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Evaluation of tea clones for resistance/tolerance to mites infestations and the influence of environmental factors on mites dynamics in Kenyan tea farms

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Keywords: Tea, clones, mites infestations, environmental factors.

Running title: Tea clones resistance to mites infestations and environmental factors.

Abstract: Mites infestations reduce yields in tea production world wide. However, some tea cultivars are resistant/tolerant to mites attack. The resistance/susceptibility can also be influenced by abiotic factors. This study evaluated some new tea clones for mite resistance/susceptibility and influence of Environmental factors (weather parameters) on dynamics of mite infestations of Kenyan tea at different ecological zones, Kangaita, Kipkebe and Timbilil. Maximum population of mites was reported during March when maximum temperature, average rainfall and relative humidity ranges for the sites were 23.9-28.7°C, 27.7-50.1mm and 38.0-70.4% respectively. There was a sharp decline in mites population in April when average rainfall was high (398.4-514.4mm) which was accompanied by reduction in maximum temperature (18.8-27.5°C) and increase in relative humidity (44.0-82.2%). The minimum population density was found during August which was characterized by low maximum temperature (16.4-26.6°C), low average rainfall (4.8- 190.5mm) and high average relative humidity (46.0-80.9%). The mites infestation levels highly correlated with maximum temperatures in Kangaita ($r^2 = 0.801$), Kipkebe ($r^2 = 0.693$) and Timbilil ($r^2 = 0.744$). There were significant ($p \leq 0.05$) monthly variations in clonal mite infestations at all sites. Susceptible clones showed higher monthly mite infestations variations than the resistant/tolerant clones. Of the clones evaluated for the first time, eight new clones were identified as tolerant/resistant while two clones were susceptible to mites attack. Resistant/tolerant clones are recommended for commercial exploitation while mitigation strategies should be put in place in mites prone areas during hot seasons with high monthly temperatures and low humidity.

Keywords: Tea; clones; mites; infestation; weather parameters; Kenya.

Introduction

Kenya is the third leading world tea (*Camellia sinensis* (L) O. Kuntze) producer and the largest tea exporter[1], making it a major cash crop for the country. The Kenya tea industry grew very rapidly due to use of high yielding varieties, appropriate agronomic inputs and conducive environment for production[2]. The fast rise in production has introduced some challenges. For example, some high yielding varieties released to the industry are prone to biotic and abiotic stresses leading to productivity losses. Pest infestations are a major problem in many tea growing countries causing huge loses. Yield losses up to US $500 million per annum have been recorded in India[3]. Where mite infestations are high, their management in tea is usually through the use of synthetic pesticides. This results in undesirable effects such as proliferation of pesticide-resistant generations of pests, devastation of natural enemies, environmental contamination, and high pesticide residues in tea[4]. The problem of pesticide residues in processed tea has led to issuance of maximum residue limits (MRLs) on different pesticides to reduce the level of contamination of tea offered for trade[5]. For the Kenya tea industry, use of pesticides on tea is prohibited and control of pests is strictly through use of cultural practices including use of resistant/tolerant tea cultivars and agronomic inputs that deter pests attack[6, 7].

In Kenya tea is grown in two main geographical regions, Mount Kenya and Aberdare in east and

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Mau Ranges in west of the Rift Valley. While pest infestations are relatively rare, sporadic yield losses caused by mites infestations have been estimated to be up to about 50%, during prolonged drought around the Mount Kenya region in the east of the Rift Valley[7]. Red crevice mites (RCM) (*Brevipalpus phoenicis* Geijskes) and red spider mites (RSM) (*Oligonychus coffeae* Nietner) cause significant yield losses to the Kenya tea industry[6]. The RCM are prevalent in the east of Rift Valley while RSD at the west of Rift Valley[6]. These mites are characterized by very high rate of population increase and high densities[8]. Normally mites attack the upper surface of mature leaves where they feed on chlorophyll of the maintenance foliage, but in severe cases young leaves are also attacked leading to defoliation and occasional death of the tea bushes[9, 10]. Distinct seasons occur in the tea growing regions in Kenya[11] which are classified as cold and wet (rainy season), cold and dry (cold season) and warm and dry (dry season). Mites infestations levels in tea are influenced by temperature, rainfall and relative humidity among other climatic factors in Bangladesh[12]. It is not known if the variations in these climatic factors could be responsible for the differences in mites attack to tea in the different parts of Kenya.

Tea improvement programme in Kenya is achieved through breeding and selection of cultivars for high yields, acceptable quality and tolerance to abiotic and biotic stresses including pests infestations[13]. Recently, the Kenya tea industry imported some tea varieties from Tanzania[14]. These clones have not been evaluated for tolerance/resistance to mites and if such tolerance/resistance varies with location of production and time of the year. The performance of these clones and some recently developed clones in Kenya relative to cultivars in production and the dynamics of changes in mite attack with time of the year were compared in three locations in Kenya.

Materials and methods

Trials were carried out in three sites; at Kangaita Tea Research Sub-station, Tea Farm at Kerugoya, Mount Kenya (37º 7.8'E and 0º 19.8'S, 2130 m above mean sea level [amsl]), Kipkebe Tea Estate, Sotik (35º 3.0'E and 0º 17.0'S, 1740 m amsl) and Timbilil Tea Estate, Kericho of the Tea Research Foundation of Kenya (35 º 21.0'E and 0º 15.0'S, 2180 m amsl). The mites sampling was superimposed on on-going Clonal Field Trials at the sites established in the year 2005 to evaluate the agronomic performance of the newly released Kenyan (TRFK) clones, imported Tanzania (TRIT) clones relative to some commercial clones in production in Kenya[14]. At each site, the plots were arranged in a randomized complete block design with three replicates, each plot consisting of 20 plants, planted at 1.22m by 0.75m planting spacing. The clones used were:- Tanzania clones: TRIT 201/16, TRIT 201/43, TRIT 201/44, TRIT 201/47, TRIT 201/50, TRIT 201/55, TRIT 201/70, TRIT 201/73, TRIT 201/75 and TRIT 201/82. Commercial clones: AHP SC12/28, AHP S15/10, AHP SC31/37, EPK C12, EPK TN15-23, TRFCA SFS150, TRFK 11/4, TRFK 12/19, TRFK 31/8 and TRFK 6/8. New Kenyan clones: TRFK 18/19, TRFK 18/22, TRFK 18/3, TRFK 301/4, TRFK 301/5, TRFK 301/6, TRFK 303/1199, TRFK 303/178, TRFK 303/216, TRFK 303/259, TRFK 303/577, TRFK 371/3, TRFK 371/6, TRFK 371/8, TRFK 381/5, TRFK 400/4, TRFK 400/10, TRFK 430/5, TRFK 430/7, TRFK 430/61, TRFK 430/63, TRFK 430/90, TRFK 480/378, TRFK 481/200 and TRFK 481/272.

After bringing into bearing, the clones received recommended agronomic and cultural management inputs[2, 15]. Monthly data on the mite infestation were recorded from each plot. Ten mature leaves per bush were plucked randomly once every month, then the mites were brushed using mite brushing machine (Model–Leedom Engineering, USA) and the number counted under the dissecting microscope[6]. The obtained mites data were transformed, log e (x+1) and then subjected to analysis of variance (ANOVA) using MSTAT-C statistical package. Three factor randomized complete block design was used with site as main treatment, clone as sub treatment and month as sub - sub treatment. Eight months meteorological data of maximum and minimum temperature, relative humidity and rainfall of the experimental areas were also collected covering the three seasons (dry season, January- March; rainy season, April-.June and cold season, July-August). Regression analysis was done using Microsoft Office Excel to determine the relationship between infestation levels of mites and three environmental variables.

Results and discussions

Mites populations varied ($p \leq 0.05$) with sites (Table 1). Kangaita, near Mount Kenya in the east of Rift Valley recorded higher ($p \leq 0.05$) mean mite infestations than

Table 1: Changes in the dynamics of mites with clones in the three sites

Clone	Kangaita	Kipkebe	Timbilil	Mean clone	STDEV	CV (%)
AHP SC 12/28	15 (2.76)	6 (2.01)	4 (1.51)	7 (2.09)	6	70.3
AHP S 15/10	18 (2.97)	7 (2.14)	4 (1.61)	8 (2.24)	7	76.3
AHP SC 31/37	8 (2.19)	4 (1.56)	3 (1.38)	5 (1.71)	3	52.9
EPK C12	5 (1.74)	3 (1.44)	2 (1.19)	3 (1.46)	2	45.8
EPK TN 15-23	16 (2.84)	5 (1.75)	2 (1.18)	5 (1.92)	7	96.1
TRFCA SFS 150	11 (2.50)	5 (1.86)	3 (1.40)	6 (1.92)	4	65.7
TRFK 11/4	11 (2.51)	5 (1.71)	4 (1.58)	6 (1.93)	4	56.8
TRFK 12/19	10 (2.37)	3 (1.40)	3 (1.35)	4 (1.70)	4	75.8
TRFK 18/19	8 (2.24)	3 (1.41)	4 (1.50)	5 (1.72)	3	52.9
TRFK 18/22	9 (2.31)	5 (1.76)	2 (1.33)	5 (1.80)	4	65.8
TRFK 18/3	16 (2.82)	7 (2.07)	4 (1.41)	7 (2.10)	6	69.4
TRFK 301/4	4 (1.66)	3 (1.28)	2 (1.15)	3 (1.36)	1	33.3
TRFK 301/5	8 (2.15)	5 (1.81)	3 (1.42)	5 (1.79)	3	47.2
TRFK 301/6	4 (1.62)	3 (1.29)	2 (1.10)	3 (1.34)	1	33.3
TRFK 303/1199	4 (1.61)	3 (1.32)	2 (1.11)	3 (1.35)	1	33.3
TRFK 303/178	4 (1.70)	3 (1.35)	3 (1.31)	3 (1.45)	1	17.3
TRFK 303/216	4 (1.69)	3 (1.49)	2 (1.25)	3 (1.48)	1	33.3
TRFK 303/259	9 (2.31)	4 (1.67)	3 (1.47)	5 (1.81)	3	60.3
TRFK 303/577	4 (1.54)	3 (1.29)	2 (1.15)	3 (1.33)	1	33.3
TRFK 31/8	5 (1.75)	2 (1.21)	2 (1.24)	3 (1.4)	2	57.7
TRFK 371/3	10 (2.39)	3 (1.49)	3 (1.33)	5 (1.74)	4	75.8
TRFK 371/6	4 (1.66)	4 (1.43)	3 (1.34)	3 (1.48)	1	15.7
TRFK 371/8	8 (2.24)	4 (1.64)	3 (1.39)	5 (1.76)	3	52.9
TRFK 381/5	9 (2.00)	4 (1.53)	3 (1.33)	4 (1.62)	3	60.3
TRFK 400/10	10 (2.31)	6 (1.91)	3 (1.34)	5 (1.85)	4	55.5
TRFK 400/4	7 (2.10)	6 (1.48)	4 (1.68)	5 (1.75)	2	27.0
TRFK 430/5	6 (1.97)	4 (1.61)	3 (1.33)	5 (1.57)	2	35.3
TRFK 430/61	8 (2.18)	4 (1.62)	2 (1.17)	4 (1.66)	3	65.5
TRFK 430/63	6 (2.01)	4 (1.63)	2 (1.20)	5 (1.76)	2	50.0
TRFK 430/7	6 (2.01)	4 (1.68)	2 (1.13)	4 (1.61)	2	50.0
TRFK 480/378	7 (2.06)	4 (1.50)	3 (1.27)	4 (1.61)	2	44.6
TRFK 480/90	8 (2.25)	4 (1.67)	2 (1.24)	4 (1.67)	3	65.5
TRFK 481/200	8 (2.25)	5 (1.76)	3 (1.27)	5 (1.76)	3	47.2
TRFK 481/272	8 (2.21)	2 (1.28)	2 (1.22)	4 (1.57)	3	86.6
TRFK 6/8	4 (1.68)	2 (1.25)	2 (1.04)	3 (1.33)	1	43.3
TRIT 201/16	17 (2.90)	7 (2.05)	4 (1.55)	8 (2.16)	7	72.9
TRIT 201/43	5 (1.77)	3 (1.43)	3 (1.27)	3 (1.49)	1	31.5
TRIT 201/44	4 (1.53)	3 (1.42)	3 (1.34)	3 (1.43)	1	17.3
TRIT 201/47	10 (2.44)	4 (1.53)	2 (1.24)	5 (1.74)	4	78.1
TRIT 201/50	3 (1.48)	2 (1.19)	2 (0.95)	2 (1.20)	1	24.7
TRIT 201/55	5 (1.77)	3 (1.38)	2 (1.08)	3 (1.41)	2	45.8
TRIT 201/70	8 (2.16)	5 (1.77)	3 (1.35)	5 (1.76)	3	47.2
TRIT 201/73	5 (1.83)	3 (1.26)	2 (1.20)	3 (1.43)	2	45.8
TRIT 201/75	10 (2.42)	4 (1.60)	2 (1.16)	5 (1.73)	4	78.1
TRIT 201/82	4 (1.57)	3 (1.40)	2 (1.14)	3 (1.36)	1	33.3
Mean site	7 (2.11)	4 (1.56)	3 (1.29)	4 (1.65)	6	70.3
CV (%)		18.86 (2.94)				
Interactions ($p \leq 0.05$)		0 (0.18)		0 (0.10)		

Note: Figures in parenthesis are Log e (x+1) transformation of mite population

Kipkebe and Timbilil, in the west of Rift Valley. The trend was similar to previous observations[6, 7] where mite infestations were higher in the east than west of the Rift Valley in Kenya despite the differences in cultivars used in the studies. The results confirm that the differences are due to the weather parameters, not the cultivars. Thus, mite infestations on Kenyan tea depend on geographical region, and tea plantations in the east of the Rift Valley require cultivars resistant/ tolerant to mites attack for realization of high yields. Although both Kipkebe and Timbilil are located on the west of the Rift Valley, the mite infestation level in Kipkebe was higher ($p \leq 0.05$) than that in Timbilil. Tea cultivars susceptible to mites attack should therefore be avoided for commercial exploitation in Kipkebe to avoid yield losses[6]. For the mean of the three locations, there were variations ($p \leq 0.05$) in the levels of mites infestation with cultivars per ten leaves (Table 1) which varied between 2 (log e (x+1) = 1.20) and 8 (log e (x+1) - 2.24) for TRIT 201/50 and AHP S15/10 respectively. This demonstrates that the cultivars were different in their tolerance/resistance/susceptibility to mites attack. Despite the lower ($p \leq 0.05$) level of mites infestations in Kipkebe and Timbilil than in Kangaita, clones that had high or low levels of infestation were similar in all locations. However, the changes in magnitude of mites infestation levels varied with clones culminating in significant ($p \leq 0.05$) interactions effects between the population of mites on clones and locations (Table 1). Indeed the dynamics of monthly mites infestations in individual clones varied with location and the extent of variations were not uniform (Tables 2, 3 and 4). The results of the variations of mites infestations in the 45 clones at Kangaita, Kipkebe and Timbilil are presented in Tables 2, 3 and 4 respectively. At each site, mites infestations varied ($p \leq 0.05$) with clones, similar to previous observation[16]. The results demonstrate the variations in tolerance/ susceptibility of the tea cultivars being evaluated to mites attack. Cultivar selection is therefore a viable option in the management of mites infestations in tea production. The extent of the variations also changed with clones, ranging from 3 to 18 for TRIT 201/50 and AHP S15/10 respectively in Kangaita. However, the range was much lower in Kipkebe and Timbilil for the same clones. The tolerant/resistant clones showed low variations while susceptible clones had large variations.

Monthly mites population varied significantly ($p \leq 0.05$) in the different clones in all the sites. Five clones (AHP SC12/28, AHP S 15/10, EPK TN 15-23, TRFK 18/3 and TRIT 201/16) had high ($p \leq 0.05$) mites infestations levels, especially in Kangaita, ranging from 15 for clone AHP SC12/28 to 18 for clone AHP S15/10. These clones were classified as susceptible to mites infestations and may not be suitable for commercial exploitation in Kangaita. However, sixteen clones (TRFK 31/8, TRIT 201/55, TRIT 201/73, EPK C12, TRFK 301/4, TRFK 301/6, TRFK 303/1199, TRFK 303/178, TRFK 303/216, TRFK 303/577, TRFK 371/6, TRFK 6/8, TRIT 201/43, TRIT 201/44, TRIT 201/82 and TRIT 201/50) had low ($p \leq 0.05$) mites infestation levels, ranging from 3 for clone TRIT 201/50 to 5 for clone EPK C12 (Table 2) even in Kangaita with high mite infestation level (Table 1). These clones are recommended for commercial exploitation in Kangaita and regions with high mite infestations as a strategy for reduction of yield losses due to mite infestations. In previous studies, clones EPK C12, TRFK 301/4, TRFK 303/1199, TRFK 6/8, TRFK 303/259 TRFK 12/19, TRFK 31/8, AHP S15/10, TRFK 303/577 TRFK 12/19 and TRFCA SFS 150 exhibited resistance against tea mites in both field and green house experiments [6, 7, 16-18]. The present study confirms these observations except on clones TRFK 303/577, TRFK 12/19, and TRFCA SFS 150 that were moderately resistant and AHP S15/10 that showed susceptibility especially in Kangaita. Resistance of tea clones to *O. coffeae* had also been observed in Sri Lanka[19]. The difference in clonal tea mite infestations had been attributed to morphometric and genetic variability that exist among tea cultivars[20, 21.] Use of resistant tea varieties is one of the components of integrated pest and disease management[12]. Tea varieties, such as IRB88-15 from Yakubita variety (Japan), CP-1 and TV-26 in South East-Asia, and 31/11 and 303/199 in Africa (Kenya) not only exhibited resistance against pests but also controlled grey blight to a great extent[22]. Thus use of resistant tea varieties may offer a solution to farmers and associated stake holders who face the challenge of growing beverage crops in a sustainable way to obtain optimal yield and quality while maintaining the biodiversity and soil fertility with least ecological disruption[23.]

In Kangaita and areas prone to mite infestation, clones AHP SC 12/28, AHP S 15/10, EPK TN 15-23, TRFK 18/3 and TRIT 201/16 should be avoided

Table 2: Changes in the dynamics of mites with clones and months in Kangaita

Clone	January	February	March	April	May	June	July	August	Mean clone	STDEV	CV%
AHP SC 12/28	40 (3.72)	27 (3.33)	34 (3.54)	44 (3.81)	27 (3.33)	4 (1.52)	3 (1.46)	3 (1.38)	15 (2.76)	17	75
AHP S 15/10	15 (2.77)	33 (3.53)	59 (4.10)	68 (4.23)	24 (3.21)	7 (2.11)	6 (1.90)	6 (1.93)	18 (2.97)	24	90
AHP SC 31/37	31 (3.46)	16 (2.83)	18 (2.97)	12 (2.57)	8 (2.15)	2 (1.20)	3 (1.25)	2 (1.06)	8 (2.19)	10	87
EPK C12	11 (2.48)	13 (2.61)	14 (2.68)	6 (2.00)	4 (1.55)	1 (0.83)	1 (0.69)	2 (1.06)	5 (1.74)	5	83
EPK TN 15-23	88 (4.49)	47 (3.87)	48 (3.90)	25 (3.26)	18 (2.97)	3 (1.37)	4 (1.60)	3 (1.27)	16 (2.84)	30	102
TRFCA SFS 150	56 (4.04)	27 (3.33)	17 (2.88)	17 (2.87)	8 (2.24)	3 (1.47)	5 (1.83)	3 (1.33)	11 (2.50)	18	105
TRFK 11/4	27 (3.34)	34 (3.54)	26 (3.29)	10 (3.32)	3 (2.40)	3 (1.43)	3 (1.29)	3 (1.50)	11 (2.51)	13	97
TRFK 12/19	33 (3.52)	19 (2.99)	29 (3.39)	12 (2.58)	16 (2.86)	1 (0.83)	3 (1.37)	3 (1.44)	10 (2.37)	12	84
TRFK 18/19	31 (3.46)	16 (2.86)	44 (3.81)	18 (2.95)	8 (2.26)	3 (1.37)	2 (1.13)	1 (0.83)	8 (2.24)	15	100
TRFK 18/22	7 (2.11)	29 (3.42)	30 (3.43)	17 (2.89)	14 (2.73)	3 (1.29)	2 (1.20)	3 (1.43)	9 (2.31)	11	87
TRFK 18/3	44 (3.81)	66 (4.21)	35 (3.60)	34 (3.56)	19 (3.00)	6 (2.00)	2 (1.20)	2 (1.23)	16 (2.82)	23	88
TRFK 301/4	9 (2.29)	11 (2.51)	9 (2.30)	6 (1.99)	3 (1.46)	2 (0.96)	2 (1.06)	1 (0.69)	4 (1.66)	4	72
TRFK 301/5	13 (2.63)	16 (2.86)	7 (2.70)	18 (2.93)	7 (2.07)	3 (1.43)	2 (1.11)	4 (1.52)	8 (2.15)	6	70
TRFK 301/6	7 (2.10)	16 (2.85)	12 (2.56)	2 (1.27)	4 (1.61)	1 (0.83)	2 (0.92)	1 (0.83)	4 (1.62)	6	100
TRFK 303/1199	4 (1.60)	15 (2.75)	13 (2.67)	5 (1.83)	3 (1.30)	2 (0.96)	2 (0.92)	1 (0.83)	4 (1.61)	5	95
TRFK 303/178	8 (2.17)	17 (2.87)	16 (2.85)	2 (1.23)	3(1.43)	4 (1.56)	2(1.00)	2 (0.92)	4(1.70)	6	94
TRFK 303/216	4 (1.52)	17 (2.87)	17 (2.88)	5 (1.79)	2 (1.13)	1 (0.69)	3 (1.37)	3 (1.29)	4 (1.69)	7	101
TRFK 303/259	11 (2.50)	14 (2.74)	7 (2.10)	19 (3.00)	23 (3.17)	4 (1.60)	2 (1.16)	2 (1.20)	9 (2.31)	8	77
TRFK 303/577	7 (2.14)	7 (2.13)	8 (2.90)	17 (1.60)	4 (1.25)	2 (0.83)	1 (0.69)	2 (0.83)	4 (1.54)	5	86
TRFK 31/8	5 (1.73)	12 (2.61)	15 (2.77)	8 (2.19)	6 (1.92)	1 (0.83)	1 (0.83)	2 (1.13)	5 (1.75)	5	83
TRFK 371/3	20 (3.04)	21 (3.07)	23 (3.17)	22 (3.12)	24 (3.21)	2 (1.06)	2 (0.96)	3 (1.46)	10 (2.39)	10	70
TRFK 371/6	4 (1.60)	11 (2.45)	17 (2.91)	5 (1.73)	3 (1.29)	2 (0.96)	3 (1.33)	2 (1.00)	4 (1.66)	5	91
TRFK 371/8	21 (3.11)	26 (3.28)	23 (3.19)	7 (2.11)	11 (2.45)	2 (1.13)	3 (1.34)	3 (1.29)	8 (2.24)	10	82
TRFK 381/5	6 (1.96)	20 (3.05)	24 (3.20)	16 (2.85)	6 (1.94)	2 (1.16)	2 (0.83)	2 (1.00)	9 (2.00)	9	91
TRFK 400/10	23 (3.17)	16 (2.82)	31 (3.48)	24 (3.20)	12 (2.58)	2 (1.06)	2 (1.13)	2 (1.06)	10 (2.31)	11	81
TRFK 400/4	16 (2.84)	22 (3.12)	22 (3.14)	14 (2.87)	8 (2.15)	1 (0.69)	2 (0.92)	2 (1.06)	7 (2.10)	9	81
TRFK 430/5	8 (2.22)	15 (2.75)	14 (2.73)	14 (2.70)	7 (2.11)	2 (0.92)	2 (1.06)	3 (1.29)	6 (1.97)	6	69
TRFK 430/61	14 (2.72)	19 (3.02)	20 (3.03)	26 (3.30)	8 (2.24)	2 (1.16)	2 (1.23)	1 (0.69)	8 (2.18)	10	84
TRFK 430/63	21 (3.11)	33 (3.52)	20 (3.04)	15 (2.79)	7 (2.04)	1 (0.69)	2 (1.06)	1 (0.69)	6 (2.01)	12	94
TRFK 430/7	16 (2.83)	18 (2.95)	20 (3.04)	43 (3.79)	7 (2.04)	1 (0.69)	2 (1.06)	1 (0.69)	6 (2.01)	14	106
TRFK 480/378	9 (2.26)	15 (2.78)	20 (3.06)	10 (2.37)	5 (1.76)	2 (1.06)	5 (1.72)	3 (1.43)	7 (2.06)	6	73
TRFK 480/90	36 (3.61)	32 (3.49)	29 (3.39)	22 (3.13)	7 (2.11)	2 (1.06)	2 (1.00)	2 (1.13)	8 (2.25)	15	90
TRFK 481/200	14 (2.72)	32 (3.49)	29 (3.39)	22 (3.13)	7 (2.11)	2 (1.06)	2 (1.00)	2 (1.13)	8 (2.25)	12	91
TRFK 481/272	10 (2.42)	24 (3.20)	18 (2.94)	12 (2.57)	9 (2.31)	3 (1.48)	3 (1.34)	3 (1.37)	8 (2.21)	8	75
TRFK 6/8	4 (1.67)	7 (2.06)	8 (2.91)	9 (2.26)	4 (1.67)	1 (0.69)	2 (1.06)	2 (1.16)	4 (1.68)	3	65
TRIT 201/16	26 (3.29)	55 (4.02)	74 (4.32)	98 (4.40)	19 (2.99)	3 (1.43)	3 (1.37)	3 (1.37)	17 (2.90)	36	104
TRIT 201/43	6 (1.98)	17 (2.91)	20 (3.03)	8 (2.19)	4 (1.52)	2 (0.96)	1 (0.69)	1 (0.83)	5 (1.77)	7	99
TRIT 201/44	6 (1.94)	9 (2.29)	15 (2.77)	3 (1.43)	2 (1.06)	1 (0.83)	1 (0.69)	2 (1.20)	4 (1.53)	5	101
TRIT 201/47	22 (3.12)	25 (3.07)	23 (3.16)	21 (3.11)	45 (3.83)	3 (1.27)	4 (1.69)	3 (1.25)	10 (2.44)	15	79
TRIT 201/50	6 (1.90)	9 (2.29)	9 (2.29)	5 (1.73)	2 (0.96)	2 (0.96)	1 (0.69)	2 (0.96)	3 (1.48)	3	72
TRIT 201/55	11 (2.49)	17 (2.88)	16 (2.84)	5 (1.73)	2 (1.23)	1 (0.83)	2 (1.16)	2 (1.00)	5 (1.77)	7	95
TRIT 201/70	4 (2.58)	29 (3.41)	30 (3.43)	18 (2.95)	8 (2.15)	1 (1.06)	1 (0.83)	1 (0.83)	8 (2.16)	12	109
TRIT 201/73	5 (1.83)	12 (2.60)	17 (2.87)	10 (2.40)	3 (1.45)	2 (1.06)	3 (1.29)	2 (1.13)	5 (1.83)	6	83
TRIT 201/75	33 (3.54)	17 (2.90)	19 (2.98)	15 (2.80)	15 (2.79)	2 (0.92)	3 (1.37)	7 (2.07)	10 (2.42)	10	73
TRIT 201/82	4 (1.60)	10 (2.40)	14 (2.72)	7 (2.07)	4 (1.54)	1 (0.83)	1 (0.69)	1 (0.69)	4 (1.57)	5	91
Mean month	13 (2.65)	19 (2.98)	21 (3.09)	13 (2.61)	7 (2.10)	2 (1.11)	2 (1.15)	2 (1.15)	7 (2.11)	17	75
CV (%)					15.71 (2.75)						
LSD (p≤0.05)					0 (0.01)						
Interactions (p≤0.05)					1 (0.47)				0 (0.19)		

Note: Figures in parenthesis are Log e (x+1) transformation of mite population

Table 3: Changes in the dynamics of mites with clones and months in Kipkebe

Clone	January	February	March	April	May	June	July	August	Mean lone	STDEV	CV (%)
AHP SC 12/28	14 (2.70)	16 (2.85)	12 (2.60)	23 (3.17)	4 (1.52)	2 (1.13)	2 (1.13)	2 (0.963)	6 (2.01)	8	86
AHP S 15/10	5 (1.71)	12 (2.53)	27 (3.34)	21 (3.10)	10 (2.42)	3 (1.37)	3 (1.37)	3 (1.27)	7 (2.14)	9	87
AHP SC 31/37	3 (1.50)	7 (2.06)	8 (2.25)	7 (2.10)	3 (1.42)	2 (1.10)	2 (1.06)	2 (0.96)	4 (1.56)	3	61
EPK C12	5 (1.80)	7 (2.09)	10 (2.41)	5 (1.78)	2 (1.00)	1 (0.83)	1 (0.83)	1 (0.83)	3 (1.44)	3	83
EPK TN 15-23	16 (2.85)	17 (2.88)	10 (2.42)	3 (1.34)	4 (1.61)	1 (0.69)	2 (1.11)	2 (1.06)	5 (1.75)	7	95
TRFCA SFS 150	24 (3.20)	16 (2.81)	12 (2.54)	5 (1.83)	4 (1.60)	1 (0.69)	3 (1.39)	1 (0.83)	5 (1.86)	8	101
TRFK 11/4	7 (2.11)	13 (2.61)	14 (2.73)	6 (1.94)	6 (1.96)	1 (0.83)	1 (0.80)	1 (0.69)	5 (1.71)	5	85
TRFK 12/19	3 (1.27)	9 (2.29)	4 (1.69)	5 (1.71)	4 (1.52)	1 (0.83)	1 (0.83)	2 (1.06)	3 (1.40)	3	72
TRFK 18/19	2 (1.16)	4 (1.52)	5 (1.76)	5 (1.71)	6 (1.90)	3 (1.37)	2 (1.06)	1 (0.83)	3 (1.41)	2	51
TRFK 18/22	3 (1.50)	13 (2.61)	10 (2.39)	14 (2.69)	5 (1.78)	2 (1.16)	2 (1.13)	1 (0.83)	5 (1.76)	5	85
TRFK 18/3	22 (3.13)	23 (3.18)	16 (2.80)	10 (2.37)	7 (2.02)	2 (1.13)	2 (0.92)	2 (0.96)	7 (2.07)	9	84
TRFK 301/4	3 (1.37)	4 (1.54)	5 (1.71)	4 (1.60)	2 (0.96)	1 (0.83)	3 (1.27)	2 (0.96)	3 (1.28)	1	44
TRFK 301/5	8 (2.18)	11 (2.48)	13 (2.61)	6 (1.96)	6 (1.97)	2 (1.23)	2 (1.13)	2 (0.92)	5 (1.81)	4	68
TRFK 301/6	2 (1.06)	7 (2.03)	10 (2.37)	2 (0.92)	2 (0.96)	1 (0.69)	3 (1.50)	1 (0.83)	3 (1.29)	3	93
TRFK 303/1199	2 (1.20)	8 (2.18)	2 (0.96)	4 (1.66)	3 (1.43)	2 (1.20)	1 (0.83)	2 (1.10)	3 (1.32)	2	73
TRFK 303/178	3 (1.37)	6 (1.98)	10 (2.42)	2 (1.20)	2 (1.19)	1 (0.83)	1 (0.83)	2 (1.06)	3 (1.35)	3	92
TRFK 303/216	3 (1.44)	12 (2.59)	13 (2.61)	4 (1.66)	2 (1.00)	2 (1.06)	1 (0.69)	1 (0.83)	3 (1.49)	5	103
TRFK 303/259	6 (1.88)	5 (1.78)	9 (2.33)	12 (2.53)	4 (1.66)	2 (1.19)	2 (1.20)	1 (0.83)	4 (1.67)	4	74
TRFK 303/577	7 (2.04)	2 (0.94)	12 (2.53)	3 (1.27)	1 (0.83)	2 (0.96)	2 (0.92)	1 (0.83)	3 (1.29)	4	103
TRFK 31/8	3 (1.29)	2 (1.20)	9 (2.33)	2 (1.13)	2(1.13)	2 (0.96)	1 (0.69)	2 (0.96)	2 (1.21)	3	90
TRFK 371/3	5 (1.83)	10 (2.42)	14 (2.68)	3 (1.37)	1 (0.69)	1 (0.83)	2 (1.06)	2 (1.06)	3 (1.49)	5	100
TRFK 371/6	3 (1.48)	6 (2.01)	10 (2.38)	4 (1.67)	2 (1.06)	1 (0.83)	2 (1.20)	1 (0.83)	4 (1.43)	3	85
TRFK 371/8	11 (2.50)	13 (2.63)	14 (2.73)	3 (1.29)	2 (1.13)	2 (1.06)	2 (0.96)	1 (0.83)	4 (1.64)	6	93
TRFK 381/5	3 (1.50)	3 (1.37)	12 (2.58)	13 (2.65)	2 (1.13)	2 (1.00)	2 (1.06)	2 (0.96)	4 (1.53)	5	97
TRFK 400/10	6 (1.94)	8 (2.23)	5 (2.79)	16 (2.83)	7 (2.07)	2 (1.06)	3 (1.29)	2 (1.06)	6 (1.91)	5	75
TRFK 400/4	5 (1.83)	6 (1.74)	12 (2.57)	5 (1.75)	2 (1.20)	2 (1.06)	3 (1.06)	2 (1.00)	6 (1.48)	3	73
TRFK 430/5	3 (1.37)	7 (2.03)	25 (3.26)	19 (3.00)	2 (1.20)	6 (0.96)	1 (0.83)	2 (0.96)	4 (1.61)	9	110
TRFK 430/61	5 (1.78)	8 (2.18)	14 (2.73)	7 (2.03)	3 (1.29)	2 (0.96)	3 (1.23)	1 (0.83)	4 (1.62)	4	79
TRFK 430/63	6 (1.90)	7 (2.09)	13 (2.67)	4 (1.67)	4 (1.60)	2 (1.06)	2 (0.92)	2 (1.10)	4 (1.63)	4	75
TRFK 430/7	7 (2.03)	11 (2.51)	19 (2.95)	7 (2.04)	4 (1.52)	1 (0.83)	1 (0.83)	1 (0.69)	4 (1.68)	6	98
TRFK 480/378	5 (1.78)	2 (1.20)	11 (2.51)	4 (1.51)	4 (1.60)	2 (1.10)	3 (1.27)	2 (1.06)	4 (1.50)	3	73
TRFK 480/90	12 (2.53)	13 (2.65)	16 (2.81)	5 (1.78)	2 (1.20)	1 (0.69)	2 (0.92)	1 (0.82)	4 (1.67)	6	95
TRFK 481/200	4 (1.65)	10 (2.41)	16 (2.82)	20 (3.06)	2 (1.06)	2 (1.16)	2 (0.96)	2 (0.92)	5 (1.76)	7	100
TRFK 481/272	3 (1.46)	6 (1.94)	11 (2.47)	3 (1.50)	1 (0.83)	1 (0.69)	1 (0.69)	1 (0.69)	2 (1.28)	4	105
TRFK 6/8	2 (1.20)	3 (1.37)	8 (2.18)	3 (1.46)	3 (1.37)	1 (0.69)	2 (0.92)	1 (0.83)	2 (1.25)	2	78
TRIT 201/16	14 (2.71)	20 (3.03)	24 (3.21)	12 (2.53)	6 (1.93)	2 (1.23)	1 (0.83)	2 (0.93)	7 (2.05)	9	87
TRIT 201/43	3 (1.37)	9 (2.28)	8 (2.15)	4 (1.69)	2 (1.06)	2 (1.13)	1 (0.83)	2 (0.92)	3 (1.43)	3	77
TRIT 201/44	5 (1.72)	6 (1.88)	10 (2.42)	3 (1.37)	3 (1.37)	1 (0.83)	2 (0.92)	1 (0.83)	3 (1.42)	3	79
TRIT 201/47	4 (1.67)	6 (1.98)	12 (2.56)	6 (1.98)	2 (1.23)	1 (0.83)	2 (1.13)	1 (0.83)	4 (1.53)	4	88
TRIT 201/50	2 (1.20)	3 (1.43)	8 (2.15)	3 (1.29)	2 (0.96)	2 (0.96)	1 (0.69)	1 (0.83)	2 (1.19)	2	82
TRIT 201/55	5 (1.84)	9 (2.26)	9 (2.33)	2 (1.23)	1 (0.83)	1 (0.83)	2 (0.92)	1 (0.83)	3 (1.38)	3	93
TRIT 201/70	10 (2.36)	13 (2.61)	11 (2.51)	17 (2.91)	2 (1.06)	2 (1.06)	1 (0.69)	1 (0.69)	5 (1.77)	6	89
TRIT 201/73	3 (1.37)	4 (1.55)	7 (2.12)	3 (1.37)	2 (0.92)	2 (0.96)	2 (1.06)	1 (0.69)	3 (1.26)	2	62
TRIT 201/75	10 (2.38)	11 (2.50)	13 (2.65)	3 (1.29)	2 (1.13)	2 (1.06)	2 (0.96)	1 (0.83)	4 (1.60)	5	90
TRIT 201/82	2 (1.20)	6 (1.98)	11 (2.50)	5 (1.84)	2 (1.05)	2 (1.06)	1 (0.69)	1 (0.83)	3 (1.40)	3	92
Mean month	5 (1.81)	7 (2.14)	11 (2.48)	5 (1.87)	3 (1.34)	2 (0.98)	2 (0.99)	1 (0.90)	4 (1.56)	8	86
CV (%)					19.84 (2.99)						
LSD (p≤0.05)					0 (0.09)						
Interactions (p≤0.05)					1 (0.50)				0 (0.18)		

Note: Figures in parenthesis are Log e (x+1) transformation of mite population

Table 4: Changes in the dynamics of mites with clones and months in Timbilil

Clone	January	February	March	April	May	June	July	August	Mean clone	STDEV	CV (%)
AHP SC 12/28	6 (1.92)	3 (1.37)	4 (1.65)	13 (2.63)	2 (1.06)	2 (1.10)	2 (1.2)	1 (0.83)	4 (1.51)	4	95
AHP S 15/10	3 (1.46)	5 (1.78)	7 (2.07)	17 (2.91)	6 (1.92)	2 (1.20)	1 (0.83)	1 (0.69)	4 (1.61)	5	100
AHP SC 31/37	3 (1.37)	4 (1.65)	8 (2.21)	5 (1.71)	3 (1.27)	1 (0.83)	2 (1.06)	0 (0.16)	3 (1.38)	2	77
EPK C12	4 (1.60)	5 (1.84)	8 (2.24)	1 (0.83)	1 (0.83)	1 (0.69)	1 (0.83)	1 (0.69)	2 (1.19)	3	97
EPK TN 15-23	6 (1.93)	3 (1.29)	6 (1.92)	2 (1.16)	1 (0.69)	2 (0.96)	1 (0.69)	1 (0.83)	2 (1.18)	2	77
TRFCA SFS 150	13 (2.66)	5 (1.77)	6 (1.94)	3 (1.27)	1 (0.83)	2 (1.06)	1 (0.69)	2 (1.00)	3 (1.40)	4	97
TRFK 11/4	6 (1.92)	7 (2.10)	8 (2.21)	5 (1.78)	4 (1.66)	2 (1.10)	2 (1.06)	1 (0.83)	4 (1.58)	3	59
TRFK 12/19	2 (0.96)	6 (1.93)	11 (2.47)	4 (1.65)	3 (1.27)	1 (0.83)	1 (0.69)	2 (0.96)	3 (1.35)	3	90
TRFK 18/19	3 (1.46)	4 (1.66)	10 (2.38)	4 (1.66)	5 (1.75)	3 (1.27)	2 (0.96)	1 (0.83)	4 (1.50)	3	68
TRFK 18/22	2 (0.96)	4 (1.52)	5 (1.81)	2 (1.19)	3 (1.37)	1 (0.83)	1 (0.83)	2 (1.16)	2 (1.33)	1	57
TRFK 18/3	11 (2.47)	6 (2.01)	7 (2.07)	1 (0.83)	3 (1.33)	1 (0.69)	1 (0.69)	6 (1.13)	4 (1.41)	4	81
TRFK 301/4	2 (0.96)	9 (2.29)	5 (1.78)	2 (1.10)	1 (0.69)	1 (0.83)	1 (0.69)	1 (0.83)	2 (1.15)	3	104
TRFK 301/5	5 (1.78)	5 (1.77)	9 (2.29)	2 (1.20)	3 (1.44)	2 (1.06)	2 (0.96)	1 (0.83)	3 (1.42)	3	72
TRFK 301/6	1 (0.82)	7 (2.03)	6 (1.98)	1 (0.83)	2 (0.92)	1 (0.69)	1 (0.69)	1 (0.83)	2 (1.10)	3	100
TRFK 303/1199	2 (0.92)	5 (1.83)	6 (1.88)	1 (0.83)	1 (0.69)	2 (1.10)	1 (0.83)	1 (0.83)	2 (1.11)	2	84
TRFK 303/178	3 (1.29)	5(1.85)	7 (2.14)	3 (1.27)	2 (1.06)	2 (0.96)	2 (0.96)	2 (0.92)	3 (1.31)	2	56
TRFK 303/216	2 (1.20)	7 (2.02)	10 (2.40)	2 (1.23)	2 (1.06)	1 (0.69)	2 (0.96)	2 (0.96)	2 (1.25)	3	92
TRFK 303/259	2 (1.10)	5 (1.77)	7 (2.05)	9 (2.29)	3 (1.46)	2 (1.06)	2 (1.06)	2 (0.96)	3 (1.47)	3	68
TRFK 303/577	2 (1.06)	4 (1.54)	10 (2.38)	2 (0.92)	1 (0.83)	1 (0.82)	1 (0.83)	1 (0.83)	2 (1.15)	3	113
TRFK 31/8	1 (0.69)	3 (1.50)	8 (2.24)	2 (1.06)	2 (0.96)	4 (1.65)	1 (0.83)	2 (0.96)	2 (1.24)	2	80
TRFK 371/3	5 (1.76)	2 (1.23)	10 (2.40)	2 (1.06)	3 (1.46)	2 (1.06)	1 (0.83)	1 (0.83)	3 (1.33)	3	93
TRFK 371/6	3 (1.46)	7 (2.12)	10 (2.42)	3 (1.37)	2 (1.16)	1 (0.69)	1 (0.83)	1 (0.69)	3 (1.34)	3	94
TRFK 371/8	6 (1.94)	10 (2.40)	9 (2.29)	2 (1.06)	1 (0.83)	1 (0.83)	1 (0.83)	1(0.96)	3 (1.39)	4	100
TRFK 381/5	1 (0.83)	6 (1.89)	7 (2.11)	5 (1.78)	3 (1.43)	2 (1.20)	1 (0.69)	1 (0.69)	3 (1.33)	2	75
TRFK 400/10	3 (1.27)	3 (1.33)	6 (1.95)	6 (1.95)	4 (1.55)	2 (0.96)	1 (0.76)	2 (0.96)	3 (1.34)	2	55
TRFK 400/4	3 (1.37)	4 (1.65)	11 (2.48)	10 (2.41)	17 (2.87)	4 (1.52)	1 (0.83)	3 (1.29)	4 (1.68)	5	83
TRFK 430/5	2 (0.96)	5 (1.77)	4 (1.60)	2 (1.10)	3 (1.29)	2 (0.96)	1 (0.69)	1 (0.69)	3 (1.33)	1	57
TRFK 430/61	3 (1.46)	3 (1.37)	7 (2.12)	2 (1.23)	2 (0.96)	1 (0.69)	1 (0.69)	1 (0.83)	2 (1.17)	2	80
TRFK 430/63	3 (1.37)	3 (1.48)	9 (2.35)	2 (1.06)	1 (0.83)	2 (0.96)	1 (0.83)	1 (0.69)	2 (1.20)	3	97
TRFK 430/7	1 (0.83)	3 (1.48)	7 (2.07)	1 (0.83)	3 (1.34)	2 (0.96)	1 (0.83)	1 (0.69)	2 (1.13)	2	87
TRFK 480/378	3 (1.29)	2 (0.92)	10 (2.43)	4 (1.70)	2 (0.92)	2 (0.96)	2 (0.92)	2 (0.96)	3 (1.27)	3	82
TRFK 480/90	4 (1.60)	3 (1.33)	13 (2.63)	3 (1.29)	2 (0.95)	1 (0.69)	1 (0.69)	1 (0.69)	2 (1.24)	4	114
TRFK 481/200	2 (1.20)	7 (2.12)	10 (2.41)	2 (1.20)	1 (0.69)	2 (0.96)	1 (0.69)	2 (0.92)	3 (1.27)	3	98
TRFK 481/272	2 (1.16)	5 (1.78)	10 (2.40)	2 (1.06)	2 (1.11)	1 (0.83)	1 (0.69)	1 (0.69)	2 (1.22)	3	104
TRFK 6/8	1 (0.83)	3 (1.37)	5 (1.71)	2 (1.00)	2 (1.06)	1 (0.69)	1 (0.69)	2 (0.96)	2 (1.04)	1	64
TRIT 201/16	8 (2.20)	4 (1.66)	11 (2.49)	2 (1.13)	4 (1.55)	3 (1.29)	1 (0.69)	3 (1.37)	4 (1.55)	3	74
TRIT 201/43	1 (0.83)	9 (2.34)	7 (2.02)	2 (0.92)	2 (1.06)	2 (1.10)	1 (0.83)	2 (1.06)	3 (1.27)	3	93
TRIT 201/44	4 (1.60)	6 (1.98)	12 (2.59)	2 (0.96)	1 (0.83)	2 (0.96)	2 (0.96)	1 (0.83)	3 (1.34)	4	100
TRIT 201/47	2 (1.20)	5 (1.80)	8 (2.19)	2 (1.29)	2 (0.96)	1 (0.69)	1 (0.83)	2 (0.96)	2 (1.24)	2	84
TRIT 201/50	1 (0.83)	3 (1.34)	3 (1.46)	2 (0.96)	1 (0.62)	1 (0.83)	1 (0.69)	1 (0.83)	2 (0.95)	1	56
TRIT 201/55	2 (0.96)	3 (1.37)	7 (2.07)	2 (1.23)	2 (0.92)	1 (0.69)	1 (0.69)	1 (0.69)	2 (1.08)	2	84
TRIT 201/70	8 (2.18)	5 (1.79)	7 (2.10)	3 (1.37)	2 (1.06)	2 (0.92)	1 (0.69)	1 (0.69)	3 (1.35)	3	75
TRIT 201/73	2 (1.20)	5 (1.83)	6 (2.00)	3 (1.27)	2 (0.96)	1 (0.69)	2 (0.96)	1 (0.69)	2 (1.20)	2	67
TRIT 201/75	4 (1.54)	4 (1.54)	5 (1.72)	1 (0.83)	2 (1.06)	2 (1.06)	1 (0.83)	1 (0.69)	2 (1.16)	2	64
TRIT 201/82	2 (0.96)	2 (1.13)	7 (2.14)	2 (1.23)	2 (0.96)	2 (0.96)	1 (0.69)	2 (0.96)	2 (1.14)	2	74
Mean month	3 (1.36)	4 (1.70)	8 (2.15)	3 (1.35)	2 (1.12)	2 (0.95)	1 (0.81)	1 (0.87)	3 (1.29)	4	95
CV (%)					22.68 (3.12)						
LSD (p≤0.05)					0 (0.08)						
Interactions (p≤0.05)					1 (0.47)				0 (0.17)		

Note: Figures in parenthesis are Log e (x+1) transformation of mite population

to reduce yield losses due to mite infestations. The sixteen clones that resisted mites attack and showed low mite infestation dynamics can be considered suitable for cultivation in Kangaita and other mite prone areas. Compared to Kangaita, mite infestations in Kipkebe and Timbilil were low. Indeed, even the seasonal dynamics of monthly variations were much higher in Kangaita compared to Kipkebe and Timbilil. Consequently, cultivars that were very susceptible to mite infestations in Kangaita only showed moderate susceptibility levels in Kipkebe and tolerance in Timbilil. Clones AHP SC 12/28, AHP S 15/10, TRFK 18/3, TRIT 201/16, TRFK 400/4 and TRFK 400/10 showed moderate mites infestation in Kipkebe (Table 3) and are likely to suffer yield losses when there is an outbreak of mites especially during hot and dry seasons[6]. All clones in Timbilil had very low population of mites throughout the study period ranging from 2 to 4 (Table 4). Indeed, even the susceptible clones in both Kangaita and Kipkebe had low mite infestations and showed low monthly variations (Table 4). These results demonstrate that mite infestation is a minor threat to tea production in the west of the Rift Valley of Kenya , but a major problem in the east of Rift Valley, as had also been observed[6, 7].

Changes in weather parameters such as rainfall, temperature and humidity influence mites infestation levels[9]. The mites population varied significantly ($p \leq 0.05$) in different months at different sites (Tables 2 to 4) as the weather factors also changed (Table 5). The population of mites increased progressively from January reaching peak in March with mean month range of 13 -21 mites per ten leaves in Kangaita, 5 -11 mites per ten leaves in Kipkebe and 3 - 8 mites per ten leaves in Timbilil (Tables 2, 3 and 4). There was then a sharp fall in April [13 (2.61), 5 (1.87) and 3 (1.35) in Kangaita, Kipkebe and Timbilil respectively] when both monthly rainfall range for the sites (398.4-514.4mm) and humidity (44.0-82.2%) were high but a reduction in maximum temperature (18.8-27.5°C). Population reached minimum in August in all site, which was characterized with relatively low monthly rainfall (4.8-190.5 mm), relatively low mean monthly temperatures (13.3-19.1°C) and high humidity (70-83 %). The first three months of the study coincided with the dry season which was characterized with low monthly rainfall (0-50.1 mm), relatively high mean monthly temperatures (15.3 - 20.1°C) and low humidity (38-70 %) in all the sites (Table 5). In different clones, mite numbers were low during the rainy season and high during dry period in both Kangaita and Kipkebe[6]. Similar pattern was observed in the present study, but the mites dynamics changes with clones and sites (Tables 2 to 4). These results demonstrate that mite dynamics are to a larger extent controlled by weather parameters. The weather conditions between January and March were suitable for mite development [15] leading to population increase in all sites. Except for with the use of resistant clones in Kangaita, mitigation measures may be necessary. However levels of mite infestations in Timbilil and Kipkebe were not high enough to warrant mitigation treatment even in clones considered susceptible. However, the mitigation efforts must avoid the use of pesticides to control mites. Use of resistant clones like those established in this study, remain a viable method to ensure reduced yield losses due to mite infestations in the season. There were significant ($p \leq \leq 0.05$) interactions effects in the mite infestation levels between clones and months. These observations demonstrate that mite infestation levels in the different clones varied from month to month. Susceptible tea clones showed high mites dynamics while tolerant/resistant clones showed low mites dynamics. The extent of the variations in different clones was a fair measure of their tolerance/ resistance/susceptibility. It is necessary to use resistant clones in mites prone areas to reduce possible yield losses caused by mite infestations during dry seasons.

The mites infestation levels highly correlated with maximum temperatures (Table 6) in Kangaita ($r^2 = 0.801$), Kipkebe ($r^2 = 0.693$) and Timbilil ($r^2 = 0.744$), but not with minimum temperatures ($r^2 = 0.167$, 0.074 and 0.359 respectively) implying that changes in maximum temperature are more critical in mites dynamics in tea fields. High monthly temperatures encouraged mite infestations levels. The high temperature accelerated the developmental rate and reduced the duration of developmental stages; the life cycle of *O. coffeae* completed within 5 days at 30.28°C and 13 days at 18.80°C [24]. The mite infestations levels showed a moderate inverse correlation with relative humidity in both Kangaita ($r^2 = 0.548$) and Timbilil ($r^2 = 0.699$) but low in Kipkebe ($r^2 = 0.368$). The results confirm observations in Bangladesh [9] that hot and dry weather with low humidity led to high infestation of red spider mites. The fluctuation in mite populations showed no relationship with rainfall in the three sites (Kangaita, Kipkebe and Timbilil with r^2 values of 0.000, 0.004 and 0.074 respectively), similar to the Bangladesh study [9]. Where mite infestations are high, use of resistant clones may be a viable way of controlling mites. However, when this is not possible, farmers must be armed with appropriate mitigation strategies in hot seasons with low relative humidity.

Conclusions and recommendations

Of the clones that were evaluated for the first time, TRFK 303/216, TRFK 371/6, TRIT 201/43, TRIT 201/44, TRIT 201/50, TRIT 201/55, TRIT 201/73 and TRIT 201/82 were identified to be resistant to mites attack while TRFK 18/3 and TRIT 201/16 were susceptible. Cultivation of susceptible clones; in mite prone areas should be avoided. High maximum monthly temperatures and low relative humidity were predictors on infestation levels of mites in the tea farms. Farmers need to have strategies of controlling mite infestations during the hot seasons with low humidity. Infestation levels of mites on clones varied significantly with regions and seasons. There is need for the development of region specific suitable clones.

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