Walnut Grower News

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Increasing the Competitiveness of Walnut Growers: Economic vs. Environmental Impacts

Agriculture in California faces many challenges – foreign competition, rising prices for fuel and fertilizer, increasing regulations, water availability and climate change. As a farmer it's hard to know how to respond and where to turn for the latest information.

This publication presents information on two of those challenges of particular interest to California walnut growers – climate change and water quality impacts from use of pest control chemicals. A research team from the University of California, Davis (UCD) and the University of Calilfornia Cooperative Extension (UCCE) has examined these important issues and this publication includes their analysis and recommendations to help walnut growers make informed decisions and increase economic viability.

Inside:

Walnuts and Pest Management

Growers of all crops in California are under increasing regulatory pressure to minimize contamination of surface water from agricultural chemicals. This is important for walnut growers, since some of the commonly used chemicals in walnut production have been shown to impact water quality, thus affecting the health of humans, aquatic species and wildlife.

These pesticides can also harm a wide variety of natural enemies that reside in orchards. Natural enemies can keep secondary pests in check through biological control. However, disruption of natural enemy control through use of broad spectrum conventional pesticides can result in secondary pest outbreaks, and trigger the need for further pesticide applications to control them.

Walnut growers have a choice of pest control products that range from those that selectively target only the pest of interest to those that target a broad spectrum of many species, including pests, natural enemies, and other terrestrial and aquatic wildlife. Figure 1 (page 3) provides a surface water quality ranking for a series of chemical products used by walnut growers. The ranks were calculated using the environmental impact quotient (EIQ) model, based on average use and active ingredient toxicity and exposure characteristics. The 'application rank' column shows the probable impact to surface water quality of one application at the average rate used on walnuts. The 'statewide rank' column shows the probable cumulative impact based on the use of the active ingredient by all growers and all commodities in California.

It is highly recommended that growers use the products with green colors in both the application rank column and the statewide rank column. The UCD team recommends that growers avoid using the products with red colors in both columns. When the products with one green color and one red color in these two columns are used, growers should evaluate the case carefully and weigh the risk before using.

The use of the lower-risk products may initially seem more costly. However, the use of these products may allow natural enemies to establish and survive, and therefore, keep secondary pest populations such as mites at low levels. Thus the use of lower-risk products has a greater potential for effective biological control and can replace the need for certain pesticides, lowering overall pest management costs. Depending on the grower's current practices, the potential savings could make an alternative pest management system economically competitive with conventional systems.

Results

The same team of researchers reviewed the pest management practices of 891 growers on about 35,000 acres of walnuts in San Joaquin, Stanislaus and Merced Counties during the years 2002 through 2006. They compared the potential water quality impact and cost of each pest management strategy to a hypothetical alternative using the lower-risk products deemed by walnut pest management experts to be effective in

controlling the same pests.

The project found that 96 percent of the strategies analyzed used products that would have a negative impact on water quality if the pesticides were to reach a water supply. However, if the products used in these strategies were replaced entirely by low-risk products of equivalent effectiveness, 43 percent or nearly half of the strategies would have a similar or lower cost when using the low-risk products. The use of these lower-risk products was assumed to maintain biological control and eliminate the need for a miticide. Thus, by using selective low-risk products, nearly half of the growers analyzed could lower the potential for water quality impacts and save on pesticide costs through reduced need for miticides.

Active Ingredient	Example of Product(s)	Application Rank	Statewide Rank
Phosmet	Imidan	1	4
Diazinon	Diazinon	2	6
Malathion	Malathion	3	5
Propargite	Omite	4	2
Dicofol	Dicofol	5	15
Azinphos-Methyl	Guthion	6	21
Chlorpyrifos	Lorsban	7	1
Endosulfan	Thiodan	8	11
Fenbutatin-Oxide	Vendex	9	19
Parathion Methyl	Penncap-M	10	25
Bifenazate	Acramite	11	9
Naled	Dibrom 8	12	10
Carbaryl	Sevin	13	16
Methidathion	Supracide	14	30
Permethrin	Pounce, Ambush	15	3
Spiridoclofen	Envidor	16	18
Pyridaben	Sanmite	17	35
Methoxyfenozide	Intrepid	18	8
Clofentezine	Apollo	19	33
Hexythiazox	Onager	20	17
Tebufenozide	Confirm	21	37
Bacillus Thuringiensis	Dipel	22	22
Fenpyroximate	Fujimite	23	20
Bifenthrin	Brigade	24	7
Oxydemeton-Methyl	Metasystox_R	25	23
Pyriproxyfen	Knack	26	27
Esfenvalerate	Asana	27	12
Spinetoram	Delegate	28	26
Diflubenzuron	Dimilin	29	32
Cyfluthrin	Baythroid	30	14
Lambda-Cyhalothrin	Warrior	31	13
Etoxazole	Zeal	32	34
Deltamethrin	Decis	33	31
Acetamiprid	Assail	34	29
Abamectin	Agri-mek	35	24
Gamma-Cyhalothrin	Proaxis	36	38
Spirotetramat	Movento	37	39
Chlorantraniliprole	Altacor	38	36
Spinosad	Success	39	28

Figure 1: Surface water quality rankings of commonly used pesticides based on individual applications and total statewide use in California. Red = highest impact, green = lowest.

Conclusions

The results suggest that there may be an economic benefit to using low-risk pesticide products if biological control can be employed as a tool in the grower's pest control strategy. While individual low-risk products may cost more than their conventional equivalents, it is possible that a lower-risk pest management system could save the grower money overall while protecting human health and water quality - if biological control can be effectively exploited.

Climate Change Impact

Walnuts and Decreasing Winter Chill

As walnut growers, you know the importance of cold temperatures during the winter dormant period. To avoid injury from cold weather, walnuts and other deciduous trees lose their leaves in the fall and go into a dormant state. To break dormancy, the trees need a certain amount of winter chill, which has traditionally been measured in chilling hours (defined as hours with temperatures between 32 and 45 degrees Fahrenheit). Each walnut cultivar has a different chilling requirement, but without the necessary chilling, flowering and pollination may be impacted - resulting in yield loss.

There is plenty of evidence that California's climate is warming and the results could be dramatic, making the state too warm to grow many of the fruit and nut crops our economy depends on, including walnuts.

UCD researchers have been investigating the losses in winter chill for walnuts and looking at ways that growers can respond to this new challenge. When planting walnuts, growers consider many factors, but matching the chill requirements with the climate of their growing area is a must. The UCD team found evidence that measuring the number of Chilling Hours, the traditional approach, may produce misleading results, particularly as the climate gets warmer. They recommend using an alternative method, known as the 'Dynamic' or 'Chill Portions' Model, which they found to be much more accurate for walnuts.

The researchers on this study found that "In some parts of California's agriculturally rich Central Valley, winter chill has already declined by nearly 30 percent. This factor could have a tremendous impact on the productivity of walnuts, which may no longer be able to fulfill their chilling requirements in the future. Growers will now need to look at new factors such as varietal chill requirements in the face of potential

temperature increases when considering new plantings as well as possibly making some changes in the way they farm existing walnut orchards."

Minghua Zhang, UCD Principal Investigator for this project, notes that, "Since orchards often remain in production for decades, it is important that growers now consider whether there will be sufficient winter chill in the future to support the same tree cultivars throughout their producing lifetime."

To prepare their projections, the researchers used hourly and daily temperature records for every day between 1950 and 2000, as well as 18 climate scenarios projected for later in the 21st century. They introduced the concept of "safe winter chill," the amount of chilling that can be safely expected in 90 percent of all years.

The study found that in all projected scenarios, winter chill in California declined substantially over time. This could mean that by the end of the 21st century, the Central Valley may no longer be suitable for growing currently used cultivars of walnuts, pistachios, peaches, apricots, plums and cherries.

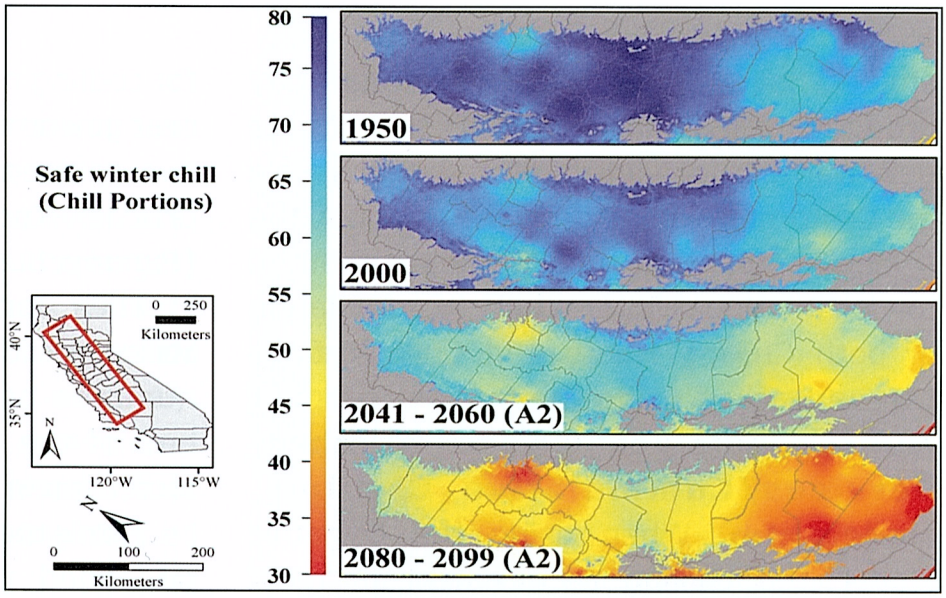

Figure 2: Typical safe winter chill in California's Central Valley in 1950, 2000, 2041–2060 and 2080–2099, showing decreasing winter chill proportions over time.

Possible Alternatives

The research team noted that growers may be able to change some orchard management practices involving planting density, pruning and irrigation to alleviate the effects on productivity of declining winter chill. Another option would be transitioning to different tree species or cultivars that do not demand as much winter chill. However, more research will be needed to quantify the effects of these measures.

There are also agricultural chemicals that can be used to partially make up for the lack of sufficient chilling in many crops, such as the growth regulator Dormex which has shown success when used on cherries. Initial trials on walnuts showed promising results.

A better understanding of the physiological and genetic basis of plant dormancy, which is still relatively poorly understood, might provide additional strategies to manage tree dormancy, and help growers cope with future agro-climatic challenges.

Chilling Models

Most growers are familiar with the Chilling Hours Model as a method to measure winter chill. For this project, the researchers used Chill Portions, as calculated by the Dynamic Model. The traditional Chilling Hour numbers showed a very strong response to warming, and several

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studies have shown that this model may produce misleading results, as the climate gets warmer. It may therefore be advisable for California walnut growers to adopt the Dynamic Model as their standard method for estimating winter chill. Accumulation of both Chilling Hours and Chill Portions can be tracked using the tools at **http://fruitsandnuts.ucdavis.edu/Weather_Services/Cummulative_Chilling_Models.htm.** When using the Dynamic Model, the chilling requirement of most walnut cultivars appears to be around 60 to 70 Chill Portions.

Walnuts and Pests

Another aspect of the research examined the potential effects of climate change on walnut pests. Using degree-day models and climate model projections, they predicted changes in generation numbers for codling moth (*Cydia pomonella* L.), navel orangeworm (*Amyelois transitella* Walker), two-spotted spider mite (*Tetranychus urticae* Koch) and European red mite (*Panonychus ulmi* Koch).

Their conclusions were that the Central Valley would see increases in pest generation numbers between the year 2000 and the end of the 21st century due to projected increases in temperature.

The expected pest generation numbers depended on which greenhouse gas emissions scenario was adopted; however, substantial increases were projected even for the most optimistic scenario. The results showed that:

- codling moth is likely to increase from 2.7 to 3-3.6 generations
- mite species are likely to increase from 11.3 - 13.7 to 12.9 -19.7 generations per

Relevant Publications

Luedeling, E, K.P.Steinmann, M. Zhang, P. Brown, J.A. Grant, and E. Girvetz. 2010. Climate change effects on walnut pests in California. Global Change Biology, Online. http://www3.interscience.wiley.com/journal/123447339/abstract

Steinmann, K. P, M. Zhang, J. A. Grant, C. Pickel, R. E. Goodhue, and K. Klonsky. 2010. Quantifying economic and environmental tradeoffs of walnut arthropod pest management. Agricultural Systems 103: 294-306

Luedeling E, M. Zhang, E.H. Girvetz. 2009. Climatic changes lead to declining winter chill for fruit and nut trees in California during 1950-2099. PLoS One, 4:e6166

Luedeling E, M. Zhang, V. Luedeling, E.H. Girvetz. 2009. Sensitivity of winter chill models for fruit and nut trees to climate change. Agriculture, Ecosystems and the Environment, 133: 23–31

Luedeling E, M. Zhang, G. Mcgranahan, C. Leslie. 2009. Validation of winter chill models using historic records of walnut phenology. Agricultural and Forest Meteorology, 149: 1854–1864

growing season

• navel orangeworm is likely to increase from 2.9 to 3.1-3.2 generations

Due to their high reproductive rate, mites are likely to respond with the largest increase among the pests analyzed. Climate change may also affect the natural enemies of mites, both directly and indirectly. Webspinning mites are often considered "secondary pests" in the sense that orchard populations may be maintained below economically damaging levels by natural enemy populations. Changes in the distribution ranges, population sizes or generation numbers of these natural enemies could affect mite pest pressure, either positively or negatively.

Unfortunately, degree-day models to predict insect physiology are only available for certain pests, and almost no beneficial insects, so that there is no basis at present for predicting how climate change may affect the ecological balance.

These findings suggest that there is a likelihood that pest pressure will increase for many of the most important pests. The need to understand how to effectively employ biological control of pests may become even more important, especially if pesticide regulation is tightened further in the future.

Conclusions for walnut farmers

• Climate change impacts California agriculture, especially specialty crop growers such as walnut farmers.

• The Chilling Hours Model may not be suitable for California. The Dynamic Model is a better tool for estimating winter chill.

• Climate change will influence pest dynamics; however, more information is needed to better understand how these changes will impact pest management.

• Pesticide use trends are available for specialty crops based on request (http://agis.ucdavis.edu).

• Growers can reduce the surface water quality impacts of pesticides with use of alternative products at reasonable costs by employing effective biological control.

• Choice of pest control materials can impact secondary pest outbreaks and reduce the need for miticides or additional chemical controls.

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LAWR = Land, Air, and Water Resources, UCD = University of California, Davis; UCCE = University of California, Cooperative Extension; IPM = Integrated Pest Management; CAFF = Community Alliance with Family Farmers; CDPR = California Department of Pesticide Regulation; CDFA = California Department of Food and Agriculture; ICRAF = World Agroforestry Centre

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