Winter drought effects on *Ratibida pinnata* reproductive ecology

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Introduction

Climate change effects, such as increased temperatures and decreased precipitation, can alter plant morphology and lead to a disruption in pollination systems and the reproductive success of plants (Miller-Struttman et al. 2015; Rafferty and Ives 2012). Pollinator responses to climate change, such as altered foraging activity, body size, and life span, could impact patterns of pollen flow and pollination success of flowering plants (Scaven,V.L. and Rafferty, N.E 2013). Altered weather patterns, such as droughts, can have long term impacts (Farooq et al. 2009). Missouri experienced winter droughts in 2013, 2014, 2017 and 2018 which potentially impacted the native plants and their pollination systems at Shaw Nature Reserve. *Ratibida pinnata* is a hardy, herbaceous perennial plant in the Asteraceae family, which blooms June to August. In this study, we used *R. pinnata* as a focal species to determine the impact of drought winters on the plants' morphology and pollination success. Specifically, the following questions were addressed:

Questions:

1. Did Missouri experience drought during the winter seasons of December 2013 through February 2018?
2. Are there morphological differences in *R. pinnata* between drought and non-drought years?
3. What is the difference in pollination system pre and post drought-winter years?
4. Is there a difference in average percentage of viable seed sets between pre and post winter droughts?

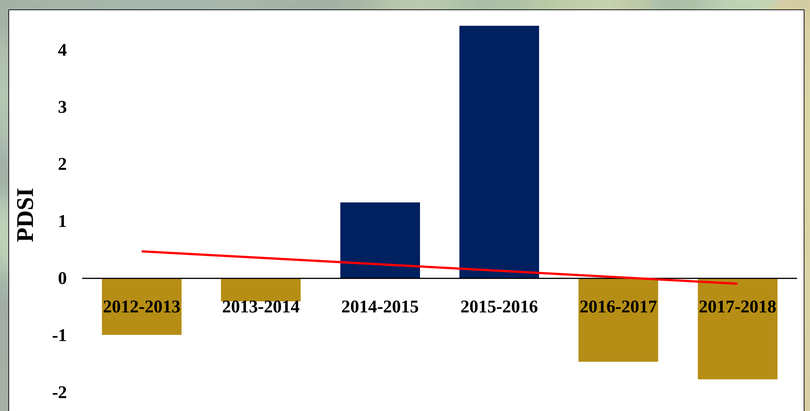

Fig. 5: Drought winters in Missouri compared to non-drought years (NOAA data).

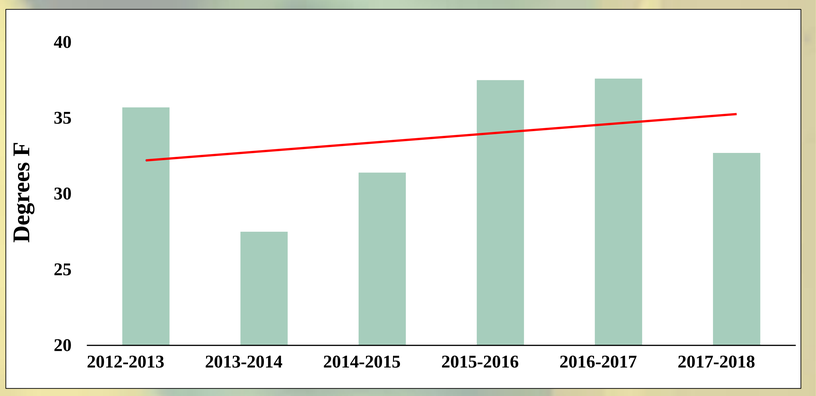

Fig. 6: Average temperature in winter months versus previous years (NOAA data).

Acknowledgments

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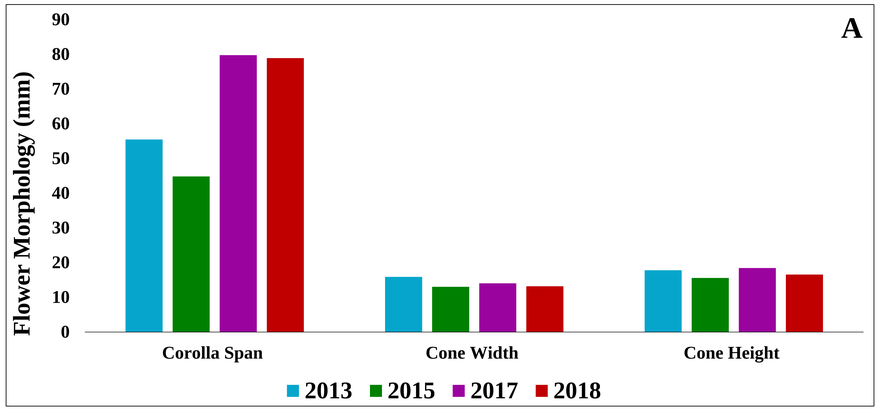

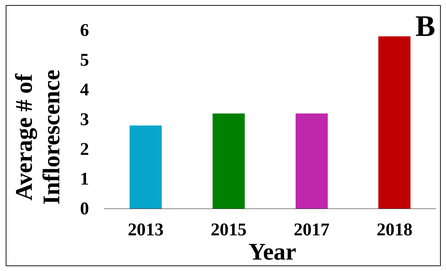

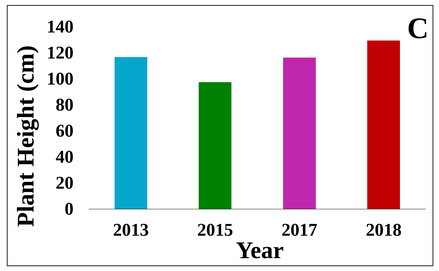

Fig. 2: A, B and C are comparisons of measured morphology of non-drought (2015) versus drought years (2013, 2017 and 2018).

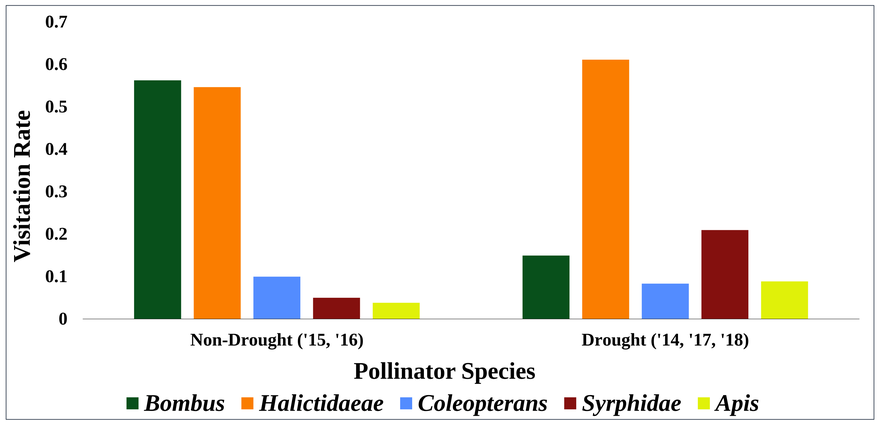

Fig. 3: Pollinator visitation rates compared in non-drought and drought years.

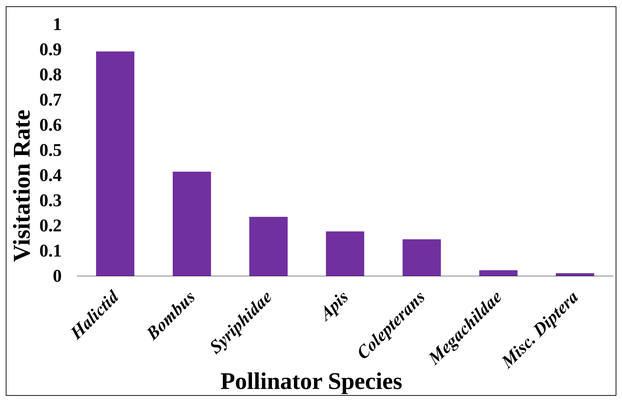

Fig. 4: The average visitation rates for all pollinators from 2014 to 2018.

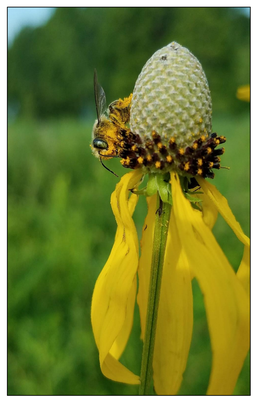

Fig. 8: *Apis* pollinating *Ratibida pinnata*.

Methods

This research was conducted at Shaw Nature Reserve, located in Gray Summit, Missouri. This study compares data from drought years 2013, 2014, 2017, 2018 and non-drought years 2015 and 2016. We measured the morphological traits, height, corolla span, cone height, cone width and inflorescences of *R. pinnata*. Pollination system data were collected in years 2014-2018. Average percentage of viable seeds were compared to previous years to determine any variation in reproductive success.

Results

1. Missouri experienced a drought during the winter months in 2013, 2014, 2017 and 2018 (Fig. 5).
2. In the drought year 2018, inflorescence (*p=0.017*), height (*p=0.000*) and corolla span (*p=0.000*) show morphological differences compared to a non-drought year, 2015. Between the years 2013 and 2018, there are statistical differences in inflorescence (*p=0.026*), height (*p=0.027*), corolla span (*p=0.001*) and cone width (*p=0.000*).
3. In non-drought years, the main pollinators were *Bombus* (56%) and *Halictidae* (55%), while in drought years, *Halictidae* were the main pollinators accounting for 61%.
4. There was a statistical difference in percent viable seed (*p=0.001*) between non-drought (2015) and drought year (2018).

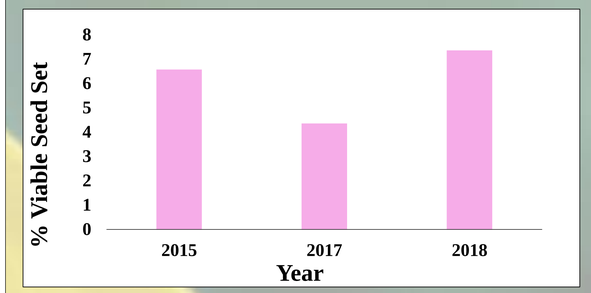

Fig. 1: The average percent viable seed set between years 2015, 2017 and 2018. Non-drought year 2015 versus drought year 2018 shows a statistical difference.

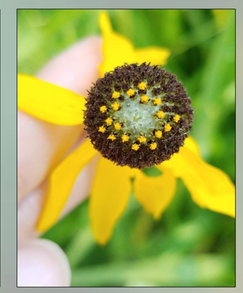

Fig. 7: *R. pinnata* at Shaw Nature Reserve.

Discussion

In the years 2013, 2014, 2017 and 2018, Missouri experienced a winter drought, caused by a low amount of precipitation and higher average temperatures (Fig. 5 and 6). *R. pinnata* morphology shifted in the drought years, showing increased number of inflorescences, height and corolla span (Fig. 2). The non-drought year 2015 is morphologically the smallest compared to the other years. Our results also show a dramatic decrease in *Bombus* pollination in post-drought years, which agrees with previous studies (Miller-Struttman et al. 2015; Rafferty and Ives 2012). Collective across all years (2014-2018), *Halictidae* is the pollinator with the highest visitation rate (89%) (Fig. 4). This highlights the importance of including abiotic data when evaluating and managing pollination systems. The percentage of viable seeds between 2015 and 2018 showed a lowered reproductive success (Fig. 1), possibly caused by the winter drought. Further research is needed to determine extensive drought impacts on this population.

References

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