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Ground Water In Mountainous Area And Forest Vegetation

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ABSTRACT

There are much misgivings outside the hydrological discipline on the location and behaviour of the mountainous water table under forest vegetation and there are many conflicting assertions about the depth of the tree rootings and water table and its seasonal fluctuations. The real concern is whether the two are effectively related or not. Some of the observations indicates that the fluctuations in water table are due to movement of water for irrigations or rural use and lesser recharge from sub soil layer which causes a depression of the water table far a sizable area around. Some times rural people tap aquifers which are for below the superficial water table with which plant roots are associated. The most tenable hypothesis could be drawn that the tap roots of trees are not the major absorber of water from water table in low lying area. However, where the superficial roots system comes in contact with the capillary fringe of water table direct absorption could be possible.

INTRODUCTION

The effects of forest on mountainous ground water have not been studied in detail but whatever limited studies have been done indicate noncoherent results. While the American studies claim the collapsing of water table as a result of deforestation or forest fire, the Swiss studies seem to indicate no effects on water table when a forest stand changed to grass land (Hamilton & King, 1983). Similarly Sanraj (1984) observed that plantation of Eucalyptus tree in Nilgiris resulted in significant lowering of base flow. There exists some data which indicate shallowing of water tables following forest clearing (Boughton, 1970) due to replacement of deep rooted trees, which were able to use soil moisture at depth by shallow rooted annuals.

RESULTS

A study on ground water regiment under E.glabucus was therefore conducted at Osamund, Nilgiris (Mathur and Rai 1980). Before plantation the area was covered with a thick mat of natural grass, typical of the woen lock downs and consisted of Chrysopogon Zeylenicus, Andropogon polyptychen, Themeda triandra etc. In low lying pockets some shola forests also existed. The area was planted in 1958 with Eucalyptus globulus and first coppiced in 1968 after which coppice shoot up. There were 4097 trees planted in the catchment with an average spacing of 2m * 2m. The average height of the tree was 12m and average B.B.H. 9.5 cm for main coppice shoot and 6.7cm for secondary coppice shoot. Soil water levels in the watershed was measured through the piezomatric holes of 7.5 cm diameter made with the help of soil auger and then tops protected by masonry structures. The depth of the ground water table at all these points were measured daily using electronic water level indicator. The average minimum depth of water table was measured as 1.519m in December and maximum of 6.204m in March. The average fell in the water table was 1.3m. Since the recorded water levels was below the root zone of eucalyptus globulus, it was felt that the root system has not absorbed moisture from the ground water table for physiological functions. However, in the low lying areas where the water table was higher and very close to the root zone, the tree roots might have reached the capillary fringe to absorb moisture and utilize it for physiological activities with better growth performance since the roots have the capacity to utilize water through capillary fringe during period of scarcity and from the stored water of upper soil layers during excess availability.

In order to evaluate the effect of eucalyptus globulus on ground water selected two small natural watersheds, predominantly under blue gum and under grass were selected. A network of our wells in the grass land catchment and a network of six wells in the blue gum catchment in these watersheds were established and the level of water in these wells monitored. The average water level in the catchments for the period 1980-83 are given in table 1 analysis of which shows that the water table rose to maximum in July/August due to monsoon rains and gone to lowest in the month of May/June . It was observed that there was a fall of 29cm in the water table in grassland and 70 cm in Blue gum.

Table 1: Average level of water table(m) in Osamernal(Nilgiries)

	Grassland		Blue gum	
Year	May/June(m)	July/Aug(m)	May/June(m)	July/Aug(m)
1980	118.68	121.68	182.90	185.43
1981	118.60	121.21	182.51	185.25
1982	118.33	120.95	182.20	185.03
1983	117.82	120.85	180.80	185.13

Average recharge and depletion of ground water table between May/June and July/August

Year	Recharge	Depletion	N.Fall	Recharge	Depletion	N.Fall
1980	2.39	2.47	0.08	2.53	2.92	0.39
1981	2.61	2.88	0.27	2.74	3.05	0.31
1982	2.62	3.13	0.51	2.83	4.23	1.40
Mean	2.54	2.83	0.29	2.70	3.40	0.70

A longterm hydrological study to assess the effect of blue gum plantation on water yield from catchment was conducted by Sharda et. al.(1987) in Nilgiris. Two identical catchments consisting of grass, sholas and swamps were selected in which one was kept at control and the other planted with blue gum. It was found that raising of blue gum brought significant reduction in the total run off during the first rotation of 10 years. The reduction amounted to 867.74 mm for the entire rotation of 10 years and 87.00 mm for one year which was 16% less than open grass lands. No significant difference was observed in soil moisture level during first five years. There was a lowering of soil moisture in eucalyptus catchment during the second five years period. The eucalyptus extracted water mainly from upper soil layers (50cm depth) where as the deeper soil layer remained unaffected. The data on the water table fluctuations for the period 73-82 did not reveal any significant difference in ground water depletion where as the data on water table fluctuations for the period from 1976 through 1982 were found significant at 1 percent level. It was inferred that blue gum has affected the water level in the swamp during lean periods and during the second half of the first rotation (10 years) when they had maximum height and D.B.H.

In order to study whether eucalyptus exhibits the phreatophytic characteristics by way of obtaining water freely from the water table for maximal transpiration and to demonstrate whether there is a direct abstraction or otherwise by the eucalyptus tree from the water tables deeper than 1.5 ma study was conducted in the eucalyptus plantation of 1970 (after first coppicing) in the compartment 3A of Horai block of Kishanpur Range, Tarai East Forest Division (U.P.) by Reynolds et.al. (1987). For this purpose a transact of 3 km at an inclination of 6m/km was selected and at approximately equal distances ten locations for boring wells of 15 cm diameter were marked. At the each bored well stevenson water level recorder was emplaced and observations recorded for one or two days along with manual measurement two to three times between 0900 and 1800 hrs. What ever possible the depth of the water table was simultaneously assessed with the help of resistivity meter. The above study indicated that in the case of wells with deeper water table (where the water table was out of range of the roots) maximum rate of rise was in the late afternoon or early evening, whereas maximum rate of fall of the water table was after the mid. night (Table 2) . The water table was therefore at its shallowes early in the night and deepest in the forenoon. It seemed that fluctuation was out of phase with direct abstraction in these cases, perhaps because of transmission through a capillary zone above the water table. However, in case of wells which have shallow water table with superficial root system in contact with, capillary fringe the diurnal fluctuation was in phase with the expected course of transpiration through the day and caused by the local absorption of water by tree root.

It was thus evident from the above that the rooted hybrid eucalyptus trees had difficulty in reaching the water table in most of the areas. The limited annual fluctuations of the water table in adjoining area as given in table 3 also suggested that the relation of the roots to the water table was not seasonal. Roots could have easily gone downwards with the falling water tables even if they were unable to survive beneath it when it was shallow. Thus the most enable hypothesis was that the taproot of

Table 2: Record of water level in Tarai Area (U.P.)

Inspection Well No.	Depth of watertable(m)		Rise(r) or Fall(f)in 24 hrs (mm)	Time of deepest watertable(hr)	Time of shallowest watertable(hr)
2	1.67	2.45	f 1.5	1200-1430	1900-2400
3	2.14	2.49	nil	1230-0710	0130
4	1.40	1.97	r 1.0	1500-1800	rising

5	1.62	1.85	nil	1700-2200	1100
7	2.41	2.95	r 25.0	-	-

eucalyptus was not a major absorber of water from the water table but if the capillary fringe of the water table had been shallower than 1.5m then the water absorption could have been possible by the roots.

Table 3: Mean monthly water table of the area

Location	Month	Maximum depth(m)	Month	Minimum depth(m)
	June	9.3	April	8.4
	August	9.3		
Lalkuan	September	9.3		
	November	9.3		
	December	9.3		
Pipalparao	July	4.4	September	4.0
Gangapur	May	1.2	October	4.0
	June	1.2	August	0.5

Mathur et al (1984) collected water samples from piezometric holes drilled in grass land natural shola forest and eucalyptusglobulus plantations in the high hill of Nilgiris (Tamilnadu) (the depth of holes were 5.11 and 8m respectively). The data of pH of ground water given in table 4 to show that there was no significant effect level along an adverse effect on ground water pH due to vegetal covers. Views expressed that large scale plantation of eucalyptus globulus in Nilgiris causes adverse effect on the quality of ground water was not substantiated by this study and on the contrary proved no adverse effect on ground water pH due to blue gum plantation although the area contained heavy leaf littor in partially or highly decomposed stage. A very minor seasonal variation in ground water pH was however, noticeable in rainy ano dry seasons in three types of vegetation, with pH decreased in rainy season than in the winter seasons. This is a contradiction with the findings of Reynolds et. al. (1987) in Tarai area of U.P. where a minor increase in pH of groundwater was found after the rainy seasons. However the differences in both the clases were non significant and no inference could be drawn except addition of certain ions to the groundwater by the sub surface flow from higher gradients.

Table 4 : Average pH of ground water during monsoon and non-monsoon in Nilgiries

Season	Grass				Shola				Eucalyptus globulus			
	1980	81	82	83	1980	81	82	83	1980	81	82	83
Monsoon	5.9	5.9	5.4	-	6.2	5.9	5.6	-	5.9	5.6	5.9	-
Nonmonsoon	-	6.0	6.9	6.7	-	6.3	6.3	6.7	-	6.2	6.3	6.3

Table 5 : pH of ground water before and after monsoon in Tarai area in Eucalyptus hybrid plantation

Inspection Well No.	Before monsoon(May)	After monsoon(Oct.)
4	6.78	7.24
5	6.50	7.65
6	7.10	8.86
7	6.97	7.91
8	6.35	7.33
9	6.95	7.50
10	7.11	7.91

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