EFFECT OF TOMATO *Lycopersicon esculentum* (Mill) VARIETIES ON DEVELOPMENT TIME FECUNDITY AND LONGEVITY OF RED SPIDER MITE *Tetranychus evansi* (Baker & Pritchard)

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ABSTRACT
Tomato *Lycopersicon esculentum* (Mill), is an important source of income to many small scale farmers in Kenya and is a major dietary component. The production of tomatoes is however constrained by several pests with Red spider mite *Tetranychus evansi* (Baker & Pritchard) being the most important dry season pest in Eastern and Southern Africa. Control of *T. evansi* has mainly been by chemicals sprays, which has resulted in problem of pest resistance and pollution of the environment. This study was therefore an attempt to look into alternative environmentally friendly ways of controlling *T. evansi* in tomatoes. To determine the effect of tomato varieties on development time, fecundity and longevity of *T. evansi* an experiment was conducted in a conviron incubator maintained at 25 ± 2°C ,50-70% relative humidity and photoperiod 12:12 L:D a complete randomized design (CRD) arrangement replicated four times in Kenya Agricultural Research Institute, Njoro, Kenya. The tomato varieties assessed were: Cal J, Onyx, Roma VFN, Riogrande, Money maker, Eden F1, Anna F1, and Wild type. The results showed that the, mortality rate for protonymph, deutonymph and adult stages was highest in Wild type (95%) and lowest in variety Money maker (50%). In addition, the average number of eggs per female mite was significantly higher on variety Money maker (52.4) and Riogrande (48.6), while the least number of eggs was recorded on Wild type (9.1). Tomato variety, Money maker was highly susceptible and Wild tomato was most resistant. Since only eight tomato varieties were evaluated, there is therefore need to evaluate more tomato varieties to identify high yielding and less susceptible varieties that can be recommended to farmers. Varietal resistance could become an integral part of an Integrated Pest Management (IPM) programme.
Key words*: Deutonymph, IPM, Lycopersicon esculentum, Protonymph, Tetranychus evansi*

INTRODUCTION
Tomato *Lycopersicum esculentum* (Mill) is the world's most popular vegetable, with an annual world production of 80 million metric tons (FAO, 2001). Kenya produces an estimated 318,639 metric tons and earning cash value of Ksh 5.1 billion (KARI, 1996). In Kenya, it is one of the most important local vegetable crops ranking second to *Brassica* (cabbage and kales) in quantities produced and value (KARI, 1996). The increased popularity in tomato production may be attributed to both its high yield potential, high prices and a continuous source of income (Kamau, 1985), and perhaps more than any other vegetable, it has a higher monetary return per unit area. Tomato growing is thus an important undertaking by low to moderate class earners and goes along way in supporting the fight against poverty and nutritional improvement in Kenya. In Kenya, tomato is grown in almost all arable areas including semi arid and arid areas using irrigation. However, the major tomato production constraints in Kenya are Red spider mite (*T. evansi),*

bacterial wilt, late blight, plant parasitic nematodes, insect pests, lack of high yielding varieties and poor agronomic practices (KARI, 1996).

Red spider mite (*T. evansi),* is a major pest of solanaceous crops including tomato, pepper, eggplant, tobacco and nightshade (Quereshi, *et al.,* 1969., Ramalho and Flechtmann, 1979). It is the most important dry season pest of tomatoes in eastern and southern Africa. Kamau, 1985, reported that these are serious pests of tomato crop grown in areas where the crop experience periods of hot and warm dry weather. *Tetranychus evansi.* causes serious damage to the tomatoes by reducing their yields and affecting quality, not to mention the cost of pesticides used by the farmers (Saunyama and Knapp, 2003). Compounding their effects is the fact that in many instances, farmers have listed Red spider mites as a disease (Yang *et al., 2004)* because they are unable to recognize their minute sizes on crop surfaces. Resistant tomato varieties to Red spider mites have been reported in some countries. For instance, in USA, Kalohi lines recorded high tolerance to mite injury (Varela *et al*., 2003). In Brazil, some promising tomato genotypes tolerant to *T .evansi* have been identified (Varela *et al*., 2003). There are many tomato varieties commercially available to growers in Kenya; however these varieties have not been screened to compare their resistance levels to Red spider mites. This study was conduced to determine the effect of tomato varieties on *T. evansi* development time, fecundity and longevity.

MATERIALS AND METHODS

Mite culture

A stock culture of Red spider mite *T. evansi* was established in green house at KARI- Njoro (0^0 20'S 35^0 56'E, 2164 m above sea level). The initial culture was collected from Horticulture Department (Field 3), Egerton University-Njoro, Kenya and reared on potato plants. The reared red spider mites were later used in laboratory experiment carried out at KARI- Njoro. Red spider mite, *T. evansi* was identified in consultation with International Centre of Insect Physiology and Ecology (ICIPE)–Nairobi.

Development time from egg to adult

Studies on the effect of tomato varieties on the development time from egg to adult of *T. evansi* were done in a conviron incubator maintained at 25 ± 2 ºC, 50-70 % relative humidity and photoperiod 12:12 L:D (Helle and Sabelis, 1985). Small Petri dishes (100 mm diameter) were loaded half with cotton wool and kept wet by adding 5ml of clean water in the morning and evening. Ten leaf discs from each tomato variety with a diameter of 20 mm each were punched from the tomato varieties using a cork borer. The leaf discs were placed in individual Petri dishes, the underside facing up. Thin layer of vaseline was placed on the edges of the leaf disc to prevent the mite from walking a way from the leaf disc and drowning.

Ten female mites were taken from the colony, put on each leaf disc for each tomato variety separately and left for six hours to allow egg laying. Afterwards, eggs were removed (killed) using fine camel hair brush leaving only two eggs per leaf disc. Petri dishes containing leaf discs were then placed in an incubator in a complete randomized design (CRD) arrangement replicated four times. The leaf discs were checked after every 12 hours with the aid of a dissecting microscope and development time from egg to larva, protonymph, deutonymph and adult, as well as adult survival and sex were noted and recorded. Leaf discs were changed after every three days to provide fresh leaves for mites to feed on.

Fecundity and longevity

Studies on the effect of tomato varieties on fecundity and longevity of *T. evansi* were done in a conviron incubator maintained at 25 ± 2 ºC, 50-70 % relative humidity and photoperiod 12:12 L:D (Helle and Sabelis, 1985). Small Petri dishes (100mm diameter) were loaded half with cotton wool and kept wet by adding 5 ml of clean water in the morning and evening. Ten leaf discs with a diameter of 20 mm from each tomato variety were punched using a cork borer. The leaf discs were placed in individual petri dishes, the underside facing up. Thin layer of vaseline was placed on the edges of the leaf disc to prevent the mite from walking a way from the leaf disc and drowning. One female deutonymph was placed on each leaf disc for each of the ten leaf disc per tomato variety. Petri dishes containing leaf discs were then placed in an incubator in a complete randomized design (CRD) arrangement replicated four times. The number of eggs was counted and recorded using dissecting microscope after every 48 hours and killed until the mite died. The fecundity and adult longevity on each leaf disc was recorded. Leaf discs were changed after every three days to provide fresh leaves for mites to feed on.

Data analysis

Data collected was organized and Analysis of variance (ANOVA) was done using the General linear model (GLM) procedure of SAS 2001 version 8.02. Means were separated using Tukey's Studentized Range Test.

RESULTS

There was no significant difference ($P>0.05$) on incubation period, and duration of larval stage in all the varieties tested (Table 1.1). However, there was significant difference ($P<0.05$) on duration of protonymph, and duetonymph stages and as well as adult survival among tomato varieties (Table 1.1 and Table 1.2).The mortality rate of protonymph, duetonymph and adult stages was highest in wild type with 44.4%, 70.0% and 66.7% respectively and lowest in Money maker with 15.0%, 23.5% and 23.1% respectively. The total development period (egg to adult) ranged between 8.9 to 11.0 days Table 1.1 and 1.2). The average number of eggs laid per female mite was significantly higher on Money maker which was not significantly different ($P>0.05$) from Riogrande (Table 2). The least number of eggs was recorded on Wild variety which was significantly different from all the varieties.

DISCUSIONS

The results on incubation period and duration of larval stage may be because the mites are not feeding on the host plant and therefore there is possibly that there is neither morphological nor chemical effect on the mite development at this stage. The significance difference in the duration of time taken on these stages (Protonymph, Duetonymph and adult) may be because at these stages the mite has started feeding on the host plant. The difference in duration may therefore be attributed to the different morphological traits such as trichomes and surface waxes as well as secondary plant metabolites on different tomato varieties (Anathakrishnan, 2001). The difference in mortality rate in the present study may be due to difference in host plant characteristics. This is similar to what was reported by Chatzivasileiadis and Sabelis , 1997,1998., Chatzivasileiadis *et al*., 1999., Maluf *et al*., 2001 ., Cedola and Sanchez, 2003) where compounds from tomato trichome were reported to produce exudates such as methyl ketons and zingiberene that were reported to be toxic to spider mites. High densities of glandular type IV trichomes on L. hirsutum, and non-glandular type V trichomes on L. esculentum were also found by Simmons and Gurr (2005). Glandular trichome types I, IV, VI and VII are known to release secretions on touch that are sticky and toxic (Van haren *et al*., 1987). Nihoul, 1993, Kennedy, 2003, Simmons and Gurr, 2005). The secretions immobilize mites or kill them. The total development period (egg to adult) ranged between 8.9 to 11.0 days.

Similar results were reported by Wesonga *et al.,* (2005). It was noted that the period of *T. evansi* from egg to adult on tomato leaves ranged from 6.5 to 11.5 days. Meyer, (1996) also reported that the life cycle is 9 to 12 days resulting to 24-30 generations in a year. The difference in time taken for eggs to hatch and larva that completed the cycle indicated that development and population increase of *T. evansi* depends on host type. In this case Money Maker is a more suitable host compared to Wild type and other commercial varieties tested because 50% of the larvae reached the adult stage. Similar results were also reported by Isutsa *et al*., (2006) where it was reported that 58 % of the larvae on Money maker reached adult stage. Host plants can exert profound effects on the biology of spider mites including *T. evansi* Jeppson *et al*., (1975). In this study the average ratio of male to female was 1:2.6.This is less compared to what was reported by Qureshi et al (1969) that the ratio of male to female was about 1:10. These difference may be due to difference in test plant varieties used and also different laboratory conditions i.e. temperature and relative humidity. However, the results seems to be almost similar to work done by Moutia (1958) who reported that the sex ratio on tomato plants in the field was 1:3.3. The short life cycle and high ratio of female to male indicate that on suitable host and favorable climatic conditions *T. evansi* can reproduce rapidly and cause severe crop losses. In the present study, highest mortality was recorded on Wild type while lowest mortality was recorded on variety Money maker. Similar results were also reported by Snyder and Carter (1984 and 1985) where it was reported that mite survival was lower in *L. hirsutum* var. *hirsutum* that possessed fewer type VI trichomes than *L. esculentum,* and concluded that trichome type VI could be responsible for the high levels of resistance in this species.

The results on fecundity and longevity of *T. evansi* agree with what was reported by Isutsa *et al*., (2006) where the highest total number of eggs laid by an individual female mite was reported on Money maker. From the results, Money maker seems to be a preferred host plant for egg laying as compared to wild type. Similar results were also reported by Murungi *et al.,* 2009 where preference to Money maker was attributed to trichome density and plant emitted volatiles. This may be attributed to the different morphological traits such as trichomes and surface waxes as well as secondary plant metabolites (Anathakrishnan, 2001). The wild type may also be releasing some chemicals that repel the mite away and therefore not laying eggs on them. These reports agree with the work done by by Wesonga, *et al.* (2005) who reported that, the wild *Lycopersicon* accessions (*L. hirsutum* and *L. peruvianum*) were found to be the most repellent to the spider mites.

Table 1.1: Effect of tomato varieties on duration (days) of incubation, larvae and protonymph stages of Red spider mite (*T. evansi)*

Variety	Incubation period No. of Eggs	Larvae Duration (mean days)	Total no	Protonymph Duration (Mean days)	Total no	Duration (Mean days)
Cal J	20	4.1a	18	2.8a	13	1.7ab
Onyx	20	4.1a	19	2.7a	14	1.7ab
Roma VFN	20	4.2a	18	2.8a	13	2.0ab
Riogrande	20	4.1a	20	2.8a	16	2.0ab
Money maker	20	4.1a	20	2.8a	17	2.3a
Eden F1	20	4.3a	20	2.8a	16	2.1ab
Anna F1	20	4.2a	20	2.7a	14	1.7ab
Wild type	20	4.3a	18	2.6a	10	1.0b
Mean		4.18		2.76		1.83
SE		0.30		0.14		0.15
CV %		22.4		16.37		25.0

Means within a column followed by the same letter are not significantly different using Tukey HSD test, $\alpha = 0.05$.

Table 1.2: Effect of tomato varieties on duration (days) of detonymph stage, a dult stage, sex and mortality of Red spider mite (*T. evansi)*

Variety	Deutonymph Total no (Mean no of days (Egg to Adult) Duration)		Total no	Adult Total duration	Sex	Sex Mortality (%)	
			Male Female		(Egg to Adult)		
Cal J	7	1.3ab	5	9.9a	1	4	75
Onyx	7	1.8a	4	10.3a	2	2	80
Roma VFN	5	1.3ab	3	10.3a	-	3	85
Riogrande	12	1.5ab	9	10.4a	2	7	55
Money maker	13	1.8a	10	11.0a	3	7	50
Eden F1	9	1.3ab	5	10.5a	2	3	75
Anna F1	9	1.3ab	6	9.9a	2	4	70
Wild type		1.0b	1	8.9b	-	1	95
Mean		1.41		10.17			
SE		0.14					
CV %		31.33					

Means within a column followed by the same letter are not significantly different using Tukey HSD test, $\alpha = 0.05$.

Table 2: Effect of tomato varieties on fecundity and longevity of *T. evansi*

Variety	**Fecundity (mean no. of eggs laid/female)**	**Average longevity days**
Cal J	32.0b	7.5b
Onyx	23.0c	7.2b
Roma	23.9c	6.7b
Riogrande	48.6a	8.2b
Money maker	52.4a	12.8a
Eden F1	31.3b	7.6b
Anna	33.2b	7.4b
Wild type	9.1d	4.8c
Mean	31.94	7.78
SE	1.48	0.34
CV %	19.03	13.8

Means in the same column followed by the same letter are not significantly different using Tukey HSD test, $\alpha = 0.05$

CONCLUSION AND RECOMMENDATIONS

The development, fecundity, adult longevity and survival of *T. evansi* varied with varieties. It was evident that antibiotic effect existed especially in Wild tomato variety. Tomato variety Anna F1 had higher yields in spite of high mite population and damages an indication of tolerance to mite damage. The present study did not study the mechanisms of resistance and there is a need to comprehensively study the mechanisms and sources of resistance.

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REFERENCES

Ananthakrishnan, T.N. 2001. Insects and plant defense dynamics. Science Publishers Inc., Enfield, (NH), USA.

Cedola, V.C. and Sanchez, N.E. 2003. Effect of tomato pubescence on development, survival and fecundity of *Tetranychus urticae* Koch and *Neoseiulus californicus* (McGregor) (Acari: Tetranychedae, Phytoseiidae). Acarologia, 3:255-260.

Chatzivasileiadis, E.A., Boon, J.J. and Sabelis, M.W. 1999. Accumulation and turnover of 2-tridecanone in *Tetranychus urticae* and its consequences for resistance of wild and cultivated tomatoes. Experimental and Applied Acarology, 23:1011-1021.

Chatzivasileiadis, E.A. and Sabelis M.W. 1997. Toxicity of methyl ketons from tomato trihomes to *Tetranychus urticae* Koch. Experimental and Applied Acarology, 21:473-484.

Chatzivasileiadis, E.A. and Sabelis M.W. 1998. Variability in susceptibility among CUumber and tomato strains of *Tetranychus urticae* Koch to 2-tridecanone from tomato trichomes: Effects of host plant shift. Experimental and Applied Acarology, 22:455-466.

FAO. 2001. State of food and agriculture. Food and Agriculture Organization. Rome, Italy.

Helle, W. and Sabelis, W.M. 1985. Spider mites, their biology, natural enemies and control, Vol. 1 B Elsevier, Amsterdam: 141-160.

Isutsa, D.K., Wesonga, J.M., Onyango, M.O., Njoroge, J.B., Waiganjo, M.M., Agong, S.G., Fricke, A., Hau, B. and Stuetzel, H. 2006. Proceedings of the Fifth Workshop on Sustainable Horticultural Production in the Tropics, Egerton University, Njoro, Kenya.

Jepson, L.R., Keifer, H.H. and Baker, W.E. 1975. Mites injurious to economic plants. University of California press.

Kamau, A.W. 1985. The biology and control of tomato russet mite, Acolops Lycopersci (Massee) (Acarina: Eryophyidae) in Kenya, Ph.D. Thesis, University of Nairobi.

Kenya Agricultural Research Institute. 1996. Annual report.

Kennedy, G.G. 2003.Tomato, pests parasitoids and predators: titrophic interactions involving the genus *Lycopersicon.* Annual Review of Entomology, 48:51-72.

Maluf, W.R., Campos, G.A. and Das Gracas, C.M. 2001. Relationships between trichome types and spider mites (*Tetranychus envansi*) repellence in tomatoes with respect foliar Zingiberence Contents. Euphytica. 121(1):73-80.

Meyer, M.K. 1996. Mite pests and their predators on cultivated plants in South Africa. Vegetables and berries. Plant protection research institute handbook No. 6, ARC – Plant Protection Research Institute. Pretoria.

Mountia, L.A. 1958. Contributing to study of some phytophagous mites and their predators in Mauratius. Bull. Entomol. Res. 49:59-75.

Murungi, L.K., Knapp, M., Masinde, P.W., Onyambu, G., Gitonga, L. and Agong, S.G. 2009. Host-Plant acceptance, fecundity and longevity of *Tetranychus evansi* (Acari: Tetranychidae) on selected tomato accessions. Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya.

Nihoul, P. 1993. Controlling glasshouse climate influences the interaction between tomato glandular trichome spider mite and predatory mite. Crop Protection, 12:443-447

Quereshi, A.H., Oatman, E.R. and Fleschner, C.A. 1969. Biology of the spider mite, *Tetranychus evansi*. Annals of Entomological Society of America 62:899-902.

Ramalho, F.S. and Fletchtmann, C.H. 1997. Niveis de infestacao de *Tetranychus evansi* Baker and Pritchard, 1960 em diferentes fases de desenvolvimento do tomateiro. Rev. Agricult. 54, 51-56.

SAS Institute. 2001. SAS/SAT, Version 8.02.SAS Institute Inc; Cary, North Carolina, USA.

Saunyama, I.G. and Knapp, M. 2003. The effect of pruning and trellising of tomatoes (*Lycopersicon esculentum* Mill) on red spider mite (*Tetranychus evansi* Baker and Pritchard) incidence and crop yield in Zimbabwe. Afri. Crop Sci. J. 11:269-277.

Simmons, A.T. and Gurr, G.M. 2005. Trichomes of Lycopersicon species and their hybrids:effect on pests and natural enemies. Agricultural and Forest Entomology 7:265-276.

Snyder, J.C. and Carter, C.D. 1984. Leaf trichomes and resistance of *Lycopericon hirsutum* and *L. esculentum* to spider mites *Tetranychus urticae* Koch. J. Amer. Soc. Hort. Sci. 109:837-843.

Snyder, J.C. and Carter, C.D. 1985. Trichomes on leaves of *Lycopericon hirsutum* and *L. esculentum* and their hybrids. Euphytica 34: 53-64.

Van Haren, R., Steenhuis, M., Sabelis, M.W. and De ponti, O. 1987. Tomato stem trichomes and dispersal success of *Phytoseiulus persimilis* relative to its prey *Tetranychus urticae*. Experimental and Applied Acarology 3:115-121.

Varela, A.A., Seif, A.A. and Loehr, B. 2003. A guide to IPM in tomato production in Eastern and Southern Africa. ICIPE Science Press, Nairobi. Pp. 21-26.

Wesonga, J.M., Masinde, P.W., Losenge, T., Ngamau, K., Agong, S.G., Anjichi, V., Fricke, A., Hau, B. and Stützel, H. 2005. Proceedings of the Fourth Workshop on Sustainable Horticultural Production in the Tropics. Department of Horticulture, Moi University, Eldoret, Kenya.

Yang, P.M., Les, S.Y. and Joliffe, F. 2004. Farmers knowledge perceptions and practices in transgenic Bt Cotton in small producer systems in northern China. Crop Protection Journal.

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