CROP GEOMETRY'S IMPACT ON COTTON-BASED CROPPING SYSTEMS

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DOI:10.48047/ejmcm/v07/i03/622

Abstract

The experimental field featured a flat, gently sloping surface that was well-drained and composed of loamy sand. From a depth of 0 to 15 centimetres, the soil in the experimental field had a low organic carbon and accessible nitrogen content, a medium phosphorus content, a high potassium content, and a slightly alkaline response. The number of plants (per net plot) in 2019, 2019, and in the pooled study did not change considerably between DAS 20 and harvest. Plant height of cotton at 30 days after sowing (DAS) was not significantly affected by treatments during the experimental period or in the pooled result, but plant height at 60 DAS was significantly higher under the paired row cotton + 4 rows of green gramme (T8) treatment in 2019, 2019, and the pooled result, and was found to be comparable to the paired row cotton + 3 rows of groundnut (T4), paired row cotton + 4 rows of groundnut (T5), and paired row cotton.

Keywords: *Crop Geometry's, Cotton-Based, Cropping Systems.*

1. Introduction

Cotton, the king of fibre, is one of the most significant and vital cash crops in history, with far-reaching effects on the global economy and social fabric. When it comes to fibre quality, no other crop can compete with cotton. Cotton is so vital that it is sometimes referred to as "White Gold" because of its value. Millions of farmers and others involved in its trading, processing, manufacturing, and associated businesses rely on it for their living. Cotton, a member of the Malvaceae family, is a major cash crop. The textile sector in India relies heavily on cotton, hence the crop plays a significant part in the country's economy.[1]

As a versatile crop that provides lint, oil, seed meal, hulls, and linters, cotton is very valuable and widely grown by farmers across the globe. Despite competition from synthetic and mixed fibres, it continues to have a prominent role in the textile industry. The oil found in cotton seed is utilised in the production of both vegetable oil and soap. The cake that remains after oil is extracted is high in protein and may be fed to animals.[2-3]

Cotton yarn is one of India's most valuable exports, and the textile industry there accounts for around 11% of the country's entire industrial output, 14% of the manufacturing sector's output, 4% of the GDP, and 12% of the country's overall export profits.[4-5]

Because it is ultimately linked with root development, shoot growth, and fructifications, the optimal planting pattern allows the plant to make the most of growing conditions. The efficiency with which natural resources are used to boost cotton output is largely dependent on a farm's planting pattern, which is only one of several agronomic practises. There was an increase in yield compared to traditional planting thanks to paired row planting and skip row planting, and space was made available for growing intercrops without reducing the number of plants in the base crop. It has been documented that different row planting designs have been used to maximise the use of resources and the use of environmental factors such as sunlight, temperature, rainfall, humidity, etc. Crop yields have been increased via the adoption and refinement of new planting methods. found that pairing or skipping cotton rows had no influence on yield or fibre quality, and that changing cotton seeding spacing had the same result. Therefore, research into the optimal planting pattern is required to boost output per plant. Because of the unpredictable nature of the monsoon and the prevalence of pests and diseases, especially bollworms, the production of cotton cultivars with a longer lifespan than 180 days is now at greater risk. As a result, the intercropping technique is gaining favour as an alternative to monocropping, particularly in rainfed regions. Therefore, it is used primarily as a means of mitigating risk, with the added benefits of raising economic production per acre and preserving the health of the soil.[6-7]

2. Literature review

Daisy, M. and Rajendran, K. (2019)experimented with the best plant spacing and nitrogen levels to maximise the output of newly produced Bt cotton on sandy loam soil at the Punjab Agricultural University's Regional Research Station in Bhatinda, Punjab. They found no statistically significant variation in the total number of monopodial branches across the different cotton plant spacings. designed a field study using three Bt. strains (Bunny Bt., Ajit 155 Bt., and RCH-2 Bt.) and four different spacings (90 cm x 60 cm, 120 cm x 45 cm, 150 cm x 30 cm, and 180 cm x 30 cm). Compared to 150 cm x 30 cm and 180 cm x 30 cm, they discovered that tighter spacing of 90 cm x 60 cm and 120 cm x 45 cm resulted in a much larger number of sympodial branches per plant. Plant spacing was likewise shown to have no effect on the number of monopodial branches per plant.[8]

Buttar, G. S. and Singh, P. (2019) To determine the optimal spacing and fertiliser level for Bt and Non-Bt cotton during kharif 2008, 2009, and 2010 at the Regional Agricultural Research Station, Lam, Guntur (AP). The research found that broader spacing (120 cm × 60 cm) recorded considerably greater growth contributing characteristics than tighter spacing (90 cm x 45 cm) over the course of three years. Plant height, dry matter production, leaf area, days to 50% flowering, and number of monopodia were not affected by the planting pattern in a field experiment conducted during kharif 2007 and 2008 at College Farm, College of Agriculture, Rajendranagar, Hyderabad on sandy loam soils.[9]

Chandrasekaran, H. and Venkatesan, M. (2018) The influence of plant geometry and nutrient levels on Bt cotton yield was studied in an experiment done at Marathwada Krishi Vidyapeeth, Parbhani, during kharif 2009-2010. Plant height was found to be substantially greater with a spacing of 180 cm × 30 cm compared to 120 cm x 45 cm. Pakistan on loamy soil in 2006-2007 to examine the growth, production, and earliness response of cotton to row spacing and nitrogen management found that the plant geometry 90 cm x 60 cm recorded a considerably larger number of sympodias/plant. Cotton plants with a 60 cm row spacing grew much taller than those with 75 cm and 90 cm between rows in both years.[10]

Donald, C. M. and Hamblin, J. (2018) The response of Bt cotton to high density planting and nitrogen levels by fertigation was investigated in a field experiment conducted on calcareous soil at the College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) from 2016–2017 to 2018–2019. When comparing data from different years, they found that 30-60-30 cm x 30 cm paired row spacing produced considerably higher plant heights for Bt cotton. Bt cotton with a larger spacing of 120 cm x 45 cm (S4) was shown to have the highest number of sympodial branches per plant in all three growing seasons combined.[11]

Gadade, G. D. and Rao, M. R. K. (2017) To determine the most profitable Bt cotton based intercropping method for use in rainfed settings, a three-year field experiment was carried out at the Cotton Research Station in Nanded during the kharif seasons of 2007-2008, 2008-2009, and 2009-2010. In both regular and paired row plantings, they found that solo Bt cotton produced the heaviest bolls and the largest yields per plant. The solitary cotton in regular planting treatment consistently produced the highest seed cotton yield across all years and in the pooled analysis. All types of intercropping resulted in a reduced seed cotton yield compared to pure cotton.[12]

ISSN 2515-8260 Volume 07, Issue 03, 2020

3. Methodology

During the Kharif seasons of 2019 and 2020, the Department of Agronomy at Anand Agricultural University, Anand, India ran an experiment named "Effect of crop geometry in cotton based cropping system" on the college agronomy farm. Information on what was tried and how, along with the methods and tools used, in this study.

3.1 Experimental site

The current study was undertaken at the Agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand, India, during the kharif seasons of 2019 and 2020 in plots 32-A and 24-C, respectively, to accomplish the aforementioned goals.

3.2 Varietal description

3.2.1 Cotton

The test crop utilized in this study is the cotton variety GTHH 49 (BG II), which was introduced in 2014 by the Agricultural Research Station in Talod, SDAU. GTHH 49 (BGII) is recommended for commercial cultivation under irrigated conditions throughout the state of Gujarat due to its high seed cotton yield, lint yield, ginning outturn, bolls per plant, oil content, and calculated oil yield, as well as its resistance to sucking pests like jassids and thrips.

3.2.2 Groundnut

Types of Groundnuts In the current study, cotton was grown along rows of Gujarat Groundnut 34 (GG 34). The variety GG 34 was chosen for this study since it was released in 2018 by the Regional Research Station at the Anand Agricultural University in Anand (Gujarat), making it well suited to the state of Gujarat's unique climate and growing conditions.

3.3 Experimental details

Research into the "Effect of crop geometry in cotton-based cropping system" included the following experimental methods, which are explained in full below.:

3.4 Treatment details

In the current experiment, 32 plots were divided into 8 treatments, such as traditional cotton planting, paired row planting, and intercropping groundnut and green gramme between two rows of cotton.

Treatment	**Treatmentdetails**
T_1	Conventionalplantingof cotton(120cm×45cm)
T_2	Pairedrowplantingof cotton (60-180-60cm× 45 cm)
T_3	Paired rowcotton+ 2 rowsof groundnut
T_4	Paired rowcotton+ 3 rowsof groundnut
T_5	Paired rowcotton+ 4 rowsof groundnut
T_6	Pairedrowcotton+ 2rowsof green gram
T_7	Pairedrowcotton+ 3rowsof green gram
T_8	Pairedrow cotton+ 4rowsof greengram

3.5 Statistical analysis

The statistical study of cotton crop data followed the randomized block design approach outlined by Cocharan and Cox (1967). SASS statistical software at the library of Anand Agricultural University's Department of Agricultural Statistics. At the 5% level of significance, we produced "F" values and compared them to the "F" values in the table. Coefficient of variation (CV%) and standard error of the mean (SEm) value were also determined..

4. Results

4.1Effect of treatments on yield attributes and yield

Table 4.1 displays information on the amount of harvested bolls per plant and how it was affected by the various treatments.

Due to differences in crop geometry between years and in the pooled mean, the data on the number of plucked bolls/plant in Bt cotton was very variable. In both years, the crop geometry 120 cm × 45 cm (Conventional planting) yielded the highest number of plucked bolls per plant (43.35 and 44.68). Whereas the pooled mean of plucked balls per plant with traditional planting was much higher (44.02). Meanwhile, in 2019, there was no statistically significant difference between treatments T2 [Paired row planting of cotton (60-180-60 cm x

45 cm)], T3 (Paired row cotton + 2 rows of groundnut), T4 (Paired row cotton + 3 rows of groundnut), T6 (Paired row cotton + 2 rows of green gramme), and T7 (Paired row cotton + 3 rows of green gramme). In 2020, T2 and T6 treatments were found to be equivalent to traditional planting. Under T8 (Paired row cotton + 4 rows of green gramme), the annual and combined minimum number of bolls harvested per plant was 35.04, 36.37, and 35.70.

Table 4.1: Variation in boll harvest rates between treatments

Treatment		**Numberof plucked bolls/plant**		
		2019	**2020**	**Pooled**
T_1:Conventional plantingofcotton(120cm ×45cm)		43.35	44.68	44.02
T_2:Paired rowplantingofcotton (60-180-60cm×45cm)		40.03	40.78	40.41
T_3:Pairedrowcotton +2rows of groundnut		39.98	39.84	39.91
T_4:Pairedrowcotton +3rows of groundnut		38.68	38.48	38.58
T_5:Pairedrowcotton +4rows of groundnut		35.60	36.97	36.28
T_6:Pairedrowcotton+2rowsof greengram		39.33	40.09	39.71
T_7:Pairedrowcotton+3rowsof greengram		40.24	38.20	39.22
T_8:Pairedrowcotton+4rowsof greengram		35.04	36.37	35.70
SEm±	Y			0.58
	T	1.68	1.60	1.09
	Y×T			1.64
CD(P=0.05)	Y			NS
	T	4.93	4.72	3.12
	Y×T			NS
CV%		8.60	8.14	8.37

Table 4.2 displays the effect of different treatments on average boll weight (g), which shows that there was no statistically significant difference between years or between pooled results, but that the average boll weight (g) of cotton was numerically higher under conventional planting of cotton (120 cm x 45 cm) in both 2019 and 2020.

Table 4.2: The effects of various treatments on cotton's average boll weight

Treatment		Averageboll weight (g)		
		2019	**2020**	**Pooled**
T_1:Conventional plantingofcotton(120cm ×45cm)		3.96	3.92	3.94
T_2:Pairedrowplantingofcotton (60-180-60cm×45 cm)		3.90	3.92	3.91
T_3:Pairedrowcotton+2rowsof groundnut		3.90	3.92	3.91
T_4:Pairedrowcotton+3rowsof groundnut		3.82	3.91	3.86
T_5:Pairedrowcotton+4rowsof groundnut		3.75	3.81	3.78
T_6:Pairedrowcotton+2rowsof greengram		3.82	3.82	3.82
T_7:Pairedrowcotton+3rowsof greengram		3.85	3.71	3.78
T_8:Pairedrowcotton+4rowsof greengram		3.81	3.82	3.81
SEm±	Y			0.04
	T	0.11	0.12	0.08
	Y×T			0.12
CD(P=0.05)	Y			NS
	T	NS	NS	NS
	Y×T			NS
CV%		5.79	6.25	6.02

4.2 Effect of treatments on quality parameters

Table 4.3 shows that there was no statistically significant difference in ginning % of cotton crop between the two years and the pooled mean as a result of treatment differences in crop geometry (either planting pattern or intercropping scheme). This is because Bt cotton hybrids are genetically uniform, hence little variation in ginning rates was seen.

Table 4.3: The effect of various treatments on the cotton ginning %

Treatment	Ginningpercentage (%)		
	2019	**2020**	**Pooled**
T_1:Conventional plantingofcotton(120cm ×45cm)	37.05	37.31	37.18

T_2:Paired rowplantingofcotton (60-180-60cm×45cm)		36.52	36.95	36.74
T_3:Pairedrowcotton+2rowsof groundnut		37.07	36.66	36.87
T_4:Pairedrowcotton+3rowsof groundnut		37.74	37.50	37.62
T_5:Pairedrowcotton+4rowsof groundnut		36.87	37.84	37.36
T_6:Pairedrowcotton+2rowsof greengram		38.33	37.76	38.04
T_7:Pairedrowcotton+3rowsof greengram		34.60	36.65	35.63
T_8:Pairedrowcotton+4rowsof greengram		34.09	36.62	35.36
SEm±	Y			0.47
	T	1.54	1.04	0.89
	Y×T			1.32
CD(P=0.05)	Y			NS
	T	NS	NS	NS
	Y×T			NS
CV%		8.45	5.60	7.15

Table 4.4 displays information about the oil content (%) of Bt cotton and how it was affected by different treatments. The data show that the oil content (%) of cotton seed did not significantly vary across the years or in the pooled mean, regardless of the planting pattern or intercropping system used. The genetic feature responsible for oil production in oil seeds is relatively stable throughout time.

Table 4.4: The effect of processing on cottonseed oil content

Treatments	**Oilcontent(%)**		
	2019	**2020**	**Pooled**
T_1:Conventional plantingofcotton(120cm ×45cm)	17.59	17.93	17.76
T_2:Paired rowplantingofcotton (60-180-60cm×45cm)	17.34	17.66	17.67
T_3:Pairedrowcotton +2rows of groundnut	17.51	17.49	17.50
T_4:Pairedrowcotton +3rows of groundnut	17.47	17.63	17.55
T_5:Pairedrowcotton +4rows of groundnut	17.82	17.66	17.74

T_6:Pairedrowcotton+2rowsof greengram		17.63	17.54	17.58
T_7:Pairedrowcotton+3rowsof greengram		16.72	17.58	17.15
T_8:Pairedrowcotton+4rowsof greengram		17.93	17.44	17.69
SEm±	Y			0.28
	T	0.86	0.71	0.52
	Y×T			0.79
CD(P=0.05)	Y			NS
	T	NS	NS	NS
	Y×T			NS
CV%		9.82	8.05	8.98

4.3 Effect of treatments on performance of intercrop

Table 4.5 displays the average pod yield and haulm production of groundnut (kg/ha) across all treatments in the 2019 and 2020 growing seasons, as well as in the pooled findings.

Growing groundnut as an intercrop between two, three, or four rows of Bt cotton resulted in significantly different pod yields and haulm yields. According to Table 4.26, treatment T4 (Paired row cotton + 3 rows of groundnut) had the highest yields of all the treatments in both 2019 and 2020, with a total of 1173, 1417, and 1295 kg/ha. Treatment T3 (Paired row cotton + 2 rows of groundnut) recorded the lowest pod yield of 876, 838, and 857 kg/ha in 2019, 2020, and pooled data, respectively. Treatment T5 (four rows of groundnut intercropped between paired cotton) came in second.

Table 4.5: Groundnut pod and haulm yield in response to various treatments

Treatments	**Podyield(kg/ha)**			**Haulm yield(kg/ ha)**		
	2019	**2020**	**mean**	**2019**	**2020**	**Mean**
T_3:Pairedrowcotton+ 2rows of groundnut	876	838	857	1798	1920	1859
T_4:Pairedrowcotton+ 3rows of groundnut	1173	1417	1295	2358	2468	2413
T_5:Pairedrowcotton+ 4rows of groundnut	1011	957	984	2511	2565	2538

Table 4.6 displays the effects of various treatments on the seed and stover production of green gramme (kg/ha) in 2019, 2020, and as an average value.

Green gramme seed and stover yields clearly vary when intercropped with cotton in varying row ratios between paired rows. According to the data in Table 4.7, the best seed yield was achieved with the T7 treatment (Paired row cotton + 3 rows of green gramme) in 2019, 2020, and on average, while the worst pod yield was achieved with the T8 treatment (Paired row cotton + 4 rows of green gramme).

Table 4.6: Green gramme seed and stover production in response to various treatments

Treatments	Seedyield (kg/ha)			Stoveryield (kg/ha)		
	2019	2020	mean	2019	2020	Mean
T_6:Pairedrowcotton+2rowsof greengram	558	738	648	976	1152	1064
T_7:Pairedrowcotton+3rows of greengram	702	956	829	1118	1428	1273
T_8:Pairedrowcotton+ 4rows of greengram	538	712	625	1138	1454	1296

5. Conclusion

In-field measurements revealed that conventional cotton planting led to the most robust crop development and best yield (120 cm x 45 cm). Intercropping did affect cotton's growth and productivity, although the results for paired row cotton were almost equal. In terms of compatibility, cotton and groundnuts or green grams planted in rows of two or three are ideal. Planting Bt cotton in paired rows at 60–180 cm 45 cm spacing and intercropping it with groundnut or green gramme at 45 cm 10 cm spacing has been shown to enhance yield, net realization, and BCR throughout the kharif season in two years' worth of field tests.

6. References

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