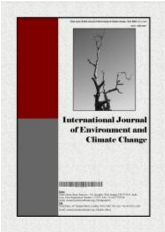

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Seasonal Incidence of Ginger Shoot Borer (*Conogethes punctiferalis*) and its Correlation with Abiotic Factors

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out in the Experimental farm, Department of Entomology, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus during 2018 and 2019 to study the seasonal incidence of ginger shoot borer (*Conogethes punctiferalis*) and its correlation with abiotic factors. The results revealed that the incidence of *C. punctiferalis* was observed from 120 DAP (Days after planting) in D_1 (15th February planting) which falls in the second week of June and for D_2 (17th March planting) the incidence of *C. punctiferalis* was observed from the second week of July and for D_3 (16th April planting) the incidence of *C. punctiferalis* was observed from the second week of August respectively for both the years. In both the experimental year, the highest incidence of *C. punctiferalis* was observed at 210 DAP in D_3 which falls in the second week of November whereas the lowest incidence was recorded at 120 DAP in D_1 which falls in the second week of June respectively. Among the weather parameters, maximum temperature and rainfall showed negative correlation whereas maximum relative humidity (RH) showed positive correlation on the incidence of *C. punctiferalis* for both the years respectively.

Keywords: Conogethes punctiferalis; seasonal incidence; abiotic factors.

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1. INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) belongs to the family *Zingiberaceae* is a herbaceous perennial and an important cash crop grown for its rhizome which is used as a spice and for its medicinal value. Ginger can be grown both under rain fed and irrigated conditions. However, being an exhausting crop it is not desirable to grow ginger in the same land year after year (2). The crop grows well at a temperature of 19°C- 28°C and a humidity ranging from 70-90% [1]. The productivity of most of the spice and condiment crops is considerably low in India due to many reasons among which infestation by pests and pathogens is a major factor which causes significant yield losses [2]. Bacterial and fungal diseases, insect pests and parasitic nematodes causes economic losses in ginger cultivation [3]. Among the several insect pests reported on ginger, the shoot borer, *Conogethes punctiferalis* Guenee, is the most severe. Crop yield can be significantly affected when more than 45% of shoots in a clump are damaged [4]. Information on incidence of ginger shoot borer at each stages of the crop and their relation with weather parameters will help to take up appropriate control measures. The meteorological parameter like temperature play a pivotal role in the biology of any insect pest and is the most crucial abiotic factor influencing the rate of growth and development of insect pests and is important for timing of effective control measures. The study on the relationship between weather parameters and incidence of insect pests helps to find out under what weather conditions, pest would appear, which will help to forewarn the farmers to resort to preventive measures against such pest in time. Such information is therefore essential in developing integrated pest management systems with ecological and economical balance. Therefore an attempt has been made to study the effect of the changes in abiotic factors in relation to shoot and fruit borer on ginger crop under Nagaland Agro-climatic conditions.

2. MATERIALS AND METHODS

To study Seasonal incidence of ginger shoot borer and its correlation with abiotic factors a field experiment was carried out in the Experimental farm, Department of Entomology, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus during 2018 and 2019.The ginger variety Nadia was used in the experiment. The ginger crop was raised according to recommended agronomic practices. Plots measuring 14.5 m x 2.8 m size each replicated 3 times was maintained in order to study the seasonal incidence of ginger shoot borer under natural condition. Ginger was planted based on three different assigned dates of planting (15th February, 17th March and 16th April). For this purpose, five numbers of plants was selected randomly from each plot and tagged to assess the incidence of insect pests during the course of crop growth.

The extent of incidence of the pest was recorded by counting the number of infested shoots to the total number of shoots on the 5 randomly selected plants at fortnightly intervals and expressed as percentage with the formula mentioned below:

> Per cent shoot infestation (%) = No. of infested shoots / Total No. of shoots (including infested ones) x 100

The status of the pest was considered based on number of insects occurring on the plant. To study the effect of major abiotic factors *viz.,* maximum and minimum temperature, morning and afternoon relative humidity, rainfall and sun shine hours on pest infestation, a correlation coefficient and multiple linear regression was worked out taking fortnightly larval population as dependent variable with the standard week mean meteorological data as independent variables. The important weather parameters were collected from ICAR Research Complex, NEH Region, Jharnapani, Nagaland to correlate with infestation of ginger shoot borer.

3. RESULTS AND DISCUSSION

3.1 Seasonal Incidence of Ginger Shoot Borer (*Conogethes punctiferalis*)

The data from the two year experimental trial (Table 2) reveals that the incidence of *Conogethes punctiferalis* in the year 2018 was observed from 120 DAP (Days after planting) with 10.70 larvae per plant in D_1 (15th February planting) which falls in the second week of June followed by D_2 (17th March planting) with 11.65 larvae per plant which falls in the second week of July and D_3 (16th April planting) with 12.72 larvae per plant which falls in the second week of August.

Table 1. Meteorological observations during the period of study (June to December 2018 and June to December 2019)

Sl. No.	2018						2019					
	Month	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	Month	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.			Max.	Min.	Max.	Min.	
1	June 2018	33.40	24.20	94.00	73.00	354.70	June 2019	33.50	24.10	91.00	69.00	195.00
2	July 2018	33.20	24.90	92.00	72.00	240.00	July 2019	33.00	24.90	93.00	72.00	271.30
3	August 2018	33.50	24.90	94.00	71.00	302.80	August 2019	34.10	24.90	93.00	73.00	274.50
4	September 2018	33.60	23.90	94.00	67.00	115.70	September 2019	32.70	23.90	94.00	72.00	173.40
5	October 2018	29.90	20.10	96.00	67.00	64.00	October 2019	30.30	21.70	95.00	73.00	244.80
6	November 2018	28.20	14.10	97.00	54.00	13.30	November 2019	28.80	16.30	97.00	64.00	52.90
7	December 2018	24.60	11.00	96.00	56.00	50.00	December 2019	24.80	12.00	96.00	57.00	15.00

Table 2. Incidence of ginger shoot borer, *Conogethes punctiferalis* on ginger variety Nadia at different dates of sowing during 2018 and 2019

Date of sowing	Shoot borer incidence (%)														
	120 DAP			150 DAP			180 DAP			210 DAP			240 DAP		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
15th February: (D_1)	10.70 (19.09)	11.40 (19.73)	11.05 (19.41)	12.22 (20.46)	12.87 (21.02)	12.55 (20.74)	14.15 (22.10)	14.72 (22.56)	14.44 (22.33)	16.52 (23.98)	17.05 (24.39)	16.79 (24.18)	15.47 (23.16)	15.90 (23.49)	15.69 (23.33)
17th March: (D_2)	11.65 (19.95)	12.42 (20.62)	12.04 (20.29)	13.50 (21.55)	14.10 (22.05)	13.80 (21.80)	15.24 (22.97)	15.80 (23.41)	15.52 (23.19)	17.75 (24.92)	18.10 (25.17)	17.93 (25.04)	16.50 (23.96)	16.97 (24.32)	16.74 (24.14)
16th April: (D_3)	12.72 (20.89)	13.50 (21.55)	13.11 (21.22)	14.75 (22.58)	15.35 (23.06)	15.05 (22.82)	16.40 (23.88)	17.26 (24.55)	16.83 (24.21)	18.90 (25.77)	19.28 (26.05)	19.09 (25.91)	17.62 (24.82)	18.16 (25.22)	17.89 (25.02)
SEm±	0.27	0.30	0.20	0.28	0.33	0.22	0.32	0.35	0.24	0.29	0.31	0.21	0.27	0.31	0.20
CD (P= 0.05)	1.07	2.78	0.66	1.09	2.78	0.71	1.24	2.78	0.77	1.15	2.78	0.69	1.04	2.78	0.66

Note: Figures in the table are mean values and those in parenthesis are arc sine transformed values

The incidence of the *C. punctiferalis* in the year 2019 was also observed from 120 DAP (Days after planting) with 11.40 larvae in D_1 (15th February planting) which falls in the second week of June followed by D_2 (17th March planting) with 12.42 larvae per plant which falls in the second week of July and D_3 (16th April planting) with 13.50 larvae per plant which falls in the second week of August respectively.

In both the years of experimental trials, the incidence of *C. punctiferalis* showed an increasing trend till 210 DAP and then decreased thereafter. In both the experimental year, the highest incidence of 18.90 and 19.28 of *C. punctiferalis* larvae per plant was observed at 210 DAP in D_3 which falls in the second week of November whereas the lowest incidence of 10.70 and 11.40 larvae per plant was recorded at 120 DAP in D_1 which falls in the second week of June for both the years respectively.

Pooled data (Table 2) reveals that the highest total mean population of 19.09 larvae per plant was observed in third date of planting (D_3) and the least mean population of 11.05 larvae per plant of *C. punctiferalis* was observed in first date of planting (D_1).

The findings of the present study are in line with that of Koya [5], who stated that the percentage of shoots bored by *C. punctiferalis* in ginger was at the minimum of 5% in July and it steadily increased reaching a peak of 14.8% in November. It is also in partial agreement with the work of Jacob [6], who reported that incidence of *C. punctiferalis* in ginger was highest during September to October. Patel et al. [7] also stated that higher activity of the pest was observed from first week of November to second week of January, with a peak level (20.04) on third week of November.

3.2 Influence of Weather Parameters on Ginger Shoot Borer (*Conogethes punctiferalis*)

The correlation (Table 3a) of *C. punctiferalis* with the abiotic factors for the year 2018 had revealed a nonsignificant negative effect with maximum temperature on all the three planting dates. Correlation of minimum temperature with the incidence of *C. punctiferalis* showed a significant positive effect on D_1, negative non-significant on D_2 whereas significant negative effect on D_3. Correlation of maximum relative humidity (RH) with the incidence of *C. punctiferalis* showed a non-significant, positive effect on D_1 whereas significant positive effect on D_2 and D_3. Correlation of minimum relative humidity (RH) with the incidence of *C. punctiferalis* showed a significant negative effect on D_1 and D_3 respectively whereas non significant negative effect on D_2. Correlation of rainfall with the incidence of *C. punctiferalis* showed a non-significant negative effect on D_1 and D_2 whereas significant negative effect on D_3 respectively.

The correlation (Table 3b) of *C. punctiferalis* with the abiotic factors for the year 2019 also revealed a non significant negative effect with maximum temperature on all the planting dates i.e D_1, D_2 and D_3 respectively. Correlation of minimum temperature with the incidence of *C. punctiferalis* showed a non-significant negative effect on D_1, D_2 and. Correlation of maximum relative humidity (RH) with the incidence of *C. punctiferalis* showed a non-significant positive effect on $D_{1,}$ and D_2 whereas significant positive effect on D_3. Correlation of minimum relative humidity (RH) with the incidence of *C. punctiferalis* showed a non-significant positive effect on D_1 whereas non-significant negative effect on D_2 and D_3 respectively. Correlation of rainfall with the incidence of *C. punctiferalis* showed a non-significant negative effect on all the three planting dates respectively.

The present finding is in line with the work of Goel and Kumar [8] who have stated that maximum and minimum temperature showed significant positive effect on per cent infestation of capsule by shoot and capsule borer, *C. punctiferalis*. It is also in line with the work of Kasareddy et al. [9] who have mentioned that population of *C. punctiferalis* was significant and positively correlated with relative humidity and rainfall. Rashmi [10] stated that the incidence of borer showed significant positive correlation with maximum temperature, while the relative humidity and rainfall showed a negative correlation with the incidence of shoot borer. Stanley et al. [11] reported that increasing relative humidity increases damage caused by *C. punctiferalis*. Madhuri [12] reported that incidence of *C. punctiferalis* showed significant and positive correlation with maximum temperature, whereas relative humidity showed significant and are negatively correlation while rainfall showed non significant and negative correlation which agrees to the present findings.

Table 3a. Correlation coefficient (r) of ginger shoot borer, *Conogethes punctiferalis* incidence with abiotic factors during June to December - 2018

Pearson correlation coefficient	Ginger shoot borer incidence		
	15th February: (D_1)	17th March: (D_2)	16th April: (D_3)
Maximum temperature (ºC)	-0.327	-0.730	-0.815
Minimum temperature (ºC)	0.447	-0.690	-0.885*
Maximum relative humidity (%)	0.485	0.899*	0.938*
Minimum relative humidity (%)	-0.944*	-0.613	-0.921*
Rainfall (mm)	-0.828	-0.839	-0.934*

Table 3b. Correlation coefficient (r) of ginger shoot borer, *Conogethes punctiferalis* incidence with abiotic factors during June to December - 2019

Pearson correlation coefficient	Ginger shoot borer incidence		
	15th February: (D_1)	17th March: (D_2)	16th April: (D_3)
Maximum temperature (ºC)	-0.454	-0.763	-0.818
Minimum temperature (ºC)	-0.428	-0.658	-0.819
Maximum relative humidity (%)	0.864	0.762	0.988**
Minimum relative humidity (%)	0.723	-0.308	-0.686
Rainfall (mm)	-0.173	-0.510	-0.821

Note: df = (5-2) = 3; $r_{0.05}$ = 0.878; $r_{0.01}$ = 0.959
** = Significant at 5% level of significance*
*** = Significant at 1% level of significance*
Those values in the table without assign any symbols are non-correlated at 5% and 1% level of significance respectively

4. CONCLUSION

Hence the knowledge on seasonal incidence of pest and their correlation with abiotic factors will help in developing integrated pest management systems and indicating at what stage of the crop the management practices should be taken up to reduce shoot borer infestation which cause heavy losses to cultivators.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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