

Seasonal incidence of pod fly, *Melanagromyza obtusa* (Malloch) on Pigeonpea in relation to abiotic factors

GD Hadiya¹, RK Thumar², DB Sisodiya³, AD Kalola⁴

¹ Agricultural Research Station, Anand Agricultural University, Derol, Gujarat, India

² Department of Nematology, B. A. College of Agriculture, AAU, Anand, Gujarat, India

³ Department of Agricultural Entomology, B. A. College of Agriculture, AAU, Anand, Gujarat, India

⁴ Department of Agricultural Statistics, B. A. College of Agriculture, AAU, Anand, Gujarat, India

Abstract

A field experiment was carried out to study the effect of abiotic factors on seasonal incidence of pod fly, *M. obtusa* on pigeonpea at Agricultural Research Station, Anand Agricultural University, Derol during *Kharif*, 2022-23 and 2023-24. In 2022-23, maggot population ranged from 0.05 to 0.92 maggot/pod and peak population was found in the 1st SMW, while pupal count ranged from 0.24 to 0.85 pupa/pod, with a peak in the 2nd SMW. Maximum pod (36.00%) and seed damage (44.75%) occurred in the 5th SMW. Pupal count was significant negative association with maximum temperature ($r = -0.632^*$) and significant positive association with evening relative humidity ($r = 0.672^*$). Pod damage was highly significant negative relationship with evaporation ($r = -0.861^{**}$) while, significant negative association with maximum temperature ($r = -0.785^*$). Seed damage was highly significant positive association with morning ($r = 0.797^{**}$) and evening relative humidity ($r = 0.762^{**}$) while, highly significant negative relationship with maximum temperature ($r = -0.839^{**}$) and evaporation ($r = -0.852^{**}$). In 2023-24, similar trends were observed, with peak maggot and pupal populations of 0.97 maggot/pod and 0.71 pupa/pod in the 2nd and 3rd SMW, respectively. Highest pod (37.67%) and seed damage (46.44%) was recorded in the 5th SMW. The maggot population showed highly significant negative association with evaporation ($r = -0.820^{**}$). However, it has significantly positive relationship with evening relative humidity ($r = 0.703^*$) and significant negatively correlation ($r = -0.603^*$ and -0.702^*) with maximum temperature and bright sunshine hours, respectively. Pupal incidence exhibited significant negative correlation with maximum temperature ($r = -0.645^*$). Highly significant negative association was observed between pod damage and minimum temperature ($r = -0.861^{**}$), while rainfall also exhibited a significant negative relationship ($r = -0.788^*$). Seed damage highly significant negative association with minimum temperature ($r = -0.820^{**}$) while, significant negative relationship with maximum temperature ($r = -0.713^{**}$).

Keywords: Pigeonpea, Pod Fly, *Melanagromyza obtusa*, Seasonal incidence, Abiotic factors

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is an important pulse crop and a major component of the vegetarian diet. It is a rich source of protein, enhances soil fertility through biological nitrogen fixation, and fits well into various cropping systems without disrupting main cereal and oilseed crops. Additionally, its plant residues serve as valuable fodder. In India, pigeonpea is cultivated over an area of 41.31 lakh hectares, with a total production of 34.17 lakh tonnes and a productivity of 827 kg/ha (Anonymous, 2024)^[1]. In Gujarat, the crop is grown on 2.64 lakh hectares, producing 2.27 lakh tonnes, with a productivity of 1163 kg/ha (Anon., 2024)^[1]. About 250 insect species belonging to 8 orders and 61 families are known to infest pigeonpea from the seedling to harvesting stages, with virtually no plant part remaining free from insect attack (Upadhyay *et al.*, 1998)^[11]. Among the pod borer complex, the pod fly, *M. obtusa* is the most noxious pest of pigeonpea across South-East Asia, causing seed damage varying from 20 to 80 per cent (Subharani and Singh, 2009)^[9]. Taxonomically, *M. obtusa* belongs to the family Agromyzidae under the order Diptera. It infests the crop from the pod filling stage to pod maturity. Owing to the damage caused by *M. obtusa*, the scientific research for the efficient management in pigeonpea ecosystem required to be reinforced. Prior to

formulating an insect-pest management strategy for a particular agroecosystem, it is necessary to have fundamental knowledge on the abundance and their distribution in relation to climatic factors, as this information aids in identifying the appropriate timing and suitable effective control measures. (Chakravarty and Agnihotri, 2017)^[3].

Materials and Methods

A field experiment on seasonal incidence of pod fly, *M. obtusa* on pigeonpea in relation to abiotic factors was carried out at Agricultural Research Station, Anand Agricultural University, Derol (Gujarat), India, during *Kharif* 2022-23 and 2023-24. Pigeonpea crop was sown in mid-July in the field at the spacing of 90 × 20 cm. All recommended agronomic practices were implemented to cultivate the crop. The crop was kept free from the application of any insecticide throughout the season. The entire plot was divided into five sectors having equal size (18 × 4.8 m). From each sector, five plants were randomly selected. After initiation of pod formation, three pods were collected randomly from each plant at weekly intervals till the harvest of the crop. Collected pods were brought to the laboratory. Based on the characteristic external symptoms ("Window" or exit pin-head like hole) damaged pods and

healthy pods were separated and accordingly per cent pod damage was calculated. Further, the pods were opened and their seeds were separated into healthy and damaged. Finally, healthy and damaged seeds were counted from each pod and based on this per cent seed damage per pod was calculated. From each pod, the number of maggots and pupae were counted. In order to investigate the influence of weather factors on population fluctuation of *M. obtusa* and their damage in pigeonpea, the data on abiotic parameters viz., maximum temperature (MaxT) and minimum temperature (MinT), morning relative humidity (RH1) and evening relative humidity (RH2), evaporation (EP), bright sunshine (BSS) and rainfall (RF) were correlated with the data on *M. obtusa* population and its damage. Week-wise data on various weather factors recorded at Agriculture Meteorological Observatory, Agricultural Research Station, AAU, Derol during 2022-23 and 2023-24 were utilized to work out correlation study.

Results and Discussion

Population of Pod Fly and Its Damage on Pigeonpea

Maggot: During the *Kharif*, 2022-23, the data on population of maggots are presented in Table 1 that commenced from 48th Standard Meteorological Week (SMW) i.e. 1st week of

December and persisted till 1st week of February (5th SMW) which was ranged from 0.05 to 0.92 maggot/pod. Population showed increasing trend from 1st week of December (48th SMW) and reached its highest peak (0.92 maggot/pod) during 1st week of January (1st SMW) and there after population started decreasing trend up to the 1st week of February (5th SMW). The data on maggot population (Table 2) for the *Kharif* season of 2023-24 revealed that the population emerged in the 48th SMW with 0.23 maggot per pod and declined to 0.08 maggot per pod by the 5th SMW. The incidence began to rise from the first week of December (48th SMW), reaching its peak (0.97 maggot/pod) in the second week of January (2nd SMW) and thereafter, the population exhibited a gradually declining trend until the first week of February (5th SMW). Chavan *et al.* (2018) [4] and Dhande *et al.* (2023) [5] reported that the occurrence of *M. obtusa* in pigeonpea was first observed during the 47th SMW. Ugale *et al.* (2024) [10] noted the initial presence of *M. obtusa* maggots in the 46th SMW and the population gradually increasing and attaining its maximum density in the second week of January. Similarly, Bhadani and Patel (2019) [2] recorded the peak occurrence of pod fly maggots in the 1st and 2nd SMW.

Table 1: Seasonal incidence of pod fly and its damage on pigeonpea (*Kharif*, 2022-23)

Month	SMW	No. of maggot/ Pod*	No. of pupa/ Pod**	Pod damage # (%)	Seed damage* (%)	Temperature (°C)		Relative Humidity (%)		BSS (hrs)	RF (mm)	EP (mm)
						Max.	Min.	RH1	RH2			
November- 2022	47	0.00	-	-	0.00	31.3	15.6	76.2	41.8	7.8	0.0	6.1
	48	0.21	0.00	-	6.25	29.6	12.4	71.7	34.8	7.9	0.0	5.6
December	49	0.43	0.24	0.00	11.26	30.4	13.1	79.6	41.2	8.5	0.0	6.3
	50	0.48	0.25	5.33	16.28	29.2	13.3	84.8	66.6	7.3	0.0	5.6
	51	0.53	0.29	13.33	19.46	31.0	16.0	83.4	67.2	8.2	0.0	6.1
	52	0.57	0.55	17.33	24.24	31.1	14.5	84.1	58.7	7.7	0.0	5.8
January- 2023	1	0.92	0.64	22.67	28.38	27.9	11.1	82.6	62.2	7.9	0.0	5.7
	2	0.75	0.85	26.67	34.78	26.7	11.5	84.4	70.5	8.1	0.0	4.3
	3	0.72	0.77	29.33	40.00	25.0	11.4	90.2	67.9	8.1	0.0	4.1
	4	0.27	0.74	33.33	42.37	26.9	10.9	82.0	62.5	8.4	0.0	4.5
February	5	0.05	0.39	36.00	44.75	26.2	11.3	91.3	65.4	6.4	0.0	4.1

(i) n - Total number of observations; *n=11, **n=10, # n=9 (ii) SMW- Standard Meteorological Week, Max-Maximum, Min-Minimum, RH1- Morning, RH2- Evening, BSS- Bright Sunshine hours, RF- Rainfall and EP- Evaporation

Pupa: During *Kharif*, 2022-23, the data on pupal count are represented in Table 1 indicated that the pupal count first appeared in the 49th SMW (2nd week of December) and remained until the 1st week of February (5th SMW), fluctuating from 0.24 to 0.85 pupa per pod. The pupa count showed an increasing trend from the 2nd week of December (49th SMW), reaching the highest peak (0.85 pupa/pod) during the 2nd week of January (2nd SMW), followed by a gradual decline until the 1st week of February (5th SMW). The data on pupal count (Table 4.2) showed that it first appeared in 49th SMW [(0.32 pupa/pod) (Second week of December)] during *Kharif*, 2023-24. Afterwards, the population gradually increased and reached peak (0.71 pupa/pod) in 3rd SMW (3rd week of January). Subsequently, the incidence of pupa gradually diminished reaching its minimal level (0.53 pupa/pod) at 5th SMW (first week of February). Earlier, Patange *et al.* (2017) found that the pupa

count of the pod fly peaked in the 4th SMW in pigeonpea which closely aligns with the present study.

Pod damage: During *Kharif* 2022-23, the data on per cent pod damage (Table 1) was first observed in the 50th SMW (3rd week of December) 5.33 per cent and continued until the 1st week of February (5th SMW), reaching a maximum of 36.00 per cent. The pod damage percentage exhibited a steadily increasing trend, reaching its highest level in the 1st week of February (5th SMW). The data on per cent pod damage due to pod fly during *Kharif*, 2023-24 (Table 2) showed an initial infestation (6.67%) in the 3rd week of December (50th SMW) and persisted until the first week of February (5th SMW). The extent of pod damage followed a consistent upward trend, attaining its maximum level (38.67%) in the first week of February (5th SMW). Patange *et al.* (2017) [7] reported that pod damage was highest during the 4th SMW.

Table 2: Seasonal incidence of pod fly and its damage on pigeonpea (*Kharif*, 2023-24)

Month	SMW	No. of maggot/ Pod*	No. of pupa/ Pod**	Pod damage # (%)	Seed damage* (%)	Temperature (°C)		Relative Humidity (%)		BSS (hrs)	RF (mm)	EP (mm)
						Max.	Min.	RH1	RH2			
November- 2023	47	0.00	-	-	0.00	34.0	18.2	86.3	35.6	8.1	0.0	6.2
December	48	0.23	0.00	-	7.22	32.4	16.9	84.2	48.0	7.1	0.0	5.8
	49	0.35	0.32	0.00	13.67	28.9	17.7	87.9	65.0	6.3	25.0	5.0
	50	0.63	0.24	6.67	18.24	27.2	18.8	88.9	71.8	2.2	9.0	1.4
	51	0.52	0.35	16.00	23.18	29.4	16.0	84.9	58.8	7.1	0.0	3.6
	52	0.65	0.56	20.00	27.27	28.1	15.5	81.1	57.8	5.9	0.0	3.1
January- 2024	1	0.77	0.53	24.00	32.23	29.7	15.2	85.8	57.9	7.2	0.0	3.6
	2	0.97	0.67	29.33	36.03	26.2	14.6	93.6	67.5	4.5	0.0	2.4
	3	0.79	0.71	32.00	41.03	28.7	15.8	89.3	74.1	4.4	0.0	2.5
	4	0.24	0.64	36.00	43.15	28.0	11.0	82.0	53.9	8.5	0.0	4.3
February	5	0.08	0.53	38.67	46.44	28.1	10.0	84.9	59.8	8.8	0.0	4.5

(i) n - Total number of observations; *n=11, **n=10, # n=9 (ii) SMW- Standard Meteorological Week, Max-Maximum, Min-Minimum, RH1- Morning, RH2- Evening, BSS- Bright Sunshine hours, RF- Rainfall and EP- Evaporation

Seed damage: During *Kharif*, 2022-23, the per cent seed damage as depicted in Table 1, was initially recorded in the 48th SMW (1st week of December) 6.25 per cent and persisted until the 1st week of February (5th SMW), reaching a peak of 44.75 per cent. The extent of per cent seed damage followed a progressive upward trend, with the maximum level of damage observed in the 1st week of February (5th SMW). The data on per cent seed damage during *Kharif*, 2023-24 (Table 2) found an initial infestation from 48th SMW (1st week of December) and succeeded till 1st week of February (5th SMW) which varied between 7.22 to 46.44 per cent. The maximum (46.44%) seed damage was recorded during 1st week of February (5th SMW). Patange *et al.* (2017) [7] reported that pod fly induced seed damage was the highest during the 4th SMW. Similarly, Srinivas *et al.* (2019) [8] observed that seed damage first appeared in the 44th SMW and persisted until the 8th SMW, with the most severe impact occurring at the 8th SMW. These findings closely correspond with those of the present study.

Correlation of Pod Fly and its Damage on Pigeonpea in Relation to Weather Parameters

Maggot: Correlation coefficient data between incidence of maggots and weather factors during *Kharif*, 2022-23 presented in Table 3 revealed that morning relative humidity, evening relative humidity and bright sunshine showed non-significant positive association (with ‘r’ values 0.309, 0.512 and 0.372, respectively). Maximum temperature, minimum temperature and evaporation exhibited non-significant negative association (r = -0.244, -0.245 and -0.053, respectively). In *Kharif*, 2023-24, the correlation study between maggots and weather factors presented in Table 3 indicted that all parameters under investigation showed significant impact on the incidence of maggots except minimum temperature, relative humidity

and rainfall. Maggot population showed highly significant negative association (r = -0.820**) with evaporation. Whereas, maggot population found significantly positive correlation (r = 0.703*) with evening relative humidity and significant negative relationship (r = -0.603* and -0.702*) with maximum temperature and bright sunshine hours, respectively. However, it exhibited a non-significant positive association with minimum temperature (r = 0.163) and morning relative humidity (r = 0.510), while rainfall showed a non-significant negative correlation (r = -0.071). Bhadani and Patel (2019) [2] who reported a significant negative correlation between the pod fly maggot and maximum temperature. Patange *et al.* (2017) [7] reported a maggot population exhibited a significant negative association with maximum temperature and evaporation and non-significant positive correlation with evening relative humidity. Additionally, non-significant negative correlation between maggot density and rainfall as well as minimum temperature. Srinivas *et al.* (2019) [8] found that maggot population exhibited a significant negative relationship with mean temperature. Ugale *et al.* (2024) [10] pod fly populations exhibited a highly significant negative association with minimum temperature and non-significant negative correlations were recorded for maximum temperature. However, non-significant positive correlation was observed between maggot population and morning relative humidity and bright sunshine hours. Harshita *et al.* (2022) [6] reported that non-significant negative relationship was observed between the pod fly maggot population and maximum temperature, minimum temperature and rainfall. However, the maggot population exhibited a non-significant positive correlation with morning relative humidity. Dhande *et al.* (2023) [5] revealed that non-significant negative correlation was found between pod fly population and rainfall.

Table 3: Correlation coefficient between weather parameters and pod fly and its damage on pigeonpea

Weather Parameters Pod fly incidence and its damage	Year	n	Temperature (°C)		Relative Humidity (%)		BSS (hrs)	RF (mm)	EP (mm)
			Max.	Min.	RH1	RH2			
Maggot/Pod	2022-23	11	-0.244	-0.245	0.309	0.512	0.372	-	-0.053
	2023-24		-0.603*	0.163	0.510	0.703*	-0.702*	-0.071	-0.820**
Pupa/Pod	2022-23	10	-0.632*	-0.478	0.541	0.672*	0.204	-	-0.615
	2023-24		-0.645*	-0.566	0.157	0.371	0.045	-0.326	-0.416
Pod damage (%)	2022-23	9	-0.785*	-0.643	0.598	0.569	-0.286	-	-0.861**
	2023-24		-0.161	-0.861**	-0.142	-0.259	0.456	-0.788*	0.082
Seed damage (%)	2022-23	11	-0.839**	-0.689*	0.797**	0.762**	-0.208	-	-0.852**
	2023-24		-0.713*	-0.820**	0.018	0.524	0.049	-0.326	-0.481

(i)*Correlation is significant at the 0.05 level (2-tailed) (ii)** Correlation is significant at the 0.01 level (2-tailed) (iii) SMW- Standard Meteorological Week, Max-Maximum, Min-Minimum, RH1- Morning, RH2- Evening, BSS- Bright Sunshine, RF- Rainfall, EP- Evaporation (iv) n - Total number of observations

Pupa: The correlation data between pupal count and weather parameters during *Kharif*, 2022-23 revealed that maximum temperature showed a significant negative association ($r = -0.632^*$) and evening relative humidity observed significant positive association ($r = 0.672^*$). While, the pupal count exhibited a non-significant positive correlation with both morning relative humidity ($r = 0.541$) and bright sunshine hours ($r = 0.204$). The abiotic factors *viz.*, minimum temperature and evaporation had non-significant negative relationship (with 'r' values -0.478 and -0.615, respectively) with pupal count (Table 3). The correlation coefficient data during *Kharif*, 2023-24 exhibited that pupal incidence shows significant negative correlation with maximum temperature ($r = -0.645^*$) while, non-significant positive correlation with morning relative humidity, evening relative humidity and bright sunshine hours ($r = 0.157, 0.371$ and 0.045 , respectively). The remaining weather factors *viz.*, minimum temperature ($r = -0.566$), rainfall ($r = -0.326$) and evaporation ($r = -0.416$) found non-significant negative association with pupal count (Table 3). Patange *et al.* (2017) [7] pupal count exhibited a non-significant negative association with rainfall, minimum temperature and evaporation. However, pupal population showed non-significant positive correlation with evening relative humidity. Ugale *et al.* (2024) [10] reported that pupal count of pod fly exhibited negative correlations with both maximum and minimum temperature. However, the relationships between bright sunshine hours and the pupal population were found to be statistically non-significant.

Pod damage: The correlation analysis (Table 3) between per cent pod damage and weather parameters during *Kharif*, 2022-23 indicated that highly significant negative relationship with evaporation ($r = -0.861^{**}$). Significant negative correlation was observed between maximum temperature and per cent pod damage ($r = -0.785^*$). The data on correlation between per cent pod damage and weather parameters recorded during *Kharif*, 2023-24 showed that minimum temperature ($r = -0.861^{**}$) had a highly significant negative correlation while, rainfall ($r = -0.788^*$) had significant negative association with per cent pod damage. The abiotic factors *viz.*, bright sunshine hours and evaporation ($r = 0.456$ and 0.082 , respectively) registered non-significant positive association whereas, maximum temperature ($r = -0.161$), morning relative humidity ($r = -0.142$) and evening relative humidity ($r = -0.259$) found non-significant negative association with the per cent pod damage (Table 3). Patange *et al.* (2017) [7] stated that pod damage showed a non-significant negative relation, with maximum temperature, morning relative humidity and evening relative humidity. Whereas, significant negative relation was observed between pod damage and maximum temperature as well as rainfall. Chavan *et al.* (2018) [4] found that significant negative relationship between minimum temperature and pod damage. These reports are in alignment with the current findings on the correlation between pod damage and weather parameters.

Seed damage: During *Kharif*, 2022-23, morning relative humidity ($r = 0.797$) and evening relative humidity ($r = 0.762^{**}$) showed a highly significant positive correlation with per cent seed damage. In contrast, maximum temperature ($r = -0.839^{**}$) and evaporation ($r = -0.852^{**}$) exhibited highly significant negative associations with seed

damage. In contrast, the abiotic factors minimum temperature ($r = -0.689^*$) found a significant negative relationship and bright sunshine hours ($r = -0.208$) demonstrated a non-significant negative relationship with per cent seed damage (Table 3). During *Kharif*, 2023-24, a highly significant inverse correlation was observed between per cent seed damage and minimum temperature ($r = -0.820^{**}$). Additionally, maximum temperature ($r = -0.713^*$) revealed a significant negative association with per cent seed damage. However, non-significant positive relationship was observed with morning and evening relative humidity and bright sunshine hours ($r = 0.018, 0.524$ and 0.049 , respectively), whereas rainfall and evaporation ($r = -0.326$ and -0.481) showed a non-significant negative relationship with per cent seed damage (Table 3). Patange *et al.* (2017) [7] observed that significant negative correlation between seed damage and maximum temperature. Srinivas *et al.* (2019) [8] concluded that seed damage exhibited significant negative relationship with minimum temperature, mean temperature and rainfall.

Conclusion

Based on the two years of field experimentation, it can be concluded that the seasonal occurrence study revealed the incidence of pod fly on pigeonpea started from first week of December and persisted till first week of February. Peak activity of pod fly was observed during the 2nd to 4th week of January while revealed in the highest pod and seed damage observed in the first week of February (5th SMW). During first year pupal population and pod damage were significantly negative relationship with maximum temperature, while pod damage and seed damage was highly significant negative association with evaporation. Seed damage had also found highly significant negative relationship with maximum temperature while, highly significant positively associated with morning and evening relative humidity. During second year, maggot population exhibited a highly significant negative association with evaporation and positive association with evening relative humidity. It also showed a significant negative association with maximum temperature and bright sunshine hours. Pupal incidence remained significantly negative correlated with maximum temperature. Pod damage had highly significant negative associated with minimum temperature whereas, significantly negative association with rainfall. A highly significant negative relationship was observed between seed damage and minimum temperature, while the association with maximum temperature was also significantly negative.

Conflict of Interest

The authors declare that there are no conflicts of interest associated with this work.

Acknowledgement

The authors are thankful to the Director of Research and Dean Post Graduate Studies, Anand Agricultural University (AAU), Anand for providing all the necessary facilities and encouragement during the present research work. The authors also extend their gratitude to the Unit Head, Agricultural Research Station, AAU, Derol for offering the essential facilities and support throughout the course of the study. The authors are also grateful to Professor and Head, Department of Agricultural Statistics, BACA, AAU, Anand

for the help rendered in data analysis and interpretation of result.

References

1. Anonymous. Selected State-wise Area, Production and Productivity, 2024. <https://www.indiastatagri.com/table/agriculture/selected-state-wise-area-production-productivity-a/1456845>
2. Bhadani DJ, Patel JJ. Seasonal incidence of pod fly, *Melanagromyza obtusa* infesting pigeonpea. International Journal of Pure Applied Bioscience, 2019;7(2):44–50.
3. Chakravarty S, Agnihotri M. Seasonal incidence and natural parasitization of leaf webber, *Pammene critica* (Meyrick) (Lepidoptera: Tortricidae) on pigeonpea. Environment and Ecology, 2017;35(1):128–133.
4. Chavan AP, Chavan KA, Latake SB, Kute NS, Mhase LB, Rangari PS. et al Incidence and damage severity of pod borers complex in pigeonpea. International Journal of Agriculture Sciences, 2018;10(18):7141–7144.
5. Dhande MR, Rode NS, Pawar SR. Studies on seasonal incidence of major insects of pigeonpea in Jalna district, Maharashtra. The Pharma Innovation Journal, 2023;12(9):563–567.
6. Harshita AP, Gopali JB, Ramanagouda SH, Basavaraja N, Rudresh DL, Mulla SR. et al Seasonal incidence of major insect-pests infesting vegetable pigeonpea. The Pharma Innovation Journal, 2022;11(3):23–26.
7. Patange NR, Chiranjeevi B, Manickavasagam S. Impact of weather parameters on parasitoids of pigeonpea pod fly, *Melanagromyza obtusa* (Malloch). The Bioscan, 2017;12(1):29–31.
8. Srinivas G, Sushil Kumar, Patel NM. Seasonal abundance of pod fly *M. obtusa* and seed damage on pigeonpea in relation to weather factors and cropping systems. Journal of Entomology and Zoology Studies, 2019;7(1):1404–1408.
9. Subharani S, Singh TK. Yield loss assessment and economic injury level of pod borer complex in pigeonpea. Annals of Plant Protection Sciences, 2009;17:299–302.
10. Ugale MV, Bantewad SD, Gore SH. Seasonal incidence of major insect-pests of pigeonpea in relation to weather parameters. International Journal of Advanced Biochemistry Research, 2024;8(12):396–401.
11. Upadhyay RK, Mukerji KG, Rajak RL. IPM system in Agriculture, 4 pulses. New Delhi, 1998, 99.