Survey of the incidence and severity of root-knot and *Fusarium* wilt diseases in some tomato-growing areas in the Central Region of Ghana

Y. OPOKU-ASIAMA & M. A. YEBOAH

(Y. O.-A.: Department of Crop Science, School of Agriculture, University of Cape Coast, Cape Coast, Ghana; M. A. Y.: Savanna Agricultural Research Institute, CSIR, Tamale, Ghana)

ABSTRACT

Tomato cultivation in the Central Region of Ghana is severely limited by two soil-borne diseases, namely root-knot and *Fusarium* wilt. A survey investigated the incidence and severity of these diseases in four farming communities in the Central Region of Ghana, namely, Kwapro, Esuekyir, Asebuputubew, and Asebuekrofor, and also identified the pathogenic species of the *Fusarium* and root-knot nematodes associated with the diseases. The survey was carried out between August and November 1996 with six farms selected from each of the farming communities. On each farm, two or more 20-m^2 areas were marked off and 30 plants sampled in each marked area to assess wilt incidence and severity. Soil and plant samples were randomly taken from each field for laboratory analysis. The results indicated that the incidence of the wilt disease was 58.3, 54.0, 52.0 and 48.0 per cent at Kwapro, Esuekyir, Asebuputubew and Asebuekrofor, respectively. Also, disease severity was highest at Kwapro (1.51) and lowest at Asebuputubew (0.94). The root-knot galling indices showed Kwapro as the most infected with root-knot disease. The prevalent *Fusarium* sp. identified to be associated with the wilt disease was *Fusarium solani* (70.6 %). However, other *Fusarium* spp. such as *F. equisiti* (11.7 %), *F. moniliforme* (7.7 %), and *F. acuminatum* (2.7 %) were also isolated. For *Meloidogyne* spp., *M. incognita* was the most predominant in all the surveyed areas, with traces of *M. javanica* at Asebuputubew.

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RÉSUMÉ

OPOKU-ASIAMA, Y. & YEBOAH, M. A.: *Enquête sur la fréquence et la sévérité de tubercule radical et les flétrissures de* Fusarium *en quelques zones de la culture de tomate dans la région centrale du Ghana.* La culture de tomate dans la région centrale du Ghana est sévèrement limitée par deux maladies véhiculées par le sol, à savoir le tubercule radical et le flétrissement *Fusarium*. Une enquête s'est déroulée pour étudier la fréquence et la sévérité de ces maladies en quatre collectivités rurales dans la région centrale du Ghana à savoir, Kwapro, Esuekyir, Asebuputubew et Asebuekrofor et aussi pour identifier les espèces pathogènes de *Fusarium* et les nématodes de tubercule radical liés aux maladies. L'enquête s'est déroulée entre août 1996 et Novembre 1996 avec six champs sélectionnés de chacune des collectivités rurales. Sur chaque champs deux ou plus de 20 m^2 de superficie étaient délimitées et 30 plantes étaient échantillonées en chaque zone délimitée pour évaluer la fréquence et la sévérité de flétrissement. Les échantillons de sol et de plante étaient enlevés au hasard de chaque champs pour l'analyse de laboratoire. Les résultats indiquaient que la flétrissure se produisait avec fréquence de 58.3, 54.0, 52.0 et 48.0 % respectivement à Kwapro, Esuekyir, Asebuputubew, et Asebuekrofor. De plus, la sévérité de maladie était la plus élevée à Kwapro (1.51) et la plus faible à Asebuputubew (0.94). Les indices de galle de tubercule radical montraient Kwapro comme le plus infecté par la maladie de tubercule radical. L'espèce de *Fusarium* répandue identifiée d'être associé à la flétrissure était *Fusarium solani* (70.6 %), toutefois d'autres espèces de *Fusarium* telles que *F. equisiti* (11.7 %), *F. moniliforme* (7.7 %), et *F. acuminatum* (2.7 %) étaient également isolées. Pour l'espèce *Meloidogyne*, *M. incognita* était la plus prédominante dans toutes les zones de l'enquête avec les traces de *M. javanica* à Asebuputubew.

Introduction

Tomato (*Lycopersicon esculentum*, Mill) is one of the most important vegetable crops in Ghana, both in area and production (FAO, 1994). In 1987, tomato contributed 130,000 t to the total agricultural growth of Ghana (PPMED, 1991). Despite the large acreage put under cultivation, the total production is insufficient to meet the national demand throughout the year. This is because in areas of intensive cultivation, increased build up of diseases, especially those which are soil borne, are often observed (Wills, 1962).

In 1995, tomato diseases suspected to be caused by nematodes and fungi were reported in some districts in the Central Region of Ghana (MOFA, 1995). Infected plants showed stunted growth, leaf chlorosis, wilting, and dead plants with disintegrated internal tissues as the above-ground symptoms, while the below-ground symptoms were root galling and cessation of root growth. These diseases were a serious constraint to tomato production in the region. Although no statistical data were available, their occurrence led to heavy losses in yield, especially during the rainy season (April-July) when weather conditions were favourable for producing tomato and disseminating the pathogens. While some reports cover nematodes associated with vegetable crops in some parts of Ghana, the study area has none.

This survey, therefore, aimed at assessing the incidence and severity of the diseases in tomato fields in four farming communities where the diseases had been reported. Also, it was the aim of the study to isolate and identify the pathogenic species of fungi and nematodes associated with the diseases in the surveyed areas.

Materials and methods

Site selection and fieldwork

The survey was conducted in the Central Region of Ghana from August to November 1996. Four tomato-growing areas were selected, based on reports received from farmers, by the Plant Protection and Regulatory Services Department (PPRSD) of the Ministry of Food and Agriculture. The selected areas included Kwapro, Asuekyir, Asebuekrofor, and Asebuputubew (Fig. 1). The vegetation comprised coastal thicket with forest perennials. The area has a bimodal rainfall pattern with an average range of 1200 - 1930 mm. The major rainy season is from April to July and the minor rainy season between September and December.

Six farms were selected in each growing area with the help of an extension officer or chief farmer of the area. Also, the willingness of the farmer to cooperate after explaining the purpose of the study was considered in selecting the farms. In a selected farm of an average size of 0.25 ha, two or more 20-m^2 areas were marked with a measuring tape. Moving along diagonals of the marked areas, 30 tomato plants were sampled and assessed for wilt

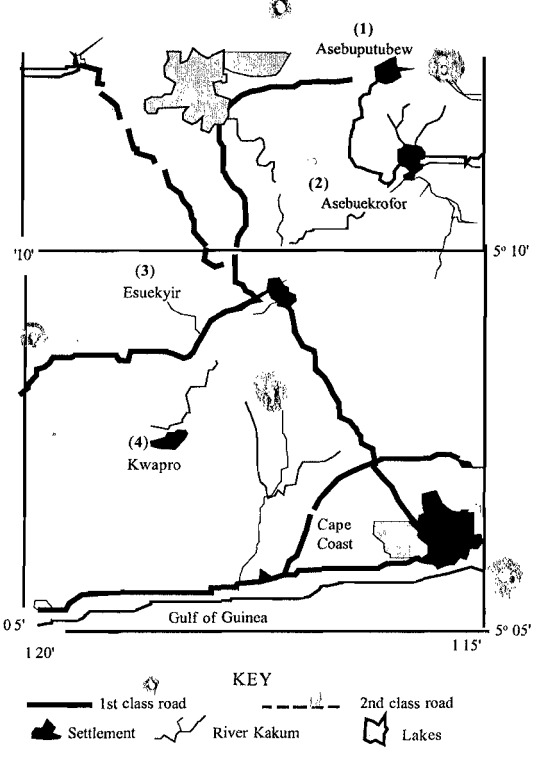

Fig. 1. Map of survey sites numbered 1, 2, 3, 4 and underlined.

severity and incidence with a rating system of 0-4; 0 = healthy; 1 = few wilted leaves; 2 = stunted growth, primary leaf chlorosis; 3 = severe chlorosis of almost all leaves with severe leaf drop; and 4= death with darkened or disintegrated internal tissues. Ten diseased plants were randomly uprooted from each site, bulked, and put in labelled black polyethylene bags to prevent dehydration. Soil auger was used to take soil samples randomly around tomato root zones and also put into black polyethylene bags, which were later tied with strings and labelled for laboratory analysis.

The data were analysed by selecting farms as replicates (six farms per area) and areas as treatments (four areas). The randomized complete block design (RCBD) with four treatments and six replicates was used, and analysis of variance was used to test the differences between treatments (areas). The data on disease scores were log-transformed to accomplish independence of treatment mean and variance before the analysis. The LSD test was used to compare parameters for different areas.

Laboratory analysis

Adhering soil on the roots was washed under tap water and root-knot infection per root system was assessed per farm on a scale of 0-5, where,

0 = no gall or egg masses,
1 = 1 to 2 galls or egg masses,
2 = 3 to 10 egg masses,
3 = 11 to 30 egg masses,
4 = 31 to 100 egg masses, and
5 = more than 100 egg masses (Taylor & Sasser, 1978).

Bioassay was performed by transferring soil samples from each surveyed field into plastic pots and a susceptible tomato cultivar (Apawa) grown in them. After 8 weeks, plants were checked for galls and egg masses on the roots were scored.

Perineal pattern preparation and identification

Perineal patterns were prepared from gravid adult females from diseased plants from individual surveyed fields from which nematode species were identified (Taylor, Dropkin & Martin, 1955). At least five slides, each bearing four perineal patterns, were prepared for each surveyed field. Perineal patterns were identified under a compound microscope with the aid of a pictorial key (Hartman *et al.,* 1981).

Fungal isolation and identification

The fungi were isolated from roots and stems of diseased tomato plants collected from the field during the survey. The roots and stems were washed and cut into 5-mm segments and surface sterilised in 0.1M NaOCl solution for 30 sec and then rinsed three times with distilled water. The roots and stems were plated separately on potato dextrose agar (PDA) plus streptomycin (200 mg/l). The inoculated plates were incubated for 3 days on the laboratory bench. The plates were observed daily for fungal growth from tissue segments. The fungal growths were transferred unto fresh PDA until cultures of all isolated fungi were pure. The emergent colonies were examined under microscope and identified with the aid of appropriate keys (Gilman, 1957; Booth, 1971). The percentage frequency of occurrence of each isolate was determined.

Results

Incidence and severity of wilt disease in surveyed areas

Variability in wilt incidence among the surveyed areas was minimal (Fig. 2). Kwapro recorded the highest percent incidence of 58.3, followed by Esuekyir and Asebuputubew with incidence of 54 and 52 per cent, respectively. The least disease incidence of 48.0 per cent was recorded at Asebuekrofor.

The wilt severity in the surveyed areas (Table 1) indicated a significant difference ($P<0.05$) between Kwapro and Esuekyir, Kwapro and Asebuputubew, as well as between Kwapro and Asebuekrofor. No significant difference was observed in wilt severity between Esuekyir and Asebuputubew. Also, the lowest mean wilt

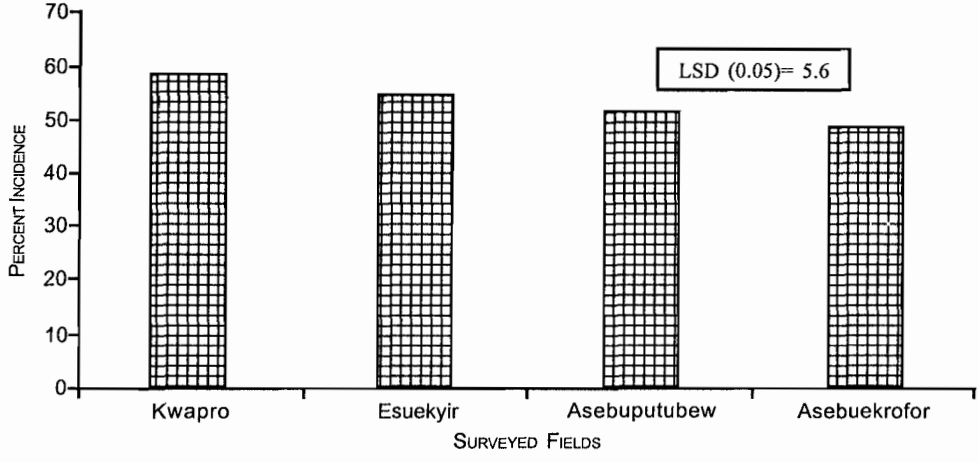

Fig. 2. Incidence of tomato wilt disease in surveyed fields in the Central Region of Ghana.

severity of 0.94 at Asebuekrofor was significantly different from wilt severities observed at the other three surveyed areas.

Assessment of root-knot nematode infection in the surveyed areas

Fig. 3 shows the results of assessing root-knot infection on tomato plants sampled in the surveyed areas. The differences in the galling indices were not marked, which ranged between 1.0 and 2.2. The highest mean index of 2.2 was recorded at Kwapro and the lowest mean index of 1.0 was recorded at Asebuekrofor. The mean galling indices recorded at Esuekyir and Asebuputubew were 1.8 and 1.1, respectively. However, from the bioassay used to determine whether root-knot nematodes were in the soils of the surveyed areas (Fig. 4), Esuekyir recorded the highest mean infection index of 2.96, followed by Kwapro and Asebuputubew with mean infection indices of 2.67 and 2.41, respectively. The least mean index value of 1.90 was recorded at Asebuekrofor.

Identification of Meloidogyne *spp. in surveyed areas*

Table 2 shows the species of *Meloidogyne* found in the surveyed areas. The results show

TABLE 1

Means of Tomato Wilt Severity in Surveyed Fields in the Central Region of Ghana

Area	*Mean wilt severity*
Kwapro	'.51[a]
Esuekyir	1.00[c]
Asebuputubew	1.02[bc]
Asebuekrofor	0.94[d]
SE±	0.13
CV %	22.0

Means followed by the same letters are not significant at $P = 0.05$.

that *M. incognita* and *M. javanica* were the main species found in the surveyed areas. *Meloidogyne incognita*, the most prevalent species, was found in all the four surveyed areas. However, *M. javanica*, which was not common, was found in traces at only Asebuputubew.

Fungal spp. associated with wilt disease of tomato in surveyed areas

The results indicate that in all the four surveyed areas, wilted tomato plants were infected with one or more species of *Fusarium* (Fig. 5). At Kwapro, the three species of *Fusarium* isolated were *F.*

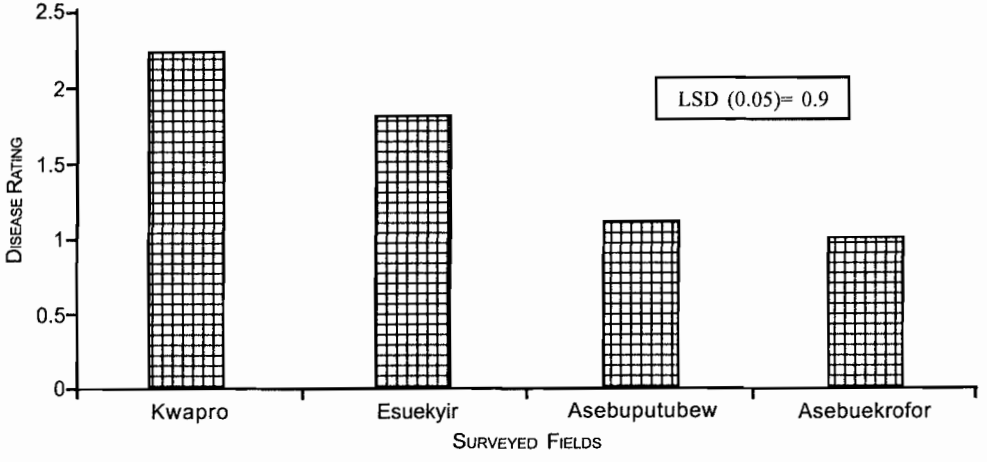

Fig. 3. Root-knot disease assessment on tomato plants sampled from the fields.

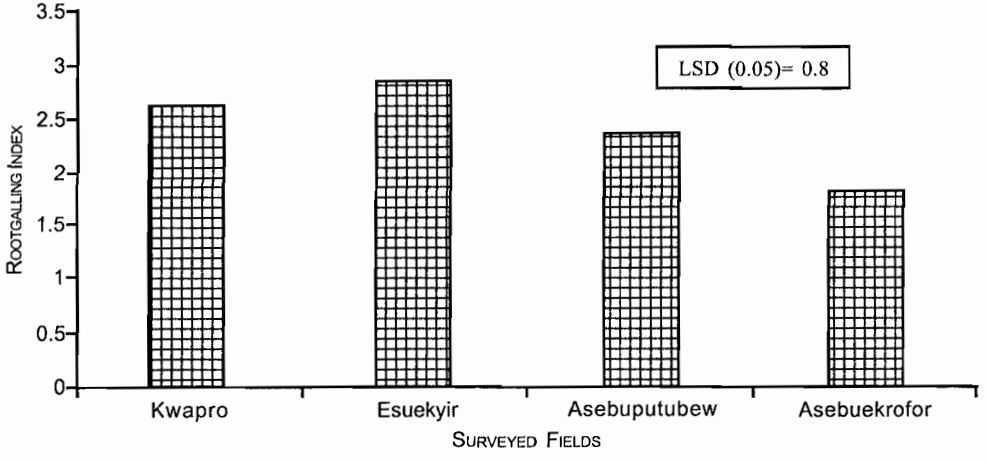

Fig. 4. Root-knot nematode infection in the bioassay test.

solani (81.7 %), *F. equisiti* (10.3 %), and *F. moniliforme* (2.5 %) in infected plants. At Esuekyir, the two *Fusarium* species isolated were *F. solani* (70 %) and *F. moniliforme* (13.3 %). At Asebuputubew, the *Fusarium* species isolated were *F. solani*, *F. equisiti*, *F. acuminatum*, and *F. moniliforme*. At Asebuekrofor, the isolated species in the diseased plants were *F. solani* (55.8 %), *F. equisiti* (16.6 %), and *F. moniliforme* (7.5 %).

Fig. 5 shows the frequency of occurrence of *Fusarium* species in the diseased plants from surveyed areas. The combined data from all fields indicate that *F. solani* infected 70.63 per cent of diseased plants. *Fusarium solani* was, therefore, the most predominant *Fusarium* species, followed by *F. equisiti* which was observed in 11.67 per cent of the diseased plants. *Fusarium moniliforme* and *F. acuminatum* were found in 7.7 and 2.7 per cent, respectively, of the diseased plants.

Discussion

The occurrence of *F. solani, F. equisiti, F. moniliforme,* and *F. acuminatum* in association

TABLE 2

Species of Root-knot Nematodes Isolated and Identified in the Surveyed Fields in the Central Region of Ghana

Area	*Species*	
	M. incognita	M. javanica
Kwapro	++	-
Esuekyir	++	-
Asebuputubew	++	+
Asebuekrofor	++	-

+ = Present ++ = Abundant - = Not present

Fusarium which cause tomato wilt disease may be influenced by prevailing environmental conditions of the area. It is also possible that apart from the ubiquitous nature of *Fusarium*, continuous cultivation of tomato on the same piece of land might have enhanced the rapid multiplication and spread of *Fusarium* in the region. This is because the Central Region is known for its extensive cultivation of tomato.

The predominance of *M. incognita* in the areas surveyed suggests that the root-knot nematode is endemic in these areas. This confirms the findings by Edward (1953) and Addo (1970) that

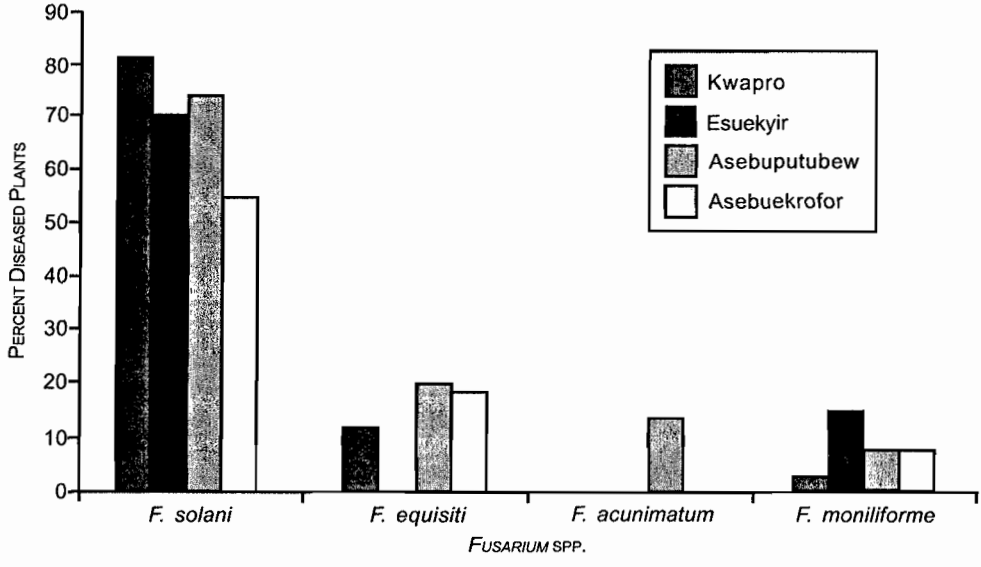

Fig. 5. Frequency of occurrence of four *Fusarium* spp. of infected plants from the field.

with tomato in all the surveyed areas in the Central Region of Ghana probably suggests their prevalence in soils in the region. Similar association of *Fusarium* with tomato has been reported elsewhere (Kapoor, 1998). From a survey of tomato wilt syndrome, Kapoor (1998) isolated *Fusarium* spp. such as *F. oxysporum, F. solani, F. semitectum, F. equisiti* and *F. chlamydosporum*; *F. oxysporum* was the most prevalent.

However, in this study, *F. solani* was commonly associated with tomato wilt in the Central Region of Ghana. This suggests that the species of *M. incognita* is an important pest of tomato in Ghana. It is possible that the continuous cultivation of tomato in the four areas surveyed may have caused the high incidence of *M. incognita*. The observed differences in the incidence of *Meloidogyne* spp. in the areas surveyed could be attributed to differences in the moisture content of the soils collected from these areas. This result is confirmed by the findings that lack of moisture in soil weakens the nematode larvae (Hemeng, 1981).

The findings have further shown that *Fusarium*

wilt and root-knot diseases are prevalent in all the study areas. This could be attributed to several factors. It is possible that the continuous cropping of tomato to meet all-year-round demand may have provided a favourable environment for the growth and development of these organisms. Also, the giant cells induced by the root-knot nematodes might have increased susceptibility to the wilt pathogen. This view is supported by several studies where root-knot nematodes increased the susceptibility of the tomato plant to wilt pathogens (Sidhu & Webster, 1981; Tacconi & Spotelli, 1982; Abawi & Baker, 1984).

Conclusion

Observations and data from this study indicated that root-knot and wilt diseases were widespread in all the fields in the study areas. *Meloidogyne incognita* and *F. solani* were the most prevalent organisms isolated from diseased plants. It is suggested that growers in these areas must integrate control procedures to minimise losses from these two organisms. This practice would include rotation with grass crops and the use of fumigant nematicides. Also, it is important that seed producers in the Central Region of Ghana test all varieties under local conditions for field resistance to these diseases before they are distributed to farmers.

Acknowledgement

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