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Biodrainage: To Control Waterlogging and Salinity

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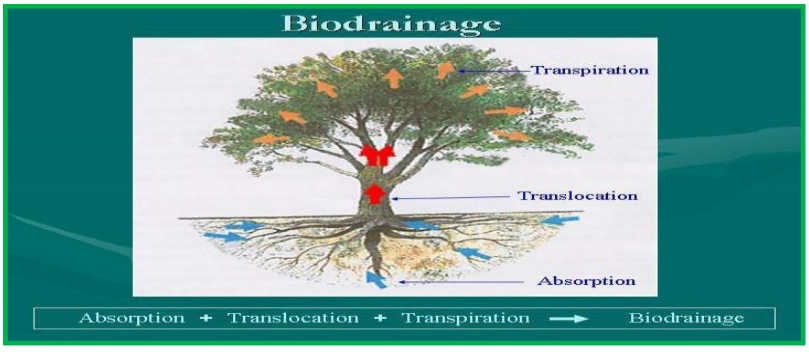
Abstract

The introduction of canal irrigation without adequate provision for drainage in arid and semi-arid regions has resulted in rising of groundwater table leading to waterlogging and salinization in large areas in irrigation commands. These problems are due to various factors, including seepage from unlined canals, inadequate provision of surface and subsurface drainage, over-irrigation and use of poor-quality groundwater for irrigation. Globally, about 10% of the land area is affected by waterlogging and over 6% by salinity (FAO, 2008). In India, different levels and types of salinity affect about 6.7 million ha of land, of which nearly half are under irrigated agriculture (ICAR, 2010). It is projected that about 13 million ha in the irrigation commands of India will be affected by waterlogging and soil salinity by 2025. Conventional sub-surface drainage systems can be a potential solution to these problems provided these are properly designed, installed, maintained and operated. But these are more expensive and also causes environmental problems. Due to the limitations of the conventional engineering-based drainage systems there is a need for alternative approaches to maintain the agricultural sustainability in the long term. The alternative approaches must be effective, affordable, socially acceptable, environment friendly, sustainable and upgrade natural resources of land and water. Biodrainage comprising of deep-rooted vegetation with high rate of transpiration seems the promising option.

Introduction

Biodrainage can be defined as pumping of excess soil water using bio-energy through deep rooted vegetation with high rate of transpiration. The biodrainage system consists of fast-growing tree species, which absorb water from the capillary fringe situated above the level of ground water table. The absorbed water is translocated to different parts of plants and finally more than 98% of the absorbed water is transpired into the atmosphere mainly through the stomata. This combined process of absorption, translocation and transpiration of excess ground water into the atmosphere through the deep-rooted vegetation defines the concept of bio-drainage. Trees perform the function of removing water and other



compounds like salts from soil and water and can be called as biological filters for waste disposal. Increase in tree densities leads to increase in root biomass which in turn helps to remove more moisture as well as increases the soil porosity for higher percolation. Fast growing Eucalyptus species known for luxurious water consumption under excess soil moisture condition are suitable for biodrainage. Hence, bio drainage through tree will be an eco-friendly way for reducing salinization and for drainage of excess water in addition to harvesting a quantum of biomass. The characteristics features of waterlogged areas are wet, spongy surface, standing pools of water, poor aeration of soil, dark-colored surfaces in water. The mechanical and physical means of draining the water involves costly measures and the cheap source of drainage is biodrainage.

Advantages of Biodrainage Systems

The advantages of biodrainage systems over the conventional engineering based sub-surface drainage systems are as given below:

1. It is cost effective.
2. Here is no such maintenance cost after third year.
3. There is no operational cost because the plants use their bio-energy to drain out the excess ground water into the atmosphere.
4. There is no such requirement of drainage outfall and disposal of drainage effluent.
5. There is no issue of environmental pollution, as the plants drain out filtered fresh water into the atmosphere.
6. In- situ solution of the problem of water logging and salinity.
7. It can be considered both preventive as well as curative system for waterlogging and salinity.
8. Moderates the temperature of the surrounding by transpiration and a cushion for.
9. It helps in moderating the temperature of the surrounding by transpiration and a cushion for moderating frost, cold and heat wave impacts.
10. It is involved in the process of carbon sequestration.
11. It helps in purification of the atmosphere by absorbing carbon dioxide and releasing oxygen.
12. It provides ways for generating higher income to the farmers due to the production of food, fodder, fuel wood and small timber.
13. It assures people's participation as the biodrainage plantations on farmer's field belong to the individual farmers.

Significance of Biodrainage

Thornburn and George (1999) that the evaporation from the soil takes place up to a depth of 4 m. Therefore, we must have a planning to keep this soil depth of 4m free from waterlogging to minimize the process of salinization of soils and to sustain the productivity of crop. For this, we need fast growing trees like Eucalyptus having their root system penetrating at least up to this depth.

Suitable Tree Species for Biodrainage

Species of tree that can be used successfully for the purpose of biodrainage are: Tamari troupii, *Acacia pennatula, A. tortilis, Casuarina glauca, C. equisetifolia), Eucalyptus camaldulensis, Leucaena leucocephala Casuarina cunninghamiana, Eucalyptus tereticornis, Acacia auriculiformis, Guazuma ulmifolia, Leucanea shannonii, Samanea saman, Albizzia caribea, Senna atomeria, Terminalia arjuna, Pongamia pinnata Syzygium cumini.*

Mechanism of Biodrainage

The root systems of trees expropriate saturated zone or unsaturated capillary fringe above water table and control shallow water table. The primary objective of a bio-drainage system

is to lower a shallow groundwater table to below the critical depth of the capillarity-induced evaporative processes that cause salinization that is 2 m below ground surface (Heuperman et al. 2002; Kapoor 2001). For efficient biodrainage system, trees should be fast growing having high-rate transpiration system so that they absorb sufficient quantity of water from the capillary fringe above the ground water table. The roots of herbaceous annuals have less or no contact with water table. The absorbed water is translocated to different parts of plants and finally more than 98% of the absorbed water is transpired into the atmosphere mainly through the stomata. Under ideal conditions, a tree canopy can reduce the level of water table by 1–2 m over a time period of 3–5 years (Gafni and Zohar, 2001; Heuperman et al., 2002; Kapoor, 2001). The process of absorption, translocation and transpiration of excess ground water into the atmosphere by the deep-rooted plants defines the concept of biodrainage.

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