Effect of Abiotic Factors on the Population Dynamics of Red Spider Mite, *Tetranychus urticae* Koch. of Brinjal in Malwa Region

ABSTRACT

Field experiments were conducted to investigate the population dynamics of the red spider mite (*Tetranychus urticae* Koch) in brinjal and its relationship with various abiotic parameters during the 2020 and 2021 crop seasons at Patan farm, Krishi Vigyan Kendra, Mandsaur, Malwa region of Madhya Pradesh. The findings indicated that the red spider mite population initiated in the 30th and 31st standard weeks in 2020 and 2021, respectively. The peak population of mites per 2 cm^2 leaf area was observed in the 43rd standard week (11.52) in 2020, while the highest population was noted in the 41st standard week (9.91) in 2021. It was evident that mite infestation was substantial during October in both years. There was a noteworthy positive correlation between the population of predatory mites, maximum temperature, and sunshine hours with the red spider mite pest, while a negative correlation was observed with relative humidity.

Keywords: *Tetranychus urticae*, Brinjal, Population dynamics, Correlation

INTRODUCTION:-

Among the vegetables, brinjal is extensively cultivated in the country, holding a significant place in the diet of most consumers. Although it covers the area of 0.753 million hectares in the country, its production at 13023 million tonnes [1] This low yield can be attributed to the constant threat of various pests from sowing to harvesting. In recent times, there has been a shift in the agricultural landscape, with mites emerging as a serious pest in many crops, including brinjal. The spider mite, *Tetranychus urticae* Koch, poses a significant threat to brinjal crops, particularly during the spring, summer, and post-rainy seasons. This crop is infested primarily by six different mite pest species, namely *Tetranychus urticae*, *T. macfarlanei, T. ludeni, Brevipalpus phoenicis, Polyphagotarsonemus latus*, and *Aceria*

Comment [A1]: Introduce the plant in one sentence.
Write the scientific name of the plant.

UNDER PEER REVIEW

lycopersici [2,3]. Among these mite species, *T. urticae* is responsible for causing the loss of foliage in the crop plants, resulting in a reduction in the economic yield of fruits, ranging from 20-45%, depending on the cropping season and agro-climatic conditions. *T. urticae* is well-adapted to various environmental conditions and causes damage by extracting the contents of leaf cells through feeding [4,5]. This direct damage includes the loss of chlorophyll, stunted growth, stippling, webbing, leaf yellowing, defoliation, leaf burning, reduced fruit size and quality, the appearance of various plant deformities, and in extreme cases, plant death. Indirect effects of mite feeding may lead to decreased photosynthesis and transpiration. Due to their high reproductive potential and extremely short life cycle, coupled with frequent acaricide applications, this mite has developed resistance to almost all conventional pesticides currently in use [6,7]. The mites become serious pests due to their ability to have multiple generations per season. Their phytophagous nature, high reproductive potential, and short life cycle have contributed to rapid resistance development to many acaricides, even after just a few applications [8,9]. Since the incidence of red spider mites varies with the seasons, it is essential to have a comprehensive understanding of their seasonal dynamics, which will inform the development of effective management strategies. Therefore, we conducted a study to explore the correlation between weather factors and the incidence and population dynamics of spider mites in brinjal.

Comment [A2]: Almost all three sentences have the same meaning.
Sum up.

UNDER PEER REVIEW

MATERIALS AND METHODS

The field experiments were carried out at Krishi Vigyan Kendra, Patan Farm, Mandsaur (M.P.) in 2020 and 2021, using Brinjal variety 'Arka Anand' and following recommended agronomic practices for the Malwa region, except for plant protection measures. The brinjal plants were spaced at 60 x 45 cm² and replicated thrice. Weekly samples were taken from five randomly selected plants in each plot to record the total number of mites in a 2 cm² leaf area. Observations on the population of Red Spider mites were made on five randomly chosen plants from each replication (total 15 selected plants) at standard weekly intervals. The incidence of Red Spider mites was recorded based on the number of mites per 2 cm² leaf area for Red Spider mites, following method [10]. Meteorological data were collected from the K.N.K. College of Horticulture observatory in Mandsaur. Correlation analysis between Red Spider mites population and abiotic factors (weather variables) was conducted using.

RESULTS AND DISCUSSION

The study conducted during the brinjal crop seasons of 2020 and 2021 revealed that red spider mites began appearing on the 30th and 31st SMW of 2020 and 2021, respectively (Table 1&2 or Fig. 1&2). It was observed that the mite population steadily increased throughout the crop growth period, particularly during weeks 30th to 43th, with a rapid increase in mite buildup.

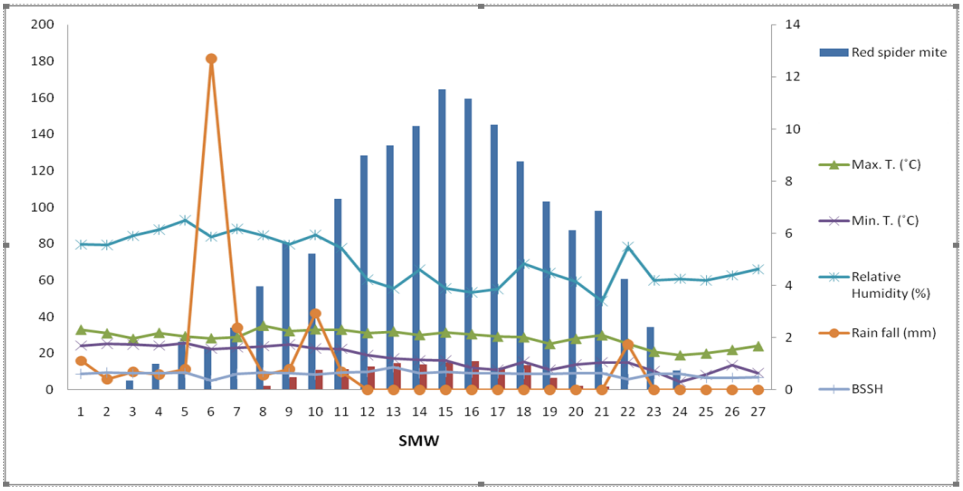

Fig 1 Population dynamics of red spider mite in relation with abiotic factors during *Kharif*- 2020

After the 43rd standard week, there was a gradual decline in the mite population, which continued until the 3rd standard meteorological week. The highest average population of *T. urticae* per 2 cm^2 leaf area was recorded during the 43rd SMW (11.52) in 2020, followed by the 44th (11.16) and 45th (10.16) standard weeks.

Table 1:- Population dynamics of *T. urticae* abiotic factors on brinjal under field condition. (*Kharif* - 2020)

S. No.	SMW	Mean mite/ 2x2 cm^2 leaf bit	Max. T. (˚C)	Min. T. (˚C)	Relative Humidity (%)	Rain fall (mm)	BSSH
1	29	**0.00**	33.00	24.28	79.56	16.00	8.78
2	30	**0.01**	31.00	25.14	79.43	6.00	9.54
3	31	**0.37**	28.00	24.71	84.28	10.00	9.11
4	32	**1.01**	31.28	24.28	87.71	8.50	9.28
5	33	**1.85**	29.41	25.57	92.85	11.50	9.45
6	34	**1.61**	28.29	22.43	83.85	181.50	5.11

UNDER PEER

7	35	**2.38**	29.00	23.14	88.14	34.00	8.87
8	36	**3.98**	35.14	23.87	84.57	8.00	9.78
9	37	**5.67**	32.14	24.86	79.57	11.50	9.23
10	38	**5.23**	33.11	22.50	84.86	42.00	8.45
11	39	**7.32**	33.00	22.43	77.71	10.00	9.65
12	40	**8.98**	31.11	19.01	60.52	0.00	9.84
13	41	**9.36**	32.00	17.21	55.52	0.00	12.61
14	42	**10.11**	30.10	16.25	65.85	0.00	9.27
15	43	**11.52**	31.40	15.97	55.71	0.00	9.90
16	44	**11.16**	30.51	11.91	53.57	0.00	9.36
17	45	**10.16**	29.10	11.02	55.35	0.00	9.20
18	46	**8.76**	28.78	15.48	69.00	0.00	8.89
19	47	**7.23**	25.14	11.05	64.00	0.00	9.03
20	48	**6.11**	28.00	13.84	59.35	0.00	9.19
21	49	**6.87**	29.90	15.12	48.71	0.00	9.34
22	50	**4.25**	25.41	14.95	78.42	25.00	5.94
23	51	**2.41**	21.00	10.30	60.12	0.00	8.71
24	52	**0.74**	19.00	4.33	60.93	0.00	9.03
25	1	**0.00**	20.00	8.23	60.01	0.00	6.45
26	2	**0.00**	22.00	13.47	62.79	0.00	6.79
27	3	**0.00**	24.00	9.27	66.04	0.00	6.80

In 2021, mite buildup started from the 31st standard week and continued to increase until the 41st standard week, which marked the peak of mite population. After the 41st week, the mite population declined rapidly, disappearing by the 51st standard week. The highest population of *T. urticae* per 2 cm^2 leaf area was recorded during the 41st (9.91) in 2021, followed by the 40th (9.80) and 42nd (8.33) standard weeks, respectively. This population increase was associated with high temperatures and low humidity on brinjal, as reported by Singh and Singh [11]. Kumar and Sharma [12] also observed a similar trend, with mites appearing in the 1st week of August during the rainy season and reaching their maximum population in the first week of October on brinjal. The mite population gradually increased and then abruptly decreased during the 3rd week of October, disappearing completely by the first week of January.

In regions where brinjal is cultivated year-round, mites were found throughout the year, with high populations in March, April, June, and October [13]. Predatory mites appeared in the

UNDER PEER REVIEW

first fortnight of June, with their population increasing in the subsequent months. *T. cinnabarinus* infested okra in May, with its population gradually increasing [14]. *T. urticae* in brinjal during the first week of September, persisting until November 2014 [15,16,17].

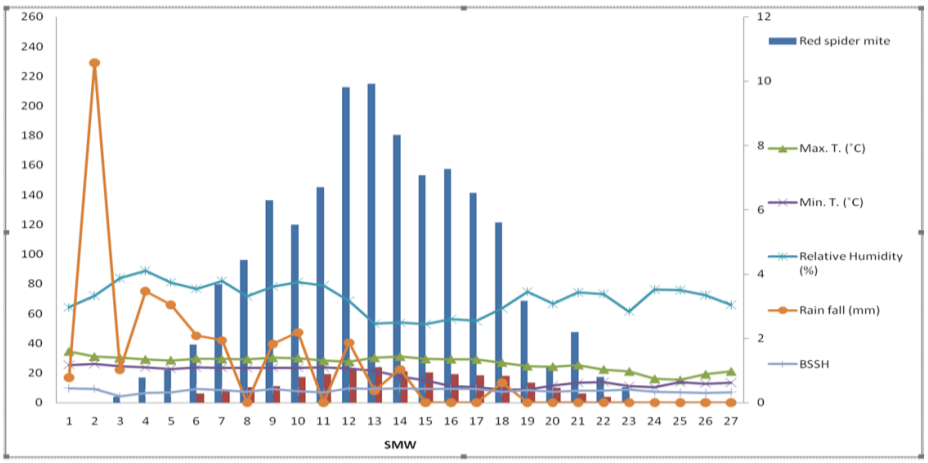

Fig 2 Population dynamics of red spider mite in relation with abiotic factors during *Kharif*- 2021

Table 2:- Population dynamics of *T. urticae* abiotic factors on brinjal under field condition (*Kharif* - 2021)

S. No.	SMW	Mean mite/ 2x2 cm^2 leaf bit	Max. T. (˚C)	Min. T. (˚C)	Relative Humidity (%)	Rain fall (mm)	BSSH
1	29	**0.00**	34.56	25.51	64.25	17.00	9.71
2	30	**0.00**	31.00	26.23	72.04	229.00	9.49
3	31	**0.17**	30.12	24.84	83.96	22.12	4.17
4	32	**0.77**	29.13	23.70	88.96	75.00	6.71
5	33	**1.00**	28.54	22.91	81.07	66.00	6.94
6	34	**1.80**	29.69	23.70	76.75	45.00	9.50
7	35	**3.67**	29.41	23.54	81.90	42.00	8.40
8	36	**4.43**	29.29	23.33	71.65	0.00	7.21
9	37	**6.30**	30.17	23.57	78.32	39.50	9.24
10	38	**5.53**	30.00	23.56	81.40	47.40	7.73

UNDER PEER

11	39	**6.70**	28.20	23.90	78.98	0.00	6.93
12	40	**9.80**	27.50	22.99	68.50	40.50	9.76
13	41	**9.91**	30.21	21.46	53.04	8.20	9.41
14	42	**8.33**	31.04	17.63	53.85	22.50	9.57
15	43	**7.07**	29.34	15.01	52.79	0.00	9.46
16	44	**7.27**	29.26	10.89	56.29	0.00	9.51
17	45	**6.53**	29.04	10.17	55.00	0.00	9.19
18	46	**5.60**	27.00	8.71	63.43	13.50	7.51
19	47	**3.17**	24.56	8.84	74.86	0.00	8.37
20	48	**1.10**	24.27	11.56	66.50	0.00	7.37
21	49	**2.20**	25.30	13.24	74.29	0.00	8.33
22	50	**0.80**	22.31	13.86	73.29	0.00	8.09
23	51	**0.47**	21.00	11.11	61.43	0.00	9.11
24	52	**0.00**	16.00	10.09	76.29	0.00	7.37
25	1	**0.00**	15.20	13.70	75.79	0.00	6.87
26	2	**0.00**	19.00	12.76	72.36	0.00	6.54
27	3	**0.00**	21.00	13.41	65.79	0.00	7.12

Vegetable crops were susceptible to phytophagous mites throughout the year, with the most severe infestations occurring during the summer months (April to July) and the post-monsoon period (September to October). During the rainy season, mite species had a minor to mild pest status, while during the winter season (December to February), their occurrence was negligible on commonly grown vegetables.

Correlation and regression analysis: -

Correlation and regression analysis conducted for 2020 and 2021 showed a significant positive correlation of *T. urticae* with maximum temperature (r = 0.416* and 0.455* during 2020 and 2021, respectively) and potential sunshine (r = 0.496* and 0.482* during 2020 and 2021, respectively). Relative humidity exhibited a significant negative correlation with red spider mites (r = -0.507* and -0.483 during 2020 and 2021, respectively), while minimum temperature and rainfall

Table 3 :- Correlation and regression studies of red spider mite in relation with abiotic parameters on brinjal under field condition (*Kharif*- 2020 & 2021)

UNDER PEER REVIEW

Year		2020			2021		
S. No	**Biotic and abiotic parameters**	**Correlation coefficient (r)**	**R^2**	**Regression line**	**Correlation coefficient (r)**	**R^2**	**Regression line**
1.	**Max.Temp. (^{0}C)**	0.416*	R^2 = 0.173	y = 0.388x – 6.389	0.455*	R^2 = 0.207	y = 0.317x - 5.055
2.	**Min.Temp. (^{0}C)**	-0.162	-	-	0.075	-	-
3.	**Relative Humidity (%)**	-0.507*	R^2 = 0.257	y = -0.156x + 15.69	- 0.483*	R^2 = 0.233	y = -0.158x + 14.61
4.	**Rain Fall (mm)**	-0.222	-	-	- 0.166	-	-
5.	**BSSH (hr)**	0.496*	R^2 = 0.245	y = 1.337x - 7.059	0.482*	R^2 = 0.232	y = 1.191x - 6.258

* Significant at 5% level of significance, * *Significant at 1% level of significance

showed no significant correlation. Linear regression analysis indicated that in 2020, the mite population increased by 0.39 and 1.33 percent for every unit increase in maximum temperature and daylight hours, respectively. Maximum temperature and sunshine contributed to 17% and 24% of the variation in the mite population, respectively. Relative humidity had a 25% impact on the mite population, with a 1% increase in relative humidity resulting in a 0.15 percent decrease in the mite population. Similar trends were observed in 2021 (Table 3). In the field, *T. urticae* was first observed in August, with peak activity in October. Higher temperatures favored mite population growth, while rainfall had an adverse effect. The rain was thought to wash away nymphs and adults due to heavy downpours. Regardless of the crop season, the mite population was highest in April and May. Prassanna, Sekhar *et al.*, Monica *et al.* and Naga *et al.*, [18,19,20,21] have also reported significant positive correlations between mite population and maximum temperature, along with negative correlations with relative humidity and rainfall. Jadav *et al.* [22] reported a similar relationship between abiotic factors and red spider mites in okra crops.

CONCLUSION

UNDER PEER REVIEW

Red spider mites first appear on brinjal in first week of August; the population peaks in October and rapidly declines in December and January. The population of red spider mites positively correlation with maximum temperature and sunshine hours, while negative correlation with relative humidity and rainfall. This study would be helpful in reduced the losses of brinjal by adopting suitable IPM technique for control of red spider mites.

REFERENCES

1. Indian Horticulture Database, 2021-22.
2. Gupta SK. Handbook of plant mites of India, Sri Aurobindo Press, Calcutta, India. 1985; 520.
3. Prasad R, Singh J. Status of mite pest fauna prevailing in brinjal agro-ecosystem, Uttar Pradesh J. Zool. 2011; 31: 15-23.
4. Mondel M and Ara N. Biology and fecundity of the two spotted spider mite, *Tetranychus urticae* Koch. (Acari: Tetranychidae) under laboratory conditions, J. Life Earth Sci. 2006; 1: 43-47
5. Kumaran N, Douressamy S, Ramaraju K. Bioefficacy of botanicals to two spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae) infesting okra (*Abelmoschus esculentus* L.). Pestology. 2007;31: 43- 49.
6. Chiasson H, Bostanian NJ, Vincent C. Acaricidal properties of a chenopodium-based botanical, J. Econ. Entomol. 2004; 97: 1373-1377
7. Van Leeuwen T, Dermauw W, Veire M, Van de, Tirry L. Systemic use of spinosad to control the twospotted spider mite (Acari: Tetranychidae) on tomatoes grown in Rockwool, Exptl. Appl. Acarol. 2005; 37: 93-105.
8. Devine GJ, Barber M, Denholm PS. Incidence and inheritance of resistance to acaricides in European strains of the two-spotted spider mite (*Tetranychus urticae*) (Acari: Tetranychidae). Pest Manage. Agric. Sci.2001; 57: 443-448.
9. Stumpf N, Nauen R. Cross-resistance, inheritance and biochemistry of mitochondrial electron transport inhibitor- acaricide resistance in *Tetranychus urticae* (Acari: Tetranychidae). J. Econ. Entomol.2001; 94: 1577- 1583.
10. Poe SL. Sampling mites on soybean. In: Kogan, M. & Hezrog, D.C. (eds) Sampling methods in soybean entomology. Springer-Verlag, New York.1980; 312–323
11. Singh RN, Singh J. Incidence of *Tetranychus cinnabarinus* (Boisd). (ACARI :Tetranychidae) in relation to weather factors in Varanasi. Pestology.1993; 13: 18-23.
12. Kumar V, Sharma DD. Bioecology and chemical control of spider mite, *Tetranychus indeni* Zecher on Okra. Indian J. Pl. Prot.1991; 21: 68-71.
13. Bhullar MB, Ghai JK. Seasonal abundance of phytophagous and predatory mites infesting brinjal in Punjab. Annals Biol.2003; 19: 231-234.

Comment [A3]: Use more recent sources if possible.

UNDER PEER REVIEW

14. Singh DK, Sardana HR, Kadu LN. Efficacy of certain pesticides against red spider mite, *Tetranychus cinnabarinus* Koch infesting Okra. Indian J. Ent. 2004; 66: 282-284.
15. Sonika GR, Jangra M. Incidence of *Tetranychus urticae* Koch on brinjal under field and screen house conditions. Emer Life Sci Res. 2017; 3(2): 16-22.
16. Siddhapara MR. Biology, seasonal incidence and management of red spider mite, Tetranychus urticae Koch in okra. Ph. D. Thesis (Unpublished) Junagadh Agricultural University, Gujarat. 2015.
17. Singh AK, Koul K, Shankar U, Singh SK, Mondal A, Singh M. Seasonal incidence and management of red spider mite, *Tetranychus urticae* Koch on Okra, Abelmoschus esculentus (L.) Moench. Journal of Entomology and Zoology Studies.2018; 6 (2): 650-656.
18. Prasanna KP. Seasonal incidence and management of Tetranychid mites in brinjal. M. Sc. (Agri.) Thesis (Unpublished). University of Agricultural Sciences, Dharwad, Karnataka. 2007.
19. Sekhar DC, Reddy DJ, Rahman SJ, Reddy AR, Narendranath VV. Ecology and management of red spider mite, *Tetranychus urticae* Koch on grape. Acta Horticulturae. 2008; 78(5): 335-342
20. Monica VL, Kumar A, Chand H, Paswan S, Kumar S. Population dynamics of *Tetranychus urticae* Koch on brinjal crop under north Bihar conditions. Pest Mgmt Hort Ecosyst. 2014; 20 (1): 47-49.
21. Naga BL, Sharma A, Khinchi SK, Kumawat KC. Seasonal incidence of mite, *Tetranychus cinnabarinus* (Boisduval) and natural enemies on okra in semi arid Rajasthan. Journal of Pharmacognosy and Phytochemistry. 2017; 6(3): 186-189
22. Jadhav YT, Mane SR, Shinde DS. Seasonal incidence, correlation and regression among weather parameters against mites on summer okra. Internat. J. Plant Protec. 2016; 9(2): 494-497.

UNDER PEER REVIEW