Linda Chalker-Scott, Ph.D., Extension Horticulturist and Associate Professor,
Puyallup Research and Extension Center, Washington State University

The Myth of Organic Superiority Part II
"Botanically derived pesticides are safer than synthetics"

The Myth

Ever since the advent of synthetic pesticides in the 1930's we have grown increasingly wary of using these substances on our landscapes. Excessive use of DDT and other persistent pesticides has left a legacy of environmental damage and created populations of pesticide-resistant pests. We have since rediscovered the wide array of natural pesticides found in the microbial and plant worlds, recognized and used before civilization deemed them primitive. Not only can these natural alternatives be purchased, but we can also make "home-brews" by following the numerous recipes available on the Web and elsewhere. If it's good enough for nature, isn't it good enough for us?

The Reality

There is a wealth of useful information on botanically-derived pesticides on the Web and it would be redundant to repeat it here. Instead, I think it's important to consider *why* plants make these substances in the first place and what the implications are regarding their use.

Plants manufacture an enormous variety of chemicals; this is their line of defense against predators, parasites, and competitors. Unlike most animals, plants are pretty much stuck in their environment and cannot escape suboptimal conditions except through reproduction. Instead, they use the solar energy they've harnessed to manufacture not only sugars, but various protective compounds as well. "Nature red in tooth and claw" could be reworded for the plant kingdom as "Nature red in leaf and root." It's safe to say that we haven't even scratched the surface in identifying and characterizing all the plant-derived defense chemicals that exist.

The principal chemical families known to have biocidal properties (the ability to kill living organisms) are the ***alkaloids*** (including nicotine, ryania, and sabadilla); the ***terpenoids*** (including neem and pyrethrins); and the ***flavonoids*** (including rotenone). These commonly used and easily available compounds are discussed briefly below.

- **Nicotine** is a well-known alkaloid extracted from the leaves of *Nicotiana* and once easily available as nicotine sulfate. This highly neurotoxic chemical is generally not available for home use and poses a threat to any animal that inhales or touches it. Unfortunately, there are still publications and websites encouraging the use of "tobacco teas" but brewing these decoctions should be avoided.
- **Ryania** is a mixture of compounds extracted from the roots and stems of the tropical plant *Ryania speciosa*. The principle active ingredients in ryania are ryanodine and related alkaloids. It is a relatively selective, ingestible, neurotoxic insecticide with low to moderate toxicity for birds, fish, and mammals. It is fairly persistent in the environment, though its environmental biodegradation is not yet well understood.
- **Sabadilla** is extracted from seeds of the tropical genus *Schoenocaulon*. Two alkaloids comprise the active ingredients of this extract, which like other alkaloids have a neurotoxic effect upon insects. Sabadilla works either as an ingestible or contact insecticide and unfortunately affects bees as well as targeted pests. It has very low toxicity to mammals and is not persistent in the environment.
- **Neem** is a mixture of chemicals extracted from the seeds (and sometimes the leaves and bark) of the Asian tree *Azadirachta indica*. The principle active ingredient of neem is the bitter terpenoid azadirachtin, which is an insect feeding deterrent and a growth regulator. Neem extracts prevent

insects from maturing and completing their lifecycle, reducing the local insect population. It has very low toxicity to mammals.

- **Pyrethrins** belong to the terpenoid family and were originally extracted from chrysanthemum flowers. Once ingested, these compounds affect the nervous systems of a broad range of insects, knocking them down or killing them. Though short-lived, natural pyrethrins are extremely toxic to fish and bees and somewhat toxic to birds, but pose little hazard to mammals. Some insects have the ability to detoxify pyrethrins and are therefore resistant to the natural compounds. Synthetic pyrethroids have been developed which are more effective against insects and less toxic to other life forms.
- **Rotenone** is a flavonoid (commonly and erroneously identified as an alkaloid) extracted from the roots of a number of different tropical legumes, including *Derris* and *Lonchocarpus* spp. Though it degrades quickly, it is both a contact and ingestible insecticide that kills a wide range of insects, including beneficials. It is highly toxic to fish and slightly toxic to waterfowl. Furthermore, recent studies have linked chronic rotenone exposure to Parkinson's disease in humans.

All pesticides, natural or synthetic, undergo extensive testing to determine toxicities to laboratory organisms and to predict threats to ecosystems. Before any pesticide can be licensed for use, an LD_{50} must be established: this is the amount of the chemical necessary to cause death (lethal dose) in 50% of the test population (typically rats). Therefore, a low LD_{50} translates to a higher potential risk for humans and other organisms. Below are ranges of LD_{50}'s found for several common pesticides, reported in milligrams of pesticide per kilogram of animal weight. These numbers vary depending on species tested. To put this in a bit of human risk perspective, compare the LD_{50} for aspirin (1,200), and for glyphosate (5,600):

- Nicotine 55
- Sevin 246-283
- Rotenone 132-1,500
- Pyrethrin 200-2,600
- Ryania 750-1,200
- Malathion 1,000-10,000
- Sabadilla 4,000-5,000
- Neem > 5,000

From this table alone it should be evident that botanically derived pesticides are not always safer than synthetics and in some cases are much worse. Botanical insecticides can harm non-target species such as beneficial insects, fish, birds, and mammals. This is plant warfare and no distinctions are made between friends and enemies.

Improper and continual use of pesticides, whether naturally or synthetically derived, will increase the likelihood that resistant pest populations will evolve. Nature is not static; to survive, organisms must constantly adapt to a changing environment and this includes chemical exposure. The faster a species can reproduce the more likely it is that chemically resistant populations will arise.

Instead of being so quick to use chemical controls of any sort, we should be willing to adopt the philosophies of Plant Health Care and Integrated Plant Management. By maintaining a healthy, diverse soil and plant environment, and by utilizing cultural, physical, and biological forms of pest control, we can dramatically reduce our dependence on chemicals, natural or synthetic, that ***by their nature*** will kill other organisms and weaken the stability of a landscape system.

The Bottom Line

- Botanically derived pesticides are not always “safe” and some are more hazardous than synthetics
- Any improperly used pesticide will contaminate nearby terrestrial and aquatic systems
- Use of broad-spectrum pesticides will kill beneficial insects, leaving plants open to attack from pests
- Continual use of any pesticide will eventually induce pesticide resistance in pest species

For more information, please visit Dr. Chalker-Scott’s web page at http://www.theinformedgardener.com.