Research Article
The J. Res. PJTSAU 51(3&4) 10-22, 2023

IN-SITU MOISTURE CONSERVATION AND NUTRIENT MANAGEMENT STRATEGIES ON GROWTH AND YIELD OF RAINFED COTTON IN SEMI ARID REGIONS

E. ANUSHA[1], G. PRATIBHA[2] , M. MADHAVI[1], K. SRINIVAS[2], B.M.K. RAJU[2], I. SRINIVAS[2], K.V. RAO[2], V.K. SINGH[2] and K. BHANU REKHA[1]

[1]Department of Agronomy, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad
[2]ICAR-Central Research Intitute for Dryland Agriculture, Hyderabad

Date of Receipt: 20-11-2023 Date of Acceptance: 18-12-2023

ABSTRACT

A Field study entitled "Influence of resource conservation technologies on cotton productivity, profitability and environment in rainfed *Alfisols* of Semi-Arid Tropics (SAT)" was conducted at CRIDA, Hyderabad, during rainy season, 2021-222 and 2022-23. Experiment was laid out in a split-plot design with five *in-situ* moisture conservation *viz*., M_1: Flat bed sowing with CRIDA 6 row planter, M_2: Flat bed with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA ridge planter, M_4: Raised bed and furrow with CRIDA raised bed planter and M_5: Conservation furrow at 30 - 40 DAS after interculture operations as main plots and nutrient management practices as sub plots *viz*., S_1: control (No fertilizer), S_2: 100% recommended dose of NPK (120:60:60) and S_3: 125% recommended dose of NPK (150:75:75) allocated randomly and replicated thrice. The *in-situ* moisture conservation method, raised bed (M_4) recorded higher lint yield (506 kg ha^{-1}) and seed cotton yield (1427 kg ha^{-1}) and was followed by conservation furrow at sowing (M_3), conservation furrow at 30-45 DAS (M_5), flat bed with dhaincha as live mulch (M_2) and flat bed (M_1). These higher yields were due to higher plant height (100.8 cm), monopodial branches plant^{-1} (3.1), sympodial branches plant^{-1} (16.0), dry matter production (3567 kg ha^{-1}). Among the nutrient management practice 125 % recommended dose of NPK (150:75:75) recorded performed higher plant height (108.2 cm), monopodial branches plant^{-1} (3.2), sympodial branches plant^{-1}(16.1), dry matter production (3812 kg ha^{-1}), lint yield (495 kg ha^{-1}) and seed cotton yield (1412 kg ha^{-1}) and was followed by 100 % recommended dose of NPK (120:60:60) and control treatment. So, it is concluded that raising of cotton on raised bed along with application of 125 % RDF of NPK (150:75:75) realized higher lint and seed cotton yield (621 and 1717 kg ha^{-1}).

KEYWORDS: Moisture, nutrient, growth, ridge and furrow, yield, conservation furrow and mulch

Cotton (*Gossypium hirsutum* L.) is an essential cash crop that is known as the 'King of Fibre' and plays a major role in the farmers' as well as country's economy. It is also known as 'White gold'. The cotton crop, contributes significantly to India's foreign exchange, employment and has significant export potential for raw cotton and value-added goods. This crop provides a source of income for 60 million people in India through cultivation, processing and textiles. It contributes to 29 % of the national gross domestic product. In India it is grown in an area of 13.28 M ha with a production of 35.24 M bales, and productivity of 491 kg ha^{-1}. In India, during 2020-21 higher area (4.54 M ha) and production (10.1 M bales) were recorded in Maharashtra. But higher productivity was recorded from Punjab (690 kg ha^{-1}). Telangana ranked second in area (2.35 M ha) with a production of 5.7 M bales and a productivity of 418 kg ha^{-1} (CCI, 2021).

Cotton productivity in rainfed areas is very low compared to the potential productivity due to drought, erratic rainfall, and moisture stress during the crop growth and degraded soils. Cotton, being a long duration crop, suffers from moisture stress during flowering and boll formation which adversely affects the crop growth and yield. Hence measures are needed to conserve the soil moisture and improve the crop productivity. In this background rainwater conservation *in-situ* / *ex-situ* is a critical factor for higher yield and rain water use efficiency in drylands. In-situ moisture conservation is an important method to conserve soil moisture and improve the crop productivity.

Water and nutrients exhibit strong synergistic interaction for their effect in crop growth and yield. But the rainwater uses without balanced nutrient application is ineffective. Cotton requires adequate supply of moisture and nutrients to optimize the seed cotton yield, quality and net profit (Aladakatti *et al.,* 2011). Nutrients are main factors limiting crop production besides moisture. However, imbalanced fertilizer application due to moisture stress is very

Email: anushaetikala12@gmail.com

common in rainfed regions. Nutrient-use efficiency in rainfed cropping systems is often very low due to moisture stress that limits the availability of nutrients. Hence nutrient utilization can be improved by optimum and synergistic interaction with other inputs. Hence nutrient and moisture availability should be addressed simultaneously to enhance both water and nutrient use efficiency.

MATERIAL AND METHODS

Field experiment was conducted at Gunegal Research Farm, ICAR-Central Research Institute for Dryland Agriculture (ICAR-CRIDA), Hyderabad, Telangana State during 2021-2022 and 2022-2023 rainy season. The geographical location of the farm is 17.08°N latitude and 78.66°E longitude and 542 m above mean sea level. Average seasonal (June-December) rainfall during the experimental period was 858.5 mm and 833.5 in 2021-22 and 883.5 in 2022-2023. Average annual maximum and minimum temperature during experimental period was 29.93°C and 20.25°C, respectively. The soil of the experimental site is Alfisol with sandy clay loam texture. The experimental site is low in N (195.4 kg ha^{-1}), medium OC (0.6 %), P (18.3 kg ha^{-1}) & K (200.6 kg ha^{-1}). The crop was sown during 29th June of 2021-2022 and 2022-2023 years, respectively. The experiment was laid out in split-plot design with 5 *in-situ* moisture conservation as main plots include M_1: Flat bed sowing with CRIDA 6 row planter, M_2: Flat bed with dhaincha as live mulch, the dhaincha crop was sown in between the crop rows at 45 DAS the crop was harvested with brush cutter and spread between the rows as mulch. M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter and M_5: Conservation furrow at 30 - 40 DAS, after first interculture operation the furrows were formed with bullock drawn implement at 45 DAS and sub plot treatments 3 nutrient management practices, as subplot were S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75) replicated thrice. *In-situ* moisture conservation treatments were assigned to the main plots (120 m^2) which were split randomly into three sub plots (15 m^2). A buffer strip of 3 m was maintained between the main plots. The observations on crop growth, yield attributes of the cotton were recorded at physiological maturity stage of crop growth. Five plants were selected randomly and labelled in the net plot and all the biometric observations were recorded during different crop growth stages. The lint yield was estimated from the net plot after excluding the border rows *i.e*., two rows on either side (gross plot size = 12.72 m^2). Data were analyzed statistically by analysis of variance method for split plot design using proc glm of SAS software version 9.2. Tukey's studentized range test (HSD) was employed to offer corrections to P-values while doing multiple comparisons. P value less than 0.05 has been used as the criteria for rejecting the null hypothesis of equality of means for main plot treatments, subplot treatments and interaction between main plot and subplot treatments separately.

RESULTS AND DISCUSSION

Effect of *in-situ* moisture conservation and nutrient management practices on crop growth

Growth parameters progressively increased with the ontogeny of the crop up to harvest irrespective of the treatments. Different moisture conservation treatments had significant effect on crop growth at all crop growth stages.

Plant height is a crucial growth factor. It illustrates the plant's vitality. Plant genetical character, management factors and environmental conditions play a significant role in determining plant height. Irrespective of the treatments, plant height increased with the increase in age of the crop. Among *in-situ* moisture conservation practices raised bed significantly recorded higher plant height (100.8 cm) which is on par with conservation furrow at sowing (99.0 cm) and lowest was recorded in flat bed method (89.8 cm). Raised bed recorded higher plant height (1.81 %, 5.33 %, 9.22 % and 12.29) over conservation furrow at sowing treatment, conservation furrow at 30-45 DAS, flat bed +live mulch and flat bed method without moisture conservation The increase in plant height might be ascribed to the increased availability of nutrients due to moisture supply and restricted weed growth. These results are in conformity with findings of Kumari *et al*. (2019). Among nutrient management practices 125 % RDF recorded higher plant height (108.2 cm) followed by 100 % RDF (102.1 cm). The lowest was recorded in control treatment (76.3 cm). 125 % RDF recorded 6 % and 41.83 % more plant height over 100 % RDF and control treatment, respectively. Lower plant height is because

of lower nutrient availability and soil moisture conditions. These findings are in agreement with Kumari *et al.,* (2019), Vani *et al.,* (2020) and Siddu and Aladakatti (2021).

Raised bed with 125 % RDF recorded higher plant height (113.1 cm) which was on par with conservation furrow at sowing with 125 % RDF (111.6 cm) and was followed by conservation furrow at 30-45 DAS with 125 % RDF (109.4 cm), raised bed with 100% RDF (107.3 cm), conservation furrow at sowing with 100 % RDF (105.0 cm), flat bed with dhaincha as live mulch with 125 % RDF (104.3 cm), conservation furrow at 30-45 DAS with 100 % RDF (102.9 cm) and flat bed with 125 % RDF (102.9 cm). Lowest plant height (70.0 cm) was recorded with flat bed without moisture conservation with control.

Number of monopodial branches increased with advancement in crop age. Data pertaining to number of monopodial branches plant^{-1} are influenced with *in-situ* moisture conservation and nutrient management practices. Raised bed recorded higher number of monopodial branches plant^{-1} (3.09) due to better soil moisture availability and absorption of more moisture and nutrients this resulted in vigorous plant growth and higher number of monopodial branches. Conservation furrow at sowing (2.84) was on par with conservation furrow at 30-45 DAS (2.74). Lowest (2.41) was recorded in flat bed without moisture conservation. These results are in conformity with findings of Pendke *et al.,* (2001) and Hulihalli and Patil (2004). Among nutrient management practices 125 % RDF recorded higher monopodial branches plant^{-1} (3.15) and the lower monopodial branches (2.1) was recorded in control. Similar findings were reported by Vora *et al.,* (2016), Muthukrishnan *et al.,* (2017) and Vani *et al.,* (2020).

Raised bed with 125 % RDF recorded higher number of monopodial branches plant^{-1} (3.5) which was on par with raised bed with 100% RDF (3.4) and conservation furrow at sowing with 125 % RDF (3.3) and was followed by conservation furrow at 30-45 DAS with 125 % RDF (3.1), conservation furrow at sowing with 100% RDF (3.1), flat bed with dhaincha as live mulch with 125 % RDF (3.0), conservation furrow at 30-45 DAS with 100 % RDF (3.0), flat bed with 125% RDF (2.8), flat bed with dhaincha as live mulch with 100 % RDF (2.7), flat bed with 100 % RDF (2.6) and raised bed with control (2.4) they were significantly on par with each other. Lower number of monopodial branches plant^{-1} (1.8) was recorded with flat bed without moisture conservation with control.

In-situ moisture conservation showed significant effect on sympodial branches plant^{-1}. Raised bed recorded higher number of sympodial branches plant^{-1} (16.00). This was due to availability of adequate moisture, nutrients and light deciding growth and development reflected in higher number of sympodial branches and lowest (11.91) was recorded in flat bed without moisture conservation. Among nutrient management practices 125 % RDF recorded higher sympodial branches plant^{-1} (16.13) and was followed by 100 % RDF (14.75) and control treatment (11.12). This difference in number of sympodial branches plant^{-1} can be attributed to genetic makeup and environmental changes, which reduced the number of nodes resulting in reduction in number of sympodial branches plant^{-1}. Similar findings were reported by Singh *et al*., (2018) and Sankaranarayanan *et al.,* (2021).

Interaction of sympodial branches plant^{-1} was significantly influenced by *in-situ* moisture conservation and nutrient management practices. Raised bed with 125% recorded higher number of sympodial branches plant^{-1} (18.6) and was superior over rest of the treatments. Conservation furrow at sowing with 125 % RDF (17.1) and raised bed with 100 % RDF (16.8) were on par with each other. This was due to sufficient amount of moisture with nutrient availability to the crop. This leads to the higher productivity of crop and the lesser number of sympodial branches plant^{-1} (9.0) was recorded with flat bed without moisture conservation with control.

Dry matter production (kg ha^{-1})

The crop yield is function of source and sink relationship. Raised bed recorded higher dry matter production (3567 kg ha^{-1}) compared with other treatments. Lower dry matter production (2834 kg ha^{-1}) was recorded in flat bed without moisture conservation and was on par with flat bed with dhaincha as live mulch (2978 kg ha^{-1}). Raised bed method recorded higher dry matter production of 7.85%, 13.76%, 19.80% and 25.86 % over conservation furrow at sowing, conservation furrow at 30-45 DAS, flat bed +live mulch and flat bed without

moisture conservation, respectively. This might be due to soil moisture conservation techniques that facilitate prolonged availability of moisture as compared to flat bed without moisture conservation. These results are in conformity with Dangore *et al.,* (2001) and Ambika *et al.,* (2019).

Nutrient management practices also significantly influenced the dry matter production. 125 % RDF (S_3) recorded higher dry matter production (3812 kg ha^{-1}) and was on par with 100 % RDF (3697 kg ha^{-1}). This might be attributed to higher and more consistent nutrient availability which would have led to an increase in the number and area of leaves, which in turn would have improved photosynthetic activity and eventually led to the generation of biomass. These results are in conformity with those of Maurya *et al.,* (2009). Lowest dry matter production (1988 kg ha^{-1}) was observed in control.

Raised bed with 125 % RDF recorded highest dry matter production (4230 kg ha^{-1}) and was followed by raised bed with 100 % RDF (4113 kg ha^{-1}), conservation furrow at sowing with 125 % RDF (3976 kg ha^{-1}), conservation furrow at sowing with 100 % RDF (3847 kg ha^{-1}), conservation furrow at 30-45 DAS with 125 % RDF (3751 kg ha^{-1}), conservation furrow at 30-45 DAS with 100 % RDF (3662 kg ha^{-1}), flat bed with dhaincha as live mulch with 125 % RDF (3628 kg ha^{-1}), flat bed with dhaincha as live mulch with 100 % RDF (3503 kg ha^{-1}), flat bed with 125 % RDF (3476 kg ha^{-1}) and flat bed with 100 % RDF (3359 kg ha^{-1}) and inturn were on par with each other. The lowest dry matter production (1668 kg ha^{-1}) was recorded in flat bed without moisture conservation with control which is on par with flat bed with dhaincha as live mulch with control (1802 kg ha^{-1}).

Effect of *in-situ* moisture conservation and nutrient management practices on yield

Lint yield (kg ha^{-1}) and seed cotton yield (kg ha^{-1}) was significantly influenced by *in-situ* moisture conservation and nutrient management practices. The higher yields were due to improved yield components *i.e.,* number of squares, number of bolls $plant^{-1}$, mean boll weight and seed cotton yield $plant^{-1}$.

Lint yield (506 kg ha^{-1}) and seed cotton yield (1427 kg ha^{-1}) were significantly higher in raised bed. It might be due to increased availability of nutrients, moisture supply, better root penetration, better drainage, less soil compaction and restricted weed growth compared to conventional methods. *In-situ moisture* conservation in the soil profile reservoir plays an important role in conservation of maximum possible rain water in the soil and there by the availability of more moisture for longer time improved the yield of cotton. These results are in conformity with findings of Pendke *et al.,* (2001), Hulihalli and Patil (2004), Arora and Bhatt (2012). Significantly lower lint yield (282 kg ha^{-1}) and seed cotton yield (506 kg ha^{-1}) was recorded with flat bed without moisture conservation this was probably due to restricted water and air movement due to poor soil physical properties results in lower yield. Similar results were reported by Ambika *et al*., (2019) and Vinay *et al.,* (2022)

Nutrients at different levels significantly influenced the yield. Among nutrient management practices 125 % RDF recorded higher lint yield (495 kg ha^{-1}) and seed cotton yield (1412 kg ha^{-1}). This was due to the favorable effect of improved soil moisture and supply of nutrients throughout the crop growth period. The lowest lint yield (239 kg ha^{-1}) and seed cotton yield (733 kg ha^{-1}) was recorded in control. No fertilizer application and without moisture leads to nutrient imbalance and decreased the lint and seed cotton yield. Similar results were reported by Reddy *et al*., (2017) and Ali and Ahmad, (2021).

Raised bed with 125 % RDF recorded higher lint yield (621 kg ha^{-1}) and was superior over rest of the treatments. Raised bed with 100 % RDF (583 kg ha^{-1}) followed by conservation furrow at sowing with 125 % RDF (573 kg ha^{-1}), conservation furrow at sowing with 100 % RDF (543 kg ha^{-1}) they were significantly on par with each other. The lowest lint yield (171 kg ha^{-1}) was recorded in flat bed without moisture conservation with control which is on par with flat bed with dhaincha as live mulch with control (201 kg ha^{-1}). Raised bed with 125 % RDF recorded 7.72 %, 19.80 %, 30.27% and 43.96 % higher lint yield over conservation furrow at sowing with 125 % RDF, conservation furrow at 30-45 DAS with 125 % RDF, flat bed with dhaincha as live mulch with 125 % RDF and flat bed with 125 % RDF, respectively.

Highest seed cotton yield (1717 kg ha^{-1}) was recorded with raised bed with 125 % RDF and was on par with raised bed with 100 % RDF (1645 kg ha^{-1}) followed by conservation furrow at sowing with 125 % RDF (1601 kg ha^{-1}), conservation furrow at

Table 1. Plant height, number of monopodial branches, number of sympodial branches and dry matter production of cotton at harvest as influenced by *in-situ* moisture conservation methods and nutrient management practices

Treatments	Plant height (cm)			Monopodial branches plant^{-1}			Sympodial branches plant^{-1}			Dry matter production (kg ha^{-1})		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Main plot												
M1	91.1	88.5	89.8	2.5	2.3	2.4	12.0	11.8	11.9	2912	2757	2834
M2	93.3	91.3	92.3	2.7	2.5	2.6	13.2	12.9	13.0	3028	2928	2978
M3	99.8	98.3	99.0	2.9	2.8	2.8	15.0	14.8	14.9	3361	3255	3308
M4	101.6	100.0	100.8	3.2	3.0	3.1	16.2	15.8	16.0	3612	3522	3567
M5	96.3	95.1	95.7	2.8	2.7	2.7	14.3	13.9	14.1	3210	3073	3141
SE(m)±	1.09	0.26	0.57	0.06	0.04	0.04	0.13	0.14	0.11	59.35	72.42	46.36
CD (p=0.05)	3.56	0.83	1.87	0.20	0.14	0.14	0.43	0.44	0.35	193.52	236.14	151.22
Sub plot:												
S1	77.2	75.4	76.3	2.2	2.0	2.1	11.3	11.0	11.1	2014	1963	1988
S2	102.9	101.3	102.1	3.0	2.9	3.0	14.9	14.6	14.8	3791	3602	3697
S3	109.2	107.2	108.2	3.2	3.1	3.2	16.3	16.0	16.1	3869	3755	3812
SE(m)±	0.69	0.33	0.39	0.05	0.05	0.03	0.12	0.11	0.10	83.32	73.94	65.38
CD (p=0.05)	2.05	0.96	1.14	0.15	0.14	0.10	0.35	0.32	0.30	245.75	218.11	192.87
Interaction												
M×S												
SE(m)±	1.67	0.65	0.91	0.11	0.10	0.08	0.26	0.24	0.22	186.30	153.19	128.05
CD (p=0.05)	4.58	2.15	2.56	0.33	0.32	0.22	0.79	0.71	0.67	549.50	487.71	431.27
SxM												
SE(m)±	1.90	0.44	1.00	0.11	0.07	0.08	0.23	0.24	0.19	102.79	125.43	80.29
CD (p=0.05)	3.83	1.48	2.08	0.26	0.22	0.17	0.59	0.55	0.49	373.11	350.04	292.61

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 1.1. Interaction between *in-situ* moisture conservation method and nutrient management practices on plant height of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	71.3	97.9	104.0	91.1
M2	75.3	99.6	105.0	93.3
M3	81.1	105.5	112.8	99.8
M4	82.7	108.2	114.0	101.6
M5	75.6	103.4	110.0	96.3
Mean	77.2	102.9	109.2	96.4
	Main	**Sub**	**MXS**	**SXM**
S.Em±	1.09	0.26	1.67	1.90
CD (p=0.05)	3.56	0.83	4.58	3.83
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	68.7	95.6	101.2	88.5
M2	73.1	97.3	103.5	91.3
M3	79.7	104.6	110.4	98.3
M4	81.3	106.4	112.3	100.0
M5	74.2	102.3	108.8	95.1
Mean	75.4	101.3	107.2	94.6
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.26	0.33	0.91	1.00
CD at 5%	0.83	0.96	2.56	2.08
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	70.0	96.8	102.6	89.8
M2	74.2	98.4	104.3	92.3
M3	80.4	105.0	111.6	99.0
M4	82.0	107.3	113.1	100.8
M5	74.9	102.9	109.4	95.7
Mean	76.3	102.1	108.2	95.5
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.57	0.39	0.91	1.00
CD at 5%	1.87	1.14	2.56	2.08

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 1.2. Interaction between *in-situ* moisture conservation method and nutrient management practices on monopodial branches plant^{-1} of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1.8	2.7	2.9	2.5
M2	2.1	2.8	3.1	2.7
M3	2.2	3.2	3.3	2.9
M4	2.5	3.4	3.5	3.2
M5	2.1	3.1	3.2	2.8
Mean	2.2	3.0	3.2	2.8
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.06	0.05	0.11	0.11
CD (p=0.05)	0.20	0.15	0.33	0.26
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1.7	2.5	2.7	2.3
M2	1.9	2.7	2.9	2.5
M3	2.1	3.0	3.2	2.8
M4	2.3	3.3	3.4	3.0
M5	2.1	2.9	3.1	2.7
Mean	2.0	2.9	3.1	2.7
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.04	0.05	0.10	0.07
CD at 5%	0.14	0.14	0.32	0.22
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1.8	2.6	2.8	2.4
M2	2.0	2.7	3.0	2.6
M3	2.2	3.1	3.3	2.8
M4	2.4	3.4	3.5	3.1
M5	2.1	3.0	3.1	2.7
Mean	2.1	3.0	3.2	2.7
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.04	0.03	0.08	0.08
CD at 5%	0.14	0.10	0.22	0.17

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 1.3. Interaction between *in-situ* moisture conservation method and nutrient management practices on sympodial branches plant^{-1} of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	9.1	12.9	14.0	12.0
M2	10.9	13.7	15.1	13.2
M3	12.1	15.8	17.1	15.0
M4	12.7	17.1	18.7	16.2
M5	11.5	15.0	16.4	14.3
Mean	11.3	14.9	16.3	14.1
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.13	0.12	0.26	0.23
CD (p=0.05)	0.43	0.35	0.79	0.59
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	8.9	12.6	13.9	11.8
M2	10.4	13.4	14.8	12.9
M3	11.8	15.7	17.0	14.8
M4	12.5	16.6	18.5	15.8
M5	11.3	14.7	15.9	13.9
Mean	11.0	14.6	16.0	13.8
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.14	0.11	0.24	0.24
CD at 5%	0.44	0.32	0.71	0.55
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	9.0	12.8	13.9	11.9
M2	10.6	13.6	14.9	13.0
M3	12.0	15.7	17.1	14.9
M4	12.6	16.8	18.6	16.0
M5	11.4	14.8	16.1	14.1
Mean	11.1	14.8	16.1	13.9
	Main	**Sub**	**MXS**	**SXM**
S.Em±	0.11	0.10	0.22	0.19
CD at 5%	0.35	0.30	0.67	0.49

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 1.4. Interaction between *in-situ* moisture conservation method and nutrient management practices on dry matter production (kgha^{-1}) of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1731	3484	3522	2912
M2	1832	3588	3663	3028
M3	2117	3919	4048	3361
M4	2346	4184	4307	3612
M5	2042	3781	3806	3210
Mean	2014	3791	3869	3225
	Main	**Sub**	**MXS**	**SXM**
S.Em±	59.35	83.32	186.30	102.79
CD (p=0.05)	193.52	245.75	549.50	373.11
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1606	3234	3430	2757
M2	1772	3419	3593	2928
M3	2085	3776	3904	3255
M4	2371	4042	4154	3522
M5	1979	3542	3697	3073
Mean	1963	3602	3755	3107
	Main	**Sub**	**MXS**	**SXM**
S.Em±	72.42	73.94	153.19	125.43
CD at 5%	236.14	218.11	487.71	350.04
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	1668	3359	3476	2834
M2	1802	3503	3628	2978
M3	2101	3847	3976	3308
M4	2359	4113	4230	3567
M5	2011	3662	3751	3141
Mean	1988	3697	3812	3166
	Main	**Sub**	**MXS**	**SXM**
S.Em±	46.36	65.38	128.05	80.29
CD at 5%	151.22	192.87	431.27	292.61

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 2. Lint yield (kg ha^{-1}) and seed cotton yield (kg ha^{-1}) of cotton as influenced by *in-situ* moisture conservation methods and nutrient management practices

Treatments	Lint yield (kg ha^{-1})			Seed cotton yield (kg ha^{-1})		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Main plot						
M1	295	271	282	896	822	859
M2	341	322	328	990	945	967
M3	494	441	462	1398	1272	1335
M4	539	480	506	1499	1356	1427
M5	424	385	401	1246	1122	1184
SE(m)±	8.73	8.74	7.09	24.83	20.29	20.11
CD (p=0.05)	28.29	28.93	23.46	82.23	67.19	66.59
Sub plot:						
S1	264	224	239	794	671	733
S2	480	440	453	1349	1289	1319
S3	534	477	495	1473	1351	1412
SE(m)±	6.10	7.92	5.11	16.92	20.71	11.64
CD (p=0.05)	18.12	23.53	15.16	50.25	61.53	34.58
Interaction						
M×S						
SE(m)±	14.15	16.89	11.71	39.63	42.91	29.26
CD (p=0.05)	43.88	51.72	36.24	123.03	130.76	91.63
SXM						
SE(m)±	15.13	15.13	12.27	43.01	35.14	34.83
CD (p=0.05)	42.30	54.22	35.34	117.43	141.12	81.52

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

sowing with 100 % RDF (1573 kg ha^{-1}) they were significantly on par with each other. Raised bed with 125 % RDF recorded 6.76 %, 14.97 % 27.83 % and 39.19 % higher seed cotton yield over conservation furrow at sowing with 125 % RDF conservation furrow at 30-45 DAS with 125 % RDF flat bed with dhaincha as live mulch with 125 % RDF and flat bed with 125 % RDF. The lowest seed cotton yield (546 kg ha^{-1}) was recorded in flat bed without moisture conservation with control which is on par with flat bed with dhaincha as live mulch with control (622 kg ha^{-1}). Similar results are reported by Kumari *et al*., (2019) and Ambika *et al*., (2019)

CONCLUSION

Experimental results revealed that *in-situ* moisture conservation and nutrient management practices significantly enhances the crop growth and yield under rainfed Alfisols. It is concluded that the raised bed conservation method with 125 % recommended dose of NPK (150:75:75 kg ha^{-1}) and their interaction effect shows improved the growth and yield parameters of rainfed cotton.

Table 2.1. Interaction between *in-situ* moisture conservation method and nutrient management practices on lint yield of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	178	351	369	295
M2	204	375	455	341
M3	310	568	623	494
M4	351	622	673	539
M5	275	482	548	424
Mean	264	480	534	419
	Main	**Sub**	**MXS**	**SXM**
S.Em±	8.73	6.10	14.15	15.13
CD (p=0.05)	28.29	18.12	43.88	42.30
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	169	312	332	271
M2	202	345	420	322
M3	249	519	555	441
M4	282	566	593	480
M5	217	457	482	385
Mean	224	440	477	380
	Main	**Sub**	**MXS**	**SXM**
S.Em±	8.74	7.92	16.89	15.13
CD at 5%	28.93	23.53	51.72	54.22
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	171	325	348	282
M2	201	352	433	328
M3	271	543	573	462
M4	314	583	621	506
M5	239	464	498	401
Mean	239	453	495	396
	Main	**Sub**	**MXS**	**SXM**
S.Em±	7.09	5.11	11.71	12.27
CD at 5%	23.46	15.16	36.24	35.34

Main plot:*In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

Table 2.2. Interaction between *in-situ* moisture conservation method and nutrient management practices on seed cotton yield of cotton

Sub treatments				
2021				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	567	1019	1100	896
M2	629	1080	1261	990
M3	937	1600	1657	1398
M4	1007	1666	1823	1499
M5	831	1383	1525	1246
Mean	794	1349	1473	1206
	Main	**Sub**	**MXS**	**SXM**
S.Em±	24.83	16.92	39.63	43.01
CD (p=0.05)	82.23	50.25	123.03	117.43
2022				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	525	955	987	822
M2	615	1003	1216	945
M3	727	1547	1544	1272
M4	833	1625	1610	1356
M5	656	1315	1396	1122
Mean	671	1289	1351	1103
	Main	**Sub**	**MXS**	**SXM**
S.Em±	20.29	20.71	42.91	35.14
CD at 5%	67.19	61.53	130.76	141.12
Pooled mean (2021 & 2022)				
Main treatments	**S1**	**S2**	**S3**	**Mean**
M1	546	987	1044	859
M2	622	1041	1239	967
M3	832	1573	1601	1335
M4	920	1645	1717	1427
M5	744	1349	1460	1184
Mean	733	1319	1412	1154
	Main	**Sub**	**MXS**	**SXM**
S.Em±	20.11	11.64	29.26	34.83
CD at 5%	66.59	34.58	91.63	81.52

Main plot: *In-situ* moisture conservation: M_1: Flatbed sowing with CRIDA 6 row planter, M_2: Flatbed +live mulch with dhaincha as live mulch, M_3: Conservation furrow at sowing with CRIDA Ridge planter, M_4: Raised bed and furrow with CRIDA Raised bed planter, M_5: Conservation furrow at 30 - 40 DAS after interculture operations, Sub plot: Nutrient management-S_1: control (without fertilizer), S_2: 100% Recommended dose of NPK (120:60:60) and S_3: 125% Recommended dose of NPK (150:75:75)

REFERENCES

Aladakatti,Y.R., Hallikeri, S.S., Nandagavi, R.A., Naveen, N.E., Hugar, A.Y and Blaise. 2011. D. Yield and fibre qualities of hybrid cotton (*Gossypium hirsutum*) as influenced by soil and foliar application of potassium. Karnataka Journal of Agricultural Science. 24(2):133-136.

Ali, H and Ahmed, M.I. 2021. Agronomic efficiency and profitability of cotton on integrated use of phosphorus and plant microbes. Brazilian Journal of Biology. 81(2): 484-494.

Ambika, V., Yadahalli, G. S., Chittapur, B. M., Kulkarni, S., Yadahalli, V. G and Malakannavar, S. 2019. Growth and yield of Bt cotton influence by land configuration and nutrient levels under rainfed situation. Advances in Research. 18(2): 1-7.

Arora, S and Bhatt, R. 2012. Impact of improved soil and *in-situ* water conservation practices on productivity in rainfed foothill region of North-west India.

CCI, 2021. Cotton Corporation of India. http:// cotcorp.gov.in/statistics.aspx.

Dangore, S. T., Chaudhari, C. S., Panchabhai, P. R and Deshpande, R. M. 2001. Effect of land configuration and nutrient management on growth and yield of rainfed cotton. Journal of Soils and Crops. 11(2): 219-222.

Hulihalli, U. K and Patil, V. C. 2004. Moisture use efficiency of cotton in relation to *in-situ* moisture conservation practices and organic manures under rainfed conditions. Indian Journal of Dryland Agricultural Research and Development. 19(2): 154-163.

Kumari, CH. P., Devi, K.B.S., Rekha, K. B., Sridevi, S and Reddy, S.N. 2019. Effect of in situ moisture conservation practices and integrated nutrient management practices on growth and yield of Bt cotton. The Journal of Research of PJTSAU. 47(1): 17-23.

Mankar, P.S., Pawar, W.S., Mendhe, S.N., Deshpande, R.M and Chimote, A.N. 2008. Effect of land configuration and addition of weed biomass on moisture content, fertility status and yield of cotton. Punjabrao Krishi Vidyapeeth Research Journal. 32(1):15-19.

Maurya, B.R., H. Ram and S.S. Prasad. 2009. Impact of soil amendments on properties of the salt affected rice soil. Journal of Indian Society of Soil Science. 57: 385- 388.

Muthukrishnan, P., Thavaprakaash, N and Srinivasan, K. 2017. Effect of organic nutrient management practices in comparison with conventional method on performance of cotton in Tamil Nadu. Madras Agricultural Journal. 104 (1-3): 15-22.

Pendke, M. S., Lomte, M. H and Shinde, J. S. 2001. Impact of land configuration on hydrological properties of soil and yield of cotton. Journal of Maharashtra Agricultural Universities. 26(1): 6-7.

Reddy, D.D., Blaise, D., Kumrawat, B and Singh, A.K. 2017. Evaluation of integrated nutrient management interventions for cotton (*Gossypium hirsutum*) on a vertisol in Central India. Communications in Soil Science and Plant Analysis. 48(4): 469-475.

Sankaranayanan, K., Praharaj, C.S., Narayini, P and Gopalakrishnan, N. 2011. Growth, yield and quality of Bt cotton (*Gossypium hirsutum* L.) hybrids under varied planting pattern, NPK levels and seasonal variations. Indian Journal of Agricultural Sciences. 81(9): 871-874.

Siddu, M and Aladakatti, Y.R. 2021. Response of Bt cotton (*Gossypium hirsutum*) to liquid bio-fertilizer consortia with varied levels of major nutrients. Journal of Farm Science. 34(1): 44-48.

Singh, P., Devasahayam, M and George, P.J. 2018. Effects of refuge crops and sowing dates on the growth and yield performance of Bollgard II variety of cotton (*Gossypium hirsutum* L.) in Allahabad condition. Journal of Pharmacognosy and Phytochemistry. 7(4): 2881-2885.

Vani, K.P., Rekha, K.B and Nalini, N. 2020. Yield and nutrient uptake of Bt cotton as influenced by composted waste, organic and inorganic fertilizers. Chemical Science Review and Letters. 9(34): 432-441.

Vinay, G., Vani, K. P., Padmaja, B., G. Jayasree, G., Triveni, S and Yakadri, M. 2022. Productivity and profitability of HDPS cotton influenced by genotypes and INM practices. The Journal of Research of PJTSAU. 50(4): 82-94.

Vora, V.D., Vekariya, P.D., Hirpara, D.S., Rakholiya, K.D., Sutaria, G.S and Akbari, K.N. 2016. Influence of integrated nutrient management on growth and yield of Bt cotton (*Gossypium hirsutum* l.) under dry farming condition. Indian Journal of Dryland Agricultural Research and Development. 31(1): 25-29.