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**Research Paper**

# Response of saline water irrigated greengram (*Vigna radiata*) to land configuration, fertilizers and farm yard manure in Tapi command area of south Gujarat

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## ABSTRACT

A field experiment was conducted during 2008-09 and 2009-10 post-rainy seasons at Navsari, Gujarat to evaluate the effects of land configuration, fertilizers and farm yard manure (FYM) application on productivity, water use efficiency, nutrient uptake, soil fertility status and the economics of green gram (*Vigna radiata* L.) cultivation. The raised bed method of planting was found superior as was evident from significant increase in growth and yield attributes, grain (0.93 t/ha) and stover yield (2.27 t/ha), irrigation water use efficiency (IWUE), nitrogen (N), phosphorus (P) and potassium (K) uptake, net returns (₹37.6 × $10^3$/ha) and B:C ratio (3.9) and decrease in plant mortality percent. Application of 100% recommended dose of nitrogen (20 kg/ha) and phosphorus (40 kg $P_2O_5$/ha) recorded significantly higher growth and yield attributes, grain and stover yield, IWUE, NPK uptake, available NPK in the soil, net returns and B:C ratio over the application of 75% of recommended dose of N and P. Similarly, the application of FYM at 5t/ha recorded statistically higher growth and yield attributes, grain and stover yield, IWUE, NPK uptake, available NPK in the soil after harvest, net returns and B:C ratio and decrease in plant mortality percent over no FYM application.

***Key words :*** Farm yard manure, Greengram, Irrigation water use efficiency, Nitrogen, Phosphorus, Raised-bed planting



Rice (*Oryza sativa*) followed by rice is the most dominant cropping sequence in the *Tapi* command area of south Gujarat due to its higher productivity and profitability. But during low rainfall years and limited or unavailability of canal water, farmers have to grow crops other than rice during the post-rainy (*rabi*) season and due to favourable agro-climatic conditions and short growing period, green gram is the preferred post-rainy season crop. Cultivation of green gram during the post-rainy season gives higher yield due to favourable soil moisture regime, less attack of insect pests and diseases, and enhanced photosynthetic activity due to clear skies. There is need to standardize agronomic practices for the cultivation of post rainy season green gram in south Gujarat. Satisfactory crop establishment through suitable land configuration methods is important as heavy black soils (Vertisols) of this region are prone to temporary waterlogging after irrigation due to low infiltration rate particularly, in the fields used for growing lowland paddy in the preceding rainy season. Waterlogging even for a short period proves detrimental to the crop of green gram particularly during the early growth phase. Further, when canal water is not available farmers have to use ground water for irrigation which is saline in nature due to proximity to the sea coast, and greengram being sensitive to salinity hazard, suitable land configuration becomes important for successful cultivation of greengram. Raised bed method of sowing has been found helpful to minimize the effects of temporary waterlogging and salt injury on plants (Dhimmar, 2003 and Akbar *et al.,* 2007).

Farm yard manure (FYM) is known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties, and balanced plant nutrition (Kumar *et al.,* 2011). Fertilizers play vital role in maintaining/improving soil fertility as the sources of readily available nutrients to plants. It is thus, imperative to evaluate the effects of FYM application in conjunction with chemical

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fertilizers on the growth and yield of post-rainy season greengram in Vertisols of south Gujarat. Application of a starter dose of nitrogen (N) through chemical fertilizers meets the nitrogen needs of the plants during the early phase when biological nitrogen fixation has not commenced, while phosphorus (P) is essential for root development in young plants. The present study was therefore, undertaken to evaluate the effects of raised bed method of sowing, fertilizer rates and FYM application on productivity, profitability and sustainability of post-rainy season green gram grown, irrigated with saline water, on Vertisols of south Gujarat.

## MATERIALS AND METHODS

The experiment was conducted at the Practical Crop Production Farm of Navsari Agricultural University, Navsari to study the effect of land configuration, fertilizer rates and FYM on growth, yield, soil fertility and economics of post-rainy season greengram during two consecutive post-rainy seasons in 2008-09 and 2009-10. The experimental site is geographically located at 20˚ 57´ N latitude and 72˚ 54´ E longitude at an altitude of 10 m above the mean sea level. The experimental soil was a Vertisol (Ustocrepts, Jalalpur series; 66.25% clay), alkaline in reaction (pH 7.8), low in available N (225.0 kg/ha), medium in available-P (15.41 kg/ha) and high in available-K (291.66 kg/ha). The treatments included eight combinations of two levels of land configuration (flat bed and raised bed planting), two levels of fertilizer rates (100 % of recommended dose of N and $P_2O_5$ and 75 % of recommended dose of N and $P_2O_5$) and two levels of FYM (0 and 5tFYM/ha). The recommended dose of N and and P was 20 and 17.6 kg/ha, respectively. The experiment was laid out in factorial randomized block design with four replications. Just after the harvest of the preceding paddy crop, field was irrigated and prepared for the sowing of green gram using two cross-cultivations and two harrowing operations, followed by planking with a wooden beam attached behind a tractor to reduce clod size. The raised beds were prepared by opening deep furrows at predetermined spacing with tractor mounted 'ditcher' and spreading the excavated soil on either side of the furrows manually to prepare raised beds. The size of raised beds was 3.6 × 4.5 m with each bed accommodating 12 rows of greengram. N and P were applied as per treatments through urea (46.0% N) and single super phosphate (16.0% $P_2O_5$), respectively as basal dose. FYM was applied as per the treatment and was manually incorporated into the upper 15 cm soil depth. Green gram 'CO- 4' was sown on 25 and 18 November and harvested on 15 and 10 March in 2008-09 and 2009-10, respectively. The crop was sown with tractor drawn seed drill using recommended seed rate of 20 kg/ha and maintaining spacing of 30 × 10 cm. Thinning of plants was done 25 days after sowing to remove extra plants. In addition to one pre-sowing irrigation for the field preparation, the crop was given a total of six irrigations during the growing season using borewell water (EC 2.75 dS/m). There was no serious insect-pest attack or disease infestation during the crop growth period. Irrigation water use efficiency (IWUE) was computed by dividing seed yield (kg/ha) with total amount of water applied (mm) for raising the crop, and is expressed as kg /ha-mm of water used. Economic analysis of the data was done based on the prevailing cost of inputs/ operations and price of the marketable produce. The data collected from the experiment were subjected to statistical test by following 'Analysis of variance technique' as suggested by Panse and Sukhatme (1985).

## RESULTS AND DISCUSSION

### *Growth attributes*

Growth attributes *viz.* plant height, dry matter accumulation, branches per plant, number of nodules per plant and nodule weight/plant showed significant improvement under raised bed method of sowing as compared to flat bed method of sowing (Table 1). Improvement in growth attributes may be attributed to favourable aeration-moisture regime under the raised bed sowing due to seepage of extra irrigation water out of beds into furrows, leading to a more conducive environment for better root growth and respiration and higher soil biological activity as compared to conventional sowing on flat beds. Sowing on raised beds was particularly helpful as the experimental soil with high clay content (66.25%) is susceptible to waterlogging. These results confirm the findings of Dhimmar (2003). Application of 100 % recommended dose of fertilizers (RDF) recorded significantly higher plant height, dry matter accumulation, number of branches per plant, number of nodules per plant and nodule weight per plant as compared to the application of 75% of RDF. This was likely due to adequate supply of N and P to the plants with the application of 100% RDF. External supply of N in adequate amount at planting is crucial for the establishment and initial growth of plants when plants do not receive biologically fixed nitrogen. Similarly, P plays an important role in root development and proliferation thus, influencing overall nutrient and water uptake by plants. P increases nitrogenase activity of root nodules, which results in improved biological N fixation. These results confirm the findings of Ambhore (2004). Significant increase in all the growth parameters was recorded with the application of FYM at 5 t/ha as compared to no FYM application. This is likely due to balanced supply of nutrients to crop plants with FYM application besides, favourable effects of FYM

**Table 1.** Effects of land configuration, fertilizer rates and farm yard manure application on growth and yield attributes, yield, harvest index, protein content in seed and economics of green gram grown during post-rainy season (Pooled data of two years)

| Treatment | Plant height (cm) | Dry matter production/ plant (gm) | Branches/ plant | Nodules/ plant | Nodule weight/ plant (mg) | Pods/ plant | Seeds/ pod | 100-seed weight (gm) | Grain yield (t/ha) | Stover yield (t/ha) | Harvest index (%) | Protein in seed (%) | Net returns (× $10^3$ ₹/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Land configuration methods* | | | | | | | | | | | | | | |
| Flat bed method | 41.6 | 16.2 | 4.0 | 16.2 | 20.1 | 22.8 | 7.6 | 4.4 | 0.83 | 2.12 | 28.0 | 19.6 | 31.9 | 3.6 |
| Raised bed method | 44.2 | 17.2 | 4.3 | 17.2 | 21.2 | 25.6 | 8.2 | 4.8 | 0.93 | 2.27 | 29.5 | 20.2 | 37.6 | 3.9 |
| SEm± | 0.7 | 0.3 | 0.1 | 0.3 | 0.4 | 0.4 | 0.1 | 0.1 | 0.01 | 0.04 | 0.3 | 0.3 | 0.5 | 0.06 |
| CD (P=0.05) | 2.0 | 0.8 | 0.2 | 0.8 | 1.0 | 1.1 | 0.4 | 0.2 | 0.04 | 0.11 | NS | NS | 1.6 | 0.18 |
| *Inorganic Fertilizers* | | | | | | | | | | | | | | |
| 75% RDF | 41.9 | 16.3 | 4.1 | 16.2 | 20.1 | 22.9 | 7.5 | 4.4 | 0.83 | 2.13 | 28.3 | 19.7 | 32.6 | 3.6 |
| 100% RDF | 44.0 | 17.2 | 4.3 | 17.2 | 21.2 | 25.5 | 8.3 | 4.7 | 0.93 | 2.27 | 29.2 | 20.2 | 36.8 | 3.9 |
| SEm± | 0.7 | 0.3 | 0.1 | 0.3 | 0.4 | 0.4 | 0.1 | 0.1 | 0.01 | 0.04 | 0.3 | 0.3 | 0.5 | 0.06 |
| CD (P=0.05) | 2.0 | 0.8 | 0.2 | 0.8 | 1.0 | 1.1 | 0.4 | 0.2 | 0.04 | 0.11 | NS | NS | 1.6 | 0.18 |
| *FYM (t/ha)* | | | | | | | | | | | | | | |
| 0 | 41.1 | 16.1 | 4.1 | 16.1 | 20.1 | 22.9 | 7.5 | 4.4 | 0.83 | 2.08 | 28. | 19.3 | 34.4 | 4.3 |
| 5 | 44.7 | 17.3 | 4.3 | 17.3 | 21.2 | 25.4 | 8.3 | 4.7 | 0.93 | 2.31 | 29.5 | 20.2 | 35.0 | 3.2 |
| SEm± | 0.7 | 0.3 | 0.1 | 0.3 | 0.4 | 0.4 | 0.1 | 0.1 | 0.01 | 0.04 | 0.3 | 0.3 | 0.5 | 0.06 |
| CD (P=0.05) | 2.0 | 0.8 | 0.2 | 0.8 | 1.0 | 1.1 | 0.4 | 0.2 | 0.04 | 0.11 | NS | 0.8 | NS | 0.18 |

Cost of raised-bed making: ₹600/ha; Urea: ₹5.20/kg; SSP: ₹3.30/kg; FYM: ₹1.00/kg; selling price: seed (₹50/kg), stover (₹1.50/kg)

on physical, chemical and biological properties of soil (Kumar *et al.*, 2011).

### *Yield attributes and yield*

Land configuration had significant effects on yield attributes and yield of greengram. Number of pods/ plant, number of seeds/pod and test weight was significantly higher under raised bed method of sowing as compared to flat bed method of sowing (Table 1). This can be attributed to better growth of plants in terms of dry matter accumulation, number of branches/plant, number of nodules/plant and nodule weight under raised bed method which in turn improved photosynthesis and N utilization for development of sink. Similarly, sowing on raised beds improved grain and stover yield of greengram by 12.24% and 7.05%, respectively as compared to flat bed sowing. This might have been caused by significant improvement in overall growth and yield attributes of greengram due to sowing on raised beds, which led to higher crop yield. These results are in conformity with those of Dhimmar (2003). Application of 100% RDF significantly improved yield attributes and yield over the application of 75% RDF. The increase in grain and stover yield due to 100% RDF was 11.66 and 6.77, respectively over application of 75% RDF. Application of 100% RDF probably ensured sufficient supply of N and P to plants for development of yield attributes, which ultimately resulted into higher grain and stover yield. Similar results have also been reported by Ambhore (2004). The application of FYM at 5t/ha significantly increased yield attributes as well as yield of greengram over no application of FYM. The respective increase in grain and stover yield due to FYM application was 11.24 and 11.27 per cent over no FYM application. This perhaps was caused by favourable effects of FYM application on growth attributes, which contributed higher photosynthates for the reproductive parts of the plants. These results confirm the findings of Kumar et al., (2011). However, land configuration, fertilizer rates and FYM application did not significantly affect the harvest index of greengram.

### *Protein content*

Land configuration, and fertilizer rates did not significantly affect protein content in grain (Table 1). These results are in accordance with the conclusions of Abedi et al., (2010,) who reported that the quantity of albumins-globulins is scarcely influenced by N nutrition. However, FYM application significantly improved the grain protein content. It seems that FYM improved physical, chemical and biological properties

of the soil and this led to improved root growth and development and improved water and nutrient uptake resulting into improved grain quality in terms of higher grain protein content (Abedi et al., 2010).

### *Plant mortality percent*

It was found that raised bed method of sowing significantly reduced plant mortality percent (8.4%) as compared to sowing on the flat beds (9.1%) (Table 2). This was probably due to lower salt injury to plants under raised bed method of sowing as plants had lesser exposure to saline irrigation water (EC 2.75 dS/m) (Akbar et al., 2007). Further, improved aeration and conducive air-water relationship under raised bed method of sowing might have contributed to healthy growth and development of plants thereby reducing mortality percent. As against this, plants on the flat bed were subjected to temporary waterlogging which might have accentuated the detrimental effects of salts from saline irrigation water. Eventhough no data were collected on soil salinity but lesser salt encrustation was observed on the raised beds compared to flat beds. Reduced waterlogging effects on crops grown on raised beds have also been reported by Singh et al., (2010). Fertilizer management did not significantly affect the mortality percent of green gram plants. However, the application of FYM significantly reduced the mortality percent of greengram plants. This could be due to improved soil health leading to better establishment and growth and development of plants in FYM treated plots.

### *Irrigation water use efficiency*

IWUE increased significantly when greengram was planted on raised beds (14.90%) compared to flat beds, which is attributed to higher seed yield on raised beds compared to flat beds. Higher IWUE under raised bed method of planting has also been reported by Kaur (2003) in wheat. Application of 100% RDF recorded markedly higher IWUE over application of 75% RDF (Table 2). The application of FYM at 5 t/ha significantly improved the IWUE over no application of FYM. The improvement in IWUE due to application of 100% RDF and FYM at 5t/ha may be attributed to improved grain productivity. These results support the findings of Channabasavanna et al., (2003).

### *Nutrient uptake*

The uptake of N and P by plants was significantly higher under raised bed method of sowing as compared to flat bed method. This might be due to better root growth and consequently higher yield of both grain and stover under raised bed sowing, resulting in higher N and P uptake. The application of 100% RDF also led to significant increase in nutrient uptake by greengram over application of 75% RDF. This may be attributed to improved availability of N and P due to application of 100% RDF. Application of FYM at 5t/ha, significantly improved N and P uptake over no FYM application which was probably due to balanced and sustained supply of nutrients to plants due to FYM application. Similar findings have also been re-



**Table 2.** Effects of land configuration, fertilizer rates and farm yard manure application on plant mortality, IWUE, N and P uptake, and available NPK in the soil after harvest of post-rainy season green-gram (Pooled data of two years)

| Treatment | Plant mortality (%) | IWUE (Kg/ha-mm | Grain N uptake (kg/ha) | Stover N uptake (kg/ha) | Grain P uptake (kg/ha) | Stover P uptake (kg/ha) | Available N (kg/ha) | Available P (kg/ha) | Available K (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| *Land configuration methods* | | | | | | | | | |
| Flat bed method | 9.1 | 2.3 | 26.0 | 19.5 | 0.9 | 1.7 | 243.0 | 17.2 | 291.9 |
| Raised bed method | 8.4 | 2.7 | 30.7 | 22.3 | 1.1 | 1.9 | 247.0 | 17.8 | 302.1 |
| SEm± | 0.2 | 0.04 | 0.4 | 0.3 | 0.02 | 0.03 | 3.8 | 0.2 | 4.7 |
| CD (P=0.05) | 0.5 | 0.1 | 1.3 | 1.0 | 0.05 | 0.09 | NS | NS | NS |
| *Inorganic fertilizers* | | | | | | | | | |
| 75% RDF | 8.9 | 2.4 | 26.6 | 19.5 | 0.9 | 1.7 | 238.2 | 17.1 | 295.8 |
| 100% RDF | 8.6 | 2.6 | 30.8 | 22.3 | 1.1 | 1.9 | 251.7 | 17.9 | 304.2 |
| SEm± | 0.2 | 0.04 | 0.4 | 0.3 | 0.02 | 0.03 | 3.8 | 0.2 | 4.7 |
| CD (P=0.05) | NS | 0.1 | 1.3 | 1.0 | 0.05 | 0.09 | 11.29 | 0.7 | NS |
| *FYM (t/ha)* | | | | | | | | | |
| 0 | 9.2 | 2.4 | 26.3 | 19.2 | 0.9 | 1.7 | 238.0 | 17.1 | 291.0 |
| 5 | 8.3 | 2.7 | 30.4 | 22.6 | 1.1 | 1.9 | 252.0 | 17.9 | 308.9 |
| SEm± | 0.2 | 0.04 | 0.4 | 0.3 | 0.02 | 0.03 | 3.8 | 0.2 | 4.7 |
| CD (P=0.05) | 0.5 | 0.1 | 1.3 | 1.0 | 0.05 | 0.09 | 11.3 | 0.7 | 13.8 |

IWUE=Irrigation water use efficiency, Initial available NPK in soil: 225, 15.41 and 291.66 kg/ha, respectively.

ported by Naidu et al., (2009) who reported higher nutrient uptake with the application of 100% RDF alongwith organic manures.

### *Available NPK in soil after harvest of crop*

Land configuration methods did not significantly affect the available N, P and K in soil after harvest of the crop (Table 2). Similar results have also been reported by Dhimmar (2003) in cowpea. Application of 100% RDF significantly improved soil available N and P content over 75% RDF, but available K was not affected significantly due to fertilizer rates. Application of FYM at 5t/ha, significantly improved the available NPK in soil compared to no FYM application. This may be attributed to the fact that first crop sown after FYM application is able to uptake only partial amount of nutrients from FYM due to slow release of nutrients from FYM besides, FYM might have led to adsorption of mineral nutrients on organic 'micelles' thereby reducing their leaching from the soil. These results support the findings of Kumar et al., (2011).

### *Economics*

Raised bed method of sowing recorded significantly higher net returns (₹37.6 × $10^3$/ha) and benefit: cost ratio (3.9) over flat bed method of sowing (Table 1). This was due to higher yield of seed and stover under raised bed sowing. Dhimmar (2003) also reported higher economic returns in cowpea planted on raised beds compared to conventional sowing on flat beds. Application of 100% RDF recorded significantly higher net returns and benefit: cost ratio as compared to application of 75% RDF, which might be attributed to improved productivity with 100% RDF. The application of FYM at 5t/ha could not statistically improve the net returns over no FYM application. B:C ratio was significantly reduced due to application of 5 t FYM/ha compared to no FYM application. This is attributed to increase in cost of cultivation due to FYM application.

It is concluded that the post-rainy season green gram, irrigated with saline bore well water, should be planted on raised beds landform, and supplied with 20 kg N and 40 kg $P_2O_5$ in conjunction with 5 t FYM /ha for getting higher productivity, grain quality, economic returns and improving soil fertility of the heavy textured *Vertisols* of south Gujarat.



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