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Studies on the effect of land configuration and spot application of organic manures on growth and yield of *Bt* cotton (*Gossypium hirsutum* L.)

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Abstract
To study the effect of land configurations and spot application of organic manures on yield of *Bt* cotton under Alfisols of Northern Karnataka was conducted during kharif season 2018–2019. The experiment was at College of Agriculture, Hanumanamatti, Karnataka and it was laid out in split plot design with three replications. The experiment consist of two main plot treatments *viz*., M_1: ridge and furrow method of sowing and M_2: flat bed method of sowing and six sub plot treatments *viz*., S_1: RDF-Control, S_2: RPP-Package of practice, S_3:S_1 + Blanket application FYM @ 5 t ha^{-1}, S_4:S_1 + Spot application FYM @ 5 t ha^{-1}, S_5: S_1 + Blanket application vermicompost @ 2.5 t ha^{-1}, S_6: S_1 + Spot application vermicompost @ 2.5 t ha^{-1}. The two year mean data revealed that plants grown under ridge and furrow method (M_1) of sowing had significantly higher growth and growth attributes, yield and yield attributes. With respect to Sub-plot treatment, (S_6) RDF+ spot application vermicompost @ 2.5 t ha^{-1} recorded significantly higher growth and growth attributes, yield and yield attributes. Among different treatment combination, the $M_1 \times S_6$: plots supplied with RDF+ Spot application of vermicompost @ 2.5 t ha^{-1} (S_6) under ridge and furrow method of sowing (M_1) found to be effective over other treatments.

Keywords: *Bt* cotton, growth parameter, yield parameters, Spot application, Land configuration, *Alfisol*

Introduction
Cotton is most important fiber crop not only in India but of entire world. Cotton in India provides direct livelihood to 6 million farmers. Cotton cultivation consumed 44% of the total pesticides used in the country. The preamble of organic farming has been aimed at conservation and optimized utilization of all natural resources for a reasonable profitability under the guiding factor of sustainability of the agriculture. Constant increasing high cost of chemical fertilizers and organic manure creating economic problems to the small and marginal farmers and on the other hand soils are becoming ill due to imbalance utilization of chemical fertilizers. During last decade, it is quite satisfying to find that organic cultivation proved its way for increased adoption of non-chemical farming. In Northern Karnataka, particularly in Haveri district, cotton productivity is low due to poor distribution of rainfall and low resources investment by farmers. To overcome this problem, 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 as well as chemical fertilizers to combat the environmental hazards and optimal exploitation and combination of organic and inorganic material will be beneficial to increase crop yield, soil health and sustainable productivity. The mixed applications are not only complementary but synergistic as well since organic inputs have beneficial effects beyond their nutritional contents.

Spot application/Banding refers to placing nutrients/manures on one side, or on both sides of the seed or seedlings at planting. Banding fertilizer/ results in improving nutrient availability near the banded site for a longer period of time than broadcasting. Generally, research results have shown under such conditions that only one-half to two-thirds as much fertilizer is required when banded as compared to broadcast. Banding becomes more efficient with more widely spaced rows. (Mahler, 2001) [4].

Keeping these things in view, a study was initiated with an objective to know the effect of the effect of land configuration and spot application of organic manures on dynamic of potassium in Alfisols in *Bt* cotton (*Gossypium hirsutum* L.).

Material and Methods

The experiment was conducted during kharif season of 2018 & 2019 at research farm, College of Agriculture, Hanumanamatti, Ranebennur, Haveri district, which is situated in the Northern Transition Zone (Agro climatic Zone-8) of Karnataka. The soils of the experimental area were red soil with low available nutrients, The result of the chemical analysis indicated that, the soils have pH 7.25 with electrical conductivity 0.50 dSm^{-1} and organic carbon content was 1.75 g ha^{-1}. The available nitrogen, potash and phosphorus content of soil were 182, 225 and 16.8 kg ha^{-1} respectively. The treatment details consist of two main plot treatment *viz*. M_1: ridge and furrow method of sowing and M_2: flat bed method of sowing and six sub plot treatments *viz*., S_1: RDF-Control, S_2: RPP-Package of practice, S_3:S_1 + Blanket application FYM @ 5 t ha^{-1}, S_4:S_1 + Spot application FYM @ 5 t ha^{-1}, S_5: S_1 + Blanket application vermicompost @ 2.5 t ha^{-1}, S_6: S_1 + Spot application vermicompost @ 2.5 t ha^{-1}. The treatments were replicated thrice. The remaining all the cultural and plant protection measures were adopted as per package of practices. The data obtained various parameters were analyzed in RBD statistical procedure (Panse, 1985) [8].

Results and Discussion

I. Effect on growth and growth parameters.

The two year mean data on plant height (cm) and number of sympodial branches per differed significantly due land configuration and organic manures application (table 1). The data showed that, ridge and furrow method (M1) of sowing resulted in significantly higher plant height at 90 and 120 DAS (79.7 cm and 124.5 cm, respectively) over flat bed method (M2) of sowing in which lowest plant height was recorded at 90 and 120 DAS (76.5 and 118.7 cm, respectively). Similarly with respect to sympodial branches, ridge and furrow method (M1) of sowing resulted in significantly higher number of sympodial branches per plant at 90 and 120 DAS (16.2 and 22.2 plant-1, respectively) over flat bed method (M2) of sowing in which lowest number of sympodial branches was recorded at 90 and 120 DAS (15.3 and 20.5 plant-1, respectively). Among sub plot treatments, RDF+ spot application of vermicompost @ 2.5 t ha-1 (S6) recorded significantly higher plant height at 90 and 120 DAS (87.8 and 131.4 cm, respectively) and number of sympodial branches per plant at 90 and 120 DAS (18.5 and 23.4, respectively) and it was on par with sub plot treatments which received, RDF+ spot application of FYM @ 2.5 t ha-1 (S4), RDF+ blanket application of vermicompost @ 2.5 t ha-1 (S4), RPP (S2). Significantly lowest plant height and less number of sympodial branches was noticed RDF only (S1) treatment at 90 and 120 DAS. Among the different treatment combinations (M1S6), ridge and furrow method (M1) of sowing combined with RDF+ spot application of vermicompost @ 2.5 t ha-1 (S6) recorded significantly higher plant height at 90 and 120 DAS (86.4 and 131.5 cm, respectively) and number sympodial per plant at 90 and 120 DAS (18.5 and 24.3 cm, respectively) as compared to other treatment combinations. Significantly lowest plant height and number of sympodial branches per was observed in (M_2S_1). The plants grown under ridge and furrow method (M1) of sowing recorded significantly higher plant height and number of sympodial branches and these results were in similar line with Pore and Bhake (1992) [7] and Gaidhane *et al*. (2007) [2].

Table 1: Plant height and number of Sympodial branches per plant of *Bt* cotton at different growth stages as influenced by land configuration practices and application of organic manures (Mean of two year)

Treatments	Plant height (cm)		Number of Sympodial branches plant^{-1}	
	90 DAS	120 DAS	90 DAS	120 DAS
Main plot (M)				
M_1	79.7	124.5	16.2	22.2
M_2	76.5	118.7	15.3	20.5
S. Em ±	0.8	0.6	0.2	0.17
C.D. (P=0.05)	2.5	1.9	0.7	0.5
Sub plots (S)				
S_1	75.7	115.6	12.4	18.8
S_2	78.7	122.1	15.2	20.6
S_3	75.3	118.5	14.7	19.9
S_4	83.4	127.1	17.1	23.2
S_5	84.2	124.3	16.2	21.7
S_6	87.8	131.4	18.5	23.4
S. Em ±	1.4	2.3	1.0	0.5
C.D. (P=0.05)	4.5	6.8	3.1	1.6
Interactions (M×S):				
M_1×S_1	73.2	116.1	12.8	18.9
M_1×S_2	77.4	124.2	16.2	20.7
M_1×S_3	75.0	127.9	15.1	19.8
M_1×S_4	82.5	130.3	17.9	23.2
M_1×S_5	80.2	129.0	16.7	22.0
M_1×S_6	86.4	131.5	18.5	24.3
M_2×S_1	74.7	115.3	12.6	18.8
M_2×S_2	77.5	121.6	15.4	20.3
M_2×S_3	75.2	118.2	14.8	19.3
M_2×S_4	83.6	125.9	16.9	22.2
M_2×S_5	79.5	126.2	15.8	21.8
M_2×S_6	83.2	129.1	18.0	23.1
S. Em ±	1.8	2.6	1.1	1.2
C.D. (P=0.05)	5.5	7.7	3.5	3.7

M_1: Ridge and furrow method of planting S_5: S_1+Blanket application of Vermicompost @ 2.5t ha^{-1}

M_2: Flatbed method of planting S_6: S_1+ Spot application of Vermicompost @ 2.5t ha^{-1}
S_1: RDF only (Chemical fertilizers) RPP: FYM @ 10 t ha^{-1}+ 180: 90: 90 kg of N P_2O_5 K_2O ha^{-1}
S_2: RPP (Recommended package of practice) RDF: 180: 90: 90 kg of N P_2O_5 K_2O ha^{-1}
S_3: S_1+Blanket application of FYM @ 5t ha^{-1}
S_4: S_1+Spot application of FYM @ 5t ha^{-1}

Table 3: Number of good opened bolls (plant^{-1}), yield per plant and yield of of *Bt* cotton as influenced by land configuration practices and application of organic manures (Mean of two year)

Treatments	Number of bolls (plant^{-1})	Cotton yield (q ha^{-1})	Cotton yield (q ha^{-1})
Main plot (M)			
M_1	45.2	125.5	22.5
M_2	39.7	112.0	19.7
S. Em ±	0.3	0.5	0.3
C.D. (P=0.05)	0.9	1.4	1.0
Sub plots (S)			
S_1	36.1	86.5	16.7
S_2	39.2	101.3	17.8
S_3	36.7	109.5	19.5
S_4	44.8	135.0	26.0
S_5	42.4	110.5	23.7
S_6	47.1	139.8	28.5
S. Em ±	2.14	2.5	2.3
C.D. (P=0.05)	6.51	6.9	6.2
Interactions (M×S):			
M_1×S_1	36.8	94.3	16.5
M_1×S_2	39.2	105.4	19.4
M_1×S_3	37.3	94.8	18.6
M_1×S_4	44.2	131.5	26.3
M_1×S_5	43.0	116.5	23.8
M_1×S_6	48.3	140.5	26.5
M_2×S_1	36.1	90.5	16.2
M_2×S_2	39.5	99.8	19.4
M_2×S_3	36.1	90.0	18.3
M_2×S_4	45.7	128.5	26.8
M_2×S_5	42.5	114.8	22.7
M_2×S_6	46.3	133.5	27.5
S. Em ±	3.08	3.6	2.4
C.D. (P=0.05)	NS	NS	NS

M_1: Ridge and furrow method of planting S_5: S_1+Blanket application of Vermicompost @ 2.5t ha^{-1}
M_2: Flatbed method of planting S_6: S_1+ Spot application of Vermicompost @ 2.5t ha^{-1}
S_1: RDF only (Chemical fertilizers) RPP: FYM @ 10 t ha^{-1}+ 180: 90: 90 kg of N P_2O_5 K_2O ha^{-1}
S_2: RPP (Recommended package of practice) RDF: 180: 90: 90 kg of N P_2O_5 K_2O ha^{-1}
S_3: S_1+Blanket application of FYM @ 5t ha^{-1}
S_4: S_1+Spot application of FYM @ 5t ha^{-1}

I. Effect on yield and Yield parameters

The two-year mean data on number of good opened bolls per plant, yield per plant and cotton yield are influenced significantly due land configuration and organic manures application and are presented in Table 2. The data showed that, ridge and furrow method (M_1) of sowing resulted in significantly higher number of good opened bolls (45.2 plant^{-1}), yield per plant (125.5 g plant^{-1}) and cotton yield (22.5 q ha^{-1}) over flat-bed method (M_2) of sowing in which lowest number of good opened bolls (39.7 plant^{-1}), yield per plant (112.0 g plant^{-1}) and cotton yield (19.7 q ha^{-1}). With respect to the different organic manure application at different forms and doses, RDF+ spot application of vermicompost @ 2.5 t ha^{-1} (S_6) recorded significantly higher number of good opened bolls (47.1 plant^{-1}), yield per plant (139.8 g plant^{-1}) and cotton yield (28.5 q ha^{-1}) and it was on par with sub plot treatments which received, RDF+ spot application of FYM @ 2.5 t ha^{-1} (S_4), RDF+ blanket application of vermicompost @ 2.5 t ha^{-1} (S_4), RPP (S_2). Significantly lowest number of good opened bolls (36.1 plant^{-1}), yield per plant (86.5 g ha^{-1}) and cotton yield (16.7 q ha^{-1}) was observed in RDF only (S_1). Among the different main plot and sub plots treatment combination treatments, The ridge and furrow method (M_1) of sowing combined with RDF+ spot application of vermicompost @ 2.5 t ha^{-1} (S_6) recorded higher number of good opened bolls (48.3 plant^{-1}), yield per plant (140.5 g ha^{-1}) and cotton yield (26.5 q ha^{-1}) as compared to other treatment combinations. Lowest number of good opened bolls (36.1 plant^{-1}), yield per plant (94.5 gm plant^{-1}) and cotton yield (16.2 q ha^{-1}) was observed in RDF under flat-bed method (M_2S_1). However, the other treatment combinations involving ridge and furrow method with spot application of organic manures recorded higher number of good opened boll compared to blanket application of organic manure with fla-bed land. The variation in number of good and yield per plant under study was due to available soil moisture and nutrient availability. These results were similar findings of Mankar *et al.* (2008) [5], Kaynak (1995) [3] and Copur (2006) [1].

Conclusion

Ridge and furrow method of sowing (M_1), RDF+ spot application of vermicompost @ 2.5 t ha^{-1} (S_6) and combination of RDF+ spot application of vermicompost @ 2.5 t ha^{-1} under ridge and furrow method of sowing (M_1S_6) beneficial in enhancing growth and yield in *Bt* cotton in *Alfisols* under rainfed condition found benefited.

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