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Neonicotinoid Insecticide Use and Pollinator Protection in Several Crops and Recreational Turf in Arizona and New Mexico

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Summary
The neonicotinoid insecticides are used in a wide variety of crops and in recreational turf in Arizona and throughout the southwestern states. Neonicotinoids provide very effective alternatives to broad-spectrum insecticides and help to preserve natural enemies for biological control of insect pests in many crops. They are available in a variety of products and modes of delivery, including very important seed treatments that help to protect plants at stand establishment, soil applications and delivery through drip irrigation systems, which greatly reduce any potential exposure of workers and pollinators, as well as over-the-top spray treatments when needed. They are used in rotation with other modes of action to help preserve effectiveness and reduce the potential for resistance in pest populations. Some Arizona crops for which neonicotinoids play a critical role in the control of key pests include cotton, lettuces, cole crops (e.g., broccoli, cauliflower, cabbage), melons, celery, pecans, potatoes and chile peppers.

Who We Are
The Arizona Pest Management Center is host to the University of Arizona's expert IPM scientists including Ph.D. entomologists, weed scientists and plant pathologists with expertise in the strategic tactical use of pesticides within IPM programs that protect economic, environmental and human health interests of stakeholders and the society at large.

Dr. Peter Ellsworth is Director of the APMC, State IPM and Pesticide Coordinator for Arizona and Professor of Entomology / Extension IPM Specialist with expertise in developing IPM systems in cotton and other crops and measuring implementation and impact of IPM and pest management practices. Dr. Al Fournier is Associate Director of the APMC / Adjunct Associate Specialist in Entomology, holds a Ph.D in Entomology, and has expertise in evaluating adoption and impact of integrated pest management and associated technologies. He serves as a Comment Coordinator for the Western IPM Center, representing stakeholders in the desert Southwest states. Mr. Wayne Dixon holds a B.S. in Computer Information Systems and develops tools and data used in IPM research, education and evaluation, including management of the APMC Pesticide Use Database.

These comments are the independent assessment of the authors and the Arizona Pest Management Center as part of our role to contribute federal comments on issues of pest management importance and do not imply endorsement by the University of Arizona or USDA of any products, services, or organizations mentioned, shown, or indirectly implied in this document.

Our Data and Expert Information

Through cooperative agreements with Arizona Department of Agriculture, the Arizona Pest Management Center obtains use of, improves upon, and conducts studies with ADA's Form L-1080 data. Growers, pest control advisors and applicators complete and submit these forms to the state when required by statute as a record of pesticide use. These data contain information on 100% of custom-applied (i.e., for hire) pesticides in the state of Arizona. Grower self-applied pesticide applications may be under-represented in these data. In addition, the Arizona Pest Management Center is host to scientists in the discipline of IPM including experts in the usage of this compound in our agricultural systems. We actively solicit input from stakeholders in Arizona including those in the regulated user community, particularly to better understand use patterns, use benefits, and availability and efficacy of alternatives. The comments within are based on the extensive data contained in the Arizona Pest Management Center Pesticide Use Database, collected summary input from stakeholders and the expertise of APMC member faculty.

Neonicotinoid Use in Arizona and New Mexico Crops

Lettuce

Arizona growers are one of the leading producers of fresh-market vegetables in the U.S., producing vegetables and melons at an estimated total economic contribution of over $2.5 billion in 2015 (Kerna et al. 2016). This includes over 90% of all fresh lettuce consumed in the U.S. in the winter, valued at over $920 million in the 2015–2016 season (USDA-NASS 2017a). According to Lettuce Pest Losses and Impact Assessment surveys conducted annually, neonicotinoids play a vital role in control of whiteflies. A single soil application of imidacloprid is used in fall and spring lettuce for early season control of whiteflies and aphids, a practice that has increased markedly since 2009, with about 92% of fall acreage treated in 2016 at top of the label rates (0.375 lb AI/ac), and 82% of spring 2017 acreage. Foliar neonicotinoids were used on 23% of fall 2016 acres and 27% or spring 2017 acres (Palumbo 2017a). According to the Arizona Pest Management Center Pesticide Use Database, thiamethoxam is the second most commonly used neonicotinoid AI after imidacloprid in both head lettuce and leaf lettuce (Fournier et al. 2017).

Cole Crops

Arizona produces fresh market broccoli, cauliflower and cabbage. In 2016, over 17,800 combined acres harvested were valued at over $190 million (USDA-NASS 2017a). Neonicotinoid insecticides play an important role in the protection of *Brassica* crops (broccoli, cauliflower and cabbage), from damage due to the invasive stink bug, *Bagrada hilaris,* or the Bagrada bug, a major pest of Arizona cole crops since the fall on 2010. The Bagrada bug causes economically significant stand losses and yield/quality reductions to these crops if not properly managed. Annual surveys of pest control advisors over the seven-year period since the pest arrived indicate that Bagrada populations and treatment levels have declined in the past few years, but that preventative applications, especially at stand establishment, remain critical to minimize crop losses. A new broccoli seed treatment containing clothianidin, Nipsit, accounted for 41 and 66% of the total direct seeded-broccoli acres reported in 2015 and 2016, respectively, and PCAs reported that Nipsit provided good-excellent control of bagrada adults at stand establishment. Nipsit also provides excellent control of flea beetles including the very large pale-striped flea beetle, another important pest at stand establishment. Seed treatments result in fewer foliar sprays needed for Bagrada control. While a variety of pyrethroids are the most widely used insecticides against Bagrada bug, both as chemigations and foliar applications, neonicotinoids including thiamethoxam (in a pre-mix with the pyrethroid lambda-cyhalothrin; Endigo), dinotefuran and to a lesser extent imidacloprid are sometimes used, and are important rotational chemistries (Palumbo 2017b).

Melons

Arizona produces fresh market cantaloupe and watermelons. In 2016, over 20,000 combined acres harvested were valued at over $98 million (USDA-NASS 2017a). Thiamethoxam and other neonicotinoids are increasingly important to control whiteflies, which vector cucurbit yellow stunting disorder virus (CYSDV) that impacts, melons, watermelons and squash. Infected plants show yellowing around leaf veins and brittle, curled leaves. Fruits from infected plants often taste bad due to a reduction in sugars, making them unmarketable, leading to economic loss. The virus is transmitted from plant-to-plant exclusively by the whitefly vector, *Bemisia tabaci,* which is "entirely responsible for virus spread over short distances (e.g., within and between fields). The virus is not transmitted mechanically (by touch) nor is it seed-transmitted. Consequently, the disorder is almost always associated with whiteflies; it does not take many insects to spread the virus" (Davis et al. 2017). Since the virus first appeared in Arizona melons in 2006, aggressive control of *B. tabaci*, especially whitefly adults, has been the best defense.

Many Arizona melons are planted from transplants and are grown on beds with drip irrigation. Common practice is to apply thiamethoxam via drip irrigation immediately after planting, and continue to treat every two weeks, via drip, rotating to other chemistries including flupyradifurone (Sivanto) and dinotefuran (Venom). A foliar application is also applied every eight days to control whiteflies. They use Endigo (a premix of thiamethoxam and the pyrethroid, lambda-cyhalothrin) in rotation with Exirel (cyantraniliprole). Sivanto and Exirel provide alternative modes of action to help reduce resistance pressures. All neonicotinoids are applied at the maximum label use rates for whitefly control. Imidacloprid is used in the same manner as thiamethoxam as well, but some growers have discontinued its use because of resistance /

efficacy concerns. The only effective alternatives to neonicotinoids are flupyradifurone through drip irrigation and cyantraniliprole for foliar applications, but because of the frequency of applications required to maintain low enough populations of whiteflies to prevent CYSDV transmission, these would not provide sufficient control on their own. Other growers, especially of spring watermelons can accomplish their needed whitefly control with only a single application of imidacloprid at the full rate, 21 days before harvest. According to IPM guidelines for insect control on desert melons, soil applications of imidacloprid (Admire Pro, Alias, and other generics), thiamethoxam (Platinum, Durivo) or dinotefuran (Venom) at planting is the industry standard for control of SWF in vegetables and melons. Soil applied neonicotinoids have been shown to effectively control whiteflies when injected at moderate to high rates 1.5 - 3 inches below the seed line (sub-seed furrow) just prior to planting. They are also effective at controlling whiteflies when applied immediately through low pressure drip irrigation systems (Palumbo 2017c).

Growers in Arizona have many practices in place to protect pollinators (Killian 2016), and melons are no exception. In some cases, pest control advisors maintain long-term, ongoing relationships with bee keepers, and this contributes to their excellent communication. In these cases, there have been no issues with bee kills. Delivery of insecticides via drip helps to minimize the number of sprays and potential exposure of bees to insecticides, and all foliar applications are applied at night (between nightfall and 4 am) so that the chemical is dry in the morning by the time bees are actively foraging.

Celery

Based on the Arizona Pest Management Center Pesticide Use Database, imidacloprid (as well as acetamiprid) is used by celery growers every year, and thiamethoxam in recent years. Overall, neonicotinoids represent about 5% of all reported insecticide sprays on celery (Fournier et al. 2017). Thiamethoxam plays an important role in celery production for control of aphids. Some growers use it on every acre, a single application at the full label rate of 13oz. applied through drip irrigation, mixed with a different mode of action for lepidopteran control. The application is made about 30 days before harvest in late-seasons plantings (e.g., planted around October). Earlier in the season they primarily use spirotetramat (Movento) for aphid control. Thiamethoxam via chemigation is ideal for aphid control in celery, because any foliar insecticide applications result in clusters of dead insects in the celery stalks and marketability issues, due to the vertical nature of celery plants. Potential alternatives to neonicotinoids in celery include sulfoxaflor (Sequoia), spirotetramat (Movento) and flonicamid (Beleaf). Neonicotinoids applications via drip irrigation minimize any concerns about pollinator exposure.

Chile Peppers

In 2016, Arizona produced 1,600ac of chile peppers valued at over $4.4 million and New Mexico produced 8,700ac valued at over $50.5 million (USDA-NASS 2017a, b). Chile peppers are the third most valuable crop in New Mexico, following pecans and alfalfa (USDA-NASS 2017b). Neonicotinoid insecticides are used to protect young seedling populations of peppers from damaging flea beetles, and for early season control of aphids and thrips. Some Arizona growers use imidacloprid seed treatments while other growers use in-furrow treatments of imidacloprid at planting at full label rates. One Arizona PCA said, “We need all the help we can get when these crops are small.” Additional foliar applications of neonicotinoids are used, if needed, later in the season, including products like acetamiprid (Assail) and other active ingredients. The APMC Pesticide use database includes reports of dinotefuran and thiamethoxam as well as imidacloprid use in peppers (Fournier et al. 2017).

In New Mexico chile peppers, curly top virus is a major concern. The virus causes stunted plants, thickened leaves, and results in production of unmarketable fruits (Goldberg 2001). One crop consultant said yield losses could be as high as 50 to 80% in extreme cases. However, such instances are rare because of careful scouting and preventative practices. The disease is vectored by the beet leafhopper (*Circulifer tenellus*), "which is able to transmit the virus after feeding on an infected plant for as little as one minute and can subsequently transmit the virus for the remainder of its lifetime" (Goldberg 2001). Aggressive control of the insect vector (once it is detected based on scouting) is the best practice for minimizing curly top virus infection rates. Once disease symptoms are apparent in the plants, it is too late for effective management. Growers are so concerned about transmission in peppers, they spray nearby alfalfa with an insecticide before each cutting to help minimize leafhopper movement into Chiles. An application of thiamethoxam (Actara or Platinum) applied via drip irrigation just after planting at the full label rate is standard practice to control sucking insects including beet leafhopper. The goal is to reduce leafhopper populations in order to reduce virus transmission.

Another key pest of New Mexico chiles is leafminers. The larvae feed within chile leaves and cotyledons, causing loss of photosynthetic area of the leaves, desiccation, and leaf loss (English 1999). Regular scouting determines the need for treatment. Topical application of pyrethroids is used to control the adults. Application of systemic neonicotinoids are used to control the larvae inside the plant. If leafminers are present, applications are made every third day. They use clothianidin (Belay), thiamethoxam (Durivo) and dinotefuran (Scorpion) in rotation with other modes of action such as chlorantraniliprole (Coragen) and bifenthrin (Capture). All products are applied at full label rate, but only in infested fields.

Neonicotinoids, particular clothianidin (Belay) and thiamethoxam (Actara) are important for managing outbreaks of pepper weevils. It is a rare but devastating event, when this pest moves in from the desert. If not controlled quickly, populations spread rapidly and growers have to plow the field under. Neonicotinoids are the most effective and most efficient management tool for pepper weevils. Alternatives include pyrethroids and other broad-spectrum insecticides, which are detrimental to preserving natural enemies in the field.

Pollinator protection is important to chile growers. Peppers are self-pollinating plants. However, when they are in flower, bees are attracted to the field. Most insecticide applications, including neonicotinoids, are applied through drip irrigation. They generally do not apply foliar insecticides when peppers are in flower. Flowering is spread out because they use continuous plantings of chiles for continuous harvest. If foliar applications are needed, sprays are done at night to avoid impact on pollinators.

<u>Pecans</u>
In 2016, Arizona growers harvested 14,300 acres of pecans valued at over $67 million (USDA-NASS 2017a). Pecans are the number one economic crop of New Mexico, with 40,000 acres harvested in 2016 valued at over $213 million (USDA-NASS 2017b). Imidacloprid (e.g.,

Wrangler) is applied in both pecans and pistachios, as a soil application or through injection, and provides aphid control with without harming beneficial insects. It is effective and affordable for growers. The APMC Pesticide Use Database indicates that thiamethoxam is also used in Arizona pecans (Fournier et al. 2017). Alternatives to neonicotinoids in pecans include flonicamid (Carbine) for aphids, lygus and stinkbugs, and sulfoxaflor (Transform) for lygus, which also help to preserve beneficial insects. In general, growers try to manage insect pests in a way that has minimal impacts on pollinators or other beneficial insects. Broad-spectrum insecticides are only used as a last resort, and in cases of less common occasional pests that are not on other labels. Pollinators are not particularly drawn to pecans, but growers are mindful of pollinator protection. Foliar applications of insecticides, if needed, are generally early season, pre-bloom applications.

Corn

In 2016, Arizona growers harvested 94,000 acres of corn grown for silage (44,000ac) or grain (50,000ac). Grain corn alone was valued at nearly $50 million (no estimate available for silage corn) (USDA-NASS 2017a). According to Dr. Randy Norton, Director of Safford Agricultural Center in southeastern Arizona, clothianidan is a critically important seed treatment in field corn (e.g., Poncho 1250). It provides very good control of corn root worm species, and growers have seen no negative impacts on bee populations.

Potatoes

Imidacloprid (e.g., Provado) is used for psyllid and aphid control in potatoes. A single, full rate application is used. It is effective and helps preserve beneficial insects. There are alternative insecticides, but imidacloprid is important in a chemical rotation for resistance management. The APMC Pesticide Use Database indicates that imidacloprid is reportedly used every year on Arizona potatoes (Fournier et al. 2017).

Neonicotinoid Use in Recreational Turf in Arizona

The Arizona golf industry is a strong contributor to the state economy with a total economic contribution of $3.9 billion in sales in 2014, including golf facility operations, golf tourism, and golf-related businesses (Duval et al. 2016). According to Kai Umeda, University of Arizona Area Extension Agent for Turfgrass Science, several neonicotinoid active ingredients are used in recreational turf with imidacloprid being the most readily available. The primary target pests for most neonicotinoid applications in recreational turf are masked chafer beetle larvae, the black turfgrass Ataenius, and certain billbug species. These are primarily a problem on golf course greens, fairways and tees, although the masked chafer is also an important pest of sports fields and may be treated in baseball sports complexes in Arizona. Most treatments are done at the high label rate. Some golf courses treat turf areas preventatively, although many courses use traps to determine peak adult populations to enable the most effective timing of treatments, as larvae hatch out (usually in late June for Phoenix). In most cases, a single application is used for masked chafer control. For black turfgrass Ataenius and billbugs, spot treatments are used on greens where visible damage occurs. Some courses may also apply spot treatments on fairways for these pests. Available alternatives for masked chafer control include organophosphate chemistries (e.g., trichlorfon), which are still used as a rescue treatment for masked chafer, and chlorantraniliprole (Acelepryn), which is softer on natural enemies. Either imidacloprid or clothianidin are preferred because of price, effectiveness and selectivity.

Golf courses generally do not have much flowering vegetation to attract pollinators, or if they do, floral plantings are generally in rough areas around golf course edges. This limits potential exposure of pollinators to neonicotinoid insecticides. And because applications for masked chafer are timed for peak larval emergence, there is a narrow window of possible exposure.

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