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Studies on the effect of *in situ* soil moisture conservation techniques, soil conditioner (Pusa hydrogel) with stress management practices on fibre quality parameters and productivity of rainfed cotton

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ABSTRACT : A field experiments was conducted at Tamil Nadu Agricultural University, Coimbatore, Regional Research Station, Aruppukottai, during *rabi* of 2016 and 2017 to study the impact of *in situ* moisture conservation and stress management practices on soil moisture retention and productivity of cotton under rainfed vertisol with the test variety SVPR - 2. The experiments were laid out in split plot design replicated thrice. The main plot treatments consisted of different *in situ* moisture conservation measures *viz.,* Broad Bed and Furrows (I_1), Ridges and Furrows (I_2) and Compartmental Bunding (I_3). The sub plot comprises of the stress management practices *viz.,* Soil application of Pusa hydrogel @ 5 kg/ha (S_1), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2) , Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (5%) Kaolin (S_3), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of Salicylic acid 100 ppm (S_5) and Control (S_6). The results of this study showed that treatment combination of broad bed and furrow with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha had recorded significantly higher values of the quality parameters *viz.*, seed index and lint index and seed cotton yield 1,580 kg/ha (2016) and 1,943 kg/ha (2017). Higher fibre length, uniformity ratio, micronaire value, fibre strength and elongation percentage recorded under BBF.

Key words: Broad bed and furrows, fibre quality, Pusa hydrogel, rainfed cotton

Cotton as a crop as well as a commodity plays an important role in the agrarian and industrial activities of the nation and has a unique place in the economy of our country. Cotton, popularly known as "White Gold" is cultivated mainly for fibre and additionally as an important source of edible oil. India devotes more area to cotton than any other country in the world. At present, India ranks first in area with 11.88 M ha, accounting 30 per cent of world average and 22 per cent (351 lakh bales of lint) of the world cotton production with a lint productivity of 568 kg/ha (Anonymous, 2017). Nearly 65 per cent of the cotton crop is cultivated under rainfed condition in the country. In Tamil Nadu, 1.33 lakh ha area is under cotton cultivation with a production of 6.5 lakh bales with and lint productivity of 620 kg/ha. India has been the traditional home of cotton and their textiles. India has progressed substantially in improving both production and productivity of cotton over the last five years, transforming from a net importer of cotton, to the largest exporters, shipping 6.9 million bales (2015-2016) followed by USA (Kannan *et al.*, 2017).

Water stress is one of the most important factors limiting crop productivity and adversely affects square and boll formation, lint yield and fibre quality of cotton. The loss of productivity due to the lack of rainfall, poor retention capacity of soil due to intensive cultivation and insufficient soil moisture at critical stages of crop growth to withstand stress has threatened cotton farming. Water scarcity and rapid environmental changes necessitated the researchers to find a way to conserve the available water in a proper way to achieve sustainable crop production. The technology should be efficient to help farmers to grow more with fewer resources and less environmental impact and higher resource use efficiency.

To combat such adverse soil moisture scarcity conditions, matching integrated drought management practices need to be evolved. Rainfed areas can be made productive and profitable by adopting improved technologies for rainwater conservation and harvesting and commensurate agricultural production technologies. Soil management practices are tailored to store and conserve as much rainfall as possible by reducing runoff and increasing storage capacity in the soil profile. The most efficient and cheapest way of conserving rainfall is to hold it *in situ*. The principle behind the different *in situ* moisture conservation practices is to increase the infiltration by reducing the rate of runoff, temporarily impounding the water on the surface of the soil to increase the opportunity time for infiltration and modifying the land configuration for inter plot water harvesting (Muthamilselvan *et al.*, 2006).

The moisture stress during crop growth period is the primary cause for the yield reduction in cotton. To improve the soil moisture availability, by reducing the evaporation losses and retaining the moisture in effective rooting zone. The soil application of superabsorbent polymers (SAPs) is found to be the promising technology for rainfed areas. However, very limited research work has experimented on the use of polymers as soil moisture retainers. One of such developed product is 'Pusa hydrogel' which is first successful indigenous semi-synthetic super absorbent technology for conserving water and enhancing crop productivity and thereby increases the water use efficiency (Anonymous, 2012). To reduce transpiration losses, foliar application of nutrient formulations, growth regulators, anti-transpirants etc. are being tried by many researchers. Keeping this in view, an attempt was made to study the impact of *insitu* moisture conservation, stress management practices on crop growth indices and productivity of cotton under rainfed agroecosytem.

MATERIALS AND METHODS

Field experiments were was conducted at Tamil Nadu Agricultural University, Regional research station, Aruppukottai, during *rabi* season of 2016 and 2017 with the test variety SVPR-2. The experimental site comes under the southern agro-climatic zone of Tamil Nadu and geographically situated at 9º 33'N latitude and 78º 05' E longitude at an altitude of 50 m above mean sea level. North east monsoon season is found to be more favourable in Aruppukottai region since 42 per cent of annual rainfall is being received during this monsoon season. The soil of the experimental fields was medium deep, well drained vertisol (Type Chromusterts) in texture. The soil low in available nitrogen, low in available phosphorus and high available potassium. All package of practices were carried out as per recommendation of (Anonymous, 2012).

The experiment was laid out in split plot design, replicated thrice. The mainplot treatments consisted of different *in-situ* moisture conservation measures *viz.*, Broad Bed and Furrows (I_1), Ridges and Furrows (I_2) and Compartmental Bunding (I_3). The subplot comprises with stress management practices *viz.*, Soil application of Pusa hydrogel @ 5 kg/ha (S_1), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (5%) Kaolin (S_3), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4), Soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of Salicylic acid 100 ppm (S_5) and Control (S_6).

The data analysis for the probability occurrence of 30 years rainfall in a standard week showed that there is a possibility occurrence of getting more than 80 per cent of consecutive dry spell is laid with 45th and 50th standard weeks. So, to avoid stress, foliar spray has given at 45th and 50th standard weeks for the years of study 2016 and 2017 based on historical rainfall probability analysis by Markov chain method to fix foliar spray application during the experimentation period.

Fiber Quality Parameters

Sample preparation : Seed cotton was randomly selected and picked from each treatment during harvesting. Thus collected seed cotton was hand cleaned from dried leaves, insects damaged bolls and subjected for ginning. Cleaned and ginned lint samples of about 100g was packed and labeled for quality testing.

High volume instrument system (HVI) : Various conventional instruments are integrated in to a single compact operating system by using a state of art technology in optics, machines, and electronics. The high volume instrument system provides measurement of fibre span length (mm), fibre fineness (μg/inch), fibre strength (g/tex), fibre maturity ratio and uniformity ratio. Cotton samples were tested for fibre quality parameters at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore with HVI instrument (in ICC mode) by the method adopted from ASTM D-5867 procedure by Sundaram and Krishna Iyer (1979).

Bartlett's earliness index (BI) : Earliness of crop under various treatments was determined by working out the Bartlett's index on the basis of seed cotton obtained at every picking (Bartlett, 1947).

$$\text{Bartlett's index} = \frac{P_1 + (P_1 + P_2) + (P_1 + P_2 + P_3) \ldots\ldots (P_1 + P_2 + P_3 + P_n)}{(P_1 + P_2 + P_3 + \ldots\ldots\ldots P_n)n}$$

Where,

P_1 - Seed cotton weight in first picking,

P_2 - Seed cotton weight in second picking,

P_3 - Seed cotton weight in third picking,

P_n - Seed cotton weight in nth picking, and

n - Total number of pickings.

Seed cotton yield : The seed cotton yield was obtained from net plot area was shade dried, weighed at each picking and yields of all picking were added and calculated as kg/p plot and then expressed in kg/ha. The data obtained were subjected to statistical analysis and were tested at five per cent level of significance to interpret the treatment differences as suggested by Gomez *et al.*,(1984).

RESULTS AND DISCUSSION

Effect of *in situ* moisture conservation and stress management practices on quality parameters of cotton : *In situ* moisture conservation measures and moisture stress management practices had a significant positive influence on majority of the quality parameters of seed cotton. The different quality parameters of cotton *viz.*, seed index, lint index, ginning percentage, fibre length, micronaire, bundle strength and bartlett's index are presented below.

Seed index (g): *In situ* moisture conservation measures and stress management practices significantly influenced the seed index. *In situ* moisture conservation measures, BBF (I_1) recorded significantly highest seed index of 8.32 g in 2016 and 8.23 g in 2017 followed by I_2 (RF). Lowest seed index was observed in CB (I_3) with 8.16 and 8.08 g in 2016 and 2017, respectively. Stress management practices exerted a significant influence on seed index in both the years of experimentation. The highest seed index

List of fiber quality parameters

S.No.	Characters	Formulae/Method	Reference
1.	Staple length (mm) -2.5 per cent span length	Balls sledge sorter instrument	(Sundaram, 1974)
2.	Fibre fineness (Micronaire value 10-6 g/inch).	Air flow method using micronaire tester	(Sundaram, 1974)
3.	Bundle strength (g/tex)	Tenacity 1/8 gauge on stelometre	(Sundaram and Krishna Iyer, 1979)
4.	Fibre uniformity ratio	Digital fibrograph (50 per cent span length / 2.5 per cent span length) x 100	(Sundaram and Krishna Iyer, 1979)

of 8.39 g and 8.29 was recorded with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4), respectively during 2016 and 2017. However, it was comparable with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2) and soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (5%) kaolin (S_3). Lower seed index of 8.11 and 8.03 g was recorded under control (S_6) during 2016 and 2017, respectively. (Table 1 and 2)

Lint index (g) : Among *in situ* moisture conservation measures, BBF (I_1) recorded significantly highest lint index of 4.15 in 2016 and 4.24 in 2017 followed by I2 (RF). The Lowest lint index was observed in CB (I3) with 4.06 and 4.11 g in 2016 and 2017, respectively. Stress management practices had a marked influence on lint index in both the seasons. Among the stress management practices, the highest lint index of 4.18 g and 4.21 was recorded with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) during in 2016 and 2017, respectively. It was comparable with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2) and soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (5%) kaolin (S_3). The lowest lint index of 4.06 g in 2016 and 4.11 g in 2017 was recorded in control (S_6). (Table 1 and 2)

Ginning percentage : The *in situ* moisture conservation and stress management practices did not have significant influence on ginning percentage during both the years of experimentation. However, the numerically higher ginning percentage of 35.38 and 35.68 per cent registered under BBF (I_1) in 2016 and 2017, respectively. CB (I_3) registered the numerically the lowest ginning percentage of 34.22 and 35.02 per cent in 2016 and 2017, respectively. Likewise, soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) registered higher ginning percentage during both years of experimentation (35.71 in 2016 and 35.85 in 2017) than other treatments. (Table 1 and 2)

Micronaire value : Among *insitu* moisture conservation measures, BBF (I_1) recorded the significantly lesser micronaire value of 4.20 in 2016 and 4.35 in 2017 over the rest of the treatments during both seasons. Higher micronaire value of 4.41 in 2016 and 4.51 in 2017 was observed with CB (I_3). Regarding the stress management practices, the lowest micronaire value of 4.18 in 2016 and 4.26 in 2017 was recorded with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) and it was comparable with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2). The plot with no stress management practices, control (S_6) recorded with highest micronaire values 4.43 and 4.60, respectively of 2016 and 2017. (Table 3 and 4)

Span length (mm) : It is evident from the data that BBF (I_1) recorded the highest span length of 28.72, 28.18 mm, respectively during 2016 and 2017. The lowest span length was recorded under CB (I_3) with 28.28 and 27.81 mm in 2016 and 2017, respectively. Further, soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) recorded significantly higher span length of 28.94 mm in 2016 and 28.42 mm in 2017 and was comparable with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2). The span length was found to be low in (control plot) S_6 (28.14 and 27.72 mm, respectively of 2016 and 2017). (Table 3 and 4)

Bundle strength (g/tex) : The bundle strength of rainfed cotton raised under BBF (I_1) was significantly higher with 21.05 and 20.83 g tex^{-1} during 2016 and 2017, as compared to the rest of the treatments during both seasons. The bundle strength was lower under compartmental bunding (I_3) with 20.66 and 20.45 g/tex in 2016 and 2017, respectively. Likewise, soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) registered superior bundle strength of 21.88 and 21.59 g/tex during 2016 and 2017. Respectively which was followed by

Table 1. Effect of *in situ* moisture conservation and stress management practices on quality parameters of rainfed cotton during *rabi* 2016-2017

Treatments	Seed index (g)				Lint index (g)				Ginning percentage (%)			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	8.23	8.12	8.09	**8.15**	4.09	4.05	4.03	**4.06**	34.40	34.04	33.60	**34.01**
S_2	8.34	8.24	8.20	**8.26**	4.19	4.14	4.08	**4.14**	36.10	35.38	34.60	**35.36**
S_3	8.31	8.25	8.18	**8.25**	4.15	4.10	4.07	**4.11**	36.10	35.31	34.50	**35.30**
S_4	8.54	8.36	8.26	**8.39**	4.24	4.19	4.12	**4.18**	36.30	35.73	35.10	**35.71**
S_5	8.30	8.20	8.15	**8.22**	4.13	4.11	4.06	**4.10**	35.00	34.64	34.30	**34.65**
S_6	8.19	8.10	8.05	**8.11**	4.07	4.04	4.00	**4.04**	34.40	33.83	33.20	**33.81**
Mean	**8.32**	**8.21**	**8.16**		**4.15**	**4.11**	**4.06**		**35.38**	**34.82**	**34.22**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.03	0.07	0.11	0.12	0.02	0.03	0.05	0.05	0.05	0.53	0.70	0.75
CD (p = 0.05)	0.10	0.14	NS	NS	0.04	0.06	NS	NS	NS	NS	NS	NS

Table 2. Effect of *in situ* moisture conservation and stress management practices on quality parameters of rainfed cotton during *rabi* 2017-2018.

Treatments	Seed index (g)				Lint index (g)				Ginning percentage (%)			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	8.15	8.07	8.00	**8.07**	4.22	4.16	4.05	**4.14**	35.50	35.16	34.70	**35.12**
S_2	8.30	8.23	8.15	**8.23**	4.26	4.22	4.15	**4.21**	35.90	35.60	35.40	**35.63**
S_3	8.25	8.17	8.08	**8.17**	4.24	4.20	4.14	**4.19**	35.80	35.45	35.20	**35.48**
S_4	8.39	8.27	8.21	**8.29**	4.27	4.21	4.15	**4.21**	36.20	35.84	35.50	**35.85**
S_5	8.22	8.13	8.04	**8.13**	4.25	4.20	4.13	**4.19**	35.70	35.40	34.90	**35.33**
S_6	8.09	8.03	7.98	**8.03**	4.18	4.12	4.02	**4.11**	35.00	34.74	34.40	**34.71**
Mean	**8.23**	**8.15**	**8.08**		**4.24**	**4.19**	**4.11**		**35.68**	**35.37**	**35.02**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.04	0.07	0.12	0.12	0.02	0.03	0.05	0.06	0.15	0.21	0.31	0.29
CD (p = 0.05)	0.08	0.15	NS	NS	0.04	0.07	NS	NS	NS	NS	NS	NS

Table 3. Effect of *in situ* moisture conservation and stress management practices on micronaire value, span length (mm) and bundle strength (g/tex^{-1}) of rainfed cotton during *rabi* 2016-2017

Treatments	Micronaire				Span length (mm)				Bundle strength (g/tex)			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	4.25	4.33	4.45	**4.34**	28.60	28.27	27.95	**28.27**	20.49	20.35	20.30	**20.38**
S_2	4.18	4.28	4.39	**4.28**	28.94	28.75	28.64	**28.78**	21.29	21.09	20.90	**21.09**
S_3	4.11	4.23	4.37	**4.24**	28.66	28.52	28.33	**28.50**	21.06	20.84	20.76	**20.89**
S_4	4.24	4.33	4.39	**4.18**	29.17	28.93	28.71	**28.94**	22.35	21.79	21.50	**21.88**
S_5	4.08	4.17	4.29	**4.32**	28.52	28.32	28.16	**28.33**	20.99	20.65	20.45	**20.70**
S_6	4.32	4.42	4.54	**4.43**	28.40	28.13	27.89	**28.14**	20.09	20.04	20.02	**20.05**
Mean	**4.20**	**4.29**	**4.41**		**28.72**	**28.49**	**28.28**		**21.05**	**20.79**	**20.66**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.02	0.06	0.10	0.10	0.11	0.21	0.34	0.36	0.07	0.14	0.23	0.24
CD (p = 0.05)	0.06	0.12	NS	NS	0.30	0.42	NS	NS	0.19	0.28	NS	NS

Table 4. Effect of *in situ* moisture conservation and stress management practices on micronaire value, span length (mm) and bundle strength (g/tex) of rainfed cotton during *rabi* 2017-2018

Treatments	Micronaire				Span length (mm)				Bundle strength (g/tex)			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	4.41	4.52	4.64	**4.52**	28.09	27.73	27.32	**27.71**	20.26	20.15	20.14	**20.18**
S_2	4.30	4.35	4.44	**4.36**	28.24	28.25	28.05	**28.18**	20.98	20.86	20.61	**20.82**
S_3	4.32	4.44	4.54	**4.43**	28.18	28.04	27.86	**28.03**	20.79	20.63	20.52	**20.65**
S_4	4.21	4.25	4.32	**4.26**	28.66	28.41	28.19	**28.42**	22.26	21.36	21.14	**21.59**
S_5	4.34	4.42	4.58	**4.45**	27.95	27.94	27.90	**27.93**	20.69	20.47	20.32	**20.49**
S_6	4.50	4.61	4.69	**4.60**	27.93	27.71	27.52	**27.72**	19.98	19.96	19.94	**19.96**
Mean	**4.35**	**4.43**	**4.54**		**28.18**	**28.01**	**27.81**		**20.83**	**20.57**	**20.45**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.03	0.06	0.11	0.11	0.06	0.18	0.24	0.25	0.11	0.17	0.29	0.30
CD (p = 0.05)	0.08	0.13	NS	NS	0.24	0.37	NS	NS	0.30	0.35	NS	NS

Table 5. Effect of *in situ* moisture conservation and stress management practices on uniformity ratio (%), elongation (%) and barlett index of rainfed cotton during *rabi* 2016-2017.

Treatments	Uniformity ratio (%)				Elongation (%)				Barlett index			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	48.42	48.38	48.34	**48.38**	4.17	4.15	4.13	**4.15**	0.6183	0.6254	0.6326	**0.6254**
S_2	49.14	48.98	48.81	**48.98**	4.43	4.37	4.30	**4.37**	0.6089	0.6176	0.6262	**0.6176**
S_3	48.97	48.85	48.72	**48.85**	4.40	4.33	4.25	**4.33**	0.6106	0.6179	0.6253	**0.6179**
S_4	49.34	49.20	49.05	**49.20**	4.78	4.59	4.40	**4.59**	0.6106	0.6134	0.6162	**0.6134**
S_5	48.86	48.69	48.52	**48.69**	4.27	4.23	4.20	**4.23**	0.6174	0.6232	0.6291	**0.6232**
S_6	48.18	48.16	48.14	**48.16**	4.10	4.05	4.00	**4.05**	0.6223	0.6391	0.6559	**0.6391**
Mean	**48.82**	**48.71**	**48.60**		**4.36**	**4.29**	**4.21**		**0.6147**	**0.6228**	**0.6309**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.03	0.15	0.20	0.21	0.03	0.08	0.10	0.11	0.0034	0.0070	0.0098	0.0100
CD (p = 0.05)	0.12	NS	NS	NS	0.12	NS	NS	NS	NS	NS	NS	NS

Table 6. Effect of *in situ* moisture conservation and stress management practices on uniformity ratio (%), elongation (%) and barlett index of rainfed cotton during *rabi* 2017-2018.

Treatments	Uniformity ratio (%)				Elongation (%)				Barlett index			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	48.31	48.23	48.16	**48.23**	4.07	4.05	4.02	**4.05**	0.6170	0.6297	0.6424	**0.6297**
S_2	49.06	48.91	48.76	**48.91**	4.38	4.26	4.13	**4.26**	0.6148	0.6208	0.6267	**0.6208**
S_3	48.87	48.74	48.62	**48.74**	4.18	4.17	4.16	**4.17**	0.6174	0.6225	0.6277	**0.6225**
S_4	49.16	49.08	49.01	**49.08**	4.58	4.42	4.26	**4.42**	0.6070	0.6198	0.6327	**0.6198**
S_5	48.78	48.54	48.31	**48.54**	4.12	4.10	4.08	**4.10**	0.6144	0.6245	0.6346	**0.6245**
S_6	47.88	47.91	47.95	**47.91**	3.99	3.96	3.93	**3.96**	0.6244	0.6323	0.6402	**0.6323**
Mean	**48.68**	**48.57**	**48.47**		**4.22**	**4.16**	**4.10**		**0.6158**	**0.6249**	**0.6341**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
SEd	0.04	0.07	0.22	0.23	0.03	0.05	0.08	0.08	0.0026	0.0102	0.0137	0.0145
CD (p = 0.05)	0.16	NS	NS	NS	0.11	NS	NS	NS	NS	NS	NS	NS

Table 7. Effect of *in situ* moisture conservation and stress management practices on seed cotton yield (kg/ha) under rainfed condition during *rabi* 2016 and 2017

Treatments	*Rabi* 2016				*Rabi* 2017			
	I_1	I_2	I_3	**Mean**	I_1	I_2	I_3	**Mean**
S_1	1,112	1,039	979	**1,043**	1,457	1,373	1,299	**1,376**
S_2	1,369	1,260	1,084	**1,238**	1,686	1,579	1,475	**1,580**
S_3	1,229	1,160	1,065	**1,151**	1,582	1,484	1,389	**1,485**
S_4	1,580	1,350	1,253	**1,394**	1,943	1,785	1,631	**1,786**
S_5	1,189	1,094	992	**1,092**	1,544	1,472	1,411	**1,476**
S_6	998	884	724	**869**	1,328	1,107	893	**1,109**
Mean	**1,246**	**1,131**	**1,016**		**1,590**	**1,467**	**1,350**	
	I	**S**	**I at S**	**S at I**	**I**	**S**	**I at S**	**S at I**
S.Ed	33	33	61	57	32	48	71	68
CD (p = 0.05)	90	67	138	116	117	100	178	141

soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of (1%) KCl (S_2). It was also found that significantly inferior bundle strength was registered under control (S_6) with 20.05 and 19.96 g/tex, respectively of 2016 and 2017. (Table 3 and 4)

Uniformity ratio : From the present investigation it was found that among the *insitu* moisture conservation measures, BBF (I_1) recorded higher uniformity ratio of 48.82 (2016) 48.68 (2017) than the CB (I_3). However, it was comparable with RF (I_2) and significantly superior than I_3 (CB). With respect to stress management practices, either alone or in combination with *in situ* moisture conservation measures did not show any significant influence on uniformity ratio during both the years of experimentation. (Table 5 and 6)

Elongation : The data recorded on elongation percentage showed a notable variation due to the *in situ* moisture conservation measures. The BBF (I_1) recorded higher elongation per cent of 4.36 in 2016 and 4.22 in 2017 than the rest of the treatments and significantly superior to I_3 (CB) during both the years. The lowest elongation percentage was recorded in the CB (I_3), but it was comparable with RF (I_2) in both years of study. (Table 5 and 6)

Bartlett's index : *In situ* moisture conservation measures and stress management practices did not exerted any significant influence on bartlett's index. However, there was a numerical variation observed between treatments. The investigation also revealed that, BBF (I_1) recorded numerically lesser (0.6147 and 0.6158, respectively at both years of study) bartlett's index which indicated that there was some delay in crop maturity over other treatments. Further, soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha (S_4) recorded numerically lesser (0.6134 and 0.6198 during first and second year, respectively) bartlett's index.

The quality parameters of seed cotton are heritable. However, environmental and crop management practices can influence the quality parameters to some extent. BBF with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha had significantly influenced the quality parameters *viz.*, seed index and lint index. This may be due to favorable soil moisture regime for proper crop development and better boll formation and development ultimately led to better fibre properties. Further, it may be due to better seed filling under unstressed environment provided by soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha.

Higher fibre length, uniformity ratio, micronaire value, fibre strength and elongation percentage also due to favourable moisture conditions maintained under BBF. The earliness of the crop as measured by Bartlett's index revealed that there was some delay in crop maturity caused by broad bed and furrows. This may be due to the extended vegetative growth, and delayed boll opening and boll maturity, associated with constant and adequate availability of moisture. Polymers may help in retaining soil moisture towards the maturity stage of crop and increased the number of pickings. This might have given more opportunity for the fibre to grow longer (Rehman *et al.*, 2011). (Table 5 and 6)

Effect of *in situ* moisture conservation and stress management practices on seed cotton yield : Yield is contributed by different yield components and any influence made by extraneous factor, will alter the yield significantly. In the present study, increased seed cotton yield could be attributed to better crop growth and yield components due to consistent soil moisture availability due to combined influence of BBF, soil conditioner and foliar application of PPFM.

The broad bed furrow system significantly influenced the seed cotton yield as compared to other land configuration. BBF recorded significantly higher seed cotton yield of 1,246 (2016) and 1,590 kg/ha (2017) which was 23 per cent (2016) and 19 per cent (2017) higher as compared to compartmental bunding. Increment in seed cotton yield was due to more soil moisture availability at the root zone which favoured better crop growth, more nutrient uptake and higher translocation leading to production of larger leaf area index which was responsible for harvesting more solar energy. This coupled with higher stomatal conductance and transpiration rate resulted in accumulation of more dry matter and yield components and ultimately the seed cotton yield. This is in similarity with the findings of Muralidaran and Solaimalai (2005). Higher seed cotton yield was realized with complementary alliance of moisture conservation measures with stress management practices in the present study. Significant influence by stress management practices also recorded with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha, which registered higher seed cotton yield of 1,394 and 1,786 kg/ha during 2016 and 2017, respectively.

The increased seed cotton yield under soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha was 60 per cent during 2016 and 61 per cent in 2017 over control. This may be due to increase in growth and yield related attributes. Further, it could be because of sufficient availability of soil moisture due to super absorbent polymer under water stress condition, which in turn lead to better translocation of water, nutrients and photo assimilates and finally better plant development. Similar findings were also reported by El-Hady *et al.,* (1981) under water stress condition. However during stress, presence of photosynthetically active leaf area due to moisture availability by SAP exhibited more chlorophyll meter readings was also positively correlated to yield. Similar findings were reported by Johnkutty and Palaniappan (1995). (Table 7)

The present study revealed that foliar application of PPFM when combined with soil application of Pusa hydrogel resulted in enhanced seed cotton yield. The enhancement of yield was associated with increased boll plant through improved boll retention. Significant increase in seed cotton yield with the application of PPFM was reported by Dhale *et al.*, (2010). The beneficial influence by PPFM may be attributed to several factors such as, release of growth promoting substances like auxins, particularly indole-3-acetic acid (IAA) and indole-3-pyruvic acid, zeatin, zeatin riboside, proliferation of beneficial organisms in the phylosphere and reacted cytokinins by methylotrophs were enhance the plant growth of crops due to vegetative growth of the plant attributed to increase in the yield of a crop. Hence, it could be concluded that foliar application of PPFM favourably influenced the seed cotton yield. The combination of BBF with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha recorded higher yield with an increase of 133 and 150 per cent during 2016 and 2017, respectively than the compartmental bunding with control. This may be due to the favourable environment provided by the *in situ* moisture conservation and stress management practices, which enhanced the growth and yield attributing characters of cotton during both the years of study.

CONCLUSION

The results of this study showed that treatment combination of broad bed and furrow with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha had recorded significantly higher values of the quality parameters *viz.*, seed index and lint index. Higher fibre length, uniformity ratio, micronaire value, fibre strength and elongation percentage recorded under BBF in both the years of experimentation. The higher values indicate that the moisture conservation and stress management practices improved fibre quality performance leading to higher yield potential of rainfed cotton. Broad bed and furrows combined with soil application of Pusa hydrogel @ 5 kg/ha + foliar spray of PPFM @ 500 ml/ha during the stress period was found to be the best agronomic management practice in order to enhance fibre quality parameters and yield in cotton under rainfed vertisols.

REFERENCES

Anonymous, 2012. Pusa Hydrogel: An Indigenous semisynthetic superabsorbent technology for conserving water and enhancing crop productivity Indian Agricultural Research Institute, New Delhi, India.

Anonymous, 2012. *Crop Production Guide*. Tamil Nadu Agricultural University: Coimbatore, India.

Anonymous, 2017. *Status Paper of Indian Cotton:* Directorate of Cotton Development, Government of India.

Bartlett, M. S. 1947. The use of transformations. *Biomet.* **3**: 39-52.

Dhale, D.A., Chatte, S.N. and Jadhav, V.T. 2010. Effect of bioinoculents on growth, yield and fibre quality of cotton under irrigation. *Res. J. Agricul. Biol. Sci.*, **6** : 542-47.

El-Hady, O.A., Tayel, M.Y. and Lotfy, A.A. 1981. *Super Gel as a soil conditioner II-Its effect on plant growth, enzymes activity, water use efficiency and nutrient uptake.* Paper presented at the 3rd International Symposium on *"Water supply and Irrigation in the open and under protected cultivation"* 119.

Gomez, K. A., Gomez, K. A. and Gomez, A. A. 1984. *Statistical Procedures for Agricultural Research* : John Wiley and Sons.

Johnkutty, I. and Palaniappan, S.P. 1995. Use of chlorophyll meter for nitrogen management in lowland rice. *Fert. Res.*, **45** : 21-24.

Kannan, V., Srinivasan, G., Babu, R., Thiyageshwari, S., and Sivakumar, T. 2017. Effect of Biochar, Mulch and PPFM Spray on Leaf Relative Water Content, Leaf Proline, Chlorophyll Stability Index and Yield of Cotton under Moisture Stress Condition. *Internat. J. Curr. Microbiol. Appl. Sci.* **6**: 604-11.

Muralidaran, C. and Solaimalai, A. 2005. A study on land configuration methods, row spacing and time of nitrogen application on nutrient uptake and yield of cotton in dryland condition of western zone of Tamil Nadu. *Karnataka J. Agricul. Sci.* **18** : 1-3.

Muthamilselvan, M., Manian, R. and Kathirvel, K. 2006. *In situ* moisture conservation techniques in dryfarming-A review. Agricultural Reviews - *Agricul. Res. Comm. Centre,* **27** : 67.

Rehman, A., Ahmad, R. and Safdar, M. 2011. Effect of hydrogel on the performance of aerobic rice sown under different techniques. *Plant Soil Environ.* **57**: 321-25.

Sundaram, V. 1974. Definitions of some technical terms used in cotton development, trade and technology. *Cotton Deve.* **4** : 35-40.

Sundaram, V. and Krishna Iyer, K. 1979. Handbook of methods of tests for cotton fibres, yarns, and fabrics. : CIRCOT, Mumbai, India.

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