Environment & Ecology 29 (3B) : 1517—1521, 2011
 ISSN 0970-0420

Effect of Cultivar, Radial Distance and Depth on Root Distribution in Guava (*Psidium guajava* L.)

N. SINGH, V. M. PRASAD[1], BHAWNA BANGARI, SHWETA UNIYAL, K. K. MISRA*

Department of Horticulture, G. B. Pant University of Agriculture & Technology
Pantnagar, Uttarakhand, India
[1]Allahabad Agricultural Deemed University, Allahabad, Uttar Pradesh, India
E-mail : misrakk_hort@rediffmail.com
**Correspondence*

Abstract

The root distribution studies of sixteen-year-old guava cultivars viz. Allahabad Safeda and Sardar were conducted. The experiment was carried out in three factor randomized block design with two cultivar (Allahabad Safeda and Sardar), three radial distances (0—60, 60—120, 120—180 cm) and three depths (0—20, 20—40, 40—60 cm). Cultivar Allahabad Safeda had the extensive root system than Sardar. Among the interactions cultivar × radial distance; cultivar × depth; radial distance × depth and cultivar × radial distance × depth, Allahabad Safeda × 0—60 cm radial distance, Allahabad Safeda × 0—20 cm depth, 0—60 cm radial distance × 0—20 cm depth, Allahabad Safeda × 0—60 cm radial distance × 0—20 cm depth gave significantly higher dry weight of all categories of roots, respectively. Most of the feeder roots were present at 0—60 cm radial distance and 0—20 cm depth. Thus, fertilizers and irrigation water may be applied in this zone irrespective of cultivars for better utilization of these inputs by the tree roots.
Key words : *Psidium guajava,* Cultivar, Radial distance, Depth, Root.

Guava (*Psidium guajava* L.) belongs to the family Myrtaceae and is cultivated throughout the tropical and subtropical regions. The cultivars Allahabad Safeda and Sardar are popular and important cultivars of guava in North India. The fruits of Allahabad Safeda are large in size, round in shape with smooth skin and yellowish-white in color. It can withstand drought condition to a great extent whereas Sardar guava fruits are large, roundish ovate in shape with primrose-yellow skin and white pulp. Root distribution study is one of the important aspects of fruit trees which had wide spread root system. The extent and activity of root system of trees govern the size and growth of the aerial part to a great extent. The study of root system of tropical and subtropical fruits is meager in India (1). Root distribution pattern of tree is influenced by a number of factors such as tree age, season, rootstocks, scion variety, soil texture, fertility, tillage, growing condition and other cultural practices (2). The knowledge of root distribution pattern is helpful in economizing the use of expensive inputs like fertilizers and water (3) and variation in results is expected with the change of orchard environment and cultivar. It is also important in surveying the new areas of commercial orcharding. The information of the study of the root system of a species in a location cannot be applied as such in other locations. Therefore, there is an urgent need of such studies in different agroclimatic regions. The direct excavation of the

Table 1. Effect of cultivar, radial distance and depth on dry weight of fibrous, thin, medium, thick and total roots.

Treatments	Dry weight (g) Fibrous roots	Thin roots	Medium roots	Thick roots	Total roots
Cultivars					
Allahabad Safeda	129.18	149.43	860.56	2739.26	3947.65
Sardar	70.00	102.65	682.00	1707.16	2562.00
CD (*P*=0.05)	0.028	0.020	0.011	0.005	0.006
Radial Distances (cm)					
0—60	198.99	233.14	1265.10	4360.82	6058.10
60—120	65.20	130.69	725.18	1172.39	2137.29
120—180	34.58	74.28	323.57	1136.41	1569.10
CD (*P*=0.05)	0.035	0.024	0.015	0.007	0.007
Depths (cm)					
0—20	152.58	229.58	1156.62	2664.38	4266.86
20—40	98.72	135.66	787.57	2064.38	3086.33
40—60	47.47	72.88	369.66	1921.20	2411.29
CD (*P*=0.05)	0.035	0.024	0.015	0.007	0.007

Table 2. Effect of interaction (cultivar × radial distance) on dry weight of fibrous, thin, medium and thick roots (g).

	Radial distance (cm)					
	Fibrous roots			Thin roots		
Cultivars	D_1 (0—60)	D_2 (60—120)	D_3 (120—180)	D_1 (0—60)	D_2 (60—120)	D_3 (120—180)
Allahabad Safeda	265.44	76.39	45.71	330.31	157.86	80.12
Sardar	132.54	54.01	23.46	135.97	103.52	68.45
CD (P=0.05)		0.049			0.035	

Table 2. Continued.

	Radial distance (cm)					
	Medium roots			Thick roots		
	D_1 (0—60)	D_2 (60—120)	D_3 (120—180)	D_1 (0—60)	D_2 (60—120)	D_3 (120—180)
Allahabad Safeda	1626.20	593.82	361.69	4969.80	1491.51	1756.47
Sardar	904.00	856.53	285.48	3751.84	853.28	516.35
CD (P=0.05)		0.008			0.009	

roots provides a clear cut picture of the entire root system of a tree as it exists naturally but some of the roots are lost due to working with large soil volume. The purpose of this study was to investigate the zone of active root system in guava cultivars for economizing the use of fertilizers and irrigation as no information is available on root distribution pattern of guava under Allahabad condition.

Methods

The experiment was conducted at the Department of Horticulture, Allahabad Agricultural Deemed University, Allahabad, on 16-year-old uniform healthy trees of guava cultivars Allahabad Safeda and Sardar. The trees were maintained under uniform cultural practices since the planting. The experiment was conducted in three factor randomized block design with two cultivars (Allahabad Safeda and Sardar), three radial distances (0—60, 60—120 and 120—180 cm) and three depths (0—20, 20—40 and 40—60 cm). Eighteen treatment combinations thus formed were replicated thrice. In each tree, a circle of 180 cm radius was drawn around the trunk and 1/8th portion of the area was marked on the south-east side of the tree for excavation. This 1/8th portion was further divided into three sectors i.e., at 0—60 cm (D_1), 60—120 cm (D_2) and 120—180 cm (D_3) distance from the tree trunk. Each sector was excavated at three different depths i.e. 0—20 cm (d_1), 20—40 cm (d_2) and 40—60 cm (d_3).

Table 3. Effect of interaction (cultivar × depth) on dry weight of fibrous, thin, medium and thick roots (g).

	Depth (cm)					
	Fibrous roots			Thin roots		
Cultivars	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
Allahabad Safeda	224.87	119.92	42.75	319.96	160.91	87.42
sardar	80.29	77.53	52.19	139.19	110.41	58.33
CD (P=0.05)		0.060			0.043	

Table 3. Continued.

	Depth (cm)					
	Medium roots			Thick roots		
Cultivars	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
Allahabad Safeda	1747.44	380.95	453.30	4842.46	1982.30	1393.03
Sardar	565.80	1194.19	286.03	525.64	2146.46	2449.37
CD (P=0.05)		0.030			0.012	

Table 4. Effect of interaction (radial distance × depth) on dry weight of fibrous, thin, medium and thick roots (g).

	Depth (cm)					
	Fibrous roots			Thin roots		
Radial distance (cm)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
D_1 (0—60)	280.81	204.40	111.74	345.67	252.93	100.82
D_2 (60—120)	111.52	62.10	21.08	232.57	94.53	64.97
D_3 (120—180)	65.41	28.76	9.59	110.49	59.52	52.85
CD (P=0.05)		0.049			0.035	

Table 4. Continued.

	Depth (cm)					
	Medium roots			Thick roots		
Radial distance (cm)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
D_1 (0—60)	2606.08	783.80	405.44	4503.13	4140.04	4439.28
D_2 (60—120)	534.26	1179.82	461.45	1657.51	1499.06	360.62
D_3 (120—180)	329.52	399.10	242.09	1955.36	554.03	899.85
CD (P=0.05)		0.008			0.012	

The roots were collected from each sector separately and washed with water on a wiremesh. The fibrous roots were then graded into the four categories on the basis of their diameter viz. <0.2 cm, >0.2 cm to 0.5 cm, >0.5 cm to 1.5 cm and >1.5 cm and above. These roots were designated as fibrous, thin, medium and thick (4). After grading of roots in above four categories, the roots were then surface dried under fan. The dried roots were then put in the paper bags and kept in an oven at 60 C ± 1 for 72 hours for drying and the constant dry weight of roots was recorded. The amount of root was then expressed as grams of dry roots per cubic meter volume of soil. Data were subjected to an analysis of variance in three factor randomized block design as suggested by Snedecor and Cochran (5) and interpretation of results was made on the basis of *f* test. The critical differences (CD) at 0.05 level of probability were worked out for comparing treatment means.

Results and Discussion

Effect of Cultivar

The dry weight of fibrous, thin, medium, thick and total roots differed significantly among the culti-

Table 5. Effect of interaction (cultivar × radial distance × depth) on dry weight of fibrous and thin roots (g).

	Fibrous roots (g)								
	D_1 (0—60)			D_2 (60—120)			D_3 (120—180)		
Cultivar	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Allahabad Safeda	442.31	259.54	94.46	140.58	65.63	22.96	91.72	34.57	10.83
Sardar	119.32	49.27	129.01	82.45	60.36	19.21	39.10	22.94	8.35
CD (P=0.05)					0.085				

Table 5. Continued.

	Thin roots (g)								
	D_1 (0—60)			D_2 (60—120)			D_3 (120—180)		
Cultivar	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Allahabad Safeda	491.59	319.12	180.24	314.85	110.56	48.16	153.45	53.04	33.87
Sardar	199.76	186.74	21.40	150.29	78.50	81.79	67.53	66.10	71.83
CD (P=0.05)					0.060				

Table 6. Effect of interaction (cultivar × radial distance × depth) on dry weight of medium and thick roots (g).

	Medium roots (g)								
	D_1 (0—60)			D_2 (60—120)			D_3 (120—180)		
Cultivars	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Allahabad Safeda	3908.76	580.70	389.15	799.50	269.46	712.51	534.04	292.70	258.23
Sardar	1303.40	986.89	421.73	269.01	2090.17	210.40	125.00	505.50	225.95
CD (P=0.05)					0.014				

Table 6. Continued.

	Thick roots (g)								
	D_1 (0—60)			D_2 (60—120)			D_3 (120—180)		
Cultivars	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Allahabad Safeda	7997.01	4440.81	2471.56	3018.35	1020.27	435.90	3512.00	485.81	1271.61
Sardar	881.55	3839.27	6534.69	296.67	1977.84	285.33	398.71	622.25	528.08
CD (P=0.05)					0.017				

vars. The Allahabad Safeda gave significantly higher dry weight of fibrous roots than Sardar (Table 1). Roy et al. (6) studied the feeder root distribution pattern of guava cultivar. Allahabad Safeda, Banarasi and seedless and reported that the maximum feeder root density was found in all ciltivars at 0—30 cm soil depth. Rao and Mukherjee (7) studied the feeder root distribution of vegetatively propagated mango cv Fazli, Langra and Himsagar and found the roots were decreased with increase in radial distances. Patel (8) studied the root system of 11-year-old healthy trees of guava cultivars Sardar grafted on seedling rootstock and found maximum dry weight of all categories of roots at 0—20 cm depth.

Effect of Radial Distance

The influence of radial distance on various categories of roots (fibrous, thin, medium, thick) as well as total weight of roots was found to be significant. Among the radial distances, 0—60 cm radial distance from the tree trunk gave significantly higher dry weight of fibrous, thin, medium, thick and total roots (Table 1). In lemon (budded on trifoliate orange rootstock) the maximum dry weight of fibrous roots was observed at 0—60 cm away from the tree trunk (3). Further increase in radial distance significantly reduced the dry weight of all categories of roots as well as total roots. Similar declining pattern of dry weight of roots with increase in radial distance from tree trunk was reported by Singh and Misra (2) in bael and Misra and Jaiswal (9) in karonda.

Effect of Depth

The effect of soil depth on various categories of roots was found to be significant. The dry weight of fibrous, thin, medium, thick and total roots at 0—20 cm depth was significantly more than the dry weight of all categories of roots at 20—40 cm and 40—60 cm depth (Table 1). Misra et al. (3) studied the root distribution on 17-year-old trees of lemon cv Pant Lemon-1 budded on trifoliate orange roots revealed maximum dry weight of fibrous roots at 0—20 cm depth. Maximum dry weight of feeder roots in karonda (*Carissa carandas* L.) was recorded at 0—20 cm depth from the soil surface which decreased with increasing soil depth (9). Singh and Misra (10) studied the root system of 18-year-old uniform healthy trees of grapefruit cultivar New Zealand budded on trifoliate orange root stock and found maximum volume and dry weight of fibrous roots at 0—20 cm depth which decreased with increasing depth of soil. Misra and Dabral (11) studied the root system of litchi and also reported that the maximum dry weight of active roots was observed at 0—30 cm depth from the soil surface which significantly decreased with increased depth.

Effect of Interactions

The interaction between cultivar and radial distance revealed that Allahabad Safeda × 0—60 cm ra-

Table 7. Effect of interactions (a) cultivar × radial distance and cultivar × depth, (b) radial distance × depth, and (c) cultivar × radial distance × depth on dry weight of total roots (g).

(a)

Cultivars	Radial distances (cm) D_1 (0—60)	D_2 (60—120)	D_3 (120—180)	Depths (cm) d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
Allahabad Safeda	7191.75	2407.23	2243.96	7222.38	2644.08	1976.50
Sardar	4924.44	1867.34	894.24	1311.35	3528.58	2846.10
CD (P=0.05)		0.011			0.013	

(b)

Radial distances (cm)	Depths (cm) d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
D_1 (0—60)	7671.98	5381.18	5121.13
D_2 (60—120)	2667.33	2836.40	908.13
D_3(120—180)	2461.28	1041.40	1204.63
CD (P=0.05)		0.011	

(c)

Cultivars	D_1 (0—60) d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	D_2 (60—120) d_1 (0—20)	d_2 (20—40)	d_3 (40—60)	D_3 (120—180) d_1 (0—20)	d_2 (20—40)	d_3 (40—60)
Allahabad Safeda	12839.66	5600.18	3135.42	4536.25	1465.93	1219.54	4291.22	866.13	1574.54
Sardar	2504.30	5162.18	7106.83	798.42	4206.88	596.71	631.33	1216.68	834.72
CD (P=0.05)					0.019				

dial distance gave significantly higher dry weight of fibrous, thin, medium, thick and total roots (Tables 2 to 7). Among the interaction between cultivar × depth, the higher dry weight of fibrous, thin medium, thick and total roots was observed with Allahabad Safeda × 0—20 cm depth (Tables 3 and 7). The interaction between radial distance and deptj indicated that the maximum dry weight of fibrous, thin, medium, thick and total roots was recorded with 0—60 cm radial distance × 0—20 cm depth (Tables 4 and 7). Among the interaction between cultivar × radial distance × depth, Allahabad Safeda at 0—60 cm radial distance × 0—20 cm depth gave significantly higher dry weight of fibrous, thin, medium, thick and total roots (Tables 5 to 7). Singh and Misra (10) recorded variation in dry weight of feeder roots in various cultivars of bael.

References

1. Roy R. N., D. P. Rao, S. K. Mukherjee and B. K. Chaterjee. 1987. Studies on feeder root distribution of litchi (*Litchi chinensis* Sonn.) cv Bombai. *Ind. Agric.* 31 : 33—41.
2. Singh N. and K. K. Misra. 2000. Studies on feeder root distribution pattern of grapefruit lemon (*Citrus paradisi*) on trifoliate orange rootstock. *Ind. J. Agric. Sci.* 70 : 611—612.
3. Misra K. K., R. Singh, A. K. Singh, R. Singh, D. Rai and H. R. Jaiswal. 1999. Studies on root distribution pattern of lemon (*Citrus limon* Burm.) on *Poncirus trifoliate* rootstock. *Prog. Hort.* 31 : 101—104.
4. Aiyappa K. M. and K. C. Srivastava. 1965. Studies on roots system of Coorg mandarin seedling trees. *Ind. J. Hort.* 22 : 122—130.
5. Snedecor G. W. and W. G. Cochran. 1988. *Statistical methods*. Oxford and IBH Publ. Co., New Delhi, India. 329—330 pp.
6. Roy D. P., D. K. Dora and B. K. Das. 1993. Studies on feeder root distribution of different varieties of guava. *Ind. J. Hort.* 50 : 197—201.
7. Rao D. P. and S. K. Mukherjee. 1985. Feeder root distribution of different varieties of mango. *Ind. J. Hort.* 42 : 189—198.
8. Patel V. B. 1997. *Effect of plant spacing on root distribution pattern of guava (Psidium guajava* L.). M.Sc. thesis. G. B. Pant Univ. Agric. and Tech., Pantnagar, India. 86 pp.
9. Misra K. K. and H. R. Jaiswal. 2001. Studies on the root distribution pattern of karonda. *Adv. Hort. For.* 8 : 75—80.
10. Singh S. K. and K. K. Misra. 2002. Effect of tree age and season on root distribution pattern of bael (*Aegle marmelos* Correa). *J. Non-Timber Forest Prod.* 9 : 43—46.
11. Misra K. K. and M. Dabral. 2005. Studies on root distribution pattern of litchi (*Litchi chinensis* Sonn.). *Prog. Hort.* 37 : 124—127.