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# Effects of the invasive tomato red spider mite (Acari: Tetranychidae) on growth and leaf yield of African nightshades

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ABSTRACT

The tomato red spider mite, *Tetranychus evansi* Baker and Pritchard, is one of the most serious pests of solanaceous crops in Africa. Field experiments were conducted to investigate its effects on the growth and leaf yield of five African nightshade species viz. *Solanum americanum*, *S. sarrachoides*, *S. scabrum*, *S. tarderemotum* and *S. villosum* during the 2008 and 2009 growing seasons. Plants were infested with 2–4 day-old female spider mites which were allowed to multiply. The number of mite motiles increased throughout the growing season in unsprayed plots and this number varied significantly between the African nightshade species. Except for *S. sarrachoides*, leaf damage was high on the other four *Solanum* species irrespective of the spraying regime during both seasons. However, *S. scabrum* had a significantly greater leaf area ratio (ratio of leaf area to total plant weight) and specific leaf area (ratio of leaf area to total leaf dry weight) during both seasons. Overall yields were 1.5 times more in *S. scabrum* and *S. sarrachoides* compared to *S. americanum*, *S. tarderemotum* and *S. villosum*. Our results show that *T. evansi* infestation affects the leaf area ratio and specific leaf area of African nightshade species differentially which eventually determines the plant's overall leaf yield. These findings present an opportunity for evaluation and selection of African nightshade species that can withstand spider mite infestation in small holder farms for increased vegetable production in Africa.



## 1. Introduction

African nightshades (Solanaceae) comprise closely related leafy species which are grouped together in the '*Solanum nigrum*' complex (Edmonds and Chweya, 1997). Part of this group includes *Solanum americanum* Miller, *S. sarrachoides* Sendtner, *S. scabrum* Miller, *S. tarderemotum* Bitter and *S. villosum* Miller, which are consumed widely in parts of eastern and southern Africa as indigenous leafy vegetables (Schippers, 2000). Despite their role in food nutritional security (Grubben and Denton, 2004), African nightshades suffer severe damage from various arthropod pests (Fontem and Schippers, 2004; Rosa et al., 2005; Murungi et al., 2010). One of the most serious pests of solanaceous crops in Africa is the tomato red spider mite, *Tetranychus evansi* Baker and Pritchard. Spider mites feed by penetrating the leaf surface with their stylets and suck out the cell contents (Tomczyk and Kropczyńska, 1985). This leads to a reduction in the total chlorophyll content and net photosynthetic rate of leaves (Park and Lee, 2005) causing crop losses of up to 90% (Sibanda et al., 2000).

Laboratory studies have reported differential suitability of the five African nightshade species as hosts for *T. evansi* (Murungi et al., 2010). Of the five species, only *S. sarrachoides* negatively affected the intrinsic rate of increase and doubling time of *T. evansi*. However, little is known about the interaction of *T. evansi* and its effects on growth and productivity of African nightshades under field conditions. In this study, we present data from two field experiments showing that African nightshades have distinct yield differences as a result of *T. evansi* infestation, which is influenced by the plant's growth parameters (Hunt, 1990).

*Abbreviations:* RGR, Relative growth rate; ULR, Unit leaf rate; LAR, Leaf area ratio; SLA, Specific leaf area; LWR, Leaf weight ratio; REML, Restricted maximum likelihood.

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## 2. Materials and methods

### 2.1. Study site

Field experiments were conducted at the Jomo Kenyatta University of Agriculture and Technology (JKUAT) farm in Juja, Kenya (latitude 0° 10′ 48′ S, longitude 37° 07′ 12′ E, altitude 1525 m above sea level) during September to November, 2008 (Season I) and February to April, 2009 (Season II) to investigate the interaction of five African nightshade species and *T. evansi* populations. During both seasons, *S. sarrachoides* (accession number; GBK 028726), which was obtained from the Gene Bank, Kenya and *S. villosum* (accession number; MW 13), *S. scabrum* (accession number; SS 52), *S. americanum* (accession number; SA) and *S. tarderemotum* (accession number; MW 03) that were obtained from the World Vegetable Centre (AVRDC, Arusha, Tanzania) were used. Conditions at the study sites were as follows: soil: pH 6.4–6.8; N: 90–95 mg $l^{-1}$; weather: temperature 21–22 °C; relative humidity 70–73% were measured at JKUAT and Thika meteorological station (latitude 0° 59′ S, longitude 37° 04′ E, altitude 1548 m above sea level).

### 2.2. Treatments and experimental layout

Experiments were laid out as a split plot in a randomized complete block design with three replicates (Fig. 1). Main plots consisted of the spraying regimes at two levels; one sprayed with an acaricide (Abamectin 1.8%) purchased from a local agrochemical store in Nairobi, Kenya and the other was left unsprayed. Sub-plots consisted of the five species of African nightshade. Each subplot measured 2 m × 2 m with a 2.7 m distance between them and an inter- and intra-row plant spacing of 30 cm × 30 cm. A 2 m empty strip was left between the main plots to prevent any drift of acaricide spray which was applied at a rate of 0.5 ml $l^{-1}$ of water using a knapsack sprayer fitted with a hollow cone nozzle.

### 2.3. Crop establishment

Seedlings of the respective African nightshade species were established in a greenhouse (temperature 23 ± 1 °C; relative humidity 60–70%) as previously described (Murungi et al., 2010). These plant species were transferred at the five leaf stage into polythene bags (5 cm in width × 15 cm in depth) filled with a mixture of soil: manure (3:1 v/v) and placed outside under a shade for three weeks to acclimatize to the field conditions. Plants were watered daily and fertilized only during the second week with 1.5 g of NPK plant$^{-1}$. Three weeks later, the plants were taken to the field and planted into treatment plots in a random manner for each species. The plants were watered daily and weeded on a weekly basis. After two weeks, 3 g of calcium ammonium nitrate (26% N) was applied to each plant.

### 2.4. Mites

Mites, *T. evansi*, were obtained from a colony maintained on tomato plants (variety 'Money Maker') in a rearing room at the International Centre of Insect Physiology and Ecology (*icipe*) at a temperature of 25 ± 1 °C, relative humidity 60–70% and 12:12 light: dark photoperiod.

### 2.5. Spider mite counts and damage assessment

Scouting for natural *T. evansi* infestation on African nightshade species was done on a weekly basis for three consecutive weeks after transplanting. Since no mites were found on the plants, artificial infestations were initiated. Tomato leaves that were heavily infested with two to four day-old young females of *T. evansi* were excised from the colony at *icipe* and transferred to JKUAT in 'khaki' envelopes placed in a cool box. Infestations were established by placing four tomato leaflets on the adaxial leaf surface of respective African nightshade species. Counting the number of mites began 14 days after infestation and continued at seven day intervals for six consecutive weeks. Three leaves were individually removed from the top, middle and bottom levels of respective plants, placed into khaki paper bags in cool boxes packed with ice and taken to the laboratory for processing. The motile stages namely, larvae, nymphs and adults were counted on both sides of the leaf under a dissecting microscope (×25). Leaf damage rating followed a method previously described (Hussey and Parr, 1963) on a scale of 0–5 where 0 = no damage, 1 = 0–20%, 2 = 20–40%, 3 = 40–60%, 4 = 60–80% and 5 = 80–100% damage.

### 2.6. Plant growth and yield analysis

Plants that were sampled for mite counts were harvested, placed into labeled polythene bags in cool boxes packed with ice and taken to the laboratory for processing. All the above ground parts including leaves, flowers, fruits and stems of each species were separated. Fresh weight of all leaves was determined using a weighing balance including those assessed for spider mite damage.

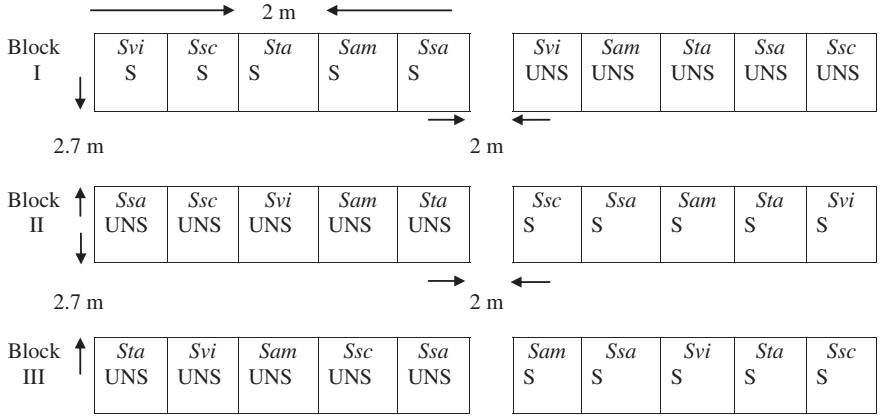


**Fig. 1.** Arrangement of main plots and sub-plots in the field season during season I and season II. *Svi* = *S. villosum*; *Ssc* = *S. scabrum*; *Sta* = *S. tarderemotum*; *Sam* = *S. americanum*; *Ssa* = *S. sarrachoides*; S = sprayed; UNS = unsprayed.