SEWAGE WATER AS POTENTIAL FOR THE TREE GROWTH - A STUDY ON TEAK, (*TECTONA GRANDIS*) PLANTATION

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Introduction

The increase in the human population in the Urban areas and the rapid pace of industrialisation have led to dramatic increase in the quantity of waste/sewage water released into streams and lakes, over recent years. These discharges are the most common sources of pollution. But such sewage/waste water, can be used for irrigating the tree crops thereby minimising environmental pollution, and utilising its mineral potentials as well.

Forest tree cultivation with sewage

In India, private farmers generally grow vegetable crops of all kinds in the sewage water farms (Misra and Srivastava, 1990). But in such farms along with beneficial nutrients, some toxic metals such as Cd, Cr, Cu, Zn and Pb also get introduced in the food chain which might have toxic effects on animals including human beings (Misra and Srivastava, 1990). However, in forestry crops wherein the end product is wood (non edible), the possibility of health hazards is almost ruled out.

Pinus radiata and a number of Eucalypt species have been successfully grown by utilization of the waste waters (Cromer, 1980; Edgar and Stewart, 1978). A study undertaken by Central Soil Salinity Research Institute, Karnal (Anon., 1990) had shown that forestry crops such as *Eucalyptus* hybrid (*E. tereticornis*), Leucaena (*Leucaena leucocephala*) and Poplar (*Populus* spp.) can be grown successfully by using raw sewage water. Amongst the forestry crops, Teak (*Tectona grandis*) had shown early boosts in the growth when irrigated (Joshi and Farooqui, 1991). In the present study teak plantations raised by one of the progressive farmers near Dhule in Maharashtra are evaluated and future prospects of using sewage water as potential for irrigation are discussed.

Case Study of Irrigated Teak in Dhule

Dhule is situated between Longitude 75°20' East and Latitude 21°10' North, falls under Western Maharashtra Dry (Scarcity) zone. The average annual rainfall is 675 mm. The rainy months are from June to September and climate is extreme i.e. maximum temperature 46.7°C and minimum 6°C. The soil of the tract is generally black loam (Khisty, 1964).

During the year 1987, Shri Dwarkadas Agarwal raised teak plantation on his farm at Dhule at a spacement of 2 m x 2 m

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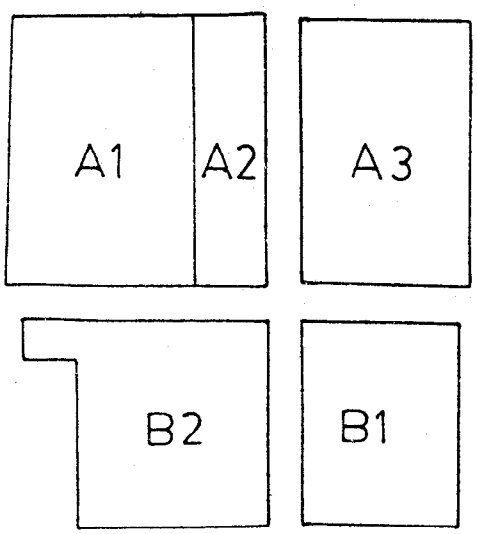
covering an area of 1.5 ha on an experimental basis. The area can be divided into five blocks viz A1, A2, A3, B1 and B2. The number of plants and various treatment given to the plot are shown vide Figure 1 and Table 1. The blocks A1, A2 and B2 were channel irrigated with the untreated sewage water (SW) once in twenty days. A1 was thinned in 1991 (SWT) and B2 was supplemented with earthworm castings (SWEC). The blocks A3 and B1 were irrigated with the well water once in twenty days by channel (WW).

In the block A1, out of 936 stumps planted, 413 plants were thinned by removing alternate row during the third year in 1991, thereby increasing the spacement to 4 m x 2 m. The observations in the form of height, girth and survival per cent were recorded separately in the aforesaid blocks in 1991 and survival per cent was recorded one year thereafter. The results were analysed statistically by using ANOVA test.

Fig. 1



Experiment Layout

Index :

I. Sewage Water (SW)
A1 - Thinned (SW)
A2 - (SW)
B2 - Earthworm Castings (SWEC)

II. Well Water (WW)
a3+b1 - (WW)

Table 1

Number of plants in each treatment and survival in 1991, 1992 and 1994.

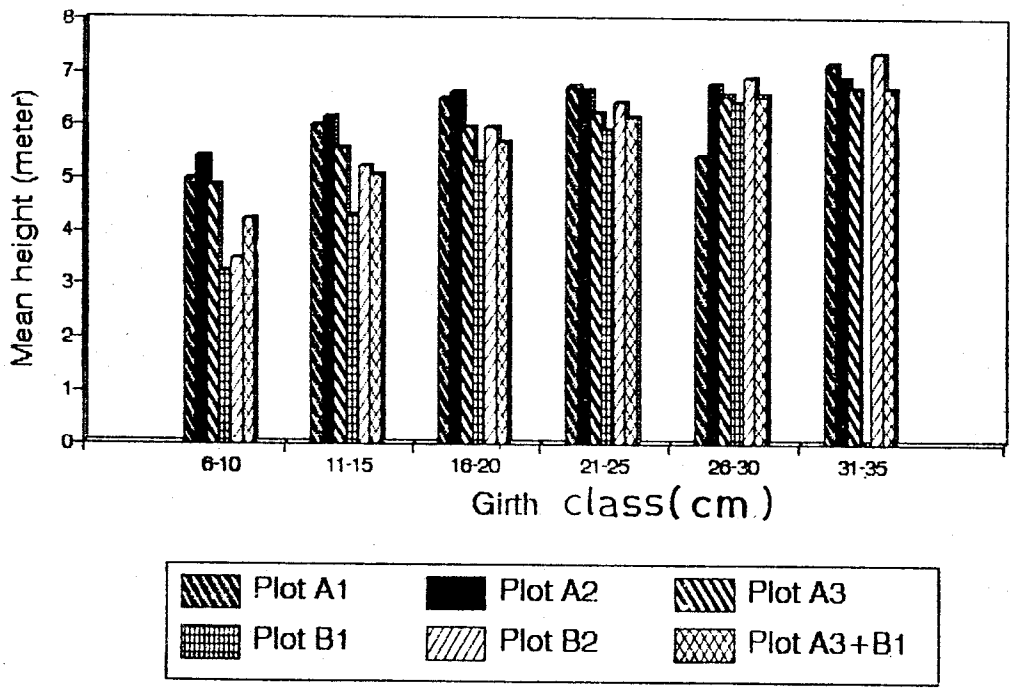
Plot No/Treatment	Total planted in 1987	Total thinned in 1991	Obs. recorded in '91		Obs. recorded in '92		Obs. recorded in '94	
			No. of Surviving plants	Mort-ality since '87 (%)	Survi-ving plants	Mortality since '91 (%)	Survi-ving plants	Mortality since 92 (%)
Sewage Water (SW)								
A1/Thinned (SWT)	936	413	476	8.98	417	12.39	408	2.16
A2/(SW)	507	-	454	10.45	289	36.34	288	-
B2/Earth-worm Castings (SWEC)	881	-	836	5.10	681	18.54	574	15.12
Well Water (WW)								
A3+B1/(WW)	1476	-	1338	9.34	1189	11.14	1096	7.82

Table 2

Comparative height, girth, total tree volume, volume per ha, MAI in different plots with Sewage Water (SW), Well Water (WW) and Sewage water + Earthworm Castings (SWEC).

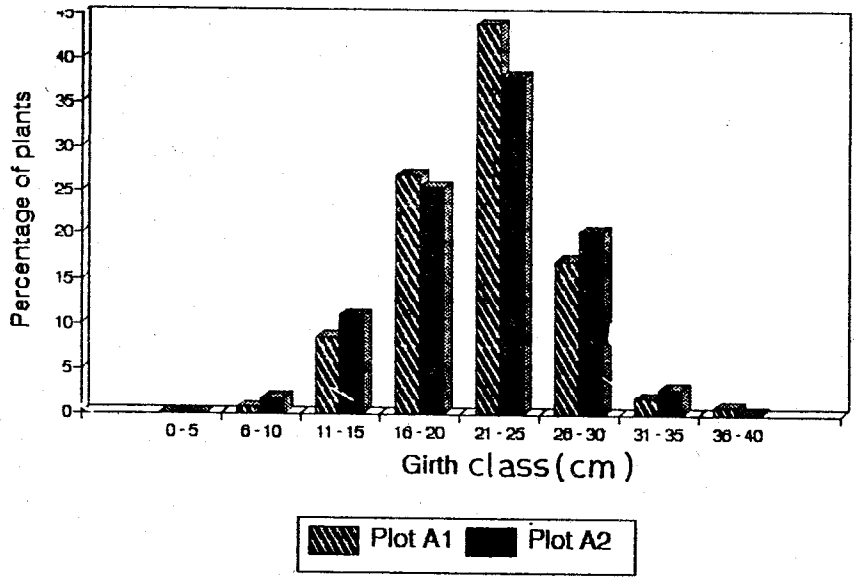
Girth class (cm)	Plot A1			Plot A1			Plot B2			Plot A3 + B1		
	No. of plants	Mean ht. (m)	Volume (m^3)	No. of plants	Mean ht. (m)	Volume (m^3)	No. of plants	Mean ht. (m)	Volume (m^3)	No. of plants	Mean ht. (m)	Volume (m^3)
0-5	0	-	-	0	-	-	2	3.15	-	40	2.25	-
6-10	3	4.97	-	8	5.43	-	28	3.49	-	83	4.22	-
11-15	41	6.01	0.163	50	6.13	-	98	5.22	-	274	5.07	0.517
16-20	128	6.52	0.862	116	6.61	0.729	247	5.96	1.347	609	5.69	2.923
21-25	209	6.72	2.220	173	6.68	1.820	349	6.43	3.411	294	6.13	2.594
26-30	82	5.39	1.620	93	6.78	1.410	104	6.91	1.521	36	6.58	0.505
31-35	9	7.16	0.202	13	6.91	0.280	8	7.39	0.172	2	6.70	0.037
36-40	4	5.43	0.097	1	-	-	0	-	-	0	-	-
Total	476	6.62±0.71	5.164	454	6.61±0.53	4.239	836	6.11 ±1.00	6.451	1338	5.49±1.04	6.576
Avg. Girth		22.15 ± 4.61			21.89 ± 5.13			20.68 ± 4.84			17.34 ± 4.96	
Vol./ha (m^3)		27.123			23.342			19.221			12.287	
M.A.I.		6.780			5.835			4.822			3.071	

Fig. 2



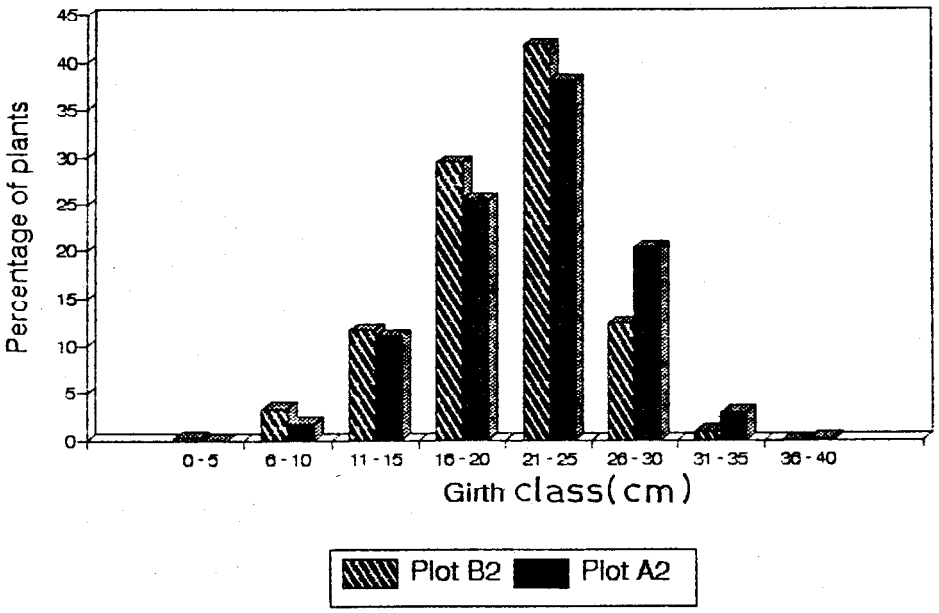
Comparative growth (girth GBH OB) in the plots receiving varied treatments

Fig. 3



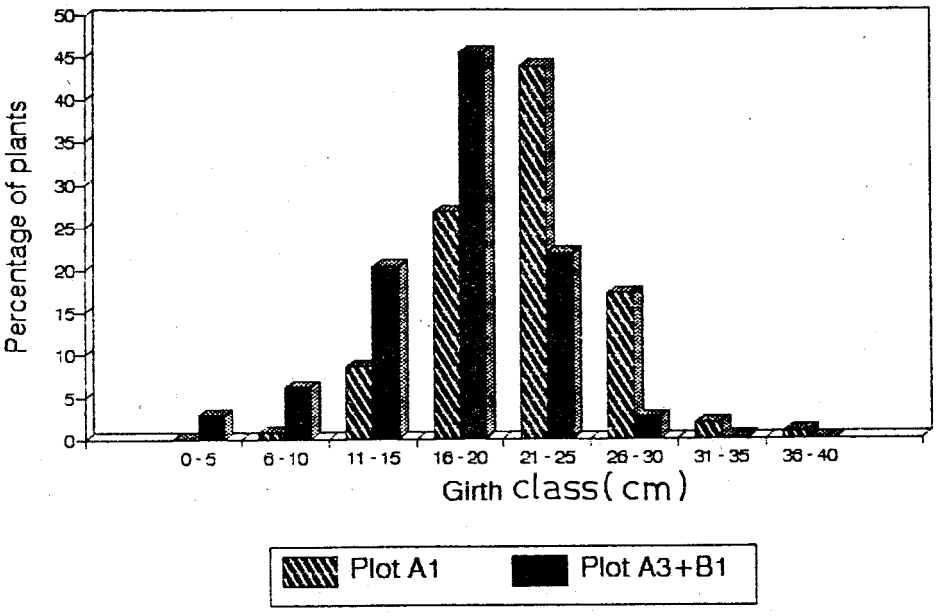
Plant percentage in the treated plot (A1 and A2)

Fig. 4



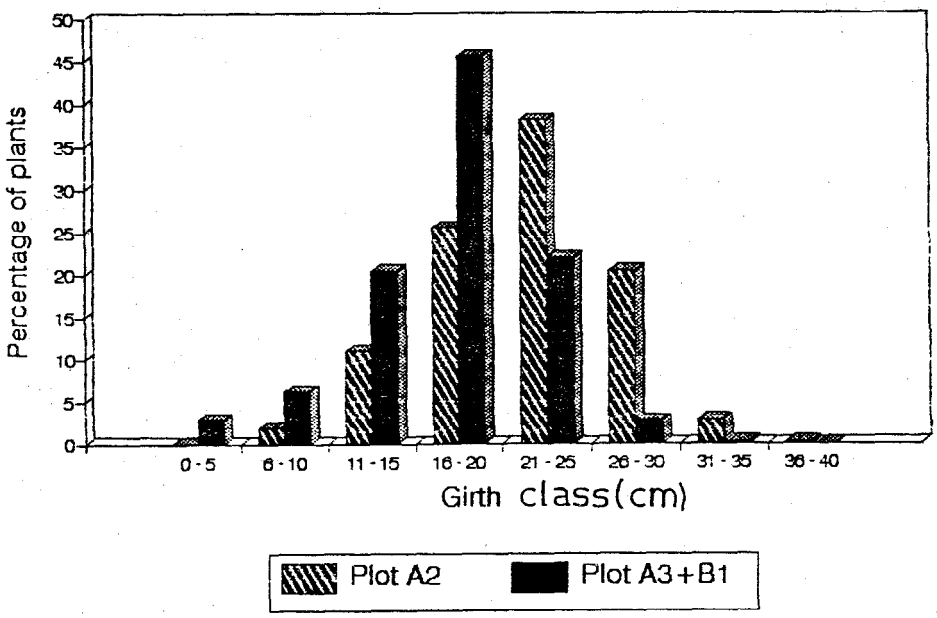
Plant percentage in various girth classes (A2 and B2)

Fig. 5



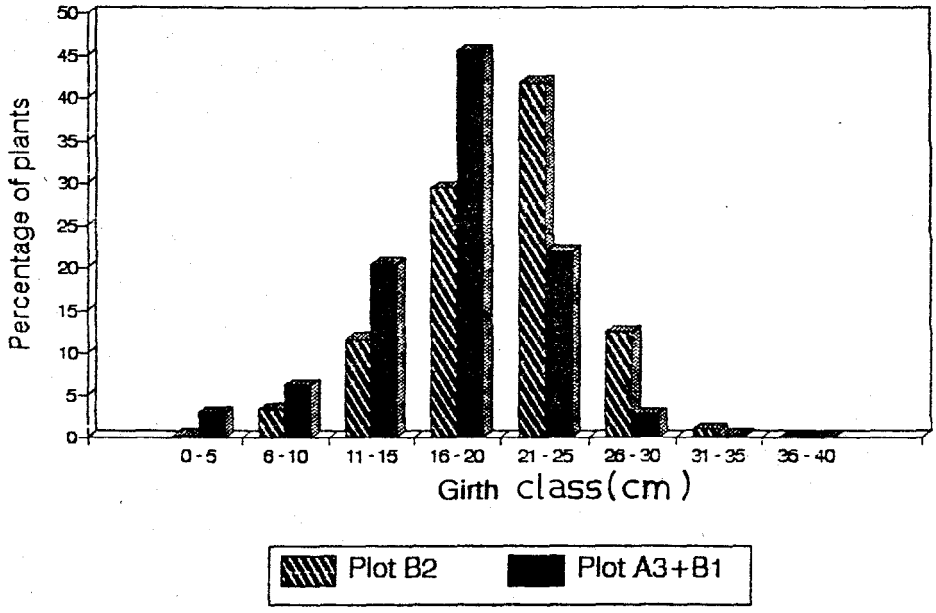
Plant percentage in various girth classes (A3 and B3)

Fig. 6



Plant percentage in various girth classes (A2, A3 and B1)

Fig. 7



Plant percentage in various girth classes (B2, A3 and B1)

Results and Inferences

The results are depicted in Table 2 and Figures 2-7. The observations recorded in 1991 (Table 2) reveal that the growth in terms of height and girth are significantly higher ($P<0.01$) in the plots irrigated with sewage water (SW) (Plots A1, A2 and B2) when compared to that of plots irrigated with well water (WW) (Plots A3 and B1).

The plots A1 and A2 which were irrigated with the SW alone showed significantly higher growth ($P<0.001$) in terms of height and girth when compared to the plot B2 wherein the sewage irrigation was supplemented with earthworm castings (SWEC) Table 2.

The plants in all the plots were divided into 5 cm girth classes. The number of plants in each girth class and the mean height in all the plots were calculated and are shown in Table 2 and Figure 2. The mean height in all the plots in these classes did not show any significant difference. The plots A1, A2 and B1 which were irrigated with SW and which displayed better growth have more number of plants in the higher girth classes viz 26-30 and 31-35 cm, whereas, in A3+B1 which were irrigated with well water, the number of plants were more in 10-15 and 21-25 cm girth classes (Table 2).

The volume in various girth classes and total volume was calculated from the total tree volume table of Singh (1981) in all the plots vide Table 2. As thinning was carried out just before recording the observations, the volume per ha for A1 was calculated assuming full stocking. The volume per hectare in the plots A1 (SWT) and A2 (SW) was 27.12 and 23.34 m^3 per ha, respectively. It was then followed by the plot B2 (SWEC) which was 19.29 m^3/ha. In the plots A3+B1 (WW) the volume was 12.28 m^3/ha. The Mean Annual Increment (MAI) was 6.78, 5.83 and 4.82 m^3/ha in the plots A1 (SWT), A2 (SW) and B2 (SWEC) respectively as against 3.07 m^3/ha in the plots A3+B1 (WW) treated with the well water (WW) (Table 2).

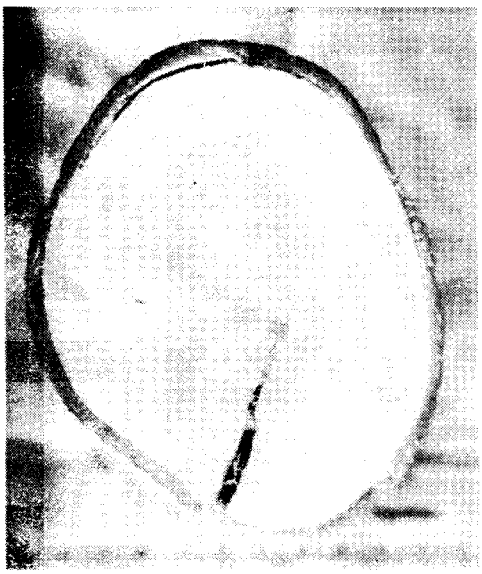
The survival of the plants recorded in 1991 and 1992 reveal that during one year period mortality was higher in the plots A2 (SW) and B2 (SWEC) i.e. 36% and 18% respectively as compared to A3+B1 (WW) and A1(WST) i.e. 10-12% (Table 1). However, by 1994 conditions have improved in A1 and A2. Higher mortality has continued in B2.

Poles thinned from the plot A1 (SWT) during 1991 when put to sale were not preferred by the purchasers. A cross section taken from the samples collected from this plot shows that the proportion of sapwood is more when compared to that of the heartwood. The close weavy rings for which teak is valued are absent. The sample collected also exhibited early development of cracks (Radial Shakes) in it Fig. 8.

Discussion

Studies on irrigated teak (*Tectona grandis*) plantations have revealed that the irrigation boosts growth, and is comparable to site quality I and II as against the prevailing site quality III and IV of Maharashtra. The diameter, volume and basal area of the irrigated plantation in the site quality III are comparable to site quality I and II (Joshi and Farooqui, 1991). In the present study, irrigation with sewage water (SW) had shown significantly higher growth ($P<0.01$) when compared to that of the plants irrigated with well water (WW) (Table 2).

Fig. 8



Pole Cross section

The volume per hectare in the plots irrigated with SW i.e. A1 (SWT), A2 (SW) and B2 (SWEC) was found to be 27.12, 23.34 and 19.29 m^3/ha respectively as against the plots A3+B1 (WW) irrigated with WW which was 12.28 m^3/ha. If the teak crop is irrigated with SW, gains are substantial over that of WW and ultimately much higher when compared to that of the rainfed plantations.

Sewage waters are rich in N, P, K and S Central Soil Salinity Research Centre, Karnal had reported that 181, 29, 270 and 150 kg per hectare N, P, K and S are added respectively by giving 5 irrigations of 7.5 cm each of untreated SW (Anon., 1990). The micronutrients Zn, Cu, Fe and Mn @ 1.28, 0.75, 4.68 and 1.37 kg are also added respectively. Though SW is being used for raising vegetable crops by the farmers in India, the possibility of toxic metals such as Cd, Cr, Fe, Cu, Zn and Pb getting into the food chain of animals and human beings cannot be ruled out (Misra and Srivastava, 1990). However, forestry crops wherein the usable parts are wood, timber or pulp, there is no chance of toxic metals and pathogens entering the food chain.

In the present study, teak (*Tectona grandis*) and study conducted by CSSRC, *Eucalyptus* (*Eucalyptus tereticronis*), Subabul (*Leucaena leucccephala*) and Poplar (*Populus* spp.) have shown excellent growth when treated with SW. The possibility of utilising such huge quantity of 12500 million litres/day of the SW in our country (Anon., 1990) for tree farming will ensures safe disposal of the waste waters and utilisation of a N, P, K and micro-nutrient rich water, thereby reducing the fertilizer cost on raising the tree plantations.

Irrigation with SW has enhanced growth but in the short span of one year, the mortality was higher in the plots A2 (SW) and B2 (SWEC), being 36% and 18% respectively. In the present study, the plants are being treated with SW throughout the year. As teak is a deciduous plant, it does not remain active throughout the year, as such it cannot bio-drain effluents during the dormant period of the plant. The excessive water (and nutrients) perhaps making the plants vulnerable for pathogen attack, thereby causing the high mortality.

The other reason for the mortality may be due to the fact that in the present study, the SW was utilised without diluting it to adjust with the nutrient requirement of the plant. The treatment of SW was given through the year which might have increased the soil fertility and resulted in production of the pathogens which are responsible for high mortality. NEERI, Nagpur had also suggested that SW should be diluted to adjust with the requirement of the crop (Anon., 1985). However, the

nutrient requirement of teak at various stages of the growth are not known. A detailed study of the water and nutrient requirement of teak during various stages of its growth, is therefore essential to arrive at definite conclusions.

The cross section of the stem collected from the material thinned in 1991 from the plot A1 (SWT) reveal that the proportion of sapwood is more when compared to that of heartwood. The wavy rings, which are characteristics of teak are also absent. Further, the sample collected had shown early splitting and development of the cracks (Radial-Shakes) Fig. 8). Though, the gain is substantial as evident by 5-6 m^3/ha/ann of the M.A.I. of the stem wood alone, together with branchwood it becomes quite attractive, but it appears that both strength and grain pattern for which teak is valued, are lacking. As such when desirable strength and grain pattern are absent, it will not fetch the price expected from (rain fed) teak. However, even if it is sold as firewood, it will give approximately 5-6 tonnes of firewood. Therefore, it appears that even if the timber quality is deteriorated and if it fetches the price of firewood, venture of irrigated teak can be viable.

Besides, the crop is bio-draining the SW which are otherwise hazardous. In agricultural crops, there is the possibility of toxic metals getting into the food-chain (Misra and Srivastava, 1990), but in the forestry crops wherein the end product is wood (non edible) such possibility is ruled-out. Thus, raising the forestry crops in SW not only gives substantial amount of revenue, but it is also eco-friendly as it bio-drains the SW and reduces the pollution hazards. By taking safety factors into consideration such cultivation can be best option.

Conclusions

1. Treatment of SW definitely enhances the height, girth and volume.

2. Returns of 5-6 m^3 of the stemwood ah ann, together with branch wood, are quite attractive and even if timber quality detoriates and fetches lower price, it would give more returns than that from agricultural crops.

3. SW should be utilised by diluting it to adjust with the requirement of the crop. It should not be supplied during the dormant period of the plant to avoid mortality.

4. The plants bio-drain the SW thereby decreasing the pollution hazards. Unlike vegetables, the usable parts being wood (non-edible), there are no health hazards.

5. Therefore, it is Eco-friendly and economically viable to utilise SW for irrigating forestry crop.

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SUMMARY

Discharge of Sewage Water (SW) is primary source of pollution especially near big cities. But their irrigational and manural potential can be harnessed for production of arboreal biomass. In Maharashtra and adjoining states a large number of farmers are going for irrigated teak (*Tectona*

grandis) **plantations. Use of SW in this context will not only decrease cost of plantation by saving expenditure on manuring, but will reduce the pollution as well. In a case study of teak plan actions irrigated with SW, it was observed that growth in terms of height and girth were significantly higher (P<0.01) than the growth from plots irrigated with well water. However, mortality was higher in the plots irrigated with SW. Prospects of using SW as a potential for irrigation are discussed.**

वृक्ष वृद्धि के लिए गन्दी नालियों के जल की संभावनाएँ - सागौन (*टैक्टोना ग्रांडिस*) का एक अध्ययन

एम०जी० गोगटे, यु०एम० फारूकी व वी०एस० जोशी

सारांश

गन्दी नालियों का पानी छोड़ना, विशेषतः बड़े नगरों के पास, प्रदूषण का एक मुख्य कारण है । परन्तु उसकी सिंचाई और खाद संभावनाओं का उपयोग वृक्षों के जैवपुंज उत्पादन के लिए काम लाया जा सकता है । महाराष्ट्र और उसके साथ लगते राज्यों में बहुत सारे किसान सिंचाई करके सागौन (*टैक्टोना ग्रांडिस*) रोपवन उगाने में लगे हैं । इस संदर्भ में गन्दी नालियों का जल उपयोग करने से रोपवन लगाने का खर्च घट जाएगा क्योंकि खाद डालने का खर्च बचेगा, इससे प्रदूषण भी कम हो जाएगा । सागौन के रोपवन की सिंचाई इस गन्दे पानी से करने के एक अध्ययन में देखा गया कि कुएँ के पानी से सींचे भखूण्डों में हुई वृद्धि की तुलना में इससे हुई ऊँचाई और परिधि की वृद्धि सार्थकतः अधिक थी (पी <0.01) । किन्तु नालियों के पानी से सींचे गए भूखण्डों में पादप मरण अधिक हुआ । सिंचाई करने के लिए नालियों के पानी के उपयोग की संभावनाओं का विवेचन किया गया है ।

References

Anon. (1985). Waste Water Treatment. *Annual Report*, NEERI, Nagpur.

Anon. (1990). *Sewage Water : Utilisation Through Forestry Brochure*, Published by Central Soil Salinity Res. Institute, ICAR, Karnal (Haryana) pp 1-15.

Cromer, R.N. (1980) Irrigation of radiata pine with waste water : A review of the Potential for tree growth and water Renovation. *Aust. Forestry* **43 (2) :** 87-100.

Edgar, J.G. and H.T.L. Stewart (1978). Waste Water disposal and reclamation using *Eucalyptus* and other trees. *Inst. Assoc. on Water Pollution Research Paper* **12,** 11p. Melbourne, Australia.

Joshi, V.S. and U.M. Farooqui (1991). Irrigated teak plantations in Maharashtra - A case study, *International Teak Symposium,* Thiruvananthapuram, Kerala. 1991.

Khisty, K.N. (1964). *Working Plan for the West Dhule Forest Division,* Nasik Circle, Maharashtra State, 1965-66 to 1984-85.

Misra, S.G. and C.P. Srivastava (1990). Management of Sewage Water. *Environmental Planning and Management in India.* Vol. II, Ed. R.K. Sapru, Ashish Publishing House, New Delhi.

Singh, S.P. (1981). Total Tree Volume Table for *Tectona grandis* (Teak) *Indian Forester,* **107** (10) : 621.