Factsheet 18/11

Cucumbers

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Cucumber green mottle mosaic virus (CGMMV)

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Cucumber green mottle mosaic virus **(CGMMV) has become a persistent problem on some cucumber nurseries in the UK. The number of affected nurseries is increasing as the disease can spread rapidly through a crop reducing yields by up to 25%. This factsheet will help growers to identify the virus. It also provides guidance on how to stop the virus entering crops; how to reduce spread once it has occurred and; how to clean-up to prevent recurrence.**

Background

CGMMV is a disease that has affected many cucumber nurseries across the world (Figure 1). The virus does not appear to be present in the USA but is found in Canada, Europe, Russia, the Middle East, India, Korea and Japan. In the UK it was first recorded in the Lea Valley area and was common in that area by the early 1960s. By the mid-1960s it was widespread mainly because of the practice of using locally produced (and infected) seed of the cultivar Butchers Disease Resistor. Since then the disease has been recorded in many countries affecting a range of cucurbit species including cucumber, gourd, melon and watermelon, though not marrow.

The virus is spread by infected seed with virus particles carried on both the outside and the inside of the testa (seed coat). Virus particles are transferred to the developing cucumber seedling as it emerges which then provides a focal infection point within the crop. The virus is easily transmitted by crop workers on their hands, clothing, knives and other equipment and extensive spread occurs well before visual symptoms are seen. The virus is also spread by root contact and may occur in runoff. There are no known insect vectors.

Once the virus is transferred to a new host plant it rapidly spreads and multiplies within that plant but it does not show symptoms for up to 14 to 21 days post the initial infection. However the virus can be spread to other plants, e.g. by leaf contact, during this period. This makes the spread of the virus so widespread throughout affected crops because infected plants are symptomless for this short but significant period.

The level of crop infection has increased with the introduction of multiple cropping because of spread during replanting. The amount of crop loss is connected to the age of the plant at the time of infection - the earlier the infection the greater the losses. When crops are replanted many are infected at that stage without showing symptoms. Second replant infection rates can be close to 100% shortly after planting.

1 ***Cucumber green mottle mosaic virus*** **showing typical dark green patches and leaf blistering**

Biology

CGMMV occurs as a number of strains across the world with at least two of these strains being present in the UK. The nomenclature of viruses is similar to that of plants but it was initially confusing because the same virus was given different common names.

The infection is localised to begin with but may spread via the vascular system into a systemic infection. The exact mechanism that the virus uses to move throughout the plant is unknown. Virus particles are found throughout the plant and can even be found in small quantities in pollen.

CGMMV is classified as:-

group	IV:(+) strand RNA virus
family	virgaviridae
genus	tobamovirus
species	*Cucumber green mottle mosaic virus*
Synonyms	*Tobacco mosaic virus* (watermelon strain) Cucumber virus 3 Cucumber virus 4 (Aucuba mosaic strain) Cucumis virus 2 (Aucuba mosaic strain) *Bottle gourd Indian mosaic virus*

The various strains that have been identified are:-

CGMMV - type strain
Aucuba mosaic strain
Kyuri strain - now re-classified as the C-strain of (Kyuri) KGMMV-C
Yoda strain - now re-classified as the Y-strain of KGMMV-Y
Zucchini strain - now found to be distinct from CGMMV and classified as a different virus, *Zucchini green mottle mosaic* (ZGMMV).

Symptoms

Leaf symptoms of the type strain are quite easy to identify as they produce a characteristic dark green / light green mottled appearance on the youngest leaves, although severity may vary with cultivar. Light areas are flattened in appearance and the dark areas raised. Symptoms disappear as the foliage ages and there are usually no symptoms on the fruit, although some strains do produce fruit symptoms (Figures 2, 3, 4 & 5).

2 Early symptoms just starting to show in the head of the plant

3 Closer examination shows the typical symptoms just starting to appear

4 Darker patches and leaf blisters more clearly visible

5 Symptoms becoming less clear as the leaves expand

When CGMMV infection occurs on young plants in the replanting period (i.e. at higher light levels) infected plants can sometimes wilt. This can be confused with *Pythium* infection but in the case of virus infection the roots are healthy and wilting may only occur in the middle of the plant with the highest and lowest leaves being less affected.

Occasionally, lighter leaf mottling occurs. This pale strain is still CGMMV but is thought to be the Aucuba strain or a similar yet to be identified strain (Figures 6, 7, 8 & 9). The pale strain does not appear to spread as fast as the type strain but it still reduces yield. Its symptoms stay visible as the leaves expand – an attribute that is not shared by the type strain.

Most fruit is unaffected and can be marketed as normal but there are occasional problems with fruit symptoms which may be caused by combinations with other viruses or by the presence of different strains of CGMMV.

6 Similar mottling pattern but much paler patches

7 As the disease develops the pale pattern spreads

8 Pale patches are very angular

9 Close up of pale patch

Effect on marketable yield

The effect on yield will vary with variety but it is affected by the age of plant at the time of infection and also by the presence of other diseases, particularly other virus diseases.

Experimental work carried out in the mid-1960's by Dr John Fletcher in the Lea Valley established a reduction of yield in the order of 15% from early infection for the varieties used at that time. There has been no similar work carried out since but comparisons of commercial output between nurseries would suggest an overall yield loss of up to 25% have occurred which would indicate higher yield losses in affected blocks.

If plants are further stressed by fungal diseases such as *Pythium* or *Verticillium* then losses are increased. Plant death can result with the corresponding loss in yield where other viruses, particularly necrosis viruses such as *Tobacco necrosis virus* and *Melon necrotic spot virus*, are involved (Figures 10 & 11).

10 Leaf infection with *Tobacco necrosis virus*

11 Plant infection with *Melon necrotic spot virus*

Disease control

Keeping the virus out

Seed Treatment

The virus can be transmitted by seed therefore it is important to use virus-free seed. Dry heat treatment at 70°C for three days has been shown to be effective at inactivating the virus so all seed should be treated in this way. This has long been standard practice for all commercial cucumber seed but growers are advised to always ask whether this treatment has been carried out, particularly on new trials material.

Visitors

Visitors are a potential source of infection. The best option is to have none - growers should keep all visitors that do not need to see the crop out of the crop! Packhouse workers, technical staff, biological control advisers, crop consultants, seed company representatives and other growers all have access to infected fruit and crops and can carry the virus. Any visitors allowed into the crop should be provided with coveralls, shoe covers and gloves. Visitors must thoroughly wash their hands in hot soapy water using the hand washing facilities that are present for staff. Hot soapy water is more effective than alcohol gel in preventing the spread of viruses. Alcohol gel after hand washing further improves hand disinfection but alcohol gel when used alone is less effective.

All persons entering the crop must follow the same procedure outlined for visitors if they have just visited another crop, regardless of how well the crop looked because crops may be infective without showing symptoms for many days.

Foot dips are also useful - if nothing else they do indicate the need for hygiene precautions. They must be placed so that they cannot be avoided. Dips should also disinfect wheels of all transport vehicles as they enter and leave. Growers are advised to replace disinfectant regularly as this is better than topping it up.

Dealing with a suspect plant

It is important to have any suspect plants identified quickly as spread can be rapid. The best action is to sample any suspect plants by removing the tops for analysis and then removing the remaining parts of the plants from the crop to help limit spread. When removing suspect plants take out the whole slab not just the suspect plant by first removing the drippers then leave the plants to wilt for a few hours - this helps dry out the slab and thus prevents infected feed solution from leaking everywhere.

At the end of the day bag up the suspect plants, the drip stakes and the slab and remove from the glasshouse avoiding contact with other plants in the row as you move. Dispose of the bag away from the site. Wash hands thoroughly and change clothes before returning to the crop.

Plant clinics at STC and Fera are able to identify CGMMV. Growers are advised to seek confirmation if they are uncertain. Contact details for plant clinics can be found under ‘Other information’ in this Factsheet.

Slowing / restricting the spread of virus

Early plant removal is the best action as this reduces the level of virus in the crop and slows spread within a crop. It is essential to spot the virus infection early and remove infected plants at the earliest stage. Early identification is essential as the virus can be present in plant sap well before any symptoms appear in the foliage resulting in considerable spread throughout the crop once infection has occurred.

Growers should mark off any row where virus infection is suspected and carry out any crop activity in that row at the end of the day preferably using an overall kept in that row for that work.

Hand dips

The use of hand dips can have some effect in slowing down disease movement from plant to plant. If an effective material is used to dip hands and knives between every plant there is little or no transfer of infected sap from one plant to the next. Milk as skimmed milk or as a solution made from milk powder has some effect as a hand and knife dip. The major problem that reduces the effectiveness of this action is that staff do not dip their hands / knives frequently enough to make it worthwhile. If they did it would improve the effectiveness of the procedure and reduce or slow down disease spread. Disinfectants such as tri-sodium phosphate (TSOP) have been used in the past on the assumption that they "kill" the virus - they do not. They only reduce the spread of the virus. TSOP is also quite corrosive which results in workers rinsing their hands after dipping which completely nullifies the effect of the disinfectant. Other dipping materials may be of value but the same issue applies. Getting staff to dip hands and knives between every plant is not easily achievable. If staff comply and are consistent then chances of restricting spread are greatly increased.

Knife policy

Many nurseries in the Netherlands, where CGMMV is also a problem, have adopted a policy of using a different knife for every path as a result of the difficulties encountered in implementing an effective dipping practice when carrying out crop work. This means that any infection within a row is restricted to that single row - at least in the short term. More growers in the UK could adopt a system for holding a knife at the end of every row (Figure 12). The knife is picked up when staff start crop work or harvesting in that row and returned when work in that row is complete. This removes the risk of spread of infection from the knife. The speed of spread is further reduced if workers also dip their hands in milk between each row.

To avoid confusion and to prevent mix up, each row and each knife should be numbered. This provides good knife control for audit purposes. Knives should be removed and cleaned regularly in suitable disinfectant and must be cleaned at the end of each crop.

12 Restricting knife use to one bay will help reduce spread of virus

Tolerant varieties

One of the most encouraging things to occur in the control of CGMMV is the introduction of varieties that are tolerant of the virus. Rijk Zwaan are the first of the seed companies to offer this with their BonDefence series of varieties. The varieties are not resistant to the virus but they appear to reduce the spread and / or multiplication of the virus in the plant resulting in reduced symptom expression and spread. The net result is much reduced appearance of symptoms in the crop and more importantly - an improved yield compared to infected non-tolerant varieties. The first of these varieties is BonBon which is now available for planting from April onwards. This variety also has powdery mildew tolerance thus increasing its usefulness. At the time of writing (September 2011) it is too early to state how useful the new varieties will be but early results look promising. It is most important to remember that these new tolerant varieties may still be infected with the virus and precautions aimed at restricting spread (especially to other, non-tolerant varieties on the nursery) during the cropping period and at the end of season clean up should be maintained.

End of crop clean up

Another important thing to remember with CGMMV is that all parts of the plant carry the virus and can carry it over to the following year. All plant parts need to be removed from the growing house. Where crops are grown in soil growers should aim to remove as much of the root system as possible together with all crop debris and then to steam sterilise the soil. Crop debris should be removed from the growing house and disposed of off-site where crops are grown in isolated media. The virus can remain active for more than a year in plant debris so do not leave debris on site. It is important to remove the crop debris when it is wilting rather than when it is dead because dead leaves are very brittle and break into hundreds of pieces that will be impossible to clear up. Thorough cleaning is important therefore aim to remove every trace of plant material to include, for example, the removal of tendrils from crop wires.

Growing media should also be removed and disposed of off-site. The best policy is NOT to reuse growing media that is infected with CGMMV. If growing media is to be reused then it must be thoroughly steam disinfected before reuse and, once treated, it must be stored where it cannot be re-contaminated. It is best to carry out any treatment offsite or after all clean up activity is complete.

Disinfection

Once crop debris is removed the glasshouse structure should be disinfected. Disinfectants work very well on clean surfaces and less-well on dirty surfaces. Structures and implements must be washed down with a high pressure washer using soapy water first before disinfection rather than using the disinfectant solution to clean the implement. No comparative tests on disinfectant (Table 1) effectiveness against CGMMV have been carried out. Growers are advised to read Factsheet 20/03 titled 'Pepino mosaic virus of tomato - new results on virus persistence and disinfection' which lists disinfectant effects on a similar virus of tomato.

Virkon S and Horticide/Omnicide are probably the most widely used products for structural disinfection where contact times are limited, with the others being used for cleaning equipment, trays etc where longer contact times are possible.

Chemical disinfectants can be harmful to operators. For example, products containing glutaraldehyde (eg Horticide, Unifect G) may cause burns and sensitisation by skin contact. Carefully follow the directions for use and observe the safety precautions on the product label.

Table 1: Suitable disinfectants

Active ingredient	Commercial material	Dilution rate	Uses
gluteraldehyde	Horticide and Unifect G	1:100	All
peroxygen blend	Virkon S	1:100	Structure / equipment
benzoic acid	Menno Florades	1:25	Equipment / foot dips
peracetic acid	Jet 5	1:125	Equipment / foot dips

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Other information

Regular changes occur in the approval status of pesticides arising from changes in legislation or for other reasons. For the most up to date information, please check with your preferred supplier, BASIS registered adviser or the Communications Branch at the Chemicals Regulation Directorate (CRD), Tel (01904) 455775, www.pesticides.gov.uk

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