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Title: **"Manipulating vineyard irrigation amounts to reduce insect pest damage"**

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The authors manipulate irrigation amounts in a Thompson Seedless vineyard to determine the response of leafhoppers to changes in plant vigor.

• Before starting, a little introduction on the variegated leafhopper (*Erythroneura variabilis*) in the San Joaquin Valley. There are normally 3 generations. Each generation is comprised of successive nymph stages –called instars- which are differentiated by a number. Each instar is, obviously, larger than its predecessor.

Few eggs -1st Instar - 2nd Instar- 3rd Instar- 4th Instar-5th Instar-Adult	*Late May to early June*
Adult-5th Instar-4th Instar-3rd Instar-2nd Instar-1st Instar- Egg	*Mid- to late July*
Egg-1st Instar - 2nd Instar- 3rd Instar-4th Instar-5th Instar-Few adults	*Early September*

• There are two opposite hypothesis to explain the relationship between insect populations and host plant growth. The first states that stressed or slow-growing plants are the ones most susceptible to insect attack. The second states that vigorous plants are the ones favoring insects. So which is true?

• The authors applied the following irrigation treatments: 0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, and 1.4 times ETc, using 8 replications of 38 vines each. ETc was measured from a lysimeter in the Kearney Agricultural Center in years 1991 to 1993 (average value was 5100 liters/vine, or 675 mm, per year). Then they tracked the vine growth and the leafhopper populations for each irrigation level.

• The **vine growth parameters** measured included: leaf area, shoot lengths, pruning weights, and leaf total nitrogen. They also measured midday leaf water potential. The **leafhopper population parameters** measured included: nymph density, nymph size, nymph mortality, adult movement, and egg deposition.

• Some of the leafhopper population parameters –like the first and the last above- required a simple inventory of nymphs or eggs on a specific number of leaves at specific times throughout the season. Others required a little bit more sophistication. Nymph size, for example, was measured using as a reference the dry mass of about 300 fifth instar individuals after they had been oven-dried. Nymph mortality was studied by isolating young individuals in cages, and monitoring their survival after the cages had been placed back in the canopies of each irrigation treatments. Adult movement was studied using a “catch-release” technique (which involved the following routine: catching adults, anesthetizing them with CO_2, marking them with a fluorescent dye, releasing in each irrigation treatment, recapturing, and evaluating how many flew to which treatment on a windless day).

• The authors found that: 1) Leaf water potential, leaf area, and pruning weights were proportional to the amount of water applied. This was expected: the more water, the more growth. They also found that leaf N was inversely proportional to the amount of water applied, that is, the more water, the less N, on a per leaf area basis. 2) Differences in densities of leafhoppers among irrigation treatments increased as the season progressed. 3) The amount of leafhoppers nymphs increased as the water increased. 4) The nymph mortality was greater in deficit irrigation treatments, as compared to the well-irrigated ones. 5) Collected adults increased as the amount of water applied increased. 6) The amount of adults marked, released and recaptured was proportional to the amount of irrigation. That is, more leafhoppers tended to fly to the vines with the highest water regimes. And finally, 7) Females deposited significantly more eggs on high irrigation leaves than on water deficit leaves.

• Even though the amount of adults was higher in higher water regimes, the relationship changed depending on the season. Leafhopper collections in 1992 showed a linear relationship, whereas collections in 1993 showed a non-linear relationship with a peak at 0.8 irrigation level. That means that adult populations were at their peak at 0.8 ETc, then decreased at higher water levels.

• In their detailed discussion, the authors offer some points for reflection:

- when changing water amounts and plant vigor, canopy temperature and humidity is also changed. Leafhopper eggs are highly sensitive to temperature. Adults might also prefer shaded, cooler leaves. The effect of the host quality –the plant- can simply not be separated from the effect of the environmental quality –the canopy microclimate.

- even though vigorous vines sustain more leafhoppers, the economic damage can be more tolerable for these vines than for stressed, smaller vines. This increased tolerance may be a trade-off against higher leafhopper populations.

- important differences in leafhopper densities were not obvious until the second generation, probably because, despite the different water treatments, there was plenty of water across treatments in the soil profile and from the rain. So we need to keep in mind that pesticide decisions might need to be made before we actually see population differences.

- even though the authors only examined leafhoppers, water will also affect other insect pests. For example, reduced vine growth due to water stress increased the densities of Pacific spider mite.

- similarly, water stress will also affect other insects that might be desirable. Poor leaf quality has been associated with greater mortality of natural enemies.

In summary, leafhopper densities were a linear function of applied water amounts. So it is not a good idea to irrigate above 80% ETc otherwise we will attract more leafhoppers and will not be compensating with increased crop yields.

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