

Prevalence Of Mistletoe On Citrus Trees In The Abura-Asebu-Kwamankese District Of The Central Region Of Ghana

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ABSTRACT:- Mistletoes, which are plant parasites in the families, *Loranthaceae* and *Viscaceae*, have been reported to cause severe damage to cocoa, citrus and many other fruit trees in Ghana. Participatory and field surveys were carried out to assess the prevalence of the parasite on selected orange orchards in the Abura-Asebu-Kwamankese district of the Central Region of Ghana, a major citrus producing area in Ghana. Both structured and unstructured questionnaires were administered to 40 citrus farmers in the district to find out farmers views about the prevalence and control of the parasite in the district. A field assessment of the incidence and severity of the mistletoe in 20 citrus orchards was also conducted. The results revealed high incidence and severe infestation of citrus by the mistletoe. This obligate parasite attacks citrus plants as early as three years after planting and causes severe damage to citrus trees by retarding growth, causing yield loss and mortality. All the respondent farmers control the parasite mechanically, with 95% of them pruning with machete and only 5% using standard pruner. It was observed that the citrus farmers do not effectively control the mistletoe as all the 20 orchards surveyed had incidences of the parasite with as many as 20 per citrus plant. Painful bites from *Crematogaster* ants, lack of standard pruner and regeneration of the parasite after pruning were identified as the major constraints to effective control of the parasite. Eighty percent of the farmers believe that the parasite is spread by birds whilst the remaining 30% think mistletoe is spread by contaminated pruning equipment. Nineteen alternative hosts were identified around the citrus orchards, which were believed to be the sources of inoculum for the spread of the parasite.

Index Terms: citrus, mistletoe infestation, yield loss, parasitic plant, alternate hosts

1 INTRODUCTION

Citrus is one of the most important fruit crops grown by both large and small scale farmers in Ghana. The crop is grown mainly in the Central, Eastern and Ashanti Regions of Ghana, but thrives well in other parts of the country with similar favourable climatic factors. Cultivation of citrus is a source of livelihood to many people in the rural areas as well as those involved in retailing the fruits in urban centres. Citrus cultivation also encourages establishment of cottage industries for the processing of juice for local consumption and for export. It is also a source of foreign exchange to Ghana through the export of the fresh fruit to neighbouring countries such as La Côte d'Ivoire, Burkina Faso, and Togo. For instance, in year 2009, 11,028 metric tonnes of fresh orange were exported, generating foreign exchange of US\$ 875000 to the country [1]. Besides the economic importance, citrus fruits have both nutritional and health benefits. The juice of a ripe orange or mandarin contains about 12% sugar and soluble solids, 1% citric acid and 50mg vitamin C (ascorbic acid) per 100g. One glass of orange juice is therefore sufficient to provide the daily requirement of vitamin C [2].

Citrus provides phytochemicals (monoterpenes, limonoids, flavonoids, carotenoids and hydroxycinnamic acid) which help to reduce the risk or retard the progression of several serious disease disorders including cardiovascular disease, heart disease, hypertension, stroke, cancer, neural tube defects and anaemia [3]. Notwithstanding the contribution of orange to the economy of Ghana and its nutritional values, there has recently been a decline in the production of the crop resulting in a reduction in foreign exchange derived from its export. The volume of exported orange, for instance, declined from 11,028 metric tonnes in 2009 to 10,729 metric tonnes in 2010. The corresponding foreign exchange also dropped from US\$ 875,000 in 2009 to US\$ 654,000 in 2010, representing 25.3% decline [1]. The drop in citrus production in the country is attributable to several production constraints including pests and disease infection, poor management practices and poor marketing by producers. However, severe infection by mistletoe is believed to be a major contributing factor to this decreasing trend in production [4]. Over 60% incidence of mistletoe in citrus orchards has been reported elsewhere [5] to cause severe damage to fruit tree crops, which include growth loss, mortality and reduced yields [6]. However, there are no research reports on effective ways of controlling the parasite in the country. Information on the incidence and effect of mistletoe in citrus orchards in Ghana is also scanty. This study was therefore aimed at determining the incidence and effects of mistletoe infection and factors responsible for the spread of the parasite in orange orchards in Ghana.

2 MATERIALS AND METHODS

The study was conducted at Abura-Asebu-Kwamankese (AAK) District of the Central Region of Ghana during the 2009-10 crop season. The area falls within the semi-deciduous forest with bimodal rainfall pattern. It is the main citrus producing centre in the Central Region and the leading producer in the country. Both descriptive survey and field assessment were carried out. The descriptive survey was conducted through the use of questionnaire. Each

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questionnaire had a total of 43 questions, constructed in both structured and unstructured forms. With the structured forms, all the possible answers were provided on the questions. On the other hand, no possible answers were provided for the unstructured questions and respondents provided their own answers from own perspectives. Forty orange farmers randomly selected from ten villages participated in the study. Field assessment of the incidence and severity of the parasite were also carried out in 20 randomly selected orange orchards in the study area. In each orchard, 40 orange plants were randomly selected and examined for the presence of mistletoe as well as the number of mistletoe per plant. Parasite infection severity rating of 0 to 5 was adopted for scoring the number of mistletoe per plant as indicated below:

Score	Description
0	- No incidence (no mistletoe)
1	- 1-5 per plant
2	- 6-10 per plant
3	- 11-15 per plant
4	- 16-20 per plant
5	- > 20 per plant

The severity indices (SI) for the mistletoe' infestations of the citrus plants were assessed using the formula below [7].

$$SI (\%) = \{(P \times Q)\} / (M \times N) \times 100$$

Where P = severity score, Q = number of infected plants having the same score; M = total number of plants observed, N = maximum rating scale number. Per cent mistletoe incidence in an orchard was also calculated using the formula:

% Incidence (orchard)

$$= \frac{\text{Number of plants with mistletoe infestation}}{\text{Total number of plants assessed in an orchard}} \times 100$$

The alternate hosts to the mistletoe observed around the study area were identified and recorded. Data generated was subjected to statistical analysis, using Statistical Product for Service Solutions software version 14.0 (SPSS V14.0). Data were presented as frequency distributions and percentages.

3 RESULTS AND DISCUSSION

3.1 The age at which the parasite attacks the citrus plants, the damage it causes and mean yield loss

The study revealed that mistletoe is prevalent on orange orchards in the Abura-Asebu-Kwamankese district in the Central region of Ghana and is having a devastating effect on orange production. Forty-five percent of the farmers reported that the parasite attacks their citrus plants as early as 3 years after planting whilst 50% of them said it attacks citrus at the plant ages of 6 to 10 years (Table 1). This is a clear indication of the threat of the mistletoe to the citrus industry in Ghana. Most of the farmers complained of a drastic drop in yield of their citrus plants when attacked by the mistletoe (95%), poor growth of the citrus plants (65%) and mortality when severely infected (55%) (Table 2). They added that mistletoe infestation results in yield loss averaging between 5% and 85.5% (Table 3). This agrees with the findings of studies on

the prevalence of mistletoe on the citrus orchards in the Eastern Region of Ghana [4] and in Sudan [5], [6]. It was reported that mistletoe infestation causes drastic growth retardation, yield loss and subsequent killing of the citrus plants [4], [5], [6].

3.2 Species of mistletoe in farmers' orchards and mode of dispersal

Tapinanthus bangwensis characterized by red flowers was the dominant mistletoe (80%) which occurred in the farmers' orchards. Only 10% of them have experienced only *Phragmanthera incana* (characterized by white flowers), in their orchards while the rest (10%) have experienced both *T. bangwensis* and *P. incana* in their orchards (Table 4). This is consistent with the reports that *T. bangwensis* is the most destructive mistletoe accounting for about 70% of the citrus mistletoe in Ghana [4], [8], [9]. Most of the farmers (70%) believed that birds are the chief agents of dispersal of the parasitic mistletoe, while the others (30%) said that it was dispersed by pruning equipment (Table 5). This finding agrees with the report that a bird (*Pogoniulus chrysonocus*) is responsible for the dispersal of the parasite [10]. There are also reports that birds play a subsequent role in long-distance dispersal [11] and mistletoes generally are regarded as bird-dispersed [12], [13]. The spread of the parasite by pruning equipment is also corroborated by another scientist [14] who reported that harvesting tools and pruners are carried from infected to healthy trees during harvesting and pruning operations.

3.3 Methods of mistletoe control and the associated problems

All the farmers employ mechanical means of parasite control by cutting the mistletoe from the infested orange plants (Table 6), using machete (97.5%), with only one farmer (2.5%) using standard pruner (Table 6). The farmers however, complained of ants' bites which deter them from climbing the citrus plants in order to cut the mistletoe (Table 7), hence mechanical control with machete are ineffective. This might have accounted for the high incidence and high level of infestation of the parasite. It has also been reported that the citrus – mistletoe union provides shelter for *Crematogaster* ants which has a very painful bite [8]. In this case the standard pruner could be the best option since the operator does not have to climb a tree in order to cut the mistletoe. Unfortunately only one of the respondent farmers owned the standard pruner. Regeneration of mistletoe after cutting was also mentioned by the farmers as a hindrance to effective control of the parasite (Table 7). It has been recommended that an infected branch should be cut at least 30 cm below the point of attachment of the mistletoe to ensure the removal of the penetrating cortical haustoria that extend up and down the branches, so as to prevent its regeneration [15]. It is possible that the farmers lack such knowledge hence the ineffective control and consequent regeneration of the mistletoe. The farmers therefore want government's interventions in a diverse ways to combat the mistletoe menace in their orchards (Table 8). About 37.5% want the government to supply them with standard pruner on credit, 20% want chemicals to control the ants which hinder their effort in controlling the parasite; about 32.5% want the Ministry of Food and Agriculture (MoFA) to control the mistletoe for them while the other 10% want chemicals for direct control of the parasite.

3.4 Alternate hosts of mistletoe

Several alternate hosts were identified during the study. Among the 10 alternate hosts mentioned by the farmers, *Theobroma cacao* was the most frequent (20%), whereas *Funtumia elastica* and *Persea americana* were less frequent, each forming only 2.5% (Table 9). During the field survey, 16 alternate hosts were identified, some of which had been mentioned by the farmers (Table 10). *Alstonia boonei* was the most frequently observed (8 observations) whereas *Gliricidia sepium*, *Jatropha* spp and *Manihot esculentum* were each sighted only once, indicating they were less frequently observed (Table 10). The numerous alternate hosts identified near the citrus orchards might have at least, in part, been responsible for the high incidence and severity of the parasite recorded. The parasite could easily be dispersed from any of the alternative hosts into the citrus orchards by birds and other dispersal agents. A considerable damage caused to perennial crops such as citrus, cocoa, avocado, coffee, cola, sheanut and rubber through the activities of mistletoe has also been reported [16]. It is important to note that the infested citrus could also serve as a source of inoculum for infestation of cocoa, which is a major source of foreign exchange for the country. The incidence of mistletoe on cocoa plants is therefore very worrying. Prevalence of mistletoe in cocoa farms in Ghana has been reported [17]. Effective control of the mistletoe is therefore very necessary in order to save citrus and cocoa industries.

3.5 Incidence and severity of mistletoe on orange orchards

All the 20 fields assessed had incidence of mistletoe infestation, with percentage incidence ranging from 84 – 100% per orchard (Table 11). The level of infestation was also very high in the various orchards with the severity indices ranging between 20% and 90%, (level of infestation ranging from 5 to over 20 mistletoe parasite per plant. This indicates that the parasite is highly prevalent in the area and the infection level is very severe, suggesting that the parasite poses a serious threat to the growth and yield of the citrus orchards. This finding agrees with the report of the prevalence of mistletoe on the citrus in the Eastern Region of Ghana [4]. An urgent control of the parasite is therefore quite imminent in order to save the citrus industry and to reduce poverty levels among citrus farmers in the country.

4 CONCLUSIONS

It is clear from the study that there is a high incidence and severity of mistletoe infestation in the study area, with a consequent growth reduction, yield loss and plant mortality. Farmers should therefore be encouraged to remove the parasite from their orchards. However, majority of the farmers do not have standard pruner for efficient and regular pruning. It is recommended that the government of Ghana, through the Ministry of Food and Agriculture, should supply standard pruner on credit to the farmers.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to Mr. E.O. Tetteh, a Technician of the Asuansi Agricultural Station of the Ministry of Food and Agriculture, for his assistance during the field survey.

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Table1. Age at which mistletoe attacks citrus plants

Age	Frequency	Percentage
1-5	18	45.0
6-10	20	50.0
Any age	2	5.0
Total	40	100.0

Table2. Economic damage of mistletoe on citrus

Damage	Response	Percentage (%)
Stunted growth	26	65
Mortality	22	55
Reduced yield	38	95

Table3. Mean yield loss of citrus infected by mistletoe

Mean yield loss (%)	Frequency	Percentage (%)
5.0	2	5
15.5	6	0
25.5	2	5
35.5	8	20
45.5	14	35
55.5	8	20
65.5	4	10
75.5	2	5
85.5	2	5
95.5	0	0
Total	40	100

Table4. Types of mistletoe observed by farmers in their citrus farms

Species	Frequency	Percentage
<i>Tapinanthus bangwensis</i> (red flowers)	32	80.0
<i>Phragmanthera incana</i> (yellow flowers)	4	10.0
Both types	4	10.0
Total	40	100.0

Table5. Mode of dispersal of mistletoe in citrus orchards

Mode of dispersal	Frequency	Percentage
Birds	28	70
Pruning equipment	12	30
Wind	0	0
Pollinating insects	0	0
Total	40	100

Table6. Methods of controlling mistletoe in citrus orchards

Method	Frequency	Percentage
Mechanical (standard pruner)	1	2.5
Mechanical (machete)	9	97.5
Chemical control	0	0.0
Biological control	0	0.0
Shade management	0	0.0
Total	40	100.0

Table7. Problems associated with the control of mistletoe

Problem	Frequency	Percentage
Lack of funds	4	10.0
Presence of ants on trees	24	60.0
Regeneration after cutting	4	0.0
Lack of standard pruner	8	20.0
Total	40	100.0

Table8. Government's required intervention to combat the parasite in the district

Expected Assistance	Frequency	Percentage
Provision of standard pruner	15	37.5
Chemicals to control parasite	4	10.0
Chemicals to control ants	8	20.0
MOFA assistance in controlling parasite	1	32.5
Total	40	100.0

Table9. Identification of alternate host plants of mistletoe by respondent farmers

Host plants	Frequency	Percentage
<i>Bambusa vulgaris</i>	6	15
<i>Persea americana</i>	1	2.5
<i>Manihot esculentus</i>	7	17.5
<i>Theobroma cacao</i>	8	20
<i>Piptadeniastrum africana</i>	3	7.5
<i>Alstonia boonei</i>	4	10
<i>Khaya ivorensis</i>	4	10
<i>Funtumia elastica</i>	1	2.5
<i>Alchornea cordifolia</i>	3	7.5
<i>Solanum torvum</i>	3	7.5
Total	40	100

Table10. Alternate hosts observed by the authors during field assessment

Alternative host	Frequency of observation
<i>Acacia</i> spp	4
<i>Alstonia boonei</i>	8
<i>Alchonea cordifolia</i>	4
<i>Azadirachta indica</i>	2
<i>Baphia nitida</i>	2
<i>Ceiba pentandra</i>	5
<i>Gliricidia sepium</i>	1
<i>Jatropha</i> spp	1
<i>Khaya ivoriensis</i>	3
<i>Leucaena leucocephala</i>	2
<i>Mangifera indica</i>	2
<i>Manihot esculentum</i>	1
<i>Manihot glazeovii</i>	4
<i>Persea Americana</i>	2
<i>Psidium guayava</i>	2
<i>Theobroma cacao</i>	5

Table11. Percentage incidence and severity of mistletoe infestations on 20 citrus orchards

Orchard	% Incidence of mistletoe	Severity index (%) ^a
1	100	34
2	96	32
3	96	36
4	100	48
5	96	40
6	92	44
7	100	60
8	100	54
9	100	86
10	96	68
11	100	70
12	84	32
13	84	24
14	84	20
15	100	28
16	94	90
17	100	64
18	80	56
19	98	79
20	96	86

^a Parasite severity index was based on 1 to 5 severity scale where 1 denotes 1 – 5 parasites per plant, and 5 denotes more than 20 parasites per plant.