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# Evaluation of taro leaf blight disease (*Phytophthora colocasiae*) incidence on Kenyan and Pacific Island taro (*Colocasiae esculenta*) accessions in Kakamega (Western Kenya)

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**Key words:** *Phytophthora colocasiae*, Accession, Incidence, Weather, Western Kenya

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## Abstract

Taro (*Colocasiae esculenta*) is an important staple crop for millions in most parts of the world. Humans obtain important nutrients such as calcium, phosphorus, iron, Vitamin C, thiamine, riboflavin and niacin from Taro. However its production in Kenya has faced challenges, such as the taro leaf blight disease caused by the fungus *Phytophthora colocasiae*. Racib that produces spores which are released in water and spread through rain splashes during the Kenyan rainy season when infection increases due to high temperature and high humidity. Pathogen control has relied on the use of fungicides that are too expensive. This study was thus initiated to evaluate the *Phytophthora colocasiae* disease incidences under field condition in Western Kenya. Disease incidence was assessed on two taro accessions namely; *Colocasiae esculenta* var antiquorum (L) *Schott* and *Colocasiae esculenta* var. *esculenta* (L) Schott when the total number of leaves and the number of infected leaves counted was expressed as a percentage of the total number of leaves per plants of each accession under varying climatic factors such as; Relative humidity, temperature and rainfall collected during the duration of the study period in Kakamega, Kenya. The data obtained when subjected to analysis of variance (ANOVA) showed higher percentage of mean disease incidence on Kenyan taro accessions than the Pacific island taro accession, thereby indicating a high adaptability of the Pacific taro to Kenyan weather conditions. After this study, it became clear that the high effect of weather parameters appeared to have an effect on disease incidences. Pathogen Infection increased under high relative humidity (86%), high temperature (29.6°C) and high rainfall amounts (223.9mm). These results support the urgent need to develop sufficient control measures for the Kenyan taro accessions, possibly through genetic manipulation of the from Pacific taro so as to come up with resistant accessions suitable for Kenyan weather that consists of a humid, warm and high annual rainfalls.

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## Introduction

Taro (*Colocasiae esculenta*) an ancient crop, grown for its edible starchy corms, highly nutritive leaves, ornamental, medicinal and traditional uses (Chiejina and Ugwuja, 2013). Cultivation of taro in most African countries is mainly by small-scale resource poor farmers. It plays an important role in the livelihood of these farmers who are mainly women. It has got the ability to tolerate shade more than most tropical crops. In Kenya, particularly Kakamega County, it provides alternative source of carbohydrate mainly used for break first. It is naturally tasty and can be eaten with satisfaction even without other ingredients for stew. Despite the importance of this crop in Kenya, it is given limited attention in research compared to other root and tuber crops such as sweet potato and cassava (Tarla *et al.,* 2016). Taro leaf blight disease caused by *Phytophtora colocasiae* has become an economic disease in taro growing regions of Kenya. The symptoms of the blight include; small water soaked irregular dark brown necrotic lesions on the leaf lamina which enlarge rapidly and coalesce to form dark brown irregular necrotic lesions with concentric color patterns (Adinde, 2016). These would eventually cover the entire leaf and destroy it within a few days (Charles *et al.,* 2011). The conditions that are required for taro leaf blight epidemic to occur are still not well understood although environment has been identified as a factor that can influence the process (Chiedina and Ugwuja, 2013). A comprehensive knowledge of the incidence of this disease in Western Kenya is paramount to solving its disease management challenges.

Before this study, *P. colocasiae* leaf blight disease incidences for the two taro accessions namely; *Colocasiae esculenta* var antiquorum (L) Schott and *Colocasiae esculenta* var esculenta (L) Schott were unknown, even though taro disease had always presented a serious management challenge to taro productivity in the entire Kakamega county and western Kenya in general, therefore this study was initiated to provide information that could not only provide knowledge disease incidences that was unknown but also help future management exercises that could utilize or needed to compare the susceptibility and tolerance to these two taro accessions to the destructive leaf blight disease that provided a major problem to farmers who grow this root tuber in Western Kenya.

## Materials and methods

*Study area*

The Study was conducted In Kakamega, Kenya located at the Masinde Muliro University of Science and Technology farm from September 2013 to April 2014.

*Determination of disease incidence*

When determining disease incidence, (100) one hundred and seven taro suckers both from Kenya (56) and Pacific Island (51) selected for investigation for taro leaf blight incidence. The experiment was arranged in a completely randomized design (CRD). Disease incidences was determined when recorded counts of the diseased leaves of the two taro cultivars was expressed as percentage of the total number of leaves per plants according to Opara *et al.* (2012). This formula was expressed as follows;

$$\text{Percentage (\%) disease incidence} = \frac{\text{Number of leaves affected per accession}}{\text{Total number of leaves sampled per accession}} \text{X100}$$

The resistance and the susceptibility levels of the 37 taro genotypes were evaluated on a 0-100% incidence scale against taro leaf blight. An incidence level of less than 10% represented resistance and more than 50% represented susceptibility according to Rana, 2006.

Collection of meteorological data from Kakamega weather station was performed on a monthly basis. Relative humidity recorded in the morning and afternoon, minimum, average and maximum monthly temperature, and average rainfall prevailing at the observation sites were collected from Kakamega meteorological station for the interpretation of results. The weather changes were scored against the different accessions of taro used.

Level of incidence and of taro leaf blight pathogen was observed and recorded monthly.

**Table 1.** Kenyan and Pacific Taro Accessions.

| KNY/KIS/81 | KNY/KIS/81 | CE/IND/6 | CE/MAL/14 | BL/HW/08 | CE/IND/01 |
|---|---|---|---|---|---|
| KMM/MM1/75 | CE/IND/01 | CE/MAL/14 | CE/IND/6 | KNY/SYA/50 | KNY/SYA 51 |
| BL/SM/111 | CE/JP/03 | KMM/MM2/76 | BL/SM/111 | BL/HW/08 | CE/JP/03 |
| KMM/MM2/76 | KNY/KIS/81 | BL/HW/26 | CE/IND/01 | CE/MAL/14 | BL/HW/26 |
| BL/SM/111 | CE/MAL/14 | CE/IND/6 | KNY/KIS/81 | CE/JP/03 | CE/IND/01 |
| BL/SM/120 | KMM/MM1/75 | KNY/SYA/50 | BL/SM/120 | KMM/MM1/75 | KNY/SYA 51 |
| BL/SM/128 | BL/SM/158 | CE/JP/03 | BL/SM/120 | BL/SM/128 | BL/SM/120 |
| KMM/MM1/75 | BL/SM/158 | KMM/MM1/75 | CE/IND/6 | KNY/SYA/50 | BL/SM/158 |
| BL/HW/08 | KNY/SYA 51 | BL/HW/26 | KMM/MM2/76 | KNY/SYA/50 | BL/HW/26 |
| BL/HW/08 | BL/HW/26 | BL/HW/08 | BL/HW/08 | BL/HW/26 | BL/SM/128 |
| KMM/MM2/76 | CE/THA/24 | BL/HW/26 | KMM/MM2/76 | BL/HW/08 | KNY/SYA 51 |
| **KNY/LVC/22** | CE/THA/24 | KNY/LVC/22 | CE/THA/24 | KNY/LVC/21 | KNY/CTR/33 |
| KNY/BSA/41 | KNY/KAK/16 | KNY/ELD/75 | KNY/KTL/61 | KNY/KAK/16 | KNY/KTL/61 |
| KNY/CTR/33 | KNY/KTL/61 | KNY/BSA/41 | CE/THA/24 | KNY/ELD/75 | CE/THA/07 |
| KNY/LVC/21 | KNY/LVC/22 | KNY/ELD/75 | KNY/LVC/21 | KNY/KTL/61 | KNY/LVC/22 |
| KNY/LVC/20 | KNY/KAK/16 | KNY/BSA/41 | KNY/CTR/33 | CE/THA/07 | KNY/ELD/75 |
| KNY/KAK/16 | KNY/LVC/20 | KNY/KTL/61 | KNY/LVC/20 | KNY/KAK/16 | KNY/CTR/33 |
| KNY/CTR/33 | KNY/LVC/20 | CE/THA/07 | KNY/LVC/21 | CE/THA/07 | |

Key: Green- Kenyan accessions of taro.

Blue- Pacific Island accession of taro.

*Analysis*

The results obtained on the different taro accessions were analyzed using analysis of variance (ANOVA) and the least significant difference (LSD) used to separate the means at 5%. Correlation analysis was used to compare mean differences as described by Obi, (2002).

## Results

*Relative humidity viz percentage taro leaf blight disease incidence*

The result of the disease survey revealed higher percentage mean disease incidence (27.9%) on Kenyan taro than on Pacific Island taro (10.8%). The result showed that weather factors contributed to differences observed in taro leaf blight disease incidence. Relative humidity of 64% recorded in the morning posted the highest disease incidence of 40.69% for the Kenyan taro and 17.0% for the Pacific taro. The lowest relative humidity recorded at the same time of 56.5% posted percentage incidences of 25.89% and 2.61% for Kenya and Pacific respectively.

The highest relative humidity recorded in the morning hours was 66%, during which the percentage incidence for Kenya was 30.732% and Pacific island taro was 23.118%. Relative humidity 64% and 66% were significantly $p<0.05$ different in percentage disease incidence of Kenyan and Pacific taro. Investigation performed under humidity recorded in the afternoon indicated that the highest humidity recorded of 55% posted the highest percentage incidence for both Kenyan and Pacific Island taro (Fig. 1.2). The highest percentage incidence for the Kenyan taro (40.696%) was recorded under humidity 46% while for Pacific taro the highest percentage incidence of 23.118% was recorded under RH 52%. Significant differences ($p<0.05$) in percentage incidence was realized at RH 52% and 55%. RH 55% did not show any leaf infection presenting 0% disease incidence. RH 52% and 46% were also significantly ($p<0.05$) different in % incidence for both Kenyan and Pacific taro (Fig. 1.2).

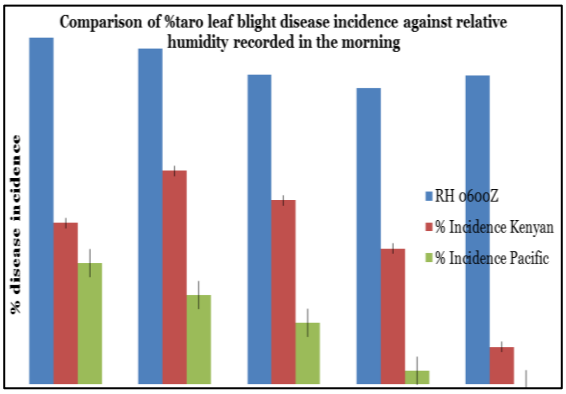


**Fig. 1.1.** Comparison of TLB disease incidence against RH 0600Z (morning) between Kenya and Pacific taro.

*Temperature viz percentage taro leaf blight disease incidence*

Incidence was highest (40.421%) for the Kenyan taro at minimum temperature of 15.1°c. The lowest percentage disease incidence level was registered at a minimum temperature of 14.5°c for both Kenyan and Pacific taro (Fig. 1.3). Percentage incidences on 15.1°c (17.00%) and 14.4°c (11.725%) were significantly ($p>0.05$) the same for the Pacific taro (Fig. 1.3). The highest percentage incidence was realized with the Kenyan taro (40.421%) than the Pacific taro highest percentage incidence (23.118%) as shown on (Fig. 1.3).

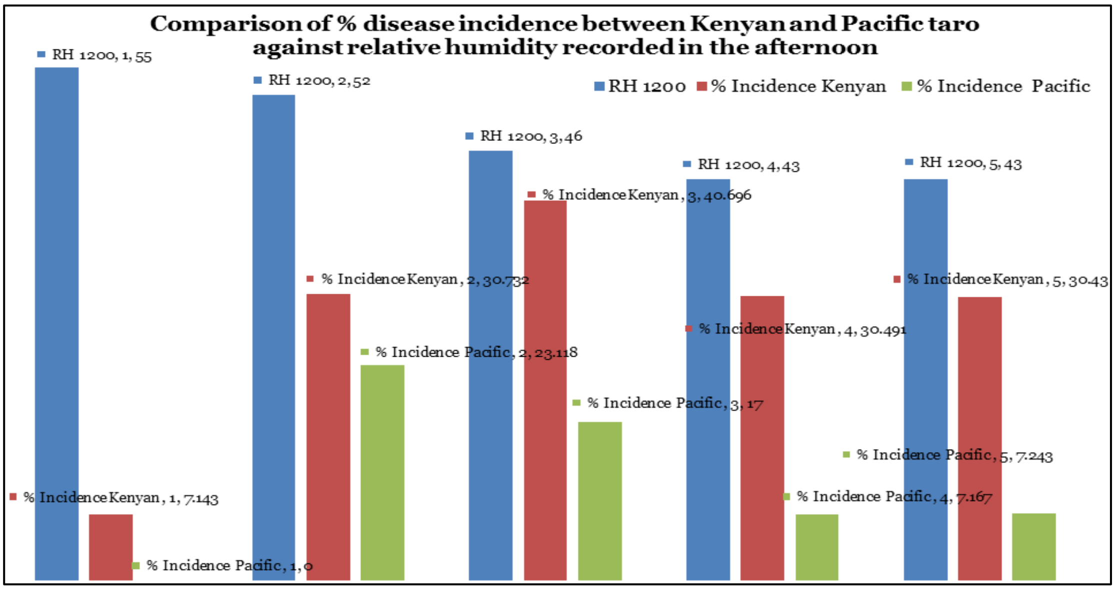


**Fig. 1.2.** Comparison of % disease incidence between Kenya and Pacific taro accessions against relative humidity RH1200 (afternoon).

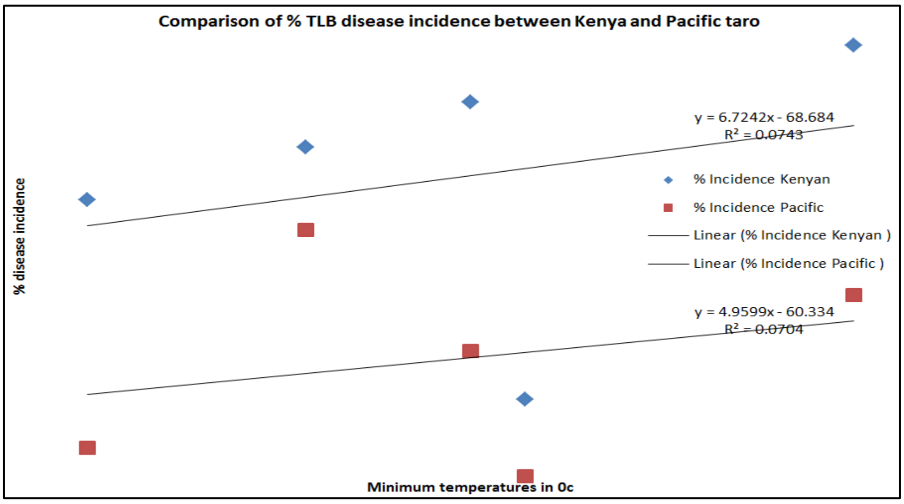


**Fig. 1.3.** Comparison of the % TLB disease incidence against minimum temperatures between Kenya and Pacific taro.

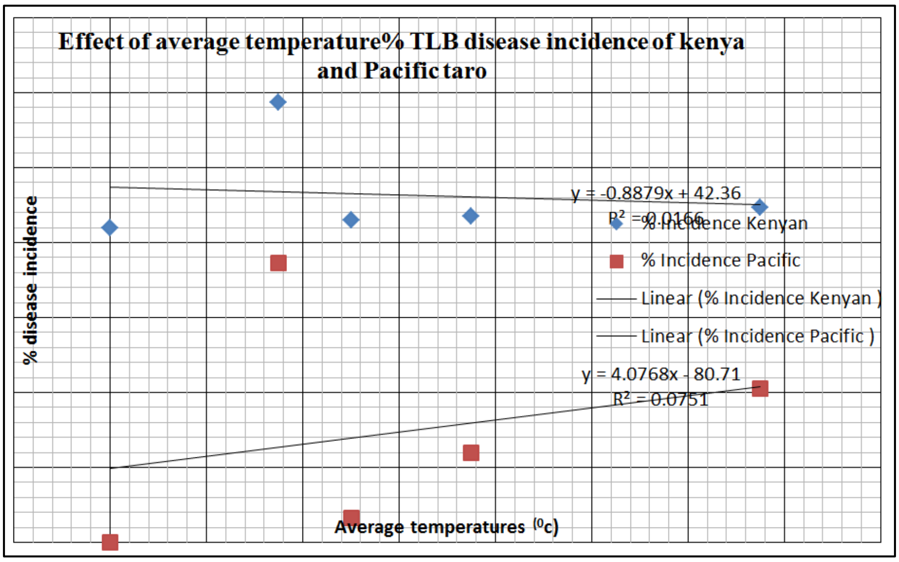


**Fig. 1.4**. Comparison of the effect of average temperature on TLB disease incidence on Kenyan and Pacific taro.

Highest percentage disease incidence for both Kenyan and Pacific taro was recorded at an average temperature of 21.35°c with disease incidence 29.35% and 18.657% respectively. Average temperature of 21°c recorded nil disease incidence on Pacific taro but 21% on Kenyan taro (Fig. 1.4). The mean infected leaves and % TLB disease incidence for both Kenyan and Pacific taro were highly ($p<0.05$) significant at maximum temperature 28.6ºc and 27.5ºc. There was no significant difference ($p>0.05$) between temperature 28.6°c and 29.6°c in terms of % disease incidence on Kenyan taro accessions but the same temperatures were significantly ($p<0.05$) different in disease incidence of Pacific taro (Fig. 1.5). Maximum temperature 29.6°c recorded the highest percentage disease incidence (40.421%) on Kenyan taro while 28.6°c recorded the highest percentage disease incidence (23.118%) on Pacific Island taro. Temperature 27.5°c recorded the lowest percentage disease incidence for both Kenyan and Pacific taro (Fig. 1.5). In this case temperature 29.6°c was optimum for the pathogen on Kenyan accessions and 28.6°c optimum for the pathogen on Pacific accessions. There was significant difference ($p<0.05$) between the maximum temperature 28.6°c and 29.6°c in terms of % disease incidence.

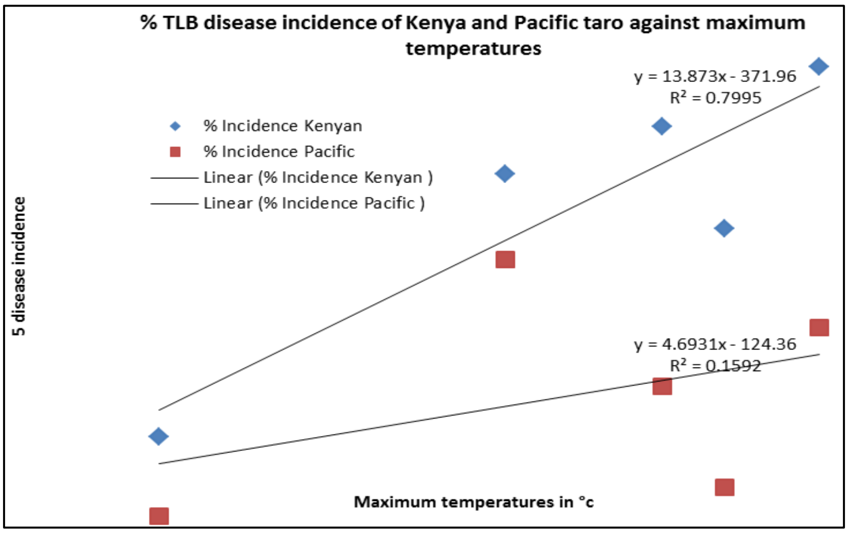


**Fig. 1.5.** Comparison of TLB disease incidence of Kenya and Pacific measured against maximum temperatures.

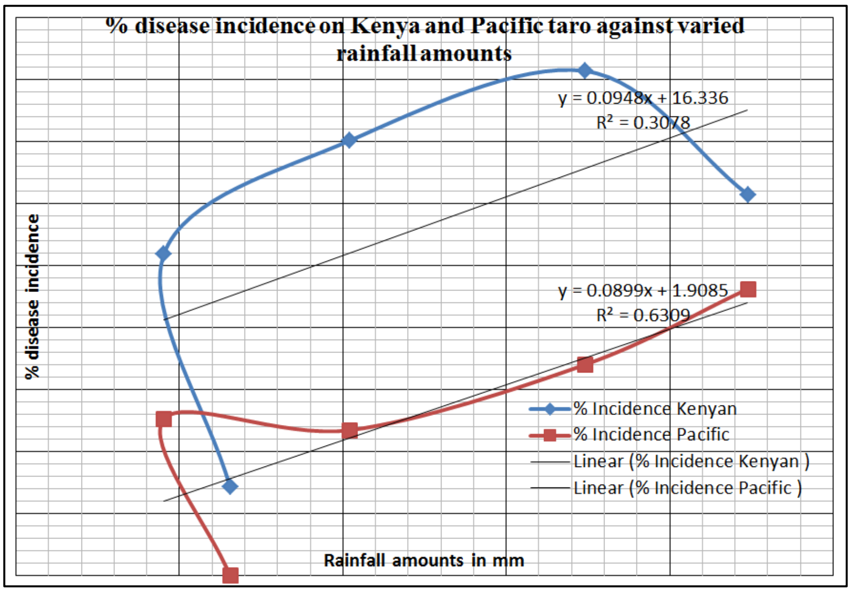


**Fig. 1.6.** Comparison of Taro leaf blight disease incidence of Kenya and Pacific taro against varied rainfall amounts.

*Rainfall viz percentage taro leaf blight disease incidence*

The range of rainfall amount recorded during the course of the study was 45.2-223.9mm within the years 2013 and 2014. The highest percentage disease incidence on Kenyan taro was 40.696% realized at rainfall amount of 174mm and the lowest percentage disease incidence (7.143%) at rainfall amount of 65.5mm (Fig. 1.6). On the other hand, Pacific island taro highest percentage TLB disease incidence was 23.118% at rainfall amount of 223.9mm and the lowest incidence of 0% at 65.5mm of rainfall (Fig. 1.6). Disease incidence for the Pacific Island taro was highly significant ($p<0.05$) among the varied mean monthly rainfall as shown on (Fig. 1.6). The disease infection seemed to increase with increase in the amount of rainfall. Compared to the Kenyan taro, Pacific taro registered lower mean percentage disease incidence than Kenyan.

*Kakamega station meteorological data*

The variation in weather parameters in 2013, were; rainfall between 5.5mm and 65.5mm, Minimum temperature between 13.9°c and 15.4°c, average temperature between 16.25°c and 21.2°c, maximum temperature between 17.1°c and 27.5°c, RH1200 between 55% and 58% and RH600 between 68% and 89%. In 2014, the rainfall ranged between 45.2mm and 223.9, minimum temperature between 13.7°c and 15.1°c, average temperature between 21.25°c and 22.35°c, maximum temperature between 28.4°c and 29.6°c, RH1200 between 43% and 52% and RH 600 between 56.5% and 66%.The weather conditions affected the spread of taro leaf blight as well as the development of taro tubers and leaves.

**Table 2.** Agro-metrological data showing mean monthly rainfall (mm), minimum, average and maximum temperature ($^0$C), relative humidity (%) of the study sites for the period of taro field study (2013 and 2014).

| Year | Rainfall(mm) | Minimum temp (°C) | Average temp (°C) | Maximum temp (°C) | R.H 1200 (%) at 10am | R.H 0600Z (%) at 4pm |
|---|---|---|---|---|---|---|
| 2013 | | | | | | |
| April | 24.9 | 15.4 | 16.25 | 17.1 | 68 | 82 |
| May | 13.2 | 14.5 | 21.35 | 27.4 | 59 | 86 |
| June | 9.2 | 14.5 | 20.75 | 26.8 | 58 | 89 |
| July | 5.5 | 13.6 | 20.5 | 26.7 | 53 | 86 |
| August | 17.2 | 13.9 | 20.5 | 26.4 | 58 | 82 |
| September | 16.1 | 14 | 20.6 | 27.2 | 58 | 80 |
| October | 12.4 | 14.7 | 20.45 | 27.5 | 59 | 71 |
| November | 7.7 | 14.8 | 21.2 | 27.3 | 63 | 73 |
| December | 65.5 | 14.5 | 21 | 27.5 | 55 | 58.8 |
| 2014 | | | | | | |
| January | 45.2 | 13.7 | 21.5 | 29.3 | 43 | 56.5 |
| February | 102.2 | 14.4 | 21.75 | 29.1 | 43 | 59 |
| March | 174 | 15.1 | 22.35 | 29.6 | 46 | 64 |
| April | 223.9 | 14.1 | 21.25 | 28.4 | 52 | 66 |

**Source:** Meteorological station at Kakamaga (2013-2014).

**Discussion**

The result of this present study has shown low mean percentage *Phytophthora colocasiae* disease incidence that were both below 50% for Kenya and Pacific taro. The Kenyan category of taro accessions, according to Rana, 2006 scale was considered moderately resistant falling between 25.1-37.5% disease occurrence while the Pacific category were highly resistant recording between 0-12.5% disease occurrence. The result shows that Kenyan accessions are more susceptible to the pathogen than Pacific. However it is indicative of great hope of obtaining resistant varieties of taro.

The high resistance of the Pacific accessions could be due to the varietal differences and availability of disease resistant compounds which inhibit the proliferation of the pathogen. This concurs with the report by Chiejina and Ugwuja, 2013 that high disease resistance of plants could be as a result differences in varieties and their phenol content. The 27.9% disease incidence in Kenyan taro indicated prevalence of the disease approaching the level of susceptibility hence need to develop genetically resistant cultivars in Kenya. The present result has indicated that weather conditions have effect on infection and spread of taro leaf blight.

The taro leaf blight infection has shown positive correlation with relative humidity, temperature and rainfall. The infection correlation with relative humidity was up to RH89%, temperature was up to 29.6°c and rainfall was up to 223.9mm. All of which were the highest recorded during the course of the study. This result concurs with the report by Hiraide, 2016 that weather conditions have influence on infection rates in plants regardless of their degree of genetic resistance.

## Conclusions

The two categories of accessions (Kenyan and Pacific Island), differed in their resistance reaction against taro leaf blight. It was however noted that Kenyan categories were generally moderately resistant but the Pacific Island categories were generally highly resistant. Environmental factors play a great role in determining disease incidence in Kenya. Other parameters of Epidemic such as leaf wetness, vapor pressure deficit, microclimate and sunshine hour should be investigated in Kenya for the development of weather friendly accessions.

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