# BIODRAINAGE FOR RESTORATION OF CANAL COMMAND WATERLOGGED AREA IN INDIAN DESERT

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Indira Gandhi Nahar Pariyojana (IGNP) is boon to the northwestern part of India. However, improper and overuse of water coupled with seepage from the canal has created the problem of water logging and salinity development. Conventional drainage techniques involving surface and sub surface drainage infrastructures are costly proposition and they require extensive construction and maintenance. Bio-drainage is seen as an effective alternative with additional environmental benefits.

A field experiment was initiated at 1357 RD of the main canal, near Ghantiali village, 32 km from Nachna towards Mohangarh, on the left side of the canal road in Jaisalmer district. Seepage water from the canal is accumulated in a depression covering an area of 3 ha. Depth of inundation at the lowest depression was 100 cm, which varied seasonally being maximum in winter months. Soil is deep sandy in nature with pH ranging from 8.4 to 9.1, electrical conductivity (EC) ranging between 0.25 and 2.30 $dSm^{-1}$and soil organic carbon (SOC) range between 0.03 and 0.37% at different soil depths.

Seeds of four tree species viz. *Eucalyptus camaldulensis* Dehnh., *E. fastigata* Deane & Maid., *E. rudis* Endl. and *Corymbia tessellaris* (F. Muell.) K.D. Hill & L.A.S. Johnson. were procured from CSIRO, Australia. Raised bunds (60 cm high, 60 cm wide and 2 m apart) were prepared in waterlogged (inundated water of 15-25 cm) area to provide comfortable root zone for young seedlings. Seedlings were raised in the nursery and planted on the raised bunds at a spacing of 2 m in blocks. Observations on growth and physiological parameters recorded periodically. When the plants were four and half year old after transplanting, a biomass estimation was made. Ground water was monitored through observation pits in each species.

## Growth and biomass

Performance of *E. rudis* was the best among the tree species with respect to growth and biomass. Plant height, crown spread and GBH were highest in *Eucalyptus rudis*. Plants of *E. rudis* were 107%, 93% and 81% thicker and 11%, 15% and 31% taller than *E. camaldulensis*, *E. fastigata* and *C. tessellaris* respectively. Average crown spread was also higher by 74 to 90% in *E. rudis*. Among the four species highest biomass was recorded in *E. rudis* followed by *C. tessellaris*, *E. camaldulensis* and *E. fastigata* (Table 1). More than eight fold biomass was recorded in *E. rudis* compared to *E. fastigata*. When compared with *E. camaldulensis* it was four and half fold higher. Component wise biomass allocation to leaf+branches was high (39% of total biomass) in *E. rudis* and low (8.6%) in *C. tessellaris*. Biomass allocation to stem component was high in *E. fastigata* (63.3%) followed by *C. tessellaris* (54.4%), *E. camaldulensis* (51.2%) and

*E. rudis* (32%). In case of root component it was high in *C. tessellaris* (37%) followed by *E. camaldulensis* (35%), *E. rudis* (29%) and *E. fastigata* (23.7%).

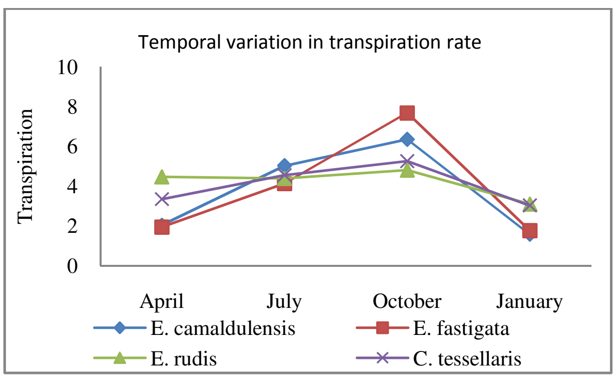
Table 1. Growth of four and half year old plants under waterlogged condition at 1357 RD, IGNP.

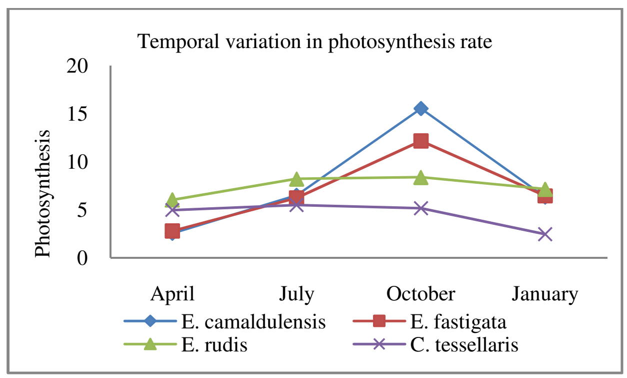
| Species | Height (cm) | Crown dia (cm) | GBH (cm) | Biomass (kg/plant) |
|---|---|---|---|---|
| *Eucalyptus rudis* | 1386 | 412 | 56 | 196 |
| *Eucalyptus camaldulensis* | 1250 | 232 | 27 | 44 |
| *Eucalyptus fastigata* | 1201 | 214 | 29 | 24 |
| *Corymbia tessellaris* | 1060 | 237 | 31 | 57 |

*Physiological parameters*

*E. rudis* maintained uniform transpiration and photosynthesis rate throughout the year which may be an indication of its efficiency in utilizing soil water and attaining better growth. Temporal variation in transpiration and photosynthesis was high in case *E. fastigata* and *E. camaldulensis* plants (Fig. 1). Along with steady rate of transpiration and photosynthesis, *E. rudis* has larger crown spread too that may be helpful in reclaiming waterlogged area at a faster rate. *E. rudis* may have high water use by virtue of its greater crown spread and transpiration rate.

Fig. 1. Temporal variation in transpiration and photosynthesis in different species




**Rooting depth and ground water depletion**

Rooting depth was high in *E. rudis* where root penetrated up to a depth of 125 cm. Number of lateral roots and thickness of roots were also high in *E. rudis*. Lateral spread of roots was high in *E. camaldulensis*. Mostly the roots were spread along the bunds that were prepared during plantation. Rooting depth in each species indicated the ground water level too as the root growth seized on reaching the water level. Ground water level receded by 145 cm (from stagnant water of 20 cm to a depth of 125 cm) in *E. rudis* plot. In *C. tessalllris*, *E. camaldulensis* and *E. fastigata* water level receded by 90 cm, 70 cm and 60 cm respectively. *E. rudis* has been observed to have a strong network of surface roots, which may be part of its adaptation to the waterlogged

**Soil properties**

Significant variation was observed in different soil layers with respect soil organic carbon (SOC), EC, $NH_4$ and $NO_3$ – N and $PO_4$ – P. All these variables were high in the top 0-25 soil layer. Soil pH did not vary significantly in different soil layers however, it was high in deeper layers. SOC, EC and $NO_3$ – N concentration in 0-25 cm soil was significantly high in *E. rudis* plots compared to other species whereas, $PO_4$ – P was high in *E. fastigata* and *C. tessellaris*. Species wise no significant variation was observed in pH and $NH_4$ – N. High EC in top soil layers may be because of salt accumulation in the active root zone which is a common phenomenon in plants growing in soils with shallow water table. There have been significant changes in EC and soil organic carbon in the plantation over a period of three years. Soil analysis indicated increase in all the nutrients, especially $NH_4$ and $NO_3$ – N. High SOM in *E. rudis* plot may be because of more addition of plant litter compared to other species by virtue of more foliage/ crown growth. Higher transpiration pool in *E. rudis* might have resulted in high values of electrical conductivity.

**Conclusion**

The growth behavior, biomass accumulation by the plants and physiological parameters suggests that *E. rudis* has high potential to be used as an efficient bio-drainage species in IGNP area. This species is known to have ability to grow on poor soils subjected to occasional flooding and moderate saline sites. In the present study however, *E. rudis* has outperformed other species in a perennial waterlogged condition. *E. rudis* is reported as one of the few native species of eucalypts in Western Australia region to withstand elevated levels of salinity and prolonged water logging without a substantially decreased growth performance. *C. tessellaris* is also known to have tolerance to drought and hot climate. However, the species has performed well under water logged condition in Indian desert.

Apart from the planted species, *Prosopis juliflora*, *Tamarix dioca* and *Saccharum munja* also have come up in the area with recession of ground water table as natural succession and contributed significantly for further lowering of ground water table and increasing productivity. Which suggests that along with tree species shrubs and bushes can also play a major role in increasing productivity of waterlogged area.

Growth of different tree species under waterlogged condition in Indira Gandhi Nahar Pariyojana