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Influence of Weather Parameters on Abundance of Litchi Fruit Borer (*Conopomorpha sinensis*, Bradely, 1986)

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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

Litchi (*Litchi chinensis* Sonn) is a subtropical fruit belonging to family Sapindaceae. India is the second largest global producer of Litchi, next only to China. Litchi fruit borer (*Conopomorpha sinensis* Bradely,1986 (Lepidoptera: Gracillaridae), attacks Litchi plant during different seasons. Their seasonal abundance causes damage to different plant parts including the fruits and leaves throughout the year. Their abundance and therefore damaging potentialities are affected by different environmental factors such as temperature, relative humidity, seasonal variations *etc.* An attempt has been made through this research work to precisely ascertain the impact of some of

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these factors on the proliferation of this pest. The result obtained will help in devising their control measures. The correlation analysis revealed significant negative correlation between proliferation of pest and temperature, relative humidity, rainfall, wind velocity. Among various weather parameters average temperature and precipitation shows positive and significant correlation with fruit damage.

Keywords: Litchi; fruit borer; abiotic factors; seasonal incidence; correlation and regression analysis.

1. INTRODUCTION

"Litchi (*Litchi chinensis* Sonn) is an important evergreen subtropical fruit crop belonging to family Sapindaceae. It has high nutritive value and refreshing taste and consumed as fresh fruit, pulp and various processed products like squash, RTS, wine ***etc".*** (Singh et al.,2012) [1]. "India occupies second position in terms of cultivation area and production after China" [2]; Dubey et al. [3]. "It is an important subtropical evergreen fruit crop having juicy white aril with high nutritive value, attractive colour and refreshing taste known as the queen of the fruits. Insect pests are major restraints in healthy, Litchi production apart from some abiotic stresses. Nearly 42 insect species and mite pests have been reported to attack, Litchi trees and fruits at different stages of growth and fruiting" [4]. "Borer, bugs, leaf roller, looper, weevils and mites are the important group of pests affecting litchi production. Among them Litchi fruit and shoot borer, *C. sinensis* is a major pest, responsible for infestation at different crop phases *i.e.,* leaf shoot (09-70%) and fruit (25-60%) resulting in severe economic losses" [5]. The damage is primarily caused by the larvae. The head of the larvae is light brown, having a dark brown prothoracic shield. Abiotic factors such as temperature, relative humidity, wind velocity have profound impact on the multiplication and growth of this pest. Since the pest reproduces more proficiently in warm and humid environment, in such conditions it's population builds up in very short span of time and the damage to the fruits is severe. Therefore, Litchi fruit and shoot borer and their relation to major abiotic environmental factors were studied.

Appearance, **field biology and seasonal abundance**: "Based on literature and records, the adult of *C. sinensis* are greyish brown in colour with a wing spread of 12.0- 15.0 mm. The body is 6.0-7.0 mm long with zigzag coloured pattern. The apex of the fore wing is yellowish-brown but silver grey hind wing is smaller and silvery antennae are longer than wings. Larvae are yellowish in colour with brownish head. The colour of pupa is greenish on dorsal side and greenish yellow on ventral side. Adults are nocturnal in habit and mating usually takes place during dusk with scale like eggs laid on young shoots, under surface of the leaf or near the calyx of litchi fruits. During winter months, leaf buds are preferred for oviposition. The total number of eggs laid by a single female varies from 30 to 49, usually 5-6 eggs per day .Incubation period lasts for 4 to 5 days. The fully grown larvae come out of the fruit and pupate on the litchi surface under oval cocoon. Longevity of the adults varies from 4 to 7 days. During fruiting seasonal pest completes usually 3 overlapping generations. The larvae of this pest mine the young leaves, shoots and bore the litchi fruits. During the month of August to February the leaf infestation due to pest activity varied between 7.10 to 72.5 per cent, while tree infestation ranged 47.7 to 88.9 per cent" [6].

2. MATERIALS AND METHODS

An field experiment were conducted during the fruiting seasons of litchi in 2020 -2021 and 2021-2022 respectively throughout March to June at the litchi orchard of National Research Centre on Litchi (NRCL) 87" N latitude, 64" E longitude at an elevation of 210 m. The soil of the experimental field was typically gangetic alluvial having clay loam texture, neutral in reaction, and moderate in fertility with good water holding capacity. The number of Litchi fruits infested by fruit borer was counted from each replication by visualizing the symptoms of infestation *viz.,* a pinhead hole from with little yellowish brown excreta oozing out. The observation was taken at an interval of 3 days. The period of observation was 15 days (18th of March 2022) to 71 days (2nd June 2022) after fruit setting. "For quantifying the degree of infestation by the fruit borer, 100 fruits were randomly selected from each replication, where one tree served as one replication. Fruits having the symptoms of fruit borer infestation were counted and transformed to percentage value to study the relationship of major abiotic factors with fruit borer infestation, different meteorological parameters were also recorded simultaneously. Data obtained from the study were analysed both descriptive and linear

multiple regression and analysis of variance were used in showing the relationship between major abiotic environmental factors and fruit infestation".

3. RESULTS AND DISCUSSION

Data on the infestation of fruit borers was collected from the field and is presented in (Table 1 and Fig. 1). The observation was recorded on15th march 2022 in order to study the infestation caused by Litchi fruit borer (3.33%) and found to appear on 26th march that is 21 days after the fruit setting. "It was observed that the newly emerged larvae were leaving the pinhole injuries on the skin of the fruit in two distinct stages of fruit growth. The primary or first phase of infestation appeared at 21 days after fruit set when the fruits were small, tender, young and having no pulp formation. The second phase of the outbreak was found to start after 54 days fruit set on 10.05.2022. The infestation caused by borer at this stage was 37.66%, when the fruits were developing red in colour leading towards maturation. In the second phase of infestation the larvae bored at any portion of fruit and fed on the soft tissue inside it. The cause of the fruit dropping in both phases of infestation was due to undetermined factors, due to unhealing injury in fruit growth. During the second phase of infestation the bored hole provided the entry path for fungus, resulting in rotting of fruits, leading to unfit for consumption and fruit dropping".

The data pertaining to the seasonal abundance of Fruit borer *C. sinensis* infestation in litchi at ICAR -NRCL orchard from 2020 -2021 were recorded just after fruit set on 15th day when fruits were cardamom size no infestation was recorded. On 21st day, 24th day 27th day 30th day and 33rd day it was noticed a slight increase of 3.00, 5.33%, 8.33%, 11%, 14.66%, respectively. There was slight increase recorded on the 36th day after fruit set when the fruit was at young fruit stage. On 39th, 43rd, 45th 48th, 51st it was observed 30%, 34%, 36%, 39% 39% respectively. While on 54th day there was a little decrease and observed 37%. On 57th day and 60th day at the time of fruit colour break it was recorded the highest 40 % and 42%. Again on 63rd day it reduced a little and observed 39%, and later on it reduced gradually on 66th day it was 30% and 23% on 69th day 23%. It was least recorded 10 % on 71st day. F-value was 17.17 % and P-value was recorded <0.001.

The F-value for temperature T max. was 5.31, T min. was recorded 5.66 and T avg. was 5.95. relative humidity (RH) was observed 8.23. Precipitation was noticed 1.47. wind speed was 4.17 and cloud cover was 6.68. P-value was <0.001 for T (max) and T (min) was <0.001 while T (average) was 5.9. P-value for relative humidity was significant <0.001 .P- value for precipitation was 0.127 .wind speed was significant <0.001. Cloud cover was also <0.001 and LSD for T (max) 1.95 and T (min) was 1.45, while Average mean was 1.76 .Relative humidity was 10.74 .Precipitation was 0.05 ,wind speed was 7.54 and cloud cover was 8.63. The regression result for average temperature and multiple linear regression was found significant, -121.67 - 2.85X1 +4.25X2 (Table 2). In recent years *C. sinensis* has established itself as a major pest of litchi. The ever increasing degree of anthropogenic activities to the environment might be responsible for the changes in the dynamics of fruit borer population in litchi. Seasonal availability damage to litchi fruit has been observed. The present study revealed damage potential and seasonal activities of *C. sinensis*.

According to Hameed et al. [6], "the borer causes maximum damage to litchi during May to June, and its population was insignificant from October to March but reappeared in April". Lall and Sharma (1978) observed "its maximum population density in September and lowest in December. Almost similar observation was made" by [7,8]. It was also observed by "that among all the abiotic factors ,rainfall has little influence on the activity of pest species ,because of the fact that fruits were harvested before the rainy seasons. According to Lall and Sharma, during the offseason, the borer survives on alternate hosts. rainfall there is a 3.45% positive effect on degree of infestation by litchi fruit borer". "It was apparently found that infesting litchi by fruit borer elicits the greatest economic effects. The results revealed that litchi fruit borer could be controlled using mechanical, botanical and chemical control tactics". "Dissimilarities in results between the previous and the present study may be due to the meteorological parameters, frequency of spray material and mode of action, application time, variety of litchi and price. The finding of this study based on different approaches hold a good promise in litchi fruit borer management. The present findings are slight different with the reports of earlier workers" (Lall and Sharma 1978) [6,9,10,11,12,13].

Table 1. Fruit borer, *C. sinensis* infestation in litchi at ICAR-NRCL orchard from 2020-22

Days after fruit set	% Fruit borer infestation	
	(2020-2021)	(2021-2022)
15	0.00 ± 0.00	0.23 ± 0.05
18	0.00 ± 0.00	0.23 ± 0.05
21	3.00 ± 1.53	3.23 ± 1.58
24	5.33 ± 1.45	5.56 ± 150
27	8.33 ± 1.76	8.56 ± 1.81
30	11.00 ± 1.15	11.23 ± 1.20
33	14.66 ± 0.88	14.98 ± 0.93
36	25.00 ± 2.65	25.32 ± 2.70
39	30.67 ± 2.40	30.98 ± 2.45
43	34.67 ± 6.39	34.98 ± 6.43
45	36.00 ± 5.03	36.32 ± 5.07
48	39.00 ± 7.37	39.32 ± 7.41
51	39.67 ± 3.28	39.35 ± 3.32
54	37.33 ± 3.18	37.02 ± 3.22
57	40.00 ± 1.15	39.69 ± 1.19
60	42.67 ± 8.25	42.35 ± 8.29
63	39.67 ± 3.38	39.35 ± 3.42
66	30.33 ± 4.26	30.02 ± 4.30
69	23.00 ± 1.73	22.69 ± 1.77
71	10.33 ± 2.85	10.02 ± 2.89
F- value	17.17	29.41
P- value	<0.001	<0.001
LSD	10.58	9.74

LSD: Latin Square Design

Table 2. Impact of different weather parameters on fruit borer infestation in litchi

Variables observed	Temperature (max)	Temperature (min)	Temperature (avg)	Relative humidity	Precipitation	Wind speed	Cloud cover
Fruit borer infestation (%)	0.30*	0.35*	0.25	0.01*	0.28	0.37	0.13

Association of different weather parameters and fruit borer infestation in litchi

Multiple linear regression

$$\text{Fruit borer infestation (\%)} = -121.67 - 2.85\,X_1 + 4.25\,X_2 + 4.87\,X_3 - 0.41\,X_4 + 0.79\,X_5 + 0.39\,X_6 + 1.68\,X_7 - 0.67\,X_8 \; (R^2 = 68.5)$$

Stepwise regression

$$\text{Fruit borer infestation (\%)} = -172.67 - 3.14\,X_1 + 2.22\,X_2 - 0.22\,X_3 \; (R^2 = 43.5)$$

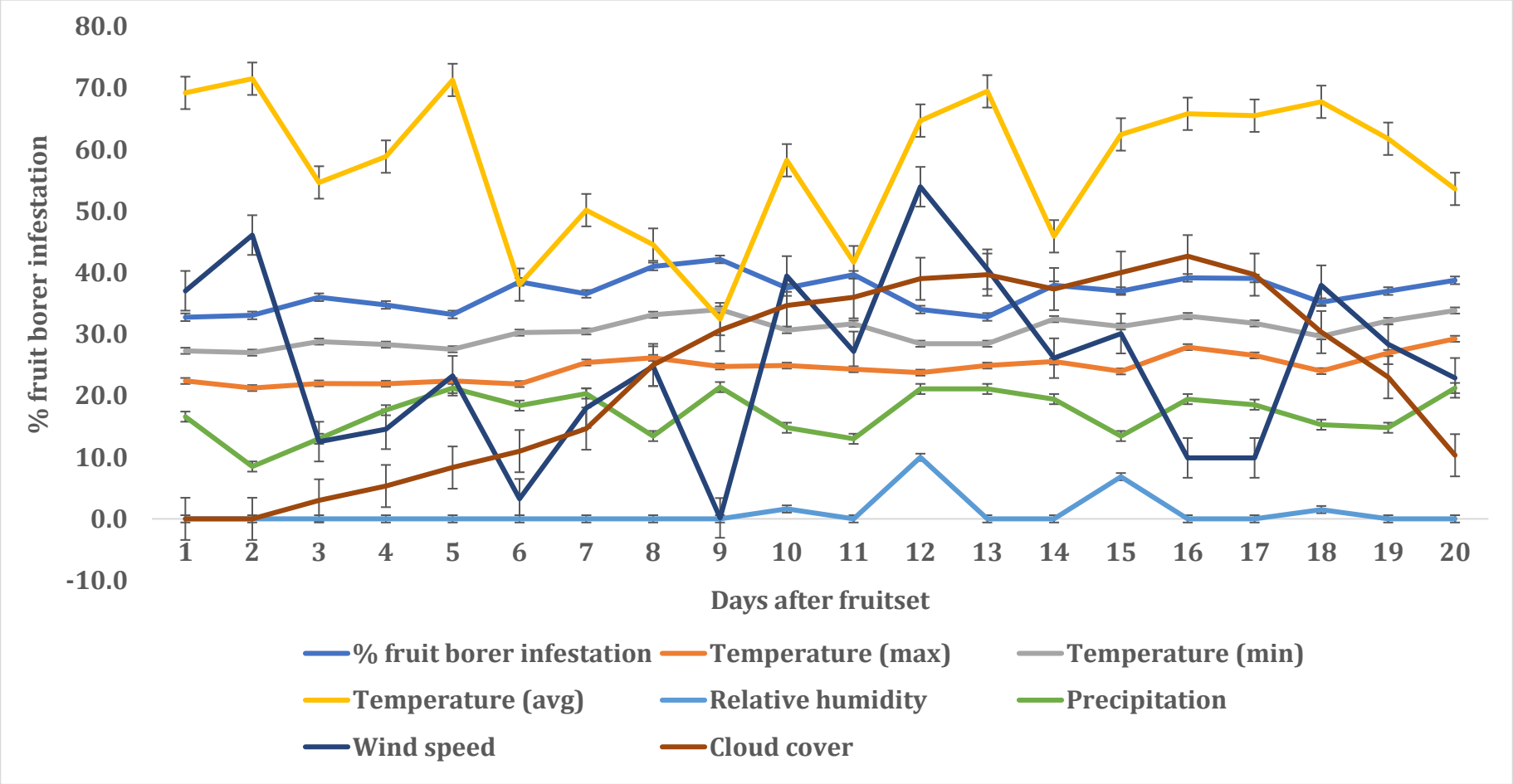

Fig. 1. Depicts the impact and association of different weather parameters on fruit borer infestation in litchi

4. CONCLUSIONS

It is evident from the present study that the activity of the pest species has a profound influence of average temperature (5.95) and is positively correlated with the factors like temperature and relative humidity. Relative humidity was found to have less impact (8.23) because of the fact that fruits were harvested before the rainy season. However, it was general observation that fruit infestation suddenly increased when there was a pre monsoon rainfall in May and June. The present findings are in close conformity with the reports of earlier.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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