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Studies on the effect of season, radial distance and depth on root distribution in guava cv. Allahabad Safeda

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ABSTRACT

Root distribution studies were carried out on 16-year-old trees of guava cultivar Allahabad Safeda in three factor randomized block design with two seasons (spring and autumn), three radial distances (0-60, 60-120, 120-180 cm) and three depths (0-20, 20-40, 40-60 cm). The spring season gave significantly higher dry weight of fibrous and thin roots than autumn season while autumn season gave significantly higher dry weight of thick roots. Most of the feeder roots were present at 0-60 cm radial distance and 0-20 cm depth. Therefore, fertilizers and irrigation water may be applied in this zone irrespective of seasons for better utilization of these inputs by the tree roots. The interactions between seasons, radial distances and soil depths in all types of roots were found to be significant.

Key words: *Psidium guajava*, season, radial distance, depth, feeder roots.

INTRODUCTION

Allahabad Safeda is very popular and important cultivar of guava in north India. The fruits of this cultivar are large in size, round in shape with smooth skin and yellowish-white in colour. It can withstand drought conditions at a very great extent. Root distribution study is one of the important aspects of fruit trees, which have wide spread root system. The knowledge of root distribution pattern is helpful in economizing the use of inputs like fertilizers and irrigation. It is also important in surveying the new areas of commercial orchard. The root distribution is influenced by a number of factors such as tree age, season, rootstocks, scion variety, soil texture, fertility, tillage, growing conditions and other cultural practices (Singh and Misra, 11). 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 agro-climatic regions. The direct excavation of the 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. However, no information is available on root distribution pattern of guava under Allahabad conditions. Therefore, there is need to study the root distribution pattern of guava.

MATERIALS AND METHODS

The present investigation was undertaken during 2006-07 and 2007-08 in the Department of Horticulture, Allahabad Agricultural Deemed University, Allahabad. The experiment was conducted on 16-year-old uniform and healthy trees of guava cultivar Allahabad Safeda planted at 8 m in the square system. The experiment was laid out with three factor randomized block design with two seasons (spring and autumn), 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). The roots were collected from each sector separately and washed with water on a wiremesh. The fibrous roots were then graded into four categories on the basis of their diameter, *viz.* (i) < 0.2 cm, (ii) > 0.2 cm to 0.5 cm, (iii) > 0.5 cm to 1.5 cm and (iv) > 1.5 cm. These roots were designated as fibrous, thin, medium and thick (Aiyappa and Srivastava, 1). 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 ± 1°C for 72 h 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 metre soil volume. The data obtained in the experiment was subjected to analysis of variance in three factor randomized block design taken season,

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radial distance and depth as factors and interpretation of results was made on the basis of 'f' test. The critical differences at 0.05 level of probability were worked out for comparing treatment means.

RESULTS AND DISCUSSION

The effect of seasons on dry weight of fibrous, thin and thick roots indicate significant variation among the treatments while there was a non-significant effect of seasons on variation in dry weight of medium and total roots. The spring season gave significantly higher dry weight of fibrous and thin roots while the autumn season produced significantly higher dry weight of thick roots. Singh and Misra (10) found that spring season gave significantly higher dry weight of active roots as compared to autumn season. The higher dry weight of fibrous and thin roots in spring season might be due to the favourable soil aeration, moisture and temperature during spring season. The higher dry weight of thick roots in autumn season might be due to the shedding of fibrous and thin roots during rainy season because of higher water table. Seasonal variation in feeder root distribution pattern was reported in Kinnow mandarin and Pearl tangelo (Chandra and Yamdagani, 3), Coorg mandarin on rough lemon rootstock (Iyenger and Keshava, 4), guava (Kotur *et al.*, 5; Purohit and Mukherjee, 9).

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. 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 (Misra *et al.*, 8). 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 (10) in *bael*, and Misra and Jaiswal (7) in *karonda*.

The effect of soil depth on various categories of roots was found to be significant. The dry weight of fibrous roots at 0-20 and 20-40 cm depth was at par and significantly more than the dry weight of fibrous roots at 40-60 cm depth. Maximum dry weight of fibrous roots in *karonda* (*Carissa carandas* L.) was recorded at 0-20 cm depth from the soil surface which decreased with increasing soil depth (Misra and Jaiswal, 7). The dry weight of fibrous roots in litchi was found maximum at 0-30 cm soil depth and with increasing the soil depth the dry weight of fibrous roots decreased (Agnihotri *et al.*, 2). The maximum dry weight of thin roots was noted with 40-60 cm depth which was significantly higher than 0-20 and 20-40 cm depth. The maximum amount of medium, thick and total roots was recorded at 20-40 cm depth.

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

Treatment	Dry weight (g)				
	Fibrous roots	Thin roots	Medium roots	Thick roots	Total roots
Season					
Spring	293.56	356.00	1187.89	3446.56	5284.00
Autumn	262.78	326.67	1184.45	3551.78	5325.67
CD at 5%	0.019	0.023	NS	0.009	NS
Radial distance (cm)					
0-60	597.83	695.17	2676.50	6421.67	10391.00
60-120	152.00	217.17	603.17	2695.50	3667.83
120-180	84.67	111.67	278.83	1380.33	1855.50
CD at 5%	0.024	0.029	0.025	0.009	0.005
Depth (cm)					
0-20	301.50	297.67	664.67	1278.17	2542.00
20-40	294.67	348.83	1490.67	4980.33	7114.50
40-60	238.33	377.50	1403.17	4239.00	6258.00
CD at 5%	0.024	0.029	0.024	0.009	0.005

Table 2. Effect of interactions (a) season × radial distance and (b) season × depth and (c) radial distance × depth on dry weight of fibrous, thin, medium and thick roots (g).

(a)

Season	Radial distance (cm)											
	Fibrous roots			Thin roots			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)	D_1 (0-60)	D_2 (60-120)	D_3 (120-180)	D_1 (0-60)	D_2 (60-120)	D_3 (120-180)
Spring	618.67	171.00	91.00	737.67	219.00	111.33	2677.67	603.67	282.33	6333.67	2625.67	1380.33
Autumn	577.00	133.00	78.33	652.67	215.33	112.00	2675.33	602.67	275.33	6509.67	2765.33	1380.33
CD at 5%		0.03			0.04			0.04			0.013	

(b)

Season	Depth (cm)											
	Fibrous roots			Thin roots			Medium roots			Thick roots		
	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 (0-20)	d_2 (20-40)	d_3 (40-60)	d_1 (0-20)	d_2 (20-40)	d_3 (40-60)
Spring	1432.67	606.00	250.00	295.33	382.00	390.67	747.67	1213.00	1303.00	123.00	4823.67	4285.00
Autumn	278.33	283.33	226.67	300.00	315.67	364.33	581.67	1468.33	1503.33	1325.33	5137.00	4193.00
CD at 5%		0.06			0.05			0.04			0.02	

(c)

Radial distance (cm)	Depth (cm)											
	Fibrous roots			Thin roots			Medium roots			Thick roots		
	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 (0-20)	d_2 (20-40)	d_3 (40-60)	d_1 (0-20)	d_2 (20-40)	d_3 (40-60)
D_1 (0-60)	671.00	601.00	521.50	590.00	791.00	704.50	1390.00	3541.50	3098.00	2954.50	8818.00	7492.50
D_2 (60-120)	148.00	219.00	89.00	201.50	161.50	288.50	344.00	737.50	728.00	555.50	4277.00	3254.00
D_3 (120-180)	85.50	64.00	104.50	101.50	94.00	139.50	260.00	193.00	383.50	324.50	1846.00	1970.50
CD at 5%		0.03			0.04			0.04			0.013	

Table 3. Effect of interactions (seasons × radial distances × depths) on dry weight of fibrous, thin, medium and thick roots (g).

Season	Fibrous roots (g)									Thin roots (g)								
	D_1 (0-60)			D_2 (60-120)			D_3 (120-180)			D_1 (0-60)			D_2 (60-120)			D_3 (120-180)		
	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Spring	714.00	610.00	532.00	165.00	237.00	111.00	95.00	71.00	107.00	590.00	851.00	772.00	206.00	193.00	258.00	90.00	102.00	142.00
Autumn	628.00	592.00	511.00	131.00	201.00	67.00	76.00	57.00	102.00	590.00	731.00	637.00	197.00	130.00	319.00	113.00	86.00	137.00
CD at 5%					0.06									0.07				

Season	Medium roots (g)									Thick roots (g)								
	D_1 (0-60)			D_2 (60-120)			D_3 (120-180)			D_1 (0-60)			D_2 (60-120)			D_3 (120-180)		
	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3
Spring	1656	3484	2893	315	905	591	272	150	425	2833	8555	7613	541	4111	3225	319	1805	2017
Autumn	1124	3599	3303	373	570	865	248	236	342	3076	9081	7372	570	4443	3283	330	1887	1924
CD at 5%					0.06									0.017				

Table 4. Effect of interactions (a) season × radial distance and season × depth, (b) radial distance × depth, and (c) season × radial distance × depth on dry weight of total roots (g).

(a)

Season	Radial distance (cm)			Depth (cm)		
	D_1 (0-60)	D_2 (60-120)	D_3 (120-180)	d_1 (0-20)	d_2 (20-40)	d (40-60)
Spring	10367.67	3619.33	1865.00	2598.67	7024.67	6228.67
Autumn	10414.67	3716.33	1846.00	2485.33	7204.33	6287.33
CD at 5%		0.07			0.008	

(b)

Radial distance (cm)	Depth (cm)		
	d_1 (0-20)	d_2 (20-40)	d_3 (40-60)
D_1 (0-60)	5605.50	13751.50	11816.50
D_2 (60-120)	1249.00	5395.00	4359.50
D_3 (120-180)	771.50	2197.00	2598.00
CD at 5%		0.007	

(c)

Radial distance	D_1 (0-60)			D_2 (60-120)			D_3 (120-180)		
Season/Depth	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 (0-20)	d_2 (20-40)	d_3 (40-60)
Spring	5793.00	13500.00	11810.00	1227.00	5446.00	4185.00	776.00	2128.00	2691.00
Autumn	5418.00	14003.00	11823.00	1271.00	5344.00	4534.00	767.00	2266.00	2505.00
CD at 5%					0.011				

Misra and Dabral (6) 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.

Among the interactions, season × radial distance, season × depth, radial distance × depth and season × radial distance × depth on dry weight of fibrous, thin, medium, thick and total roots were found significant. The interaction between season × radial distance reveals that the spring season × 0-60 cm radial distance gave significantly higher dry weight of fibrous, thin and medium roots while autumn × 0-60 cm radial distance gave significantly higher dry weight of thick and total roots. The interaction between season × depth indicates that the maximum dry weight of fibrous root was found with spring × 0-20 cm depth while the maximum dry weight of thin roots was recorded at 40-60 cm depth in each season. The maximum dry weight of medium roots was found with autumn × 40-60 cm depth while in case of thick roots, it was recorded with autumn × 20-40 cm depth. Among the interaction between radial distance × depth, 0-60 cm radial distance × 0-20 cm depth gave significantly higher dry weight of fibrous roots while maximum dry weight of thin, medium, thick and total roots was recorded at 0-60 cm radial distance × 20-40 cm depth. Among the interaction season × radial distance × depth, spring season × 0-60 cm radial distance × 0-20 cm depth gave significantly higher dry weight of fibrous roots while the maximum dry weight of thin roots was found at spring × 0-60 cm radial distance × 20-40 cm depth. The maximum dry weight of medium, thick and total roots was observed at autumn × 0-60 cm radial distance × 20-40 cm depth.

On the basis of above findings it may summarized that the interactions between seasons, radial distances and soil depths in all types of roots were found to be significant. The spring season gave significantly higher dry weight of fibrous and thin roots than autumn season while autumn season gave significantly higher dry weight of thick roots. Most of the feeder roots were present at 0-60 cm radial distance and 0-20 cm depth. Therefore, fertilizers and irrigation water may be applied in this zone irrespective of seasons for better utilization of these inputs by the tree roots.

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