

Competitive interactions of *Metopolophium festucae* subsp. *cerealium* and *Rhopalosiphum padi*, as mediated by water limitation of their shared wheat host.



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Intern with Regional Approaches to Climate Change in Pacific Northwest Agriculture (REACCH PNA)

ISSUE: Climate change is affecting ecosystem and community level processes.

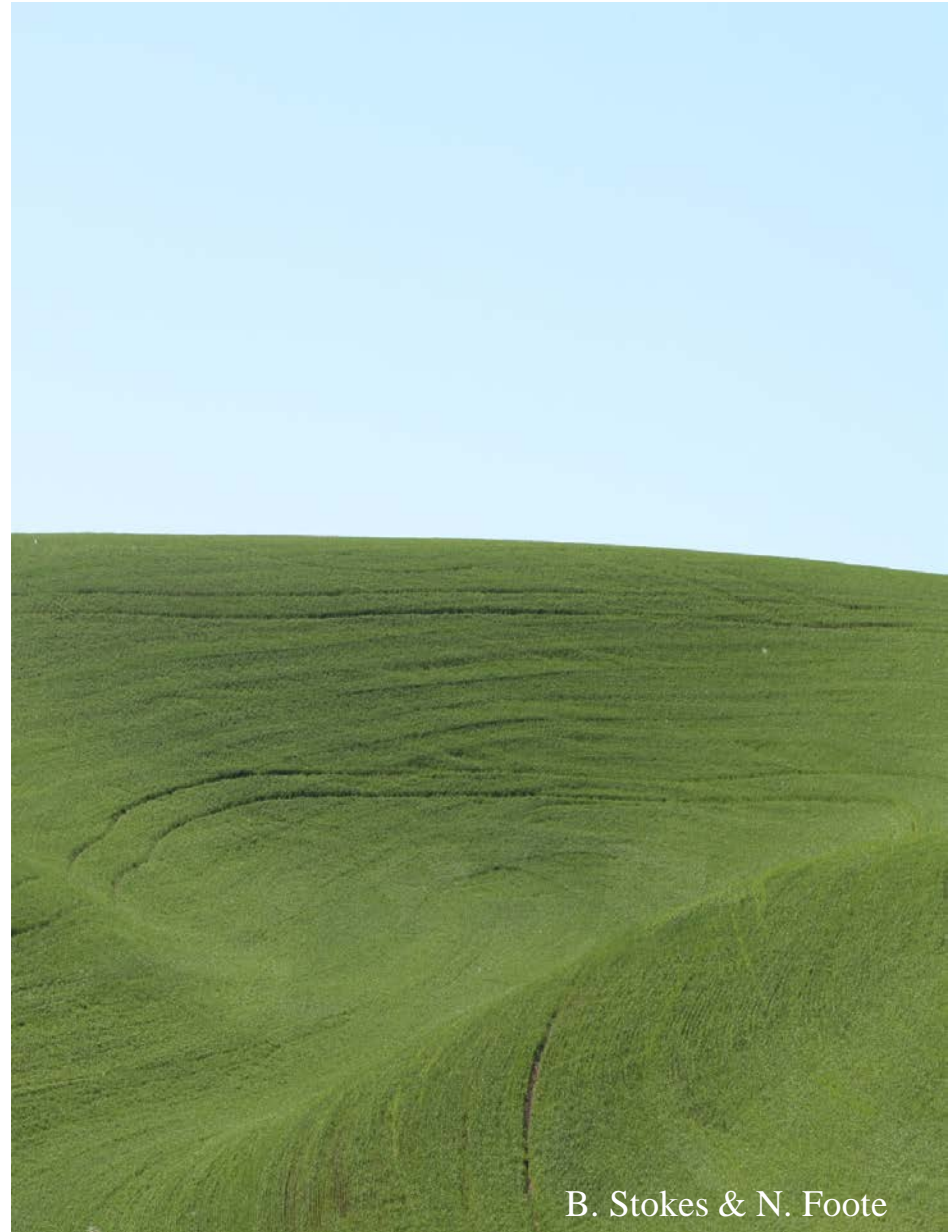
Regional: Environmental stress in agricultural systems poses great risk to cereal crop viability and productivity.

“Abiotic conditions are driving forces behind the interspecific interactions between herbivorous insects.”

(Gonzales *et al.*, 2001)

Local: Cereal pest invasiveness could be affected by drought conditions within the Palouse agro-ecosystem.

(Bale *et al.*, 2002)



B. Stokes & N. Foote

Study System

Metopolophium festucae
cerealium → MFC (Stroyan)
(yellow aphid)

Rhopalosiphum padi (L.) → RP
(black aphid)

Wheat (*Triticum aestivum* L.)
variety 'Kelse'

(WSU Uniform Extension Variety
Testing Program)



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Experimental Design

General Research Question:

How will water limitation impact, MFC and RP, with respect to species performance and within plant competitive interactions?

Basic Study Design:

- 1) Plants will be grown under drought conditions (limited water availability) and replete conditions (ample water availability) in a greenhouse environment.
- 2) Plants will be exposed to MFC and RP, together on the same plant and alone on a plant, and stored in growth chambers throughout exposure.
- 3) Intrinsic growth rate will be calculated from per plant counts taken 3x over the exposure period after initial species release on the plants.

Specific Research Question(s):

- 1) Will there be a competitive effect on population growth rate (r) in host plants infested with both aphid species?
- 2) Will water availability affect MFC and RP aphid population growth rates?
- 3) Will population growth rate vary by species and by host plant water availability?
- 4) Will water availability affect competition amongst host plants infested with both species?

Hypotheses

H1_a There is competition between MFC and RP when reared on the same spring wheat host plant.

H1₀ There is no competition between MFC and RP when reared on the same spring wheat host plant.

H2_a There is an effect of water availability (drought or replete) on competitive interactions between MFC and RP.

H3_a Water availability (drought or replete) has an effect upon MFC and or RP aphid population growth rates.



Methodology



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Wheat procedures

- **Green house:** Two plants (var. Kelse) were grown in a single pot containing (~335 g dry hort. Mix) for 14 days with unlimited H₂O supply, then withheld H₂O entirely for 5 days.
 - 60 pots total, 120 plants total
 - Greenhouse conditions: 25 C daytime temperature, 16:8 photoperiod
- **Watering regime:** On day 20, watering treatments began and were ongoing throughout experiment duration.
 - Drought and Replete: → (D_{10%} and R_{80%})
 - 10 and 80% mL H₂O: g dry soil
 - H₂O supplied once every 48 hours to simulate these conditions.



MFC and RP procedures

Species Source

- Each aphid species originated from Kambitsch experimental farm, and were obtained from cage colonies at Manis Entomological laboratory.

Plant infestation

- F_0 reproductive individuals (6 per plant) were selected for clip cage install.
- F_1 offspring (8 per plant) were selected for clip cage release and infest within 24 hours of install.
- F_1 individuals were installed 2 cm from the ligule of the second leaf below flag and (oriented randomly) on all host plant pots.



Aphid and host plant treatment(s)

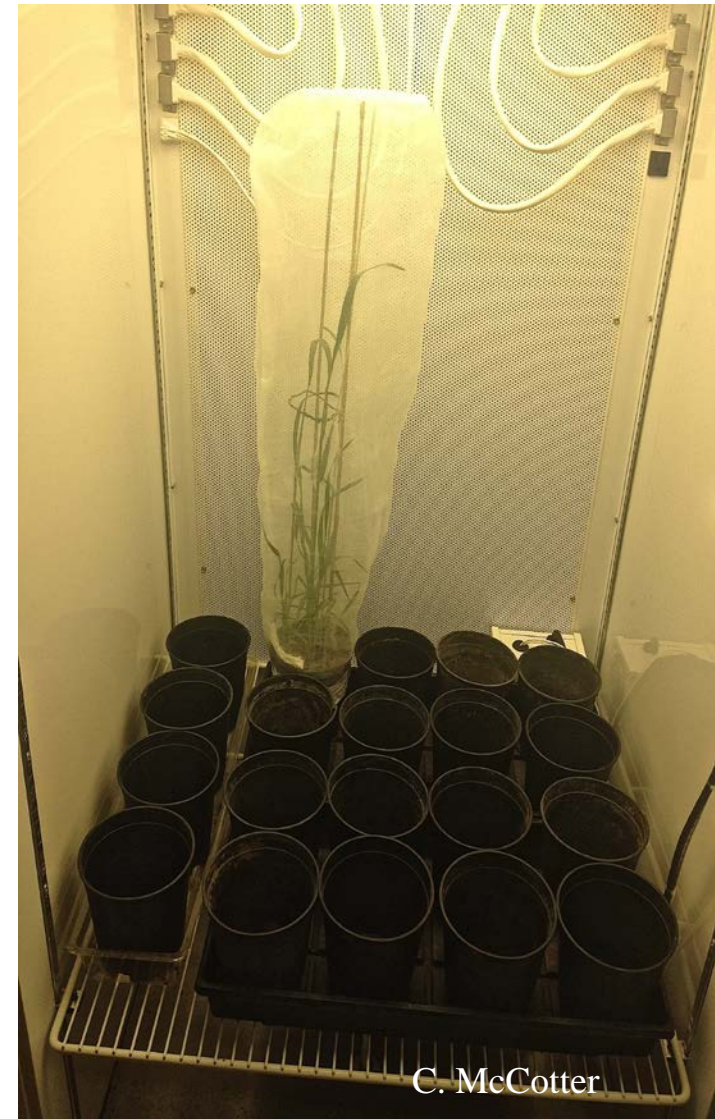
- Randomized plant to aphid(s) factorial design.
 - Replete + (RP)
 - Drought + (RP)
 - Replete + (MFC)
 - Drought + (MFC)
 - Replete + (RP/MFC)
 - Drought + (RP/MFC)
- 15 replications/treatment group.
- All treatments housed amongst four growth chamber microcosms.



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Growth Chamber Conditions and Experimental Measures

- ***Conditions***
 - Plants and aphids caged and housed for 10 days at 25°C
 - 16:8 hour photoperiod, 10:00 pm (dark)- 8:00 am (light)
- ***Count measures***
 - Three total counts undergone on all 60 pots and 120 plants.
 - Counts made by species according to water treatment (drought or replete) and species present (one or two).
- ***Destructive sampling***
 - Host plant dry mass of all water and species treatments taken post final day ten count



Calculation(s) and Statistical Analyses

- *Intrinsic rate of increase (r)*
 - Cumulative per species sums plotted by number of individuals per day of count across 10 day period.
 - $d(n)/d(t)$ calculated from each interval plot and compiled by water treatment and by species present (single or both).
- *Statistical analyses undergone*
 - Two sample t-test(s), one way and multi-way ANOVA(s)



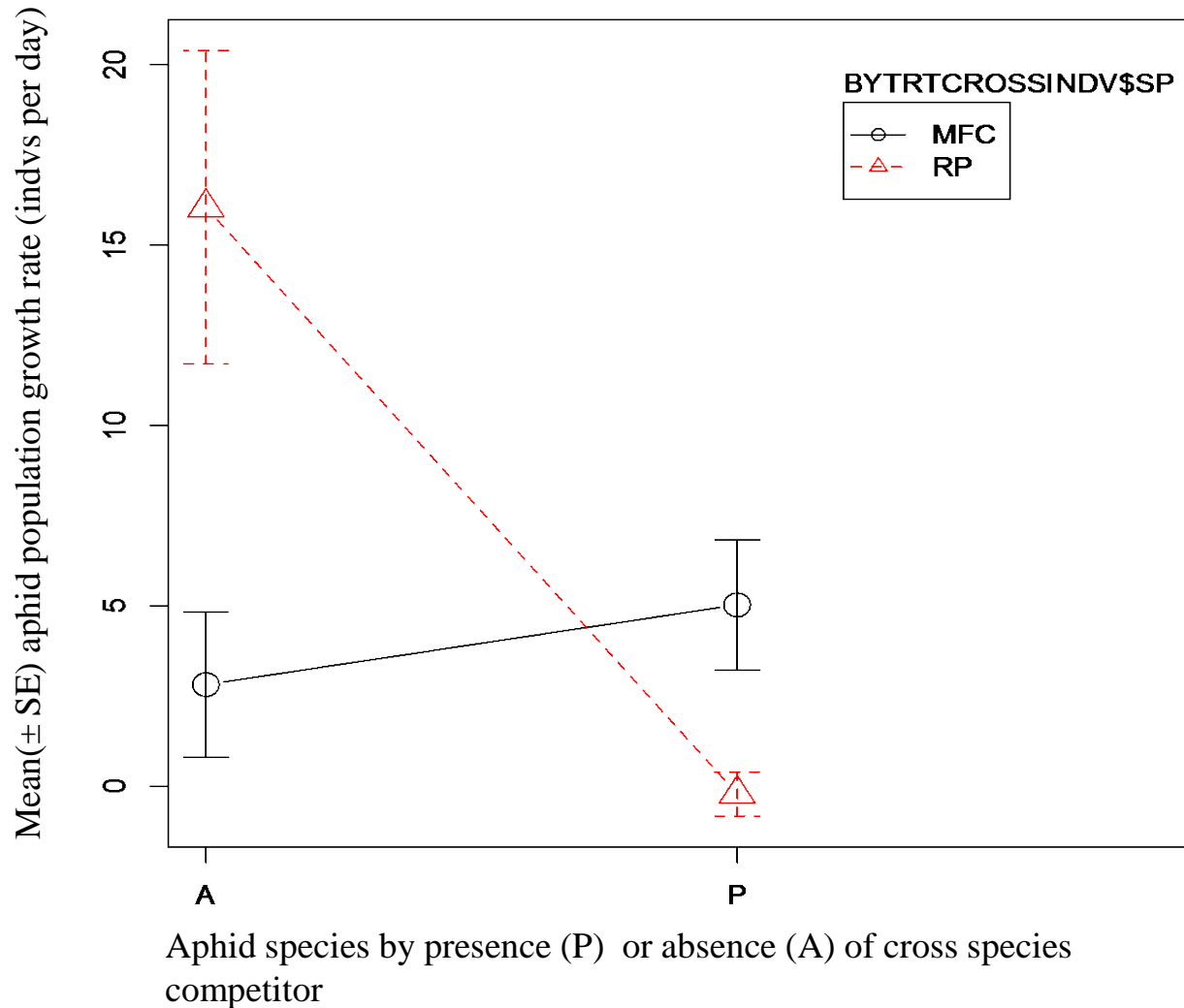
Results



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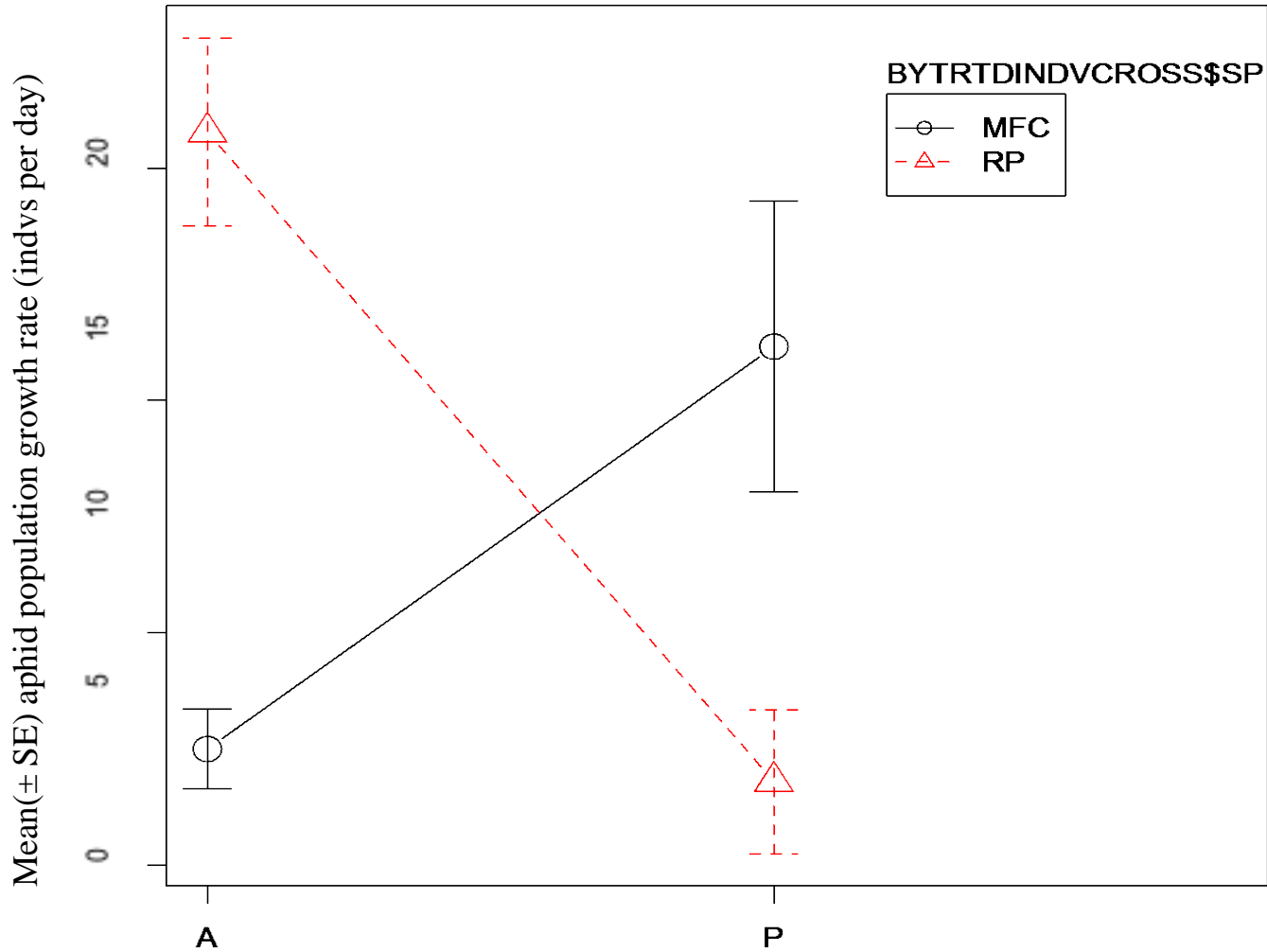
Alternate accepted: H1_a There is competition between M.F.C and RP when reared on the same spring wheat host plant.

Null accepted: H2₀ There is not an effect of water availability (replete) on competitive interactions between M.F.C and RP.



Alternate accepted:H1_a There is competition between M.F.C and RP when reared on the same spring wheat host plant.

Alternate accepted:H2_a There is an effect of water availability (drought) on competitive interactions between M.F.C and RP.



Aphid species by presence (P) or absence (A) of cross species competitor

Null accepted: H₃₀ Water availability (drought or replete) has no effect upon M.F.C and or RP aphid population growth rates.

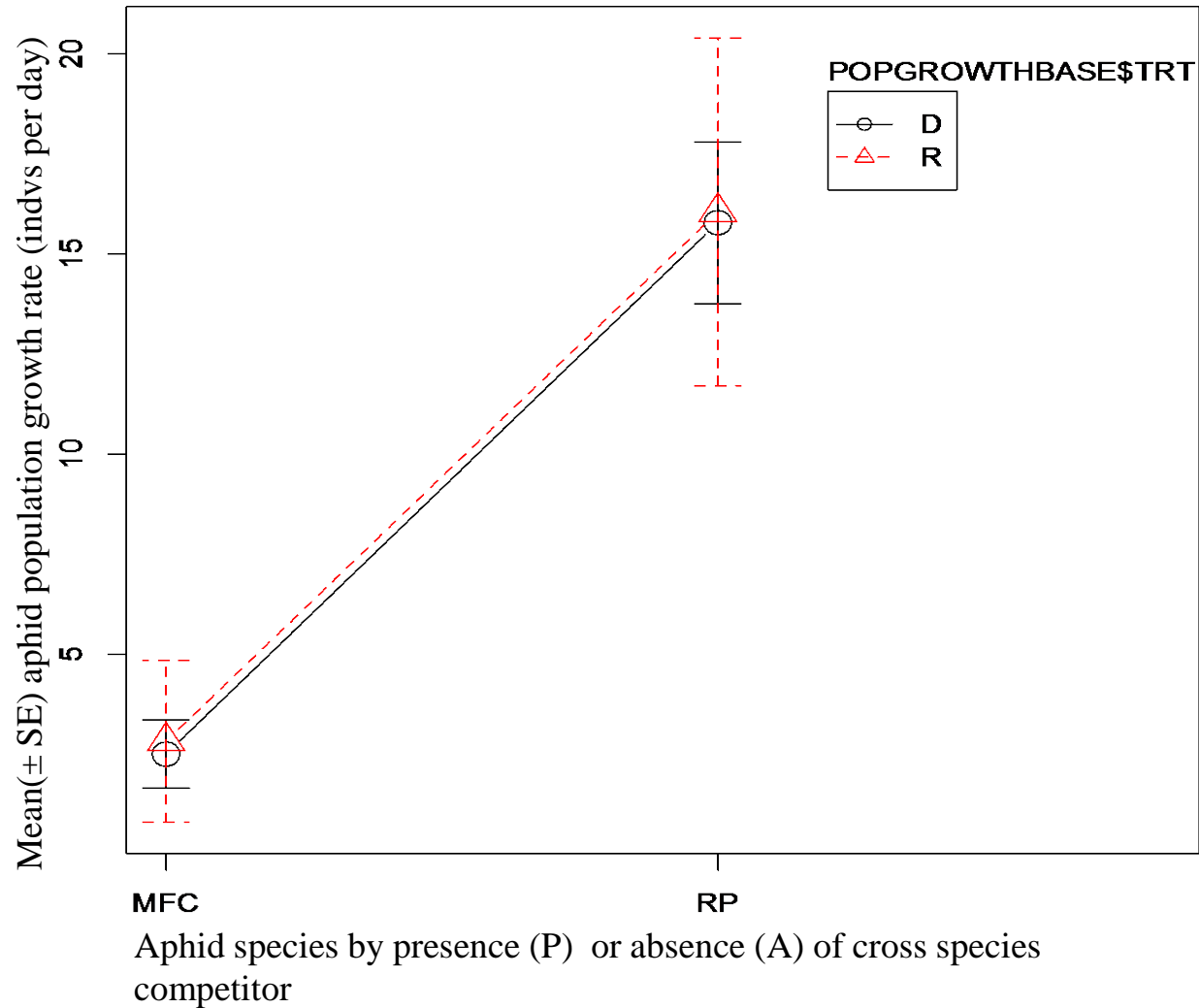
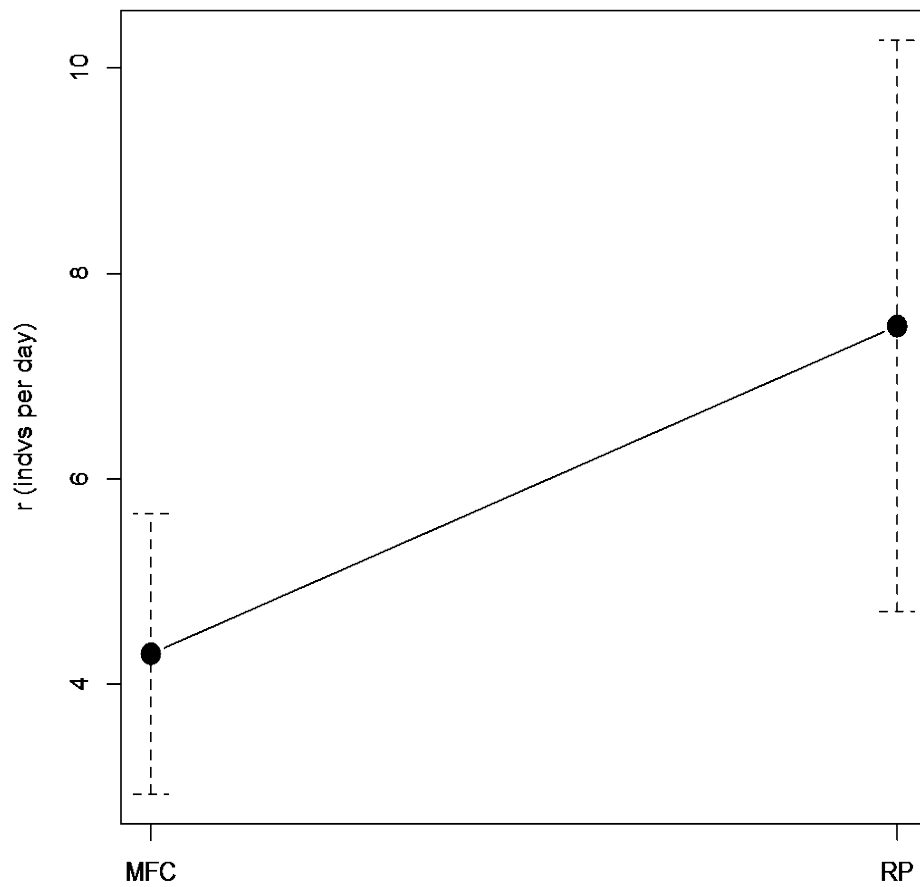
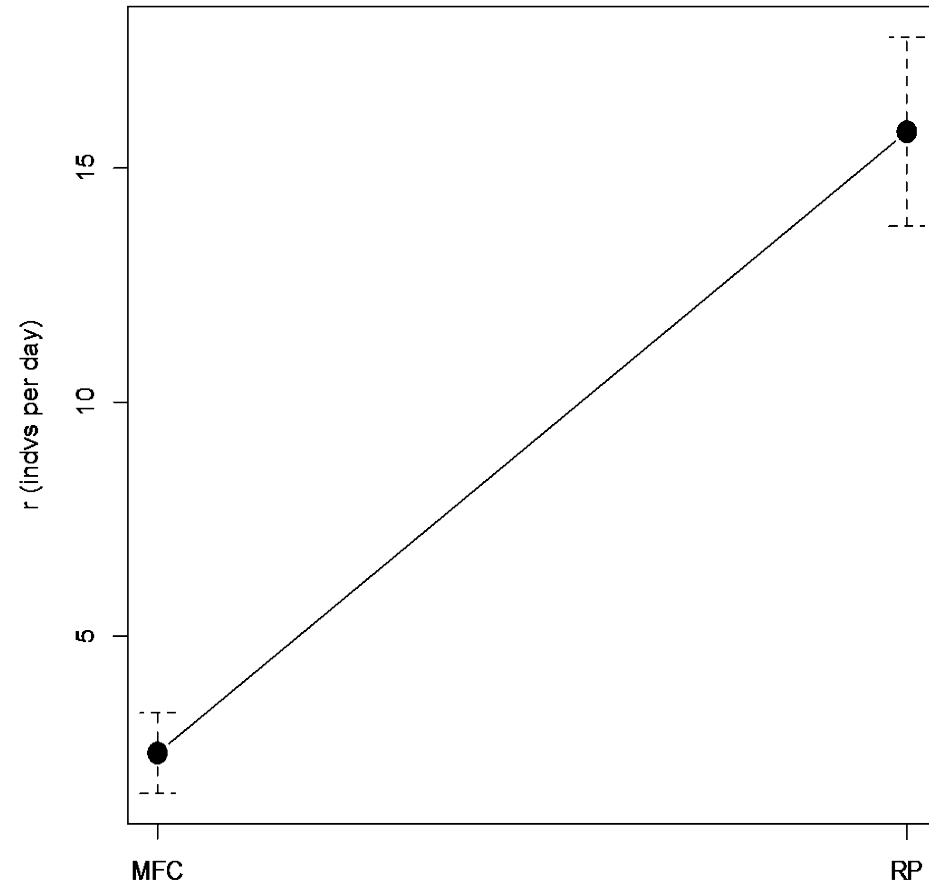


Table 1. Multi-way ANOVA on aphid growth rate (r) per plant (RP and or MFC) for water (drought/replete) and competition (presence of RP or MFC competitor).

Source of variation	df	MS	F	P	
Competition (r)					
Replete: (RPMFC)					
C	1	601.01	10.19	0.0032	←
SP	1	32.31	0.54	0.4648	
C:SP	1	667.28	11.31	0.0021	←
Competition (r)					
Drought:(RPMFC)					
C	1	142.07	3.06	0.0905	←
SP	1	4.37	0.09	0.7609	
C:SP	1	975.86	21.05	<0.0001	←
Competition (r)					
Drought:Replete:(RPMFC)					
C	1	667.93	12.66	<0.0001	←
SP	1	6.57	0.12	0.7253	
TRT	1	89.91	1.7	0.1968	
C:SP	1	1626.38	30.82	<0.0001	←
C:TRT	1	64.53	1.22	0.2732	
SP:TRT	1	25.58	0.48	0.4889	
C:SP:TRT	1	16.76	0.32	0.5751	
Host plant (r)					
Drought:Replete: (MFC or RP)					
SP	1	1104.46	15.08	<0.0001	←
TRT	1	0.56	0.0076	0.9312	
SP:TRT	1	0.06	0.0001	0.9942	



Aphid Species (by replete trt)



Aphid species (by drought trt)

Table 2. One way ANOVA on aphid growth rate (r) per plant (RP or MFC) for water (drought/replete) treatment.

Source of variation	df	MS	F	P
Replete: (MFC or RP)				
SP	1	562.1	4.683	0.0513
Host plant (r)				
Drought: MFC or RP				
SP	1	542.3	24.53	<0.0001

Conclusions

1) Will there be a competitive effect on population growth rate (r) in host plants infested with both aphid species?

-Yes

2) Will water availability affect MFC and RP aphid population growth rates?

-No

3) Will population growth rate vary by species amongst water limited and water enriched host plants?

-Yes

4) Will water availability affect competition amongst host plants infested with both species?

-No

Limitations and Recommendations

- 1) Host plant viability
- 2) Field Contamination; *Sitobion avenae* (Fabricius), *S.avenae*.
- 3) Use of top bottom spatial density records for chi-square test of independence(s)
- 4) Further analysis of MFC and RP competitive interaction and performance on drought treated plants.



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