ALTERNARIA STEM AND LEAF BLIGHT OF SWEET POTATO (*IPOMOEA BATATAS* (L.) LAM.): A NEW DISEASE IN THE HIGHLANDS OF PAPUA NEW GUINEA

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ABSTRACT

A new disease on sweet potato (Ipomoea batatas) (*L.) Lam.*) *causing black lesions on stems and petioles that eventually lead to dieback of vines was reported in the Western Highlands Province of Papua New Guinea in early 1987. Isolations from necrotic lesions on stems and petioles yielded the fungi* Alternaria alternata, Phoma exigua, Phomopsis ipomoeae, Fusarium oxysporum, F. solani, F. subglutinans, F. lateritium *and the bacteria* Bacillus sp. *and* Pseudomonas cichorii. *Pathogenicity tests on isolates of* A. alternata, P. ipomoea, F. oxysporum, F. solani, F. subglutinans, F. lateritium *and a* Colletorichum sp. *at Kuk Agricultural Research Station in 1987 and 1988 conformed that* A. alternata *was the causal agent of stem and leaf blight of sweet potato.*

Keywords: *Pathogenicity, lesions, disease symptoms, hyphae, fungi.*

INTRODUCTION

Species of the fungus *Alternaria* have been reported as causing or being associated with leaf spot and, leaf and stem blight of sweet potato from India, Malaysia, Senegal, Ethiopia, New Caledonia, Rwanda, South Africa and Bazil (Waller 1984, Clark and Moyer 1988, Lenne 1991, Lopes and Boiteux 1994). *Alternaria* leaf spot of sweet potato has a worldwide distribution, while *Alternaria* stem and leaf blight has only been reported in Ethiopia (Clark and Moyer 1988). Lenne (1991) cited *Alternaria alternata* (Fr.) Keissler, *A. capsici-annui* Savul and Sandu-ville, *A. solani* Sorauer and *A. tenuissima* (Pers.) as the causal agents for leaf and stem blight on sweet potato. Waller (1984) identified *Alternaria bataticola* Tamamoto as the cause of leaf spot in the Southern Highlands of Papua New Guinea (PNG) and Clark and Moyer (1988) reported a species of *Alternaria* causing rot of stored sweet potato tubes. Storage rot is neither common nor important. Lenne (1991) also reported *A. alternata, A. capsici-annui, A. sesami* (Kaw.) Moh. and Ben., *A. solani* and *A. tenuissima* occurring on wild species of *Ipomoea*.

Leaf spot and stem blight are the two main *Alternaria* diseases of sweet potato, where stem blight is considered as the more severe disease (Clark and Moyer 1988). Symptoms of leaf spots only occur on older leaves. The lesions are light brown with dark-brown concentric rings and well-defined margins.

Stem blight causes small, gray to black, oval lesions on stems and petioles. Under humid conditions, the lesions enlarge and eventually girdle the stems and petioles and in dry weather conditions the lesions become bleached and cracked.

There are no reports of cultural or chemical control of either leaf spots and leaf and stem blight of sweet potato. However, some varieties of sweet potato are resistant to *Alternaria* (Clark and Moyer 1988, Lenne 1991).

This paper presents the results of pathogenicity tests following an outbreak of an unknown disease on sweet potato at Kamuga village in the Western Highlands Province, PNG in February 1987.

MATERIALS AND METHODS

Isolation and identity of pathogens

Diseased stems and petiole pieces collected from the field at Kuk Agricultural Research Station (KARS) and Kamuga village were soaked separately in running water under a tap for 1 hour. The samples were rinsed in deionised water, then transferred to a laminar flow cabinet where they were surface sterilised by immersion in 70% ethanol for 5-10 seconds, followed by flaming or immersion in 70% ethanol for

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60 seconds. The samples were rinsed three times in sterile water and blot dried with clean paper tissues. Thin sections of diseased stem and petiole were cut out aseptically using a pair of forceps and a sharp scalpel blade and plated onto potato dextrose agar (PDA) or water agar (WA).

Necrotic lesions were also incubated in moist chambers for 24 h to induce sporulation and spores and external hyphae were transferred with a sterile needle to plates containing PDA or WA. No antibiotics were used in the culture medium.

All isolated fungi from each media were subcultured using a hyphal-tip placed onto fresh PDA and WA until a pure culture was obtained. Isolates of *Fusarium* were subcultured onto carnation leaf agar (CLA) using single spores (Burgess *et al.* 1981, Burgess and Liddell 1988). Bacterial isolates were subcultured onto PDA. All cultures were incubated at room temperature under 9 h light provided by two fluorescent tubes.

Cultures of *Alternaria*, other fungi and bacterial isolates were identified by the International Mycological Institute, U.K. while the *Fusarium* isolates were identified by the Fusarium Research Laboratory, University of Sydney.

Plants

Six highly susceptible varieties: Mond Amb (Kuk 962), Langapin (Kuk 867), Karuku (Kuk 537), Teka (Kuk 787), Gorokagi (Kuk 546) and an unnamed variety (Kuk 469) were selected for inoculation tests. Mond Amb and Langapin were from the Kuk sweet potato collection while Karuku and Teka were local varieties from Kamuga village where stem and leaf blight was first reported.

The plants were raised in a field nursery. Clean and disease-free terminal vines were collected and washed in tap water to remove soil and plant debris. The bottom-end of a 30 cm long terminal shoot was placed in a 250 ml conical flask containing 200 ml of deionised water for about 14 days to allow roots to develop from the node submerged in the water. Vines with vigorous or healthy growth were selected and transplanted into 13.5 cm diameter plastic pots containing steam-sterilised soil. Each vine was staked with a small wooden stick and allowed to grow for 7 days before pathogenicity tests were conducted. Twelve plants of each variety were used for stem and petiole inoculations; four for treatments with the fungal inoculum and two as control (one for each treatment - wounded or non-wounded).

Inoculation

Two week old isolates of *A. alternata*, *Phomopsis ipomoeae*, *F. oxysporum*, *F. solani*, *F. subglutinans* and *F. lateritium* and a *Colletotrichum* species grown on PDA were used as primary inoculum. A single agar block containing hyphae of each fungus was cut out and placed directly on the surface of the stem or petiole (either wounded or non-wounded) with a sterile scalpel blade. The agar and inoculum were held in position by a piece of moist absorbent cotton wool wrapped around the stem and petioles. Control or check plants were inoculated with agar alone. Each test plant was covered with a clean and moist plastic bag for 24 h after which the plastic bag and cotton wool were removed. The plants were watered twice daily using a fine mist atomizer to keep the inoculated tissues moist and were observed throughout the trial.

RESULTS

Disease symptoms

The initial symptoms in the field was the appearance of small, black, oval or circular lesions about 1 mm in diameter on the stems and petioles. The lesions became irregular when they coalesced. Under favourable weather conditions, the lesions continued to enlarge and completely girdled the stem (Plate 1) and petiole. Under stress conditions, severe infections eventually resulted in the death of the whole terminal shoot or individual leaves. The lesions were initially superficial and became depressed as they increased in size. An individual lesion on the stem could enlarge to 5 cm in length.

Affected leaves initially showed general yellowing and eventually drying off the whole leaf blade or lamina. Infection on the lower surface of the leaf would also lead to uneven chlorosis of the leaf blade. Occasionally, death of leaves on one side of the stem above the lesion was observed. This occurred when a lesion did not completely girdle the stem, especially with varieties that had thicker stems. Shoot or tip die-back was also another symptom associated with the disease. It was uncommon in wet weather except on varieties with thinner stems and petioles. Die-back was usually common in dry weather conditions when the lesions completely girdled stems and petioles and had become bleached and cracked.

Organisms associated with the symptoms

Alternaria sp. was isolated more frequently from stem and petiole lesions on sweet potato varieties from Kamuga and Kuk Agricultural Research Station. The isolates were identified as *Alternaria alternate* (IMI 13066b, 13066e), *Phomopsis ipomoea* (IMI 13066c), *Phoma exigua*, *F. oxysporum* (FRL 9818) *F. solani* (FRL 9826), *F. subglutinans* (FRL 9827) and *F. lateirtium* (FRL 9820), *Bacillus* sp. (IMI 13066i),

Figure 1. A black lesion on stem caused by *A. alternata*.

Psedomonas cichorii (IMI 13066h) and unidentified specie of *Colletotrichum*.

Pathogenicity tests

***Alternaria alternata* (IMI 13066b, 13066e)**

The isolate of *A. alternata* was highly virulent when inoculated on unwounded and wounded stems and petioles of all test varieties. Black-brownish, water soaked lesions measuring 10-15 mm in length and 5 mm in width developed on stems and petioles within 2-3 days. In general, the lesions were black in colour and developed up to 15-35 mm within 16 days (Table 1). Most petioles had been girdled by then. Lesions were about 40 mm long and had completely girdled most stems by 31 days. One of the stem lesions on injured plants developed up to 60 mm long. Longitudinal cracks were observed on some lesions after 10 days. Disease symptoms did not develop on control plants.

***Phomopsis Ipomoeae* (IMI 13066c)**

P. ipomoeae fungus caused necrosis of stems and petioles of most treated plants while check plants remained normal. It appeared that necrosis was more evident on injured tissues but only became apparent after 5 days. The lesions were slightly depressed and black-brown in colour, up to 5 mm long and 3 mm wide, and ceased growing after 10 days. The isolate, *P. ipomoeae* appeared to be non-pathogenic under the test conditions.

***Fusarium* spp. (FRL 9818, FRL 9826, FRL 9827, FRL 9820)**

The isolates of *F. oxyxporum, F. solani* and *F. subglutinans* caused similar disease symptoms on both wounded and non-wounded stems and petioles. Slight necrosis (black) or bleaching was observed, particularly on injured stems and petioles. Necrotic lesions did not develop and cause severe symptoms like that observed in the field. It appeared that *F. oxysporum, F. solani* and *F. subglutinans* are weak or secondary pathogens.

The isolate of *F. lateritium* was highly virulent compared with the other *Fusarium* isolates. Black lesions up to 40 mm long were produced with whitish sporodochia in the centres on old necrotic stems and petioles. In some instances, stems and petioles were completely girdled by the lesions and this subsequently led to the collapse of the whole leaf or stem. The fungus caused similar disease symptoms to that caused by *A. alternata* except there was no production of spore masses in the centers of old or more advanced lesions.

***Colletorichum* sp.**

This isolate initially produced small, water-soaked dark-brown dot-like lesions on surfaces of both wounded and non-wounded stems and petioles. The lesions on surfaces of both wounded and non-wounded stems and petioles. The lesions differed in numbers from a few to many and did not appear to increase or enlarge in size from the time the cotton wool was removed. However, necrosis of tissue around the point of injury (up to 3 mm in thickness)

Table 1. **Development of symptoms on petiole and stem of a sweet potato inoculated with an isolate of *Alternaria alternata*.**

Test Isolate	Test Variety	Days Inoculation	Treated				Control	
			Petiole Wounded	Petiole Non-wounded	Stem wounded	Stem Non-wounded	Petiole Wounded	Stem wounded
Alternaria Alternata (IMI 13066b)	Mond Amb (Kuk 962)	3	Water-soaked, black-brown lesion, 15 mm x 5 mm	Water-soaked, black-brown lesion, 10 mm x 6 mm	Water-soaked, black-brown lesion, 12 mm x 5 mm	Water soaked, black-brown lesion, 10 mm x 5 mm	No symptom	No symptom
		6	Black lesion, 17 mm long, girdled three quarters of the petiole	Black lesion, 20 mm long, almost girdled the petiole.	Black lesion, 25 mm long, girdled half the stem	Black lesion, 14 mm x 7 mm	"	"
		9	Black lesion, 19 mm long, girdled three quarters of the petiole.	Yellowing of the leaf blade and petiole. The petiole had collapsed.	Black lesion, 33 mm long. Bleachin effect on the lesion.	Black lesion, 17 mm x 7 mm, with slight cracking.	"	"
		16	Black lesion, 20 mm long and almost girdled the petiole.		Black lesion, 37 mm long, girdled three quarters of the stem.	Black lesion, 18 mm long, girdled three quarters the stem.		
		31	Black lesion, 30 mm long completely girdled the petiole		Black lesion, 40 mm long, almost girdled the stem.	Black lesion, 18 mm long, girdled three quarters of the stem		

did occur, particularly on injured petioles of some varieties. The isolate appeared to be either a very weak pathogen or non-pathogenic under the test conditions.

DISCUSSION AND CONCLUSION

The results showed that *A. alternata* isolates (IMI 13066b, 13066e) readily caused infection and produced disease symptoms on stems and leaves. It appeared that lesion development and expansion were much faster on most treated plants as compared to that observed in the field. This is usually encountered in pathogenicity tests because the primary inoculum and environmental conditions in the screenhouse are different from that in the field. Despite this, the characteristic symptoms of *Alternaria* stem and leaf blight was evident on most stems and petioles inoculated with the fungus.

Except for *F. lateritium* the other fungi tested failed to produce typical symptoms of stem and leaf blight and are probably weak pathogens or saprophytes colonizing necrotic tissues of the stems and petioles. There was no infection observed on control plants. The isolate of *F. lateritium* was highly virulent and caused similar disease symptoms as that caused by *A. alternata*. The only significant difference was that *F. lateritium* produced masses of spores in the centres of old or more advanced lesions in the screenhouse and field conditions. Initially the spore

masses were whitist-orange in colour but turned black as it aged or dried up. The fungus has been reported (Kokoa unpublished) as the causal agent of a new disease (stem rot) on sweet potato in certain parts of the PNG highlands.

A. alternata isolates (IMI 13066b, 13066e) were shown to be the primary causal agent of stem and leaf blight on sweet potato in the highlands of PNG. This is the first time the disease has been reported and confirmed in PNG. It was initially thought that the disease would be confined to parts of the Western Highlands Province where the disease was originally reported. However, disease surveys carried out in 1988 and 1989 showed that the disease had spread to other parts of the Western Highalnds and to Simbu Province. It was found that infected vines used for planting material was the primary means by which the disease had spread over long distances within a short period of time. Although the source of the intial infection is not known, *A. alternata* has a wide host range and further pathogencity tests are required to identify which other hosts are susceptible to the isolate from sweet potato.

Alternaria stem and leaf blight has been considered by Clark and Moyer (1988) as a serious foliar disease on sweet potato. Field observations made during field surveys conducted by the plant pathology section of the Highlands Food Crops Team (HFCRT) in 1988 and 1989 showed that *Alternaria* stem and leaf blight could be a serious disease problem in the highlands provinces particularly, in association with other diseases (*Phomopsis* die-back, scab, viruses) and stress factors (dry weather, low soil fertility) (unpublished HFCRT papers). Serious blight or die-back was evident particularly on varieties with thin stems in prolonged dry weather conditions. There is very little information available on many aspects of the disease such as yield loss and disease control. Further follow-up surveys of 1988 and 1989 should establish the distribution and effect of the disease on sweet potato production in the highlands, and to recommend possible areas of research.

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