Pollinator Protection in Apples

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Overview of Production:

North Carolina ranks seventh nationally in apple production, with approximately 7,000 acres grown predominately in the western piedmont and mountainous regions of the state. Henderson County accounts for almost 70% of the total production, but other counties with significant acreage include Alexander, Cleveland, Haywood, Lincoln, Polk, and Wilkes. Fruit are grown for both processing and the fresh market, with total value of the crop varying between $25-30 million. With increasing retail markets for tourism in NC and diminishing prices for processing apples, most new plantings are now intended for fresh market channels. Trellised, high-density plantings (600 – 1000 trees per acre) account for the majority of new plantings.

Pollination Needs:

Apples are self-incompatible and require pollen from a different cultivar to produce fruit. Hence, apple orchards frequently contain multiple varieties or are interspersed with crabapples to serve as pollinizers. Individual orchards often change cultivars every two to six rows to ensure cross pollination. Because apple cultivars bloom at different times, it is important to select different cultivars that bloom at approximately the same time when planting new orchards.

Apples are dependent on bees for pollination, and both wild and honey bees can provide this service. Pollination needs have traditionally been met by the use honey bees, including bees kept by growers and hives rented from beekeepers. Hives are typically placed in orchards at a recommended rate of one hive per orchard (Ambrose 1990), and can remain in orchards for up to two weeks; or from one to two days before the king bloom of early cultivars appears until bloom is complete on late-blooming cultivars.

Wild bees are also important pollinators of apples, particularly in the eastern United States where more than 100 different species are reported to visit apple orchards (Park et al. 2012). The vast majority of wild bees are solitary bees that are either ground or cavity nesters. Ground nesters require access to bare ground and well drained soils, while cavity nesters utilize cavities in trees and wooden structures. Wild bees are highly efficient pollinators, and on a per visit basis can be more effective than honey bees (Thomson et al. 2001, Winfree et al. 2007). However, the flight range of most wild bees is only several hundred yards, while honey bees can forage up to two miles from their hive. Common wild bees found in eastern apple orchards include bumble bees, carpenter beets, mining bees, and mason bees (*Osmia* spp.), including the Japanese orchard bee (*O. cornifrons*) that is native to Japan but released in the mid-Atlantic region in the 1970s (Biddinger et al. 2011).

Orchard Pesticides and Bees:

Insecticide and fungicides are commonly used in apple orchards to manage a diverse complex of insects and diseases. Protection of pollinators is an important component of integrated pest

management programs, and the following guidelines can help to minimize pesticide impacts on bee populations.

- Do not apply pesticides, other than those that are non-toxic to bees, while contracted hives are in an orchard or when bees are foraging in an orchard;

- Wild bees that are nesting in the ground within the orchard or in non-managed habitats adjacent to orchards are susceptible to drift from pesticides sprayed in orchards. Hence, whenever possible select products and formulations that are least harmful to bees. Avoid dusts and microencapsulated formulations of pesticides, as they are easily picked up by bees and can be returned to the hive;

- If an insecticide toxic to bees needs to be sprayed, apply at night or the early morning when bees are not foraging and when winds are calm to minimize pesticide drift.

The dependence of apple growers and on bees for pollination of their crops has makes them well aware of the potential dangers of pesticides to bees, and it is rare that bee kills occur during the apple bloom period. However, there are other times during the season when bees are potentially vulnerable to pesticide exposure.

- Chemical thinning of apples with the insecticide carbaryl (Sevin®) is a standard practice in the apple industry, and carbaryl is considered to be highly toxic to bees. The Sevin label states that it may be used for thinning between 80% petal fall and 16 mm fruit size. In addition, petal fall is also an important time for insecticidal control of plum curculio. It can be difficult to schedule thinning and plum curculio sprays in orchards that have multiple cultivars with a wide range of boom periods. It is not uncommon for late-blooming apples to be in full bloom when early cultivars need thinning or plum curculio sprays. When planting orchards, choose cultivars to synchronize the bloom period to the greatest extent possible.

- Orchard floor management is an important component of bee protection in orchards, because pesticide drift onto the orchard floor is an unavoidable occurrence when spraying apples with air blast sprayers. Flowering weeds on the orchard floor can be an attractive food source for both honey bees and wild bees, and their presence makes them vulnerable to exposure when insecticides and fungicides are applied. Clover is perhaps the most common bee-attractive weed in many orchards. Selective herbicides can help to to maintain grass groundcovers free of flowering weeds. Mowing to remove flowers shortly before spraying is also an effective strategy.

Below is a list of pesticides commonly used in apple orchards and their toxicity to honey bees. This list was taken from Park et al. (2012) and updated with information on recently registered pesticides. Unfortunately there is a paucity of information on the response of wild bees to pesticides, and those few studies that do exist suggest that the response of the bumble bee (Cresswell et al. 2012) and Japanese orchard bee (Biddinger et al. 2012) cannot be extrapolated for all pesticides. Nonetheless, the overall guideline outlined for protecting bees discussed above is relevant to both honey and wild bees.

Toxicity Rating of Common Insecticides and Fungicides Used in Apples.

Chemical Class	Common Name	Trade Name	Toxicity Rating			
			Non	Low	Moderate	High
Carbamates	oxamyl	Vydate			X	
	carbaryl, methomyl	Sevin, Lannate				X
Organophosphates	chlorpyrifos, diazinon, phsomet	Lorsban, Diazinon, Imidan				x
Neonicotinoids	chlothianidin, dinotefuran, imidacloprid, thiamethoxam	Belay, Venom, Admire, Actara,				X
	acetamiprid, flupyradifurone	Assail, Sivanto		X		
Pyrethroids	bifenthrin, cyfluthrin, deltamethrin, esfenvalerate, fenpropathrin, gamma-cyhalothrin, lambda-cyhalothrin, permethrin, zeta-cypermethrin	Brigade, Baythroid, Decis, Asana, Danitol, Proaxis, Warrior, Perm-Up, Mustang Max				X
Insect Growth Regulators	methoxyfenozide	Intrepid	X			
	buprofezin, pyriproxyfen	Centaur, Esteem		X		
	novaluron	Rimon				X
Diamides	chlorantraniliprole	Altacor	X			
	cyantraniliprole	Exirel				X
Oxadiazines	indoxacarb	Avaunt			X	
Avermectins	abamectin, emamectin benzoate	Agr-Mek, Proclaim				X
Spinosyns	spinetoram	Radiant				X
Tetronic Acids	spirodiclofen, spirotetramat	Envidor, Movento		X		
Biopesticides	*Bacillus thuringiensis*, *Cydia pomonella* virus	Dipel, Cyd-X	X			
Pyridincarboxamids	flonicamid	Aria		X		
Other insecticides	azadirachtin, horticultural oils,	Aza-Direct/Neem, Stylet oil			X	
	kaolin clay	Surround		X		
Miticides	acequinocyl, clofentizine, cyflumetofen, extoxazole, fenpyroximate, hexythiazox	Kanemite, Apollo, Nealta, Zeal, Portal, Savey	X			
	bifenazate	Acramite			X	
	pyridaben	Nexter				X
Fungicides	captan, mancozeb	Captan, Dithane/Manzate,				
	sterol inhibitors, strobilurins	Indar/Nova/Rally, Flint/Sovran		X		
	lime sulfur, sulfur					x
Plant growth regulators	ethephon, NAA/1-Naphthaleneacetic acid, prohexadione calcium, gibberellin A_4A_7	Ethrel, Fruitone, Apogee, Provide	X			