Fungicides revisited: A critical look at copper- and sulphur-based fungicides in organic agriculture

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The use of copper- and sulphur-based fungicides in organic agriculture is a matter of some controversy among organic growers. These products are permitted under the Canadian organic standards because they are mineral-derived rather than synthetically manufactured chemicals. However, this does not mean they are free from toxic effects. By definition, all pesticides, including fungicides, are toxic, and although copper and sulphur are essential plant micronutrients, they do have toxic effects to plants and other organisms, depending on their dose. These fungicides are therefore usually listed as a last resort for use in organic or ecological farming systems. They have been used for many years and are effective at treating several plant diseases, however it is necessary to weigh their effectiveness against the hazards they pose to humans and the environment.

Copper is a heavy metal, does not degrade, and persists in the environment (4). The soil environment has naturally-occurring copper, and soil tests should be done to determine the levels of this metal before adding more to the environment. Copper can be toxic to plants at differing levels depending on the species, and can accumulate in perennial crops such as grapes (4). The soil type and characteristics will determine how much copper from the soil is available to plants and thus will determine whether the system can handle more copper (5). In the Northeastern US, maximum soil concentrations for copper have been recommended based on soil type, from 40 ppm (sandy soils) to 60 ppm (silt loam) to 100 ppm (clay soils), in order to protect against toxicity to plants and negative impacts on soil life (6). Copper is toxic to most organisms, highly toxic to fish, and has been linked to liver disease in vineyard sprayers after years of exposure (3). It is listed as a Class II pesticide in the World Health Organization (WHO) Pesticide Hazard classification scale, which ranges from Class I (most dangerous) to Class IV (least dangerous) (8). Due to these hazards, the European Union has been working on banning copper-based fungicides since 2002. However, suitable alternatives have been difficult to develop.

Sulphur is less persistent in the soil environment than copper. However, sulphur also can be toxic to plants at varying levels, according to the species, especially at high air temperatures or when mixed with oil products (3). Sulphur has a low toxicity to beneficial insects, aquatic species, and mammals, including humans (3) and is rated as a Class IV pesticide in the WHO Pesticide Hazard Classification (8). Sulphur is a preventative fungicide and needs to be applied to plants before they develop any diseases, which could result in the non-essential and possibly overuse of this chemical. It has been noted that sulphur is applied at rates far exceeding that of copper and synthetic fungicides; this could increase its toxic effects simply based on quantity (1).

A recent study comparing organic and conventional crop protection strategies revealed that copper- and sulphur-based fungicides are as harmful as conventional fungicides. The study was based on a model called the environmental impact quotient (EIQ), which was developed to help farmers take environmental impacts into account when making decisions about pest management (7). The model takes into consideration hazards to farm workers, consumers and the environment. Copper and sulphur-based fungicides had similar EIQ values to conventional fungicides (2). The study also noted that fungicides with low EIQ could be more hazardous if applied more often than high EIQ fungicides (2). This model was tested for apple production in the USA and concluded that organic pest management

strategies had twice the total environmental impact score than conventional pest management strategies due to the high application rate of sulphur and rotenone (7). Organic growers should be aware of the potential for some approved organic fungicides to be as harmful to the environment as conventional fungicides if overused.

Although these hazards should be taken seriously, copper and sulphur-based fungicides used as a last resort and in moderation can be safe and effective. However, there are many preventative ways to fight disease that do not involve the use of chemical fungicides. A more systemic approach begins with building good soil health, planting crops that are suitable to your soil type and climate, employing crop rotation, avoiding monocultures, using disease resistant plant varieties, and maintaining appropriate watering and feeding regimes. There are also several less toxic methods for disease control including biological controls such as Bt, essential oils such as neem oil, and plant products such as garlic teas. For further information on disease control and toxicity issues please refer to the online resources below.

Helpful online resources:

Chatham County Center North Carolina Cooperative Extension:
www.ces.ncsu.edu/chatham/ag/SustAg/diseaselinks.html

Sustainable Agriculture Research and Education: http://www.sare.org/publications/farmpest.htm

National Sustainable Agriculture Information Service:
http://attra.ncat.org/

Resource Guide for Organic Insect and Disease Management:
http://www.nysaes.cornell.edu/pp/resourceguide/index.php

For information on copper and sulphur toxicity:

ExToxNet: Extension Toxicology Network. A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan State University, Oregon State University, and University of California at Davis: http://pmep.cce.cornell.edu/profiles/extoxnet/index.html

The WHO recommended classification of pesticides by hazard and guidelines to classification:
www.who.int/ipcs/publications/pesticides_hazard/en/

References

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8. World Health Organization: The WHO recommended classification of pesticides by hazard and guidelines to classification: www.who.int/ipcs/publications/pesticides_hazard/en/