International Journal of Economic Plants

https://ojs.pphouse.org/index.php/IJEP

Crossref

IJEP February 2024, 11(1): 001-006

Article IJEP5076b

Full Research

Doi: HTTPS://DOI.ORG/10.23910/2/2024.5076b

Impact of Abiotic Factors on Occurrence of Capsule Borer and Sucking Pests in Sesamum

P. Divya[1*], S. Dhurua[2], M. S. V. Chalam[1], S. Govinda Rao[3] and Gummadidala Chaitanya[4]

[1]Dept. of Entomology, S. V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh (517 502), India

[2]Dept. of Entomology, Agricultural College, Naira, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh (532 185), India

[3]Dept. of Statistics and Computer Applications, Agricultural college, Naira, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh (532 185), India

[4]Dept. of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India

Corresponding Author

P. Divya

e-mail: divyaponnangi97@gmail.com

Article History

Received on 20th December, 2023

Received in revised form on 24th January, 2024

Accepted in final form on 19th February, 2024

Abstract

A field experiment was conducted at Agricultural college, Naira, Srikakulam, Andhra Pradesh, India during early summer (January–April) of 2021 to know about the incidence of leaf webber and sucking pests viz., leafhopper (*Hishimonus phycitis* Distant) and whitefly (*Bemisia tabaci* Gennadius) its relation with main weather factors. Results revealed that a peak incidence of mean capsule borer population per plant were recorded in 9th and 11th standard weeks, respectively. The correlation study revealed that the *Antigastra* larvae had significantly positive correlation with maximum temperature (r=0.48) and significantly negative correlation with relative humidity (r=- 0.71). The regression analysis revealed that these factors accounted for approximately 59.8% of the variation in the capsule borer population (R^2=0.598). The incidence of leafhopper (*Hishimonus phycitis* Distant) and whitefly (*Bemisia tabaci* Gennadius) were started during 5th and 4th SMW attained their peaks during 11th an 12th SMW respectively. The correlation study revealed that the leafhopper showed significant positive correlation with maximum temperature (r=0.623) and minimum temperature (r=0.283) and significantly negatively correlated with morning and evening relative humidity (r=-0.165, r=-0.122) respectively. While the correlation study between whitefly population and weather parameters revealed that the it showed positive correlation with maximum (r=0.821) and minimum (r=0.120) temperature and negatively correlated with morning and evening relative humidity (r=-0.097, r=-0.182) respectively whereas, rainfall showed non-significant correlation (r=0.00) with the both sucking pests.

Keywords: Antigastra, correlation, leaf hopper, standard week, regression, white fly

1. Introduction

Sesamum (*Sesamum indicum* L.) a vital oilseed crop, holds global significance due to its cultivation across both tropical and temperate regions. Belonging to the Pedaliaceae family, this crop is renowned for its oil-rich seeds with diverse applications. It is a short duration crop (90-100 days), and with two distinct types of seeds *viz.,* white and black and both yield edible oil. Sesame is attacked by many insect pests such as shoot and capsule borer, sesame gall fly, leaf hoppers, hawk moth, aphids, thrips, pod bugs etc. (Dilipsundar et al., 2019) Notably, India takes the lead as the world's largest sesame producer, boasting a substantial cultivation area. The annual expanse dedicated to sesame cultivation in India spans about 1.79 mha, contributing to 45% of the global cultivation area (Anonymous, 2019 and 2017). the major constraint is the damage by insect pests (Kefale et al., 2021; Rao et al., 2013;), This effort yields a total production of 802,000 tonnes in the country, with a productivity rate of 448 kg ha^{-1} (Anonymous, 2019) In the specific case of Andhra Pradesh, sesame occupies 61,000 ha of cultivation area, yielding 20,000 t and achieving a productivity of 321 kg ha^{-1} (Anonymous, 2019).

significant challenges arise from the menace of leaf webber and capsule borer, particularly the *Antigastra catalaunalis* species, which relentlessly afflict sesame plants. The ramifications are stark, with potential yield losses reaching a staggering ninety percent. Virtually all plant parts, except the root, fall victim to these pests. At the initial stages of growth, the caterpillars exhibit their destructive nature by binding tender leaves together while feeding (Gangwar et al., 2014; Choudhary et al., 2015). Damage from insect pests ranged from 5% to 50% of the total sesame production. Insects reduce about 25% of the potential yield of sesame in the world. There are a number of pests known attacking sesame. Among various insect pests responsible for the low productivity of sesame, the insect pests associated with flowering phase usually inflicts very severe damage to the crop. Piercing sucking insects have great economic importance to sesame plants (Kinati, 2017; Roy, 2021). Given the paramount role of abiotic environmental factors in influencing insect pest populations, it becomes imperative to forecast larval population for each standard week based on prevailing weather conditions. Intriguingly, sesamum contends with over 67 species of insect pests during various phases of its growth cycle (Bondre et al., 2016 ;Ahirwar et al., 2009). The likes of Leafhopper (*H. phycitis* Distant) and whitefly (*B. tabaci* Gennadius) are sap-sucking culprits that inflict damage on leaves, flowers, and pods. The aftermath manifests as leaf margins curling downwards, stunted plant growth, and eventual yield reduction. (Wazire and Patel, 2016; Myint et al., 2020) and additionally, Leafhoppers and whiteflies act as vectors for phyllody and leaf curl diseases in sesamum, respectively (Biswas and Das, 2011; Thangjam and Vastrad, 2015; Piploda et al., 2023). Nymphs and adults of *O. albicinctus* and *B. tabaci* suck the plant sap in addition to transmitting phyllody and leaf curl diseases. This wealth of insight aids in comprehending population dynamics and determining appropriate spray treatments. Taking these multifaceted factors into account, the current study seeks to delve into the influence of abiotic factors on the population dynamics of *A. catalaunalis* and the complex of sap-sucking pests (Mishra et al., 2015; Kumar et al., 2023; Kumar et al., 2012b) This investigation occurs in natural conditions within the premises of the Agricultural College situated in Naira, located within Andhra Pradesh's Srikakulam district, positioned in the North coastal zone.

2. Materials and Methods

2.1. Study sites

The experiment was carried out during early summer (January–April) of 2021, Srikakulam, Andhra Pradesh, India. The study was focused on studying the incidence of larvae in the YLM-66 variety of plants. The observations were made weekly, starting from the first week after sowing and continuing until harvest, on a 200 m^2 bulk plot without any insecticidal treatment. The YLM-66 variety was sown in the second fortnight of January, with a spacing of 30 cm between rows and 10 cm between plants, following recommended agronomic practices. To gather data on the incidence of capsule borer, 10 plants were randomly selected from 10 different spots within the plot. The number of larvae present on each of these selected plants was recorded, and the mean pest population per plant was calculated by averaging the counts. Additionally, the experiment collected weather parameters such as temperature, relative humidity, and rainfall. The collected data on the pooled pest population (number of larvae).

2.2. Method of data collection

On the Incidence sucking pests (leafhopper and white fly) were recorded by (2+1+2) method i.e. two upper leaves, one middle leaf and two lower leaves of randomly selected 10 plants from 10 spots of plot and mean pest population was computed per plant. Capsule borer population was computed by recording the larval number in each capsule. The analysis involved conducting a simple correlation to examine the relationship between the pest population and weather parameters. Furthermore, a multiple linear regression was performed to assess the combined influence of temperature, relative humidity, and rainfall on the pest population.

3. Results and Discussion

3.1. Impact of abiotic factors on occurrence of capsule borer

From the table 1 and Figure 1 it was clear that the incidence of capsule borer started initially during 5^{th} standard meteorological week *i.e.* 15 days after sowing with mean population of 1.1 larvae per plant. The maximum and minimum temperatures on an average prevailed during 5^{th} standard week were 30^0C and 18.2^0C, whereas, the average morning and evening relative humidity were 86.2 and 50.8 per cent respectively, and the rainfall recorded was 0.0 mm. A peak incidence of mean capsule borer population per plant *i.e.,* 4.5–4.6 larvae were recorded in 9^{th} and 11^{th} standard weeks, respectively, during which period maximum, minimum temperature were 36.7˚C, 36˚C, and 21.7˚C, 22.5˚C respectively and the average morning and evening relative humidity were 83.5 82.2% and

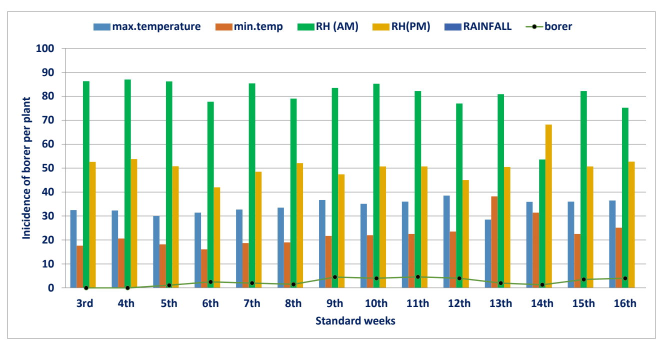

Figure 1: Influence of weather factors on incidence capsule borer (*Antigastra catalaunalis*) in sesamum crop

47.4, 50.7%, while, rainfall was 0.0 mm. This shows capsule borer incidence was increased with increase in maximum and minimum temperatures and relative humidity and rainfall has a non-significant effect on incidence of borer population. The current findings corroborated with the findings of Kumar et al. (2012b), Basha (2016) and Piploda et al. (2023) who observed that *A. catalaunalis* had a negative association with morning relative humidity, a positive correlation with

Table 1: Influence of abiotic factors on the incidence of Capsule borer (*Antigastra catalaunalis*) in sesamum crop during *rabi*, 2020–21

SMW	Temperature (˚C)		RH (%)		Rainfall (mm)	Average number of larvae plant^{-1}	Avg. number of sucking pest population plant^{-1}	
	Max temp	Min temp	RH (AM)	RH (PM)			Leafhopper plant^{-1}	Whitefly plant^{-1}
4th	32.3	20.6	87.0	53.8	0.0	0.0	0.0	5.0
5th	30.0	18.2	86.2	50.8	0.0	1.1	2.0	7.0
6th	31.4	16.1	77.7	42.0	0.0	2.5	4.0	10.0
7th	32.7	18.7	85.4	48.5	0.0	2.0	5.0	12.0
8th	33.5	19.0	79.0	52.1	0.0	1.5	3.3	9.0
9th	36.7	21.7	83.5	47.4	0.0	4.5	6.0	12.0
10th	35.1	22.0	85.2	50.7	0.0	4.0	5.0	10.0
11th	36.0	22.5	82.2	50.7	0.0	4.6	6.5	16.0
12th	38.5	23.5	77.0	45.0	0.0	4.0	7.2	17.0
13th	28.5	38.2	80.9	50.5	0.0	2.0	0.0	0.0
14th	35.9	31.4	53.6	68.2	0.0	1.3	0.0	0.0
15th	36.0	22.5	82.2	50.7	0.0	3.5	0.0	0.0
16th	36.5	25.1	75.2	52.7	0.0	4.0	0.0	0.0

maximum temperature.

The data corresponds to correlation for the assessment of relationship between the borer population and the abiotic factors are presented in Table 2 and Figure 2. Among the five parameters correlated with borer population, rainfall (r=0.000) showed non-significant correlation, morning and evening relative humidity (r=-0.436 and r=-0.078 respectively) showed negative correlation with the borer population, while the maximum temperature (r=0.729) and minimum temperature (r=0.333) were positively correlated with *A. catalaunalis* population. The present results were in line with the who observed the positive correlation between temperature and *A. catalaunalis* population.

The data on the occurrence of borer population was subjected to multiple linear regression analysis and results are presented

Table 2: Simple correlation between abiotic factors and capsule borer (*Antigastra catalaunalis*) population in Sesamum crop during *rabi*, 2020–21

Abiotic (Weather parameters)	Correlation coefficient (r)
X_1-Maximum temperature (°C)	0.729
X_2-Minimum temperature (°C)	0.333
X_3-Morning relative humidity (%)	-0.436
X_4-Evening relative humidity (%)	-0.078
X_5-Rainfall (mm)	0.000

**p*=0.05

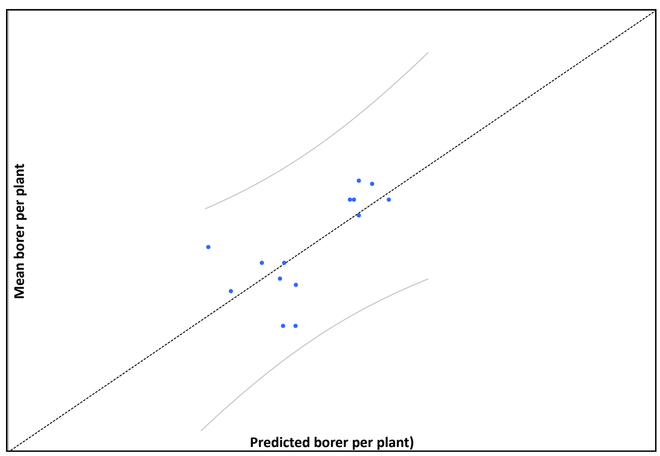

Figure 2: Distribution plot depicting the mean Capsule borer (*Antigastra catalaunalis*) plant^{-1}

in Table 3 and Figure 3. The results of the analysis revealed that the abiotic factors were able to cause variation in the incidence of *A. catalaunalis* to the extent of 59.8% (R^2=0.598) out of which the maximum temperature (r=0.729) and the minimum temperature (r=0.333) showed significant positive correlation, whereas, morning and evening RH (r=- 0.436), (r=-0.078) showed significant negative influence on the population of *A. catalaunalis.*

Based on the a fore mentioned study, several conclusions were drawn. Firstly, the incidence of capsule borer in sesame plants was observed to commence during the 5th standard meteorological week. Additionally, peak incidences of the mean capsule borer population per plant were recorded

Table 3: Multiple linear regression between abiotic factors and capsule borer (*Antigastra catalaunalis*), population in Sesamum crop during *rabi*, 2020–2021

Variable	Partial regression coefficient	Standard error	t- value
X_1-Maximum temperature (°C)	0.513	0.318	1.614
X_2-Minimum temperature (°C)	-0.123	0.263	-0.469
X_3-Morning relative humidity (%)	-0.101	0.123	-0.822
X_4-Evening relative humidity (%)	-0.038	0.064	-0.601
X_5-Rainfall (mm)	0.000	1.299	0.000
Regression equation	4.345+(0.513) X_1+X_2 (-0.123)+(-0.101)+X_3 (-0.038)+X_4 (0.000) X_5+1.299		
Intercept (A)		4.345	
R^2 value		0.598	
Adjusted R^2 value		0.359	

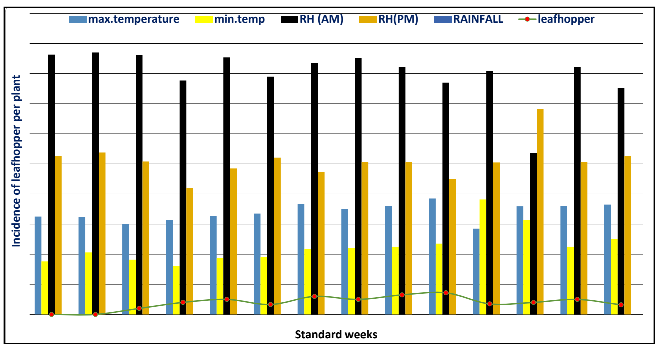

Figure 3: Influence of weather factors on incidence of leafhopper (*Hishimonus phycitis*) in sesamum crop

during the 9th and 11th standard weeks. Through the correlation analysis, it was determined that there was a significant positive correlation between the presence of *Antigastra* larvae and maximum temperature (r=0.48). Conversely, a significant negative correlation was found between the larvae and relative humidity (r=-0.71). Furthermore, multiple regression analysis was conducted to assess the collective impact of significant abiotic factors on the capsule borer population The present results were with the findings from Thakur et al. (2019) and Kumar et al. (2012b) who observed the positive correlation between temperature and *A. catalaunalis* population.

The analysis revealed that these factors accounted for approximately 59.8% of the variation in the capsule borer population (R^2=0.598). To summarize, the study indicated that the incidence of capsule borer in sesame plants begins around the 5th week, with peak incidences occurring in the 9th and 11th weeks. The presence of Antigastra larvae exhibited a positive correlation with maximum temperature and a negative correlation with relative humidity. Moreover, the combined effect of significant abiotic factors accounted for 59.8% of the variation in the capsule borer population.

3.2. Impact of abiotic factors on occurrence of capsule borer and sucking pests

Pooled data of weather parameters and incidence of major sucking pests of sesamum during *rabi,* 2020–21 presented in Table 1 indicated that incidence of sucking pests *i.e.* leafhopper and whitefly were started during 5th and 4th SMW (2/plant, 5/plant) including both nymph and adult population respectively and they were peak at 11th and 12th SMW during (6.5–7.2 / plant, 16–17/plant) respectively where the temperatures were high in respective standard weeks. Correlation data of sucking pests leafhopper and whitefly population with abiotic factors *viz.*, minimum, maximum temperature, relative humidity and rainfall is given in Table 4 and 5 and Figure 4 and 5. There was a significant and negative correlation was observed between

Table 4: Correlation of sucking pests population of sesamum with meteorological factors

Sucking pests	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Max temp	Min temp	RH (AM)	RH (PM)	
Leafhopper	0.623	0.283	-0.165	-0.122	0.000
Whitefly	0.821	0.120	-0.097	-0.182	0.000

**p*=0.05

Table 5: Multiple linear regression between abiotic factors and leaf hopper (*Hishimonus phycitis*) population in Sesamum crop during rabi, 2020–2021

Variable	Partial regres-sion coefficient	Standard error	t- value
X_1-Maximum temperature (°C)	0.923	0.526	1.448
X_2-Minimum temperature (°C)	-0.183	0.356	-0.514
X_3-Morning relative humidity (%)	-0.165	0.166	-0.991
X_4-Evening relative humidity (%)	-0.122	0.087	-1.412
Rainfall (mm)	0.000	1.759	0.000
Regression equation	4.542+(0.923)X_1+(-0.183)X_2+(-0.165+X_3(-0.122)X_4+(0.000) X51.759		
Intercept (A)		4.542	
R^2 value		0.593	
Adjusted R^2 value		0.166	

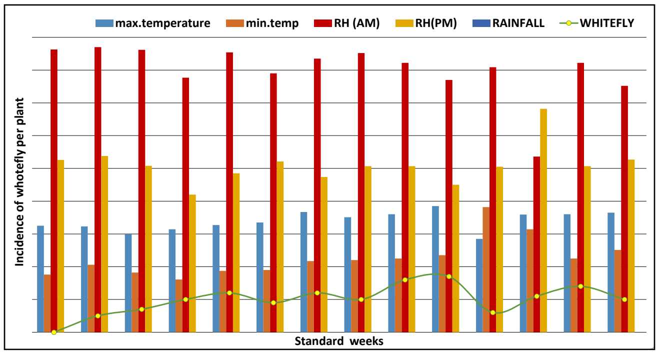

Figure 4: Influence of weather factors on incidence whitefly (*Bemisia tabaci*) in sesamum crop

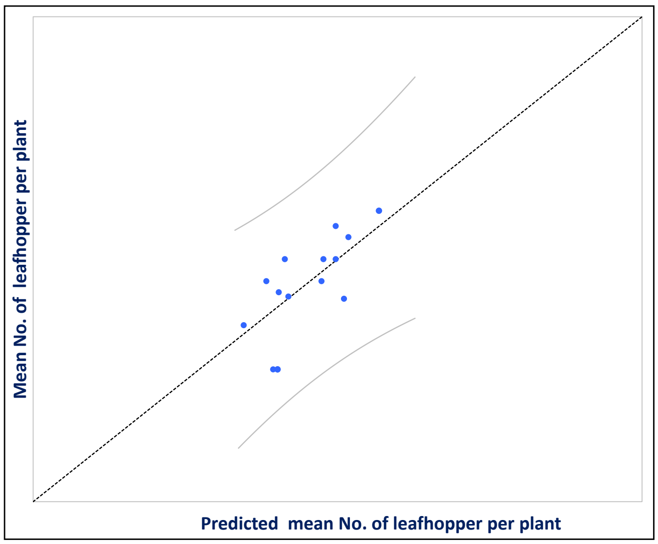

Figure 5: Distribution plot depicting the mean leafhopper (*Hishimonus phycitis*) plant^{-1}

sucking pest population and relative humidity. However, they had significant and positive correlation with maximum temperature and minimum temperature. Rainfall showed non-significant relation with the sucking pest population. Table 4 and 5 clearly indicated that the abiotic factors were able to cause variation in the incidence of leafhopper to the extent of 59.3 per cent (R^2=0.593) out of which the maximum temperature (r=0.923) showed significant positive correlation and the minimum temperature (r=-0.183), morning and evening relative humidity (r=-0.165), (r=-0.122) showed significant negative influence on the population of leafhopper. As well as abiotic factors were able to cause variation in the incidence of *B. tabaci* to the extent of 44.6 per cent ($R^{2=}$0.446) out of which the maximum temperature (r=0.821) and the minimum temperature (r=0.120) showed significant positive correlation with the *B.tabaci* population. Whereas, morning and evening RH (r=-0.097), (r=-0.182) showed significant negative influence on the population of whitefly (Table 6 and Figure 6).

Mishra et al. (2011), Kumar et al. (2012) and Piploda et al. (2023) also revealed that the sucking pests viz., leafhopper and whitefly population in sesamum showed significant positive correlation with the maximum and minimum temperatures, where as negatively correlated with morning and evening relative humidity.

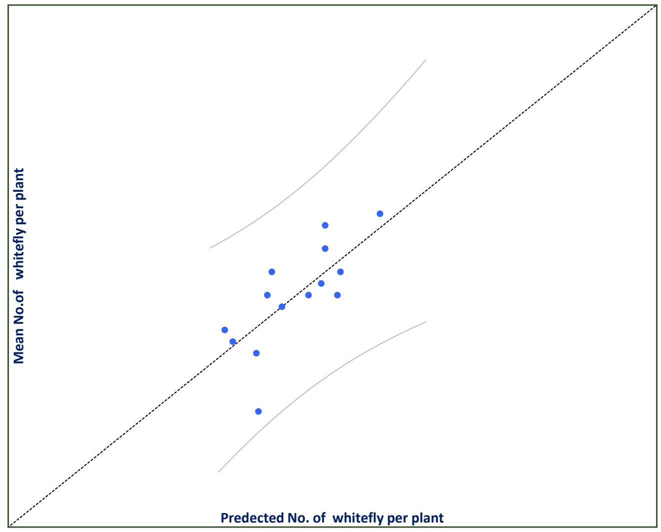

Figure 6: Distribution plot depicting the mean whitefly (*Bemisia tabaci*) plant^{-1}

Table 6: Multiple linear regression between abiotic factors and whitefly (*Bemisia tabaci*), population in sesamum crop during *rabi*, 2020-2021

Variable	Partial regression coefficient	Standard error	t- value
X_1-Maximum temperature (°C)	1.123	1.041	1.079
X_2-Minimum temperature (°C)	-0.437	0.861	-0.508
X_3-Morning relative humidity (%)	-0.272	0.402	-0.677
X_4-Evening relative humidity (%)	-0.294	0.210	-1.400
X_5-Rainfall (mm)	0.000	4.252	0.000
Regression equation	$18.010+X_1(1.123)+X_2(-0.437)+X_3(-0.272)+X_4(-0.294)+(0.000)X_5+4.252$		
Intercept (A)	18.010		
R^2 value	0.446		
Adjusted R^2 value	0.269		

4. Conclusion

As per the studies sucking pests i.e. Leafhopper (*H. phyciti*) and white fly (*B. tabaci*) and capsule borer *A. catalaunalis* had a significant and negative correlation between pest population and relative humidity. While, they had significant and positive correlation with maximum temperature and minimum temperature. The abiotic factors were able to cause variation in the incidence of leafhopper of 59.3% and in whitefly it is up to the extent of 44.6%. 59.8% of the variation in the capsule borer population.

5. References

Ahirwar, R.M., Gupta, M.P., Smita, B., 2010. Bio ecology of leaf roller/ capsule borer, *Antigastra catalaunalis* (Dupochel). Advances in Bioresearch 1(2), 90–104.

Anonymous, 2019. Agricultural statistics at a glance 2019. Directorte of Economics and Statistics, Department of Agriculture, Cooperation and Farmers welfare, Ministry of Agriculture and Farmers Welfare. Available from https://eands.dacnet.nic.in/.Accessed on 10th August, 2021.

Anonymous, 2019. Agricultural statistics at a glance 2019. Directorte of Economics and Statistics, Department of Agriculture, Andhra Pradesh. Available from https://des.ap.gov.in/. Accessed on 11th August, 2021.

Anonymous, 2017. Annual Report of Oilseeds Division, Department of Agriculture, Cooperation & Farmers' welfare, Krishi Bhawan, New Delhi.https://agriwelfare.gov.in. Accessed on 9th June, 2021.

Basha, A.N., 2016. Seasonal occurrence of the sesame capsule borer, *Antigastra catalaunalis* (Duponchel) and parasitism rate of the ecto-larval parasitoid *Bracon hebetor* in sesame plants at Ismailia. Journal of Applied Plant Protection 5(1), 9–21.

Bondre, C.M., Pandey, A.K., Thomas, M., 2016. Studies on succession and population dynamics of major insect pests of sesame. Progressive Research 11(8), 5249–5251.

Choudhary, S., Kumawat, K.C., Yadav, S.R., 2015. Seasonal incidence of insect pests of sesame in relation to environmental factors. Indian Journal of Plant Protection 43(2), 231–232.

Dilipsundar, N., Chitra, N., Gowtham, V., 2019. Checklist of insect pests of sesame. Indian Journal of Entomology 81(4), 928–944.

Gangwar, D.S., Sandeep, S., Katiyar, R.R., Akhilesh, K., Singh, R.S., Mrigendra, S., Sarvendra, S., Rai, V.P., 2014. Population dynamics and infestation of insect pests of sesamum and their correlation with environmental factors. Journal of Experimental Zoology India 17(2), 797–800.

Kumar, R., Shamshad, A.A., Chnadra, U., 2012b. Incidence of *Antigastra catalaunalis*, Dup. in different Varieties of Sesame. Molecular Entomology 3(3), 15–17.

Kumar, R., Shamshad, A., Chandra, U., 2012. Seasonal incidence of sap feeders on sesame (*Sesamum indicum* L.) and correlation with abiotic factors. Journal of Applied Plant Protection 18(1), 41–48.

Kumar, N., Sharma, M.L., 2023. Seasonal incidence of major insect pests of sesame. Indian Journal of Entomology, 201–204.

Kinati, K., 2017. The survey on field insect pests of sesame (*Sesamum indicum* L.) in east wollega and horo guduru wollega zones, west Oromia, Ethiopia. International Journal of Entomology Research 2, 22–26.

Kefale, Y., Ambaw, A., Worku, M., Gelaye, M., 2021. Assessment of major insect pests and diseases of sesame (*Sesamum orientale* L.) in West Gondar Zone, Ethiopia. Abyssinia Journal of Science and Technology 6(1), 6–11.

Mishra, M.K., Gupta, M., Thakur, S.R., Raikwar, R.S., 2011. Seasonal incidence of major insect pests of sesame in relation to weather parameters in Bundelkhand zone of Madhya Pradesh. Journal of Agrometeorology 17(2), 263–264.

Myint, D., Gilani, S.A., Kawase, M., Watanabe, K.N., 2020. Sustainable sesame (*Sesamum indicum* L.) production through improved technology: An overview of production, challenges, and opportunities in Myanmar. Sustainability 12(9), 3515.

Piploda, S., Hussain, A., Yadav, A.K., 2023. Seasonal abundance of major insect pests of sesame and their relationship with abiotic factors. Journal of Experimental Zoology India 26(2), 1801–1805.

Rao, P.V.R., Anuradha, G., Prasuna, K., Shankar, V.G., Siddiq, E.A., 2013. Inheritance of powdery mildew resistance in sesame (*Sesamum indicum* L.)-a Review. International Journal of Bio-resource and Stress Management 4(4), 614–619.

Roy, N., 2021. Population dynamics and economic thresholds-based time series for smart pest management of sesame. International Journal of Tropical Insect Science 41(4), 2573–2584.

Sandhya, G., Veera, B.R.B., Bharathi, D., Rao, G.P., Devi, R.S.J., Reddy, M.G., 2022. Effect of different dates of sowing, insect vector population and weather parameters on sesame phyllody disease incidence in Andhra Pradesh, India. Phytopathogenic Mollicutes 12(2), 135–141.

Thakur, S.R., Nayak, M.K., Ratan, S., Tiwar, U.K., 2019. Seasonal incidence of major insect pests of Sesame with relation to weather parameters in Bundelkhand Zone of Madhya Pradesh, bulletin of environment. Pharmacology and Life Sciences 8(10), 125–127.

Thangjam, R., Vastrad, A.S., 2015. Evaluation of insecticides for the management of sesame phyllody vector, *O. albicinctus* distant. Indian Journal of Entomology 77(3), 230–234.

Tripathi, J.K., Srivastava, J.P., Tripathi, A., Agarwal, A., 2007. Efficacy of different insecticides against *Antigastra catalaunalis* Dup. infesting sesamum. Journal of Plant Protection and Environment 4(2), 81–84.

Wazire, N.S., Patel, J.I., 2016. Estimation of losses by leaf webber and capsule borer, *Antigastra catalaunalis* (Duponchel) in Sesamum. Indian Journal of Entomology 78(2), 184–191.