THE ASIAN JOURNAL OF HORTICULTURE
Volume **8** | Issue 2 | December, 2013 | 452-455

Research Paper

Article history :
Received : 09.04.2013
Revised : 03.09.2013
Accepted : 18.09.2013

Root distribution pattern of walnut (*Juglans regia* L.)

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ABSTRACT : Root distribution pattern of walnut trees grafted on seedling rootstock was studied on at three radial distances from tree trunk and soil depth. The length and mass of fine roots (diameter less than 1mm) was maximum (2633.52 cm and 19.43 g, respectively) within the tree canopy *i.e.* at a distance 2/3rd from tree trunk to drip line. It was significantly low near the tree trunk and towards the drip line. The length and mass of the fine roots was more in the surface layer (2498.65 cm and 14.22 g, respectively). As the soil depth increased the RLD and RMD of the fine roots decreased significantly. RLD of thicker roots was not significantly influenced by the radial distance from the tree trunk but the RMD decreased significantly from the tree trunk to the drip line. Thicker roots were significantly more in the surface layer of the soil.

KEY WORDS : Walnut, Root distribution, Soil depth, Radial distance

HOW TO CITE THIS ARTICLE : Dar, K.R., Wani, M.S., Najar, G.R., Peer, F.A, Chattoo, M.A., Simnani, S.A. and Ali, Angrej (2013). Root distribution pattern of walnut (*Juglans regia* L.). *Asian J. Hort.*, **8**(2) : 452-455.

Fruit plants grow and produce at one place. By the time they are of bearing age, they have extensive root system and are able to exploit nutrients from the soil. The roots are less visible and equally important part of the tree. Fine roots are the main components of the root system through which plants absorb water and nutrients. These roots are generally less than 1.0 mm in diameter (De-Silva *et al*., 1999). The knowledge of root distribution pattern of fruit trees help in optimising the use of inputs like fertilizers and irrigation. It is also important in identifying new areas for extending the commercial cultivation of the fruit crops. The information on the root distribution of a particular fruit crop at a particular location cannot be applied as such to other fruit crops and locations. The direct excavation of the roots gives a clear cut picture of the entire root system of a tree as it exists naturally. Most of the walnut orchards of Kashmir valley are mostly on marginal lands. No attempt has been made to determine the nutritional status of walnut plantations and their root distribution pattern in Kashmir valley. In order to increase walnut productivity and, thus, provide better returns to the farmers it becomes imperative to study the root distribution pattern as a first step for appliance of agricultural practices in walnut production.

RESEARCH METHODS

The study on root distribution pattern of walnut trees was carried in the Fruit Orchard of Division of Fruit Science, SKUAST-K. The experiment was conducted on walnut trees cv. Wusan, grafted on seedling rootstock, of uniform age and vigour planted 10m apart under square system. The experiment was laid out with two factor Randomized Block Design with three radial distances (1/3rd of the distance from tree trunk to drip line, 2/3rd of the distance from tree trunk to drip line and from near the drip line of the trees) and three depths (0-30, 30-60 and 60-90 cm). The nine treatments thus formed were replicated thrice. In each tree soil monolith measuring 30 cm in length, 30 cm in breadth and 30 cm in depth was excavated on the south east side at different distances from the tree trunk. Soil monolith was taken from a soil depth of 0-30, 30-60 and 60-90 cm at each distance. The roots were collected separately from each monolith by washing it on a 2 mm sieve. For measuring their length and weight, the roots were divided into two categories *i.e.* less than 1 mm in diameter and more than 1mm in diameter designated as fibrous roots and thicker roots (Alyappa and Srivastava, 1965). After grading the roots, they were dried under shade. After recording the root length of the roots, the dried roots were put in the paper bags and kept in an oven at

60 ± 1^0C for 72 hours for drying and the constant dry weight of roots was recorded. The root length and mass obtained from the soil monolith was expressed in centimetres and grams, respectively. The data obtained in the experiment were subjected to analysis in two factor randomised block design with radial distance and soil depth as factors. The critical differences at 0.05 level of probability was worked out for comparing treatment means.

RESEARCH FINDINGS AND DISCUSSION

The effect of radial distance from tree trunk and soil depth had a significant influence in the root length density and root mass density. Maximum density of fibrous roots (2633.52 cm) was observed within the canopy of the tree *i.e.* at a distance 2/3rd from tree trunk to drip line (Table 1). The density of roots then decreased and was minimum (292.10 cm) at the drip line. However, the density of roots more than 1mm in diameter was not significantly affected by the radial distance from the tree trunk. Watson *et al.* (2006) obtained root densities of 0.1028 to 0.2911 cm per cm^{-3} which is equivalent to 1028 to 2911 cm per m^{-3}. Mengel and Kirkby (1987) reported that root morphology is genetically controlled but is also influenced by environmental factors. In dicotyledons, a tap root is formed at an early stage which extends deeply into the soil. Later the laterals are formed. Even though the root system is quite large the majority of the roots are concentrated near the centre. Atkinson *et al.* (1980) reviewed cases where 36 to 82 per cent of the root system for apple and pears were within the 1 m2 area of the trunk. A higher proportion of roots less than 1mm in diameter have been found at a certain distance from the trunk (Faust, 1989). Similar observations have been made by De Silva *et al.* (1999) and Mulia and Dupraz (2006).

Soil depth also had a significant influence on the length of roots. As the soil depth increased, the density of roots decreased. Maximum length of fibrous roots (2498.65 cm) and those of the thicker roots (954.02 cm) was observed within 0-30 cm soil depth. Faust (1989) reported that majority of roots occur in the range of 0-80 cm with about 70 per cent at 0-30 cm soil depth. Soil aeration is often the determining factor in how deep the majority of the roots penetrate. About 70 per cent of the roots less than 1mm in

Table 1 : Effect of radial distance and soil depth on the root length density of walnut (*Juglans regia* L)

Treatments	Root length density (cm)					
	Less than 1mm diameter			More than 1mm diameter		
	2007	2008	Mean	2007	2008	Mean
L_1 = 1/3rd from trunk to drip line	991.61	924.12	957.87	694.12	472.28	583.20
L_2 = 2/3rd from trunk to drip line	2835.03	2432.02	2633.52	516.01	447.90	481.96
L_3 = at drip line	311.99	272.20	292.10	483.34	419.56	451.45
C.D. (P=0.05)			243.95			N.S.
D_1 = 0-30cm soil depth	2644.98	2352.32	2498.65	1091.13	816.91	954.02
D_2 = 30-60cm soil depth	1259.41	1074.92	1167.16	511.67	444.15	477.91
D_3 = 60-90cm soil depth	234.25	201.11	217.68	90.66	78.68	84.67
C.D. (P=0.05)			243.95			166.33

Table 2 : Effect of interactions of radial distance and soil depth on the root length density of walnut (*Juglans regia* L)

Treatments	Root length density (cm)					
	Less than 1mm diameter			More than 1mm diameter		
	2007	2008	Mean	2007	2008	Mean
L_1D_1	1504.15	1492.33	1498.24	1493.97	906.12	1200.04
L_1D_2	971.49	845.56	908.53	427.01	370.63	398.82
L_1D3	499.2	434.48	466.84	161.38	140.08	150.73
L_2D1	5794.21	5036.72	5415.47	1139.54	989.12	1064.33
L_2D_2	2527.52	2104.06	2315.79	337.5	292.95	315.23
L_2D_3	183.34	155.28	169.31	71	61.64	66.32
L_3D_1	636.57	527.9	582.24	639.9	555.49	597.7
L_3D_2	279.21	275.13	277.17	770.52	668.87	719.69
L_3D_3	20.2	13.58	16.89	39.61	34.32	36.97
C.D. (P=0.05)			422.54			288.09

L_1 = 1/3rd from trunk to drip line
L_2 = 2/3rd from trunk to drip line
L_3 = at drip line
D_1 = 0-30cm soil depth
D_2 = 30-60cm soil depth
D_3 = 60-90cm soil depth

Table 3 : Effect of radial distance and soil depth on the root mass density of walnut (*Juglans regia* L)

Treatments	Root mass density (g)					
	Less than 1mm diameter			More than 1mm diameter		
	2007	2008	Mean	2007	2008	Mean
L_1 = 1/3rd from trunk to drip line	5.16	3.18	4.17	62.01	64.08	63.05
L_2 = 2/3rd from trunk to drip line	20.85	18.00	19.43	47.34	48.96	48.15
L_3 = at drip line	1.10	0.45	0.78	42.84	44.19	43.52
C.D. (P=0.05)			0.07			0.30
D_1 = 0-30cm soil depth	16.13	12.31	14.22	100.26	103.68	101.97
D_2 = 30-60cm soil depth	10.43	8.94	9.69	46.08	47.61	46.85
D_3 = 60-90cm soil depth	0.55	0.38	0.47	5.85	5.95	5.90
C.D. (P=0.05)			0.07			0.30

Table 4 : Effect of interactions of radial distance and soil depth on the root mass density of walnut (*Juglans regia* L)

Treatments	Root mass density (g)					
	Less than 1mm diameter			Less than 1mm diameter		
	2007	2008	Mean	2007	2008	Mean
L_1D_1	2.62	0.97	1.79	42.93	44.37	43.65
L_1D_2	2.22	1.93	2.07	15.39	15.93	15.66
L_1D_3	0.32	0.28	0.3	3.69	3.78	3.74
L_2D_1	12.7	11.01	11.86	37.8	39.15	38.48
L_2D_2	7.94	6.9	7.42	7.92	8.19	8.06
L_2D_3	0.21	0.09	0.15	1.62	1.62	1.62
L_3D_1	0.81	0.33	0.57	19.53	20.16	19.85
L_3D_2	0.27	0.11	0.19	22.77	23.49	23.13
L_3D_3	0.02	0.01	0.02	0.54	0.54	0.54
C.D. (P=0.05)			0.12			0.52

L_1 = 1/3rd from trunk to drip line
L_2 = 2/3rd from trunk to drip line
L_3 = at drip line
D_1 = 0-30cm soil depth
D_2 = 30-60cm soil depth
D_3 = 60-90cm soil depth

diameter were concentrated in 0-50 cm soil layer (Sharma and Chauhan, 2005).

Root mass density was significantly influenced by the radial distance from the tree trunk as well as the soil depth (Table 3). Maximum mass (19.43 g) of fibrous roots was observed at 2/3rd distance from the tree trunk. Thicker roots (with diameter more than 1 mm) were more (63.05 g) near the tree trunk. The length of the roots also showed a similar variation with respect to the radial distance from the tree trunk and the soil depth. The variation in the mass of roots follows a similar pattern as that of root length. Similar observations have been recorded by Sharma and Chauhan (2005).

The interaction influence of radial distance from the tree trunk and the soil depth had a significant influence on the root distribution pattern of fibrous and the thicker roots. The roots were concentrated at 2/3rd distance from tree trunk to drip line in a soil depth of 0-30 cm. The length and mass of fibrous roots was the highest in this region. The length and mass of these roots was lower near the tree trunk and towards the drip line in the surface layer (0-30 cm) of the soil. The length and mass of fibrous roots was also lower in the sub-surface layers of soil. The thicker roots were more concentrated towards the tree trunk in the surface layer of the soil. In this region maximum root length and root mass was observed. The length and mass of these roots decreased as the radial distance increased and the soil depth increased (Table 2 and 4).

These findings indicate that the feeder roots are more dense within the tree canopy and that too in the surface layer (0-30 cm) of the soil. The fertilizers and irrigation waters may, thus be applied in this very area for better absorption by the feeder roots to get maximum benefits from the trees.

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