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Effect of Land Configuration and Fertilizer Management Practices on Growth, Yield and Yield Attributes and Economics of Summer Cowpea (*Vigna unguiculata* L.) under South Gujarat Condition

J.R. Joshi[1*], V.M. Patel[1], H.L. Barad[1], S.M. Macwan[1] and Javid Ehsas[1]

[1]Pulses and Castor Research station, N.A.U., Navsari, Gujarat, India
[2]Department of Agronomy, N.M. College of Agriculture, N.A.U., Navsari,

**Corresponding author*

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A B S T R A C T

A field experiment was carried out during summer 2015 at the Pulses and Castor Research station, Navsari Agricultural University, Navsari to evaluate land configuration and fertilizer management practices on growth and yield parameters, yield, quality and economics of cowpea (*Vigna unguiculata* L.) cultivation. Experimental plot was clayey soil having a pH 7.95 and poor in available nitrogen (210 kg/ha), medium in available phosphorus (35.15 kg/ha) and considerably rich in available potash (340.50 kg/ha). To study three methods of land configuration *viz*., (flat bed, ridge and furrow and raised bed) and five fertilizer management practices (FYM 4 t/ha, bio-compost 2 t/ha, FYM 2 t/ha + 50% RDF, bio-compost 1t/ha + 50% RDF and 100% RDF) were evaluated in split plot design with three replications. The raised bed method of planting was recorded significantly higher growth and yield attributes, seed yield (921 kg ha^{-1}), stover yield (1992 kg ha^{-1}), net returns ((₹ 36,692 ha^{-1}) and BCR ratio (3.12) than flatbed method of sowing. Application of 100% recommended dose of fertilizer gave significantly higher valve for all growth and yield attributes, seed yield, stover yield, net returns and BCR ration than other treatments.

Introduction

Pulses are considered as an important part of food crop occupying a unique position in agriculture and also an important component of food grain crops because of their high nutritive value. Pulses have inherent capacity to fix atmospheric nitrogen and adaptability to a wide range of agro-ecological cropping systems and management ability. Cowpea (*Vigna unguiculata* L.) is a multipurpose *kharif* and warm season pulse crop. It is more cosmopolite and grown in most of the regions of India which showed very encouraging results and promises to meet pulse production. It is grown for its long green pods as vegetables, seeds and pulses, as green manure, as well as green fodder. In India, it is cultivated in 654 lakh ha with an annual production of 599 lakh tonnes leading to average productivity of 916 kg ha^{-1} (Anonymous, 2015).

Cultivation of cowpea in summer season is increasing in Gujarat, especially in South Gujarat where perennial water supply from Ukai- Kakrapara project is available to meet the demand of irrigation. But, pulses crop are very sensitive to water logging and salt injury. Poor quality irrigation water is the important factors for low productivity of summer season crop in south Gujarat. The land configuration can play an important role for easy and uniform germination as well as growth and development of plants. It is particular useful in areas having poor quality of irrigation water because it helps to avoid direct contact of young plants with saline irrigation water. Raised bed method of sowing has been found helpful to minimize the effect of temporary water logging and salt injury of plants (Dhimmar, 2003; Akbar *et al.*, 2007).

Fertilizers play vital role in maintaining/ improving soil fertility status as the readily available nutrient to plants. Inadequate or excess supply of any plant nutrient limit may the crop production. Among the plant nutrients, nitrogen and phosphorus are the most important and expensive nutrient and it has marked effect on the plant growth in pulses crops. Cowpea being a leguminous crop, utilize atmospheric nitrogen through symbiotic nitrogen fixation to meet a major parts of its nitrogen requirement. The formation of root nodule and nitrogen fixation starts at about 15-20 days after sowing. Thus, a starter does of nitrogen may be required for boosting the initial growth stage. Phosphorus has been found to be limited factor in legume production. It promotes the flowering and aids in setting of pods. It plays a vital role in nodulation and improves the protein content in legume crops. The present study was therefore, undertaken to evaluate the effect of land configuration and fertilizer management practices on productivity profitability of summer season cowpea under south Gujarat condition.

Materials and Methods

The experiment was conducted at farm of Pulses and Castor Research Station, Navsari Agricultural University, Navsari (Gujarat) to study the response of summer cowpea (*Vigna unguiculata* L.) to land configuration and fertilizer management practices under south Gujarat condition during summer season of the year 2015.The experimental plot was geographically located at 20º 57' N latitude and 72º 54' E longitude at an altitude of 10 meters above the mean sea level. Navsari is coming under south Gujarat heavy rainfall zone. The climate of this region is characterized by fairly hot summer, moderately cold winter and humid and warm monsoon with heavy rainfall. The soil of experimental plot was clayey in texture with 7.95 pH, low in available nitrogen (210 kg/ha), medium in available phosphorus (35.15 kg/ha), fairly rich in available potassium (340.50 kg/ha) as well as slightly alkaline in reaction. There were fifteen treatment combinations consisting of three methods of land configuration *viz*., (flat bed, ridge & furrow and raised bed) and five fertilizer management practices (FYM 4 t/ha, bio-compost 2 t/ha, FYM 2 t/ha + 50% RDF, bio-compost 1t/ha + 50% RDF and 100% RDF). These were evaluated in split plot design, where method of land configuration sowing were allocated to main plots, while fertilizer management practices were assigned to sub-plots and replicated thrice. The raised beds were prepared by using tractor drawn raised bed maker and ridge and furrow were prepared by manually. Gujarat cowpea 4 (GC 4) variety was sown on 24th February, 2015 at a row spacing of 45 X 10 cm (Normal) and 30 X 30 X 45 X 10 cm (pair row on raised bed) using seed rate of 25 kg/ha and fertilized with 20-40-00 N-P2O5-K2O/ha. The experimental plot was manured as per treatments with organic fertilizer and chemical fertilizer before sowing of crop. The require quantity of FYM

and biocompost as well as chemical fertilizer in the form of urea and DAP (Diammonium phosphate) manually applied in opened furrows as per treatment before sowing. Gap filling and thinning were done when necessary and harvesting was done when crop was fully matured.

Results and Discussion

Growth attributes

Cowpea plants exhibited significant response to various land configurations and fertilizer management practices on growth attributes. The periodical observation *viz*., plant height, dry matter accumulation and number of nodules per plant (Table 1) at 60 DAS and harvest stage showed significant difference due to land configuration methods except at number of branches per plant and day to 50% flowering.

The maximum values for plant height (43.09, 45.37 cm), dry matter accumulation per plant (25.17, 36.33 g) and number of nodules per plant (53.57, 47.60) at 60 DAS and at harvest were recorded under raised bed method of sowing than flatbed method of sowing. This might be due to maintain of proper air moisture regimes under raised bed method of sowing which improved supply of required moisture, available nutrients, soil aeration and better soil environment ultimately resulted in better growth and development of crop.

Sowing on raised bed was particularly helpful as experimental soil content was highly clay (66.40%) is susceptible to waterlogging problem for over irrigation. The findings are in complete agreement with earlier work done by Shete *et al.*, (2010), Jat *et al.*, (2012) and Shinde (2012).

Application of 100% recommended dose of fertilizers (RDF) resulted in significantly higher plant height, dry matter accumulation and number of nodules per plant at 60 day after sowing and harvest stage but, it was statistically Sam bar with application of 50% RDF + FYM 2 t/ha over other treatments.

Improvement in growth attributes due to application of inorganic fertilizer enhanced the availability of nutrients especially nitrogen which is mainly responsible for vegetative growth and phosphorus played important role in root development and increased nodule activity in plant. These results confirm the findings of Abayomi *et al.,* (2008), Choudhary and Yadav (2011) and Khandelwal *et al.*, (2013).

Yield attributes and yield

Land configuration methods did not influence significantly for number of seeds per pod and 100 seed weight (Table 2). While number of pods per plant and yield was influenced significantly.

Number of pods per plant was significantly higher under raised bed method of sowing as compared to flatbed method of sowing. The better performance of cowpea crop observed in term of plant height, dry matter accumulation per plant and number of root nodules per plant obtained under raised bed method of sowing which ultimately reflected in higher number of pods per plant of summer cowpea.

Further, higher number of pods per plant under raised bed method of sowing resulted in significantly higher seed yield (921 kg ha^{-1}). The increased in seed yield under raised bed was 21.02 % over flatbed methods of sowing. Similar trend was also observed for stover yield (1992 kg ha^{-1}) of cowpea because of higher dry matter accumulation per plant under raised bed method of sowing.

Table.1 Effect of land configuration and fertilizer management practices on growth and growth attributes of summer cowpea (*Vigna unguiculata* L.) under south Gujarat condition

Treatments	Plant height (cm)		Number of nodules per plant		Dry matter accumulation per plant (g)		Number of branches per plant		Days to 50% flowering
	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	
(A) Land configuration									
L_1: Flat bed	37.90	39.28	45.50	39.71	22.39	30.27	3.61	4.05	44.47
L_2: Ridge and furrow	41.02	43.13	50.51	45.54	24.60	34.55	3.80	4.24	44.60
L_3: Raised bed	43.09	45.37	53.57	47.60	25.17	36.33	3.82	4.32	45.13
S. Em. ±	1.12	1.22	1.70	1.17	0.55	0.98	0.07	0.10	0.71
C. D. (P=0.05)	4.42	4.79	6.67	4.61	2.17	3.86	NS	NS	NS
C. V. %	10.71	11.09	13.20	10.27	8.89	11.30	7.37	9.62	6.18
(B) Fertilizer management									
F_1: FYM (4 t ha^{-1})	39.69	41.23	46.44	41.52	22.76	32.23	3.69	4.16	44.22
F_2: BC (2 t ha^{-1})	36.72	38.57	44.22	40.10	21.79	29.81	3.61	4.04	43.56
F_3: 50 % RDF + FYM (2 t ha^{-1})	41.96	43.70	53.58	47.55	25.51	35.19	3.80	4.24	45.00
F_4: 50 % RDF + BC (1 t ha^{-1})	40.61	42.59	49.71	43.44	24.11	33.66	3.73	4.20	44.44
F_5: 100 % RDF	44.38	46.88	55.36	48.82	26.09	37.68	3.89	4.38	46.44
S. Em. ±	1.22	1.36	1.85	1.40	0.65	0.97	0.08	0.12	0.70
C. D. (P=0.05)	3.57	3.96	5.40	4.08	1.90	2.83	NS	NS	NS
C. V. %	9.01	9.54	11.13	9.48	8.12	8.63	6.26	8.63	4.73

Table.2 Effect of land configuration and fertilizer management practices on yield, yield attributes and quality of summer cowpea (*Vigna unguiculata* L.) under south Gujarat condition

Treatments	Number of pods per plant	Number of seeds per pod	100 seeds weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha$^{-1)}$	Harvest index (%)	Protein content (%)	Protein yield (kg ha^{-1})
(A) Land configuration								
L_1: Flat bed	9.24	10.11	10.60	761	1704	30.80	19.60	149.67
L_2: Ridge and furrow	10.35	10.33	11.05	853	1871	31.24	20.08	171.42
L_3: Raised bed	11.04	10.49	11.18	921	1992	31.51	20.29	187.14
S. Em. ±	0.24	0.14	0.20	24.7	43.3	0.32	0.32	7.21
C. D. (P=0.05)	0.93	NS	NS	97	170	NS	NS	28.30
C. V. %	9.02	5.13	7.18	11.31	9.05	4.01	6.14	16.48
(B) Fertilizer management								
F_1: FYM (4 t ha^{-1})	9.60	9.96	10.82	791	1779	30.74	19.80	157.07
F_2: BC (2 t ha^{-1})	9.24	9.57	10.57	759	1713	30.62	19.69	149.79
F_3: 50 % RDF + FYM (2 t ha^{-1})	10.60	10.60	11.06	882	1925	31.38	20.19	178.60
F_4: 50 % RDF + BC (1 t ha^{-1})	10.33	10.39	10.95	846	1854	31.29	20.03	169.09
F_5: 100 % RDF	11.27	11.04	11.32	948	2007	31.88	20.23	192.49
S. Em. ±	0.28	0.17	0.25	29.5	43.6	0.36	0.34	7.41
C. D. (P=0.05)	0.81	0.48	NS	86	127	NS	NS	21.64
C. V. %	8.19	4.82	6.89	10.49	7.05	3.48	5.12	13.13

Table.3 Effect of land configuration and fertilizer management practices on economics of summer cowpea (*Vigna unguiculata* L.) under south Gujarat condition

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha$^{-1)}$	Gross realization (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})			Cost of cultivation (₹ ha^{-1})	BCR
				Fixed cost (₹ ha^{-1})	Variable cost (₹ ha^{-1})	Total cost (₹ ha^{-1})		
(A) Land configuration								
L_1: Flat bed	761	1704	44866	15526	0	15526	29340	2.89
L_2: Ridge and furrow	853	1871	50134	15526	1200	16726	33408	3.00
L_3: Raised bed	921	1992	54018	15526	1800	17326	36692	3.12
(B) Fertilizer management								
F_1: FYM (4 t ha^{-1})	791	1779	46666	15526	12000	27526	19140	1.70
F_2: BC (2 t ha^{-1})	759	1713	44802	15526	11000	26526	18276	1.69
F_3: 50 % RDF + FYM (2 t ha^{-1})	882	1925	51800	15526	7073	22599	29201	2.29
F_4: 50 % RDF + BC (1 t ha^{-1})	846	1854	49716	15526	6573	22099	25617	2.25
F_5: 100 % RDF	948	2007	55428	15526	2147	17673	37755	3.14

This might due to the cumulative effect exerted from improvement in soil environment, aeration, root development, optimum moisture-air equilibrium throughout the crop growth period besides easily supply of available nutrients to the crop resulted in better growth and development ultimately reflected in higher seed and stover yields. The results are in accordance with finding of Pramanik *et al.,* (2009), Shete *et al.,* (2010), Jat *et al.,* (2012) and Shinde (2012). Application of 100% RDF significantly improved yield attributes and yield over other treatments. Significantly higher values for number of pods per plant, number of seeds per pod were recorded under treatment receiving 100 % RDF than other treatments. The higher value of yield attributes with application of100% RDF were largely attributed to better growth of plant in term of plant height, dry matter accumulation per plant and number of root nodules per plant which resulted in higher production of photosynthates were utilized by the plant for development of sink under adequate supply of nutrients through recommended dose of fertilizers gave higher number of pods per plant and number of seeds per pod. The present findings are in agreement with those reported by Abayomi *et al.,* (2008) and Das *et al.,* (2011). Similarly, seed yield and stover yield were also recorded significantly higher with application of 100% RDF than other treatments. Application of 100% RDF gave 24.90% and 17.16% higher seed and stover yield than application of biocompost 2 t/ha, respectively. The higher yield under these treatments might be due to cumulative effect of better yield attributes (number of pods per plant and number of seeds per pod) and higher nutrient uptake by cowpea. The positive response in terms of seed and stover yield of cowpea to inorganic fertilizer have also reported by Channabasappa *et al.,* (2004), Patel *et al.,* (2010), Choudhary and Yadav (2011), Choudhary *et al.,* (2013), and Verma *et al.,* (2014).In case of harvest index (Table 2), there is no significant difference in land configurations and fertilizer management practices.

Quality control

Different land configuration methods and fertilizer management practices did not exert any significant effect on protein content (Table 2) whereas, it had significant effect on protein yield (Table 2). Significantly higher protein yield (187.14kg ha^{-1}) was noted under raised bed method of sowing as compared to flatbed method of sowing. This increase in protein yield was mainly due to higher seed yield under raised bed method of sowing. The result was confirmed by Jat *et al.,* (2012) and Shinde (2012). The results (Table 2) revealed that various fertilizer management practices had significant effect on protein yield. The higher protein yield (192.49 kg ha^{-1}) was noted with treatment 100 % RDF than other treatments. The higher protein yield with these treatments might be due to higher seed yield. Similar findings were also reported by Dekhane *et al.,* (2011) and Verma *et al.,* (2014).

Economics

Economics is the major consideration for the farmers while taking a decision regarding the adoption of new technology. Raised bed method of sowing recorded higher net returns (₹ 36,692 ha^{-1}) and benefit cost ratio (3.12) over flatbed method of sowing (Table 3). This was due to higher yield of seed and stover under raised bed method of sowing. These results are conformity with those reported by Pramanik *et al.,* (2009) and Jat *et al.,* (2012). Application of 100% RDF recorded higher net returns (₹ 37755 ha^{-1}) and benefit cost ratio (3.14) as compared to other treatments. The higher net returns and BCR under these treatments was mainly due to higher yields

and low cost of cultivation. Similar results were also reported by Choudhary *et al.*, (2013), Khandelwal *et al.*, (2013) and Verma *et al.*, (2014).

It can be concluded that summer cowpea var. GC 4 should be sown on raised bed method (90 cm width X 45 cm wide and 30 cm deep furrow) and fertilized with 100% recommended dose of fertilizer (20:40:00 kg $N:P_2O_5:K_2O$ ha^{-1}) under South Gujarat condition for obtaining higher yield and monetary returns.

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