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PRODUCTION OF WATER FROM SOIL BY SOLAR ENERGY FOR BIOMASS ENERGY PLANTATION

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ABSTRACT

Increase of forest cover in arid regions of developing countries is useful from both environment and energy point of view. Because of lack of irrigation water, tree plantations are difficult to achieve in such conditions. This paper presents a novel method of producing water by solar energy in arid lands and its use for tree seedlings. The method involves digging a pit in the ground and covering it with a glass cover. Water collected from the pit is then fed to the tree seedlings. The pit has dimensions of 0.9 m x 0.9 m x 0.6 m and produces on an average 300 ml of water every day. Data has shown that seedlings supplied with this water had 100% survival rate. Details of the experiment, together with long term data of water collection from the pit, are given.

KEYWORDS

Soil water evaporation; Solar energy; Biomass production; Earth water stills.

INTRODUCTION

Environmental degradation because of lack of green cover is one of the major problems in developing countries. The problem is even more severe in the arid regions. For example in India the Government has established an ambitious program of putting forest on 5 million hectares (mh)/year. However, because of lack of sufficient water the program has been a nonstarter (Anon, 1987). Various strategies, like aerial seedling, handwatering and sowing the seedlings during rainy season have been tried for energy plantations in developing countries but only with limited success (Prasad, 1988). Consequently a very high level of mortality has been observed inspite of using these strategies (Vohra, 1985).

A novel strategy of producing water from the soil and then feeding this water to seedlings is outlined in this paper.

The soil-bound water in semi-arid and arid regions is not available to the roots of small seedlings because the root system is shallow and its osmotic potential is not sufficient to extract the tightly bound water in the soil. Extraction of this water by solar energy and its supply to seedlings is one of the solutions. The production of water from soil in arid regions is an age-old technology and has been used as a strategy for human survival in deserts. However, there is limited data on daily yield, seasonal variation etc. Limited work has been reported for one such experiment but for only 20-30 days' output (Ahmedzadeh, 1978). This paper therefore presents extensive data collected from last two and half years together with seasonal variation in water yield and its effect on seedling growth.

EXPERIMENTAL METHODS

Five Soil Water Evaporation Stills (SWES) were fabricated and put over the pits. Figure 1 shows the schematic of the still together with the pit dimensions. The design of SWES is same as that of solar water still.

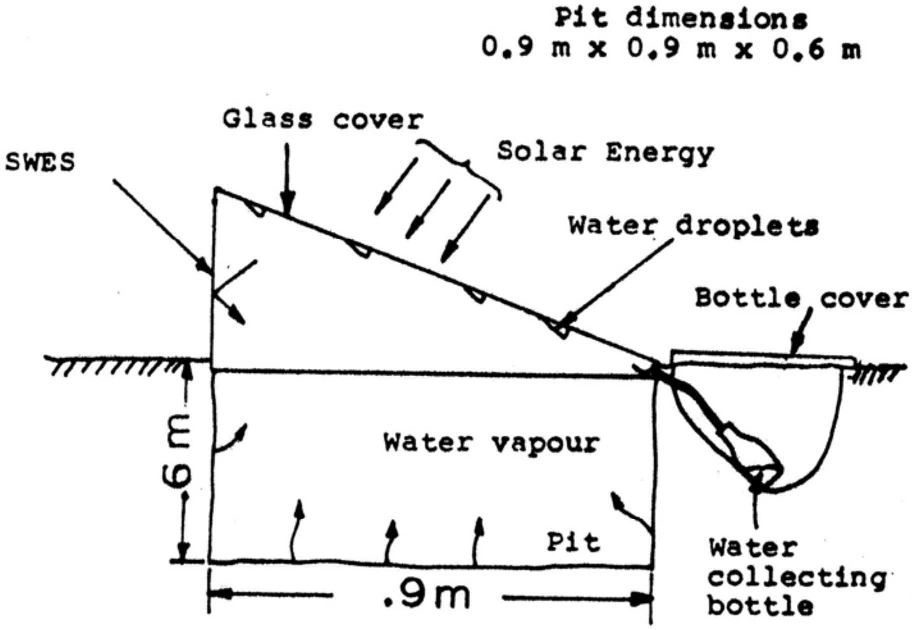

Fig. 1 Schematic of Soil Water Evaporation Still (SWES)

Table 1 shows the details of the experiment. There were three soil water evaporation experiments (SWEE) and in each of these experiments the same set of SWES was used. Thus the stills are reusable and can be used only during the time of seedling establishment. Water, which was collected daily in bottles, was measured and given to the seedlings in the morning. The water produced from each SWES was supplied in equal amounts to the four seedlings (treatment I). In another treatment the same quantity of water as was obtained from SWES in 7 days was supplied to another set of seedlings once a week (treatment II). Seedlings, which were rainfed, formed the control (treatment III). The growth parameters like basal diameter, plant height and mortality were measured at every three months' interval. The experiment was conducted in an area where average soil depth was between 20-26 cm. Below that was soft rock (murum).

Table 1. Details of SWEE Experiments

Description	SWEE 1	SWEE 2	SWEE 3
1. Species planted	***P. juliflora***	***A. indica***	***L. leucocephala***
2. Duration of experiment	July-1988- July 1989 (13 months)	Sept. 1989- August 1990 (12 months)	Sept. 1990-present
3. Spacing of seedlings	Four seedlings around each pit.	Four seedlings around each pit.	2 m x 2 m
4. Soil depth, (avg.) cm	20 (rest 40 cm was soft rock)	26 (rest 34 cm was soft rock)	20 (rest 40 cm was soft rock)
5. Rainfall (mm) during period of experiment	762	701	317
6. Replications	5	5	5
7. Treatments	3	3	3
8. Area of experimental plot, (m^2)	167	316	374
9. Total no. of seedlings planted	28	40	60

RESULTS AND DISCUSSIONS

Table 2 gives the summary of the results. Figure 2 shows the typical water production from SWES for different months. Also plotted in this figure are the rainfall and solar radiation data. As can be seen, initially the water production is higher since the pit takes time to stabilize. Thus the February 1988 output is more as compared to that in February 1989 (Fig. 2). This also explains the high average output for SWEE3 (Table 2) where the experiment is only 5 months' old.

TABLE 2 Results

Description	SWEE 1	SWEE 2	SWEE 3
1. Average daily water production per pit (ml/day)	285	351	631
2. Seedlings survival rate (%)			
i) treatment I	100	100	100
ii) treatment III	100	75	83.3
3. Growth characteristics : Volume increment (cm^3/growth period)			
i) treatment I	72.16	96.81	8.07
ii) treatment II	59.59	-	14.11
iii) treatment III	57.20	75.15	6.09

Table 2 also shows that the survival rate is 100% for the plants fed water from SWES. Since each SWES supplies water to 4 plants, on an average about 70-80 ml of water is given to each seedling.

That this much water is capable of helping seedlings survive is surprising, and it is possible that it is acting like a drip irrigation system. Analysis of growth rate for three experiments reveals no statistically significant differences between rainfed and SWES fed seedlings though the growth rate for treatment I was higher than that of treatment III. The experiment is still in progress to see the effect on species like L. leucocephala and Bamboo – two species which are relatively more susceptible to water stress.

It is also interesting to note that seedlings supplied water in treatment II had the best growth rate and survival percentage for SWEE3. This could be because of water reaching the roots system. Whereas supply of 70-80 ml/day allows the plants to survive, it does not provide enough water for better growth rate. It should also be pointed out that though the first years are critical for survival of seedlings, the growth rates do not show too much statistical difference. This difference is evident at later stages. However it should be noted that treatment II did not show the dramatic growth rate for SWEE1. This could be because of the hardy and drought resistant nature of ***P. juliflora***

CONCUSIONS

Based on this work the following conclusions can be drawn.

1. SWES supplied water helps in 100% survival rate of seedlings.
2. Seedlings supplied water as in treatment I had better growth rate as compared to that fed water from treatment III. SWEE3 showed that the growth rate for treatment II was best.
3. SWEE is reusable and can be used to establish seedlings in very arid regions.

ACKNOWLEDGEMENT

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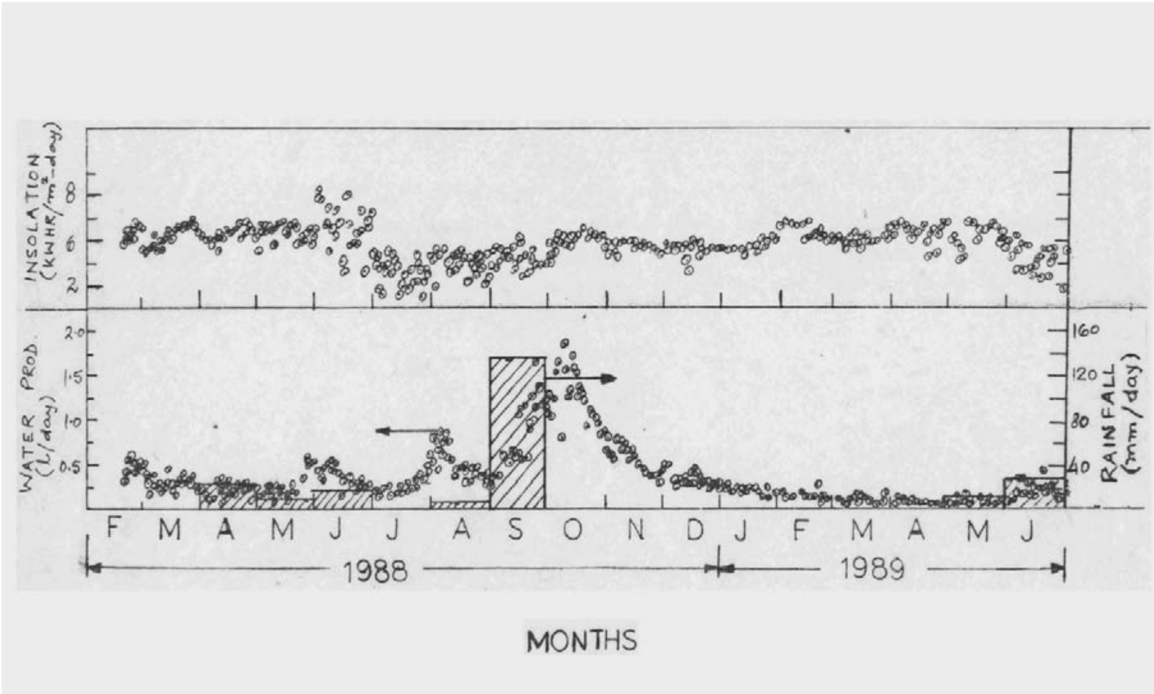

Fig. 2

SWEE experiment in field

A news story on this technology appeared in [Indian Express on May 13, 1992].

Recently a short history of all [water related work at NARI is written and presented here].

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