Grower Summary

PO 016

The role of environmental factors in the incidence of Pansy mottle syndrome (PaMS)

Final 2015

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The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

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Read the label before use: use pesticides safely.

Further information

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Project title:	The role of environmental factors in the incidence of Pansy mottle syndrome (PaMS)
Project number:	PO 016
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Report:	Final report, April 2015
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Date project commenced:	1 May 2013
Date project completed (or expected completion date):	30 April 2015

GROWER SUMMARY

Headline

High light levels, vapour pressure deficit (VPD) and temperatures are potentially linked to expression of pansy mottle syndrome (PaMS) symptoms.

Background

Pansy mottle syndrome (PaMS) has been reported (though not understood) since the 1960s, and is recognised as a measureable or visible change in plant growth and function (physiological response). Typical symptoms include leaf distortion, mottling, leaf bleaching, stunting and apical blindness (**Figure 1**). The extent of PaMS may vary from year to year on nurseries; bedding plant species including *Antirrhinum*, *Gerbera*, marigold, *Petunia*, *Primula*, stocks, sweet pea and *Verbena* can display similar symptoms. Determination of the cause is complicated by the transient and intermittent nature of plant response, difficulty in replicating the symptoms and linking the cause with effect (McPherson, 2010). The condition has become more common in recent years, and this has renewed interest in identifying the causal factors.

Figure 1. PaMS symptoms recorded site A, batch 1, 2013.

Grower observation suggests that PaMS may be varietal, with incidence occurring in specific seed batches and colours. Outbreaks have also been linked to environmental factors, occurring under humid conditions including warm, wet and windy weather when glasshouse vents are shut, causing humidity to increase within the glasshouse. Plug size (greater risk of PaMS in the larger module tested), growing media, and the plant hormone methyl-salicylate (associated with plant stress) also appear to promote the incidence of PaMS. Symptoms do not appear to be directly increased by fungicide, adjuvant or plant growth regulator application, the light or irrigation regimes tested, virus (tests proved negative), low irrigation or boron/calcium (levels confirmed adequate by plant tissue analysis) (McPherson, 2010). Although not a direct cause, pesticides, plant growth regulators or adjuvants may be involved in the development of PaMS by contributing to plant stress. PaMS does not generally appear to spread between plants (McPherson, 2010). Other research has linked growth distortion with boron deficiency under high relative humidity conditions (100%); these conditions decrease water loss via transpiration, resulting in reduced boron uptake and movement from the roots to the shoot (Krug *et al*, 2013). The precise trigger however for the expression of PaMS symptoms remains unknown. As symptoms have proven difficult to replicate both on grower holdings and in research facilities, the approach taken for this study was to collect production and environmental data from nurseries during commercial pansy production for modelling together with symptom expression to identify trigger point(s) of PaMS.

Expected deliverables

To investigate the role of selected environmental factors on the incidence of PaMS, and identify any causal relationships between the incidence of PaMS and environment through, a) monitoring the nursery environment (humidity, temperature, light) and root development within commercial bedding plant production systems and b) controlled environment cabinet experiments.

Summary of the project and main conclusions

Nursery monitoring

Data was collected from four commercial nurseries (sites A-D) located in Hertfordshire, East Yorkshire, West Sussex and Essex respectively between June and September 2014. The sites were selected to include sites with a sustained record of PaMS, and one site where PaMS does not generally occur. These sites were also selected because they grow pansies from seed, so the production process from sowing to marketing could be monitored.

Four batches of pansy were monitored at sites A, three at site B, and two batches at sites C and D. Each batch was monitored using a Tinytag Plus 2 data logger (temperature and humidity), a Watchdog 1000 series microstation data logger with an external LightScout Quantum Light 3 Sensor PAR probe (temperature, humidity and light) and a WaterScout SM100 soil moisture sensor (connected to the Watchdog 1000 data logger). Data loggers were set to record data every 15 minutes. Data loggers were pole mounted within the crop at canopy height so they recorded the environmental conditions the plants experienced. The light sensor was positioned above the crop (**Figure 2**). Two different production systems were in use on the nurseries taking part in the monitoring: coir ‘teabags’ in clear green plastic trays and peat based growing medium in packs. Due to the shape of the coir ‘teabags’, sensors were placed horizontally through the coir, whilst in the peat based system the sensors were place vertically into the growing media (**Figure 3**).

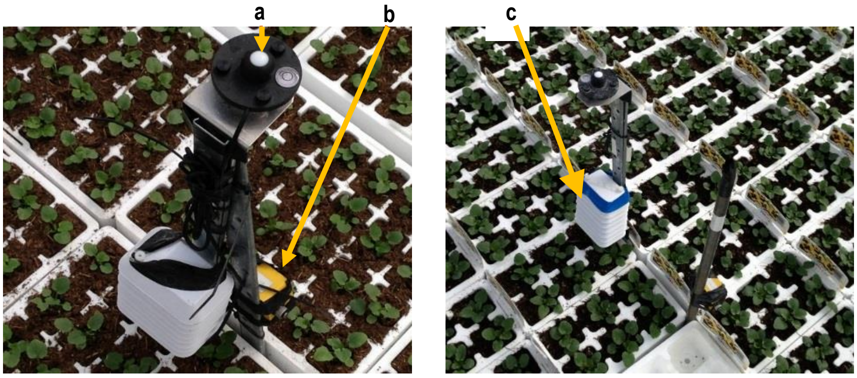

Figure 2. Positioning of data loggers and light sensor within a batch of pansies: a) LightScout Quantum Light 3 Sensor PAR probe; b) Tinytag Plus 2 data logger (temperature and humidity); c) Watchdog 1000 series data logger housed within a radiation shield for protection against solar radiation and water damage

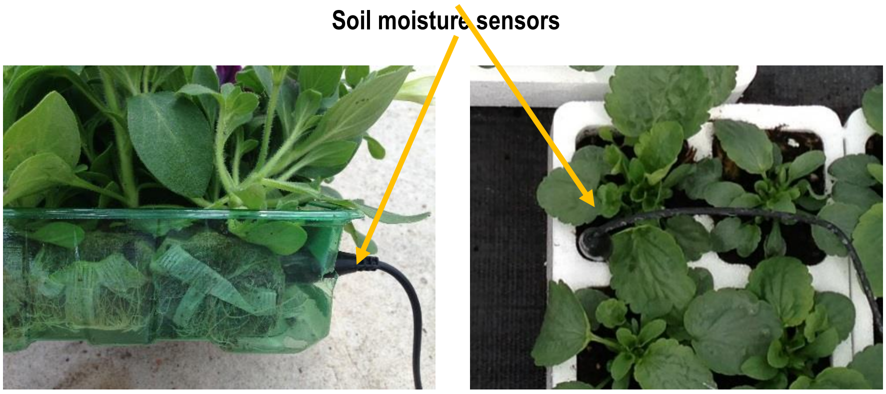

Figure 3. Positioning of SM100 Soil Moisture Sensor within a coir system, inserted horizontally (image left); and in a peat based system inserted vertically (image right) production systems

In 2013, although there was low occurrence of PaMS symptoms in the monitored batches across the four sites, a potential association was tentatively muted between environmental factors and the occurrence of PaMS symptoms. This association was derived from the observation that the VPD, temperature and PAR received by the plants in site A, batch 1 were higher than for the other batches at the same site and also for batches at other sites. It was suggested that light levels could be a factor, in combination with high VPD and temperature that may lead to symptom development. However the sample size of one precluded any robust statistical analysis of the environmental data.

There were no significant occurrences of PaMS in the monitored batches in 2014, and consultation with the wider bedding plant sector similarly indicated few cases of PaMS within the industry. Data analysis showed that high VPD did occur in all batches on a number of occasions however, daily light integral (DLI) was generally lower across all batches, including when VPD was higher than 4 kPa. DLI was generally lower in 2014 (Error! Reference source not found.) than 2013 (Error! Reference source not found.). At site A in 2013, there was a sustained period (~20–50 days from sowing) when DLI was between 100-150 mol/m^2/day. In 2014, DLI generally peaked below 100 mol/m^2/day, but with a number of peaks above 150 mol/m^2/day) and sparser peaks above 150 mol/m^2/day, across the four batches. DLI was calculated per sampling period, based on a 24 hr day.

Nursery experience suggests that the absence or reduction of root hairs (water roots), as occurs when plants are grown under continually wet growing media conditions, may contribute to triggering PaMS. Root zone issues may impose additional stress on plants either because water is present within the root zone but plants are unable to take up water or nutrients because of the lack of root hairs, or there is no water present.

Recording of growing media moisture data was improved in 2014 through the use of soil moisture sensors, which provided more consistency in the data collected and indicated that none of the batches became critically dry during the monitoring period. Linking this information with the root assessments, where root hair development was good in all of the assessed batches provides an indication that roots were not critically under- nor over-watered during production.

If PaMS symptoms are associated with stress due to high water requirements under high light and temperature conditions, including for photosynthesis, then we would expect the stress to have been lower in 2014 due to the lower light levels. Lower light levels – along with less extreme temperatures and high VPD events – recorded in the nursery monitoring in 2014 would also help to explain the reduced incidence of PaMS across the industry.

Vapour pressure deficit describes the drying effect of air; high VPD occurs under high temperature, low humidity conditions, where high VPD is greater than 2.0 kPa (dry air) and low VPD is less than 0.2 kPa (humid air). Most plants grow well in the middle of this range (0.5 kPa to 0.95 kPa), with pansies performing well around 0.6-0.7 kPa. To put high VPD into context, VPD greater than >5.3 kPa is reported in the Sonoran Desert of Southern California. The data suggested a potential link between high VPD, high temperature and the development of PaMS symptoms.

Controlled environment work

Seeds of Pansy Matrix Autumn Select were sown (31 March 2014) into 288 trays (24 trays), using Bulrush growing media, at Bryants Nursery, Hertfordshire. The environment (temperature, humidity, and light) was monitored using two Tinytag data loggers and two Watchdog 1000 series data loggers with light sensors. The pansy plugs were transported to ADAS Boxworth on 14 April (cotyledon stage) where they were grown on in a glasshouse compartment, maintained between 15 and 25°C. Of the trays of plugs, six from each irrigation treatment remained in the glasshouse throughout the trial, where the environment continued to be monitored.

Irrigation treatments

Plants were grown under two irrigation regimes, wet and dry. The intention had been to provide these two different irrigation treatments (wet and dry) from sowing to encourage greater root hair development under the dry treatment, and water roots (no root hairs) under the wet treatment, but this had not been achieved. The pansies were uniform, with a similar number of root hairs visible on all plants on arrival at ADAS Boxworth, when the two irrigation regimes were applied, but although the two irrigation treatments at Boxworth did achieve greater root hair development under the dry regime, water roots were not present on the plants grown under the wet treatment (Error! Reference source not found.). Reassessment of the roots following the cabinet treatments indicated no change in root hair development.

Two controlled environment cabinets (Sanyo Fitotron SGC097.CPX.F) were set to 35°C and 30% relative humidity and, with the addition of silica gel / cobalt chloride crystals, VPD >3 was achieved on each cabinet treatment day. The cabinet treatments ran for five consecutive days (5 – 9 May 2014) once the plants had reached 3 – 4 true leaves (**Table 1**). Plants were assessed daily for PaMS symptoms for two weeks post treatment, but no symptoms were expressed in either wet or dry treatments.

Table 1.Controlled environment treatments

Treatment no.	Location		Treatment
1a 1b	Glasshouse	Wet Dry	15-25°C
2* 3*	Cabinet Cabinet	Wet Dry	Temperature (>35ºC), VPD (>3), 6 hrs on 5 consecutive days

*Plants were returned to the glasshouse between treatments

PaMS symptoms did not occur in any of the plants subjected to the controlled environment work. A maximum instantaneous light level of 1021 µmol/m^2/s was achieved. During the 2013 monitoring, light levels reached ~1300-1400 µmol/m^2/s when high VPD conditions were experienced, and this correlated with nursery experience where more PaMS developed in glasshouses without screens, and with higher light levels. The lack of symptom development under high VPD and temperature conditions in the controlled environment work may also support the theory that high light levels in association with high VPD and temperature are required for PaMS symptoms to develop – and root development or root zone water balance may also prove to play an important role.

Financial Benefits

Published statistics (Defra, 2014) estimate pansy production in England and Wales at 9.4 million plants with a farm gate value of £2.1 million in 2004 (21p/plant); these values are likely to have increased in subsequent years. It is difficult to quantify plant losses due to PaMS for several reasons (the intermittent and variable nature of PaMS, growers rogueing distorted plants, unreported incidence, incidence identified as PaMS), however, reports have been received of 5-20% of batches on individual nurseries being affected. Based on Defra data, this would to equate to losses of £21,000 (1% of crop affected), £105,000 (5% of crop affected) or £420,000 (20% of crop affected). Additional costs are also incurred by nurseries in refilling plug trays or packs once affected plants have been discarded.

Action Points

The results of this study suggest a causal link between environmental conditions (high VPD, temperature and light) and the expression of PaMS symptoms, however, this is based on the results from a single site in year 1. The precise triggers and sequence of events that lead to PaMS still remain to be elucidated within the current project but growers should take measures to monitor environmental conditions, and reduce plant stress:

1) Monitor VPD and temperature.
2) Ensure that during periods where extreme high temperatures are predicted measures are taken to reduce plant stress by providing shade, maximum ventilation appropriate to prevailing weather conditions and adequate irrigation. High VPD may be reduced by increasing relative humidity by, for example, path damping and use of mist irrigation where available.
3) Ensure healthy plant root development through careful application of water; over-application of water will limit root development, particularly in tray module production units.