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# Assessments on Re-emerging Infections Plant Diseases: Treating on Coffee Industry in Horizon Plantation

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**Abstract**
**Background:** Coffee *(Coffee arabica* L.) Coffee accounts thirty three percent of Ethiopia's total export earnings and sustains the livelihoods of more than one million coffees growing households. Besides its importance coffee production treated with number biotic factors of which diseases are major.Coffee is prone to a number of diseases that attack fruits, leaves, stems and roots, and reduce yield and spent of additional management costs. Major coffee diseases in Ethiopia are Coffee berry diseases (*Colletotrichum kahawae*), Coffee wilt disease (*Gibberella xylarioides)* and coffee leaf rust (*Himalia vestatrix)* however, the rest diseases including thread blight considered minor.However, the prevalence and economic importance of reemerging coffee diseases in Limmu coffee plantation industry is a challenge and not sufficiently studied. **Objective:** The aim of this paper were assessed the re-emerging infections of coffee diseases leaf rust and thread blight to determine the intensity of the disease and their effects. **Materials and Methods** The research conducted in Gomma-1 coffee farm for leave rust assessments and Suntu coffee farm for thread blight disease (black rot). The sampling method for selecting locations and farm were selected using purposive sampling method and a predetermined criterion, where distance between the blokes, five coffee tree were random sampled with in a plot. **Results:** The survey result showed that,mean disease incidence and severity coffee leave rust at Gomma-1 41.1% and 11.5% respectively. Thread blight mean disease incidence 31.8%, range (15% - 52%). The data showed that estimated loss due to thread blight reach 4% from annual coffee production at Suntu coffee farm or ($101,791) revenue. **Conclusion:** These epidemics should be considered as a warning for the future, as they were enhanced by weather conditions consistent with climate change. Appropriate actions need to be taken in the near future to address this issue including: the development and establishment of resistant coffee cultivars; the creation of early warning systems; the design of crop management systems adapted to climate change.
**Keywords:** Climate change, Coffee leaf rust, Disease intercity, Thread blight
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## INTRODUCTION

Coffee (*Coffea arbica* L.) is the world's favorite drink, the most important commercial crop-plant, and coffee ranked as the fifth most important trade commodity after wheat, cotton, maize, and rice [1]. Worldwide there are about 20 million coffee farming families and around 100 million people depend on coffee for their livelihoods [2]. The crop plays an important role in income and employment in developing countries like Africa, Asia and Latin America [3]. *C. Arabica* plays an exclusive role in Ethiopia coffee economy and the country is the fifth largest global exports [4]. Coffee contributed 33% of Ethiopia's total export earnings [5].

Fungal phytopathogens pose serious problems worldwide in the cultivation of economically important plants, especially in the tropical and subtropical regions [6].

Ethiopian coffee producers, however, are currently facing many difficulties yield losses due to emerging serious fungal diseases. Coffee diseases are among the major biotic constraints of coffee in Ethiopia that attack fruits, leaves, stems and roots and thereby reduce the yield and marketability of the crop. Coffee in the country is attacked by a number of diseases among which coffee berry disease (CBD), coffee leaf Rust (CLR) and coffee wilt Disease (CWD) are the major ones [7].

Coffee leaf rust: is caused by a fungus-*Hemileia vastatrix*, the fungus kills the section of the leaves on which it grows. If the infection is severe this causes premature leaf fall. The trees ability to produce carbohydrates is then reduced [8]. Vegetative growth and berry growth and size are then significantly reduced [9].The roots and shoots are starved of plant food due to leaf fall and the berries using up the carbohydrates. A heavy infestation of leaves not only reduces the assimilation area but also results in a complete defoliation diminishing the next year's crop tremendously [10]. This will lead to a reduction in the number of bearing nodes, thus a reduction in crop production for the next crop year.

The thread blight disease is a fungal disease which attacks the coffee and the coffee plant. The fungus *Corticium koleroga* (previously *Pellicularia koleroga*, *Ceratobasidium noxium*) causes thread blight (also called black rot or koleroga) of coffee and some other tropical or subtropical woody plants, including citrus species [11]. The disease associated with fungal pathogens from the *Ceratobasidium* species complex is considered an emerging

 

one and has a very wide hosts ranging from annual herbaceous monocots to perennial woody fruit trees with many kinds of symptoms [12].

Symptoms include dark brown or black decay and rot of leaves, twigs, and berries followed by defoliation, berry drop, and dieback. Affected leaves may hang from strong fungal mycelial threads that can be seen on twigs and petioles. Whole plantings can be affected resulting in severe crop damage and can be very destructive during the rainy season. This fungus remains dormant during the dry season but spreads rapidly under wet conditions. Disease development is favored by heavy rainfall, high atmospheric humidity shade, and overhanging branches. Thread blight diseases on Ethiopian coffee was observed for first time at Gera and Metu agricultural research sub-stations in 1978 and it might have been existed before [13].Thread blight of coffee outbreak was observed in different coffee plantations like at Limmu in 2008, at Bebeka in 2012 and at Limu horizon in 2014 [14].

Currently re-emerging unexpected disease epidemic there was coffee thread blight and Coffee leaf rust in Limmu coffee Farm. Although many works have been undertaken in many parts of coffee producing areas of Ethiopia in relation with incidence, severity, distribution, and resistance to CBD, but information in cause of Coffee leaf rust and Coffee thread blight in Limmu coffee plantation is not yet well documented. The aim of the studies to determine the intensity of currently re-emerging unexpected disease epidemic there were coffee thread blight and Coffee leaf rust and estimates economic significant at Limmu Coffee Farm.

## MATERIAL AND METHODS

**Description of the Study Area:** Surveys were carried out in south western part of Ethiopia in Limmu coffee plantation at Gomma 1 coffee farm is situated at about 416km to Southwest of Addis Ababa. The survey coffee leaf rust was conducted during the year of 2013-2014 season at Latitude $7^0$ 57'N and longitude $36^0$ 42'E and altitude range of 1340-1800m a. s.l. The maximum and minimum temperature is $30^0$c and 11.8, respectively with the mean rainfall recorded are 1600mm per annum. Suntu coffee farm is situated at about 431km to Southwest of Addis Ababa. The survey thread blight was conducted during the year of 2014 -2015 cropping season at Latitude $8^0$ 05'N and longitude $36^0$ 57'E and altitude range of 1600-1700m a. s.l. The maximum and minimum temperature is $32^0$c and $10^o$c, respectively with the mean rainfall recorded are 1720mm per annum.

**Sampling Methods:** The sampling method for selecting locations and block were selected using purposive sampling method and a predetermined criterion, where distance between the blokes ranged from 1 to 2 Km. plot size 10 x10$m^2$ the 5 coffee tree were random sampled with in a plot. The procedure of sampling method was as follows: -within a block have 4 plots were 20 coffee trees assessed from each tree randomly select two coffee branch and from each branch observe 8 coffee leaves for leaf rust.

### Disease assessments coffee leaf rust

**Incidence:** The disease incidence was scored by counting diseased and healthy trees.

Disease incidence (I) = $\frac{\text{Number of infected coffee plant}}{\text{Total number of coffee plant assessed}} \times 100$

**Severity:** The disease severity index (DSI in a scale ranging from 1 – 4) was scored on infected branches in the field site using the following scale: class 1 = no disease; class 2 = one rust pustule/leaf; class 3 = two rust pustules/leaf and class 4 = three and more rust pustules/leaf.

The DSI was calculated using the formula: $n_1 + n_2 \times 2 + n_3 \times 3 + n_4 \times 4 / n_1 + n_2 + n_3 + n_4$

$n_1$ = number of leaves in class 1, $n_2$ = number of diseased leaves in class 2, etc

### Disease assessments for thread blight

**Incidence:** Field survey of black rot were carried out in the selected coffee farm; for each plant the incidences were determined by counting the number of visibly diseased coffee plant.

Disease incidence (I) = $\frac{\text{number of infected coffee plant}}{\text{Total number of coffee plat assessed}} \times 100$

**Yield loss assessment:** Berry counting- 5 trees/plot were randomly selected and each tree divided into 3 strata of branches (top, middle and bottom). From each stratum two branches were selected to calculate yield loss. Depending on the coffee field sizes across each coffee block 5 plots were assessed.

**Data analysis :**

Analysis of variance (ANOVA) was performed using single stagenested design (tree was nested under farm) and time of rust assessment made (dry season) for thread blight at summer conditions were considered. Mean comparison tests were applied wherever appropriate using the Fisher protected significant difference test (LSD) at a probability level of 5%. The statistical analysis was performed using SAS statistical package [15].

## RESULT AND DISSECTIONS

**Incidence and severity of Coffee leaf rust:** The result of disease assessment in our study indicated that there was

 

significant (P < 0.05) difference among selections in disease incidence and severity. Significantly higher CLR incidence was recorded in selection 74-148 (68.6%) followed by 74-1(68 %) and 74-140 (58.7%), whereas the lowest incidence was observed in selection 7440 (15.8%) and 74-110 (14.4%) (Fig.1), similarly, significantly (P<0.05) higher CLR severity was measured at selection 74-148 and 74-1 while lower severity was recorded at 74-110 and 74-140. Generally, the mean disease incidence and severity of all the surveyed selections in Gomma one Coffee farm were 42% and 15-5% (Fig.1) respectively.

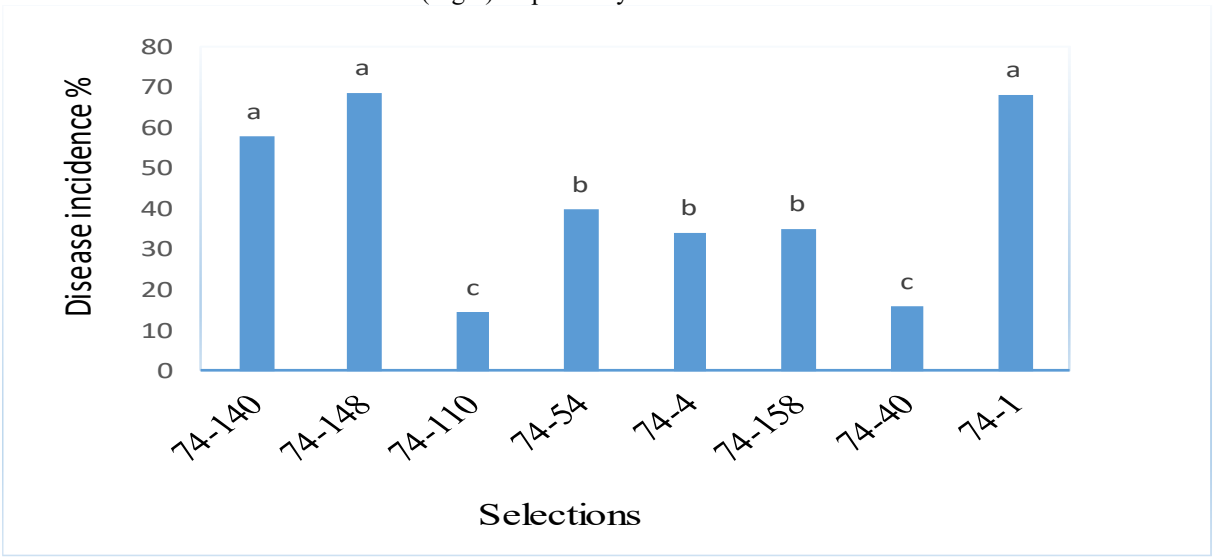


Figure 1. Coffee leaf rust incidence in Gomma one coffee farm at 2014/15

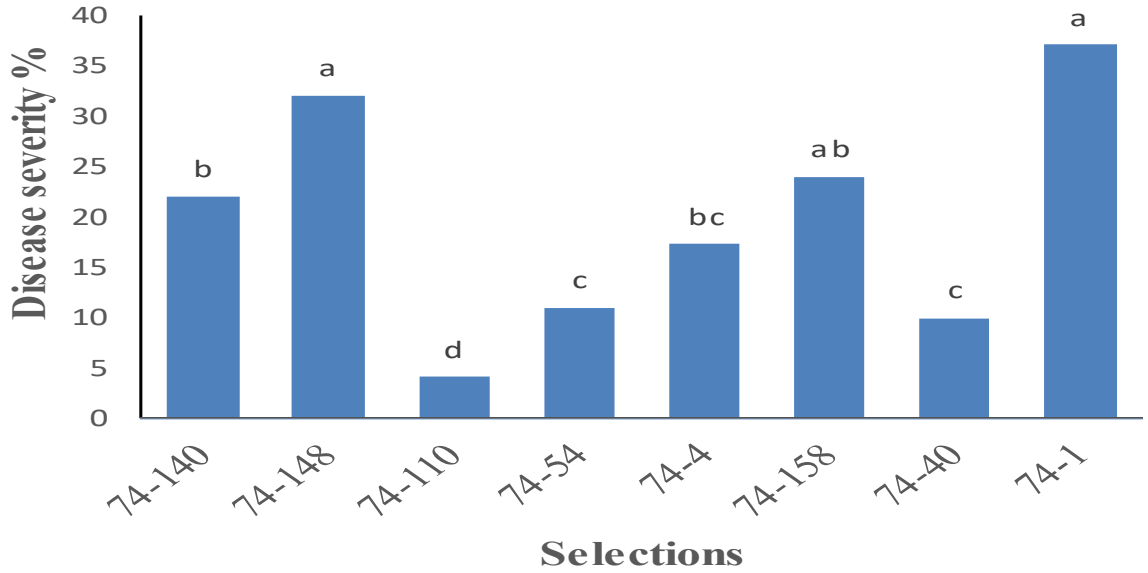


Figure 2.Coffee leaf rust disease severity in Gomma one coffee farm at 2014/15

CLR assessments in the rainforests of Ethiopia reported by Hindorf and Omondi [16] its presence in all fields differing in incidence high rust incidence of 31.1% was recorded, for instance, in 2008 at Yayu, followed by Berhane-Kontir (21.4%) and Bonga (7.9%) in forest coffee populations. The occurrence of rust in the forest coffee populations varied significantly from season to season (Chala *et al.*[17]. Our finding also showed that CLR mean incidence was as high as 42% which indicates increased the importance of the disease in the study area. Considering the severity of the disease, Chala *et al.*[17] reported 0.08% to 5.9%, mountains forest coffee populations found in southwest Ethiopia. The mean severity of Coffee leaf rust in our study in Limmu coffee plantation at Gomma one coffee farm was 15.5% which higher to the previous studies in Ethiopia (Fig 2). Studies also show that there is an increasing trend Coffee leaf rust disease in Limmu Coffee farm.

In Brazil, losses have been estimated to be about 30% and an annual loss of about 4500 tons of coffee was estimated in Kenya in the 1960s [16]. Avelino et al.[18] were reported the production has been considerably reduced in Colombia (by 31 % on average during the epidemic years compared with 2007) and Central America

 

(by 16 % in 2013 compared with 2011–12 and by 10 % in 2013–14 compared with 2012–13). Generally, coffee leaf rust incidence and severity varied among selections which planted at Gomma one southwest Ethiopia. This could be because of difference in weather conditions that can be manifested through differences in rainfall, temperature, sun shine and humidity.

Table 1 Pearson correlation coefficient (r), between leaf rust disease intensity and weather data during year 2014 in Gomma-1 coffee farm.

| | Severity | Incidence | Rain fall | Temperature |
|---|---|---|---|---|
| Incidence | 0.746* | | | |
| Rain fall | 0.143ns | 0.439ns | | |
| Temperature. | 0.589ns | 0.602ns | -0.089ns | |
| Sunshine | 0.453ns | 0.778* | 0.153ns | 0.562ns |

In this study, when the relationship between environmental factors (Table 1) and disease incidence and severity (Fig.1and.2) were considered, there was significantly ($p < 0.05$) positive correlation between selections, disease incidence and severity ($r$=0.746). There was positive correlation between mean temperature, sunshine and disease incidence ($r$= 0.60) and severity ($r$ = 0.58) but, non-significant difference. Furthermore, there was positive correlation between mean rainfall (Table 1) and disease incidence and severity (Fig. 1 and 2). Rain plays the most important role in disease development. It provides moisture for spore germination and aids in dispersal. Seasonal variation in disease incidence is largely due to variation in rainfall patterns. Temperature is the most important environmental factor influencing germination and infection. The minimum, optimum, and maximum temperatures reported to be 15.5, 22, and 28 $^{oC}$. On leaves, minimum and maximum temperatures are slightly lower, 12.5 and 32.5 $^{oC}$, respectively [8,16].

At time of surveying at Gomma one coffee farm heavy crop the damage caused by coffee rust was the result of reduced photosynthetic capacity of infected leaves and premature defoliation or leaf drop associated with high infection levels. Vegetative growth and berry growth and size are reduced and are generally related to the amount of rust in the current year. The impact of rust, however, can have a longer term impact. Leaf rust associated defoliation and the strong carbohydrate sink of the berries cause shoots and roots to starve and consequently to dieback, thereby reducing the number of nodes on which coffee will be produced next year. Since next year's production of coffee occurs on wood produced this season, the tip and shoot dieback caused by the rust can seriously reduce the following season's crop by 50% at Gomma coffee farm which was similar result researchers have estimated losses caused by rust between 30 and 80% [8]. CLR was first reported in Ethiopia in 1934, but the disease had existed for a long time in other countries without causing epidemics or eradications of certain varieties of *C. arabica*. The long-term co-existence of coffee and rust coupled with the high genetic diversity of coffee populations and a high level of horizontal resistance might have kept the rust at low levels [19]. Other factors such as the low average productivity associated with shade and the existence of biological agents such as the hyper parasite *Verticillium lecanii,* were also believed to play an important role in maintaining CLR at low levels.

**Symptom:** The thread blight on assessed farm includes dark brown or black decay and rot of leafs (Fig 3), twinge and berries followed by defoliation berry drop, and die back of primary branches, affected leafs hang from strong fungal mycelia treads that can be seen on twinges and petioles (Fig 3). Whole plant can be affected resulting in sever crop damage. These threads eventually become dark brown in color. Further infection caused by the disease would be result in dead stems, dried flowers and coffee berries would be also infected by turning black rotted.

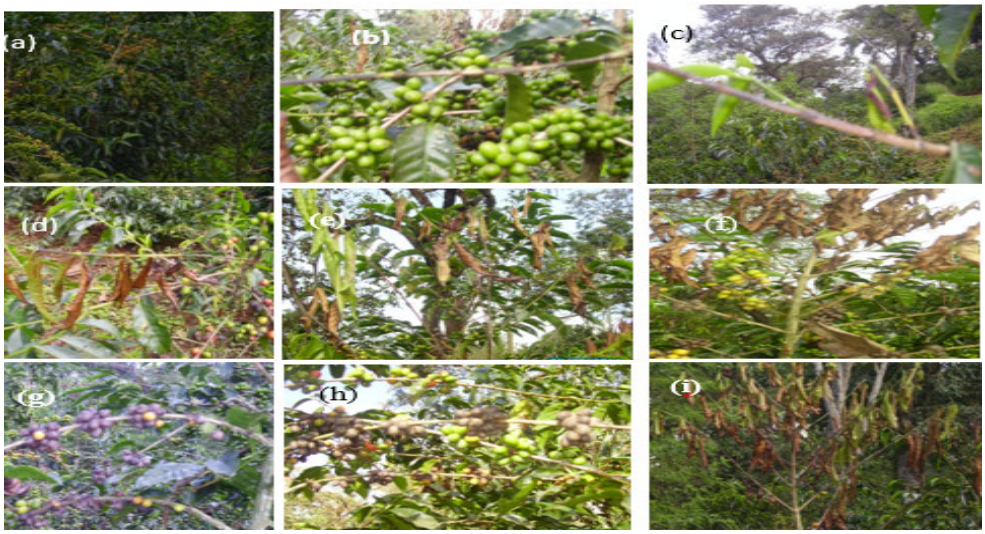

Figure 3 Syptom of thread blight on the different coffee organ

 

The thread blight (black rot) disease outbreak assessment on thirteen commercial of coffee selection the result revealed the disease was presence in all plots. There was significant difference among commercial coffee selections incidence for thread blight at Suntu coffee farm were statistically significant with in selection ($p < 0.01$) high mean 56%, 52%, 44% and 40% diseases incidence 74-87, 74-40,74-110 and 74-112 respectively (Fig.4). However, 74-4, 74-1and 75-227 coffee selection showed lowest diseases incidence 16%,16% and 20% respectively (Fig 4). According to Girma *et al*., [20] thread blight diseases of coffee was one of locally important coffee diseases in Ethiopia. The disease syndrome was observed since 1978 at Metu and Gera agricultural research sub-centers, southwestern Ethiopia. This disease sporadically occurs between June and September, but increasingly becoming important at high land coffee growing areas around Gera, Metu and "Gumer" Limmu.

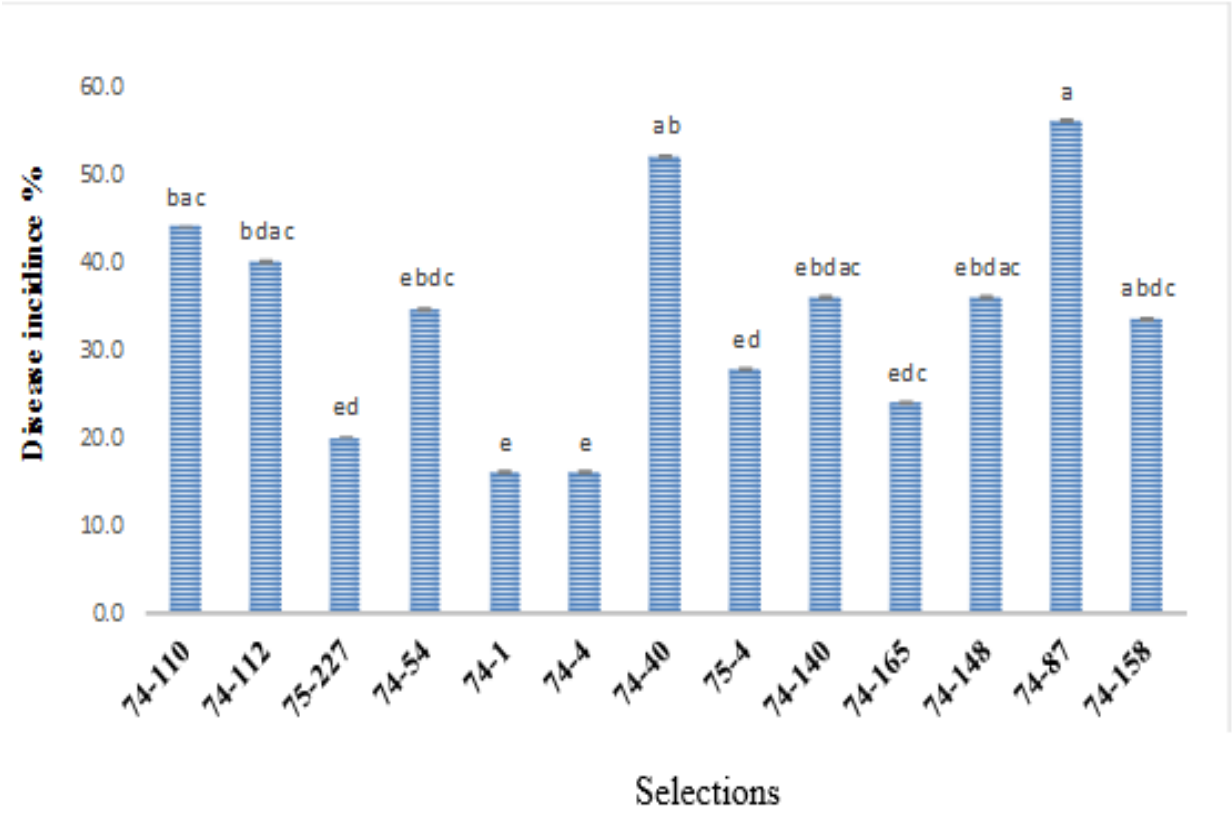


Figure 4 Incidence of coffee thread blight on different released coffee berry disease resistance cultivars

Thread blight of coffee outbreak was seen for first time in 2008 at Limmu coffee plantation farm of "Gumer" with mean diseases incidence and severity of 49.2 and 9.8, respectively [14]. Currently in 2014 number of coffee farms such as Duwina coffee farm of AgriCeft PLC, Limmu coffee Plantation of Horizen PLC and coffee research subcenters such as Gera, Haru, Mugi and Awada reported similar coffee Kife *et al*.[14] disease symptoms in the same season. These observations suggested that such weather calamities might have predisposed the coffee plants to threadblight infections.

The economic impact of coffee thread blight reduction of quantity and quality of yield, the data showed that estimated yield loss due to thread blight reach 381quntal from annual coffee production at Suntu coffee farm (Table 2).

Table 2 Coffee production losses due to coffee third blight during production season at Suntu coffee farm

| | |
|---|---|
| Estimated clean coffee yield /qt/ha | 6.9 |
| Yields loss due to disease/qt/ha | 0.27 |
| Diseased among total area | 55.25 |
| Total production area | 1412 |
| Total clean coffee yields loss in quintals | 381.24 |

 

Table 3 Additional cost spent for coffee production during disease happed at Suntu coffee farm

| Production cost | | Disease management cost | Total cost |
|---|---|---|---|
| Labor cost(US$) | 3520.00 | 9069.00 | 12589.00 |
| Material cost(US$) | 5237.00 | | 5237.00 |
| Other cost(US$) | 262.00 | | 262.00 |
| Total cost(US$) | 9019.00 | 9069.00 | 18088.00 |

Additional cost spent for coffee production during disease happed at Horizon plantation Suntu coffee farm and Costs of control using cultural practices were estimated at US$18088 (Table 3). Income loss due to thread blight of coffee disease during the production season 2014/2015 at Suntu coffee farm US$ 101791 (Table 4).

Table 4 Income loss due to thread blight of coffee disease during the production season at Suntu coffee farm

| | |
|---|---|
| Average clean coffee price/qt (US$) | 267.00 |
| Total clean coffee price loss (US$) | 101791.00 |
| Total cost spent (US$) | 18088.00 |
| Ground total loss duo to coffee tread blight or black rot (US$) | 119879.00 |

According to Cavalcante and Sales [12] thread blight caused by the phytopathogenic fungi (*Corticium koleroga*) is an important disease of Coffee in India, Trindad and Tobego. In Ethiopia the disease had first been recorded in 1978 at Gera and Mettu Agricultural Research Sub-centres [21]. Thread blight diseases on Ethiopian coffee was known for more than 40 years and considered as minor coffee disease. The result of the study was in line with Belachew *et al*.[14] it is increasingly becoming an important disease and has been observed in wide coffee growing regions of Ethiopia.

## CONCLUSION

Coffee is prone to a number of diseases that attack fruits, leaves, stems and roots, and reduce yield and spent of additional management costs. Coffee rust disease is present in all Horizon plantation, Limmu coffee farm. Its incidence varies from selection to selections. The finding also showed that coffee leaf rust mean incidence which indicates increased the importance of the disease in the study area. Coffee thread blight caused by *Corticium koleroga* (Cke) Hoehnel is a, re-emerging and devastating disease that causes severe damage in Limmu coffee plantation Suntu farm and treat in coffee industry. The occurrence and distribution of the disease is varying from selection to selections. The disease epidemics is found to be favored by prolonged rainfall and high relative humidity and prevalence of wet and humid conditions, that perhaps reflects one of the climate change scenarios. These epidemics should be considered as a warning for the future, as they were enhanced by weather conditions consistent with climate change. Appropriate actions need to be taken in the near future to address this issue including: the development and establishment of resistant coffee cultivars; the creation of early warning systems; the design of crop management systems adapted to climate change. Additional detailed characterization of the thread blight causing organisms or pathogen of Arabica coffee is essential.

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