ORIGINAL ARTICLES

Prevalence and Intensity of Mango (*Mangifera indica* L.) **Anthracnose Caused by *Colletotrichum* Species in** South-western of Ethiopia

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ABSTRACT

Mango (*Mangifera indica* L.) anthracnose caused by *Colletotrichum* spp. is considered as the most important mango disease in the humid tropics. The disease widely occurs in some parts of Ethiopia that has characteristically tropical humid weather condition. However, in southwest Ethiopia the prevalence and intensity of the disease is not sufficiently studied. In the study the prevalence, incidence and severity of the disease was assessed in some humid parts of Ethiopia. The study was conducted during the 2013 to 2014 production seasons by sampling a total of 36 plots in 9 locations in south west Ethiopia. The sampling method for location and plot selection was purposive sampling using a predetermined criterion, while mango trees were randomly sampled within a plot. Disease incidence and severity on mango trees were measured on leaves, panicles and fruits. The disease is prevalent in all locations and plots assessed. However, disease incidence and severity of mango anthracnose varied significant ($p < 0.05$) across the locations. The mean incidence of the disease on leaves, panicles and immature fruits was 76%, 71% and 68%, respectively, while the mean disease severity was 49%, 47%, and 41%, respectively. Seka-Chokorsa area had the highest mean disease incidence (90%) and severity (61%), while Gura-Ferda had the least mean disease incidence (39%) and severity (24%). Generally, the mean mango anthracnose incidence and severity were 71% and 45.7%, respectively, in the studied areas. The disease was influenced by rainfall, altitudinal gradient and temperature. The study revealed that mango orchards in southwest Ethiopia are under mango anthracnose disease pressure suggesting the need for appropriate management practices.

Key words: Ethiopia, Gura-Farda, Incidence, Mango anthracnose, Severity

INTRODUCTION

Mango (*Mangifera indica* L.) is an important fruit crop in Ethiopia (Yeshitela and Nessel, 2004; Alemayehu *et al.,* 2014; Ayantu *et al.,* 2014) and other tropical and subtropical countries of the world (Evans and Mendoza, 2009). Mango is one of the most popular fruit crops in several tropical and subtropical countries and considered as the "King of Fruits" (Kumar *et al.,* 2011). Mangoes account for approximately half of all tropical fruits produced worldwide.

Apart from economic importance, mango is a tree and environmentally friend to fight against drought, used as shade and fire wood (Bally, 2006). The Food and Agriculture Organization (FAO) estimates worldwide mango production at nearly 39,000,000 tons and the production of mango in Ethiopia are 11,446.2 tons per year on average (FAO, 2010).

Mango is affected by a number of diseases at all stages of development, from seedlings in the nursery to the fruits in storage or transit (Ploetz, 2003; Prakash, 2004). Of these, the disease anthracnose caused by *Colletotrichum* spp. is one of the most economically important pathogenic genera affecting a wide range of hosts in the tropics and subtropics (Cai *et al*., 2009; Cannon *et al*., 2012; Damm *et al*., 2012).

Mango anthracnose causes premature fruit drop and direct reduction in quality of ripe fruits (Damm *et al*., 2012). Anthracnose affects young leaves resulting in severe spots and blackening of tips. Affected flowers fall off, causing lowered fruit set. The most conspicuous symptom of the disease is the circular, dark, sunken anthracnose lesions on ripe fruits (Jayasinghe and Fernando, 2009; Phoulivong *et al*. 2010). In areas where rain is prevalent during flowering and fruit set, anthracnose can cause destruction of the inflorescences and infection and drop of young fruits where this can obviously lead to serious losses, reaching up to 35% of the harvested fruits (Martinez *et al*., 2009).

The disease incidence has been reported to be 32% in South Africa (Sanders *et al.,* 2000), 64.6% in Costa Rica during 1990 (Arauz *et al.,* 1994) and could reach almost 100% in fruits produced under wet or very humid conditions (Arauz, 2000)**.** The incidence and severity of mango anthracnose were reported to be 77% and 46%, respectively, in south Ethiopia (Alemayehu *et al.,* 2014).

However, the prevalence and intensity of mango anthracnose in some parts of Ethiopia is not sufficiently studied. Therefore, the present research was initiated with the objective of assessing the prevalence, incidence and severity of mango anthracnose in mango growing areas of in southwest Ethiopia.

MATERIALS AND METHODS

Survey area: Survey was carried out during the year of 2013-2014 production seasons in different agro-ecological zones of Ethiopia. The survey areas included nine major mango growing districts, namely Seka-Chokorsa, Mana, Gomma, Limmu-Kossa, Chora-Botor, Gimbo, Gura-Ferda, Arjo-Dedessa (Chawaka) and Bako-Tibe (Fig.1) that lied within 7^0 12'N to 9^0 6'N latitude and 35^0 27'E to 37^0 09'E longitude and altitudes ranging from 1000 to 2500 m. a. s. l. (Table 1).

Table 1: Geographic location and climatic conditions of the study areas in 2014

Location	Coordinates	Mean altitude (m)	Mean temperatures (°C)	Mean annual rainfall (mm)
Chora-Botor	37° 29′E-8° 36′N	1637	20	2152
Gura-Farda	36° 08′E-6° 96′N	1029	24	729
Bako-Tibe	37° 09′E-9° 06′N	1500	20	1430
Arjo-Dedesa(Chawaka)	36° 40′E-8° 40′N	1295	23	907
Mana	36° 45′E-7° 45′N	1710	21	1605
Gomma	36° 45′E-7° 50′N	1560	21	1361
Seka-Chokorsa	36° 28′E-7° 05′N	1810	20	1364
Limu-Kossa	36° 44′E-7° 49′N	1650	20.7	1680
Gimbo	36° 14′E-7° 16′N	1714	19	1847

The sampling method for selecting locations and plots in a location was purposive sampling method and a predetermined criterion, where distance between the fields ranged from 10 to 15 km. From each plot six mango trees were randomly sampled and within a location 24 mango trees were assessed. Mango leaves, immature fruits and panicles exhibiting symptoms were sampled from the bottom, middle and upper parts of the tree canopy to assess the disease.

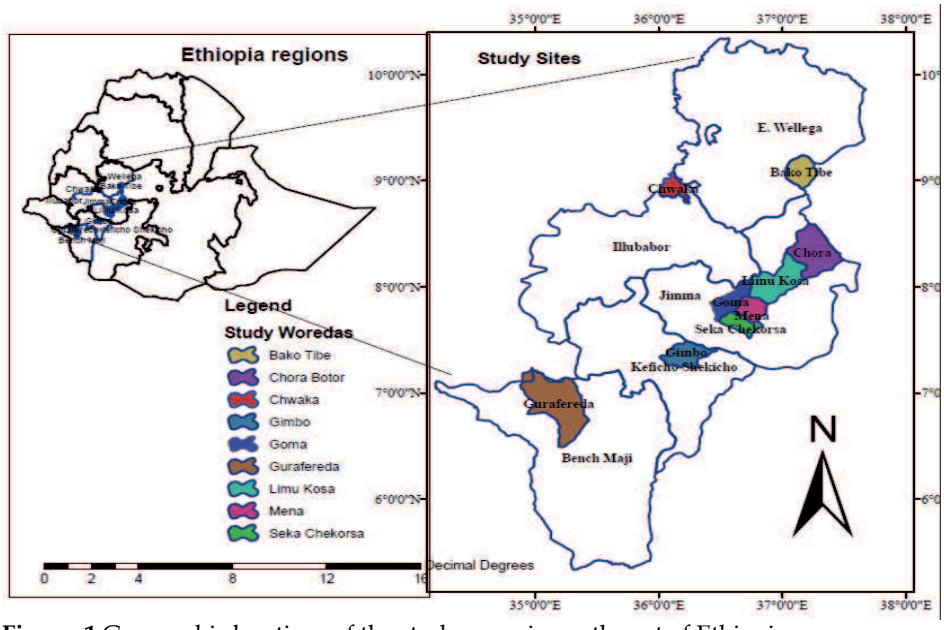

Figure: 1 Geographic locations of the study areas in southwest of Ethiopia.

Disease Assessment

Prevalence of the diseased fields in which the disease symptoms were observed to the total number of fields visited in each location.

$$\text{Percent of occurrence (Prevalence)} = \frac{\text{Number of fields with mango anthracnose}}{\text{Total number of fields plot visited}} \times 100$$

Disease incidence: Disease incidence were determined by counting the number of visibly diseased leaves, immature fruit and panicles following Masyahit *et al.* (2009) methods as follows:

$$\text{Disease incidence (DI)} = \frac{\text{Number of infected leaves, panicles and fruit}}{\text{Total number of assessed leaves, panicles and fruit}} \times 100$$

Disease severity: Disease severity: on leaves, fruit and panicles was estimated based on percentage of the area covered by lesions of the disease. Disease severity on plant parts is recorded using a five-point rating scale which is Indian based recommendation on the percentage of leaves, panicles and fruit area affected by the disease as presented by Akhtar *et al*. (2002), where 1= no lesions; 2 = 1 to 3 lesions; 3 =4 to 6 lesions; 4 =7 to 15 lesions; and 5 = more than 30 percent of the surface is covered with lesions. The numerical ratings were converted to disease severity index (DSI) using the following equation Mayee and Datar**,** (1986).

$$\textbf{Disease severity (DSI)} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of observations}} \times \frac{100}{\text{Maximum rating observed}}$$

Statistical analysis

The disease survey was conducted in three sage nested designs. Correlation analyses were also performed to correlate disease intensity with weather factors. Data generated from the study were analyzed using Statistical package SAS 9.2 software (SAS, Inc., 2008). Mean values among the treatments were compared by the mean separated by LSD values test at $\alpha = 0.05$ level of significance.

RESULTS AND DISCUSSION

Prevalence of mango anthracnose disease: The result of field surveys revealed the prevalence and distribution of mango anthracnose in the nine surveyed districts. In another study by Ayantu *et al.* (2014), where the distribution of the diseases was surveyed in three different districts (*woredas)* of, southwest of Ethiopia the prevalence of mango anthracnose was found to be 100% though the intensity varied. This suggests that mango growing areas southwest of Ethiopia were under continuous pathogen pressure and their effects may vary weather conditions that occur and types of variety that grow in the farmers' field. Various studies have also demonstrated the distribution of anthracnose of mango in all areas of mango production in the world (Weir *et al.,* 2012; Syed, *et al.,* 2014). This is often in areas where there is continuous rainfall and high humidity. Kamle *et al.* (2013) states that mango anthracnose has been recognized as the most important disease of field and post-harvest disease of mango worldwide. Anthracnose affects the fruit production in all countries where mangoes are grown, particularly where high humidity prevails during the cropping season.

Incidence and severity of mango anthracnose disease: The result of disease assessment in our study indicated that there was significant ($P < 0.05$) difference among locations in disease incidence and severity (Fig 2a &b). Significantly mango anthracnose incidence was recorded in Seka-Chekorsa (90%) followed by Limmu-Kossa (85 %), Bako-Tibe (81%), Gomma (81%) and Mana (76%), whereas the incidence was observed in Gura-Ferda (39%) and Arjo-Dedesa (Chawaka) (55%) (Fig.2a) similarly, significantly ($P<0.05$) higher mango anthracnose severity was measured at Seka-Chekorsa (59%) and Limmu-Kosa, while lower severity was recorded at Gura-Farda and Arjo-Dedesa. Generally, the mean disease incidence and severity of all the surveyed locations in south west Ethiopia was 71% and 46%, respectively.

Mango anthracnose disease incidence has been reported to be 32% in South Africa (Sanders *et al*., 2000), 65% in Costa Rica (Arauz *et al*., 1994). The disease incidence can reach almost 100% in fruit produced under wet or very humid conditions (Arauz, 2000). In a study made in south Ethiopia anthracnose incidence was also reported to be 77% (Alemayehu *et al*., 2014). Another study in Ethiopia carried out by Ayantu *et al*. (2014) indicated that the disease incidence under farmers' filed range from 41 to 72% on leaf and 36 to 74% on fruit. Our finding also showed that mango anthracnose incidence is 71% which indicates the importance of the disease in the study area. Considering the severity of the disease, (Ayantu *et al*., 2014) found 38 to 63% in some part of Ethiopia. The severity of mango anthracnose was reported to be 46% in south Ethiopia (Alemayehu *et al*., 2014). The mean severity of mango anthracnose in our study in south west Ethiopia was 46% which matches to the previous studies in Ethiopia. The present and the previous studies that mango anthracnose is an important disease in the farmers' field that can affect the yield and marketability of the crop. The disease has made mango production non-attractive and non-marketable to farmers and home gardeners (Ayantu *et al*., 2014). Studies also show that there is a declining trend in yield and quality of mango in Ethiopia due to diseases and poor agronomic practices of which mango anthracnose is among the major once (Chowdhury and Rahim, 2009; Alemayehu *et al*., 2014)

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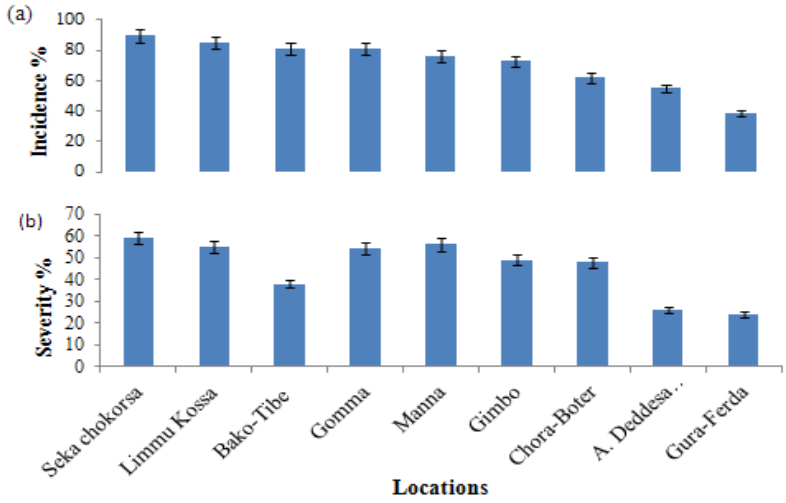

Figure: 2 Mean disease incidence (a) and disease severity (b) of mango anthracnose across location in southwest of Ethiopia)

Our study has also tried to see if the disease incidence and severity on the different plant organs follows the same pattern across location or not. The incidence of mango anthracnose on leaves, panicles and fruits has been shown in (Table 2). The study showed that significantly higher disease incidence on leaves, panicles and fruits were recorded at Seka-Chekorsa and Limmu-Kossa. On the other hand, significantly lower mango anthracnose incidence on leaves, panicles and fruits was at Arjo-Deddesa and Gura-Farda (Table 2).

Table 2: Incidence of anthracnose on leaves panicles and mango fruits in southwest of Ethiopia

Location	Incidence (%)		
	Leaves	Panicles	Fruits
Seka-Chokorsa	97[a]	87[a]	85[a]
Limmu-Kossa	92[b]	82[b]	81[b]
Bako-Tibe	82[c]	83[b]	79[b]
Gomma	82[c]	83[b]	78[c]
Mana	79[d]	78[c]	72[d]
Gimbo	68[e]	76[d]	75[d]
Chora-Boter	66[f]	62[e]	59[e]
Arjo-Dedesa (Chawaka)	63[g]	53[f]	50[f]
Gura-Ferda	51[h]	34[g]	32[g]
LSD ($P < 0.05$)	1.28	1.1	1.2
CV (%)	5.1	4.8	3.8

*Means with the same letter are not significantly different from each other at $P < 0.05$.

This is similar result with the overall disease incidence when disease is analyzed irrespective of plant organs. Similar result is shown in disease severity also (Table 3).

Table 3: Severity of anthracnose on leaves panicles and attached mango fruits in south west Ethiopia

Location	Severity (%)		
	Leaves	Panicles	Fruits
Limmu-Kossa	61[a]	57[b]	52[c]
Gimbo	55[b]	56[c]	40[e]
Seka-Chokorsa	53[c]	57[b]	62[a]
Mana	51[d]	59[a]	55[b]
Gomma	48[e]	55[d]	55[b]
Chora-Boter	48[e]	53[e]	43[d]
Bako-Tibe	46[f]	47[f]	26[f]
Arjo-Dedesa (Chawaka)	31[g]	30[g]	20[g]
Gura-Ferda	30[h]	29[h]	17[h]
LSD($P < 0.05$)	0.64	0.6	0.7
CV (%)	4.1	4.0	5.2

* Means with the same letter are not significantly different from each other at $P < 0.05$.

Generally, mango anthracnose incidence and severity varied across geographical locations of southwest of Ethiopia.

In this study, when the relationship between environmental factors (Table 1) and disease incidence and severity (Fig.2) were considered, there was significantly positive correlation between altitude and disease incidence (r=0.90) and severity (r=0.85). There was negative correlation between mean temperature and disease incidence (r = -0.84) and severity (r = -0.62) but, significant only for incidence. Furthermore, there was positive correlation between mean rainfall (Table 1) and disease incidence and severity but, significant only for incidence (Table 4).

Table 4: Pearson correlation coefficient (r), between disease intensity and weather data during year 2014 in southwest Ethiopia.

	Location	Severity %)	Incidence (%)	Altitude (m)	Temperature (^{0}C)	Rainfall (mm)
Severity	0.45[ns]	-				
Incidence	0.62[ns]	0.87[ns]	-			
Altitude	0.57[ns]	0.85**	0.90**	-		
Temperature	-0.45[ns]	-0.62[ns]	-0.84**	-0.88*	-	
Rain fall	0.62[ns]	0.59[ns]	0.76*	0.77**	-0.84**	-

ns = statistically not significant, *= significant at $p < 0.05$, **= significant at $p< 0.01$

In the study highest anthracnose incidence and severity was recorded at Seka-Chekorsa and Limmu-Kossa and other areas that were more or less at higher altitude, found to receive high rainfall and get relatively low temperature. On the contrary, Arjo

Deddesa and Gura-Ferda experienced minimum disease incidence and severity. These are areas situated at low altitude that receive low amount of rainfall and high temperature. From our result that high disease incidence and severity at Seka-Chekorsa and Limmu-Kossa could be attributed to high rainfall and altitude. Studies have already indicated that anthracnose causes significant impact in areas where rainfall is prevalent (Arauz, 2000; Onyeani *et al.,* 2012; Alemayehu *et al.,* 2010; Alemayehu *et al.,* 2014; Ayantu *et al.,* 2014).

The incidence of the disease can reach almost 100% in fruit produced under wet or very humid condition (Akem, 2006). Among the different environmental factors, rainfall is known to play significant role in releasing of conidia from acervuli and their subsequent spreading in the field (Agrios, 2005). In addition, facilitating infection as conidia need moisture on the surface of the plant tissue to germinate and cause infection. This is because infection occurs when a conidium lands in a splash droplet on the surface of the fruit in the natural environment, and adheres and germinates to produce a germ tube, which develops a terminal apperesorium. An infection peg then emerges and penetrates into the outer wax layer and the cuticle of the fruit skin (Flaishman and Kolattukudy, 1994).

CONCLUSION

The result of the study showed that the disease is prevalent at all assessed locations in southwest Ethiopia clearly indicating its importance at the study areas. This is because the prevalence of mango anthracnose was 100%. However, disease incidence and severity varies depending on the prevailing weather conditions. The study revealed that mango orchards in southwest Ethiopia are under mango anthracnose disease pressure suggesting the need for appropriate management practices. Additional research is advisable to determine the amount of yield loss, to understand the level of the importance of the disease.

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