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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 2118-2121
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www.thepharmajournal.com
Received: 02-06-2022
Accepted: 06-07-2022

NP Pathan
Assistant Professor, Department of Plant Protection, College of Horticulture, S.D.A.U., Jagudan, Gujarat, India

DB Sisodiya
Professor and Head, Department of Entomology, BACA, A.A.U., Anand, Gujarat, India

AR Mohapatra
Ph.D. Scholar, Department of Entomology, BACA, A.A.U., Anand, Gujarat, India

Corresponding Author
NP Pathan
Assistant Professor, Department of Plant Protection, College of Horticulture, S.D.A.U., Jagudan, Gujarat, India

Population dynamics of stem fly, *Melanagromyza sojae* (Zehntner) infesting black gram (*Vigna mungo* L.) in summer season

NP Pathan, DB Sisodiya and AR Mohapatra

DOI: https://doi.org/10.22271/tpi.2022.v11.i8Sab.15194

Abstract
The infestation of *Melanagromyza sojae* infesting black gram started from 1st WAS *i.e.*, 13th SMW (16.67%) during summer, 2017. Thereafter the infestation increased gradually and its highest infestation was observed on 7th May 2017 *i.e.*, 19th SMW (78.33%). Minimum temperature (MinT) and morning vapour pressure (MoVP) showed highly significant positive association with infestation (0.509** and 0.522**, respectively). Evening vapour pressure (EvVP) exhibited significant positive association (0.440*). During summer 2021, infestation initiated from 1st WAS *i.e.*, 13th SMW (15.00%) then infestation increased gradually and its peak incidence was observed on 5th May 2021 *i.e.*, 18th SMW (80.00%). Minimum temperature (r = 0.769**) and evening vapour pressure (r = 0.510**) exhibited highly significant positive association, while morning vapour pressure (0.495*) showed significant positive association.

Keywords: Black gram, *M. sojae*, minimum temperature and morning vapour pressure

Introduction
Black gram or urd is one of the important pulse crop in India. Black gram (*Vigna mungo* L.) reported to be originated in India. Quantitatively black gram is very good source of protein. It is mainly cultivated in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal, Punjab, Haryana, Tamil Nadu, Karnataka and Gujarat. In Gujarat, the production of black gram is 73560 tons with 669 kg/ha productivity from an area of 1, 09, 960 hectares in 2018-19. The major black gram producing districts in Gujarat are Sabarkantha, Panchmahal, Dahod, Vadodara, Mehsana and Bharuch. It is also cultivated to some extent in Rajkot, Surendranagar and Junagadh districts (Anonymous, 2019) [2]. In India, 60 insect pest species are known to attack black gram at different stages of crop growth (Lal and Sachan, 1987) [6]. Yield loss due to stem fly varies between locations and according to the plant growth stage. It is reported to cause 100% infestation and 33.84% stem tunnelling caused by *M. sojae* in soybean at Pantnagar in Uttarakhand (Gaur *et al*., 2015) [4].

Materials and Methods
A study on population dynamics of stem fly in black gram was carried out in variety GU 1 (Gujarat Urd 1). To study the population dynamics, the crop was raised in 20 x 10 m plot size with a spacing 45 x 10 cm during summer 2017 and 2021 at Entomology farm, B. A. College of Agriculture, AAU, Anand. The plot was kept free from any plant protection measures. The plot was divided into six equal sectors. Size of each sector was 10 x 20 m. From each sector, 10 plants were observed. For stem fly infestation, ten randomly selected plants were uprooted from each plot and brought to the laboratory. The roots of uprooted plants were gently washed in tap water to remove adhered soil. The numbers of stem fly infested plants out of 10 plants were recorded. The observations were recorded at every three days interval started from one week after germination till harvest. The data thus obtained were analysed by following standard statistical technique (Steel and Torrie, 1980) [13].
In order to study the instantaneous effect of weather parameters on population fluctuation of stem fly, the data of abiotic parameters *viz.*, bright sunshine (BSS), rainfall (RF), wind speed (WS), maximum (MaxT) and minimum (MinT) temperature, morning (RH_1), evening (RH_2) relative humidity, Morning Vapour Pressure (MoVP), Evening Vapour Pressure (EvVP) and Evaporation were correlated. Week-wise data on various parameters recorded at Department of Agril. Meteorology, B. A. College of Agriculture, Anand Agricultural University, Anand

during 2017 and 2021 were utilized.

Result and Discussion

The population dynamics of stem fly, *M. sojae* was carried out during summer 2017 & 2021 and data on infestation of *M. sojae* were presented in Table 1 and 2, respectively.

Activity of *M. sojae* during summer, 2017

The data on infestation caused by *M. sojae* during summer, 2017 are presented in Table 1. It can be seen clearly from the data that the activity of *M. sojae* started from 1st WAS *i.e.*, 13th SMW (16.67%). Then the infestation increased gradually and its peak was observed on seventh May, 2017 *i.e.*, 19th SMW (78.33%). Thereafter, infestation steadily declined. It was observed that during the later stage of crop, infestation was declined, but it remained more or less throughout the crop period. Overall, infestation caused by *M. sojae* was ranged from 16.67 to 78.33 per cent.

Table 1: Seasonal incidence of stem fly, *M. sojae* infesting black gram (Summer, 2017)

Months	SMW	Date of observation	Infestation (%)
April	13th	01-04-2017	16.67
	14th	04-04-2017	28.33
		07-04-2017	31.67
	15th	10-04-2017	35.00
		13-04-2017	38.33
	16th	16-04-2017	43.33
		19-04-2017	46.67
		22-04-2017	48.33
	17th	25-04-2017	51.67
		28-04-2017	65.00
	18th	01-05-2017	66.67
		04-05-2017	73.33
	19th	07-05-2017	78.33
		10-05-2017	75.00
		13-05-2017	73.33
May	20th	16-05-2017	71.67
		19-05-2017	70.00
	21st	22-05-2017	68.33
		25-05-2017	66.67
	22nd	28-05-2017	65.00
		31-05-2017	63.33
		03-06-2017	61.67
June	23rd	06-06-2017	58.33
		09-06-2017	58.33
	24th	12-06-2017	56.67
SMW = Standard Meteorological Week			

Activity of *M. sojae* during summer, 2021

The data on infestation caused by *M. sojae* during summer, 2021 are presented in Table 2. The data indicated that the activity of *M. sojae* started from 1st WAS *i.e.*, 13th SMW (15.00%). Then the infestation increased gradually and reached to its peak activity on 5th May, 2021 *i.e.*, 18th SMW (80.00%) in the first week of May, 2021. In subsequent weeks, the infestation decreased and reached to 55.00 per cent during 2nd week of June *i.e.* 23th SMW.

Table 2: Seasonal incidence of stem fly, *M. sojae* infesting black gram (Summer, 2021)

Months	SMW	Date of observation	Infestation (%)
March	13rd	30-03-2021	15.00
April	14th	02-04-2021	26.67
		05-04-2021	33.33
		08-04-2021	36.67
	15th	11-04-2021	40.00
		14-04-2021	45.00
	16th	17-04-2021	46.67
		20-04-2021	53.33
	17th	23-04-2021	55.00
		26-04-2021	66.67
		29-04-2021	66.67
May	18th	02-05-2021	75.00
		05-05-2021	80.00
	19th	08-05-2021	76.67
		11-05-2021	75.00
	20th	14-05-2021	73.33
		17-05-2021	71.67
		20-05-2021	70.00
	21st	23-05-2021	68.33

June	22nd	26-05-2021	65.00
		29-05-2021	63.33
		01-06-2021	61.67
	23rd	04-06-2021	58.33
		07-06-2021	56.67
		10-06-2021	55.00
SMW = Standard Meteorological Week			

From available source of literature, it revealed that very few workers have attempted to study the seasonal occurrence of stem fly, *M. sojae* on black gram. Yadav *et al.* (2020) [14] from Uttar Pradesh found that the maggots of stem fly found to attack on black gram stem from seedling stage and continued up to the end of vegetative stage. The damage was more severe on seedlings as compared to mature plants. This is in accordance with the present finding. The report of Manohar and Balasubramanian (1980) [8] from Tamil Nadu deviated from the finding of present study, who stated that the infestation of stem fly, *O. phaseoli* in black gram was lowest in crops sown in September, October and November and highest in those sown in March, July and August. This discrepancy might be due to variation in locality, ecological conditions, cropping pattern, variety and cropping systems.

Correlation matrix of the relationship between weather parameters and infestation of *M. sojae*

In nature, the population of insect-pests is never truly stable. The rise and fall of the population density of any organism depends on many abiotic factors like temperature, rainfall, humidity *etc*. To know the effect of various weather parameters on the infestation caused by (*M. sojae*) infesting black gram, simple correlation was worked out between three days mean infestation (%) and three days mean value of different weather parameters.

The data on correlation between weather parameters and infestation caused by *M. sojae* during summer, 2017 are presented in Table 3. The analysis of correlation between infestation and weather parameters and infestation caused by *M. sojae* during summer, 2017 revealed that the minimum showed highly significant positive association (with 'r' value 0.509** and 0.522**, respectively). Eevening vapour pressure (EvVP) exhibited significant positive association (0.440*). Bright sunshine hours (BSS), wind speed (WS), maximum temperature (MaxT), morning relative humidity (MoRH) and evening relative humidity (EvRH) showed positive correlation while evaporation had negative association.

The results of the analysis on correlation between infestation and weather parameters during summer, 2021 revealed that minimum temperature (MinT) and evening vapour pressure (EvVP) showed highly significant positive association (with 'r' value 0.769** and 0.510**, respectively). Morning vapour pressure (MoVP) exhibited significant positive correlation (0.495*). The abiotic factors *viz*., rainfall (RF), wind Speed (WS), maximum temperature (MaxT), evening relative humidity (EvRH) and evaporation (EP) showed positive correlation while bright sunshine hours (BSS) and morning relative humidity (MoRH) showed negative correlation.

Table 3: Correlation coefficient (r) between weather parameters and infestation of *M. sojae* in black gram (n = 25)

Weather Parameters	Correlation co-efficient (r)	
	Summer, 2017	Summer, 2021
Bright Sunshine Hours (BSS), hr/day	0.278	-0.184
Wind Speed (WS), km/hr	0.145	0.346
Maximum Temperature (MaxT), ºC	0.213	0.074
Minimum Temperature (MinT), ºC	0.509**	0.769**
Morning Relative Humidity (RH1), %	0.172	-0.210
Evening Relative Humidity (RH2), %	0.301	0.388
Morning Vapour Pressure (VP1), mm of Hg	0.522**	0.495*
Evening Vapour Pressure (VP2), mm of Hg	0.440*	0.510**
Evaporation (EP), mm	-0.124	0.161
* Significant at 5% level ** Significant at 1% level		

On the basis of field studies on relation between stem fly infestation in black gram and various abiotic factors (weather parameters), it can be concluded that minimum temperature had highly significant positive correlation, while morning and evening vapour pressure had significant positive association with stem fly infestation during summer season.

Sharma *et al*. (1997) [12] also reported that temperature had significantly and positive correlation with stem fly, *O. phaseoli* infestation in soybean crop. According to Mangang *et al*. (2017) [7], the stem fly infestation on soybean and minimum temperature correlated significantly and favoured the development of stem fly. More ever to this Motaphale *et al*. (2017) [9] also reported the per cent infestation of *M. sojae* on soybean positively and significantly correlated with minimum temperature. All these reports are in conformity with the present findings wherein minimum temperature had significant positive association with stem fly infestation in black gram. However in contrast to above, minimum temperature had significant negative correlation with stem fly incidence in green gram (Irulandi and Balasubramanian, 1999) [5], black gram (Nayak *et al*. 2004) [10] and soybean (Yadav *et al*. 2015 and Panwar *et al*. 2021) [15, 11] has also been reported by few earlier workers in past. Wind speed showed significant negative relationship with stem fly infestation in black gram. This finding corroborates with the report of Irulandi and Balasubramanian (1999) [5] and Ahirwar *et al*. (2014) [1] who reported negative association between these two variables on green gram and soybean crops, respectively. In present investigation, no clear relationship was established between infestations of stem fly and relative humidity. This is in concurrence with the report of Fand *et al*. (2019) [3] who concluded the study and reported that both

morning and evening relative humidity did not affect the field incidence on *M. sojae* in soybean. Positive correlation was established between infestation of stem fly and vapour pressure. Significantly positive relationship was observed between these two variables during summer season of 2017 (r = 552**) and 2021 (r = 0.495*). Similarly, evening vapour pressure and stem fly infestation recorded during summer, 2021 showed highly significant positive (r = 0.510**) correlation. From the available sources of literature, it is revealed that none of the worker in past has attempted to established correlation between stem fly infestation and vapour pressure and hence the present finding could not be compared and discussed.

Conclusion

The infestation of *M. sojae* initiated from 1st week after sowing (WAS) *i.e*., 13th SMW during summer. Thereafter the infestation increased gradually and its highest infestation was observed during 19th and 18th SMW of summer, 2017 (78.33%) and 2021 (80.00%), respectively. During summer, 2017 and 2021, minimum temperature (0.509** and 0.769**), evening vapour pressure (0.440* and 0.510**) and morning vapour pressure (0.522** and 0.495*) showed significant positive association with infestation of stem fly.

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