

ROOT DISTRIBUTION PATTERN, GROWTH AND YIELD ATTRIBUTES OF GUAVA (*PSIDIUM GUAJAVA* L.) AS INFLUENCED BY RAISED BED AND MULCHING UNDER HIGH DENSITY PLANTING SYSTEM

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Abstract

The root distribution pattern, growth and yield of guava were studied on the trees planted at 3 m × 3 m spacing on raised bed whose basin area was covered with black polythene mulch (RBM), raised bed without mulch (RBM) and flat bed (FB). Findings showed that the root density varied in horizontal and vertical position. Maximum feeding roots (< 2mm thickness) were recorded up to 20 cm radial distance from tree trunk at 0-15 cm depth under raised bed with mulch (RBM) and without mulch (RBM) conditions. However, at 16-30 cm depth, fibrous roots (< 2mm thickness) were found uniform in all the growing conditions of the tree. Root mass of 2-5 mm thick were found significantly higher (1.84 g) in 0-15 cm depth at 20 cm radial distance from trunk. Maximum (1.62g) root mass (2-5 mm thick roots) was noted in 16-30 cm depth at 40 cm radial distance from trunk in RBM, while the lowest in flat bed. Root mass of 2-5 mm thick roots were found similar in 0-15 and 16-30 cm depth at 60 and 80 cm radial distance. Canopy spread, collar diameter and yield per tree were recorded maximum in the tree grown at RBM condition.

Introduction

Guava (*Psidium guajava* L.) belonging to Myrtaceae, is poor man's fruits as it has nutritional properties within the reach of poor people. It responds well to improvise floor and canopy management strategies too, apart from genetic potential. A proper understanding of root distribution pattern is of very important paramount importance for chalking out strategy for the efficient utilization of available resources. The root system plays important role in physiological and biological functions, which determines yield and quality of fruit plants. The horizontal and vertical root distribution pattern of the fruit trees are the indicative of nutrient and water uptake efficiency, ultimately determines the productivity. Orchard floor management strategy such as mulching, growing plants on the raised bed influenced the water and nutrient availability which also affect horizontal and vertical growth of root system in guava. For standardization of methods and depth of fertilizer application in any fruit crops, knowledge on availability of feeding roots distribution is pre-requisite. A few research works have been done in guava regarding root distribution pattern (Moutoun *et al.* 1975, Patil *et al.* 1999, Bassoi *et al.* 2002). Planting density also affects root distribution pattern. Ramakrishna *et al.* (2006) and Singh *et al.* (2012) studied the positive impact of mulching on root distribution, yield and growth of the tree.

The present experiment was carried out to study the root distribution pattern of guava at variable growing conditions under high density planting (HDP) to study the horizontal and vertical distribution of guava roots under different management ecosystems. The experimental findings will help to understanding of the intensity of the feeding roots, and distribution of root synthesized chemicals where water and nutrients could be applied for their efficient utilization by the tree.

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Materials and Methods

The experiment was conducted at the Experimental Farm of ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, Uttar Pradesh, India during 2019 and 2020. Lucknow experienced mean annual rainfall of 950 mm, with extreme hot in summer while cold and frost in winter during 2019-20. The soil is sandy loam, free of stone and deep with 0.46 per cent organic matter content. Five years old guava variety 'Lalit' grafted on seedling rootstock, planted at 3 m × 3 m spacing was selected for the experiment. The experiment was carried out in randomized complete block design, comprised of 3 treatments i.e. raised bed covered with inorganic mulch of 100 micron black polythene (RBM) (T₁), raised bed without mulch (RBM) (T₂) and flat bed (FB) (T₃). For making the raised bed, guava planting was done followed by earthing up the basin with 2 m width, 15-20 cm high, and whole bed was covered with black polythene mulch (RBM) after spreading drip line with 2 drippers of 4 l per hr. The trees were maintained under uniform cultural practices since planting. The recommended dose of farm yard manure @ 40-50 kg per tree and fertilizers @ 250-125-250 g NPK from 5 years of age in form of water soluble fertilizers were applied. The water soluble fertilizers i.e. Urea (46%), Urea phosphate (17-44-0), Sulphate of potash (0-0-50) and NPK of 19:19:19 grade were applied in 12 split doses.

Root distribution study was carried out in December after fruit harvest. The soil excavation was done from trunk to 20, 40, 60 and 80 cm distance from main trunk after earmarking circular line with the help of lime powder. The vertical root distribution was studied by taking out soil sample by inserting steel core of 7.5cm in diameter and 75 cm long from 0-15 cm and 16-30 cm deep. For the horizontal root distribution studies, the soil samples from the horizontal blocks of 20, 40, 60, and 80 cm were collected at 0-15 and 16-30 cm depth at four points in replicated form. The collected soil samples were thoroughly washed under running water to remove soil particles adhered with the roots. The roots were categorized in to < 2 mm thick and 2-5 mm thick roots (Plate 1).

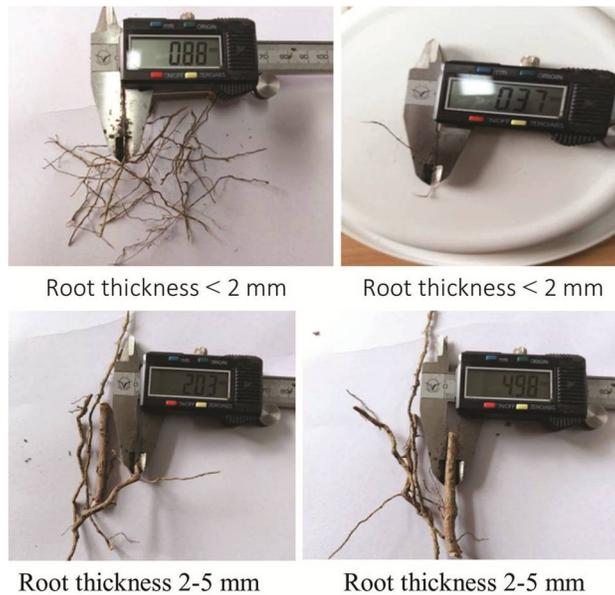


Plate 1. Root thickness range of guava under different management systems.

The fresh roots from each block of horizontal and vertical were collected in a tray and the weed roots and soil particles were removed from the root sample. The roots were grouped as per root thickness in < 2 mm and 2-5 mm thick roots using digital vernier calliper as well as digital serew gauge, fresh root weight were recorded using electronic balance (Fig. 1). Yield data were recorded per tree basis during fruit harvest. Eighteen fruits from each replication were randomly collected for data recording. The treatments were replicated six times, data collected were analyzed using ASSISTAT 7.6 beta software, and sigma plot was used to prepare graphical presentation of data. The standard error means (SEM) in the vertical bar charts was computed using Sigma Plot 10 (Systat 21 software, Inc.).

Results and Discussion

Results showed that root mass of < 2 mm thick roots were maximum (1.68 g) in guava of raised bed (RBM) with mulching (RUBM) at 20 cm horizontal distance from trunk and 0-15 cm soil depth, while minimum root mass (0.93g.) were recorded in FB system (Fig 1). The error bar on graphs showed that there was no significant difference on root mass in similar orchard floor management system at 16-30 cm depth (Fig 2).

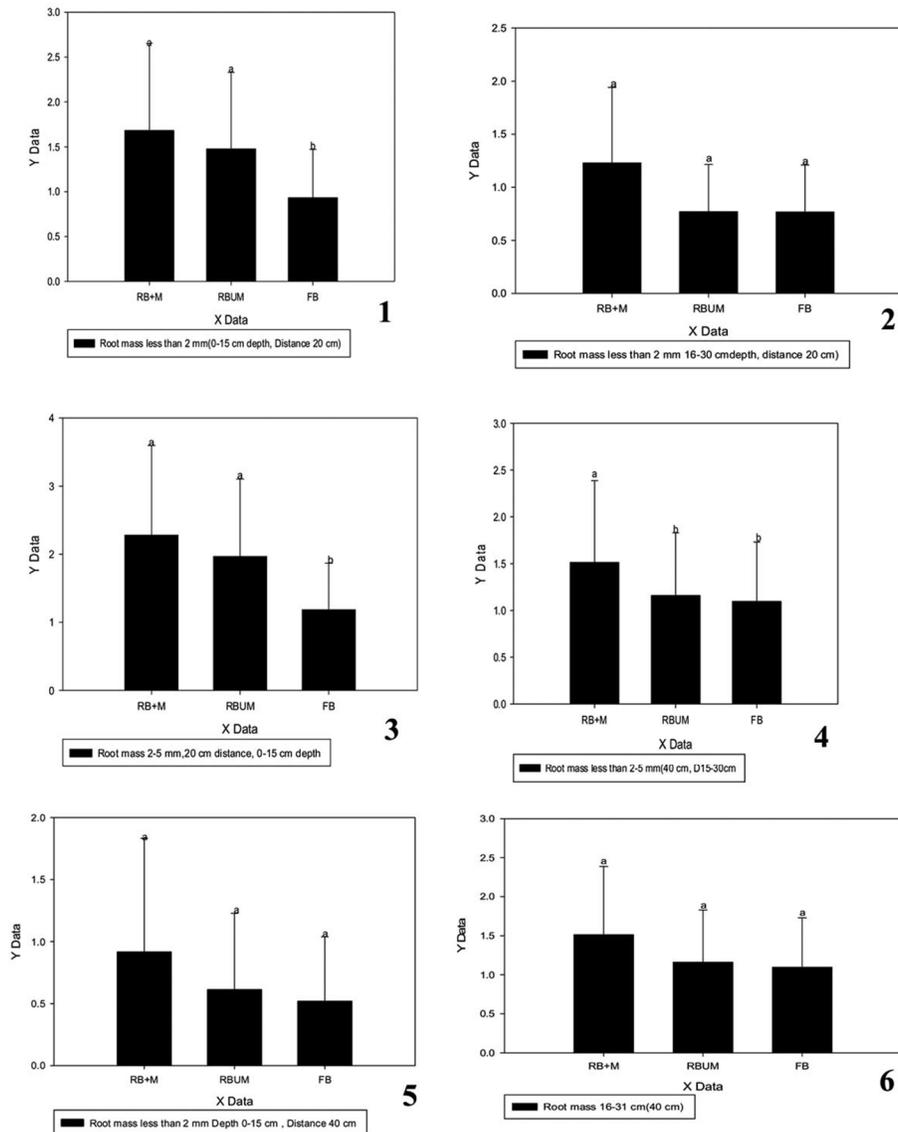
It is obvious from error bar that data are more variable from mean in case of root mass magnitude for < 2mm root thickness at the radial distance of 40 cm from the tree trunk from 0-15 and 16-30 cm depth were recorded non significant in RBM, RUBM and FB (Figs 3 and 4). Similarly the variation in root mass of < 2 mm thick roots were also found non-significant in the 60 cm and 80 cm radial distance from main trunk in 0-15 and 16-30 cm depth (Figs 5, 6, 7 and 8).

Total root mass of 2-5 mm thick roots from soil depth of 0-15 cm at 20 cm radial distance from tree trunk were found significant, maximum root mass (1.84g) was recorded in RBM system which was at par to RUBM (1.72g), while minimum (1.15g) was recorded in flat bed (Fig 9). Similar trend in the root mass was recorded from 16-30 cm depth at 40 cm radial distance (Fig. 10). Maximum root mass (1.62g) was noted in RBM while minimum (1.21g) under Flat bed (Fig. 11) at 40 cm horizontal distance and 0-15 cm depth, similarly maximum root mass (1.51g) was recorded in RBM system and minimum 1.16g and 1.09 g in RUBM and FB system at the radial distance of 40 cm from trunk (Figs 12 and 13).

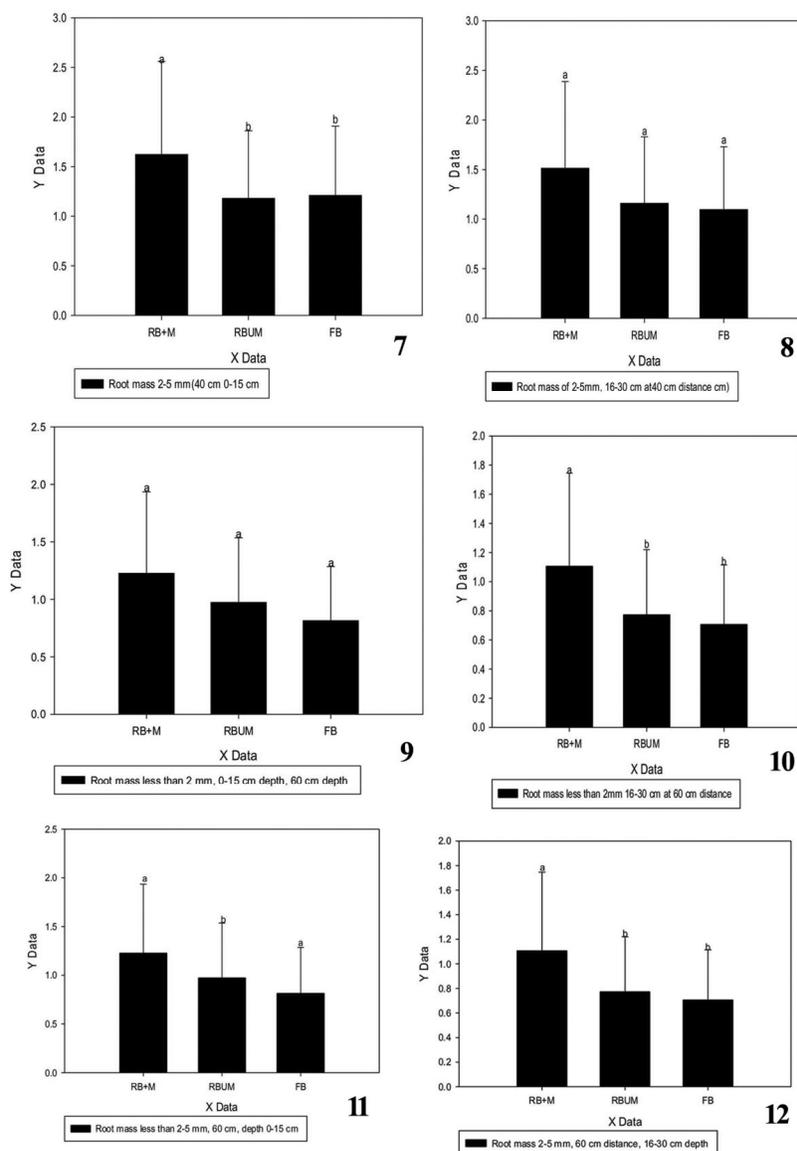
However, no significance variation was recorded in the root mass beyond 40 cm radial distance in 0-15 cm depth, under different RBM, RUBM and FB system (Fig. 14). Maximum root mass (1.16g) was recorded in RBM and minimum (0.70g) in FB system at 16-30 cm soil depth at 60 cm radial distance from trunk (Fig. 15). At 80 cm radial distance from trunk in 0-15 cm depth, the root mass was maximum (0.74g, 0.68 g) under RBM and RUBM system, minimum (0.11g) in FB system. However, root mass was not found significant under RBM, RUBM and FB system at 16-30 cm depth at 80 cm radial distance (Fig 16). Significantly tree spread in N-S & EW was recorded maximum (2.24, 2.28m) in RBM while it was minimum (1.50m), 1.48 m under flat bed system (Fig 17 and 18). Similarly collar diameter was recorded maximum (10.72cm) under RBM which was on par to RUBM and minimum (6.76 cm) in FB. Maximum fruit numbers, fruit weight and yield per tree were recorded (141.67), (190.67g) and (27.62 kg), respectively in RBM growth system, while it was minimum in flat bed guava planting system (Fig. 19, 20 and 21). Understanding of horizontal and vertical root distribution pattern is one of the important aspects of fruit cultivation, which determines ability to withstand drought, tree growth as well as yield. Root distribution pattern is influenced by variety, rootstock, use of inputs, mulching, soil texture, electrical conductance and soil pH etc.

Maximum fibrous roots (< 2mm) recorded in raised bed with mulching (RBM) system up to 0-15 cm depth and the root mass decreased in the subsequent layers (depth block). Mulching film layers on the soil surface prevents water evaporation and thus promotes rain water penetration in

the soil, resulted soil moisture accumulation in the root zone (Ramakrishna *et al.* 2006). As the raised bed make the soil loose and pulverized soil further covering the surface with black polythene mulch keeps the root zone moist, which may develop favorable condition to grow on the upper layers. These results are more or less similar to the findings of Singh *et al.* (2012) in guava variety Allahabad Safeda, Gao *et al.* (2014) opined that root hairs intensity decreased subsequently with increase in soil depth.



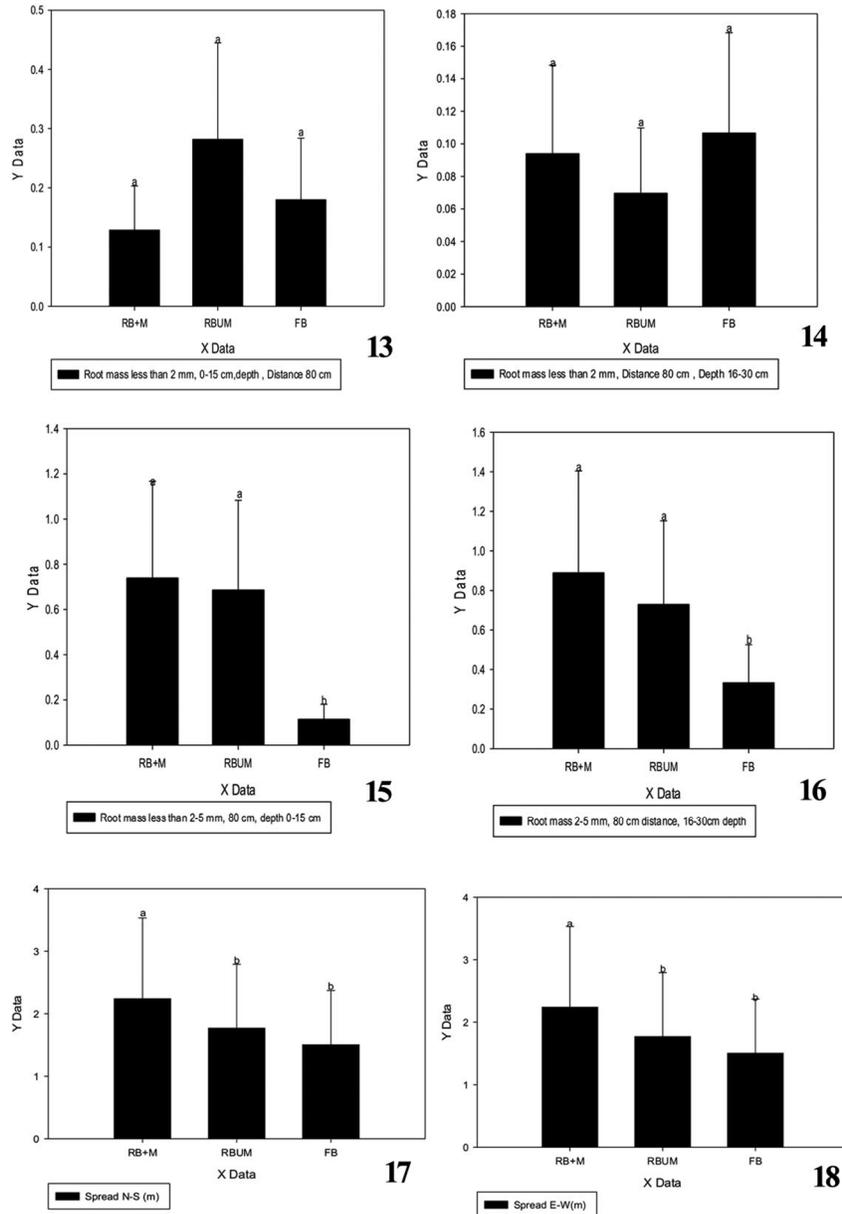
Figs 1-6. 1. Root mass < 2 mm 0-15 cm depth at 20 cm horizontal distance. 2. Root mass < 2 mm 16-30 cm depth at 20 cm horizontal distance. 3. Root mass of 2-5 mm, 0-15 cm depth at 20 cm horizontal distance. 4. Root mass of 2-5 mm, 16-30 cm depth at 20 cm horizontal distance. 5. Root mass < 2 mm 0-15 cm depth at 40 cm horizontal distance. 6. Root mass < 2 mm 16-30 cm depth at 40 cm horizontal distance.



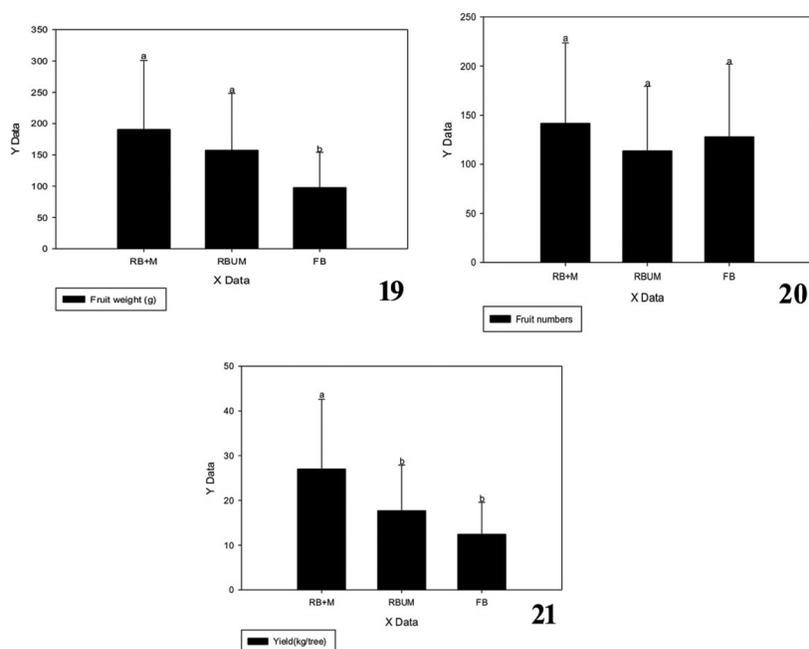
Figs 7-12: 7. Root mass of 2-5 mm, 0-15 cm depth at 40 cm horizontal distance. 8. Root mass of 2-5 mm, 16-30 cm depth at 40 cm horizontal distance. 9. Root mass < 2 mm 0-15 cm depth at 60 cm horizontal distance. 10. Root mass < 2 mm 16-30 cm depth at 60 cm horizontal distance. 11. Root mass of 2-5 mm, 0-15 cm depth at 60 cm horizontal distance. 12. Root mass of 2-5 mm, 16-30 cm depth at 60 cm horizontal distance.

Root density of fibrous roots progressively decreased with increase in the depth and radial distance from trunk. These findings are in agreement with the findings of Singh and Mishra (2000) and Singh *et al.* (2012)). Mishra and Dabral (2005) studied the root system and recorded maximum active roots up to 0-30 cm depth. Root mass of 2-5mm thick roots were recorded 0-15 and 16-30 cm depth up to 60 cm radial distance under all the management systems (RBM, RBUM

and FB). However, 2-5 mm thick roots density decreased beyond 60cm of radial distance from trunk. Maximum concentration of < 2mm thick roots in the first layer of root zone and more concentrate of 2-5 mm thick roots in deeper soil layers, helps to absorb more water and nutrients from deeper layers more effectively (Nagarajah 1987).



Figs 13-18: 13. Root mass of <2mm 0-15 cm depth at 80 cm horizontal distance. 14. Root mass of <2mm 16-30 cm depth at 80 cm horizontal distance. 15. Root mass of 2-5mm, 0-15 cm depth at 80 cm horizontal distance. Root mass of 2-5mm, 16-30 cm depth at 80 cm horizontal distance. 17. Average canopy spread in north- south under different growing system. 18. Average canopy spread in east- west under different growing system.



Figs 19-21: 19. Average fruit weight (g) under different growing system. 20. Average fruit numbers under different growing system. 21. Average fruit yield under different growing system

Root mass of 2-5 mm thick roots were recorded more under RBM, and also RBUM system in the deeper layers, which indicates favorable impact of mulching and raised bed treatment in guava. These findings are in conformity with the findings of Somkuwar *et al.* (2012) in grape, grafted on different rootstocks. Maximum canopy spread (north-south and east-west) and collar diameter was recorded in RBM system, which could be attributed to the favorable impact of mulching and soil pulverization (raised bed) in the tree basin. Mulching with plastic film prevents water evaporation, an increase of water percolation, develop conducive condition for the feeding roots density, thereby improve water and nutrient acquisition for the canopy growth (Ramakrishna *et al.* 2006, Maji and Das 2008). Trees with raised bed and mulching (RBM) resulted in maximum yield and fruit weight due to increased feeding roots in the upper layers of the soil profile, loose and pulverized soil with appropriate moisture level, similar results were also reported by Mo *et al.* (2013), Singh *et al.* (2015) and Bhattacharyajee *et al.* (2020).

Growing guava on raised bed coupled with inorganic plastic mulch resulted better rhizosphere due to pulverization of root zone, more moisture retention and better growing ecosystem for the growth of the roots. The root distribution pattern both in horizontal and vertical fashion were significantly influenced by growing conditions of guava trees. Maximum concentration of feeding roots was recorded at upper layers i.e. 0-15 cm depth and 20 cm horizontal distance from main trunk. Hence, the observations obtained from the present experiment may help in decision making for precise and efficient input use in guava production.

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