Influence of major abiotic factors on the population trend of *Tetranychusurticae* Koch on okra at Samastipur, Bihar, India

Abstract:

Field experiments were conducted to study the populationfluctuation of the phytophagous mite(*Tetranychusurticae*Koch) in okra and its relation with different abiotic factors under field conditions during summer 2023 at Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. The population of*T.urticae* in okra commenced from the first fortnight of March and reached its peak of 34.60 mites/ 2.5cm^2 leaf areas on the first fortnight of June. There was a positive and significant correlation of the population of *T. urticae* with maximum temperature (r = 0.779**) and minimum temperature (r = 0.699*).

Keyword: Correlation, okra, Seasonal incidence, Tetranychidae

Introduction:

Okra, *Abelmoschus esculentus* (L.) Moench (family: Malvaceae**),** is one of the world's oldest, traditional cultivated vegetables. Its primary centre of origin in Africa probably Ethiopia and is grown in many Asian countries and other parts of the world. Within India, its cultivation occurs during both the summer and rainy seasons. It is commonly farmed as a summer crop in Northern India and is also prevalent as a winter crop in states like Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu. (Lal and Sinha, 2005). In India okra crop is cultivated in an area of 0.531 million hectares and its production is 6.47 million tons (Anonymous, 2020-21).

"The low yield of okra is attributed to the attack of different pests from sowing to harvesting. Recently, there has been a change in agricultural scenario and mites are becoming serious pests in most crops and okra is no exception. The spider mite, *Tetranychusurticae*Koch, poses a serious threat to okra crop particularly during spring, summer and post rainy seasons. This crop is infested mainly by six different mite pest species, *viz*., *T. urticae*, *T. macfarlanei*, *T. ludeni*, *Brevipalpusphoenicis* (Gij.), *Polyphagotarsonemus latus* (Bank)and *Acerialycopersici* (Wolff.)",(Gupta, 1985; Prasad and Singh, 2011). "Out of these mite species, *T. urticae*is responsible for causing the loss of foliage of the crop plant resulting in a reduction of the economic yield of fruits ranging from 20-45% depending upon cropping season and agro-climatic conditions. *T. urticae*is well adapted to various environmental conditions, causing loss of quality and yield or death of plants by sucking out the contents of leaf cells" (Mondel and Ara, 2006, Kumaran *et al*., 2007).

"*T. urticae*causes direct damage in terms of loss of chlorophyll, stunting of growth, stippling, webbing, leaf yellowing, defoliation, leaf burning, reduction in size and quality of fruits, the appearance of various types of plant deformities, followed by death etc. which severely affect the yield and in extreme outbreaks, plant death. Indirect effects of mite feeding may include decreased photosynthesis and transpiration. Due to high reproductive potential and extremely short life cycle, combined with frequent acaricide applications this mite has developed resistance to almost all conventional pesticides in vogue" (Chiasson *et al*., 2004; Van Leeuwen *et al*., 2005). "The mites become serious pests because they have several generations per season. Phytophagous nature, high reproductive potential and short life cycle contributed to rapid resistance development to many acaricides even after few applications" (Devine *et al.,* 2001; Stumpf and Nauen, 2001). Since the degree of incidence of red spider mites changes with the season, it is desirable to have a thorough understanding of the seasonal incidence of the mite, which will lead to the development of suitable management programs. Hence, an attempt was made to correlate the effect of weather factors on the incidence and population dynamics of the spider mite in okra.

Materials and Methods:

Field trials were conducted from the first fortnight of March 2023 to second fortnight of July during the *summer*, 2023 at the Vegetable Research plot of Dr Rajendra Prasad Central Agricultural University, Pusa, Bihar. Okra cultivar of the variety "Kashi Kranti" was sown on 3rd February 2023. The plot selected had uniform topography with well-drained sandy loam soil. The latitude, longitude and altitude of the place are 85.67^0 E 25.98^0 Nand 52.92 m respectively. The climate in this region is hot dry summers with mild winters. Other climatic factors such as rainfall, temperature and humidity in this region are highly favourable for the growth of vegetables and other crops in all seasons with the proliferation of mites infesting a variety of crops.

A bulk-plot was raised to conduct research on the populationfluctuation of major mites associated with okra. The crop was cultivated by following appropriate agricultural practices and managed without the application of any insecticide. The population of mites was recorded at fortnight intervals. Five places were selected for each host and three leaves were plucked randomly from host plants for recording population. All the leaves were mixed, labeled, and brought to the laboratory of the Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar for counting the mites. Care was taken to avoid disturbance to the natural population of mites on the leaf. All the mites were counted under a stereo binocular microscope. The whole population was recorded on $2.5cm^2$ areas at four spots per leaf and the mean population was recorded. The meteorological data were taken from the meteorological section, Dr Rajendra Prasad Central Agricultural University, Pusa, Bihar. After that, these abiotic parameters werecorrelated with the corresponding pest population. For testing the significance of the simple correlation coefficient, the't' test was applied. The multiple regression coefficients and multiple correlation coefficient (R) of the mite population in relation to abiotic factors were also computed. The significance of all the multiple correlation coefficients (R) was tested for their significance by applying the 'F' test. The value of the coefficient of determination (R^2) was calculated to highlight the joint contribution of independent variables on mite population.

Results and Discussion:

The population of *T. urticae*was recorded on okra in different months from the 1st fortnight of March to the 2nd fortnight of July in 2023 is presented in Table 1 and Fig 1. The *T. urticae* population started increasing from the 2nd fortnight of March and reached its peak during the summer months. The maximum population of *T. urticae*was recorded in June 1st fortnight (34.57) during 2023 when the maximum temperature, minimum temperature, relative humidity maximum and minimum relative humidity, and total rainfall were 40.26°C, 23.88°C, 71.66%, 34.20%, 0.00 mm, respectively. The populations of *T. urticae* was gradually reduced from the June 2nd fortnight to the July 1st fortnight with a decrease in temperature. The minimum incidence of *T. urticae* was recorded in March 1st fortnight (0.37).

The present findings are somewhat consistent with that of Mandal *et al.* (2006) who observed that red spider mite populations on okra fluctuated significantly between 2000 and 2001, peaking during the 15th standard meteorological week and decreasing until the 24th SMW. The population increased gradually from March to July .Similarly Kumar*et al.* (2015) observed that the population of red spider mites on okra during the crop was higher in May and the temperature was also high during the period. Veerendra*et al* (2015) revealed that the population of *T. urticae* in grape vineyards, began in November 2012 and increased until April 2013.

The population of *T. urticae*had a positive and significant correlation with maximum temperature (r= 0.779**) and minimum temperature (r = 0.699*) in Table 2. There was a negative and non significant relation of the *T. urticae population* with maximum relative humidity (r = –0.375) and minimum relative humidity (r = –0.068). The rainfall had a positive and non-significant correlation (r =0.306) with the *T. urticae* population. The regression equation for the data, with a population(Y) as the dependent variable and weather factors as the independent variables, was as follows:

$$Y = -184.644 + X_1 (1.129) + X_2 (4.626) - X_3 (1.333) - X_4 (0.810) - X_5 (0.107)$$

X_1 =Maximum temperature, X_2 = Minimum temperature, X_3 = Maximum relative humidity, X_4 = Minimum relative humidity, X_5 = Rainfall.

Based on the calculation, the coefficient value (R^2) was derived as 0.7456which suggests that 74% of the fluctuations in the red spider mite population were attributed to the impact of abiotic factors. In other words, the R^2 value indicates that per cent of the variation in the red spider mite population was influenced by abiotic factors.

This finding is somehow inconsistent with the results of Mohanasundaram and Sharma (2011)revealed that the population of *T. urticae*had a non-significant positive correlation with temperature (maximum, minimum and average), maximum relative humidity and weekly total rainfall while the population had a significant positive correlation with minimum and average relative humidity.

The present findings study differ slightly from the findings of Singh *et al.* (2018), who revealed that the mite population fluctuation showed a highly significant negative correlation with minimum temperature and a significant negative correlation with maximum temperature and rainfall.

These findings obtained are inconsistent with the results of Ghosh (2019) who revealed that the mite population exhibited a significant positive correlation with various temperature measures (maximum, minimum, and average). Additionally, there was a significant positive correlation with both minimum and average relative humidity.

CONCLUSION

The population of *T. urticae*was the highest during the 1st fortnight of June 2023. There was a positive significant correlation of the *T. urticae* population withmaximum temperature and minimum temperature.

ACKNOWLEDGEMENTS

The authors are grateful thanks to the Head, Department of Entomology and Department of Horticulture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar for providing necessary facilities during the course of experimentation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

REFERENCES

Anonymous. Indian Horticulture Database Ministry of agriculture, Government of India, 85, Sector-18, Gurgaon-122015. 2020-21.

Chiasson, H., Bostanian, N.J. and Vincent, C. Acaricidal properties of a chenopodium-based botanical, J. Econ. Entomol. 2004; 97: 1373-1377.

Devine, G. J., Barber M. and Denholm, P. S. Incidence and inheritance of resistance to acaricides in European strains of the two-spotted spider mite (*Tetranychusurticae*) (Acari: Tetranychidae). Pest Manage. Agric.Sci. 2001; 57: 43-448.

Ghosh, S. K. Climate impact on red spider mite (*Tetranychus*sp. Koch) infesting eggplant (*Solanum melongena* L.) and their management using plant extracts. Journal of Entomological Research. 2019; **43** (3): 345-350.

Gupta, S.K. Handbook of plant mites of India, Sri Aurobindo Press, Calcutta, India. 1985; pp 520.

Kumar, D., Raghuraman, M., Singh, R. N., Santeswari. and Singh, J. Effect of environmental factors on the population of spider mite, *Tetranychusurticae*Koch on okra in Varanasi region,Effect of Environmental Factors. 2014;**4** (Special issue): 231-235.

Kumaran, N., Douressamy, S. and Ramaraju, K. Bio-efficacy of botanicals to two spotted spider mite, *Tetranychusurticae* (Acari: Tetranychidae) infesting okra (*Abelmoschus esculentus* L.). Pestology. 2007; **31** (9): 43-49.

Lal, O. P., and Sinha, S. R. Impact of imidacloprid seed treatment along with some insecticidal sprayings against insect pests of okra. Indian Journal of Entomology.2005; **67** (4): 328-333.

Mandal, S. K., Sattar, A., and Banerjee, S. Impact of meteorological parameters on population build up of red spider mite in okra, *Abelmoschus esculentus* L. under North Bihar condition. Journal of Agricultural Physics. 2006; **6** (1): 35-38.

Mohanasundaram, A., and Sharma, R. K. Abundance of pest complex of okra in relation to abiotic and biotic factors. Annals of Plant Protection Sciences. 2011; **19**(2): 286-290.

Mondel, M. and Ara, N. Biology and fecundity of the two spotted spider mite, *Tetranychusurticae*Koch. (Acari: Tetranychidae) under laboratory conditions, J. Life Earth Sci. 2006; 1: 43-47.

Prasad, R. and Singh, J. Status of mite pest fauna prevailing in brinjal agro-ecosystem, Uttar Pradesh J. Zool. 2011;31: 15-23.

Singh, A. K., Koul, K., Shankar, U., Singh, S. K., Mondal, A. and Singh, M. Seasonal incidence and management of red spider mite, *Tetranychusurticae* Koch on okra, *Abelmoschus esculentus* (L.) Moench. Journal of Entomology and Zoology Studies. 2018; **6**: 650-656.

Stumpf, N. and Nauen, R. Cross-resistance, inheritance, and biochemistry of mitochondrial electron transport inhibitor- acaricide resistance in *Tetranychusurticae*(Acari: Tetranychidae). J. Econ. Entomol. 2001; 94: 1577- 1583.

Van Leeuwen, T., Dermauw, W., Veire, M. Van de. and Tirry L. Systemic use of spinosad to control the two spotted spider mite (Acari: Tetranychidae) on tomatoes grown in Rockwool, Exptl. Appl. Acarol. 2005; 37: 93-105.

Veerendra, A. C., Udikeri, S. S. andKarabhantanal, S. S. Dynamics of two spotted red spider mite, *Tetranychusurticae*Koch (Acari: Tetranychidae) in grape vineyards and its correlation with abiotic factors and a predator.Journal of Entomology and Zoology Studies. 2015;**3** (6): 373-376.

Table 1:Population fluctuation of*Tetranychusurticae*on okra during *summer* 2023

Interval	*Mean population of *T.urticae* mites/2.5cm^2 leaf area	Temperature (℃)		Relative humidity (%)		Total Rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
1st Fortnight March	0.37	31.11	14.67	93.33	48.67	0.00
2ndFortnight March	2.53	30.18	16.73	89.06	50.56	18.00
1st Fortnight April	8.23	35.67	16.20	76.80	27.46	0.00
2nd Fortnight April	13.43	35.80	20.73	71.06	34.27	0.00
1st Fortnight May	30.10	35.71	19.93	75.07	37.20	1.40
2nd Fortnight May	33.63	35.20	22.52	82.56	52.18	16.80
1st Fortnight June	34.57	40.26	23.88	71.66	34.20	0.00
2nd Fortnight June	29.67	36.27	25.36	86.20	55.20	92.60
1st Fortnight July	25.30	33.22	19.70	89.20	50.40	59.40
2nd Fortnight July	6.20	32.45	20.20	85.30	51.20	24.00

*** Mean of 5 plants per plot, 3 leaves of leach plant and one leaf 2.5 cm^2 areas of four spots.**

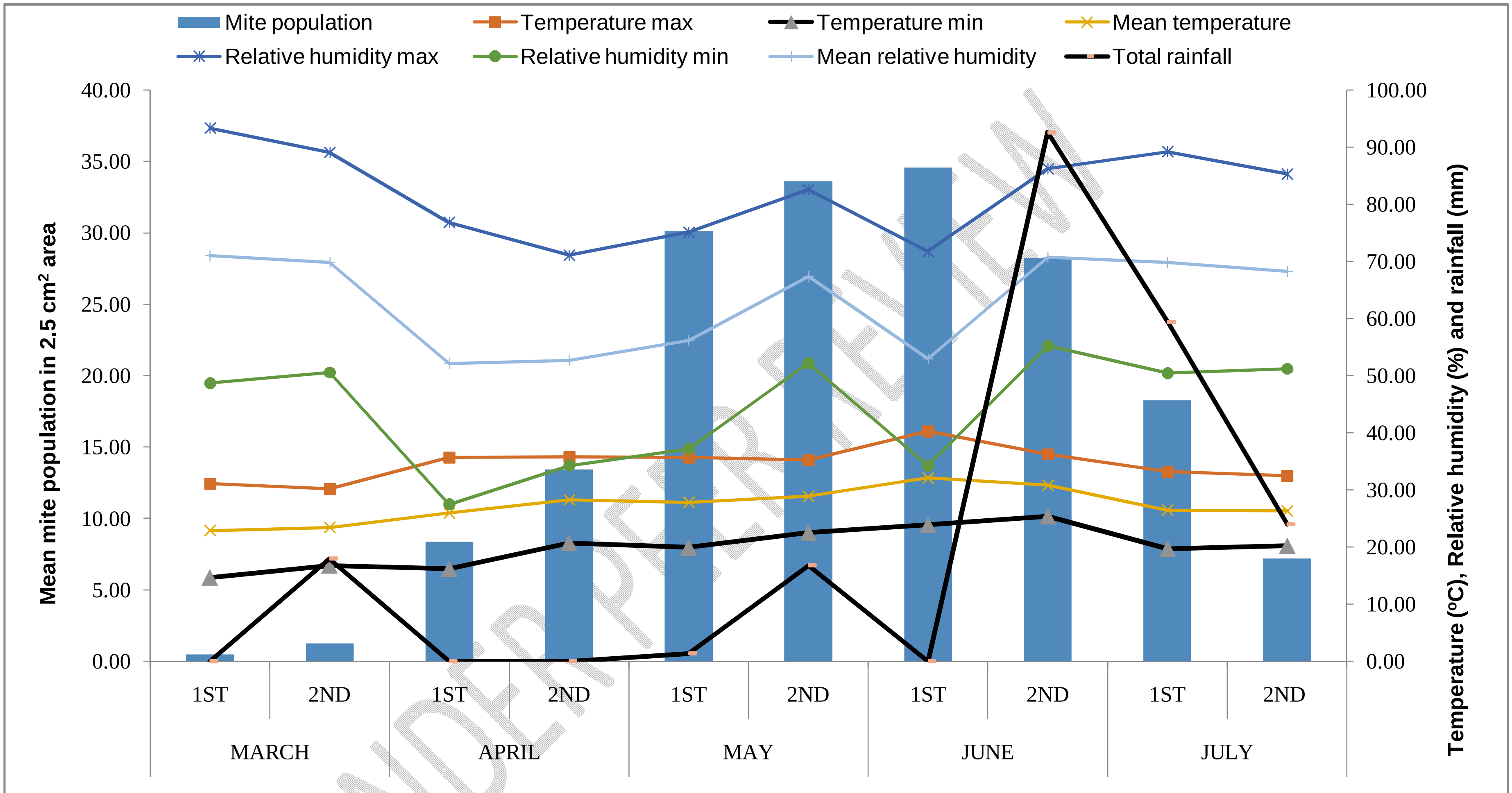

Fig 1-Influence of weather parameters on the population of *Tetranycusurticae* on okra crop during *summer* 2023

Table 2: Correlation coefficients and regression equation of *Tetranycusurticae*with weather parameters on okra crop during *summer* 2023

Correlation Factor	Temperature (℃)		Relative humidity (%)		Rainfall
	Maximum	Minimum	Maximum 700hr	Minimum 1400 hr	
Red spider mite	0.779**	0.699*	-0.375^{NS}	-0.068 ^{NS}	0.306^{NS}
Regression factor	**Regression equation**			**Multiple R^2 Value**	**R^2 Value**
Red Spider Mite	Y= -184.644 +X_1 (1.129) + X_2 (4.626) -X_3 (1.333) -X_4 (0.810) -X_5 (0.107)			0.8751	0.7456

Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level.**

X_1- Maximum temperature, X_2- Minimum Temperature, X_3-Relative humidity 700hrs, X_4- Relative humidity 1400 hrs, X_5- Rainfall, R_2- Coefficient of Determination