Indirect effects of field management on pollination in hybrid onion seed production

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- Hybrid onion seed is an important specialty crop in California.

- For seed set, pollinators move pollen between male and female (male sterile) plants.

- Primary pollinator is the honey bee.

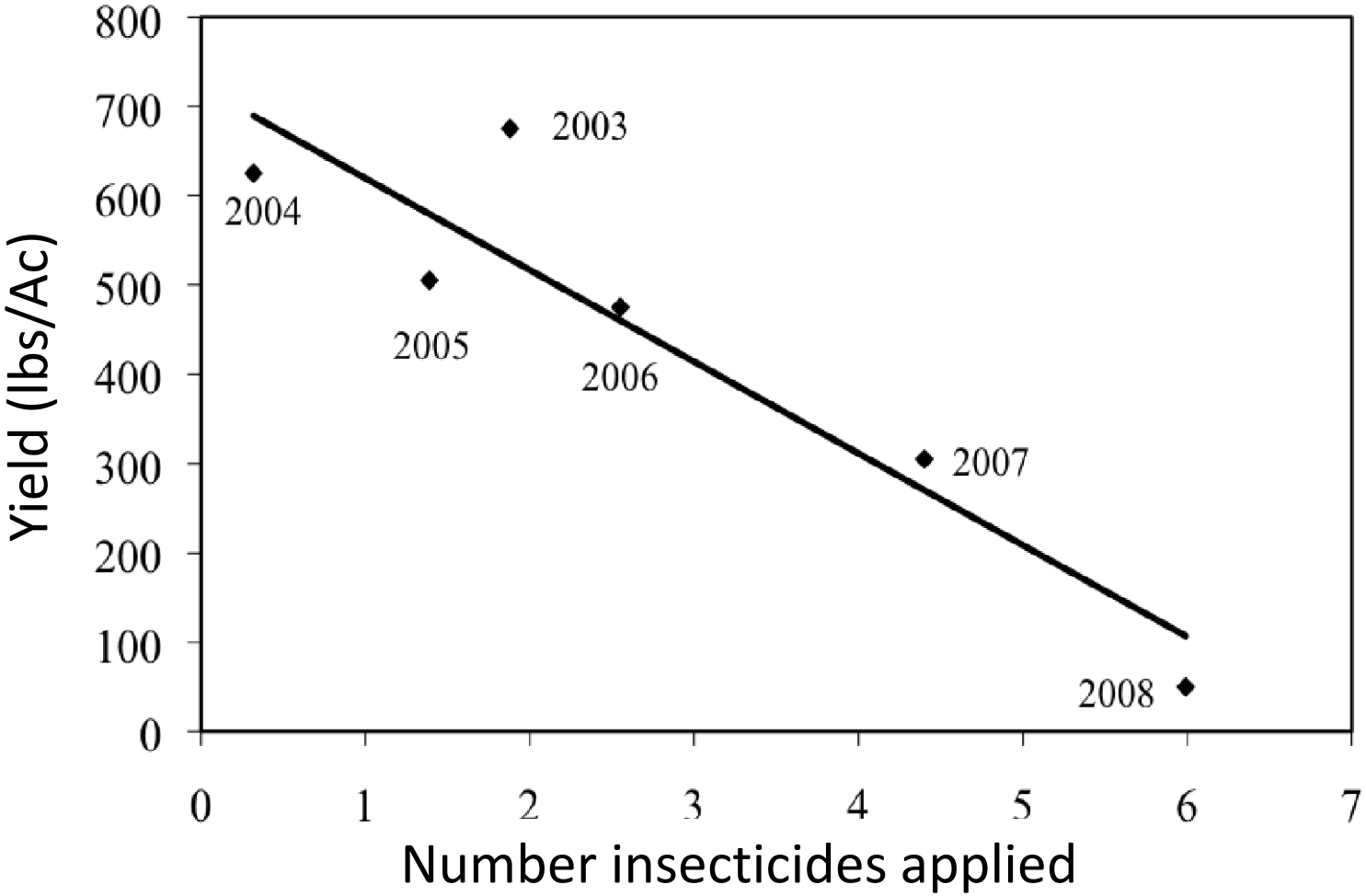
- Yields have significantly declined since 2003.

- Declines coincided with increase in insecticide use to control onion thrips.

- Onion thrips vector Iris Yellow Spot Virus (IYSV) – newly emergent disease.

(*Thrips tabaci* Lindeman)

- Years with high per-field insecticide applications had low yields



Long and Morandin, Cal Ag, 2010

Research focused on factors that affect honey bee pollination in onion seed production.

Questions:

1. Does irrigation affect nectar production and pollinator attraction?

2. Are there differences in pollen viability between fields related to insecticide use?

3. Does insecticide use affect pollinator visitation?

4. What factor is most important for onion seed set?

- 17 commercial sites in 2012, 12 in 2013

- Pollinator activity

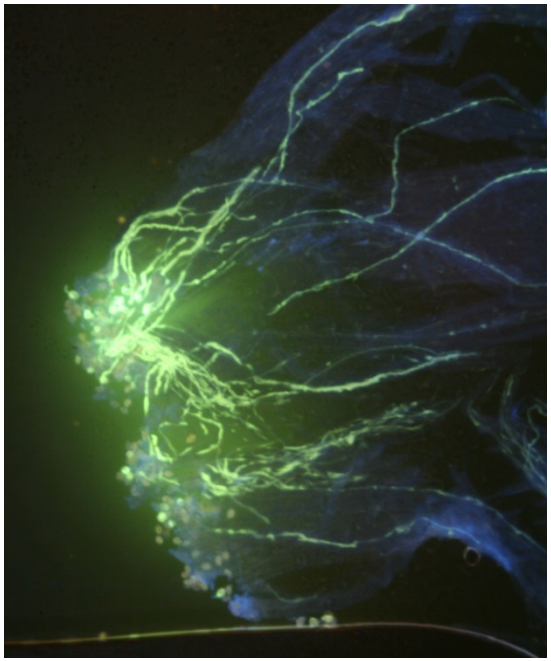
  Counted honey bee visitors to male and female umbels throughout bloom

- Quantified nectar production
  - Bagged umbels for 24 hours, measured nectar produced with microcapillary tubes

- Soil moisture
  - 1-foot cores taken within field. Weighed, dried re-weighed.
  - Percent moisture calculated

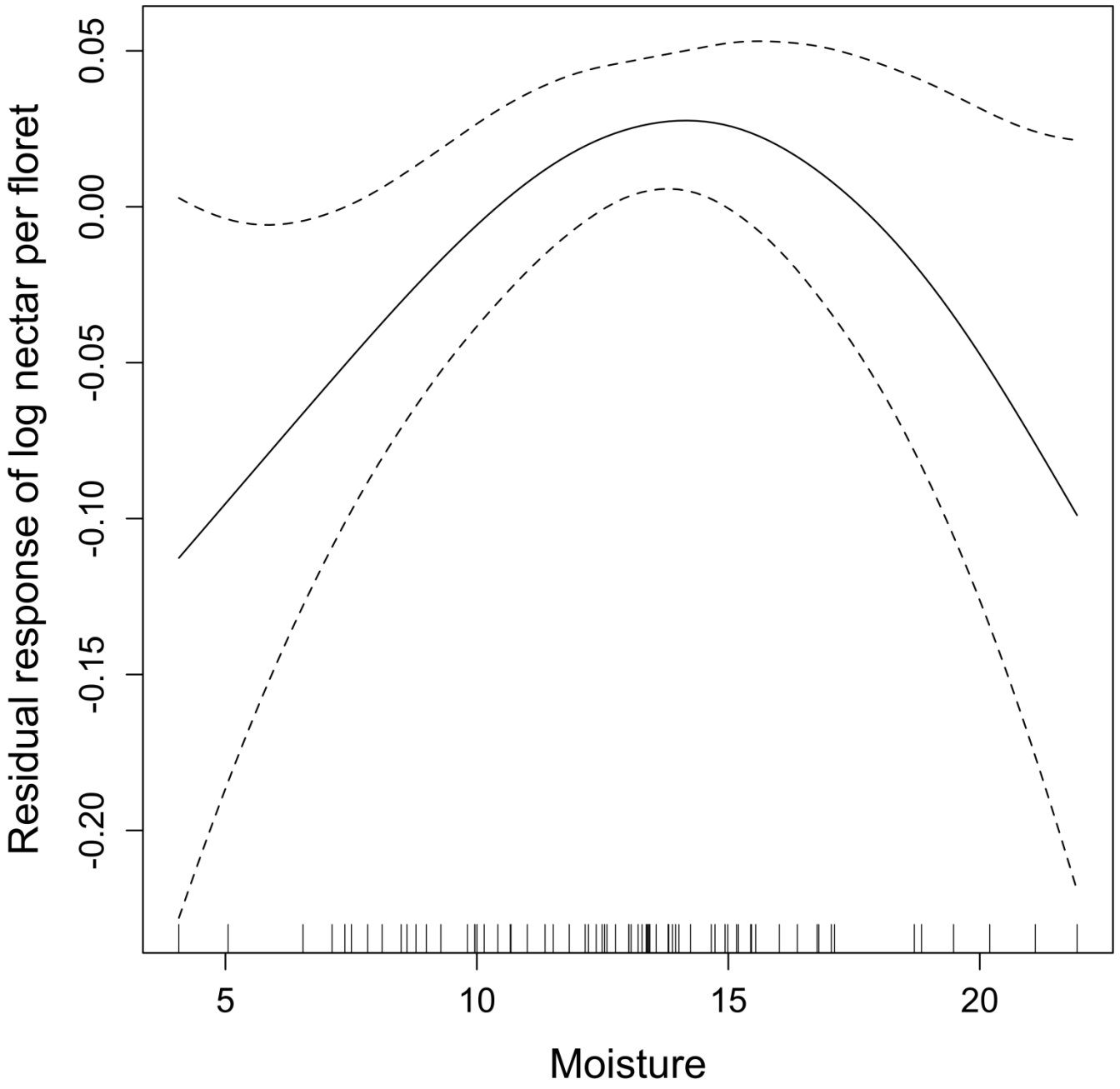
- Post-hoc data on
  - insecticide use

- **Pollen tube growth: controlled crosses**
- Bagged 15 female umbels per site.
- Pollinated 1-3 stigmas on each umbel with pollen from same site.
- Stigmas stained to visualize pollen tubes germinating at the tip of the stigma.



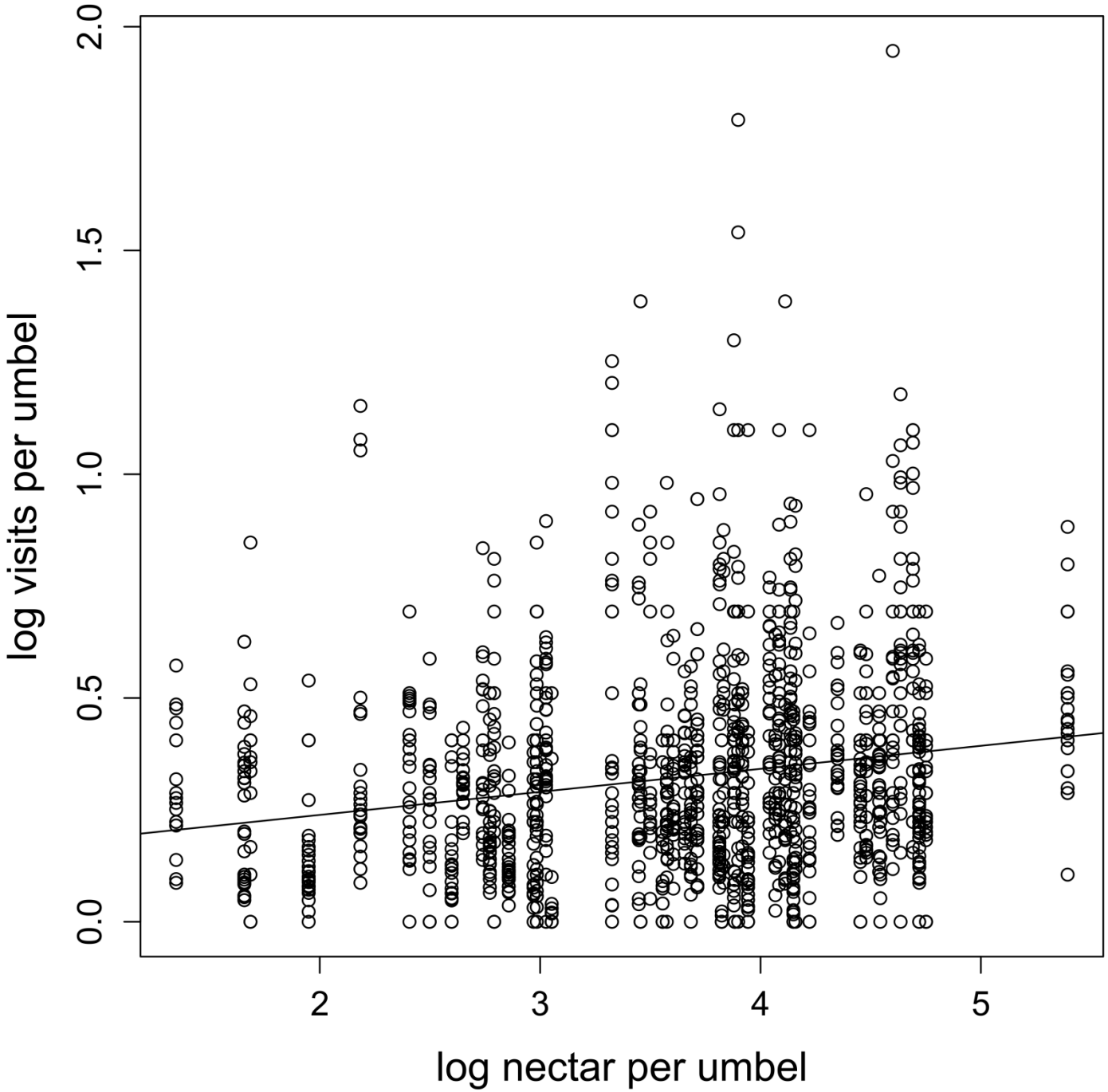
1. Does irrigation affect nectar production and pollinator attraction?

Nectar responded to soil moisture non-linearly ($p<0.0001$)



High nectar flowers experienced higher honey bee visitation

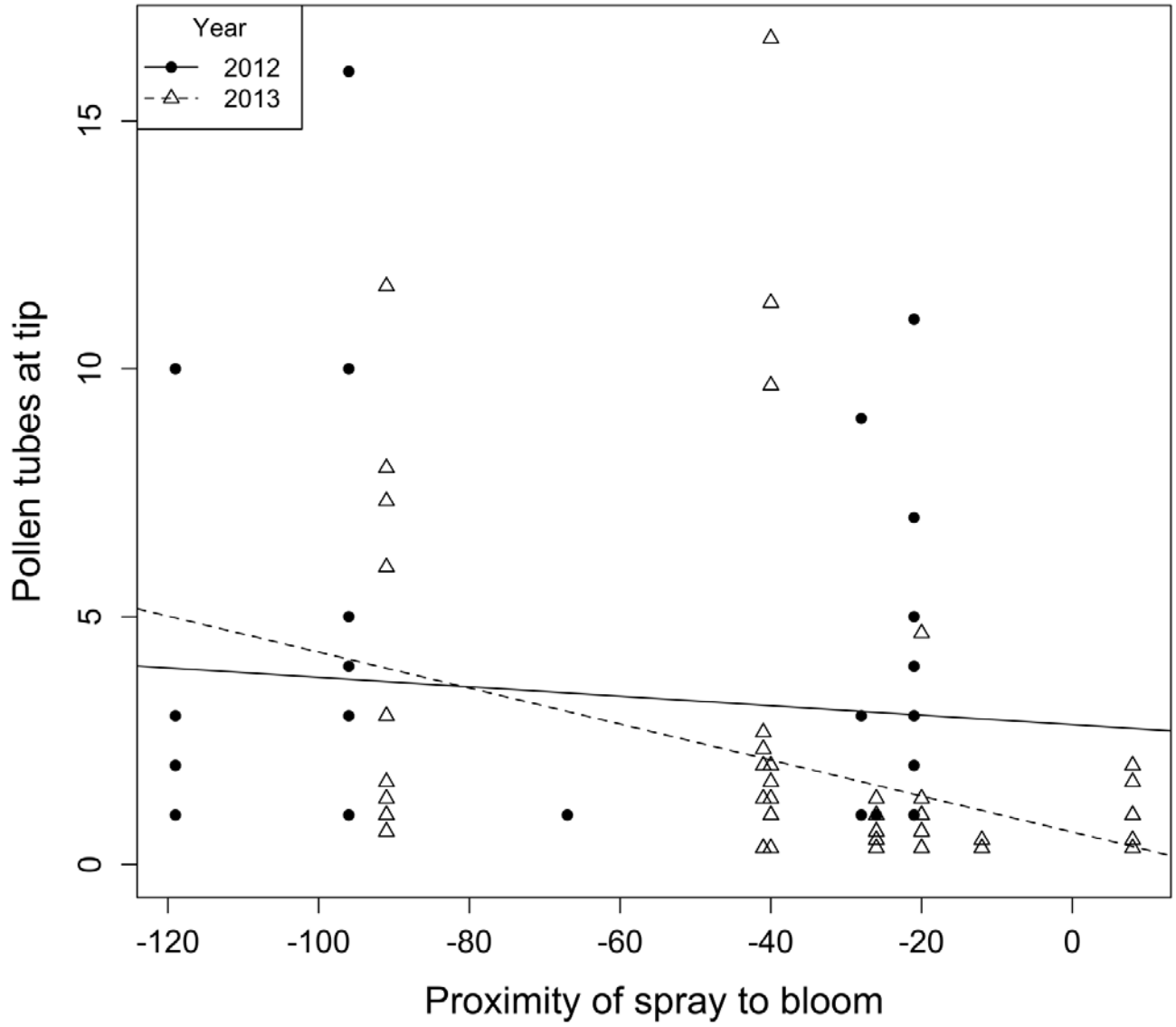
($p<0.0001$)

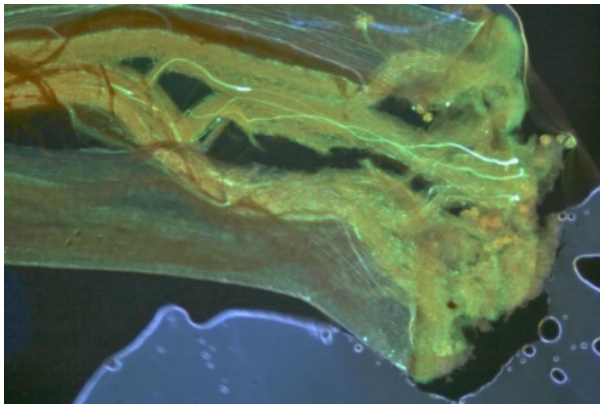


- Water stress affected nectar production at both extremes
  - Drought stress is known to reduce nectar production in wild plants
  - Over irrigation may cause oxygen stress in the roots, reduce nectar production
- **Foraging bees are sensitive to nectar rewards, prefer high-nectar flowers**

2. Are there differences in pollen viability between fields related to insecticide use?

Timing of insecticide sprays relative to bloom were important in pollen tube growth in 2013.



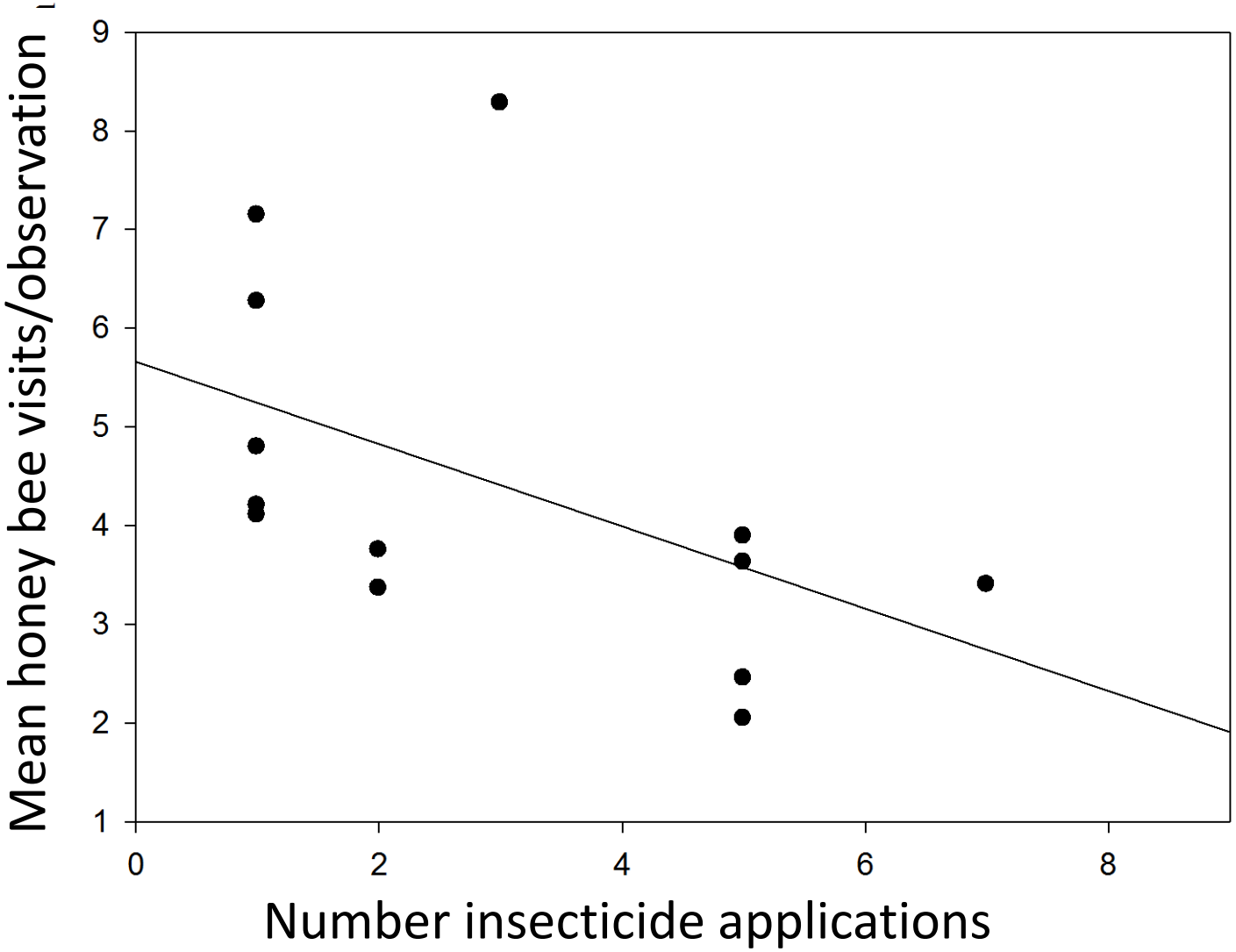


p= 0.0034

3. Does insecticide use affect pollinator visitation?

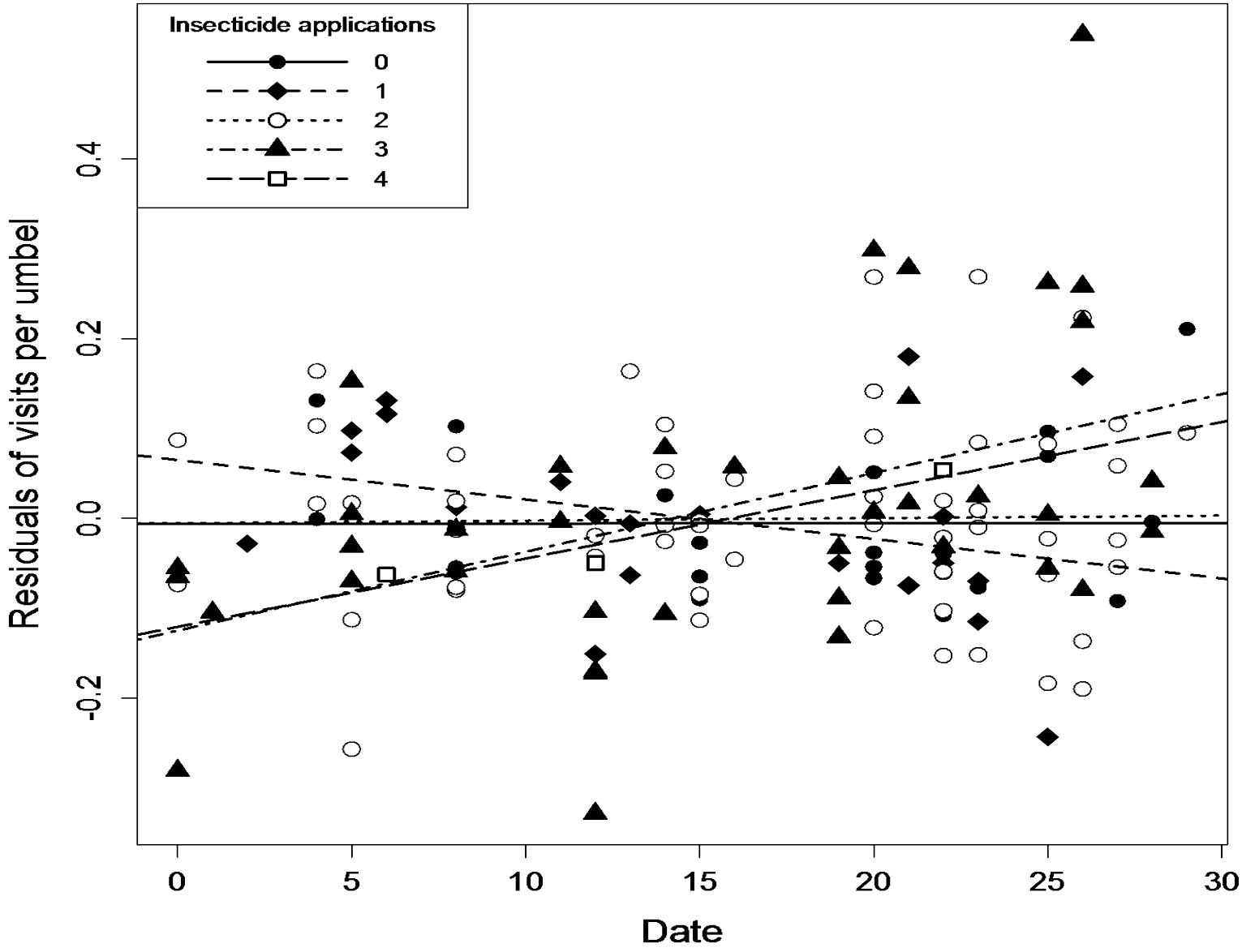
Previous research: 2009 field surveys

- Negative correlation between insecticide use and visitation
- Honeybee visitation key for seed set



Long and Morandin, Cal Ag, 2010

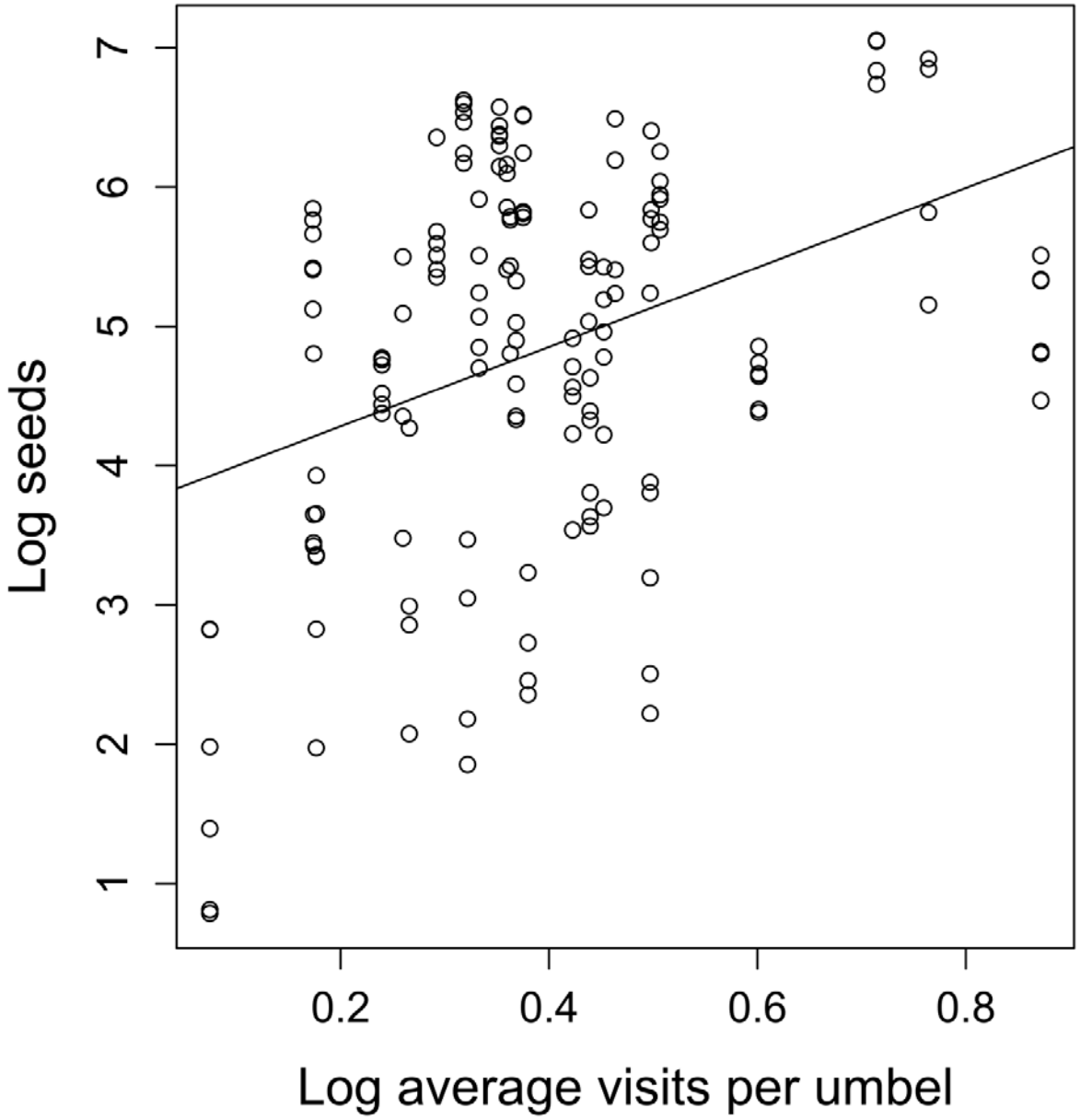
Patterns in pollinator visitation over time were affected by insecticide use, $p < 0.0001$.



4. What factor is most important for onion seed set?

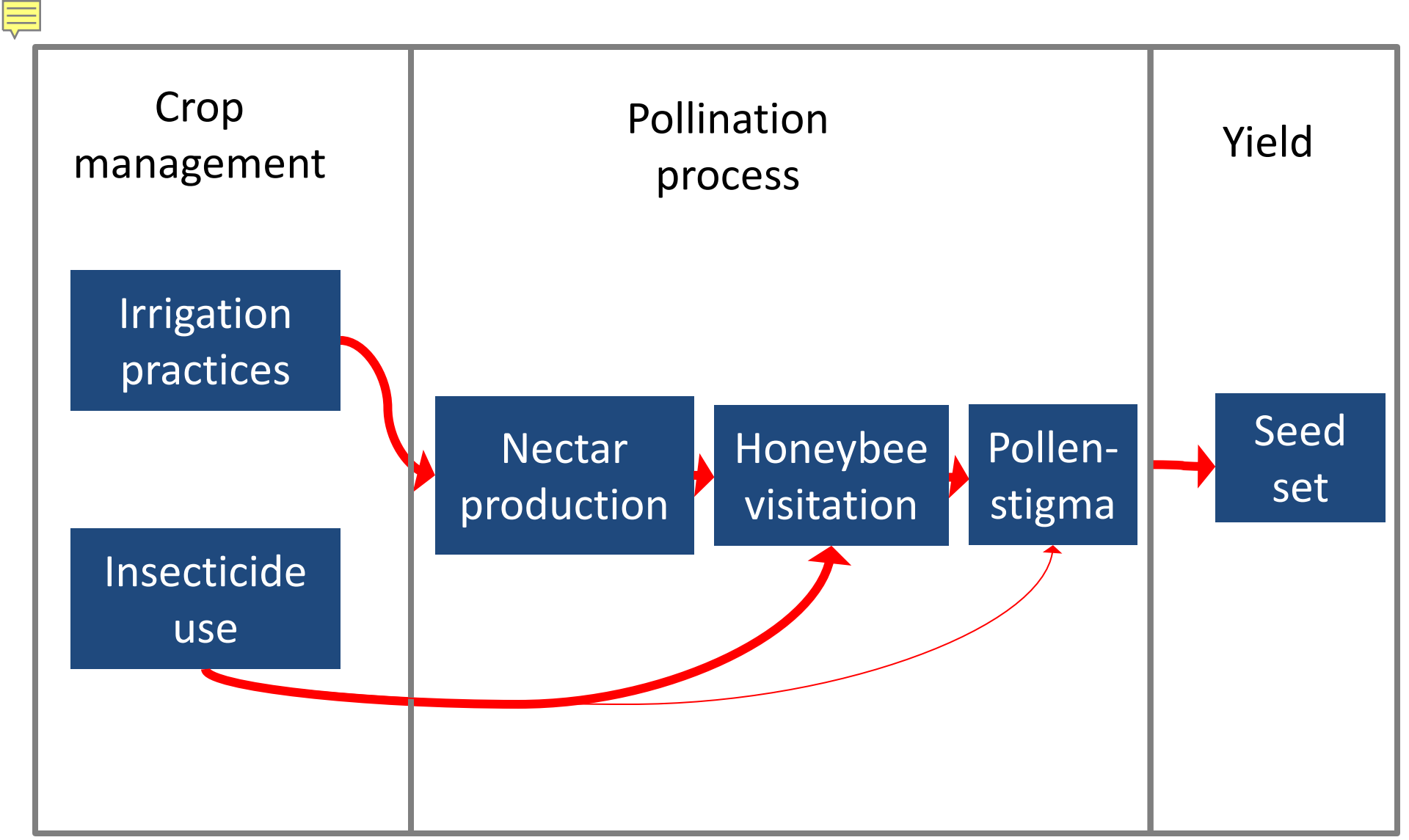
Pollinator visitation is the single-most important variable for onion seed set in commercial fields.

Seeds per umbel increased with honey bee visitation (p= 0.026)



Summary

- Irrigation impacts nectar production, which was important for pollinator visitation.
- Insecticides affect honey bee flower visitation.
- Honeybee visitation was positively related to yield.
- Timing of insecticide use maybe important for pollen germination.

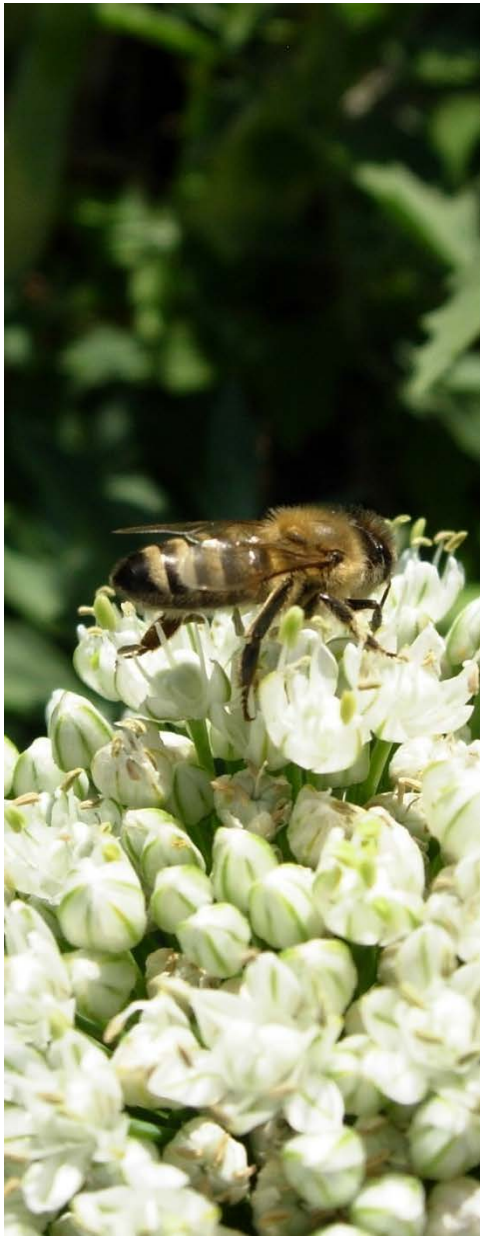

Crop management
Pollination process
Yield
Irrigation practices
Insecticide use
Nectar production
Honeybee visitation
Pollen-stigma
Seed set

Implications

- Results highlight the importance of considering the indirect effects of management on the pollination process.

- In hybrid onion, advise continued moderation in insecticide use.

- Manage water carefully during bloom for maximum nectar production.



Funding:

- California Department of Food and Agriculture
- Onion growers of California (CGORAB)

Field assistance: Kirsten Northfield, Andrea Drager, Genoa Starrs, Gloria Solorio, Gracie Galindo

Seed companies: Sakata Seeds, Nunhems Inc, Seminis, Pacific Seeds


Questions?