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Impact of Abiotic Factors on Population Fluctuation of Major Pod Borers in Black Gram under Western U.P. Conditions

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ABSTRACT

Background: Black gram (*Vigna mungo* L.) is the member of Asian *Vigna* crop group and also known as urdbean grown in spring and *Kharif* season in the Indian subcontinent. It is the fourth most important short-duration pulse crop grown in India. Black gram crop is attacked by a number of insect pests from sowing to harvest in the field as well as in storage condition. Among these insect-pests pod borers *i.e.* spotted pod borer, *Maruca vitrata* (Geyer) and gram pod borer, *Helicoverpa armigera* (Hubner) are serious insect-pests of black gram causing seed and pod damage. Therefore, keeping these views in mind, the present study aimed to study the population fluctuation of major pod borers (*M. vitrata* and *H. armigera*) in black gram.

Methods: The research trials were conducted during two consecutive years *i.e. Kharif*, 2018 and 2019 at CRC of SVPUAT, Meerut to observe the population dynamics of major pod borers in black gram. A plot size of 200 m^2 with black gram variety 'Pant Urd-31' was sown manually 5-7 cm deep on 18 August, 2018 for the first year experiment and on 20 August, 2019 for the second year experiment, by following standard agronomical practices and the crop was maintained without insecticide application.

Result: The study on the seasonal incidence of pod borers *viz*., *M. vitrata* and *H. armigera* start from 39th to 44th standard week and both the larvae attain their peak in 41st and 42nd standard week during *Kharif*, 2018 and 2019.

Key words: Black gram, *Helicoverpa armigera*, *Maruca vitrata*, Population dynamics.

INTRODUCTION

Pulse crops have a unique position in sustainable crop production as they provide highly nutritive food and keep the soil alive and productive. Pulses are an integral part of our diet and we consume them in a number of ways. The pulse crops are also important for the management of soil fertility due to their nitrogen fixation ability (Kantar *et al*. 2007). India is the largest pulse growing country in the world both in terms of area as well as production covering 46.87 per cent of area and 36.75 per cent production (Anonymous, 2018). India is the largest pulse growing country in the world both in terms of area as well as production covering 46.87 per cent of area and 36.75 per cent production (Anonymous, 2018). Therefore, the more intensive interventions are required to increase production and productivity of pulses in the country.

In India, the important pulse crops are Chick pea, pigeon pea, mung bean, urd bean, lentil and field pea. The major pulse-producing states are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh, which together accounts for about 80% of the total production (Ali and Gupta, 2012).

Black gram (*Vigna mungo* L.) is the member of Asian *Vigna* crop group and also known as urdbean grown in spring and *Kharif* season in the Indian subcontinent. It is the fourth most important short-duration pulse crop grown in India and can be grown in multiple cropping systems like mixed crop and intercrop apart from sole cropping due to its short duration. It can be grown as intercrop with pigeonpea, maize, sorghum, cotton and sugarcane. It can also be grown as green manure and fodder crop. Popularity of this pulse is due to its nutritional and industrial values (Nene, 2006). The product is usually sold as whole Urd bean or *urd dal*. It is one of the most important components in the famous preparation of South dishes, *e.g.* idli, dosa, vada etc. Black gram is a rich source of protein (24%), carbohydrate (59.6%), fat (1.4%), mineral (3.2%) and fiber (0.9%) (Tiwari and Shivhare, 2016).

Black gram is a staple crop in the central and South East Asia; however it is extensively used only in India and now grown in the Southern United States, West Indies, Japan and other tropics and subtropics (Delic *et al*. 2009). India is

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the largest producer as well as consumer of black gram. Black gram accounts for about 13 per cent of total pulse production of India. In India, black gram is grown in 43.50 lakh hectares. with an annual production of 27.51 lakh tonnes and productivity of 632 kg per ha. In Uttar Pradesh, it occupies an area of 5.65 lakh hectares with a production of 2.83 lakh tonnes and productivity of 501 kg per ha **(**www.indiastat.com**,** 2018).

This low productivity of black gram may be due to abiotic and biotic factors. Among biotic factors a number of insect-pests belonging to different orders have been recorded from various parts of the world. A number of insect pests belonging to different orders have been recorded from various parts of the world. In India, 60 insect species are known to attack black gram at different stages of crop growth (Lal and Sachan, 1987). Among these insects-pests pod borers *i.e.* spotted pod borer, *Maruca vitrata* (Geyer) and gram pod borer, *Helicoverpa armigera* (Hubner) are the serious insect-pests of grain legumes causing seed and pod damage. *Maruca vitrata* is an important insect-pest of black gram, which appears on the crop from vegetative to reproductive stage and cause substantial damage to flowers, as well as to pods by webbing and also boring. The damage inflicted by *Helicoverpa armigera* is generally confined to flower heads, seeds and pods. The pod borers, *M. vitrata* and *H. armigera* are considered to be important in causing economic losses to the farmer (Reddy *et al.,* 1998). Hence, it is very much essential to note down the population buildup of major pod borers in black gram so as to take up the management practices in time. Similarly, various weather parameters are known to influence the population build up and suppression. Therefore, an attempt was made to study the population fluctuation of *M. vitrata* and *H. armigera* in relation to weather parameters that prevail in Western plain zone of Uttar Pradesh, in order to explore the possibility of forecasting the incidence of pod borers and damage to black gram crop.

MATERIALS AND METHODS

In order to study the population dynamics of major pod borers *i.e*., *M. vitrata* and *H. armigera* on black gram with relation to abiotic factors i.e. temperature, relative humidity and rainfall. The field experiment was conducted at Crop Research Centre, Chirodi, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during *Kharif*, 2018 and 2019. A plot size of 200 m^2 with black gram variety 'Pant Urd-31' was sown manually 5-7 cm deep on 18 August, 2018 for the first year experiment and on 20 August, 2019 for the second year experiment. Observation on major pod borers larvae were recorded at weekly intervals starting from 50% flowering to harvesting of crop from 10 randomly selected plants from untreated control plots. The trend of pod borers population build-up was determined by working out the mean number of larvae/ 10 plants. Simultaneously, weather data were collected from Department of Soil Science, SVPUAT, Meerut. The influence of key meteorological parameters on the pest incidence was worked out with simple correlation **(**Gomez and Gomez, 1984).

$$r = \frac{Sxy}{[(Sx^2)\ (Sy^2)]^{1/2}}$$

Where,

r = Simple correlation coefficient.

Sx^2 = Correlated sum of squares for meteorological parameter.

Sy^2 = Correlated sum of squares for pest incidence.

Sxy = Correlated sum of cross products.

RESULTS AND DISCUSSION

The data pertaining to population dynamics of major pod borers (*Maruca vitrata* and *Helicoverpa armigera*) with respect to weather parameters and the correlation analysis between them were presented in the Table 1 and 2 during *Kharif*, 2018 and 2019, respectively.

Population dynamics of *Maruca vitrata* during *Kharif*, 2018

The observations on population dynamics of *M. vitrata* in black gram were recorded from 39th to 44th standard week with mean larval population ranged from 4.67 to 18.33 larvae per ten plants during *Kharif*, 2018 (Table 1). The larval population of *M. vitrata* during *Kharif*, 2018 was first reported at 39th standard week (last week of September) with 4.67 larvae per ten plants when the maximum and minimum temperature were 32.57°C and 23.00°C, relative humidity at morning and evening was 94.00 and 72.14 per cent, respectively. During the period 5.29 mm rainfall was recorded. The pest activity increased from the first week of October and reached its peak at 41st standard week (second week of October) with 18.33 larvae per ten plants when the maximum and minimum temperatures were 34.14°C and 18.71°C, relative humidity at morning and evening was 87.00 and 55.00 per cent, respectively whereas, 0.49 mm rainfall was recorded. The larval population started to decline (17.00 larvae per ten plants) during the 42nd standard week (third week of October) when the maximum and minimum temperatures were 34.43°C and 15.00°C, respectively. The relative humidity recorded at morning and evening was 90.00 and 51.00 per cent, respectively and rainfall was 0.20 mm. The minimum population of *M. vitrata* (2.00 larvae per ten plants) was recorded during 44th standard week (last week of October and first week of November) when the maximum and minimum temperature were 31.71°C and 12.00°C. The relative humidity recorded at morning and evening was 91.14 and 45.43 per cent, respectively and rainfall was 0.46 mm.

Population dynamics of *Maruca vitrata* during *Kharif*, 2019

The population dynamics of *M. vitrata* in black gram during *Kharif*, 2019 presented in Table 2. The results revealed that the mean larval population of *M. vitrata* ranged from 3.67 to 16.33 larvae per ten plants. The larval population was rapidly increased from first week of October (40th standard week) and attended its peak of 16.33 larvae per ten plants during 42nd standard week (third week of October) when the maximum and minimum temperatures were 32.04°C and 18.47°C, relative humidity at morning and evening were 94.74 and 60.96 per cent, respectively and rainfall was 0.00 mm was recorded. The larval population started decline (6.00 larvae per ten plants) during the 43rd standard week (fourth week of October) when the maximum and minimum temperatures were 30.07°C and 15.87°C. The relative at morning and evening were 94.19 and 50.86 per cent, respectively and rainfall was 0.00 mm. The minimum population of *M. vitrata* (1.33 larvae per ten plants) was recorded during 44th standard week (last week of October and first week of November) when the maximum and minimum temperatures were 29.77°C and 15.76°C, relative humidity at morning and evening were 93.74 and 53.74 per cent, respectively. During the period 0.00 mm rainfall was recorded.

The present findings are in accordance with Rathod *et al*. (2017) who reported that the incidence of spotted pod borer (*M. vitrata*) was commenced in the 39th standard week. The present findings uphold the views of Berani *et al*. (2017) who reported that the activity of *M. vitrata* was observed for short period with low larval population from mid-September to October. The present findings are dissimilar with Yadav and Singh (2015) who reported that the incidence of *Maruca vitrara* started from 35th standard week (last week of August and first week of September) and attended its peak during 38th standard week (Fourth week of September) with 2.4 larvae/plant. Patel (1997) who found that the incidence of this pest started after 5th week of sowing (2nd week of August). The peak incidence of spotted pod borer was recorded during last week of October and there after it declined.

Correlation between larval population of *M. vitrata* and weather parameters during *Kharif*, 2018 and 2019

The results of the simple correlation (r) between *M. vitrata* larval population and weather parameters demonstrate that the correlation between maximum temperature and *M. vitrata* larvae population had significant positive correlation (r= 0.813* and 0.815*) (Table 3). Whereas minimum temperature and *M. vitrata* larvae population found non-significant positive correlation (r= 0.225 and 0.155) during *Kharif*, 2018 and 2019, respectively (Table 3). Further the morning relative humidity and *M. vitrata* larvae population showed non-significant negative correlation (r= -0.349) during *Kharif*, 2018 and non-significant positive correlation (r= 0.096) during *Kharif*, 2019 whereas, the correlation between *M. vitrata* larvae and evening relative humidity was found non-significant negative correlation during *Kharif*, 2018 (r= -0.030) and 2019 (r= -0.002). During *Kharif*, 2018 and 2019 rainfall and *M. vitrata* larval population had non-significant negative correlation with r= -0.407 and -0.119, respectively.

The interactions between *M. vitrata* larval population and prevailing weather parameters as obtained in the present investigation are in line with the findings of Manjunath (2014) who reported that larval population of *M. vitrata* exhibited significant positive correlation with maximum temperature. The present results are in conformity with Sravani *et al*. (2015) who reported the significant positive correlation between maximum temperature and *M. vitrata* larval population and positive correlation with minimum temperature and morning relative humidity. Whereas, rainfall and evening relative humidity had negative correlation with larval population of *M. vitrata*. Similar observations were made by Sonune *et al*. (2010) who found that the pest population of *M. vitrata* showed positive correlation with

Table 1: Population dynamics of major pod borers in relation to weather parameters during *Kharif*, 2018.

Standard week no.	Dates	Larvae / 10 plants		Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
		M. vitrata	*H. armigera*	Max.	Min.	Morning	Evening	
39	24 Sep-30 Sep	4.67	2.33	32.57	23.00	94.00	72.14	5.29
40	01 Oct-07 Oct	13.67	7.00	35.86	20.71	96.14	58.86	0.00
41	08 Oct-14 Oct	18.33	9.33	34.14	18.71	87.00	55.00	0.49
42	15 Oct-21 Oct	17.00	12.00	34.43	15.00	90.00	51.00	0.20
43	22 Oct-28 Oct	6.67	6.33	32.71	13.43	90.57	49.14	0.00
44	29 Oct-04 Nov	2.00	3.33	31.71	12.00	91.14	45.43	0.46

Table 2: Population dynamics of major pod borers in relation to weather parameters during *Kharif*, 2019.

Standard week no.	Dates	Larvae / 10 plants		Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
		M. vitrata	*H. armigera*	Max.	Min.	Morning	Evening	
39	24 Sep-30 Sep	3.67	1.67	31.40	22.59	94.84	72.31	2.06
40	01 Oct-07 Oct	10.33	5.33	31.21	20.56	95.19	60.71	3.27
41	08 Oct-14 Oct	14.67	7.67	31.94	18.94	93.53	57.01	0.00
42	15 Oct-21 Oct	16.33	10.33	32.04	18.47	94.74	60.96	0.00
43	22 Oct-28 Oct	6.00	4.67	30.07	15.87	94.19	50.86	0.00
44	29 Oct-04 Nov	1.33	2.00	29.77	15.76	93.74	53.74	0.00

Table 3: Correlation between mean larval population of *M. vitrata* and *H. armigera* with weather parameters during *Kharif*, 2018 and 2019.

Season	Weather parameters	*M. vitrata* Correlation coefficient (r) 2018	*M. vitrata* Correlation coefficient (r) 2019	*H. armigera* Correlation coefficient (r) 2018	*H. armigera* Correlation coefficient (r) 2019
Kharif, 2018 and 2019	Max. Temp (°C)	0.813*	0.815*	0.635	0.675
	Min. Temp (°C)	0.225	0.155	-0.180	-0.072
	Relative humidity morning (%)	-0.349	0.096	-0.484	0.035
	Relative humidity evening (%)	-0.030	-0.002	-0.363	-0.165
	Rainfall (mm)	-0.407 NS	-0.119	-0.606	-0.306

*Significant at 5% level (P = 0.05); NS- Non significant.

maximum temperature (r = 0.2051) and mean bright sunshine hours (r = 0.5397).

Population dynamics of *Helicoverpa armigera* during *Kharif,* 2018

The results revealed that (Table 1) during *Kharif*, 2018 the mean larvae of *H. armigera* ranged from 2.33 to 12.00 larvae per ten plants and the larval activity initially observed in 39th standard week (last week of September) as 2.33 larvae per ten plants. After this, larval density increased gradually and reached to a peak level (12.00 larvae per ten plants) on 42nd standard week (third week of October). At peak level of larval population the maximum, minimum temperature, relative humidity at morning and evening and rainfall were 34.43°C, 15.00°C, 90.00, 51.00 per cent and 0.20 mm, respectively. The larval population started decline (6.33 larvae per ten plants) during the 43rd standard week (fourth week of October) when the maximum and minimum temperatures were 32.71°C and 13.43°C, relative humidity at morning and evening was 90.57 and 49.14 per cent, respectively and rainfall was 0.00 mm. The minimum population 3.33 larvae per ten plants of *H. armigera* were recorded during 44th standard week (last week of October and first week of November) when the maximum and minimum temperatures were 31.71°C and 12.00°C, relative humidity at morning and evening was 91.14 and 45.43 per cent, respectively and rainfall was 0.46 mm.

Population dynamics of *Helicoverpa armigera* during *Kharif,* 2019

Similarly, during the second year of study *i.e*. *Kharif*, 2019 the larval activity of *H. armigera* was observed initially in 39th standard week (last week of September) with mean population of 1.67 larvae per ten plants and larval density increased gradually and reached to a peak level (10.33 larvae per plants) on 42nd standard week (third week of October). At peak level of larval population the maximum, minimum temperature, relative humidity at morning and evening and rainfall were 32.04°C, 18.47°C, 94.74, 60.96 per cent and 0.33 mm, respectively (Table 2). The larval population started decline (4.67 larvae per ten plants) during the 43rd standard week (fourth week of October) when the maximum and minimum temperatures were 30.07°C and 15.87°C, relative humidity at morning and evening was 94.19 and 50.86 per cent, respectively. During the period 0.00 mm rainfall was recorded. The minimum population (2.00 larvae per ten plants) of *H. armigera* was recorded during 44th standard week (last week of October and first week of November) when the maximum, minimum temperature, relative humidity at morning and evening and rainfall were 29.77°C, 15.76°C, 93.74, 53.74 per cent and 0.00 mm, respectively.

The present findings are supported by the findings of Shivaraju *et al*. (2011) who reported that the peak larval incidence of *H. armigera* was observed during third week of October (42nd SMW). The present finding also got support from the observations of Rathod *et al*. (2017) who reported that the peak larval population of gram pod borer (*H*. *armigera*) was recorded in 42nd SMW (third week of October). The present findings are dissimilar with Jakhar *et al*. (2016) who reported that *H. armigera* incidence started in 40th SMW (First week of October) and peak incidence in 43rd SMW (Fourth week of October). Chaitanya (2012) reported that *H. armigera* incidence initiated during third week of November and reached peak during second fortnight of December.

Correlation between larval population of *H. armigera* and weather parameters during *Kharif*, 2018 and 2019

demonstrate that the correlation between maximum temperature and *M. vitrata* larvae population had significant positive correlation (r= 0.813* and 0.815*) (Table 3).

After analyzed the data of simple correlation (r) between *H. armigera* larval population and weather parameters, demonstrate that the correlation between maximum temperature and *H. armigera* larvae population had non-significant positive correlation (r-= 0.0635 and 0.675) (Table 3). whereas, minimum temperature and *H. armigera* larvae population found non-significant negative correlation (r=-0.180 and -0.072) during both years *i.e*. *Kharif*, 2018 and 2019. Further the morning relative humidity and *H. armigera* larvae population were showed non-significant negative correlation(r= -0.484) during *Kharif*, 2018 (r= -0.484) and non-significant positive correlation (r=0.035) during *Kharif*, 2019 whereas, correlation between *H. armigera* larvae and evening relative humidity was observed to have non-significant negative correlation (r= -0.0363 and-0.0165) during both the seasons. During *Kharif*, 2018 and 20019 rainfall and *H. armigera* larval population had non-significant negative correlation with r= -0.606 and -0.306, respectively.

These findings are supported by Shivaraju *et al*. (2011) who reported that *H. armigera* had positive correlation with maximum temperature and negative correlation with minimum temperature and relative humidity. The present findings are in conformity with Sarkar and Roy (2016) who reported that larval population of *H. armigera* showed positive correlation with maximum temperature and negatively correlated with minimum temperature. Kapoor and Shankar (2019) reported that the positive correlation between weekly mean maximum temperature and gram pod borer larval density, negative correlation with morning relative humidity and rainfall. Kumar (2016) studied the relationship of weather factors with *H*. *armigera* incidence and showed positive significant association with maximum temperature, sunshine hours and wind velocity.

CONCLUSION

Based on this results it can be concluded that the seasonal incidence of pod borers *viz*., *M. vitrata* and *H. armigera* start from 39th to 44th standard week. The *M. vitrata* larval population attended its peak (18.33 and 16.33 larvae per ten plants) on second week of October and third week of October (41st and 42nd standard week) during *Kharif*, 2018 and 2019 and *H. armigera* larval population reached its peak (12.00 and 10.33 larvae per ten plants) on 42nd standard week (third week of October) during both the years. The present study also indicates that population dynamics of pod borers (*M. vitrata* and *H. armigera*) is one of the most important objectives of pest management in order to explore the possibility of forecasting the incidence of pod borers and damage to black gram.

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REFERENCES

Ali, M. and Gupta, S. (2012). Carrying capacity of Indian agriculturepulse crops. Current Science. 102: 874-88.

Anonymous, (2018). Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Krishi Bhavan, New Delhi.

Anonymous, (2018a). Ministry of Agriculture and Farmers Welfare, Govt. of India.www.indiastat.com.

Berani, N.K., Pathan, N.P., Godhani, P.H. (2017). Populationdynamics of lepidopteran insect pest of black gram, *Vigna mungo* (L.) Hepper. Trends in Biosciences. 10: 419-422.

Chaitanya, T. (2012). Bioecology and management of pod borers in redgram. M.Sc. Thesis, Acharya N. G. Ranga Agricultural University, Hyderabad.

Delic, D., Stajkovic, D., Kuzmanovic, N., Rasulic, S., Milicic, B.(2009). The effects of rhizobial inoculation on growth and yield of *Vigna mungo* L. in Serbian soils. Biotechnology in Animal Husbandry. 25: 1197-1202.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. pp. 644-645.

Jakhar, B. L., Singh, N., Venilla, S., Patel, M. H., Vekaria, M. V., Patel, D. B., Panickar, B. (2016). Influence of climate change on *Helicoverpa armigera* (Hubner) in pigeonpea. Journal of Agriculture and Ecology. 2: 25-31.

Kantar, F., Hafeez, B.G., Shivkumar, S.P., Sundaram, N.A., Tajera, P. (2007). Chickpea; Rhizobium Management and Nitrogen Fixation. In: Chickpea Breeding and Management. pp. 179-192.

Kapoor, B. and Shankar, U. (2019). Seasonal incidence of *Maruca vitrata* Geyer and *Helicoverpa armigera* Hubner on black gram [*Vigna mungo* (L.) Hepper]. Journal of Entomology and Zoology Studies. 7: 1083-1087.

Kumar, L (2016). Studies on insect pest complex of mungbean (*Vigna radiata* Linn.) and urdbean (*Vigna mungo* Linn.) along with their management in field and storage conditions. Ph.D. Thesis, GBPUAT, Pantnagar. 253-256 p.

Lal, S.S. and Sachan, J.N. (1987). Recent advances in pest management in pulses. Indian Farming. 37: 29-32 (1987).

Manjunath, G.N. (2014). Studies on population dynamics, varietal screening and management of spotted pod borer, Maruca vitrata (Geyer) in blackgram. M.Sc. Thesis, University of Agricultural Sciences, Dharwad.

Nene, Y. L. (2006). Indian pulses through the millennia. Asian Agri-history. 10: 179-202.

Patel, A. G (1997). Population dynamics, varietal screening and chemical control of pest complex of cowpea *(Vigna unguiculata* Walps)., M.Sc. Thesis, GAU, Sardarkushinagar.

Rathore, H. K., Vyas, A. K., Ahir, K. C., Saini, A., Kumar, P. (2017). Population dynamics of major insect pests and their correlation with weather parameters in pigeonpea (*Cajanus cajan* [L.] Mill Sp.). The Bioscan, 12: 01-04.

Reddy, C.N. (1998). Pest complex and their sucession on pigeonpea variety. Indian Journal of Entomology,. 60: 334-338.

Sarkar, P.K. and Roy, D. (2016). Incidence and bio-rational management of blackgram pod borer complex with lufenuron and its non-target toxicity. Green Farming. 7: 901-906.

Shivaraju, C., Ashok Kumar, C.T., Singh, S.K., Thippaiah, M. (2011). Seasonal incidence of pod borer complex on blackgram, *Vigna mungo* (L.). Journal of Entomological Research. 35: 39-42.

Sonune, V. R., Bharodia, R.K., Jethva, D. M., Dabhade, P.L. (2010). Seasonal incidence of spotted pod borer, *Maruca vitrata* on blackgram. Legume Research. 33: 61-63.

Sravani, D., Mahalakshmi, M.S., Sandhyarani, C., Kumari, V.P. (2015). Seasonal incidence of spotted pod borer,*Maruca vitrata* (Crambidae, Lepidoptera) on greengram under unsprayed conditions. International Journal of Pure Applied and Biosciences. 3: 152-158.

Tiwari, A.K. and Shivhare, A.K. (2016). Pulses in India: Retrospect and Prospectus. Published by Director, Govt. of India, Ministry of Agri. and Farmers Welfare, Directorate of Pulses Development, Vindhyachal Bhavan, Bhopal (M.P.).

Yadav, N.K. and Singh, P.S. (2015). Population dynamics of insect pests of mungbean [*Vigna radiata* (L.) Wilczek] in gangetic plains. Journal of Food Legumes. 28: 82-84.