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ASSOCIATING LIGHT TRAP CATCHES OF SOME MAJOR RICE INSECT PESTS WITH PREVAILING ENVIRONMENTAL FACTORS

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The insect pests of rice were found for a specific duration throughout the year, however, dominancy of insects was comparatively higher from mid-March to May and from August to mid-October, in case of White Stem Borer and Yellow Stem Borer during both the years, 2009 and 2010; while from September to start of April of next year in case of Pink Stem Borer. On comparing the weather parameters, importantly temperature and humidity, it was evident that the insect trap was recorded higher within specific range of temperature that varies from 18 to 35°C in case of White and Yellow Stem Borers, and shows significant relationship with total insect catch. Maximum traps were observed during April where average temperature was 30-33°C, considering it optimal temperature for insect catch by light traps. However, in case of Pink Stem Borer, insect trap was found to occur below 32°C during all winter season. Association analysis of temperature with insect catch clearly accentuates the strong relationship of activity of these insects with environmental temperature. At the same time, it was also discovered that this relationship is within specific temperature range, i.e. between upper and lower threshold of activity, below and above of this range, temperature conferred no effect on activity of these insects.
Keywords: *Oryzae sativa*, insect traps, stem borer, environment, temperature relationship

INTRODUCTION

Rice (*Oryzae sativa*) is second largest staple food crop in Pakistan and is major source of export earnings in recent years (Anonymous, 2011-12). It accounts for 4.4 percent of value added in agriculture and 0.9 percent in GDP (Pakistan Economic Survey, 2011-2012). In Pakistan, stem borers are a great threat to traditional basmati growing areas of Punjab province. Reduction in basmati yields has been estimated at 20-25% by yellow and white stem borer. During an outbreak season, 70 to 90% of crop may be damaged, and in certain cases, crop is left un-harvested in the field due to the cost of harvesting being higher than the yield obtained (Baloch, 1975). It is also reported that the attack of rice stem borers in late transplanted crop is as high as 80% in some parts of Lahore district (Srivastava, 2003).

Insect light trap is one of the very effective tools of insect pest management in organic agriculture as it is equally effective for both the sexes of insect pests and also substantially reduces the carry-over pest population. The insect pests of all cereal crops, pulse crops, vegetable crops as well as horticultural crops can be mass trapped by using light traps.

The term 'Light trapping' refers to "attracting moths with light, but sampling them by hand or net". Light can be assumed to sample the community more 'neutrally' than using food or pheromones, where specializations are more likely to occur (Southwood and Henderson 2000). The use of artificial light sources is a commonly employed technique to attract night-active Lepidoptera for the study of taxonomy, biogeography and biodiversity (Holloway *et al.,* 2001; Intachat and Woiwod, 1999).

Light trapping yields a large number of specimens with a minimum of effort (Holloway *et al.,* 2001; Fiedler and Schulze, 2004). This is particularly true for automatic light-traps (Southwood and Henderson, 2000), which do not even require the presence of the researcher during trapping.

Collections of a light trap provide significant clue to the diversity of insects active even at night (Southwood and Henderson, 2000), their respective affinity to light and to understand and predict how populations function (Southwood and Henderson, 2000). While neither the physiological mechanism, as used by Spencer *et al*. (1997), Sotthibandhu and Baker (1979), Hsiao (1973) and Bowden (1984); nor the evolutionary significance (Holloway, 1967) of this well-known attraction is known to a satisfying degree, it also offers a number of advantages over alternative methods such as torchlight-transects (used by Birkinshaw and Thomas, 1999), baiting with fruits, red wine (Sussenbach and Fiedler, 1999, 2000), cheese or shrimp paste malaise traps (Butler *et al*., 1999), suction traps, rotary traps or other methods of passively sampling.

Therefore, the following study was conducted to ascertain comparative effectiveness of weather conditions such as temperature and humidity on activity of adults of these insect pests in rice along with their comparative attraction and efficacy of light traps regarding these insects.

MATERIALS AND METHODS

The present studies were carried out to investigate the comparative population of different rice insect pests on light trap, from 2009-2010 in the experimental fields of Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan. Rice nursery was sown during 1st week of June and transplanted after one month. All the standard agronomic measures, water and fertilizers applications were adopted according to recommended schedule for rice. Light trap with certain modifications were incorporated according to essential requirements of fields and trapped insects were evaluated. The trap (Jermy type) had four constituent parts i.e. collecting chamber, funnel shaped lid, light source and a lid from the top to protect from unexpected showers. The light source was a 100W normal electrical bulb, 200cm above the ground. Chloroform was used for the killing. The light traps were installed in four different places at weekly intervals. Killing jars were changed as required by hand and trapped insects were identified and counted. The weather data was collected from record book of Meteorological Department, Lahore, Pakistan.

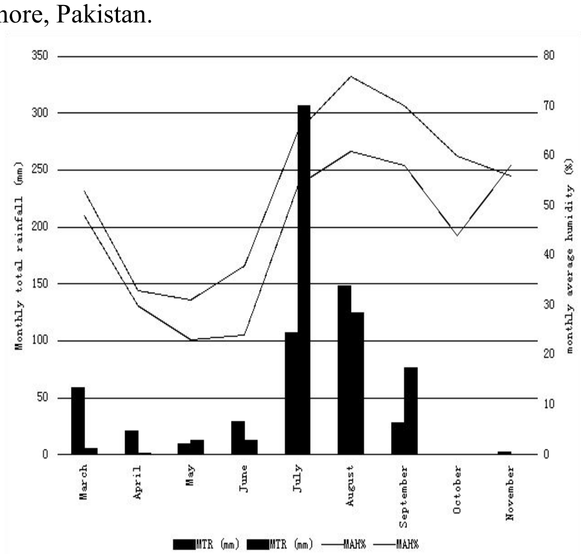
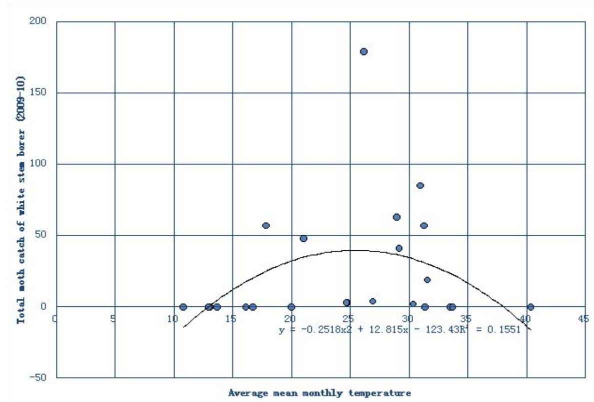


Figure 1. Monthly total rainfall (MTR) and monthly average humidity percentage (MAH%) at Kala Shah Kaku for years, 2009 and 2010.

The data were then subjected to regression analysis for ascertaining the efficacy of environmental factors on light trap catches of the insect pests, using minitab statistical software V 1.6 and graphical representation by using Excel version 2010.

RESULTS AND DISCUSSIONS

By comparing insect catch data for Yellow and White Stem Borers with temperature data of both the years, it becomes clear that moths are most active between 23 and 30°C and no flight occurred below 18°C (Fig. 2a,b). Therefore, zones of inactivity; both upper and lower threshold temperature limits may be specified for both the moths.



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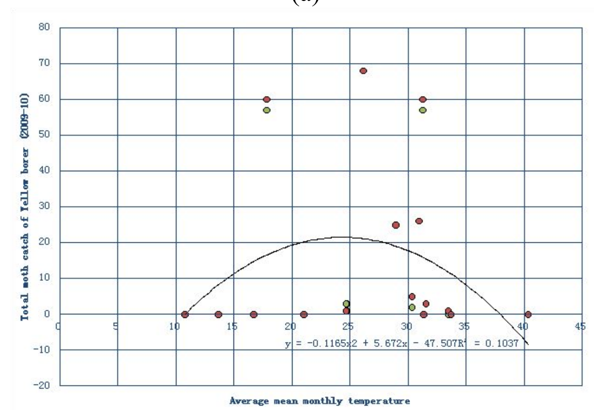

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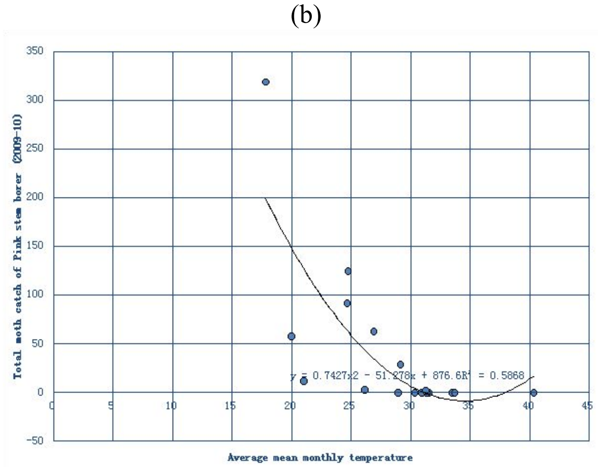
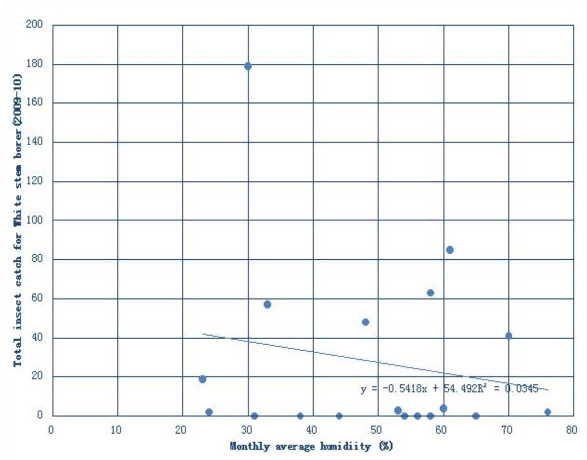
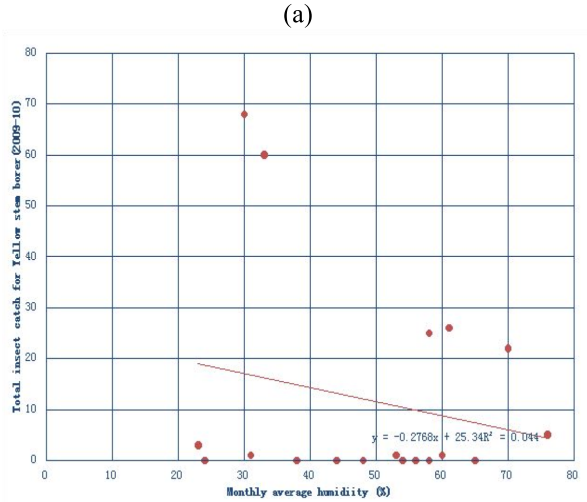


(c)

Figure 2. Association analysis of total insects catches for all three insects with average mean monthly temperature during the years 2009 and 2010



(a)



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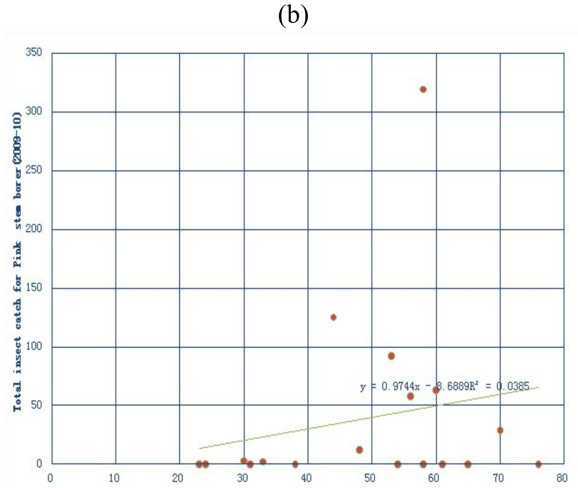

(c)

Figure 3. Association analysis of total insect catch for all the three stem borers with average monthly humidity (%) during the years 2009 and 2010.

As depicted in Figure 4, it becomes obvious that after mid-March (2nd week), 2009, when average temperature crosses 18°C, that may also be entitled as lower temperature threshold of activity (LTA), activity of both the insects increases and shows maximum trap catch near mid-April when average temperature was recorded 29-31°C. Afterwards, as temperature increases, activity of both the insects again lowers and becomes null near second week of May, when temperature goes above 33°C also entitled as upper temperature threshold of activity (UTA). No insect tarps were observed from second week of May up to first week of August of both the years, during that period daily average temperature remained above upper threshold temperature limit. Nearly same trend was observed during 2010. It was because temperature during this duration was high enough for optimum insect flight hence no traps were observed.

After first week of August, when temperature touches UTA, the incest traps were again observed which becomes maximum near start of September, 2009, where temperature was recorded 31°C that may be called as optimum temperature for activity of both the insects. However, this varies from optimum activity of first population, which was recorded 29°C (average) as optimum temperature of activity (fig. 6). This variation was due to differences in relative humidity during advents of both the population. During 2nd population, relative humidity was recorded much higher (71% & 81% for 2009 & 2010, respectively), than the 1st population (where relative humidity was 46% and 40% for 2009 & 2010, respectively).

Afterwards, activity of both the insects decreased, as evident from light trap data. When temperature again decreased below LTA i.e. 23°C. The difference in LTA for both populations was due to relative humidity differences. After first week of October, 2009, catches due to light traps became zero. This zone of inactivity continuous until mid of March, 2010, when temperature again increased above LTA of both the insects. Fluctuations in populations of both the borers with temperature and humidity can be clearly seen in Figure 4 and 5 for the year 2009 and 2010, respectively.

During studying with Light trap catches of adults of Yellow Stem Borer from 1997 to 1999, Santiago and Sebastian, 1999 also concluded that two population peaks, one during the years-from last week of March to third week of May, and second from September to October were observed. Pathak and Zeyaur, 1994 also reported that maximum number insect activities in case of YSB and WSB was observed above at 29°C, while no activity below 15°C.

Contrary to the trapping data of Yellow and White Stem Borer, Pink Stem Borer showed completely different results. Although, it has been studied earlier in Japan that even with one trap, installed every 80 hectares, only 50% of the PSB population was trapped by light traps. The moths were mostly attracted towards UV and green inflorescent lights.

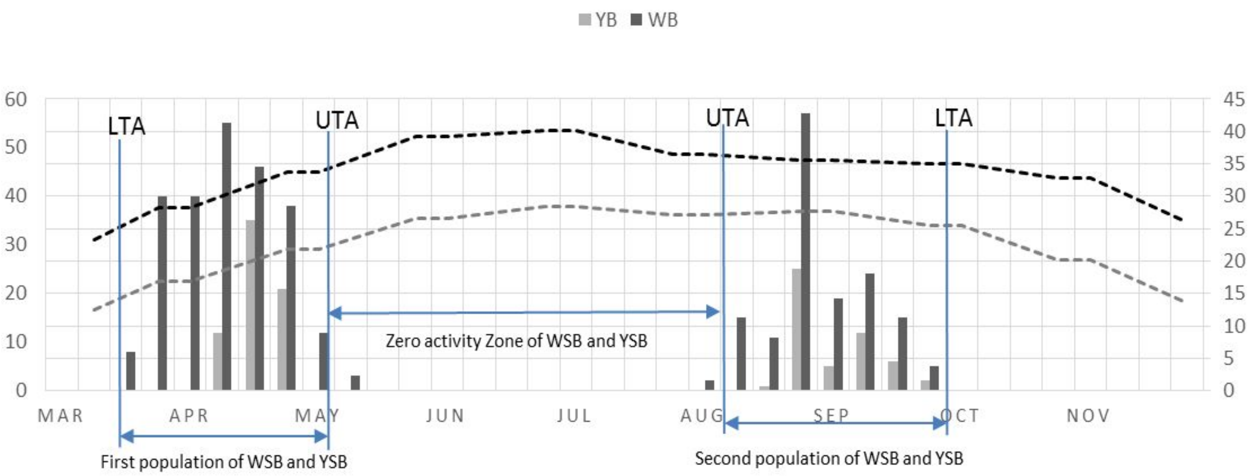

Figure 4. **Population trend of White (WB) and Yellow (YB) stem borer adults collected from light trap, Kala Shah Kaku, 2009 as affected by environmental temperature fluctuation.**

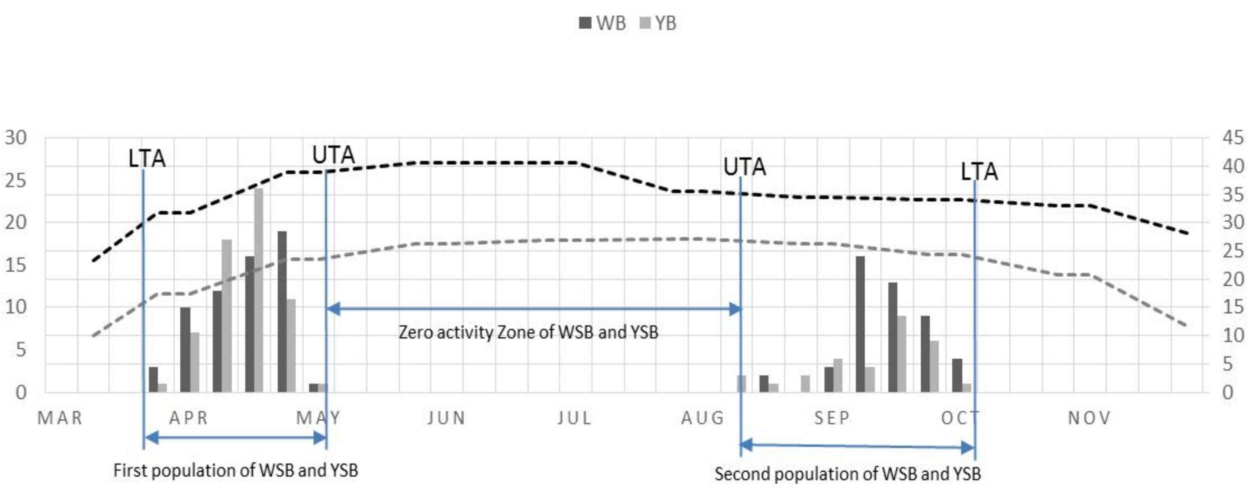

Figure 5. **Population trend of White (WB) and Yellow (YB) stem borer adults collected from light trap, Kala Shah Kaku, 2010 as affected by environmental temperature fluctuation.**

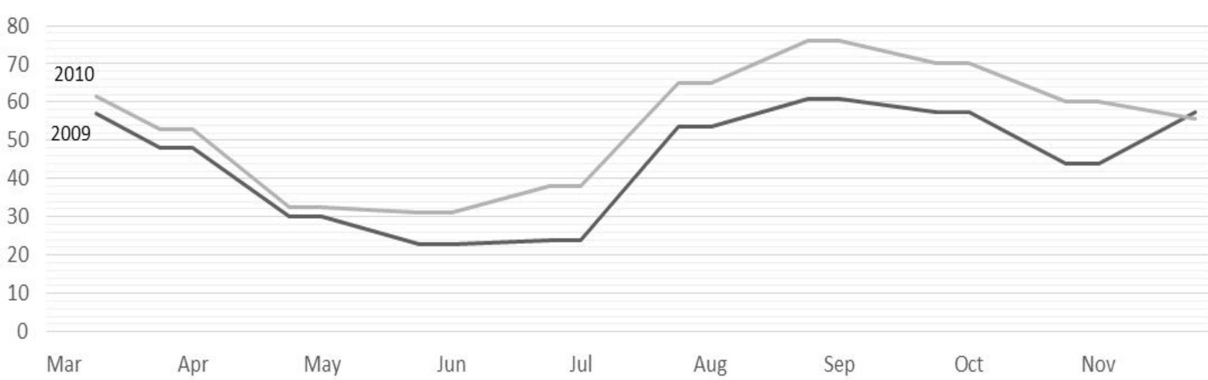

Figure 6. **Average relative humidity percentage at Kala Shah Kaku during 2009 and 2010.**

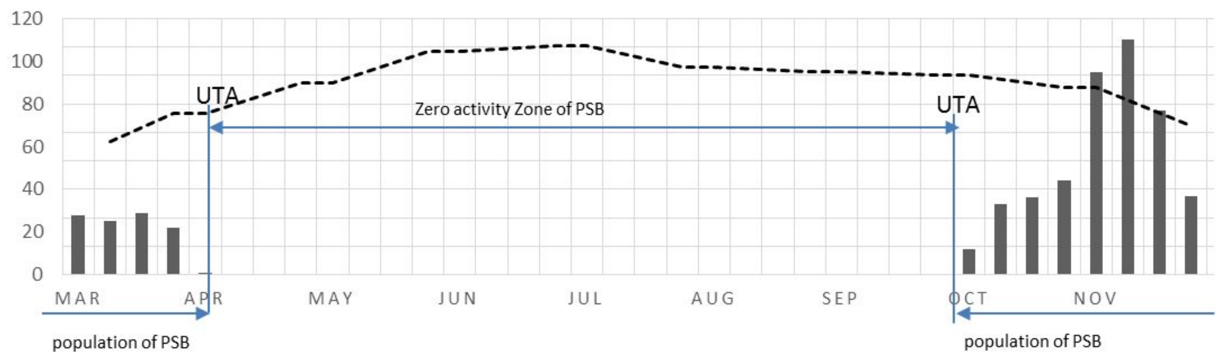

Figure 7. Population trend of Pink stem borer (PSB) adults collected from light trap, Kala Shah Kaku, 2009 as affected by environmental temperature fluctuation.

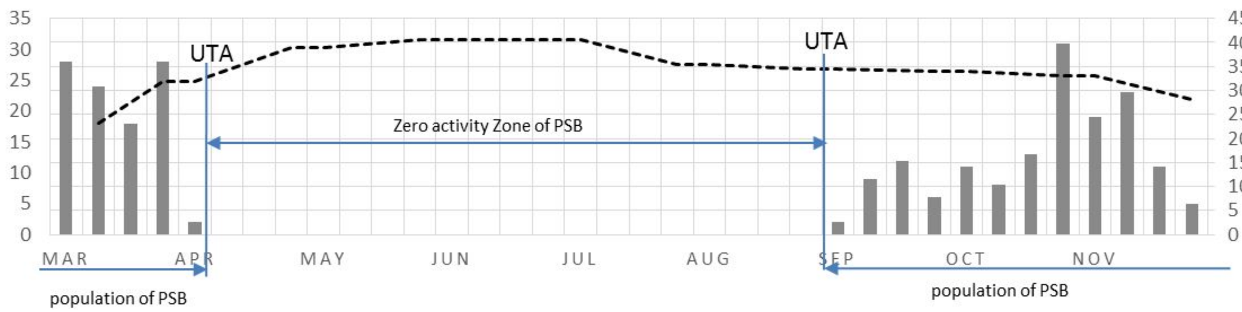

Figure 8. Population trend of Pink stem borer (PSB) adults collected from light trap, Kala Shah Kaku, 2010 as affected by environmental temperature fluctuation.

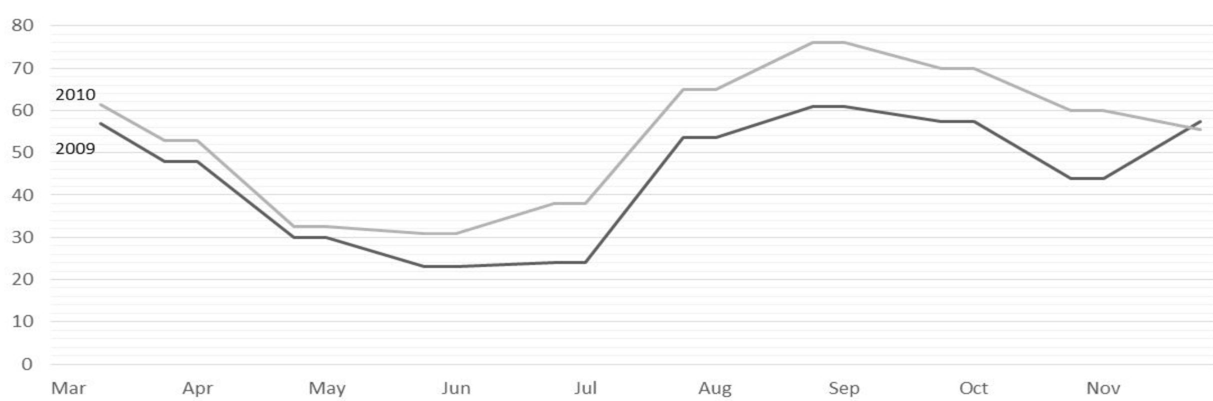

Figure 9. Average relative humidity percentage at Kala Shah Kaku during 2009 and 2010.

However, simple light traps were also proved to be efficient for trapping the moths (Pathak and Zeyaur, 1994). In this study, zones of inactivity as well as upper and lower temperature threshold of activities were also different from those in case of other both insects. In case of Pink Borer, light trap data showed that zone of inactivity started from first week of April, during both the years where UTA was recorded at 32°C. However, zero activity zone ends up to 1st week of October, 2009 (UTA=35°C) and 1st week of September, 2010 (UTA=34°C). Early appearance of population after zero activity zone was majorly due to high relative humidity in 2010 as compared to 2009 during same months. It was observed that, there was only one zone of zero activity which describes continuous appearance of population of PSB during both the year emphasizing the importance of UTA. LTA plays no role in disappearance of population. In other words, the experimental area falls within the zone where average lower temperature remains above LTA of PSB throughout the year. Therefore, LTA of PSB is still needed to be investigated. However, it was reported by many other researchers as well, that activities of PSB moths was mostly recorded during winter, and ceases above 33°C. While, in Pakistan, mean monthly temperature, throughout the year, doesn't fall below the LTA of PSB, therefore, in this study, only UTA could be found out.

It clearly appears from the study that lower and upper temperature threshold is important climatic factors determining insect flight and insect catch. However, upper acts less often than the lower. Atkins (1960) also concluded the same results that insect flight increased rapidly with temperature up to 20-22°C, which ultimately leads towards to the insect catch. It can further be concluded that between 25 to 35°C, temperature does not affect the insect flight and hence the insect catch. Nowinszky (2012) and Ramamurthy *et al.* (2010) also concluded the similar results while using light traps for lepidopterans. Fluctuations in population of adult borer can be visualized in Figure 7 and 8 for year 2009 and 2010, along with the fluctuations in temperature and humidity (Fig. 9)

The abundance of specimens at light may also be influenced by weather, temperature and humidity and have been clearly documented and discussed by many researchers in case of different insects (Persson, 1976; Muirhead-Thompson, 1991; Holloway *et al*., 2001; Intachat *et al*., 2001; Yela and Holyoak, 1997; McGeachie, 1989; Brehm, 2002).

***Regression analysis*:** Results clearly showed that during the months of activity of white and yellow stem borers, there was a significant positive relationship with average temperature as evinced by R^2 value (0.16 and 0.11 for white and yellow stem borer) as depicted in Figure 2a,b. Bell shaped curves in figure also shows the higher incidence of insect catch within a specific range of temperature for both the insects which becomes maximum at middle. In case of pink stem borer, there was a high but negative association with temperature (R^2=0.59). The curve in Figure 2c clearly shows that above 32°C no considerable insect catch was observed, however it increased as temperature was decreased. There is still need to discover the lowest threshold of activity for pink borer. Ramamurthy *et al.* (2010) also concluded that average temperature showed highest and significant relationship with coleopterans, lepidopterans and hemipterans when all types of insect traps were considered together.

Comparing data with average relative humidity (Fig. 3a,b,c) it becomes evident that insect trap showed non-significant relationship with relative humidity as depicted by lower R^2 (0.035) in case of white stem borer; while, significantly positive in case of yellow and pink stem borer (0.344 and 0.339 erspectively). However, it may be concluded that humidity has positive effect on early appearances of both yellow and pink borers while negligible in case of WSB moths. Maximum trap catch of white and yellow stem borers were observed at 30% relative humidity. Average catch were observed 40-80% RH. In case of pink stem borer, maximum moth catch was observed at 58-60% RH (Fig. 3c).

***Conclusion*:** Hence, the knowledge of insect catch in light traps may also be used for developing measures to safeguard the health of agriculture environments. Present study provides scientific information on insect attraction toward light trap under specific environmental conditions of temperature and humidity. It also appears from the results that lower and upper temperature threshold are important climatic factors determining insect flight and insect catch. Based on this information, it may be suggested to avoid late sowing as well as transplanting to hamper the incidence of pink stem borer. Transplanting should be done before end of June, in order to avoid yield losses by second populations of borers, i.e. before onset of mid-August, so that crop should be in grain filling stage before the peaks of adult populations. Therefore, farmers in the study area may be advised to plan their nursery sowing and transplanting in such a way to avoid the periods coinciding with the peak population densities of these insects since more attack is likely to occur during these periods. Moreover, managing vigorous pest scouting and insecticidal sprays keeping in consideration of peak population activity months for these insects, may be helpful in crop management.

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