The Potential of Using Organic Amendments for Improved Revegetation of Native Plants in Kuwait's Desert Lands

Ali M Quoreshi, Sheena Jacob, Mini T. Sivadasan, Rini R. Thomas, Anitha Jasmine and Anisul Islam
Desert Agriculture and Ecosystems Program, Environment and Life Sciences Research Center
Kuwait Institute for Scientific Research www.kisr.edu.kw

Abstract

Revegetation effort with native plant species in Kuwait's desert soils is highly challenging due to poor in soil structure, lack of organic matter, limited moisture retention capacity, and low nutrients. Therefore, effective research is essential in the area of soil system improvement in order to improve revegetation of native plants, biodiversity conservation, and desert rehabilitation activities. A trial was proposed to develop an effective revegetation and restoration technique, and to test the effectiveness of different rates of alfalfa green (AG) pellets as an organic amendment on the success of revegetation of native grass species. The alfalfa pellets are usually used as soil amendment and contain a full range of naturally occurring slow release of micro and macro nutrients as well as plant growth stimulant. It is expected that alfalfa green pellets may improve soil structure and moisture retention capacity. In this study, alfalfa pellets were applied at the rate of 5000 kg/10000 m^2, 10,000 Kg/10000 m^2, 15000 Kg/10000 m^2, and no alfalfa pellets applied as control. These four levels of treatments were assigned to both irrigated and non-irrigated plots. Seeds of *Pennisetum divisum* and *Cenchrus ciliaris* were sown at a rate of 17.7 Kg/ha. In general, results indicate that there was increase in plant biomass and growth in both grass species when the plots received alfalfa pellets and also with increase in the amount of alfalfa amendment. The nitrogen uptake (N content mg/per plant) was also found to be increasing in both irrigated and non-irrigated plots when treated with alfalfa pellets compared to control plots for both the grass species. The preliminary results demonstrate the potential of using alfalfa pellets as desert soil amendment for improving growth and establishment of native grass species in degraded desert soils.

Introduction

- Soils of Kuwait's desert are generally sandy with extremely low in organic matter (<1%), having very low nutrients and high amount of calcareous material (Mahdi and Suleiman, 2002). The desert lands are known to have low moisture availability as well as low water-holding capacity. Short growth period, unpredictable environment with respect to availability of water and extreme arid conditions are some of the factors influencing the growth and establishment of native desert plants. Therefore, some effective restoration methods need to be followed to promote quick establishment of initial native cover plants (Suleiman et al., 2010)
- Desert sandy soil typically has low available water-holding capacity and lacks organic matters is low in essential nutrients. This study was intended to investigate the possibility of improved establishment of native grass species when using different levels of AG pellets as an organic amendment, and also to provide useful information and some insight on the capacity of alfalfa green pellets to improve soil structure and soil moisture retention capacity, enhance the native microorganism populations which are of fundamental importance in facilitating proper environment for plant establishment and growth on sandy desert soil.

Objective

- To evaluate the effectiveness of Alfalfa Green (AG) pellets in the successful establishment of two grass species *(Pennisetum divisum* and *Cenchrus ciliaris*) on sandy desert soils.

Methods

- The methodology encompasses a field trial and testing feasibility of using AG pellets with or without irrigation to improve soil structure, soil moisture retention capacity, and natural slow release of nutrients, and consequently, better revegetation success and quick vegetation cover. A seed mix of two grass species was selected for this study and applied to all treatments. This research was designed with field plot establishment in desert soil condition. The experiment was conducted using a split-split plot randomized design with eight treatments and three replicates. The individual treatments were assigned randomly in each plot. The treatments were divided into two groups: irrigated and non-irrigated plots. Each application rate of AG pellets in both irrigated and non-irrigated group had 3 replicates for a total of 24 experimental units. Each group was treated with AG pellets at the following rates: 0, 5, 10, and 15 metric tons/ha. The pellets were applied as top dressing and then incorporated into sand using rotovator at 20 cm depth.
- Seeding for both the grass species was done at the rate 17.7 Kg/ha. After one growing season, data was collected on total plant biomass, soil physical characteristics (bulk density), and plant nutrient analysis (for determining tissue nitrogen concentration). Nitrogen content per plant was calculated using the formula (Timmer, 1997);

$$\text{Nitrogen content / plant} = \frac{\%\ \text{nitrogen} * \text{dry biomass of plant (mg)}}{100}$$

Results

- Preliminary results indicate that there was increase in plant biomass with increase in the amount of alfalfa amendment compared to control treatment (Figs 1 &2).
- Soil bulk density is shown in Table 1, and it was found to reduce with alfalfa amendment.
- Compared to control treatment, the nitrogen content per plant was increased in both irrigated and non-irrigated plot by increasing the amount of alfalfa amendment for both the plant species (Fig 3 & 4).

Conclusions

- An optimum range of 10 tons/ha of alfalfa provided better conditions for facilitating establishment and to obtain maximum biomass production for *Cenchrus ciliaris*.
- Whereas 15 tons/ ha of alfalfa is required for better establishment and maximum biomass production for *Pennisetum divisum*.
- An obvious positive trend of increasing nitrogen content per plant with increasing rate of alfalfa application for both the plant species indicate the efficient nutrient uptake occurred when using AG pellets to desert soil.
- However, the results presented here should be treated as preliminary and additional data and validations in final data collection are pending.

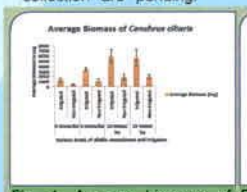

Fig. 1. Average biomass of *Cenchrus ciliaris* at various levels of alfalfa amendment and irrigation.

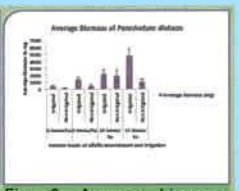

Fig. 2. Average biomass of *Pennisetum divisum* at various levels of alfalfa amendment and irrigation.

Fig. 3. Nitrogen content per plant in *Cenchrus ciliaris*.

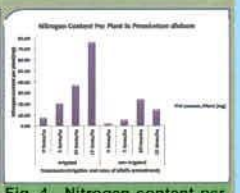

Fig. 4. Nitrogen content per plant in *Pennisetum divisum*.

Treatments (rate of alfalfa amendment)	Irrigation	Average Initial bulk Density (g/cm3)	Average bulk Density (g/cm3) (after alfalfa amendment)
0 tones/ha	Irrigated	1.7	1.7
	Non iirigated	1.6	1.6
5 tones/ha	Irrigated	1.7	1.5
	Non iirigated	1.7	1.6
10 tones/ha	Irrigated	1.7	1.5
	Non iirigated	1.7	1.5
15tones/ha	Irrigated	1.7	1.5
	Non iirigated	1.7	1.5

Table1. Average bulk density before and after alfalfa amendment.

Fig.5. Rotovator in use for alfalfa amendment into the desert soil.

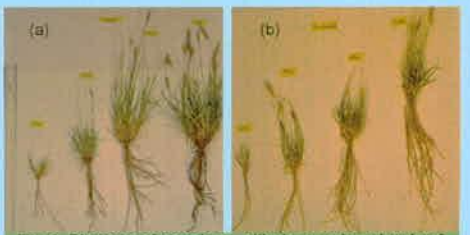

Fig. 6. Biomass of *cenchrus ciliaris* at various levels of alfalfa amendment (0, 5, 10, 15 tones/ha) in (a) irrigated plot (b) non irrigated plot.

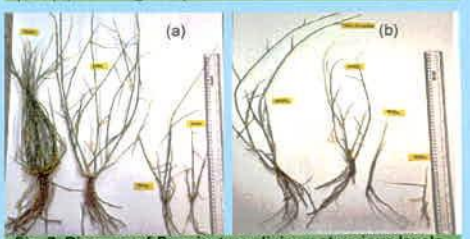

Fig. 7. Biomass of *Pennisetum divisum* at various levels of alfalfa amendment (0, 5, 10,15 tones/ha) in (a) irrigated plot (b) non irrigated plot.

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Researchers Contact Details: Dr. Ali M.Quoreshi, Desert Agriculture and Ecosystems Program, Environment and Life Sciences Research Center, Kuwait Institute for Scientific Research, Safat, Kuwait. E.mail: aquoreshi@kisr.edu.kw