International Journal of Science, Environment and Technology, Vol. 4, No 5, 2015, 1365 – 1372

ISSN 2278-3687 (O)
2277-663X (P)

POPULATION DYNAMICS OF MITE, *ACERIA TULIPAE* (KEIF.) ON GARLIC (*ALLIUM SATIVUM* L.) AND ITS MANAGEMENT UNDER BENGAL BASIN

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Abstract: Garlic (*Allium sativum* L.) is one of the most important spice crops in West Bengal grown during the winter months (October/November to March/April). But mite pest *Aceria tulipae* (Keifer) causes heavy damage and limits its production. Mite infestations were found as early as the two to three-leaf stage of the crop, during the last week of December. The population was found to be increased gradually and reached the maximum during mid-February thereafter gradually decline by the end of March with the onset of high temperature. Both temperature and relative humidity (max) had a non significant and positive relationship with the garlic mite population. The five varieties evaluated were found infested by the mite; Goldana, local were most susceptible and Katki was found to be the least susceptible. One days after spraying ethion was found most effective and very low population (2.13 mites per sq. cm.) was found in this treatment very closely followed by profenophos (2.19 mites per sq. cm.). There is no significant difference between these two treatments. Ten days after spraying dicofol was found to be the most effective acaricide and very low population (1.40 mites per sq. cm.) was found in this treatment closely followed by ethion (3.0 mites per sq. cm.).
Keywords: Incidence, variety, acaricides, sustainable management, spices.

Introduction

Garlic (*Allium sativum* L.) is one of the most important spice crops in West Bengal grown during the winter months (October/November to March/April), covering an area of more than 10,000 hectares, particularly in the Jirat and Balagar areas of Hooghly district, the Nakashipara and Bethuadahari areas of Nadia district and the Lalgola and Baharampur areas of Murshidabad district. The garlic mite, *A. tulipae* (Keifer) has been identified as one of the constraints in garlic production in West Bengal. It is also known as the dry bulb mite and considered as one of the most damaging mite pests of garlic. Navia *et al.* (2010) listed this eriophyid mite as an invasive alien species, which had accidentally invaded China (Hong *et al.* 2006) and Japan (Mito and Uesugi 2004) and was encountered on *Allium cepa*, *Allium sativum* and *Tulipa* spp. Puttarudriah and Channabasavanna (1958) reported *A. tulipae* for the

*Received Sep 13, 2015 * Published Oct 2, 2015 * www.ijset.net*

first time in India infesting garlic crops in Mysore. Pawar *et al.* (1990) studied the response of garlic varieties to *A. ulipae* in Maharashtra.

The damage signs due to mite attack appeared as twisting and curling of leaves, which did not open properly, creating a micro-environment on the upper leaf surface where all the biological stages of the mite, namely eggs, nymphs, and adults, colonized along the mid-rib. In heavy infestations, leaves showed yellow streaks, most often along the mid-rib and leaf margin. The mite caused damage to the surface of stored garlic bulbs resulting in their eventual drying or decay. During last few years, this mite has emerged as a serious pest of garlic in all the areas, both in the field and in storage conditions, causing huge annual losses. It is a seed garlic borne mite species and therefore severe infestation was also noticed due to use of infested seed bulbs. The mites colonized on the upper surface of leaves along the midrib grooves, creating a congenial micro-environment for their colonization. As the mite population increased, the leaves expressed typical curling and twisting, producing a malformation that impeded the growth and development of leaves, which failed to open properly. Both nymphs and adults were found to suck sap from the upper leaf tissues. Infested plants remained stunted and sickly in appearance. In a heavily infested field, the leaves showed typical symptoms of curling, leading to the formation of a pig tail like symptoms on leaves.

The infested leaves typically arched downwards with the tip tucked into the next young leaves Channabasavanna 1966). Yamashita *et al*. (1996) and Koo *et al*. (1998) demonstrated that mosaic and streak symptoms were induced by the garlic mite-borne mosaic virus of the genus *Rymovirus* (Potyviridae) vectored by *A. tulipae*. This mite was also reported to transmit onion mite-borne latent virus in onion and shallot mite-borne latent virus in shallot (Dijk *et al*. 1991). Later, Dijk and Vlugt (1994) isolated other viruses transmitted by *A. tulipae* from rakkyo, shallot and wild leek. The mite caused damage to the surface of stored garlic bulbs (Na *et al*. 1998), resulting in their eventual drying or decay (Laffi and Raboni 1994). *Aceria tulipae* is also known to cause severe crop losses to garlic in all production areas around the world, reducing yields up to 23% (Larrain 1986). Budai *et al*. (1997) reported a 20–100% infestation of garlic cloves and a considerable amount of storage loss. The productivity of garlic is affected due to attack of pest and diseases (Nonnecke 1989). It was also found to cause damage to stored garlic bulbs (Na *et al*., 1998; Debnath and Karmakar 2013). Pawar *et al*., (1990) also conducted similar studies on varietal susceptibility and reported that out of the seven varieties tested, G-41, IC-49383 and G-1 were the most tolerant to *A. tulipae*

infestations. As a consequence, research was conducted to study the population dynamics and evaluate garlic cultivars grown by the farmers to manage this destructive mite pest for better crop yield.

Materials and methods

Location and soil type

The experiments were conducted in the AB block farm, Kalyani under Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Nadia, West Bengal, India. The area is situated in 22^0 57' N latitude and 88^0 29' E longitudes with elevation of 9.75 m above MSL. The soil type is sandy loam with PH range 5.75 to 6.5.

Population dynamics and correlation with weather parameters

Garlic var. Goldana was grown under field conditions to study the population dynamics and to establish the relationship of the mite population with abiotic factors. The mite population was recorded at weekly intervals during the 2014-15 cropping season. The number of active stages of mites per cm^2 leaf area was recorded on 10 leaves from 10 randomly selected plants (i.e. one leaf per plant) along the diagonal line of the plots. Incidences of mite population were correlated with important weather parameters such as the maximum temperature, minimum temperature, maximum humidity, minimum relative humidity and total rainfall. The correlation was studied to ascertain the role of abiotic factors on the population dynamics of the mite.

Varietal screening

The varietal screening was carried out in the winter months of 2014–2015. The experiment was carried out in a randomized block design with three replications for each of the cultivars. Five garlic cultivars were planted with a row-to-row distance of 15 cm and a plant-to-plant distance of 10 cm. All the selected cultivars were considered as treatment variables and the required cultural practices such as irrigation, weeding, and fertilizer application was adopted equally to ensure uniform growth of all the cultivars. The number of mature and immature stages of mites per cm^2 leaf area on 10 leaves from 10 randomly selected plants in each of the 24 plots was recorded at 7-day intervals.

Management of mite

The acaricidal trial was carried out in the winter months of 2014–2015 (17.11.2014 to 31.03.2015). The experiment was carried out in a randomized block design with three replications for each of the treatments. The cultivar, Gangajali was planted with a row-to-row distance of 15 cm and a plant-to-plant distance of 10 cm. The crop was cultivated with

required cultural practices such as irrigation, weeding, and fertilizer application was adopted equally to ensure uniform growth of all the plants. Seven acaricides were tested against *A. Tulipae* infesting garlic cultivar gangajali. The name and dose of the acaricides were listed in the table 4. Spraying was started with the infestation of the crop. Three round of spraying was applied at 11 days intervals. Before starting of spraying pretreatment count of mite were taken. Number of mite population per square cm in different treatments were taken at 1, 3, 5, 7 and 10 days interval for each spraying.

Results and Discussion

Population dynamics and correlation with weather parameters

None of the abiotic parameters showed a significant effect on the mite population (Table-1). Both temperature and relative humidity (max) had a non significant and positive relationship with the garlic mite population. A negative, but statistically non-significant relationship was found between mite population and minimum relative humidity. Mite infestations were found as early as the two to three-leaf stage of the crop, during the last week of December. The population was found to be increased gradually and reached the maximum during mid-February thereafter gradually dwindle by the end of March with the onset of high temperature. In 2015, notable infestations were first recorded in the forth-night of January (9.65 mites/cm^2). Then the population rapidly increased towards February and attained a peak during the last week of January (16.6 mites/cm^2) when the mean maximum temperature, minimum temperature, and relative humidity of the standard meteorological week were 28.26°C, 10.26°C, and 79.86%, 51.14% respectively. The population declined thereafter, possibly because of the high mean temperature and moderate rainfall and maturity of the crops. A very low population was found at the end of February (2.9 mites/cm^2).

Table-1. Population fluctuation of *A. tulipae* on garlic (cv. *Goldana*) during 2014-15 in respect of prevailing weather parameter

Date of observation	Mean no. of mite/cm^2	Temperature (^{o}C)		Relative Humidity (%)		Total Rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
05.1.2015	0.75 (1.14)	27.44	18.14	91.0	70.0	0.5
12.01.2015	1.66 (1.47)	24.94	10.23	85.15	59.28	0.0
19.01.2015	9.65 (3.19)	25.66	9.6	84.43	57.7	0.0
26.01.2015	16.6 (4.04)	28.26	10.26	79.86	51.14	0.0
04.02.2015	13.4 (3.73)	28.28	11.19	79.44	49.33	0.0
11.2.2015	4.50 (2.24)	28.78	12.66	78.14	43.57	0.0
20.2.2015	2.9 (1.84)	31.38	16.11	85.33	52.11	0.0
Pearson's *r*		0.611	0.533	0.056	-0.464	--

Varietal screening

None of the garlic cultivars were found to be resistant against the mite but the severity of the infestation varied significantly among them (Table 2 & 3). The mite was observed to establish its population during the second fortnight of January and increased rapidly to a peak level during the last week of January, when the maximum mite population was recorded in the susceptible cultivar Goldana (16.60 mites/cm^2 leaf) followed by local variety (15.4 mites/cm^2 leaf). During first week of February local variety contains higher mite population (15.4 mites/cm^2 leaf). The cultivar Katki always showed the minimum infestation (Table 5,5a). Thus the results on the varietal responses to garlic mite revealed that the mite initiated its population on garlic during the second fortnight of December and attained the maximum level during January before dwindling. Very few mite populations were encountered during the second week of March because of the prevalence of adverse weather conditions and also due to the crop maturity. All the varieties were found infested by the mite; Goldana, local were most susceptible and Katki was found to be the least susceptible.

Table-2. Field evaluation of garlic cultivars against *Aceria tulipae* (mean no. of mites/cm^2 leaf area) during 2014-15

Garlic cultivar	Mean mite population /sq.cm leaf							Yield ton/ha
	05.1.2015	12.1.15	19.1.15	26.1.15	4.2.15	11.2.15	20.2.15	
Single dana	0.9b (1.18)*	1.50a (1.41)	5.12c (2.37)	12.3b (3.58)	14.0b (3.81)	9.84a (3.22)	3.9b (2.10)	**8.50c**
Local	1.3a (1.34)	1.44a (1.39)	8.55b (3.01)	15.4a (3.99)	16.5a (4.12)	5.42bc (2.43)	2.3cd (1.67)	**9.45c**
Goldana	0.75bc (1.14)	1.66a (1.47)	9.65a (3.19)	16.6a (4.14)	13.4bc (3.73)	4.50c (2.24)	2.9c (1.84)	**11.12b**
Gangagali	1.4a (1.38)	1.50a (1.41)	7.65b (2.85)	13.3b (3.71)	12.6c (3.62)	6.13b (2.57)	4.8a (2.30)	**10.18bc**
Katki	0.50c (1.0)	0.50b (1.0)	2.77d (1.81)	4.50c (2.24)	5.60d (2.47)	1.34d (1.36)	1.6d (1.45)	**14.25a**

Similar alphabets denote homogeneous means due to Duncan's test

*Values in parentheses are square root transformed

Table-3. Field evaluation of garlic cultivars against *Aceria tulipae* (%plant affected) during 2014-15

Garlic cultivar	Progress of development of symptoms by *A. tulipae* on five garlic cultivars at different date of observation							overall	Yield t/ha
	19.12.14	26.12.14	02.1.15	13.1.15	4.2.15	15.2.15	25.2.15		
Single dana	0.5*a (5.74)	0.68b (6.24)	1.02c (7.08)	2.03b (9.15)	10.76a (19.61)	12.27a (20.94)	18.33c (25.71)	6.94 (15.83)	**8.50c**
Local	0.36ab (5.32)	0.45d (5.59)	0.45d (5.59)	1.5d (8.13)	5.98c (14.75)	7.43b (16.36)	13.25b (21.77)	4.20 (12.52)	**9.45c**
Goldana	0.19bc (4.76)	0.89a (6.77)	1.25b (7.60)	1.76c (1.65)	6.95c (15.84)	11.24a (20.04)	17.40c (25.03)	5.67 (14.38)	**11.12b**
Gangajali	0.12c (4.52)	0.55c (5.88)	1.61a (8.36)	3.71a (11.84)	8.82b (17.78)	13.53a (22.0)	21.20a (27.76)	6.93 (15.82)	**10.18bc**
Katki	0.27bc (5.03)	0.44d (5.56)	0.58d (5.97)	0.67e (6.21)	0.83d (6.62)	1.15c (7.38)	5.82d (14.56)	1.39 (7.90)	**14.25a**

Similar alphabets denote homogeneous means due to Duncan's test

Values in parentheses are square root transformed.

Management of mite:

Bio-efficacy of different acaricides were presented in the table 4. One days after spraying ethion was found most effective and very low population (2.13 mites per sq. cm.) was found in this treatment very closely followed by profenophos (2.19 mites per sq. cm.). There is no significant difference between these two treatments. Higher population was found in fenpyroximate treated plot (3.69 mites per sq. cm) as compared to untreated control (6.25 mites per sq. cm.). Similar trend was found at three days after spraying. Five days after spraying profenophos was found most effective acaricide and very low population (1.88 mites per sq. cm.) was found in this treatment very closely followed by spiromesifen (1.89 mites per sq. cm.). There is no significant difference between these two treatments. Higher population was found in difenthuron treated plot (2.94 mites per sq. cm) as compared to untreated control (6.71 mites per sq. cm.). Seven days after spraying all acaricides provide similar type of control (1.70 to 3.42 mites per sq. cm) and there were no significant differences among these seven treatments but were significantly different from untreated control (6.19 mites per sq. cm.). Ten days after spraying dicofol was found to be the most effective acaricide and very low population (1.40 mites per sq. cm.) was found in this treatment closely followed by ethion (3.0 mites per sq. cm.). There was a significant difference between these two treatments. Almost similar population was found in fenpyroximate (4.34 mites per sq. cm) and fenazaquin (5.08 mites per sq. cm) treated plot as compared to untreated control (6.78 mites per sq. cm.).

Table- 4. Overall efficacy of acaricides against *A. tulipare* on garlic (Mean of three sprays)

Acaricides	Doses	Pre-treat. count	No. of mite per square cm in different treatments					Yield ton/ha.
			1 DAS	3DAS	5 DAS	7 DAS	10DAS	
T1=Dicofol	2.5 ml/L	4.48 (2.23)	2.70*bcd (1.79)	3.22b (1.93)	2.86bc (1.83)	1.70b (1.48)	1.40d (1.38)	11.33
T2=fenazaquin	1.0 ml/L	4.73 (2.29)	3.10bcd (1.90)	2.76bc (1.81)	2.41bc (1.70)	3.42b (1.98)	5.08b (2.36)	12.12
T3=fenpyroximate	1.5 ml/L	4.70 (2.28)	3.69b (2.05)	2.58bc (1.76)	2.52bc (1.74)	3.21b (1.93)	4.34b (2.20)	12.41
T4=Spiromesifen	1.0 ml/L	4.54 (2.25)	2.53cd (1.74)	2.54bc (1.74)	1.89c (1.55)	2.11b (1.62)	2.17cd (1.64)	13.54
T5=Diafenthirun	1.0 g/L	4.61 (2.26)	3.59bc (2.02)	3.01bc (1.87)	2.94b (1.85)	3.14b (1.91)	4.26b (2.18)	12.55
T6=Profenophos	1.0 ml/L	4.09 (2.14)	2.19d (1.64)	2.0c (1.58)	1.88c (1.54)	2.10b (1.61)	2.09cd (1.61)	15.66
T7=Ethion	1.0 ml/L	4.23 (2.17)	2.13d (1.62)	1.89c (1.54)	2.15bc (1.63)	2.31b (1.68)	3.0c (1.87)	15.67
T8= Controled	---	4.60 (2.26)	6.25a (2.60)	6.11a (2.57)	6.71a (2.69)	6.19a (2.59)	6.78a (2.70)	9.12

Similar alphabets denote homogeneous means due to Duncan's test
*Values in parentheses are square root transformed

Acknowledgement

The authors are thankful to AINP on Agril. Acarology, ICAR, New Delhi and BCKV, Mohanpur, Nadia, West Bengal for providing fund and facilities.

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