

Leaf reddening disease of pineapple in Ghana

R. T. AWUAH

Department of Crop Science, Crop Protection Section, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

ABSTRACT

A disease of pineapple, which threatens production of the exportable Smooth Cayenne pineapple, is reported. The disease has been observed in several commercial plantings in the Akwapim South, Ga and Gomoa districts, respectively, in the Eastern, Greater Accra and Central regions of Ghana. Reddening of the leaves (often interspersed with diffuse, irregular chlorotic patches), leaf dieback and plastic-like leaf consistency are the major above-ground symptoms. Diseased plants have reduced root systems, but internal browning of the underground stem is absent, indicating non-involvement of vascular wilt organisms, which have so far not been isolated from such plants. Mealybugs and ants are sometimes, but not always, associated with diseased plants. Nematodes of the genera *Pratylenchus*, *Aphelenchus* and *Helicotylenchus* have been recovered, though infrequently, from roots and root zone soil of diseased plants. Based on these preliminary results and field observations, it is hypothesized that the new disease of pineapple in Ghana could be of complex etiology with nematodes perhaps constituting one major group of primary causal agents and stress factors (e.g. soil moisture stress, low soil fertility and weed competition) being either primary agents or pre-disposing factors. Ongoing studies seek to conclusively determine the etiology of the disease as well as some factors affecting its epidemiological development. Until this is done, it is proposed that the disease be simply referred to as "red leaf disease" of pineapple after its dominant and most readily recognized symptom. Control measures for the disease are much needed if production of pineapple for export is to be sustained. To the author's knowledge, this is the first-published, detailed account of a disease of this nature in Ghana.

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RÉSUMÉ

AWUAH, R. T.: *La maladie de roussissement foliaire d'ananas au Ghana.* Une maladie d'ananas, qui menace la production de l'ananas exportable Smooth Cayenne est rapportée. La maladie a été observée en plusieurs plantations commerciales dans les districts d'Akwapim South, Ga et Gomoa respectivement dans les régions de Eastern, Greater Accra et Central du Ghana. Le roussissement de feuilles (souvent parsemées de patchs chlorotiques irréguliers diffus). La perte de feuilles et tige et la consistance de feuilles comme plastique sont les symptômes majeurs au-dessus du sol. Les plantes malades ont des systèmes racinaires réduits mais le brunissement interne de la tige sous terre est absent. Indiquant la non-participation des organismes de dessèchement vasculaire qui jusque-là n'ont pas été isolés de telles plantes. Les aleurodes et les fourmis sont parfois, mais pas toujours, associés aux plantes malades. Les nématodes de genres *Pratylenchus*, *Aphelenchus* et *Helicotylenchus* ont été réparés, quoique peu fréquemment, de racines et du sol de la zone de racine des plantes malades. Basé sur ces résultats préliminaires et les observations sur le terrain, on est parti de l'hypothèse que la nouvelle maladie d'ananas au Ghana pourrait être d'étiologie complexe avec les nématodes constituant peut-être un groupe majeure d'agents causaux premiers et les facteurs de pression par ex. la pression d'humidité du sol, la faible fertilité du sol, la compétition de mauvaise herbe étant soit les agents premiers soit les facteurs de prédisposition. Les études en cours cherchent à déterminer de façon concluante, l'étiologie de la maladie ainsi que quelques facteurs influant sur le développement d'épidémiologie. Avant que ceci soit faite, il est proposé que la maladie soit simplement appelée "la maladie feuille rouge" d'ananas d'après son symptôme dominant dont elle est plus facilement reconnue. Des mesures de lutte contre la maladie sont les plus grandes exigées si la production d'ananas réservé à l'exportation devrait être soutenue. A ma connaissance, ceci est le premier compte rendu détaillé publié d'une maladie de cette nature au Ghana.

Introduction

Pineapple [*Ananas comosus* (L.) Merr.] has become an important horticultural crop in Ghana because of its promotion by the Government of Ghana as a non-traditional export crop. From 1983 to 1996, the amount of fresh pineapple exported from Ghana consistently increased from a mere 500 to 27,600 metric tons (an increase of over 5000% ; Anon., 1997), making pineapple the leading non-traditional export crop in Ghana. Increase in production resulted primarily from expansion in the area planted to the crop; especially in the Akwapim South, Ga and Gomoa districts, respectively, in the Eastern, Greater Accra and Central regions of Ghana.

The position of pineapple as a leading non-traditional export crop in Ghana may, however, be short-lived because of the appearance of a new and threatening disease which is fast spreading to several commercial plantings. The disease is present on the exportable Smooth Cayenne pineapple and the non-exportable Sugar Loaf type. However, the latter appears to be more tolerant to the disease.

The disease was first observed during the late 1980s and early 1990s in the Akwapim ridge area (Akwapim North and South districts; Anamuah, personal communication), an area with a relatively long history of pineapple cultivation in Ghana. The disease has since been observed in major pineapple holdings in the Ga and Gomoa districts. It has even been observed in backyard plantings and is believed to be present wherever the Smooth Cayenne type pineapple is grown.

The origin of the disease is speculative. Many think with expansion in the pineapple industry during the 1980s, suckers imported from La Cote d'Ivoire to supplement local sources were responsible for introducing the disease as well as the mealybug, *Dysmicoccus brevipes*, into Ghana. The mealybug is known to be present in La Cote d'Ivoire (Abutiare, unpublished).

Although stakeholders in the pineapple industry recognize the widespread and threatening nature of the new pineapple disease

in Ghana, the disease has not been documented enough. The major communication on the disease in Ghana is an unpublished work by Abutiare, which assumes the disease to be the same as that reported elsewhere (Rohrbach *et al.*, 1988) to be caused by a virus and vectored by mealybugs. A critical study of the new pineapple disease is, therefore, needed and a published account of it given to serve as a reference-point document on which future works would be based.

The purpose of this provisional report, therefore, is to describe in detail field presentation of the disease; and, based on preliminary information, critical field observations and a review of pertinent literature, hypothesize on its cause(s). A new name, based on the dominant symptoms, is proposed for the disease. The implications of the disease *vis-a-vis* intensification of pineapple cultivation in Ghana, ongoing studies and areas for future studies are also briefly discussed.

Symptoms and presentation of the disease

Field symptoms of the disease generally appear as slight leaf chlorosis accompanied by diffuse, pale-green and irregular patches or spots intermingled with pinkish patches on the concave surface of the leaf (Fig. 1A). The pink patches deepen in colour, become reddish and spread to involve a substantial portion of the leaf. The pale-green patches or spots often persist at this stage (Fig. 1B). The red colouration of the leaves constitutes the major diagnostic symptom of the disease. Affected leaves desiccate from the tips, and either topple over backward (Fig. 1C) or remain upright with inward rolling of the lamina from the tip downward (Fig. 1D). At the "red leaf" stage and sometimes before that, the leaves become plastic-like in consistency. If plants are diseased early in their development, they become severely stunted.

The root systems of severely affected plants fail to develop properly (Fig. 1E), and such plants can be easily removed from the soil by gentle pulling. However, internal browning of the underground stem is absent (Fig. 1F), except for

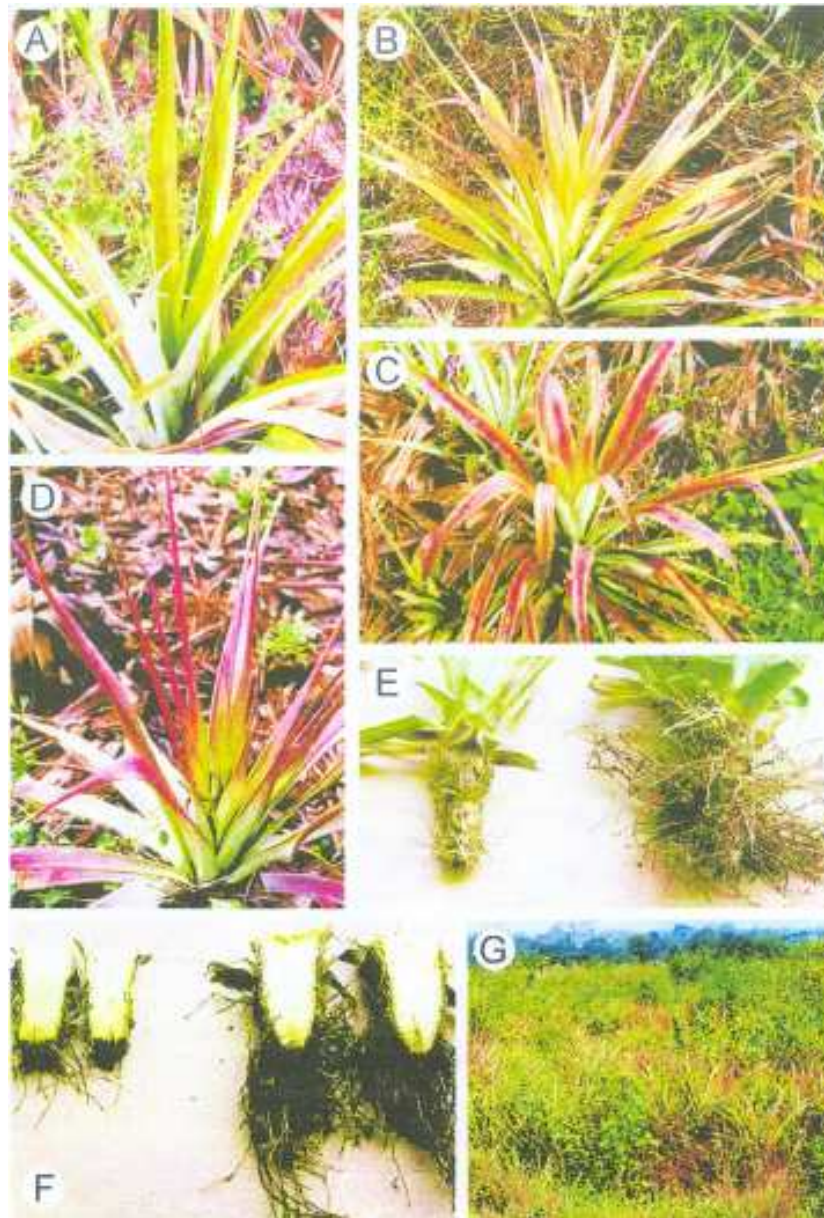


Fig. 1. Symptoms of the red leaf disease. **A.** Leaf chlorosis interspersed with reddish and greenish patches on the concave surface of leaf blades (note the reddened leaves of severely diseased plants in the background). **B.** Deepening of the red colouration (note the persistence of the diffuse green patches). **C.** Toppling over backward of affected leaves. **D.** Plant with several affected leaves remaining in upright positions (note the inward rolling and die-back of leaves). **E.** Reduced root development in diseased plants (left) compared with extensive root development in healthy plants (right). **F.** Longitudinal section of stems of diseased (left) and healthy (right) plants (note absence of internal browning). **G.** Part of an abandoned farm with diseased plants.

termite colonization.

On fallowed lands, the disease is generally absent or mild, but it becomes increasingly severe with successive plantings, often leading to abandonment of farms (Fig. 1G). The disease is also prominent on lands with previous histories of plantings with crops other than pineapple.

A mealybug, identified recently as *Dysmicoccus brevipes* (Cockerell), and ants mainly *Pheidole megacephala* F. and *Crematogaster africana* Mayr (Padi, 1997) are found in association with diseased plants. However, not all diseased plants have visible mealybug infestation.

Most diseased plants ultimately bear fruits, but the size of the fruit depends on the developmental stage of the plant at which it became diseased. If the disease attacks the young plant and becomes severe before “forcing” to flower, the resulting fruits if any, are small and generally do not develop to marketable maturity. However, if the disease is mild before “forcing”, most fruits would be marketable.

Possible cause(s) of the new pineapple disease in Ghana

Two types of pineapple diseases which fit the above syndrome have been described in the literature. The first and certainly the most widely studied is the so-called mealybug wilt (MBW) of pineapple generally thought to be, though not conclusively proven, of viral etiology (Ullman *et al.*, 1989; German, Ullman & Gunasinghe, 1992; Hu *et al.*, 1997). The implicated virus is a double-stranded RNA virus, flexuous in shape and accordingly classified as a closterovirus (Gunasinghe & German, 1986; Ullman *et al.*, 1989). Two mealybug species, *Dysmicoccus brevipes* Cockerell (pink species) and *D. neobrevipes* Beardsley (grey species), are known to be principal transmitters of the virus in Hawaii (Rohrbach *et al.*, 1988). A third, *Pseudococcus longispinus* Targioni-Tozzetti, is also capable of viral transmission, albeit to a limited extent (Rohrbach *et al.*, 1988). While *D. brevipes* is

parthenogenetic (males are absent) and generally confined to the lower parts of the pineapple plant, specifically in the leaf axils or on the surface roots (Rohrbach *et al.*, 1988; Petty, 1994), *D. neobrevipes* is bisexual and occurs mainly in the crowns of plants and also on developing fruits (Rohrbach *et al.*, 1988). Both mealybugs are attended by ants of which *P. megacephala* F. is prominent. It has been reasoned that because mealybugs are involved in this type of wilt, the disease generally originates from the edges of the field and spreads inwards along the direction of the transmitting mealybugs (Illingworth, 1931; Beardsley *et al.*, 1982; German *et al.*, 1992). Thus, the synonym “edge wilt”.

The other type of pineapple disease with a similar presentation is simply referred to as “wilt disease”. Reported in the Zululand of the Republic of South Africa (Willers, 1992), it is known in local parlance as “rooidood” (Afrikaan; literally meaning “red dead”). Though the presentation of “rooidood” is similar to that of the classical MBW, “rooidood” is not virus-mediated (double-stranded RNA virus could not be detected in diseased tissue; Willers, 1992); it is thought to be caused by the totality of stress imposed on the pineapple plant of which the feeding of *Pratylenchus brachyurus* and of mealybugs are considered important (Willers, 1992). According to the author, feeding of the nematode destroys the root systems of plants, making such roots inefficient in absorption of water and nutrients. This results in chlorosis and wilting of leaves. Such roots are also prone to attack by secondary decay organisms. The mealybugs supposedly secrete toxins into plants during feeding.

The new pineapple disease in Ghana has been assumed to be the same as the virus-mediated MBW in which mealybugs are thought to play a role in transmitting the virus (virus-mealybug hypothesis). Because it has also been assumed that suckers and associated mealybugs are primary sources of inoculum for introducing the virus to virus-free areas, the recommendation is for farmers to plant healthy-looking suckers after

pre-plant treatment with a suitable insecticide, such as Dursban, to kill the mealybugs. Despite these, the spread of the disease has not been controlled.

However, the epidemiological development of the disease in commercial pineapple plantings suggests non-involvement of mealybugs in disease development. First, in this new disease, diseased plants do not originate from the edges of fields (edge wilt; as in the virus-mediated MBW; Illingworth, 1931; Beardsley *et al.*, 1982; German *et al.*, 1992), but are rather distributed in groups and randomly throughout an affected field, suggesting involvement of soil factors. Second, ants and especially mealybugs are generally few (if present at all) on diseased plants. Several diseased plants have been noticed to be free of mealybug infestation. Petty (1994) made a similar observation in South Africa. This is contrasted with the classical MBW in which the numbers of mealybugs and ants correlate strongly with the level of wilt development (Rohrbach *et al.*, 1988). Third, it has been observed in commercial plantings that there is noticeable remission of disease symptoms after prolonged rainfall, indicating involvement of soil moisture in disease expression. In a KNUST field trial, diseased, mealybug-bearing suckers, when grown on beds with improved soil nutrition and moisture levels, showed remarkable recovery from the disease until “forced” to flower, although such plants were growing alongside severely diseased ones. The final evidence of possible non-involvement of mealybugs in the disease is derived from on-farm trials at two commercial plantings in the Ga District. In the trials, suckers treated with the insecticide, Dursban, to kill the associated mealybugs were not superior, concerning disease incidence and severity, to suckers that did not receive any insecticide treatment (Awuah, 1997).

Preliminary results of ongoing studies on the disease indicate that conserving soil moisture through plastic mulching and applying NPK fertilizer to the soil have a palliative effect on the disease (Awuah, 1997). Plant parasitic nematodes,

mainly of the genera *Pratylenchus* and *Helicotylenchus*, have been isolated from the roots and root zone soil of diseased plants, but these have not been tested for pathogenicity (Awuah, 1997). *Helicotylenchus* and *Pratylenchus* are known to be pathogens on pineapple (Willers, 1993). Some diseased plants also have their underground stems colonized by termites and other insects. Whether these insects are involved in disease expression remains unknown. To date, no vascular wilt fungus has been isolated from the internal tissue of the underground stem, which is not discoloured even in severely diseased plants. These preliminary results and the distribution pattern of diseased plants in the field suggest that the new pineapple disease in Ghana may be of complex etiology with, perhaps, nematodes being one of the primary causal agents (soil biotic factor hypothesis). Factors such as low soil water, low soil nutrient levels, and stress resulting from weed competition could either be primary agents or just factors that pre-dispose plants to increased disease severity (stress factor hypothesis).

Until the cause of the disease in Ghana is conclusively proven, it should not be presumptively referred to as “mealybug” wilt as is so now. It is proposed that the disease be simply referred to as “red leaf disease” (RLD) of pineapple. Naming the disease after its dominant and readily noticeable symptom type is consistent with the general principles of naming plant diseases (Agrios, 1988). This has precedent even in pineapple pathology. In Lorna Bonita (Oaxaca), Mexico, a similar disease of pineapple is referred to by its dominant symptom as “marchitez roja” (Spanish; meaning “red wilt”) virus disease and not “mealybug” wilt, although many think the insect is involved in the disease (Tores-Navarro, Lozoya-Saldana & Uriza-Avila, 1989). Willers (1992) also reported that in Zululand of South Africa, the word “rooidood” (Afrikaan; literally meaning “red dead”) is used to designate a disease of pineapple with a similar presentation as that being reported here.

Implications of the red leaf disease and ongoing future research

As promotion of pineapple for export continues, more investors could become involved in the industry, and pineapple planting would increase nationwide. For production to be increased and maintained, owners of new farms would have to guard against outbreak of the disease on their farms; and on farms where the disease is already present, its spread must be contained. The red leaf disease, if left uncontrolled, would affect the pineapple industry in at least two main ways. First, the exportable pineapple fruit weight is between 0.9 and 2.5 kg, the ideal being 1.8 - 2.2 kg. If the red leaf disease is severe, these fruit weights cannot be realised. Consequently, the export trade in the crop would suffer. Second, continued presence of the disease on a farm without any prospects for control would result in depressed yields and possible abandonment of the farm. This would discourage prospective pineapple farmers. Overall, national pineapple production would decline.

A package for managing the red leaf disease is, therefore, required; and this should be based on sound research results. The research should start with a conclusive diagnosis of the cause(s) of the disease. Meriting urgent attention should be a clear demonstration of the presence of the pineapple closterovirus (PCV) in diseased pineapple plants and involvement of mealybugs in its transmission. Sether, Ullman & Ru (1998) used tissue blot immunoassay (TBIA; Hu *et al.*, 1997) to detect the virus in pineapple plants exposed to viruliferous mealybugs; thus, demonstrating mealybug transmission of the virus. A collaborative study has been initiated with Dr John Hu of the University of Hawaii to use TBIA to detect the PCV in pineapple leaf samples in Ghana.

If the PCV is detected in Ghanaian pineapple samples, pathogenicity tests would have to be run before an aetiological role could be assigned to the virus. This is necessary because views on the cause, especially the viral nature of the MBW

wilt, are not definitive enough. Ullman *et al.* (1989), while admitting that a closterovirus-like particle is present in diseased pineapple plants, indicated the need to determine the aetiological significance of the virus through demonstration of Koch's postulates. Based on detection of the PCV in symptomatic and asymptomatic pineapple plants, Hu, Sether & Ullman (1996) concluded that the virus may not be the sole causal agent of the mealybug wilt disorder. Hu *et al.* (1997) have also hypothesized that the PCV alone does not cause MBW, and that the disease has a complex etiology involving more than one transmissible factor, which they suggested could be a badnavirus. This virus has been detected together with PCV in pineapple plants in Australia (Wakman *et al.*, 1995). Hu *et al.* (1997) also admitted to possible interaction between the PCV and stress (an insect toxin) secreted into plants through feeding of mealybugs. However, the authors did not mention possible involvement of edaphic factors in disease development. Sether *et al.* (1998) managed to transmit the PCV to healthy pineapple plants, but the study did not indicate whether successful transmission of the virus resulted in expression of typical MBW symptoms. The authors' conclusion that the study provides a tool for evaluating the role of the PCV in the MBW disease suggests that the cause of MBW is still unknown, and that the viral aetiology of the disease is still hypothetical.

Because of the perceived involvement of edaphic stress factors in the new disease being reported, the need is to determine which factors are important. The effects of plastic mulching (for soil moisture conservation), NPK and micro-nutrient fertilization, and weed management on the incidence and severity of the red leaf disease are now being studied at KNUST (mini plot and pot experiments), but promising treatments must be validated in field trials. Also meriting investigations are the roles of nematodes and arthropods, especially termites found associated with roots of severely diseased plants.

In the long term, pineapple cultivars tolerant

of the disease must be developed. Mutational breeding is now popular in Ghana, having been used for cassava with considerable success. Perhaps, the technology could be applied to pineapple to produce disease-tolerant and horticulturally acceptable cultivars.

Effective management of the disease would be a big boost to the pineapple industry, which is now threatened by the red leaf disease.

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