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Characterization of whole plant nutrient utilization efficiency under heterogeneous environmental conditions

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Water is well known, as limiting factor for plant productivity in desert and availability of nutrient has also been determined as a critical factors that limiting plant growth in arid region. In the Thar regions the total amount of annual precipitation may be too small to induce physiological activity, constituently plant have developed adaptations such as intensive internal nutrient cycling to overcome limitation in nutrient uptake. In the work presented here, author assessed variability in whole plant Nutrient Utilization Efficiency (NUE) of plant nitrogen, phosphorus, sodium, potassium, calcium and iron in a woody perennial plant – *Corchorus depressus* under pulse, inter-pulse and non pulse events. ANOVA analysis revealed that seasonal events were non-significant factor for NUE of nitrogen, sodium and calcium, but for other nutrients significant variability were brought by both spatial and temporal factors as well as by their interaction. Community dynamics study revealed that low phyto-diversity of a habitat (*i.e.* dominance of *C. depressus*) supports P NUE in this plant. Higher P NUE were recorded with lower availability of soil P and organic carbon and higher Fe and Ca NUE were recorded with reverse trends of moisture and organic carbon, these finding supported by the theory of nutrient use efficiency suggested that nutrient efficiency increases uni-modally with decrease soil resources. NUE of Na and K increasing with decreasing contents of soil phosphorus in linear and exponential fashions, respectively. However, Na NUE shows synergistic effect with soil nitrogen in exponential manner. Synergistic relationship between total soil N availability and Na NUE indicates the potential role of this plant in bioremediation of salt.

Key words : Pulse, Inter-pulse and non-pulse events, Spatial factors, Nutrient use efficiency, Principal component analysis

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INTRODUCTION

Plant productivity in desert is extremely variable from year to year. Much of variation can be attributes to variation in rainfall (Noy-meir, 1973). In unproductive desert habitats, water availabilities are often highly pulsed, with both frequent and irregular water availability (Cable, 1969; Noy-Meir, 1973; Knapp and Smith, 2001). The importance of this irregularity to plant growth and/or survival is often considered in term of inter-year (Knap and Smith, 2001) or inter-seasonal variation winter versus spring rainfall (Welzin and McPherson, 2000). Goldberg and Novoplansky (1997), gave a "two-phase resource hypothesis" and made the distinction between the period when resources are available ("pulse") and when resource are too low for plant use ("inter-pulse"), during which time most mortality will occur. According to them in low productive environment, these inter-pulses may be the primary environmental factors to which plants respond.

Resource pulses are thought to be important drivers of community dynamics in desert ecosystem (Beatley, 1974). Plants in arid and semi arid systems are primarily limited by water but nutrient may be co-limiting. Summer precipitation pulses can affect eco-physiological parameters directly by increasing soil water availability and also by effects on nutrient availability (Synder *et al.,* 2004). Many short term isotopic and eco-physiological studies have demonstrated that desert plant species, functional groups and life stages differs in the capacity to use summer resources pulse (Schwinning *et al.,* 2002, Ivans *et al.,* 2003). Mathur (2005) reported fluctuation in net negative and positive associations among annuals as well as among perennials in 12 different successional stages during pulse, inter-pulse and non-pulse events.

The term nutrient use efficiency widely used as a measure of the capacity of a plant to acquire and utilize nutrients for production of timber, crops or forages. Definition of nutrient efficiency varies greatly (Gourley *et al.,* 1994). With regards to yield parameters, nutrient efficiency has been defined as the ability to produce a high plant yield in a soil or other media