Fungicide Types

There seems to be a fair degree of confusion among rose growers concerning different types of fungicides and their usage. This article attempts to shed at least a little light on this picture. Although the remarks are applicable generally, they are slanted primarily, where appropriate, to the principal disease of roses: blackspot.

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Basically, there are two different classes or types of fungicides, as set forth below.

• Broad spectrum, multi-site surface protectants, which do not enter the leaf. When sprayed on a rose plant, the active ingredient remains on the leaf surface.

• Single-site, usually locally systemic, types which do enter the leaf. When sprayed, the active ingredient penetrates to the interior of the leaf. Note that penetration occurs only as long as the leaf is wet, however.

SURFACE PROTECTANT

The first type has been around for years and was the first kind of fungicide to be used. Bordeaux mixture falls in this category, as do also such products as *Daconil, Fungi-Gard,* (both of these are chlorothalonil), *Captan, Mancozeb, Maneb,* etc.

Why are they called broad spectrum, multi-site surface protectants?
Because:

• Their mode of action is such as to enable them to act against a relatively broad spectrum of fungal diseases.

• Their mode of action also is such as to attack or damage more than one site in a fungus ("multi-site") in contrast to just one site (such as figuratively wringing its neck).

• And, as noted, they remain on the leaf surface, not penetrating to the interior. Sometimes they are called contact fungicides.

Surface protectants are essentially of no utility against an existing blackspot infection insofar as curing it is concerned. Their primary usefulness in such instances is to help limit further spread of the infection. They do this by acting as a surface barrier, limiting spread by poisoning a new fungus as the spore germinates and sends out a germ tube. These preparations do not kill spores, per se, however.

They also are subject to being washed off, and of course do not move up to protect new growth.

This category has a major advantage, however, in that it does not, so far anyway, give rise to a build up of resistant strains of fungi which are then immune to its action. But it has the basic disadvantage that, in order to be of any utility, it must be on the leaf prior to a spore landing there. This has the important consequence, as is readily apparent, and as should be duly noted, that any new growth occurring since the time of prior spraying is not protected.

SINGLE SITE

The second category, the single-site, so-called locally systemic fungicides are of more recent development. *Triforine, Funginex, Bayleton (Strike), Banner Maxx, 3336, Rubigan, Immunex,* etc., fall in this category. These enter the plant and in general work against only one site in the fungus, interfering with something like a specific metabolic process or similar function. The action of working against only one site gives rise to the general designation of "single-site." An analogy might be equivalent to cutting off its head — if it had one.

A significant drawback to this general class of fungicides is the potential emergence of resistance to the fungicidal action. In many, it takes only one gene change to go from susceptible to resistant, and numerous fungi have made this change.

It should be noted that, although these fungicides are frequently also referred to as being "systemic," it actually would be more correct if it were "locally systemic." The fungicide is carried by the xylem stream out to the ends of the leaf, say, but is not translocated upward — to new growth, for example.

This latter property also has an immediate consequence in that, as in surface protectants, new growth occurring since the last spraying is not protected by this class of fungicide either.

RESISTANCE DIGRESSION

We should say a brief word about resistance buildup. As most rosarians prob-

ably know, resistance to fungicidal action is a very real phenomenon and must be taken into account in our spray programs. So far, resistance is a problem only with the single-site, systemic fungicides. The reasoning is generally as follows.

If a given fungicide attacks only a single site in a fungus, it is essentially automatically on shaky ground. By single site, we mean that a given step in its metabolic process might be attacked, or disrupted. In the so-called sterol inhibitor fungicides, for example, which includes *Triforine, Rubigan, Bayleton (Strike)* and others, the production by the fungus of a sterol used in its cell membrane is disrupted. This damages the fungus, interfering with its growth.

In any fungal population, however, there are apt to be some strains with slight variations in metabolism, for example. Perhaps a small segment of the population make the sterol in a slightly different manner, and in a manner not bothered by the fungicide. Or perhaps it has learned to degrade the fungicide. Or whatever.

So this initially small segment is not damaged or killed by the fungicide. But the remaining susceptible segment is killed. When this happens, the lack of fungal competition leaves room for the resistant strain to expand. Eventually it will be the dominant strain and, lo and behold, the fungicide no longer works.

This slight difference between a susceptible and non-susceptible strain might be controlled by a single fungal gene. So perhaps a slight mutation, involving only one gene, might make the difference between resistant and susceptible. It is generally accepted that this sort of thing can and does happen when resistance occurs.

The situation is different for a multi-site surface protectant. Here, the fungus would have to be smart enough to make enough change in enough different genes to make each of the sites attacked by these fungicides not susceptible. So far, none have been this smart — that we know of anyway. This is the reason for the lack of resistance buildup.

THUS

Because of the above, single-site fungicides, which are so popular and widely used, must be used with a careful eye on the resistance problem. This means generally several things. Current wisdom recommends that, first, they should always be used with a companion fungicide of the multi-site surface protectant type. My own preference is for combining the two types in the same spray tank. *Mancozeb* and *Daconil* are two of the most effective surface protectants.

Occasionally, it would also be prudent to switch to a different single-site, with another mode of action. *Triforine* and *3336,* for example, have different modes of action.

Also, it is considered best that single-sites not be used in a manner whereby they are the only fungicide used, time after time. This is simply an invitation to trouble from resistance buildup, and numerous instances of such usage and consequent resistance are known.

Single sites are not subject to wash-off by rain. Because they enter the leaf and are carried in the xylem stream to the leaf extremity, it is probable that they give more complete coverage than a surface protectant spray.

It should be remembered, however, that they do not translocate to new growth. In this respect they are similar to the multi-site surface protectants. So, generally speaking, growth since the last spraying is not protected.

THE $64 QUESTION

Wouldn't it be nice to have something enter the plant and take action against the blackspot fungus being shielded inside. We have noted that the single site fungicides do enter the leaf. The question, however, is whether, even though inside, they have any effect in curing an existing blackspot infection.

In brief, the answer is no. If you want to cure blackspot, you better get out the pruning shears.

There is no evidence of which I am aware, either in my own experience, the word from manufacturers, or other rosarians to whom I have spoken, that any of today's fungicides have any curative action against an established blackspot infection. In fact, when considering their mode of action, it is difficult to see how any curative action could be attributed thereto.

Nor, incidentally, is there much, if any, curative action against powdery mildew. *Rubigan* is reported to have some curative action against powdery mildew, but I have not personally seen any significant evidence thereof in a major infestation.

It appears possible that a forthcoming surface fungicide, chemically akin to baking soda and combined with a selected surfactant, developed by Dr. Ken Horst of Cornell, may be curative against powdery mildew. Horst's test results look good, but the product is not yet on the market insofar as I have seen.*

Powdery mildew grows on the surface of leaves, etc., but obtains nourishment by sending haustoria below the surface and tapping into plant cells. So the question becomes whether, even if something acts to eliminate the surface growth, can or will the fungus regenerate from the haustoria.

At this time, the best approach for disease control is to continue to regard aggressive sanitation, coupled with regular preventive application of both surface protectant and systemic fungicides, as the way to go.

Remember: prevention is the key to disease control, achieved through aggressive sanitation and regular spraying with appropriate fungicides. Cure, per se, seems best and only achieved with the likes of pruning shears.

Note: As a for instance: in prior conversations with the makers of Rubigan, *they recommended that, for reasons related to resistance buildup, it not be used more than necessary in any growing season. Two or three times max would be their choice, and this at the period of greatest disease pressure. They also prefer that a companion fungicide be used concurrently, as described above.*

** The EPA has now approved the fungicide developed by Dr. Horst, and it is now on the market. For consumer use on ornamentals it's marketed by Bonide Products under the brand name* Remedy. *W. A. Cleary is marketing it for commercial use on ornamentals in North America as* First Step.

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