The Ecological Role of *Cornulalca aucheri* (Amaranthaceae) in the Stabilization of Degraded Sandy Soils in Kuwait: The Case Study of Liyah Area

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Abstract

Cornulaca aucheri is an annual and biannual herb considered as a disturbance indicator currently visible and widely distributed in disturbed lands in Liyah area in Kuwait. Such area suffers from severe land degradation due to multiple interacting factors such as, overgrazing, camping and recreation, gravel and sand quarrying, military activities and natural processes. A restoration program was applied after the quarry surface irregularities were refilled and levelled. During the past 10 years of rehabilitation, noticeable healthy cover of *Cornulaca* sp. has been seen especially around an artificial lake and playas. The existence of such species in high density means that the restoration program was a success and was transitted from bare ground to *Cornulaca* and annual forb state. This is a lower state of Range State Transition Succession model, but it is better than bare soil. *Cornulaca* sp. is a native desert plant that grows in arid conditions. Despite its spiny leaves, it provides good food for camels and increases the supply of milk produced by lactating females. It is about 80 cm tall and has a stem that is branched from the base with new faster greenery growth in the summer. It shows good environmental potential to be managed as natural types used for restoration of degraded lands in desert areas.

Keywords

Land degradation • Range • State transition
State rehabilitation

1 Introduction

Omar (2000) proposed the Range Succession and State/Transition Model (RSST) (Fig. 1). At the upper level of the RSST model, the perennial species dominate and, the range conditions improve. In contrast, annual species overlook and range condition decline at the lower levels of the model. The succession state at Liyah area starts from the lower level (bare land) but after a ten-year protection and restoration, the level shifts to dominant of *Cornulaca* and annual forbs state. The section below high lights the annual plant *Cornulaca aucheri*.

The area of Liyah is about 179 km^2 (1.12% of total area of Kuwait). It is almost flat terrain interrupted by a group of hills including Liyah Ridge (approximately 100 m above sea level), dry valleys and depressions (playas). The abundance of aeolian and gravel deposits led to the gravel extraction activities in the early sixties of the last century (Alhajerif et al. 2008). The soil in the northern part of Liyah area is deflated showing coarse sand or granules and rich with calcium carbonate. The study area suffers from soil crusting, compaction, soil loss, missing silt from the soil, low density of the vegetation cover and loss of biodiversity, due to the extensive gravel extraction activities. The condition of the area was further exacerbated by the rainfall scarcity, intense wind and water erosion.

2 Methods

To achieve our research purposes the following tasks were carried out: Surveying the dominated native plants to identify the range condition. Identifying the morphological parameters (length and width of plant and height of sand body) for 20 Nabkhas of *Cornulaca* plants. Measuring the depth and direction of the roots for five *Cornulaca* plants. Measuring the pH and electrical conductivity for 20 *Cornulaca* nabkhas parameters.

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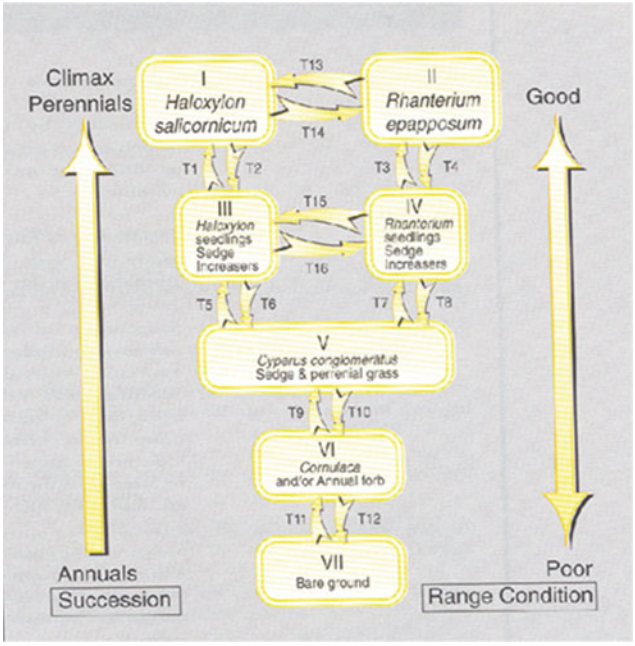

Fig. 1 The succession model for *Haloxylon* and *Rhanterium* community types (Omar 2000)

3 Results and Discussion

In dry seasons the territory of the study area becomes brown, and the majority of the plants appear to be dead. Only *Cornulaca* plants are green and healthy. *Cornulaca* community is one of the most abundant shrubs in rehabilitated Liyah area. They are considered as indicators of land degradation, and poor ingenuity type of annual shrub colonizes the smooth sand sheet about >10 cm thick. The preferred sites for this plant are wadis, depressions, and playas. The plants have spread to areas that were previously dominated by perennial plant such as, *Rhanterium epapposum, Haloxyon salicornicum*, and *Cyperus conglomerates*. This plant grows, blooms and seed sets in the favorable conditions in the summer season. It has stems that branch from the base with new growth in summer, smooth spiny leaves that become stiffer as the plant matures.

It is annual or short-lived perennial, 94.2 cm in average length at the artificial lake and 141.7 in average height at the playa (Table 1), and succulent branched from base. Leaves are linear-filiform to triangular-subulate, 4–10 mm long, greyish-green, recurved, white spine and densely woolly in axils. Flowers 1–8, in axils of leaf-like bracts, surrounded by white hair. It has the ability to form medium sized nabkha. It can be used for sand fixation and for control measures because it can trap sand. The average heights of sand body at the artificial lake and at playa are 67.1 and 82.9 cm, respectively. The morphological measures of *Cornulaca* sp. at playa are larger than around artificial lake. The soils in playa are loosely consolidated than the soil around the artificial lake allowing the deep penetration of roots.

Such plants grow in alkaline soil having a pH value between 7.2 and 7.9 and low electrical conductivity from 2.4 to 3 μS cm^{-1}. Thus there is an adaptation to survive in an arid environment through developing many physical and behavioral mechanisms similar to desert animals. For example, their stem is vertically-erect, coated with waxy water proof cuticles, green that maximize light interception during the early and late hours of the day but avoids the midday sun, because excessive heat may damage the plant tissues and have special fleshy tissues to conserve and store water (Hewitt 1993). The leaves are linear to reduce transpiration and recurved to protect from the wind action and to withstand heat and bright. Their leaves have special modification, they ended with a silver spine and stomata chamber covered with hair to reflect the light and the heat. The root

Table 1 The morphological dimensions of *Cornulaca* sp. around the artificial lake and playa in Liyah, Kuwait

No.	Artificial lake			Playa		
	Length (cm)	Width (cm)	Height of the sand body (cm)	Length (cm)	Width (cm)	Height of the sand body (cm)
1	143	147	68	130	120	107
2	130	149	84	133	133	80
3	79	80	71	130	185	103
4	102	100	67	122	128	82
5	111	135	58	154	155	73
6	92	99	81	147	142	71
7	85	90	72	157	155	70
8	60	88	65	122	105	67
9	70	72	47	167	125	94
10	70	90	58	155	142	82

Table 2 Depth of roots (cm) of *Cornulaca* sp. playa, Liyah

No	Length of root (cm)	Direction
1	55	Vertical
2	50	Vertical
3	100	Horizontal
4	70	Vertical
5	90	Vertical

system sustains growth in dry periods by extending either horizontally or vertically according to water availability in the soil, thus offsetting the effects of drought. This root system can also penetrate deeply into the soil about one meter to reach moisture level (Table 2). These shrubs can survive in the dry ecosystem due to their ability to harvest rapidly and efficiently from limited water resources, such as mist and dew. Habitats of these water preserving plants are often in areas with high temperatures and low rainfall. In addition many native plants prefer to grow inside or near *Cornulaca* shrub. It supplies food and shade for other plants.

4 Conclusion

Desert shrub plant can be used for rehabilitation programs in degraded soil for the following socioeconomic, environmental and ecological criteria (SER news 2016):

- the capacity to grow in nutrient-poor soil,
- the ability to grow on the disturbed area, undulating sandy plains, sand sheet, gravelly plains, rocky debris, top and slopes of sand accumulation and off roads,
- the modification of root system (horizontal or vertical) that can quickly reach the residual soil moisture,
- they are equipped to survive in an ecosystem that contains scarce water sources,
- the rapid growth in summer season and the ability to regenerate easily,
- the potential to control shifting sands through the development of small nabkha,
- the ability to resist strong wind, hot temperature and lightness during the day,
- the capacity to provide forage for wildlife and livestock especially for camels,
- the capability to assist in protection of soil against movement by wind or water and,
- they have a high artistic value in bringing diversity and color to the arid landscape.

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