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Weather Variability Influence on Occurrence and Damages of *Mononychellus tanajoa* Bonder (*Acarina*: *Tetranychidae*) on Selected Cassava Varieties in the Lake Zone, Tanzania

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Authors' contributions

This work was carried out in collaboration between all authors. Author BSW designed the study, wrote the protocol and the first draft of the manuscript. Author GMR made conceptual contributions, corrections and objective criticisms; he was assisted by author ABK. While author SJ coordinated the fields work with close supervision. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted in the Lake Zone, the leading cassava producing Zone in Tanzania during the 2015 and 2016 dry seasons. It was aimed at establishing the influence of the weather variables on occurrence and damages caused by Cassava green mites (CGM), *Mononychellus tanajoa* on commonly grown cassava varieties. The experiments were laid out in a Split plot design with varieties as sub plots and locations as main plots. The three locations were; Ukiruguru, Ng'ombe and Kishiri, the former two being in Misungwi and the other one in Kwimba districts respectively. Infestation of *M. tanajoa* was allowed to occur naturally. Results suggested that mites population and damage varied significantly ($P<0.05$) among varieties, data collection dates and locations in both years. Generally, Kwimba in 2015 and Ukiruguru in 2016 recorded the highest population of

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M. tanajoa while N'gombe had the lowest counts in both years. The highest root yield was recorded at Ukiriguru in both seasons. In both years, Liongo Kwimba and Naliendele were comparatively the most susceptible varieties while Suma and Kyaka were found to have tolerated/resisted the pest. Rainfall, relative humidity and temperatures contributed either positively or negatively to the survival, perpetuation of and damage by *M. tanajoa* in both seasons.

Keywords: Cassava; damage; dynamics; M. tanajoa; population and varieties.

1. INTRODUCTION

Arthropods variably responds to seasonally unfavourable environmental conditions, mainly heat, cold, or drought. Migration to over seasoning habitats, dormancy ranging from quiescence to diapause, and acquired hardiness are three common adaptations that arthropods have developed to cope with temporarily adverse climatic conditions [1]. Several improved and commercial cassava varieties have been bred and officially released in Tanzania (mostly in 2010) targeting improved yield and resistance to major diseases, but limited information exists on their response to the combined effect of *M. tanajoa* and the environment.

Cassava is a subsistence food to 200 million poor people in the African continent and also plays an important role in the generation of employment and income, especially for small and medium producers [2].

Cassava green mite: *Mononychellus tanajoa* Bondar. (Acari: Tetranychidae) is the most important among pests that attack cassava in Tanzania [3,4]. *Mononychellus* sp. was first reported in the country in 1972 at Ukerewe Islands [4,5]. It attacks mainly shoots and leaves of cassava reducing both photosynthetic rate and root dry matter [4]. Severely damaged leaves dry out and fall off, which can cause a characteristic candle stick appearance Moreover, as a result of the reduced plant growth, starch in the storage roots is slowed and sometimes even reversed. The root yield losses in the absence of any control measures can reach up to 50% [4]. Since the first occurrence of *M. tanajoa* in East Africa, the pest has expanded its distribution to the entire cassava growing belts, where it causes estimated yield losses ranging between 30-80 % [5,6].

In the Lake zone, the pest is more devastating with losses ranging from 20% to 80% tuber yield loss if left uncontrolled [6]. It is not known that if such variations are related to environmental differences or varied response of cassava varieties that are commonly grown.

Despite its importance and diverse use, cassava production in Tanzania (5462454 million metric tons) and the rest of African countries (149479840 million metric tons) is grossly low compared to world production statistics (256529314 million metric tons) [7]. Several efforts have been made since mid-1980s by the Tanzanian National Root Crop Research Program and International organizations particularly the International Institute of Tropical Agriculture (IITA) to breed for new varieties with acceptable agronomic qualities mainly yield. From 1990s to date, the breeding efforts were diverted to management of viral diseases, the Cassava Mosaic Disease (CMD) and Cassava Brown Streak Disease (CBSD). Such efforts have greatly addressed disease problems although has not improved the production to great extent. Excerpts in production data from early 2000s to date indicates that the cassava production in Tanzania ranges from 45737 (in 2003) to 57.228 tons/ha (in 2012) which is far less than that of India, 262,400 (in 2003) and 364,770 tons/ha (in 2012) in Asian countries [7]. As such many other biotic and abiotic production constraints remain to be addressed among which cassava green mite.

Researches that are geared towards understanding the ecology and the importance of the pest in relation to the environmental variables in the Lake Zone are scarce. The current studies were aimed at exploring these facts on *M. tanajoa*. The outcome(s) could be useful in designing strategies to manage *M. tanajoa* to minimum damage threshold level and subsequent losses in Tanzania.

2. MATERIALS AND METHODS

Mwanza region is located in the Lake Zone, the leading cassava producing zone that accounts for 37.43% of the total cassava in Tanzania, followed by the Southern zone, 26.50%; the Eastern zone, 12.36%; while the remaining other five zones produce only 24.15% of the cassava root yield in the country [8]. Three different field trials were conducted for two consecutive years (2015 and 2016) to assess the influence of weather variability on the occurrence and damage of *M. tanajoa* on commercial and popular local cassava varieties. The three sites, Ukiruguru Lake Zone Agricultural Research and Development Institute (LZARDI) located at 02^0 43.156'S, 033^0 01.43'E and 4000 m above sea level, N'gombe village located at 02^0 45.743'S and 033^0 01.838'E and 3888m above sea level and Kishiri village located at 02^0 48.694'S, and 033^0 22.161'E and 4023 m above sea level in Misungwi and Kwimba districts respectively, were selected for the experiments (Fig. 1). Nine different cassava varieties; Naliendele (NLD) Kiroba (KRB), Meremeta (MRM), Belinde (BLD), Liongo Kwimba (LNG), Suma (SUM), Mkombozi (MKZ), Kyaka (KYK) and Namikonga (NMK) were planted at each location and these were randomized into nine plots in a Split Plot Design with locations as main plots while varieties as sub plots and these were replicated three times making a total of twenty seven plots. The treatments were allocated to a plot size of 36 m^2 with 1m path (boarder) between plots and 2 m between blocks, respectively. One stem cutting (30 cm long) was planted at a spacing of 1x1 m within and between rows giving a total of 10000 plant population ha^{-1} in a 1924 m^2 plot. This was allowed under natural infestation by the mites.

2.1 Population Assessment of *M. tanajoa*

Cassava green mite population was monitored at monthly intervals starting at three months after planting i.e from March and ending in September respectively for each seasons by the visual counting of the mites on the top fully open five leaves using a hand lens (Model No. YT1045/50 mm). In each plot, eighteen cassava plants within a net plot were sampled randomly for assessment while leaving out the border rows to avoid boarder effects [4].

2.2 Leaf Damage Assessment

The leaf damage was recorded using a scale of 1 to 5 (i.e. 1 means no obvious symptom, 2 = less than 5% of leaf chlorosis, 3 = more than 5% but less than 50% of leaf chlorosis, 4 = more than 50% of leaf chlorosis with significant reduction in leaf area and 5 = leaf is dead and has dropped) a result of the damage by the mites as reported by [9].

2.3 Statistical Analysis

Collected data were subjected to analysis of variance (ANOVA) in a Split plot design using the GenStat software 15th edition [10]. Treatment means were compared using the Least Significant Difference (LSD) at 5% level of significance ($P \leq 0.05$). While all the numerical data with low counts or zero values were transformed into log y+1 [11]. Yield data were taken in kilograms and subjected into tons $ha^{-1.}$ Regression analysis was run to predict the effect of some weather variables on the population and damage of *M. tanajoa*.

3. RESULTS AND DISCUSSION

Results in Fig. 3 indicated that both the population and damage of cassava green mite in the two seasons (2015 and 2016) were significant *(P = .05)*. Higher population and damage were recorded in 2016 compared to 2015. Between the two seasons, *M. tanajoa*

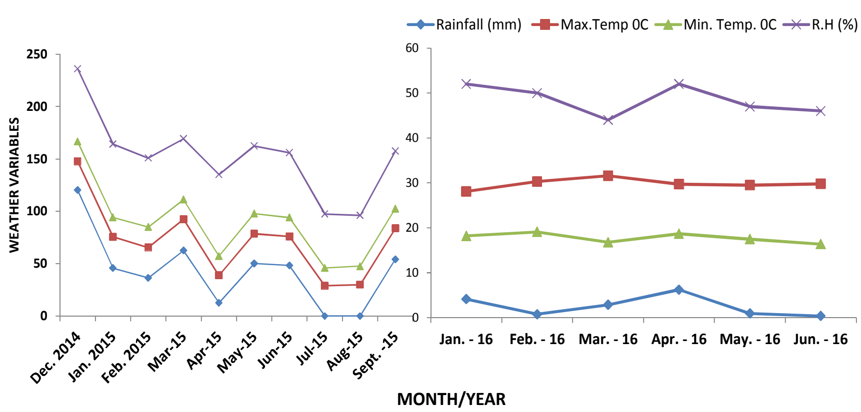


Fig. 1. Weather variables for the 2015 and 2016 of the study areas in the Lake Zone, Tanzania

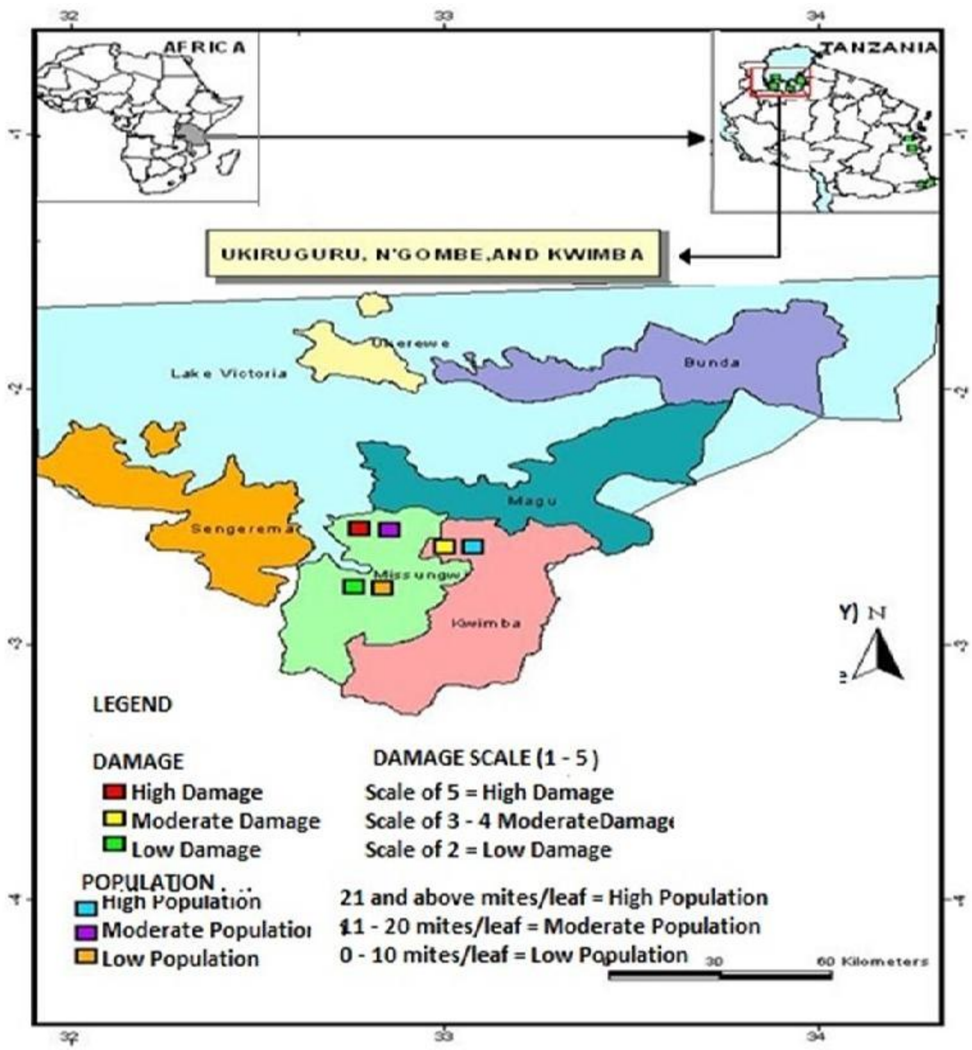
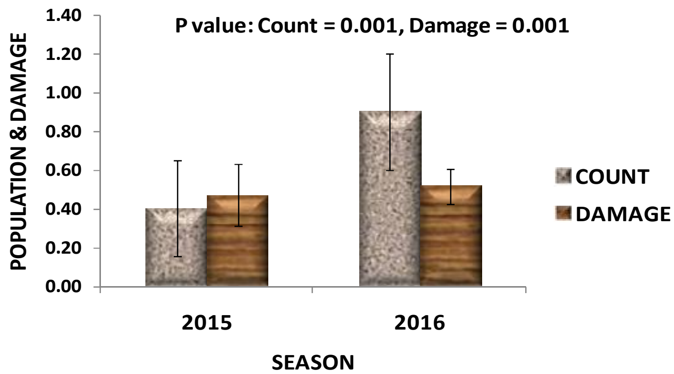


Fig. 2. Map of Tanzania showing the study areas in Mwanza Region

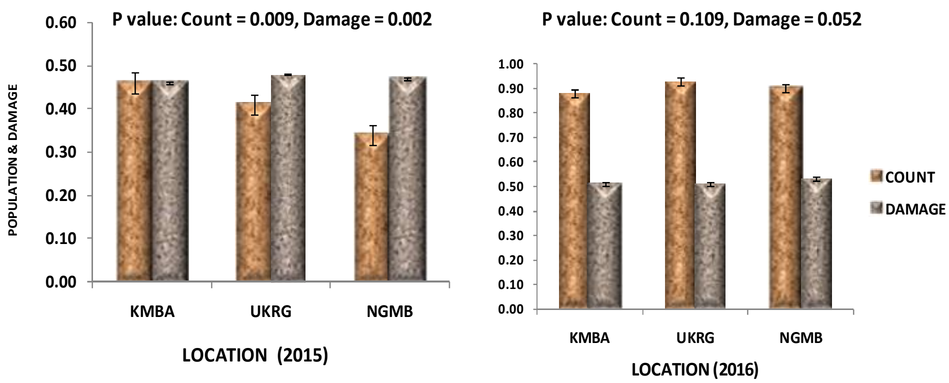
population and damage were found to be significant *(P = .05)* in 2015 with cassava planted in Kwimba (0.46) recording the highest mites' population; followed by Ukiruguru (0.41) while Ng'ombe (0.34) had the lowest population (Fig. 4). Conversely, Ukiruguru (0.48) recorded the highest damage followed by N'gombe (0.47) while Kwimba (0.46) had the least damage during the 2015 cassava growing season. Meanwhile, the damage by *M. tanajoa* was significantly different *(P = .05)* among the locations whereby Kwimba and Ukiruguru were statistically similar while N'gombe having the highest level of damage in 2016.However, the population by cassava green mite was generally higher in 2016 compared to 2015, despite the insignificant difference among the three locations. A similar result by Wudil et al. [12] revealed that a comparative analysis of *M. tanajoa* population among districts indicated Kwimba and Misungwi districts of the Lake Zone recorded the highest population compared to all other Zones in the country across the two seasons.

The difference in the number and damage of the mites between years could be due to the higher temperatures recorded in 2015 compared to 2016. Moreover, other factor such as differences in varieties and other environmental variables especially rainfall and relative humidity probably contributed to the perpetuation and damage by *M. tanajoa* [12]. The higher population at Kwimba in 2015 could be attributed to the fact that Kwimba is considered the driest among the locations, evident by the dry spell recorded during the month of March when the sampling started and rainfall had declined thus account for



SD±: Count (2015) = 0.247, Damage = 0.298 Count (2016) = 0.157, Damage = 0.094

Fig. 3. Population and damage by *M. tanajoa* during 2015 and 2016 seasons



SE±: Count = 0.009, Damage = 0.002; SE±: Count = 0.109, Damage = 0.052

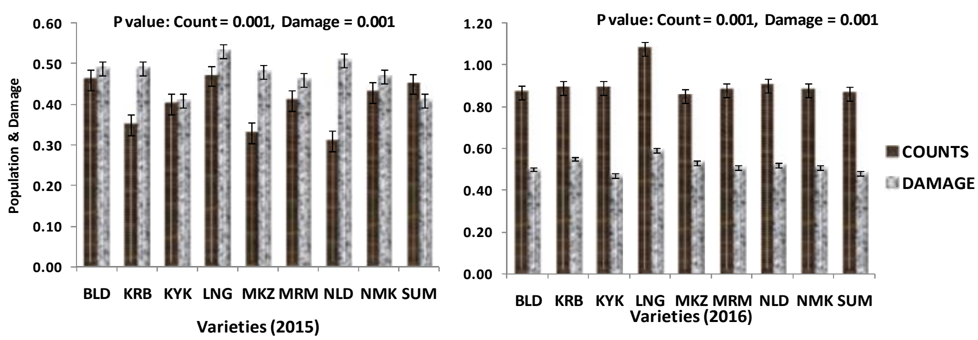
Fig. 4. *M. tanajoa* population and damage in three different locations in Mwanza region, Tanzania

Key: KMBA = Kwimba, UKRG = Ukiruguru, NGMB = N'gombe

high mite density but decreased to a certain level in subsequent months, especially at Ng'ombe and Ukiruguru at irregular intervals. This indicated that the dynamics of the mite's population across locations was irregular with its peak at Kwimba in August and June but drastically decreased to the lowest in July. This was also reported by [13] that high *M. tanajoa* densities were proved to occur in an irregular pace. More so, drier conditions might have encouraged the survival, perpetuation and distribution of cassava green mite. Conversely, in 2016 low mite's population was observed suggesting the impacts of high rainfall on the pest [12].

The observed response of cassava varieties to *M. tanajoa* in 2015 and 2016 was shown (Fig. 5). There were significant (P≤0.05) differences in the population and damage caused by *M. tanajoa* in both years among the cassava varieties. Liongo Kwimba recorded the highest mite population (0.47 in 2015 and 1.08 in 2016) and damage (0.53 in 2015 and 0.89 in 2016) in the two seasons respectively while Naliendele (0.31 in 2015) recorded the lowest mite counts. However, Kyaka (0.41) and Suma (0.41) appeared to have the least damage in 2015. Several authors [3,14, 15] reported that limited availability of fresh plant growth (during the main part of the dry season) and heavy rainfall (in the middle of the rainy season) are the factors keeping the pest populations low. The higher population at Kwimba in 2015 could be attributed to inadequate and irregular rainfall recorded in the study area due to the onset of rainfall but mite population decreased in subsequent months, especially at Ng'ombe and Ukiruguru at irregular intervals, which indicated that the dynamics of the mite's population across locations was irregular with its peak in August and June at Kwimba but drastically decreased to the lowest in July. This was also reported by [13] that high *M. tanajoa* densities were proved to occur in an irregular space [3,14,15] Moreover, the damage was observed to fluctuate as reported by [9].

The responses of some cassava varieties to *M. tanajoa* population in three locations were found to be significant ($P \leq 0.05$) (Fig. 6). In 2015, Belinde (0.46) and Liongo Kwimba (0.47) varieties generally recorded higher number of mite's infestation while Mkombozi (0.40, 0.31 and 0.28) and Naliendele (0.27, 0.38 and 0.28) had the lowest number of *M. tanajoa* across the locations. Similarly in 2016, Liongo Kwimba (1.04, 1.10 and 1.10) recorded the highest number of mites in all the three locations followed by Naliendele (0.90, 0.94 and 0.87), Kyaka (0.86, 0.90 and 0.91) and Kiroba (0.90, 0.92 and 0.86). The lowest mite count was recorded on Suma (0.81), Namikonga (0.88) and Mkombozi (0.80) at the three study sites. This could be due to the inherent susceptibility or resistance/tolerant of the respective cassava varieties. Consequently, varietal differences as per the number and damage of *M. tanajoa* could not only be attributed to weather variables but also to the inherent characteristics of the genotype. Similar result was reported by Toko and Onzo [13,16] that the variation in *M. tanajoa* population density among the genotype may be associated with factors inherent in the different genotypes. Moreover, in another research in Tanzania, [12] reported that generally, most of the cassava varieties found during the two diagnostic surveys were varied which might affect the differences and similarities that exist across the zones in the two years.



SE±: Count = 0.025, Damage = 0.017; SE±: Count = 0.033, Damage = 0.010

Fig. 5. Population dynamics and damage by M. tanajoa on commercial and popular Cassava Varieties in Mwanza region, Tanzania

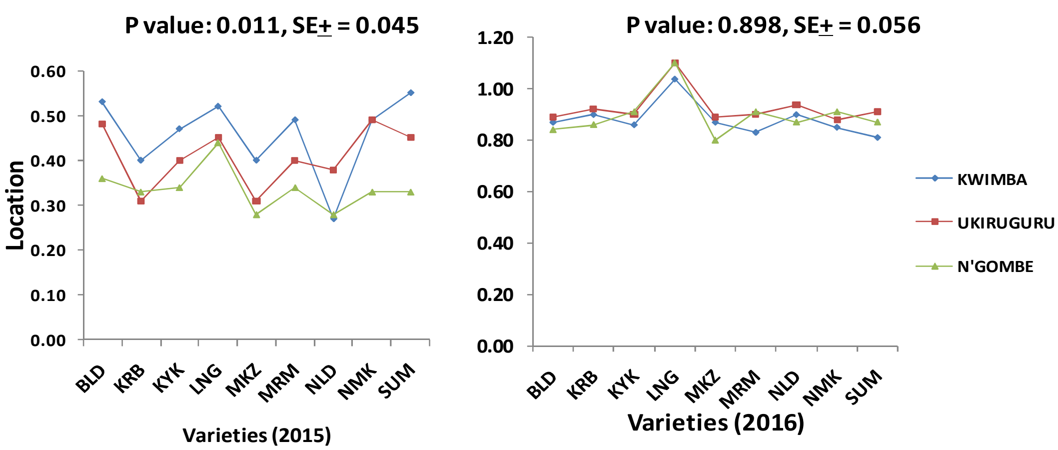


Fig. 6. The variation in *M. tanajoa* population on tested cassava varieties among the three experimental sites in Mwanza

The effects of the interaction between cassava varieties and location on the damage by *M. tanajoa* were not significant (Fig. 7). However, in 2015, Liongo Kwimba (0.53, 0.53 and 0.54) recorded higher damage across the locations followed by Naliendele (0.52, 0.49 and 0.51) and Belinde (0.51, 0.49 and 0.50) with Suma (0.37, 0.46 and 0.39) having the lowest damage compared to other varieties. Similarly, Liongo Kwimba (0.57, 0.61 and 0.60) and Kiroba (0.54, 0.54 and 0.57) recorded higher damage in all the three locations in 2016 and Kyaka (0.46, 0.46 and 0.48) was found to have the least damage among all other varieties (Fig.v 8). In both years, the interaction effect between the tested varieties and locations on root weight ha^{-1} was not significant (Fig. 9). All the eight varieties were found to be statistically similar. Moreover, among the other varieties, Kyaka performed better than the seven other varieties. The lowest root weight was recorded by Liongo Kwimba in all the three locations in the order Ukiruguru (9960.00 kg-1), Kwimba (6560.00 kg-1) and N'gombe (12000.00 kg-1) respectively. The damage on cassava varieties led to high loss of the cassava leaves and subsequent reduction in the photosynthetic ability of the cassava and the yield, especially on the susceptible varieties. This has been reported by researchers that the damage has been equated to the loss of biomass and is an indicative loss of the leaf photosynthetic area [17].

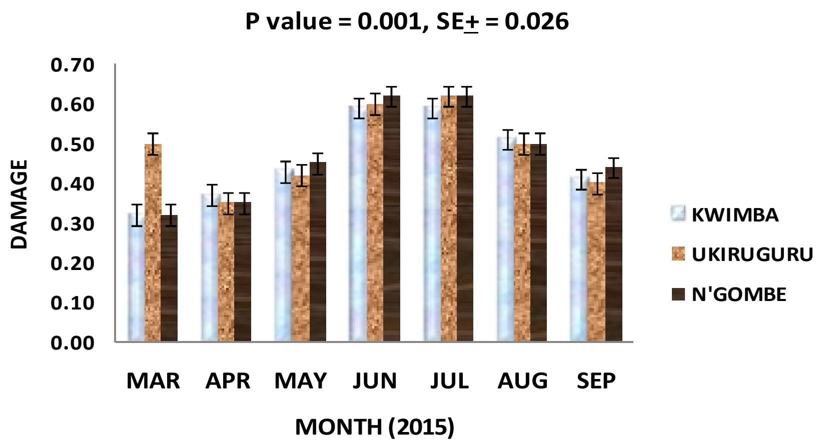


Fig. 7. Interaction effects of cassava varieties and location on damage by *M. tanajoa* in the Mwanza region, Tanzania in 2015

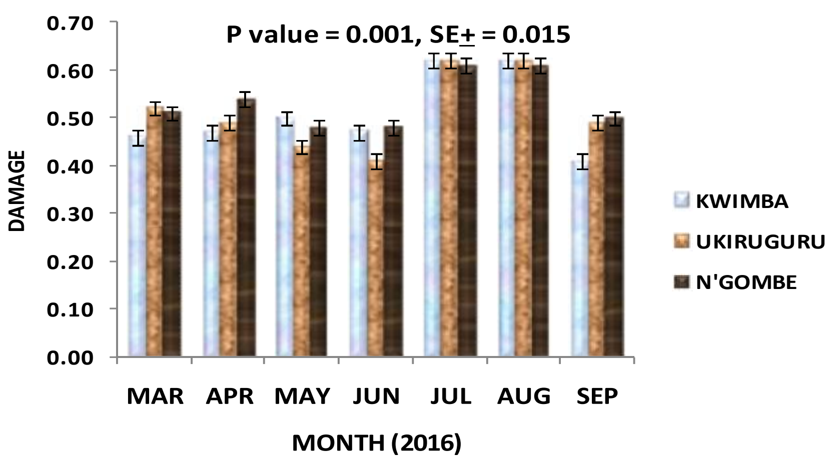


Fig. 8. Interaction effects of cassava varieties and location on damage by *M. tanajoa* in the Mwanza region, Tanzania in 2016

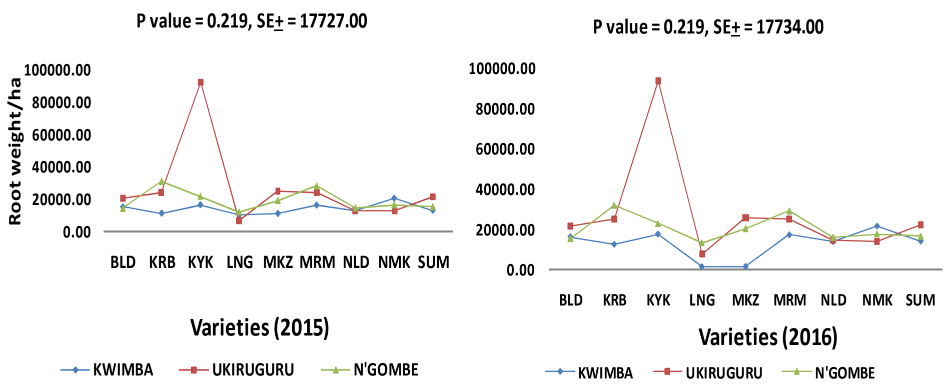


Fig. 9. Interaction effects between variety and location on Average Root Weight (ha^{-1}) as influenced by *M. tanajoa* in Mwanza region, Tanzania

Multiple regression analysis was conducted to predict the effects of the weather variables on the population and damage of *M. tanajoa* in the Lake zone, Tanzania in 2015 and 2016 rainy and dry seasons (Table 1). Four weather variables (rainfall, relative humidity, and maximum and minimum temperatures) were simultaneously entered into the analysis and a question what was the percentage contribution of each of the dependent variables to the population and damage of *M. tanajoa*. The overall variance explained by the three predictors was 1.1% in 2015 and 34.3% in 2016 which means that all the predictors accounts for 1.1% and 34.3% variance to the number of *M. tanajoa* in (in 2015) and 2016.. Rainfall and minimum temperature were positively correlated to the mites' count while relative humidity and maximum temperature negatively related to *M. tanajoa* population of in 2015 such as rainfall (β = 0.000574, p $\leq$0.028), relative humidity (β = -0.0331, p$\leq$0.003), maximum temperature (β = -0.1788, p$\leq$0.002), and minimum temperature (β = 0.1449, p$\leq$0.006) this explains that with increase in a unit of each variable (relative humidity and maximum temperature) will decrease *M. tanajoa* population. However in 2016, there were negative relationship between rainfall and relative humidity while it was positive with the maximum and minimum temperature. The fluctuations in damage caused by *M. tanajoa* within and across seasons could be attributed to differences in weather variables over time and space as well as inherent differences among the tested cassava varieties [16]. The difference in the number and damage of the mites between years could be due to the higher temperatures recorded in 2015 compared to 2016. Moreover, other factors such as differences in varieties and other environmental variables especially rainfall and relative humidity probably contributed to the perpetuation and damage caused by *M. tanajoa*. This explained that with an increase in unit of the rainfall and relative humidity, there was decrease in the mites' counts in 2016 vice versa in the case of maximum and minimum temperatures [12,16].

Table 2 shows that the relationship among the weather variable was significant (P$\leq$ 0.05). Rainfall was found to be positively correlated to *M. tanajoa* damage in 2015 and negatively in 2016. The relative humidity was negatively correlated to damage in both years while maximum and minimum temperatures were negatively correlated in 2015 and positively in 2016. The fluctuations in damage caused by *M. tanajoa* within and across seasons could be attributed to differences in weather variables over time and space as well as inherent differences among the tested cassava varieties.

Generally, the population and damage were higher in 2016 compared to 2015 which could be as a result of the higher amount of rainfall in 2015. Several researchers [12,13,14,15,16,17, 18] have reported a negative correlation between rainfall and number of mites. This could be due to the fact that the population build-up of the pest started at the onset of the dry season or end of the rainy season which is May, while July to August were the peak periods and thus, the damage was subsequently higher. The damage led to high loss of the cassava leaves and subsequent reduction in the photosynthetic ability of the cassava and the yield, especially on the susceptible varieties. This has been reported by researchers that the damage has been equated to the loss of biomass and is an indicative loss of the leaf photosynthetic area [19].

Table 1. Regression analysis of some weather variables against *M. tanajoa* count during 2015 and 2016 rainy and dry seasons in Mwanza region, Tanzania

	2015 Count			2016 Count		
Parameter	**Beta (β Value)**	**SE±**	**P Value**	**Beta (β Value)**	**SE±**	**P Value**
Constant	4.80	1.37	(0.001)**	-7.99	1.16	(0.001)**
Rainfall	0.000574	0.000261	(0.028)*	-0.11429	0.00834	(0.001)**
RH	-0.0331	0.0110	(0.003)**	-0.02773	0.00286	(0.001)**
Max. Temp	-0.1788	0.0566	(0.002)**	0.1273	0.0239	(0.001)**
Min. Temp	0.1449	0.0523	(0.006)*	0.3840	0.0371	(0.001)**

Figures in parentheses are P values (significant at ≤0.005)
Key: RH = Relative Humidity, Max. Temp. = Maximum Temperature, Min. Temp. = Minimum Temperature

Table 2. Regression analysis of some weather variables against *M. tanajoa* damage during 2015 and 2016 rainy and dry seasons in Mwanza region, Tanzania

	2015 Damage			2016 Damage		
Parameter	**Beta (β Value)**	**SE±**	**P Value**	**Beta (β Value)**	**SE±**	**P Value**
Constant	3.890	0.702	(0.001)**	-1.159	0.353	(0.001)**
Rainfall	0.000786	0.000134	(0.001)**	-0.02350	0.00255	(0.001)**
RH	-0.00100	0.00567	(0.860)	-0.013411	0.0087	(0.001)**
Max. Temp	-0.0704	0.0291	(0.016)*	0.01907	0.00728	(0.009)**
Min. Temp	-0.0692	0.0268	(0.010)*	0.1015	0.0113	(0.001)**

Figures in parentheses are P values (significant at ≤0.005)
Key: RH = Relative Humidity, Max. Temp. = Maximum Temperature, Min. Temp. = Minimum Temperature

4. CONCLUSION

The present studies have indicated that in both years, cassava varieties had responded differently to *M. tanajoa* infestation at different locations and different times of the two seasons in Lake Zone, Tanzania. Generally, the population and damage were higher in 2016 compared to 2015 season but followed similar trends across months and locations. The regression of some weather variables against the population and damage inflicted by *M. tanajoa* in both seasons predicted that all the weather variables tested have contributed either positively or negatively to the survival, perpetuation of and damage by *M. tanajoa* in both seasons. However, more researches should be carried out, especially breeding and molecular research to improve the adapted locals especially Liongo Kwimba.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Zundel C, Hanna R, Scheidegger U, Nagel P. Living at the threshold: Where does the neotropical phytoseiid mite, *Typhlodromalus aripo* survive the dry season? Experimental and Applied Acaroogy. 2007;41:11–26.
2. Andre R, Machi F, de Cássia N, Esteca P, Bergamim Arthur M. Adriani G, Arthur V. A review on *Mononychellus tanajoa* (Bondar, 1938) pest of cassava in Brazil. Australian Journal of Basic and Applied Sciences. 2014;8(3):342–348.
3. Yaninek JS, Moraes GJ, Markham RH. Handbook on the cassava green mite (*Mononychellus Tanajoa*) in Africa: A guide to its biology and procedures for implementing classical biological control. 1989; IITA:140.
4. Évila CC, Adenir V, Teodoro A, Rêgo S, Anilde G, Maciel S, Renato S. Population structure and dynamics of the cassava green mite, *Mononychellus tanajoa* (Bondar) and the predator *Euseius ho* (DeLeon) (Acari: Tetranychidae, Phytoseiidae). Arthropods. 2012;1(2):55-62.
5. Nyiira ZM. Report of investigation of cassava mite, *Mononychellus tanajoa* (Bondar). Kawanda Research Station, Kampala, Uganda, Unpublished Report. 1972;14.

6. Msabaha MAM, Ndibaz RE, Nyango AK. Cassava research advances in Tanzania for the period 1930–1988. Tanzania Agricultural Research Organisation, Ministry of Agriculture and Livestock Development, Tanzania. 1988;25.
7. Food and Agricultural Organization. FAOSTAT Database; 2013. Available:http:/www.fao.org (Site visited on 12th March, 2014).
8. Report on TZNY Cassava. Cassava: Adding Value for Africa. Driving demand for Cassava in Tanzania: Draft Report. 2012;61.
9. Nukenine EN, Hassan AT, Dixon AGO, Fokunang CN. Population dynamics of cassava green mite, *Mononychellus tanajoa* (Bondar) (Acarina: Tetranichidae) as influenced by varietal resistance. Pakistan Journal of Biological Sciences. 2002;5(2):177–183.
10. GenStat, Genstart Statistical Analysis System. SAS User's Guide Statistics 2004 Edition. Statistical Analysis System Institute, Cary; 2004.
11. Eric S. Inference fundamentals, virginia tech. Fall. STAT 5034/CRN 96072, Printing services. 540-231-6701, 1425 S. Main Street. 2013;356.
12. Wudil BS, Rwegasira GM, Kudra AB, Jeremiah S. Spatial and temporal distribution of cassava green mite, *Mononychellus tanajoa* bonder (Acarina: Tetranychidae) in Tanzania. Archives of Current Research International. 2017;8(3): 1–13.
13. Toko M, Yaninek JS, O'Neill RJ. Response of *Mononychellus tanajoa* (Acari: Tetranychidae) to cropping systems, cultivars, and pest interventions. Environmental Entomology. 1996;25:237-249.
14. Onzo A, Hanna R, Sabelis MW. Temporal and spatial dynamics of an exotic predatory mite and its herbivorous mite prey on cassava in Benin, West Africa. Environmental Entomology. 2005;34:866–874.
15. Hanna R, Onzo A, Lingeman R. Seasonal cycles and persistence of an acarine predator-prey system on cassava in Africa. Population Ecology. 2005;47:107-117.
16. Wudil BS, Rwegasira GM, Kudra AB, Jeremiah S. Response of some cassava varieties to *Mononychellus tanajoa* bondar. (Tetrachynidae: Acarina) Infestation in the Lake Zone, Tanzania. 2016;7(4):1-9.
17. Akinlosotu TA, Leuschner K. Outbreaks of two new pests (*Mononychellus tanajoa*) in southern Nigeria. Tropical Pest Management. 1981;27:247-250.
18. Teodoro AV, Klein AM, Tscharntke T. Temporally mediated responses of the diversity of coffee mites to agro forestry management. Journal of Applied Entomology. 2009a;133:659-665.
19. Teodoro A, Klein AM, Reis PR. Agro forestry management affects coffee pests contingent on season and developmental stage. Agricultural and Forest Entomology. 2009a;11:295-300.

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