Screens stop insects

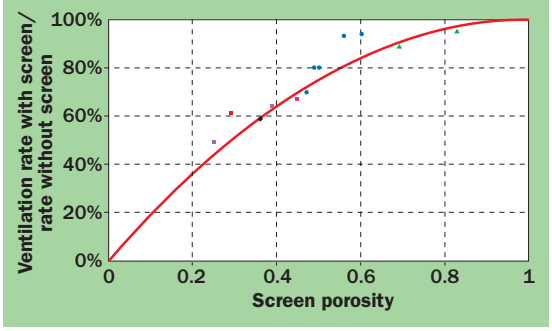
Screens will prevent insects entering a greenhouse but do inhibit natural ventilation. There are other ways of increasing airflow.

By Bernard Bailey, formerly at Silsoe Research Institute

Photo 1. Insect screen fitted to a ventilator in a Venlo glasshouse. The screen is manufactured to have a concertina shape which unfolds as the ventilator opens.

Insects in greenhouse crops can be pests because of the damage they cause directly by feeding and indirectly by the transmission of diseases such as Impatiens Necrotic Spot Virus and Tomato Spotted Wilt Virus. These are transmitted by the Western Flower Thrips *Frankliniella occidentalis*. Biological control has been used for many years to control greenhouse pests. A well-known example is the control of the whitefly, *Besmia tabaccii* by the parasitic wasp *Encarsia formosa*. However, the number of pesticides available for effectively controlling the diseases of greenhouse crops, including those transmitted by insects, is decreasing, and they are also expensive. Consequently growers are now seeking to prevent the diseases from occurring by using insect screens to stop the insects that transmit them from entering the greenhouse. This enables a reduction in pesticide use, which is not only advantageous from an economic viewpoint, but also reduces the potential for diseases to develop resistance to the remaining pesticides. Furthermore it is desirable when bees are used for pollination. In southern Spain for example, insect screens are fitted to more than 90% of the greenhouses. Insect exclusion is now considered as the first step in developing an integrated approach to greenhouse pest management.

Figure 1: The rate of ventilation is reduced when an insect screen is fitted to greenhouse ventilators. The change in ventilation depends on the porosity of the screen. The points represent values measured in greenhouses in The Netherlands, Morocco and Spain; the curve is given by Equation (1)



Screen selection - In selecting an insect screen the most important requirement is to exclude the target insect. To do this, the openings in the screen must clearly be smaller than the size of the insect. The maximum sizes of the openings in a screen to exclude some important insect pests are given in *Table 1*. Many insect screens have a regular structure with square or rectangular openings and are made from uniform threads. They are generally characterised by the term "mesh", which is the number of threads per inch in each direction. For example, a 50-mesh screen has 50 threads per inch of material. If the mesh and thread thickness are known the size of the opening can be obtained by subtracting the thread size from the reciprocal of the mesh; so a 50 mesh screen with a thread thickness of 0.15 mm has openings with a width of 0.35 mm (i.e. 1/50 = 0.02 inches = 0.5 mm; subtracting the thread thickness of 0.15 mm gives 0.35 mm) in each direction. If the openings

but slow airflow

Photo 2. An insect screen fitted to a roof ventilator. The distortions formed where the five strings that prevent the net from billowing outwards are attached to the reinforcing strip half way up the screen can be seen.

Table 1: Maximum dimension of openings in a screen to exclude insects

Insect	Hole size (mm)	Mesh*
Serpentine leaf miner *(Liriomyza trifolii)*	0.61	34
Sweet potato whitefly *(Bemisia tabacci)*	0.46	42
Melon aphid *(Aphis gossypii)*	0.34	52
Greenhouse whitefly *(Trialenrodes vaporarum)*	0.29	58
Silverleaf whitefly *(Bemisia argentifolii)*	0.24	66
Western flower thrips *(Frankliniella occidentalis)*	0.19	76

* Based on thread diameter of 0.15 mm

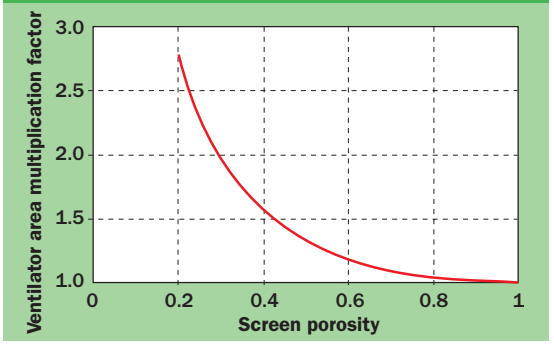
are rectangular the screen will have a different mesh number in each direction, for example a 40 x 60 mesh screen will have openings of 0.48 mm by 0.27 mm if the thread thickness is 0.15 mm.

Airflow resistance - Fitting appropriate screens over the ventilators will certainly keep insects out; unfortunately it also increases the resistance to airflow, which reduces the effectiveness of natural ventilation. In the Netherlands a comparison of two glasshouses, one with screens and one without, showed that on sunny days the temperature in the screened house was, on average, 5˚C higher than in the unscreened house.
The resistance of an insect screen to the flow of air is related to the size of the holes in the screen. In a 50-mesh screen with threads 0.15 mm in diameter, the area of each opening is 0.35 mm times 0.35 mm, or 0.1225 mm^2. The area of screen that contains this opening, which is based on the size of the opening and the thread thickness, is 0.5 mm times 0.5 mm or 0.25 mm^2. The area of an opening divided by the total area defines the screen porosity; in this case the porosity is 0.49. The screen porosity is an important property as it determines the effect of the screen on the ventilation rate as shown in *Figure 1*. The curve is a good representation of values measured in different greenhouses with different screens and is defined by:
(1) Vs/Vns = porosity (2 - porosity)
where Vs is the ventilation rate with the screen and Vns the value without the screen. The porosity of a screen can range from 0 (a screen with no holes) to 1 (a completely open screen).

This reduction in ventilation can be overcome by increasing the area of the screened ventilator. The larger area of screen will provide more holes so increasing the area for the flow of air. *Figure 2* shows the factor by which the area of a screened ventilator should be increased to offset the reduction in ventilation. The curve is defined by:
(2) As/Av = 1 / [porosity (2-porosity)]
where As is the area of the screened ventilator and Av the area of the original ventilator.

Increasing airflow - In film plastic covered greenhouses it is often possible to increase the area of sidewall ventilators opened by rolling the film cover around a metal pipe. Either lowering its base or raising the top can increase the vertical extent of the ventilator opening. Unfortunately, it is not so easy for multi-span greenhouses with roof ventilation. One possibility would be to increase the maximum opening angle that the ventilators can be opened which would require the ventilator operating mechanism to be modified. In general it is only feasible to increase the size of

Figure 2: The factor by which the ventilator area must be increased when an insect screen is fitted so the ventilation rate is not reduced



Here, the entire side wall is covered in netting to prevent insects entering.

ventilators if the decision to use insect screens is made before the greenhouse is built. However, making the screen as large as possible can offset the reductions in ventilation.
One way in which this can be done when screens are fitted to roof ventilators is shown in *Photo 1*. The screen is pre-formed to have a concertina shape, which unfolds as the ventilator opens and folds up again when the ventilator closes. These pre-formed screens are more expensive than the basic screen material and maintenance can be problem. However, useful increases in area can be obtained.
A rather simpler system is shown in *Photo 2*. The screen is fitted to the ventilator and is prevented from billowing outwards by restraining strings or elastic attached near each corner and at points in between.

Other entry points - Although ventilators are the main way in which insects can enter a greenhouse they are not the only one. Doors left open, especially in a windward facing wall, allow air and insects to enter. Gaps or holes in the greenhouse cover also provide points of entry, where again their passage may be assisted by the inflow of air. Consequently, good maintenance of the greenhouse is required if effective insect exclusion is to be achieved. The requirement for maintenance also applies to the insect screens themselves as holes can develop as a result of wear. Also after a period of use, especially in dusty areas, screens can become partially blocked by dust and insects, and this reduces the effectiveness of ventilation.
It is also good practice to remove weeds and plants from around the outside of greenhouses. This will eliminate possible insect habitats and so reduce the population of insects in the vicinity of a greenhouse. □