Powdery Mildew

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Within recent years the floricultural industry has witnessed an almost incredible advance in the science of insect control. Not only do the materials at present available give unbelievably high kills, but many of the methods of application are easier and more economical than anything we would have dared hope for only a short time ago. First came the sodium selenate soil treatment which was, and still is one of the simplest and most effective means of controlling insects and leaf nematodes on many crops. Soon afterward the use of azobenzene as a fumigant for controlling red spiders and many other insects was developed by Professor W. E. Blauvelt.

Growers had hardly learned to pronounce azobenzene before the use of aerosols containing HETP or TEPP threatened to replace it. And now straining at the leash is the most remarkable aerosol of them all - Parathion. But, as so often happens, the solution of one type of problem has brought into focus another.

Perhaps at no time in the past have the powdery mildews been so important or so difficult to cope with, and, as we shall see later, this situation may in considerable part be laid at the door of the new techniques of insect control. It is proposed here to present some fundamental facts which may in part explain this situation and help us to keep better control of mildew - though the author is not sufficiently rash as to offer either a simple or a certain remedy for rose mildew!

Temperature and Powdery Mildew

Let us look first at the effect of temperature on the powdery mildew fungus itself and later consider its relation to relative humidity - which is equally, if not more, important.

Powdery mildew has often been considered a cool weather fungus, and this is true enough if we define cool. In floriculture "cool" commonly connotes temperatures below 55°F., and by this criterion many of the powdery mildews could not be considered cool weather fungi.

The optimum temperature for maximum germination of rose mildew spores, for example, is about 70°F., while the temperatures for most rapid germination run from 76° to 82°F. Careful tests have shown about 20% germination after 5 hours at 82° and 14% at 76°, with only 7 1/2 % after 7 hours at 70°, though the total germination after 48 hours was greatest at 70°. One reason for this is that higher temperature hastens those processes leading to death of the spores as well as those causing germination. But the significant thing is that, with proper relative humidities, infection can occur very rapidly around 80° - before the loss of viability becomes a serious factor.

Looking at the effect of temperature on other processes, we find that temperature of 76-82° not only hasten germination, but also speed up spore production. For instance, some new spores of rose mildew are produced in as little as 3 days at these temperatures, but not at 70°. And after 5 days sporulation is much more copius at 76° than at 70°.

It may be emphasized here that mildew is a fast operator as fungi go. We see that germination and infection may occur in as little as 3 or 4 hours, contrasted with 8 to 10 hours for such fungi as the carnation leafspot and rose blackspot organisms and over 24 hours for the Septoria causing chrysanthemum leafspot. We find new spores being produced in as little as 4 days with mildew as contrasted with 10 days to 2 weeks with the other diseases mentioned. This means that mildew has a very short life-cycle which pyramids the rapidity with which the disease may become epidemic. It may be well to inject here also the fact that the spores are very readily detached and carried by air currents which enables them to be moved very rapidly to new infection centers without the need of splashed water. In fact, this rapidity of movement is somewhat essential for maximum development of the potentialities of the fungus.

As was alluded to before, temperature also affects the degradation processes and we find that at 92-94°F., spore viability drops to nothing after 24 hours even at favorable humidities, while the spores may remain alive almost twice that long at 70°. Even at best, however, the spores do not survive more than about 2 days. This may be contrasted with the spores of most fungi, which may survive for weeks, months or even years. It also gives us a flicker of hope that if we find the right material, the eradication of mildew from a moderately isolated greenhouse may be a possibility.

One more point on temperature - at temperatures continuously in the 90's or perhaps as low as 85, mildew could not persist. But we cannot grow roses or other greenhouse crops at such temperatures, nor would many of us want to.

Effect of Relative Humidity

Although temperature is important in its effect on mildew, relative humidity is perhaps the more important controlling factor, since temperature is favorable at least part of most every day in all areas where roses can be grown. When we study the effects of relative humidity in the laboratory we find some apparently contradictory results. Very careful tests have shown, for example, that rose mildew spores do not germinate at relative humidities below 95% on glass slides. Any greenhouseman would be willing to swear that mildew develops at much lower humidities. And laboratory tests using rose leaves in the same apparatus back up this belief. We find, for example, good germination and infection at relative humidities as low as 25% to 30%. The explanation of this appears to lie in the fact that the relative humidity at the surface of the leaf, which is constantly transpiring water, is almost always up above 95%. This offhand looks rather discouraging but it should be pointed out that the percentage germination on leaves falls off rapidly as the relative humidity of the atmosphere falls below 95% and is only about half as great when the relative humidity reaches 50%.

Looking further we find that, as with temperature, other processes are affected by relative humidity. Thus, development of the mildew mycelium is <u>much poorer</u> at 20% relative humidity than at 97%. Likewise, the production of spores is <u>greatly reduced</u> at low humidities. Relative humidity is of further importance in its effect on longevity of the spores. The lower the humidity the more rapidly the spores lose viability, this being very marked at higher temperatures.

It is seen, then, that while no single effect of low relative humidity would alone limit mildew, the combination of effects would be very important. At low relative humidity fewer spores germinate and fewer infections develop; these in turn grow more slowly and produce fewer spores, which succumb more rapidly, germinate more poorly and produce fewer new infections; etc., etc. Maintenance of low humidity thus pays compound interest.

We cannot finish discussion of relative humidity without calling attention to the greatest apparent paradox of all - that while powdery mildews require high humidity at the leaf surface for germination and infection the spores will not germinate well and the fungus will not develop in liquid water. Most growers are now aware of the fact that frequent springing hinders mildew development and this has led to the erroneous assumption by some that high humidity discourages mildew. We must distinguish between high humidity and the formation of liquid water - a slight, but important difference.

Effect of Temperature on Relative Humidity

We come now to the effect of temperature on relative humidity, which calls at last for a practical definition of relative humidity. At any given temperature the air will hold just so much moisture before it condenses to liquid water, fog, or dew, at which point the atmosphere is saturated.

The <u>relative humidity</u> is the percentage of the actual amount of moisture in the air at a given temperature relative to the total amount necessary for saturation. Now then, the amount necessary for saturation varies with the temperature, more being needed at high temperatures, so that if we have a little less than is necessary for saturation at a given temperature a slight drop in temperature may make that amount sufficient for s saturation. This may be clearly illustrated during cold weather by noting the vapor condensation when one exhales. The amount of water in the breath is not sufficient for saturation at body temperature but when suddenly chilled it becomes sufficient and the vapor is evident.

This same thing happens in a greenhouse when the air is suddenly chilled by drafts. Here the vapor may not be evident but the relative humidity may be raised high enough to favor mildew. The striking effect of relatively slight drops in temperature is shown by the fact that at 70°F. a drop in temperature of only 0.2 of a degree is sufficient to raise the relative humidity from 99% to 100%. It should be pointed out that in a greenhouse, which has abundant air-leaks, gradual changes in temperature have much less effect. Sharp drops in temperature, however, are almost immediately followed by equally sharp rises in relative humidity.

Summary of Temperature-Humidity Relations

A review of the evidence leads us to the conclusion that, although mildew development is directly affected by temperature, there is little likelihood of achieving any appreciable control by growing susceptible crops above or below the optimum range for the fungus. Powdery mildews develop over too wide a range to permit this. Relative humidity, however, has a marked effect on many of the life processes of powdery mildews, and although we cannot expect to eliminate mildew by controlling relative humidity, we may be able to reduce its severity.

We have seen that relative humidity is directly affected by changes in temperature, rising rapidly when the temperature is suddenly lowered. The maintenance of uniform temperature throughout the greenhouse should therefore be attempted at all times - certainly no rapid drops in temperature should be permitted, even though this may mean some heat throughout the year. Admittedly, this will not completely control mildew, but it may help greatly.

In the relationship between liquid water and mildew we find at least a partial explanation of the increase in rose mildew during the past few seasons. The old practice of syringing with water for red spider control definitely helped to keep mildew in check. Furthermore, a number of the insecticidal sprays which were used for many years had a controlling effect on mildew. Now, however, with the use of sodium selenate, fumigants, and aerosols for insect control, mildew is able to build up unhindered. Despite this, no one wants to go back to the relatively poor insect control afforded by syringing and spraying, and it is hoped that a renewed attack on the problem will give us a means of controlling mildew which is satisfactory from all angles.

Comments on

Existing Mildew Treatments

Within the past few months several materials new to us have been offered as mildew controls. Most of these have not been adequately tested so that we cannot pass judgment. Very startling claims are made for some of these, but we are not yet in a position to condemn or approve them - and may not be for some time to come. We have not yet forgotten the long series of red spider sprays, many of which looked good at first but later fell down or eventually proved to "harden" or otherwise injure the plants.

Some of the old standbys still prove effective for mildew on most crops other than roses. For example, mildew on snapdragons, chrysanthemums, hydrangeas, etc., usually yields readily to sulfur dusts or sprays. Malachite green solution, or malachite green and sulfur, are also effective in most mildew cases and still occasionally save the day with roses. The generally poorer results now obtained with malachite green on roses may find an explanation in the fact that this treatment was developed in the days when syringing was generally practiced and mildew was usually much less severe to start with than it is today.

Attention may be called to a case recently observed by us in which good old-fashioned soap and soda was effective in practically eradicating a severe case of rose mildew. This involved repeated applications of soap and soda spray followed by syringing to wash off the deposit. The value of this treatment, as with other soapy materials, may lie in the fact that a large proportion of the mildew mycelium is thoroughly wetted and killed.

All of the materials which have been adequately tested to date, however, are either not sufficiently effective for rose mildew, or cause some plant injury, or involve an excessive amount of labor. The need for a renewed attack on the problem is therefore obvious.

*Most of the data in this paper are taken from Cornell Memoir, 223, "The Effect of Temperature and Relative Humidity on the Powdery Mildew of Roses", by Dr. Karla Longrée.

Your editor,

Kenneth Post