Survey and Identification of Viruses Infecting Tomato Crops in Guam

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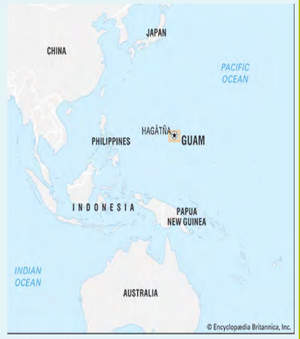
Introduction

In the past 40 years, several viruses have been identified on tomatoes in Guam; however, only with the introduction of new begomoviruses has production been impacted. In 2007, viral disease-like symptoms, including mosaic, leaf curl and chlorosis were associated with losses as high as 20% in some fields of 'Solar Set' tomatoes.



In 2011, typical viral symptoms of leaf curling, chlorosis and stunting were associated with total field losses of the variety 'Season Red'. Surprisingly the occurrence and severity of these symptoms in Season Red have decreased in recent years, while simultaneously symptoms of leaf curl, leaf purpling and slight stunting have increased. In early 1980's, *Tobacco mosaic virus* (TMV), *Tomato mosaic virus* (ToMV) and *Cucumber mosaic virus* (CMV) were known to occur on Guam. These three viruses plus *Potato virus Y* (PVY) tested positive with ELISA in 2006.

Tomato samples tested in 2007 and 2011 identified a putative begomovirus production. Further characterization in 2013 determined it to be a unique strain of *Ageratum yellow vein virus* (AYVV) with the highest nucleotide sequence identity of 90-91% to several isolates of AYVV, from China (Accession no. FJ869908), Japan (AB306314), Taiwan (DQ866134), and Thailand (JN809821). Second highest identity was less than 90% to *Ageratum yellow vein China virus* (AYVCNV) from China (AJ558120 and AJ849916) and the Philippines (EU487045). Additional analysis using deep sequencing of small RNAs and virus identification (Li et al., 2012; Zheng et al., 2017) using samples collected in 2013 to 2015, identified the presence of *Potato virus Y* (PVY), *Southern tomato virus* (STV), *Tobacco streak virus* (TSV), *Tomato bushy stunt virus* (TBSV), and *Tomato spotted wilt virus* (TSWV). The association of virus like symptoms with yield losses, has leads us to believe a range of viruses are impacting production.

Tomato virus symptoms present at the time *Ageratum yellow vein virus* "AYVV" was detected.

Stunting

Yellowing and Interveinal chlorosis

Leaf curling

Two week grow-out of 'Season Red' cherry seedlings from transplant tray. The transplant with severe symptoms failed to grow (left). Transplant with moderate symptoms had slight growth (middle).Transplant with no symptoms produced a normal size plant (right).

Within an infected field symptoms may range from severe to slight.

Commercial varieties offer resistance to Guam's tomato viruses.

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Positive test results for four tomato sample collected on 12/29/16 in Yona, Guam

Sample #	Leaf Symptoms	Cmm	CMV	ToMV	TBSV	PVX	AYVV
1	Yellowing	X	X	X			
2	Yellowing	X			X	X	
3	Yellowing	X			X		
4	Purpling	X			X	X	X

Samples were positive for: Cmm *Clavibacter m. michiganensis*, CMV *Cucumber mosaic Virus*, ToMV *Tomato mosaic virus,* TBSV *Tomato bushy stunt virus,* PVX *Potato virus X,* and AYVV *Ageratum yellow vein virus.*

Samples tested negative for: AMV *Alfalfa mosaic virus*, GRSV/TCSV *Groundnut ringspot/Tomato chlorotic spot virus*, INSV *Impatiens necrotic spot virus*, PepMV *Pepino mosaic virus*, PVY *Potato virus Y,* TEV *Tobacco etch virus*, TMV *Tobacco mosaic virus*, ToRSV *Tomato ringspot virus*, TSWV *Tomato spotted wilt virus*, and POTY *Potyvirus group*.

Tomato plants with interveinal purpling and chlorosis

In 2007, tomatoes in Guam began showing a mixture of symptoms with varying degrees of stunting, leaf distortion, and foliar discoloration. Production losses ranged from none to total. Subsequent research has contributed the majority of these symptoms to a group of viruses that have been identified in Guam. However, one set of symptoms that has increased in recent years and remains unresolved is yield suppression accompanied by leaves with interveinal purpling and chlorosis.

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