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CONTENTS

Impact of weather parameters on the population dynamics of major insect pests of sugarcane under the *Tarai* ecosystem of Pantnagar

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ABSTRACT: The sugarcane crop was attacked by various insect pest mainly *Pyrilla,* whitefly, mealybug, ash weevil, grasshopper, early shoot borer, top shoot borer and internode borer, attacked the sugarcane crop. Study on the population dynamics of these pests revealed that infestations began in the second fortnight of April 2022 and continued until harvesting. The second fortnight of June had the peak infestation of early shoot borer (26.67%), whereas the first fortnight of September showed the highest level of top shoot borer infestation (36.67%). The infestation of internode borer peaked (26.67%) during the second fortnight of December. The first fortnight of October and November observed the highest numbers of *Pyrilla* eggs, nymphs and adults, with population densities of 3.03, 5.50 and 6.23/leaf, respectively. In the second fortnight of October, the highest number of whiteflies was observed at 2.03/three leaves. The study additionally examined at the relationship between weather parameters and insect infestations. A significant positive correlation was found between minimum temperature and early shoot borer infestations. Top shoot borer incidence was considerably positively correlated with both morning and afternoon relative humidity. The minimum and maximum temperatures were significantly negatively correlated with *Pyrilla* egg populations. The incidence of grasshoppers exhibited a positive correlation with maximum temperature, minimum temperature and afternoon relative humidity, while mealybug and ash weevil infestations showed a substantial positive correlation with afternoon relative humidity.

Key words: Incidence, population dynamics, sugarcane ecosystem, weather parameters

Sugarcane (*Saccharum officinarum*) occupies an area of about 4.73 million hectares of land, with an annual production of approximately 434 million tonnes as per Press Information Bureau (2023). Around 45 million farmers rely heavily on sugarcane farming, which also supports various secondary activities related to its cultivation and harvesting (Selladurai, 2021). Being a long-duration crop, taking 10 to 18 months to mature, sugarcane is highly susceptible to numerous insect pests and diseases. These infestations result in significant economic losses, with a 20% reduction in cane yield and a 15% decline in sugar recovery (Kumar *et al.,* 2019). Borers are the most common subtropical pests in the sugarcane ecosystem and they have the potential to cause huge devastation. Among these, lepidopteran borer species are chronic and widespread early shoot borer (*Chilo infuscatellus* Snellen), top borer (*Scirpophaga excerptalis* Walker) and stalk borer (*Chilo auricilius* Dudgeon) (Rana *et al.*, 2011). Sugarcane borers cause holes and tunnels in internodes, preventing food from reaching the aerial regions of the stem and leaves. These borers severely affect the center leaf spindle, which eventually dries up and forms a dead heart symptom that can be removed. Early shoot borer caused a yield loss of 22-33%, whereas top borer caused a 21-48% loss (Paudel *et al.,* 2021). Sucking insect pests are responsible for a loss of around 24.1% by mealybugs, 1.43 % by scale and 28 % by *Pyrilla,* with sucrose content losses ranging from 2-34 % and an overall potential yield loss of 28 to 50 % recorded (Paudel *et al.,* 2017). *Pyrilla* attack results in purity losses of roughly 3-26 % (Gangwar *et al.,* 2008). Mealybug and whitefly, among other sucking insect pests of sugarcane, are widely distributed throughout the world's sugarcane growing regions. Thirty different species of mealybugs are known to attack sugarcane worldwide, with nine of those species occurring in India, according to Jayanthi *et al.* (2016). With all of the losses caused by insect pests, it is imperative to create management strategies to lower losses from insect pests while raising sugarcane crop yield. The amount of insect pest, crop stage and the development of insect pest populations all of which are strongly impacted by environmental factors determine the se*variety* of losses. Since insect populations reach their greatest activity and cause significant loss during specific times. Therefore, in order to develop an effective pest control strategy in accordance with changing environmental conditions, research on the population dynamics of insects and their interactions with abiotic and biotic factors is extremely significant.

MATERIALS AND METHODS

Experimental site: Field experiments on sugarcane were carried out during 2022-23 at the Norman E. Borlaug Crop Research Centre (N.E.B.C.R.C.), located at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. Pantnagar is situated at 29° N latitude, 79.30° E longitude, with an elevation of 243.84 meters above mean sea level (MSL) in the "*Tarai"* region of Northern Uttarakhand. The plots were not treated with any insecticides and all standard agronomic practices were followed to cultivate the crop.

Meteorological Observations: The region experiences a humid subtropical climate, characterized by hot, dry summers, a hot and wet monsoon season and chilly winters. Relative humidity peaks at 90-94% in July and ~~February~~, then drops to 45-50% in March and April, continuing to decrease until the monsoon season begins. Meteorological data, including minimum and maximum temperatures, relative humidity recorded at 0712 and 1412 hours and rainfall (in mm), were collected throughout the experimental period from April 2022 to February 2023, based on records from the University Meteorological Observatory at N.E.B.C.R.C., Pantnagar.

Population dynamics of sugarcane insect pest

Observations were made fortnightly on the variety Co 0238 in 5 m x 5 m plots, starting from the first fortnight of April, 2022 until the crop was harvested, with three replications using a randomized block design. Pest incidence was assessed based on the type of damage caused by each pest and the symptoms shown by the plants in response to the infestation.

For borers: The percentage of borer incidence, based on symptoms like dead hearts, bunchy top and infested plants, was determined from ten randomly selected plants per replication. The percentage incidence was then calculated as per the formula (AICRP, 2020).

$$\text{Percent Incidence} = \frac{\text{Total number dead heart / infested cane}}{\text{Total number of cane observed}} \times 100$$

For Sucking Pests

Pyrilla: The populations of *P. perpusilla* egg batches, nymphs and adults were evaluated separately from three leaves (upper, middle and lower) on a total of 10 randomly selected plants per replication**.** Average individual can be calculated as per the formula (Joshi *et al.,* 2018).

$$\text{Average egg batches or individual/plant} = \frac{\text{Total number of egg batches or individuals}}{10}$$

Mealybug: The percentage of sugarcane infestation by mealybugs was recorded from the vegetative stage until harvest, using 10 plants per replication. The percentage incidence was calculated using the following formula:

$$\text{Percent Incidence} = \frac{\text{Number of infested cane}}{\text{Total number of healthy cane}} \times 100$$

Whitefly: The population of puparia was recorded from 10 canes per replication, taking into account the upper, middle and lower leaves of the cane and average is calculated

For defoliators: The population of ash weevil and grasshopper was recorded from 10 canes at random from all the three replication and the average was worked out.

Statistical analysis

The data was analyzed for correlation between weather parameters such as minimum and maximum temperature, relative humidity and rainfall with insect populations, using SPSS software.

RESULTS AND DISCUSSION

For borers

Early shoot borer: The early shoot borer (*C. infuscatellus*) (Figure 1) was first identified in the second fortnight of April, 2022. Based on the data gathered during the examination, the percentage of infestation varied between 6.66% and 26.67%. Table 1 showed the maximum activity that was seen during the second two weeks of June. Table 2 represents a correlation studies between pest population and weather factors in which a, non-significant positive correlation was observed with morning and afternoon relative humidity (r = 0.224), while a significant positive relationship was identified with minimum temperature (r = 0.696*) and rainfall (r = 0.749*). There was a non-significant negative connection with the maximum temperature (r = -0.018).

Top shoot borer: From the second fortnight of June to the first fortnight of November, the incidence of top shoot borer infestation was reported, as shown in Table 1, with different life stages illustrated in the (Figure 2) The percentage of infestation ranged from 6.07% to 36.67%, with the highest infestation of 36.67% occurring in the first fortnight of September. A simple correlation study was carried out to determine the relationship between weather conditions and the top borer infestation. Table 2 indicates that many parameters exhibited non-significant positive correlations with the percentage of top borer infestation, however the morning relative humidity at 0712 hours revealed a substantial positive correlation with pest incidence (r = 0.632*).

Internode borer: The sugarcane internode borer began showing activity in the first fortnight of October and continued until the crop was harvested, as indicated in Table 1 and Figure 3. The percentage of infestation ranged from 6.67% to 26.67%, with the highest infestation recorded in the second fortnight of December at 26.67%, followed by a declining trend. A simple correlation analysis between percentage infestation and weather conditions revealed a significant negative correlation with both maximum temperature (r = -0.677*) and minimum temperature (r = -0.709*). In contrast, a significant positive correlation was found with morning relative humidity (r = 0.763), while afternoon relative humidity (r = 0.420) and rainfall (r = -0.073) showed non-significant positive and negative correlations, respectively.

For sucking pests

Sugarcane leafhopper: In the present study, the population of *Pyrilla* (eggs, nymphs and adults illustrated in Figure 4) was recorded from June to February, with its initial appearance noted in the first fortnight of June as show in Table 1. The highest counts were observed in November, with an average of 3.03 egg batches/leaf, 5.50 nymphs/leaf and 6.23 adults per leaf recorded in the second fortnight of November, the first fortnight of October and the first fortnight of November, respectively. Correlation analysis with weather variables showed that egg populations had a significant negative correlation with both maximum (r = -0.614**) and minimum temperatures (r = -0.474*) as presented in Table 2. In contrast, the correlation analysis between nymph and adult populations showed non-significant correlation with all the weather factors.

Mealybug: The population of mealybugs (Figure 5a.) was monitored from the second fortnight of April to the first fortnight of January as presented in Table 1. Infestation levels varied from a minimum of 3.33% to a maximum of 49.00%, with peak infestation recorded in the first fortnight of November at 49.00%. Correlation analysis with weather parameters revealed a significant positive correlation with morning relative humidity (r = 0.492*), while non-significant negative correlations were found with afternoon relative humidity (r = -0.030), minimum temperature (r = -0.395), maximum temperature (r = -0.262) and rainfall (r = -0.124) (Table 2).

Whitefly: Whitefly activity began in the first fortnight of September and continued until the second fortnight of February as shown in Table 1 and Figure 5b. The highest population was recorded in the second fortnight of October, averaging 2.03/ leaves. Correlation analysis between weather factors and whitefly populations showed non-significant correlations with weather factors as detailed in Table 2.

Defoliators: The ash weevil (*Myllocerus subfasciatus*) (Figure 5c.) was first observed in the second fortnight of June, with peak population recorded in the second fortnight of August (0.43 weevils/plant) as detailed in Table 1. Correlation analysis with weather parameters showed a significant positive correlation with afternoon relative humidity ($r = 0.708^*$), while other weather factors showed non-significant correlation as shown in Table 2.

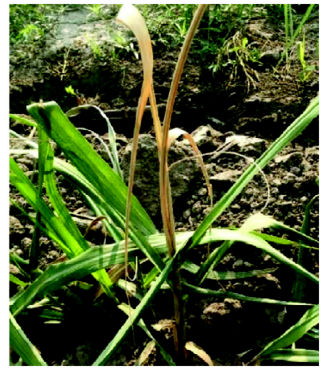
Grasshopper populations (Figure 5d.) began to appear during the rainy season, with the highest count recorded in the first fortnight of August (0.30 grasshoppers/plant) as depicted in Table 1. Correlation analysis (Table 2) indicated significant positive correlations with minimum temperature ($r = 0.723^{**}$), maximum temperature ($r = 0.513^*$) and afternoon relative humidity ($r = 0.628^*$), while correlations with other weather factors were non-significant.

The succession of major borer complexes, sucking pests and defoliators along with their symptoms in different parts of sugarcane presented in Table 1. During the 2022-23 crop season, several borer pests were observed, including early shoot borer, top borer and internode borer. Sucking pests like *Pyrilla*, mealybug and whitefly were also present. Among the defoliators, ash weevil and grasshoppers were also detected. Several workers had reported the incidence of sugarcane insect pests. In the current study, early shoot borer incidence was recorded in the second fortnight of April, aligning somewhat with Vijay Laxmi Rai (2014) observed the occurrence of early shoot borer from the first week of May to the second week of July, with peak activity in May. Similarly, the pest's presence from the first

Table 1: Population dynamics of insect pests of sugarcane during 2022-23

Month	Fortnight	Borer complex			Sucking pests					Defoliators	
		% infestation by ESB	% infestation by TSB	% infestation by IB	No. of pyrilla/ leaf			% infestation by mealybug	No. of whitefly/ leaves	No. of ash weevil/ plant	No. of grass-hopper/ plant
					Egg	Nymph	Adult				
April	i	-	-	-	-	-	-	-	-	-	-
	ii	6.67	-	-	-	-	-	10.00	-	-	-
May	i	13.33	-	-	-	-	-	-	-	-	-
	ii	16.67	-	-	-	-	-	-	-	-	-
June	i	20.00	-	-	-	0.07	0.17	16.67	-	-	-
	ii	26.67	6.67	-	0.03	0.13	0.30	20.00	-	0.10	-
July	i	23.33	10.00	-	0.07	0.33	0.47	-	-	0.27	0.10
	ii	13.33	13.33	-	0.10	0.50	1.00	-	-	0.33	0.17
Aug	i	-	20.00	-	0.27	0.63	1.10	20.05	-	0.37	0.30
	ii	-	26.67	-	0.36	1.13	1.37	23.00	-	0.43	0.17
Sep	i	-	36.67	-	0.53	1.47	3.13	25.00	1.03	0.13	0.07
	ii	-	30.00	-	0.93	3.63	3.47	26.67	1.29	0.20	0.10
Oct	i	-	23.33	10.00	1.33	5.50	4.87	33.67	1.71	0.07	0.07
	ii	-	16.67	13.33	1.77	4.10	5.93	38.33	2.03	-	0.07
Nov	i	-	6.07	15.00	2.13	3.37	6.23	49.00	1.87	-	-
	ii	-	-	16.67	3.03	2.97	4.00	43.00	1.38	-	0.03
Dec	i	-	-	23.33	2.33	2.30	3.33	34.33	1.43	-	-
	ii	-	-	26.67	1.63	1.50	2.80	26.67	1.11	-	-
Jan	i	-	-	20.00	1.07	0.93	1.40	3.33	0.88	-	0.10
	ii	-	-	14.33	0.33	0.40	0.33	-	0.77	-	0.08
Feb	i	-	-	10.00	-	0.30	0.23	-	0.67	-	-
	ii	-	-	6.67	-	0.17	-	-	0.66	-	-

i- 1st fortnight; ii- 2nd fortnight; ESB- early shoot borer; TSB- top shoot borer; IB- internode borer



Early shoot borer Larva **Dead heart by early shoot borer**

Fig. 1: Early shoot borer attack on sugarcane

Egg mass of Top borer **Top shoot borer larva** **Top shoot borer pupa**

Top shoot borer adult **Top shoot borer damage**

Fig. 2: Top shoot borer life stages and damage symptom

week of April to the first week of July had peak activity .0in May and an infestation rate ranging between 3.50 to 22.7% (Shivashankara *et al.,* 2018). Rao *et al.* (2010), found that relatively warmer conditions (with a minimum temperature below 23.8°C) and dry nights promoted its occurrence. Kaur and Sangha (2021) recorded top borer activity beginning in June and peaking in September, with an infestation rate of 27.50% during 2016. However, no pest activity was observed during the winter months. The current study partially aligns with the findings of Asha *et al.* (2021) observed a high infestation of *C. sacchariphagus indicus* in sugarcane crops planted in June and July, with a significant positive correlation to both maximum and minimum temperatures while in current study correlation was found negatively significant with maximum and minimum temperature and positively

Internode borer larva **Internode borer damage**

Fig. 3: Internode borer infesting sugarcane crop

Egg mass of *Pyrilla* ***Pyrilla* nymph** ***Pyrilla* adult**

Fig. 4: Pyrilla life stages on sugarcane

Table 2: Correlation between the population dynamics of sugarcane insect pests and weather factors sugarcane during 2022-23

Weather parameters	% infestation of ESB	% infestation of TSB	% infestation of IB	Pyrilla/ leaf			No. of whitefly/ leaves	% infestation by mealybug	No. of ash weevil/ plant	No. of grass-hopper/plant
				Egg	Nymph	Adult				
Max temp	-0.018^{NS}	0.009^{NS}	-0.677*	-0.474*	0.115^{NS}	-0.178^{NS}	0.372^{NS}	-0.262^{NS}	-0.027^{NS}	0.513*
Min. temp	0.696*	0.295^{NS}	-0.709*	-0.614**	0.143^{NS}	-0.279^{NS}	0.208^{NS}	-0.395^{NS}	0.492^{NS}	0.723**
RH (0712 hrs.)	0.224^{NS}	0.299^{NS}	0.763*	0.463^{NS}	0.325^{NS}	0.405^{NS}	0.148^{NS}	0.492*	0.531^{NS}	-0.225^{NS}
RH (1412 hrs.)	0.224^{NS}	0.632*	0.420^{NS}	-0.271^{NS}	0.244^{NS}	-0.112^{NS}	-0.127^{NS}	-0.030^{NS}	0.708*	0.628**
Rainfall	0.749*	0.294^{NS}	-0.073^{NS}	-0.389^{NS}	0.118^{NS}	-0.135^{NS}	-0.007^{NS}	-0.124^{NS}	0.346^{NS}	0.338^{NS}

*Significant at 5 percent probability level; ** Significant at 1 percent probability level; ESB- early shoot borer; TSB- top shoot borer; IB- internode borer; Max temp= maximum temperature; Min. temp= minimum temperature; RH(0712 hrs.)= morning hour srelative humidity' RH(1412 hrs.)= evening hours relative humidity

significant with morning relative humidity. Kumar *et al.* (2008) reported the maximum population of *Pyrilla* egg batches, nymphs and adults at 6.67, 22.67 and 18.00 per leaf, respectively, during the first and second fortnights of August in the Pantnagar region, which contradicts the present findings. Choudhary *et al.* (2015) found that average rainfall negatively affected the *Pyrilla* population, while morning and afternoon relative humidity, along with total rainfall, had a positive impact. The present investigation is consistent with the findings of Miah *et al.* (2019), found a positive significant correlation between

a. Different species of mealybugs

b. Whitefly puparia **c. Ash weevil** **d. Grasshopper**

Fig. 5: Different insect pests reported in sugarcane

mealybug infestation and relative humidity, but a negative correlation with temperature and rainfall, with peak activity in September. Paudel *et al.* (2017) identified whitefly as a minor insect along with the scale insect in the sugarcane ecosystem. The current findings are in partial contradiction with Masood *et al.* (2011) findings, who reported that relative humidity during the months of October and November played a positive and significant influence in population fluctuations while, in present findings no weather factor showed significant correlation with mealybug infestation. Whereas, defoliators like ash weevil and grasshopper infestation was also recoded in present investigation causing minor losses to the crop.

CONCLUSION

On studying the population dynamics of insect pests in the sugarcane ecosystem offers important insights into the timing of pest outbreaks, the crop's vulnerable stages and peak periods of pest activity. By analyzing the correlation between pest occurrence and weather factors, it becomes easier to identify which climatic conditions affect pest populations. This information is valuable for advising farmers on effective crop management strategies based on the crop's growth stage and prevailing weather factors.

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REFERENCES

AICRP (2020). Technical Report 2020-21 Entomology. https: //iisr.icar.gov.in/iisr/aicrp/download/PIReport-ENT-2020-21.pdf.

Asha, N., Patel, V. N., Sugeetha, G., Pankaja, N. S. Mahdev, J. and Kamaraddi, V. (2019). Antixenosis and antibiosis of sugarcane varieties on the incidence of sugarcane internode borer, *Chilo sacchariphagus indicus*. *International Journal of Chemical Studies,* 7(6): 1008-1012

Choudhary, A. K., Amrate, P. K. and Chatterjee, A. (2015). An unusual incidence and population dynamics of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk) and its natural enemies in Madhya Pradesh, India. *Ecology Environment and Conservation,* 20: 337-342.

Gangwar, S. K., Srivastava, D. C., Tewari, R. K., Singh, M. R. and Rajak, D. C. (2008). Management of *Pyrilla perpusilla* Walker in sugarcane with ecto-parasitoid, *Epiricania melanoleuca* Fletcher during epidemics in sub-tropical India. *Sugar Tech.,* 10(2): 62-165.

Jayanthi, R., Srikanth, J. and Sushil, S. N. (2016). Sugarcane. *'In: Mani, M., Shivaraju, C. (Eds.)' Mealybugs and their Management in Agricultural and Horticultural Crops.'* Springer, New Delhi, Pp: 287-296.

Joshi B, Soni V.K. and Rana, D.K. (2018). Population status of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk.) and its natural enemies at Kabirdham District of Chhattisgarh, India. *Int. J. Curr. Microbiol. App. Sci*., 7: 250-255.

Kaur, J. and Sangha, K. S. (2021). Seasonal Incidence of Borer Complex in Sugarcane. *Indian Journal of Entomology,* 83(2): 194-197.

Kumar, D., Ahlawat, D. S., Yadav, S. S., Kumar, L., Kalkal, D. and Saini, V. K. (2019). Biochemical resistance in sugarcane, tentative conclusions and new research directions-I. *Journal of Entomology and Zoology Studies,* 7(4): 602-608.

Kumar, S., Khan, M. A. and Kuldeep, S. (2008). Natural parasitization of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk.) in Uttarakhand. *Asian Journal of Biological Sciences,* 3(2): 286-288.

Masood, N., Ali, A., Ahsan, M. and Javed, N. (2011). Whitefly (*Aleurolobus barodensis* Mask.) population fluctuation in diverse spatio-temporal conditions on sugarcane crop native to Pakistan. *International Research Journal of Plant Science,* 2: 179-185.

Miah, M. N. A., Miah, M. R. U., Alam, M. Z. and Hossain, M. M. (2019). Influence of Weather on Sugarcane Mealybugs and Their Natural Enemies. *Asian Research Journal of Agriculture,* 11(1): 1-9.

Paudel, K., Bhandari, K., Upadhyay, S. K. and Ansari, A. R. (2017). Study of Sugarcane Insects Pests and their Natural Enemies in Central and Western Terai Region of Nepal. '*In: Proceedings of the 30th National Winter Crops Workshop'*, Pp: 453-456.

Paudel, K., Dangi, N., Ansari, A. R. and Regmi, R. 2021. Screening of sugarcane genotypes against Top Borer (*Scirpophaga exerptalis* Walker) infestation *Journal of Agriculture and Natural Resources,* 4(2): 148-154.

Press Information Bureau (2023). First Advance Estimates of production of major *Kharif* crops 2023-24. Retrieved from https: //pib.gov.in/PressReleaseIframePage.aspx?PRID=1972233#: ~ : text=Total%20Kharif%20pulses%20production%20during, sugarcane%20production%20of%204222.55%20LMT.

Rana, Z. A., Shahzad, M. A., Naseer, S., Hameed, A., Ul-Haq, I. and Saleem, M. (2011). Effect of chemical and biological control measures and their integration against sugarcane borers. *Science International,* 23(2): 143-145.

Rao, N. V., Rao, C. V. N., Bhavani, B. and Naidu, N. V. (2010). Influence of intercrops on incidence of early shoot borer, *Chilo infuscatellus* Snellen in Sugarcane. *Journal of the Entomological Research Society,* 34(3): 275-276.

Selladurai, M. (2021). Performance of agro based Industries in India with special reference to Sugar Industry. *Research Explorer*, 9(31): 45-51.

Shivashankara, Karnatak, A. K., Subbanna, A. R. N. S. and Kumar, J. (2018). Study on population dynamics of early shoot borer in sugarcane ecosystem at Pantnagar. *Journal of Pharmacognosy and Phytochemistry, 5(1): 20-25.*

Vijay Laxmi Rai. (2014). Studies on diversity of major insect-pest of sugarcane along with efficacy of some novel insecticides against termites in field and household ecosystem. Doctoral thesis, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, 121 p.

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