Eco-physiological Studies on Three Aquatic Plant Species of Ponnani Kolelands

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Abstract

The Kole wetland, one of the largest, highly productive and one of the rice granaries of Kerala, has been declared in Ramsar convention for protection. Ponnani Kole, the study area, is situated in south-west of Malappuram and north-west of Thrissur districts, is the northern most extension of the Vembanad Kole Ramsar site. However, to the best of our knowledge, no solemn attempts were made to study the ecological impacts of these Kole wetlands especially emphasising biodiversity, physico chemical characters and human dependence. The present study is based on field survey and laboratory analysis of selected species. The study reveals the significant variation in stress physiology among plants grown in the area of high ecosystem diversity. It is also noticed, a massive destruction of the vegetation in the Koleland are very high due to natural and anthropogenic activities. Soil erosion also very high in Koleland and this leads to declination of vegetation as well. Study elucidated the physiological changes and related tolerance mechanism that occur in three plants according to the ecological variations during different seasons.

Key words: Ecophysiology, Macrophytes, Kolelands, Antioxidant, Metabolites

Introduction

Wetlands are transitional areas between land and water and are distinguished by wet soils, plants that are adapted to wet soils and a water table depth that maintains these characteristics (Kamau, 2009). The ability of wetlands to transform and store organic matter and nutrients has resulted in wetland being described as 'the kidneys of the landscape (Brix, 1994). Aquatic plants refer to a diverse group of aquatic photosynthetic organisms large enough to be seem with the naked eye, and the vegetative parts of which actively grow either permanently or periodically (for at least several weeks each year) submerged below, floating on, or growing up through the water surface. These include aquatic vascular plants, aquatic mosses and some larger algae. Aquatic plants are grouped into life forms, each of which relates differently to limiting factors and has distinct ecological functions in aquatic ecosystems. Life form groups include emergent macrophytes (plants that are rooted in sediment or soils that are periodically inundated, with all other structures extending into the air), floating-leaved macrophytes (rooted plants with leaves that float on the water surface), submersed macrophytes (rooted plants growing completely submerged), free submerged macrophytes (which are not rooted but attached to other macrophytes or submerged structures) and free-floating macrophytes (plants that float on the water surface). The kole land of Ponnani area is blessed with diversity of ecological characters which are determinately affected the growth and development of the plants growing these area. Minute diversity of the edaphic characters significant changes in the metabolism and related anatomical characters. Even though the plants are growing these changing habitat, they may adapted to survive by adjusting the physiological characters through phytochemical methods. Several tolerance mechanisms are already established by halophytic plants. Based on the mechanisms of tolerance, three plants are selected to screen the ecophysiological methods to survive the changing habitat while the global warming and associated climate changes are happening day by day. In the light of the above mentioned ecological problem, a study is elucidated to pinpoint the detailed ecophysiological characters of three medicinal plants both phytochemically and anatomically.

Materials and Methods

Plants were harvested from the different areas of Ponnani Koleland. Whole plants in each area were carefully cleaned using well water. The present study is an attempt to screen ecophysiological characters of three plants through the detailed study of adaptation by morphological studies such as Leaf area and Stomatal index. In order to explore the detailed physiological aspects, Dry weight distribution, Proline Content (Bates *et al*. (1973), Chlorophyll Content (Arnon (1949), Total Phenolics (Folin and Denis, 1915) Peroxidase activities Heath and Packer (1968) are studied by standard protocol.

Results and Discussion

Morphological Analysis of Aquatic Plants

Bacopa monnieri (Linn.) Pennell Common Name: Water hyssop Local Name: Brahmi (Mal.) Field identification notes: A common slender creeping gregarious patch forming medicinal herb in marshy and wet areas of Ponnani. Stem ascending up to a length of 30 cm indistinctly four sided with 6 to 20 mm long, heart shaped fleshy leaves arranged oppositely without a stalk, 2 leaves at a node. Axillary flowers with a flower stalk, 1 – 2 cm long, white to pink in colour. Habit: Semi aquatic prostrate or creeping annual or perennial herb Taxonomic description: Stem glossy green, glabrous. Leaves glabrous, deccusite, sessile, sacculent, shiny green, obovate, obtuse at apex. Flowers axillary, white with bluish tinge, with a green or black spot inside. Stamens 4, filament unequal in length, fruit a globose capsule, seeds rounded. Phenology: Flowering & Fruiting: Throughout the year. Habitat: Marshy abandoned field and other wet areas like margins of paddy fields. Growing luxuriantly in moist fields, forming a mat of monospecific community, associated with Fimbristylis, Ludwigia etc.

Eleocharis dulcis (N. L. Burman) Trinius ex Henschel Common Name: Chinese water chestnut Local Name: Chelly (Mal.) Field identification notes: An emergent annual sedge very common in the rice fields of Ponnani. 1 to 1.5 m tall, unpluckable deep rhizome. Cylindrical stem like leaves tubular joined end to end septate like a bamboo stick, grass green to dark green in colour. Spike at the tip of the cylindrical leaves. Habit: Erect annual herb Taxonomic description: Stout rhizome with fibrous roots, stem simple tufted, terete, fluted. Leaves reduced to sheaths. Inflorescence terminal, cylindrical spikelet. Stamens 3, hypogynous bristles, 6 –7, styles bifid, anther lobes brown to yellow. Nuts smooth, orbicular, obovoid, planoconvex. Phenology: Flowering & Fruiting: April - August Habitat: Paddy fields, abandoned fields Ecological Notes: Major noxious weed of paddy fields, associated with *N. nouchali, L. hexandra, P. repens* etc. Sometimes forms monospecific community in abandoned fields.

Ludwigia perennis Linn. Common Name: False loose strife Local Name: Kandathil Kanthari (Mal.) Field identification notes: Plants grow in marshes and highly polluted waters in semiaquatic conditions. Leaves linear lanceolate. Stem brownish, profusely branched. Flowers axillary, yellow small, ovary inferior. Habit: Erect herb Taxonomic description: Stem erect glabrous, leaves alternate, lanceolate, margins shallowly serrate, undulate, apex acute. Flowers axillary, yellow, solitary. Sepals 4, petals 4, stamens 4, capsule oblong with persistent sepals, glabrous. Phenology: Flowering: June, November. Leaf flushing: Maximum between June and August. Fruiting: July, December Habitat: Bunds of paddy fields, banks of marshy areas Ecological Notes: Growing interspersed on the bunds of paddy fields and small channels. Associated with A. philoxeroides, L. adscendens etc.

Eco-Physiological Analysis

Number of abiotic stresses, such as drought, heat, heavy metals, soil salinity, flooding, and cold, are responsible for the reduction of the growth, development, and productivity of plants globally. Main content of the water are the chlorides, sulphates and carbonates of sodium, potassium, calcium and magnesium. Sodium is the most predominant cation and chloride is the predominant anion. As a consequence, ion toxicity, lead to chlorosis and necrosis, mainly due to Na+ accumulation that interferes with many physiological processes in plants. The harmful effect of sediment can vary depending on climatic conditions, light intensity, plant species or soil conditions (Table). Most soil adaptive mechanisms in plants are accompanied by certain morphological and anatomical changes. Under high soil stress conditions, plants have to activate different physiological and biochemical mechanisms in order to cope with the resulting stress. Such mechanisms include changes in morphology, anatomy, water relations, photosynthesis, the hormonal profile, toxic ion distribution and biochemical adaptation. Some important salt resistance mechanisms are ion homeostasis, stomatal regulation, ion compartmentalization, osmoregulation/osmotic adjustment, hormonal balance changes, stimulation of the antioxidative defense mechanism, and the accumulation/exclusion of toxic ions from cells and tissues. Leaf growth was found to be significantly reduced due to the different ecological variation among aquatic plant species. Plants showed reduced leaf area but comparatively less retardation in leaf growth was observed in all plants. Stomatal index of plants grown in the Koleland showed significant changes. High salinity areas of Ponnani Kolland resulted in significant decrease of stomatal index in the lower epidermis in comparison with that of other plants. Dry weight distribution of leaf tissue of bot hplants assessed and only negligible fluctuations were observed in the distribution of dry matter content of leaves of the plants. The increase in the proline content during developmental stages of leaves was highly significant. It is believed that Salt-tolerant species show increased or unchanged chlorophyll content under salinity conditions, whereas chlorophyll levels decrease in salt-sensitive species (Table).

Eutrophication is a natural phenomenon of ageing in lakes, where organic material gradually accumulates in the lake basin during the geological history of the lake (UNEP, 1993). Eutrophication can also be defined as the enrichment of water body with plant nutrients particularly nitrates and phosphates, resulting in the nuisance of algal blooms and aquatic macrophytes (Awange and Ong'ang'a, 2006). Increased concentrations of nutrients through runoff from agricultural land and changes in land use which increase run off contribute to eutrophication (Nzengy'a and Wishitemi, 2001). There are usually two consequences of eutrophication on plant communities: (1) an increase in emergent plant biomass and (2) a decrease in plant species diversity at high production levels (McJannet *et al*., 1995). The numbers of rare plants in wetland communities are also known to decrease as nutrient supply increases (McJannet *et al*., 1995). Changes in species composition, loss of overall plant diversity, conversion of a unique flora to one dominated by a few common species, and replacement of native species by exotics have been reported in connection with nutrient enrichment in several types of wetlands (Verhoeven and Schmitz, 1991). The construction of wetlands to reduce the amount of pollutants and nutrients from runoff and waste waters from different sources has become more common in recent years, as a measure to prevent the pollution and eutrophication of the recipient water bodies (Huang and Pant, 2009). Constructed wetlands have been successfully used to retain nutrients from treated wastewaters (Gale et al., 1993; Romero *et al*., 1999). Macrophytes remove pollutants by (i) directly assimilating them into their tissues, (ii) providing a suitable environment for microbial activity and (iii) slowing down water movement flow rates and thereby allowing sedimentation to take place (Nzengy'a and Wishitemi, 2001). Wetlands may be an integral part of integrated riparian management systems and are highly efficient at denitrification because of their large quantities of organic sediments and decaying plant material (Schultz *et al*., 1994).

Conclusion:

The present study has been carried out with the elucidation of ecophysiological changes and related tolerance mechanisms in three selected plants. The study revealed the responses and diagnostic features of three plants such as; *Bacopa monnieri, Eleocharis dulcis* and *Ludwigia perennis*. Morphological adaptations were studied along with the metabolic changes. According to plants growing in different habitats of Kolewetland, plants improved the environmental adaptability by different tolerance mechanisms by adjusting their morphological and phytochemical characters. The analytical data suggested that the ecophysiolgical traits are important for the adaptations of these three plants to survive the changing environment that my influence of light capture, plant growth, development and reproduction. The leaf anatomical traits affecting the photosynthetic assimilate transport, and photosynthetic activity that contribute the ecophysiological aspects of the plants. **Table**: Ecophysiological studied on three selected Aquatic plants

Name of Plant	Leaf Area	Stomatal Index		Dry Weight Distribution	Prolin Content	Chlorophyll content				Total Phenolics	Peroxidase activity
		Lower epidermis	Upper epidermis			Chl. a	Chl. b	Chl.a,b	Total		
Bacopa monnieri	276.9±3.67	31.18±1.70	23.65±1.54	17.77±0.04	0.407±0.01	1.49±0.07	0.86±0.02	1.63±0.07	2.27±0.13	1.78±0.10	23.97±1.03 (4.67±0.16)
Eleocharis dulcis	621.3±2.10	61.13±1.50	46.25±1.24	26.82±0.03	0.915±0.02	0.72±0.02	0.43±0.01	1.67±0.04	1.15±0.07	3.12±0.15	135.7±8.20 (6.54±0.12)
	747.8±2.40	81.37±1.45	53.25±1.20	31.18±0.05	0.785±0.01	0.91±0.02	0.42±0.02	2.16±0.09	1.33±0.08	3.49±0.22	21.43±0.96 (3.45±0.12)
Ludwigia perennis	293.2±4.20	41.23±1.82	25.70±1.48	19.21±0.07	0.311±0.02	1.84±0.10	0.93±0.05	1.97±0.05	2.77±0.16	1.95±0.20	31.36±1.02 (3.06±0.20)

(Values in parenthesis are specific activity) Values are mean of 5 replicates ±standard error)

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