Shrub (*Prosopis velutina*) recruitment in Sonoran grasslands: precipitation, not herbaceous cover, matters most

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Submission #45

Background

- Sonoran Desert grasslands, like those at the Santa Rita Experimental Range in Arizona, have seen substantial increases in velvet mesquite (*Prosopis velutina*) cover the past century.[1]
- The abiotic (precipitation) and biotic (livestock grazing, ants and rodents) conditions enabling shrub recruitment are not well known.[2]

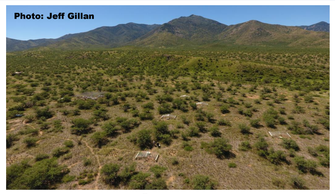


Figure 1. Change in velvet mesquite cover in the Desert Grassland Station exclosure (study site) from 1918 to 2000. Station 091, Santa Rita Experimental Range Repeat Photography Archive.

How do precipitation, livestock grazing, and rodent/ant herbivory interact to influence velvet mesquite recruitment?

Hypothesis

Velvet mesquite recruitment is contingent on the coincidence of:

High and frequent monsoon season precipitation

+

Reduced grass cover from livestock grazing

+

Lows in rodent/ant population cycles

Methods

Automated Rainfall Manipulation Systems (ARMS)[3] used to manipulate precipitation (PPT) (Fig. 2)

- 10 (2.5 X 5 m) plots → Ambient PPT
- 10 (2.5 X 5 m) plots → +65% PPT (Wet)
- 10 (2.5 X 5 m) plots → -65% PPT (Drought)

Within Each PPT Treatment:

- "Grazing"/Clipping (half of each plot to height of 15 cm)
- Rodent and/or Ant Exclusions (10 cm diameter areas)

Seedling Recruitment

- ❑ Seeds (n = 5 per exclusion treatment, 2400 total) sown at start of each monsoon season
- ❑ Seedlings monitored July - September 2017 through 2019 (~11 weeks/year)

Herbivory

- ○ Location and evidence of herbivory (cotyledon, true leaves, stem) recorded weekly

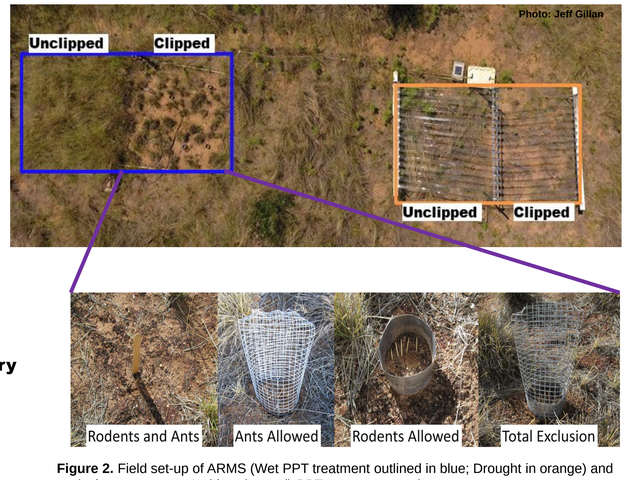


Figure 2. Field set-up of ARMS (Wet PPT treatment outlined in blue; Drought in orange) and exclusion treatments. Ambient (control) PPT treatment not shown.

Results

Precipitation and Shrub Recruitment

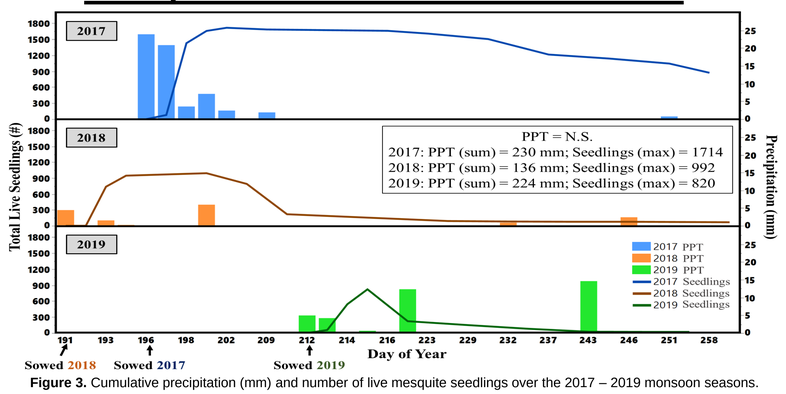


Figure 3. Cumulative precipitation (mm) and number of live mesquite seedlings over the 2017 – 2019 monsoon seasons.

- **Total PPT lowest in 2018; comparable in 2017 and 2019, but recruitment in 2019 reduced relative to 2018**
- **Seedlings sensitive to frequency and magnitude of PPT events**
- **Recruitment lowest under drought conditions**
- **Recruitment comparable in ambient and wet treatments**

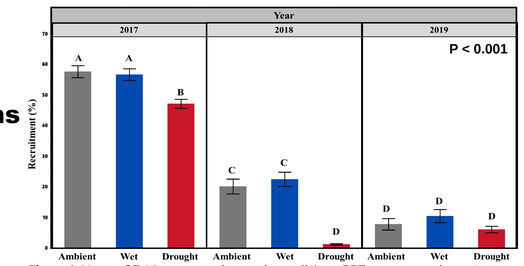


Figure 4. Mean ± SE 1st year mesquite recruitment (%) per PPT treatment and year. Letters indicate *post-hoc* Tukey's HSD results (different letters indicate significant ($p < 0.05$) differences).

Rodent/Ant Herbivory

- **Recruitment lower in areas with rodent + ant access in wettest year (2017), not in drier years**

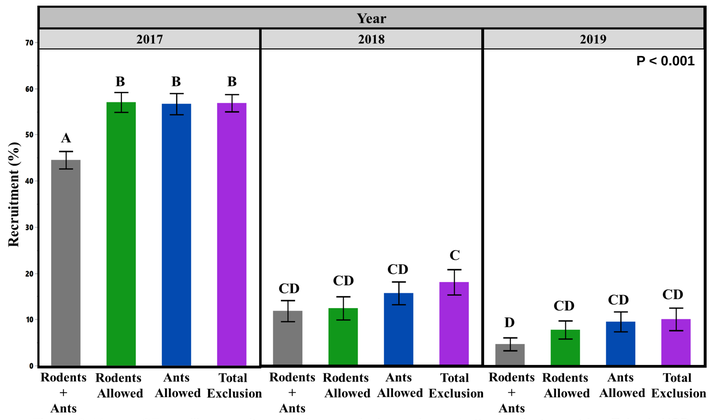
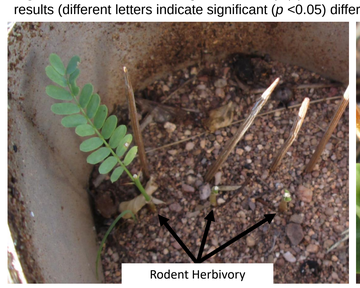
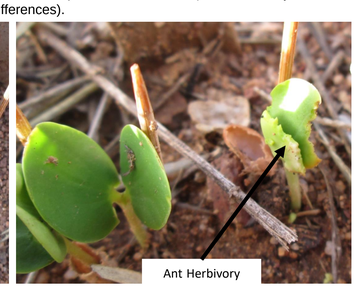


Figure 6. Mean ± SE seedling recruitment (%) per exclusion and year. Letters indicate *post-hoc* Tukey's HSD results (different letters indicate significant ($p < 0.05$) differences).





Rodents and Ants

Ants Allowed

Rodents Allowed

Total Exclusion

Simulated Grazing/Clipping

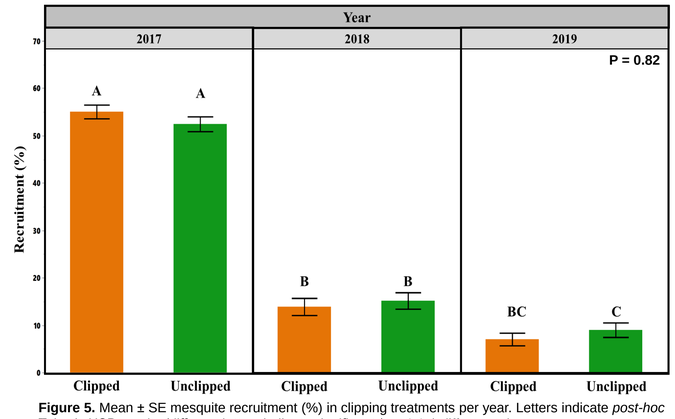


Figure 5. Mean ± SE mesquite recruitment (%) in clipping treatments per year. Letters indicate *post-hoc* Tukey's HSD results (different letters indicate significant ($p < 0.05$) differences).

- **Heavy grass defoliation/utilization had no significant effect on seedling recruitment in any year**
- **No clipping effect across all exclusion and PPT treatment combinations (data not shown)**

Summary

Velvet mesquite recruitment:

(i) was comparable for ambient/wet PPT regimes; slightly reduced by drought treatments in 2017, markedly reduced in 2018 and 2019 (Fig. 4)

(ii) not promoted by grass defoliation/simulated grazing (Fig. 5)

(iii) only modestly constrained by rodent/ant herbivory (Fig. 6)

Conclusions

Velvet mesquite recruitment:

(i) is sensitive to intra-seasonal PPT event patterns (Fig. 3)

(ii) is not episodic with respect to PPT and can potentially occur under most PPT-livestock grazing-herbivore combinations

References

1. McClaran, M. P. 2003.RMRS-P-30. USDA FS, Rocky Mtn Research Station, Tucson, AZ. **2.** Eldridge, D.J. et al. 2011. *Ecology Letters* 14(7): 709–22. **3.** Gherardi, L. A. & Sala, O. E. 2013. *Ecosphere*, 4(2), 1-10.

Acknowledgements

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