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Population dynamics of dry bulb mite, *Aceria tulipae* (Keifer) infesting stored garlic in West Bengal, India

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Abstract
Garlic is popular in India for multiple uses as spices, botanicals and herbal medicine. It is found to be infested by dry bulb mite, *Aceria tulipae* both in field and storage condition. The present research work deals with the objectives to record the population dynamics of *A. tulipae* infesting stored garlic. The mite population was significantly negative correlated with temperature and positively correlated with relative humidity. The pattern of incidence of mite on the selected varieties of garlic was similar. The varieties like Goldana, Najipuri, Gangajali, Kadamkanali Local were most susceptible type while Katki, Purulia Local were least susceptible type.

Keywords: Garlic mite, Eriophyoidea, Storage pest, *Aceria tulipae*, Eriophyidae

Introduction
Garlic (*Allium sativum* L; Alliaceae), is an important aromatic spice [14] which originated in central Asia [19]. The major garlic producing countries are China, South Korea, Egypt, India, Spain, USA, Thailand and Turkey. It is popular in India as Ayurvedic medicines for various diseases [7]. Garlic can also be used as botanicals to manage insect pests. It is frequently infested by several insects and mite pest in field and storage. In West Bengal, *Aceria tulipae* (Keifer) can be considered as a major yield reducing factor for garlic.
Keifer described an eriophyid mite, *Aceria tulipae* from the specimen collected from tulip bulbs [12]. Later, Keifer had reported about the infestation of wheat by the same mite [11]. From then, *A. tulipae* continued to be named as wheat curl mite, until publication of Shevtchenko [23]. Shevtchenko first established that the mite infesting onion and wheat are independent species but they are very close in morphology. He nominated the wheat curl mite as new species *Aceria Triticum* in 1970. Amrine & Stasny determined that Keifer [13] also finally described the wheat curl mite, giving it the name *Aceria tosichella* which has priority over Triticum [23] but unfortunately many scholars continued to call wheat curl mite as *Aceria tulipae* or *Eriophyes tulipae* until the catalog by Amrine and Stasny was published, and for several years thereafter [3]. Most researchers now realize that *A. tulipae* is restricted to the Liliaceae: tulips, onions and garlic. Still, a few authors mentioning the wheat curl mite as *Aceria tulipae* the publication [1] [6] [20]. Morphological description of *A. tulipae* had been carried out by Keifer [12], Shevchenko [23], Chandrapatya [4] and Halliday [10]. Other than the garlic, this mite species also attacks onion, leek, tulip etc. At vegetative stage this mite colonizes along the midribs which later migrate to the mature bulb and transferred to the storage [5]. *Aceria tulipae* is primarily regarded as a pest of stored garlic, for example in the southern USA [15] [24] and southern France [8]. Dry bulb mite, *Aceria tulipae* as the main invertebrate pest in all garlic productions areas around the world [8]. It was recognized that infested garlic cloves usually showed some tissue breakdown in the form of one or more brownish sunken spots [17]. The mite passes its entire life cycle between the cloves of stored garlic bulbs and its feeding causes drying and loss of quality. Keeping in this context, the present research work was conducted to study population dynamics of dry bulb mite, *A. tulipae* Keifer infesting stored garlic of West Bengal, India.

Materials and Methods
Population dynamics of *Aceria tulipae* in stored garlic
Garlic (var. *Goldana*) was kept in separate brown paper bags to study the relationship of the mite population with abiotic factors. The garlic in brown paper bags were kept free from any acaricide application.

Six bags containing one Kg of garlic per bag was considered for the study of population dynamics of the mite. The experiment was done during 1st week of March, 2019 to February, 2020.

To investigate the relationship of mite with abiotic factors, 10 cloves from 10 garlic bulbs randomly collected and the population of the mite was observed under MAGNUS MSZ-Bi stereo-zoom binocular microscope. The number of mature and immature mites (except eggs) was recorded per clove. The data was recorded in 15th days interval. The correlation was studied to ascertain whether abiotic factors had a significant effect on the population dynamics of the mite or not.

Varietal preferences

The varietal preferences of *Aceria tulipae* was investigated on seven varieties of garlic. viz., Katki, Najipuri, Gangajali, Purulia local, Kadamkanali local, Natherdanga local, and Goldana. The Garlic bulbs were kept in 21 clean brown paper bags at the rate of 1kg per bag; all the bags were stored under room temperature conditions in the laboratory of Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal.

The experiments on varietal preference were carried out in a randomized block design with three replications for each of the seven garlic cultivars. For each treatment three replication i.e., three numbers of brown paper bag of one Kg garlic were kept for the experiment.

Three number of randomly selected garlic clove was taken out from each bag and the population of the mite was observed under MAGNUS MSZ-Bi stereo-zoom binocular microscope. The number of mature and immature mites (except eggs) per clove was recorded. In case of high population of mite, a nematode counting dish (produced by Ajoy kumar & co.) was utilized.

Morphometry of *Aceria tulipae* Keifer

Garlic were collected from farm storage in air-tight polyethylene bags and taken to the laboratory. The mites were collected and mounted on microscopic slides in modified Berlese medium [2]. The morphological characters of mounted specimens were examined under Olympus BX 41 phase contrast microscope (100X oil immersion objective with 10X eye-piece) equipped with ocular micro meter and drawing tube. All measurements were taken as per proper recommendation [9] and were given in micrometres (μm). The number of measured specimens (n) is given within parentheses in the description. They refer to the length of the characters unless specified otherwise and express range values except in case of constant value [16].

Results

Population dynamics of *Aceria tulipae* in stored garlic

Seasonal incidence of the mite

During March, 2019 to February, 2020, the dry bulb mite, *A. tulipae* was found to infest stored garlic throughout the year (fig. 1). The initial population right after procuring the freshly stored garlic from farmers during 15th March 2019 was low (22.7 miles per clove). Then the population started increasing almost irrespective of the summer rainy and winter seasons. During the end of summer season i.e. 30th June, 2019 the population of the mite was 79.3 miles per clove. In rainy season i.e. end of July; end of August the population of the mite was 111.0 and 191.0 mite per clove respectively. The rate with which mite population increased had got a pace from October, 2019 when 336.7 to 414.7 mites per clove were observed in 15 days interval. At the end of winter months i.e. February 2020, the mite population was very high (1054.3 and 1296.0 mite per clove).

Impact of weather parameters on population dynamics of A. tulipae

The variation of mite population per clove was recorded at 15th days interval and was analyzed in the context of variation of weather parameters. The data pertaining to relationship between population of *A. tulipae* and weather parameters have been presented. The results indicated that maximum and minimum temperature had negative and significant effect (r= -0.893 and -0.787 respectively) on mite population. However, relationship of mites with maximum relative humidity (r= 0.495) was significant and positive. The Minimum relative humidity and rainfall had negatively correlated with the mite population. It is obvious from the experiment that this mite prefers low temperature and high moisture in storage condition also.

Varietal screening

The observations recorded on the seasonal incidence of *A. tulipae* on different garlic varieties during March, 2019 to February, 2020 have been recorded. None of the garlic cultivars were found to be resistant against the mite but the severity of the infestation varied significantly among them. The mite was observed to establish its population during the second fortnight of March when Goldana (27.5 mite/ clove) was the most susceptible to it, followed by Najipuri (25.3 mite/clove), Gangajali (22.0 mite/ clove) and Kadamkanali Local (19.0 mite/clove). The incidence of mite was low in the variety Katki (4.3 mite/ clove) and Purulia Local (8.5 mites/ clove). Then a gradual increase in mite population was observed since August 2019 when 212.0 mite per clove was recorded which increased to 308.7 mite per clove in the month of September, 2019 on *Goldana*. Similar trend was found in all other varieties also. During February 2020, the mite population was found to reach the peak when *Goldana* was remaining the most susceptible cultivar with 1175.2 mites per clove followed by *Najipuri* with 1060.7 mites per clove. The differences recorded in the rate of incidence among various months were significant irrespective of variety.

Discussion

The dry bulb mite, *A. tulipae* is very common in stored garlic throughout the year and it also cause significant damage in storage [15]. High population of *A. tulipae* (1 to 4500 scale) during a survey conducted in Korea Republic recorded during 1994-95 [18]. It can survive in summer months by maintain a minimum population. Population reduction of *A. tulipae* was recorded at high temperature (>31 °C) [8]. As it prefers low temperature, a heavy mite feeding was found to cause havoc damage to stored garlic during the winter months.

It is evident from the present investigation that the incidence of the garlic mite differed significantly among seven varieties of garlic. Several varieties found to be susceptible to *A. tulipae.* The pattern of incidence of mite on the selected varieties of garlic was similar. The varieties like Goldana, Najipuri, Gangajali, Kadamkanali Local were most susceptible type while Katki, Purulia Local were least

susceptible type. It was recorded that boting garlic varieties (Bzeneckey Mutant VF, Sochi 25, Tiraspol, Zailijskij) were highly infested, non-bolting varieties (Czerga, SIR 10 new breeding, Gjirokaster) were infested weakly or not at all (Kelcyre) [21]. The highest abundance of mite was found out in semi-bolting garlic variety (Plovdiv Rogosh) with total number up to 1to 1500 individuals in one clove.

Table 1: Varietal screening (mean no. of mites/clove) of *Aceria tulipae* Keifer on different garlic verities during 2019-20.

	Mean mite per clove												Mean
	March	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	
T-1 (Goldaan)	27.5	45.3	64.0	84.3	132.7	212.0	308.7	460.7	632.7	784.3	940.5	1175.2	405.7
	(5.2)^{g}	(6.7)^{f}	(8.0)^{f}	(9.2)^{e}	(11.5)^{g}	(14.6)^{g}	(17.6)^{g}	(21.5)^{g}	(25.2)^{f}	(28.0)^{g}	(30.7)^{f}	(34.3)^{f}	
T-2 (Najipuri)	25.3	45.0	64.3	83.2	118.5	188.7	291.8	438.5	597.2	757.7	904.7	1060.7	381.3
	(5.0)^{f}	(6.7)^{f}	(8.0)^{f}	(9.1)^{e}	(10.9)^{f}	(13.7)^{f}	(17.1)^{f}	(20.9)^{f}	(24.4)^{e}	(27.5)^{f}	(30.1)^{e}	(32.6)^{e}	
T-3 (Gangajali)	22.0	40.7	58.0	76.2	110.8	167.8	265.8	412.8	559.0	731.3	874.7	1038.7	363.2
	(4.7)^{e}	(6.4)^{e}	(7.6)^{e}	(8.7)^{d}	(10.5)^{e}	(13.0)^{e}	(16.3)^{e}	(20.3)^{e}	(23.6)^{d}	(27.0)^{e}	(29.6)^{d}	(32.2)^{d}	
T-4 (Kadamkanali Local)	19.0	35.0	53.5	73.8	103.8	157.8	253.7	402.5	551.5	720.8	868.2	1035.0	356.2
	(4.4)^{d}	(5.9)^{d}	(7.3)^{d}	(8.6)^{d}	(10.2)^{d}	(12.6)^{d}	(15.9)^{d}	(20.1)^{d}	(23.5)^{d}	(26.8)^{d}	(29.5)^{d}	(32.2)^{d}	
T-5(Katki)	4.3	13.0	20.7	31.5	42.3	67.0	104.8	137.0	179.7	219.7	262.2	302.8	115.4
	(2.1)^{a}	(3.6)^{a}	(4.5)^{a}	(5.6)^{a}	(6.5)^{a}	(8.2)^{a}	(10.2)^{a}	(11.7)^{a}	(13.4)^{a}	(14.8)^{a}	(16.2)^{a}	(17.4)^{a}	
T-6 (Purulia Local)	8.5	16.7	29.2	40.5	52.0	74.0	112.5	148.0	189.0	232.5	274.3	319.8	124.8
	(2.9)^{b}	(4.1)^{b}	(5.4)^{b}	(6.4)^{b}	(7.2)^{b}	(8.6)^{b}	(10.6)^{b}	(12.2)^{b}	(13.7)^{b}	(15.2)^{b}	(16.6)^{b}	(17.9)^{b}	
T-7 (Natherdanga Local)	14.3	28.0	40.2	54.0	70.3	99.8	139.8	177.3	222.8	266.5	310.8	359.7	148.6
	(3.8)^{c}	(5.3)^{c}	(6.3)^{c}	(7.3)^{c}	(8.4)^{c}	(10.0)^{c}	(11.8)^{c}	(13.3)^{c}	(14.9)^{c}	(16.3)^{c}	(17.6)^{c}	(19.0)^{c}	
	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
CD 5 %	0.180	0.130	0.098	0.243	0.315	0.328	0.127	0.220	0.167	0.170	0.156	0.173	
Sem	0.058	0.042	0.032	0.079	0.102	0.107	0.041	0.071	0.054	0.055	0.051	0.056	

*Figures in the parentheses are square root transformed value
Same letters denote homogenous means on Duncan's multiple range test

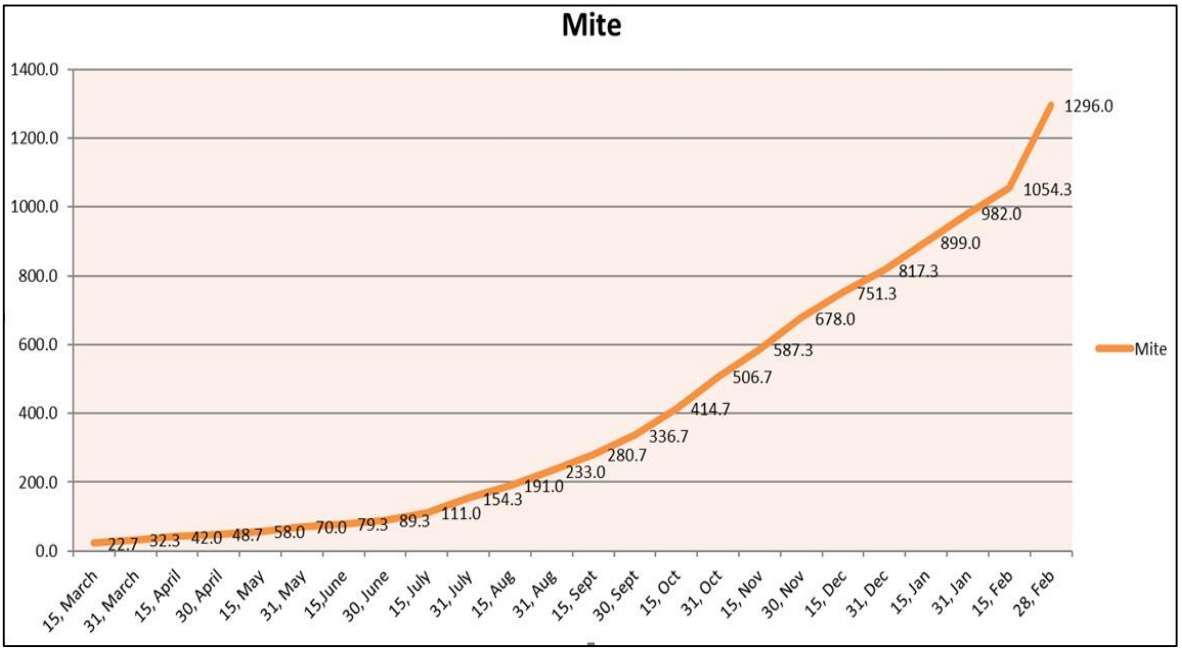

Fig 1: Seasonal incidence of the mite *Aceria tuliape* (Var: Goldana)

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