Management on *Tetranychus urticae*, Koch (Acari: Tetranychidae) infestation in different plants

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Abstract- The two-spotted spider mite, *Tetranychus urticae* Koch is a polyphagous and one of the most serious agricultural pest in the world which limits the yield leading to huge economic losses. Documentation of the population abundance and spatial distribution of this pest in different plants and selection of newer management practices provide new scope to combat spider mites. Under heavy infestations of *T. urticae*, plants suffer massive leaf drop and yield loss. Because of the negative impact of *T. urticae* on different crops, various management practices are followed i.e., use of botanicals, cultural and physical practices, chemicals and biological against *Tetranychus urticae.*

Keywords*:* Botanicals, management, mite, *Tetranychus urticae*

INTRODUCTION

T. urticae is a chelicerate herbivore with a wide host range as approximately 4000 host plant species have been described worldwide which is infested by it (Migeon *et al.,* 2010). In addition to tomato, it is also recorded on joscpks coat, lady's finger, kathua, cucumber, brinjal, bottle gourd, bean, spinach, loofah, bitter melon, radish, pointed gourd and cowpea (Kumral *et al*., 2018). Under heavy infestations of *T. urticae*, plants suffer massive leaf drop and yield loss. Because of the negative impact of *T. urticae* on crops, various management practices are followed to control *T. urticae* infestation. Roy *et al*. (2011) reported that methanolic extracts of *Ocimum tenuiflorum* (3%) exhibited acaricidal activities against *T. neocaledonicus* with the mortality of 97 percent. Tehri and Gulati (2014) also reported that Omite (0.05%) caused high toxicity (98.72% over untreated control) of *T. urticae* under field trials after four sprays. Because of the negative impact of *T. urticae* on different crops, various management practices are followed i.e., use of botanicals, cultural and physical practices, chemicals and biological against *T. urticae.*

1. Use of botanicals against *Tetranychus urticae*

There are several reports on botanicals like, common tancy, wormwood extracts (Chiasson *et al*., 2001), neem (Martinez-Villar *et al*., 2005), aak, oleander (Islam *et al*., 2008), marigold, garlic, pepper (Rusch *et al.,* 2010), which are effective against *T. urticae* adults. According to Miresmailli *et al*. (2006) out of six concentrations (2.5, 5, 10, 20, 40 and 80 ml litre^{-1}) of *Rosmarinus officinalis*, 40ml litre^{-1} and 10ml litre^{-1} caused complete mortality (100%) of mites on tomato and bean plants, respectively. Methanolic fruit extracts of hot pepper and ethanolic extracts of *Datura stramonium* leaves and seeds exhibited acaricidal, ovicidal and repellent activities against two-spotted spider mite, *T. urticae*. *Neem* cake @ 200 kg/ha + *O. sanctum* (10% aqueous leaf extract) recorded 15.81 t/ha fruit yield with 47.65 per cent increase over control (Kumar *et al*., 2009). Gopal (2000) reported that methanol extract of *Vernonia inermea* and *Vitex negundo* at 6, 8 and 10 per cent caused 4.4, 8.8, 36 and 4.4, 22, 50 walk off response in *T. urticae* after 24 h on rose leaves. Chandrashekar (2002) reported 72.2 and 80 percent walk off response in *T. urticae* after 12 and 24h of treatment with neem oil (3%). Geroh (2007) reported that *Pongamia pinnata* and *Eucalyptus globulus* oil caused 82.3 and 76.1 per cent reduction in *T. urticae* population on okra. Reddy *et al*. (2014) reported that tomato leaves treated with *Cinnamomum camphora* leaf extract (8%) recorded 59 percent oviposition deterrence index. Gulati *et al*. (2006) reported the effectiveness of *W. somnifera* extract at 5 and 10 per cent concentrations against *T. urticae* on okra. Likewise, Tehri and Gulati (2014) reported that *W. somnifera* (7.5%) and *G. glabra* (7.5 and 5%) were effective in reducing the *T. urticae*

population to 84.64, 76.75 and 75.26 per cent after spray as compared to control on cucumber. Yanar *et al*. (2011) reported the efficacy of methanol extracts of 12 plant species, out of which *Lolium perenne* L. (flower, leaf), *Anthemis vulgaris* L. (flower) and *Chenopodium album* L. (flower, leaf) resulted in 82 to 93.5 percent mortality in mites. Erdogan *et al.* (2012) determined the efficacy of of *Allium sativum*, *Rhododendron luteum*, *Helichrysum arenarium*, *Veratrum album* and *Tanacetum parthenium* against *T. urticae*. The highest mortality effect of the plant extracts against larvae and adult mite occurred at a concentration of 12 percent while it was lowest at 1percent. Al-Alawi (2014) found that aqueous leaf extract of *Pyrus syriaca* caused 65 per cent mortality followed by *Achillea biebersteinii* (64%) against the adult *T. urticae*.

The inhibitory effects of naturally occurring plant polyphenols such as tannic acid, ellagic acid, ferulic acid, caffeic acid, stilbene, quercetin, curcumin and chlorogenic acid against glutathione transferase have been reported by many researchers (Coruh *et al*., 2007). Herbivore-induced plant volatiles (HIPVs) from sour orange plants has a marked repellent effect on conspecific mites associated with the production of the terpenes a-ocimene, a-farnesene, pinene and D-limonene, and the green leaf volatile 4-hydroxy-4-methyl-2-pentanone (Agut *et al*., 2015).

Water extract of *O. basicilum* (@15%) caused 74 percent adult mortality and complete inhibition of *T. urticae* fecundity (Isabel *et al*., 2016). Eliminix (0.4%) and pestoneem (0.5%) applied as an organic treatment caused 60.63 and 56.91 per cent reduction in *T. urticae* population on tomato (Phukan *et al.*, 2017). Seifi *et al*. (2018) reported that polar extracts and fractions of *Moringa peregrina* has acaricidal, oviposition deterrence and repellent activity against *T. urticae* under *in vitro* conditions; Ethyl acetate fraction (LC_{50} 4.26 mg ml^{-1}) had the highest contact toxicity and repellency up to 6h after treatment, ovicidal mortality was 70 percent in hexane (LC_{50} 10.35 mg ml^{-1}) fractions and methanol extract (LC_{50} 6.464 mg ml^{-1}) led to 55.49 percent mortality of eggs. Ogayo *et al*. (2019) reported that plant extract of *O. gratissimum* and *Leonotise nepetifolia* at 12 percent concentration showed highest efficacy (82.75 and 69.06 %) against *T. urticae* which led to increase in pod numbers and pod yield in French bean.

2. Use of cultural and physical practices against *Tetranychus urticae*

T. urticae populations in unplowed fields reached critical densities nearly one month earlier than in plowed fields (Craig *et al.*, 1982). They further reported that fall flaming disengaged the residual mite population from its food supply. Surfactants may also have direct or indirect effects on soft-bodied arthropods. Cowles *et al*. (2000) showed that trisiloxane, generally considered as an inert ingredient; either suffocates or disrupts the important physiological processes in *T. urticae*. Saunyama and Knapp (2003) reported that unpruned and untrellised plots had 37.7 and 30.2 mites/leaf while the pruned and trellised plots had 4.6 and 17.3 mites/ leaf on tomato infested by *T. evansi*.

3. Use of chemicals against *Tetranychus urticae*

Several acaricides are listed for the control of *T. urticae* on different crops including synthetic pyrethroids (Jacobson *et al.*, 1999). Sekh *et al.* (2007) observed an excellent control of two spotted spider mite on brinjal with spiromesifen 240 SC @ 0.7 ml /l coupled with significant increase in fruit yield. In another study, Omite (0.05%) gave 69.19 percent reduction in *T. urticae* population followed by dimethoate (0.03%) which gave 57.97% mortality (Patil *et. el*. 2014). Fenazaquin @ 125 and 150 g a. i. /ha recorded significantly lowest mite population (3.5-4.8/4 cm^2 leaf area) followed by dicofol @ 250g a.i./ha at 10 days after spraying on tomato (Misra, 2011). Pahla *et al*. (2014) and Baladhiya *et al*. (2018) reported that Spiromesifen 240 SL gave the maximum reduction (100%) in *T. urticae* population after seven days on tomato and brinjal, respectively. Integrated control of *T. urticae* on tomato reported by Afifi *et al*. (2015) showed highest reduction percentages (≤ 70 %) in *T. urticae* numbers after the treatments of *Phytoseiulus persimilis* + Milbeknock 1% EC followed by *P. persimilis* + Nimbecidine 0.03%EC, *P. persimilis* + *Paecilomyces fumosoroseus* + Nimbecidine 0.03% EC and *P. persimilis* + *P. fumosoroseus* + Milbeknock 1% EC, which averaged 76.76, 74.89, 73.91 and 73.31 percent, respectively.

4. Use of biological agents against *Tetranychus urticae*

Biological control of *T. urticae* with phytoseiid predatory mites has been successful mainly in

protected environments but also in open fields in many parts of the world (Zhang, 2003). Castagnoli *et al*. (2004) released a generalist predator, *Neoseiulus californicus* to control *T. urticae* on tomato, sweet pepper and eggplant at a 1:8 predator: prey ratio. The mean densities of *T. urticae* per leaflet were 9.15, 2.03 and 52.26 under the low and high predator–prey ratios and control treatments, respectively on tomato (Ferreo *et al*., 2011). *Phytoseiulus macropilis* is also reported as potential biological agent against *T. urticae* in tomato crops under greenhouse conditions (Coombs and Bale, 2014). The combination of Milbeknock 1% EC or Nimbecidine 0.03% EC with *Phytoseiulus persimilis* was highly effective for management of the *T. urticae* on tomato plants in open field (Afifi *et al*., 2015).

Fungal entomopathogens have also been used against *Tetranychus urticae* such as *Hirsutella thompsonii* Fisher (Aghajanzadeh *et al.,* 2006), *Metarhizium anisopliae* (Metschnikoff) Sorokin, *Beauveria bassiana* (Balsamo) Vuillemin (Geroh, 2011) and found effective. Adult mites exposed to treated leaves laid fewer number of eggs (31 to 50 eggs / female) as compared to untreated leaves (121 eggs/female). Shi and Feng (2004) reported that *B. bassiana* and *Paecilomyces fumosoroseus* were capable of infecting *T. urticae* eggs at the concentrations of 58, 298 and 1306 conidia/mm^2 , but the ovicidal activity of the *B. bassiana* isolate was greater than that of the *P. fumosoroseus* isolate. Commercial formulation of *B. bassiana* (Naturalis L.) recorded 98 per cent reduction of nymphs and adult, *T. urticae* infesting tomato under glass house conditions. The combination of Naturalis-L and *P. persimilis* on tomato caused up to 98 percent reduction within 7 days of treatment (Chandler *et al*., 2005). Zang *et al*. (2018) reported *Isaria cateniannulata* conidia at 2×10^7 conidia/ml caused 100 percent mortality of *T. urticae* female.

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