Growth form and germination requirements can shape plant diversity and community structure in arid Arabian deserts

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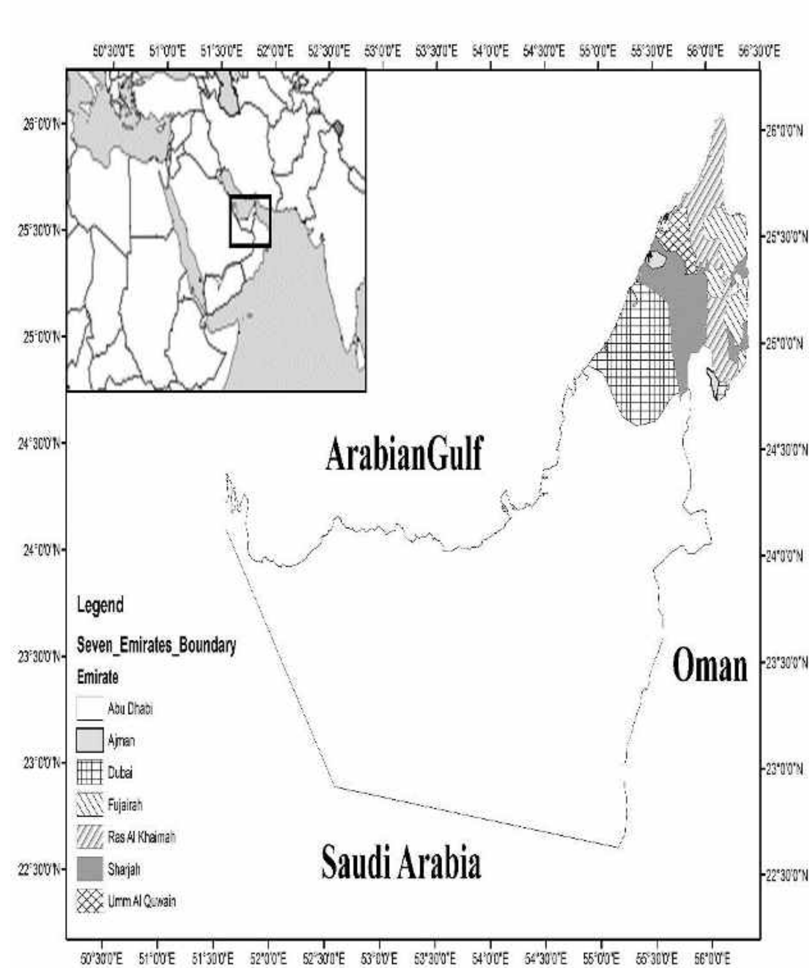
Study area

- The United Arab Emirates (UAE) is located at the southeastern part of the Arabian Peninsula.
- It is hyper-arid region with a hot-sunny climate and low sporadic rainfall.



Overview

- Seed dormancy is an adaptation of many plant species in unpredictable heterogeneous environments, such as arid desert.
- Dormancy advantage, delay seed germination until the arrival of favourable conditions that allow seedling establishment and minimize seedling mortality.
- Light, temperature and moisture are the most important factors that determine germination time and place in desert environments.

Overview

Seed size:

- Generally, large seeds produce bigger seedlings with better competitive ability than smaller seeds, especially under resource-limited.

Overview

- In general, dormancy is negatively correlated with seed mass and size.
- lower dormancy in large-seeded species and high dormancy in small-seeded species.
- Opposite trend reported by Wang et al. (2016), he investigated the relationship of seed mass and dormancy in 124 species found that heavier seeds (> 1 mg) had higher dormancy than smaller seeds (<0.1 mg).

Overview

Growth Form:

- In trees, The heavier diaspore unit (fruit or seed) of trees might be dispersed down by gravity or dispersed away from the crown.
- Small shrubs have dense short canopy laid over the ground so limit the dispersal for heavier seeds, but lighter seeds have the chance to be dispersed by winds.
- Herbs have shorter opened crown that might allow their lighter seeds to disperse far away from maternal plants.

- **The relationship between storage place and growth form would be especially important for species have aerial seed bank.**

Growth forms

Aims

Assess the impact of plant growth form, seed storage, and seed size on light and temperature requirements during germination of 23 desert plants with aerial seed bank.

Methods

- **Mature fresh** seeds of the 23 species were collected during **May – June 2015** from the northern emirates, UAE.
- These fresh seed **divided into two parts;** one part was germinated immediately and the second stored in brown paper bags at room temperatures (20±2 ºC) until their germination with field storage seeds.
- **In February 2016, field storage seed** of the same species were collected (from the canopy or soil) and germinated.

Methods

- The germination was conducted in petri-dishes containing one disk filter paper, with 10 ml distilled water.
- Four replicates of 25 seeds.
- Fresh and stored seeds were germinated in three programmed incubators set at 15/25°C, 20/30°C and 25/35°C in both alternating 12h light/12h darkness and continuous darkness .

Methods

Methods

- Germination recorded with emergence of the radicle.
- Germinated seedlings were counted and removed every alternate day for 24.
- average seed mass was determined by weighing three replicates, each of 100 seeds.
- average seed size was assessed by measuring the length of 50 seeds.

Methods




Methods

- Assessed final germination percentage, Relative light germination (RLG, expresses the light requirement for seed germination), and The germination rate (GRI).
- Used ANOVA and Pearson correlation coefficients to data analysis by using SYSTAT, version 13.0.

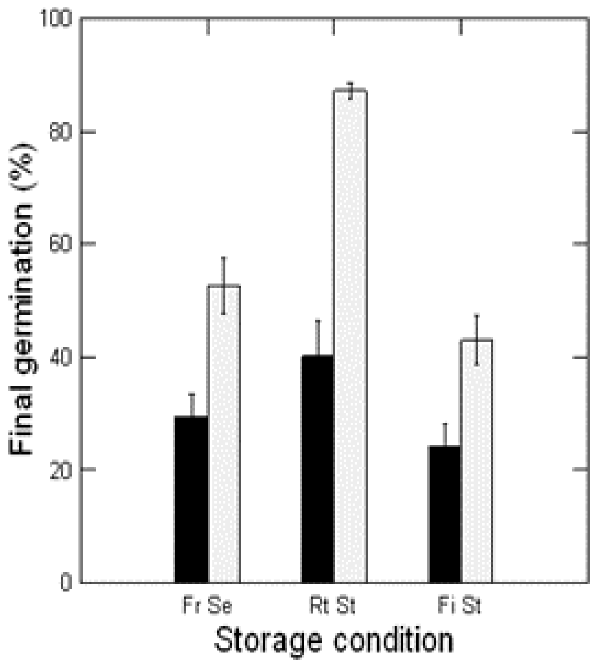
Results

- Herbaceous plants have smaller and lighter seeds.
- Room temperature storage improved final germination.
- Germination of herbaceous and trees species was greater than that of shrubby plants.
- Germination in light was greater than in darkness.
- Unlike light, temperature had limited role in seed germination

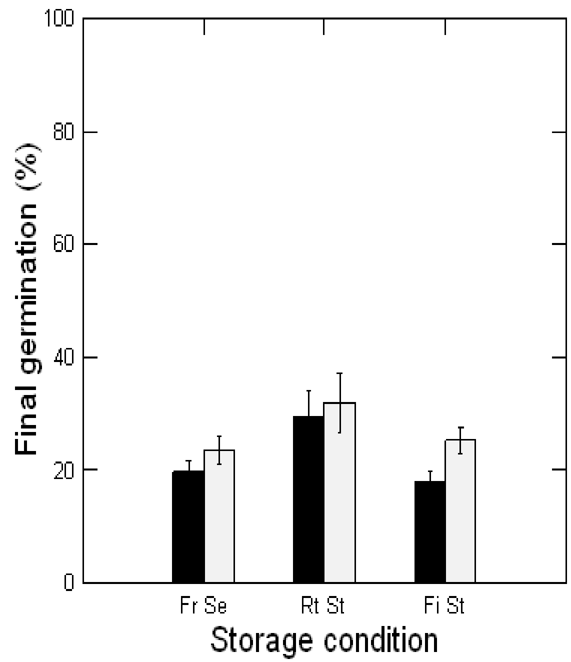
Results

- Final germination of growth form.

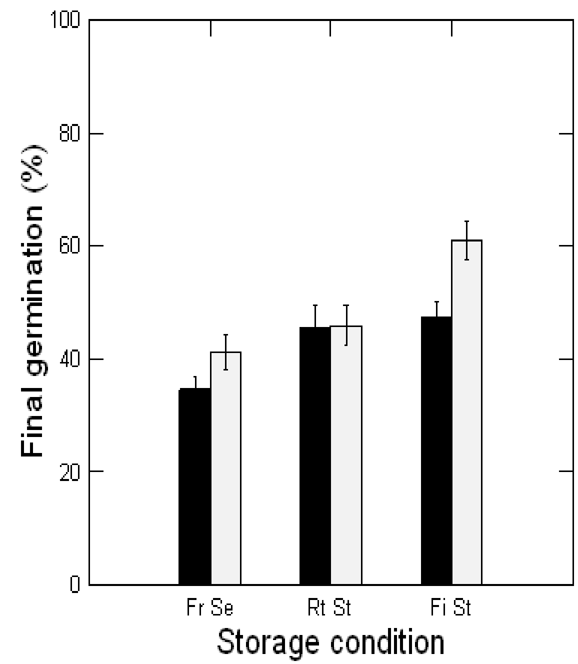
Herbaceous



Shrubs

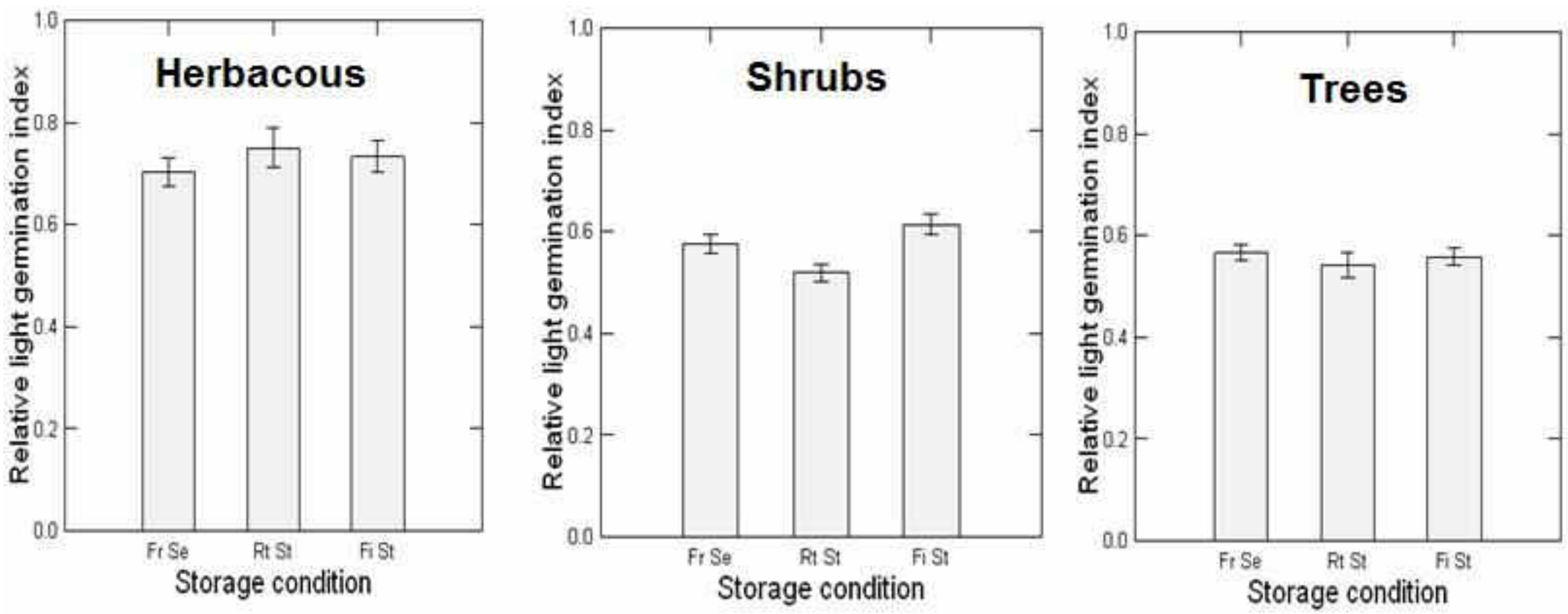


Trees



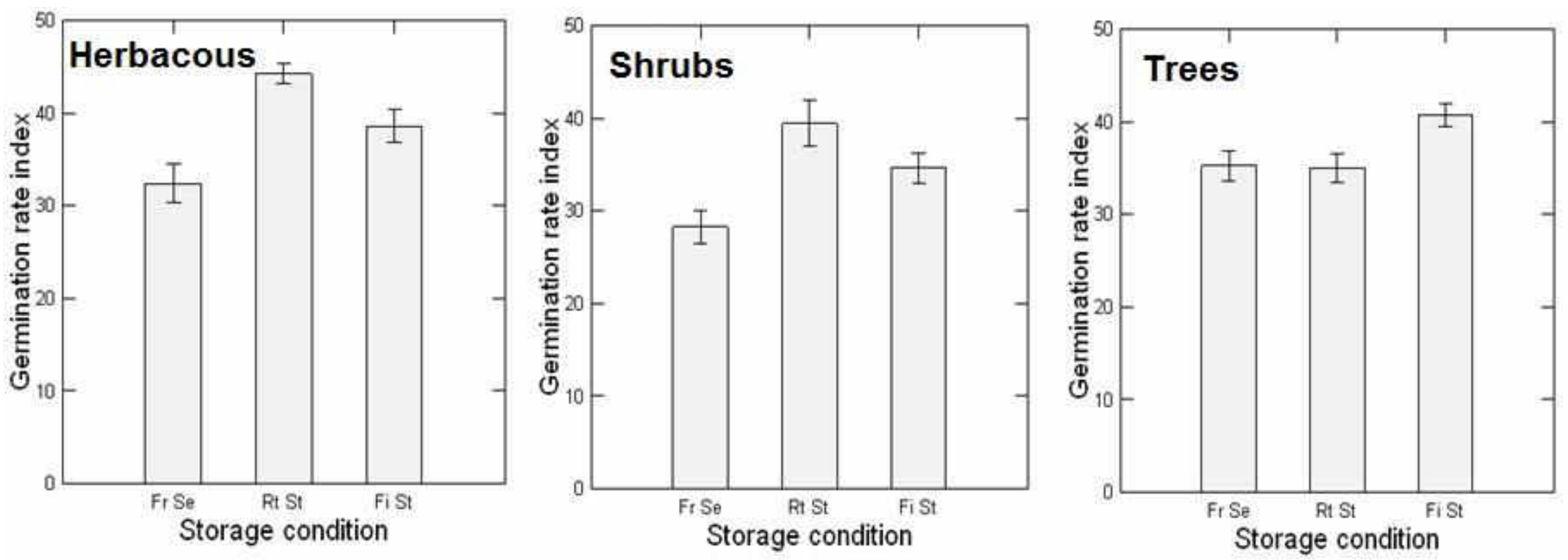
Results

- RLG was positively photoblastic (near from 1 value) in herbaceous plants (0.73), but was neutrally in both shrubs and trees (near from 0.5 value).



Results

- **(GRI),** Both herbaceous and shrubby species, room temperature seeds attained faster germination than fresh seeds and field stored seeds.



Results

- **The relationships between seed size and final germination :**

- P**ositive in dark** and negative in light. This indicates that more large-seeded-species germinated better in dark, but more small-seeded species germinated better in light.

- Germination was positive in herbaceous and trees, but negative in shrubby species.

Results

- The relationship between seed size and LGI was positive in shrubs; but was negative in herbs and trees.
- GRI was greater for bigger seeds of herbs and shrubs. But in trees the greater was for small seeds.

Discussion

- **Generally,** shrubs and trees attained lower germination than herbaceous plants. This indicates that smaller seeds germinate much more than larger seeds.
- Smaller seeds of herbs have greater chance for dispersal with winds than larger seeds of the other growth forms and explore new favourable condition, especially in the unpredictable desert habitats.

Discussion

- **In herbaceous plants,** the small-seeded herbs contribute their seeds to soil seed bank, but large-seeded invest more in their regeneration.

- Herbs with small seeds distribute the risk along time and retain a fraction of un-germinated seeds for the future.

Discussion

- Small-seeded herbs required more light for germination, but large-seeded ones germinated better in darkness.
- Small seeds buried too deep in the soil avoid possible fatal germination.
- Small seeds have little resources that limit seedling emerge from a depth deeper than superficial soils.
- The more food reserves of larger seeds enable them to emerge even from a deeper soil.

Discussion

- Germination of larger seeds at deeper soil ensures that they will be closer to the wet soil, which would increase the chance of the seedling establishment.

Discussion

- **In shrubs,** large-seeded species germinate less than small-seeded ones.
- Fewer large seeds that could germinate do that mainly in light.
- Canopy of small shrubs are dense, rounded and laid over the ground so heavier larger seeds are expected to be retained under the canopies would expose them to lower R:FR (red/far-red) ratio and consequently result in lower germination, especially in dark.
- larger seeds of shrubby plants should be dispersed away from their canopies.

Discussion

- The better chance of small seed for germination under the canopies of nurse plants to provide shade protect them from direct thermal radiation.
- The reduction of germination of the larger seeds under the canopy would reduce inter- and intra-specific competition.
- large seeds that would germinate away from canopies can produce bigger seedlings that might adapt to dryness of exposed soils.

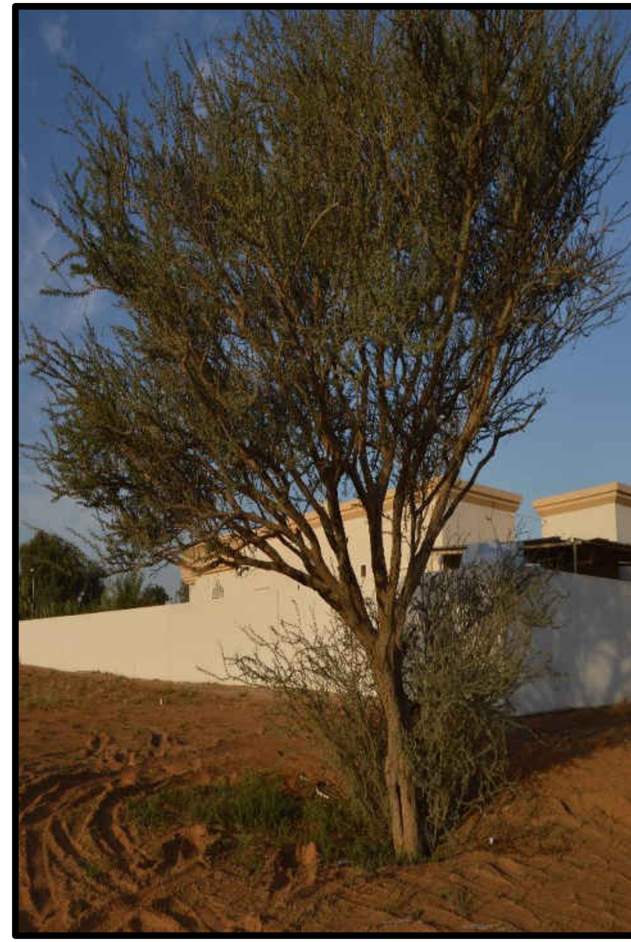
Discussion

- **In trees,** species with large-seeded trees germinated more in dark, but small-seeded ones germinated better in light.

- The result could be explained according to the mode of dispersal of the studied tree species.
- Heavy diaspore unit which dispersed primarily by gravity germinated under the canopies

Discussion

- Endozoochorous species would disperse within the feces of grazing animals and consequently germinate in darkness; either within the feces or when feces buried in soil.
- When large seeds germinated under tree canopies they will produce larger seedlings that could compete with the maternal trees in the long term.



Discussion

- Field storage didn't improve germination of seeds of herbaceous and shrubby plants, but improved it in seeds of trees.
- Under field condition, physical dormancy of many species is broken down by sand scarification.
- Diurnal fluctuations in day and night moisture and temperatures could result in break down physical dormancy.

Discussion

- Room temperature storage resulted in greater germination of herbaceous and shrubs seeds.
- Room temperature storage could mimic the natural conditions under litters and dead plants.

Conclusion

- The seed size and storage, and light requirement during germination of species belong to different growth forms could explain their distribution in the community and consequently could help explain community structure and composition.

- It is important to differentiate between the effects of storage of seeds retained in the maternal tissue crowns of the plants (i.e., serotiny) and that of seeds stored on soil surface.

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