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Population of predacious phytoseiid mites, *Euseius kenyae* (Swirski and Ragusa) on coffee treated with different soil applied fertilizers

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Predacious phytoseiid mites, *Euseius kenyae* (Swirski and Ragusa) plays a major role in management of coffee thrips and other pests such as Phytophygous mites in coffee. Their conservation under various agro-ecosystems remains importance. An assessment on effect of organic and inorganic fertilizer sources on augmentation and conservation of *E. kenyae* was carried out at Coffee Research Station (CRS), Ruiru. Compound organic and inorganic fertilizers were applied on mature coffee trees as the treatments. There were no biocides sprayed to control the coffee pests. The population of *E. kenyae* was assessed monthly. Fertilizers significantly increased the number of *E. kenyae*. The mites' population initially increased and thereafter leveled out. The population of *E. kenyae* was increased by 2.3, 1.8 and 1.3 folds under organic compost, N.P.K. 22:6:12 and N.P.K. 17:17:17 respectively when compared with control. Temperature and rainfall fluctuations affected the population of *E. kenyae* either positively or negatively. To enhance conservation of *E. kenyae* under coffee growing agro-ecosystems, farmers are encouraged to use organic manure. This will benefit the management of coffee thrips and other insect pests as well as the conservation of environment.

Key words: Predacious phytoseiid mites, *Euseius kenyae*, organic compost, inorganic fertilizers, agro-ecosystems.

INTRODUCTION

Coffee is the most important commodity in the international agricultural trade, representing a significant source of income to several Latin American, African and Asian countries (DaMatta, 2004). It is the second most important legally traded commodity in the world after oil with a worldwide value worth about US$ 80 billion (International Coffee Organization, 2011). It is also a major export earner in about 80 tropical and sub tropical countries in Africa, Asia and Latin America. Globally, the commodity supports livelihoods of over 120 million people (Osorio, 2002) where in Africa alone it is a primary export crop with 33 million people growing it mainly on their subsistence farms (Kotecha, 2002). However, a number of constraints deter its production in many countries.

In Kenya for example, growing coffee faces a lot of challenges such as increased incidences of coffee pests (insect pests, diseases/pathogenic micro-organisms and weeds). The increasing incidences of these pests and consequently their management have significantly constrained the economical production of coffee in the country. The insect pests of coffee that are found in

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Kenya and are of economic importance include Coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari); Coffee Thrips*, Diarthrothrips coffeae* Williams; Antestia bugs, *Antestiopsis* spp and Leaf miners, *Leucoptera* spp. Their management in order to reduce crop loss involves use of several strategies such as chemicals and biological control agents. However, some of these strategies are expensive and an affordable to many farmers.

In coffee agro-ecosystems especially in Kenya, presence of diverse biological control agents such as predacious phytoseiid mites have been reported (El-Banhawy et al., 2009). The majority of these are facultative predators that feed on a wide range of prey including red spider mites, gall and rust mites while others feed on fungal spores, pollen, honey dew and exudates from plants, but rarely plant tissue (Zhang, 2003; Vega et al., 2007). Predacious mites found in coffee controls coffee pests such the red coffee mite, *Oligonychus ilicis* (McGregor) and *D. coffeae* (Mugo et al., 2012). The presence and the abundance of predacious phytoseiid mites in the field are influenced by a number of factors. For instance, environmental factors that include biotic (plant conditions, type of vegetation, prey distribution, competition, parasitism, Predation and disease) and abiotic or physical factors (temperature, humidity, photoperiod, rainfall and winds) affect the population and behaviour of phytoseiid mites (McMurtry et al., 1970). Other factors such as hot-dry conditions (El-Banhawy, 1995), prey density and time of release (Hariyappa and Kulkarni, 1988; Zhang et al., 1992) and insecticides sprays (McMurtry et al., 1970) are known to affect the abundance of predacious mites

In Kenya, there are several species of predacious mites locally known to exist. Among them, *Euseius kenyae* (Swirski and Ragusa) with potential to manage secondary pests like *D. coffeae,* is the most common and widely distributed in all coffee growing agro-ecological zones (El-Banhawy et al., 2009; Mugo et al., 2012). Despite this, some strains of *E. kenyae* in Kenya are reported to have developed some resistance to Chlorpyrifos® that has commonly been in use to control key insect pests of coffee for many decades (Mugo et al., 2011).

Although many factors influence the abundance of predacious mites as well as their spread in the field, the effect of fertilizer use as sources of plant nutrient on abundance of predacious mites has not been studied. Shah et al. (2003) established that the abundance of epigeal coleopteran fauna (polyphagous predators in agro ecosystems) was greatest in organically managed farms as compared to conventional farms, a situation that was related to greater food resources from weeds, seeds and prey availability from the invertebrates associated with organic manures. Thus, this study was carried out to establish the effect of soil applied organic and inorganic fertilizers on the abundance of *E. kenyae* on coffee farming agro-systems. This aimed to promote the augmentation and conservation of *E. kenyae* for effective biological control of secondary coffee insect pests such as Thrips.

MATERIALS AND METHODS

Experimental site

An experiment on different soil applied compound fertilizer sources [Organic (N.P.K: 0.8:0.2:1.0) and inorganic fertilizers (N.P.K: 17:17:17 and N.P.K: 22:6:12)] was carried out at Coffee Research Station (CRS), Ruiru from 2005 to 2011 (an equivalent of 72 months). Coffee Research Station is situated in the main coffee growing agroecozone (Upper Midland 2) in Kenya and located at an altitude of 1608 m a.m.s.l (above mean sea level). Its mean annual rainfall is 1058 mm, bimodally distributed with main rainy season (Long Rains) from March to May and Short rains from November to December. The soil at the CRS is humic and euric nitosol (Kikuyu Red Loam) which is dark reddish brown to dusky red with a depth of 1.5 to 2.0 m, friable and free draining with acid humic topsoil. It is of volcanic origin and is formed *in situ* by the decomposition and leaching of tertiary trachytic lava and tuff deposits. It has high clay content (often 60 to 80%), high holding water capacity, good porosity and drainage, and weak acid.

The experiment was laid out at CRS in a coffee block with about 1000 mature coffee trees of Arabica coffee hybrid, Ruiru 11 that is resistant to two main coffee diseases, Coffee Berry Disease and Leaf Rust. The block was sub- divided into sub- blocks where fertilizers were applied. The trees had a planting of close spacing of 2 × 2 m giving a total of 2500 trees per hectare. Agronomic practices such as pruning, liming, handling and weeding were carried out as recommended by Coffee Research Foundation (CRF).

Experimental design and treatments

The compound fertilizer sources, inorganic fertilizers (N.P.K 17:17:17 and N.P.K. 22:6:12) and Organic compost (N.P.K. 0.8:0.2: 1.0), were ground applied as the treatments and their effect on populations of *E. kenyae* assessed at CRS from 2005 to 2011. Plots with no fertilizer applied were included in the experiment as control.

A Randomized Complete Block Design (RCBD) was applied to per sub-block. Each treatment had a sub-block/plot with 16 mature coffee trees and four replicates. Two rows of coffee trees were left between the sub-blocks and the periphery as guard rows. In all the sub-blocks, Gypsum (Lime/calcium source) was applied at a nominal rate of 300 g /tree annually according to results of soil analysis so as to improve Calcium level that was found inadequate. Calcium ammonium nitrate (CAN: 26:0:0) was applied as a supplement in the sub-blocks treated with inorganic compound fertilizers as recommended by CRF.

Sampling of predacious mites

Four coffee trees at the center of each plot were sampled fortnightly to monitor the population of *E. kenyae*. The *E. kenyae* were dislodged from the coffee branches using a beating stick and collected in a collecting board, counted and recorded. The beating was lasted for one minute in each sub block among the four trees at the centre.

Data analysis

Data collected on population of *E. kenyae* for each treatment were summarized as means for each year and presented as a graph with

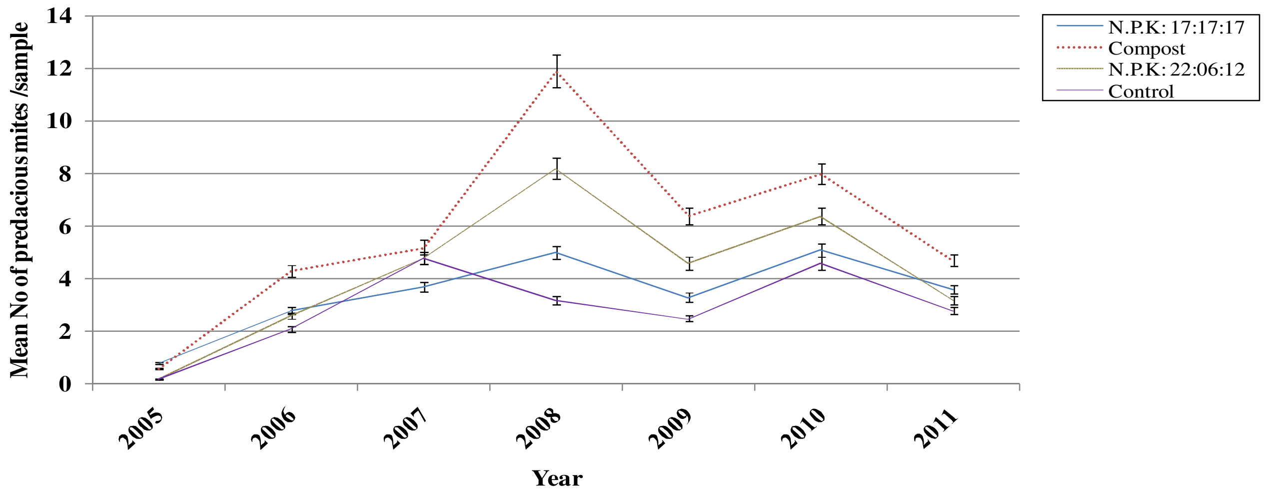

Figure 1. Effect of organic and inorganic fertilizers on population of predacious mites, *Euseius kenyae* (Swirski and Ragusa).

error bars. Data were also presented using logarithmic trend lines for each treatment per month for entire study period.

RESULTS

The population of *E. kenyae* during the start of the trial was below one (Figure 1). This significantly increased with time in all the treatments. In the first three years (2005 to 2008) the population of *E. kenyae* showed an upward trend. And thereafter, an oscillation was observed from all the treatments. The population of *E. kenyae* per sample remained significantly (P< 0.05) higher under coffee treated with organic compost (N.P.K: 0.8:0.2:1.0) as compared with all the other fertilizer sources and control (Figure 1). The controlled plots had significantly (P<0.05) lower population of *E. kenyae* than that where either organic or inorganic fertilizers were applied.

In 2008, the highest population of *E. kenyae* per sample was recorded at 11.9 under coffee treated with organic compost. This was significantly (P<0.05) higher than any other treatment. The other treatments during the same year also significantly (P<0.05) varied from each other with lowest population of *E. kenyae* per sample observed under controlled plot. This trend continued in the subsequent two years (2009 to 2010). However, in 2010 there was significantly (P<0.05) higher population of *E. kenyae* per sample when compared with 2009 in reverence to each treatment. In 2011 a significant drop was observed under any of the treatments.

The population of *E. kenyae* increased with time for all the treatments (Figure 2a to d) but later leveled out. A trend showing the highest population increase was observed under coffee treated with organic compost (Figure 2b), followed by N.P.K 22:6:12 (Figure 2c), N.P.K. 17:17:17 (Figure 2a) and control (Figure 2d) in that order. After 72 months, the populations of *E. kenyae* under various fertilizer treatments and control leveled out at 4.2, 7.5, 5.6 and 3.2 for N.P.K 17:17:17, organic compost, N.P.K 22:6:12 and control respectively (Figure 2a to d). The fertilizer treatments, when compared to the control were 1.3, 2.3 and 1.8 folds under N.P.K 17:17:17, organic compost and N.P.K 22:6:12 respectively. The population of *E. kenyae* under organic compost was double that of N.P.K 17:17:17.

Temperatures and rainfall variation during the study period affected the population dynamics of *E. kenyae*. The mean monthly temperature ranged between 13.4 to 23.1°C with an overall mean of 20°C (Figure 3). Falling of temperatures to below 20°C showed a fall in mean monthly precipitation. Likewise temperatures rise above 20°C caused an increased mean monthly rainfall (Figure 3).

The population of *E. kenyae* oscillated during the study period (Figure 4). Different peaks were observed that depended on temperature overall mean of 20°C. Temperatures above 20°C favourably increased the population of *E. kenyae*. However, any temperatures below 20°C was found to be associated with decline in population of *E. kenyae* (Figure 4). The highest peaks under various fertilizer sources occured in month of August 2008 with highest population (29.1) of *E. kenyae* per sample occurring under organic compost while during the same time the lowest population (7.5) of *E. kenyae* per sample was attained under control. The highest population of *E. kenyae* per sample occurred following the drop in temperature to 16.8°C in July 2008 and subsequently its increase to 20.5°C in October 2008. Temperature drop in month of November 2008 to 13.4°C led to decreased population of *E. kenyae* per sample with lowest population (1.1) recorded in March 2009 under controlled plots before an upward trend was observed thereafter (Figure 4).

Increase in rainfall decreased the population of *E.*

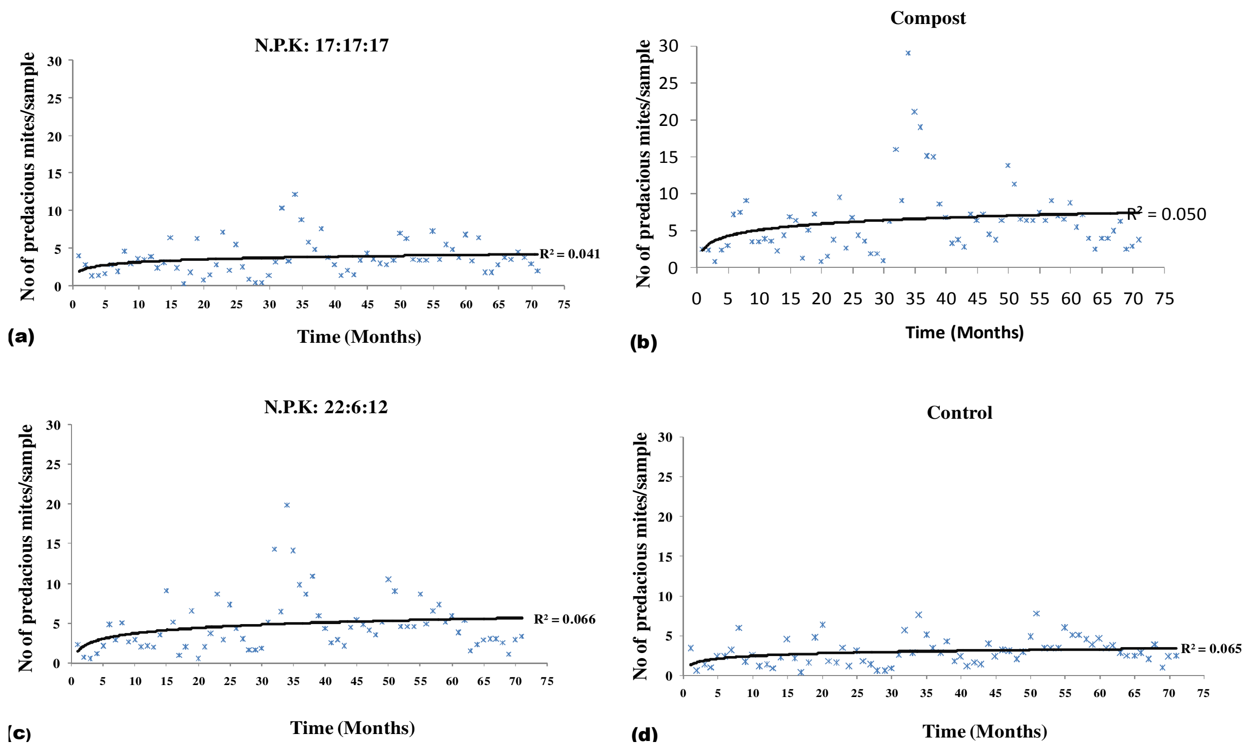

Figure 2. Population of *Euseius kenyae* (Swirski and Ragusa) on coffee treated with different fertilizers (a) N.P.K. 17:17:17, (b) Compost, (c) N.P.K. 22:6:12 and (d) Control.

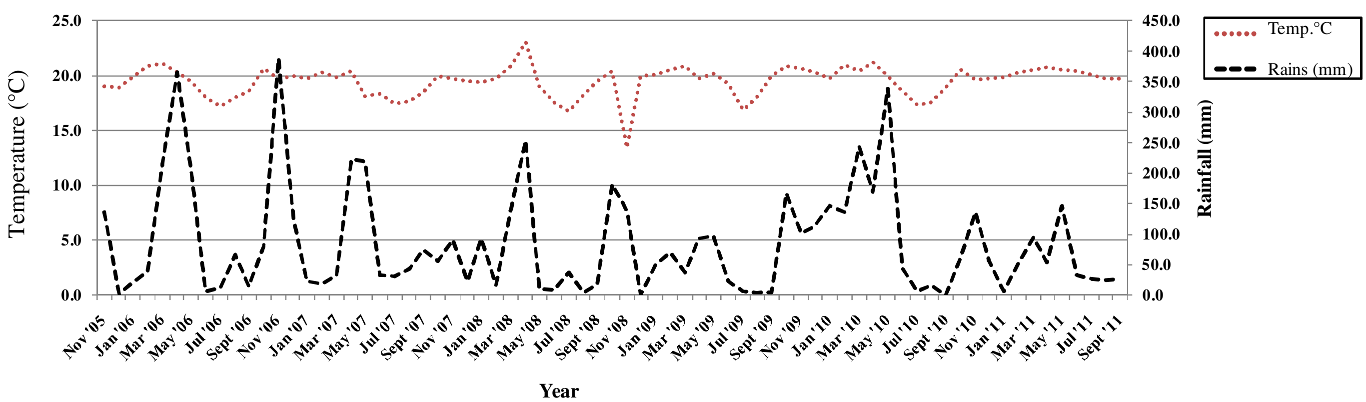

Figure 3. Temperatures and rainfall variation from year 2005 to 2011.

kenyae per sample (Figure 5). Highest mean rainfall (Approximately 380 mm) in month of November 2006 2008 had highest population of *E. kenyae* per sample observed during the trial period (Figure 5). Subsequent rainfall increase between October to November 2008 led to decreased population of *E. kenyae* per sample

DISCUSSION

The population of *E. kenyae* increased in number irrespective of the treatments applied before stabilizing. lowered down the population of *E. kenyae* in all the treatments. Low rainfall in months of May to September This indicated a less polluted coffee farming agro-ecosystems that was associated with non spray of biocides against any coffee pests. The coffee sub blocks treated with organic compost had significantly higher population of *E. kenyae* compared to blocks where inorganic fertilizers were applied. The organic compost unlike the inorganic fertilizers with toxic filler materials enhanced the population of *E. kenyae.* This is likely to have resulted from a wide alternative food sources under organic compost than the inorganic fertilizers. Shah et al.

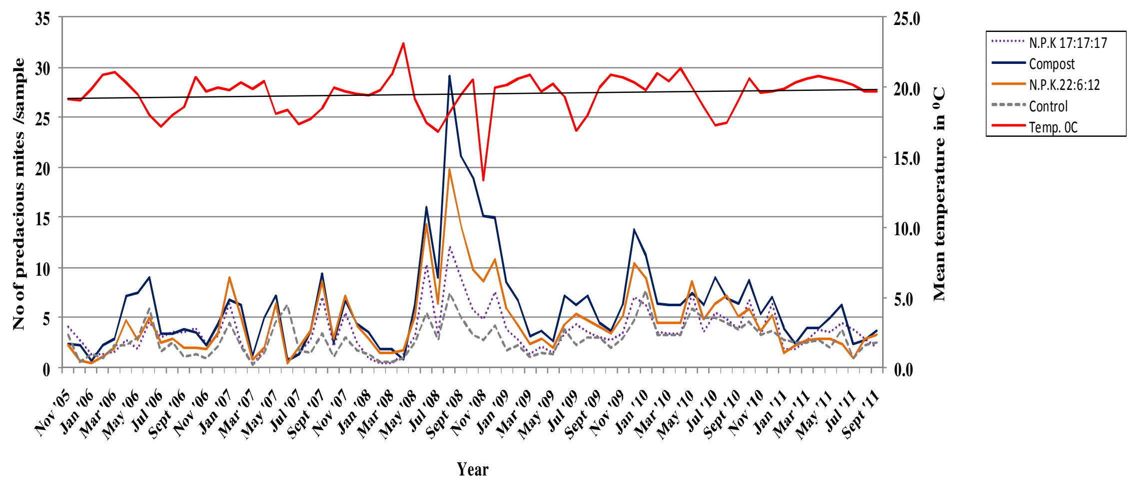

Figure 4. The effect of temperatures on *Euseius kenyae* (Swirski and Ragusa) population dynamics under different soil applied fertilizers.

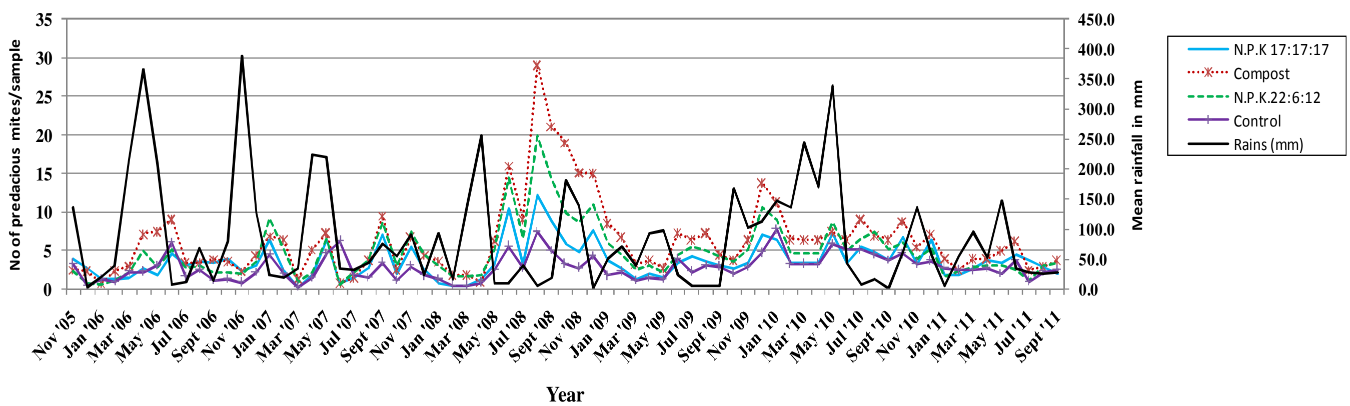

Figure 5. The effect of rainfalls on *Euseius kenyae* (Swirski and Ragusa) population dynamics.

(2003) working with epigeal coleopteran fauna observed that their abundance was greatest in organically managed farms when compared to conventional ones. This was related to greater food resources from weeds,seeds and prey availability from the invertebrates associated with organic manures.

The population of *E. kenyae* varied from one year to the other. This was associated with either biotic or abiotic factors. For instance, the temperature and rainfall variations were found to affect the populations of *E. kenyae* under various organic or inorganic fertilizer sources. Temperatures above 20℃ were associated with increased population of *E. kenyae* under different treatments indicating that this could have been the favourable field conditions for *E. kenyae* augmentation. However, increased rainfall negatively affected the population of *E. kenyae*. The highest rainfall of 380 mm attained during the study period resulted in the lowest population of *E. kenyae* under the different treatments. Though this was the case, low rainfalls indicated the population increase of *E. kenyae*. High and low rainfalls were associated with decreased and increased temperatures respectively. When temperatures are optimal the number of generations per season for various organisms especially insects tend to increase leading to the observed increased population of *E. kenyae*. The observed effect of both the temperature and rainfall on population and behavior of phytoseiid mites have previously been reported (McMurtry et al., 1970).

Conclusion

In conclusion, organic compost (organic fertilizer) augmented and conserved the population of *E. kenyae,* that biologically controls *D. coffeae*. Thus in coffee agro-ecosystems, use of organic compost is important in order to augment and conserve bio-control agents through reduced use of toxic inputs such as inorganic fertilizers.

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REFERENCES

DaMatta FM (2004). Ecophysiological constraints on the production of shaded and unshaded coffee. A Review. Field Crop Res. 86:99-114.

El-Banhawy EM (1995). A survey of the natural enemies of phytophagous mites on citrus in South Africa. A report presented to Outspan Citrus Centre, Nelspriut, South Africa, P. 15.

El-Banhawy E, Irungu L, Mugo HM (2009). Survey of predacious phytoseiid mites (Acari: Phytoseiidae) inhabiting coffee trees in Kenya with descriptions of some new species. *Acarologia XLIX* 3-4:121-137.

Hariyappa AS, Kulkarni KA (1988). Biology and feeding efficiency of the Predatory mite, *Amblyseius longispinosus* (Evans) and chili mite, Polyphagotarsonemus latus(Banks). J. Biol. Control. 2:131-132

International Coffee Organization (2011). URL: http://www.ico.org/ (accessed August 22, 2011)

Kotecha S (2002). 'Coffee in Africa: Impacts and Issues of Low Price Crisis'. Discussion Paper prepared for the Inter African Coffee Organization Ministerial Conference in Equatorial Guinea. Malabo, September, 2002

McMurtry JA, Huffaker CB, van de Vrie M (1970). Ecology of tetranychid mites and their natural enemies: A review. I. Tetranychid enemies: their biological characters and the impact of spray practices. Hilgardia 40:331-390.

Mugo HM, Irungu LW, Ndegwa PN (2012). Population dynamics of predacious phytoseiid mites, *Euseius kenyae* and coffee thrips, *Diarthrothrips coffeae* and their Interactions in coffee agro ecosystems in Kenya. Int. J. Sci. Nat. 3 (2):316-323

Mugo HM, El- Banhawy EM, Irungu LW, Ndegwa PN, Mburu DM (2011). Resistance of Predacious mites, *Euseius kenyae* (Acari: Phytoseiidae) to chlorpyrifos (Dursdan®) in Kenyan coffee farms. J. Agric. Sci. Technol. 13(1):53-64.

Shah PA, Brooks DR, Ashby JE, Perry JN, Wolwod I P (2003). Diversity and abundance of the coleopteran fauna from organic and conventional management systems in Southern England. Agric. Forest. Ent. 5(1):51-60.

Vega FE, Ochoa R, Astorga C, Walter DE (2007). Mites (Arachnida: Acari) inhabiting coffee domatia: A short review and recent findings from Costa Rica. Int. J. Acarol. 33(4):291-295

Zhang ZQ (2003). Mites of Greenhouses: identification, biology and Control. CABI Publishing: Wallingford, Oxon OX10 8DE, UK. 44 Brattle Street, 4th Floor, Cambridge, MA 02138, USA:

Zhang ZQ, Sandness JP, Nyrop JP (1992). Foraging time and spatial patterns of predation in experimental populations. A comparative study of three mite predator- prey systems (Acarina: phytoseiidae: Tetranychidae). Oecologia 90(2):185-196.