Establishment of Arfaj (Rhanterium epapposum) Community as Fundamental to Mitigate Climate Change in Kuwait

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Introduction
Climate Change Impact on Biodiversity in Kuwait

• The region is threatened physically and biologically by the global warming phenomena.
• More severe and harsh climatic conditions will cause increase in formation of sand dunes, sand encroachment, and extreme dust storms.
• Drought will cause more water demand for local consumption and irrigation.
• Losses in plant cover will be due to sand encroachment or erratic rainfall periods causing runoff and flooding.

Native Plants and Climate Change

- “Many rare, threatened, and endangered native plants are more susceptible to extinction caused by climate change due to small population sizes and limited suitable habitat types.” [https://www.dfg.ca.gov/habcon/plant/clima](https://www.dfg.ca.gov/habcon/plant/clima).

- “Invasive plant species pose a threat to native plants because invasives tend to do well in the changing conditions that climate change is thought to promote” [https://www.dfg.ca.gov/habcon/plant/clima](https://www.dfg.ca.gov/habcon/plant/clima).

Large-scale Restoration Program

- The United Nations Compensation Commission awarded the State of Kuwait about 800 m USD for restoration of damaged lands due to the invasion of Kuwait in 1990-91. “Kuwait Environmental Remediation Program (KERP)”

- Five areas have been designated for restoration of damaged ecosystems.

- A revegetation program is established for re-vegetation of damaged lands by massive production of native plants involving private producers.
Total Protected Area: 1,680 km²

Requirements:
3k kg native seeds, 24 m seedlings and 699k trees in 8 years
Re-vegetation of 79.2 km².
Key native plants of Kuwait
Farsetia aegyptia  
Brassicaceae

Rhanterium epapposum  
Asteraciaea

Calligonum comosum  
Polygonaceae

Cenchrus ciliaris  
Poaceae
Panicum turgidum
Poaceae

Pennisetum divisum
Poaceae

Lasiurus scindicus
Poaceae

Cyperus conglomeratus
Poaceae
Arfaj (*Rhanterium epapposum* Oliv.)

- It is the national plant of Kuwait and one of the two climax plant species covering 2% of Kuwait.
- It is a C₃ desert shrub that can form monotonous stands covering vast areas of north-eastern Arabia and grows as a perennial woody shrub approximately 80 cm high with many stems branching out from the base.
- Its restoration is essential to maintaining cultural heritage, ecological integrity, conservation of wildlife habitat and species, environmental sustainability and preserving recreation opportunities.
- Was selected for this study because of its widespread appearance, versatile use and potential to adapt to most of Kuwait’s landscapes.
Objective

To establish simple and economically feasible method to propagate *Rhanterium* massively by involving local producers so that it can be used in revegetation of degraded lands.
Methodology

- Seed collection
- Seed processing
- Seeding & germination
- Acclimatization
- Transplanting
- Field planting
- Monitoring
Seed Collection

1- Abdali
2- Subbiya
3- Sulaybia
4- Wafra
Seed processing
Seed processing equipment & tools
Seed storage room
Seed Germination
Transplanting
Acclimatization
Irrigation system installation
Monitoring
Results
Result and analysis of *Rhanterium* seed germination during late summer (season 1) and late winter (season 2)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Season 1</th>
<th>Season 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groups</strong></td>
<td>Average</td>
<td>Variance</td>
</tr>
<tr>
<td>1.Seeds without any treatment (control)</td>
<td>78</td>
<td>5.33</td>
</tr>
<tr>
<td>2.Seeds without any treatment, roofed</td>
<td>69</td>
<td>5.33</td>
</tr>
<tr>
<td>3.Seeds oven dried, unroofed</td>
<td>89</td>
<td>40.00</td>
</tr>
<tr>
<td>4.Seeds oven dried, roofed</td>
<td>70</td>
<td>12.67</td>
</tr>
<tr>
<td>5.Seeds wetted with water, unroofed</td>
<td>75</td>
<td>3.33</td>
</tr>
<tr>
<td>6.Seeds wetted with water, roofed</td>
<td>65</td>
<td>28.67</td>
</tr>
<tr>
<td>7.Seeds oven dried and wetted, unroofed</td>
<td>72</td>
<td>22.67</td>
</tr>
<tr>
<td>8.Seeds oven dried and wetted/roofed</td>
<td>92</td>
<td>2.67</td>
</tr>
<tr>
<td>9.Seeds threshed, unroofed</td>
<td>82</td>
<td>34.67</td>
</tr>
<tr>
<td>10.Seeds threshed, roofed</td>
<td>85</td>
<td>54</td>
</tr>
</tbody>
</table>
Findings

- The upright positioning and exposed nature of capitulum in the soil are the two important things to consider for good seed germination.

- Acclimatization of container grown plants after germination is of importance in developing proper root system before planting into the field.

- The optimal season remains the month of November.
### Drip irrigation system details

<table>
<thead>
<tr>
<th>Number</th>
<th>Drip Irrigation Details</th>
<th>Emitter Status</th>
<th>Pipe Status</th>
<th>Dripper Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central line gives water through flexible hoses on either side of the main line</td>
<td>Attached with flexible hose</td>
<td>Exposed to open sunlight</td>
<td>2 liter/hour</td>
</tr>
<tr>
<td>2</td>
<td>Central line gives water through flexible hoses on either side of main line</td>
<td>Attached with hose but 10cm above ground with support of pipe</td>
<td>Covered except emitters</td>
<td>2 liter/hour</td>
</tr>
<tr>
<td>3</td>
<td>Central line gives water direct by making special holes on the pipe</td>
<td>No emitters, holes on pipe</td>
<td>Exposed</td>
<td>2 liter/hour</td>
</tr>
<tr>
<td>4</td>
<td>No irrigation lines, depended on rainfall</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

- **Central line** gives water through flexible hoses on either side of the main line.
- **Attached with flexible hose**
- **Exposed to open sunlight**
- **2 liter/hour**
Average height of the plants under three drip irrigation systems

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip 1</td>
<td>47.71</td>
<td>29.24</td>
</tr>
<tr>
<td>Drip 2</td>
<td>53.71</td>
<td>47.24</td>
</tr>
<tr>
<td>Drip 3</td>
<td>48.71</td>
<td>36.24</td>
</tr>
<tr>
<td>Control</td>
<td>25.43</td>
<td>81.62</td>
</tr>
</tbody>
</table>
Average quantity of capitulum of the plants under three drip irrigation systems

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip 1</td>
<td>2,923.86</td>
<td>1,540,368</td>
</tr>
<tr>
<td>Drip 2</td>
<td>3,174.71</td>
<td>3,296,647</td>
</tr>
<tr>
<td>Drip 3</td>
<td>3,153.86</td>
<td>957,432</td>
</tr>
<tr>
<td>Control</td>
<td>1,014.00</td>
<td>476,611</td>
</tr>
</tbody>
</table>
Conclusions

- The establishment of Arfaj (*Rhanterium epapposum*) community has been a great success at the farm level and can be adopted in other farms.

- The economic feasibility of establishing Arfaj community in a large scale has been assessed and found that the reported methodology could be effectively used with some modifications of the irrigation system in the field.
The present methodology proved to be highly effective to establish native plant communities in order to restore degraded lands.

The resultant plant community will soon start hosting a number of insects, rodents, birds, and other fauna, which eventually help to create an ecosystem within a limited time period.

Local producers can be involved in restoration programs by producing native plans for multiple uses.

The impact of present strategy on mitigating greenhouse emissions needs further study.
Kuwait Climate, Water and Vegetation Programme

KISR
Development of decision support tool for the terrestrial biodiversity of Kuwait
Eng. Waleed Roy

KUWAIT UNIVERSITY
Remote sensing project
Dr. Hala

MIT
Climate Modelling project
Pro. Fatih

MIT
Eco-Hydrological modelling
Pro. Rafael

Funded by Kuwait Foundation for Advancement of Sciences
MIT MODELS

- **Tin-Based Real-Time Integrated Basin Simulator (t-RIBBS) model** that simulates future predictions of biodiversity when coupled with two other models.
- These other coupled modules are the **Bartlett Lewis Model** for stochastic generation of rainfall, which captures high intensity spatially variable events.
- And the **VEGGIE Model** to incorporate dynamic vegetation. The latter model simulates how different plant functional types survive in such arid conditions.

*The interaction of these projects will give a clearer vision and understanding of past, present and future aspects of the biodiversity of Kuwait.*