perform well under marginal and adverse environments and with less input. The availability of Bt gene in desi cultivars would be desirable. Further, improvement in boll weight and shattering tolerance would be necessary to boost area under desi cotton. There is a need for exploitation of variability existing in the germplasm through hybridization and other innovative techniques for enhancing productivity.

Another important aspect is the possibility for improvement in existing Ginning Out Turn (GOT) in the present cultivars. The GOT in G hirsutum varieties in north zone ranges between 33-35% where as a GOT of more than 40.0% is quite common in many cotton growing countries. A total of 7234 accessions of G hirsutum were evaluated during the period 2012-13 to 2016-17 at ICAR-CICR Regional Station Sirsa and GOT upto 42.9% was observed (Meena et.al., 2019) in some accessions. The GOT of BG II hybrids presently being cultivated in north zone, is just around 35%.

However, in a study conducted at Sirsa regional station of ICAR-Central Institute for Cotton Research during three years, the GOT ranged between 31.4-39.3% in 96 BG II test hybrids in 2019-20; between 27.4-39.8% in 100 test hybrids and between 34.0-42.3% in 81 test hybrids during 2018-19 & 2017-18 respectively (personal communication). This shows that there is ample scope for recommendation of BG II hybrids with higher GOT. With average seed cotton yield of 20.0 q/ha, a 5% higher GOT can translate into an additional productivity of lint by 100kg.

Plant Type

The row to row spacing of 67.5cms and plant to plant spacing of 30cms (67.5x30cms) were followed in general in the North zone, when varieties were under cultivation with 49383 plants per ha. Later, when hybrids were introduced, the recommended spacing was 67.5x60cms or higher with a maximum of 24691 plants per ha. Today more than 98% of the area in the North zone is under BG II hybrids planted at 67.5x60cms spacing. In recent years, demonstrations on high density planting were conducted using varieties where a spacing of 67.5 x 10cms was fixed with plant population of around 1,50,000 per ha. Few varieties, non-Bt as well as Bt amenable for high density planting, were released during the past five years but they have not yet been accepted by the farmers. The main question appears to be of optimum plant density for productivity enhancement as when wider spacing's are followed, even a few missing plants bring down production considerably. In the case of high-density plantings with bushy genotypes, the issue of non-retention of lower squares is common. Moreover, the plants of currently available genotypes tend to become lanky with weak stem leading to lodging.

Reduction in boll weight is also recorded under high density plantings. These problems need researchable solutions and a complete package with proper plant type, growth retardants and defoliants coupled with mechanical picking options can lead to success of this technology.

Biotic and Abiotic Stresses

Damage due to sucking pest in Bt hybrids is an important impediment that needs serious attention for achieving higher productivity. Whitefly populations were building up since 2012-13 which led to its epidemic in 2015-16, imparting a severe blow to cotton productivity in the zone. However, new management recommendations and coordinated efforts by all stake holders in the subsequent years helped in restoring the productivity levels. The increased incidence and prolonged appearance of thrips due to climate variations, noted in recent years is also a cause of concern.

The abiotic stresses like untimely rains and new wilt coupled with whitefly, fungal foliar pathogens and nutrient deficiency in August led to severe yield reductions in Haryana during the 2020 crop season. The issue of improper root development in BGII hybrids has also come up as a reason for aggravated new wilt symptoms in the months of August/September leading to sudden loss of crop (Sain et al,2021). Pink bollworm incidence due to transport of cotton seed from central and south zone harboring resistant larvae and its subsequent spread on BGII hybrids in few locations around ginning factories and oil extraction units was first noticed in 2018-19. Their infestation levels increased during the subsequent years- 2019-20 & 2020-21. This is a new threat for cotton in this zone with severe consequences unless addressed immediately. (Rishi et al,2020, Monga 2021).

The Way Forward

Soil fertility is an important issue and introduction of nitrogen fixing crops like moong and cluster bean in crop rotations is necessary, no matter how we do it. Incorporation of crop residues like decomposed cotton stalks is another proven technology to restore organic matter content in the soil in the long run. Saline water issues can be tackled through micro irrigation systems in certain affected areas. Soil and water conservation principles need to be incorporated in cotton production system on a urgent basis.

Other researchable issues for breaking yield barriers- retention of early formed squares, optimising crop duration and plant density, improving boll weight and shattering tolerance in desi cottons, GOT improvement in varieties and hybrids and tackling biotic and abiotic stresses are the need of the hour.

Reinvigoration of State Seed Corporations will help making available quality seeds of promising cotton varieties. Krishi Vigyan Kendras can have a greater role through bringing the productivity constraints in the focus of researchers. State Agricultural Universities need research emphasis beyond All India Coordinated Research Project on Cotton to solve the practical field problems of farmers. A greater coordination among the different ICAR institutes dealing with different crops/commodities in the zone and between ICAR-CICR and SAUs will enable strengthening of basic research and strategic research.

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