Impact of Spider Mite Feeding On Vegetable Crops

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Abstract

Agriculture plays an important role to determine the economy of Kerala. Being primarily an agricultural state, contribution of Kerala to the vegetable crop industry is a crucial one. However, despite the rich diversity of our vegetable crops, knowledge on their faunal composition, particularly of spider mites as pests and other related details remains very much limited. In recent years due to random use of chlorinated hydrocarbons for control of general pests, which in turn kill their natural enemies, and because of using high yielding varieties and improved agricultural practices, many mite species which were of less importance or of no value at all during the past have assumed the status of major pests. These, among other factors have further aggravated the situation of the problem of spider mites as pests.

The plant feeding mites (Acari: Tetranychidae) has piercing and sucking type of mouth parts with which it pierces the leaf tissue and sucks the plant sap. The point of suction is marked by the appearance of white spots which gradually coalesce to form chlorotic patches, necrotic patches etc. Spider mite feeding cause various types of direct damage like loss of chlorophyll, appearance of striplings or bronzing of foliage, stunting of growth, formation of galls and erineal patches thereby causing an array of deformities and reduction of yield. The intensity of damage ranging from simple mechanical injury to complex physiological alterations of the plant tissues would lead to collapse of the photosynthetic machinery of the plant. Apart from direct damages, many are known to act as vectors of plant viral diseases causing more potential loss to growers. In many instances, lack of information about the correct identity of spider mites, their biology and ecology caused serious consequences to agriculture.

In view of their importance in agriculture, the present study is thought to be highly warranted, as it is envisaged with a view to provide information on the impact of feeding of the spider mites.

Keywords: Spider mite, stylets, chlorotic spots, webbing, necrotic patches.

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1. Introduction

The spider mites have been recognized as sporadic pest of vegetable crops and many other economically important plants (Jeppson *et al.*, 1975; Gupta, 1985; Sangeetha and Ramani, 2011a; Pankaj and Abhishek 2015; Young *et. al.* 2019). They are well known for their extraordinary ability to colonise vegetable plants, to replenish all the available nutrients and to cause serious injuries to its host plants (Chen *et al*., 2005; Ji *et al.*, 2005). The mites occur invariably on both the leaf surfaces preferably near the petioles of mature leaves causing crinkling, drying and defoliation of affected leaves (Reis *et al.*, 2000; Childers *et al.*, 2003; Saritha and Ramani, 2013). This has raised their importance as pests in terms of the degree of damage induced. Vegetable plants are highly susceptible to attack by spider mites as many species emerged as the prominent faunal element on them (Binisha and Bhaskar, 2013). Whereas a large body of work is available on the breeding biology of these mites, much less is known about the feeding injury induced by spider mites on their host plants. In the present study, the feeding characteristics and damage induced by spider mites on vegetable crops is addressed.

2. Materials and Methods

2.1 Outdoor culturing of mites

Live cultures of spider mites were maintained in the field to observe closely the mode of infestation, progressive damage symptoms induced on the host plant and also to make quantitative estimation of damage potential of the concerned species. To achieve this objective, two mite treatments (i) M^-, mite free plants and (ii) M^+, plants artificially infested with mites, were included in a randomized block design plots (3mx3m) which was replicated four times within a season. Cultivation of host plants was done by planting stem cuttings or seedlings of vegetable crops in enriched soils prepared for the study. The plots were irrigated regularly and the plants were made mite-free by spraying a broad-spectrum insecticide thiodicarb to eliminate mite pests and predators (Reddall *et al*., 2004). Artificial infestations of M^+ plants were done by stapling mite-infested leaf bits grown in the glass house 60 days after planting. The plots were covered with fine nets to ensure protection from pest attack and to reduce the risk of cross infestation between M^+ and M^- plots.

2.2 Indoor culturing of mites

Live cultures of different stages of the mites were maintained in the laboratory at 30 $\pm$ 2ºC and 70 $\pm$ 5% relative humidity on fresh leaves of host plants, collected from the plots at an interval of 2 days or at the time of need. Mite culturing was carried out following the leaf flotation technique (Sangeetha and Ramani, 2007a). Each culture set consisted of 2–4 leaves, kept in petri dishes lined with moistened cotton pads and was treated as an experimental unit. Stock cultures of the mites were also maintained in the laboratory in the same manner so as to ensure constant supply of life stages.

3. Results

3.1 Qualitative assessment of feeding injury

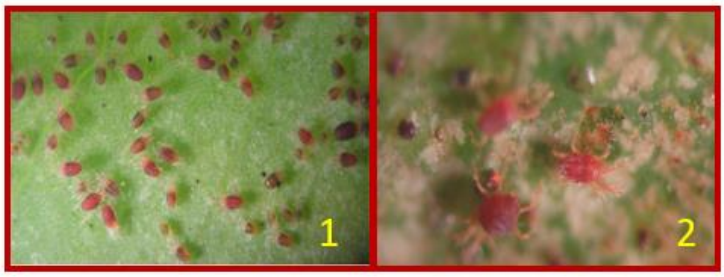
Studies on feeding activities of all life stages of spider mites on host leaves, damage symptoms and progress of infestation was made through repeated field cum laboratory studies.

3.2 Morphological responses of feeding

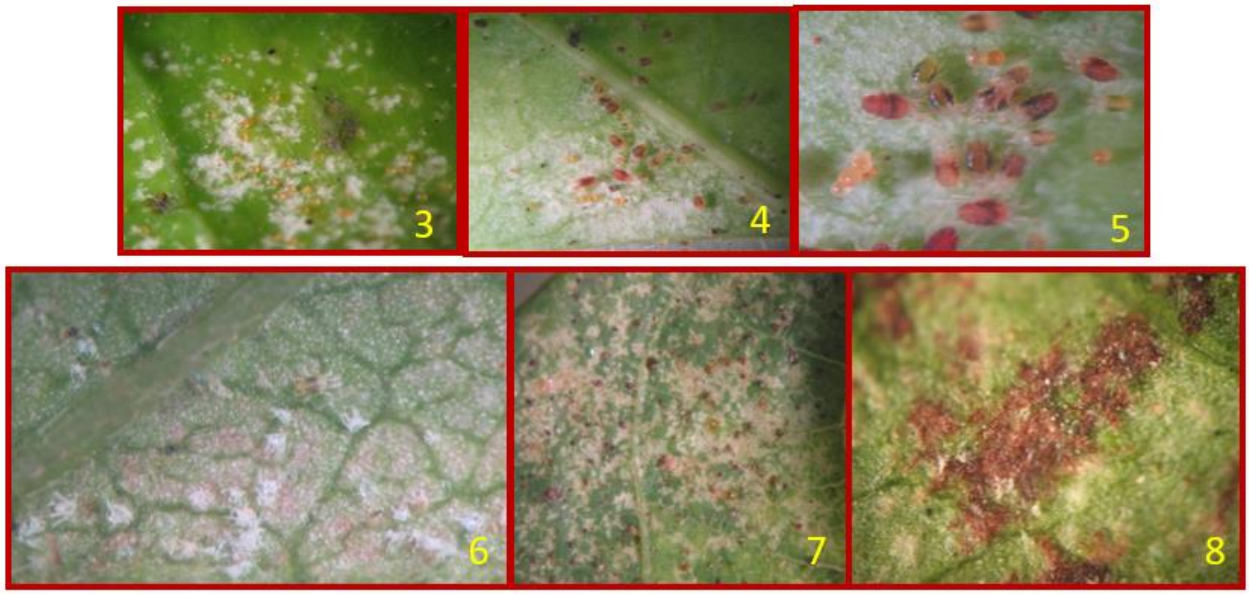
3.2.1. *Feeding activity of Spider mites*

[Figs. 1 & 2]: Spider mites represented the category of ‘leaf suckers’. Mites colonised the mature leaves and built large colonies. However, young or newly sprouted leaves of the host plant were left unfed by the mite. The adults, larval and nymphal stages equally engaged in active feeding by piercing their stylets set on protrusible stylophore that could be seen moving back and forth during feeding and sucking the tissue fluids out from the leaves. The colony structure of the mites as reflected in the current study were complex attained through construction of thinner complicated webbing on the leaf surface connecting the petioles and major veins of the leaf. Females initiated oviposition soon after web construction and laid golden brown eggs at random on the leaf

surface. As feeding progressed, faecal matter was deposited as black globules that spread on the leaf surface soon after ejection from the body. Such black patches could be seen scattered all over the leaf surface amidst a separate layer formed of webbing, egg cases, moulting skin, eggs and life stages, dust particles and damage symptoms. This coating imparted a cumulative effect on the retardation of photosynthesis by preventing the absorption of light by the residual chlorophyll left unfed by the mite.Formation of such a thick layer over the leaf surface could be explained on the basis of earlier reports by Haq (1997), Sumangala and Haq (2000), Reddall *et al*. (2004) and Sangeetha and Ramani (2007b).



Figs: 1 & 2 - Feeding activity of Spider mites



Figs: 3 to 8 - Damage symptoms induced by Spider mites

3.2.2. ***Damage symptoms induced by Spider mites***

[Figs. 3 to 8] : Feeding injury to the host leaf was marked by the appearance of characteristic spots and later patches at the areas of suction of sap from the plant cells. Initial symptoms of damage were manifested in the form of numerous white spots at the points of feeding on the leaf surface.

Continuous sucking by all stages of this mite from leaves and petioles caused fusion of these spots and formation of large chlorotic patches. Following this, a change in colour from white to yellowish brown patches could be observed. Severe infestation and prolonged feeding encompassed the formation of dark brown patches, crinkling

and subsequent drying and defoliation of affected leaves. Attack by these mites was so severe that the whole plantation appeared to be crinkled due to water loss through the feeding punctures produced on the leaves. This had a negative impact on the growth and vigour of majority of the vegetable plants (Park and Lee, 2002 & Puchalska, 2006). This observation is also in support of the findings of Reddy and Baskaran (2006) at much lower infestation levels of *T. ludeni* on four varieties of egg plants.

3.2.3. *Ultrastructural damages from mite feeding*:

The feeding activity of these mites also induced mechanical injury to epidermal and mesophyll tissue and hence heavy water loss from the leaf tissues. The cells were distorted, punctured, with empty spaces and also showed severe reduction in chlorophyll content. Even the cells that were not punctured directly by mite feeding had coagulated protoplasm (Sangeetha, & Ramani, 2011b). These results clearly reflect on the capacity of spider mites in damaging their host plants by inducing mechanical damage aggravated by biochemical alterations.

4. Conclusion

Results of the feeding experiments of spider mite species conducted in the laboratory on different host leaves reflected on prolific feeding by all active life stages *viz.*, larval, nymphal (proto & deuto) and adult stages by piercing the leaves with the stylets and sucking the cell contents out. Combined and extensive feeding by the mites resulted in acute chlorosis of the leaves. Prolonged feeding in huge numbers led to premature leaf abscission, yield loss, branch dieback and even death of the plant. Studies on cytological alterations resulting from mite feeding using transmission electron microscopy showed reduction in the number of cells and chloroplasts, alterations in cell structure, increase in space in the spongy layer, extensive disruption of the mesophyll cells and even reduction of chloroplasts in adjacent unpunctured cells. The overall impact of spider mite feeding had resulted in the total destruction of the photosynthetic machinery of the plant leading to its final collapse. These results thus clearly established the potentiality of the leaf sucking forms in damaging the host plants.

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