

Grapevine red blotch virus vector research

Investigation into the biology and behavior of the three-cornered alfalfa hopper and their relationship with vineyards

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UCCE IPM Advisor
Serving Sonoma, Napa, Mendocino and Lake Counties





**Phylogeny of Geminivirus Coat Protein Sequences and Digital PCR
Aid in Identifying *Spissistilus festinus* as a Vector of
Grapevine red blotch-associated virus**

Bahder, B. W., F. G. Zalom, M. Jayanth, and M. R. Sudarshana. 2016. *Phytopathology*. 106(10): 1223-1230.



- *Spissistilus festinus* – Three-cornered alfalfa hopper (3CAH)
- Vector of GRBV
- Native to the US
- Studied predominantly on alfalfa, soybeans, and peanuts in the southern United States
- Previously considered only an incidental pest of grapevines due to girdling
- Very little was known about their association with grapes



What plant species serve as
hosts for 3CAH in vineyards?

Feeding and Reproductive Weed and Cover Crop Hosts

- Ten weed and ten cover crop plant species commonly found in vineyards were tested as feeding and reproductive hosts in no-choice tests with a standard in each run of the experiment
- Adult survival, girdling, and nymphal emergence were documented every 7 days for 4 weeks



Table 1: Weed species tested as feeding and reproductive hosts of *Spissistilus festinus*

Scientific Name	Common Name	Family	Girdles	Nymphs	% Survival ^a ± SEM
<i>Acmispon americanus</i>	Spanish clover	Fabaceae	Yes	Yes	91.7 ± 4.8
<i>Taraxacum officinale</i>	Dandelion	Asteraceae	Yes	Yes	70.8 ± 19.7
<i>Lotus corniculatus</i>	Birdsfoot trefoil	Fabaceae	No	Yes	58.3 ± 16.0
<i>Poa pratensis</i>	Kentucky bluegrass	Poaceae	Yes	No	25.0 ± 8.3
<i>Senecio vulgaris</i>	Common groundsel	Asteraceae	Yes	Yes	20.8 ± 15.8
<i>Plantago lanceolate</i>	Buckhorn plantain	Plantaginaceae	No	No	8.3 ± 4.8
<i>Daucus carota</i>	Wild carrot	Apiaceae	Yes	No	4.2 ± 4.2
<i>Convolvulus arvensis</i>	Field bindweed	Convolvulaceae	Yes	Yes	4.2 ± 4.2
<i>Kickxia elatine</i>	Sharppoint fluvellin	Plantaginaceae	No	No	0
<i>Cynodon dactylon</i>	Bermuda grass	Poaceae	No	No	0

^a Survival of adults for first 2 weeks on plants

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Table 2: Cover crop species tested as feeding and reproductive hosts of *Spissistilus festinus*

Scientific Name	Common Name	Family	Girdles	Nymphs	% Survival ^a ± SEM
<i>Pisum sativum</i>	Magnus Peas	Fabaceae	Yes	Yes	91.7 ± 4.8
<i>Vicia faba</i>	Bell beans	Fabaceae	No	Yes	83.3 ± 11.8
<i>Bromus hordeaceus</i>	Blando brome	Poaceae	Yes	Yes	33.3 ± 6.8
<i>Vicia benghalensis</i>	Purple vetch	Fabaceae	Yes	Yes	30.2 ± 8.4
<i>Medicago lupulina</i>	Black medick	Fabaceae	Yes	Yes	25.0 ± 10.8
<i>Trifolium subterraneum</i>	Subterranean clover	Fabaceae	Yes	Yes	16.7 ± 11.8
<i>Trifolium incarnatum</i>	Crimson clover	Fabaceae	Yes	Yes	12.5 ± 4.2
<i>Vicia villosa ssp. Varia</i>	Woollypod vetch	Fabaceae	Yes	Yes	12.5 ± 4.2
<i>Brassica sp.</i>	Mustard	Brassicaceae	No	No	0
<i>Avena sativa</i>	California red oats	Poaceae	No	No	0

^a Survival of adults for first 2 weeks on plants

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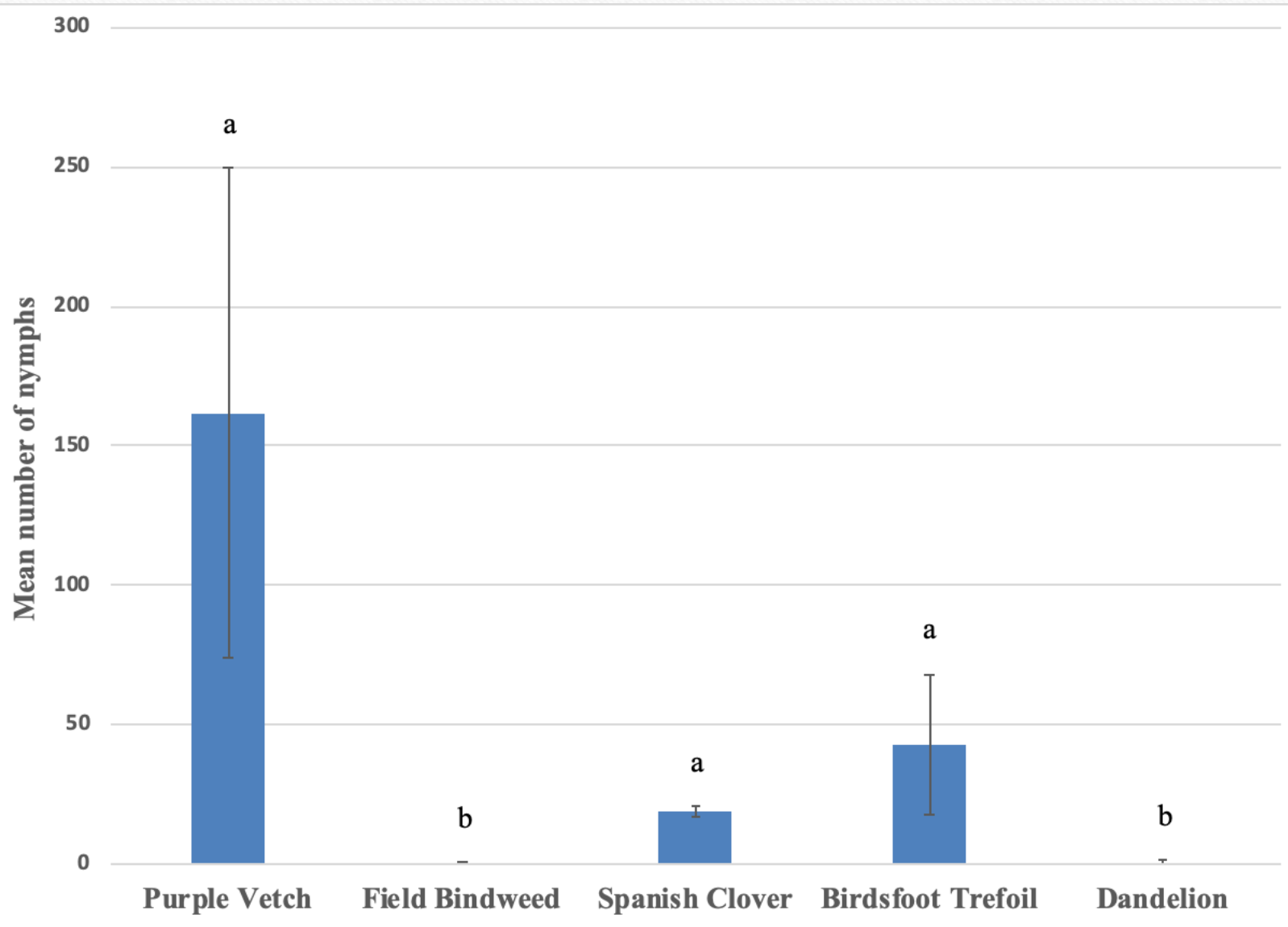
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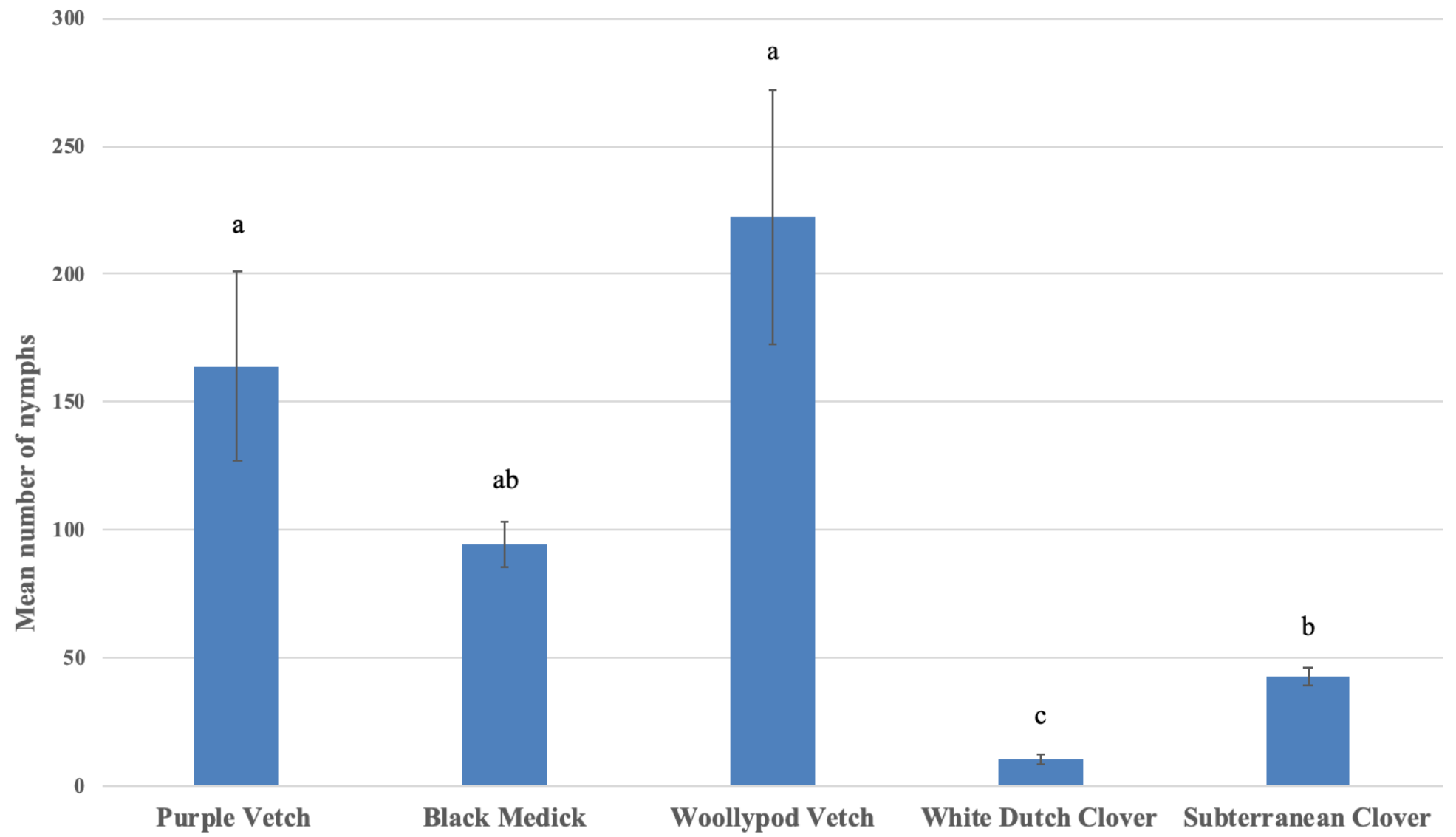
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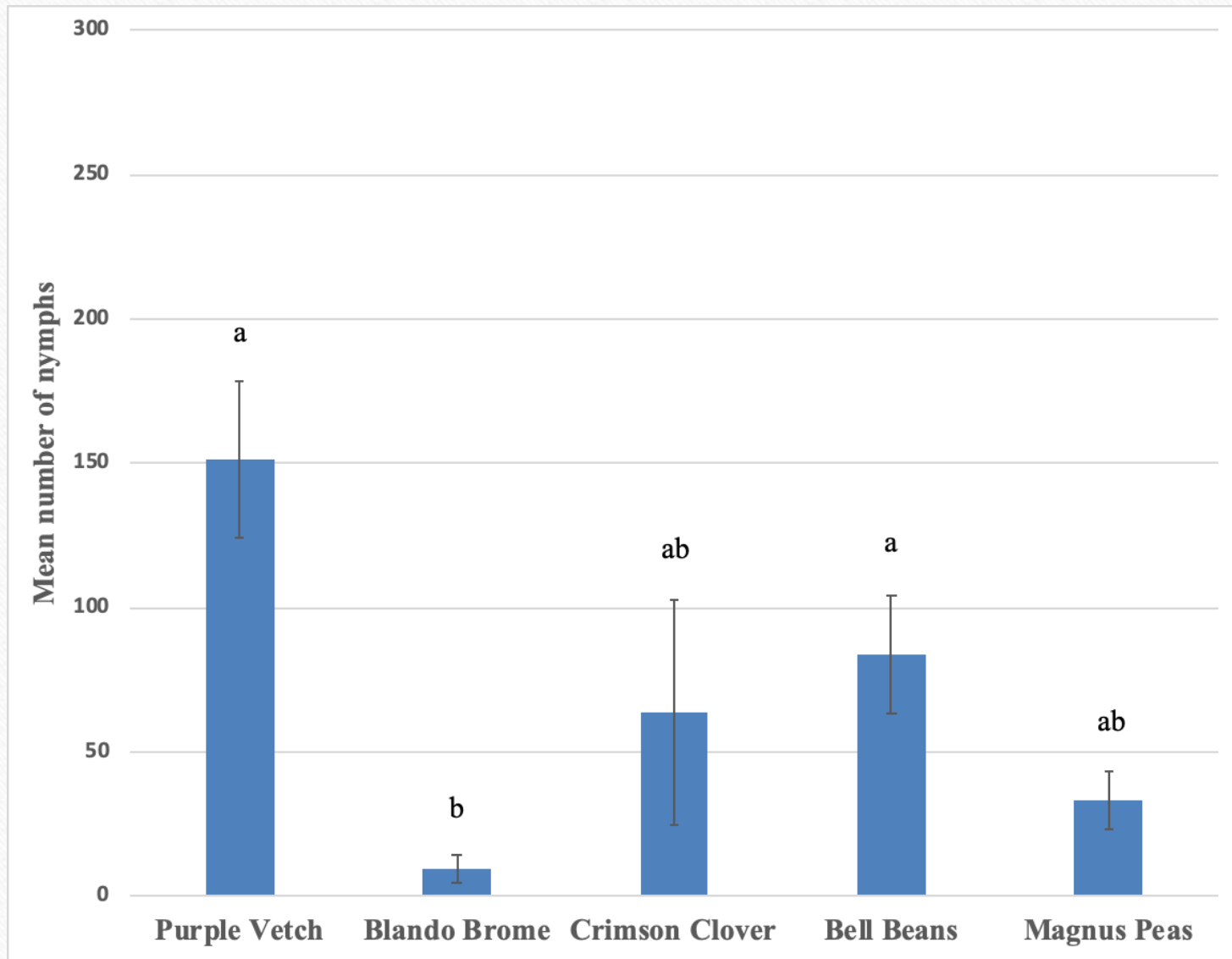
Preference Testing



- Vineyard Weeds - field bindweed, Spanish clover, birdsfoot trefoil, dandelion, and purple vetch
- Cover Crops 1 - black medick, white Dutch clover, subterranean clover, woollypod vetch, and purple vetch
- Cover Crops 2 - blando brome, crimson clover, bell beans, magnus peas, and purple vetch









Two non-reproductive cover
crop hosts found...but
growers needed more options



Two non-reproductive cover
crop hosts found...but
growers needed more options

We tested 15 more commonly
planted cover crops

Table 1: Cover crop species tested as feeding and reproductive hosts for *Spissistilus festinus*

Scientific Name	Common Name	Family	Girdles	Nymphs ^a	% Survival ^b ± SEM
<i>Fagopyrum esculentum</i>	Buckwheat	Polygonaceae	Yes	Yes	96.7 ± 3.7
<i>Triticum x secale</i>	Trios Triticale	Poaceae	Yes	Yes	86.7 ± 3.7
<i>Sorghum sudanense</i>	Piper Sudangrass	Poaceae	Yes	No	76.7 ± 7.5
<i>Secale cereale</i>	Winter Ryegrain	Poaceae	Yes	No	73.3 ± 9.5
<i>Lolium multiflorum</i>	Annual Ryegrass	Poaceae	Yes	Yes	73.3 ± 4.6
<i>Hordeum vulgare</i>	Barley UC 937	Poaceae	Yes	No	63.3 ± 14.9
<i>Raphanus sativus</i>	Daikon Radish	Brassicaceae	No	No	63.3 ± 10.9
<i>Vicia benghalensis</i>	Purple Vetch	Fabaceae	Yes	Yes	60.0 ± 21.6
<i>Trifolium alexandrinum</i>	Berseem Clover	Fabaceae	Yes	Yes	20.0 ± 7.0
<i>Lolium perenne</i>	Perennial Ryegrass	Poaceae	No	No	3.3 ± 3.7
<i>Vulpia myuros var. hirsuta</i>	Zorro Fescue	Poaceae	No	Yes	0
<i>Dactylis glomerata</i>	Orchard Grass	Poaceae	No	No	0
<i>Festuca rubra</i>	Creeping Red Fescue	Poaceae	No	No	0
<i>Festuca arundinacea</i>	Fawn Tall Fescue	Poaceae	No	No	0
<i>Festuca ovina spp. duriuscula</i>	Hard Fescue	Poaceae	No	No	0
<i>Eschscholzia californica</i>	California Poppy	Papaveraceae	No	No	0

^a Oviposition was indicated by nymph emergence

^b Survival of adults for first 2 weeks on plants

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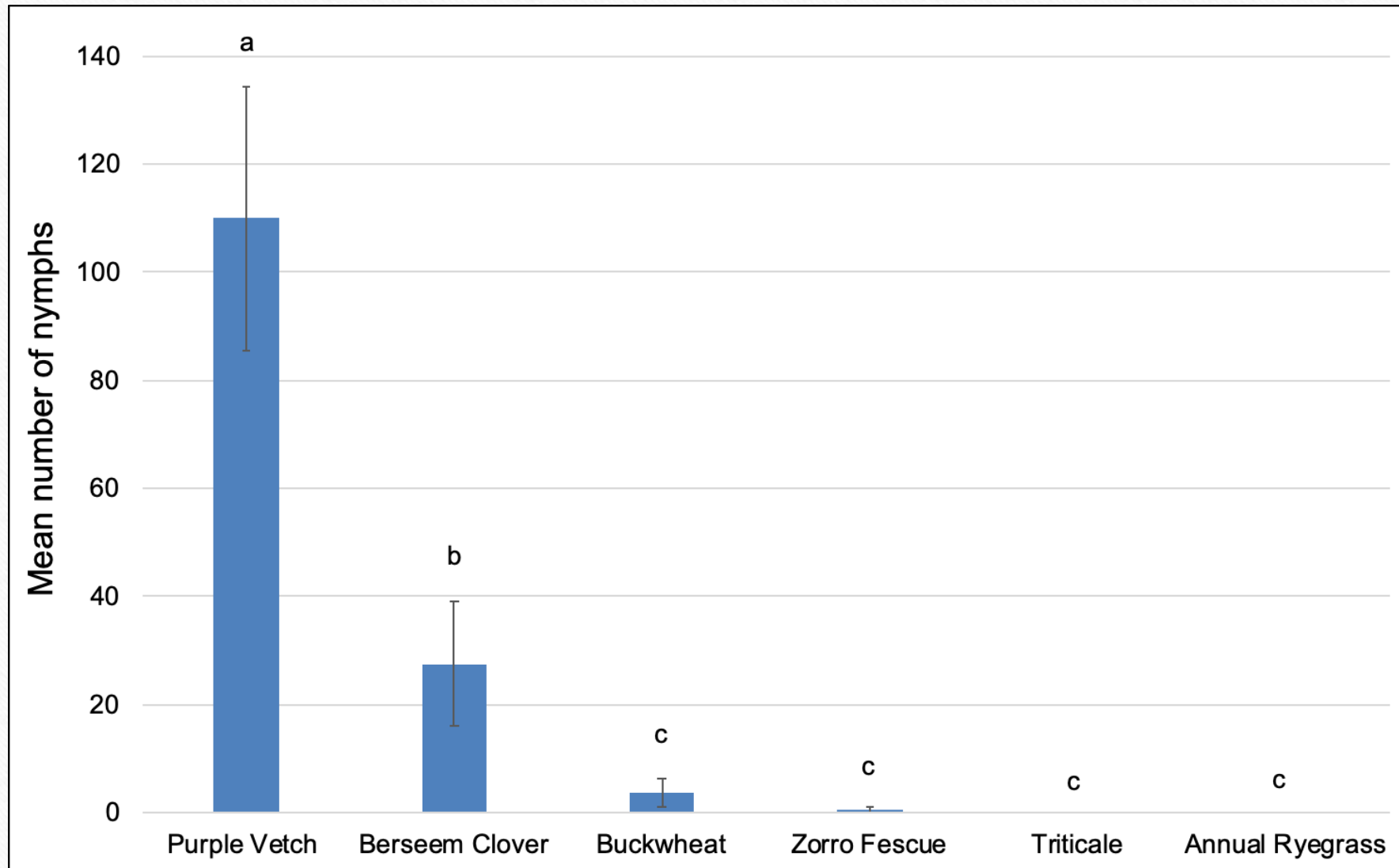
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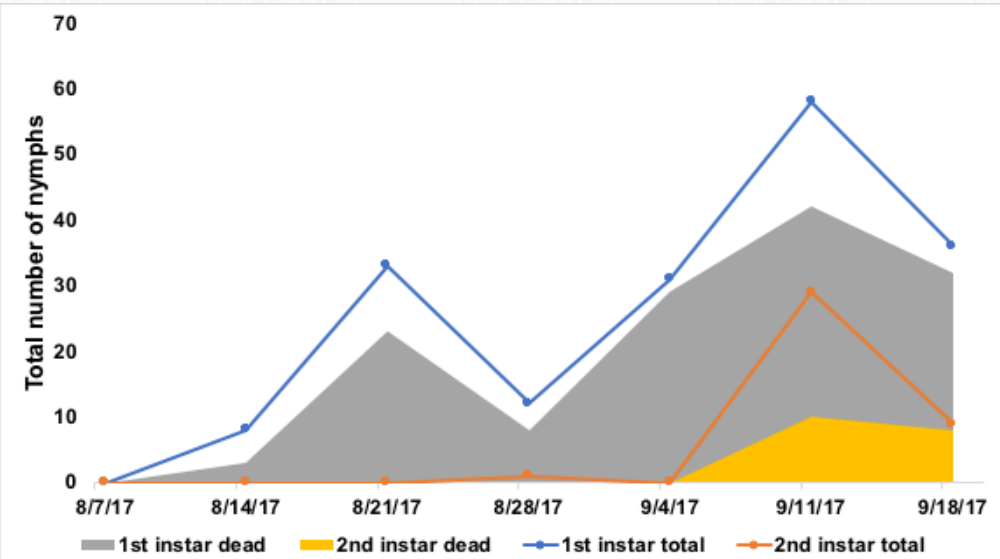
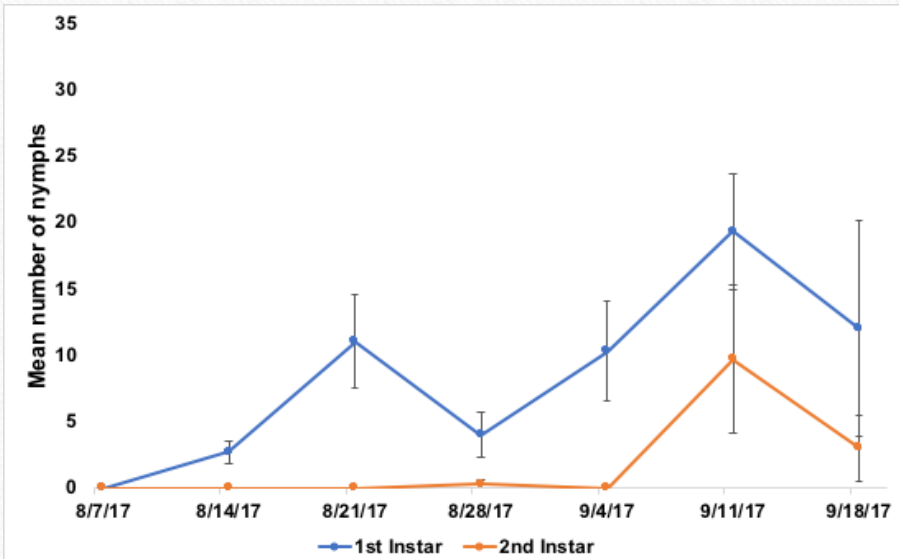
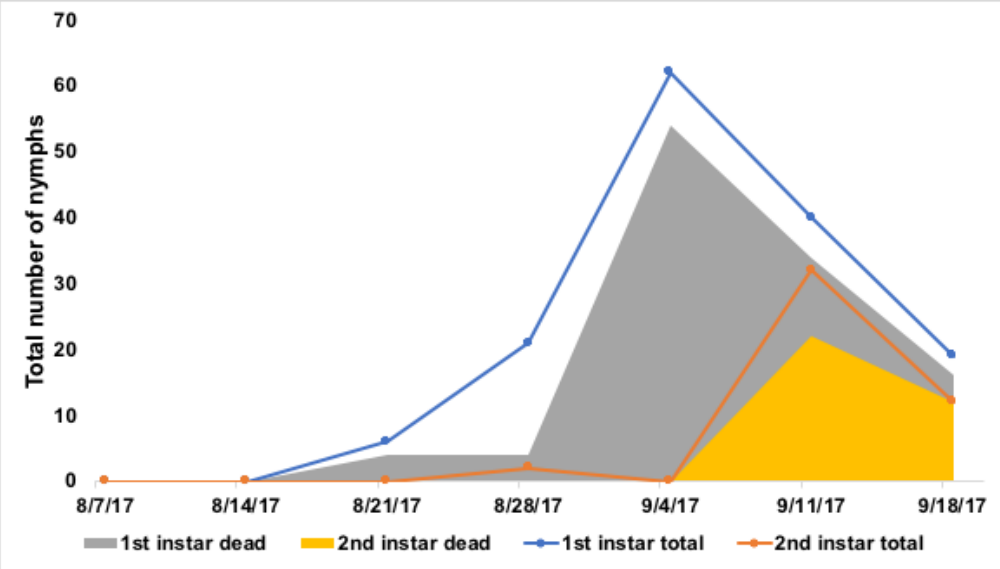
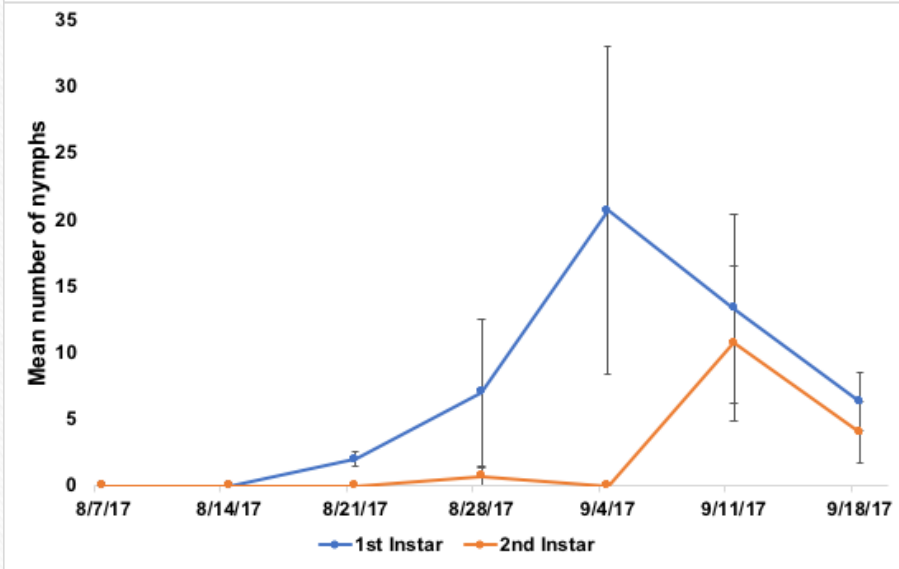


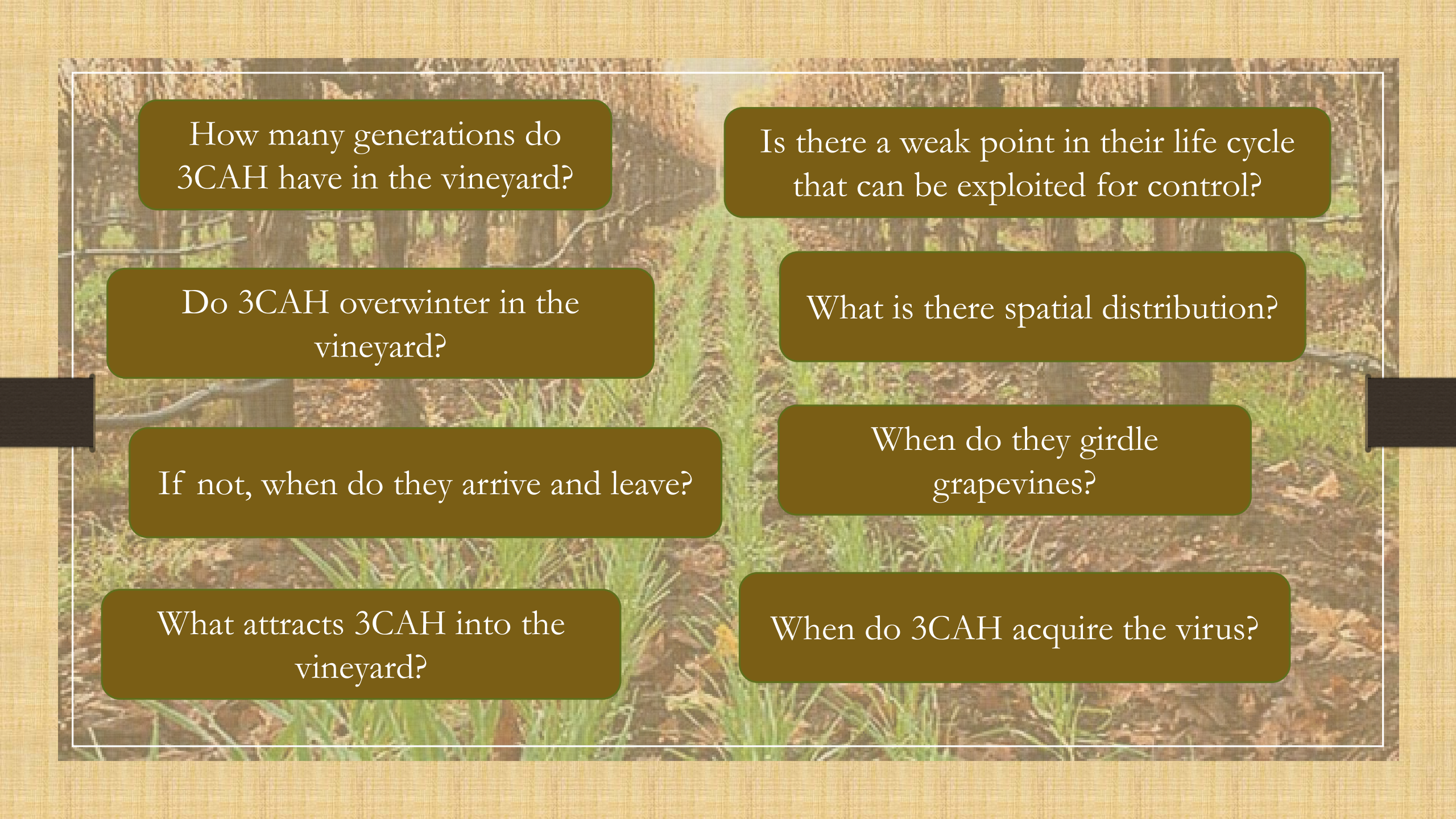


Are grapevines a reproductive
host?

Testing *Vitis vinifera* as a reproductive host of 3CAH



A**B**



How many generations do 3CAH have in the vineyard?

Is there a weak point in their life cycle that can be exploited for control?

Do 3CAH overwinter in the vineyard?

What is their spatial distribution?

If not, when do they arrive and leave?

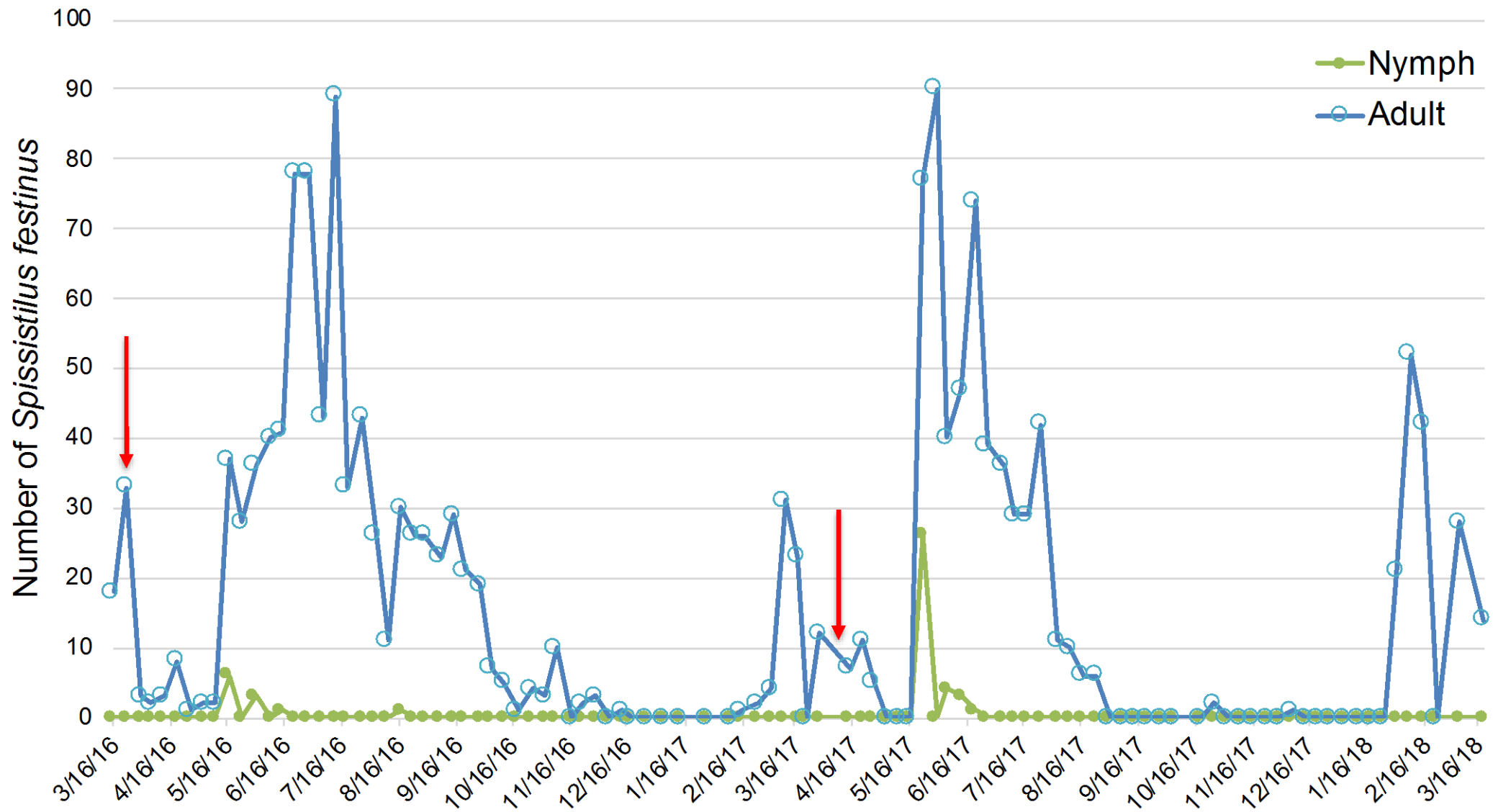
When do they girdle grapevines?

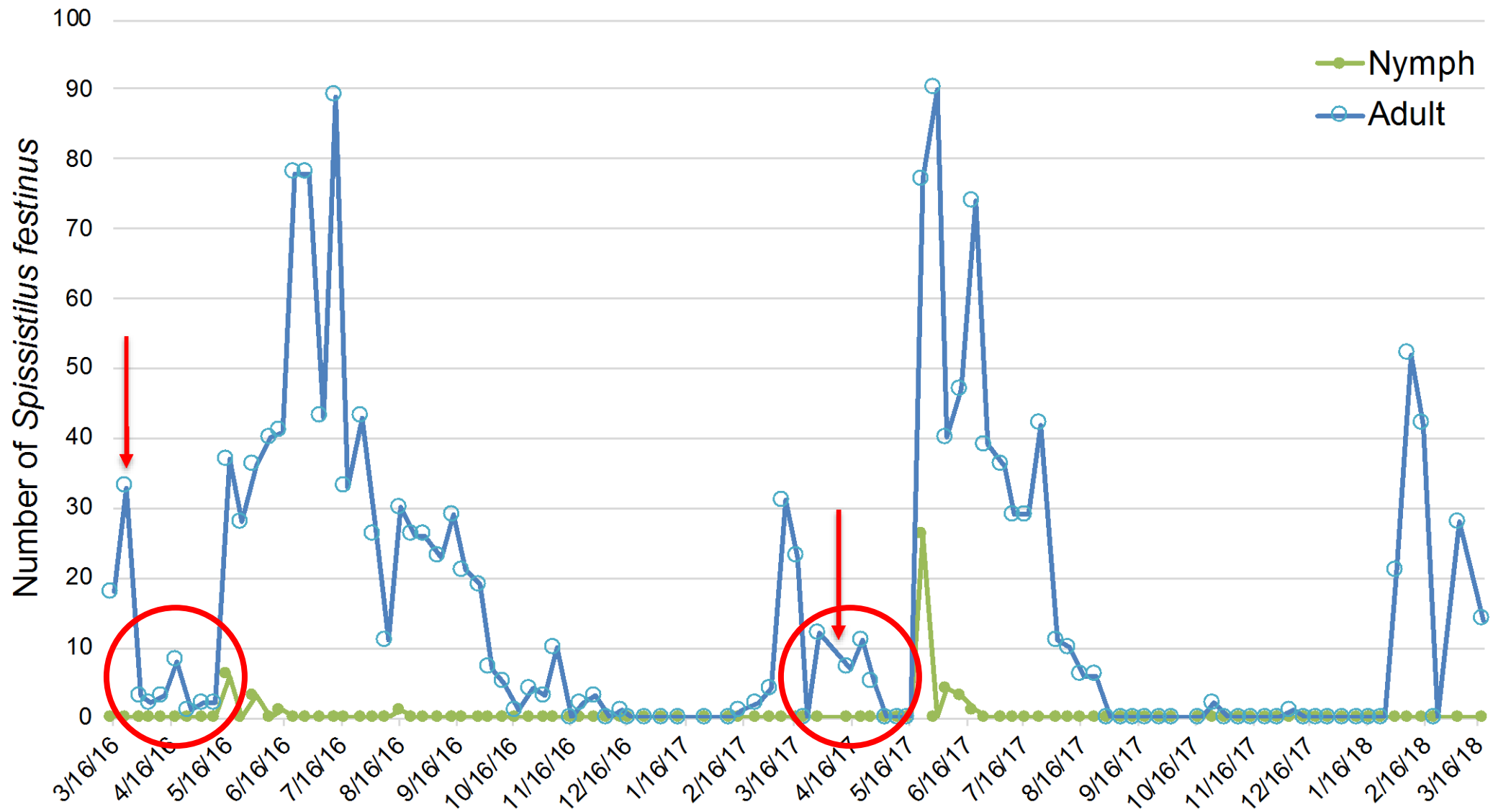
What attracts 3CAH into the vineyard?

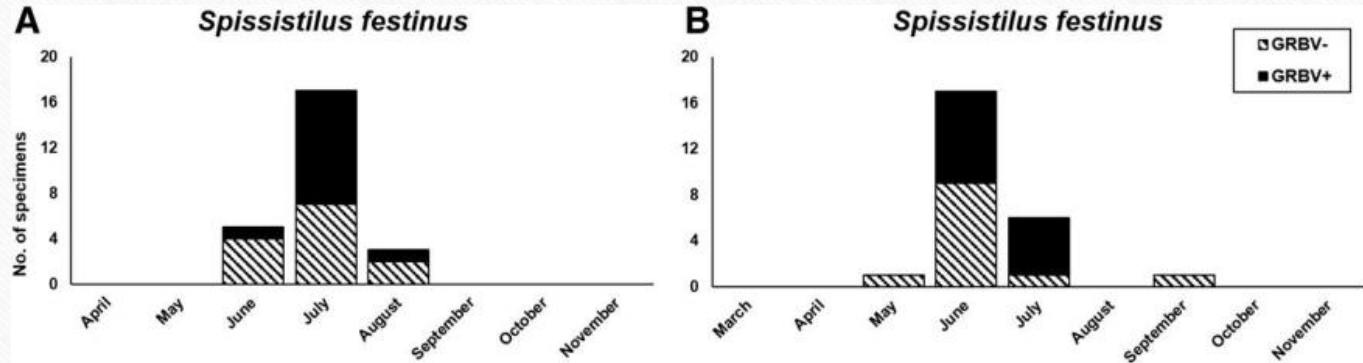
When do 3CAH acquire the virus?

Seasonal dynamics of 3CAH in the vineyard

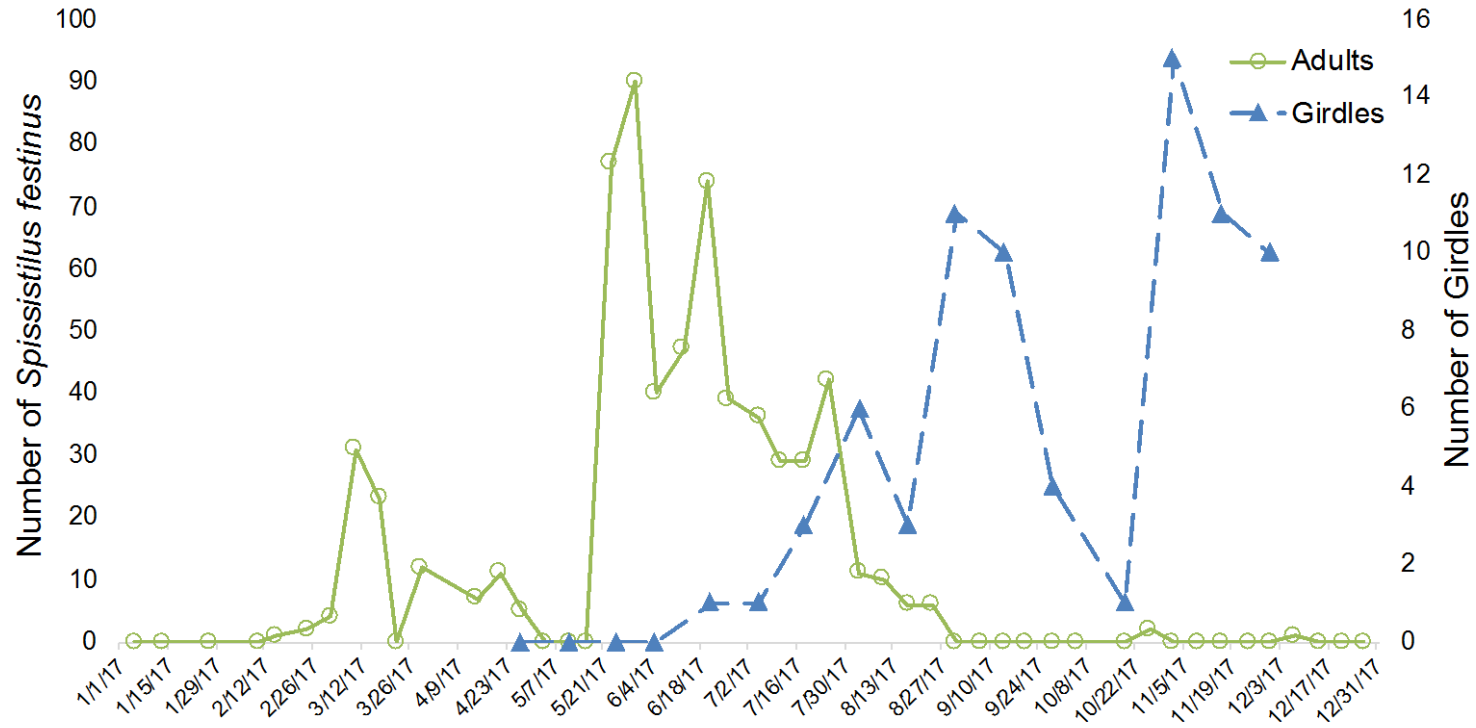




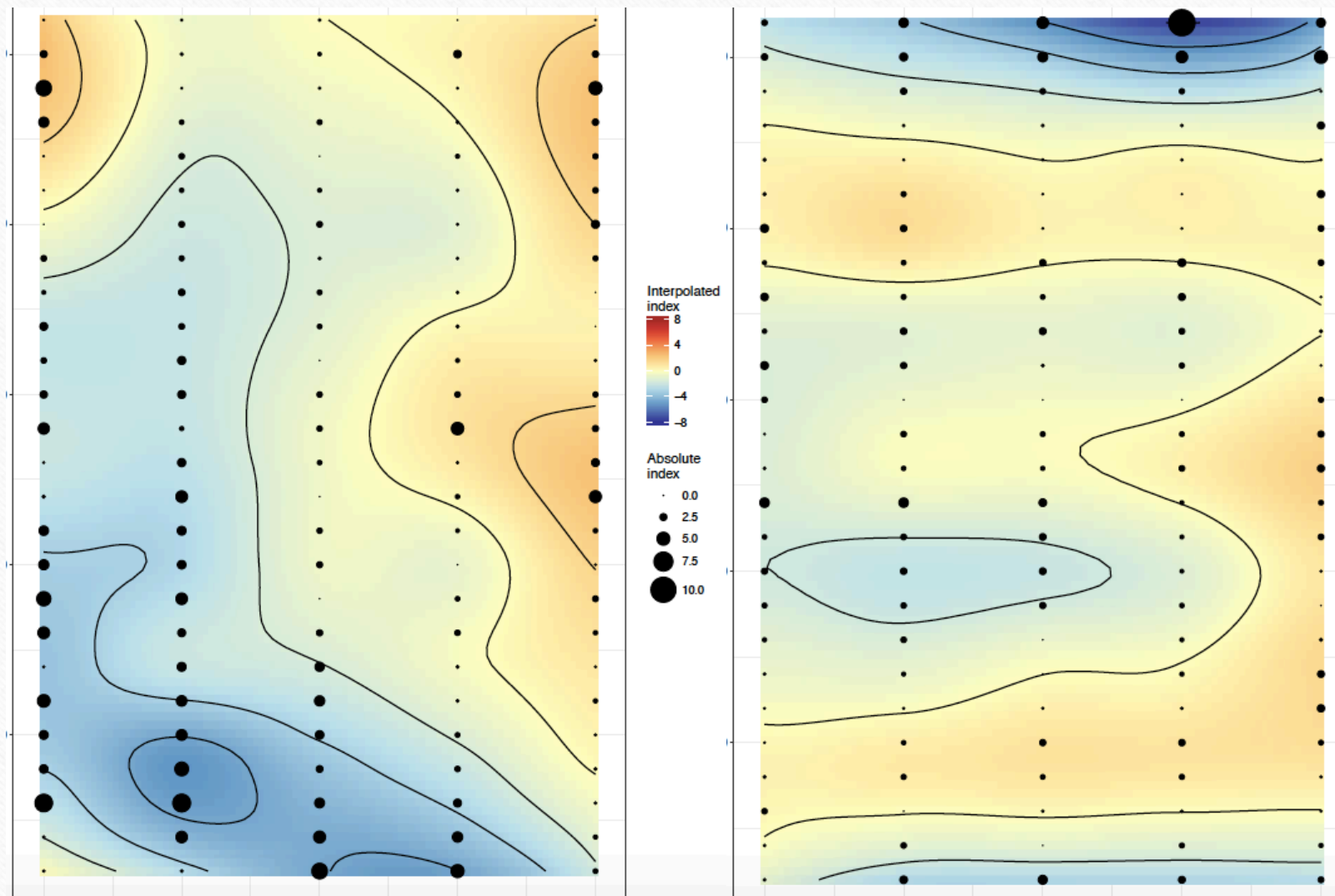




Cieniewicz, E. J., S. J. Pethybridge, G. Loeb, K. Perry, and M. Fuchs. 2018. Insights into the Ecology of *Grapevine red blotch virus* in a diseased vineyard. *Phytopathology*. 108: 94-102.



Preto, C. R., Mysore R. Sudarshana, Brian W. Bahder, Emily Bick, and Frank G. Zalom. 2019. Seasonal dynamics of *Spissistilus festinus* (Hemiptera: Membracidae) in a Californian vineyard. *Journal of Economic Entomology*. 112(3): 1138-1144.




2016

2017

What if you are a no-till vineyard, plant leguminous cover crops for Nitrogen, and are concerned about Grapevine red blotch disease in your vineyard?





What if you are a no-till vineyard, plant leguminous cover crops for Nitrogen, and are concerned about Grapevine red blotch disease in your vineyard?

Kill the cover crop with steam

Can we use biocontrol?



Hippodamia convergens adults



Cryptolaemus montrouzieri larvae



Cryptolaemus montrouzieri adults



Zelus renardii nymphs



Sympherobius barberi adults



Chrysoperla rufilabris larvae



Convergent ladybird beetle



Mealybug destroyer larvae



Mealybug destroyer adults



Assassin bug nymphs



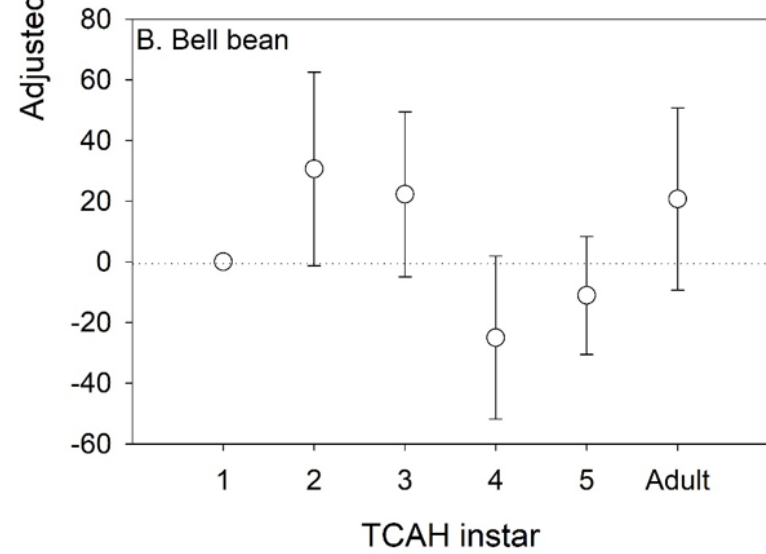
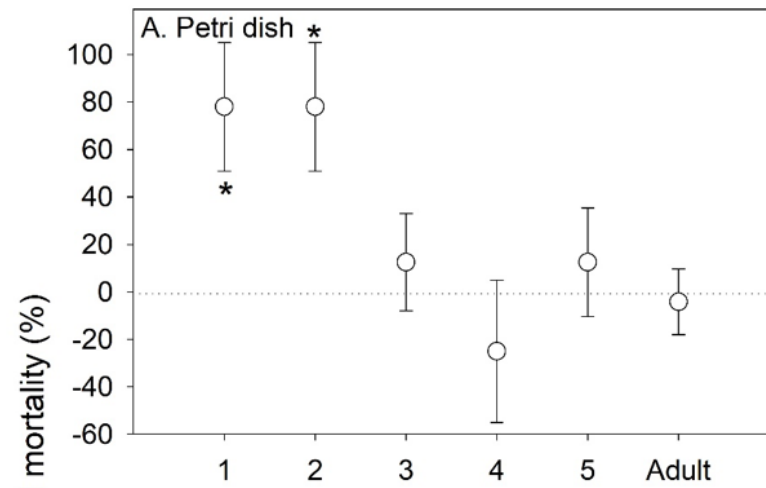
Brown lacewing adults



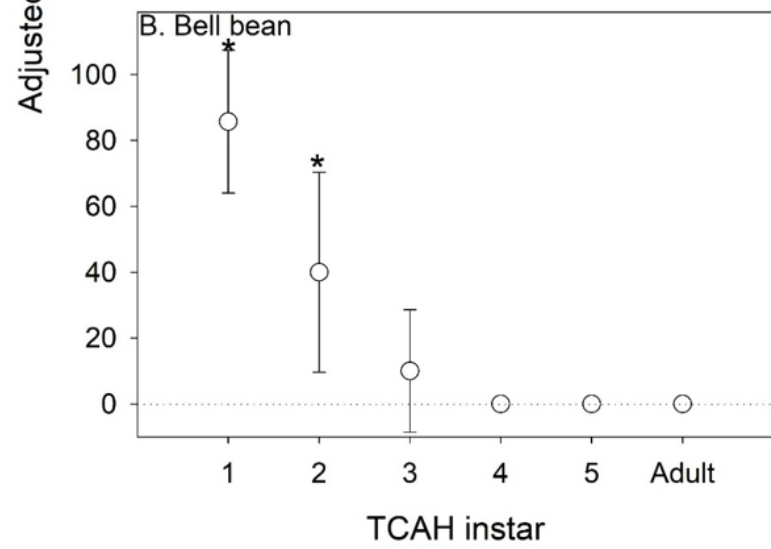
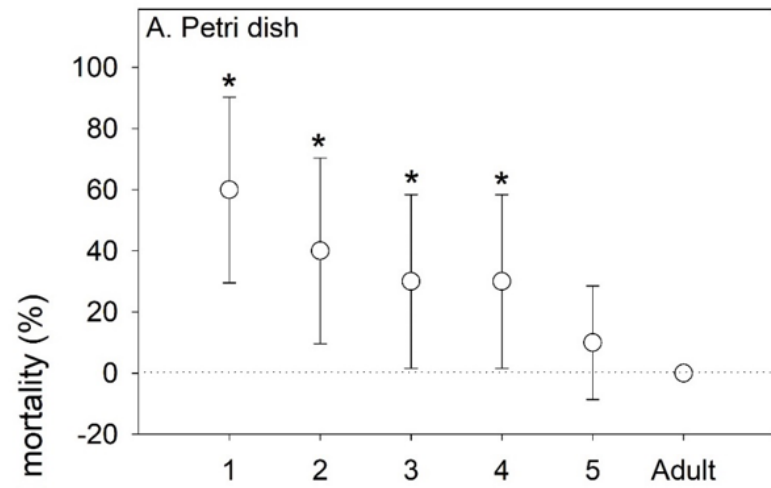
Green lacewing larvae



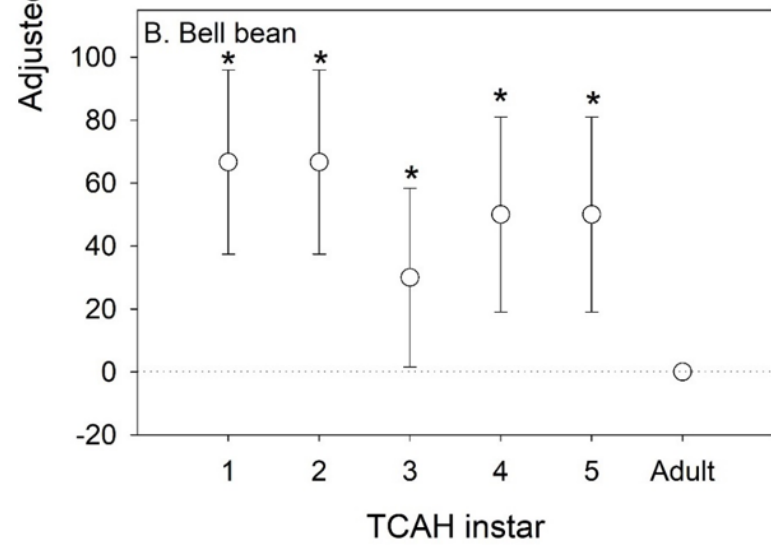
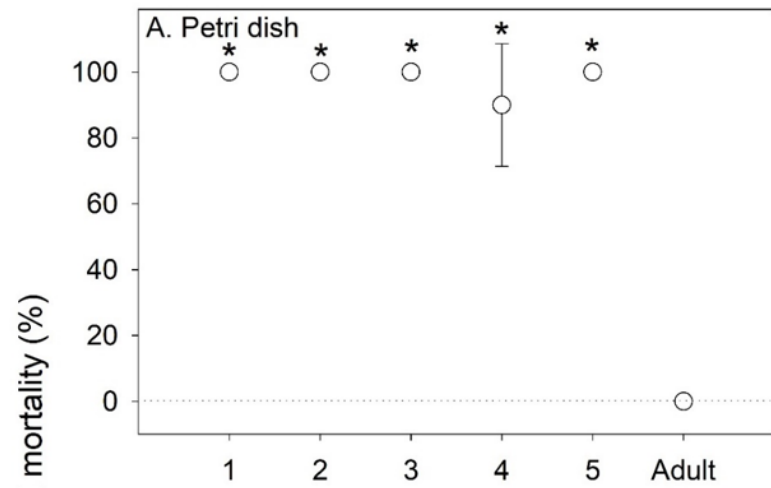
No statistically significant predation of the 5 immature stages and adults of the three-cornered alfalfa hopper by these commercially available predators



Assassin bug nymphs
(*Zelus renardii*)



Convergent ladybird beetle adults
(*Hippodamia convergens*)



Green lacewing larvae
(*Chrysoperla rufilabris*)

What have we learned and how can we use the information?

- Legumes are the preferred host of 3CAH – weeds and cover crops
 - Control of leguminous hosts
- 3CAH can reproduce on grapevines but:
 - 1) Adults do not survive or reproduce on dormant wood
 - Virus transmission not expected during grapevine dormancy
 - 2) Nymphs did not complete their life cycle on grapevines
 - Control ground vegetation that serves as hosts
- 3CAH arrive in the vineyard in late winter
 - Sampling for 3CAH is needed earlier than expected
- The overwintering 3CAH adults arrive in the vineyard before bud break and since they do not feed on dormant wood, we can deduce that 3CAH are initially attracted into the vineyard by other feeding and reproductive hosts
 - Control ground vegetation that serves as hosts

What have we learned and how can we use the information?

- Overwintering adults arrive in the vineyard to feed, lay eggs, and proceed to die off. The depression in the population is when nymphs are developing and the most susceptible stage of the insect for control
 - Till under the cover crop before the nymphs are able to complete their life cycle → remove the feeding host for nymphs and they die → large reduction in the first in-field generation and overall seasonal population
- As ground cover dies off in the vineyard, the 3CAH adults move up into the grapevine canopy to feed
 - Likely timing in which virus acquisition and transmission occurs
- Appears to be one to two generations per year
 - A large reduction in the 1st in-field generation may have an impact on the degree of virus spread → fewer insects = reduced vector mediated spread

What have we learned and how can we use the information?

- Spatial distribution is aggregated
 - Aggregate distribution → more samples needed
- Edge effect exists and possible attraction to water sources
 - Insights on where to sample near water sources, near the vineyards edge, adjacent to riparian areas, areas with leguminous cover crops/weeds, and/or high Grapevine red blotch disease occurrence

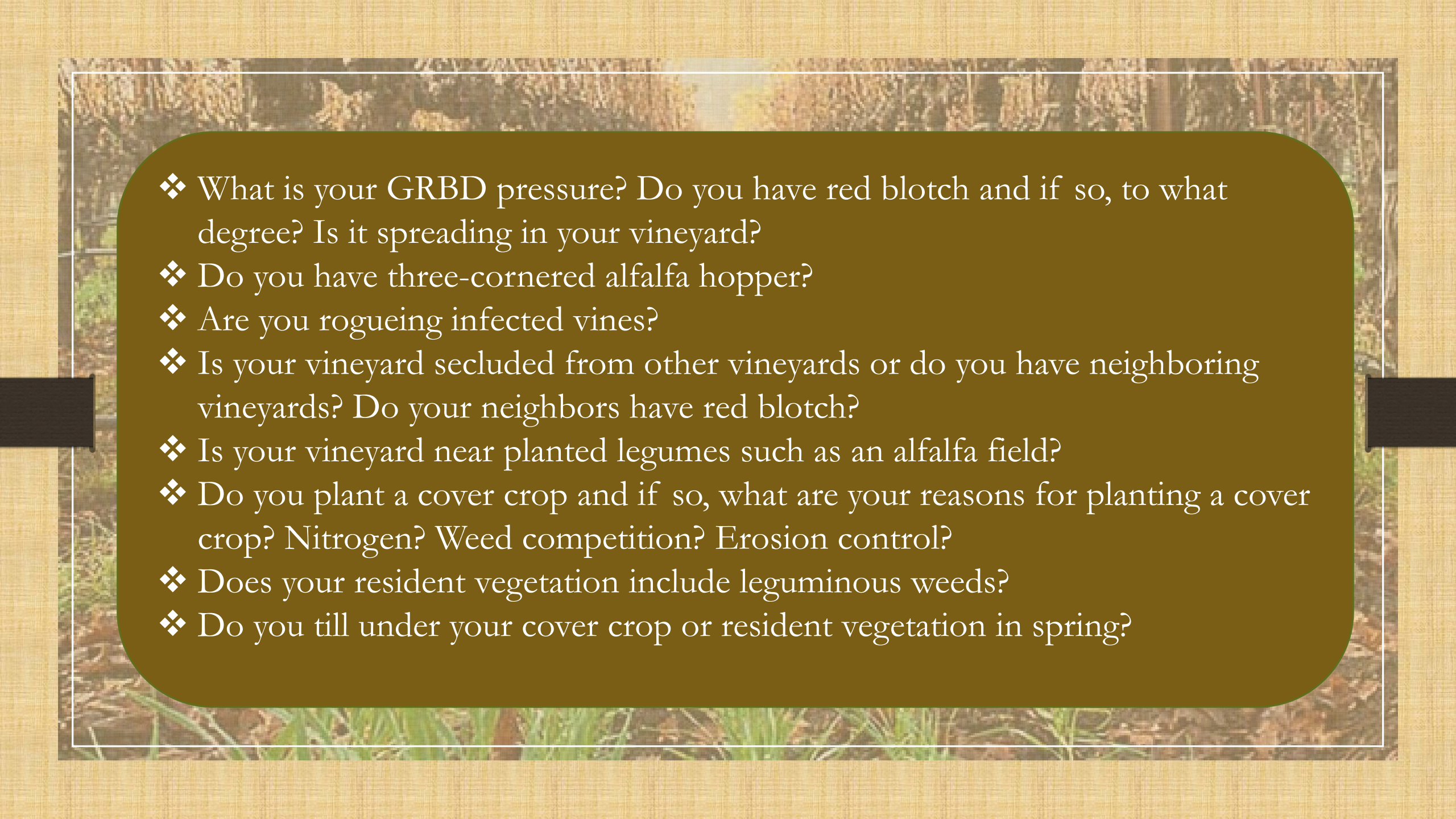


What are you to do?

A photograph of a vineyard with rows of grapevines and green plants in the foreground, overlaid with two dark green ovals containing text.

What are you to do?

There is no one-size-fits-all
answer

- 
- ❖ What is your GRBD pressure? Do you have red blotch and if so, to what degree? Is it spreading in your vineyard?
 - ❖ Do you have three-cornered alfalfa hopper?
 - ❖ Are you rogueing infected vines?
 - ❖ Is your vineyard secluded from other vineyards or do you have neighboring vineyards? Do your neighbors have red blotch?
 - ❖ Is your vineyard near planted legumes such as an alfalfa field?
 - ❖ Do you plant a cover crop and if so, what are your reasons for planting a cover crop? Nitrogen? Weed competition? Erosion control?
 - ❖ Does your resident vegetation include leguminous weeds?
 - ❖ Do you till under your cover crop or resident vegetation in spring?

Arthropods in Relation to Plant Disease

Journal of Economic Entomology, 111(6), 2018, 2531–2535
doi: 10.1093/jeet/toy236
Advance Access Publication Date: 10 August 2018
Research

Feeding and Reproductive Hosts of *Spissistilus festinus* (Say) (Hemiptera: Membracidae) Found in Californian Vineyards

Cindy R. Preto,^{1,3} Mysore R. Sudarshana,² and Frank G. Zalom¹

Vitis vinifera (Vitales: Vitaceae) as a Reproductive Host of *Spissistilus festinus* (Hemiptera: Membracidae)

Cindy R. Preto,^{1,3} Mysore R. Sudarshana,² Michael L. Bollinger,¹ and Frank G. Zalom¹

Journal of Insect Science, (2018) 18(6): 20; 1–7
doi: 10.1093/jisesa/iey129
Short Communication

Ecology and Behavior

Seasonal Dynamics of *Spissistilus festinus* (Hemiptera: Membracidae) in a Californian Vineyard

Cindy R. Preto,^{1,4} Brian W. Bahder,² Emily N. Bick,¹ Mysore R. Sudarshana,³ and Frank G. Zalom¹

Journal of Economic Entomology, 112(3), 2019, 1138–1144
doi: 10.1093/jeet/toz022
Advance Access Publication Date: 23 January 2019
Research

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American Journal of Enology and Viticulture (AJEV). doi: 10.5344/ajev.2020.19069
AJEV Papers in Press are peer-reviewed, accepted articles that have not yet been published in a print issue of the journal or edited or formatted, but may be cited by DOI. The final version may contain substantive or nonsubstantive changes.

Research Article

Identification of Non-Host Cover Crops of the Three-Cornered Alfalfa Hopper (*Spissistilus festinus*)

Cindy R. Kron^{1,2*} and Mark S. Sisterson¹

Ckron@ucdavis.edu