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Feeder Root Zone : A Key Parameter for Drip Irrigation in Litchi and Other Perenial Fruit Crops

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Abstract Fresh water resources are shrinking globally, as a consequence of climate change. The scarcity of water may severely affect the crop production. To overcome this, optimum irrigation management is required in agriculture, by adoption of modernised irrigation systems like drip irrigation. The scheduling of irrigation through drip system depends on various factors including plant root distribution, as one. The distribution of feeder roots is a prerequisite for installation of drip irrigation system and its scheduling. Therefore , the present study was carried to determine the feeder root zone of fifteen year old litchi trees planted in high density. The results revealed that most of the feeder roots were present at radial distance between 50 cm to 100 cm and soil depth of 40-60 cm. Hence, for proper utilisation of water and nutrients, the emitters must be installed at 50-100 cm radial distance for fifteen year old litchi trees.

Keywords Litchi, Rose scented, Feeder root, Drip irrigation.

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Introduction

In the present times , water availability is highly vulnerable to changing climatic conditions. The studies in past also conclude that in the coming decades, the earth's average global surface temperature is subjected to increase by 1.4°C to 3°C [1], which in turn may lead to a substantial reduction in fresh water resources, by affecting the hydrological cycle. The agriculture sector is highly dependent on water resources for irrigation. Any depletion in the latter may cause a serious setback to crop production. The agriculture sector in India mostly employs conventional methods for irrigation such as flooding or surface irrigation. This type of irrigation system uses gravity to distribute water through the root zone. As a result, only 35—40% of the total quantity of water is utilised by the plants, resulting in reduced irrigation efficiency. The basic function of irrigation is to provide water where and when it is needed. Irrigation should not be provided directly to the plants, but to the root zone. The modern irrigation tech-

niques like drip irrigation works on this basis. Drip irrigation uses capillary action to move water in all direction's through root zone. By this advanced technique, 90-95% irrigation efficiency and uniform application is achieved, resulting in better growth and yields.

Litchi (*Litchi chinensis*) is an important fruit of India. It is a rich source of minerals like calcium, vitamins and antioxidants. But, the production of litchi is limited in our country due to its stringent climatic requirements. The yield and quality of litchi fruits is highly sensitive to water scarcity, which in turn aggravate the incidences of fruit drop and fruit cracking. Thus, water deficit is a major constraint in litchi production. To ensure proper growth and production in litchi, uniform irrigation at frequent intervals is crucial, which can be achieved by drip irrigation system.

The efficient scheduling of irrigation through drip system is however, dependent on a number of factors like climatic conditions, physical and chemical properties of soil. Apart from this, the crop type, variety and its root distribution also play a critical role. In perennial fruit trees like litchi, the emitters should be spaced in such a way that the entire feeder root zone is covered. However, the root distribution varies with the plant age, which in turn may influence the drip installation and scheduling with time. Therefore, the study of feeder root zone carries immense necessity in drip irrigation system. In view of this, the present study was conducted to analyze the implication of radial distance and soil depth on fresh weight of roots and to determine the optimum soil depth and radial distance combination, with maximum feeder roots in litchi, for efficient irrigation.

Materials and Methods

The experiment was conducted at Horticultural Research Center, Patharchatta of GB Plant University of Agriculture and Technology, Pantnagar during 2015. The center is situated in terrai region. It lies at 29 North latitude. 79.3 east longitude and at an altitude of 243.84 meters above the mean sea level. The site experiences humid subtropical climate with the maximum temperature ranging from 32-45°C in summer and the minimum temperature ranging from 0-9°C in winter. The study was done on 15 year old litchi cv Rose scented planted at 5 m distance in a square geometry and maintained under uniform cultural practices. The experiment was laid out in two factor randomized block design with four radial distances (50 cm, 100 cm, 150 cm and 200 cm) and three soil depths (0-20 cm, 20-40 cm and 40-60 cm). Thus, there were 12 (4 × 3) treatment combinations, with four replications, having single tree per replication.

Soil sampling

Soil samples including roots were collected with the help of a soil auger having 10 cm internal diameter and 20 cm height. The samples were collected from four directions, i.e. north, south, east and west around the tree.

The roots were sampled from each treatment combination separately and washed with water on a wire mesh, followed by dipping in 5% hydrogen peroxide solution for 30 min and again washing with water for complete removal of soil particles. Once separated, the roots of each position of the soil profile were classified according to the diameters of the segments.

The roots were graded into 3 categories on the basis of their diameter with the help of Vernier callipers, viz., fibrous roots (<0.2) cm, thin roots having diameters ranging from 0.2 to 0.5 cm and thick roots exhibiting diameters above 0.5 cm. After grading of roots in above three categories, the roots were then surface dried under fan. Thereafter, the fresh weight of roots was computed and expressed in grams.

Results and Discussion

The results of the experiment on the effect of radial distance and soil depth on the fresh weight of fibrous roots (diameter<2 mm) are mentioned in Table 1.

Perusal of the study indicated that the maximum fresh weight of fibrous roots (1.98 g) was found at 100 cm radial distance from the trunk and at 40-60

Table 1. Effect of radial distance and soil depth on fresh weight of fibrous roots (<2 mm).

	Fresh weight of fibrous roots (g)				
	Radial distance				
Soil depth	50 (R1)	100 (R2)	150 (R3)	200 (R4)	Mean
0-20 (D1)	1.56	1.11	0.77	0.79	1.06
20-40 (D2)	1.37	1.43	0.92	0.93	1.16
40-60 (D3)	1.72	1.98	1.13	0.91	1.23
Mean	1.56	1.25	0.94	0.88	1.16
CD at 5%	Radial distance		Soil depth	Radial distance × Soil depth	
	0.19		0.22	0.38	

cm soil depth, which was followed by the fresh weight (1.72 g) recorded at 50 cm radial distance and 40-60 cm soil depth. Further more, it was recorded that the mean fresh weight of fibrous roots was maximum at 50 cm radial distance followed by 100 cm radial distance. Also, it was found that the mean fresh weight was superior at 40-60 cm oil depth which was at par with the fresh weight at all other depth levels. Thus, the study revealed that the fresh weight of fibrous roots was highest at 50 cm to 100 cm radial distance from the trunk, while in relation to soil depth all the levels exhibited a high concentration of fibrous roots, as the mean fresh weight of roots was found to be statistically at par within all the soil depth levels.

These findings were in line with the root distribution study of Garcia and Flores [2] who observed that roots with a thickness <2 mm were predominant in soil and further most of the fine roots were concentrated in the first 60 cm of soil. Similarly, Singh et al.[3] studied the root distribution of guava cultivars and found that among the radial distances, 0-60 cm radial distance gave highest dry weight of fibrous roots. Further, Santos et al. [4] also revealed that regardless of management strtegy, the root system in Mango cv Tommy Atkins, was developed in all evaluated soil volume and the highest density is concentrated from 0.50 to 1.50 m distance from the trunk and in 0.20 to 0.90 m depth in the soil.

The data pertaining to fresh weight of thin roots is mentioned in Table 2. According to the data, the highest fresh weight (0.87 g) of thin roots was recorded at 50 cm radial distance from the tree trunk and at a soil depth of 40—60 cm. However, it was observed that at 50 cm radial distance, the fresh weight of thin roots was found to be statistically at par, at both 20-40 cm and 40-60 cm soil depths, but was significantly superior to the fresh weight found at remaining radial distances. Also,when the mean values were compared, the data revealed that maximum fresh weight of thin roots is at 50 cm radial distance, which was statistically similar to the fresh weight at 100 cm radial distance and followed by 150 cm radial distance. In terms of soil depth, the

Table 2. Effect of radial distance and soil depth on fresh weight of thin roots (2-5 mm).

	Fresh weight of thin roots (g)				
	Radial distance				
Soil depth	50 (R 1)	100 (R 2)	150 (R3)	200 (R4)	Mean
0-20 (D1)	0.60	0.20	0.15	0.07	0.25
20-40 (D2)	0.82	0.54	0.47	0.35	0.54
40-60 (D3)	0.87	0.58	0.46	0.41	0.57
Mean	0.75	0.44	0.36	0.27	0.45
CD at 5%	Redial distance		Soil depth	Radial distance × Soil depth	
	0.16		0.19	0.33	

Table 3. Effect of radial distance and soil depth on fresh weight of thick roots (>5 mm).

	Fresh weight of thick roots (g) Radial distance				
Soil depth	50 cm (R1)	100 cm (R2)	150 cm (R3)	200 cm (R4)	Mean
0-20 cm (D1)	2.11	0.54	0.05	0.25	0.74
20-40 cm (D2)	6.24	1.41	0.24	0.34	2.06
40-60 cm (D3)	3.11	2.24	1.47	0.78	1.90
Mean	3.8	1.40	0.59	0.46	1.57
CD at 5%	Radial distance		Soil depth	Radial distance × Soil depth	
	1.46		1.69	2.92	

mean fresh weight was statistically at par at all the levels. But, numerically, the highest fresh weight was observed at 40-60 cm radial distance while lowest at 0-20 cm radial distance. The present results were in line with Agnihotri et al. [5] who obtained maximum weight of thin roots at 0-60 cm radial distance from the tree trunk. Similar findings were also revealed by Singh et al. [3].

The data pertaining to the effect of radial distance and soil depth on the fresh weight of thick roots is mentioned in Table 3.

The present study revealed that the fresh weight of thick roots was highest at 50 cm radial distance and 20-40 cm soil depth, which was significantly superior over the fresh weight found in remaining combinations. However, the comparison of mean values revealed, no significant difference in the fresh weight of roots at all soil depth levels. In terms of radial distance, the mean value of fresh weight was highest at 50 cm, which was statistically superior to all other levels and was followed by 100 cm radial distance. The mean fresh weight at 100 cm radial distance and remaining levels was found to be statistically similar. Garcia and Flores [2] also witnessed a high concentration of thick roots in 20-40 cm soil layer. Singh et al. [3] also observed similar results. They obtained maximum fresh weight of thick roots at 0-60 cm radial distance.

Conclusion

On the basis of above findings, it may be summarized that there was a significant effect of interactions between radial distance and soil depth in all types of roots. Most of the feeder roots were present at a radial distance between 50 cm to 100 cm and soil depth of 40-60 cm. Therefore, for fifteen year old litchi trees, the emitters must be placed at a radial distance of 50-100 cm from the trunk. The spacing and flow rate of emitters should be adjusted accordingly, for the efficient input and utilization of water and fertilizers throughout the feeder root zone.

References

1. Mall RK, Gupta A, Singh R, Singh RS, Rathore LS (2006) Water resources and climate change : An Indian perspective. Curr Sci 90 : 1610—1626.
2. Garcia SS, Flores JI (1986) Root distribution of mature avocado trees growing in soils of different texture. California Avocado Soc Yearbook 70 : 165—174.
3. Singh N, Prasad VM, Bangari B, Uniyal S, Misra KK (2012) Studies on the effect of season, radial distance and depth on root distribution in guava cv Allahabad Safeda. Ind J Hort 69 : 495—500.
4. Santos MR, Martinez AM, Sergio LR, Eugenio F (2014) Coelho fruit yield and root system distribution of Tommy Atkins mango under different irrigation regimes. Revista Brasileira de Engenharia Agricolae Ambiental 18 : 362—369.
5. Agnihotri PK, Lal RL, Mishra DS, Shukla P (2009) Root distribution pattern of litchi as influenced by seasonal variations. Ind J Hort 66 : 257—260.