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Rainfall pattern during the period January to December, 2014 was varied and different from the long-term pattern with the first quarter of the year being rather dry (Table 2). The period was generally wet (2403 mm) as compared to the long-term average of monthly cumulative rainfall (2188 mm). The month of January recorded the least rainfall (13.8 mm) although this was significantly lower than the long-term average for the month (93 mm). Estimated cumulative potential soil water deficit of 227.5 mm was recorded as compared to 129.3 mm for the previous year. Such deficit subjects tea plants to moisture stress although not severely. Considering that only one occurrence of frost (Table 3) was reported at the beginning of the year coupled with relatively adequate rainfall, tea production increased marginally in almost all the tea growing counties with a mean positive variance of 2.93% compared to the same period last year (Table 1). Production increased in counties East of Rift Valley with a mean positive variance of 4.43%, while productivity in counties West of Rift Valley increased by a mean variance of 2.02%. In West of Rift, Trans-Nzoia County recorded the highest variance increase of 15.18% as compared to Nakuru County that recorded a variance of -6.87%. In East of Rift, Muranga County had the highest variance increase of 7.77% while Kirinyaga County had a negative variance of 0.08% (Table 1). A frost incidence which was reported during the year recorded a crop loss of 1445 Kg mt (Table 2). There were 46 hail incidences causing a loss of 267,864.3 Kg mt in the West of Rift, lower than the 64 incidences with a loss of 361,027 Kg mt reported the previous year (Table 4). The incidences were highest in April and August. In 2014, Nandi region recorded the highest number of hail incidences (Table 4).
RELATIONSHIP BETWEEN HAILSTORM PHYSICAL CHARACTERISTICS AND TEA LOSSES

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ABSTRACT
A study to determine the existence of ‘hail paths’ in tea areas using historical data was carried out in the Kenyan tea growing areas, West of the Rift Valley. Hail reports files for 20 years (1991-2011) at the Tea Research Institute (former Tea Research Foundation of Kenya) were referred and data compiled and analyzed using Statistical Package for the Social Sciences (SPSS). Hail incidences reports at the Institute were received from large scale tea farmers from Nandi, Kericho and Sotik areas. Tea estates were ranked based on hail incidences records to determine the estates with the most frequent incidences. Estates that recorded an average of more than two incidences annually were considered to fall in the ‘hail path’ based on historical data. Correlation analysis between the hailstorm incidences and hailstones physical characteristics in relation to the extent of hail damage on tea was done. There were strong positive correlations between the amount of crop loss and hail incidences (r=0.805), crop loss and the area hit in hectares (r=0.827) as well as crop loss and the time (in minutes) of hail (r=0.783). Although the round shaped hailstones reportedly showed no relationship with crop loss, the oval shaped hailstones correlated positively with crop loss (r=0.747). Generally, hailstorms accompanied by thunder increased crop losses (r=0.795) as were those accompanied by lightning (r=0.809). Hailstorms accompanied by high wind velocity (tree limbs lashing about) increased crop loss (r=0.765). It was also evident that more devastating hailstorms occurred when the wind was blowing from the North East direction (r=0.833). It is worth noting that hailstorms recording high amounts of rainfall (mm) caused significant crop losses (r=0.788). Further atmospheric studies to ascertain the above mentioned relationships are recommended to assist in making informed hailstorm forecasts.
A SOCIO-ECONOMIC ASSESSMENT OF THE EXTENT OF HAIL DAMAGE ON TEA, WEST OF RIFT

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ABSTRACT

Smallholder farmers in the tea growing areas of Kenya depend greatly on tea to support their household income and livelihood. However, they face many challenges one of which is losses incurred due to hail damage. In areas like Kericho, Sotik and Nandi Hills of Kenya, the net loss of tea green leaf due to hail is estimated at 2.7 million kilograms per year. Additionally no economic assessment of the extent of loss to the industry has been done. Therefore, there was need to assess the socio-economic impact of hail damage on tea in the West of the Rift and identify hail mitigation measures that can be put in place. The baseline data was obtained through a survey conducted among the smallholder tea farmers West of the Rift Valley. Ten (10) smallholders KTDA managed tea factory catchments were purposefully selected so as to ensure regional representation and the farmers randomly selected from across the catchment for a fair sample. Farmers were sampled at tea buying centers as they brought their tea for weighing and onward transportation to the factory. The questionnaire contained demographic information of the tea farmer, access of tea farmer to basic facilities, proportion of land size, land under tea and expected incomes. The record of hail days, physical and economic impact of hail on tea bushes and hail mitigation measures were assessed. Data analysis was done using SPSS. Results obtained indicate that hail damages tea as well as all other crops leading to massive losses and most farmers were of the opinion that their tea should be insured against hail.
ABSTRACT
A large number of water- and climate-related applications, such as drought and hailstorm monitoring, are based on space borne-derived relationships between land surface temperature (LST) and the normalized difference vegetation index (NDVI). Hailstorms are known to cause one of the highest known economic losses after drought and floods in Kenya. Hence the need to map hail occurrences using Geographic Information System (GIS) and Remote Sensing in tea growing areas in Kenya. Satellite data Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature (LST) was used in this study. MODIS Night time data sets for year 2005, 2006, 2008, 2010, and 2012 were used in the present study due to their availability and during the years, more than 20 hail incidences were reported. In addition to the MODIS LST, Advance Land Observation Satellite (ALOS) images for 2010 were used. The hail paths were digitized from the land surface temperature (LST) and normalized difference vegetation index (NDVI) generated with a threshold of below +0.4. The analyzed images clearly identified repeated hail path areas but with changing patterns of spatial distribution. It was evident that the tea growing areas around Kericho and Nandi were affected throughout the sampled study years. An evaluation of the most suitable insurance package for the farmers around these areas is recommended.
SOME EFFECTS OF HAIL ON THE PHYSIOLOGY OF THE TEA PLANT – PRELIMINARY RESULTS

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ABSTRACT
Tea [Camellia sinensis (L.) O. Kuntze] is one of the most important beverage crops in the world and in Kenya, tea earns the highest foreign exchange to the country apart from creating job opportunities.

One of the major impacts of climate change is the occurrence of severe weather conditions e.g. hail, frost and drought. Past studies have shown that climate variability is the key factor on the annual yield variability of tea with annual losses due to hail reaching up to 2.7 million Kg mt in the Kenyan tea growing areas West of Rift Valley. Currently, no recovery plans have been put in place after the hail damage for tea farmers whose tea earnings is the main source of their livelihood although the estate tea growers continue in a regular hail reporting scheme. A study to determine the key physiological processes responsible for yield in tea and how these processes are influenced by environmental factors, specifically hail damage, was carried. The experiment consisted of methods of tea bush management after hail damage as treatment. The design was a RCBD, in a split plot arrangement with clones as the main plots and methods of hail damaged tea bush management as sub-treatments (T1) left to recover on their own; T2) breaking back the damaged tea bushes; and T3) light skiffing of damaged tea bushes). Significant differences in shoot population density among clones ($P<0.05$) were recorded, with clones TRFK 6/8 and BBK35 having the lowest number of active shoots per m$^2$. These two clones took the longest time ($P<0.05$) to recover at Tinderet estate. Yield differences were also recorded between clones. However, there were no significant differences arising from method of tea bush management, clonal and site differences ($P<0.05$) on response to hail damage during the study period under review. Given that the hail on all the sites during the experimental period was light, no effect of tea bush management could be found, hence more data, especially during heavy damage need to be taken.
ABSTRACT
A number of tea diseases mostly fungal and pests are suspected to be predisposed by hail. However, there is limited information on plant health (pests and diseases) responses to hail damage. In this regard, studies were carried out to determine tea pest and diseases incidences due to hailstorm(s). Incidences of diseases and pests (mites) on ‘hail path’ and ‘non-hail path’ were compared. Relationship between incidence of diseases and pests in fields affected by hail with varied tea bush management practices, clones and sites was also determined. Comparisons were also made on a clonal (PMC) field applied with varied tea bush management practices one week after a hailstorm. Pests and diseases incidences on hail and non-hail paths were compared by collecting pests population and diseases incidences data from Genotype X Environment (GxE) experimental plots with similar clones (AHP S15/10, TRFK 6/8/ Ejulu, BBK 35, EPK TN 14-3) in Kangaita Farm (non-hail prone area, East of Rift, ) and in Chepgoiben, Finlay (JFK) Estate in Kericho (hail prone area, West of Rift), laid out in a Random Complete Block Design (RCBD) and replicated 3 times. In the varied tea bush management practices, clones and site comparison, fields of four different clones were demarcated in Tinderet, Kipkebe, James Finlay (JFK), Changoi and Timbilil TRFK infill estates. The tea bush management practices were break back, skiffing, shearing and control (left to recover on its own). All laid out in a RCBD and replicated three times in every clone. Data were collected on wounds, mites population and diseases (stem canker and hypoxylon) incidences and subjected to ANOVA. Results indicate that pest (mites) and diseases (stem canker) incidences were higher in a non-hail prone area (3 incidences more) compared to hail prone area. Mite population was high on bushes left to recover on their own compared to those with Tea Bush Management practices especially one month after a hail incidence. Wounds reduces significantly (P< 0.05) when plants are skiffed compared to the other tea bush management strategies and the control. The environment created by the hail incidence is too harsh for the pest and diseases to thrive and this may be used as a tipping point for eradication of an alien organisms.