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Effect of land configuration and nutrient module on nutrient uptake by cotton

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Abstract
A field study entitled "Effect of land configuration and nutrient module on soil fertility and productivity of rainfed cotton in Vertisols" was conducted during *kharif* season of 2012-13 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment comprised of two factors involving land configuration and nutrient module. Land configuration comprised of flat bed, ridges and furrows, opening of furrow after two rows and opening of furrow after each row while nutrient module comprised of five treatments involving RDF 50:25:25 kg NPK ha-1 through chemical fertilizers, FYM @ 10t ha-1 + PSB + Azotobacter, 50% RDF + FYM @ 5t ha-1 + PSB + Azotobacter, vermicompost @2.5t ha-1 + PSB + Azotobacter and glyricidia @ 10t ha-1 + PSB + Azotobacter. Twenty treatment combinations were executed in split plot design with three replications. The results indicated that the opening of furrow in each row at 30-40 DAS and 100% RDF (50:25:25 kg NPK ha-1 through chemical fertilizer) recorded higher nutirent uptake and was found to be on par with ridges and furrows with integrated application of 50% RDF + FYM @ 5t ha-1 + PSB + *Azotobactor*. Hence, it is concluded that integrated application of 50% RDF (25:12.5:12.5 NPK kg ha-1) + FYM @5t ha-1 + PSB + Azotobactor and opening of furrow after each row at 30-40 DAS resulted in higher nutirent uptake of Vertisols under rainfed conditions.

Keywords: Land configuration, nutrient, module, cotton

1. Introduction
Cotton (*Gossypium* sp.) is an important cash crop, globally known as 'King of fiber' and play vital role in the economy of the farmers as well as the country and is popularly known as 'White gold'. It generates employment opportunities to millions not only at the production and trade, its contribution in the foreign exchange is tremendous, still there exist large potential for export of raw cotton and value added products.

In India it is grown over an area of 116.14 lakh ha with the production of 334 lakh bales and productivity of 489 kg ha^{-1}. In Maharashtra, the cotton grown area is 41.46 lakh ha with production of 74 lakh bales and productivity is 303 kg ha^{-1}. Vidarbha, which is famous specially for cotton crop, occupies an area of 14.9 lakh ha with 27.4 lakh bales and the productivity of 312 kg ha^{-1} (Anonymous, 2013) [1].

In Vidarbha, cotton is grown predominantly as a rainfed crop. As such in Vidarbha region about 89% cultivable land is under rainfed farming and rainfed cotton crop production has direct bearing on agrarian economy of region.

Cotton is mostly grown on black cotton soil i.e., Regur/vertisol. Swelling and shrinkage processes occur in all soils but Vertisols and their intergrades show a greater expression of these phenomenon. Though the cotton is an important cash crop of Maharashtra, the productivity is low because most of the area (96-97%) is under rainfed condition (Kaur *et al.*, 2007) [3].

2. Material and Methods
With a view to study the "Effect of land configuration and nutrient module on soil fertility and productivity of rainfed cotton in Vertisols", a field experiment was initiated on the research field of AICRP for Dryland Agriculture, Dr. PDKV, Akola since 2008-09. The study was undertaken during 2012-13 with the cotton crop. The details of material used and methods adopted during the course of investigation are described below under appropriate heads.

The experiment was laid out in split plot design with 20 number of treatment combinations *viz*., the details of various treatment undertaken in the experiment are:
A) Main plot: Land configuration L1: Flat bed, L2: Ridges and furrows, L3: Opening of furrow after every two rows*, L4: Opening of furrow after each row* (*30-40 DAS)
B) Sub plot: Nutrient Module M1: RDF 50:25:25 kg NPK ha-1 through chemical fertilizer, M2: FYM @ 10 t ha^{-1} + PSB + Azotobacter, M3: 50% RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter, M4: Vermicompost @ 2.5 t ha^{-1} + PSB + Azotobacter, M5: Glyricidia @ 10 t ha^{-1} + PSB + Azotobacter.
The quantity of organic manures and chemical fertilizers required for each plot was calculated as per the treatment and were incorporated into soil. Organic manures were incorporated into soil 15 days before sowing of crops, while in chemical fertilizers the 50% nitrogen and full dose of phosphorus and potassium were applied in the form of Urea, SSP, and MOP respectively at the time of sowing as basal dose and remaining half dose of nitrogen was applied as top dressing at 30 DAS.

3. Nutrient uptake by seed cotton
Data pertaining to the effect of land configuration and nutrient module on uptake of nitrogen, phosphorus and potassium by seed cotton

3.1 Nitrogen uptake by seed cotton
A) Land configuration
The effect of land configuration on uptake of nitrogen by seed cotton was found to be significant. The significantly higher nitrogen uptake (28.57 kg ha^{-1}) was recorded in land treatment opening of furrow after each row followed by land treatment ridges and furrows (27.72 kg ha^{-1}) which were found to be on par with each other. The lowest nitrogen uptake (22.74 kg ha^{-1}) was recorded in land treatment flat bed.

B) Nutrient module
The effect of nutrient module on uptake of nitrogen by seed cotton was found to be significant. The significantly higher amount of nitrogen uptake (29.85 kg ha^{-1}) was recorded with the application of 50: 25: 25 kg NPK ha^{-1} through chemical fertilizer (RDF) followed by 50% RDF + FYM @ 5 t ha^{-1}+PSB+ Azotobacter (28.86 kg ha^{-1}) which were found to be on par with each other. The lowest amount of nitrogen uptake (22.09 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha^{-1}+ PSB + Azotobacter. Similar observations were also reported by Krishnan and Lourduraj (1997) [6] and Bharambe and Tomar (2004) [5].

C) Interaction (land configuration x nutrient module)
The interaction effect between land configuration and nutrient module was found to be non significant.

3.2 Phosphorus uptake by seed cotton
A) Land configuration
The effect of land configuration on uptake of phosphorus by seed cotton was found to be significant. Significantly higher amount of phosphorus uptake (5.97 kg ha-1) was recorded in land treatment opening of furrow after each row followed by land treatment ridges and furrows (5.82 kg ha-1) which were found to be on par with each other. The lowest amount of phosphorus uptake (4.65 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module
The data in respect of uptake of phosphorus by seed cotton as influenced by nutrient module was found to be significant. The higher amount of phosphorus uptake (6.37 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg NPK ha-1 through chemical fertilizer (6.25 kg ha-1) which were found to be on par with each other. The lowest amount of phosphorus uptake (4.49 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter.

C) Interaction (land configuration x nutrient module)
The interaction effect between land configuration and nutrient module was found to be non significant with respect to phosphorus uptake by seed cotton (Table 1)

3.3 Potassium uptake by seed cotton
A) Land configuration
The effect of land configuration on uptake of potassium by seed cotton was found to be significant. The higher potassium uptake (8.02 kg ha-1) was recorded in land treatment opening of furrow after each row followed by land treatment ridges and furrows (7.53 kg ha-1) which were found to be on par with each other. The lowest uptake of potassium (6.00 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module
The data in respect of uptake of potassium by seed cotton as influenced by nutrient module was found to be significant. The higher potassium uptake (8.18 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg ha-1 through chemical fertilizer (7.98 kg ha-1) which were found to be on par with each other. The lowest potassium uptake (5.60 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter.

C) Interaction (land configuration x nutrient module)
The interaction effect between land configuration and nutrient module was found to be non significant.

4. Nutrient uptake by cotton stalk
Data pertaining to the effect of land configuration and nutrient module on uptake of nitrogen, phosphorus and potassium by cotton stalk are presented in Table 1.

4.1 Nitrogen uptake by cotton stalk
A) Land configuration
The effect of land configuration on uptake of nitrogen by cotton stalk was found to be significant. The significantly higher amount of nitrogen uptake (17.07 kg ha-1) was recorded in land treatment opening of furrow after each row followed by land treatment opening of furrow after every two rows (15.33 kg ha-1) and land treatment ridges and furrows (15.03 kg ha-1) which were found to be on par with each other. The lowest amount of nitrogen uptake (12.29 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module
The data in respect of uptake of nitrogen by cotton stalk as influenced by nutrient module was found to be significant. The significantly higher amount of nitrogen uptake (17.12 kg ha-1) was recorded with the application of 50: 25: 25 kg NPK

ha-1 through chemical fertilizer (RDF) followed by 50% RDF + FYM @ 5 t ha-1 +PSB+ Azotobacter (16.96 kg ha-1) which were found to be on par with each other. The lowest nitrogen uptake (13.16 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter. Similar findings were also reported by Bharambe and Tomar (2004) [5] and Katkar *et al*. (2007) [8].

C) Interaction (land configuration x nutrient module)
The interaction effect between land configuration and nutrient module was found to be non significant with respect to nitrogen uptake by cotton stalk (Table 4)

Table 1: Effect of land configuration and nutrient module on nutrient uptake by seed cotton

Treatment		Nutrient uptake (kg ha^{-1})		
A]	**Land Configuration**	**N**	**P**	**K**
L1	Flat bed	22.74	4.65	6.00
L2	Ridges and Furrows	27.72	5.82	7.53
L3	Opening of furrow after every two Rows	22.96	4.74	6.15
L4	Opening of furrow after each row	28.57	5.97	8.02
	SE (M) ±	0.57	0.13	0.20
	CD at 5%	1.96	0.47	0.68
B]	**Nutrient Module**			
M1	RDF 50:25:25 kg NPK ha-1 through chemical fertilizer	29.85	6.25	7.98
M2	FYM @ 10 t ha-1 + PSB + Azotobacter	23.27	4.71	6.49
M3	50% RDF + FYM@5 t ha-1 + PSB + Azotobacter	28.86	6.37	8.18
M4	Vermicompost @ 2.5 t ha-1 +PSB + Azotobacter	22.09	4.49	5.60
M5	Glyricidia @10 t ha-1 + PSB + Azotobacter	23.42	4.64	6.38
	SE (m) ±	1.06	0.21	0.32
	CD at 5%	3.06	0.61	0.91
C]	**Interaction**			
	SE (M) ±	1.059	0.423	0.63
	CD at 5%	NS	NS	NS

4.2 Phosphorus uptake by cotton stalk

A) Land configuration
The effect of land configuration on uptake of phosphorus by cotton stalk was found to be non significant. However, numerically higher amount of phosphorus uptake (9.02 kg ha-1) was recorded in land treatment opening of furrow after each row. The lowest amount of phosphorus uptake (6.74 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module
The data in respect of uptake of phosphorus by cotton stalk as influenced by nutrient module was found to be significant. The significantly higher amount of phosphorus uptake (9.91 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg NPK ha-1 through chemical fertilizer (9.51 kg ha-1) which were found to be on par with each other. The lowest uptake of phosphorus (6.63 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter. Similar observations also reported by Bhararmbe and Tomar (2004) [5].

C) Interaction (land configuration x nutrient module)
The interaction effect between land configuration and nutrient module was found to be non significant.

4.3 Potassium uptake by cotton stalk

A) Land configuration: The effect of land configuration on uptake of potassium by cotton stalk was found to be significant. Significantly higher amount of potassium uptake (35.19 kg ha-1) was recorded in land treatment opening of furrow after each row followed by opening of furrow after every two rows (30.85 kg ha-1) which were found to on par with each either. The lowest amount of potassium uptake (25.39 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module: The data in respect of uptake of potassium by cotton stalk as influenced by nutrient module was found to be significant. The significantly higher uptake of potassium (35.10 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg NPK ha-1 through chemical fertilizer (34.97 kg ha-1) which were found to be on par with each other. The lowest potassium uptake (26.77 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter.

C) Interaction (land configuration x nutrient module: The interaction effect between land configuration and nutrient module was found to be non significant with respect to potassium uptake by cotton stalk (Table 2)

Table 2: Effect of land configuration and nutrient module on nutrient uptake by cotton stalk

Treatment		Nutrient uptake (kg ha^{-1})		
A]	**Land Configuration**	**N**	**P**	**K**
L1	Flat bed	12.29	6.74	25.39
L2	Ridges and Furrows	15.03	8.40	30.56
L3	Opening of furrow after every two Rows	15.33	8.14	30.85
L4	Opening of furrow after each row	17.07	9.02	35.19
	SE (M) ±	0.63	0.48	1.26
	CD at 5%	2.17	NS	4.37
B]	**Nutrient Module**			
M1	RDF 50:25:25 kg NPK ha-1 through chemical fertilizer	17.12	9.51	34.97

M2	FYM @ 10 t ha-1 + PSB + Azotobacter	13.57	6.94	27.62
M3	50% RDF + FYM@5 t ha-1 + PSB + Azotobacter	16.96	9.91	35.10
M4	Vermicompost @ 2.5 t ha-1 +PSB + Azotobacter	13.16	6.63	26.77
M5	Glyricidia @10 t ha-1 + PSB + Azotobacter	13.83	7.40	28.03
	SE (m) ±	0.98	0.48	1.97
	CD at 5%	2.84	1.40	5.69
C]	**Interaction**			
	SE (M) ±	1.97	0.97	3.94
	CD at 5%	NS	NS	NS

5. Uptake of nutrients by cotton

Data pertaining to the effect of land configuration and nutrient module on total uptake of nitrogen, phosphorus and potassium by cotton are presented in Table 2.

5.1 Uptake of nitrogen by cotton

A) Land configuration

The effect of land configuration on uptake of nitrogen by cotton was found to be significant. The significantly higher amount of nitrogen uptake (45.64 kg ha-1) was recorded in land treatment opening of furrow after each row followed by ridges and furrows (42.75 kg ha-1) which were found to be on par with each other. The lowest nitrogen uptake (35.03 kg ha1) was recorded in land treatment flat bed.

B) Nutrient module

The data in respects of uptake of nitrogen by cotton as influenced by nutrient module was found to be significant. The higher nitrogen uptake (46.97 kg ha-1) was recorded with the application of 50: 25: 25 kg NPK ha1 through chemical fertilizer (RDF) followed by 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter (45.82 kg ha-1) which were found to be on par with each other. The lowest amount of nitrogen uptake (35.25 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter. It might be due to addition of organic sources with inorganic sources which mainly attributed to the easy availability of plant nutrients resulting in increased uptake of nitrogen. Similar results were reported by Padole *et al*. (1998) [4] and Badole and More (2000) [2].

C) Interaction (land configuration x nutrient module)

The interaction effect between land configuration and nutrient module on uptake of nitrogen by cotton was found to be non significant.

5.2 Uptake of phosphorus by cotton

A) Land configuration

The effect of land configuration on uptake of phosphorus by cotton was found to be significant. The significantly higher amount of phosphorus uptake (14.99 kg ha-1) was noticed in land treatment opening of furrow after each row followed by ridges and furrows (14.22 kg ha-1) which were found to be on par with each other. The lowest amount of phosphorus uptake (11.39 kg ha-1) was recorded in land treatment flat bed.

B) Nutrient module

The data in respect of total uptake of phosphorus by cotton as influenced by nutrient module was found to be significant. The higher phosphorus uptake (16.28 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 t ha1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg NPK ha-1 through chemical fertilizer (15.76 kg ha-1) which were found to be on par with each other. The lowest uptake of phosphorus (11.12 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter.

C) Interaction (land configuration x nutrient module)

The interaction effect between land configuration and nutrient module was found to be non significant with respect to phosphorus uptake by cotton (Table 3).

Table 3: Effect of land configuration and nutrient module on nutrient uptake by cotton

Treatment		**Nutrient uptake (kg ha^{-1})**		
A]	**Land Configuration**	**N**	**P**	**K**
L1	Flat bed	35.03	11.39	31.39
L2	Ridges and Furrows	42.75	14.22	36.71
L3	Opening of furrow after every two Rows	38.29	12.88	37.00
L4	Opening of furrow after each row	45.64	14.99	43.21
	SE (M) ±	1.06	0.59	0.61
	CD at 5%	3.67	2.06	2.01
B]	**Nutrient Module**			
M1	RDF 50:25:25 kg NPK ha-1 through chemical fertilizer	46.97	15.76	42.95
M2	FYM @ 10 t ha-1 + PSB + Azotobacter	36.84	11.65	34.11
M3	50% RDF + FYM@5 t ha-1 + PSB + Azotobacter	45.82	16.28	43.28
M4	Vermicompost @ 2.5 t ha-1 +PSB + Azotobacter	35.25	11.12	32.37
M5	Glyricidia @10 t ha-1 + PSB + Azotobacter	37.25	12.04	34.41
	SE (m) ±	1.34	0.51	0.55
	CD at 5%	3.87	1.48	1.59
C]	**Interaction**			
	SE (M) ±	2.68	1.02	1.10
	CD at 5%	NS	NS	NS

5.3 Uptake of potassium by cotton

A) Land configuration

The effect of land configuration on uptake of potassium by cotton was found to be significant. The significantly higher uptake of potassium (43.21 kg ha-1) was noticed in land treatment opening of furrow after each row. The lowest potassium uptake (31.39 kg ha-1) was noticed in land treatment flat bed.

B) Nutrient module

The data in respect of uptake of potassium by cotton as influenced by nutrient module was found to be significant. The higher potassium uptake (43.28 kg ha-1) was recorded with the application of 50% RDF + FYM @ 5 ha-1 + PSB + Azotobacter followed by RDF 50: 25: 25 kg NPK ha1 through chemical fertilizer (42.95 kg ha-1) which were found to be on par with each other. The lowest potassium uptake (32.37 kg ha-1) was recorded with the application of vermicompost @ 2.5 t ha-1 + PSB + Azotobacter. It might be due to addition of organic sources with inorganic sources which mainly attributed to the easy availability of plant nutrients resulting in increased uptake of potassium. Similar findings were also reported by Badole and More (2000) [2] and Katkar *et al.* (2002) [7].

C) Interaction (Land configuration x nutrient module)

The interaction effect between land configuration and nutrient module on uptake of potassium by cotton was found to be non significant.

6. Summary

Significantly highest uptake of N (28.57 kg ha-1), P (5.97 kg ha-1) and K (8.02 kg ha-1) by seed cotton was observed in land treatment opening of furrow after each row followed by ridges and furrows, which were found to be on par with each other. The significantly higher N (17.07 kg ha-1) and K uptake (35.19 kg ha-1) by cotton stalk were recorded in land treatment opening of furrow after each row followed by opening of furrow after every two rows, which were found to be on par with each other in respect of N (15.33 kg ha-1) and K (30.85 kg ha-1) uptake respectively. The significantly higher uptake of N by seed cotton (29.85 kg ha-1) and cotton stalk (17.12 kg ha-1) were recorded with the application of 50: 25: 25 kg NPK ha-1 through chemical fertilizer (RDF) and was on par with application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter in respect of N uptake by seed cotton (28.86 kg ha-1) and cotton stalk (16.96 kg ha-1) respectively. Similarly, significantly higher P(6.37 kg ha-1) and K (8.18 kg ha-1) uptake by seed cotton and 9.91 kg ha-1 P and 35.10 kg ha-1 K uptake by cotton stalk were recorded with the application of 50% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter and was on par with RDF 50: 25: 25 kg NPK ha-1 through chemical fertilizer in respect of P (6.25 kg ha-1) and K (7.98 kg ha-1) uptake by seed cotton and 9.51 kg ha-1 P and 34.97 kg ha-1 K uptake by cotton stalk respectively.

7. Conclusions

It is concluded that integrated application of 50% RDF (25:12.5:12.5 NPK kg ha-1) + FYM @ 5t ha-1 + PSB + Azotobactor and opening of furrow after each row at 30-40 DAS resulted in higher nutrient uptake of Vertisols under rainfed conditions.

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