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Sweet potato stem blight caused by Alternaria sp.: a new disease in Ethiopia

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Abstract

A new sweet potato disease was discovered in Ethiopia. The disease mainly affects the stems and petioles of sweet potato and the name sweet potato stem blight is proposed. The pathogen is a species of *Alternaria,* for which no definite name has been found so far.

Sweet potatoes were most susceptible, tomatoes were slightly susceptible, and muskmelons and chilli peppers were resistant. Thorn apples and onions showed slight to moderate symptoms, but *Alternaria* was not reisolated from these two species. Although all sweet potato varieties tested were susceptible, there were significant differences in sensitivity.

Additional keywords: Alternaria, host range, *Ipomoea batatas,* pathogenicity, sweet potato.

Introduction

Sweet potato is a minor crop in Ethiopia, although it is grown traditionally around Asosa and Jimma in the West and around Alemaya in the East. At present agricultural research institutions are promoting sweet potato production, and experiments in which varieties and cultural practices are compared are being conducted at several experiment stations.

In 1977 a new disease of sweet potato was discovered in an experimental field at Melkassa, characterized by expanding black lesions on stems an petioles. During the first two years after its discovery the disease was only observed in research stations, so that the question arose, whether it might have been introduced with imported planting material. However, a similar disease did not exist in the areas from which sweet potato cuttings had been obtained, viz. Nigeria (E.R. Terry, pers. comm.) or the USA (P.D. Dukes, pers. comm.). Later the disease was found on local sweet potato varieties in Western Ethiopia. The planting material originated from Asosa, close to the border with Sudan (Almaz Yilma, pers. comm.). Subsequently the disease was also observed in experimental fields of the College of Agriculture at Alemaya and in farmers' fields in Eastern Ethiopia. According to the farmers it was a new disease there (Almaz Yilma, pers. comm.).

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The objectives of the studies undertaken were: (1) to identify the pathogen causing sweet potato stem blight, (2) to test some plant species for susceptibility to this pathogen, and (3) to determine whether sweet potato varieties differed in sensitivity to the stem blight pathogen.

Materials and methods

Identification of the pathogen. When blighted tissue was incubated in a moist chamber, conidia of *Glomerella cingulata* (Stonem.) Spauld & Schrenk and of an *Alternaria* species appeared on it. Both fungi were checked for their pathogenicity to sweet potato.

Isolation. Infected material was surface sterilized in a 0.5% sodium hypochlorite solution for one minute, washed in sterile water, and plated onto potato dextrose or water agar. Moreover, single *Alternaria* spores were transferred directly from blighted tissue in a most chamber onto potato dextrose agar (PDA) or water agar.

Pathogenicity test. Five sweet potato plants, variety White Star, were each sprayed with 20 ml of a mycelial suspension of *G. cingulata* or *Alternaria* sp. one month after planting. Five control plants were sprayed with water. The plants were covered with plastic bags and placed in a greenhouse. Three and six days later observations were made on the occurrence of symptoms.

Pathogenicity on other plant species. After the first identification as *Alternaria cucumerina* (see: Results) a small host range test was conducted in a greenhouse. Muskmelon, a known host of *A. cucumerina,* and several other crops which suffer from *Alternaria* diseases, viz. tomato, onion, thorn apple and chilli pepper, were tested for susceptibility to the Ethiopian *Alternaria* isolate. A susceptible variety of sweet potato was included as a positive control.

Six weeks after planting of the test plants, a spore suspension from a 10-day-old culture of *Alternaria* sp. (1400 spores ml^{-1}) was sprayed on four plants of each species. As controls four other plants of each species were sprayed with water. The plants were incubated under plastic bags in a greenhouse for 10 days. The average minimum and maximum temperatures in the greenhouse were 4 and 18 °C. The plants were observed daily. The extent of infection was assessed according to a 0-5 scale:

0 = no symptoms;
1 = few, small lesions;
2 = from 1 to 10% infected;
3 = from 11 to 25% infected;
4 = from 26 to 50% infected;
5 = more than 50% infected.

Virulence on sweet potato varieties

Field observations. Disease assessments for stem blight were made when natural infection occurred in some variety observation trials at Melkassa. The varieties consisted of local collections and imported varieties which had been renamed as the Koka series, since the original names had been lost. Thirteen varieties were scored for blight severity in 1977 and 1979 in unreplicated observational experiments. Five of these varieties were also evaluated in a replicated experiment in 1977 (4 replications). One score was given per plot after walking along the middle rows, moving the foliage to the sides.

The scoring scale was as follows:

0 = no symptoms;
1 = a few, small lesions on up to 5% of the plants;
2 = a few, small lesions on 5 to 25% of the plants;
3 = small lesions and some enlarged lesions on 25 to 50% of the plants; some leaf drop;
4 = enlarged lesions on most plants, leaf drop moderate to severe, some plants dying;
5 = severe leaf drop, most plants dying or dead.

Greenhouse studies. Six high-yielding varieties were chosen to be tested for susceptibility to *Alternaria* sp. Cuttings were made from stems without lesions selected from a collection in an experimental field. They were planted in pots and one month after planting sprayed with a spore suspension of *Alternaria* sp. (5700 spores ml^{-1}). Four plants per variety were inoculated and four sprayed with water as controls. The plants were covered with plastic bags during the 7-days' observation period.

The leaves and stems plus petioles were scored independently for number of lesions and size of lesions, both on a 0-10 scale. The scoring scales were as follows:

number of lesions	size of lesions (largest diameter of average lesion)
0 = no lesions	0 = no lesions
1 = 1-5 lesions	1 = 0-0.5 mm
2 = 6-10 lesions	2 = 0.6-1.0 mm
3 = 11-15 lesions	3 = 1.1-1.5 mm
etc.	etc.
10 = >45 lesions	10 = >4.5 mm

Since the length of stems and petioles varied considerably, the lesion number was corrected for the total length of stems plus petioles, by multiplication with the shortest stem-plus-petiole length measured, and division by the stem-plus-petiole length in question.

Results

The disease. In the field the first symptoms were small, grey to black, oval lesions with a lighter centre on stems and petioles. The veins sometimes were infected too, especially on the lower side of the leaves. Under humid weather conditions the lesions enlarged into black areas, until stems and petioles became girdled and the leaves above the infected areas dried out. During dry conditions the lesions became bleached.

Identification of the pathogen. The usual isolation method (plating surface-sterilized, infected tissue on PDA or water agar) tended to obscure *Alternaria* sp. and favour *G. cingulata*. *Alternaria* sp. was isolated only by transferring single spores from infected tissue onto water agar or PDA.

Table 1. Means and standard deviations (μm) of the dimensions of conidia of *Alternaria* sp. isolated from sweet potato on various media.

Substrate	N	Total length	Length of body	Width of body	Width of beak
sweet potato	100	179 (62)[1]	55 (13)	15 (5)	2.0 (0.5)
malt agar	25	249 (59)	74 (12)	18 (2)	4.8 (1.3)
PDA	25	168 (37)	68 (13)	20 (4)	–
water agar	15	220 (46)	65 (12)	20 (3)	3.5 (1.3)

[1] Between brackets: standard deviations

G. cingulata did not produce any symptoms after inoculation on sweet potato. Within three days after inoculation of sweet potato with *Alternaria* sp. the same symptoms appeared as had been noted in the field. The same *Alternaria* sp. was reisolated from inoculated plants.

Under natural light/dark conditions *Alternaria* sp. sporulated abundantly on all media used, viz. malt agar, PDA and water agar. Measurements of conidia are given in Table 1. Conidial dimensions varied according to the medium. The number of longitudinal and transverse septa ranged from 0 to 7 and from 3 to 10, respectively. The beak often had one or two branches (Fig. 1).

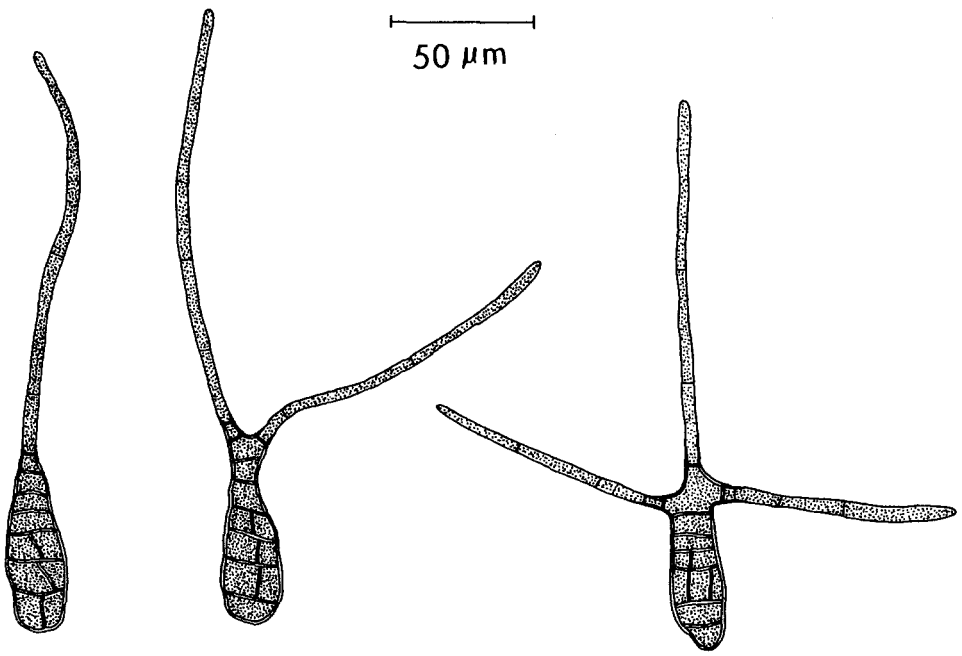

Fig. 1. Conidia of *Alternaria* sp. from blighted stems of sweet potato.

Table 2. Frequency distributions of disease severity classes estimated for four inoculated plants of six species after inoculation with *Alternaria* sp.

Test plant	Variety	Disease severity classes				*Alternaria* reisolated
		stems/petioles		leaves		
		0-1	2-4	0-1	2-4	
sweet potato	Koka 9	0	4	0	4	+
tomato	Moneymaker	2	2	4	0	+
onion	Sudan Red			0	4	–
muskelin	(unknown)	4	0	4	0	–
thorn apple	–	4	0	3	1	–
chilli pepper	P43W	4	0	4	0	–
	χ^2	15.2		20.8		

The pathogen was first identified as *Alternaria cucumerina* (Ellis & Everh.) Elliott at the Centraal Bureau voor Schimmelcultures at Baarn, the Netherlands. However, since muskmelon appeared to be immune (Table 2), a culture was also sent to the Commonwealth Mycological Institute at Kew, England, and the fungus was identified as *Alternaria* tax. sp. IV. A definite name has not yet been given to this species.

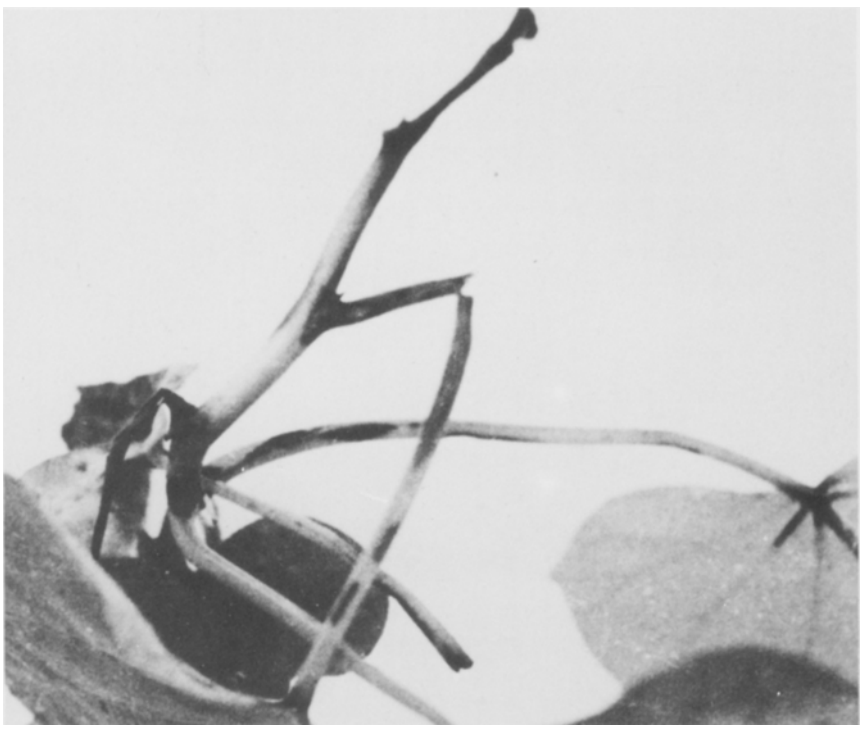

Fig. 2. Sweet potato with stem and petiole blight, eight days after inoculation with *Alternaria* sp.

Pathogenicity on other plant species. Sweet potato was the most susceptible host plant, tomato was slightly susceptible, and muskmelon and pepper were resistant (Table 2). Onion and thorn apple seemed susceptible (inoculated plants reacted with symptoms, whereas control plants remained healthy), but reisolation attempts failed. The same *Alternaria* sp. was reisolated from sweet potato and tomato 10 days after inoculation (Table 2).

Sweet potato showed the characteristic symptoms of grey lesions on petioles and stems. The lesions enlarged, became black and sunken and finally girdled the petioles and stems about 10 days after inoculation. Necrotic spots appeared on the leaves, which subsequently turned yellow and dropped (Fig. 2).

Tomato reacted with very small, black streaks on the stems; they later became more pronounced, but did not enlarge. On one leaf a fine necrotic stippling was observed. The onion leaves showed white, glassy, sunken lesions, which enlarged until the leaves became girdled. Thorn apple reacted with fine necrotic stippling on the leaves, and some leaves turned yellow and dropped. Muskmelon and chilli pepper did not develop symptoms except for some fine necrotic stippling on the leaves.

Virulence on sweet potato varieties. Field observations. There were clear differences in susceptibility among the sweet potato varieties in the field (Table 3). In the replicated experiment Koka 9 was significantly more susceptible than the other varieties. Varieties with red tubers seemed to be more resistant than those with white tubers, but the differences was not statistically significant (Chi-square test; $\chi^2 = 2.1$; $p = 0.15$).

Table 3. Morphological characteristics and severity of stem blight (*Alternaria* sp.) of thirteen sweet potato varieties in an experiment field at Melkassa.

Variety	Leaf shape	Tuber color	Blight scores		
			1977[1]	1979[1]	1977[2]
Koka 9	lobed/ovate	white	4	4	3.5 a
'A'	digitately	white	4	4	
Arba Minch	lobed		1	2	
Wondo Genet			1	1	1,3 b
Abosto	ovate/cordate	white	1	3	
Alemaya			1	1	
EPID			1	1	
Koka 14			1	3	
Koka 26			2	1	
Koka 28			2	3	
Koka 3	lobed/ovate	violet	1	2	0.5 b
Koka 25		red	0	1	0.3 b
Koka 12	ovate/cordate	red	1	1	0.8 b

[1] Not replicated.
[2] Average scores of four blocks; different letters indicate statistically significant differences between varieties (5% confidence level).

Fig. 3. Sweet potato with partly blackened veins, eight days after inoculation with *Alternaria* sp.

Greenhouse studies. All varieties tested were susceptible. The incubation period was between 24 and 41 hours. Different reaction types were observed on stems and petioles. Some varieties (Koka 9 and 14, Arba Minch) reacted with grey to black, superficial, elliptic lesions which enlarged rapidly and became sunken (Fig. 2). Other varieties showed only pale, elliptic lesions, which later turned grey (Abosto and Wondo Genet) or remained hardly visible (Koka 12). Tiny black spots, surrounded by yellow halos, were seen on the leaves of all varieties. The spots remained small, but most leaves turned yellow and dropped. Part of the veins of all varieties became black, especially on the lower side of the leaves (Fig. 3).

The same *Alternaria* species was reisolated from all inoculated varieties.

Seven days after inoculation there were no significant differences among varieties in the numbers of lesions on stems, petioles or leaves. The size of the lesions on leaves and stems/petioles differed significantly ($p < 0.025$) from one variety to another, as determined with a χ^2 test (Table 4). Expansion of the lesions was fastest on leaves and stems/petioles of Koka 9 and slowest on those of Koka 12. Some petioles of Koka 9

Table 4. Frequency distributions of disease severity classes estimated for four plants each of six sweet potato varieties, seven days after inoculation with *Alternaria* sp.

Variety	Diseases severity classes											
	leaves					stems + petioles						
	lesion number		lesion size			lesion number			lesion size			
	9	10	<3	3	>3	<4	4&5	>5	<7	7	>7	
Koka 9	1	3	0	0	4	0	3	1	0	0	4	
Abosto	0	4	1	1	2	2	1	1	0	2	2	
Arba Minch	0	4	2	2	0	1	1	2	3	1	0	
Koka 14	0	4	0	4	0	1	3	0	1	2	1	
Wondo Genet	0	4	2	2	0	3	1	0	1	1	2	
Koka 12	0	4	4	0	0	2	1	1	4	0	0	
χ^2	– [1]		29.3			– [1]			20.7			

[1] Expected frequencies smaller than one.

became girdled six days after inoculation, one day earlier than those of the other varieties. Fourteen days after inoculation most petioles and stems were girdled, and most plants had lost their original leaves (new leaves did not become infected).

Discussion

Traditional sweet potato varieties seem to be moderately resistant to stem blight in Ethiopia, especially in the western part of the country. Thus, we could hypothesize that the symptoms were noted only after new varieties had been introduced, and as they were more susceptible to the pathogen, the disease subsequently became conspicuous in the field.

At first the *Alternaria* isolate was identified as *A. cucumerina* at the Centraal Bureau voor Schimmelcultures at Baarn, the Netherlands. However, spore measurements differed greatly from those of *A. cucumerina* (Ellis and Holliday, 1970a). Besides, the beaks of the spores often had one or two branches, whereas those of *A. cucumerina* are not branched. Sweet potato has not been mentioned as a host for *A. cucumerina* (Ellis and Holliday, 1970a; Annon., 1968). *A. cucumerina* has not been recorded in Ethiopia (Stewart and Dagnatchew, 1967). It was found in Sudan, but only on *Cucurbitaceae* (Tarr, 1955). At the Commonwealth Mycological Institute at Kew the isolate was later identified as *Alternaria* tax sp. IV. A definite name has not yet been given. The isolate appears to be morphologically similar to *A. passiflorae* Simmonds (P.M. Kirk, pers. comm.), but the host range of this species is restricted to *Passiflora* spp. (Ellis and Holliday, 1970b). Detailed mycological studies are needed to determine its true identity.

In the literature, references were found of four *Alternaria* species infecting sweet potato:

1. *Alternaria tenuis,* causing leaf spots (Anon., 1979);
2. *Macrosporium* (or *Alternaria) solani,* causing footrot (Taubenhaus, 1925; Anon., 1970);
3. *Alternaria bataticola,* causing black spot disease in Japan (Yamamoto, 1960);
4. *Alternaria capsici-annui,* causing leaf spot in India (Sivaprakasam et al., 1977).

The conidial body size of the isolate in the present study does not correspond to that of *A. tenuis, A. solani* or *A. bataticola.* Conidia of *A. capsici-annui* have a smaller an unilocular beak. Contrary to that of the four species above, the beak of the isolate is clearly branched.

Although some plant species other than sweet potato were infected by the *Alternaria* isolate from sweet potato, the lesions were greatly restricted in size. Onion was an exception, in that the lesions girdled the leaves. However, *Alternaria* could not be reisolated from those lesions, and thus its pathogenicity towards onion has not been proven. The lesions on onion differed from those induced by *A. porri.* The fact that muskmelon showed a typical hypersensitive reaction to infection indicates that the species is likely different from *A. cucumerina.*

The results of disease assessments on sweet potato in the field and the greenhouse were in agreement with each other. In both cases Koka 9 appeared to be significantly more susceptible than the other varieties (except variety 'A', which was only assessed twice in single observational plots). In the field the other varieties did not differ significantly in their level of resistance, but in the greenhouse Koka 12 appeared to be more resistant and had symptoms different from those on other varieties.

In het field symptoms were seldom observed on the leaves, whereas the leaves did produce necrotic lesions in the greenhouse. This difference may be due to a higher inoculum density and more optimal environmental conditions with artificial inoculation.

Varieties with red tubers seemed to be more resistant than those with white tubers. Confirmation of this observation would be worthwhile.

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Samenvatting

Stengelnecrose van bataat veroorzaakt door Alternaria sp., een nieuwe ziekte in Ethiopië

In 1977 werd een nieuwe ziekte ontdekt in zoete bataat in Ethiopië. De ziekte wordt gekenmerkt door zwarte necrotische lesies, voornamelijk op de stengels en bladstelen. Deze lesies breiden zich uit totdat de stengels en bladstelen omringd worden en de bovenliggende weefsels afsterven. De naam stengelnecrose wordt voorgesteld.

De ziekte wordt veroorzaakt door een *Alternaria* soort, waarvoor nog geen definitieve naam gevonden is. Het zou een nog onbeschreven soort kunnen zijn. Zoete bataat was het meest vatbaar, tomaat matig vatbaar, en netmeloen en spaanse peper waren resistent. Doornappel en ui vertoonden wel symptomen, maar *Alternaria* sp. kon niet uit het zieke weefsel worden geïsoleerd. Hoewel geen van de getoetste zoete bataatvariëteiten onvatbaar waren, waren er significante verschillen in gevoeligheid.

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