

## Review

# Cocoa swollen shoot virus disease situation in Ghana: A review of current trends

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The cocoa swollen shoot virus disease (CSSVD) continues to spread in Ghana despite many years of the cutting-out of infected trees and their 'contacts'. Records gathered by the cocoa swollen shoot virus disease control unit (CSSVDCU) indicate that between October 2006 and September 2010, 28,486,309 visibly infected and 'contact' cocoa trees were removed countrywide. Out of this number, 18,332,234 trees, representing 64.4%, were removed from Western North alone, while Western South accounted for 6.1% (for CSSVD control operations, the Western Region has been divided into North and South). The Central Region accounted for 8.8% while Ashanti Region recorded 6.6%. The Volta and Brong Ahafo Regions which recorded the lowest tree removals accounted for 1.7 and 2.3%, respectively. The records indicate that 10% of trees removed in Ghana during the period occurred in the Eastern Region. Over the same period, there was no swollen shoot infection at Goaso and Berekum Districts, while Sefwi Bekwai and Essam Districts had the highest number of infected trees discovered and removed. The current trend suggests that the Western North Region has become the new epicentre of swollen shoot disease infection in Ghana.

**Key words:** Cutting-out, cocoa swollen shoot virus disease (CSSVD), outbreak, area of mass infection, epicentre, backlog, infected trees, treatment.

## INTRODUCTION

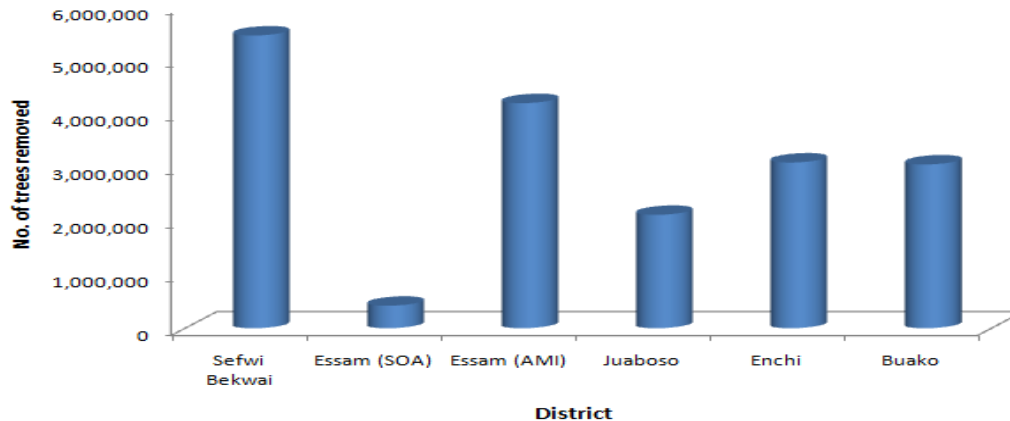
Cocoa swollen shoot disease is caused by a mealybug-transmitted virus that occurs in all the main cocoa-producing countries of West Africa. In affected plants, red vein-banding occurs in young leaves (Posnette, 1941) (Figure 9a). The reddening disappears as the leaves mature and may be followed by clearing or chlorosis along the veins (Posnette, 1941, 1947) (Figure 9b). Other symptoms of the disease include swellings in stems (Figure 9c) and roots (Figure 9d), reduction in yield, die-back and complete death of affected plants. The virus

also causes distortion in pod shape and size, sometimes with green mottling (Figure 9e). The pods become round and may sometimes become almost spherical (Posnette, 1943). The disease was first reported in 1936 when patches of dead and dying trees were found in parts of the Eastern Region of Ghana (Steven, 1936). Until recently, this was the most severely affected Region where several millions of cocoa trees have been killed by the disease.

However, the current levels of the disease in parts of the Western Region, particularly, Western North, is very high (Domfeh et al., 2010; Dzahini-Obiatey et al., 2010). This has led to the designation of an area of nearly 29,000 hectares in the Essam district as an Area of Mass Infection (AMI) (CSSVDCU, 2007). High levels of infection have also been reported from other parts of the same Region (Western North) especially, Sefwi Bekwai, Enchi, Juaboso and Sefwi Buako (Domfeh et al., 2010). The levels of infection in the Brong Ahafo (with the

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**Abbreviations:** CSSVD, Cocoa swollen shoot virus disease; CSSVDCU, cocoa swollen shoot virus disease control unit; AMI, area of mass infection; PCR, polymerase chain reaction.



**Figure 1.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the Western North Region from October 2006 to June 2010.

exception of Nkrankwanta - Dormaa Ahenkro district and Sankore - Asunafo South district), Volta, Ashanti and Central Regions have remained relatively low and scattered compared to the Eastern and Western Regions. The major constraints hampering CSSVD control operations in Ghana are farmer opposition to cutting-out, re-infection of some treated farms and the apparent lack of diagnostic leaf symptoms in some of the infected trees. This paper presents swollen shoot control efforts in Ghana between October 2006 and September 2010 and discusses the way forward.

### CSSVD situation in the various cocoa growing regions of Ghana

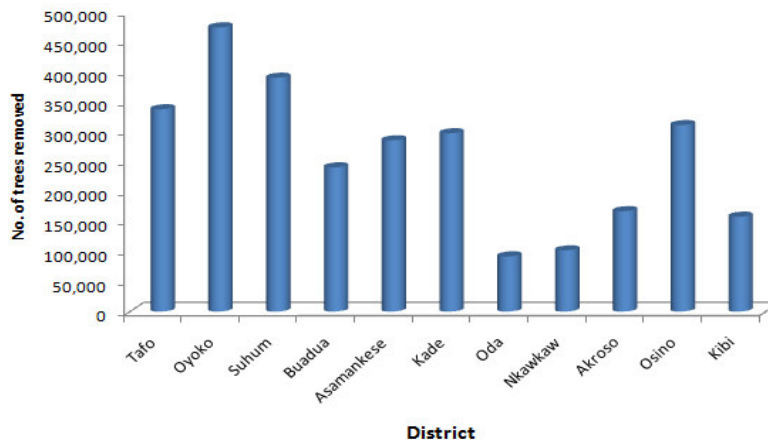
#### Western north region

The number of diseased cocoa trees removed in the Western North Region between October 2006 and June 2010 is presented in Figure 1. The Bekwai and Essam districts were the worst affected, accounting for 29.8 and 22.9% of trees removed in the Western North Region respectively. Enchi and Buako followed closely with 16.9 and 16.7%, respectively. The Western North Region alone accounted for 64.4% of the total number of cocoa trees removed nationwide from October 2006 to June 2010. By September 2010, 247,690.03 ha of cocoa area had been surveyed in the Western North Region, revealing a total of 4,186 swollen shoot disease outbreaks with an estimate of 43,884,435 trees involved. Out of the number, 756 outbreaks were completely treated (cut-out or removed), leaving 3,430 outbreaks with an estimate of 38,336,827 trees outstanding by September 2010. Since 2001, there has been an unprecedented rise in the number of CSSV infections in

the Western Region of Ghana, particularly, Western North (Domfeh et al., 2010). Currently, the Western North Region has become the new epi centre of CSSVD with the highest infection rate of 35.4% (CSSVDCU, 2010). This is a major concern to the cocoa industry in Ghana since the Western Region currently produces more than 60% of Ghana's cocoa (Annon, 2010).

Apart from opposition from farmers against cutting-out of infected cocoa trees, one of the major reasons for the rapid spread of CSSVD in the region is the lack of diagnostic leaf symptoms in the infected cocoa trees. The lack of visible leaf symptoms means that inspectors are unable to detect infections until stem swellings develop, by which with time many more trees would have become infected. Infected cocoa trees in the Eastern Region and other parts of the country exhibit leaf symptoms such as red vein-banding and vein clearing but this is not the case in parts of Western North Region, particularly the Essam district. A striking feature of the Essam AMI is the occurrence of large number of dead or dying trees. Some of the surviving trees exhibit chupon or apical swellings (Figure 9c). Generally, there is indistinct yellowing of leaves which cannot be relied on for diagnosis (Domfeh et al., 2010). The area appears to be generally poor soils judging from the conspicuous nutrient deficiency symptoms (Thresh et al., 2008). The predominant cocoa type cultivated in the area is mixed Amazon or their siblings with little or no shade (Thresh et al., 2008).

It is important to establish how different the virus strain(s) now occurring in the Western Region is/are from the strains occurring in other parts of the country. Presently, it is unclear whether we have new strain(s) of CSSV emerging or factors like the environment and genotype or their interactions account for this strange phenomenon.



**Figure 2.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the Eastern Region from October 2006 to June 2010.

To this end, comprehensive research programme has been initiated at the Cocoa Research Institute of Ghana to explain the occurrence of the phenomenon. This includes genomic characterisation of strains by polymerase chain reaction (PCR) to determine CSSV diversity in Ghana; field investigations into the role of planting material (genotype), environment (different levels of shade) and soil fertility in CSSVD symptom expression.

### Eastern region

The number of diseased cocoa trees removed in the Eastern Region between October 2006 and June 2010 is presented in Figure 2. The number of cocoa trees removed from Oyoko was 16.6% of the total number removed from the Eastern Region. Suhum and Tafo followed Oyoko in the number of trees removed with 13.7 and 11.8%, respectively. Oyoko, Kibi, Suhum and Tafo are known CSSVD endemic areas and therefore it is not surprising that they topped in tree removals. Oda and Nkawkaw recorded the lowest number of trees removed with 3.2 and 3.6%, respectively. As at September 2010, a total of 102,152.87 ha of cocoa area had been surveyed in the Eastern Region and this revealed a total of 12,447 swollen shoot disease outbreaks on 25,980.58 ha. The estimated number of trees involved in the outbreaks was 33,344,485. A total of 890 outbreaks covering an area of 2,320.90 had been completely treated by September 2010, leaving a backlog of 11,557 outbreaks with an estimate of 11,957,380 diseased trees outstanding. The main challenge to CSSVD control in the Eastern Region remains farmer opposition to cutting-out experienced in Oyoko and other districts. The Eastern Region currently

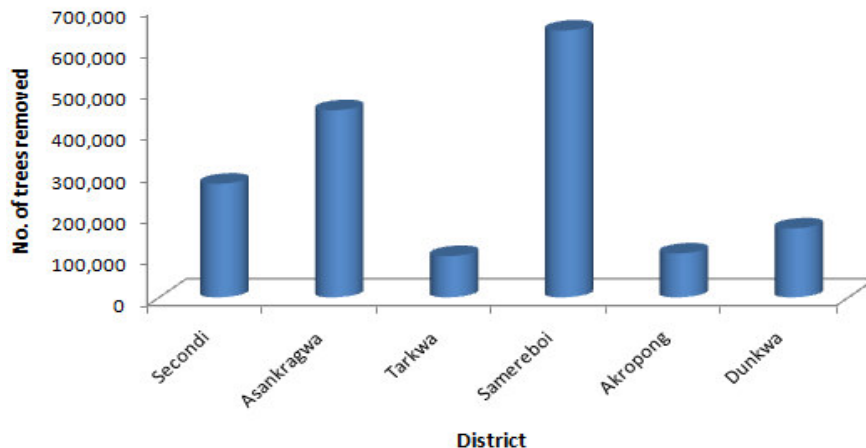
lies second in the national CSSVD incidence with an infection rate of 25.4% (CSSVDCU, 2010).

### Western south

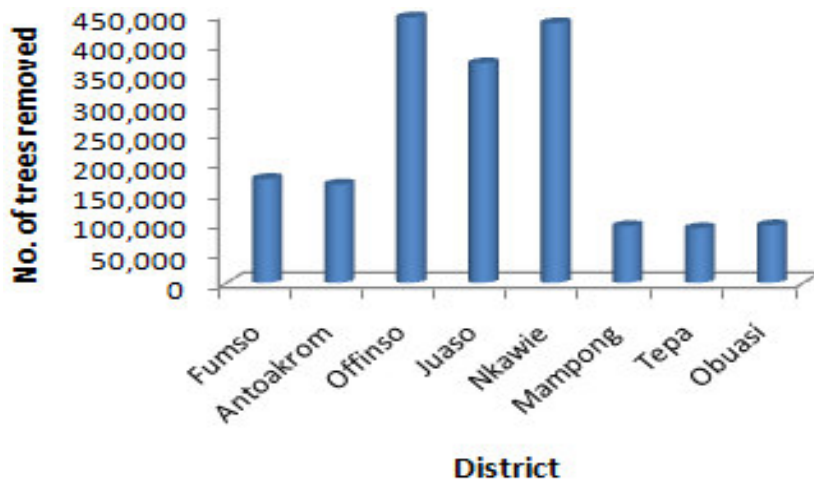
The number of diseased cocoa trees removed in the Western South Region between October 2006 and June 2010 is presented in Figure 3. The number of cocoa trees removed in the Western South Region during the period under review was 6.1% of the number removed countrywide (Table 1). Samereboi, Asankragwa and Secondi topped the Region in the number of trees removed during the period with 37, 25.9 and 15.7%, respectively. In Western South, cocoa area of 151,294.38 ha surveyed by September 2010 revealed a total of 2,679 swollen shoot disease outbreaks with an estimate of 5,247,266 trees involved. Out of the number, 751 had been completely treated by September 2010, leaving a backlog of 1,928 outbreaks with the number of infected trees involved estimated to be 1,986,398.

### Ashanti region

The number of diseased cocoa trees removed in the Ashanti Region between October 2006 and June 2010 is presented in Figure 4. The number of cocoa trees removed in the Ashanti Region during the period under review was 6.6% of the number removed countrywide (Table 1). The Offinso, Nkawie and Juaso districts topped the list of trees removed with 23.8, 23.3 and 19.7%, respectively. In the Ashanti Region, cocoa area of 163,169.64 ha had been surveyed as at September 2010 revealing a total of 1,669 swollen shoot outbreaks with an



**Figure 3.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the Western South region from October 2006 to June 2010.



**Figure 4.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the Ashanti Region from October 2006 to June 2010.

estimate of 3,322,567 trees involved. Out of the number, 805 outbreaks have been completely treated leaving a backlog of 864 outbreaks with an estimate of 1,476,758 trees by September 2010. The current CSSV infection rate for Ashanti Region is 2.6% (CSSVDCU, 2010).

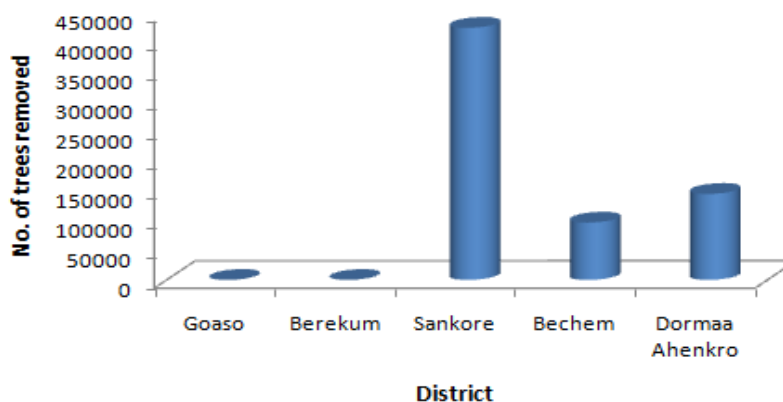
**Brong Ahafo region**

The number of diseased cocoa trees removed in the Brong Ahafo Region between October 2006 and June 2010 is presented in Figure 5. The number of cocoa trees removed in the Brong Ahafo Region during the period

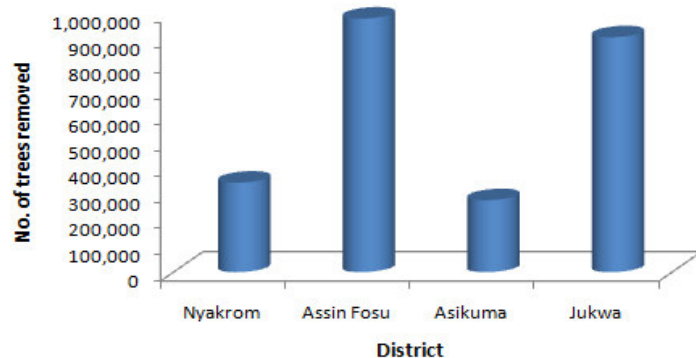
under review was 2.3% of the number removed countrywide (Table 1). The Sankore, Dormaa Ahenkro and Bechem districts topped the list of cocoa trees removed with 63.8, 21.07 and 14.5%, respectively. In the Brong Ahafo Region, cocoa area of 133,406.81 ha had been surveyed by September 2010, revealing a total of 660 swollen shoot outbreaks with an estimate of 704,263 trees involved. Out of the number, 106 outbreaks have been completely treated leaving a backlog of 554 outbreaks with an estimate of 565,986 trees as at September 2010. It must be noted that there was no swollen shoot infection detected in the Goaso and Brekum districts from October 2006 to June 2010.

**Table 1.** Number and percentage of CSSV visibly infected and 'contact' trees removed countrywide between October 2006 and June 2010.

Region	Total number of cocoa trees removed	Percentage of total
Eastern	2,858,738	10.0
Western North	18,332,234	64.4
Western South	1,742,245	6.1
Ashanti	1,874,257	6.6
Brong Ahafo	668,718	2.3
Central	2,517,168	8.8
Volta	492,949	1.7
Total	28,486,309	



**Figure 5.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the Brong Ahafo region from October 2006 to June 2010.



**Figure 6.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the central region from October 2006 to June 2010.

However, in November 2010, a team of virologists from the Cocoa Research Institute of Ghana and some staff of

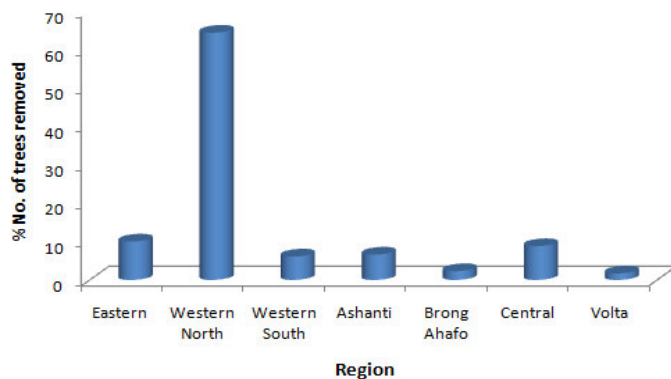
CSSVDCU (Goaso district) found CSSVD infected cocoa trees in three cocoa farms at a location called Apesika, near the Goaso cocoa station. Symptoms observed during the visit were conspicuous red vein-banding, vein clearing and stem swellings. Judging from the state of the infected trees and the extent of infection, it is likely that the disease has been present in this area for sometime now but was missed by CSSVD inspectors.

### Central region

The number of diseased cocoa trees removed in the Central Region between October 2006 and June 2010 is presented in Figure 6. The number of cocoa trees removed in the Central Region during the period under review was 8.8% of the number removed countrywide (Table 1). The Assin Fosu, Jukwa and Nyakrom districts topped the list of trees removed with 39, 36 and 13.8%, respectively. In the Central Region, cocoa area of 55,067.81 ha had been surveyed as at September



**Figure 7.** A graph showing the number of visibly infected and contact cocoa trees removed in various districts of the volta region from October 2006 to June 2010.



**Figure 8.** A graph of the percent number of CSSV infected and contact trees removed countrywide between October 2006 and June 2010.

2010 revealing a total of 2,213 swollen shoot outbreaks with an estimate of 6,707,589 trees involved. Out of the number, 630 outbreaks have been completely treated leaving a backlog of 1,583 outbreaks with an estimate of 2,626,753 trees by September 2010.

### Volta region

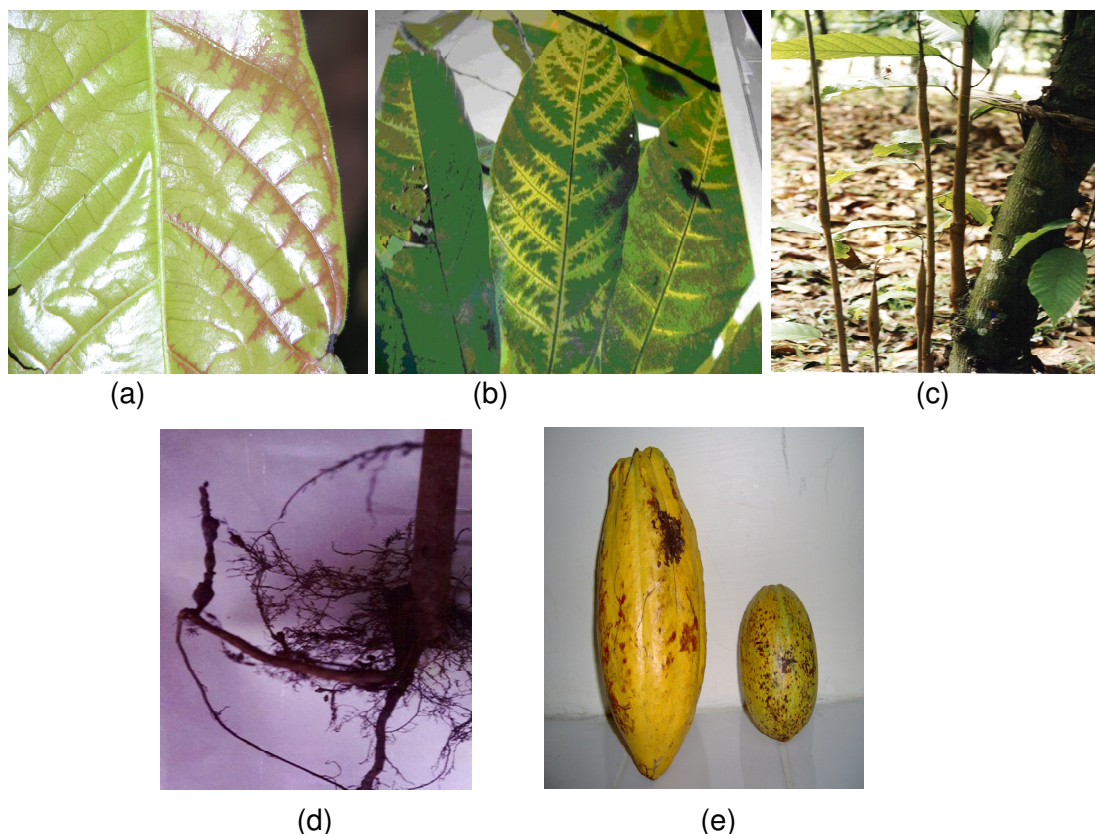
The number of diseased cocoa trees removed in the Volta Region between October 2006 and June 2010 is presented in Figures 7 and 8. The number of trees removed during the period under review in the Volta Region was very low and accounted for only 1.7% (Table 1) of the total number of cocoa trees removed countrywide. The Jasikan/Papase district had the highest tree removals (65.8%) with the remaining 34.2% being

accounted for by the Kpeve/Hohoe district. In the Volta Region, cocoa area of 22,062.34 ha had been surveyed as at September 2010 revealing a total of 472 swollen shoot outbreaks with an estimate of 2,859,883 trees involved. Out of the number, 108 outbreaks have been completely treated leaving a backlog of 364 outbreaks with an estimate of 2,342,258 trees by September 2010.

### CONCLUSION AND WAY FORWARD

Even though a lot of efforts are being made to bring the swollen shoot disease under control in Ghana, it is evident from the findings that the disease continues to spread, even to areas with no history of swollen shoot infection. The recent detection of swollen shoot disease symptoms at Goaso, for example, is of major concern. The records indicate that there is a huge backlog of diseased trees awaiting treatment. This is evident in all the regions as reported in this manuscript. It is clear that the Western North Region has become the new epicentre of the CSSVD in Ghana. It has been recommended by several authors that the swollen shoot disease must be tackled from several fronts since cutting-out alone has not been able to check the continuous spread of the disease. Perhaps, time has come to ensure rigid implementation of recommendations such as barrier cropping, use of recommended planting materials and elimination of all CSSV alternative host plants. To enhance adoption of the recommendations, demonstration farms incorporating the new innovations should be established in farmers' farms. There is also the need to intensify farmer education on the dangers of ineffective treatment or complete neglect of treatment of the disease.





**Figure 9.** Some symptoms of CSSVD. (a) Red vein-banding in a young leaf (b) Chlorotic vein clearing in mature leaves (c) Swellings in chupons (d) Root swelling induced by CSSV. (e) Distortion in pod shape and size. Two pods of comparable age, note rounded shape, reduction in size and smooth surface of the one on the right (infected).

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