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Influence of Land Configuration and Nutrient Levels on Soil Moisture and Yield of *Bt* Cotton Under Rainfed Situation

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ABSTRACT

A Field experiment was carried out during the Kharif 2016 at Main agriculture research station, University of Agricultural Sciences (UAS), Raichur, to study the effect of land configuration, nutrient management treatments and their integration effect on yield(%) and soil moisture content(%) at sowing, 90 DAS and at final picking of varied depths such as 0-15cm, 15-30cm, 30-45cm and 45-60cm. Significantly higher seed cotton yield was recorded with ridges and furrows (2403 Kg/ha) as compared broad bed and furrows (2222 Kg/ha) and flat bed sowing (1743 Kg/ha). Ridges and furrows was recorded higher soil moisture content at 0-15cm, 15-30cm, 30-45cm and 45-60cm depth of soil at sowing (28.44, 28.46, 29.27 and 29.61 % , respectively) and throughout cropping season. Nutrient levels with application of 90:45:45 NPK kg ha^{-1} (50% N through organic) was recorded higher seed cotton yield (2308 kg ha^{-1}) and soil moisture content over other treatments. Among the interaction ridges and furrows with application of 90:45:45 NPK kg ha^{-1} (50% N through organic) recorded higher seed cotton yield (2834 kg ha^{-1}) and more moisture content over other treatment combinations.

Key words: *Nutrient levels, Bt cotton, Land configurations, Moisture Content, Ridges and furrows, Broad bed and Furrows and flat bed.*

INTRODUCTION

Cotton is one of the most important cash crops commercially grown in major rainfed areas of dry sub-humid agro-climate in central region of India. Average productivity of cotton in India is 504 kg lint kg ha^{-1}, which is lower when compared to the world average of 725 kg lint ha^{-1}. Cotton is grown in 7.8 m ha in 296 districts of which 5.1 m ha is rainfed in sixteen states of the country and about 85 per cent of the rainfed cotton is grown in 30 districts (4.1 m ha). Karnataka ranks the fifth in area with 6.12 lakh ha and the fourth in production with 20 lakh bales of lint and fifth in productivity with an average lint productivity of 556 kg per ha. Major cause for low productivity of cotton is soil moisture stresses, delayed sowing and erratic rainfall. Besides this, there are other reasons for poor cotton yield.

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Drought conditions during flowering and boll development stage (August-September) adversely affects the growth. Available soil moisture at boll formation stage of cotton is very important and if it is less than 18% the plants get early senescence which reduces the cotton productivity. There is ample scope to boost the yield by adopting soil management practices for soil moisture conservation, besides various factors responsible for low productivity, major one as nutrient management influencing nutrient availability. Integrated nutrient management system is an approach through which the management of plant nutrition and soil fertility in farming system is adopted to take organic sources and recycling do not suffice the increase demand for agricultural production on fixed land area, on the other hand chemical fertilizers causes environmental hazards and have economic constraint. Therefore, optional exploitation and combination of sources, organic and inorganic material will be beneficial to increase crop yield, soil health and maintaining the long term productivity.

MATERIALS AND METHODS

A Field experiment was carried out during the *Kharif* 2016 at Main agriculture research station, Raichur, situated on the latitude of $16^0 12^1$ N latitude, $77^0 20^1$ E longitude with an elevation of 389 meters above mean sea level and is located in North Eastern Dry Zone of Karnataka. The experiment was laid out in split plot design with three replication in order to study the effect of land configuration, nutrient management and their integration effect on yield(%) and soil moisture content(%) at sowing, 90 DAS and at final picking of varied depths such as 0-15cm, 15-30cm, 30-45cm and 45-60cm.The main plot comprised of three land configuration treatments viz., M_1:broad bed and furrows, $M_{2:}$ridges and furrows and $M_{3:}$flat bed while the sub plot treatments consisted of nutrient management viz. S_1:60:30:30 NPK kg ha^{-1}, S_2:90:45:45 NPK kg ha^{-1}, S_3:60:30:30 NPK kg ha^{-1} (50% N through organic) and S_4:90:45:45 NPK kg ha^{-1} (50% N through organic). KCH14K59 BG-II (Jaadoo) variety was selected for study. Soil moisture content was measured gravimetrically (oven dry method) by taking the soil samples from each plot with the help of screw auger. The initial weight was measured on the field at the time of sampling and final oven dry weight of soil samples were measured using sensitive weighing balance. For final weight, the soil samples were kept in oven at 105ºC for 24 hours. The soil of the experimental site was deep black and clay in texture with the available nitrogen (192 kg ha^{-1}), phosphorus (30.20 kg ha^{-1}), potassium (207.42 kg ha^{-1}) and organic carbon content (0.50 %). Sowing was done by dibbling on 20th July, 2016.

RESULTS AND DISCUSSION

Effect of land configurations

In the present study, seed cotton yield was significantly influenced by different land configurations significantly among different land configurations higher seed cotton yield was recorded with ridges and furrows (2403 kg ha^{-1}) over broad bed and furrow (2222 kg ha^{-1}) and flat bed (conventional method) (1743 kg ha^{-1}) (Fig. 1). These results are in conformity with findings of Pendke *et al*.[8], Hulihalli and Patil[5], Arora and Bhatt[1] and Kasbe[6] in sorghum.

In rainfed area attempts have been made to conserve as much of rainwater as possible where it falls through land and soil treatments for better *in-situ* moisture conservation. Land configuration, a mechanical measure of *in-situ* moisture conservation in the soil profile reservoir, plays an important role in conservation of maximum possible rainwater in the soil. This can be achieved by cultural and mechanical method of tillage operations, contour cultivation, vertical mulch, ridges and furrows, broad bed furrows, opening of furrow and farm ponds[8]. Improvement in yield with ridges and furrow method of land configuration and earthing up could be attributed to conservation of in-field run-off of water during the season and enhanced entry of rain water into the soil profile for crop use. The resulting improved soil moisture status in the rooting profile helps crop growth, and the method suits especially for Vertisols[7].

In the present investigation, ridges and furrows recorded significantly higher soil moisture at the depths of 0-15, 15-30, 30-45 and 45-60 cm of soil depth (28.44, 28.46, 29.27 and 29.61 %, respectively) at the time of sowing in comparison to conventional flat bed (25.42, 25.92, 26.42 and 26.84, respectively), and thereafter throughout cropping season as evidenced from soil moisture data at 90 and at final picking (Table 1, 2 and 3). These results in line with those of Tarhalkar *et al*.[10], Bhaskar *et al.*[2] and Ravinder *et al.*[9].

Effect of nutrient levels

Persistent use of synthetic fertilizers have resulted in deterioration of soil health and increased environmental pollution. The long-term experiments so far carried out in the country and elsewhere have clearly brought out the urgent need to integrate both organic manures and inorganic fertilizers for sustainable crop production, maintenance of soil fertility and conservation of natural resources. Organic matter improves the soil structure, water holding capacity, soil organic carbon and microorganisms' population. Soil moisture was significantly influenced by nutrient levels at sowing, 90 DAS and at final picking (Table 1, 2 and 3). Significantly higher soil moisture was recorded with nutrient levels of 90:45:45 NPK kg ha^{-1} (50% N through organic) of 0-15, 15-30, 30-45 and 45-60 cm of soil depth and it was on par with 60:30:30 NPK kg ha^{-1} (50% N through organic). Lower soil moisture was recorded with 60:30:30 NPK kg ha^{-1} (100% inorganic alone) and it was on par with 90:45:45 NPK kg ha^{-1} (100% inorganic alone). These results corroborate well with by Bhriguvanshi[3] and Chalwade *et al*[4].

Effect of land configurations and nutrient levels

Cotton being long duration crop needs moisture and balanced nutrients for longer periods especially in rainfed areas to express its potential. There is a linear relation between moisture and availability of nutrients and, therefore, availability of nutrients for has to be enhanced through *in-situ* moisture conservation practices in addition to integrated nutrient management using optimum levels of fertilizers.

Interaction effect of *in-situ* moisture conservation and nutrient levels significantly influenced seed cotton yield (Fig. 1). Among different combinations, land configuration involving ridges and furrows along with application of 90:45:45 NPK kg ha^{-1} (50% inorganic and 50% organics) recorded significantly higher seed cotton yield (2834 kg ha^{-1}), while lower seed cotton yield was recorded with conventional flat bed system along with application of 60:30:30 NPK kg ha^{-1} (1694 kg ha^{-1}) in inorganic form and even higher level of fertilizer in inorganic form 90:45:45 NPK kg ha^{-1} (1763 kg ha^{-1}) was on par.

In the present investigation, combination of ridges and furrows with higher and integrated nutrient use recorded significantly higher soil moisture content during at 90DAS and at final picking at different depths (Table 2 and 3). At 90 DAS ridges and furrows along with 90:45:45 NPK kg ha^{-1} (50% N through organic) had conserved significantly higher moisture content (27.68%) at 0-15 cm depth and was found on par with ridges and furrows along with application of 60:30:30 NPK kg ha^{-1} (50% N through organic) (26.37%). Significantly lower soil moisture content was recorded in flatbed with application of 60:30:30 NPK kg ha^{-1} (17.83%) which was found on par with flatbed along with 90:45:45 NPK kg ha^{-1} (20.03%). Similar trend was noticed at 15-30, 30-45 and 45-60 cm depth also. However, at 15-30 cm, it was not found on par with flatbed along with 90:45:45 NPK kg ha^{-1} similar results were trend was recorded at final picking. Increase in moisture with the former treatments could be ascribed to effectiveness of ridges and furrow system of moisture conservation and applied FYM. Farm yard manure served both as slow releasing nutritional source and as moisture retainer attributed to organic matter directly and indirectly through improvement in soil structure which is so critical in deep black soils. Ridges and furrow reduces the runoff and provide more opportunity time for infiltration.

Fig. 1: Seed cotton yield (Kg ha^{-1}) as influenced by *in-situ* moisture conservation practices and nutrient levels

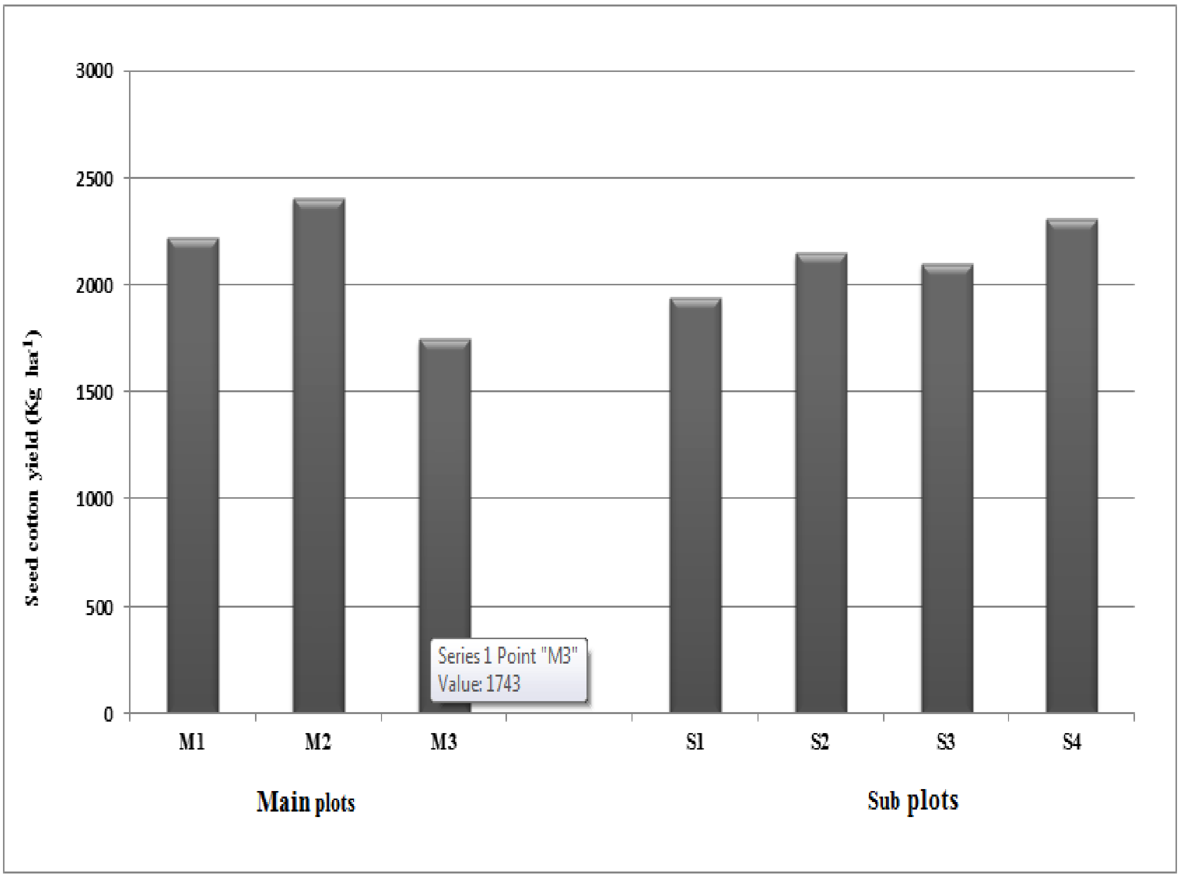

Table 1. Soil moisture at sowing of *Bt* cotton at as influenced by *in-situ* moisture conservation practices and nutrient levels

Treatment	Soil moisture content (%) at sowing															
	0-15 cm depth				15-30 cm depth				30-45 cm depth				45-60 cm depth			
	Main plot															
Sub plot	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	26.67	27.33	25.17	**26.39**	27.00	27.00	24.83	**26.28**	27.33	28.33	25.83	**27.17**	27.33	28.67	26.42	**27.47**
S_2	26.82	27.55	25.51	**26.63**	27.15	27.89	25.84	**26.96**	27.82	28.55	26.51	**27.63**	28.15	28.89	26.84	**27.96**
S_3	27.05	29.67	25.67	**27.46**	27.38	29.33	27.00	**27.91**	28.05	30.00	26.67	**28.24**	28.38	30.33	27.00	**28.57**
S_4	28.13	29.20	25.83	**27.72**	28.46	29.53	26.17	**28.05**	29.13	30.20	26.83	**28.72**	29.46	30.53	27.17	**29.05**
Mean	**27.17**	**28.44**	**25.54**		**27.50**	**28.44**	**25.96**		**28.08**	**29.27**	**26.46**		**28.33**	**29.61**	**26.86**	
Source of varience	**S.Em±**		**C.D. at 5%**		**S.Em±**		**C.D. at 5%**		**S.Em±**		**C.D. at 5%**		**S.Em±**		**C.D. at 5%**	
M	0.50		1.96		0.42		1.66		0.45		1.77		0.33		1.29	
S	0.38		NS		0.48		NS		0.39		NS		0.39		NS	
S at same level of M	0.66		NS		0.83		NS		0.68		NS		0.68		NS	
M at same or different level of S	0.76		NS		0.84		NS		0.74		NS		0.67		NS	

NOTE: N.S.- Not significant

Main plots: In-situ moisture conservation practices

M_1: Broad bed and furrows (BBF)

M_2: Ridges and furrows (R&F)

M_3: Flatbed

Sub plots: Nutrient management (S)

S_1: 60:30:30 NPK kg ha^{-1}

S_2: 90:45:45 NPK kg ha^{-1}

S_3: 60:30:30 NPK kg ha^{-1} (50% N through organic)

S_4: 90:45:45 NPK kg ha^{-1} (50% N through organic)

Table 2: Soil moisture content (%) at 90 DAS of *Bt* cotton as influenced by *in-situ* moisture conservation practices and nutrient levels

Treatment	Soil moisture content (%) at 90 DAS															
	0-15 cm depth				15-30 cm depth				30-45 cm depth				45-60 cm depth			
	Main plot															
Sub plot	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	24.57	25.43	17.83	**22.61**	22.50	25.67	17.88	**22.02**	23.50	26.53	18.70	**22.91**	22.87	26.43	15.50	**21.60**
S_2	24.67	26.33	20.03	**23.68**	22.83	25.83	20.40	**23.02**	23.70	26.83	20.73	**23.76**	23.17	26.33	18.56	**22.74**
S_3	24.83	26.37	23.82	**25.01**	23.03	27.17	20.37	**23.52**	23.92	27.17	22.82	**24.63**	23.37	26.50	22.17	**23.96**
S_4	25.17	27.68	24.50	**25.78**	24.03	27.49	22.17	**24.56**	24.03	27.35	23.17	**24.85**	23.70	27.67	22.67	**24.68**
Mean	**24.81**	**26.45**	**21.55**		**23.10**	**26.54**	**20.20**		**23.79**	**26.97**	**21.35**		**23.28**	**26.67**	**19.72**	
Source of variance	**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**	
M	0.88		3.47		0.31		1.22		0.67		2.62		0.71		2.81	
S	0.55		1.62		0.25		0.73		0.34		1.00		0.62		1.85	
S at same level of M	0.94		2.81		0.43		1.27		0.58		1.73		1.08		3.20	
M at same or different level of S	1.20		3.58		0.48		1.43		0.84		2.49		1.18		3.49	

Main plots: *In-situ* moisture conservation practices (M)
M_1: Broad bed and furrows (BBF)
M_2: Ridges and furrows (R&F)
M_3: Flatbed

Sub plots: Nutrient management (S)
S_1: 60:30:30 NPK kg ha^{-1}
S_2: 90:45:45 NPK kg ha^{-1}
S_3: 60:30:30 NPK kg ha^{-1} (50% N through organic)
S_4: 90:45:45 NPK kg ha^{-1} (50% N through organic)

Table 3: Soil moisture content (%) at final picking of *Bt* cotton as influenced by *in-situ* moisture conservation practices and nutrient levels

Treatment	Soil moisture content (%) at At final picking															
	0-15 cm depth				15-30 cm depth				30-45 cm depth				45-60 cm depth			
	Main plot															
Sub plot	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	12.00	13.25	9.05	**11.43**	12.63	13.90	8.95	**11.83**	13.82	14.47	8.18	**12.16**	13.67	14.33	8.75	**12.25**
S_2	12.33	14.25	11.47	**12.69**	12.73	14.30	10.13	**12.39**	13.95	16.13	10.53	**13.54**	13.83	14.92	9.33	**12.69**
S_3	13.17	16.16	11.56	**13.63**	13.47	16.25	12.05	**13.92**	14.04	16.13	12.68	**14.29**	13.90	15.55	10.98	**13.48**
S_4	13.17	17.72	11.75	**14.21**	13.57	16.85	12.40	**14.27**	14.20	17.28	13.80	**15.09**	14.17	16.67	11.87	**14.23**
Mean	**12.67**	**15.34**	**10.96**		**13.10**	**15.33**	**10.88**		**14.00**	**16.00**	**11.30**		**13.89**	**15.37**	**10.23**	
Source of variance	**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**		**S. Em.±**		**C.D. at 5%**	
M	0.33		1.30		0.74		2.92		0.76		2.99		0.95		3.73	
S	0.31		0.91		0.47		1.40		0.42		1.23		0.22		0.67	
S at same level of M	0.53		1.58		0.81		2.42		0.72		2.14		0.39		1.15	
M at same or different level of S	0.57		1.69		1.03		3.05		0.98		2.92		1.01		2.99	

Main plots: *In-situ* moisture conservation practices (M)
M_1: Broad bed and furrows (BBF)
M_2: Ridges and furrows (R&F)
M_3: Flatbed

Sub plots: Nutrient management (S)
S_1: 60:30:30 NPK kg ha^{-1}
S_2: 90:45:45 NPK kg ha^{-1}
S_3: 60:30:30 NPK kg ha^{-1} (50% N through organic)
S_4: 90:45:45 NPK kg ha^{-1} (50% N through organic)

CONCLUSION

Ridges and furrows, 90:45:45 NPK kg ha^{-1} (50% N through organic) and there interaction recorded higher seed cotton yield (2834 kg ha^{-1}) and more moisture content over other treatment combinations.

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