

**“EFFECT OF LAND CONFIGURATION AND INTEGRATED
NITROGEN MANAGEMENT IN GREEN GRAM
(*Vigna radiata* L.) UNDER PARTIALLY RECLAIMED COASTAL
SALT AFFECTED SOIL”**

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**IN
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BY

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ABSTRACT



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ABSTRACT

A field experiment entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” was conducted at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat during *rabi* season of the year 2015-16. The soil of the experimental field was clayey in texture, medium in organic carbon, highly saline-sodic and showed low, medium and high rating of available nitrogen, phosphorus and potassium, respectively.

Total fifteen treatment combinations comprised of three levels of land configuration (L₁: Flat bed method, L₂: Ridges and furrows method and L₃: Raised bed method) and five levels of integrated nitrogen management (N₁: 100 % N through inorganic fertilizer, N₂: 75% N through inorganic fertilizer + 25% N through FYM, N₃: 50% N through inorganic fertilizer +

50% N through FYM, N₄: 75% N through inorganic fertilizer + 25% N through vermi compost and N₅: (50% N through inorganic fertilizer + 50% N through vermi compost) were evaluated in factorial randomized block design with three replications.

Among the different land configuration methods, raised bed sowing (L₃) significantly improved the periodical plant height (at 60 DAS and at harvest) and yield attributes *viz.*, number of pods plant⁻¹ and number of seeds pod⁻¹ followed by ridge and furrow treatment (L₂). While, plant height recorded at 30 DAS, number of branches plant⁻¹, days to 50 per cent flowering and test weight of grains remained unaffected due to land configuration treatments.

In the same way, seed yield (756 kg ha⁻¹) and stover yield (1800 kg ha⁻¹) of green gram were remarkably increased under treatment L₃ followed by treatment L₂. While, Harvest index was non-significantly affected by land configuration treatments.

Different integrated nitrogen management treatments also showed discernible influence on plant stand, growth and yield parameters of green gram *viz.*, plant height at harvest, number of branches plant⁻¹, number of pods plant⁻¹, number of seeds pod⁻¹. All these parameters beard higher value with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) followed by application of 75% N through inorganic fertilizer + 25% N through vermicompost (N₄). Integrated nitrogen management did not express significant influence on plant height at 30 DAS and at 60 DAS and days to 50 per cent flowering of green gram.

With regard to seed yield, N₅ (50% N through inorganic fertilizer + 50% N through vermicompost) standing at par with N₄ (75% N through inorganic fertilizer + 25% N through vermicompost) produced significantly higher seed yield over rest of the treatments. Similarly N₅ ranked at top for bearing highest values of stover yield and harvest index but did not differ from N₄ (75% N through inorganic fertilizer + 25% N through vermicompost).

Raised bed method of sowing significantly increased protein yield as well as nutrients *i.e.*, N, P and K uptake by seed and stover over flat bed sowing (L₁) followed by ridges and furrows method of sowing (L₂) while, protein content in seed and N, P and K content in seed and stover did not influence significantly due to land configuration treatments.

The highest protein content in seed, protein yield, N and P content in seed and stover, N, P and K uptake by seed as well as N uptake by stover were found with N₅(50% N through inorganic fertilizer + 50% N through vermicompost). While, K content in seed as well as P and K content in stover and P and K uptake by stover was not influenced significantly due to integrated nitrogen management.

Raised bed method of sowing treatment significantly reduced electrical conductivity of soil over rest of the land configuration treatments. While, soil pH, OC, and ESP as well as available nutrients *i.e.*, nitrogen, phosphorus and potassium status of soil after harvest of crop failed to produced significant effect due to different land configuration treatments.

In case of integrated nitrogen management, application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) treatment remarkably reduced the electrical conductivity of soil and significantly improve OC and available nitrogen and phosphorus in soil as compare to treatment N₁. While soil pH and ESP as well as available potassium status of soil after harvest of crop were not significantly altered due to different integrated nitrogen management treatments.

All the growth and yield attributes, yield, nutrients content and uptake and chemical properties of soil were not significantly reflected due to interaction effect of L x N.

Sowing of green gram by raised bed method (L₃) obtained the highest net returns 20493 ha⁻¹ with BCR value of 1.65 followed by ridges and furrows method (L₂), whereas, the lowest net returns (Rs.11955 ha⁻¹) and BCR (1.41) were noted under flat bed sowing treatment (L₁).

The highest values of net return (Rs.22697 ha⁻¹) and BCR (1.72) were registered with treatment N₅ followed by treatment N₄. Whereas treatment N₁ recorded the lowest net return and BCR.

Thus, it can be concluded from the results of present investigation that to obtain economical seed yield of green gram *cv.* Co-4 and sustain the soil health, the crop should be grown by adopting raised bed method and fertilized with 50% N through inorganic fertilizer + 50% N through vermicompost under costal salt affected soils of South Gujarat.

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CERTIFICATE

This is to certify that the thesis entitled **“EFFECT OF LAND CONFIGURATION AND INTEGRATED NITROGEN MANAGEMENT IN GREEN GRAM (*Vigna radiata* L.) UNDER PARTIALLY RECLAIMED COASTAL SALT AFFECTED SOIL”** submitted by **Mr. PRAKASH R. LAKHANA** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **AGRONOMY** of the **NAVSARI AGRICULTURAL UNIVERSITY** is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : Navsari

(M.M. Patel)

Date : /06/2017

Major Advisor

DECLARATION

This is to declare that the whole of the research work reported here in this thesis for the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (Agriculture)** in **AGRONOMY** by the undersigned is the results of investigation carried out under the direct guidance and supervision of **Dr. M. M. PATEL**, Associate Research Scientist (Agron.), Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat(Gujarat), India and that no part of the work has been submitted for any other degree so far.

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(PRAKASH R. LAKHANA)

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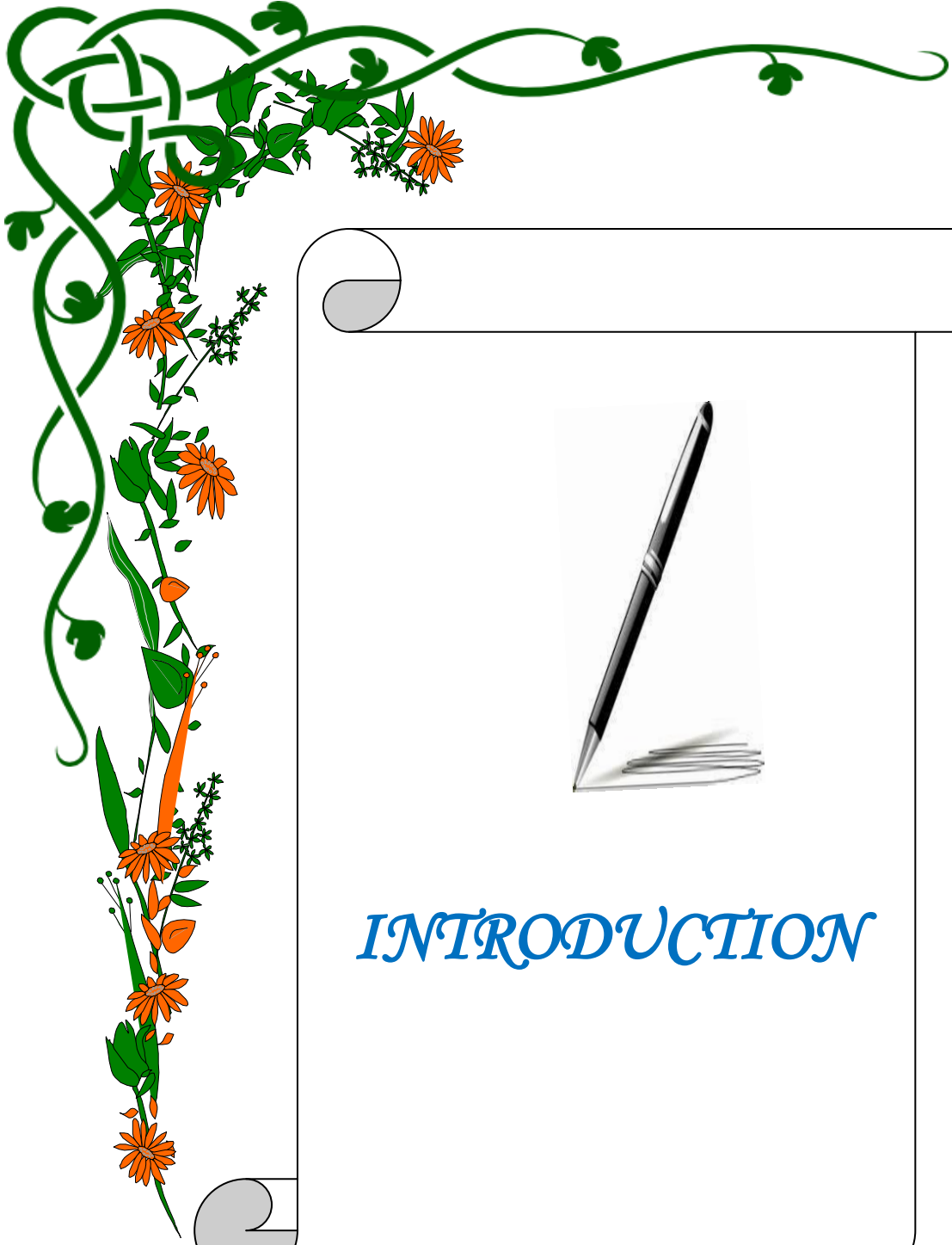
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LIST OF SYMBOLS AND ABBREVIATIONS

Symbols	
=	Is equal to
+	Plus
-	Minus
×	Multiply
∴	Colon and desh
[]	Bracket
±	Plus or minus
;	Semi colon
@	At the rate
₹	Rupee
%	Percent
&	And
Abbreviations	
G	Gram
Mg	Milligram
PSB	Phosphate solubilizing bacteria
<i>et al.</i>	And others
Ha ⁻¹	Per hectare
Cv	Cultivar
FYM	Farm yard manure
%	Percent
Ha	Hectare (s)
Viz.,	Namely
N	Nitrogen
P	Phosphorus
K	Potassium
a.m.	Ante meridian

C.D.	Critical difference
Cm	Centimeter
Contd.	Continued
C.V.	Co-efficient of variation
DAS	Day after sowing
ds m ⁻¹	Decisiemens per meter
E.C.	Electrical conductivity
GAU	Gujarat Agricultural University
ICAR	Indian Council of Agricultural Research
<i>i.e.</i>	That is
Kcal	Kilo calories
Kg/ha	Kilogram per hectare
M	Million
Max.	Maximum
Min.	Minimum
ml	Milliliter
Var.	Variety
N.M.	Navinchandra Mafatlal
S. K. Nagar	Sardarkrushinagar
SDAU	Sardarkrushinagar Dantiwada Agricultural University
p.m.	Post meridian
R.D.F	Recommended dose of fertilizer
S.Em.	Standard error of mean
SSP	Single super phosphate
DAP	Di ammonium phosphate
BCR	Benefit cost ratio



I. INTRODUCTION

Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulses in the world. Pulses are integral part of Indian dietary system because of its richness in proteins and other important nutrients such as Ca, Fe and vitamins *viz.*, carotene, thiamine, riboflavin and niacin. Indian population is predominantly vegetarian and protein requirement for the growth and development of the human being is mostly met with pulses. They are said to be poor man's meat and rich man's vegetables. Apart from the human diet, pulses form an important fraction of cattle feed and fodder as hay, green fodder and concentrates. Due to their short duration crop habit, they can be grown as main, inter, catch and green manure crop. Pulses are known to improve soil fertility as they fix atmospheric nitrogen through symbiotic nitrogen fixation with the help of bacterium called Rhizobia. Thus, every pulse plant is a mini-fertilizer factory itself.

Pulses are considered second to cereal crops and grown on marginal soils, as they are perceived to be low yielding and less remunerative crops. However, the pulse production in the country is quite low and has not been able to keep pace with the increasing population. Stagnant production together with increase in population has led to sharp decline in per capita availability of pulses from 70.3 g day⁻¹ in the year 1956 to 30.0 g day⁻¹ in the year 2001, but it is also increased up to 41.9 g day⁻¹ in the year 2014 (Anon., 2015). While, low against the minimum requirement of 80 g per capita per day as per

recommendation of WHO. Therefore, increase pulse production continues to remain a thrust area.

In India, pulses are grown in an area of 25.23 million hectares, producing of 19.27 million tonnes with an average productivity of 764 kg ha⁻¹. While in Gujarat, different pulses are grown over an area of 8.10 lakh hectares with an annual production of 7.30 lakh tonnes with the productivity of 897 kg ha⁻¹ (Anon., 2015).

Greengram (*Vigna radiata* L.) occupies prime position among pulses by virtue of its short growth period, high tonnage capacity and outstanding nutrient value as food, feed and forage. Unlike other pulses, it does not produce heaviness or flatulence. Green gram is fairly rich in carbohydrate and appreciable amount of riboflavin and thiamine. Among the pulses, greengram is one of the most important and extensively cultivated pulse crops. It is also known as mung, moong, mungo, goldengram, chickasawpea and oregon pea. It contains about 25 per cent protein, 1.3 per cent fat, 3.5 per cent minerals, 4.1 per cent fiber and 56.7 per cent carbohydrate. The protein content of green gram is two to three times more than cereals. It is consumed as a whole grain as well as dal in a variety of way in homes; being easily digestible it is preferred by patients. It is valued for its excellent taste, flavour, high digestibility and free from the “flatulency effect” which is associated with other pulses. When moong beans are allowed to sprout, ascorbic acid (Vitamin C) is synthesized besides increase in riboflavin and thiamine.

Among the pulses, greengram is one of the most important and extensively cultivated pulse crops. In India, greengram occupies

an area of about 3.51 million hectares producing 1.80 million tones with the productivity of 511 kg ha^{-1} (Anon., 2012), whereas in Gujarat, it is grown over 2.40 lakh hectares with a production of 1.28 lakh tonnes and productivity of 525 kg ha^{-1} (Anon., 2012a).

In India, salt affected soils occupy about 9.38 million ha of cultivated land of which around 41 per cent is sodic *i.e.*, 3.88 million ha and 5.5 million ha are saline soils (including coastal) (IAB, 2000). In Gujarat, an area of 1.69 million ha is affected by either salinity or sodicity or both (Minhas *et al.*, 1998). On account of higher proportion of exchangeable Na on exchange complex, the high clay containing soils of South Gujarat exhibit poor physical conditions *viz.*, low permeability, crusting and hardening of surface soil upon drying and cracking. As a result of this, restricted air and water movement in soil and poor root growth is observed. The extent of adverse effect of soil sodicity is dependent upon the texture of soil (Velayutham and Bhattacharya, 2000). Expanding problems of soil salinity and water logging have become serious issues of concern as they affect productivity and threaten the very sustainability of agriculture under coastal salt affected soils, where rice is predominant during *kharif*. High substrate salinity is a major limiting factor for crop production in coastal habitats. As with many other pulses, greengram is a salt-sensitive crop and yield is seriously reduced particularly by salinity. High salinity decreases substrate water potential and thus restricts water and nutrient uptake by the roots, high salinity may also cause ionic imbalance and toxicity in plants. Seed germination is delayed and reduced, seedling emergence and vegetative growth are suppressed under saline conditions. So far, there is a need to find out scientific

approaches for sustainable and profitable production of greengram on salt affected soils to meet the increasing demand.

Poor soil management is one of the major constraints for low productivity of crops particularly in clayey soil. The germination, penetration, development and proliferation of root in the soil are dependent on the physical conditions of soil *viz.*, looseness, friability, infiltration rate, soil crusting *etc.* moreover pulse crops are very sensitive to water logging. Water logging results in heavy plant mortality under over irrigated conditions and salt injury due to poor quality of irrigation water are the important factors for low productivity of pulse crop in south Gujarat. Therefore, land configuration can play an important role for easy and uniform germination as well as for better growth and development of plant. In these circumstances, ridge and furrow or raised bed sowing under such situation is advantageous as compared to flat bed sowing as it provides better aeration, root development and also protect the crop from water logging condition. In our country, greengram is usually sown on flat bed by seed drill. Several research workers have indicated that manipulation of sowing method provides better environment for germination, growth and development, which eventually increase the crop yield. It is particularly useful in areas having poor quality of irrigation water, because it helps to avoid direct contact of young plants with poor quality of irrigation water. Raised bed method of sowing has been found helpful to minimize the effect of temporary water logging and salt injury to plants (Akbar *et al.*, 2007). Crop yield can be increased by providing suitable sowing method. So there is need to adopt a suitable management practice like a proper sowing

method, land configuration, such as ridges and furrows and raised bed methods which have shown good promise for enhancing the performance of crop.

The main concept of sustainability in agriculture is maintenance of soil fertility and stabilized crop production in the present situation. Use of organic manures to meet nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture, since these manures generally improve the physical, chemical and biological properties along with conserving and improving the moisture and nutrient holding capacity of the soil and thereby resulting in enhanced crop productivity along with maintaining the quality of crop produce. The concept of INM for sustaining the soil fertility is not being followed by most of the farmers, leading to poor soil fertility status of Gujarat. Therefore, an attempt is made to find out a sustainable INM package for greengram.

Although the density of nutrients in organic material is comparatively modest, they have many advantages. By their nature, organic manures increase physical and biological nutrient storage mechanisms in soils, mitigating risks of over-fertilization. Organic manures like FYM and vermicompost having low nutrient content and slow nutrient release rate than inorganic fertilizers. Manures contribute to the fertility of the soil by adding organic matter and nutrients. FYM and vermicompost help for better crop yield by improving soil fertility and soil structure.

Vermicompost is an aerobically degraded organic matter which has undergone chemical disintegration by the

enzymatic activity in the guts of worms and also enzymes of the associated microbial population. It contains 0.80 to 1.10% N, 0.40 to 0.80% P_2O_5 and 0.80 to 0.98% K_2O , 10 to 52 ppm Cu, 186.60 ppm Zn, 930.00 ppm Fe and plant growth promoting substances such as NAA, cytokinins, gibberellins, etc.

Farmyard manure seems to act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. It also supplies P, K and micro nutrients like Fe, S, Mo and Zn etc in available form to the plants through biological decomposition and improves physico-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna etc. on an average FYM contains 0.50, 0.17 and 0.55 per cent of N, P and K, respectively. (Gaur, 1991)

Hence adoption of appropriate nitrogen management strategies hold a great potential in boosting the green gram yield and also for improvement of soil health. Therefore it was thought of integration of organics and inorganics.

Considering the above facts, the present experiment entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” during *rabi* season of 2015-16 at the farm of Coastal Soil Salinity Research Station, Navsrai

Agricultural University, Danti-Umbharat with the following objectives:

- To evaluate the effect of land configuration and integrated nitrogen management on growth, yield and quality of green gram.
- To study the interaction effect between land configuration and integrated nitrogen management on growth, yield and quality of green gram.
- To determine the content and uptake of N, P and K by green gram under different treatments.
- To workout the economics of different treatments.



*REVIEW OF
LITERATURE*



II. REVIEW OF LITERATURE

The productivity of crop being a complex phenomenon which is governed by numerous endogenous and exogenous factors. It can be enhanced by adopting suitable agro-techniques related to land configuration and integrated nutrient management.

An attempt has been made to review the research work published on green gram along with other pulses crop pertaining to the effect of land configuration and integrated nitrogen management on growth, yield, quality, nutrient uptake and economics. For the sake of convenience, the chapter is divided into following broad sub-heads.

2. Brief review of research work:

2.1 Effect of land configuration

2.2 Effect of integrated nitrogen management

2.3 Interaction effect of land configuration and integrated nitrogen management

2.1 EFFECT OF LAND CONFIGURATION

2.1.1 Growth attributes

A field experiment was conducted at Parbhani (Maharashtra) during *kharif* season of 1986 by Lawand *et al.* (1993) and found that flatbed sowing of cowpea resulted in significantly least value with respect to plant height and number of branches per plant.

A field experiment was carried out by Jain &Dubey (1998) at Jabalpur (Madhya Pradesh) on vertisols during *kharif* season of

1996 to find out the suitable method of sowing for soybean. They reported that flatbed sowing of soybean produced lower values over ridges sowing with respect to plant height, main root length and nodules per plant.

Shaikh and Mungse (1998) conducted a field trial at Rahuri (Maharashtra) and reported significantly higher LAI and number of branches per plant with ridges and furrows sowing over flat bed sowing at all growth stages of chickpea.

Ugale *et al.* (2000) conducted an experiment at Rahuri on response of chickpea to field layouts and irrigation depths and observed significantly higher plant height, plant spread, no. of branches per plant with ridges and furrows sowing over flat bed sowing.

Dhimmer (2003) laid out a research experiment at Navsari (Gujarat) on different sowing methods for cowpea and reported that flatbed sowing produced least values of growth parameters *viz.*, plant height, number of nodules per plant, dry matter production per plant and number of branches per plant over other method of sowing.

Shashikumar *et al.*, (2013) carried out a field experiment during *rabi* season of 2011 at Raichur and found that significantly higher number of branches per plant and days to 50% flowering of chickpea with ridges and furrow sowing method over other sowing methods.

A field experiment was taken up by Kumar and Singh (2014) at Farizabad (U.P.) and reported significantly higher values of

plant height, number of branches per plant and dry matter accumulation per plant at 60 and 90 DAS of french bean sown on raised bed.

2.1.2 Yield and yield attributes

According to Swaminathan (1971), raised bed sown arhar, urad and mung recorded significantly higher grain yield as compared to flatbed sowing.

Shrivastava and Pahalwan (1972) conducted a field experiment at Jabalpur (Madhya Pradesh) on method of sowing of soybean. They noticed significantly lower yield of soybean with flat bed method as compared to raised bed configuration. They also observed that number of pods per plant and 100-grain weight were not significantly affected by different methods of sowing.

Haranath (1981) laid out a field experiment in *kharif* season of 1979 at Tirupati (Andhra Pradesh) to evaluate different methods of sowing for green gram and reported significantly higher dry matter accumulation with bed and furrow method as compared to furrow and ridge and flat planting method.

Parameswaran *et al.* (1987) conducted an experiment on different moisture conservation techniques for rainfed groundnut and obtained significantly higher pod yield with raised bed (1217 kg ha⁻¹) as compared to ridges and furrow (1063 kg ha⁻¹) and flatbed (974 kg ha⁻¹) methods.

Shaikh and Mungse (1998) from a field experiment at Rahuri (Maharashtra) and reported flatbed sowing produced lowest pods per plant, seeds per pod, test weight, grain and stover yield of chickpea as compared to other methods of sowing.

Desai *et al.* (2000) carried out a field experiment on clayey soils of Navsari (Gujarat) to study the different land configuration *viz.*, flat bed, ridge and furrow, 1 furrow after 2 rows, 1 furrow after 3 rows and 1 furrow after 4 rows on pigeon pea. They reported that the highest grain yield was obtained with 1 furrow after 4 rows followed by 1 furrow after 2 and 3 rows.

Shinde *et al.* (2000) carried out an investigation on alkaline soil of Rahuri (Maharashtra) to study the effect of field layouts on productivity of chickpea. They found that number of pods per plant, test weight and grain yield in chickpea were significantly higher under ridge and furrow with 90 cm width as compared to flat bed and ridge and furrow with 60 cm width.

Ugale *et al.* (2000) conducted an experiment at Rahuri on response of chickpea to field layouts and irrigation depths and observed significantly higher number of pods per plant, number of seeds per plant and seed yield with ridges and furrows sowing over flat bed sowing.

A field experiment was conducted during the wet season at Himachal Pradesh Agricultural University Palampur by Sharma (2003) and reported that 61-78 per cent higher yield of black gram was observed in raised bed sowing over control.

Kantwa *et al.* (2005) evaluated different land preparation methods for pigeon pea. The broad-bed and furrow planting improved the yield attributes (pods per plant and seeds per pod) of pigeon pea over flat planting.

An experiment was carried out at Hisar (Haryana) by Dhindalwal *et al.* (2006) and found that sowing of green gram on furrow-irrigated raised-bed system (paired rows 70-20-20 cm) gave significantly higher grain yield to the tune of 15 percent over flat sown.

An experiment was taken up on chickpea during the winter season at Navsari by Patel *et al.* (2009). They found that the land configuration remarkably influenced the yield of chickpea. The ridges and furrows method of sowing significantly increased the seed and straw yield than flat bed sowing method.

Shashikumar *et al.*, (2013) carried out a field experiment during *rabi* season of 2011 at Richur. Significantly higher seed yield (21.41 qt ha⁻¹) of chickpea was ascribed to by ridges and furrow sowing over other sowing methods which was significantly higher growth and yield attributes.

Kumar and Singh (2014) carried out a field experiment at Farizabad (U.P.) and reported significantly more number of pods per plant, pod length and number of seeds per pod under raised bed as compared to flat bed sowing.

2.1.3 Quality

Shinde *et al.* (2000) investigated the effect of field layouts on productivity of chickpea at Rahuri. They found that protein content and protein yield of chickpea were significantly higher under ridges and furrows with 90 cm width as compared to flat bed and ridges and furrows with 60 cm width.

Rathore (2002) carried out a field experiment on black gram and reported significantly higher protein content and protein yield with ridges and furrows method of sowing as compared to raised bed and flat bed method of sowing on clayey soil at Navsari (Gujarat).

A field experiment was conducted by Dhimmarr (2003) at Navsari, (Gujarat) on clayey soil with medium organic carbon content, pH 7.7 and EC 0.29 dSm⁻¹ during *kharif* 2001 on cowpea and noted that protein content and protein yield of cowpea were significantly increased due to ridges and furrows method of sowing as compared to flat bed method but, it remained at par with raised bed method of sowing.

Shete *et al.* (2010) conducted an experiment at Navsari Agricultural University, Navsari on clayey soil to find out the effect of *rabi* green gram to land configuration (flat bed and raised bed), inorganic fertilizers (75 per cent RDF and 100 per cent RDF) and FYM levels (No FYM and FYM @ 5 t ha⁻¹). They found higher values of protein content and protein yield (204.56 kg ha⁻¹) with raised bed sowing over flat bed sowing.

2.1.4 Nutrient content and uptake

Nalawade and More (1993) studied the effect of land configuration *i.e.* broad bed and furrow, narrow bed and furrow as well as flat bed without furrow on groundnut at Parbhani (Maharashtra) and found higher content of N, P and K in broad bed and furrow configuration.

Bharambe *et al.* (2004) conducted a field experiment at Parbhani (Maharashtra) during *rabi* season and observed that N, P and K uptake by groundnut crop were significantly higher under broad bed and furrow as compared to flat bed at all growth stages.

Shete *et al.* (2010) conducted an experiment at Navsari Agricultural University, Navsari on clayey soil to find out the effect of *rabi* green gram to land configuration (flat bed and raised bed), inorganic fertilizers (75 per cent RDF and 100 per cent RDF) and FYM levels (No FYM and FYM @ 5 t ha⁻¹). They pointed out that the nutrient in relation to nitrogen and phosphorus content in seed and stover and total uptake by seed and stover were significantly highest under raised bed sowing over flat bed sowing.

A field experiment was conducted at Navsari (Gujarat) on clayey soil with alkaline in reaction during post-rainy seasons of 2008-09 and 2009-10 by Jat *et al.* (2012). Results revealed that sowing of greengram on raised bed recorded significantly higher N, P and K uptake by grain and stover as compared to flat bed method of sowing.

Significantly higher N, P and K uptake by both grain and stover of french bean were observed under raised bed method of

sowing as compared to flat method of sowing at Faizabad (U.P.) on saline-sodicsilty loam soil with low in organic carbon during two consecutive *rabi* seasons of 2010-11 and 2011-12 by Kumar and Singh (2014).

2.1.5 Soil chemical properties after crop harvest

A field experiment was conducted by Dhimmarr (2003) at Navsari, (Gujarat) on clayey soil with medium organic carbon content, pH 7.7 and EC 0.29 dSm⁻¹ during *kharif* 2001 on cowpea wherein no any significant variation in available N and P status of soil was noticed due to different methods of sowing.

Patel (2007) studied the effect of depth of tillage and land configuration on soil properties and yield of cotton under South Gujarat condition during 2005-06 and 2006-07 at Surat (Gujarat). The experimental soil was deep black having medium organic carbon content and pH 7.52. He observed that the ridge and furrow method of sowing reduced the bulk density and electrical conductivity of soil and increased the organic carbon and infiltration rate of soil.

A field experiment was conducted at Navsari (Gujarat) on clayey soil with alkaline in reaction during 2008-09 and 2009-10 post-rainy seasons by Jat *et al.* (2012). Results revealed that land configuration method did not significantly affect the available nitrogen, phosphorus and potassium in soil after harvest of greengram crop.

2.1.6 Economics

A field experiment was carried out by Jain & Dubey (1998) at Jabalpur (Madhya Pradesh) on vertisols during *kharif* season of

1996 to find out the suitable method of sowing for soybean. They reported that flatbed sowing of soybean gained lower net return and B:C ratio over ridges sowing.

Desai *et al.* (2000) through a field experiment on clayey soils of Navsari (Gujarat) evaluated the effect of different land configuration *viz.*, flat bed, ridges and furrows, 1 furrow after 2 rows, 1 furrow after 3 rows and 1 furrow after 4 rows on pigeon pea. They worked out the highest net return and cost benefit ratio with 1 furrow after 4 rows followed by 1 furrow after 3 rows and 1 furrow after 2 rows.

Rathore (2002) tested different land configuration treatments at Navsari and observed the lowest net profit with net BCR under flatbed sowing of black gram as compared to other methods of sowing.

Dhindwal *et al.* (2006) conducted an experiment on water productivity of furrow-irrigated rainy-season pulses planted on raised bed at Hissar (Haryana). They found that FIRB (paired row 70-20-20 cm) gave higher net return of green gram over flat bed sowing.

Pandey *et al.* (2014) carried out a field experiment to study the effect of bed configuration, fertilizer levels and their placement methods on productivity of long duration pigeon pea (*Cajanus Cajan* (L) Millsp) for four consecutive years during 2008-09 to 2011-12 at Tirhut college of Agriculture, Dholi, Bihar. They reported that raised bed planting of pigeon pea significantly enhanced the number of branches per plant, number of pods per plant, fruiting efficiency

(15.4%), seed yield (18.4%) and net return (18.6%) over flat bed sowing.

2.2 EFFECT OF INTEGRATED NITROGEN MANAGEMENT

Plant nutrients play key role for obtaining higher crop production. Inadequate and imbalance nitrogen application by farmers is the most important limiting factor in green gram production.

2.2.1 Growth attributes

Bachhav and Sabale (1996) reported that application of 50 kg N /ha of which half through urea and half through FYM significantly influenced all growth characters of soybean as compared to full dose of nitrogen applied through urea.

Kumar and Puri (2001) conducted a field experiment during *kharif* season of 1996 and 1997 at Salooni (Himachal Pradesh) to study the response of maize to nitrogen and farmyard manure where that application of 90 kg N/ha + 15 t FYM /ha resulted in maximum plant height and cob length.

Singh and Verma (2002) studied the response of French bean to application of organics and inorganics in eastern U.P. and found that 10 t FYM + 75% RDF recorded significantly higher plant height and branches per plant which remained at par with 10 t FYM + 50% RDF.

Sumathi and Rao (2007) conducted a field experiment in Andhra Pradesh on effect of organic and inorganic sources of nitrogen with different irrigation schedule on growth and yield of sunflower and found that 100% RDN through fertilizer recorded significantly

higher plant height and LAI which stood at par with 75% RDN + 25 % FYM.

Acharya and Mondal (2010) conducted a field experiment on green gram at Mohanpura (West Bengal) and found that integrated nutrient management through combination of 75% RDF and 25% nutrients through FYM resulted in higher growth attributes.

Singh *et al.* (2011) investigated the response of groundnut to biofertilizer, organic and inorganic sources of nutrient in north east India at Meghalaya and observed significantly higher plant height, number of branches per plant and number of leaves per plant with combination of Lime + FYM + 50% NPK.

Ram *et al.* (2013) studied the effect of organic and inorganic sources of nutrients on productivity, profitability and soil health in lentil under vertisols in Rajasthan and found significantly higher plant height and branches per plant with combination of RDF + vermicompost 2 t/ha.

A field experiment was carried out by Tyagi and Upadhyay (2014) on summer greengram at Research Farm, College of Agriculture, Tikamgarh (M.P.) and reported that integration of 100 per cent RDF + vermicompost@1.0 t ha⁻¹ + *Rhizobium* resulted in to significantly greater plant height (52.3cm) and number of primary branches per plant (5.8).

Vitnor *et al.* (2015) took up an experiment in *kharif* season at Department of Biological Sciences, Shiats, Allahabad (U.P.) and found significantly higher plant height (28.62 cm), numerically more

number of leaves per plant and maximum number of branches per plant (3.34) in 100% RDF + vermicompost @1.25 t ha⁻¹ + *Azotobacter* @ 375 g ha⁻¹ in greengram.

2.2.2 Yield and yield attributes

Sharma (1992) conducted a field experiment on soybean at Indore (Madhya Pradesh) during rainy season and indicated that the highest seed yield (2,669 kg /ha) and straw yield (3,020 kg /ha) were recorded due to the treatment of 6 t /ha of FYM and 20 kg N /ha.

Bachhav and Sabale (1996) reported that application of 50 kg N /ha of which half through urea and half through FYM recorded significantly higher seed and straw yields of soybean as compared to full dose of nitrogen applied through urea.

Sharma and Misra (1997) at Indore (Madhya Pradesh) indicated that tremendous enhancement in seed yield (2976 kg/ha) of *kharif* soybean was found due to combine use of FYM @ 6 t/ha and reduced level of N @ 20 kg /ha.

Kumar and Puri (2001) conducted a field experiment during *kharif* season of 1996 and 1997 at Salooni (Himachal Pradesh) to study the response of maize to nitrogen and farmyard manure and reported that application of 90 kg N and 15 t FYM /ha resulted in maximum grain per cob, test weight and yield.

Singh and Verma (2002) studied the response of French bean to application of organics and inorganics in eastern U.P. where in 10 t FYM + 75% RDF recorded significantly higher pods per plant and seed yield standing at par with 10 t FYM + 50% RDF.

Rajkhowa *et al.* (2003) at Jorhat (Assam) studied the effect of vermi compost and levels of fertilizer on greengram and they found that 100% RDF + vermi compost recorded significantly higher seed yield which remained at par with 75% RDF and 50% RDF with vermi compost.

Gawai and Pawar (2007) at Rahuri studied the nutrient balance under INMS in sorghum-chickpea achieved cropping sequence and they found that combination of 50% RDF + FYM recorded the highest grain yield of chickpea.

Acharya and Mondal (2010) observed that application of 75% RDF with 25% FYM in greengram produced the highest seed yield (1.24t ha⁻¹).

Singh *et al.* (2011) conducted an experiment on response of groundnut to biofertilizer, organic and inorganic sources of nutrient in north east India at Meghalaya and observed significantly higher pods per plant, pod weight, kernels per pod and pod yield with combination of Lime + FYM + 50% NPK.

Bachhav *et al.* (2012) at Anand studied the yield and economics of soybean as influenced by integrated nutrient management practices and found that combination of FYM @ 5 t/ha + 100% RDF realized significantly higher seed yield of soybean.

Choudhary *et al.* (2013) found out the response of organic manure and chemical fertilizer on nutrient uptake, yield and profitability of mungbean (*Vigna radiata L.*) at Bikaner, Rajasthan. The combination of vermi compost @ 0.7 t/ha + 50% RDF recorded significantly higher seed yield.

Gabhane *et al.* (2013) reported significantly higher yield with application of 25 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ through urea and SSP respectively in combination with 25 kg N ha⁻¹ through FYM in cotton and greengram intercropping system.

Ram *et al.* (2013) studied the effect of organic and inorganic sources of nutrients on productivity, profitability and soil health in lentil under vertisols in Rajasthan wherein significantly higher pods per plant, seeds per pod and grain yield were achieved with combination of RDF + vermicompost @ 2 t/ha.

Kumar and Singh (2014) from the study at Faridabad (U.P.) reported significantly higher number of pods per plant, pod length, number of seeds per pod, seed and haulm yield with application of 75% RDF + 25% N through biocompost.

Tyagi and Upadhyay (2014) conducted a field experiment on summer greengram at Research Farm, College of Agriculture, Tikamgarh (Madhya Pradesh) and found that integration of 100 per cent RDF + vermicompost @1.0 t ha⁻¹ + *Rhizobium* resulted in to significantly greater number of pods plant⁻¹ (13.5), number of seeds pod⁻¹ (10.6), 1000 seed weight (36.5g) and seed yield (1081.81kg ha⁻¹).

Vitnor *et al.* (2015) conducted an experiment at Allahabad (U.P.) during *kharif* season on greengram and reported that the application of 100% RDF + vermicompost @ 1.25 t ha⁻¹ + *Azotobacter* @ 375 g ha⁻¹ recorded significantly higher number of pods plant⁻¹ (24.77), number of seeds pod⁻¹ (14.77), number of seeds plant⁻¹

(342.74), seed yield plant⁻¹ (14.80 g), 1000 seed weight (42.52 g) and seed yield (1139.46 kg ha⁻¹).

2.2.3 Quality

Bachhav and Sabale (1996) reported that application of 50 kg N /ha of which half through urea and half through FYM significantly influenced quality parameters in *kharif* soybean.

Sharma and Misra (1997) at Indore (Madhya Pradesh) indicated that tremendous enhancement in estimated protein yield (1,149.5 kg/ha) of *kharif* soybean due to combine use of FYM @ 6 t/ha and reduced level of fertilizer N @ 20 kg /ha.

Acharya and Mondal (2010) conducted a field experiment on green gram at Mohanpura (West Bengal) and found that higher protein content was recorded with integration of 75% RDF + 25% N through FYM.

Choudhary *et al.* (2013) examined the influence of organic manure and chemical fertilizer on nutrient uptake, yield and profitability of mungbean (*Vigna radiata* L.) at Bikaner, Rajasthan and found that vermicompost @ 0.7 t/ha + 50% RDF recorded significantly higher protein content and protein yield.

Tyagi and Upadyay (2014) conducted an experiment in Madhya Pradesh on summer greengram and concluded that application of 100 per cent RDF + vermicompost @1.0 t ha⁻¹ + *Rhizobium* recorded higher protein yield (262.1 kg ha⁻¹) as well as protein content (22.2%).

2.2.4 Nutrient content and uptake

Sharma (1992) conducted a field experiment at Indore (Madhya Pradesh) on *kharif* soybean and reported the highest total uptake of N, P, K and S of 188.16, 16.33, 79.95 and 14.15 kg/ha respectively due to treatment of 6 t/ha FYM along with 20 kg/ha of N fertilizer.

Sharma and Misra (1997) from Indore (Madhya Pradesh) indicated tremendous enhancement in uptake of nutrients (235.45 N, 20.20 P, 89.98 K kg/ha) in *kharif* soybean due to combine use of FYM @ 6 t/ha and reduced level of N at 20 kg /ha.

Rajkhowa *et al.* (2003) at Jorhat, Assam studied the effect of vermicompost and levels of fertilizer on greengram and they found that 100% RDF + vermi compost recorded significantly higher N and P uptake which remain at par with 75% RDF and 50% RDF with vermicompost.

Acharya and Mondal (2010) conducted a field experiment on green gram at Mohanpura (West Bengal) and found significantly higher nutrient uptake by the crop with integration of 75% RDF + 25% N through Neematex which stood at par with combination of 75% RDF + 25% N through FYM.

Upperi *et al.* (2011) carried out a field experiment on greengram. They found that application of RDF along with FYM significantly increased organic carbon content of soil to 0.65 percent from 0.32 percent (control), which also significantly increased the uptake of N, P and K.

Choudhary *et al.* (2013) conducted a field experiment on influence of organic manure and chemical fertilizer on nutrient uptake, yield and profitability of mungbean (*Vigna radiata* L.) at Bikaner, Rajasthan. They concluded that vermi compost @ 0.7 t/ha + 50% RDF recorded significantly higher total N, P and K uptake.

Ram *et al.* (2013) studied the effect of organic and inorganic sources of nutrients on productivity, profitability and soil health in lentil under vertisols in Rajasthan. Significantly higher uptake of N, P and K with combination of RDF + vermi compost @ 2 t/ha.

Singh *et al.* (2013) conducted a field experiment in Meghalaya on groundnut and found that combination of Lime + FYM + 50% NPK recorded significantly higher uptake of N, P and K.

Tyagi and Upadhyay (2014) conducted an experiment in Madhya Pradesh on summer greengram and concluded that application of 100 per cent RDF + vermicompost @1.0 t ha⁻¹ + *Rhizobium* registered higher N, P and K uptake by seed.

2.2.5 Soil chemical properties after crop harvest

Mathan *et al.* (1996) laid out a field experiment during *kharif* season of 1991 and 1992 at Millet Breeding Station, TNAU, Coimbatore of alfisol soil and reported that the interactive effect of FYM @ 6.25 t ha⁻¹ and inorganic fertilizer (20 kg N + 50 kg P ha⁻¹) resulted in maximum available N, P and K in the soil after harvest of blackgram in both the years.

Shete, (2008) conducted a field experiment during *rabi* season of 2007-08 at Navsari to study the response of *rabi* greengram (*Vigna radiata* L.) to land configuration and inorganic fertilizer with and without FYM under South Gujarat condition. The inorganic fertilizer with and without FYM levels did not exhibit significant response on available nutrients (N, P and K) status of soil after harvest of greengram.

2.2.6 Economics

Singh and Verma (2002) studied the response of frenchbean to application of organics and inorganics in eastern U.P. and found that 10 t FYM + 75% RDF achieved maximum net return and B:C ratio which remained at par with 10 t FYM + 50% RDF.

Sumathi and Rao (2007) conducted a field experiment in Andhra Pradesh on effect of organic and inorganic sources of nitrogen with different irrigation schedules on growth and yield of sunflower. Application of 100% RDN through fertilizer realized maximum net return and B:C ratio but it stood at par with 75% RDN + 25 % FYM.

Acharya and Mondal (2010) from a field experiment on green gram at Mohanpura (West Bengal) and concluded that integration of 75% RDF + 25% N through FYM accrued maximum net return and B:C ratio.

Dongare (2011) investigated the interactive effect of organic manures and nitrogen levels during 2009-10 at Navsari. The highest net return of Rs. 63544.87 /ha and BCR of 5.55 were obtained

with treatment combination of nitrogen @ 80 kg /ha with 2.5 t bio-compost /ha.

Singh *et al.* (2011) laid out a field experiment on response of groundnut to biofertilizer, organic and inorganic sources of nutrient in north east India at Meghalaya and observed maximum net return and B:C ratio with combination of Lime + FYM + 50% NPK.

Bachhav *et al.* (2012) at Anand studied the yield and economics of soybean influenced by integrated nutrient management practices and found that combination of FYM @ 5 t/ha + 100% RDF recorded maximum net return and B:C ratio.

Choudhary *et al.* (2013) conducted an experiment on influence of organic manure and chemical fertilizer on nutrient uptake, yield and profitability of mung bean (*Vigna radiata* L.) at Bikaner, Rajasthan and observed the maximum gross return, net return and B:C ratio with combination of vermicompost @ 0.7 t/ha and 50% RDF.

Gabhane *et al.* (2013) reported significantly higher net return and B:C ratio with application of 25kg N ha⁻¹ and 25kg P₂O₅ ha⁻¹ through urea and SSP respectively in combination with 25 kg N ha⁻¹ through FYM in cotton and green gram intercropping system.

Ram *et al.* (2013) studied the effect of organic and inorganic sources of nutrients on productivity, profitability and soil health in lentil under vertisols in Rajasthan. The combination of RDF + vermin compost @ 2 t/ha realized maximum net return and B:C ratio.

Singh *et al.* (2013) conducted an experiment on groundnut in Meghalaya and found that combination of Lime + FYM + 50% NPK recorded significantly higher net return and B:C ratio.

Keerthi *et al.* (2015) conducted a field experiment on greengram during *rabi* season in Tamil Nadu and reported that application of RDF (13:25:13 NPK kg ha⁻¹) with 12.5 t/ha of FYM and 25 kg/ha ZnSO₄ secured highest net return (Rs.57806 ha⁻¹) and B:C ratio (2.43).

Tyagi and Upadyay (2015) laid out an experiment in Madhya Pradesh on summer greengram and recorded higher net return (Rs.39741 ha⁻¹) with 100% RDF + 2 t FYM ha⁻¹ + *Rhizobium* while the maximum B:C ratio (1.97) with the application of 100% RDF + *Rhizobium*.

2.3 INTRACTION EFFECT OF LAND CONFIGURATION AND INTEGRATED NITROGEN MANAGEMENT

A field experiment was conducted during *rabi*-summer season of 2003-04 to 2005-06 at Soil and Water Management Research Unit, Navasari (Gujarat) to study the effect of land configuration and soil conditioners on the productivity of *rabi* crops grown after paddy. The results showed that sorghum sown on raised bed by applying recommended dose of fertilizer along with either pressmud @ 6 t ha⁻¹ or FYM @ 10 t ha⁻¹ gave higher net income (Anon., 2007).

A field experiment was carried out at Danti-Umbharat (Gujarat) during *rabi* season of 2007-08 to 2009-10 on integrated nutrient management with and without land configuration in wheat.

The results revealed that to secure higher grain yield, wheat should be sown on raised bed along with application of 100% RDF (180-90-00 NPK kg ha⁻¹) and bio-compost or FYM @ 10 t ha⁻¹ (Anon., 2011).

Shete, (2008) conducted a field experiment during *rabi* season of 2007-08 at Navsari to study the response of *rabi* greengram (*Vigna radiata* L.) to land configuration and inorganic fertilizer with and without FYM under South Gujarat condition. The interaction consisting of land configuration and FYM levels was found to be non-significant with respect to growth and yield attributes, grain yield, protein content, nutrients(N, P and K) uptake by crop and available nutrients(N, P and K) status of soil after crop harvest of greengram. However, the highest net return and B:C ratio were realized with treatment combination of raised bed sowing method along with RDF (100 %) and no FYM followed by treatment combination of raised bed sowing method along with RDF (100 %) and FYM (5 t ha⁻¹).

A field trial was carried out by Paliwal *et al.* (2011) during 2007-08 to 2008-09 at Indore to study the effect of land configuration along with integrated nutrient management on soybean-wheat cropping system. They revealed that the interaction of vermicompost @ 5 t ha⁻¹ with 25 per cent reduction in recommended dose of fertilizers in both the crops and ridges and furrow method of sowing in soybean followed by flat bed sowing with *Gliricidia* leaves mulching (2 t ha⁻¹) in wheat recorded significantly higher growth and yield attributes, yield and N, P and K uptake by both soybean and wheat crops and also higher nutrients (N, P and K) balance after harvest of wheat crop over initial value.

A field experiment was conducted during summer season of 2011 at Navsari by Shinde *et al.* (2013) and they reported non-significant interaction effect of land configuration and bio compost on nutrient uptake by grain and stover of soybean and available N, P₂O₅ and K₂O and organic carbon in soil after harvest of crop.

A field trial was taken up by Kumar and Singh (2014) at Farizabad (U.P.) and reported that sowing of french bean on raised bed along with application of 75% N through RDF + 25% N through biocompost recorded significantly higher grain yield of french bean.



*MATERIALS AND
METHODS*



III. MATERIALS AND METHODS

A field experiment entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soil” was conducted during *rabi* season of the year 2015-16 at the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat. The details of the experimental procedure followed, materials used and techniques adopted during the course of investigation are described in this chapter.

3.1 DETAILS OF THE EXPERIMENTAL SITE

3.1.1 Experimental site

The field experiment was laid out on plot no. A-15/16 of old Danti farm at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat.

3.1.2 Climate and weather condition

The Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat is located about one kilometer away from the Arabian sea towards East and geographically at 20° 83’ N latitude and 72° 52’ E longitude with altitude of 2.5 meter above mean sea level.

According to agro-climatic conditions, Danti-Umbharat is placed under South Gujarat heavy rainfall zone. The climate of this region is characterized by fairly hot summer, moderately cold winter, humid and warm monsoon with medium to heavy rain.

Generally, pre-monsoon rain is occurred in the last week of May or first week of June. Regular South-West monsoon commences from third week of June and retreats by the end of October. Most of the precipitation is received during July and August. During monsoon, most of the days remain cloudy with less sunshine hours and annual average rainfall is approximately about 1200 mm. The winter season sets in the second week of November and continues up to the end of February. December and January are the coldest months of the season. The summer season commences in the month of March and ends by the month of May.

The mean weekly meteorological data pertaining to maximum and minimum temperature, relative humidity, sunshine hours and pan evaporation during the period of experimentation for the *rabi-2015-16* recorded at meteorological observatory of the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat are presented in Table 1 and graphically depicted in Fig. 1.

It is evident from the data that mean maximum temperature ranged from 24.4 to 37.1 and mean minimum temperature from 11.1 to 23.3 during *rabi-2015-16*. The mean morning relative humidity ranged from 49 to 85 per cent and mean afternoon relative humidity ranged from 31 to 63 per cent during *rabi-2015-16*. The mean pan evaporation ranged between 4.5 to 7.3 mm and mean bright sunshine hours varies from 5.4 to 7.6 hrs day⁻¹ during *rabi 2015-16*. There was no evidence of rainfall occurrence during the experimentation period.

In general, the weather conditions were found normal and congenial for satisfactory growth and development of green gram crop without the severe attack of any major pest and diseases during the season of investigation.

Table 3.1 : Mean meteorological data recorded at meteorological observatory of the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbarat during the course of investigation

Month	Date	Std. Week	Temp.(⁰ C)		R.H. (%)		Wind Speed (km/hr)	PE (mm/day)	Sunshine Hours
			Max.	Min.	Mor.	Even.			
November-2015	05-11	45	32.6	23.0	85	54	2.2	5.9	6.3
	12-18	46	31.8	22.3	81	61	2.2	5.9	6.4
	19-25	47	31.8	23.3	79	63	3.4	6.0	6.3
	26-02	48	29.6	19.4	68	49	3.0	5.6	6.0
December-2015	03-09	49	29.7	17.4	61	38	3.2	5.2	5.4
	10-16	50	28.2	17.7	58	46	3.2	5.7	6.4
	17-23	51	25.3	13.1	49	38	3.4	4.9	6.5
	24-31	52	24.4	12.1	56	39	4.0	4.8	6.3
January-2016	01-07	1	29.3	13.0	53	34	2.9	5.1	6.7
	08-14	2	29.7	14.7	58	32	3.1	5.2	6.9
	15-21	3	26.3	12.8	63	33	3.4	4.5	6.4
	22-28	4	26.8	11.1	57	31	3.8	4.7	5.8
February-2016	29-04	5	29.2	14.7	57	41	3.4	4.6	6.5
	05-11	6	28.6	13.3	62	42	4.3	5.3	6.8
	12-18	7	29.0	14.7	58	35	4.2	5.4	6.7
	19-25	8	31.4	17.9	57	37	4.3	6.4	7.0
March-2016	26-04	9	32.4	18.7	73	42	4.4	5.9	7.1
	05-11	10	32.8	19.4	56	46	4.3	6.3	7.2
	12-18	11	33.5	20.3	55	37	5.9	6.5	7.6
	19-25	12	34.5	19.8	54	36	4.6	6.6	7.1
April-2016	26-01	13	36.5	20.5	58	36	4.8	7.3	7.3
	02-08	14	37.1	22.3	63	34	5.7	7.3	7.3
	09-15	15	36.1	22.3	62	38	5.2	7.9	7.1
	16-22	16	37.6	24.7	61	42	6.8	7.7	9.2
	23-29	17	35.1	24.0	59	48	8.2	7.3	7.5

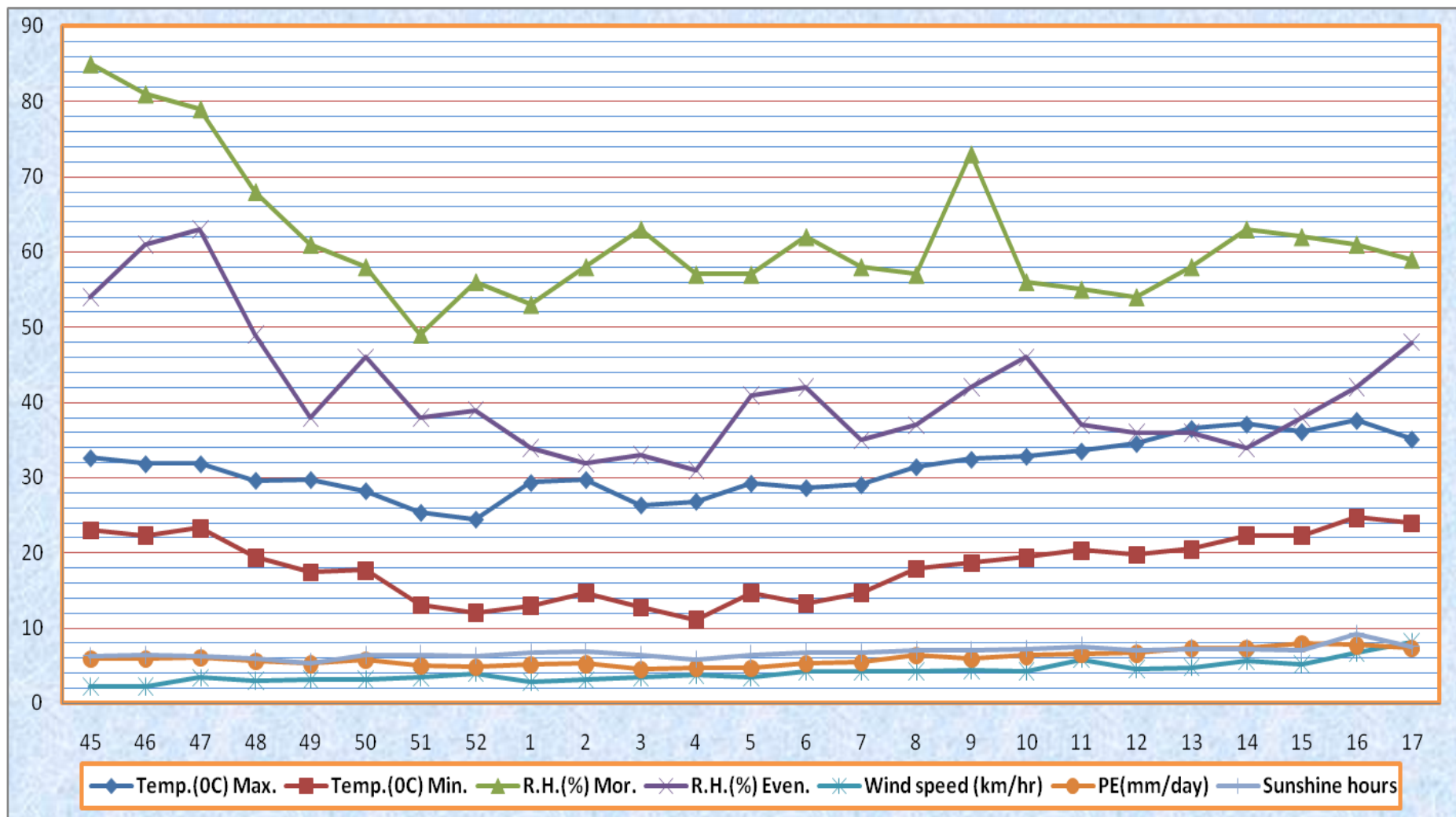


Fig.3.1 Mean meteorological data recorded at meteorological observatory of the coastal soil salinity Research station, Navsari Agricultural University, Danti-Umbhrat during the course of investigation

3.1.3 Physico chemical properties of soil

As per the classification carried out by Soil Survey Officer, Department of Agriculture, Gujarat state, Danti-Umbharat centre belongs to Jalalpur series. It has placed under the series inceptisols, sub-order ochrepts, great group ustochrepts and sub-group verticustochrepts. It has developed from alluvium of basaltic materials. The main mineralogical make up is smectite. The soil is classified as “Calcareous Soil” characterized by very high clay content, with good moisture holding capacity and low to very low permeability. It cracks heavily on drying and expands on wetting.

The experimental field has flat topography with medium slope. Representative soil samples were drawn from 0-15 cm depth from randomly selected spots over the experimental field before sowing of the crop. Samples collected from different spots were mixed thoroughly and a composite soil sample was prepared and analyzed for various physico-chemical properties of soil, the values are presented in Table 3.2 which revealed that the soil of experimental plot was clayey in texture and slightly alkaline in reaction. The soil was low in available nitrogen, medium in available phosphorus and high in potassium.

3.1.4 Source of irrigation

The canal water stored in pond was used for irrigation purpose in the present experiment.

Table 3.2: Physico-chemical properties of experimental field before experimentation.

Soil characteristics	Soil depth 0-15 cm	Methods of analysis (Reference)
A. Mechanical analysis of soil		
1. Sand (%)	12.70	International pipette method (Piper, 1950)
2. Silt (%)	19.40	
3. Clay (%)	67.90	
4. Textural class	Clay	
B. Chemical analysis of soil		
1. pH _{2.5}	8.82	Potentiometric (Jackson, 1967)
2. EC _{2.5} (dS m ⁻¹)	1.85	Conductometric (Jackson, 1967)
3. Organic Carbon (%)	0.53	Walkley and Black's rapid titration method (Jackson, 1967)
4. ESP	10.8	
5. Av. N (kg ha ⁻¹)	209	Alkaline KMnO ₄ method (Jackson, 1967)
6. Av. P ₂ O ₅ (kg ha ⁻¹)	37.1	Olsen's method (Jackson, 1967)
7. Av. K ₂ O (kg ha ⁻¹)	1553	Flame photometric method (Jackson, 1967)

3.1.5 Water table

The depth of water table of the experimental field was more than 4m below the surface throughout the period of experiment. Hence, ground water contribution to green gram was not observed in the present experimentation.

3.1.6 Cropping history of the experimental field

The cropping history of the experimental plot no. A 15/16 (Old Danti Farm) of the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umharat for the preceding three years is furnished in Table 3.3.

Table 3.3: Cropping history of the experimental field.

Year	Season	Crop	Fertilization (kg ha ⁻¹)		
			N	P ₂ O ₅	K ₂ O
Plot No. A-15/16					
2012- 2013	<i>Kharif</i>	Paddy	120	30	0
	<i>Rabi</i>	Wheat	180	60	0
	Summer	Fallow	-	-	-
2013- 2014	<i>Kharif</i>	Paddy	120	30	0
	<i>Rabi</i>	Wheat	180	60	0
	Summer	Fallow	-	-	-
2014- 2015	<i>Kharif</i>	Paddy	120	30	0
	<i>Rabi</i>	Wheat	180	60	0
	Summer	Fallow	-	-	-
2015- 2016	<i>Kharif</i>	Paddy	120	30	0
	<i>Rabi</i>	Present experiment	As per treatment		

3.1.7 Salient features of the variety

The present investigation was carried out with ‘Co 4’ variety of greengram which was released from Tamil Nadu Agricultural University, Coimbatore. This variety was released for South Gujarat during the year 1999. This variety is suitable for *rabi* season especially for South Gujarat. This variety has darkish green coloured medium sized grains and high yielding having tolerant to yellow mosaic virus. The life span of this variety is 100-110 days.

3.2 Experimental details

The details of the experimental techniques employed for this investigation entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” are described below:

3.2.1 Treatment

Total fifteen treatment combinations consisting three levels of land configuration and five levels of integrated nitrogen management.

(A) Factor-1: Land configuration (L)

L₁: Flat bed method

L₂: Ridges and furrows method

L₃: Raised bed method

(B) Factor-2: Integrated nitrogen management (N)

N₁: 100% N through inorganic fertilizer (20kg N/ha)

N₂: 75% N through inorganic fertilizer + 25% N through FYM

N₃: 50% N through inorganic fertilizer + 50% N through FYM

N₄: 75% N through inorganic fertilizer + 25% N through vermi
compost

N₅: 50% N through inorganic fertilizer + 50% N through vermi
compost

3.2.2 Experimental design and layout

The experiment comprising of fifteen treatment combinations consisting three levels of land configuration and five levels of integrated nitrogen management were studied. The experiment was laid out in factorial randomized block design (FRBD) with three replications. Treatment combinations were allotted randomly within each replication. The plan of layout is depicted in Fig.3.2

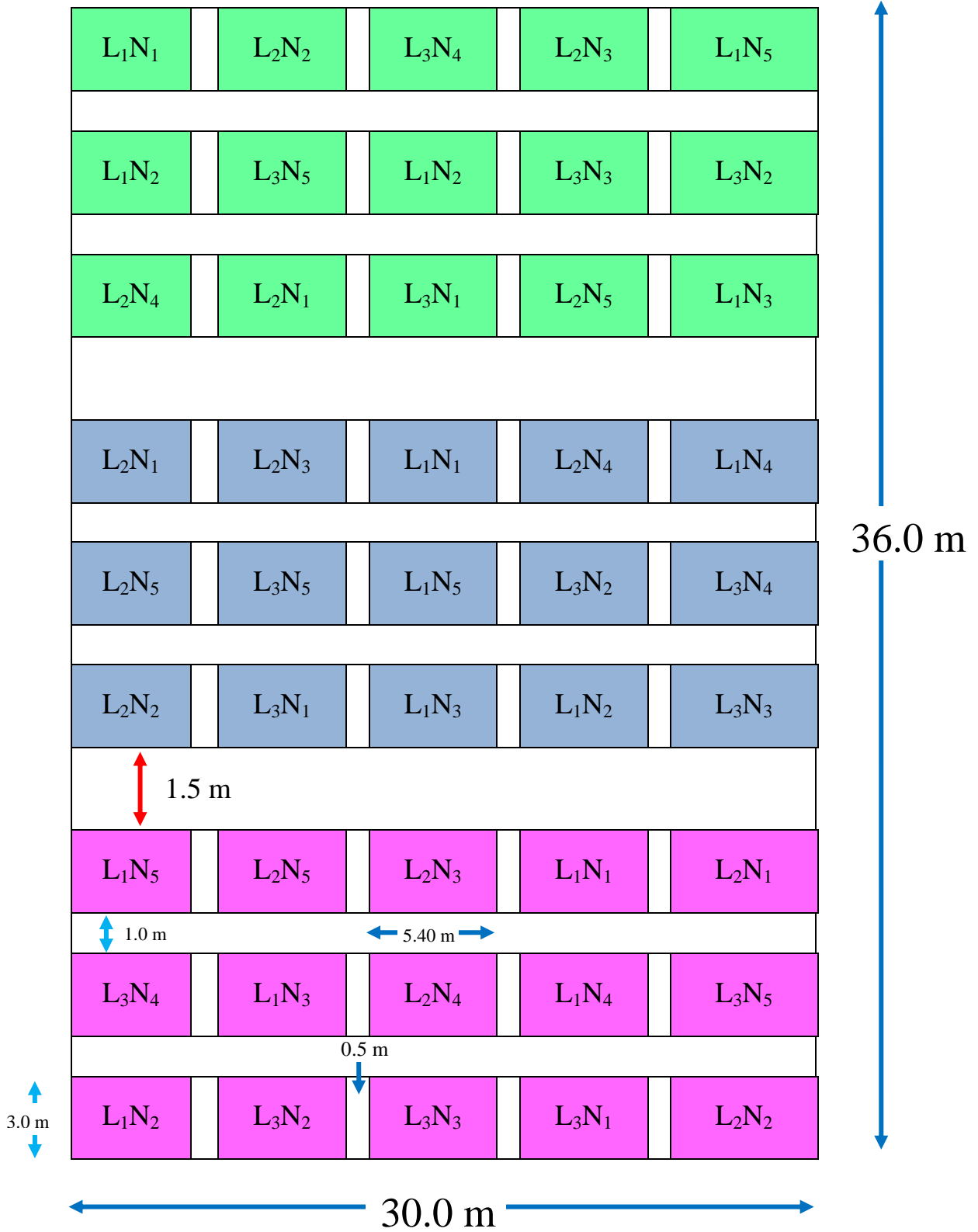


Fig 3.2 Layout plan of field experiment.

The other details of experiment are as under:

Season and year	: <i>Rabi</i> 2015-16
Total no. of plots	: 45
Plot size	: Gross plot : 5.40 m X 3.00 m : Net plot : 2.70 m X 2.60 m
Experimental area	: 1079 m ²
Crop and variety	: Green gram, Co-4
Seed rate	: 15 kg ha ⁻¹
Treatment combinations	: 15
Replication	: 3 (Three)
Recommended Fertilizer dose	: 20-40-0 NPK kg ha ⁻¹
Statistical design	: Factorial Randomized Block Design(FRBD)
Spacing	Flat bed : 45 cm x 10 cm Raised bed : 30 x10 x 75 cm (paired row)

3.3 Cultivation details

The calendar of cultural operations carried out in the experimental field during the course of investigation is given in Table 3.4.

Table 3.4: Calendar of important field operations

Sr. No.	Field operations	Date
A.	Pre- sowing operations	
1.	Ploughing	08-12-2015
2.	Layout of experiment	10-12-2015
3.	Preparation of seed bed	11-12-2015
4.	Manure application	03-12-2015
5.	Fertilizer application	12-12-2015
B.	Sowing and post sowing operations	
1.	Sowing	12-12-2015
2.	Spraying of pre-emergence herbicide	13-12-2015
3.	Thinning	22-12-2015
4.	Hand weeding	09-01-2016 27-01-2016
5.	Irrigation	12-12-2015 26-12-2015 16-01-2016 04-02-2016 23-02-2016
6.	Harvesting	15-03-2016
7.	Threshing and cleaning	20-03-2016

3.3.1 Preparation of land

The experimental field was cultivated by tractor drawn cultivar in both the directions after harvest of previous crop. Weed and crop residues were removed manually and then planking was done in both the directions to prepare fine seed bed. Lay out of the experiment was carried out manually according to the plan of layout. For sowing, flat bed, ridge and furrow and raised bed were prepared according to land configuration treatments as depicted in Fig.3.2.

3.3.2 Manure and Fertilizer application

The nitrogen content of FYM and vermicompost were 0.6 per cent and 2.1 per cent, respectively. Required quantity of organic manure *i.e.*, FYM and vermicompost were worked out for gross plot area as per treatment. FYM and vermicompost were applied in respective treatments after preparing beds, mixed it by using *kudali* and then ridge and furrow and raised beds were prepared. The inorganic fertilizers were applied in respective treatments just before sowing of crop. The sources used for nitrogen and phosphorus were urea and single super phosphate fertilizer, respectively.

3.3.3 Seed treatment and sowing

The greengram variety Co-4 was used for this experiment. The required quantity of seed was worked out for experimental area. Before sowing, the seeds were treated with liquid bio-fertilizers *i.e.* *Rhizobium* and PSB. The seeds were drilled 5 to 6 cm deep under dry soil condition with a recommended seed rate of 15 kg ha⁻¹. Then seeds

were covered properly with soil and light irrigation was applied in each plot immediately after sowing.

3.3.4 Thinning

After ten days of sowing, thinning was carried out to maintain intra row spacing of 10 cm and optimum plant stand in each plot.

3.3.5 Irrigation

The surface irrigation method was used to irrigate the crop. First irrigation was applied just after sowing to ensure good germination and better crop emergence. Subsequently, four irrigations were applied according to crop requirement as mentioned in Table 3.4.

3.3.6 Weed management

To protect the crop from weed infestation, Pendimithelin 30 EC (*a.i.* 1.0 kg ha⁻¹) was applied as pre-emergence. Subsequently, two hand weeding were carried out during early crop growth period.

3.3.7 Plant protection measures

The crop was not attacked by any pest and disease so, there was no need for any plant protection measures.

3.3.8 Harvesting and threshing

Harvesting was done by picking of mature pods twice at 20 days interval and then crop was finally harvested. The border lines, five sample plants and the net plot were harvested separately from each plot. The ring area was harvested first and removed from the experimental area. Firstly, five randomly selected plants (previously

tagged) from each net plot were harvested separately for recording necessary biometric observations and their produce was recorded separately and thereafter added to respective net plot yield. The net area was harvested simultaneously and the produce was allowed to sun dry in respective plots until constant weight was obtained. After drying, the plot wise threshing and cleaning operations were done separately. Threshing was carried out manually by beating the pods and plants with the help of wooden stick. Thereafter, seeds were cleaned manually and weight was recorded as per the treatments.

3.4 Biometric observations

The outermost rows on both sides were left as border rows and the next row adjacent to the border row on both the sides were utilized for plant sampling at periodic interval for recording observations. Five plants were selected at random from each net plot and tagged for recording observations on growth and yield attributing parameters. The methods followed for recording observations on each parameter are described here under.

3.4.1 Plant population

The initial plant stand was counted at 20 days after sowing and final plant population was recorded at harvest of crop from each net plot area.

3.4.2 Plant height (cm)

The plant height was measured in centimeters from ground level to the top of the main shoot of randomly selected five tagged plants from each plot of all the three replications at 30 and 60 DAS

and at harvest. The mean value for each plot was worked out and recorded.

3.4.3 Number of branches per plant

Number of branches per plant were counted from five pre tagged plants at harvest. The average value for each plot was worked out and registered.

3.4.4 Days to 50 per cent flowering

The number of days from the date of sowing to 50 per cent flowering were recorded for each treatment.

3.4.5 Number of pods per plant

The filled pods from previously tagged five plants were counted for each plot and mean value was worked out and recorded for each treatment.

3.4.6 Number of seeds per pod

The number of seeds obtained from randomly selected 10 pods of the five tagged plants was counted for each treatment. The value obtained was divided by the number of pods in order to get the average number of seeds per pod.

3.4.7 Test weight (g)

A representative seed samples were collected randomly from the bulk produce of each net plot and 1000 seeds were counted and those seeds were weighted by laboratory balance, which was noted as test weight of each treatment.

3.4.8 Seed yield (kg ha⁻¹)

The produce from each net plot was harvested and threshed separately after sun drying, cleaned and the seed yield was recorded in grams per net plot. The seed yield obtained per net plot was converted on hectare basis (kg ha⁻¹) and presented accordingly.

3.4.9 Stover yield (kg ha⁻¹)

Total biological yield (grain + stover) from each net plot was registered by weighing the dried harvested produce. The stover yield was worked out by subtracting the grain yield from biological yield and expressed in kilogram per hectare (kg ha⁻¹).

3.4.10 Harvest index (%)

The harvest index was computed by using formula suggested by Donald (1963) and registered separately for each treatment.

$$\text{Harvest index (\%)} = \frac{\text{Economical yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \times 100$$

3.5 Quality studies

After recording the test weight the same seeds were used for determination of protein content. Protein yield was workout using protein content of the seeds.

3.5.1 Protein content in seed (%)

The nitrogen content in greengram seed was estimated by Micro kjeldahl's method as described by Jackson (1967). The protein

content of seed was computed by multiplying the nitrogen percentage with 6.25 for each treatment.

$$\text{Protein content (\%)} = \text{Nitrogen content (\%)} \times 6.25$$

3.5.2 Protein yield (kg/ha)

The protein yield was computed by using following formula given here.

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein content in grain (\%)} \times \text{Grain yield (kg/ha)}}{100}$$

3.6 Biochemical studies

3.6.1 Plant analysis

Biochemical studies pertaining to nitrogen, phosphorus and potassium content and their uptake by both green gram grain and stover were determined as per methods described as under.

3.6.2 Nutrient content (%)

Representative plant samples from crop were taken separately from each plot for estimation of N, P and K content. The samples were oven dried at 65°C for 24 hrs, powdered by mechanical grinder and analyzed for respective nutrient content using following procedures.

3.6.3 Nutrient uptake (kg ha⁻¹)

The uptake of nutrients (N, P and K) by grain and stover were calculated using the formula given here.

Nutrient uptake (kg ha⁻¹)

$$= \frac{\text{Nutrient content in grain/stover (\%)} \times \text{Grain/stover yield (kg ha}^{-1}\text{)}}{100}$$

Table 3.5 Procedure used for analysis of nutrients content

Sr. No.	Particular	Procedure used	Reference
1.	Nitrogen (%)	Micro kjeldahl's method (diacid)	Jackson (1967)
2.	Phosphorus (%)	Vanadomolybdo phosphoric acid yellow colour method	Jackson (1967)
3.	Potassium (%)	Flame photometric method	Jackson (1967)

3.7 Soil analysis

3.7.1 Av. N, P₂O₅, K₂O, OC, pH, EC and ESP

Prior to sowing, composite soil sample was taken and analyzed for the status. After harvest of the crop, representative soil samples were taken from each plot up to 15 cm soil depth and analyzed for available N, P₂O₅, K₂O, OC, pH, EC and ESP status as per the prescribed procedure given in Table 3.6.

Table 3.6: Methods of soil analysis

SN	Parameter analyzed	Method followed	Reference
(A)	Chemical		
1.	pH	Potentiometric	Jackson (1967)
2.	EC	Conductometric	Jackson (1967)
3.	OC	Walkley and Black titration	Jackson (1967)
4.	Available N	Alkaline Potassium Permanganate method	Jackson (1967)
5.	Available P ₂ O ₅	Extraction 0.5 M NaHCO ₃ pH (8.5) Colorimetric method	Jackson (1967)
6.	Available K ₂ O	Extraction: 1N H ₄ OAC pH(7.0) Flame photometric method	Jackson (1967)

3.8 Statistical analysis

Statistical analysis of the data on various growth and yield characters studied in the investigation was carried out through the statistical analysis of variance technique as described by Panse and Sukhatme (1967). The method of analysis of variance for FRBD was used. To test the significance of result, five percent level of significance was used and the critical difference (C.D. at 5%) value was computed for making comparison among the treatment means. For remaining cases only standard error of mean was worked out. The coefficient of variation (C.V. %) was also worked out.

3.9 Economics

The gross realization in terms of rupee per hectare was worked out on the basis of seed and stover yields for each treatment and the prices of the produce prevailing in the market. The cost of cultivation for each treatment was worked out by taking the cost of all the operations right from preparatory tillage to harvesting including threshing, cleaning as well as the cost of inputs *viz.*, seeds, fertilizers and insecticides etc. The net realization was worked out by subtracting the total cost of cultivation from gross realization for each treatment and exhibited in rupees per hectare accordingly. The benefit cost ratio was also calculated for each treatment using following formula.

$$\text{BCR} = \frac{\text{Gross realization (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$



*EXPERIMENTAL
RESULTS*



IV-EXPERIMENTAL RESULT

The results of the field experiment entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” was conducted at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat during *rabi* season of the year 2015-16. Data pertaining to effect of treatments on various growth and yield parameters, yield, quality, nutrient content and uptake were statistically analyzed to test significance of results. The results of individual effect for different characters are presented in relevant tables along with statistical inferences. The results have also been presented graphically wherever felt necessary. All findings are described here under the following heads.

- 4.1 Plant population
- 4.2 Growth attributes
- 4.3 Yield and yield attributes
- 4.4 Plant analysis
- 4.5 Soil analysis
- 4.6 Economics
- 4.1 Plant population**

The data pertaining to plant stand of green gram at 20 days after sowing (DAS) and finally at harvest of crop from each net plot are presented in Table 4.1.

Table 4.1 Plant population of green gram as influenced by land configuration and integrated nitrogen management

Treatments	Plant population/net plot	
	20 DAS	At harvest
A. Land Configuration		
L1: Flat bed	152.63	139.80
L2: Ridge and furrow	153.97	141.63
L3: Raised bed	154.10	143.20
S.Em. \pm	2.09	2.34
CD (P=0.05)	NS	NS
B. Integrated Nitrogen Management		
N1: 100% N through inorganic fertilizer	155.30	142.90
N2: 75% N through inorganic fertilizer + 25% N through FYM	154.52	144.12
N3: 50% N through inorganic fertilizer + 50% N through FYM	153.52	143.34
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	151.74	137.79
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	152.74	139.57
S.Em. \pm	2.69	3.02
CD (P=0.05)	NS	NS
Interaction (L X N)	NS	NS
C.V. %	5.26	6.40

An examination of data revealed that land configuration and integrated nitrogen management did not significantly influence the initial and final plant population, which indicate that the treatments did not have any adverse effect on germination as well as on survival of the plants.

4.2 GROWTH AND YIELD ATTRIBUTES

4.2.1 Plant height

The mean data pertaining to plant height of greengram measured at different growth stages *i.e.*, 30, 60 DAS and at harvest as influenced by various levels of land configuration and integrated nitrogen management are presented in Table 4.2

4.2.1.1 Effect of land configuration

Data furnished in Table 4.2 indicated that plant height at 30 DAS was not significantly influenced due to land configuration. However, maximum plant height (13.40 cm) was noted with raised bed method (L₃) followed by ridges and furrows method (L₂) (13.08 cm).

Plant height at 60 DAS and at harvest was significantly influenced due to different land configuration methods. The plant height at 60 DAS (32.45 cm) was observed significantly higher under raised bed method (L₃) as compared to rest of the other methods. At harvest, the raised bed method (L₃) (45.75 cm) remaining at par with ridges and furrows method (L₂) (43.86 cm) recorded significantly taller plants than that of flat bed method.

Table 4.2 Plant height of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At harvest
A. Land Configuration			
L1: Flat bed	12.79	27.30	41.42
L2: Ridge and furrow	13.08	29.82	44.06
L3: Raised bed	13.40	32.45	45.75
S.Em. \pm	0.37	0.77	1.09
CD (P=0.05)	NS	2.23	3.15
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	12.90	28.29	40.00
N2: 75% N through inorganic fertilizer + 25% N through FYM	12.97	28.66	42.47
N3: 50% N through inorganic fertilizer + 50% N through FYM	13.04	29.46	44.82
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	13.23	31.03	45.58
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	13.30	31.61	45.86
S.Em. \pm	0.47	1.00	1.40
CD (P=0.05)	NS	NS	4.06
Interaction(L X N)	NS	NS	NS
C.V. %	10.89	10.01	9.6

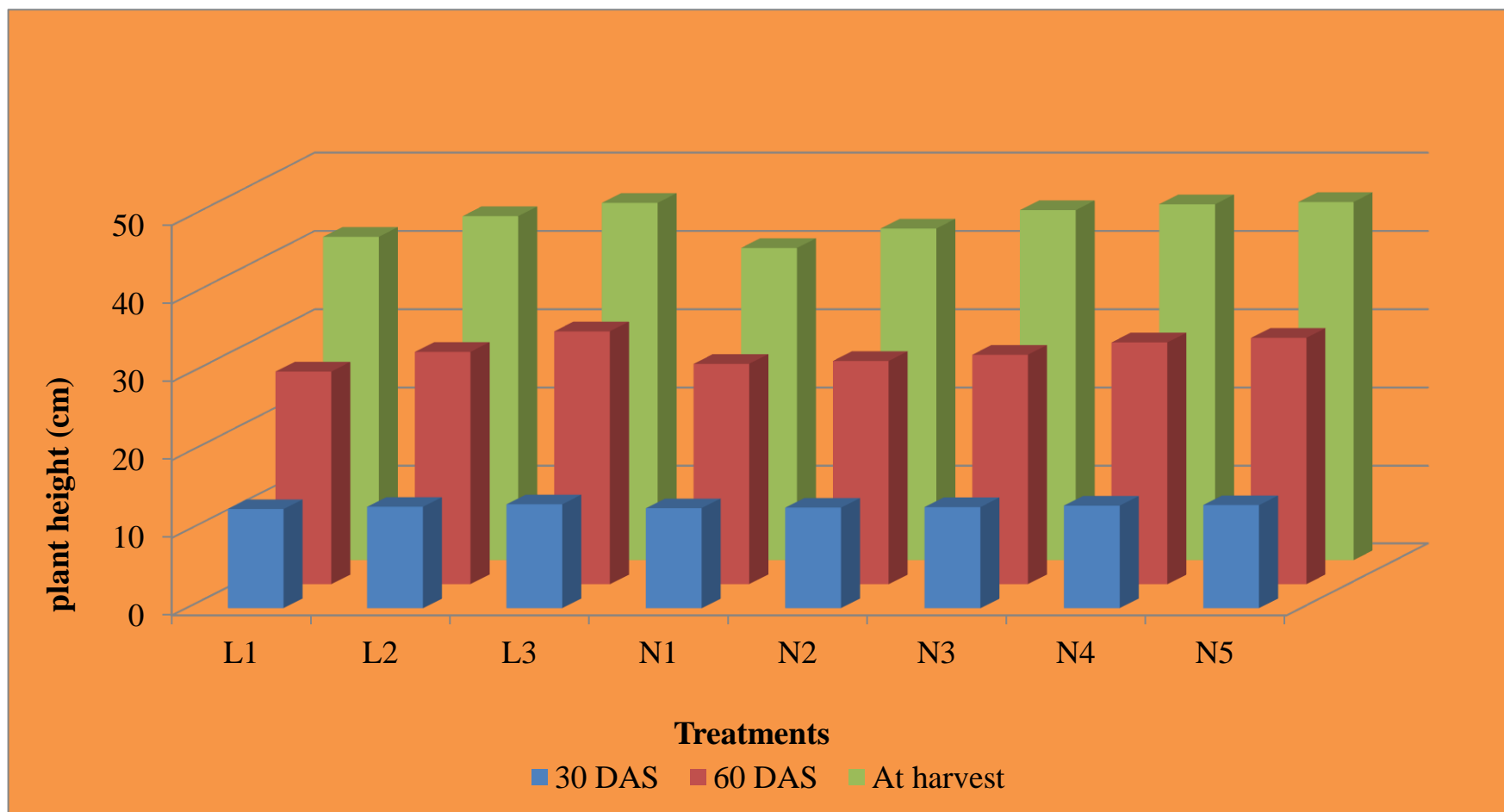


Fig-4.1: Plant height of greengram as influenced by land configuration and integrated nitrogen management.

4.2.1.2 Effect of integrated nitrogen management

The mean data presented in Table 4.2 indicated that plant height at 30 and 60 DAS was not significantly affected due to integrated nitrogen management. However, maximum plant height at 30 DAS (13.30 cm) and at 60 DAS (31.61 cm) was recorded with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅).

At harvest, plant height was significantly influenced by integrated nitrogen management. The plant height (45.86 cm) was significantly higher with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) as compared to application of 100 % N through inorganic fertilizer (N₁). Treatment N₅ stood at par with rest of the treatments with respect to plant height.

4.2.1.3 Interaction effect

The data regarding plant height at all the stages of observation did not exert their significant effect due to interaction effect between land configuration and integrated nitrogen management.

4.2.2 Number of branches per plant

The data regarding to the effect of land configuration and integrated nitrogen management on number of branches per plant registered at harvest are given in Table 4.3

4.2.2.1 Effect of land configuration

Data presented in Table 4.3 revealed that number of branches per plant at harvest was not significantly influenced due to land configuration treatments. However, raised bed method (L₃) registered higher number of branches per plant at harvest (3.68). While the least number of branches per plant at harvest (3.49) was noted under flat bed method (L₁).

4.2.2.2 Effect of integrated nitrogen management

The mean Data furnished in Table 4.3 indicated that number of branches per plant at harvest was significantly influenced by integrated nitrogen management. Application of 50% N through inorganic fertilizer + 50 % N through vermicompost (N₅) recorded significantly higher number of branches per plant at harvest (3.72) which was at par with application of 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (3.67) and 50% N through inorganic fertilizer + 50% N through FYM (N₃) (3.54). Whereas the lowest number of branches per plant at harvest (3.45) was found with application of 100 % N through inorganic fertilizer (N₁).

4.2.2.3 Interaction effect

Data exposed from table 4.3 indicated that the interaction effect of land configuration and integrated nitrogen management did not exert significant effect on number of branches per plant at harvest.

Table 4.3 Number of branches per plant and days to 50% flowering as influenced by land configuration and integrated nitrogen management.

Treatments	Number of branches per plant	Days to 50% flowering
A. Land Configuration		
L1: Flat bed	3.49	44.85
L2: Ridge and furrow	3.55	45.53
L3: Raised bed	3.68	46.61
S.Em. \pm	0.053	0.487
CD (P=0.05)	NS	NS
B. Integrated Nitrogen Management		
N1: 100% N through inorganic fertilizer	3.45	44.56
N2: 75% N through inorganic fertilizer + 25% N through FYM	3.49	44.96
N3: 50% N through inorganic fertilizer + 50% N through FYM	3.54	45.38
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	3.67	46.50
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	3.72	46.92
S.Em. \pm	0.069	0.629
CD (P=0.05)	0.200	NS
Interaction (L X N)	NS	NS
C.V. %	5.78	4.13

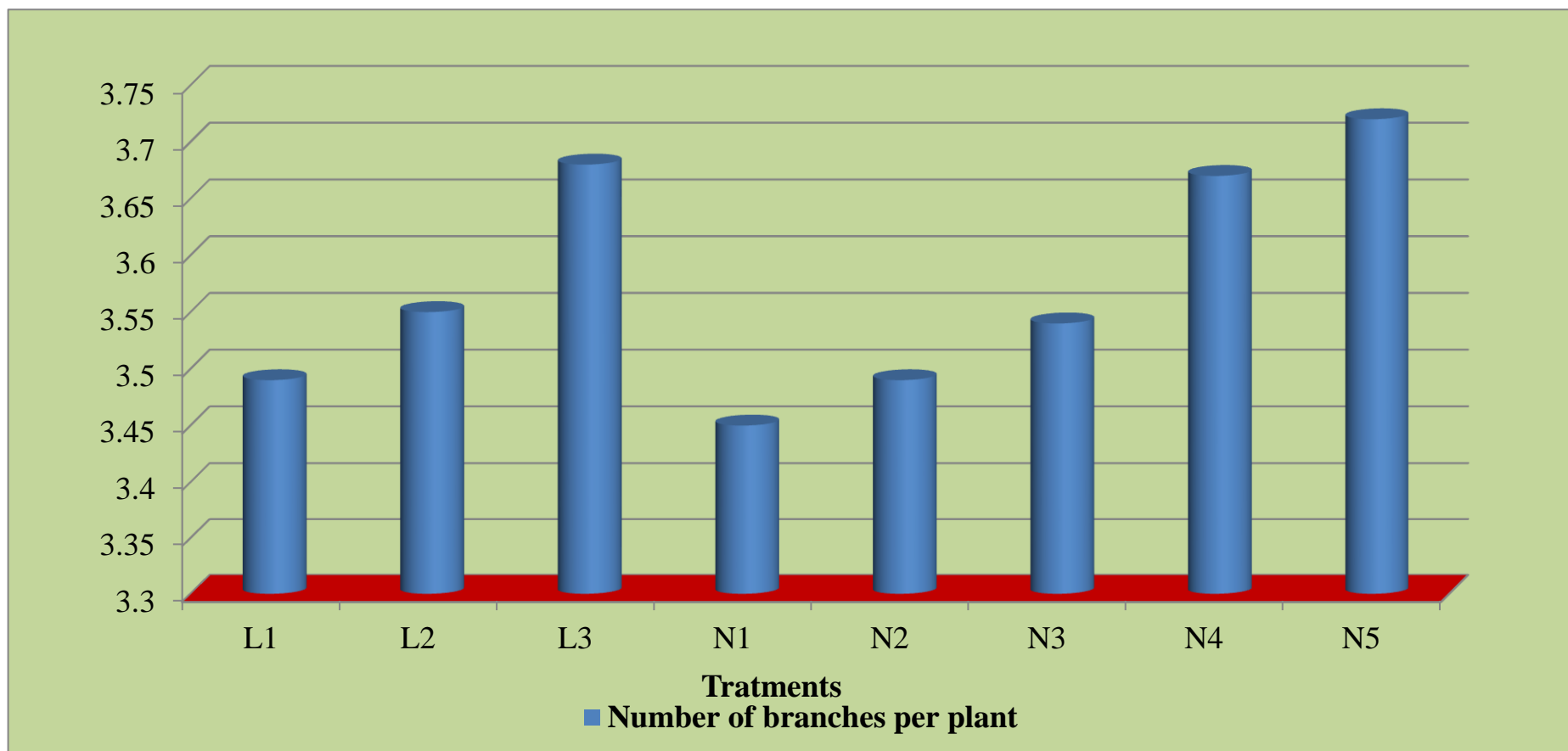


Fig-4.2: Number of branches per plant as influenced by land configuration and integrated nitrogen management.

4.2.3 Days to 50% flowering

The data relevant to the effect of land configuration and integrated nitrogen management on days to 50% flowering are presented in table 4.3.

4.2.3.1 Effect of land configuration

It is evident from the data furnished in Table 4.3 indicated that days to 50 per cent flowering in greengram was not significantly influenced by different methods of land configuration. Raised bed method (L_3) took maximum days to bring 50 % flowering (46.61) while, minimum days were required to bring 50 % flowering (44.85) with flat bed method (L_3).

4.2.3.2 Effect of integrated nitrogen management

An appraisal of data presented in Table 4.3 revealed that none of the integrated nitrogen management treatments showed significant effect on days to 50 per cent flowering. However, maximum days for 50% flowering (46.92) were noted with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) followed by application of 75% N through inorganic fertilizer + 25% N through vermicompost (N_4) (46.50).

4.2.3.3 Interaction effect

The interaction between land configuration and integrated nitrogen management failed to express the level of significance on days to 50 per cent flowering in greengram.

4.3 Yield and yield attributes

4.3.1 Number of pods per plant

Data pertaining to the effect of land configuration and integrated nitrogen management on number of pods per plant are presented in Table 4.4.

4.3.1.1 Effect of land configuration

Data furnished in Table 4.4 indicated that number of pods per plant was significantly influenced by land configuration. Significantly maximum number of pods per plant (18.58) were achieved recorded with raised bed method (L₃) which was at par with ridge and furrow method (L₂) (17.81).

4.3.1.2 Effect of integrated nitrogen management

The number of pods per plant was influenced significantly by integrated nitrogen management. Significantly maximum number of pods per plant (19.19) was recorded with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) which remained at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (18.70) and 50% N through inorganic fertilizer + 50% N through FYM (N₃) (18.17). Treatment N₁ produced the lowest number of pods per plant.

4.3.1.3 Interaction effect

Data presented in Table 4.4 showed that the interaction of land configuration and integrated nitrogen

management did not bring any variation on number of pods per plant.

4.3.2 Number of seeds per pod

The data regarding the effect of land configuration and integrated nitrogen management on number of seeds per pod are exhibited in Table 4.4. and depreciated in Fig 4.2

4.3.2.1 Effect of land configuration

Data found in Table 4.4 indicated that number of seeds per pod were influenced significantly by land configuration treatments. Significantly the highest number of seeds per pod (9.75) was recorded with raised bed method (L_3) but it remained at par with ridges and furrows method (L_2).

4.3.2.2 Effect of integrated nitrogen management

Data outlined in Table 4.4 revealed that number of seeds per pod were influenced significantly by integrated nitrogen management. Treatment N_5 (50% N through inorganic fertilizer + 50% N through vermicompost) standing at par with N_4 and N_3 registered significantly more number of seeds per pod over rest of the treatments.

4.3.2.3 Interaction effect

Data covered in Table 4.4 indicated that the interaction effect of land configuration and integrated nitrogen management was not found significant with respect to number of seeds per pod.

4.3.3 Test weight (g)

Data pertaining to the effect of different levels of land configuration and integrated nitrogen management on test weight (1000-seed weight) are presented in Table 4.4

4.3.3.1 Effect of land configuration

The data summarized in Table 4.4 revealed that the test weight of green gram was not significantly changed due to different methods of land configuration but, raised bed sowing method (L_3) obtained numerically higher values of test weight (30.18 g).

4.3.3.2 Effect of integrated nitrogen management

Data furnished in Table 4.4 showed that test weight of green gram was influenced significantly by integrated nitrogen management. Significantly higher test weight (31.16 g) was noticed with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) but it stood at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N_4).

4.3.3.3 Interaction effect

The mean data presented in Table 4.4 revealed that the interaction of land configuration and integrated nitrogen management did not exert significant effect on test weight of green gram.

Table 4.4 Number of pods per plant, number of seeds per pod and test weight of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Number of pods per plant	Number of seeds per pod	Test weight (g)
A. Land Configuration			
L1: Flat bed	16.84	8.66	29.20
L2: Ridge and furrow	17.81	9.37	29.96
L3: Raised bed	18.58	9.75	30.18
S.Em. \pm	0.362	0.258	0.367
CD (P=0.05)	1.049	0.746	NS
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	15.71	8.53	28.56
N2: 75% N through inorganic fertilizer + 25% N through FYM	16.94	8.80	29.01
N3: 50% N through inorganic fertilizer + 50% N through FYM	18.17	9.08	29.47
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	18.70	9.80	30.70
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	19.19	10.08	31.16
S.Em. \pm (L X N)	0.467	0.333	0.474
CD (P=0.05) (L X N)	1.354	0.963	1.372
Interaction(L X N)	NS	NS	NS
C.V. %	7.90	10.78	4.77

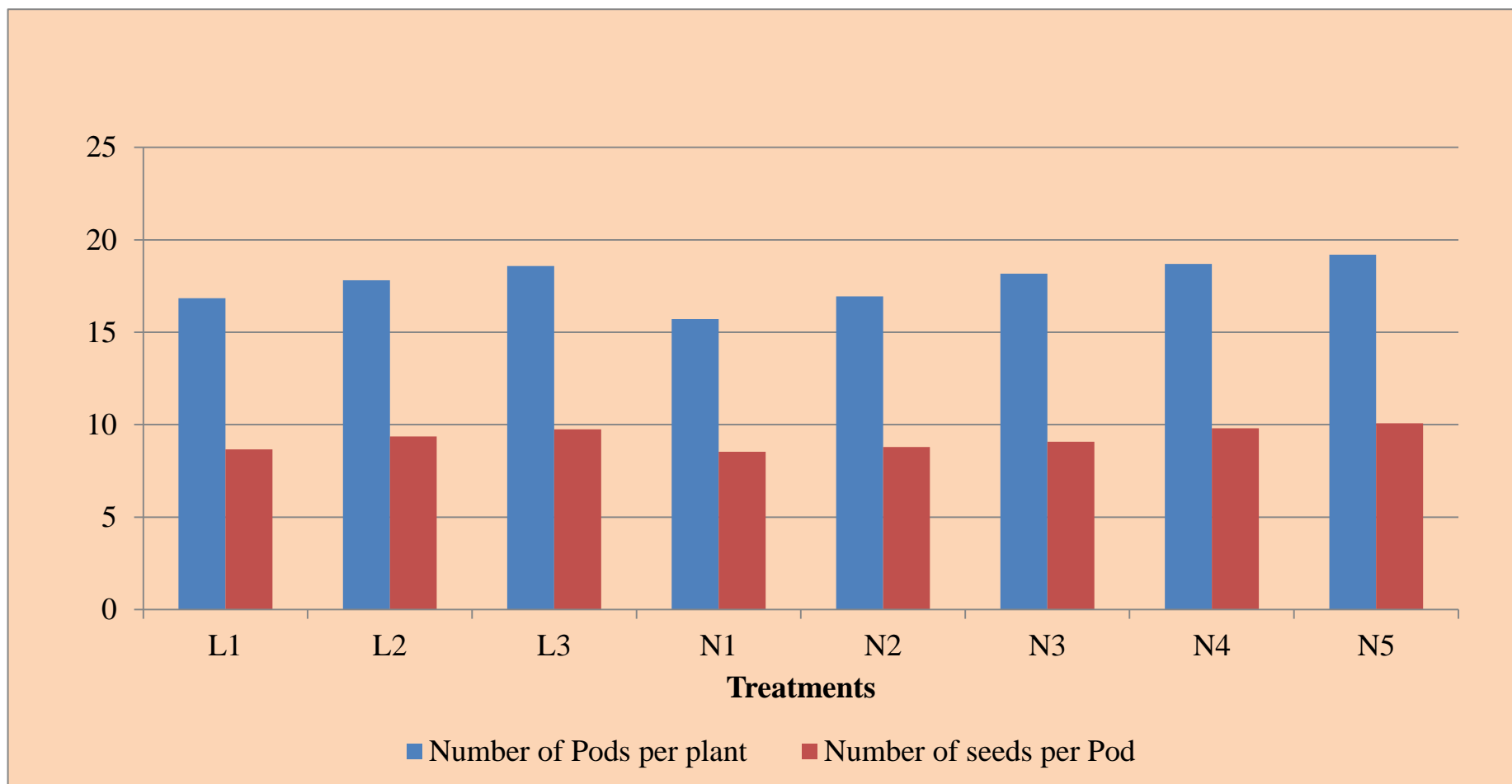


Fig-4.3: Number of pods per plant and number of seeds per pod of green gram as influenced by land configuration and integrated nitrogen management

4.3.4 Seed yield (kg ha⁻¹)

The data on seed yield of green gram as influenced by land configuration and integrated nitrogen management are presented in Table 4.5 and graphically in Fig 4.3.

4.3.4.1 Effect of land configuration

The mean data furnished in Table 4.5 revealed that different methods of land configuration significantly influenced the seed yield of green gram. Significantly the highest seed yield (756 kg ha⁻¹) was noted with raised bed method (L₃). While, flat bed method (L₁) produced significantly the lowest seed yield of green gram (596 kg ha⁻¹). A linear increase in seed yield was found from L₁ to L₃.

4.3.4.2 Effect of integrated nitrogen management

The data (Table 4.5) also revealed that seed yield of green gram was significantly influenced due to various integrated nitrogen management treatments. Application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) produced significantly higher seed yield (789 kg ha⁻¹) which was statistically at par with 75% N through inorganic + 25% N through vermicompost (N₄). While, application of 100% N through inorganic fertilizer (N₁) produced the lowest seed yield of green gram (554 kg ha⁻¹).

4.3.4.3 Interaction effect

The mean data given in Table 4.5 indicated that the interaction effect of land configuration and integrated nitrogen management was found non-significant on seed yield.

Table 4.5 Seed and stover yield and harvest index of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	HI (%)
A. Land Configuration			
L1: Flat bed	596	1532	27.91
L2: Ridge and Furrow	677	1652	28.94
L3: Raised bed	756	1800	29.46
S.Em. ±	18	36	0.44
CD (P=0.05)	53	103	NS
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	554	1577	26.12
N2: 75% N through inorganic fertilizer + 25% N through FYM	626	1609	27.88
N3: 50% N through inorganic fertilizer + 50% N through FYM	682	1640	29.34
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	729	1725	29.63
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	789	1757	30.90
S.Em. ±	23	46	0.57
CD (P=0.05)	68	134	1.65
Interaction (L X N)	NS	NS	NS
C.V. %	10.40	8.33	5.90

4.3.5 Stover yield (kg ha⁻¹)

The data regarding stover yield of green gram as influenced by different methods of land configuration and integrated nitrogen management are provided in Table 4.5 and graphically illustrated in Fig-4.3.

4.3.5.1 Effect of land configuration

A critical examination of data (Table 4.5) indicated significant effect of land configuration on stover yield of green gram. Sowing of green gram on raised bed (L₃) produced significantly higher stover yield (1800 kg ha⁻¹) as compared to flat bed method (L₁) and ridges and furrows method (L₂). While, significantly the lowest stover yield (1532 kg ha⁻¹) was found with flat bed method (L₁) sowing.

4.3.5.2 Effect of integrated nitrogen management

The data exhibited in Table 4.5 revealed that various integrated nitrogen management treatments significantly affected the stover yield of green gram. Among various integrated nitrogen management treatments, application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) registered significantly higher stover yield (1757 kg ha⁻¹) which was at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) and 50 % N through inorganic fertilizer + 50 % N through FYM (N₃) bearing the values of 1725 and 1640 kg ha⁻¹ respectively. Application of 100 % N through inorganic fertilizer (N₁) produced the lowest stover yield (1577 kg ha⁻¹) of green gram.

4.3.5.3 Interaction effect

The mean data furnished in Table 4.5 indicated that the interaction effect of land configuration and integrated nitrogen management did not exert any significant effect on stover yield of green gram.

4.3.6 Harvest index (%)

Data pertaining to harvest index of green gram are outlined in Table 4.5.

4.3.6.1 Effect of land configuration

Data summarised in Table 4.5 revealed that harvest index was not-significantly influenced by land configuration. However, maximum harvest index (29.46 %) was worked out with raised bed method (L₃) followed by ridges and furrow method (L₂) (28.94 %).

4.3.6.2 Effect of integrated nitrogen management

The harvest index was significantly influenced by integrated nitrogen management treatments. Significantly higher harvest index (30.90 %) was achieved with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) which was at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) and 50% N through inorganic fertilizer + 50% N through FYM (N₃).

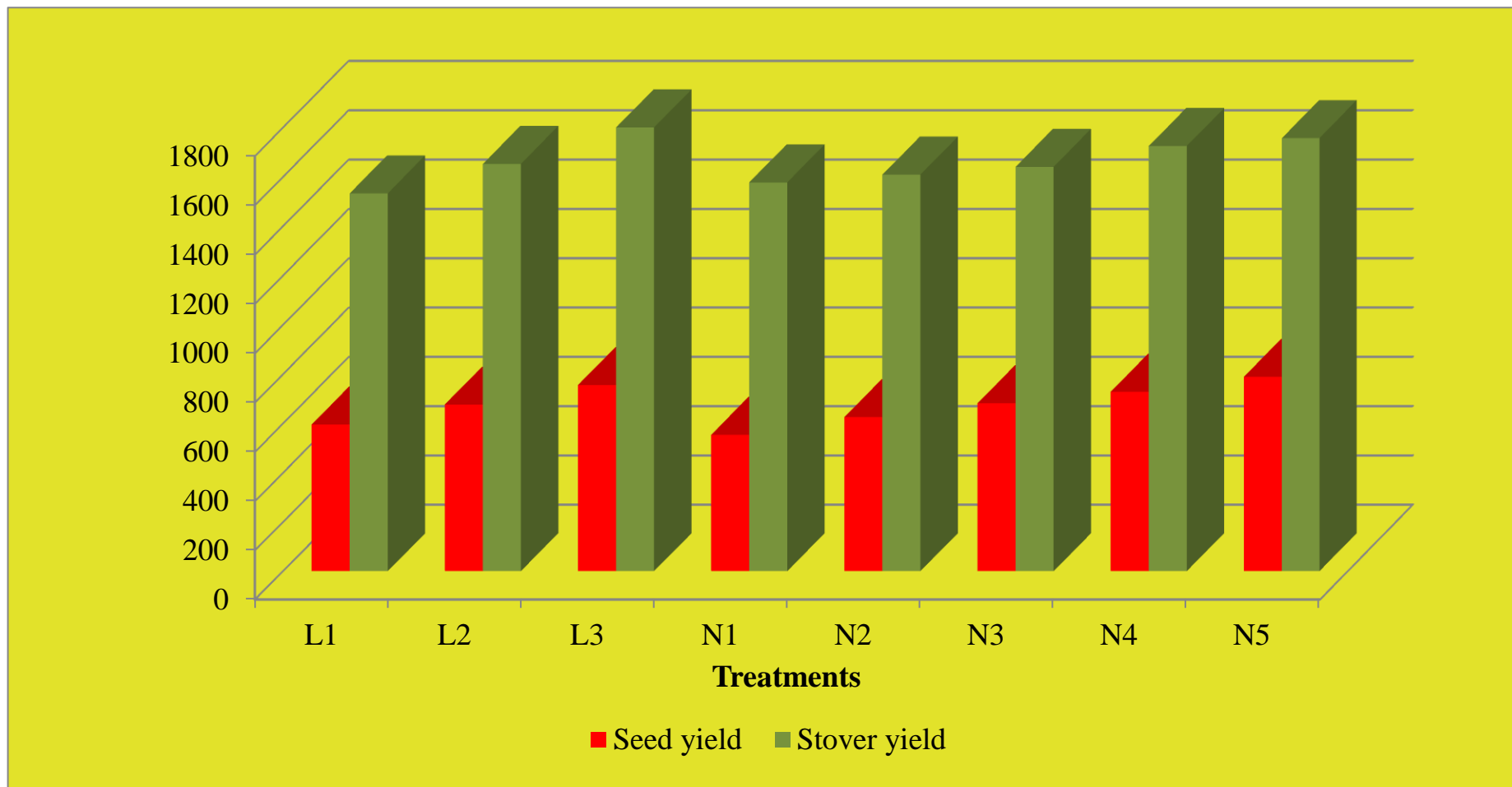


Fig-4.4: Seed and stover yields (kg ha⁻¹) of green gram as influenced by land configuration and integrated nitrogen management

4.3.6.3 Interaction effect

Data from Table 4.5 indicated that the interaction effect of land configuration and integrated nitrogen management was not observed significant on harvest index.

4.4 Plant analysis

4.4.1 Protein content in seed (%)

The data on protein content (%) in seed as influenced by land configuration and integrated nitrogen management are exhibited in Table 4.6

4.4.1.1 Effect of land configuration

Data given in Table 4.6 indicated that protein content in seed was not significantly influenced by land configuration. The maximum value of protein content in seed (19.25 %) was estimated with raised bed method (L_3). While, the minimum protein content in seed (18.57 %) was obtained under flat bed sowing (L_1).

4.4.1.2 Effect of integrated nitrogen management

Experimental results presented in Table 4.6 showed that protein content was influenced significantly by integrated nitrogen management. Significantly higher protein content (19.4 %) was obtained with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) which was at par with N_4 (75% N through inorganic fertilizer + 25% N through vermicompost) and N_3 (50% N through inorganic fertilizer + 50% N through FYM) holding the value of 19.23% 18.75 % respectively.

4.4.1.3 Interaction effect

Examination of data in Table 4.6 indicated that the interaction effect of land configuration and integrated nitrogen management was not significant with respect to protein content in seed.

4.4.2 Protein yield (kg ha⁻¹)

The data related to protein yield as affected by various treatments of land configuration and integrated nitrogen management are given in Table 4.6.

4.4.2.1 Effect of land configuration

The data included in Table 4.6 revealed that land configuration methods had significant influence on protein yield. Significantly higher value of protein yield (145.68 kg ha⁻¹) was achieved with raised bed method (L₃) as compared to ridge and furrow method (L₂) and flat bed method (L₁). With increase in level from L₁ to L₃, the protein yield was increased.

4.4.2.2 Effect of integrated nitrogen management

Outcome of the experiment trial as shown in Table 4.6 indicated that protein yield was influenced significantly by integrated nitrogen management. Significantly higher protein yield (153.32 kg ha⁻¹) was secured with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) which was statistically at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (140.6 kg ha⁻¹).

Table 4.6 Protein content and protein yield of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Protein content (%)	Protein yield (kg ha ⁻¹)
A. Land Configuration		
L1: Flat bed	18.57	111.26
L2: Ridge and Furrow	18.79	127.78
L3: Raised bed	19.25	145.68
S.Em. ±	0.20	4.30
CD (P=0.05)	NS	12.45
B. Integrated Nitrogen Management		
N1: 100% N through inorganic fertilizer	18.40	102.12
N2: 75% N through inorganic fertilizer + 25% N through FYM	18.57	116.90
N3: 50% N through inorganic fertilizer + 50% N through FYM	18.75	128.28
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	19.23	140.58
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	19.40	153.32
S.Em. ±	0.26	5.55
CD (P=0.05)	0.75	16.07
Interaction (L X N)	NS	NS
C.V. %	4.11	13.00

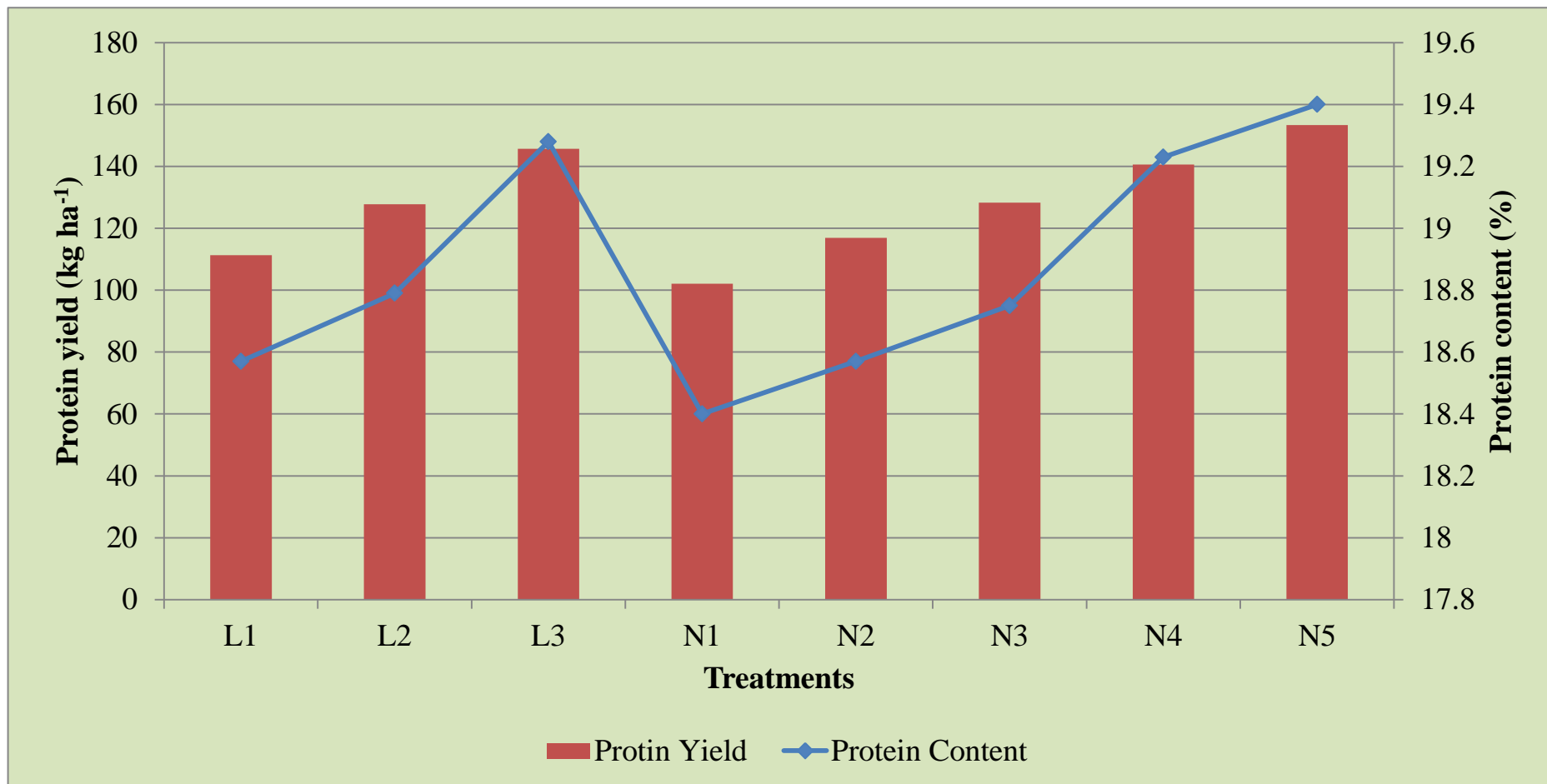


Fig-4.5: Protein content (per cent) and protein yield (kg ha⁻¹) of green gram as influenced by land configuration and integrated nitrogen management.

4.4.2.3 Interaction effect

It is evident from the data (Table 4.6) that the interaction effect of land configuration and integrated nitrogen management was not found significant on protein yield.

4.4.2 N, P and K content (%) in seed

Data regarding N, P and K content (%) in seed as influenced by land configuration and integrated nitrogen management are tabulated in Table 4.7

4.4.2.1 Effect of land configuration

The experimental data furnished in Table 4.7 cleared that land configuration treatments did not express significant influence on N, P and K content in seed (%). However, maximum N, P and K content in seed 3.08, 0.124 and 1.10 % respectively estimated with raised bed method (L₃) followed by ridge and furrow method (L₂).

4.4.2.2 Effect of integrated nitrogen management

Data presented in Table 4.7 indicated that N and P content in seed (%) was influenced significantly by integrated nitrogen management while, K content in seed (%) was not significant. Significantly higher N and P content 3.10 and 0.12 % respectively in seed was found with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) but it remained at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (3.08 %) and 50% N through inorganic fertilizer + 50% N through FYM (N₃) (3.00 %).

Table 4.7 N, P and K content in seed of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Content in seed (%)		
	N	P	K
A. Land Configuration			
L1: Flat bed	2.97	0.120	1.04
L2: Ridge and Furrow	3.00	0.122	1.06
L3: Raised bed	3.08	0.124	1.10
S.Em. \pm	0.03	0.001	0.02
CD (P=0.05)	NS	NS	NS
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	2.94	0.120	1.03
N2: 75% N through inorganic fertilizer + 25% N through FYM	2.97	0.121	1.05
N3: 50% N through inorganic fertilizer + 50% N through FYM	3.00	0.122	1.06
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	3.08	0.124	1.10
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	3.10	0.124	1.11
S.Em. \pm	0.04	0.001	0.02
CD (P=0.05)	0.12	0.004	NS
Interaction (L X N)	NS	NS	NS
C.V. %	4.11	3.35	6.11

4.4.2.3 Interaction effect

Result summarized in Table 4.7 showed that the interaction of land configuration and integrated nitrogen management did not exert significant effect on N, P and K content in seed (%).

4.4.3 N, P and K content in stover (%)

The data pertaining to N, P and K content in stover (%) as influenced by land configuration and integrated nitrogen management are tabulated in Table 4.8.

4.4.3.1 Effect of land configuration

Data furnished in Table 4.8 inferred that N, P and K content in stover (%) was not significantly influenced by land configuration. However, maximum N, P and K content in stover was 0.85, 0.09 and 1.70 % respectively with raised bed method (L₃) followed by ridges and furrows method (L₂).

4.4.3.2 Effect of integrated nitrogen management

Data presented in Table 4.8 revealed that N and P content in stover (%) was influenced significantly by integrated nitrogen management while, K content in stover (%) was not varied significantly. Significantly higher N and P content in of 0.85 and 0.09 % were noted with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) but it remained at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) and 50% N through inorganic fertilizer + 50% N through FYM (N₃).

Table 4.8 N, P and K content in stover of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Content in stover (%)		
	N	P	K
A. Land Configuration			
L1: Flat bed	0.824	0.08	1.632
L2: Ridge and Furrow	0.832	0.08	1.653
L3: Raised bed	0.849	0.09	1.703
S.Em. ±	0.007	0.001	0.020
CD (P=0.05)	NS	NS	NS
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	0.819	0.08	1.638
N2: 75% N through inorganic fertilizer + 25% N through FYM	0.825	0.08	1.647
N3: 50% N through inorganic fertilizer + 50% N through FYM	0.831	0.08	1.657
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	0.847	0.09	1.681
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	0.854	0.09	1.690
S.Em. ±	0.009	0.001	0.026
CD (P=0.05)	0.026	0.004	NS
Interaction (L X N)	NS	NS	NS
C.V. %	3.24	4.40	4.65

4.4.3.3 Interaction effect

The data from table 4.8 clarified that the interaction effect of land configuration and integrated nitrogen management was not found significant on N, P and K content in stover (%).

4.4.4 N, P and K uptake by seed (kg ha⁻¹)

Data on N, P and K uptake by seed as influenced by land configuration and integrated nitrogen management are exhibited in Table 4.9

4.4.4.1 Effect of land configuration

An examination of data furnished in Table 4.9 indicated that levels of land configuration significantly influenced the N, P and K uptake by seed. Sowing of greengram on raised bed (L₃) removed significantly higher N, P and K by seed were 23.31, 0.94 and 8.34 kg ha⁻¹, respectively as compared to rest of the treatments.

4.4.4.2 Effect of integrated nitrogen management

The data presented in Table 4.9 inferred that N, P and K uptake by seed was significantly affected due to integrated nitrogen management treatments. Application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) significantly increased N, P and K uptake by seed bearing the values of 24.53, 0.99 and 8.77 kg ha⁻¹ as compared to rest of the treatments except that of 75% N through inorganic fertilizer + 25% N through vermicompost (N₄).

Table 4.9 N, P and K uptake by seed of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Uptake by seed (kg ha ⁻¹)		
	N	P	K
A. Land Configuration			
L1: Flat bed	17.80	0.72	6.26
L2: Ridge and Furrow	20.45	0.83	7.23
L3: Raised bed	23.31	0.94	8.34
S.Em. ±	0.69	0.026	0.271
CD (P=0.05)	1.99	0.076	0.784
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	16.34	0.66	5.74
N2: 75% N through inorganic fertilizer + 25% N through FYM	18.70	0.76	6.60
N3: 50% N through inorganic fertilizer + 50% N through FYM	20.52	0.83	7.26
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	22.50	0.91	8.02
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	24.53	0.99	8.77
S.Em. ±	0.89	0.034	0.350
CD (P=0.05)	2.57	0.098	1.013
Interaction (L X N)	NS	NS	NS
C.V. %	13.00	12.30	14.40

4.4.4.3 Interaction effect

Data furnished in Table 4.9 indicated that the interaction effect of land configuration and integrated nutrient management was found non significant on uptake of N, P and K by seed.

4.4.5 N, P and K uptake by stover (kg ha⁻¹)

Data on N, P and K uptake by stover as influenced by land configuration and integrated nitrogen management are tabulated in Table 4.10

4.4.5.1 Effect of land configuration

Perusal of data in Table 4.10 inferred that N, P and K uptake by stover was influenced significantly by land configuration. Significantly the highest N, P and K uptake by stover (15.28, 1.62 and 30.65 kg ha⁻¹, respectively) was assessed with raised bed method (L₃). With increase in level from L₁ to L₃, the uptake of NPK by stover was increased.

4.4.5.2 Effect of integrated nitrogen management

Data furnished in Table 4.10 revealed that only N uptake by stover was influenced significantly by integrated nitrogen management While, P and K removed by stover were not varied. Significantly maximum N uptake by stover (14.98 kg ha⁻¹) was estimated with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) but remained at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) and 50% N through inorganic fertilizer + 50% N through FYM (N₃) bearing the values of 14.61 and 13.65 kg ha⁻¹.

Table 4.10 N, P and K uptake by stover of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Uptake by stover (kg ha ⁻¹)		
	N	P	K
A. Land Configuration			
L1: Flat bed	12.62	1.22	25.00
L2: Ridge and Furrow	13.77	1.40	27.39
L3: Raised bed	15.28	1.62	30.65
S.Em. ±	0.37	0.04	0.84
CD (P=0.05)	1.07	0.13	2.43
B. Integrated Nitrogen Management			
N1: 100% N through inorganic fertilizer	12.93	1.31	25.91
N2: 75% N through inorganic fertilizer + 25% N through FYM	13.29	1.35	26.57
N3: 50% N through inorganic fertilizer + 50% N through FYM	13.65	1.38	27.42
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	14.61	1.50	28.99
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	14.98	1.54	29.68
S.Em. ±	0.48	0.06	1.08
CD (P=0.05)	1.39	NS	NS
Interaction (L X N)	NS	NS	NS
C.V. %	10.33	12.73	11.73

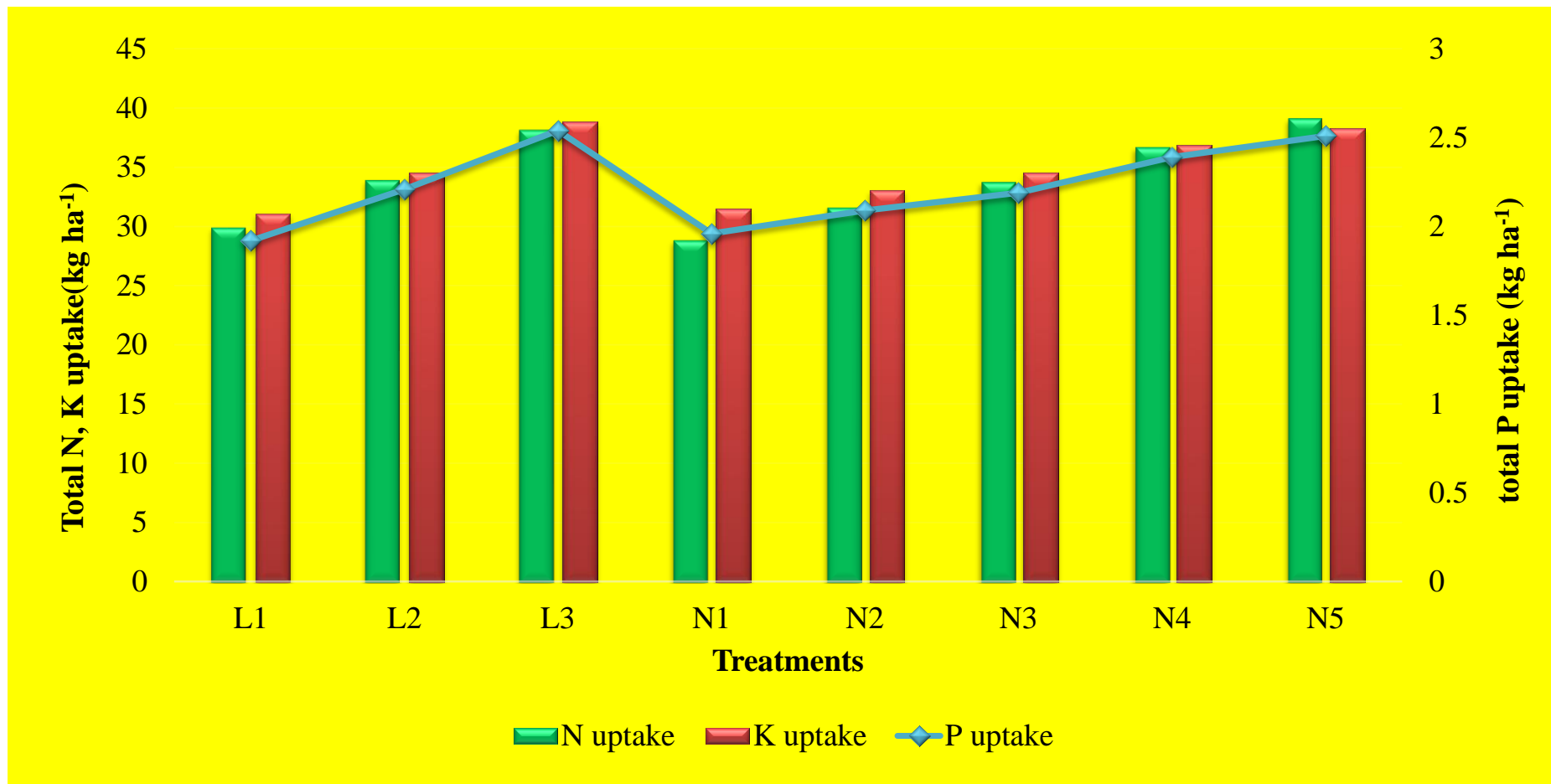


Fig -4.6: Total N, P and K uptake of green gram as influenced by land configuration and integrated nitrogen management

4.4.5.3 Interaction effect

It is evident from Table 4.10 that the interaction effect of land configuration and integrated nitrogen management was not found significant on N, P and K uptake by stover.

4.5 Soil analysis

4.5.1 Available N (kg ha^{-1}) in soil after crop harvest

The data on available nitrogen in soil after harvest of green gram crop as affected by land configuration and integrated nitrogen management are outlined in Table 4.11

4.5.1.1 Effect of land configuration

Data provided in Table 4.11 cleared that available N in soil was not significantly influenced by land configuration. However, higher available N in soil (234 kg ha^{-1}) was estimated under raised bed method (L_3) followed by ridges and furrows method (L_2) (228 kg ha^{-1}).

4.5.1.2 Effect of integrated nitrogen management

Perusal of data in Table 4.11 revealed that available N in soil was influenced significantly by integrated nitrogen management. Significantly higher available N in soil (244 kg ha^{-1}) was found with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) but it remained at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N_4) ($239.06 \text{ kg ha}^{-1}$) and 50% N through inorganic fertilizer + 50% N through FYM (N_3) ($225.95 \text{ kg ha}^{-1}$).

4.5.1.3 Interaction effect

An interaction effect of land configuration and integrated nitrogen management on available N in soil after harvest of crop was not significantly influenced.

4.5.2 Available P₂O₅ in soil after crop harvest

The data on available phosphorus in soil after harvest of green gram crop as affected by land configuration and integrated nitrogen management are presented in Table 4.11

4.5.2.1 Effect of land configuration

Land configuration treatments did not exert their significant influence on available P₂O₅. However, maximum available P₂O₅ in soil (43.27 kg ha⁻¹) was recorded with raised bed method (L₃) followed by ridges and furrows method (L₂) (41.07 kg ha⁻¹).

4.5.2.2 Effect of integrated nitrogen management

Data shown in Table 4.11 inferred that available P₂O₅ in soil was influenced significantly by integrated nitrogen management. Significantly the highest available P₂O₅ in soil (44.2 kg ha⁻¹) was estimated with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) which was at par with 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (42.93 kg ha⁻¹) and 50% N through inorganic fertilizer + 50% N through FYM (N₃) (40.91 kg ha⁻¹).

Table 4.11 Available N, P₂O₅ and K₂O in soil after harvest of green gram as influenced by land configuration and integrated nitrogen management.

Treatments	Available N (kg ha ⁻¹)	Available P ₂ O ₅ (kg ha ⁻¹)	Available K ₂ O (kg ha ⁻¹)
A. Land Configuration			
L1: Flat bed	226	40.07	1426
L2: Ridge and Furrow	228	41.07	1447
L3: Raised bed	234	43.27	1498
S.Em. ±	5.63	0.96	20.55
CD (P=0.05)	NS	NS	NS
B. Integrated Nitrogen Management			
N1: 100% RDN through inorganic fertilizer	216	39.39	1428
N2: 75% N through inorganic fertilizer + 25% N through FYM	221	39.90	1439
N3: 50% N through inorganic fertilizer + 50% N through FYM	226	40.91	1450
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	239	42.93	1479
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	244	44.20	1490
S.Em. ±	7.27	1.24	26.53
CD (P=0.05)	21.06	3.59	NS
Interaction (L X N)	NS	NS	NS
C.V. %	9.51	8.96	5.46

4.5.2.3 Interaction effect

Data in Table 4.11 indicated that the interaction effect of land configuration and integrated nutrient management was not found significant on available P_2O_5 in soil.

4.5.3 Available K_2O in soil after crop harvest

The data on available potassium in soil after harvest of green gram crop as affected by land configuration and integrated nitrogen management are summarised in Table 4.12

4.5.3.1 Effect of land configuration

Data furnished in Table 4.11 found that available K_2O in soil was not varied significantly by land configuration. However, higher amount of available K_2O in soil (1498 kg ha⁻¹) was recorded with raised bed method (L_3) followed by ridges and furrows method (L_2) (1447 kg ha⁻¹).

4.5.3.2 Effect of integrated nitrogen management

Data exhibited in Table 4.11 indicated that available K_2O in soil was not significantly influenced by integrated nitrogen management. However, maximum available K_2O in soil (1490 kg ha⁻¹) was analysed with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) followed by 75% N through inorganic fertilizer + 25% N through vermicompost (N_4) (1479 kg ha⁻¹).

4.5.3.3 Interaction effect

Data furnished in Table 4.11 revealed that the interaction effect of land configuration and integrated nitrogen management was not observed significant on available K_2O in soil.

4.5.4 Organic carbon (%)

Data pertaining to OC content of soil (%) after harvest of crop as affected by land configuration and integrated nitrogen management are furnished in Table 4.12.

4.5.4.1 Effect of land configuration

A perusal of data provided in Table 4.12 indicated that organic carbon content in soil was not significantly varied due to land configuration treatments. However, maximum values of OC in soil was 0.64 per cent registered with raised bed method (L_3) followed by ridges and furrows (L_2) (0.61 %).

4.5.4.2 Effect of integrated nitrogen management

The data pertaining to organic carbon content in soil after harvest of crop (Table 4.12) clearly indicated significant variation in OC due to treatments of integrated nitrogen management. Significantly higher organic carbon content in soil was recorded with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) as compared to application of 100 % N through inorganic fertilizer (N_1). Treatment N_5 did not differ from treatment N_2 , N_3 and N_4 in case of organic carbon content.

Table 4.12 Soil chemical properties after harvest of green gram crop as influenced by land configuration and integrated nitrogen management.

Treatments	OC (%)	pH _{2.5}	EC _{2.5} (dSm ⁻¹)	ESP (%)
A. Land Configuration				
L1:Flat bed	0.60	8.41	1.45	9.74
L2:Ridge and Furrow	0.61	8.31	1.39	9.20
L3:Raised bed	0.64	8.09	1.25	8.98
S.Em. ±	0.01	0.10	0.02	0.216
CD (P=0.05)	NS	NS	0.04	NS
B. Integrated Nitrogen Management				
N1: 100% RDN through inorganic fertilizer	0.59	8.37	1.43	9.86
N2: 75% N through inorganic fertilizer + 25% N through FYM	0.60	8.33	1.40	9.68
N3: 50% N through inorganic fertilizer + 50% N through FYM	0.64	8.29	1.38	9.00
N4: 75% N through inorganic fertilizer + 25% N through vermicompost	0.61	8.20	1.32	9.18
N5: 50% N through inorganic fertilizer + 50% N through vermicompost	0.65	8.16	1.29	8.82
S.Em. ±	0.02	0.13	0.02	0.279
CD (P=0.05)	0.05	NS	0.06	NS
Interaction (L X N)	NS	NS	NS	NS
C.V. %	8.01	4.72	4.31	8.99

4.5.4.3 Interaction effect

Both, land configuration and integrated nitrogen management combinely failed to express its significant effect on organic carbon content in soil after harvest of crop.

4.5.5 pH

Data on soil pH after harvest of crop as affected by land configuration and integrated nitrogen management are outlined in Table 4.12.

4.5.5.1 Effect of land configuration

Data presented in Table 4.12 indicated that land configuration treatments did not exert their significant effect on soil pH. However, pH value was decreased with land configuration treatments as compared to initial value.

4.5.5.2 Effect of integrated nitrogen management

Data shown in Table 4.12 inferred that pH was not-significantly influenced by integrated nitrogen management. Soil pH was slightly decreased after harvest of crop as compared to its initial value.

4.5.5.3 Interaction effect

Data exhibited in Table 4.12 cleared that interaction effect of land configuration and integrated nitrogen management did not bring significant change in soil pH.

4.5.6 Electrical conductivity

The data regarding electrical conductivity of soil after crop harvest as affected by land configuration and integrated nitrogen management are presented in Table 4.12.

4.5.6.1 Effect of land configuration

The mean data given in Table 4.12 showed that electrical conductivity was influenced significantly by land configuration. Significantly the lowest electrical conductivity (1.25 dSm^{-1}) was measured under raised bed sowing (L_3). A linear decrease in soil Ec was noted with increase in level of treatment from L_1 to L_3 .

4.5.6.2 Effect of integrated nitrogen management

Data summarised in Table 4.12 revealed that electrical conductivity was significantly influenced by integrated nitrogen management. Treatment N_5 standing at par with treatment N_4 , measured significantly lower electrical conductivity (1.29 dsm^{-1}) over rest of the treatments. The highest value (1.43 dsm^{-1}) was with N_1 (100% RDN through inorganic fertilizer).

4.5.6.3 Interaction effect

From table 4.12 it appeared that soil electrical conductivity was not varied due to combine effect of both the factors.

4.5.7 Exchangeable sodium percentage (%)

Data pertaining to ESP of soil as affected by land configuration and integrated nitrogen management are exhibited in Table 4.12.

4.5.7.1 Effect of land configuration

Exchangeable sodium percentage of soil after harvest of crop did not express any significant change due to

different treatments of land configuration (Table 4.12). However, numerically lower values of ESP (8.98 %) were seen with raised bed sowing method.

4.5.7.2 Effect of integrated nitrogen management

Data furnished in Table 4.12 revealed that exchangeable sodium percentage was not significantly influenced by integrated nitrogen management. However, minimum exchangeable sodium percentage (8.82 %) was noticed with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) followed by 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) (9.00).

4.5.7.3 Interaction effect

Data presented in Table 4.12 inferred that interaction effect of land configuration and integrated nitrogen management was not significant on exchangeable sodium percentage.

4.6 Economics

The data on economics of green gram as influenced by land configuration and integrated nitrogen management are narrated in Table 4.13.

4.6.1 Effect of land configuration

Data summarised in Table 4.13 indicated that raised bed method accrued highest net realization (Rs.20493/ha) along with BCR of 1.65 followed by ridge and furrow method (Rs.14442/ha) with BCR of 1.45.

4.6.2 Effect of integrated nitrogen management

The data from table 4.13 reflected that maximum net realization (Rs.22697/ha) was secured with 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) along with BCR of 1.72 followed by 75% N through inorganic fertilizer + 25% N through vermicompost (N_4)(Rs. 20085/ha) with BCR of 1.66.

4.6.3 Interaction effect

Data provided in Table 4.14 showed that maximum net realization (Rs.27929/ha) and BCR (1.83) were achieved by sowing the crop on raised bed and supplying with 50% N through inorganic fertilizer + 50% N through vermicompost (L_3N_5), followed by L_3N_4 sowing on raised bed and applying (75% N through inorganic fertilizer + 25% N through vermicompost) with net realization of Rs.21185/ha) with BCR of 1.65.

Table 4.13 Economics of green gram (*Vigna radiata* L.) as influenced by land configuration and integrated nitrogen management

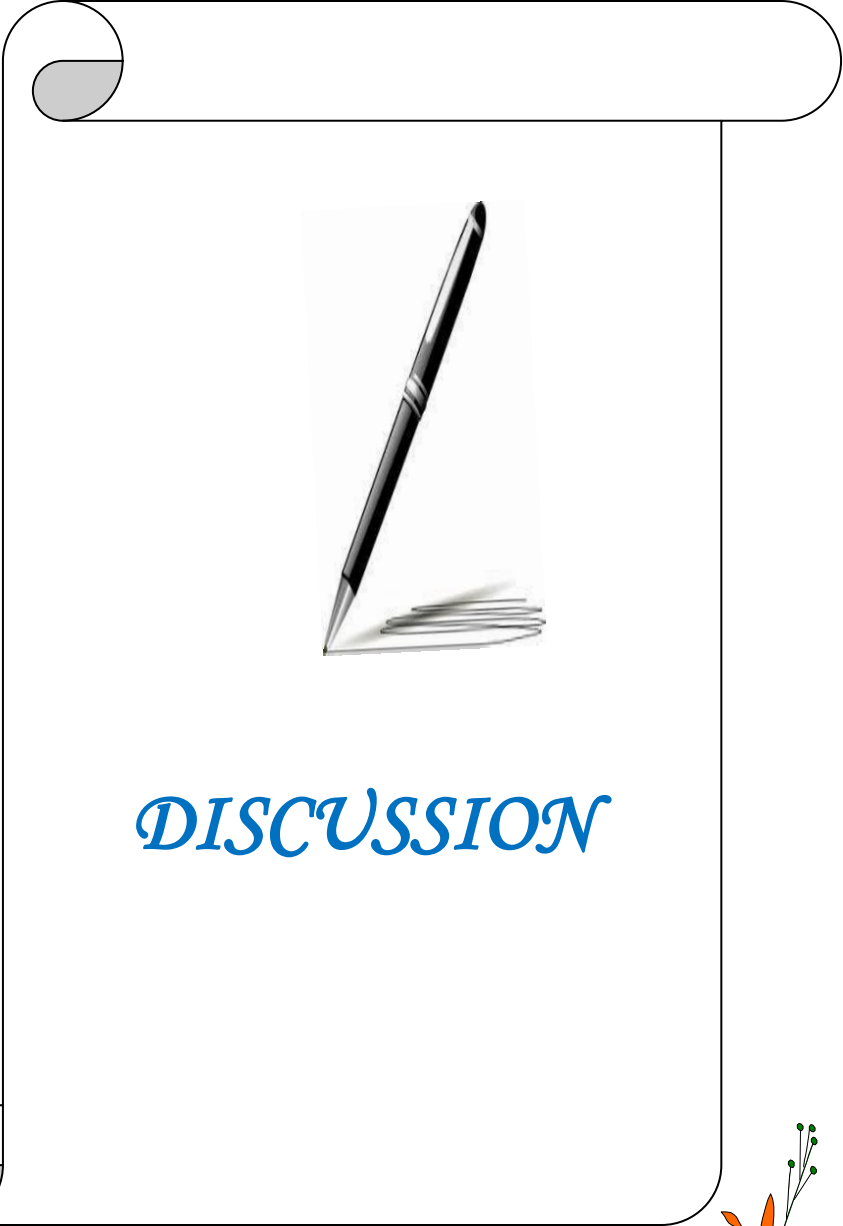
Treatments	Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Gross realization (Rs/ha)	Variable cost (Rs/ha)	Cost of cultivation (Rs/ha)	Net realization (Rs/ha)	BCR
Land configuration							
L ₁	595.66	1532.45	41106	-	29151	11955	1.41
L ₂	676.84	1652.14	46393	2800	31951	14442	1.45
L ₃	755.74	1799.92	51644	2000	31151	20493	1.65
Integrated Nitrogen management							
N ₁	554.18	1577.64	39563	277	29428	10135	1.34
N ₂	625.88	1609.13	43996	2708	31859	12137	1.38
N ₃	682.04	1640.52	47484	5100	34251	13233	1.39
N ₄	728.85	1724.32	50636	1400	30551	20085	1.66
N ₅	789.45	1756.54	54368	2520	31671	22697	1.72

Selling price of seed:-Rs. 60 kg⁻¹

Selling price of stover:-Rs. 4 kg⁻¹

Table 4.14 Economics of green gram (*Vigna radiata* L.) as influenced by interaction of land configuration and integrated nitrogen management

Treatments	Seed yield (kg ha-1)	Stover yield (kg ha-1)	Gross realization (Rs/ha)	Variable cost (Rs/ha)	Cost of cultivation (Rs/ha)	Net realization (Rs/ha)	BCR
L ₁ N ₁	513	1403	36406	277	29428	6978	1.23
L ₁ N ₂	535	1435	37840	2708	31859	5981	1.18
L ₁ N ₃	602	1466	41984	5100	34251	7733	1.22
L ₁ N ₄	666	1663	46612	1400	30551	16061	1.52
L ₁ N ₅	675	1695	47267	2520	31671	15596	1.49
L ₂ N ₁	563	1556	40004	3077	32228	7776	1.24
L ₂ N ₂	594	1588	41988	5508	34659	7329	1.21
L ₂ N ₃	684	1619	47545	7900	37051	10494	1.28
L ₂ N ₄	756	1732	52288	4200	33351	18937	1.56
L ₂ N ₅	788	1765	54340	5320	34471	19869	1.57
L ₃ N ₁	587	1772	42308	2277	31428	10880	1.35
L ₃ N ₂	749	1804	52156	4708	33859	18297	1.54
L ₃ N ₃	760	1835	52940	7100	36251	16689	1.46
L ₃ N ₄	777	1779	53736	3400	32551	21185	1.65
L ₃ N ₅	906	1810	61600	4520	33671	27929	1.83



V. DISCUSSION

An attempt to review the results are described in the previous chapter pertaining to the investigation entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” was carried out at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat showed many significant variations among different treatments. In this chapter, it is contemplated to discuss the variations observed in growth and yield attributes, yield, quality, nutrient uptake by crop, soil properties and economics under the influence of different land configuration and integrated nitrogen management. It has also been attempted to establish “cause and effect” relationship based on present investigation duly supported by available evidences and relevant literature.

The entire discussion has been partitioned into following major parts:

- 5.1 Effect of weather and soil**
- 5.2 Effect of land configuration**
- 5.3 Effect of integrated nitrogen management**
- 5.4 Interaction effect of L x N**
- 5.1 Effect of weather and soil**

Before going into discussion of the present investigation, it is important to discuss the weather conditions to which the crop was exposed and the soil conditions on which crop was grown.

The analysis of the initial soil sample indicated that the soil of experimental plot was clayey in texture, medium in organic carbon, highly saline-sodic and showed low, medium and high rating for available nitrogen, phosphorus and potassium, respectively (Table 3.2). The soil was uniform in depth. Thus, the soil was moderately suitable for growing green gram crop so, its required some additional management practices like land configuration for sowing and integrated nitrogen management for better plant growth.

Among the various factors responsible for growth and yield performance of crop, the weather conditions play a key role which mainly decides the growth and yield of crop. The various weather parameters pertaining to 2015-16 crop season are tabulated in Table 3.1 and graphically displayed in Fig. 3.1.

It could be seen from the meteorological data, the weather condition prevailed during crop period was congenial for satisfactory growth and development of the green gram crop. Likewise, no severe incidence of diseases and insect were observed during the crop growth period. Thus, whatever variations observed in the present investigation are largely attributed to treatment effects only.

5.2 EFFECT OF LAND CONFIGURATION

5.2.1 Plant population

The land configuration did not significantly influence initial and final plant population which indicate that the treatments did not have any adverse influence on germination as well as on survival of the plants. However, minimum plant population was recorded with flat bed sowing (L_1). This might be due to high salt injury to plants at initial stage under flat bed sowing as plants had higher exposure to soluble salts. Further, these soils are prone to temporary water logging after irrigation due to low infiltration rate particularly, in the field used for growing lowland paddy in the preceding rainy season and poor aeration results in plant mortality. Whereas, ridge and furrow and raised bed sowing had higher plant stand at initial stage and harvest. This was probably due to lower salt injury to plants on ridge and furrow and raised bed method of sowing as plants had lesser exposure to soluble salts. Further, improved aeration and conducive air-water relationship under raised bed sowing might have contributed to healthy growth and development of plants thereby reducing mortality.

5.2.2 Growth parameters

The various growth parameters like periodical plant height (Tables 4.2), days to 50 per cent flowering (Table 4.3) and number of branches plant⁻¹ (Table 4.3) were influenced by land configuration treatments.

Plant height at 30 DAS was not varied significantly due to land configuration treatments. Raised bed treatment (L₃) remarkably increased the plant height at 60 DAS and at harvest (Table 4.2) but, it remained at par with ridge and furrows treatment (L₂) at harvest. The magnitude of increase in plant height under raised bed (L₃) was to the tune of 5, 19 and 10 per cent at 30, 60 DAS and at harvest, respectively as compared to flat bed sowing. This might be due to maintenance of proper air moisture regimes under raised bed method of sowing which might have improved the drainage resulting in good supply of available nutrients, soil aeration, soil environment, soil biological activity and better growth and development as compared to conventional sowing as flat bed. Similar positive effect of raised bed method of sowing on growth has also been reported by Lawand *et al.* (1993) and Dhimmer (2003) in cowpea, Jain & Dubey (1998) in soybean.

The data with respect to number of branches per plant and days to 50 per cent flowering in green gram were not reflected due to different treatments of land configuration. These results lend support to those reported by Dhimmarr (2003) in cowpea, Shashikumar (2013) in chickpea.

5.2.3 Yield attributes and yields

Seed yield which is a function of yield contributing characters. In other words, the improvement in seed yield of green gram was associated with increase in yield components *viz.*, number of pods per plant, number of seeds per pod and test weight. The positive and significant relationship between

various characters evaluated seed yield indicated a strong dependence of the yield on these characters. All these yield components (Table 4.3, 4.4, 4.5) conspicuously possessed higher values except, test weight under raised bed sowing treatment (L_3) followed by ridge and furrow sowing (L_2). While, numerically higher value of test weight of green gram was registered under L_3 treatment. Raised bed sowing treatment (L_3) increased number of pods plant^{-1} , number of seeds pod^{-1} and test weight by 10.33, 12.58 and 3.36 per cent over flat bed sowing, respectively. Increased values in these yield attributes under raised bed sowing treatment might have been on account of the overall improvement in vegetative growth as evidenced by higher plant height and number of branches, which might have adequately supplied more photosynthates for development of sink due to proper drainage and better aeration as also indicated by biological activity of microorganism, which favorably influenced the flowering and fruiting and ultimately resulted into increased number of pods per plant and number of seeds per pod as well as test weight. All these improved parameters jointly increased the seed weight per plant. Similar improvement in yield attributes due to land configuration have been observed by Shaikh and Mungse (1998) in chickpea, Kumar and Singh (2014) in french bean, Shrivastava and Pahalwan (1972) in soybean

Favorable effect on green gram crop observed in terms of plant stand, growth and yield attributes under raised bed sowing treatment (L_3) had resulted into significantly higher seed yield. It could be seen from Table 4.5 that

treatment L₃ (raised bed) recorded significantly higher seed yield (756 kg ha⁻¹) as compared to rest of the land configuration treatments. The per cent increase in seed yield under raised bed (L₃) was to the extent of 11.63 and 26.80 over ridge and furrow (L₂) and flat bed treatment (L₁). This might have been caused by significant improvement in overall growth and yield attributes of green gram such as due to sowing on raised bed, which led to higher seed yield. These results are in conformity with the findings of Shrivastava and Pahalwan (1972) in soybean, Haranath (1981) in green gram, Parameswaran *et al.* (1987) in groundnut, Shaikh and Mungse (1998) and Kumar and Singh (2014).

Similarly, stover yield was also significantly higher under raised bed sowing treatment (L₃). Raised bed sowing (L₃) increased the stover yield to the tune of 17.45 and 9 per cent over flat bed treatment (L₁) and ridge and furrow treatment (L₂), respectively. This might be due to the cumulative effect exerted from better improvement in drainage, soil environment, aeration, root development, microbial activities, optimum moisture-air equilibrium throughout the crop growth besides supply of available nutrients to the crop resulting in better growth and development ultimately reflected on better stover yield. The result are supported by Dhimmar (2003) in cowpea and Haranath (1981) in greengram.

Land configuration treatments did not exert significant effect on harvest index of green gram.

5.2.4 Quality parameters

The results revealed that various land configuration treatments did not exert significant influence on protein content in greengram seed (Table 4.6). Though maximum protein content (19.25 per cent) in seed was observed under raised bed sowing treatment over ridge and furrow and flat bed sowing treatments. It is because of protein percentage, computed from nitrogen concentration by multiplying with a factor of 6.25. Raised bed sowing increased protein content in seed might be due to better availability of nitrogen to plant because of better root development and nodule formation which fix more nitrogen under this treatment. The result corroborates with the findings of Dhimmar (2003) in cowpea and Shete (2010) in greengram. Protein yield of greengram was significantly influenced due to land configuration treatments. Raised bed sowing treatment registered significantly higher protein yield ($145.68 \text{ kg ha}^{-1}$) as compared to ridges and furrows and flat bed sowing. The increased in protein yield could be attributed to higher seed yield and protein content in seed noticed under this treatment. The present results are consistent with the findings of Dhimmar (2003) in cowpea and Shete (2010) in greengram.

5.2.5 Nutrient uptake

The uptake of nutrients like nitrogen, phosphorus and potassium by green gram seed and stover were determined separately using their content in respective part and their production on hectare basis.

The scrutiny of data on nutrient uptake such as nitrogen, phosphorus and potassium by green gram crop were significantly influenced by land configuration treatments. Raised bed sowing treatment (L_3) recorded significantly higher total uptake of N, P and K by seed and stover, which were 31, 30 and 33 per cent by seed and 36, 38 and 38 per cent by stover, respectively over flat bed sowing treatment (L_1). This might be due to the fact that deeper penetration of roots and better soil environment due to better aeration, microbial activity and good drainage might have received optimum moisture and nutrients for its growth causing more nutrient recovery through seed and stover under raised bed method of sowing, which resulted into higher uptake of N, P and K nutrients by seed and stover. The results closely resembled with those of Kumar and Singh (2014) in french bean, Shete *et al.* (2010) and Jat *et al.* (2012) in greengram under raised bed method of sowing with respect to nutrient uptake from the soil.

5.2.6 Soil properties after harvest of crop

A perusal of data indicated that available nitrogen (Table 4.11), phosphorus (Table 4.11) and potassium (Table 4.11) status of soil did not exert significant difference due to different treatments of land configuration. Numerically higher values of available nitrogen, phosphorus and potassium in soil were registered under raised bed sowing treatment (L_3). These results are supported by the observations made earlier by Dhimmar (2003), Jat *et al.* (2012) in greengram and Patel (2007) in cotton

The result furnished in Table 4.12 inferred that soil reaction (pH) was not significantly influenced due to land configuration treatments. But, irrespective of the treatments, the soil pH was decreased slightly after harvest of green gram crop as compared to its initial values (Table 3.2). This is because of higher crop growth and root biomass improves organic matter in soil which may slightly reduce soil pH due to decomposition of organic matter. The result could be supported by study of Patel (2007) in cotton crop.

Electrical conductivity of soil was significantly influenced due to land configuration treatments (Table 4.12). Raised bed sowing treatment (L_3) significantly reduced electrical conductivity of soil (1.25 dS m^{-1}) than rest of the land configuration treatments. This might be due to higher accumulation of soluble salts on flat bed as compared to ridge and furrow and raised bed method. The present results are akin to those reported by Patel (2007) in cotton under ridge and furrow method.

After experimentation, it was observed that organic carbon content in soil (Table 4.12) after harvest of crop was not changed due to land configuration treatments. However, higher value of organic carbon content in soil (0.64 %) was noted with raised bed sowing over flat bed method, which might be due to the fact that more quantity of crop residues remained in the soil after harvest of crop because of better root biomass and vegetative growth under this treatment. The present results are akin to reported by Patel (2007) in cotton crop.

Exchangeable sodium percentage (Table 4.12) in soil after harvest of green gram was not influenced statistically due to land configuration treatments. ESP of soil was decreased to the tune of 8.46 per cent due to raised bed sowing treatment than flat bed. The decrease in ESP may be attributed to displacement of Na^+ by Ca^{+2} ions on exchangeable complex due to increased solubilization of CaCO_3 by the carbonic acid produced as a result of the microbial decomposition/humification of organic matter. Higher root proliferation might have been another important cause as the CO_2 exhaled by roots as a result formation of carbonic acid. These findings corroborate with the results obtained by Rathod *et al.* (2004) in gatton panic under broad bed and furrow method.

5.2.7 Effect on economics

Maximum net return of Rs. 20,493 ha^{-1} and BCR value of 1.65 were accrued under raised bed (L_3) sowing followed by ridge and furrow (L_2) method of sowing Rs. 14,442 ha^{-1} with BCR of 1.45. This was due to higher yields of seed and stover registered under raised bed (L_3) method of land configuration.

5.3 Effect of integrated nitrogen management

5.3.1 Plant population

Plant population at 20 DAS and at harvest was not significantly influenced due to different integrated nitrogen management treatments as shown in Table 4.1. It is

ascertained from the data that plant population in all the treatments was uniform which indicated that variations in growth and yield attributes as well as yield were obtained due to treatment effects only.

5.3.2 Growth attributes

The plant growth is the function of photosynthetic activity of the plant and their capacity to utilize available nitrogen. The growth and yield of green gram depends on the source and quantity of nitrogen supplied. Vegetative and reproductive growth of plant plays an important role in potential yield of green gram crop.

Plant height at 30 and 60 DAS was not significantly altered due to various integrated nitrogen management treatments (Table 4.2). Application of 50% N through inorganic fertilizer + 50% N through vermicompost (N_5) remarkably increased the plant height at harvest (45.86 cm) but, it remained at par with application of 75% N through inorganic fertilizer + 25% N through vermicompost (N_4) (45.58 cm) and 50% N through inorganic fertilizer + 50% N through FYM (N_3) (44.82 cm). Increase in plant height of green gram under N_5 was to the tune of 3.1, 11.73 and 14.65 per cent over treatment N_1 (100% N through inorganic fertilizer) at 30 and 60 DAS, and at harvest, respectively.

Number of branches per plant were significantly influenced due to different integrated nitrogen management treatments (Table 4.3). Application of 50 % N through inorganic fertilizer + 50% N through vermicompost (N_5) was

found superior, bearing maximum number of branches per plant (3.72). The increase was to the tune of 7.82 per cent over N_1 (100% N through inorganic fertilizer). This might be due to combination of organic and inorganic fertilizers provide slow, consistent and better availability of nitrogen resulted in higher plant height and number of branches per plant. Almost similar findings have also been reported by Vitnor *et al.* (2015) and Tyagi and Upadhyay (2014) in greengram and Ram *et al.* (2013) in lentil.

Days to 50 per cent flowering in green gram did not respond due to integrated nitrogen management treatments (Table 4.3). This was probably due to genetic makeup of the variety.

5.3.1 Yield and yield attributes

The various yield attributes *viz.*, number of pods plant⁻¹ (Table 4.3), number of seeds pod⁻¹ (Table 4.4) and test weight (Table 4.4) were favorably influenced by integrated nitrogen management treatments. These yield attributes played a vital role in determining final yield of green gram crop.

Application of 50 % N through inorganic fertilizer + 50% N through vermicompost (N_5) remarkably increased the number of pods plant⁻¹ (19.19), number of seeds pod⁻¹ (10.08) and test weight (31.16 %) followed by treatment N_4 [75% N through inorganic fertilizer + 25% N through vermicompost]. Significantly the lowest values of above mentioned yield attributes were registered under treatment N_1 [100% N through inorganic fertilizer]. The percentage increase in number of

Pods plant^{-1} , number of seeds pod^{-1} and test weight were to the tune of 22.15, 17.48 and 9.1 per cent under treatment N_5 as compared to treatment N_1 . This might be due to photosynthesis result and adequate supply of nutrient from inorganic fertilizers with use of organic manure. Vermicompost also contains more essential plant nutrients, number of nitrogen fixing, phosphate solubilizing and other beneficial microbes, vitamin, hormones and enzymes etc. had better effect on yield attributes due to improvement in the soil fertility. It also releases the nutrients slowly for the benefits of crop during entire crop growth period. These findings are in agreement with Singh *et al.* (2011) in groundnut, Ram *et al.* (2013) in lentil and Vitnor *et al.* (2015) in greengram

The results pertaining to seed and stover yield have been described in earlier chapter (Table 4.5) exhibited that integrated nitrogen management treatments exerted their significant influence on seed and stover yield of green gram. Among the integrated nitrogen management treatments, application of 50 % N through inorganic fertilizer + 50% N through vermicompost (N_5) produced significantly higher seed yield (789 kg ha^{-1}) and stover yield (1756 kg ha^{-1}) but remained at par with treatment N_4 (75 % N through inorganic fertilizer + 25 % N through vermicompost) which was 42 and 11.4 per cent higher seed and stover yield respectively over treatment N_1 (100% N through inorganic fertilizer). The integrated nitrogen management showed great impact on seed and straw yields of greengram. This might be due the fact that increased absorption of nutrients and their assimilation.

Supply of N in balanced quantity enabled the greengram plants to assimilate sufficient photosynthetic products. With increased photosynthetic products, coupled with efficient translocation, plant produced more pods with more number of fertile seeds with increased test weight and ultimately higher seed yield. Organic fertilizers besides supplying of nutrients, also brought an improvement towards physical properties of soil and thereby, improving nutrient and water holding capacity of soil. The increased seed yield can also be ascribed to the effect of adequate availability of NPK in soil solution, may cause increase in root growth, thereby increasing uptake of nutrients. Higher yield due to combined application of inorganic fertilizers and organic manures might have attributed to sustain nutrient supply and also as a result of better utilization of applied nutrients through improved micro-environmental conditions, especially the activities of soil micro-organisms involved in nutrient transformation and fixation. These findings are in close conformity with those of Sharma (1992) in soybean, Singh and Verma (2002) in french bean and Gawai and Pawar (2007) in chickpea.

Significantly maximum harvest index (30.90 %) was found under the treatment N₅ (50% N through inorganic fertilizer + 50% N through vermicompost) but it was at par with treatment N₄ and N₃. It might be due to higher growth and yield attributes, photosynthetic activity leading to higher dry matter accumulation, which may directly influence the grain and stover yields as well as harvest index.

5.2.4 Quality parameters

The results revealed that integrated nitrogen management has exerted significant improvement on protein content and protein yield.

Application of 50% N through inorganic fertilizer + 50% N through vermicompost treatment (N₅) has shown its superiority on protein content (19.40 %) and protein yield (153.32 kg ha⁻¹). The improvement in protein content in seed due to combined effect of inorganic fertilizer and vermicompost which may increase in nitrogen content in seed. Nitrogen is structural element of certain co-enzymes involved in protein synthesis. Increase in protein yield might be due to higher protein content and seed yield under this treatment. The present findings are in concurrence with the findings of Sharma and Misra (1997) in soybean with respect to protein yield, Acharya and Mondal(2010) in greengram with respect to protein content and Choudhary *et al.* (2013) with respect to protein content and yield of green gram.

5.2.5 Nutrient uptake

The nutrients N, P content in seed and stover were distinctly responded to integrated nitrogen management while, K content in seed and stover remained unchanged due to integrated nitrogen management. Treatment N₅ recorded higher amount of N, P and K uptake as 24.53, 0.99 and 8.77 kg ha⁻¹ by seed and 14.98, 1.54 and 29.68kg ha⁻¹ by stover when 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) was applied. This might be due to the fact that the trend of

nutrient uptake was very well resembled to per hectare yield data of various treatments. The enhanced uptake of these nutrients in the corresponding treatments could be due to the increased and sustained availability of nutrients through organic and inorganic fertilizers. The increased uptake by green gram might be due to improvement in soil physical, chemical and biological health through application of organic and inorganic fertilizers under integrated nitrogen management. The present findings corroborate with the findings of Sharma and Misra (1997), Sharma (1992) in soybean and Ram *et al.* (2013) in lentil.

5.2.6 Soil properties after harvest of crop

A perusal of data indicated the distinct change in the status of available nitrogen and phosphorus due to different treatments of integrated nitrogen management while available potassium was not affected. Considerable increase in available nitrogen and phosphorus in soil was registered with application of 50% N through inorganic fertilizer + 50% N through vermicompost.

This may be attributed primarily to the beneficial effect of integrated nitrogen management on overall physical condition of the soil. Since, the organic manure being a store house of almost all the plant nutrients required for proper growth and development of plants, its addition in soil enhanced availability of these nutrients. The significant increase in available nitrogen and phosphorus content in the soil after harvest of crop may be ascribed to the beneficial role

of vermin composting mineralization of native as well as its own nutrient content which enhanced the available nutrients pool of the soil. As a matter of fact, all the available nutrients are not taken up by the plant and the rest remains in the soil, which improves the available nutrient status of soil after harvest of crop. The favorable conditions for microbial as well as chemical activity due to addition of organic manures integrated with other nutrients augmented the mineralization of nutrient and ultimately increased the available nutrient status of the soil. These results are in close proximity with those obtained by Mathan *et al.* (1996) in black gram and Shete (2008) in green gram.

Soil reaction (pH) and exchangeable sodium percentage did not significantly influence due to integrated nitrogen management treatments. While, electrical conductivity of soil (Table 4.12) was visibly changed due to integrated nitrogen management after harvest of green gram, it varied from 1.29 to 1.43 dS m⁻¹. The least value of EC of soil (1.29 dS m⁻¹) was registered with application of 50% N through inorganic fertilizer + 50% N through vermicompost(N₅) but, it remained statistically at par with treatment N₄. This decrease might be due to the production of organic acids during decomposition of organic matter in soil.

The soil organic carbon (Table 4.12) was increased by different integrated nitrogen management treatments than initial status (Table 3.2). Significantly the highest organic carbon content in soil (0.65 %) after harvest of green gram was achieved with application of 50% N through inorganic

fertilizer + 50% N through vermicompost (N₅). Treatment N₅ increased the organic carbon content in soil by 10.16 per cent overtreatment N₁. The increase in organic carbon might be due to direct addition of organic sources of nutrients *viz.*, FYM and vermicompost, less mineralization due to the material with wider C:N ratio and also due to creation of favorable conditions for the growth of soil micro organisms.

5.2.7 Effect on economics

Maximum net return of Rs. 22697 ha⁻¹ and BCR value of 1.72 were achieved with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) followed by application of 75% N through inorganic fertilizer + 25% N through vermicompost (N₄) with net return of 20085 ha⁻¹ and BCR with 1.66. This was due to higher yield with this level, which ultimately reflected into higher net return and BCR. Similar results have been reported by Choudhary *et al.* (2013) in mungbean.

5.4 Interaction effect of L x N

5.4.1 Growth attributes

The various growth parameters like periodic plant height, number of braches per plant and days to 50% flowering were not significantly influenced by interaction of land configuration and integrated nitrogen management treatments.

5.4.2 Yield and yield attributes

Number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield and harvest index were non significantly influenced by interaction effect of land configuration and integrated nitrogen management treatments.

5.2.4 Quality parameters

The results revealed that interaction effect of land configuration and integrated nitrogen management was recorded not significantly influenced of protein content and protein yield in green gram.

5.2.5 Nutrient uptake

The results revealed that interaction effect of land configuration and integrated nitrogen management exerted non significantly influenced on N, P and K content and uptake in seed and stover in green gram.

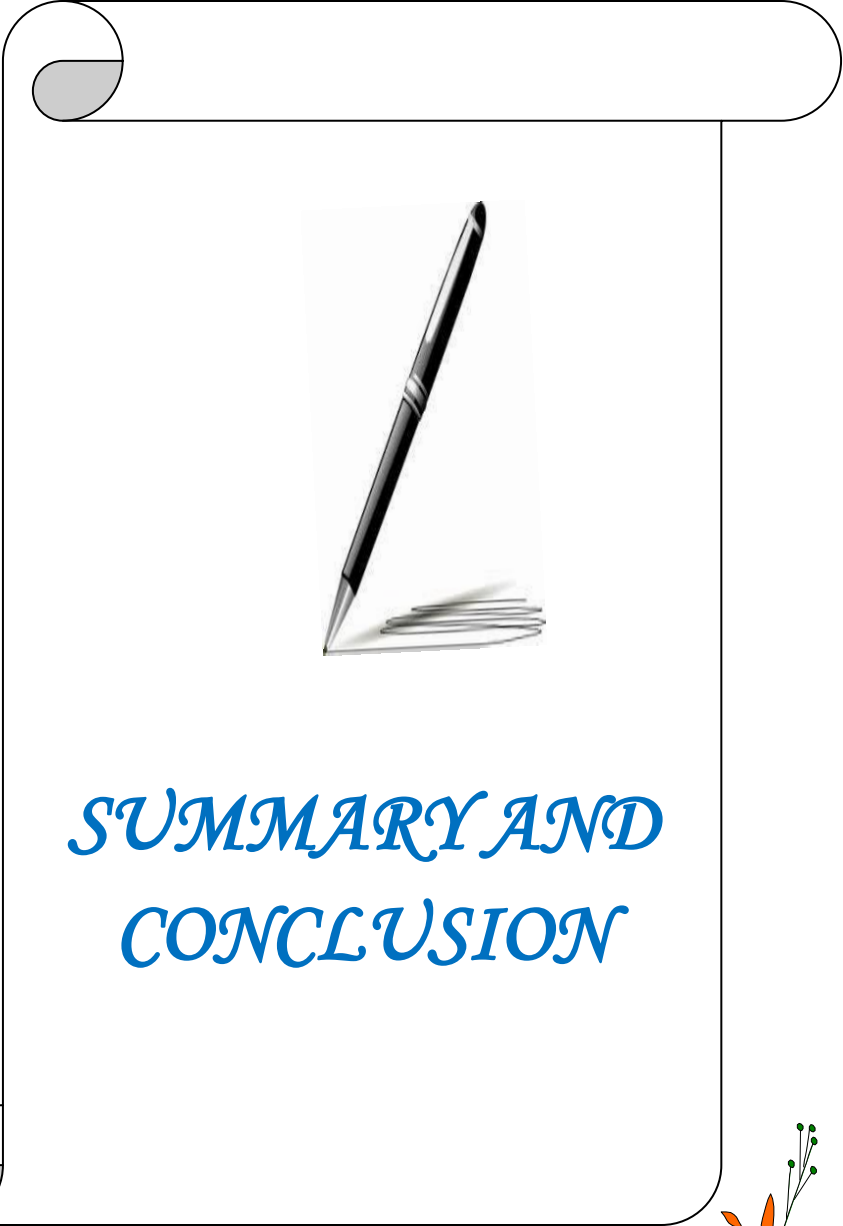
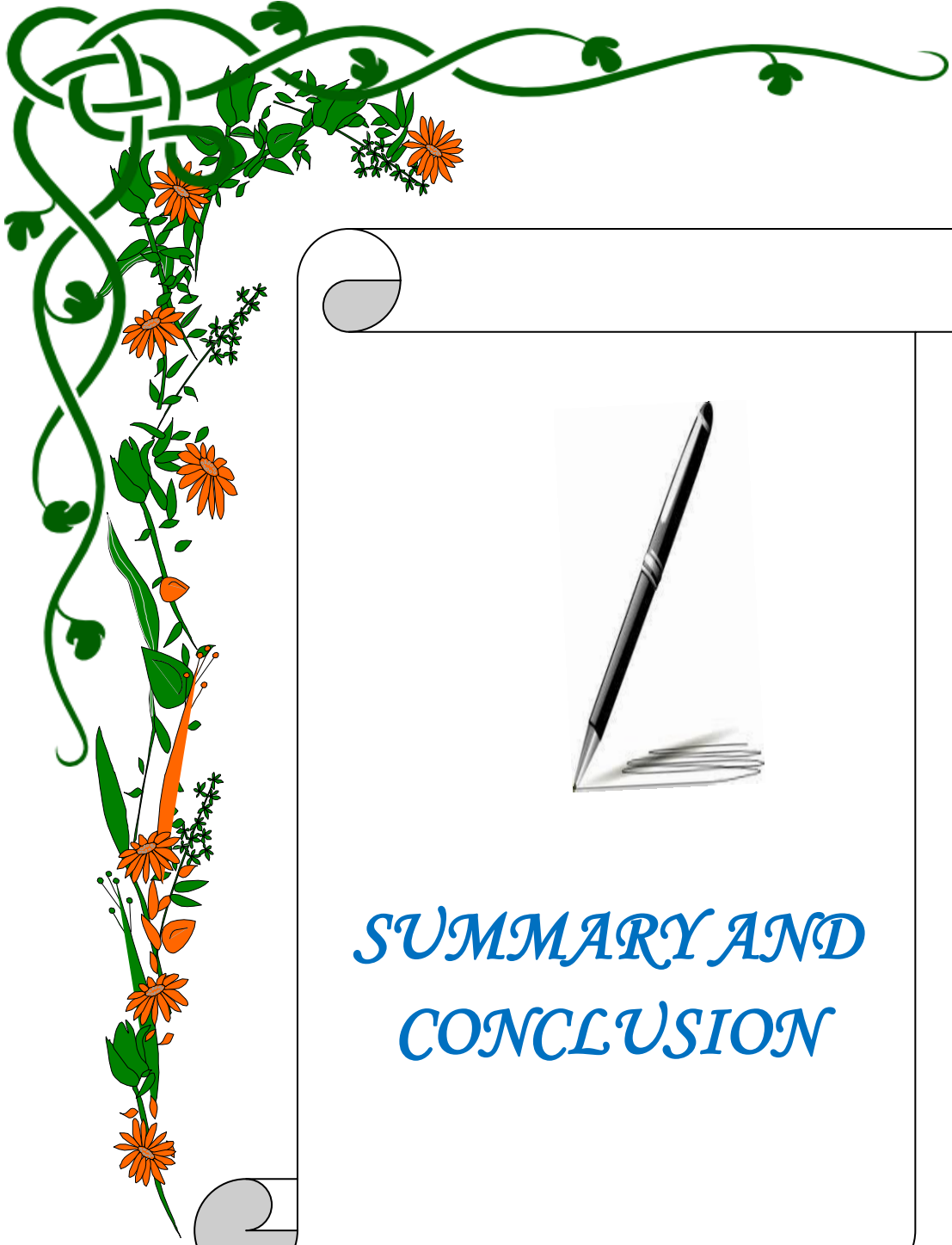
5.2.6 Soil properties after harvest of crop

A perusal of data indicated that available nitrogen, phosphorus and potassium status of soil exert non significant difference due to interaction effect of land configuration and integrated nitrogen management.

Soil reaction (pH), organic carbon, electrical conductivity and exchangeable sodium percentage did not significantly influence due to interaction effect of land configuration and integrated nitrogen management.

5.2.7 Effect on economics

Among the different combination, L₃N₅ (raised bed sowing along with application of 50 % N through inorganic fertilizer + 50 % N through vermicompost) expressed its superiority achieving the highest net return of Rs. 27929 ha⁻¹ and BCR value of 1.83. It was followed by L₃N₄ (raised bed sowing along with application of 75 % N through inorganic fertilizer + 25 % N through vermicompost) earning the net return 21185 ha⁻¹ and BCR 1.65.



*SUMMARY AND
CONCLUSION*



VI. SUMMARY AND CONCLUSION

The field experiment entitled “Effect of land configuration and integrated nitrogen management in green gram (*Vigna radiata* L.) under partially reclaimed coastal salt affected soils” was conducted at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat during *rabi* season of the year 2015-16. The results presented and discussed in the preceding chapters are summarized as below.

6.1 Effect of land configuration

1. Initial and final plant population of green gram was not-significantly influenced due to methods of and configuration.
2. Raised bed method (L_3) showed its superiority measuring the highest plant height at 60 DAS and at harvest (32.45 cm and 45.75 cm, respectively).
3. Number of branches per plant at harvest and days to 50% flowering did not respond to land configuration.
4. Raised bed method (L_3) ranked at top bearing maximum pods per plant (18.58) followed by ridge and furrow (17.81).
5. Raised bed (L_3) and ridge and furrow method (L_2) bearded statistically equal value i.e. 9.75 and 9.37, respectively for number of seeds per pod.

6. Raised bed method (L_3) recorded numerically higher test weight (30.18 g) of green gram.
7. Raised be method (L_3) surpassed rest of the methods, achieving the highest seed (756 kg ha^{-1}) and stover (1800 kg ha^{-1}) yield of green gram.
8. Land configuration did not bring any change in harvest index.
9. Quality in terms of protein content and protein yield in green gram, maximum values (19.25 % and $145.68 \text{ kg ha}^{-1}$, respectively) were noted under raised bed method (L_3) followed by ridges and furrow method (L_2).
10. N, P and K content in seed and stover were not significantly altered by land configuration methods.
11. A significant improvement in nutrients uptake *i.e.*, nitrogen, phosphorus and potassium by seed and stover was observed under raised bed method (L_3).
12. The soil reaction (pH), organic carbon, exchangeable sodium percentage of soil as well as available nutrients *i.e.*, nitrogen, phosphorus and potassium status of soil after harvest of crop were not affected significantly due to different land configuration methods.
13. The highest electrical conductivity was observed under flat bed method (L_1) but the lowest with raised bed method (L_3).

14. Maximum net realization (Rs. 20493 ha⁻¹) and BCR of 1.65 was accrued by raise bed method (L3) and followed by ridge and furrow method (Rs.14442 ha⁻¹) and BCR of 1.45.

6.2 Effect of integrated nitrogen management

1. Initial and final plant population of green gram was not-significantly influenced due to integrated nitrogen management.
2. Significantly higher plant height at harvest (45.86 cm) was noted with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) as compared to 100 % N through inorganic fertilizer (N₁).
3. Treatment N₅ (50% N through inorganic fertilizer + 50% N through vermicompost) standing at par with N₄ (75% N through inorganic fertilizer + 25% N through vermicompost) and N₃ (50% N through inorganic fertilizer + 50% N through FYM) registered significantly more number of branches per plant.
4. Days to 50% flowering was not varied by integrated nitrogen management.
5. Treatment N₅ bearing statistically equal pods (19.19) as that of N₄ (18.70) and N₃ (18.17) surpassed the treatments N₂ and N₁. Similar trend was observed for number of seeds per pod.

6. Though treatment N₅ (50% N through inorganic fertilizer + 50% N through vermicompost) record highest test weight of 31.16 g did not differ from treatment N₄ (75% N through inorganic fertilizer + 25% N through vermicompost).
7. Application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) secured significantly higher seed (789 kg/ha) and stover (1757 kg/ha) yield over N₁, N₂ and N₃ for seed yield and that of N₁ and N₂ for stover yield.
8. Treatment N₅ noted the highest HI (30.90 %) standing at par with N₄ and N₃ bearing the value of 29.69% and 29.34%, respectively.
9. Quality in terms of protein content and protein yield in green gram, significantly higher values (19.4 % and 153.32 kg ha⁻¹, respectively) were noted with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅).
10. Treatment N₅ (50% N through inorganic fertilizer + 50% N through vermicompost) estimated maximum N and P content in seed (3.10 and 0.12 %) and stover (0.85 and 0.09 %), respectively.
11. Application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) recorded significantly the highest nitrogen, phosphorus and potassium uptake by seed followed by treatment N₄

- (75% N through inorganic fertilizer + 25% N through vermicompost).
12. Significantly higher N uptake by stover (14.98 kg ha⁻¹) was found with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅).
 13. The available nitrogen and phosphorus status of soil significantly improved due to application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) followed by treatment N₄.
 14. Remarkable increase in organic carbon (0.65 %) was obtained with 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) over 100 % N through inorganic fertilizer (N₁).
 15. pH and ESP of soil after harvest of crop did not respond to integrated nitrogen management.
 16. Significantly the lowest electrical conductivity (1.29 ds m⁻¹) was observed with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) which was at par with 75 % N through inorganic fertilizer + 25 % N through vermicompost (N₄) (1.32 ds m⁻¹).
 17. Maximum net realization (Rs.22697 ha⁻¹) and BCR (1.72) was recorded with application of 50% N through inorganic fertilizer + 50% N through vermicompost (N₅) followed by 75% N through

inorganic fertilizer + 25% N through vermicompost (N_4) (Rs.20085 ha^{-1}) with BCR of 1.66.

6.3 Interaction effect

1. The interaction effect of land configuration and integrated nitrogen management was not found significant on plant population, growth parameter, yield attributes, yield, quality parameters, nutrient content and uptake as well as soil chemical properties after harvest of crop.
2. Treatment combination L_3N_5 (raised bed with 50% N through inorganic fertilizer + 50% N through vermicompost) realized maximum net return (Rs.27929 ha^{-1}) and BCR of (1.83) followed by L_3N_4 (raised bed with 75% N through inorganic fertilizer + 25% N through vermicompost) with net return of Rs.21185 ha^{-1} and BCR of 1.65.

Conclusion

In light of the results obtained from this investigation, it can be concluded that to obtain economical seed yield of green gram *cv.* Co-4 and sustain the soil health, the crop should be grown on raised bed applying 50% N through inorganic fertilizer + 50% N through vermicompost under coastal salt affected soils of south Gujarat.



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Appendix-I: Cost of cultivation (Rs./ha) of green gram

Sr. No.	Particulars	Amount (Rs./ha)
(A) Fixed cost		
1	Field preparation (Cultivator and planking) 10 hrs/ha for each preparation	3000
2	Preparation of layout, flat beds and irrigation channels (8 labour)	1200
3	Greengram seed (15 kg)	1500
4	Seed treatment (Thirum @ 3g/kg seed)	15
5	Sowing, furrow opening, gap filling and thinning (40 labour)	6000
6	Plant protection	
	Pendimethalin herbicide 30 EC @ 1 kg a.i./ha	1665
	Weeding (12 labour)	1800
7	Fertilizer	
	40 kg P ₂ O ₅ ha ⁻¹	1755
8	Application of fertilizers and herbicide (8labour)	1200
9	Cost of irrigation(5 irrigations, 6 hrs/ irrigation)	1500
10	Harvesting, threshing and cleaning (50 labour)	7500
11	Land revenue Rs.50 /ha/annum (6 months)	25
Total working capital		27160
11	Interest on working capital @ 12% (4 months)	1086
12	Supervision charges @ 10% on working capital (4 months)	905
Total Fixed (A) cost		29151
(B) Variable cost		
Land configuration		
L ₁	Flat bed	--
L ₂	Ridge and furrow (14 hr ha ⁻¹)	2800
L ₃	Raised bed (10 hr ha ⁻¹)	2000
Integrated Nitrogen Management		
N ₁	100% N through inorganic fertilizer	277
N ₂	75% N through inorganic fertilizer + 25% N through FYM	2708
N ₃	50% N through inorganic fertilizer + 50% N through FYM	5100
N ₄	75% N through inorganic fertilizer + 25% N through vermicompost	1400
N ₅	50% N through inorganic fertilizer + 50% N through vermicompost	2520

Appendix-II: Price rates used for inputs and selling produce

Sr. No.	Particulars	Amount (Rs./unit)
A) Inputs		
1	Tractor ploughing (Rs./hr)	300
2	Tractor harrowing/cultivator (Rs./hr)	200
3	Planking (Rs./hr)	150
4	Labour charges (Rs./labour/day)	150
5	Irrigation (Rs./hr)	50
6	Green gram seed (Rs./kg)	100
7	FYM (Rs./kg)	3.00
8	Vermicompost (Rs./kg)	5.00
9	Single super phosphate (Rs./kg)	7.02
10	Urea (Rs./kg)	6.38
11	Thirum (Rs./kg)	200
12	Carbendazin (Rs./kg)	243
13	Pendimethalin30 EC (Rs./lit)	510
14	Atrazine (Rs./kg)	85
B) Selling produce		
1	Green gram seed (Rs./kg)--	60
2	Green gram stover (Rs./kg)	4.0

Appendix-III Variable cost and total cost of cultivation of green gram (*Vigna radiata* L.) as influenced by interaction of land configuration and integrated nitrogen management

Treatments	Variable cost (Rs/ha)	Cost of cultivation (Rs/ha)
L ₁ N ₁	277	29428
L ₁ N ₂	2708	31859
L ₁ N ₃	5100	34251
L ₁ N ₄	1400	30551
L ₁ N ₅	2520	31671
L ₂ N ₁	3077	32228
L ₂ N ₂	5508	34659
L ₂ N ₃	7900	37051
L ₂ N ₄	4200	33351
L ₂ N ₅	5320	34471
L ₃ N ₁	2277	31428
L ₃ N ₂	4708	33859
L ₃ N ₃	7100	36251
L ₃ N ₄	3400	32551
L ₃ N ₅	4520	33671

CERTIFICATE

This is to certify that I have no objection for supplying to any scientist or worker a copy of thesis or any part of it for rendering reference service either in a library or documentation centre.

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(P. R. LAKHANA)