ISSN: 0975-833X

Available online at http://www.journalcra.com

SPECIAL ISSUE

International Journal of Current Research
Vol.3, Issue, 6, pp.328-332, June, 2011

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

SCREENING OF KENYAN TEA CLONES FOR SUSCEPTIBILITY TO MITE ATTACK AT DIFFERENT ECOLOGICAL ZONES

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ARTICLE INFO

Article History:
Received 9th April, 2011
Received in revised form
3th May, 2011
Accepted 5th June, 2011
Published online 26nd June 2011

Key words:
Tea,
Screening,
Susceptibility,
Clone,
Mite and Cultivars.

ABSTRACT

Tea growers in Kenya are faced with a number of challenges; the major one being mite attack. It is therefore necessary to continuously breed and screen tea varieties that are not only high yielding but tolerant to mite attack. A five year study was conducted at two ecological sites namely: Kipkebe Tea Estate farm at Sotik, West of Rift Valley and Tea Research Foundation of Kenya (TRFK), Kangaita Sub-station, near Mount Kenya. These studies were done with the aim of screening some Kenyan tea clones for their resistance or tolerance to the Red Crevice Mites (RCM) prevalent in the East of Rift Valley and Red Spider Mites (RSM) prevalent at the west of Rift Valley. Mite sampling was done on an on-going clonal Field Trial which was laid out in a completely randomised block design (CRBD) and replicated three times in each of the two regions. Mite population was estimated every month by sampling 10 mature leaves and taken to the laboratory where the mites were counted under a dissecting microscope after extracting them using a mite brushing machine. The mite data collected were transformed and subjected to analysis of variance using MSTAT statistical package. Annual mite population varied significantly *(P≤0.05)* in the different clones. This study showed that a number of tea clones that were tolerant to mite attack at Kipebe, Sotik and TRFKs Kangaitasub-station. Based on the results of the 36 Clones, clone AHPCG28U864 was a unique clone. It had low resistance to both RCM and RSM. On the other hand, clone EPK C/12 had high resistance to both species of mites. It was found that the Red Crevice Mite (RCM) species is the most prevalent in the Mt. Kenya region while the Red Spider Mite (RSM) species was prevalent in Kipkebe Sotik area. In both areas mite numbers were observed to be low during the rainy season and high during the dry period. This explained the fact that moisture-stressed plants are more susceptible to mite attack.

INTRODUCTION

Plant Resistance to Pest Infestation

The attempt to improve tea crop yields and quality has led to development of high yielding and genetically identical tea cultivars. Some tea clones have proved to be susceptible to pest attack in the tea growing areas resulting in yield losses, while others have shown tolerance. Crop resistance to arthropods is governed by antibiosis and tolerance or no-preference (Painter 1951). In relative antibiosis the host plant has varying effects on development and survival of pest or arthropod species. Studies in Kenya by Sudoi (1994) indicated that mites *B. Phoenicies* took shorter developmental period on susceptible clones compared to the resistant tea clones. Clone Li/9 a relatively susceptible clone supported higher number of eggs and larval stages. The same studies found the losses due to mite attack to range from 20 to 30% at in a single year.

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Application of nitrogenous fertilizer had significant effect on the damage and yield loss of tea (Sudoi, 1994). He also found that increase in leaf nutrient content as a result of soil applied N had significant impact on the incidence of mites on these leaves. Leaf damage increased with mite numbers to 10 mites per leaf. However, application of nitrogen reduced the leaf necrosis and hence mite damage resulting in reduced yield losses. The tea plants receiving nitrogen fertilizers were tolerant to the mites. This phenomenon is termed 'relative tolerance' and it entails repair, recovery or ability of host plant to withstand an infestation (De Ponti 1985; Teetes and Johnson, 1978). Certain tea clones have been observed to affect development and survival of mites (Sudoi, 1994) while in others mites prefer to lay eggs on them. Growing of resistant or tolerant clones would enable the farmers to make more money from their tea through increased production and avoiding use of expensive pest control products/chemicals. Two mite species are known to attack tea in Kenya namely Red crevice mite (RCM) or scarlet mite (*Brevipalpus phoenicis* Geijskes) and Red spider mite (RSM) (*Oligonychus coffeae* Nietner). Both of these mites, the Red Crevice Mites

and Red Spider Mites are of economic importance to tea in Kenya. The mites cause damage by sucking sap from the stem and leaves which may lead to defoliation and subsequent reduction in green leaf production (Benjamin 1967; Oomen 1984, Sudoi,1994). Mite species exhibit vertical distribution on tea bushes. Colonies of RSM prefer the upper surface of older leaves but during heavy infestation and drought, RSM inhabit both surfaces of leaf and even to young leaves. Other mites known to attack tea include Purple mites *Calacarus carinatus* Green which are found on mature lower leaves and attack is prevalent on upper leaf surface (Ranthanarayana and Ranaweera, 1970; Kaneko, 1980).

Red Crevice Mite

The red crevice mite (RCM) *Brevipalpus phoenicis,* often invariably also referred as Scarlet mite in literature (Crowe, 1965), is a major tea pest in Kenya and other tea growing regions of the world (Crowe, 1965, Benjamin 1967; Laycock and Temper, 1973, Sudoi, 1994, Sudoi, 1997). It was first reported to attack tea in Kirinyaga district in the mid 1960s (Crowe, 1965). Since then, incidences of attack have been on the increase throughout Kenya (Benjamin, 1968 and Laycock and Templer, 1973), especially during the dry season. Elsewhere the mite occurs as a sporadic pest of tea and other crops in the Azores, Malawi, Mauritius, Mozambique, Southern Africa, Uganda, and Indonesia (Oomen, 1984, Wilsons and Clifford, 1992, Jagadish *et al*, 1983, Denmark, 1984; Prieto, 1986; Goes *et al*., 1985; Wen and Lee, 1984).

Red Spider Mite

The Red Spider mite (RSM), *Oligonychus coffeae* (Nietner) belong to the family Tetranychidae and causes considerable loss in tea production in Kenya (Sudoi, 1990) and elsewhere like India and Malawi (Das 1959; Das, 1983 Mkwaila, 1983). RSM occurs in all the tea growing areas during the dry weather. Injury to tea is first evidenced from a yellowish spotting along midrib and veins of leaves and occasionally on the petioles which occur as a result of mite feeding on the leaf. White cast skin of the immature stages can be seen together with the small reddish eggs which are laid alongside the leaf vein. As feeding continues these spots turn brown and eventually the leaf becomes deeply bronzed/ necrotic and often drops from the plant, hence growth of tea is retarded (Jepson *et al*., 1975). The action control threshold value for the Red Spider mites has been estimated by Banerjee (1971) at 2-3 mites per leaf. The red spider mites' front parts of their body are red and hind part is purple. They have a simple, oval-shaped body, passes through an egg, a six-legged nymphal stage (Protonymph and deutonymph) before transforming into eight-legged adults. They have needle-like mouth parts and feed by piercing the leaves of the host plant and sucking out the fluid from the plant cells. The female can lay up to 20 eggs per day and lives for 2-4 weeks, laying hundreds of eggs. The optimal conditions for development are a temperature of 20ºC-30ºC and a relative humidity of 49-94% (Anon, 1986).

Therefore, the main objectives of these experiments were:

a) To screen the tea clones for their susceptibility to the two mite species attack.
b) To check the response of the new tea clones to mite attacks at the two tea growing regions.

MATERIALS AND METHODS

Experimental Sites

Studies to determine the resistance/susceptibility of Kenya tea clones to red crevice mites and red spider mites were conducted at two different regions at TRFKs, Kangaita Sub-station at Kerugoya, Mount Kenya and Kipkebe Tea Estate farm at Sotik, west of Rift Valley. The TRFKs Sub-station at Kangaita tea farm lies at 37º 7.8E and 19.8'S in an altitude of 2130 m a.s.l on the slope of Mt Kenya. It receives an annual rainfall ranging between 1700-2150m while temperature ranges between 14.5-17.8ºC. The long rains start in mid March while short rains start in mid October. The red crevice mite is the most prevalent mite species. Kipkebe Tea Estate, in Sotik highlands West of Rift Valley lies at 0º 17'S and 35º 3' E with an altitude of 1740 m.a.s.l and receives an annual rainfall range of between 1300-1950mm while temperature ranges between 16.6 - 20.4ºC. The long rains start in March and April while short rains start in September to December. The area around occasionally experiences outbreak of Red Spider Mites (RSM) during the dry season.

The mites sampling was done an on-going Clonal Field Trials (Botany trials) at the two sites. Kangaita sub-station mite experiment was established in the year 2000 and ended in 2005 while Kipkebe, Sotik the experiment was conducted between 2004 and 2008. Both experiments were laid out in a completely randomised block design and replicated three times with each plot consisting of 20 plants. The mite population was estimated every month by sampling randomly 10 mature leaves per plot and transporting to the laboratory in polythene bags where mites were then extracted from the leaves using a mite brushing machine (Model–Leedom Engineering, USA) and the number counted under the dissecting microscope. The number of mites per ten leaves was determined.

Data Analysis

Prior to analysis, mite data was transformed to (log e (x+1). All the data collected were subjected to analysis of variance using MSTAT statistical package.

RESULTS AND DISCUSSIONS

Red Crevice Mites B. Phoenicis at Kangaita-Sub-Station

Table 1 shows that the Red Crevice Mite (RCM) population varied significantly *(P≤0.05)* among the different clones throughout the period at Kangaita substation as shown. The annual mean RCM mites ranged from 99 to 540 for clones AHPCG28U864 and EPK C/12 respectively during the period. Among the 36 clones on a five year average, the clones with the highest RCM mite incidence were AHPCG28U864, TRFK 301/1; TRFK 31/37, TRFK 31/30, TRFK-k-Purple EPK TN-14 and TRFK301/2 while clones with the lowest mite were EPK C12, NDT.TAI, TRFK 303/231, TRFK347/573, TRFK 301/4, TRFK 7/9, TRFK 337/3, TRFK 382/1, TRFK 392/1 and TRFK 347/336. The clones that are susceptible to mite attack are not desirable and would not be recommended for growing by farmers in mite prone areas like Kangaita tea farm. Figure 1 shows that the rainfall at Kangaita sub-station ranged from 1355.4 to 2277.0mm. There are two main rainy seasons i.e. wet period, March to June and dry cold period,

Table 1: Annual population of Red Crevice Mites (RCM) (*B. phoenicis*) on 36 cultivars (clones) of tea at TRFKs Kangaita sub-station for five years

	Mean red crevice mite population and years						
Cultivars (clones)	2000	2001	2002	2003	2004	2005	Mean (2000-2005)
EPK C/12	23 (3.18)	128 (4.86)	108 (4.69)	115 (4.75)	143 (4.97)	79 (4.38)	99 (4.47)
TRFK 301/5	55 (4.03)	278 (5.63)	269 (5.60)	160 (5.08)	132 (4.89)	69 (4.25)	161 (4.91)
TRFK 301/6	68 (4.23)	180 (5.20)	220 (5.40)	130 (4.88)	199 (5.30)	98 (4.60)	149 (4.94)
NDT TAI	34 (3.56)	246 (5.51)	298 (5.70)	312 (5.75)	136 (4.92)	70 (4.26)	183 (4.95)
TRFK 381/1	51 (3.95)	135 (4.91)	220 (5.40)	310 (5.74)	150 (5.02)	158 (5.07)	171 (5.02)
TRFK 338/13	52 (3.97)	249 (5.52)	269 (5.60)	155 (5.05)	214 (5.37)	122 (4.81)	177 (5.05)
TRFK 347/573	55 (4.03)	150 (5.02)	244 (5.50)	244 (5.50)	269 (5.60)	121 (4.80)	181 (5.08)
TRFK 378/1	45 (3.83)	171 (5.15)	269 (5.60)	429 (6.06)	175 (5.17)	118 (4.78)	201 (5.10)
TRFK 382/1	42 (3.76)	205 (5.33)	220 (5.40)	396 (5.98)	220 (5.40)	124 (4.83)	201 (5.12)
GWK Ejulu	45 (3.83)	110 (4.71)	445 (6.10)	384 (5.95)	225 (5.42)	113 (4.74)	220 (5.12)
TRFK 4/12	74 (4.32)	387 (5.96)	220 (5.40)	236 (5.47)	160 (5.08)	102 (4.63)	197 (5.14)
TRFK 301/4	83 (4.43)	449 (6.11)	244 (5.50)	146 (5.99)	173 (5.16)	100 (4.62)	199 (5.14)
TRFK 392/1	56 (4.04)	160 (5.08)	199 (5.30)	356 (5.88)	267 (5.59)	137 (4.93)	196 (5.14)
TRFK 31/8	55 (4.03)	220 (5.40)	244 (5.50)	297 (5.70)	244 (5.50)	133 (4.90)	199 (5.17)
TRFCA SFS 150	15 (2.77)	326(5.79)	601(6.40)	327 (5.79)	227 (5.43)	135 (4.91)	272 (5.18)
TRFK 347/336	86 (4.47)	212 (5.36)	492 (6.20)	297 (5.70)	144 (4.98)	103 (4.64)	222 (5.22)
BBK 35	46 (3.85)	171 (5.15)	402 (6.00)	404 (6.00)	227 (5.43)	152 (5.03)	234 (5.24)
TRFK 6/8	131 (4.88)	492 (6.20)	243 (5.50)	191 (5.26)	160 (5.08)	106 (4.67)	221 (5.27)
TRFK 337/3	89 (4.50)	297 (5.70)	329 (5.80)	289 (5.67)	212 (5.36)	118 (4.78)	222 (5.30)
TRFK 301/3	132 (4.89)	445 (6.10)	445 (6.10)	214 (5.37)	186 (5.23)	107 (4.68)	255 (5.40)
TRFK 337/138	70 (4.26)	203 (5.32)	664 (6.50)	249 (5.52)	326 (5.79)	155 (5.05)	278 (5.41)
TRFK 311/287	94 (4.55)	298 (5.70)	492 (6.20)	269 (5.60)	292 (5.68)	150 (5.02)	266 (5.46)
TRFK 303/231	147 (5.00)	560 (6.33)	269 (5.60)	265 (5.58)	301 (5.71)	115 (4.75)	276 (5.50)
TRFK 7/9	107 (4.68)	691 (6.54)	364 (5.90)	430 (6.07)	182 (5.21)	103 (4.64)	313 (5.51)
TRFK 347/314	184 (5.22)	283 (5.65)	329 (5.80)	349 (5.86)	267 (5.59)	140 (4.95)	259 (5.51)
TRFK 347/26	199 (5.30)	310 (5.74)	445 (6.10)	254 (5.54)	292 (5.68)	175 (5.17)	279 (5.59)
TRFK 12/2	119 (4.79)	468 (6.15)	601 (6.40)	454 (6.12)	236 (5.47)	118 (4.78)	333 (5.62)
AHP CS 12/28	330 (5.80)	278 (5.63)	445 (6.10)	474 (6.16)	304 (5.72)	149 (5.01)	330 (5.74)
TRFK 371/1	108 (4.69)	411 (6.02)	811 (6.70)	457 (6.13)	346 (5.85)	197 (5.29)	388 (5.78)
TRFK 301/2	313 (5.75)	952 (6.86)	445 (6.10)	337 (5.82)	275 (5.62)	136 (4.92)	410 (5.85)
EPK TN 14/3	261 (5.57)	463 (6.14)	492 (6.20)	619 (6.43)	301 (5.71)	175 (5.17)	385 (5.87)
TRFK K-purple	267 (5.59)	560 (6.33)	734 (6.60)	327 (5.79)	313 (5.75)	205 (5.33)	401 (5.90)
TRFK 31/30	402 (6.00)	357 (5.88)	445 (6.10)	619 (6.43)	383 (5.95)	168 (5.13)	396 (5.92)
TRFK 31/37	119 (4.79)	625 (6.44)	897 (6.80)	560 (6.33)	497 (6.21)	168 (5.13)	478 (5.95)
TRFK 301/1	402 (6.00)	406 (6.01)	601 (6.40)	668 (6.51)	379 (5.94)	155 (5.05)	435 (5.99)
AHPCG 28U864	131 (4.88)	555 (6.32)	991 (6.90)	764 (6.64)	507 (6.23)	292 (5.68)	540 (6.12)
Mean	91 (4.52)	298 (5.70)	387 (5.96)	313 (5.75)	236 (5.47)	131 (4.88)	261 (5.51)
C.V (%)	9.42	6.9	7.07	6.5	5.3	3.9	6.91
LSD (p=0.05)	(0.7)	(0.66)	(0.2)	(0.63)	(0.48)	(0.09)	(0.17)

Figures in parenthesis are log (x+1) transformation of mite population

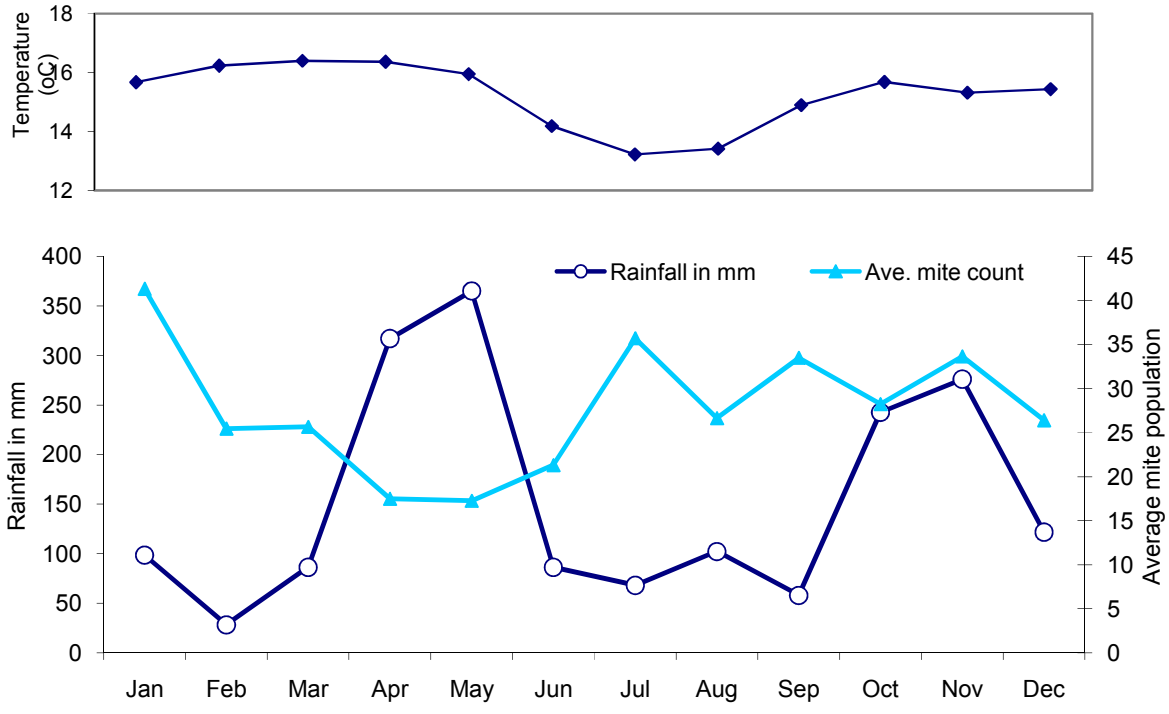

Figure 1: Trends in amount of rainfall per month, average temperature compared to mite population per ten leaves in a month (means 2000-2005 Kangaita)

Table 2: Annual population of red spider mites (RSM) (*Oligonychus coffeae*) on 36 cultivars (clones) at Kipkebe Tea Estate for five years

Cultivars (clones)	Mean population of red spider mites, Kipkebe Estate in Sotik					
	2004	2005	2006	2007	2008	Mean mites (2004-2008)
EPK C/12	59 (4.09)	84 (4.44)	38 (3.66)	3 (1.39)	25 (3.26)	42 (3.37)
NDT TAI	68 (4.23)	70 (4.26)	50 (3.93)	4 (1.61)	17 (2.89)	42 (3.38)
TRFK 303/231	64 (4.18)	95 (4.56)	42 (3.76)	1 (0.69)	23 (3.18)	45 (3.27)
TRFK 347/573	59 (4.10)	83 (4.43)	65 (4.19)	2 (1.10)	24 (3.22)	47 (3.41)
TRFK 301/4	66 (4.2)	97 (4.58)	44 (3.81)	3 (1.39)	26 (3.30)	47 (3.46)
TRFK 7/9	65 (4.19)	115 (4.75)	36 (3.61)	2 (1.10)	22 (3.14)	48 (3.36)
TRFK 337/3	64 (4.18)	102 (4.63)	47 (3.87)	2 (1.10)	26 (3.30)	48 (3.41)
TRFK 382/1	56 (4.05)	88 (4.49)	69 (4.25)	3 (1.39)	24 (3.22)	48 (3.48)
TRFK 347/314	62 (4.15)	111 (4.72)	44 (3.81)	3 (1.39)	26 (3.30)	49 (3.47)
TRFK 392/1	58 (4.08)	106 (4.67)	55 (4.03)	4 (1.61)	20 (3.04)	49 (3.49)
TRFK 347/336	64 (4.17)	105 (4.66)	47 (3.87)	4 (1.61)	26 (3.30)	49 (3.52)
TRFK 12/2	64 (4.18)	93 (4.54)	74 (4.32)	2 (1.10)	27 (3.33)	52 (3.50)
TRFK 378/1	65 (4.19)	118 (4.78)	61 (4.13)	1 (0.69)	21 (3.09)	53 (3.38)
AHP CS 12/28	65 (4.19)	116 (4.76)	62 (4.14)	3 (1.39)	20 (3.04)	53 (3.50)
TRFK 301/2	76 (4.34)	112 (4.73)	55 (4.03)	4 (1.61)	19 (3.00)	53 (3.54)
TRFK 347/26	66 (4.2)	135 (4.91)	44 (3.81)	3 (1.39)	23 (3.18)	54 (3.50)
TRFK 301/6	72 (4.29)	121 (4.80)	50 (3.93)	3 (1.39)	24 (3.22)	54 (3.53)
TRFK 337/138	74 (4.32)	104 (4.65)	64 (4.17)	1 (0.69)	34 (3.56)	55 (3.48)
GWK Ejulu	71 (4.28)	139 (4.94)	49 (3.91)	4 (1.61)	16 (2.83)	56 (3.52)
TRFK 338/13	73 (4.31)	119 (4.79)	59 (4.09)	3 (1.39)	24 (3.22)	56 (3.56)
TRFK 371/1	77 (4.36)	139 (4.94)	46 (3.85)	4 (1.61)	19 (3.30)	57 (3.55)
TRFK 31/8	65 (4.19)	131 (4.88)	69 (4.25)	4 (1.61)	25 (3.26)	59 (3.64)
TRFK 301/5	82 (4.42)	133 (4.90)	55 (4.03)	2 (1.10)	27 (3.33)	60 (3.56)
TRFK 301/3	79 (4.38)	147 (5.0)	51 (3.95)	1 (0.69)	28 (3.37)	61 (3.48)
TRFK K-purple	79 (4.38)	146 (4.99)	60 (4.11)	2 (1.10)	19 (3.00)	61 (3.52)
AHP SC 31/37	76 (4.34)	150 (5.02)	54 (4.01)	2 (1.10)	25 (3.26)	61 (3.55)
TRFK 311/287	78 (4.37)	158 (5.07)	49 (3.91)	2 (1.10)	27 (3.33)	63 (3.56)
TRFK 31/30	75 (4.33)	163 (5.10)	51 (3.95)	3 (1.39)	21 (3.09)	63 (3.57)
TRFK 6/8	71 (4.27)	157 (5.06)	47 (3.87)	3 (1.39)	35 (3.58)	63 (3.64)
TRFK 381/1	79 (4.38)	175 (5.17)	51 (3.95)	1 (0.69)	19 (3.00)	65 (3.44)
TRFK 301/1	90 (4.51)	143 (4.97)	66 (4.20)	1 (0.69)	23 (3.18)	65 (3.51)
TRFK 4/12	85 (4.45)	158 (5.07)	64 (4.17)	2 (1.10)	18 (2.94)	65 (3.55)
EPK TN 14/3	76 (4.34)	140 (4.95)	91 (4.52)	7 (2.08)	37 (3.64)	70 (3.91)
BBK 35	81 (4.41)	161 (5.09)	95 (4.56)	10 (2.40)	46 (3.85)	79 (4.06)
TRFCA SFS 150	85 (4.45)	132 (4.89)	115 (4.75)	13 (2.64)	67 (4.22)	82 (4.19)
AHP CG 28U864	121 (4.80)	272 (5.61)	158 (5.07)	12 (2.56)	69 (4.25)	126 (4.46)
Mean	71 (4.28)	124 (4.83)	58 (4.07)	3 (1.35)	26 (3.28)	21 (3.10)
C.V (%)	4.0	3.5	4.5	38.78	7.36	27.34
LSD (p=0.05)	(0.3)	(0.08)	(0.3)	(0.25)	(0.11)	(7.37)

July to September and short rains, October to December. January to March is also dry. The mite population was high during the dry period and low during the wet period showing that the rainfall above 100mm per month influenced the mite population in the field. The temperatures ranged from 15.08 to 15.6^{0}C with a mean temperature of 15.2^{0}C. These results confirm observations by Salander and Immonen (1992) where they indicated that pests prefer water stressed plants. High mite population observed in 1992 coincide with dry and slow growing period as opposed to the wet season when there is faster growth (Sudoi 1997).

The Red Spider Mites *Oligonychus Coffeae* at Kipkebe Sotik

Table 2 shows that the red spider mites (RSM) varied significantly *(P≤0.05)* in the different tea Cultivars (clones) at Kipkebe Tea Estate in Sotik. The mean RSM numbers during the period ranged from 42 to 126 mean mites for clones during the period. From the average of five years RCM mite incidences, the clones with the highest RSM mite numbers were clones AHPCG28U864, TRFCA SFS150 and BB35 while clone EPK C/12, NDT TAI, TRFK303/231, TRFK347/573, TRFK301/4, TRFK 7/9,TRFK337/3, TRFK382/1, TRFK347/314, TRFK392/1 and TRFK347/336 had the lowest incidence of mites (Table 2).

Conclusions and Recommendations

The Kenyan tea growers need tea varieties that are not only high yielding but also tolerant to mite attack. This study has shown a number of high yielding tea clones that perform fairly well in the two regions. Clones like 347/314, 301/1,301/2, AHP CS 12/28, TRFK 301/3 and TRFK K-purple are among those exhibiting superior yield potential at the two regions. Other clones exhibiting superior performance at Mt Kenya region include, EPK TN14/3, GWK Ejulu, and TRFK 347/373. The tea clones that are susceptible to mite attack are likely to suffer higher damage when there is an outbreak of mites than the ones that are resistant to mites. Based on the results of the 36 Clones, clone AHPCG28U864 is a unique clone, it had the highest incidence of both RCM and RSM, likewise, clone EPK C/12 had lowest incidence of both species of mites. These two clones can be grown in the mite prone areas without the risk of yield losses due to mites. At the Mount Kenya region, the mite species dominant in the area was found to be Red Crevice Mites (RCM). Sotik area, situated at the west of Rift valley had a different species i.e. Red Spider mites. In both areas the two mites were observed

to be low during the rainy season and high during the dry period. This explained the fact that moisture- stressed plants are more susceptible to mite attack.

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