



Pollination in a changing climate: Effects of heat and water stresses on three canola varieties

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1. INTRODUCTION

- Canola (*Brassica napus*), is an oil-seed crop of high economic importance with an annual contribution of \$43.7 billion to the Canadian economy¹⁻²
- Insect-mediated pollination of canola crops is affected by both heatwaves and water stress, with direct impacts on pollinator thermoregulation and foraging patterns, as well as indirect effects on plant physiology and rewards offered to pollinators³.
- Studies aimed at examining the extent to which warming and water scarcity influences plant phenology, pollinator activity, and crop yield remains lacking.

2. OBJECTIVE

We examined the effects of heat and water stresses on flowering phenology, floral traits and pollinator visitation in three canola varieties.

3. METHODS

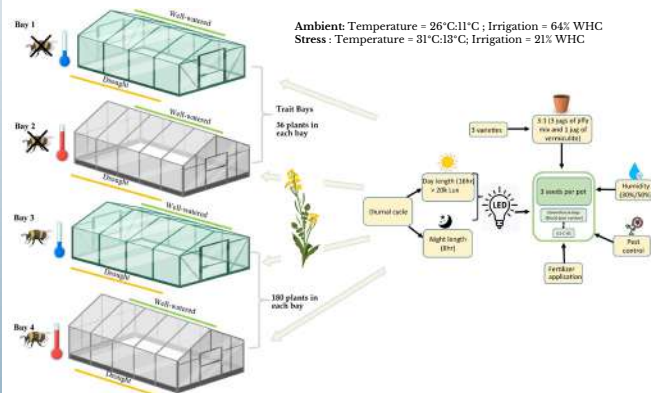


Figure 1: Experimental set up in greenhouses. Three seed varieties were used, Westar (WES), a Late and an Early Maturation (LM & EM) varieties.

5. IMPACT

Our findings informs canola growers about the effects of heat and drought on different canola varieties and does the same for beekeepers in terms of how the effects of changing climate on canola crop could affect bee foraging resources and honey yield.

6. CONCLUSION

- Warming and water stress significantly shortened flowering cycles by advancing flower onset, peak and end.
- Plants under ambient conditions produced broad flowers and large volumes of less concentrated nectar which enhanced floral visibility and attractiveness to pollinators.
- Increases in stressed conditions (heatwaves and water scarcity) above bee thermal optima negatively affect thermoregulatory and flight performance, leading to reduced pollinator abundance and visitation rate.

References

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4. RESULTS

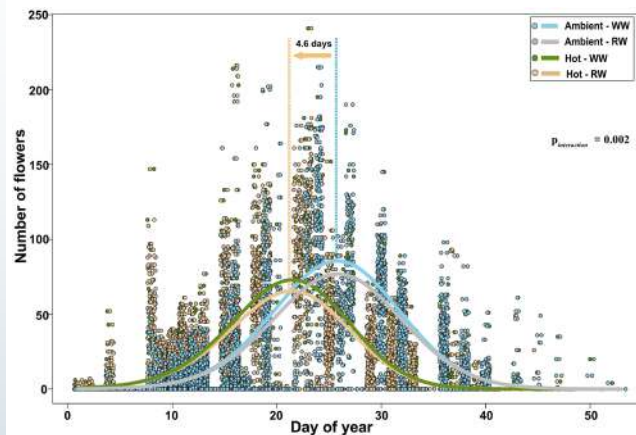


Figure 2: Flowering phenology (daily opened flowers) patterns over time for each treatment; Ambient Well-Watered (Ambient-WW), Ambient Reduced-Watered (Ambient-RW), Hot Well-Watered (Hot-WW), Hot Reduced-Watered (Hot-RW).

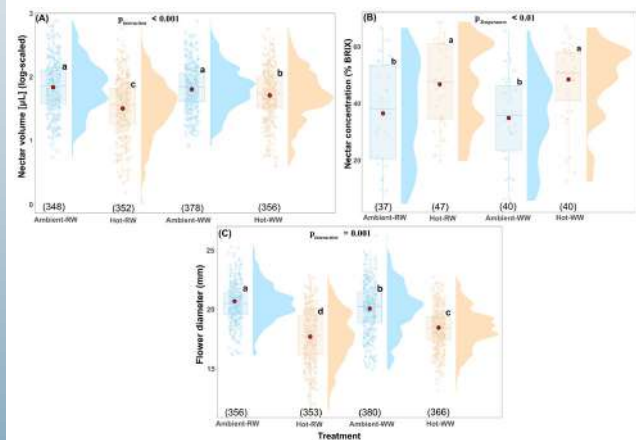


Figure 3: Effects of temperature and irrigation on floral traits (nectar volume in µL (A), concentration in %BRIC (B) and flower size in mm (C)) for each treatment. Ambient Well-Watered (Ambient-WW), Ambient Reduced-Watered (Ambient-RW), Hot Well-Watered (Hot-WW), Hot Reduced-Watered (Hot-RW).

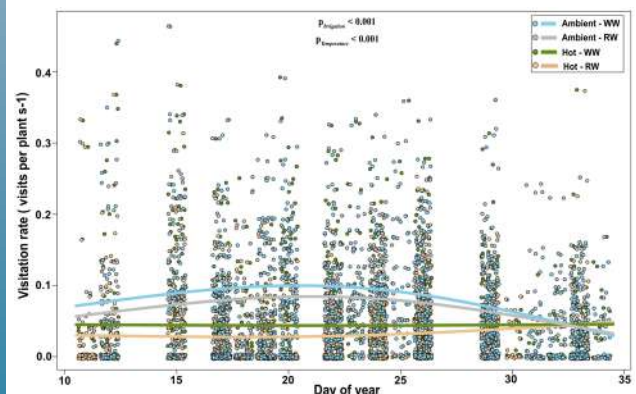


Figure 4: Patterns of visitation rate across the observation period for each treatment. Ambient Well-Watered (Ambient-WW), Ambient Reduced-Watered (Ambient-RW), Hot Well-Watered (Hot-WW), Hot Reduced-Watered (Hot-RW).

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Insect-mediated pollination is an important ecosystem service with valuable contributions to the fertilisation of crops. However, environmental threats such as heat waves and drought threaten this mutualistic interaction and thus global food security. There is a dearth of studies that explore the underlying mechanisms shaping plant-pollinator interactions and yield production in cropping systems. We examined the influence of climatic pressures (heat and water stress) on flower phenology, floral display and rewards (nectar volume, concentration and flower size), and how variations in these attracting cues drive pollinator visitation rates and seed yield in three canola varieties in Lethbridge, Alberta, Canada. We set up two temperature treatments, each in two greenhouse bays (n= 4 bays total), and two irrigation treatments within each bay. The temperature conditions were: Ambient, 26°C:11°C, mimicking the average temperatures for the past 10 years, and Hot: 31°C:13°C, representing projected mean max and min temperatures for the year 2055 in the study region. The irrigation treatments were Well-watered: 64% water holding capacity (WHC) and Reduced-watered 21% WHC, mimicking ambient and drought conditions. We found an overall advancement in flowering onset, with plants reaching peak flowering earlier in hot compared to ambient treatments, while warming and water stress jointly influenced end of flowering. Plants under ambient conditions were more attractive to pollinators as they produced broader flowers with larger volumes of less concentrated nectar when compared to plants in hot bays. In addition, plants in well-watered treatments produced significantly higher number of pods and seeds compared to plants in reduced-watered conditions, while total seed weight was significantly influenced by both warming and water stress. We found that the number of flowers produced had direct positive influences on seed yield across all treatments, meanwhile pollinator visitation rate had direct positive effects on seed yields in ambient bays. In contrast, pollinator abundance was more important for well-watered plants in hot bays. In conclusion, our study elucidates the importance of climate-mediated influences on plant phenology and flowering rewards which may limit plant-pollinator interactions and consequently the ecosystem services they provide with resulting devastating effects on global food security.