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IMPACT OF SHOOT PRUNING ON ROOT DISTRIBUTION PATTERN OF LITCHI (*LITCHI CHINENSIS* SONN.)

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ABSTRACT
Investigations were carried out at ICAR RCER, Research Centre, Ranchi during 2008 to study the effect of shoot pruning on pattern of root distribution in Senior-adult bearing plants of litchi cv. Shahi growing under alfisols of eastern India. Root samples were collected from control plants and plants which are under treatment of annual shoot pruning at a length of 75 cm at the time of harvesting since 2005. Shoot pruning resulted in significant reduction in the total weight of roots than that of control. The reduction in the total root weight of pruned plants can be attributed to a significant reduction in the weight of Grade-4 roots (>5.0 mm diameter). Significantly higher rate of biomass accumulation in Grade-4 roots of control plants was recorded at soil depths 0-30 cm (20.43 g/3683cc as compared to 3.74 g/3683cc in case of pruned plant) and 60-90 cm (15.83 g/3683cc as compared to 4.12 g/3683cc in case of pruned plant). With respect to distribution of roots at different distances from the trunk, significantly higher weight of Grade-4 roots could only be recorded at a distance of 50 cm from the trunk (13.12 g/3683cc as compared to 3.99 g/3683cc in case of pruned plant). With respect to total content of carbohydrate in different grades of roots at different distances and depths of soil, significantly higher values were recorded in case of Grade-4 roots (1.67 g/3683cc as compared to 0.49 g/3683cc in case of pruned plant).

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is one of the most important sub-tropical fruit indigenous to Southern China particularly the provinces of Kwangtong and Fukien. It is highly specific to climate and soil requirement and probably due to which the cultivation of litchi is restricted to the few countries in the World.

A proper knowledge of root distribution pattern is important for standardization of methods of fertilizer application in any fruit crops. A meager number of research work have been undertaken to study root distribution pattern in litchi (Menzel *et al.,* 1990; Roy *et al.,* 1987; Huang, 2002). Shoot pruning after fruit harvesting is a recommended practice in litchi for increasing the fruit yield. Again, in the era of high density planting or multitier cropping system in fruit crops, annual shoot pruning plays the most important role in restricting the canopy growth of trees. Below ground competition of roots for nutrients also play a very important role under these systems. Reduction in root biomass as a result of pruning has been reported in different crops. Slavtcheva and Pourtchev (2003) have reported alteration in the partitioning of root biomass among different root classes as a result of pruning. At present, no information is available on effect of shoot pruning on root distribution of litchi. Keeping this in view, an investigation was undertaken to study the effect of shoot pruning on pattern of root distribution in Senior-adult bearing plants of litchi cv. Shahi growing under alfisols of eastern India.

MATERIALS AND METHODS

The investigations were carried out at ICAR Research Complex for Eastern region, Research Centre during 2008. The soil of the experimental site was Alfisol having sandy loam texture with pH 5.9, organic carbon 0.5%, available N 42 kg/ha, available (Bray I) P 3.2 kg/ha and available K 110kg/ha (Rai *et al.,* 2002). Litchi plants (cv. Shahi) of age more than 25 years were used for studying the root distribution pattern in senior adult bearing plant. Root samples were collected from control plants and plants which are under treatment of annual shoot pruning at a length of 75 cm at the time of harvesting since 2005. Soil core method (Makkonen and Helmisaari, 1999) was used for collection of root samples. For collecting root samples, trenches of 30 cm width were excavated in North-South direction of the plants starting from the base of the tree trunk. Root samples were collected inserting a core sampler (diameter 6.25 cm) vertically downwards just adjacent to one wall of the trench. Root samples were collected from three different depths of soil (0-30 cm, 30-60 cm and 60-90 cm) at distances of 50cm, 100cm, 150 cm, 200 cm, 250 cm, 300 cm, 350 cm, 450 cm from trunk in both North and South directions. The collected samples were washed through sieve to separate the roots from the soil particles. After air drying, the root samples were separated into different grades under laboratory conditions based on root diameter viz. Grade-1 (diameter < 1 mm), Grade-2 (diameter 1-3 mm), Grade-3 (diameter 3-5 mm), Grade-4 (diameter > 5 mm) and root biomass was measured. Hence, the root weight for each sample indicated tool root weight per 3683 cc volume of soil. The

root sampling was done from six plants under each age group and one plant was considered as one replication. The concentration of carbohydrate in different grades of roots was estimated spectrophotometrically using Anthrone reagent (Thimmaiah, 1999). Estimation of total content of carbohydrate in the roots was done by using the formula,

Content of carbohydrate in root (g) = (Concentration of carbohydrate × Root weight)/100

The data on root weight and content of carbohydrate of control and pruned plants were compared for significance by Fisher 't' test at 5% level of significance (Fisher and Yates, 1974).

RESULTS AND DISCUSSION

The data on pattern of root distribution at different soil depths and distances from the trunk is presented in Table-1 and 2, respectively. The pattern of root distribution at different soil depths did not differ significantly between pruned and control plants in all the root grades except Grade-4 roots. A general decrease in weight of Grade1, 2 and 3 roots were recorded with increase in soil depth in both pruned and control plants. With respect to weight of different Grades of roots at different distances from the trunk, similar pattern was recorded in case of pruned and control plants. Although, all roots in tree crops, rather than just those newly produced are apparently effective in absorption of nutrient and water (Atkinson, 1980), Slavtcheva and Pourtchev (2003) have classified roots of diameter > 2 mm as conducting roots. In the present investigation, shoot pruning resulted in significant reduction in the total weight of roots than that of control. As evident in Fig. 1, the reduction in the total root weight of pruned plants

Table 1: Effect of shoot pruning on total weight(g) of different types of roots of litchi at different soil depths

	Grade-1 (<1.0 m diameter)			Grade-2 (1.0 to 3.0 mm diameter)			Grade-3 (3.0 to 5.0 mm diameter)			Grade-4 (> 5 mm diameter)		
	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm
Pruned	5.48	3.62	2.45	6.10	2.92	2.69	3.98	2.43	1.59	3.74	6.86	4.12
Control	6.06	3.42	2.57	5.67	3.32	2.92	5.00	4.78	2.82	20.43	13.31	15.83
Significance (Fisher 't' test)	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	**	Ns	*

Table 2: Effect of shoot pruning on total weight (g) of different types of roots of litchi at different distances from trunk

Distance from trunk	Grade-1 (<1.0 m diameter)			Grade-2 (1.0 to 3.0 mm diameter)			Grade-3 (3.0 to 5.0 mm diameter)			Grade-4 (> 5 mm diameter)		
	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)
50 cm	1.38	1.50	Ns	1.59	1.63	Ns	1.48	2.46	Ns	3.99	13.12	*
100 cm	1.66	1.72	Ns	1.90	1.91	Ns	1.50	1.81	Ns	3.03	9.99	Ns
150 cm	1.73	1.34	Ns	1.80	1.36	Ns	0.83	1.23	Ns	3.99	5.11	Ns
200 cm	1.60	1.67	Ns	1.49	1.73	Ns	1.15	1.86	Ns	1.23	9.85	Ns
250 cm	1.90	2.06	Ns	1.60	1.54	Ns	0.81	1.18	Ns	0.46	4.81	Ns
300 cm	1.50	1.55	Ns	1.46	1.54	Ns	1.16	0.88	Ns	1.13	2.41	Ns
350 cm	1.04	1.42	Ns	1.25	1.15	Ns	0.66	2.59	Ns	0.75	2.62	Ns
400 cm	0.74	0.79	Ns	0.61	1.05	Ns	0.41	0.61	Ns	0.13	1.67	Ns

Table 3: Effect of shoot pruning on total content of carbohydrate (g) in different types of roots of litchi at different soil depths

	Grade-1 (<1.0 m diameter)			Grade-2 (1.0 to 3.0 mm diameter)			Grade-3 (3.0 to 5.0 mm diameter)			Grade-4 (> 5 mm diameter)		
	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm	0-30cm	30-60cm	60-90cm
Pruned	0.56	0.33	0.25	0.60	0.30	0.30	0.46	0.31	0.16	0.43	0.75	0.40
Control	0.55	0.35	0.29	0.64	0.41	0.36	0.47	0.49	0.30	2.33	1.38	1.80
Significance (Fisher 't' test)	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	**	Ns	*

Table 4: Effect of shoot pruning on total content of carbohydrate (g) in different types of roots of litchi at different distances from trunk

Distance from trunk	Grade-1 (<1.0 m diameter)			Grade-2 (1.0 to 3.0 mm diameter)			Grade-3 (3.0 to 5.0 mm diameter)			Grade-4 (> 5 mm diameter)		
	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)	Pruned	Control	Significance (Fisher 't' test)
50 cm	0.14	0.17	Ns	0.17	0.19	Ns	0.14	0.30	Ns	0.49	1.67	*
100 cm	0.16	0.17	Ns	0.19	0.20	Ns	0.16	0.21	Ns	0.34	1.17	Ns
150 cm	0.16	0.12	Ns	0.18	0.14	Ns	0.09	0.15	Ns	0.49	0.64	Ns
200 cm	0.17	0.15	Ns	0.15	0.18	Ns	0.14	0.21	Ns	0.15	1.12	Ns
250 cm	0.18	0.18	Ns	0.16	0.17	Ns	0.07	0.13	Ns	0.05	0.53	Ns
300 cm	0.15	0.14	Ns	0.16	0.18	Ns	0.12	0.11	Ns	0.14	0.31	Ns
350 cm	0.09	0.13	Ns	0.13	0.14	Ns	0.08	0.31	Ns	0.09	0.30	Ns
400 cm	0.07	0.07	Ns	0.06	0.13	Ns	0.11	0.19	Ns	0.02	0.21	Ns

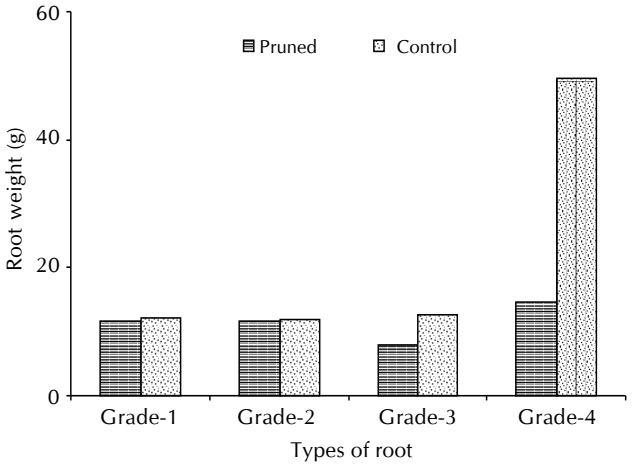

Figure 1: Effect of shoot pruning on total weight of different types of roots of litchi cv. Shahi

can be attributed to a significant reduction in the weight of Grade-4 roots (>5.0 mm diameter). The pruned and control plants did not differ significantly with respect to total weight of other grades of roots. This indicates reduced allocation of carbohydrates towards the roots which mainly function as supporting, conducting and storage roots (diameter > 5.0 mm) in case of pruned plants. Reduction in root dry weight in response to shoot pruning have been reported by several workers (Kolesnikov *et al.,* 1974, Jonkers, 1982, Myers and Ferree, 1983). Slavtcheva and Pourtchev (2003) reported increased dry root mass of feeding roots (d < 2 mm) of grape with heavier pruning and increased amount of conducting roots (d > 2 mm) with lighter pruning. Perusal of data on distribution of different grades of roots at different soil depths (Table-1) indicated significantly higher rate of biomass accumulation in Grade-4 roots of control plants at soil depths 0-30 cm and 60-90 cm. With respect to distribution of roots at different distances from the trunk, significantly higher weight of Grade-4 roots could only be recorded at a distance of 50 cm from the trunk. Zimmermann and Brown (1974) has mentioned that the growth layer at the stem-root junction in most trees is eccentric; the upper portion of the ring is usually thicker than the lower side, probably because of the direct continuity of phloem transport on the upper side and the accompanying enhanced nutrition.

With respect to concentration of carbohydrate in different grades of roots, no significant difference could be recorded between pruned and control plants. The average concentration of carbohydrate ranged between 8.73 to 12.95%. This is in contrast to findings of Peter and Lehman (2000) in *Acacia saligna* where tree pruning resulted in reduction in glucose content in fine roots (< 2 mm diamter). This can be attributed to genotypically different behavior of both the species. In case of citrus, Eissenstat and Duncan (1992) could record a reduction in the reducing sugars in fine roots of pruned trees, till 20 days after shoot pruning, but not thereafter, which is similar to the findings in the present investigation. However, with respect to total content of carbohydrate in different grades of roots at different distances and depths of soil in the present investigation, significantly higher values were recorded in case of Grade-4 roots in control plants.

Hence, the study clearly indicated an alteration in the rooting pattern as influenced by shoot pruning in litchi. Shoot pruning resulted in lower biomass and carbohydrate allocation towards thicker roots (diameter > 5 mm). No reduction in the biomass of finer roots in pruned plants indicated no possibility of reduction in below ground competition due to pruning.

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