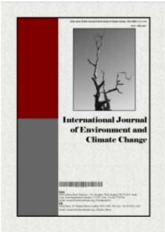

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# Influence of Land Configurations and Mulching on Plant Growth and Yield of Chickpea (*Cicer arietinum* L.)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Inadequate moisture supply and poor soil management are some of the major constraints for productivity in grain legumes like chickpea, present study was to focus on effect of land configurations and mulching in overcoming the constraints and their effect on growth and yield of chickpea. During *rabi,* 2019-20, the experiment was laid out in split plot design at College Farm, Agricultural College, Polasa, Jagtial with three land configurations ($M_1$- Flat bed, $M_2$- Ridge and furrow, $M_3$- Broad bed and furrow) as main plots and four mulching treatments ($S_1$- Control, $S_2$- Sesamum mulch, $S_3$- Gliricidia mulch, $S_4$- Paddy straw mulch) as sub plots and are evaluated for growth and yield. Significant performance of the growth parameters was observed under broad bed and furrow land configuration and in contrast, flat bed land configuration recorded the least performance. Among the mulching treatments gliricidia recorded the better performance over other treatments.

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*Keywords: Flat bed; ridge and furrow; broad bed and furrow; control; Sesamum mulch; Gliricidia mulch and Paddy straw mulch.*

## 1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important grain legume crop of Indian subcontinent, which is popularly known as chana or gram or Bengal gram. Because, of its vital role in supply of protein, calcium, iron, phosphorus, and other minerals, grain legumes are sometimes referred to as poor man's meat. Inspite of these they play important role in management of soil fertility due to its nitrogen fixing ability [1]. The chickpea seeds contain about 18-22% protein, 52-70% total carbohydrates, 4-10% fats, 6% crude fiber and 3% ash. Seeds are rich in minerals like phosphorus (340 mg/100 g), calcium (190 mg/100 g), magnesium (140 mg/100 g), iron (7 mg/100 g) and zinc (3 mg/100 g). Its leaves contain oxalic and malic acids which are very good for stomach ailments. Chickpea is the best blood purifier and it also assists in lowering of cholesterol in the bloodstream. It is used in preparing a variety of snacks and sweets. Fresh green seeds are also consumed as green vegetable [2].

Mulches are used for various reasons in agriculture but water conservation and erosion control are the most important objectives particularly in arid and semi-arid regions. Mulches can improve crop growth, yield and quality of a crop through increase in water retention, it checks evaporation, modifies the soil and air microclimate in which a plant is growing [1].

Although, chickpea is one of the major drought tolerant food legumes, but water deficit can limit growth and productivity of this crop [3]. Mulching is the best alternative which reduces the rate of water loss from soil surface and facilitates moisture distribution [4]. 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. Crop experiences terminal drought during seed development stage, as it is invariably grown on residual soil moisture after a preceding rainy crop, thereby making the terminal moisture stress as the major constraint in achieving potential productivity of chickpea [5]. Therefore, a judicious management of available soil moisture by in-situ conservation through proper land configurations can play an important role in uniform germination for better growth and development of plant as well as moisture intake, its storage and resultant yield.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site and Soil Status

A field experiment was conducted at Agricultural College, Polasa, Jagtial, PJTSAU, during *rabi,* 2019-20. The farm is geographically situated at an altitude of 243.4 m above mean sea level on 18°50'37.0"N latitude and 78°57'00.6''E longitude. It is categorized under Northern Telangana Zone of Telangana State. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction and non-saline. The fertility status of the experimental soil was low in organic carbon content (0.4%), low in available nitrogen (188 kg $ha^{-1}$), medium in available phosphorous (14 kg $ha^{-1}$) and high in available potassium (356 kg $ha^{-1}$).

### 2.2 Planting Material, Experimental Design and Statistical Analysis

Chickpea variety NBeG-3 was released from Regional Agricultural Research Station, Nandyal, Andhra Pradesh. The duration of the variety is (90-110 days) and is a bold seeded desi variety which is tolerant to drought and heat. Before sowing, the seeds were treated with carbendazim + mancozeb @ 3.5 g $kg^{-1}$. The seed material was inoculated with rhizobium culture @ 200 gms per 8 kg. To treat the seed with rhizobium culture, 10% sugar solution was prepared and mixed with seed and then the rhizobium culture was mixed with the seed. The sugar solution here acts as sticking agent.

The experiment was carried out following split plot design consisting of three land configurations as main plots and four mulching treatments as subplots and was replicated thrice. The main plot treatments included were $M_1$- Flat bed, $M_2$- Ridge and furrow, $M_3$- Broad bed and furrow and sub plot treatments were $S_1$- Control, $S_2$- Sesamum mulch, $S_3$- Gliricidia mulch, $S_4$- Paddy straw mulch. The crop was sown at 65 kg $ha^{-1}$ seed rate, with spacing of 30 cm x 10 cm.

The experimental data recorded on different parameters were analyzed statistically by applying the technique of analysis of variance for split-plot design and significance was tested by F-test [6]. Critical difference for examining treatmental means for their significance was calculated at 5 percent level of probability.

## 2.3 Methodology and Sampling

Broad bed and furrows was laid out in the field with 90 cm of bed followed by 30 cm of furrow to a height 15 cm above the ground. Ridge and furrow was laid with a row distance of 30 cm and furrow depth 15 cm. The three mulch treatments were applied in the respective plots @ 10 t $ha^{-1}$ with a thickness of 5 cm.

Tagged plants were analyzed for assessing the parameters like plant height (height was recorded from base of main stem at ground level to the growing tip) and dry matter accumulation (sampled plants were dried in hot air oven at 65±50 ˚C till the constant weight achieved), yield parameters like number of branches per plant, number of pods per branch were analyzed before harvest and parameters like seed yield (kg $ha^{-1}$), stover yield (kg $ha^{-1}$) were analyzed after harvest.

# 3. RESULTS AND DISCUSSION

## 3.1 Growth Parameters

### 3.1.1 Plant height

The results of the experiment revealed that there was no significance in plant height in early stages under land configurations and have shown significance from 50 DAS (Fig. 1), at harvest it is noticed that the highest plant height was recorded under broad bed and furrow, followed by ridge & furrow and the lowest record of plant height was noticed under flat bed (Table 1). This trend in the treatment towards plant height might be due to availability of optimum soil moisture supply by the land configuration, which resulted in the increased plant height. Cultivation of chickpea on flat bed inhibited the growth in terms of height. These results are in agreement with the findings of [7] and [8]. In case of mulching treatments greater plant height was observed under gliricidia mulch, followed by paddy straw mulch and sesamum mulch and the lowest was recorded under control, significance in the treatments started visible from 50 DAS and was noticeable till harvest. The improved plant height in chickpea under gliricidia mulching over others might be due to optimum availability of nutrients and moisture [9].

### 3.1.2 Dry matter accumulation

The results revealed that there is a gradual increase in the dry matter accumulation in every stage of crop growth until harvest (Fig. 2). This may be due to accumulation of food material at different stages in vegetative and reproductive parts of the plant. The results revealed that there was no significant difference in dry mater due to land configurations up to 25 DAS. Significantly highest dry matter accumulation is recorded in broad bed and furrow land configuration after 25 DAS till harvest (Table 1). The lowest dry matter accumulation was recorded under flat bed. Relatively higher dry matter accumulation in broad bed and furrow land configuration may be due to variation in growth parameters with land configurations which resulted in more photosynthesis and increased growth [10], [11]. In mulching treatments also the significance in the treatments started noticed from 50 DAS till harvest. Among the different mulching treatments, mulching with gliricidia recorded significantly highest dry matter accumulation and the lowest dry matter accumulation was observed in control treatment. Significantly higher dry matter accumulation under mulched treatments compared to the control might be due to the conservation of soil moisture due to mulch application, which also creates convenient soil temperature which in turn improves the microbial activity in the rhizosphere resulting in enhancement of the growth parameters [12].

## 3.2 Yield Attributes and Yield

### 3.2.1 Number of branches $plant^{-1}$

Both land configuration treatments and mulching treatments were found to be significant for parameter number of branches $plant^{-1}$. The highest number of branches was recorded in broad bed and furrow, followed by ridge and furrow and the lowest were reported when cultivation of chickpea was done under flat bed condition (Table 2). It may be due to availability of more soil moisture for better overall development of plants under broad bed land configuration [11]. The difference in the performance of different land configurations to number of branches per plant may be due to the improved growth characters *viz.,* number of branches which might be due to optimum availability of nutrients and moisture. These results are in accordance with the findings of [13]. Among the different mulching treatments gliricidia mulch recorded the highest branches per plant and the lowest number was recorded under the control treatment. The higher number of branches in a proportionate manner might be due to favourable condition of water availability for growth and development of auxiliary bud from which the branches are emerged. Similar results were reported by [9].

### 3.2.2 Number of pods branch$^{-1}$

The influence of land configuration to number of pods branch$^{-1}$ was found to be significant. Broad bed and furrow land configuration resulted in more number of pods branch$^{-1}$ and the least number of pods branch$^{-1}$ were observed in flat bed configuration (Table 2), the better performance of broad and furrow land configuration may be due to more plant height, branches and good aeration. These findings are in agreement with the results of [14]. In case of mulching treatments highest number of pods branch$^{-1}$ was observed under gliricidia mulch and the lowest was recorded under control. Drought stress greatly reduces the grain yield which is dependent on the level of defoliation due to the water stress during early reproductive growth [15].

### 3.2.3 Seed yield (kg ha$^{-1}$)

Seed yield is the final expression of physiological and metabolic activities of a plant and product of cumulative action of all factors contributing to better growth of the plant. The results of the experiment reveal that the cultivation of chickpea on broad bed and furrow land configuration resulted significantly higher seed yield and the lowest seed yield was observed in flat bed land configuration (Table 2). [16] also reported higher yields with broad bed and furrow method of planting which might be due to in-situ moisture conservation and improved root growth and nutrient access to the crop and thus increasing yield attributes and yield.

Significantly, gliricidia mulch recorded higher seed yield followed by paddy straw mulch and sesamum mulch. The lowest seed yield was recorded in control treatment. The leaf mulch might have provided the better infiltration rate, improved fertilizer availability and hence increased crop yield [17].

**Table 1. Influence of land configuration and mulching on plant height, dry matter accumulation, leaf area per plant, SPAD chlorophyll meter readings**

| Treatments | Plant height (cm) | Dry matter accumulation g m$^{-2}$ |
|---|---|---|
| | Harvest | Harvest |
| **Main treatments** | | |
| $M_1$- Flat bed | 38.70 | 723.70 |
| $M_2$- Ridge and furrow | 43.37 | 787.77 |
| $M_3$- Broad bed and furrow | 47.49 | 851.62 |
| SEm ± | 0.90 | 15.93 |
| CD (P=0.05) | 3.55 | 62.53 |
| **Sub treatments** | | |
| $S_1$ - Control | 37.00 | 718.16 |
| $S_2$ - Sesamum | 41.40 | 764.18 |
| $S_3$ - Gliricidia | 48.80 | 856.72 |
| $S_4$ - Paddy straw | 45.55 | 811.74 |
| SEm ± | 0.99 | 14.74 |
| CD (P=0.05) | 2.94 | 43.79 |
| **Interaction** | | |
| SEm ± (M x S) | 1.71 | 25.53 |
| CD (P=0.05) | NS | NS |
| SEm ± (S x M) | 1.74 | 27.25 |
| CD (P=0.05) | NS | NS |

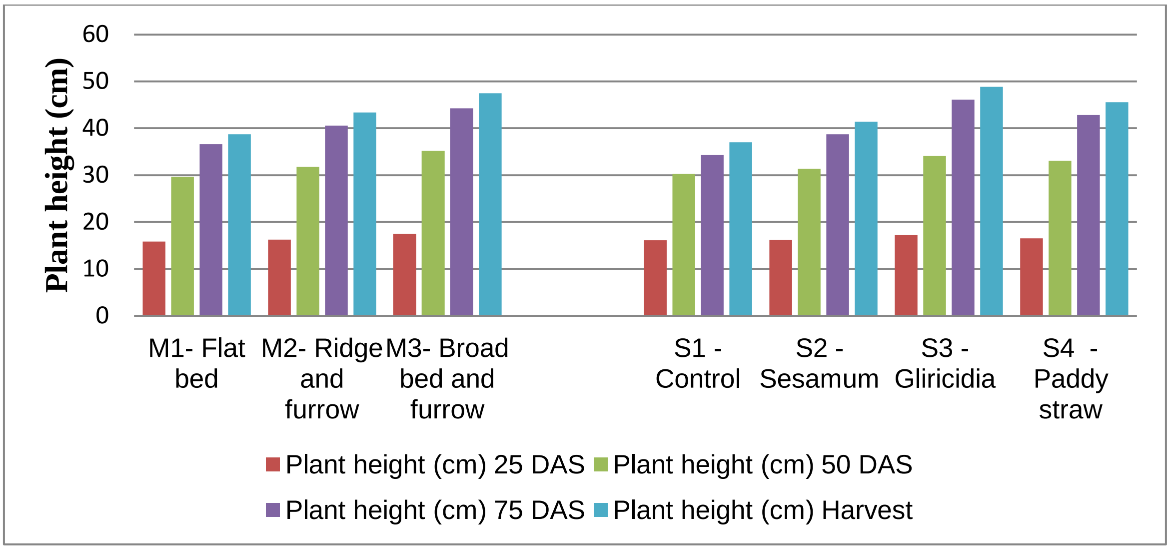


**Fig. 1. Effect of land configurations and mulching on plant height**

**Table 2. Number of branches plant$^{-1}$, Number pods branch$^{-1}$, Seed yield, Stover yield as influenced by land configurations and mulching**

| Treatments | Number of branches plant$^{-1}$ | Number of pods branch$^{-1}$ | Seed yield (kg ha$^{-1}$) | Stover yield (kg ha$^{-1}$) |
|---|---|---|---|---|
| **Main treatments** | | | | |
| $M_1$- Flat bed | 3.74 | 7.05 | 957.69 | 1905.30 |
| $M_2$- Ridge and furrow | 4.59 | 8.37 | 1226.45 | 2269.97 |
| $M_3$- Broad bed and furrow | 5.41 | 9.62 | 1444.26 | 2635.78 |
| SEm ± | 0.18 | 0.32 | 35.16 | 42.30 |
| CD (P=0.05) | 0.73 | 1.24 | 138.05 | 166.10 |
| **Sub treatments** | | | | |
| $S_1$ - Control | 3.85 | 6.71 | 1058.74 | 2044.96 |
| $S_2$ - Sesamum | 4.27 | 7.80 | 1160.91 | 2193.49 |
| $S_3$ - Gliricidia | 5.37 | 9.96 | 1365.83 | 2507.17 |
| $S_4$ - Paddy straw | 4.84 | 8.91 | 1252.38 | 2335.78 |
| SEm ± | 0.13 | 0.31 | 34.08 | 44.45 |
| CD (P=0.05) | 0.40 | 0.93 | 101.26 | 132.07 |
| **Interaction** | | | | |
| SEm ± (M x S) | 0.23 | 0.54 | 59.03 | 76.99 |
| CD (P=0.05) | NS | NS | NS | NS |
| SEm ± (S x M) | 0.27 | 0.56 | 62.04 | 78.96 |
| CD (P=0.05) | NS | NS | NS | NS |

#### 3.2.4 Stover yield (kg ha$^{-1}$)

It is evident from the data that there is a significant difference among the treatments. Broad bed and furrow resulted in significantly higher stover yield, over ridge and furrow land configuration and the least straw yield was recorded under flat bed configuration (Table 2). Among mulching treatments, significantly highest stover yield was recorded under gliricidia mulch and the lowest stover yield was recorded in the control treatment. The difference in treatments 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, which ultimately reflected on better stover yield as well as biological yield. These results are in accordance with the findings of [18] where, ridge and furrow, and the broad bed and furrow performed superior over control.

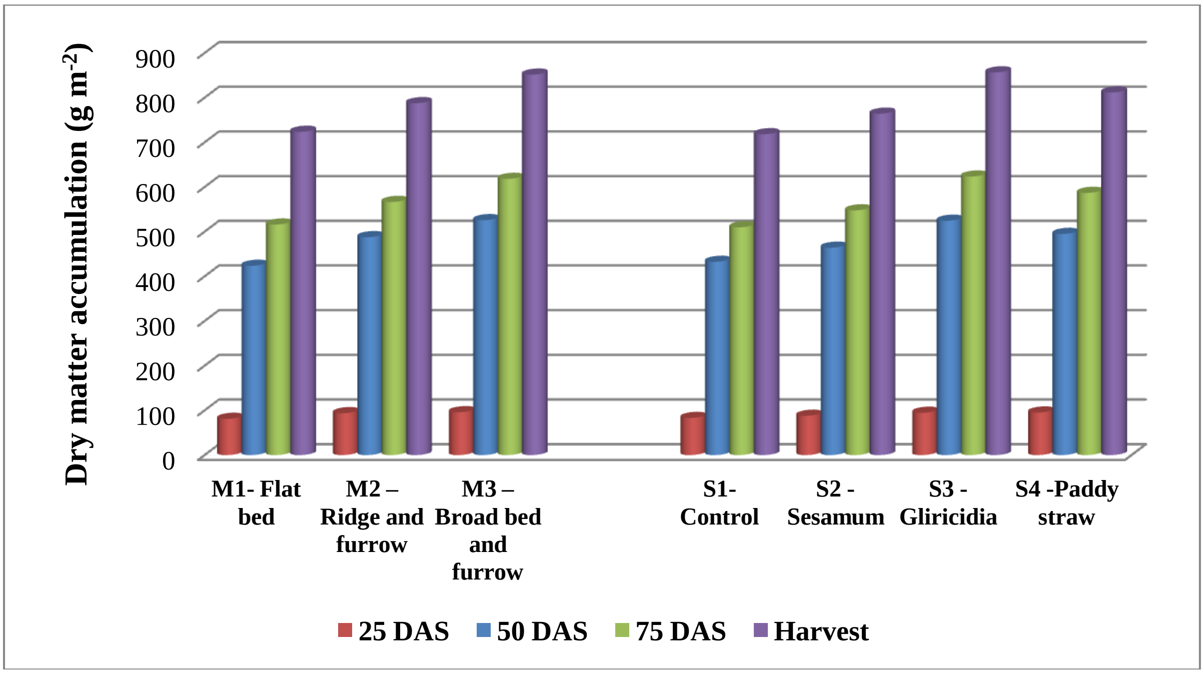


**Fig. 2. Dry matter of chickpea as influenced by land configurations and mulching**

## 4. CONCLUSION

Broad bed and furrow was found best land configuration among other land configurations and in mulching treatments gliricidia mulch was found to be highly productive which promotes better growth, yield attributes and stover yields in chickpea over other treatments. Conservation of soil moisture and creating a favorable conditions in the root zone and just above the root zone during the growth period by the land configurations and mulching has lead to the better performance of the chickpea in terms of growth and yield.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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