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The role of dominant perennial native plant species in controlling the mobile sand encroachment and fallen dust problem in Kuwait

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Abstract

In arid and semi-arid regions, the dust storms are a common phenomenon. Kuwait is an arid country and most of the lands are desert with low density of vegetation cover. Therefore these areas are exposed to dust most of the year. With the effect of wind particles move in three different modes of transport as creep, saltation and suspension. The saltating particles on hitting the surface dislodge particles to air, they remain in air for longer period and this process is called suspension. This commonly form thick sand cloud across the country during dust storm. The total numbers of dusty days in Kuwait are 255.4 days. It means that sandstorms and dust storms occur almost all the year. Most dominant plant species have the ability to trap sediments (sand and fallen dust) and form sandy mound around it called nabkha. There are three types of nabkhas based on their sizes: small, medium and large nabkha. The efficiency of trapping sediment depends on the height of canopy and size of bush of nabkhas. Different perennial plant species can form nabkhas such as *Haloxylon salicornicum, Cyperus conglomerates, Rhanterium epapposum, Astragallus spinosus,Citrullus colocynthis, Halocnemum strobilaceu*, *Salicornia europaea*, *Tamarix aucheriana, Lycium shawii* and *Nitraria* retusa. Each plant must reach 10-15 cm in height before they can effectively trap sand. Once trapped in a nabkha, these cemented particles do not readily become wind re-entrained. Individual plant can form nabkha with unique sedimentological and morphological characteristics. The efficiency of the plant species in trapping sand was measured by estimating the volume of trapped sand for each plant. *Nitraria retusa, Haloxylon salicornicum and Lycium shawii* are the most efficient plant species in Kuwait in trapping mobile sand. These species trapped an average of 2 m^3, 1.25 m^3 and 1.2 m^3 respectively, of mobile sand and fallen dust. Most surface sediments consisted of coarse, medium, fine and very fine sand and few mud. Native plant species plays a major role in minimizing, controlling and reducing fallen dust.

Keywords: Fallen dust, nabkha.

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1. Introduction

The surface of Kuwait is flat to undulating due to different sizes of sand dunes. The dominant soils are sandy. The climatic conditions are hot, dry, windy summer and cool to mild winter with scanty rainfall. The average annual rainfall is 110mm. Strong dominant north westerly winds blow most of the year causing different forms of aeolian process (254 average annual dusty days; Al-Dousari et al., 2012). In addition to environmental factors, anthropogenic activities and misuse of lands further triggers ecosystem disturbances. Due to these consequences the soil surface becomes vulnerable to land degradation resulting into dust storms, causing serious environmental and socio-economic problem. The mobile sand accumulates around and attacks buildings, roads, airbases, farms and other man-made constructions. Under such circumstances it is believed that current methods to combat desertification are not sufficient and therefore more resilient methods are needed to combat desertification. For instance, the encroached sand if mechanically removed and dumped in appropriate ways, will not result into further environmental problem, otherwise may cause problem elsewhere. The cost of this mechanical operation to remove sand is very high. It is therefore important to find sustainable ways to tackle such issues in the desert environment of Kuwait. The unsustainable ways are time consuming and non-economical.

This most appropriate ways are biological methods to control the effect of wind erosion through native plants having the ability to survive in harsh climatic conditions and trapping moving sands into nabkhas.

To address the objective of this study, field studies have been conducted to find best plant species that form sandy mound around plant called nabkha as shown Fig. 1. Nabkha is an Arabic word denoting a small sandy hillock (Cooke et al., 1993, Khalaf et al., 1995). Gautier & Chudeau (1909) defined as sandy mound around vegetation. These vegetated nabkhas the have ability to trap mobile sands moving by creep and saltation close to the ground surface. Different perennial plant species can form nabkhas either desert nabkhas (such as *Lycium shawii, Panicum turgidium, Cyperus conglomerates, Rhanterium epapposum, Astragallus spinosus*) or sabkha nabkha (e.g., *Haloxylon salicornicum, Halocnemum strobilaceu, Salicornia europaea, Tamarix aucheriana* and *Nitraria retusa*). Sabkhas are salt-scalds found mainly in the coastal lands of Kuwait and therefore plants creating sabkah nabkha are highly salt tolerant. A study carried out by Al-Dousari et al. (2008) has shown that each plant must reach 10-15 cm in height before they can effectively trap sand. Once sand particles are trapped in a nabkha, over time they are aggregated due to the presence of calcium carbonates which has cementing capacity and this way the sand particles in nabkhas are fixed and become less prone to wind erosion. Individual plant can form nabkha with unique sedimentological and morphological characteristics. Moreover, nabkhas around the same plant in one area exhibit changeable morphological features according to local wind statute.

Fig. 1. Nabkha developed around *Haloxylon salicornicum.*

2. Methodology

Field studies were conducted to investigate the morphological properties of nabkha by determining their length, width and height. These nabkhas were selected in Kuwaiti deserts (non-saline) and in salt-scalds (sabkhas) as shown in Table 1. The efficiency of the plant species in trapping sand was measured by estimating the volume of trapped sand for each plant using the double semi-conical formula (Al-Dousari et al. 2008)

$$V=1/6(W * H * L) \quad (1)$$

where V is the volume of the trapped sand in m^3, W is width of nabkha in meters, H is the height of nabkha and L is length of nabkha in meters.

Table 1. List of dominant perennial plant species within different areas in the desert of Kuwait farming nabkhas.

Perennial Plant Species	Vernacular Name
Rhanterium epapposum	Arfaj
Haloxylon salicornium	Rimth
Lycium shawii	Awsaj
Nitraria retusa	Ghardaq
Halocenum strobilaceum	Theluth
Salicornia europaea	Khraiza
Astragalus schimperi	Kidad
Panicum turgidum	Thamam
Tamarix aucheria	Tarfa
Citrulus colocynthis	Hanthal
Cyperus conglomeratus	Thandah

3. Result

During the field investigation, it has been observed that nabkhas in Kuwait are of different sizes and shapes. The majority of the nabkhas are triangular subjugated by the long leeward tail and shorter windward nose. In Kuwait, desert nabkhas are typically short, infrequently exceeding 105 cm in height and have varying lengths. On the other hand, sabkha-nabkhas are hillock-shaped and more elongated. Nabkhas can be characterized into three types: small, medium and large (Fig. 1). Small nabkhas form under *Cyperus conglomerates, Halocnemum strobilaceum, Salicornia europaea* and mediun nabkhas

occur around *Citrulus colocynthis, Astragallus spinosus*, and *Rhanterium epapposum*. Large nabkhas have been found in *Lycium shawii, Nitraria retusa, Haloxylon salicornicum* and *Tamarix aucheriana*. The large nabkha have largest size of bush and highest canopy so it was effective in trapping sediment close to the ground surface. The plant width plays an important role in controlling the shape of the nabkhas. The wider the plant, the longer the nabkha will be (e.g., *Lycium shawii, Nitraria retusa, Haloxylon salicornicum* and *Tamarix aucheriana*).

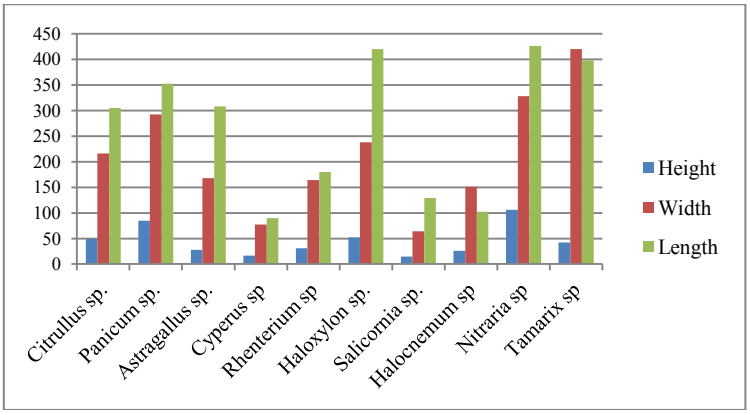

Fig. 2. Morphological parameters within nabkhas of dominant plant species. The size is in cm.

The efficiency of the dominant plant species in trapping and preventing sand movement was measured by estimating the volume of trapped sand for each plant. Fig. 2 shows that *Nitraria retusa, Haloxylon salicornicum* and *Lycium shawii* are the most efficient plant species in Kuwait in trapping mobile sand. These species trapped an average of 2 m^3, 1.25 m^3 and 1.2 m^3 mobile sand respectively.

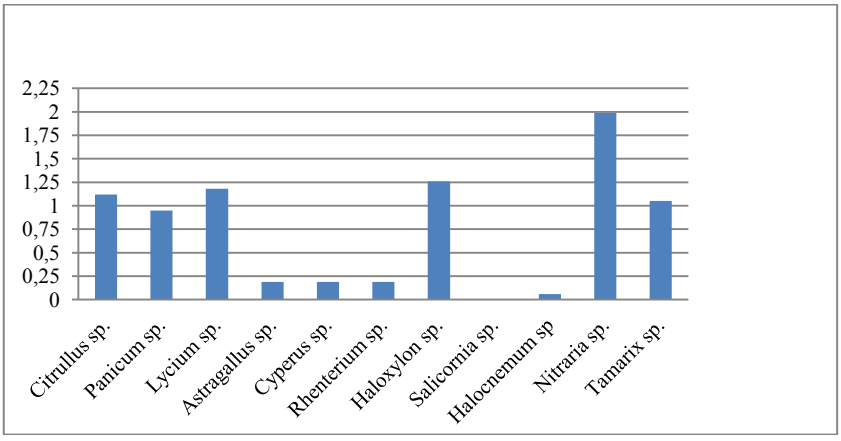

Fig. 3. The average amounts of encroached sand around in cubic meter trapped by nabkhas of different perennial plants in Kuwait.

4. Recommendations

The rangelands productivity in Kuwait is suffered from severe degradation. The rehabilitation of these degraded rangelands by using native plant species that have the ability to form nabkhas is more appropriate for sand control measures. The vegetation mounds are relics of wetter environmental conditions. The trapped sand on the nabkhas protects, conserve and feeds the plant with water and nutrients until it reaches beyond the ability of root system to reach water stored in the mound, then plant died. It is recommended to include native species efficient at mobile sand control such as *Tamarix aucheriana*, *Nitraria retusa* and *Haloxylon salicornicum* for sabkha environment, and *Lycium shawii, Panicum turgidum* and *Citrulus colocynthis* for open desert environment.

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