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Seasonal incidence of mite, *Tetranychus cinnabarinus* (Boisduval) and natural enemies on okra in semi-arid Rajasthan

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Abstract
The study on seasonal incidence of mite, *Tetranychus cinnabarinus* (Boisduval) was carried out under field conditions on okra cv. Pusa Sawani in two consecutive years, *i.e. kharif*, 2004 and 2005. The incidence of mite started in the second week of August in both the years. The population increased gradually and reached to peak in the third week of September with population of 18.78 and18.60 mites/3 leaves in 2004 and 2005, respectively. The population of this pest started to be declined from fourth week of September (10.98 mites /3 leaves) and decreased to the level of 2.66 mites/3 leaves in the second week of October and latter it disappeared from the field in first year. A similar trend of population dynamics was recorded in the second year. The mite population after attaining peak in September gradually decreased with fall in the temperature.

Keywords: Seasonal incidence, Mite, *Tetranychus cinnabarinus* (Boisduval) and Okra

Introduction
Okra, *Abelmoschus esculentus* (L.) Moench also known as *Bhindi* or lady's finger, is grown throughout India for its immature fruits and occupies an important position among vegetables (Saroda and Lal, 1981) [25]. In India, it occupied over 0.31 million hectares area with an annual production of 3.65 million tonnes (FAO Report, 2007) [11], whereas, Rajasthan occupied 4456.0 hectares area with an annual production of 11447.0 tonnes during 2005-06 (Anonymous, 2006). The fully ripened fruits and stem contain carbohydrate (7.7%), protein (2.2%), fat (0.02%), fibres (1.2%), minerals (0.7%), calcium (0.9%) and are also good source of iron, iodine and vitamins (Chauhan, 1965) [7].

The okra crop is attacked by several species of insect pests, right from the germination to the harvesting (Ambegaonkar and Bilapate, 1984) [1]. In the recent years, the importance of mites as a pest of vegetable crops has been understood all over the world. The main contributing factor for it population buildup has been the excessive reliance on pesticide leading to serious upset in natural balance (Baker and Pritchard, 1960) [3]. Among the vegetable crops, okra and brinjal are the most affected by mites causing economic loss throughout the country. The red spider mites *viz.*, *Tetranychus cinnabarinus* (Boisduval), *Tetranychus ludeni* Zacher and *Tetranychus neocaledonicus* Andre are of major significance to vegetable crops in India (Gupta, 1991 and Rai *et al.*, 1991) [12, 22]. Among the mite pests, *T. cinnabarinus* become abundant and cause appreciable damage to okra crop particularly during dry months of the year, even under drought conditions, as high as 20 per cent loss in okra has been estimated (Shankarappa *et al*., 1981) [26]. The mite is polyphagous in nature and has been reported to infest more than 110 plants including fruits, vegetables and field crops (Jeppson *et al*., 1975) [15]. It sucks the cell sap from the leaves and produce white spots which latter get covered by thick web. In windy weather, these webs are filled with soil particles. The photosynthetic activity is retarted, affected leaves loose green colour, dry up and drop pre mature, finally resulting in poor fruit setting (Rahman and Sapra, 1945; Khot and Patel, 1956; Bharodia and Talati, 1976 and Puttaswamy and Reddy, 1980) [21, 17, 5, 20]. Expanding vegetable cultivation due to availability of high yielding hybrids is providing sufficient food and congenial environment for the mite to multiply on regular basis. As such, the present investigation is carried out on seasonal incidence of *T. cinnabarinus* and its natural enemies on okra in semi-arid of Rajasthan.

Material and Methods
The experiment was conducted at Department of Entomology and Horticulture Farm, S.K.N. College of Agriculture, Jobner during *kharif*, 2004 and 2005. The observations on mite, *T.*

cinnabarinus were recorded as weekly numerical counts on okra commencing from one month after germination to the last picking of fruits. Okra variety, Pusa Sawani a commonly grown variety in this area was grown in the experiment. The observations were recorded on randomly selected five plants. For this, three leaves one each from top (young), middle (mature) and bottom (old) portions of tagged plants were plucked randomly, collected in separate labeled polythene bags and brought to the laboratory without disturbing mites for assessing population under stereo binocular microscope. Both upper and lower portions of the leaves were examined. The data so obtained were subjected to statistical analysis.

The population of predatory mite, *A. alstoniae* was recorded with prey mite, *T. cinnabarinus* simultaneously. The population of insect predator of the mite, *i.e. coccinella septempunctata* L. was also recorded on whole plants simultaneously with the population of okra mite at weekly interval. For this, the population of different stages of the predator *i.e.* egg, grub, pupa and adult was recorded.

The weather parameters, *viz.*, temperatures (minimum and maximum), relative humidity, sunshine hours and total rainfall were obtained from the meteorological observatory of Agronomy Farm, S.K.N. College of Agriculture, Jobner. The data on the population count of mite sampled on variety Pusa Sawani were pooled separately pertaining to entire crop period during 2004 and 2005. The correlation (r) between mite population and weather parameters was computed. Periodical observations were recorded in the experimental plots and surrounding areas of College Farm for collecting natural enemies of the mite pest.

Result and Discussion

The data presented in table-1 revealed that the incidence of *T. cinnabarinus* commenced in the second week of August (4.00 mites/ 3 leaves) in 2004. The population increased gradually and reached to peak in the third week of September (18.78 mites/ 3 leaves). The population of mite started to decline from fourth week of September (10.98 mites /3 leaves) and decreased to the level of 2.66 mites/3 leaves in the second week of October and latter, it disappeared from the field.

In 2005, the incidence started in the second week of August with population counts of 4.13 mites/3 leaves (Table 2). The population increased slowly in the next fortnight and reached to peak in the third week of September (18.60 mites/3 leaves) and remained more or less static till the third week of September. In the latter period of observations, a gradual decrease in mite population was observed with drastic decline in the fourth week of September reaching to negligible level (2.73 mites/ 3 leaves) in the second week of October.

Table1: Mean weekly meteorological data and population of mite, *Tetranychus cinnabarinus* (Boisduval) on okra cv. Pusa Sawani in *kharif*, 2004

S. No	Standard Meteorological week	Date of observation	Temperature (^{0}C)		Average relative humidity (%)	Total rainfall (mm)	Sunshine (hrs)	Average mite population /3 leaves
			Maximum	Minimum				
1.	32	10.08.2004	31.3	24.9	87.1	098.5	04.1	4.00
2.	33	17.08.2004	30.1	24.5	87.5	026.9	03.7	4.26
3.	34	24.08.2004	31.6	24.3	81.0	000.0	06.2	4.40
4.	35	31.08.2004	33.0	22.8	69.8	000.0	09.4	4.80
5.	36	07.09.2004	36.1	22.8	48.5	000.0	08.4	5.60
6.	37	14.09.2004	34.7	22.4	57.4	000.0	07.1	5.86
7.	38	21.09.2004	35.1	23.2	64.3	003.0	07.2	18.78
8.	39	28.09.2004	36.9	22.3	55.6	001.8	08.4	10.98
9.	40	05.10.2004	32.6	21.5	69.4	000.0	08.0	9.99
10.	41	12.10.2004	31.5	19.0	70.2	021.8	07.2	2.66

Table 2: Mean weekly meteorological data and population of mite, *Tetranychus cinnabarinus* (Boisduval) on okra cv. Pusa Sawani in *kharif*, 2005

S. No	Standard Meteorological week	Date of observation	Temperature (^{0}C)		Average relative humidity (%)	Total rainfall (mm)	Sunshine (hrs)	Average mite population/3 leaves
			Maximum	Minimum				
1.	32	10.08.2005	32.2	25.1	66.0	008.6	08.6	4.13
2.	33	17.08.2005	36.5	24.1	60.5	009.7	09.7	4.20
3.	34	24.08.2005	38.2	24.3	58.0	009.6	09.6	4.46
4.	35	31.08.2005	38.0	23.1	55.0	010.1	10.1	4.73
5.	36	07.09.2005	38.2	23.7	56.5	008.8	08.8	5.66
6.	37	14.09.2005	33.5	23.8	78.0	007.0	07.0	5.93
7.	38	21.09.2005	33.7	23.9	64.5	008.7	06.7	18.60
8.	39	28.09.2005	32.7	21.6	65.0	008.9	08.9	11.19
9.	40	05.10.2005	34.8	19.2	57.5	009.6	09.6	9.78
10.	41	12.10.2005	35.6	16.6	44.5	009.2	09.2	2.73

The peak of mite population build up was registered in the third week of September 2004 and 2005. The mite population after attaining peak in September gradually decreased with fall in the temperature. These studies are in close conformity with that of Kapoor *et al.* (2000) [16] who reported that okra sown in June had low population of tetranychids from July to September but increased in October. The present findings also got support from the studies of Putatunda and Tagore (2001) [19] who observed peak in population of *T. cinnabarinus* on okra at optimum temperature 27.95^{0}C with relative humidity of 44 per cent. Likewise, Rai and singh (1999) [23] studied the population buildup of *T. cinnabarinus* on medicinal plants at Varanasi and observed the highest population in the month of October support the present findings.

Weekly observations commencing from second week of august to second week of October during both the years, i.e.

2004 and 2005 revealed the presence of predatory mite, *A. alstoniae* and lady bird beetle, *C. septempunctata* predating the phytophagous mite, *T. cinnabarinus* under field conditions. The predatory mite appeared in the early stage of crop and continued till second week of October in both the years, however, the population of the predatory mite, *A. alstoniae* remained low throughout the crop period.

The population of *A. alstoniae* commenced in the second week of August with a population of 0.20 and 0.26 mites/ 3 leaves in 2004 and 2005, respectively. The population started to increase in the subsequent observations and reached to peak in the third week of September with counts of 0.60 and 0.73 mites / 3 leaves in 2004 and 2005, respectively. After reaching the peak, the population started to decline from the last week of September and reached to a low level in the second week of October during both the years. A similar trend was observed by different workers, who worked on different species of mites in different crops (dhooria and Butani, 1983; Putatunda and Tagore, 2001 and Bhuller and Ghai, 2003) [10, 19, 6].

In order to study the effect of different key abiotic factors such as temperature (maximum and minimum), average relative humidity, total rainfall and sunshine hours on the population buildup of okra mite, *T. cinnabarinus* in 2004 and 2005, simple correlation was worked out between different abiotic factors and mite population by pooling the data of both the years (Table 3).

Table 3: Correlation coefficient between populations of okra mite, *Tetranychus cinnabarinus* (Boisduval) with weather parameters (pooled)

Variables	Temperature (^{0}C)		Average relative humidity (%)	Total rainfall (mm)	Sunshine	Mean mite population/3 leaves
	Maximum	Minimum				
	X_1	X_2	X_3	X_5	X_6	Y_1
X_1	1.000					
X_2	0.061	1.000				
X_3	0.043	-0.065	1.000			
X_4	-0.090	-0.797**	0.474*	1.000		
X_5	-0.232	-0.358**	0.198	0.514*	1.000	
Y_1	-0.037	0.698**	-0.340	-0.778**	-0.570**	1.000

* Significant at p = 0.05
** Significant at p = 0.01

The correlation indicated significantly positive correlation between mite population and minimum temperature (0.698), whereas, it was significantly negative with sunshine hours and total rainfall, *viz.*, -0.570 and -0.778, respectively. The mite population had non-significant correlation with maximum temperature (r = -0.037) and relative humidity (-0.340). The results on determination of coefficient (R^2) and the multiple equation developed for *T. cinnabarinus* (y_1) (Table 4) indicated that the coefficient of determination (r^2 = 0.85) for abiotic factors was able to explain the variation in mite population to the extent of 85 per cent.

Table 4: Population prediction equation and R^2 of mite, *Tetranychus cinnabarinus* (Boisduval) infesting okra crop

Dependent variability	*Multiple Regression Equation*	R^2	Variation (%)
(A) For mite population	Y_1 = 532.840 - 15.279 X_1 + 7.169 X_2 - 2.622 X_3 - 0.613 X_4 -1.716 X_5	0.85	85.0
(Y_1)			

* Significant at p = 0.05
** Significant at p = 0.01
(i) Number of observations = 10
Here,
X_1 = Maximum temperature (^{0}C)
X_2 = Minimum temperature (^{0}C)
X_3 = Relative humidity (%)
X_4 = Total rainfall (mm)
X_5 = Sunshine (hr)
Y_6 = Mite population (per three leaves)

Most of the mites are poikilothermic in nature, therefore, abiotic factors play important role in their distribution and abundance. Temperature, relative humidity and light are important factors influencing dynamics of the mite (Basu and Pramanik, 1968; Singh and Saini, 1971 and Gupta *et al.*, 1976) [4, 28, 14]. The present findings are in close agreement with the results of Sharma (2006) [27] who reported the variation in the population of *T. neocalidonicus* infesting brinjal to the extent of 80 per cent. In Punjab, Sadana and Kumari (1987) [24] observed that low temperature, moderate humidity less rainfall favoured buildup of mite population. Studies of Rai *et al.* (1991) [22] strongly support the present findings who reported that in summer okra, the mite population showed a significant positive correlation with minimum temperature. Putatunda and Tagore (2001) [19] reported that the okra mite, *T. cinnabarinus* and relative humidity had negative non-significant correlation and conform the present studies. Moreover, they found that the sunshine hours had also negative correlation and was in agreement with the present findings. The present results had also indicated that rainfall had a deleterious effect on the mite. These findings are in agreement with the results obtained by Rahaman and Sapra (1945) [21] for *T. cinnabarinus*; Das (1959) [9] for *Oligonychus coffeae*, Tanaka and Inoue (1959) [29] and cheng (1966) [8] for *Panonychus citri* and Osakabe (1967) for *T. kanzawai* infesting different host plants. Gupta (2001) [13] also stated that most of the phytophagous mite species remained in the field throughout the year on one or the other hosts but population remained at low level during rainy season, when most of the mites, inhabiting in foliar region were washed away.

Conclusion

On the basis of study it is concluded that the incidence of mite and predatory mite started in the second week of August in both the years. The population increased gradually and reached to peak in the third week of September in 2004 and 2005, respectively. After attaining the peak, the population started to decline from the last week of September and reached to a low level in the second week of October during both the years. Contrary to this, the coccinellid beetle appeared in the first and second week of October and remained active for two weeks. There was significant positive correlation between mite population and minimum temperature (0.698), whereas, it was significantly negative with sunshine hours and total rainfall, *viz.*, -0.570 and -0.778,

respectively. The mite population had non-significant correlation with the maximum temperature (r = -0.037) and relative humidity (r = 0.340). The coefficient of determination (r^2 = 0.85) for abiotic factors was able to explain the variation in mite population to the extent of 85 per cent.

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