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Cotton Cultivation Practices in South-Western Part of Punjab

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ABSTRACT

The study was conducted for three consecutive years (2018/19-2020/21) to investigate the adoption status of cotton crop production practices in Sri Muktsar Sahib district in south-western Punjab. Data pooled for three years showed that the majority of farmers (67.8%) ensured crop sowing at the recommended time, while 32.8 per cent delayed cotton sowing due to the non-availability of canal water for timely pre-sowing irrigation. Concerning nutrition management, 18.5, 45.5 and 33.5 per cent of farmers applied recommended doses of N, P, and K fertilizers, respectively, and 89.5 per cent of farmers applied two or more sprays of potassium nitrate (KNO_3). For the management of insect pests, during 2018-19, ~52.9 per cent of farmers had to apply 5-6 sprays, while during the next two years, ~55.4 and 81.5 per cent of farmers applied 3-4 insecticide sprays. The average seed cotton yield during 1st year of study (2018-19) was 15.6 q ha^{-1} which was increased to 22.6 q ha^{-1} during 2019-20 and 23.1 q ha^{-1} during 2020-21. This study reiterates that there is a need to update the farmers regarding knowledge of improved cotton cultivation techniques for efficient weed, nutrition, water, and insect-pest management in cotton cultivation in Punjab.

INTRODUCTION

Cotton, scientifically known as *Gossypium hirsutum* L., holds a paramount position as the leading global fiber crop, primarily serving the textile industry (Saini et al., 2010; Yadav et al., 2017; Yadav et al., 2018). Owing to its important role in agriculture, industrial development and employment generation, it is an important cash crop of India (Singh et al., 2018). Cotton cultivation predominantly takes place in arid and semi-arid regions, in both irrigated and rainfed conditions. Cotton plants require elevated temperatures and ample exposure to radiation for optimal growth (Constable & Bange, 2015; Singh et al., 2021). Cotton-wheat cropping system is the most prevalent cotton-based system in Punjab (Singh et al., 2019), in which cotton is raised during summer season (Singh et al., 2018). Cotton is cultivated in an area of ~2.45 lakh hectares in Punjab (in south-western Punjab) during 2019-20 with total production of ~11.9 lakh bales and an average productivity of 8.29 q ha^{-1} (Anonymous, 2022). In the south-western region of Punjab, the cotton-wheat cropping system ranks as the second largest cropping system, following the dominant rice-wheat system. This system is primarily adopted on soils characterized by their light texture and limited fertility, primarily due to the poor quality of underground irrigation water (Brar & Singh, 2022; Singh et al., 2023; Singh et al., 2020a; Singh et al., 2022a; Singh & Benbi, 2021). High temperature at early growth stages causes high seedling mortality which results poor plant population (Ahmad et al., 2017; Tariq et al., 2017). Similarly, precipitation during the stage of flowering and bolting also adversely affect the crop performance (Cetin & Basbag, 2010; Brar & Singh, 2022). Therefore, extreme weather conditions can result in a substantial decline in cotton productivity. The effect of weather conditions can be minimized by adopting the improved cultivation practices such as optimum seeding rate and sowing time. Nonetheless, the soil management and crop production practices in cotton differs largely (Singh et

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al., 2021, 2022b). Besides, cotton is attacked by large numbers of insect-pests at different crop growth stages. A severe infestation of cotton whitefly (*Bemisia tabaci*) in 2015 led to a dramatic reduction in Bt-cotton yield (Singh & Sharma, 2016; Singh et al., 2021). Amongst the management practices, irrigation management, nutrition, especially potassium nitrate (KNO_3) spray at flowering initiation, weed management etc. are the other factors which influence the performance of cotton crop. To improve the cotton productivity and production, it is important to get the information regarding the adoption status of cultivation practices of cotton in an area (Singh et al., 2022b). In light of this, the present study was undertaken to assess the extent of adoption of recommended practices and the changes in the cotton cultivation area within the study area of Punjab.

METHODOLOGY

The study focused on examining Cotton Cultivation Practices in the South-Western Part of Punjab, specifically in Sri Muktsar Sahib district, over the span of three years (2018-19 to 2020-21). With approximately 32.2 thousand hectares dedicated to cotton cultivation during the 2021-22 *kharif* season, the district was purposively chosen for this study due to the crop's substantial presence as the second major *kharif* crop following rice (Anonymous, 2022). The sample selection process involved a proportional and random approach, with farmers chosen from four distinct blocks: Muktsar, Lambi, Malout, and Giddarbaha. For each of the study years, 70, 65, and 65 farmers were included, ensuring a representative distribution across the district.

To capture the required information, a meticulously designed and pretested interview schedule was employed. This schedule addressed various aspects of cotton cultivation practices, including the selection of varieties/hybrids, seed rates, seed soaking, refuge planting, sowing times, fertilizer usage, potassium nitrate spray, weed management, insect-pest control, and irrigation practices. The objective was to gauge the adoption rates of these practices among the respondents. Throughout the study period, data were systematically collected to assess the adoption rates of different cultivation practices. Each agronomic practice's adoption was quantified as the percentage of respondents implementing the respective practice. In addition to examining cultivation practices, the study also incorporated an analysis of seed cotton yield data. This information was collected, analyzed, and presented as means for each year and hybrid. This approach facilitated an understanding of productivity trends over the three-year duration of the study.

RESULTS

The total operational area of respondent farmers was 503.6, 492.4 and 520.8 ha during 2018-19, 2019-20 and 2020-21, respectively and the area under cotton crop of respondent farmers was 205 ha during 2018-19, 178.2 ha during 2019-20 and 197.4 ha during 2020-21 which accounts for 40.7, 36.2 and 37.9 per cent of total operational area during 2018-19, 2019-20 and 2020-21, respectively (Figure 1). These results showed a decline in cotton area from 2018-19 to 2019-20 while that was increased during 2020-21 in comparison to previous year. Amongst the different cotton hybrids grown in the district, the largest area was occupied by RCH 773 (44.2% of total area) and it was followed by RCH 776 (19.2%) and SP 7172 (8.2%) (Table 1).

It was observed that during 2018-19 and 2019-20, majority of the farmers (51.4 and 49.2%, respectively) used seed rate of 1500-1875 g ha^{-1} (Table 2), while during 2020-21, majority farmers used a seed rate of 2250-2750 g ha^{-1}. Overall, about 47.5 and 44.0 per cent farmers used seed rate of 2250-2750 and 1500-1875 g ha^{-1}, respectively and approximately 8.5 per cent of the farmers employed a seed rate falling within the range of 3375-3625 g ha^{-1}. Observations revealed that farmers employing lower seed rates tended to opt for the dibbling method of sowing or practiced ridge sowing. The overwhelming majority of farmers, ranging from 95.7 to 100 per cent, did not engage in seed soaking before sowing (Table 2). While the practice of seed soaking contributes to proper seed germination, farmers reported encountering difficulties in sowing of soaked seeds. To avoid the development of resistance in bollworms to Bt-cotton, it is general recommendation by Punjab Agricultural University, Ludhiana that 20 per cent area should be sown under non-Bt cotton hybrids around Bt cotton with proper plant protection measures or 5% area of non-Bt hybrids can be sown around Bt-cotton and should be kept unsprayed (Anonymous, 2022). In the study area, it was observed that farmers generally

Table 1. Hybrid/variety wise area (ha) of cotton in Sri Muktsar Sahib District of Punjab

Cotton hybrid/variety	2018-19	2019-20	2020-21	Average
RCH-650 BG II	0.0	9.8	7.6	5.8 (3.0)†
RCH-653 BG II	1.2	0.0	6.6	2.6 (1.3)
RCH-776 BG II	53.6	47.4	62.2	37.1 (19.2)
RCH-773 BG II	104.0	76.0	88.0	89.3 (46.2)
SP-7172	32.4	9.8	4.6	15.6 (8.1)
SP-7272	0.0	6.6	1.4	2.7 (1.4)
US-71	4.0	6.8	10.8	7.2 (3.7)
MRC-6588	2.4	2.4	0.0	1.6 (0.8)
US-51	6.8	9.6	0.8	5.7 (2.8)
PAU Bt-1	0.6	0.0	0.0	0.2 (0.1)
Sim Sim	0.0	9.8	15.4	8.4 (4.3)
Total	205.0	178.2	197.4	193.5

†Figures in parenthesis are percentages

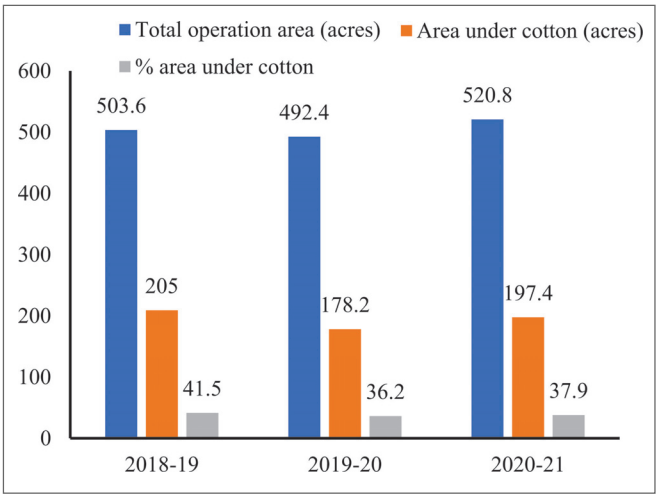

Figure 1. Total area under cotton cultivation in the study area

Table 2. Adoption of agronomic practices by the respondents of cotton cultivation in Sri Muktsar Sahib District of Punjab

Agronomic practices	Percentage of respondents			
	2018-19	2019-20	2020-21	Overall
Seed rate (g ha^{-1})				
1500-1875	51.4	49.2	30.8	44.0
2250-2750	40.0	44.6	58.5	47.5
3375-3625	8.6	6.6	10.8	8.5
Seed soaking before sowing				
Seed soaking	4.3	3.1	0	2.5
No soaking	95.7	96.9	100	97.5
Refuge plants				
Planted	35.7	15.4	18.5	23.5
Not planted	64.3	84.6	81.5	76.5
Number of KNO_3 sprays				
0	10.0	7.7	0.0	6.0
1 spray	2.9	0.0	3.1	2.0
2 sprays	34.3	0.0	26.2	20.5
3 sprays	30.0	21.5	43.1	26.5
4 sprays	22.9	33.8	27.7	28.0
>4 sprays	0.0	44.6	0.0	14.5
Irrigations (No.)				
3 irrigations	15.7	15.4	26.2	19.0
4	37.1	38.5	46.2	40.5
5	17.1	29.2	27.7	24.5
6	25.7	15.4	0.0	14.0
7	4.3	1.5	0.0	2.0
Weed management method				
Manual	78.6	80.0	78.5	79.0
Chemical	4.3	3.1	6.2	4.5
Manual + Chemical	17.1	16.9	15.4	16.5
Herbicides use pattern				
Pendimethalin 30 EC	8.6	4.6	16.9	10.0
Paraquat dichloride	5.7	7.7	4.6	6.0
Glyphosate acid	5.7	6.2	0.0	4.0
Pyrithiobac Sodium 10 EC	1.4	12.3	0.0	4.5
Propaquizafop 10 EC	0.0	0.0	0.0	0.0
Insecticide sprays (No.)				
1-2	0	0	12.3	4.0
3-4	22.9	55.4	81.5	52.2
5-6	52.9	44.6	6.2	35.0
7-8	20.0	0	0	7.0
>8	4.3	0	0	1.5

do not show interest in sowing of refuge plants as only ~35.7, 15.4 and 18.5 per cent farmers planted refuge plants during 2018-19, 2019-20 and 2020-21, respectively and overall, 23.5 per cent farmers used refuge seeds along with Bt cotton seeds (Table 2).

The optimum sowing time of cotton in the study area is 1st April to 15th of May. During 2018-19, 59.3 per cent farmers had sown cotton crop during the recommended sowing period (Figure 2). During 2019-20, over 80 per cent of the farmers adhered to the recommended sowing period for cultivating the crop. During the next year, farmers planted the crop in time, decreased to 62.7 per cent. On averaging the three year's data, it was observed that majority of farmers, approximately 67.8 per cent, planted the cotton crop during the recommended sowing period. Data on fertilizer application by cotton growers revealed that 80.0 per cent

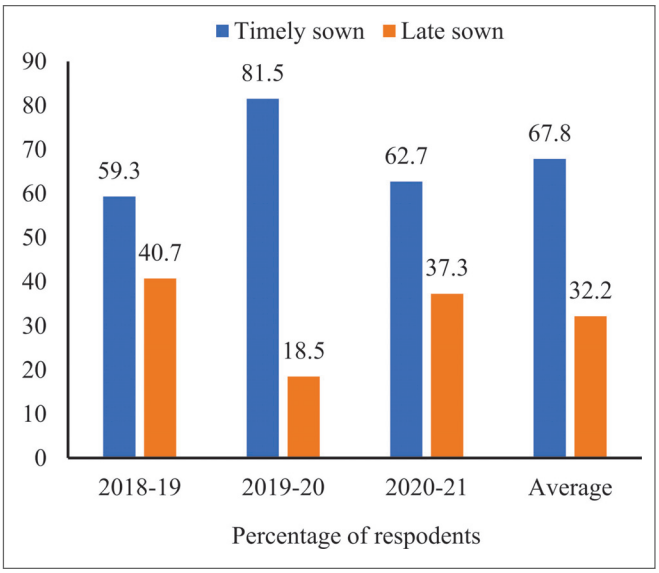

Figure 2. Sowing time of cotton in Sri Muktsar Sahib District of Punjab

farmers used more than recommended dose of N fertilizer (Figure 3). However, ~18.5 per cent farmers used recommended dose of N fertilizer. In case of P fertilizer, ~45.5 per cent farmers applied fertilizer as per recommendation and ~34 per cent farmers used less than recommended rate of fertilizer-P. The farmers who applied more than the recommended rate of P accounted for ~20.5 per cent of total farmers surveyed. Data on K use pattern showed the opposite trend as ~63.5 per cent farmers used less than recommended rate of fertilizer-K, while ~33.5 per cent farmers used the recommended rate of fertilizer-K. Proportion of those farmers is very less who used more than the recommended dose of fertilizer-K. To enhance the performance of cotton crop, four sprays of 2% KNO_3 at weekly interval starting at flower initiation is generally recommended. Data revealed that majority of farmers are aware about the importance of KNO_3spray in cotton crop as ~69 per cent farmers applied 3 or more sprays of KNO_3 (Table 2). About 22 per cent of total farmers applied 1-2 sprays of 2% solution of KNO_3 during flowering. Only 6.0 per cent of the farmers did not apply KNO_3.

The majority of farmers (~79.0%) opted for 4-6 irrigations for their cotton crops, while around 19.0 per cent applied 3 irrigations (Table 2). Besides, about 2% of farmers with light-textured soils found it necessary to apply 7 irrigations to their cotton crops. The farmers who applied only 3 irrigations were having heavy textured soils and frequent rainfall fulfilled the irrigation requirement of the crop. Amongst the weed control methods, a major group of farmers (~79.0%) adopted manual weed control methods in cotton, while ~16.5 per cent farmers used integrated weed control strategy using manual and chemical weed control methods (Table 2). Only ~4.5 per cent respondents relied on sole chemical control methods for weed management in cotton. Pendimethalin 30EC, Paraquat dichloride, Glyphosate acid, Pyrithiobac Sodium 10 EC and Propaquizafop 10 EC were the major herbicides used for weed management in the study area.

Cotton crop was mainly infested by sucking insect-pests (whitefly, jassid, thrips) during the study time in the study area.

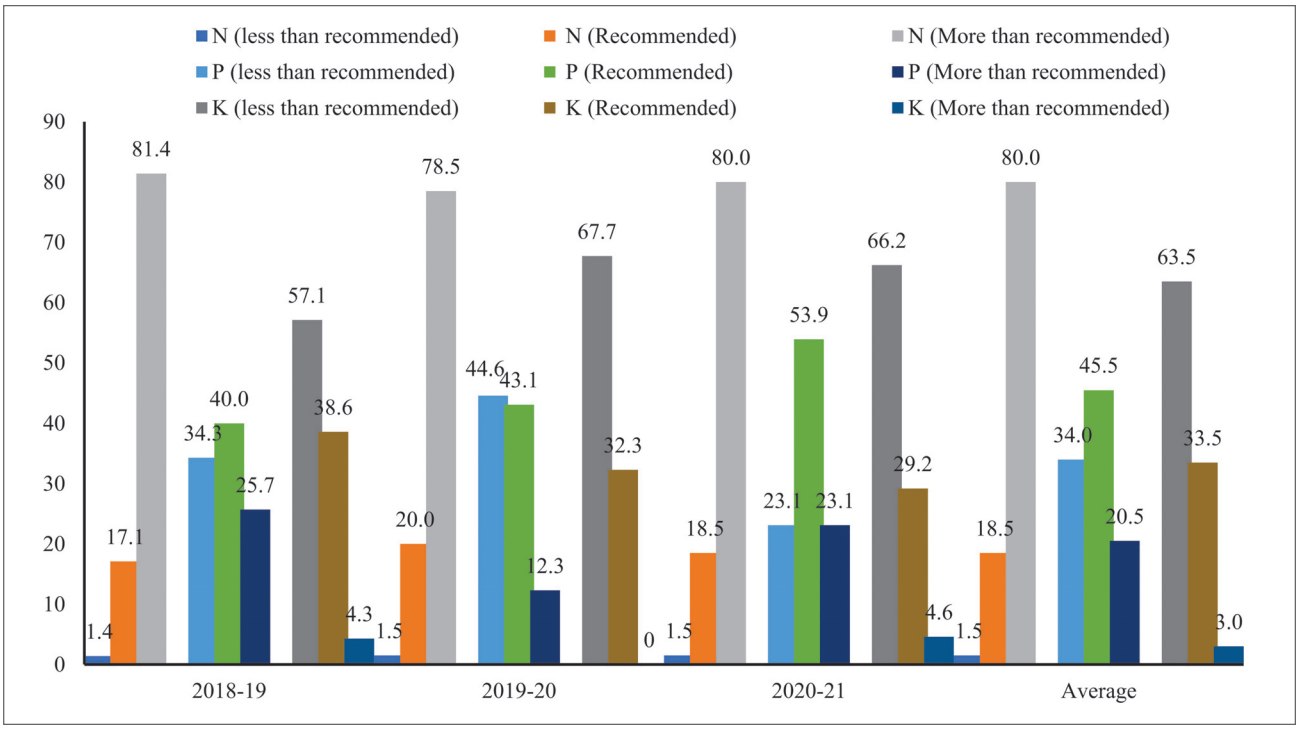

Figure 3. Fertilizer use pattern in cotton in Sri Muktsar Sahib District in south-western Punjab.

Table 3. Mean seed cotton yield of prominent *Bt*-cotton hybrids in the Sri Muktsar Sahib District of Punjab

Name of variety	Average yield (q ha^{-1})			
	2018-19	2019-20	2020-21	Average of 3 years
RCH-650 BG II	13.8	21.0	21.5	16.2
RCH-653 BG II	12.3	19.8	-	16.0
RCH-776 BG II	21.3	24.3	24.5	20.0
RCH-773 BG II	20.0	24.1	24.8	19.7
SP-7172	15.5	23.1	22.3	17.4
SP-7272	10.5	20.3	-	15.4
US-71	13.8	-	-	13.8
MRC-6588	17.0	23.8	24.5	18.8
US-51	16.3	-	-	16.3
PAU Bt-1	-	24.3	24.8	19.6
Sim Sim	-	-	19.3	13.5
Average	15.6	22.6	23.1	17.0

Farmers mainly used chemicals for insect pest management. The data revealed that during 2018-19, majority of respondent farmers (~52.9%) applied 5-6 sprays, while ~22.9 per cent farmers applied 3-4 sprays for insect pest management (Table 2). During the next year, more farmers applied 3-4 insecticide sprays (~55.4%) as compared to 5-6 sprays (~44.6%). During 2020-21, a large majority of farmers (~81.5%) applied 3-4 sprays. Overall, ~52.2 per cent used 3-4 sprays and ~35 per cent used 5-6 sprays for management of sucking pests. Very few farmers (~8.5%) had to use more than 6 sprays.

Productivity of seed cotton of different cotton hybrids during 2018-19 was lower (ranging from 10.5 to 21.3 q ha^{-1}) than their potential yield (Table 3). However, during next two years, seed cotton yield of cotton crop was in the range of 19.8-24.3 and 19.3-24.8 q ha^{-1}. Average yield of seed cotton varied from 13.5-20.0 q ha^{-1}. Mean seed cotton yield of cotton hybrids for the 2018-19, 2019-20 and 2020-21 was 15.6, 22.6 and 23.1 q ha^{-1}, respectively, with the average seed cotton yield of 17 q ha^{-1}. The highest yield of Bt-cotton was observed for RCH-773 (20 q ha^{-1}) followed by RCH-776 (19.7 q ha^{-1}).

DISCUSSION

Discussions with the respondent farmers uncovered that the factors contributing to the decline in the area under cotton crop during 2019-20, compared to 2018-19, included a lower yield in the previous year due to a high incidence of insect-pest attacks, low market prices, and a scarcity of canal water during sowing time. In contrast, the expansion of cotton cultivation area during 2020-21, compared to 2019-20, can be attributed to a rise in cotton yield in the preceding year, successful whitefly management, and the attainment of favourable market prices for cotton. Sharma et al., (2021) also reported the similar results regarding the reasons for fluctuation in area under cotton cultivation in the district. The area under any cotton hybrid/variety also depends on performance of specific cotton hybrid/variety in specific area during the previous years. Sharma et al., (2021) reported higher seed cotton yield of RCH 773 in Sri Muktsar Sahib district during the previous years which might be the reason for the highest area under this cotton hybrid during the study period. Regarding seed soaking and refuge planting also, our results corroborate the earlier findings of Sharma et al., (2021) who observed that large majority of farmers drilled seed without soaking prior to sowing and did not use refugia seed along with Bt-cotton seed. Reason for not using refuge seed was found to be the perception of farmers that refuge plants are poor

yielder and more susceptible to insect-pest infestation. Due to this reason, now a days, refuge-in-a-bag seeds are provided to farmers, which means that the refuge seeds are mixed in with the Bt seeds. This guarantees the compliance with the refuge rules. Generally, sowing time is decided by the availability of canal water in the study area. Delay in sowing might be due to non-availability of canal water during the study period. These results are in conformity with Sharma et al., (2021) who reported that more than 80 per cent of the farmers sow the Bt-cotton during the recommended sowing period. Farmers, in the study area, are using more than recommended rate of N fertilizer. Regarding P and K fertilizers in Bt cotton, farmers are, generally, advised to use fertilizers on need basis. Therefore, farmers need guidance regarding importance of balanced fertilizer use. Sharma et al., (2021) also reported the similar results regarding fertilizer use pattern. Over the years, farmers have realized the importance of KNO_3 spray in cotton crop in terms of yield improvement and economic returns (Singh et al., 2022b) which might be the reason that majority of farmers follows recommendations in this regard. The lower yield during the first year of study was attributed to a high incidence of insect-pest attacks.

CONCLUSION

The study revealed that area under cotton decreased from 2018-19 to 2019-20 due to high pest attack, low market price and shortage of canal water at sowing time. Contrarily, during 2020-21, there was an increase in cotton area which was due to effective management of whitefly, increased cotton yield and good market price of cotton during previous year. For some cotton cultivation practices such as selection of hybrids, sowing time, spray of KNO_3, irrigation application, weed management, etc., majority of farmers follow the practices recommended. However, for some practices, such as sowing of refuge seed, insect-pest management, nutrition management, especially N application, which is over used by majority of farmers, extension efforts must be strengthened for disseminating the recommended technology for efficient resource management among the cotton growers in the district.

REFERENCES

Ahmad, S., Abbas, Q., Abbas, G., Fatima, Z., Atique-ur-Rehman Naz, S., & Hasanuzzaman, M. (2017). Quantification of climate warming and crop management impacts on cotton phenology. *Plants*, *6*, 1-16.

Anonymous. (2022). Package of practices for *kharif* crops of Punjab, Punjab Agricultural University, Ludhiana.

Brar, H. S., & Singh, P. (2022). Pre-and post-sowing irrigation scheduling impacts on crop phenology and water productivity of cotton (*Gossypium hirsutum* L.) in sub-tropical north-western India. *Agricultural Water Management*, *27*, 107982.

Cetin, O., & Basbag, S. (2010). Effects of climatic factors on cotton production in semi-arid regions - A review. *Research on Crops*, *11*, 785-791.

Constable, G. A., & Bange, M. P. (2015). The yield potential of cotton (*Gossypium hirsutum* L.). *Field Crops Research, 182*, 98–106.

Saini, S. P., Manchanda, J. S., & Singh, P. (2010). Conjoint and separate application effect of coal fly ash and farm yard manure on cotton (*Gossypium hirsutum*) yield, plant nutrient concentration and soil properties. *Environment and Ecology, 28*(3B), 2011-2017.

Sharma, K., Dhaliwal, N. S., & Bishnoi, C. (2021). Adoption status of improved crop production practices in *Bt*-cotton in Sri Muktsar Sahib, Punjab. *Indian Journal of Extension Education, 57*(2), 63-68.

Singh, G., & Sharma, A. (2016). Analysis of constraints faced by *Bt*-cotton growers in Mansa district of Punjab. *Rajasthan Journal of Extension Education & Rural Development, 25*, 201-205.

Singh, G., Singh, P., & Sodhi, G. P. S. (2018). Farmers' perception towards pigeon pea cultivation as an alternate to *Bt* cotton in South-western Punjab. *Indian Journal of Extension Education, 54*, 171-179.

Singh, G., Singh, P., & Sodhi, G. P. S. (2021). Assessment and analysis of agricultural technology adoption in cotton (*Gossypium hirsutum* L.) cultivation in south-western Punjab. *Agricultural Research Journal*, *58*(2), 324-333.

Singh, G., Singh, P., Sodhi, G. P. S., Singh, R., & Singh, K. (2022b). Impact of cotton development programme on adoption of recommended Bt-cotton cultivation practices. *Indian Journal of Extension Education*, *58*(2), 149-152.

Singh, P., & Benbi, D. K. (2021). Physical and chemical stabilization of soil organic matter in cropland ecosystems under rice-wheat, maize-wheat and cotton-wheat cropping systems in north-western India. *Carbon Management*, *12*(6), 603-621.

Singh, P., Singh, G., & Sodhi, G. P. S. (2019). Applying DEA optimization approach for energy auditing in wheat cultivation under rice-wheat and cotton-wheat cropping systems in north-western India. *Energy*, *181*, 18-28.

Singh, P., Singh, G., & Sodhi, G. P. S. (2020a). Productivity, profitability and sustainability of rice-(capsicum + peas) and rice-wheat cropping systems in sub-tropical south-western Punjab. *Indian Journal of Extension Education*, *56*(1), 88-95.

Singh, P., Singh, G., & Sodhi, G. P. S. (2022a). Data Envelopment Analysis based optimization for improving net ecosystem carbon and energy budget in cotton (*Gossypium hirsutum* L.) cultivation: methods and a case study of north-western India. *Environment, Development and Sustainability*, *24*, 2079-2119.

Singh, S., Sharma, S., Nisar, S., & Choudhary, O. P. (2023). Structural stability and organic matter stabilization in soils: Differential impacts of soil salinity and sodicity. *Journal of Soil Science and Plant Nutrition*, *23*, 1751–1773.

Tariq, M., Yasmeen, A., Ahmad, S., Hussain, N., Afzal, M. N., & Hasanuzzaman, M. (2017). Shedding of fruiting structures in cotton: factors, compensation and prevention. *Tropical and Subtropical Agro-ecology, 20*, 251-262.

Yadav, S., Godara, A. K., & Nain, M. S. (2017). Attitude of farmers towards Bt cotton production technology in western Haryana. *Journal of Community Mobilization and Sustainable Development, 12*(2), 157-162.

Yadav, S., Godara, A. K., Nain, M. S., & Singh, R. (2018). Perceived constraints in production of Bt cotton by the growers in Haryana. *Journal of Community Mobilization and Sustainable Development*, *13*, 133-136.