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Prevalence of Okra Mosaic and Leaf Curl Diseases and *Podagrica* spp. Damage of Okra (*Albelmoschus esculentus*) Plants

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KEYWORDS

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incidence,
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A B S T R A C T

Pests and diseases are major biotic constraints to the production of okra in Ghana**. S**ocio-economic, pests' damage and disease assessments and their management were conducted to find the prevalence and severity of the okra mosaic disease (OMD), okra leaf curl disease (OLCD) and *Podagrica* spp. damage in Komenda-Edina-Eguafo-Abirem (KEEA) municipality in the Central Region of Ghana. Incidence of OMD and OLCD ranged from 78 to 83% and 63 to 70% respectively. The corresponding severity indices ranged from 55 to 63% and 41 to 46% respectively. Analysis of variance, however, did not show any significicant differences among the communities. Conversely, the incidence and severity of pest damage at Ayensudo Junction were significantly higher ($P < 0.05$) than those recorded at Ayensudo and Amissano which were also significantly higher than Nkontrodo. The study also revealed that majority of the farmers were females (70%), illiterates (70%) and of middle age (65%). The farmers mainly practiced mono-cropping (60%), used seeds from their own farms, managed pests and diseases with pesticides (75%) mainly after noticing the presence of pests or diseases. In conclusion, the adoption of poor agronomic practices by the farmers was the major contributing factor for the high incidences and severities of diseases and pests damage in their farms.

Introduction

Okra (*Abelmoschus esculentus* (L) Moench), a fruit vegetable crop that belongs to the Malvaceae family, is widely grown all over tropical, subtropical and warm temperate regions of the world (Lamont, 1999; Saifullah and Rabbani, 2009). The world okra production, as of 2007, was estimated at 4.8 million tons with India leading the production by 70% followed by Nigeria (15%), Pakistan (2%), Ghana (2%), Egypt (1.7%) and Iraq (1.7%) (Gulsen *et al*., 2007). India ranks first in the world with 3.5 million tonnes (70% of the total world production) of okra

produced from over 0.35 million hectares of land (FAOSTAT, 2008).

Okra is one of the most important vegetable crops grown for its tender leaves, fruit and fibrous stem (Bamire and Oke, 2003). Major areas of okra production in Ghana are Brong Ahafo, Ashanti, Northern, Volta, Greater Accra and Central regions (NARP, 1993). About 10 - 15 t /ha of yield can be obtained under good management (NARP, 1993). Okra is put into several uses which include nutritional, economic and industrial. The nutritive value of okra comprises of water, protein, carbohydrate, fat, fibre, calcium, iron, thiamine, riboflavin, nicotinamide and ascorbic acid (Tindall, 1986). The seeds of okra contain edible oil of more than 14% and the protein content varies between 15% and 26% (NARP, 1993). Okra seed oil is rich in unsaturated fatty acids such as linoleic acid (Savello *et al*., 1980), which is essential for human nutrition. The pods contain a mucilaginous substance which is used as plasma replacement or blood volume expander (Onunkun, 2012). It has also been reported to cure ulcers and relief pain from haemorrhoids (Adams, 1975). Okra is a very important soup condiment that is consumed daily in almost all homes and restaurants. The mature fruit and stem of okra contains crude fibre which is used in the paper industry.

In spite of the economic importance of okra, its production is constrained with severe pest and disease attacks. Insect pests reported to infest okra in Ghana include flea beetles (*Podagrica sp*.), cotton stainer (*Dysdercus superstitus*), white fly (*Bemisia tabaci*), and green stink bug (*Nezera viridula*) among others (Obeng-Ofori and Sackey 2003; Bi-Kusi, 2013; Senjobi *et al*., 2013). Among these pests, flea beetles (*Podagrica sp*.) are the most important in Ghana (Obeng-Ofori and Sackey 2003; Bi-Kusi, 2013; Asare-Bediako *et al*., 2014). The feeding activity of *Podagrica* sp. causes damage comprising of characteristic perforations of leaves, and irregular holes reduce the photosynthetic surface area of the leaves leading to a great reduction of yield in okra (Echezona and Offordile, 2011).

Okra plant is susceptible to at least 19 plant viruses with okra leaf curl virus (OLCV) and okra mosaic virus (OMV) being the major diseases reported in Ghana (Bi-Kusi, 2013; Asare-Bediako *et al*., 2014a,b). OLCV is transmitted by the whitefly (*Bemisia tabaci*) whereas OMV is transmitted by insects belonging to *Podagrica* species (Brunt *et al.*, 1996). The OLCV infection can cause yield losses of up to 80% Basu (1995), whereas OMV infection has been reported to cause yield losses of up to 90% (Vanlommel *et al.*, 1996; Alegbejo *et al.*, 2008). Symptoms of OLCV infection include the curling of leaves, yellowing of leaves, leaf distortion, stunted growth and reduction in yield. The OMV also induces mosaic, vein chlorosis and banding and stunted growth (Brunt *et al*., 1990; Krishnareddy *et al.*, 2003).

Effective management of these viral diseases and pest infestation is very important in order to improve yield of okra. Information on the incidence and severity of these diseases and pest attack will be an important pre-requisite for the development of appropriate and effective management strategies in order to improve the yield of okra.

This study was carried out to determine the incidence and severity of okra leaf curl and mosaic diseases and *Podagrica* spp. infestation of okra plants in KEEA, a leading okra producing centre in the Central Region of Ghana.

Materials and Method

Study area

The survey was conducted in twenty (20) okra farms selected from four communities in the Komenda-Edina-Eguafo-Abirem (KEEA) municipality of the Central region of Ghana during 2013 cropping season. These were Nkontrodo, Ayensudo, Ayensudo Junction and Amissano, which are all major okra producing communities in the municipality. The purposive sampling method was used to select the four farming communities in the municipality based on their scale of production. The KEEA municipality has both coastal savanna and forests vegetation ecologies with a bi-modal rainy season from May to June and August to October with an annual rainfall ranging between 750 and 1000 mm (Meteorological Service Department, Komenda, 2010; Parker *et al*., 2010). The area has temperatures ranging between 23.2-33.2 ºC 100 with an annual mean of 27.6 ^{o}C (Owusu Sekyere *et al*., 2011).

Research Design

The study was a descriptive survey carried out in two phases. The first phase involved a socio-economic survey using questionnaire to identify farmer's agronomic practices that influenced the incidences of diseases and pests damage in their okra farms. The second phase involved a field survey to determine the incidence and severity of okra mosaic and leaf curl diseases and *Podagrica* spp. damage on okra plants in the various communities.

The socio-economic survey

Questionnaires with both open ended and closed ended questions were administered to 10 okra farmers purposively selected from each of the four communities in the municipality. The questions were written in English and administered in both English and 'Fante' (a local language) with the help of an agricultural extension agent (AEA). In total, questionnaires were administered to 40 households during survey.

Disease and pest damage assessment

Five (5) okra fields from each community were selected at random and fifty (50) plants from each of the fields were observed for incidence and severity of okra leaf curl disease (OLCD) and okra mosaic disease (OMD) and the extent of damage caused by *Podagrica spp*. Stratified and systematic sampling techniques were used in the field survey.

Insect pest damage

The incidence and severity of pest damage was assessed based on the percentage leaf area damaged by the pests (*Podagrica spp.*). Incidence of pest damage was calculated as the number of plants with the pest damage expressed as a percentage of total number of plants observed. The severity of leaf damage by the *Podagrica* spp. was assessed using a modification of Peterson's scale for damage assessment as used by Kirsch (1986) (Table 1).

Incidence of mosaic and leaf curl diseases of okra

The number of plants showing the visual symptoms of OMD and OLCD were assessed. Disease incidences (DI) for both OMD and OLCD were calculated using the formula below (Alegbejo, 1997).

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total no of plant sampled}} \times 100$$

Table.1 Visual scale for assessing severity of pest damage of okra plants by *Podagrica* spp.

Disease score	Percentage damage	Description
0	0	No apparent damage
1	25	About a quarter (¼) of total leaf area were damaged
2	50	About half (½) of total leaf area were damaged
3	75	Three quarters (¾) of total leaf area were damaged
4	95	Only few leaves, leaves green, stem green
5	100	All leaves and stem eaten

Disease severity

The severity of OLCD was rated on individual plants sampled in the okra fields using a visual scale of 1-7 developed by Alegbejo (1997) (Table 2).

Table.2 Visual scale for rating severity of okra leaf curl disease on farmers' okra fields

Disease score	Description
0	No symptom
1	No visible disease symptom
3	Top leaves curled and slight stunting of plant
5	All leaves curled and slight stunting of plant
7	Severe curling of leaves, stunting of plant and proliferation of auxiliary branches

The severity of OMD was rated on the basis of a rating scale developed by Yayeh (1994) for virus diseases (Table 3).

Table.3 Visual scale for rating severity of okra mosaic disease in farmers' okra fields

Disease score	Description
0	Healthy, asymptomatic plant
1	Mild mosaic, mottle or chlorosis on leaves
2	Moderate chlorosis, mottle or mosaic without significant leaf distortion
3	Score 1 or 2 plus leaf malformation
4	Severe chlorosis, mottle or mosaic plus stunting or dwarfing of the whole plant
5	Score 4 plus drying and leaf drop

The disease severity indices (DSI) for OMD, OLCD and the pest damage were calculated according to the formula **(**Galanihe *et al*., 2004):

$DSI = \sum(P \times Q)/ (M \times N)] \times 100$

Where: P = severity score, Q = number of infected plants having the same score;

M = Total number of plants observed, N = Maximum rating scale number.

Data analysis

The socio-economic data were analysed using Statistical Package for Service Solution (SPSS) version 16.0 for windows and presented in the form of means, frequency distributions and percentages. Data on incidences and severity indices of OMD, OLCD and pest damage were transformed using the Arcsine transformation, in order to ensure homogeneity of the variance and normal distribution of the data. The transformed data was subjected to analysis of variance (ANOVA), and the means separated using the least significant difference (lsd) method at 5% probability level. All analyses were performed with GenStat statistical package Discovery version (Payne *et al*., 2009).

Results and Discussion

Household survey

Demographic characteristics of farmers

The results from the household survey revealed that 70% of the respondents were females whereas 30% were males (Table 4). This suggests that okra production in the municipality is dominated by females. Twenty percent (20%) of the okra farmers were young, 65% were of middle age while 15% were of old age. Majority of the farmers were illiterates (70%); only a few of them had primary (25%) and secondary (5%) education (Table 4).

Farmers' agronomic practices

All the farmers (100%) obtained their seeds from their own farms and they did not treat their seeds before sowing (Table 5). Majority of the farmers (60%) practiced mono cropping whilst the rest (40%) practiced mixed cropping.

Farmer's awareness of pest and diseases (OLCD and OMD) incidences

All the respondent farmers (100%) were aware of the pest damage on okra leaves by *Podagrica* spp. and they all indicated that they were aware of the incidence of the OLCD and OMD and the damage caused to the plants on their farms during the survey.

Pests and diseases management practices

Majority of the farmers (75%) managed pests and diseases on their okra farms by using synthetic pesticides whereas the others (25%) did not apply any control measure (Figure 1). Most of the farmers (60%) applied the pesticides based on the crop calendar whereas 40% of the farmers applied the chemicals at the sight of pests and diseases on their farms (Figure 1). The types of chemical pesticides used by majority of the farmers were recommended by agricultural extension agents (80%) whereas the others relied on agro input dealers (20%).

Field Survey Results

Incidence and severity of okra leaf curl disease (OLCD)

The incidence and severity of OLCD in okra farms in the four selected communities is shown in Table 8. The highest mean incidence of OLCD (69.5%) was recorded at Nkontrodo whereas the lowest incidence (63%) was recorded at Amissano. Analysis of variance at 5% probability level however showed no significant difference among the communities. The severity of OLCD was highest at Ayensudo junction with a mean severity index of 46.2% but this was not significantly different ($P > 0.05$) from the severity indices of 40.8%, 45.8% and 44.2% recorded at Amissano, Ayensudo and Nkontrodo respectively (Table 8).

Table.4 Background information of the respondents (Farmers)

Variable	Frequency	Percentage
Age of the farmers (years)		
<30yrs (Young age)	8	20
30-50yrs (Middle age)	26	65
>50yrs (Old age)	6	15
Total	40	100
Gender		
Male	12	30
Female	28	70
Total	40	100
Educational level		
No formal education	28	70
Primary	10	25
Secondary	2	5
Total	40	100

Source: Household Survey Data, 2014.

Table.5 Agronomic practices by the respondent okra farmers

Agronomic practices	Frequency	Percentage
Source of seeds		
Farmers own farm	40	100
Total	**40**	**100**
Seed treatment method		
No treatment	40	100
Total	**40**	**100**
Cropping pattern		
Mono cropping	24	60
Mixed cropping	16	40
Total	**40**	**100**

Source: Field Survey Data, 2014.

Table.8 Incidence and severity of okra leaf curl disease in okra fields at four communities in KEEA Municipality

Communities	%Incidence	%Severity Index
Amissano	52.8 (63.0) NS	39.6 (40.8) NS
Ayensudo	56.8 (68.4) NS	42.6 (45.8) NS
Ayensudo junction	56.3 (68.2) NS	42.8 (46.2) NS
Nkontrodo	57.3 (69.5) NS	41.5 (44.2) NS

NS – Not significant at 5% probability level Figures in parenthesis are back transformed values

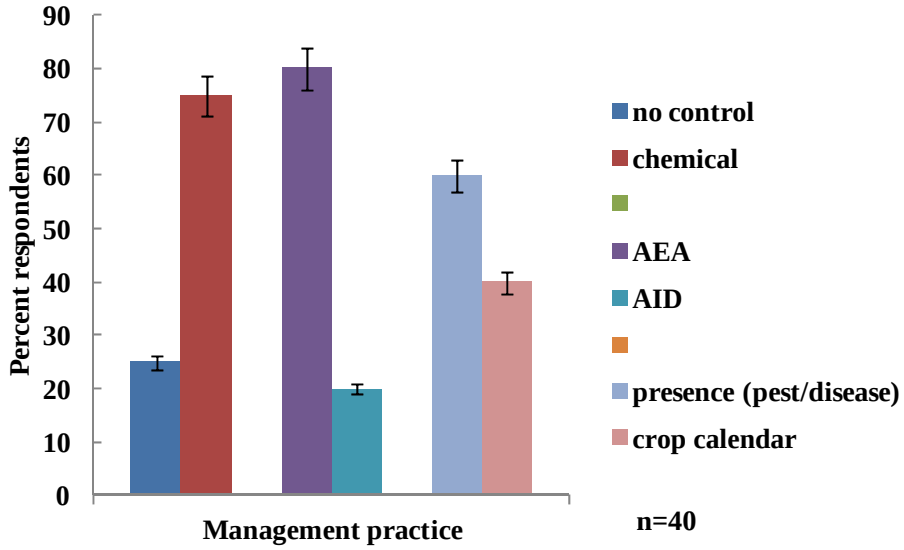

Figure.1 Diseases and pest management practices adopted by the okra farmers
AEA - Agricultural extension agent; AID - Agro input dealer

Table.9 Incidence and severity of okra mosaic disease in KEEA Municipality

Communities	%Incidence	%Severity
Amissano	62.6 (77.6) NS	48 .0 (55.0) NS
Ayensudo	67.0 (82.8) NS	51.7 (61.0) NS
Ayensudo junction	66.0 (82.2) NS	53.1 (63.2) NS
Nkontrodo	63.2 (79.4) NS	49.9 (58.4) NS

NS – Not significant at 5% probability level Figures in parenthesis are back transformed values

Table.10 Incidence and severity of leaf area damage by *Podagrica* spp in KEEA Municipality

Communities	%Incidence	%Severity
Amissano	58.3 (72.2) b	45.8 (51.4) b
Ayensudo	61.1 (76.4) b	47.9 (55.0) b
Ayensudo junction	65.1(82.0) a	53.1 (63.8) a
Nkontrodo	52.9 (63.4) c	38.9 (39.8) c
lsd ($P < 0.05$)	3.60	6.80

Mean values in the same column with differences less than the lsd are not significantly different from each other ($P < 0.05$). Figures in parenthesis are back transformed values.

Incidence and severity of okra mosaic disease (OMD)

The incidence and severity of OMD in the four selected communities is shown in Table 9. The highest incidence of OMD was recorded at Ayensudo (82.8%); followed by Ayensudo Junction (82.2%) and Nkontrodo (79.4%) while the lowest was recorded at Amissano (77.6%). There was however, no significant difference ($P > 0.05$) among the communities in respect of the mean incidences of OMD recorded.

The severity of OMD was highest at Ayensudo junction with a mean severity index of 63.2% but it was not significantly different ($P > 0.05$) from those recorded at Amissano (55%), Ayensudo (61%) and Nkontrodo (58.4%) (Table 9).

Incidence and severity of pest (*Podagrica* spp) damage on okra leaves

The incidence and severity of pest damage on okra leaves in the four selected communities of KEEA municipality is shown in Table 10. Incidence of pest damage of leaves of okra plants surveyed at Ayensudo junction (82%) was significantly higher ($P < 0.05$) than those recorded at Amissano, Ayensudo and Nkontrodo with mean incidences of 72.2%, 76.4% and 63.4% respectively, which also differed significantly among them. Mean incidence of pest damage recorded at Ayensudo was not significantly different ($P > 0.05$) from that of Amissano but significantly higher than that of Nkontrodo ($P < 0.05$).

The severity of pest damage recorded at Ayensudo junction (63.8%) was not significantly different from that of Ayensudo (55%) but significantly higher than those recorded at Amissano (51.4%) and Nkontrodo (39.8%). Severity index of OMD recorded at Amissano was significantly higher than that of Nkontrodo ($P < 0.05$).

The study has revealed high incidences and severities of both OLCD and OMD in all the communities surveyed in the KEEA municipality. More than 50% of the farms surveyed were seriously devastated by the virus as was reported by Askira (2012) when he conducted a survey on the incidence of OLCD on okra in Lake Alau area of Borno State of Nigeria. This finding thus confirms the reports of Bi-Kusi (2013) and Asare-Bediako *et al*. (2014a, b) which state that OLCD and OMD are the major diseases of Okra in Ghana. High incidences of OLCD and OMD of up to 100% have also been reported in Nigeria (Atiri and Ibidapo, 1989; Alegbejo, 1997).

The non-significant differences among the communities in terms of incidences and severities of OMD and OLCD could partly be due to similar agronomic practices adopted by the farmers or similar geographical locations of the communities. According to MoFA (2010), communities in the same area are not geographically different and have very similar soil types, rainfall and temperature patterns as well as land slope. These geographical factors are very important in the development of diseases (Chaube and Pudhir, 2005).

The study also revealed high incidence and severity of pest damage in all the communities surveyed in the municipality. This damage which was in the form of irregular holes is attributable to infestations by *Podagrica* spp (Obeng-Ofori and Sackey 2003; Echezona and Offordile, 2011). Thus, the results of this present study and that of others (Obeng-Ofori and Sackey 2003; Bi-Kusi, 2013; Asare-Bediako *et al*., 2014) have demonstrated

that *Podagrica* spp. is the most important pest of okra in Ghana. The pests feeding habits which cause perforations on the leaves reduce the photosynthetic surface area of the leaves, leading to a great reduction of yield in okra (Echezona and Offordile, 2011). This finding could at least, in part, account for low yields of okra recorded in Ghana.

The high incidences and severities of OMD, OLCD and pest damage among the communities in the KEEA municipality could partly be attributable to the poor agronomic practices by the farmers as was also reported by Cramer (1967). The study also revealed that all the farmers acquired their planting materials (okra seeds) from their own farms (uncertified source). However, this practice contributes to the spread of viral diseases (Hill and Waller, 1988; Obeng-Ofori *et al*., 2007). According to Hill and Waller (1988), majority of seedlings grown from virus contaminated planting materials will be diseased and can serve as a source of inoculum for other healthy plants which can aid the spread of the virus if vectors are present. It was also discovered that about 25% of the farmers do not spray their crops against pest and disease attacks. Such unprotected farms could be sources of inocula for the transmission of the virus diseases to uninfected farms by vectors if present. This may also partly account for the significant differences in the incidences and severities of pest damage among the communities.

The study also discovered that about 75% of the farmers relied on chemical pesticides in controlling pests and diseases and about 60% of them applied the pesticides at the sight of pests or diseases. This poor agronomic practice could result in the development of resistance in the targeted pests and pathogens (Ahmed, 1995; Ntow *et al*., 2001). Besides, the farmers might not be using the right pesticides against the targeted diseases and pests, or they might be misapplying the pesticides due to their low educational background. This might have contributed to the high incidences and severities of OLCD, OMD and pest damage recorded in the study area due to ineffectiveness of the pesticides against the pests and diseases of okra.

The majority of the farmers were practicing monocropping whereas few of them were practicing mixed-cropping. Monocropping is also characterized by dense populations with genetic homogeneity and as a result, once a disease becomes established, it can rapidly spread to epidemic proportions (Arya, 2002; Obeng-Ofori *et al*., 2007). This could account for the predominance of OMD and OLCD and pest damage in the municipality.

The study revealed high illiteracy level among the farmers (75%) and this might have contributed to their poor application of agronomic practices. High level of illiteracy among farmers could generally have a detrimental impact on their level of understanding of basic disease and pest management principles or the adoption of good agronomic practices such as roguing of diseased plants, and proper disposal of crop residues as reported by Lewis and Miller, (2004). It has also been reported that knowledge about the management of a disease is very important in the incidence and control of that particular disease (Stefferud, 1953).

Most of the okra farmers were in the middle age group of 30-50 years which are the most dedicated, committed and active work force in the farming communities. Such active work force is required in the intensive and laborious okra production which is a source of income to the farmers

(Schippers, 2000). More so most people within this age group do not have the requisite skills to enable them engage in urban small scale enterprises or businesses due to their low level of education (Askira, 2012). Despite their high illiteracy level, they are 100% aware of the diseases due to their high level of experience since most of them are middle aged and have engaged in okra farming for a long time.

Conclusion

The study has demonstrated the high prevalence and severity of OMD, OLCD and leaf damage by *Podagrica spp.* in the okra farms in KEEA district. Majority of the farmers manage these pests and diseases with synthetic pesticides whereas others do not apply any control measure. All the farmers used seeds from their own farms and majority of them practiced monocropping and only a few practiced mixed cropping. Majority of the farmers were females and illiterates and were adopting poor agronomic practices by using seeds from their own farms, spraying pesticides at the sight of pests and diseases on their farms.

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