Economic and Pest Management Evaluation of the Proposed Regulation of Nitroguanidine-Substituted Neonicotinoid Insecticides: Six Major California Commodities

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The California Department of Pesticide Regulation (DPR) will implement a regulation restricting the use of nitroguanidine-substituted neonicotinoid (NGN) insecticides on January 1, 2024. Developed to protect managed pollinators, the regulation includes three key features: 1) timing restrictions, 2) cumulative per-season use rate restrictions when multiple NGNs are used, and 3) use restrictions on individual NGNs for crops deemed highly attractive to bees. Using economic data and pesticide use data from 2017–2019, we analyze the potential economic impact of the final draft of the regulation based on the net return losses for six crops: almond, citrus, cotton, grape, strawberry, and tomato. If the regulation had been in effect, the annual net return losses for the six crops considered would have ranged from $12.137 million in 2019 to $13.316 million in 2017.

Neonicotinoids are a class of systemic insecticides that attack insects' central nervous system, blocking nicotinic acetylcholine receptors. They are effective against many sucking and some chewing insects and have become widely used since their introduction in the mid-1990s as alternatives to organophosphates and carbamates. They have comparatively low toxicity to mammals but are toxic to many insects, including bees. California's Food and Agricultural Code (FAC) section 12838 required DPR to issue a risk determination report, which it completed in July 2018. The report detailed whether uses of four NGNs (clothianidin, dinotefuran, imidacloprid, and thiamethoxam) at full label rates on different crops are high risk or low risk to bees. For example, the report found that imidacloprid-treated citrus, cotton, strawberry, and tomato could pose a high risk to bees.

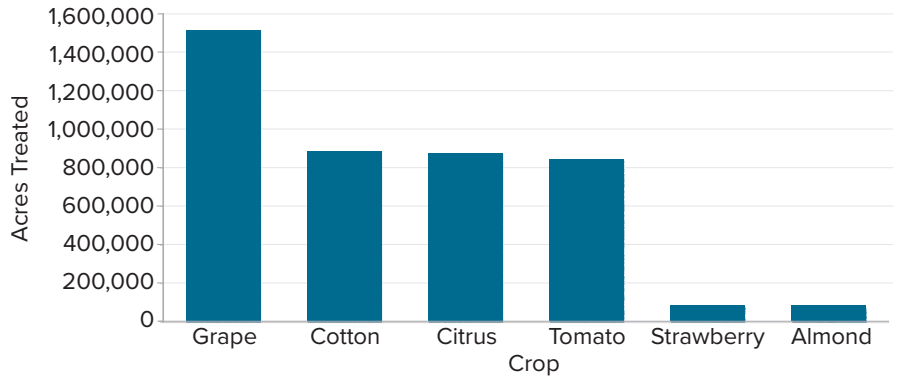
Under the January 1, 2024 regulations, NGN pesticide applications to all crops are prohibited during bloom. Citrus, stone fruit, and almonds, crops deemed highly attractive and routinely in contact with managed pollinators, are subject to additional restrictions on the cumulative pounds per acre for individual NGNs and cumulative applications of all NGNs annually, as well as restrictions on the times of year when NGNs can be applied. In other crops, including fruiting vegetables, walnuts, and berries, one NGN applied with one application method (soil versus foliar) may be used up to the cumulative amount specified on the label during a season. However, if a grower decides to use more than one NGN or more than one application method, there are restrictions on the cumulative use rates that are lower than current labels allow.

Identifying Impacts on Six Major Crops

This study uses economic data and pesticide use data from 2017–2019 to estimate the economic and pest management implications of the final draft of the proposed regulation for six crops: almond, citrus, cotton, grape, strawberry, and tomato. These crops accounted for 54% of the value of California's field crop, fruit, nut, vegetable and melon production and 57% of its agricultural exports in 2021. Total acres treated with target NGNs for each crop over the three-year period 2017–2019 are plotted in Figure 1 using DPR's Pesticide Use Report (PUR) database.

Net return losses occur if gross revenues decline as a result of decreased yield or if costs increase. For these six crops, the net return loss is due entirely to cost increases because no yield losses are anticipated due to the proposed restrictions. We estimate the change in pest management costs due to the regulation's restrictions on NGN applications. For applications that would have been prohibited, we estimate the change in pest management costs for each crop based on the acres

Figure 1. Total Acres Treated With NGNs by Crop (2017–2019)



Source: DPR Pesticide Use Report (PUR) database.

Table 1. Estimated Changes in Costs by Crop and Year ($ Millions)

Crop	2017	2018	2019
Almond	0.012	0.002	0.006
Citrus	2.917	3.063	2.968
Cotton	1.811	1.155	1.653
Grape: Raisin and Table	0.692	0.488	0.223
Grape: Wine	1.499	1.446	1.634
Strawberry	0.200	0.208	0.209
Tomato: Fresh Market	1.240	1.133	1.091
Tomato: Processing	4.945	5.650	4.353
Total	**13.316**	**13.144**	**12.137**

Source: Authors' calculations.

treated, the available alternatives, the cost of any change in the application method, and the costs per acre of the active ingredients (AIs).

The baseline total cost is established by multiplying the cost per acre for each target NGN by the acres treated with that target NGN for all applications that would be prohibited. This is compared to the cost of the regulated scenario. In the regulated scenario, we assign all the acres that had been treated with the target NGNs in prohibited applications to alternative AIs in proportion to the acreage treated with the alternative AIs. For example, if one NGN and two alternative AIs, pesticide A and pesticide B, were used on 100, 100, and 200 acres of almond, respectively, pesticide A would be used on 33 acres (33.33%) and pesticide B on 67 acres (66.67%) of almond that had been treated with the NGN. Loss estimates do not include losses owing to the more rapid development of resistance to remaining AIs by pests for which NGNs are part of the current management program.

Cost Increases

Because the applicable restrictions are crop-specific, we present the estimated cost changes by crop (Table 1).

Almond

Almond was California's third largest agricultural commodity in terms of production value, ranked behind milk/cream and grapes. Gross revenues totaled $5 billion and exports were $4.6 billion in 2021. Clothianidin is the only NGN currently registered for use in almond production. The insects most commonly targeted are leaffooted bug, stink bug, and San Jose scale. There are effective alternative AIs for each pest. The annual total cost increase to almond from the regulation is estimated to be $0.012 million or less. The absolute value of the costs is negligible because very few almond acres were treated with NGNs, and the composite alternative costs were virtually the same as clothianidin.

Citrus

Citrus—specifically grapefruit, lemon, orange, mandarin, and their hybrids—constituted one of California's top ten most economically important commodities by value, with $2.5 billion in gross revenues and $932 million in exports in 2021. NGNs are used to manage Asian citrus psyllid (ACP), citricola scale, citrus leafminer, Fuller rose beetle, and glassy-winged sharpshooter. Two NGNs are registered for California citrus: imidacloprid and thiamethoxam. Applications for ACP, a quarantine pest, are exempt from the proposed regulation. Without the use of imidacloprid, the deadly bacterial disease vectored by ACP, huanglongbing (citrus greening disease), would spread at a faster rate in the state, jeopardizing the entire industry. Setting aside quarantine applications, there would have been a cost increase of 61.6% to 66.6% for other applications to control the remaining target pests, corresponding to an annual total cost increase of $2.917 million to $3.063 million. The cost increases were driven mainly by the higher cost of the composite alternative: total cost per acre would rise by $34.02 (90.5%) on imidacloprid-treated acreage and $25.32 (54.7%) on thiamethoxam acreage.

Cotton

Cotton generated $468 million in gross revenues and $292 million in exports in 2021. All four NGNs are registered and used in cotton to target aphid, lygus bug, mite, thrips, and whitefly. The percent change in costs ranges from 28.8% to 36.6%, corresponding to an annual total cost increase of $1.155 million to $1.811 million to control the target pests. The magnitude of these changes was driven by the large acreage of treated cotton and the high material cost differences per acre between the most widely used NGN in cotton—imidacloprid ($22.04)—and specific alternatives—flonicamid ($37.01) and acetamiprid ($50.23)—that accounted for a large share of non-NGN treated acreage.

Grape

Grape was California's second largest agricultural commodity by production value, with gross revenues of $5.2 billion and exports totaling $2.2 billion in 2021. Growers use NGNs against grape phylloxera, leafhopper, sharpshooter, and vine mealybug. There are NGN alternatives that target leafhopper, mealybug, and sharpshooter, but they are more expensive. However, phylloxera management does not have good alternatives for NGNs. For table and raisin grapes, the percent change in costs on affected acreage ranges from 57.4% to 71.4%. The associated annual total cost increase to control the target pests is $0.223 to $0.692 million.

For wine grape, the percent change in annual total costs ranges from 72.0% to 73.8%. The associated annual total cost increase is $1.446 million to $1.634 million. The changes are driven mainly by the use rate restrictions on fields using more than one NGN or application method and the greater cost of alternatives.

Strawberry

In 2021, strawberry was California's sixth largest agricultural commodity by production value, with gross revenues of over $3 billion and exports of $475 million. Two NGNs are used to control sucking insect pests in strawberry: imidacloprid and thiamethoxam. Target insect pests include aphid, leafhopper, lygus, root weevil and grub, and whitefly. The use of thiamethoxam occurs after bloom has started, and blooming continues throughout the harvest season. Consequently, all applications of thiamethoxam are considered prohibited and would be replaced with alternatives. In contrast, almost all imidacloprid use occurs before bloom, so, all imidacloprid applications are considered allowed. The proposed regulation results in an estimated $0.2 to $0.209 million increase in annual total cost, which is a 29.2% increase in costs to control the target pests on acres treated with thiamethoxam.

Tomato

Tomato was California's ninth largest commodity by production value in 2021, with gross revenues of $1.2 billion and exports of $692 million. California is the largest producer of processing tomato in the United States and the second largest producer of fresh tomato. NGNs are used for aphid, flea beetle, leafhopper, leafminer, lygus, potato psyllid, stink bug, thrips, and whitefly. As systemic pesticides, the NGNs can be applied once at planting and provide effective control for an extended period of time. Without them, growers would likely need to apply multiple applications of alternative AIs, greatly increasing the treatment cost on affected acres. Our estimates show there would be a 150.5% to 186.6% increase in annual total treatment costs for fresh tomato and a 133.5% to 163.5% increase for processing tomato. In absolute terms, the annual total cost increase ranges from $1.091 million to $1.240 million for fresh market tomato and $4.353 million to $5.650 million for processing tomato to control the target pests.

Policy Implications

Over the three-year period (2017–2019), the six crops accounted for over 80% of NGN use in terms of both total acres treated and pounds of AI applied in treatments that would have been affected by the regulation (not all crops would be affected). Overall, the estimated annual net return losses for the six crops would have totaled $13.316 million in 2017, $13.144 million in 2018, and $12.137 million in 2019 if the regulation had been in effect (Table 1).

The crop-specific provisions are designed to mitigate the negative effects of NGNs on managed pollinators by reducing their exposure to NGNs. Many crops in California are dependent on managed pollinators, including almond, apple, avocado, cherry, cucumber, pumpkin, kiwi, melons (honeydew, cantaloupe, watermelons), beans (lima, blackeye, garbanzo), peach, nectarine, pear, plum, and sunflower. The 2019 value of these fourteen key crops dependent on pollination was $7.8 billion. The regulations also recognize that a targeted approach can enable some crops to maintain close to historical levels for the most critical uses, while other crops would see significant economic and pest management impacts.

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For additional information, the authors recommend:

Goodhue, Rachael, et al. 2021. "Economic and Pest Management Evaluation of Proposed Regulation of Nitroguanidine-Substituted Neonicotinoid Insecticides: Eight Major California Commodities." Prepared by OPCA CDFA; the University of California; and the UC Cooperative Extension. July 2, 2021. Available at: https://bit.ly/3EiS8mG.

Mace, Kevi, et al. 2022. "Balancing Bees and Pest Management: Projected Costs of Proposed Bee-Protective Neonicotinoid Regulation in California." *Journal of Economic Entomology* 115(1): 10–25.