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RESEARCH PAPER

Quantification of Root Biomass in Oil Palm Grown under Basin Irrigation

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ABSTRACT

This study aims to understand the root development in oil palm irrigated with basin method so as to help in the better management of nutrient and water in oil palm plantations under irrigated conditions. The study was done in an eight-year-old adult oil palm plantation and standard triangular method of sampling was followed. Results indicated that the primary roots contributed more to the total root biomass followed by secondary and tertiary roots. Maximum root biomass was at the top 0-40 cms depth and declined thereafter. The density of roots was maximum at 1 m distance from palm base and decreased with the increase in distance from palm base.

Key words : Oil palm, root biomass, root system, root distribution pattern

INTRODUCTION

Oil palm is basically a humid tropical crop native to the Guinea coast of West Africa. It needs adequate rainfall evenly distributed throughout the year (150 mm/month) for better growth and yield. It requires bright sunlight for a minimum of five hours/day with a humidity of more than 80%. Since coastal Andhra Pradesh is experiencing similar climatic conditions except for the rainfall, it was introduced as an irrigated crop and presently the area under cultivation is around 26,000 ha. But to compete in the international arena, it warrants cultivation by adopting the most scientific technologies and sincere attempts are being made towards the sustainable production of oil palm in coastal Andhra Pradesh. The root system of oil palm has been extensively studied in the past and its general structure and morphology are well known (Hartley, 1988). The oil palm has an adventitious root system consisting of primary, secondary, tertiary and quaternary roots. Primary roots emanates from the base of the trunk. The primaries give rise to secondaries, of which 70 % will grow towards the soil surface and 30 % descend to considerable depths of more than 1 m, the secondaries branch into tertiaries, which in turn give rise to quaternaries. Oil palm is mostly grown under rainfed conditions in the world. So, most of the work on the oil palm root distribution has been done under such conditions. Root studies are essential for nutrient and water management. In an earlier study, Reddy *et al.* (2002) has reported the root system of a three-year-old palm tree grown under different irrigation systems. Since most of the oil palm gardens in Andhra Pradesh are basin irrigated, this study was undertaken to determine the root biomass distribution in an adult matured plantation.

MATERIALS AND METHODS

The study was conducted in a farmer's field, where the palms were basin irrigated regularly through irrigation channels and all other standard agronomic practices were being followed. The palms were eight year old. The method for quantifying root biomass and its distribution pattern in this study was adapted from Tailliez (1971) using a triangular sampling scheme and an auger method (Chan, 1977). The basic sampling unit consisted of a triangle with three neighbouring palms at the apices. It was sub divided into 16 sub-triangles with sides 2.20 metres. One core was sampled at the centre of each triangle as shown in the Fig. 1. Roots were collected with the help of core sampler. Core sampling involves removing soil samples to the required depths with the augur. Roots were sampled using an auger with 10 cms diameter. Circular soil cores were extracted in six consecutive 10 cms depth to a total depth of 60 cms and then at 80 cms and 100 cms. On collection, each 10 cm deep soil core sample was directly placed in a plastic bag to minimize the loss of water. Samples were brought to the laboratory and palm roots were removed by hand, washed and sorted into primary, secondary and tertiary plus quaternary root classes. The roots were then oven dried at 80ºC and later weighed to determine their dry weight.

RESULTS AND DISCUSSION

The root distribution pattern studies indicated that there was wide variation in the root densities at different depths studied and at different distances from the palm. The root biomass (Table 1) at various depths in the oil palm plantations indicated that the primary roots contributed more to the total root biomass followed by secondary and tertiary roots. At the different depths, root biomass was maximum at 10-20 cms depth followed by 20-30 and 30-40 cms depth (Fig. 2). There was a constant decline of root biomass from 40 cms downwards till 100 cms. These findings confirm to that of Chan (1977) who has found that the root biomass increased from 15-45 cms and then decreased below this depth. The results of Fremond and Origias (1952) and Reddy *et al.* (2002) also suggest that the majority of the active root system is between 5-35 cms deep. It is generally recognized that the oil palm is a surface feeder and most of the root system is confined to the top 50 cms from the surface. There was very less root activity below the depth of 60 cms.

The distribution of all the types of roots was similar except for the difference of mass. The total root biomass in the entire root zone of 100 cms in an eight-year-old oil palm plantation was estimated to be 12.57 t/ha. The findings of Corley *et al.* (1971) put the figure of total root biomass at 17.79 t/ha for a 27.5-year-old plantation.

The density of roots was maximum at 1 m distance from palm base and decreased with the distance from palm base (Table 2). The maximum contribution to the root density was from primary roots followed by secondary and tertiary roots (Fig. 3). These results confirm to that of Hartley (1988) that most of the roots are concentrated around the palm base and within 0.5 m from the ground surface. From the similarity of the root system between the studies reported by Hartley and the present study, it can be concluded irrespective of the soil and climatic conditions that the oil palm root system tries to confined to the top layers of the soil and basically a surface feeder as reported in the literature. In this context, it is tempting to advice even by using basin irrigation; one can get a better water use efficiency by reducing the quantity of water per irrigation and simultaneously increasing the frequency of irrigation, which will reduce the deep percolation losses. Taking the advantage of surface feeding nature of oil palm, however, the micro irrigations will have an advantage of being able to supply required quantities of water more frequently i.e., on a daily basis and therefore, will be more efficient in oil palm than the basin irrigation system.

The variations in the root biomass between Malaysian and Indian conditions could be attributed to soil and climatic conditions and management practices.

Fig. 1: Schematic triangular sampling of root biomass using augar method (Adapted from Tailliez, 1971).

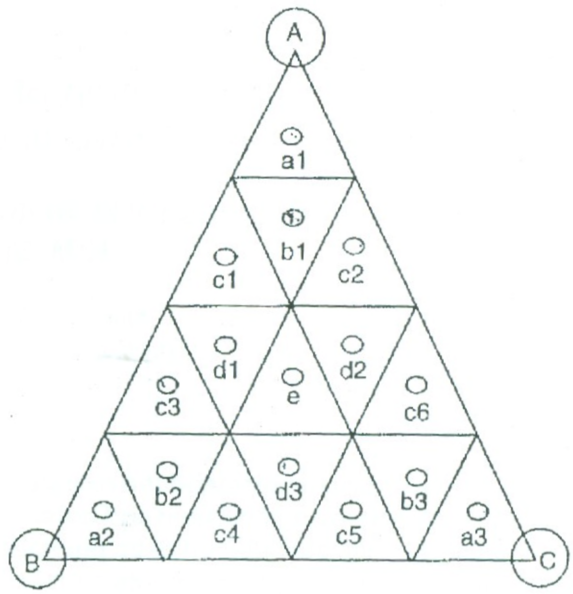


Table 1: Root biomass at various depths and positions in an eight-year-old plantation

Depth (cm)	Root dry matter (t/ha)			
	Primary	Secondary	Tertiary	Total
0-10	0.511	0.476	0.585	1.572
10-20	1.575	1.167	1.107	3.849
20-30	0.897	0.568	0.520	1.985
30-40	0.673	0.499	0.417	1.589
40-50	0.279	0.248	0.215	0.742
50-60	0.302	0.273	0.220	0.795
60-80	0.317	0.387	0.283	1.087
80-100	0. 308	0.330	0.315	0.953
0-100	4.862	3.948	3.762	12.572

Table 2: Root density of an eight-year-old oil palm plantation at various distances from palm base to a depth of 100 cms.

Distance (m)	Root density (kg/cu.m)			
	Primary	Secondary	Tertiary	Total
1	1.411	1.083	1.014	3.501
2	0.631	0.457	0.392	1.482
3	0.391	0.353	0.365	1.109
4	0.239	0.218	0.208	0.665
5	0.365	0.316	0.295	0.976

Fig. 2: Distribution of total root biomass at different depths in a eight year old oil palm plantation

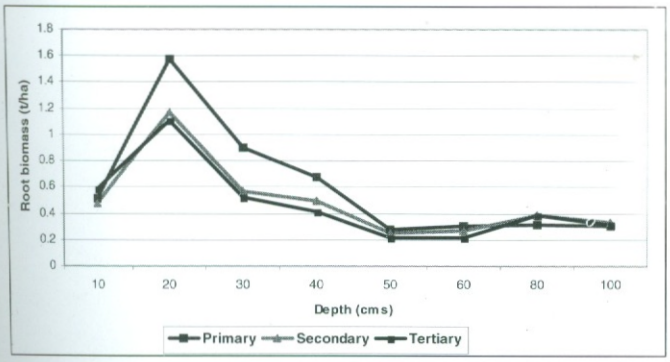
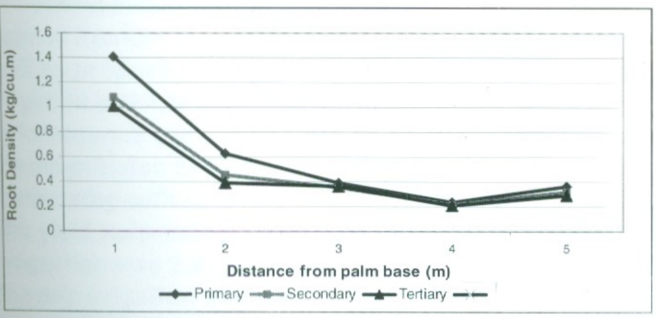


Fig. 3: Density of roots from palm base in a eight year old oil palm plantation



There is also a possibility of producing more root biomass in oil palm plantations under Indian conditions due to water limiting conditions, where in the palms tend to produce more roots (more root/shoot ratio) as an adaptive mechanism to cope up with the stress.

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