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Short Communication

Weather Factors Influencing Stem Borer Incidence and Whitebacked Planthopper Population Dynamics in Rice Crop

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ABSTRACT

Incidence of stem borer and whitebacked planthopper (WBPH) was recorded from 32nd standard meteorological week (SMW) upto crop maturity (41st SMW) at Punjab Agricultural University, Ludhiana during *kharif* 2020 and 2021. The maximum dead heart damage of 9.96% and 10.40% by stem borer was recorded during 38th SMW in *kharif* 2020 and 2021, respectively. WBPH population attained peak during 1st week of October (40th SMW) during *kharif* 2020 and 2021 with population of 4.07 and 3.52 per hill, respectively. Dead heart incidence showed non significant correlation with evening relative humidity (r = -0.31) and sunshine hours (r = -0.21) while the correlation was significant with maximum temperature (r = -0.60), minimum temperature (r = -0.94), morning relative humidity (r = 0.70) and rainfall (r = 0.73). WBPH shows non significant correlation with maximum temperature (r = -0.11), morning relative humidity (r = 0.57) and rainfall (r = -0.17) while correlation was significant with minimum temperature (r = -0.80), evening relative humidity (r = -0.74) and sunshine hours (r = 0.67). The correlation of spider count was non significant with maximum temperature (r =-0.10), morning relative humidity (r = 0.44) and rainfall (r = -0.36) while the correlation was significant with minimum temperature (r = -0.98), evening relative humidity (r = -0.95) and sunshine hours (r = 0.75).

Key words: Rice, Stem borer, WBPH, Spider, Dead heart, White earhead, Weather parameters

Introduction

Many insect pests attack rice crop. Rice stem borers are one of the key pests in subtropical to tropical Asia. Rice stem borers are monophagus (such as white stem borer and yellow stem borer) to polyphagus (pink stem borer). Stem borers form the dead hearts at vegetative stage while white heads appear after reproductive stage in case of borers' attack (Sun *et al*., 2003). Stem borers attack rice nursery and transplanted crop but their activity is observed at peak in September (Das *et al*., 2008) and causes severe losses to the crop (Siswanto, 2008). The extent of rice yield losses due to YSB (yellow stem borer) has been estimated as 20-70% (Singh *et al*., 2009). WBPH is also an important insect of rice crop. The nymph and adults suck cell sap at the base of rice plant and the leaf surface. The number of grains and the panicle length decreases when rice is infested at the panicle initiation stage. During the heading stage, damaged glumes become brown and some remain unfilled. Grains do not fill fully and ripening is delayed when plants are attacked at the maturation period. Insect pest population dynamics are considered to be influenced by both biotic and abiotic factors (Annual reports, 2014). Among the weather factors; temperature, rainfall and relative humidity play the crucial role in insect life. For this,

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it is necessary to acquire a thorough knowledge on relation of weather parameters to insect pests which will be very helpful to formalize suitable management practices in the areas where major insect pests are appearing year after year and causing serious damage to rice crops. Hence, considering the importance of insect pests of rice, an attempt has been made to study the influence of different weather factors on the incidence of major insect pests of rice.

Materials and Methods

The study was conducted at the Research Farm of the Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana during *kharif* season of 2020 and 2021. Ludhiana station is located at latitude of 30°54′ N and longitude of 75°48′ E with an altitude of 247 m above mean sea level, which is placed in the central plain region of Punjab under Trans-Gangetic agro climatic zone of India. The general climatic condition of the region is classified as sub-tropical and semi-arid with mean annual rainfall of about 760 mm out of which 75% rainfall is received during monsoon (June to September) and rest is during winters due to western disturbances. The summer temperature exceeds 38°C and sometimes reaches upto 51°C with long dry summer spells. During winter, December and January experience frost, temperature fall upto 0.5°C and the North Eastern winds are dominated. The soil of the site is classified as 'loamy sand' and belongs to 'Alluvial soils' type. The weekly meteorological data (daily maximum and minimum temperatures, rainfall, pan evaporation, sunshine hours, morning and evening relative humidity) for the crop season during *kharif* 2020 and 2021 was obtained from the meteorological observatory of the Punjab Agricultural University, Ludhiana and illustrated in Figs. 1.1 and 1.2, respectively. The mean weekly maximum air temperature during crop season ranged between 31.4 to 41.3°C in *kharif* 2020 and 27.7 to 38.0°C in 2021. Average weekly minimum temperature ranged between 14.0 to 28.5°C in *kharif* 2020 and 15.6 to 28.5°C in *kharif* 2021. The average relative humidity (%) varied between 30.1 to 78.1% and 36.4 to 82.7% during the crop growing period in *kharif* 2020 and 2021, respectively.The total amount of rainfall received during crop growing period was more in *kharif* 2021 (787.8 mm) than *kharif* 2020 (428.8mm) and the maximum rainfall received in the month of July (232.4 mm) during *kharif* 2020 and 295.8 mm in September during *kharif* 2021. The total sunshine hours during crop period *kharif* 2020 and 2021 were 173.7 hrs and 149 hrs, respectively. Due to cloudy sky conditions, sunshine hours were recorded lesser during *kharif* 2021.

The experiment was laid out in Factorial Split Plot Design with three replications comprising 2 crop establishment methods and 3 varieties in main plots and 3 nitrogen levels in sub-plots. Three varieties

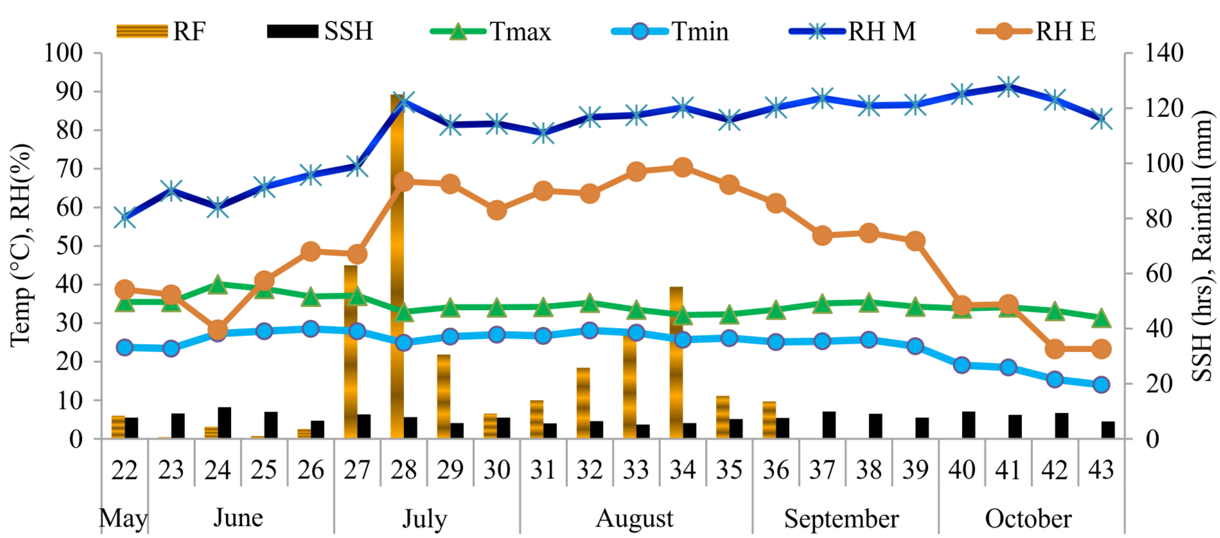

Fig. 1.1. Weekly meteorological data during rice crop season (*kharif* 2020)

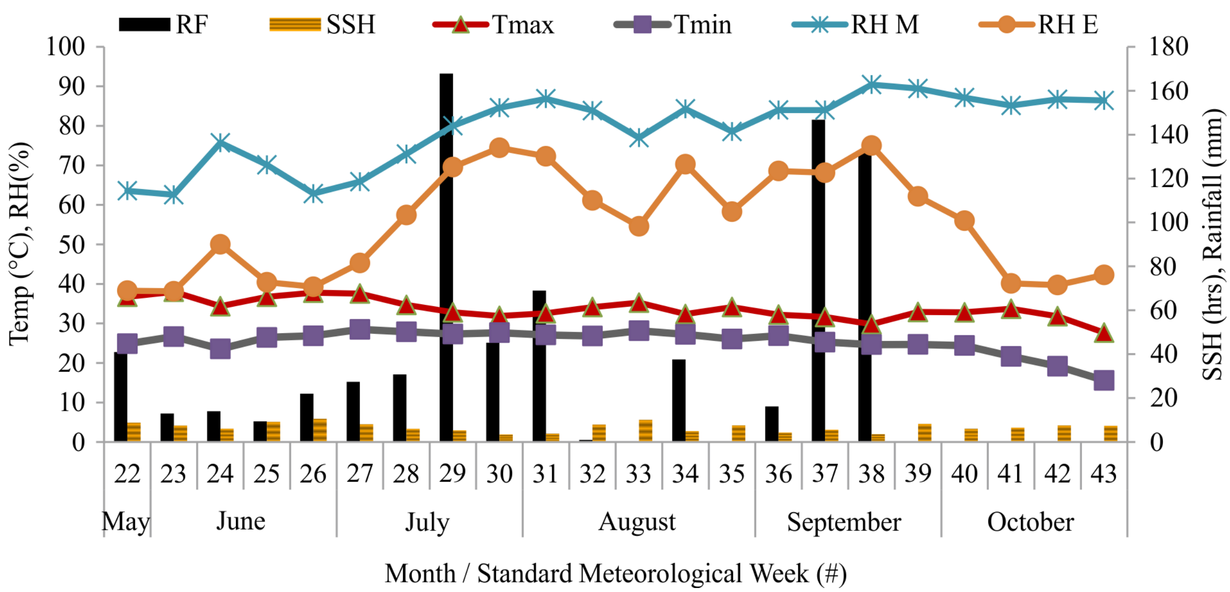

Fig. 1.2. Weekly meteorological data during rice crop season (*kharif* 2021)

viz; PR 122, PR 126 and Pusa 44 were planted with puddled transplanted method and direct seeding conventional seed drill. Three nitrogen levels viz; recommended dose, 125% of recommended dose and leaf color chart were taken. All the treatments were kept unsprayed for insects while other cultural practices were carried out as per, PAU recommendations. Insect observations were started from 32nd SMW to 41st SMW from all the treatments. Average of all treatments was calculated and presented in Table 1, and was correlated with weather parameters. Infestation of stem borers were taken on the basis of dead heart/white ear and total number of tillers/panicles from tagged plants.

The per cent incidence (dead heart/ white ears) was calculated as follows:

Dead heart percent incidence= (Number of dead heart/Total number of tillers) × 100

White earhead percent incidence = (Number of white earheads/Total number of panicles) × 100

Whitebacked planthopper adults were observed weekly starting from 32nd week to study its incidence in crop. The number of insects was recorded by slightly tilting 10 tagged plants in a plot and tapping twice or thrice at the base at weekly intervals. Insect population was recorded upto 41st SMW. Spider count was also observed by visual observation from 10 tagged plants. Average of 10 tagged plants was expressed as the number of hoppers/spiders per hill.

Correlation coefficient (r) was calculated to describe a correlation between insect incidence and weather parameters.

Results and Discussion

Incidence and seasonal abundance of stem borers, WBPH and spiders

The data on the weekly weather parameters and incidence of stem borer complex and WBPH was recorded during *kharif* 2020 and 2021 is shown in Table 1. Spider population was also recorded at weekly interval. During *kharif* 2020, the maximum temperature ranged from 32.3 to 35.5°C whereas minimum temperature ranged from 18.3 to 28°C. During *kharif* 2021 maximum temperature ranged from 29.8 to 35.3°C whereas the minimum temperature from 21.7 to 28.1°C. Morning humidity ranged between 77.1 to 91% during *kharif* 2020 and 77 to 90.4% during *kharif* 2021 whereas evening humidity ranged between 33.1 to 71.9% during *kharif* 2020 and 40.1 to 75% during *kharif* 2021. The highest rainfall of 53.2 mm was recorded during 33rd SMW of *kharif* 2020 and 146.8 mm during 37th SMW of *kharif* 2021 (Fig. 1.1 & Fig 1.2).

Table 1. Weekly incidences of rice stem borer, whitebacked planthopper and spider during of *kharif,* 2020 and 2021

Months and dates	SMW	% Dead heart/white ear			WBPH population/ hill			Spider population / hill		
		2020	2021	pooled	2020	2021	pooled	2020	2021	Pooled
6-12 August	32	1.66	1.91	1.79	0.05	0.03	0.04	0.63	0.44	0.5
13-19 August	33	2.34	2.72	2.53	0.17	0.12	0.14	0.75	0.59	0.7
20-26 August	34	3.34	3.69	3.52	0.24	0.24	0.24	0.80	0.61	0.7
27August-2september	35	5.09	5.46	5.28	0.34	0.33	0.33	0.87	0.69	0.8
3-9 September	36	6.24	6.76	6.50	0.52	0.45	0.49	0.90	0.71	0.8
10-16 September	37	8.05	8.59	8.32	0.93	0.82	0.88	1.09	0.79	0.9
17-23 September	38	9.96	10.40	10.18	2.02	0.70	1.36	1.52	1.03	1.3
24-30 September	39	7.73	8.27	8.00	1.86	0.61	1.24	2.08	1.52	1.8
1-7 October	40	8.86	9.41	9.14	4.07s	3.52	3.79	2.61	1.99	2.3
8-14 October	41	10.57	11.09	10.83	1.88	1.52	1.70	3.72	3.02	3.4

During 2nd week of August (32nd SMW) crop was recorded with 1.66 and 1.91% dead heart damage during *kharif* 2020 and 2021. It gradually increased during successive standard weeks and reached at the maximum level (9.96%) during 3rd week of September (38thSMW) during *kharif* 2020 and while 10.40% dead heart damage was recorded during *kharif* 2021 during the similar SMW. White ear heads appeared during last week of September (39th SMW) and attained peak during 41st SMW with 10.57% and 11.09% damage percentage during *kharif* 2020 and 2021, respectively. Dead heart/white ear damage percentage was higher during *kharif* 2021 than *kharif* 2020 irrespective of SMWs due to favorable conditions. Earlier studies carried by Jasrotia *et al.* (2020) have reported that the per cent dead hearts caused by *S. incertulas* incidence was highest during 38th and 39th standard week during *kharif* 2020 an 2021, respectively at Karnal, Haryana.

WBPH population was also recorded from 2nd week of August (32nd SMW). During 32nd SMW, population of WBPH was 0.05 and 0.03 per hill in *kharif* 2020 and 2021. WBPH population gradually increased during successive standard weeks and reached at the maximum level (4.07 WBPH per hill) during 1st week of October (40th SMW) during *kharif* 2020 and after that started declining which might be due to unfavorable weather conditions or drying up of sap from crop as crop approached to maturity. On the other hand, during *kharif* 2021, WBPH population increased from 32nd SMW to 37th SMW and then decreased due to heavy rainfall during 37th and 38th SMW. WBPH population again increased and attained peak during 40th SMW, and then decreased during 41st SMW. Sharma *et al.* (2018) also reported that WBPH population was first observed during first week of August (32nd SMW) and the pest activity started increasing significantly from 3rd week of August (34th SMW) in Varanasi Uttar Pradesh. The pest attained a peak level (17 insects/ 10 hills) during the first week of October (40th SMW) and the pest was observed on the crop till harvest but at minimum level.

The population of different species of spiders ranged from 0.63 to 3.72 spiders per hill and 0.44 to 3.07 spiders per hill during *kharif* 2020 and during 32nd *kharif* 2021, respectively from 32nd to 41st SMW. Spider population increased gradually from 32nd to 41st SMW during both years however heavy rainfall during 37th and 38th SMW in *kharif* 2021 resulted in a decrease of spider population as compared to *kharif* 2020. Spider population was lower in *kharif* 2021 from 32nd to 41st SMW than *kharif* 2020 that might be due to more availability of prey in *kharif 2020*. Kumar *et al*. (2017) also recorded the spider population from 31st to 42nd SMW in Hisar, Haryana and reported 17.4-39.2 spiders per 10 hills from 39th to 42nd SMW with highest spider population during 39th SMW.

Correlation of dead heart damage, WBPH and spider population with weather factors

A statistical analysis of the relationship between stem borer damage (expressed as the percentage of dead hearts) and weather parameters was carried out

(Fig 2). Dead heart percentage showed a negative correlation with maximum temperature (-0.60), minimum temperature (-0.94), evening relative humidity (-0.31) and sunshine hours (-0.21) while the correlation with morning relative humidity (0.70) and rainfall (0.73) was positive. Correlation was significant with minimum temperature while correlation was non significant with other factors. A strong negative correlation with minimum temperature suggesting that higher minimum temperatures are strongly associated with lower stem borer damage while a moderate positive correlation with rainfall implying that higher rainfall levels are positively associated with an increase in stem borer damage (dead hearts). The correlation with other weather parameters (maximum temperature, evening relative humidity, sunshine hours, morning relative humidity and rainfall) was non-significant, suggesting that while there may be some relationship, it is not statistically strong enough to be considered a determining factor for stem borer damage. Samrit *et al.* (2019) reported that minimum temperature (r= -0.501) had significant negative correlation with incidence of rice stem borer. Singh and Kular (2015) also reported non significant negative correlation of pink stem borer with maximum temperature, minimum temperature and sunshine hours while correlation was non significant positive with average relative humidity and rainfall.

Relationship between WBPH population and weather parameters was carried out (Fig. 3). Correlation of WBPH population was negative with

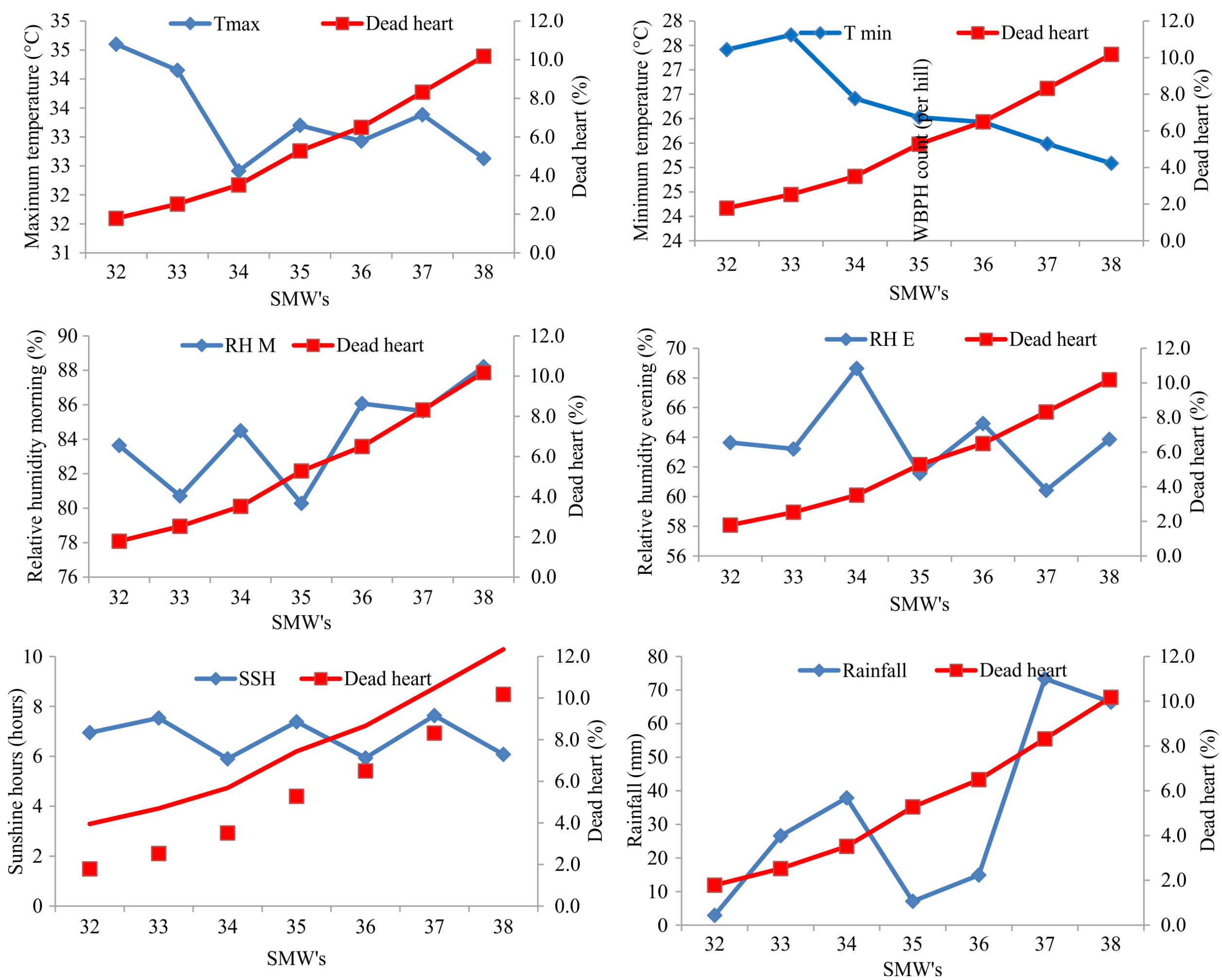

Fig. 2. Relationship between stem borers damage (% dead hearts) and weather parameters during *kharif* 2020 and 2021 (pooled data)

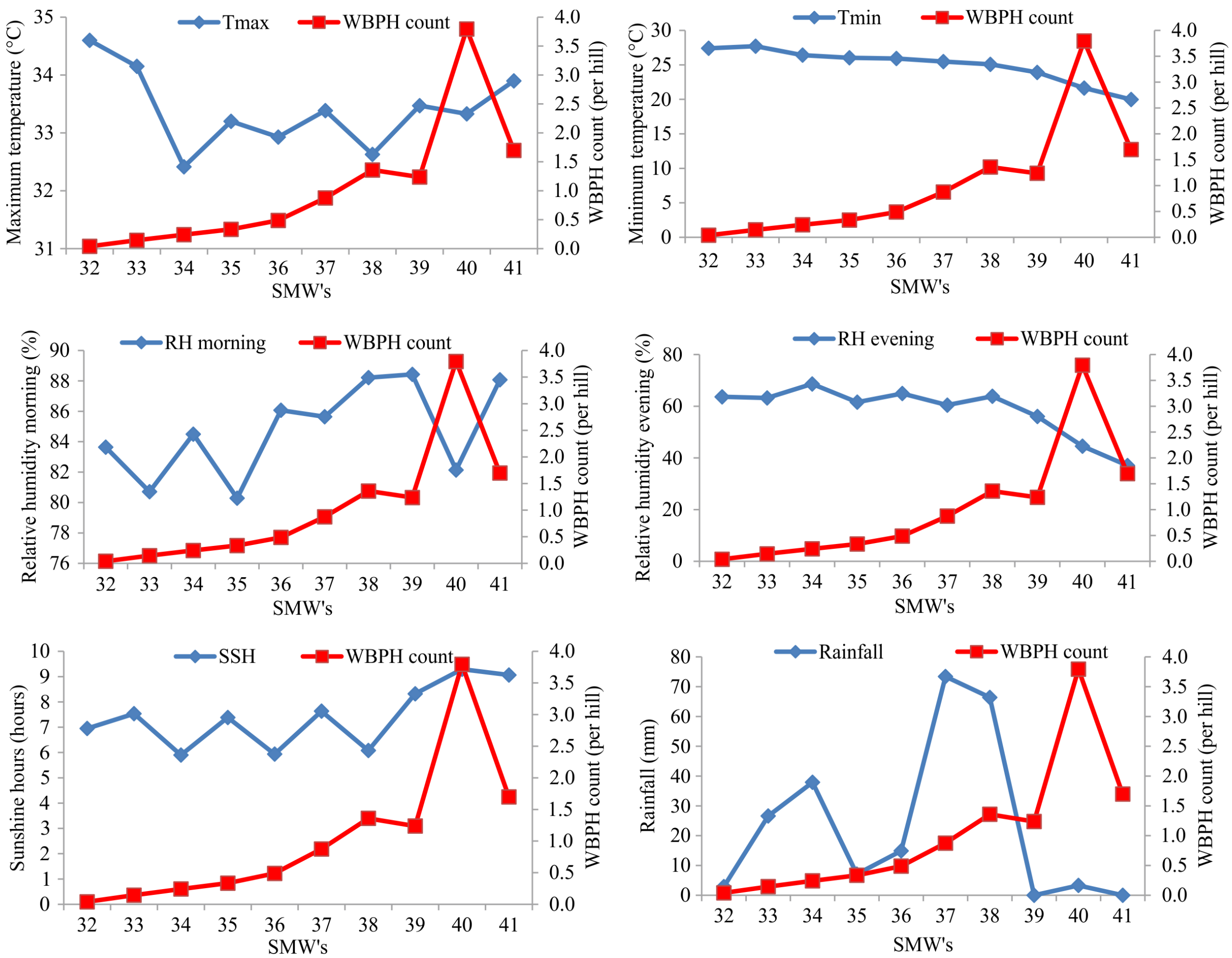

Fig. 3. Relationship between WBPH population and weather parameters during *kharif* 2020 and 2021(pooled data)

maximum temperature (-0.11), minimum temperature (-0.80), evening relative humidity (-0.74) and rainfall (-0.17) while the correlation of WBPH with morning relative humidity (0.13) and sunshine hours (0.67) was positive. Minimum Temperature and evening relative humidity showed a significant negative correlation with stem borer damage, indicating that lower minimum temperatures are likely associated with higher levels of damage while moderate positive correlation of 0.67 was observed with sunshine hours, indicating that longer sunshine hours are positively correlated with an increase in WBPH population, suggesting that warmer, sunnier conditions may favor WBPH development. Correlation was non significant with maximum temperature, morning relative humidity and rainfall. Madhuri *et al.* (2017) reported a positive correlation between mixed population of WBPH and BPH (no/hill) with morning relative humidity and sunshine hours while negative with evening relative humidity. Sharma *et al.* (2018) and Ashrith *et al.* (2017) reported a negative correlation of WBPH with rainfall. Haider *et al.* (2021) reported that WBPH was positively and negatively correlated with weather parameters but relationships were non-significant. Seni and Naik (2018) also reported that the population of plant hoppers on rice crop was significantly negatively correlated with maximum temperature (r = -0.62), minimum temperature (r =-0.76), evening relative humidity (r = -0.788) and rainfall (r = -0.58).

Relationship between spider population and weather parameters was carried out (Fig. 4). Spider population showed positive correlation with

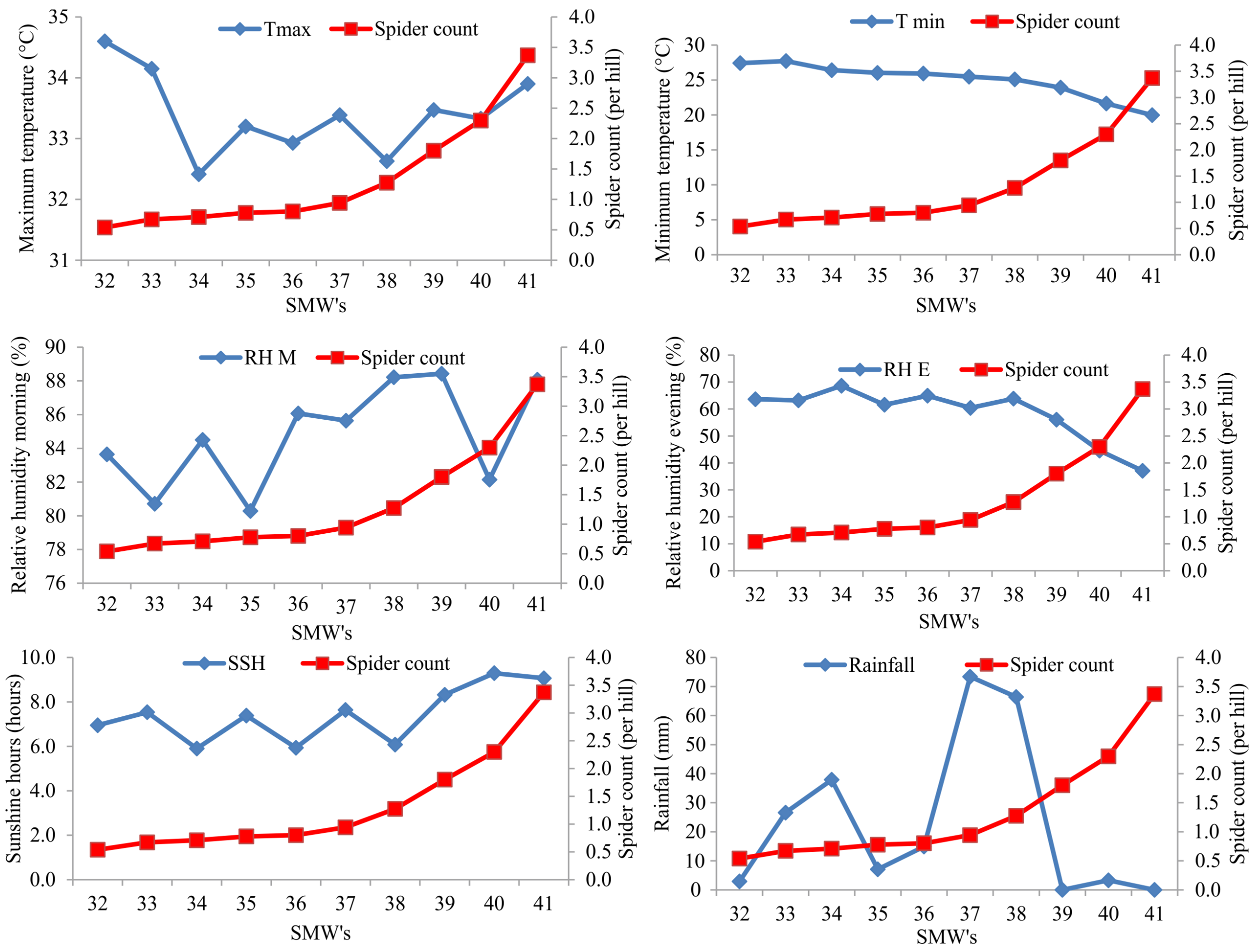

Fig. 4. Relationship between spider population and weather parameters during *kharif* 2020 and 2021 (pooled data)

maximum temperature (0.10), morning relative humidity (0.44) and sunshine hours (0.75) while correlation was negative with minimum temperature (-0.98), evening relative humidity (-0.95) and rainfall (-0.36). Spider population showed significant negative correlation with minimum temperature, evening relative humidity while the correlation was significantly positive with sunshine hours. Other factors showed non significant relationship with spider count. Prasad *et al*. (2010) also reported a positive correlation of spiders with morning relative humidity.

The relationship between spider population counts and pest damage (dead heart incidence) as well as Whitebacked Planthopper (WBPH) population was analyzed. The correlation between spider population and the percentage of dead heart damage showed a moderate positive relationship, with an R^2 value of 0.52 (Fig. 5). This indicates that approximately 52% of the variability in dead heart damage can be explained by variations in spider population, suggesting that higher spider counts might be associated with increased levels of damage. The relationship between spider population and WBPH population exhibited a slightly stronger positive correlation, with an R^2 value of 0.57 (Fig. 6). This suggests that about 57% of the variation in WBPH population can be explained by changes in spider counts. Given that spiders are natural predators of various pests, this relationship could indicate that spiders are playing a role in controlling WBPH populations. These results suggest that spider populations could be acting as a natural biocontrol

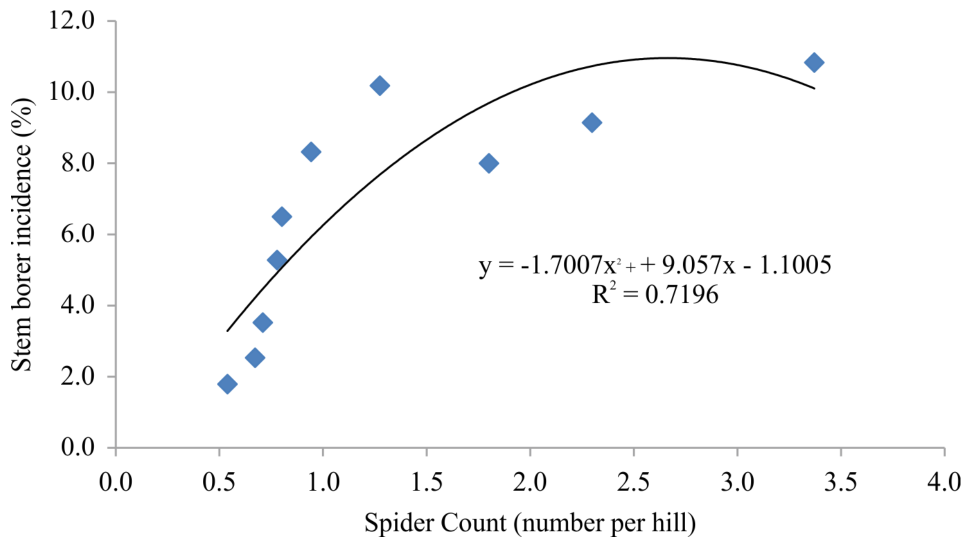

Fig. 5. Relationship between stem borer damage and spider count during *kharif* 2020 and 2021

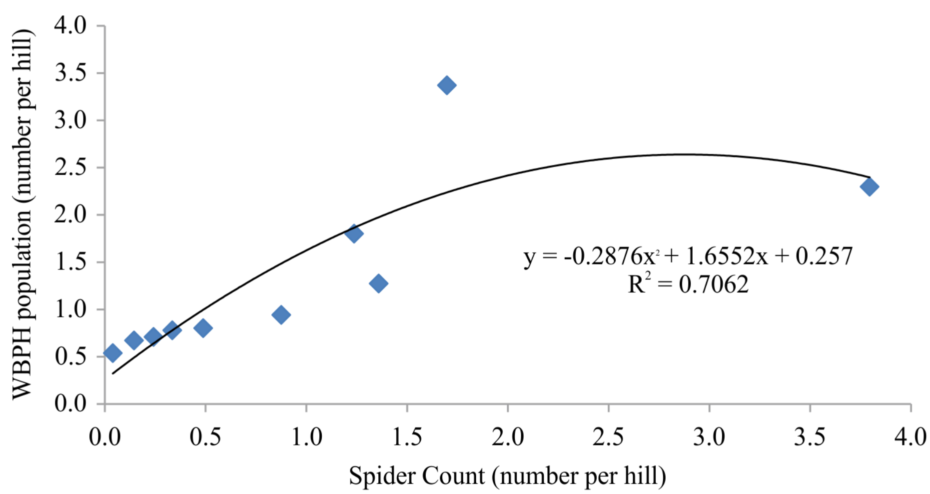

Fig. 6. Relationship between WBPH population and spider count during *kharif* 2020 and 2021

Table 2. Correlation analysis between dead hear percentage, WBPH and spider population with weather parameters during *kharif* 2020 and 2021

Weather parameters	Tmax	T min	RH M	RH E	SSH	RF
Dead heart percentage	-0.60	-0.94*	0.70	-0.31	-0.21	0.73
WBPH population per hill	-0.11	-0.80*	0.13	-0.74*	0.67*	-0.17
Spider population per hill	0.10	-0.98*	0.44	-0.95*	0.75*	-0.36

* Significant at the 0.05 level

agent, influencing both the extent of dead heart damage and the population dynamics of WBPH. However, the strength of these relationships indicates that other environmental or ecological factors may also contribute significantly to these pest dynamics.

Spiders are large part of the predatory arthropod fauna of the rice ecosystem and prey upon rice stem borer (Samrit *et al.,* 2019). Spider, Lycosa spp were observed to prey upon nymphs and adults of WBPH (Kumar *et al.,* 2017).

Conclusion

The studies demonstrate that the population dynamics of rice pests, including the stem borer complex and whitebacked planthopper (WBPH), are significantly influenced by various weather parameters. Climatic variables such as temperature, relative humidity, and rainfall directly affect the growth, development, and behavior of these insect pests. Under changing climatic conditions, pest populations are exhibiting altered behaviors, with certain minor pests escalating into serious threats in areas where they were previously of low economic importance. Therefore, this information may be helpful in developing population models for the prediction of pest build-up and forewarning the farmers for timely adoption of site specific eco-friendly and cost effective management practices.

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