The Pharma Innovation Journal 2022; SP-11(9): 1737-1741

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(9): 1737-1741

www.thepharmajournal.com
Received: 16-06-2022
Accepted: 20-07-2022

Meinaz Nissar
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Akhtar Ali Khan
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Tahmina Mushtaq
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Sarwajeet Singh Pathania
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Asma Sherwani
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Corresponding Author:
Akhtar Ali Khan
Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Influence of abiotic environment on the population dynamics of whitefly (*Trialeurodes vaporariorum*) on gerbera (*Gerbera jamesonii*) under protected cultivation

Meinaz Nissar, Akhtar Ali Khan, Tahmina Mushtaq, Sarwajeet Singh Pathania and Asma Sherwani

Abstract
An experiment was carried out to study the influence of abiotic environment on the population dynamics of whitefly (*Trialeurodes vaporariorum*) on Gerbera (*G. jamesonii*) crop at Plant Introduction Section, Tulip garden, Srinagar, India under polyhouse conditions during the years 2017 and 2018. The population trend of whitefly (*T. vaporariorum*) on Gerbera during 2017 and 2018 indicated that the whitefly population first appeared in 1st fortnight of April and remained active till 2nd fortnight of December. The adult population reached peak during 2nd fortnight of September (67.33 adults/leaf) to 1st fortnight of October (63.35 adults/leaf) while nymphal population reached to its peak value during 2nd fortnight of August (37.34, 36.09 nymphs/leaf) during the two year study period, 2017 and 2018. The correlation of weather parameters with whitefly population on Gerbera revealed that the nymphal population exhibited positive significant correlation with maximum (r =0.687**, r= 0.646**) and minimum temperature (r=0.691**, r= 0.726**) while the adult population showed positive significant correlation with maximum temperature (0.594**, r= 0.473*) during both years.

Keywords: Abiotic environment, population dynamics, whitefly (*Trialeurodes vaporariorum*), gerbera (*Gerbera jamesonii*), protected cultivation

Introduction

Whitefly is a tiny, sap-sucking insect belonging to order Hemiptera and family Aleyrodidae having worldwide distribution and is an invasive pest of vegetable and ornamental plants, especially during warm weather (Mondal *et al.*, 2019) [12]. Whiteflies consist of more than 1500 species in approximately 126 genera (Martin, 2004) [10]. The main economic damage is attributed to two species, the greenhouse whitefly (*T. vaporariorum*, Westwood) and sweet potato whitefly, (*Bemisia tabaci*, Gennadius) under field and protected conditions (Henneberry and Castle, 2001) [3]. *T. vaporariorum* has been found to be a major pest of vegetables and ornamental plants under protected environment and *B. tabaci* is mostly found under open conditions. However, it may coexist with *T. vaporariorum* on the same crop in protected conditions (Luo *et al.*, 2004) [8]. *T. vaporariorum* is sap feeders, excreting copious amounts of excess water and honeydew that support growth of mounds resulting in intolerable cosmetic damage to ornamentals and vegetables, besides greatly reducing photosynthesis, thus depleting crop yields (Nissar *et al*., 2019) [13].

Whitefly is an invasive pest that has worldwide distribution and entire life cycle takes about three weeks under favorable conditions, allowing populations to build quickly. For the application of effective control measures of any kind, knowledge of the whitefly population density is essential (Sharma *et al.*, 2017) [18]. The knowledge of pest population build up in relation to influence of abiotic environment is a prerequisite for developing weather based pest forecasting system (Janghel and Rajput (2016) [4]. Studies on seasonal abundance and population fluctuations will help in formulating effective management strategies against the pest (Rolania *et al.*, 2018) [15]. In addition, whitefly has a high reproductive rate, a high capacity for dispersion and resistance to several insecticides, which complicates control options. Control of *T. vaporariorum* is primarily accomplished through the use of conventional insecticides (Boopathi *et al*., 2015) [1]. Chemical control has resulted in the development of resistance against *T. vaporariorum* populations, and its negative environmental impact has encouraged the development of alternative pest management strategies (Faria and Wraight, 2001) [2].

Therefore, whiteflies being the vector of plant diseases and resistant to large number of insecticides worldwide, needs proper management and eradication strategies both under field and protected conditions and before the management, it is prerequisite to understand the influence of abiotic environment on the population dynamics of whitefly (*Trialeurodes vaporariorum*) on Gerbera (*Gerbera jamesonii*) under protected Cultivation.

Materials and Methods

An experiment was carried out to study the population buildup of whitefly (*Trialeurodes vaporariorum*) on Gerbera (*G. jamesonii*) crop in relation to abiotic environment at Plant Introduction Section, Tulip garden, Srinagar, India under polyhouse conditions. The experiment was conducted during the years 2017 and 2018.

Layout of experiment

The population buildup of whitefly (*T. vaporariorum*) on Gerbera was studied under polyhouse conditions. The polyhouse was divided into four plots of size 8 × 3 m. The planting was done at spacing of 40 × 30 cm. The crop was raised in pesticide free conditions.

Population estimation

Three gerbera plants were selected randomly from each plot and number of whitefly nymphs and adults were counted on two uniform sized leaves from each top, middle and bottom portion of plant. Observations were made at fortnightly intervals from April to December. The weather parameters, *viz.* temperature (maximum and minimum), relative humidity (maximum and minimum) inside polyhouse was recorded to study impact of these parameters on insect population.

Statistical analysis

The data obtained on whitefly population (nymphs and adults) and various weather parameters, *viz.*, maximum and minimum temperature and relative humidity was subjected to statistical analysis to find out the coefficient of correlation and regression using SAS-statistical package (SAS, 2000) [17].

Results

Influence of abiotic environment on the population of *T. vaporariorum* was studied during the years, 2017 and 2018 on Gerbera (*Gerbera Jamesonii*) crop under polyhouse conditions, and the results obtained from the study are presented below:

Population dynamics of T. vaporariorum

Population trend depicted by Table 1 indicated that the adult whitefly remained active on the crop throughout the period of study during 2017. The pest population was first noticed in the 1st fortnight of April with the appearance of adults (0.33/leaf). The population then increased gradually with highest adult population recorded during 1st fortnight of October (63.35 adults/ leaf) when maximum temperature, minimum temperature, relative humidity (maximum) and relative humidity (minimum) were 33.43 °C, 11.29 °C, 71.00% and 21.86%, respectively. The nymphs were first noticed during 2nd fortnight of May with population of 0.85 nymphs/leaf. The nymphal population attained peak during 2nd fortnight of August (37.34 nymphs/leaf) when minimum temperature, maximum temperature, relative humidity (maximum) and relative humidity (minimum) were 34.10 °C, 19.07 °C, 70.80% and 40.26%, respectively. The population then declined gradually with adults as low as 0.10/leaf during 2nd fortnight of December after which plants withered and died. Likewise, nymphal population reached to the lowest level of 0.72/leaf during 2nd fortnight of November and was not then noticed on the crop.

Similarly, during 2018, the population remained on the crop throughout the study period i.e., from first appearance of adults in 1st fortnight of April till 2nd fortnight of December. The peak population of adults was observed in 2nd fortnight of September with 67.33 adults/leaf when maximum temperature, minimum temperature, relative humidity (maximum) and relative humidity (minimum) were 32.13 °C, 15.49 °C, 71.53% and 36.53%, respectively while highest population of nymphs with number as high as 36.09/leaf was observed during 2nd fortnight of August (Table 2). The temperature (maximum and minimum) and relative humidity (maximum and minimum) during this period were 35.90 °C, 21.40 °C, 72.53% and 35.73%, respectively. The population then showed a declining trend and reached to lowest value of 0.22 adult/leaf in the 2nd fortnight of December and 1.42 nymphs/leaf in the 2nd fortnight of November.

Table 1: Population build-up of whitefly (*Trialeurodes vaporariorum*) on Gerbera (*Gerbera jamesonii*) under protected conditions during year 2017

Month	Fortnight	Temperature (°C)		Relative humidity (%)		Nymphs/ leaf*	Adults/ leaf*
		Maximum	Minimum	Maximum	Minimum		
April	1st	22.63	9.78	66.33	40.93	0	0.33
	2nd	27.16	13.29	73.53	51.40	0	0.60
May	1st	29.26	13.94	66.85	41.66	0	0.96
	2nd	31.43	16.12	67.60	40.53	0.85	1.77
June	1st	31.70	16.61	63.40	36.00	1.42	2.22
	2nd	31.80	19.59	71.73	49.46	8.58	8.33
July	1st	34.76	21.62	68.33	38.80	18.20	18.88
	2nd	35.20	23.10	69.60	40.86	27.55	27.77
August	1st	36.66	23.34	67.40	40.00	34.12	39.13
	2nd	34.10	19.07	70.80	40.26	37.34	49.50
September	1st	33.00	18.58	72.46	35.66	26.11	52.22
	2nd	33.96	14.86	71.93	25.33	20.61	57.22
October	1st	33.43	11.29	71.00	21.86	15.00	63.35
	2nd	29.36	7.51	57.60	35.86	6.66	40.00
November	1st	26.90	5.49	71.00	36.00	4.27	20.02
	2nd	17.60	3.71	75.35	51.28	0.72	6.21
December	1st	18.20	1.92	73.86	45.40	0	0.86
	2nd	12.56	3.10	76.80	66.46	0	0.10

*Mean of 20 plants based on three leaves from top, middle and bottom of plant

Table 2: Population buildup of whitefly (*Trialeurodes vaporariorum*) on Gerbera (*Gerbera jamesonii*) under protected conditions during year 2018

Month	Fortnight	Temperature (°C)		Relative humidity (%)		Nymphs/ leaf*	Adults/ leaf*
		Maximum	Minimum	Maximum	Minimum		
April	1st	26.03	12.28	69.00	36.00	0	0.40
	2nd	26.79	11.34	62.18	42.93	0	0.68
May	1st	27.56	14.07	65.00	48.40	0	0.88
	2nd	31.23	13.82	52.46	32.06	0.78	1.56
June	1st	36.83	18.45	53.60	36.63	1.64	2.02
	2nd	27.00	18.17	61.86	53.26	7.59	7.35
July	1st	32.63	21.15	72.00	50.60	17.38	16.95
	2nd	34.10	23.42	75.20	49.06	25.33	25.59
Aug.	1st	35.23	22.09	67.80	46.53	32.74	40.77
	2nd	35.90	21.40	72.53	35.73	36.09	50.20
Sept.	1st	35.43	19.32	65.46	37.60	20.11	55.35
	2nd	32.13	15.49	71.53	36.53	14.66	67.33
Oct.	1st	28.13	11.04	70.80	43.06	7.11	60.48
	2nd	25.60	6.50	73.93	42.80	5.23	32.11
Nov.	1st	19.06	5.40	75.33	55.06	4.11	18.00
	2nd	17.56	5.35	75.86	58.13	1.42	8.23
Dec.	1st	15.90	2.74	80.80	54.40	0	0.70
	2nd	13.77	0	81.26	48.60	0	0.22

*Mean of 20 plants based on three leaves from top, middle and bottom of plant.

Correlation and regression studies between *T. vaporariorum* population and abiotic environment

Perusal of data presented in Table 2 depicts that during year 2017, the nymphal and adult population exhibited positive significant correlation with maximum temperature with coefficient of correlation, r = 0.687** and 0.594**, respectively. The minimum temperature showed positive significant correlation (r = 0.691**) with population of nymphs but positive non-significant correlation with adult population. However, non-significant correlation was observed between *T. vaporariorum* nymphal and adult population and the maximum relative humidity. The minimum relative humidity showed negative non-significant (r = -0.690**) correlation with adult population while negative non-significant correlation with the nymphal population. Similarly, during year 2018, the nymphal population exhibited positive significant correlation with maximum temperature and minimum temperature with r = 0.646** and 0.726** respectively (Table 3). However, adult population exhibited significant positive correlation with maximum temperature (r = 0.473*) but showed positive non-significant correlation with minimum temperature. Both adult and nymphal population exhibited positive non-significant correlation with maximum relative humidity and negative non-significant correlation with minimum relative humidity. Regression studies of whitefly population with weather parameters *viz*., maximum temperature, minimum temperature, relative humidity (maximum) and relative humidity (minimum) was worked out and is depicted in Tables 4 with R^2 values of 0.58 and 0.83 for nymphal and R^2 = 0.60 and 0.63 for adult population, respectively for year 2017 and 2018. The R^2 values indicated that weather parameters significantly influenced the population fluctuation of whitefly nymphs and adults on Gerbera during the years, 2017 and 2018.

Table 3: Correlation coefficient of whitefly (*Trialeurodes vaporariorum*) population with abiotic environment on gerbera during the year 2017 and 2018

Weather parameters	Correlation Coefficients			
	No. of nymphs per leaf		No. of adults per leaf	
	2017	2018	2017	2018
Maximum temperature (°C)	0.687**	0.646**	0.594**	0.473*
Minimum temperature (°C)	0.691**	0.726**	0.33	0.357
Relative humidity maximum (%)	0.003	0.121	0.083	0.166
Relative humidity minimum (%)	-0.381	-0.151	-0.685**	-0.302

** Significant at 0.01 percent level of significance, *Significant at 0.05 percent level of significance

Table 4: Regression equation of whitefly (*Trialeurodes vaporariorum*) population on Gerbera with abiotic environment during the year 2017 and 2018

Pest population	Regression equation		R^2	
	2017	2018	2017	2018
Nymphs	Y1 = -94.12+0.795 X1 + 0.980 X2 + 1.02 X3 - 0.05 X4	Y1 = -79.94+0.841 X1 + 0.654 X2 + 0.917 X3 - 0.144 X4	0.58	0.83
Adults	Y1 = -273.13+6.331 X1 + 3.450 X2 + 2.220 X3 - 0.248 X4	Y2 = -137.93+3.20 X1 + 1.702 X2 + 1.743 X3 - 0.768 X4	0.60	0.63

Y1= whitefly nymph per leaf; Y2= whitefly adults per leaf; X1= Maximum temperature (°C); X2= Minimum temperature (°C); X3= Maximum relative humidity (%); X4= Minimum relative humidity (%)

Discussion

Population dynamics of *T. vaporariorum*

The population fluctuation of whitefly (*T. vaporariorum*) on Gerbera during 2017 and 2018 indicated that pest first appeared in 1st fortnight of April with adult population attaining peak (63.35, 67.33 adults/leaf), during 2nd fortnight of September to 1st fortnight of October while nymphal population reached to its peak value (37.34, 36.09 nymphs/leaf) during 2nd fortnight of August. These findings are supported by Kranz *et al.* (1977) [5] who reported a sharp increase in whitefly population in September and October which was directly correlated with higher relative humidity and increasing temperature. These conditions shorten the juvenile development time. During this study, it was found that temperature of 32-33 °C and relative humidity 71-72% favoured the adult population while slightly higher temperature of 34-35 °C and relative humidity 70-72% favoured the nymphal population under polyhouse conditions. While *B.tabaci* on tomato first appeared in the second fortnight of June and similar population trend, as on Gerbera was observed with adult population recording its peak (2.35, 2.70 adults/leaf) in the 1st fortnight of September and nymphal population reached its peak (3.75, 5.1 nymphs/leaf) during 1st to 2nd fortnight of August during both years of study. The present findings are in agreement with those of Singh and Butter (1985) [21] and Sharma *et al.* (2004) [19] who reported the peak period of incidence of whitefly during September-October. Our results were also more or less in conformity with Sarwar (2013) [16], who reported number of whiteflies were the highest in autumn (October). The whitefly population showed a decline after attaining peak during both years of study on both the crops. This is due to decrease in temperature and increasing age of plant as whitefly feeds on the succulent part of the plant and dry matter accumulation increases with older age of the plant and thereby population as well as infestation of whitefly is reduced (Latif and Akhter, 2013 and Rafiq *et al.*, 2008) [7, 14]. However the population was consistently higher in case of *T. vaporariorum* on Gerbera than *B.tabaci* on Tomato. This is in agreement with Sarwar (2013) [16], who stated that the abundance and population dynamics of whiteflies varied depending on species of whiteflies, area and crops attacked. It was also observed that temperature strongly influences population growth on gerbera as well as on tomato.

Correlation and regression studies between *T. vaporariorum* population and abiotic environment

During correlation studies of whitefly population with weather parameters, it was observed that on Gerbera, the nymphal population exhibited positive significant correlation with maximum (r= 0.687** and 0.646**) and minimum temperature (r= 0.691** and 0.726**) during year 2017 and 2018, respectively. The adult population showed positive significant correlation with maximum temperature r= 0.594** and 0.473* during the year 2017 and 2018, respectively whereas, correlation with relative humidity (minimum) was negative but significant (r= 0.685**) during 2017. Similar results were obtained by Syed *et al.*, 2016 who also reported highly positive and significant correlation between temperature and whitefly population on mustard. In case of *B. tabaci* on Tomato, there was significant positive correlation between the whitefly population and maximum temperature with r_{nymh}= 0.691** and 0.570** and r_{adult}= 0.633** and 0.551* during the years, 2017 and 2018, respectively. However, the minimum temperature showed positive significant correlation with population, r_{nymph}= 0.549* and r_{adult}= = 0.693** during 2018. The correlation between relative humidity (maximum) and whitefly population was non-significant during 2017 but positively significant (r_{nymph}=0.514* and r_{adult}= 0.544*) during 2018. All weather parameters contributed to *T. vaporariorum* and *B. tabaci* population fluctuation on the crops, gerbera and tomato during the study. The present study is in agreement with Sharma *et al.* (2017) [18] who reported significant positive correlation of whitefly population with maximum and minimum temperature and negative correlation with relative humidity (minimum) on tomato. The results were also in accordance with Singh *et al.* (2002) [20] where whitefly population showed significant positive correlation with maximum and minimum temperature while relative humidity was negatively correlated with whitefly on cowpea. Shrivastva and Prajapati (2012) [22] also reported significant positive correlation of whitefly population with maximum temperature while mean relative humidity (r= -0.83) exhibited negative correlation with whitefly population in blackgram (*Vigna mungo*).

This study is in conformity with Meena and Bairwa (2014) [11] who revealed a positive and significant association between the whitefly population and maximum and minimum temperature on tomato. Kumawat *et al.* (2000) [6] in their study on the seasonal incidence of whitefly (*Bemisia tabaci*) on okra have reported that maximum temperature was significantly correlated with whitefly's density. Similarly, Marabi *et al.* (2017) [9] also reported significantly positive correlation with maximum and minimum temperature (r=0.74 and r= 0.65) whereas negative correlation was expressed with relative humidity on soybean.

Conclusion

The population development of whitefly (*T. vaporariorum*) on Gerbera during 2017 and 2018 indicated that the whitefly population first appeared in 1st fortnight of April and remained active till 2nd fortnight of December. The adult population density reached peak during 2nd fortnight of September (67.33 adults/leaf) to 1st fortnight of October (63.35 adults/leaf) while nymphal population reached to its peak value during 2nd fortnight of August (37.34, 36.09 nymphs/leaf) during the two year study period, 2017 and 2018. The correlation of weather parameters with whitefly population on Gerbera revealed that the nymphal population exhibited positive significant correlation with maximum and minimum temperature while the adult population showed positive significant correlation with maximum temperature during both years.

References

1. Boopathi T, Karuppuchamy P, Singh SB, Kalyanasundaram M, Mohankumar S, Ravi M. Microbial control of the invasive spiraling whitefly on cassava with entomopathogenic fungi. Brazilian Journal of microbiology. 2015;46(4):1077-1085.
2. Faria M, Wraight SP. Biological Control of *Bemisia tabaci* with fungi. Crop Protection. 2001;20:767-778.
3. Henneberry TJ, Castle SJ. *Bemisia*: pest status, economics, biology and population dynamics. In: Virus insect plant interaction (Eds. K. F. Haris, O. P. Smith and J. E. Duffus) Academic Press San Diego, CA; c2001. p. 247-278.

4. Janghel M, Rajput MS. Efficacy of bio-pesticides against whitefly *Bemisia tabaci* on okra. Plant Archives. 2016;16(1):1102-1104.
5. Kranz J, Schmutterer H, Koch W. Diseases, pests, and weeds in tropical crops. Paul Parey, Berlin; c1977. p. 666.
6. Kumawat RL, Pareek BL, Meena BL. Seasonal incidence of jassid and whitefly on Okra and their correlation with abiotic factors. Annals of Biology. 2000;16(2):167-169.
7. Latif MA, Akhter N. Population dynamics of whitefly on cultivated crops and its management. International Journal of Bio-resource and Stress Management. 2013;4(4):576-581.
8. Luo C, Wang SQ, Cui WQ, Zhang ZL. The population dynamics of whiteflies and their in Beijing suburb. Modern Entomology Research Agricultural Science natural enemy Press Beijing, China; c2004. p. 465-468.
9. Marabi RS, Das SB, Bhowmick AK, Pachori R, Vibha, Sharma HL. Seasonal population dynamics of whitefly (*Bemisia tabaci* Gennadius) in soybean. Journal of Entomology and Zoology Studies. 2017;5(2):169-173.
10. Martin JH. Whiteflies of Belize (Hemiptera: Aleyrodidae) Part 1-introduction and account of the subfamily Aleurodicinae Quainteance and Baker. Zootaxa. 2004;681:1-199.
11. Meena LK, Bairwa B. Influence of weather and biotic parameters on the incidence of major insect pests of tomato. The Ecoscan. 2014;8(3-4):309-313.
12. Mondal B, Mondal P, Ayan D, Bhattyacharyya K. Seasonal incidence of different insect pests of tomato (*Lycopersicon esculentum* Mill.) and their correlation with abiotic factors in lateritic zone of West Bengal. Journal of Entomology and Zoology Studies. 2019;7(1):1426-1430.
13. Nissar M, Khan AA, Khan ZH, Masoodi KZ, Anwar Ali, Wani WM, *et al*. Population dynamics of whitefly (*Bemisia tabaci*, Gennadius) on tomato (*Solanum esculentum*, Mill.) crop under protected conditions in Kashmir, Journal of Entomology and Zoology Studies. 2019;7(4):804-807.
14. Rafiq M, Ghaffar A, Arshad M. Population dynamics of whitefly (*Bemisia tabaci*) on cultivated crop hosts and their role in regulating its carry-over to cotton. International Journal of Agriculture and Biology. 2008;10(5):577-580.
15. Rolania K, Janu A, Jaglan RS. Role of abiotic factors on population buildup of whitefly (*Bemisia tabaci*) on cotton. Journal of Agrometeorology. 2018;20:292-296.
16. Sarwar M. Studies on Incidence of Insect Pests (Aphids) and Their Natural Enemies in Canola *Brassica napus* L. (Brassicaceae) Crop Ecosystem. International Journal of Science Research and Environmental Science. 2013;1(5):78-84.
17. SAS Institute. SAS Users guide Statistics, release 8.1. Cary, NC, USA; c2000.
18. Sharma D, Maqbool A, Jamval VVS, Srivastava K, Sharma A. Seasonal dynamics and management of whitefly (*Bemisia tabaci*, Genn.) in tomato (*Solanum esculentum* Mill.). Brazilian Archive of Biology and Technology. 2017;60:e17160456.
19. Sharma PD, Jat KL, Takar BL. Population dynamics of insect pests of American cotton (*Gossypium hirsutum* L.) in Haryana. Journal of Cotton Research Development. 2004;18(1):104-106.
20. Singh AK, Kumar S, Pandey V. Effect of meteorological parameters on the population build-up of sap feeders on cowpea. Shashpa. 2002;9(2):149-152.
21. Singh J, Butter NS. Influence of climatic factors on the buildup of whitefly, *Bemisia tabaci* (Genn.) on cotton. Indian Journal of Entomology. 1985;47(3):359-360.
22. Srivastava AK, Prajapati RK. Influence of weather parameters on outbreak of mungbean yellow mosaic virus in blackgram (*Vigna mungo* L.) of Bundelkhand Zone of Central India. Journal of Agricultural Physics. 2012;12(2):143-151.