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**JB Bhusara**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

**MJ Dobriyal**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

**NS Thakur**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

**RL Sondarva**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

**DH Prajapati**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

**Correspondence**
**MJ Dobriyal**
Department of Silviculture and Agroforestry, College of Forestry Navsari Agricultural University, Navsari, Gujarat, India

# Growth and yield performance of green gram under *Melia composita* Plantations

**JB Bhusara, MJ Dobriyal, NS Thakur, RL Sondarva and DH Prajapati**

**Abstract**
Green gram or Mungdal (*Vigna radiata* L.) is an important pulse crop and *Melia composita* (Malabar Neem or Nimabaro) is an emerging industrial agroforestry plantation in southern Gujarat. To maximize the land utilization an agroforestry trial was laid to investigate the performance of okra varieties under different spatial arrangements of 2 year old *Melia composita* plantation with three spacing of $S_1$ (2 x 2m), $S_2$ (2x 3 m) and $S_3$ (2x 4 m) while $S_0$ as open field at College of Forestry (ACHF), Navsari Agricultural University, Navsari, Gujarat, India, during winter season of 2015-16 and 2016-17. Green gram crop ($GV_1$- Meha and $GV_2$- GM-4) were intercropped with *M. composita* reported lower growth parameters as well lower yield as compared to open condition. The results of pooled analysis of two years shown that treatment $T_2$-$S_0$ $GV_2$ recorded maximum plant height -48.23cm, number of branches per plants- 3.62, number of leaves- 247.42 number of flower per plant -34.04, average number of pod per plant- 21.31, seed yield per plant- 4.94g and per hectare- 0.81 tonnes in open condition. Similarly in intercropping the growth and yield attributes of Okra were minimum height -36.12 cm, number of branches per plants- 2.59, number of leaves- 110.57 number of flower per plant -19.13, average number of pod per plant- 15.08, seed yield per plant- 3.55g and per hectare- 0.58 tonnes were reported in $T_4$ ($S_1$ $GV_2$) i.e. in 2x 2 closer spacing while under wider spacing of $S_2$ and $S_3$ Green gram responded significantly better respectively. Hence wider spacing of S3 (2 x 4 m) can be suggested for intercropping under *M. composita* plantations in initial 2-4 years.

**Keywords:** agroforestry, green gram, *Vigna radiate*, *Melia composita*, agroforestry, malabar neem, spatial

## Introduction
The intercropping of pulses with commercial tree species in initial stages of establishment is desirable for replenishment of soil fertility by legumes and additional income to the farmers. Spatial arrangement of trees in plantation plays an important role in growth and yield of agricultural intercrops as well as on trees. In order to utilize the interspaces in early stages in closer spacing and wider spacing even in later stages of plantation development, the selection of the crops for intercropping is important. The intercropping of agricultural crops not only gives additional income to farmers but also improves the soil condition due to different intercultural practices and fertilizer application and weeding during crop period. Green gram or Mungdal (*Vigna radiata* L.) belongs to Fabaceae family is cultivated in almost all states of India. It is consumed as whole grain as well as split pulse (Dal). Almost 90% of green gram production on a world scale is produced in Asia with India as the world's largest producer, accounting for more than 50% of world production (Vijayalakshmi *et al.* 2003) [13]. Green gram is cultivated by most of farmers of Gujarat, as a short duration crop. Mung bean contains 51 percent carbohydrate, 24-26 percent protein, 4 percent mineral, and 3 percent vitamins. The protein content of green gram is two to three times more than that of cereals. *Melia composita* Wild. (Malabar Neem or Nimabaro) belongs to the meliaceae family is an indigenous species which also distributed to South East Asia and Australia. *M. composita is* very large and fast growing deciduous tree with a straight cylindrical trunk attaining a height of 20-25 m with a spreading crown and a straight bole of 9 m length and l.2-1.5 m girth. It is a short rotation multipurpose tree species which yield useful termite proof timber and also used for packing cases, cigar boxes, tea box, ceiling planks, agricultural implements, pencils, match boxes and splints musical instruments.
Mungdal is an important pulse crop and *M. composita* is emerging industrial agroforestry plantations in southern Gujarat has been started intercropped in agricultural land with a large scale plantations done for the pulpwood and paper industry. To maximize the land utilization an agroforestry trial was laid to investigate the performance of Mungdal varieties under different spatial arrangements of 2 year old *Melia composita* plantation.

## Material and Methods

*Melia composita* (Malabar Neem or Nimabaro) is an emerging industrial agroforestry plantations in southern Gujarat.To maximize the land utilization an agroforestry trial was laid to investigate the performance of Green gram/ Mungdal varieties under different spatial arrangements of 2 year old *M. composita* plantation at College of Forestry (ACHF), Navsari Agricultural University, Navsari, Gujarat, India, during winter season of 2015-16 and 2016-17. The experiments designed for intercropping of two Green gram varieties ($OV_1$- Meha & $OV_2$-GM-4) in summer season with *M. composita*, which was planted in 2014 with three spacing of $S_1$ (2 x 2m), $S_2$ (2x 3 m) and $S_3$ (2x 4 m) while $S_0$ as open field. Experiment is designed in Randomized Block Design (RBD) with eight treatments and three replications. The treatments for Green gram crop includes- $T_1$ - $S_0GV_1$=Green gram variety Meha sole; $T_2$ - $S_0GV_2$= Green gram variety Gm-4sole; $T_3$ - $S_1GV_1$=*M. composita* (2X2)+ Green gram variety Meha; $T_4$ - $S_1OV_2$=*M. composita* (2X2)+ Green gram variety GM-4; $T_5$ - $S_2GV_1$= *M. composita* (3X2) + Green gram variety Meha; $T_6$ - $S_2GV_2$= *M. composita* (3X2)+ Green gram variety GM-4; $T_7$ - $S_3GV_1$= *M. composita* (4X2)+ Green gram variety Meha; $T_8$ - $S_3GV_2$= *M. composita* (4X2)+ Green gram variety Gm-4. Growth and yield attributes as Green gram height, number of branches, number of leaves and number of flowers was recorded before final harvest by randomly selecting 5 plants in each replication and treatment. Number of pod in individual selected plant was counted at every picking and finally these were added to obtain the mean number of pods per plant. Yield per plot (4 sq.m) was worked out for respective plots and expressed in kg**.** Yield per hectare was calculated by plot value x 2500 expressed in tonne.

## Result and Discussion

The data of growth and yield parameters of Green gram as sole crop and under different spatial arrangements for both the year of study (2015-16 and 2016-17) and pooled analysis are shown in (Table-1 & 2 and Fig 1 & 2). Growth attributes of Green gram in pooled analysis of both years like plant height (48.23 cm), number of leaves (247.42), number of branches (3.62), number of flowers (34.04) and fruit per plant (21.34) recorded significantly high in $T_2$-$S_0GV_2$ i.e. open condition as compared to with *M. composita* based agroforestry system. Further, wider agroforestry tree spacing played an important role as of *M. composita* (4×2 m) on growth attributes compare to closer spacing 2 x 2 m in $T_3$ ($S_1OV_1$). It might be due to less availability of light under different spacing of trees compared to open condition. The similar reduction in growth attributes of intercrops in agroforestry was recorded by the Brahmam *et al*. (1997) [2], Shinde (2001) [11], Rani *et al.* (2015) [10], Rajalingam *et al.* (2016) [9], Bhat (2015) [1], Swamy (2008) [12] in *Gmelina arborea* and Parekh *et al.* (2005) [8]. Nandal and Singh (2005) [6] reported green gram & lentil are shade sensitive which results poor branching and pod settings in pulses.

yield parameters of Green gram showed that the maximum yield for Meha verity in the open condition as compared to the different spacings of *M. composita* as maximum yield of seed per plant(g/plant) and seed yield (tonne/ha). Green gram reported highest seed yield in $T_1$ (sole cropping with variety Meha) as 4.94 g/plant and 0.81 tonnes/ha while in intercropping maximum yield was recorded with $T_7$- (variety Meha with *M. composita* at 2 x 4 m spacing) as 4.54 g/plant and 0.75 tonnes/ha. The yield reduction in pulses in intercropping with trees also reported by Pandey *et al.* (2002) [7], Jama *et al.* (1991) and Nandal & Hooda (2005). But Korwar *et al.* (1999) [4] in *Faidherbia albida* with pulses reported that grain yield is higher for green gram and black gram in lower canopy density than the monocrops and higher canopy density, which support that if canopy is properly managed the yield reduction in intercropping with trees can be reduced.

The *M. composita* trees performed better in intercropping than in sole plantations (Fig. 3 & 4) in both the years of observations. The maximum average increment in height was in $T_4$- $S_1$ $GV_1$ as 0.66 m in two year while maximum DBH increment was in $T_9$- $S_3$ $GV_2$ as 0.89 cm. It suggests that in closer spacing the height was more while in wider spacing DBH was more with intercrops. Thus intercrops favoring the growth of *M. composita* probably due to inputs of nutrients and irrigations provided to crops will have also utilized by the trees.

**Table 1:** Growth attributes of Green gram under *Melia composita* plantations

| Treatments | Height (cm) | | | No. of branches/plant | | | No. of leaves/plant | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2015-16 | 2016-17 | Pooled | 2015-16 | 2016-17 | Pooled | 2015-16 | 2016-17 | Pooled |
| $T_1$ - $S_0GV_1$ | 48.25 | 48.21 | 48.23 | 3.59 | 3.65 | 3.62 | 256.43 | 238.41 | 247.42 |
| $T_2$ - $S_0GV_2$ | 46.52 | 46.40 | 46.46 | 3.46 | 3.49 | 3.47 | 237.30 | 218.44 | 227.87 |
| $T_3$ - $S_1GV_1$ | 38.28 | 37.32 | 37.80 | 2.80 | 2.67 | 2.74 | 141.65 | 118.59 | 130.12 |
| $T_4$ - $S_1GV_2$ | 36.74 | 35.51 | 36.12 | 2.67 | 2.51 | 2.59 | 122.52 | 98.62 | 110.57 |
| $T_5$ - $S_2GV_1$ | 41.48 | 40.95 | 41.22 | 3.06 | 3.00 | 3.03 | 179.91 | 158.53 | 169.22 |
| $T_6$ - $S_2GV_2$ | 39.91 | 39.14 | 39.52 | 2.93 | 2.84 | 2.89 | 160.78 | 138.56 | 149.67 |
| $T_7$ - $S_3GV_1$ | 44.79 | 44.58 | 44.68 | 3.33 | 3.32 | 3.33 | 218.17 | 198.47 | 208.32 |
| $T_8$ - $S_3GV_2$ | 43.16 | 42.77 | 42.97 | 3.20 | 3.16 | 3.18 | 199.04 | 178.50 | 188.77 |
| S. Em ± | 2.42 | 2.57 | 1.58 | 0.10 | 0.11 | 0.07 | 11.60 | 12.41 | 7.61 |
| C.D. at 5 % | 7.33 | 7.81 | 4.55 | 0.30 | 0.33 | 0.21 | 35.20 | 37.65 | 21.87 |
| S.Em ± (Y X T) | | | 2.50 | | | 0.10 | | | 11.99 |
| CD at 5 % (Y X T) | | | NS | | | NS | | | NS |
| CV % | 9.87 | 10.65 | 10.26 | 6.27 | 6.07 | 6.17 | 10.61 | 12.76 | 11.63 |

$T_1$ - $S_0GV_1$=Green gram variety Meha sole; $T_2$ - $S_0GV_2$= Green gram variety Gm-4sole; $T_3$ - $S_1GV_1$=*M. composita* (2X2)+ Green gram variety Meha; $T_4$ - $S_1GV_2$=*M. composita* (2X2)+ Green gram variety Gm-4; $T_5$ - $S_2GV_1$= *M. composita* (3X2)+ Green gram variety Meha; $T_6$ - $S_2GV_2$= *M. composita* (3X2)+ Green gram variety Gm-4; $T_7$ - $S_3GV_1$= *M. composita* (4X2)+ Green gram variety Meha; $T_8$ - $S_3GV_2$= *M. composita* (4X2)+ Green gram variety Gm-4

**Table 2:** Reproductive growth attributes of Green gram under *Melia composita* plantations

| Treatments | No. of flowers/plant | | | No. of pods/plant | | |
|---|---|---|---|---|---|---|
| | 2015-16 | 2016-17 | Pooled | 2015-16 | 2016-17 | Pooled |
| $T_1$ - $S_0GV_1$ | 33.51 | 34.57 | 34.04 | 21.52 | 21.11 | 21.31 |
| $T_2$ - $S_0GV_2$ | 31.64 | 32.18 | 31.91 | 20.62 | 20.23 | 20.42 |
| $T_3$ - $S_1GV_1$ | 22.28 | 20.24 | 21.26 | 16.11 | 15.83 | 15.97 |
| $T_4$ - $S_1GV_2$ | 20.41 | 17.85 | 19.13 | 15.21 | 14.95 | 15.08 |
| $T_5$ - $S_2GV_1$ | 26.02 | 25.02 | 25.52 | 17.91 | 17.59 | 17.75 |
| $T_6$ - $S_2GV_2$ | 24.15 | 22.63 | 23.39 | 17.01 | 16.71 | 16.86 |
| $T_7$ - $S_3GV_1$ | 29.77 | 29.79 | 29.78 | 19.72 | 19.35 | 19.54 |
| $T_8$ - $S_3GV_2$ | 27.90 | 27.40 | 27.65 | 18.82 | 18.47 | 18.64 |
| S. Em ± | 1.77 | 1.96 | 1.21 | 0.88 | 0.93 | 0.57 |
| C.D. at 5 % | 5.36 | 5.95 | 3.48 | 2.66 | 2.81 | 1.64 |
| S.Em ± (Y X T) | | | 1.86 | | | 0.90 |
| CD at 5 % (Y X T) | | | NS | | | NS |
| CV % | 11.35 | 12.96 | 12.16 | 8.26 | 8.90 | 8.58 |

$T_1$ - $S_0GV_1$=Green gram variety Meha sole; $T_2$ - $S_0GV_2$= Green gram variety Gm-4 sole; $T_3$ - $S_1GV_1$=*M. composita* (2X2)+ Green gram variety Meha; $T_4$ - $S_1GV_2$=*M. composita* (2X2)+ Green gram variety Gm-4; $T_5$ - $S_2GV_1$= *M. composita* (3X2)+ Green gram variety Meha; $T_6$ - $S_2GV_2$= *M. composita* (3X2)+ Green gram variety Gm-4; $T_7$ - $S_3OV_1$= *M. composita* (4X2)+ Green gram variety Meha; $T_8$ - $S_3GV_2$= *M. composita* (4X2)+ Green gram variety Gm-4

**Table 3:** Yield attributes of Green gram under *Melia composita* Plantations

| Treatments | Yield of Seed (g/plant) | | | Yield of Seed (g/plot) | | | Yield of Seed (tonne /ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2015-16 | 2016-17 | Pooled | 2015-16 | 2016-17 | Pooled | 2015-16 | 2016-17 | Pooled |
| $T_1$ - $S_0GV_1$ | 4.89 | 5.00 | 4.94 | 321.71 | 328.79 | 325.25 | 0.80 | 0.82 | 0.81 |
| $T_2$ - $S_0GV_2$ | 4.69 | 4.80 | 4.74 | 308.66 | 315.52 | 312.09 | 0.77 | 0.79 | 0.78 |
| $T_3$ - $S_1GV_1$ | 3.70 | 3.79 | 3.74 | 243.36 | 249.83 | 246.60 | 0.61 | 0.63 | 0.62 |
| $T_4$ - $S_1GV_2$ | 3.50 | 3.59 | 3.55 | 230.31 | 236.87 | 233.59 | 0.58 | 0.59 | 0.58 |
| $T_5$ - $S_2GV_1$ | 4.09 | 4.19 | 4.14 | 269.48 | 275.95 | 272.72 | 0.67 | 0.69 | 0.68 |
| $T_6$ - $S_2GV_2$ | 3.90 | 3.99 | 3.94 | 256.42 | 262.93 | 259.68 | 0.64 | 0.66 | 0.65 |
| $T_7$ - $S_3GV_1$ | 4.49 | 4.59 | 4.54 | 295.60 | 302.24 | 298.92 | 0.74 | 0.76 | 0.75 |
| $T_8$ - $S_3GV_2$ | 4.29 | 4.39 | 4.34 | 282.54 | 289.14 | 285.84 | 0.71 | 0.72 | 0.72 |
| S. Em ± | 0.24 | 0.29 | 0.17 | 15.96 | 18.53 | 10.93 | 0.04 | 0.04 | 0.03 |
| C.D. at 5 % | 0.72 | 0.88 | 0.48 | 48.43 | 56.20 | 31.42 | 0.11 | 0.13 | 0.08 |
| S.Em ± (Y X T) | | | 0.27 | | | 17.57 | | | 0.04 |
| CD at 5 % (Y X T) | | | NS | | | NS | | | NS |
| CV % | 9.87 | 11.72 | 10.86 | 10.02 | 11.35 | 10.72 | 9.28 | 10.36 | 9.85 |

$T_1$ - $S_0GV_1$=Green gram variety Meha sole; $T_2$ - $S_0GV_2$= Green gram variety Gm-4 sole; $T_3$ - $S_1GV_1$=*M. composita* (2X2)+ Green gram variety Meha; $T_4$ - $S_1GV_2$=*M. composita* (2X2)+ Green gram variety Gm-4; $T_5$ - $S_2GV_1$= *M. composita* (3X2)+ Green gram variety Meha; $T_6$ - $S_2GV_2$= *M. composita* (3X2)+ Green gram variety Gm-4; $T_7$ - $S_3GV_1$= *M. composita* (4X2)+ Green gram variety Meha; $T_8$ - $S_3GV_2$= *M. composita* (4X2)+ Green gram variety Gm-4
(Plot Size: 4 sq.m)

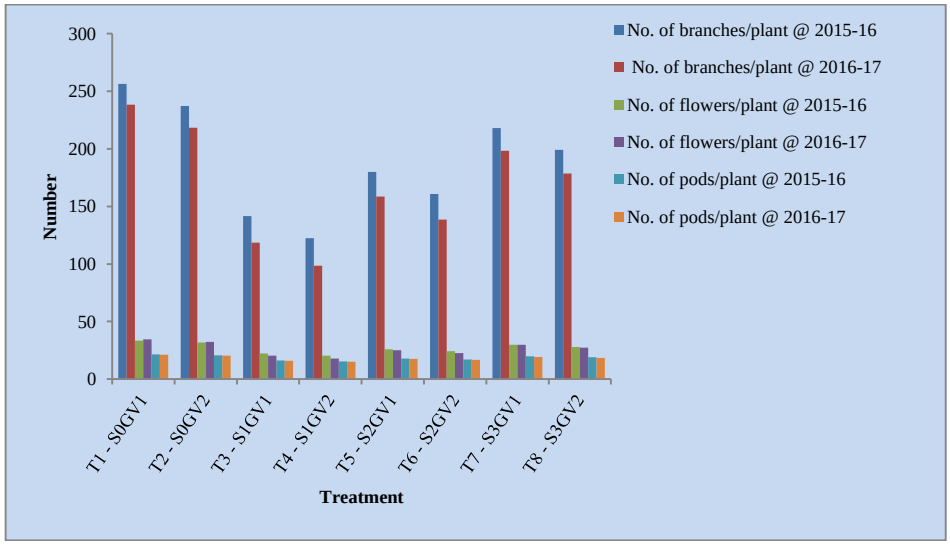


**Fig 1:** Growth attributes of Green gram under different spatial arrangements of *Melia composita* and sole cropping systems (Flowers, No. of branches, Fruits)

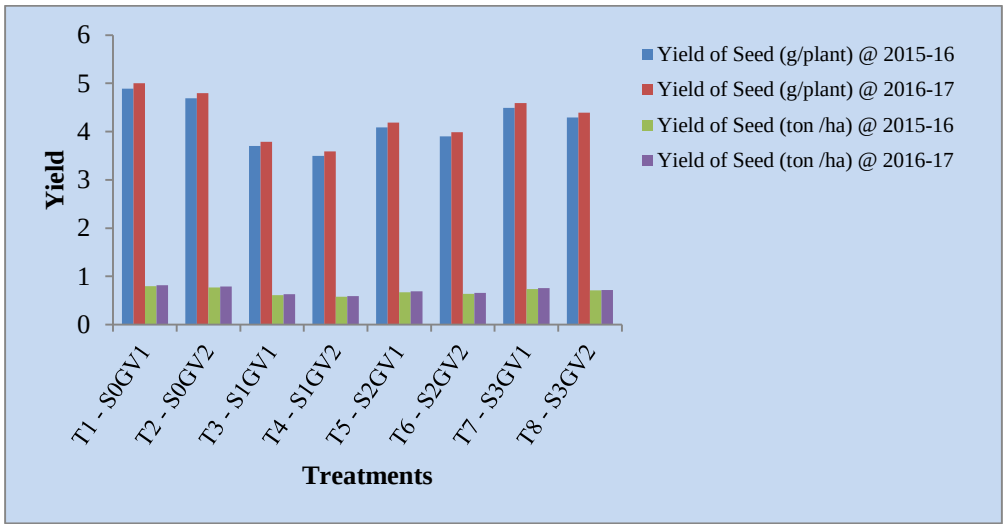


**Fig 2:** Yield attributes of Green gram under different spatial arrangements of *Melia composita* and sole cropping systems (Seed per plant and per hectare)

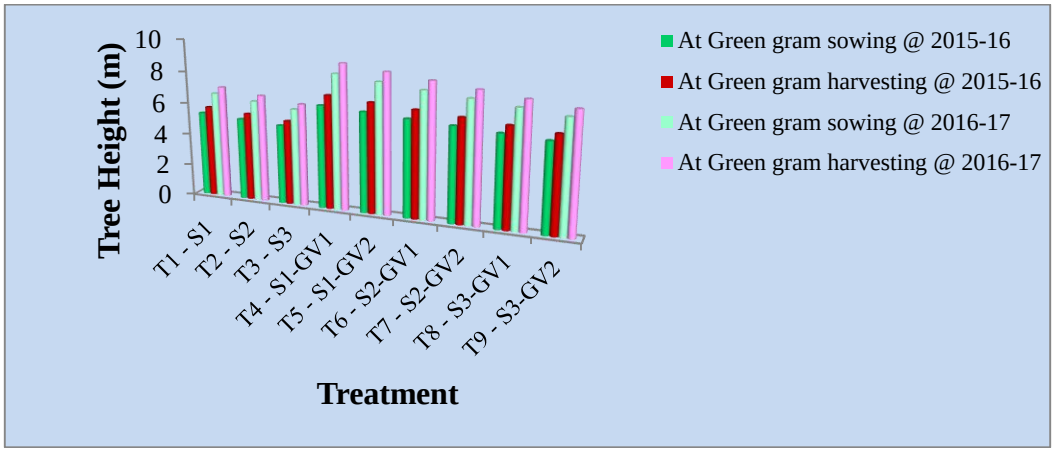


**Fig 3:** Growth attributes (Height) of *Melia composita* in different spacing under sole plantation and with Green gram intercrop

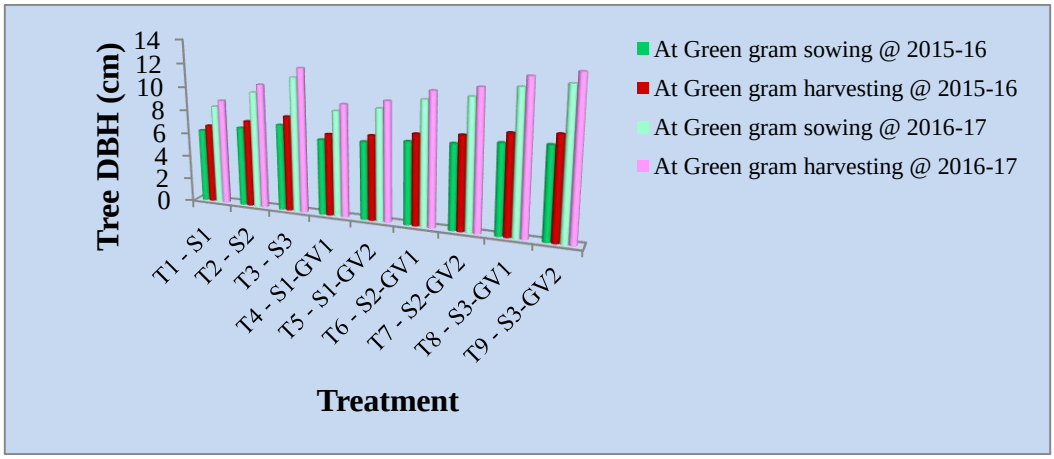


**Fig 4:** Growth attributes (DBH) of *Melia composita* in sole plantation and with Green gram intercrop

## Conclusion

Intercropping of pulses with fast growing trees provide maximum returns to the farmers as compared to sole plantation or sole cropping. The interaction of trees and crops can be utilized for maximum gain by technological interventions and good agricultural practices. The growth and yield parameters of Green gram irrespective verities were found maximum under sole cropping compared to intercropping with *M. composita*. However, contrary the growth and yield parameters of *M. composita* were found maximum with intercrops than sole plantation irrespective of spatial arrangement. The average maximum pod yield of green gram in intercropping reported in $T_7$- (variety Meha with *M. composita* at 2 x 4 m spacing) as 0.75 tonnes/ha which shows marginal reduction of 0.06 tonnes/ ha in yield than sole cropping. Hence wider spacing of $S_3$ (4x2 m) can be suggested for intercropping under *M. composita* plantations in initial 2-4 years. If we consider the economic return from the tree crop at the stage of harvesting the financial benefits was more in the intercropping systems as compare to the sole cropping systems, and it's may reduce the risk of crop failure and compensate the return from the trees.

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