Grower Summary

PO 016

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

Annual *2014*

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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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Before using all pesticides check the approval status and conditions of use.

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Further information

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AHDB Horticulture,
AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

Project title:	The role of environmental factors in the incidence of Pansy mottle syndrome (PaMS)
Project number:	PO 016
Project leader:	Dr Jill England, ADAS Boxworth
Report:	Year 1 report, April 2014
Key staff:	Dr Jill England, Project Leader Dr Dave Skirvin (ADAS), Senior Research Consultant Chloe Whiteside (ADAS), Horticulture Consultant
Location of project:	Commercial growers
Industry Representative:	Chris Need, Roundstone Nurseries, Pagham Rd, Lagness, Chichester, W. Sussex PO20 1LL. Fay Richardson, Coletta & Tyson, 324 Hull Rd, Woodmansey, Beverley, E. Yorks HU17 0RU Mike Smith, W.D. Smith & Son, Grange Nurseries, Woodham Rd, Battlesbridge, Essex SS11 7QU
Date project commenced:	1 May 2013
Date project completed (or expected completion date):	30 April 2014

GROWER SUMMARY

Headline

High 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. 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 also 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 cause.

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, specifically to monitor nursery environment (humidity, temperature, light) within commercial bedding plant production systems and identify any causal relationships between the incidence of PaMS and environment.

Summary of the project and main conclusions

Data were collected from four commercial nurseries (sites A-D) located in Hertfordshire, East Yorkshire, West Sussex and Essex respectively between July and October 2013. The sites selected included grower holdings with a record of PaMS and which produced pansies from seed to enable the entire production process be monitored. Three pansy batches were monitored at sites A and B, and two batches at sites C and D. Each batch was monitored using a Tinytag Plus 2 data logger (temperature and humidity), and a Watchdog 1000 series microstation data logger (temperature, humidity, and light). 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 1). Sowing, transplant and dispatch dates for the batches monitored were recorded along with production data for routine inputs: irrigation (method, volume, and source), fertiliser, crop protection and plant growth regulator application, and growing media was also collected. Batches were monitored daily for PaMS symptoms and the location of symptomatic plants recorded, along with the date and time of inspection.

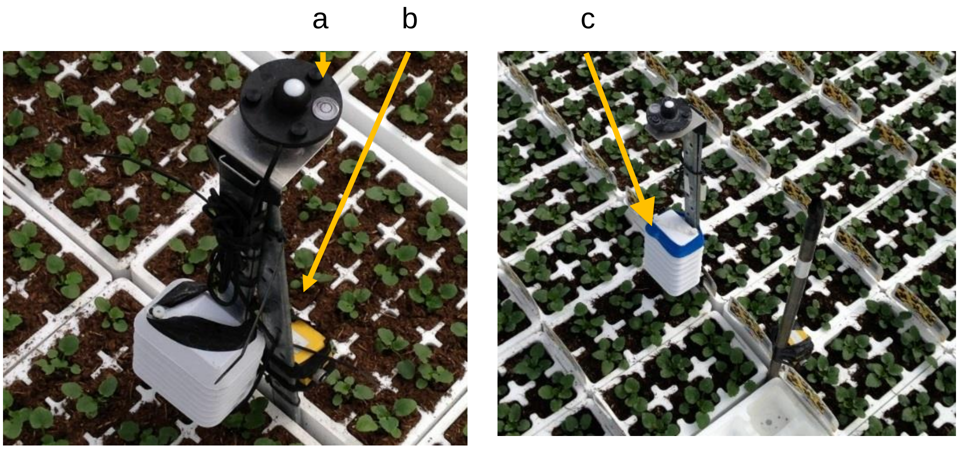

Figure 1. Positioning of data loggers and light sensor within a batch of pansies: a) LightScout Quantum Light 3 Sensor PAR probe; b) Tinytag Plus 2 data logger (temperature and humidity); c) Watchdog 1000 series data logger housed within a radiation shield for protection against solar radiation and water damage

Of the crops monitored, PaMS symptoms, including variegation and leaf distortion, developed in a single batch (site A, batch 1) of Pansy 'Autumn Mixed'. Approximately 10-20% of the batch showed the full range typical PaMS symptoms, i.e. leaf distortion, mottling, leaf bleaching, stunting and apical blindness (Figure 2). Symptoms were first noted on 9th September, two weeks post transplanting. In another batch (site A, batch 2) approximately 10-20% of the plants showed some leaf distortion, but the variegation was not present. These symptoms were first observed on 25th September.

Figure 2. PaMS symptoms recorded site A, batch 1, 2013.

Data analysis

Initial data analysis examining cumulative day degrees above a threshold of 0°C determined that for all batches data were highly consistent across the sites. For light, despite the partial loss of data due to logger failure, there was generally a high level of consistency in cumulative photosynthetically active radiation (PAR) received by the plants in different batches and sites. The PAR received by site A, batch 1, where full range of PaMS symptoms were observed, was noticeably higher than that received by all other monitored batches on all sites from around 700 day degrees after sowing (38 days after sowing). The second batch in which symptoms were observed (site A, batch 2) showed slightly higher cumulative PAR compared to the other batches (excluding site A, batch 1). However, due to losses of some of the light data, it was not possible to determine absolutely whether the high values for PAR in site A, batches 1 and 2 were unusual compared with all batches monitored, linked to the occurrence of PaMS symptoms, or part of the general variation in conditions across batches and sites.

The data showed a lack of consistency between holdings in the volume of water applied, although this may be linked to the way area irrigated was reported for each batch. The data for site A, where PaMS symptoms were observed, indicated that batch 3 received less water than batches 1 and 2 (that expressed symptoms of PaMS), particularly during the early growth stages.

Site A, batch 1 (PaMS – full range of symptoms including leaf distortion, mottling, leaf bleaching, stunting and apical blindness observed)

Based on the observation of PaMS (site A, batch 1), a more detailed assessment of the data was undertaken focussing on vapour pressure deficit (VPD) and temperature. 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 occurrence of PaMS symptoms (in contrast to reported observations) (Figure 3). The data for site A, batch 1 showed that in the two weeks prior to the occurrence of PaMS symptoms, the plants experienced a VPD greater than 4 KPa and a temperature greater than 35°C for over 1 hour on 6 days over a 10 day period, with over 4 hours exposure for both VPD and temperature on two consecutive days (4th and 5th September). This level of exposure and the clustering of events into a short period does not occur in any other batches.

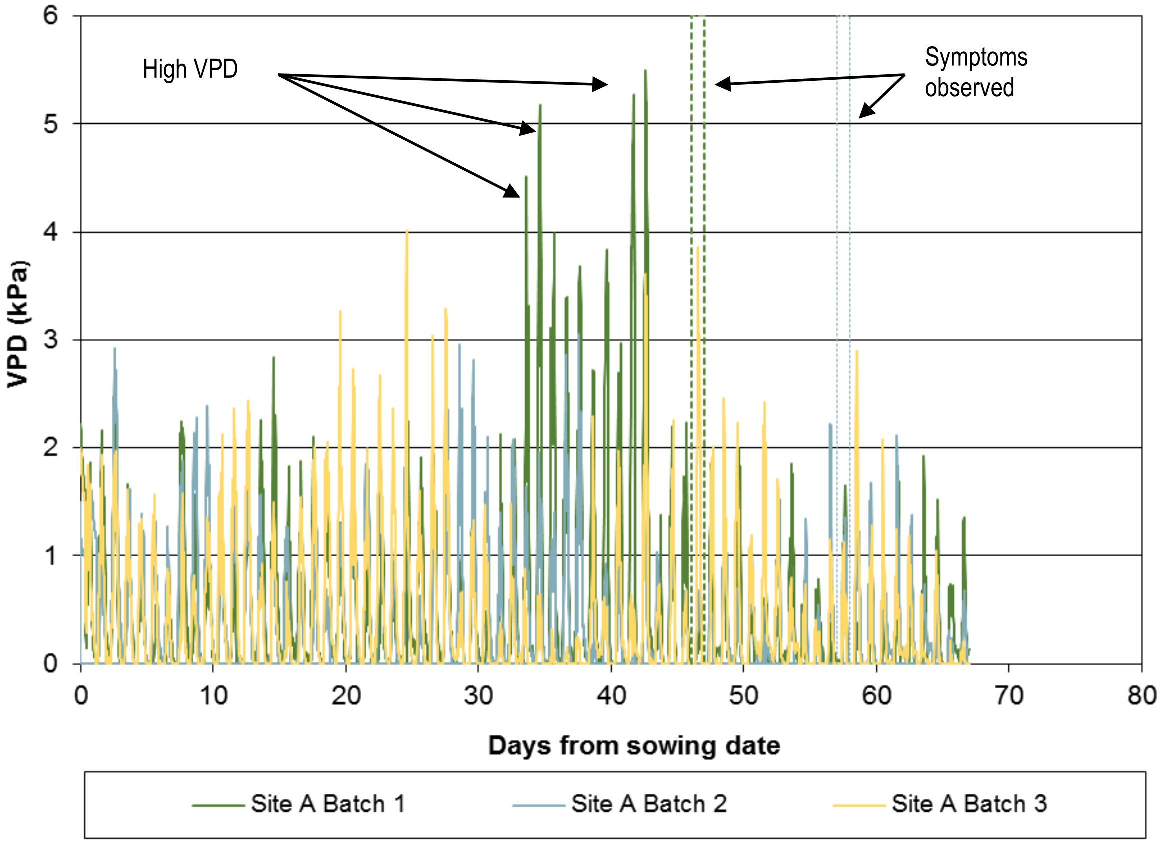

Figure 3. The vapour pressure deficit (VPD) for all batches on site A (the dashed lines show the day on which PaMS symptoms were observed for batches 1 and 2).

Site A, batch 1 was grown on in a polytunnel post transplanting rather than a glasshouse, hence there would have been less control over the environmental conditions. Given that this batch did show the variegation, then the expression of this variegation and leaf distortion could potentially be a response to stress associated with more extreme high VPD and temperature conditions in the polytunnel. It is also possible that the observed PaMS symptoms were related to the generally elevated temperatures in the polytunnel rather than specific high VPD and temperature events. As the polytunnel did not have shading, this would explain the higher light levels and daily light integral experienced by the plants after transplanting, and could be linked to the expression of PaMS symptoms.

Site A, batch 2 (PaMS symptoms observed, excluding mottling or bleaching)

Site A, batch 2, which was grown on in a glasshouse post transplanting, was observed to have leaf distortion, which was recorded as PaMS symptoms, but no association with high VPD and temperature events could be found. Assuming the high VPD and high temperature conditions are linked to PaMS, there are two possible explanations for this:

a) PaMS occurrence is driven by more than just high VPD and temperature events
b) The symptoms observed in site A, batch 2 were not PaMS symptoms

It is not possible to determine which of these explanations is more plausible using the evidence currently available from this project.

Sites B, C and D (no PaMS symptoms observed)

For site B there were no spikes of high VPD or temperature in any of the batches and no PaMS symptoms were observed on this nursery. At sites C and D there were occasional spikes of high VPD and temperature in both batches at each site, but the spikes were not as prolonged or as clustered as in site A, batch 1; no PaMS symptoms were observed

Analysis of additional data from site B

Although batches monitored at site B did not show any observable PaMS symptoms, symptoms had been observed on other batches within the same growing location earlier in the season. To cross check whether high VPD and temperature were associated with the occurrence of these symptoms, data from the Priva environmental monitoring system was analysed and used to determine the VPD for the five days prior to the occurrence of PaMS symptoms. Vapour pressure deficit was shown to exceed values of 3KPa for a minimum of 3 hours on 3 dates, 2 of which were consecutive, and to exceed 4KPa for at least 0.5 hours on each of these days, with one day having 2 hours with VPD greater than 4KPa. All of the events where VPD exceeded 3 KPa were also associated with periods when the temperature at canopy level was predicted to exceed 35°C. These results show that elevated temperatures and VPD occurred prior to observations of PaMS symptoms, providing further evidence for a potential link between these adverse environmental conditions and the occurrence of PaMS symptoms.

Despite the low occurrence of PaMS symptoms in the monitored batches across the four sites, it was possible to identify a potential association between environmental factors and the occurrence of PaMS symptoms. This association was derived from the observation that the VPD, temperature and daily light integral in Batch 1 at site A were higher than for the other batches at the same site and also for batches at other sites. It must be stressed that this association is extremely tentative due to the sample size of one, which has precluded any robust statistical analysis of the environmental data and the different symptoms and environmental factors associated with Batch 2, site A. Further data is required to confirm that high VPD and temperature events are associated with the occurrence of PaMS symptoms and the role that light levels may play in expression of symptoms.

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 the first year of this study suggested a causal link between high VPD and high temperature and the expression of PaMS symptoms. The precise triggers and sequence of events that lead to PaMS still remain to be elucidated within the current project but growers should:

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.