Research Article

Thriving Situation of White Backed Planthopper (*Sogatella furcifera* H.) in Sindh Province Pakistan

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Abstract | White-backed planthopper (WBPH) *Sogatella furcifera* is one of the most important insect pests of rice throughout the Asia. The recent abundance of pest in Pakistan is in ascending order that requires high attention. Therefore, this study was designed to observe the emerging suitation of WBPH in Sindh province which is the main stack holding area of rice. Three different ecological zones of Sindh province including Larkana, Jacobabad and Badin were selected. The study was based on a sample of 25 tillers covering all area from an acre in order to record the pest population randomly. Later, the pest population was also recorded at particular stages of rice (tillering, milking and booting) with effect of abiotic factors (temperature and relative humidity). In last, the varietal screening of 30 local rice varieties in term of pest population was observed. The data were collected for two rice growing seasons 2012 to 2013. In results, the maximum mean population of 15.25 WBPH/25 hills at 38 ^{0}C with 50% relative humidity was observed in district Badin in the first week of August, 2012. The correlation results regarding mean population of WBPH also indicated effect of temperature and relative humidity (r= 0.51, 0.63 and 0.85 in Larkana, Jacobabd and Badin). In crop stages, the WBPH was observed highest in booting stage in district Badin 11.21±0.45 in year 2012. In varietal screening, the highest population of 3.87±0.49 was recorded on IR-8 and the lowest on RH-302 (0.87±0.26). However, the results in 2013 were recorded different with the maximum mean population of 3.58±0.77 on DR-57 and the lowest on IR-8 (2.03±0.33). The present findings will be useful to manage strategy in order to reduce the pest population of WBPH in future that ultimately affect the yield of rice.

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Introduction

Rice (*Oryza sativa* L.) is the most important and staple food crop that feeds more than one-half of the global population (Maclean et al., 2002; Prasannakumara et al., 2013). The crop is subjected to attack by more than 100 species of insects and 20 of them can cause economic damage. The smaller-sized herbivores i.e. palnthoppers have replaced the larger size arthropods and became the most dominant herbivores in rice ecosystems in most Asian countries including Pakistan. Presently, white-backed planthopper (WBPH) *Sogatella furcifera* is one of the most important insect pests of rice throughout Asia (Heong and Hardy, 2009). The pest has five nymphal instar nymphs that actively feed on the host plant's phloem sap to become adults. These planthoppers feed by inserting their styles into the vascular tissue of plant

leaf blades and leaf sheaths and ingesting the sap and they are also responsible for transmitting various viral diseases in rice plants (Botroll and Schoenly, 2012).

The pest periodically erupts in tropical Asian rice growing countries and became a major threat after farmers adopted green revolution technologies in the 1960's. (Bottrell and Schoenly, 2012). After the launch of a major rice Integrated Pest Management (IPM) programme which involved combined efforts of International Rice Research Institute (IRRI, 1979) and Food and Agriculture Organization (FAO); planthoppers outbreaks were prevented between 1980-1990 (Bottrell and Schoenly, 2012). The management of WBPH by relying on chemical control once again resurged the pest and since 2003, Asian countries have faced planthopper outbreaks that were even worse than those of the 1970's (Heong and Hardy, 2009). White back planthopper remains an important pest in rice granary areas most southern Asian countries (Hafizal and Idris, 2014). A serious outbreak of *S. furcifera* was first time appeared in Pakistan in 1978, followed by 1979 and in 1982 from India. After that the pest reappeared with variable time in different seasons of rice. The reason of its resurgence were still same as previously described by various scientist and most recently reviewed by Bottrell and Schoenly (2012) which included cropping pattern of rice, new high yielding varieties, non- judicious use of insecticide, insect resistance to pesticide and rice varieties, over dose of nitrogenous fertilizer, planting method, water management, climate and absence of natural enemies. However, no present study has been conducted on recent abounding population of white backed planthopper in southern Sindh, Pakistan, which is main stack holding area of rice in that particular area. Therefore, this study has been designed to observe the population of white backed planthopper in different zones of Sindh province and its interaction with environmental factors.

Materials and Methods

Monitoring of pest population and varietal resistance

The WBPH population was conducted from three different ecological zones of Sindh province including Larkana, Jacobabad and Badin throughout the season at fortnight intervals. An acre of rice field was selected and (25) rice tillers were observed randomly from different locations. Five tillers randomly were selected from each corner and five from center. Rice tillers were thoroughly examined for recording the WBPH population. The pest population was also recorded on particular stages of rice including tillering, milking and booting with respective procedure as mentioned above. The effect of abiotic factors like temperature and relative humidity was also correlated with pest population. However, the agronomic practices were same as recommended to cultivate the rice crop. In second experiment, 30 local rice varieties were cultivated in Rice Research Institute, Dokri and varietal resistance in term of pest population over it was observed. The main purpose of the study was to know the most resistant and susceptible rice varieties of local produced. The overall, study was conducted for two consecutive years from 2012 to 2013 in rice growing seasons.

Statistical analysis

The experiments were conducted in Complete Randomized Block Design (RCBD). All experiments were conducted using 25 replications per treatment. All collected data were analysed using one-way analysis of variance (ANOVA) and Least Significant Difference (LSD) at 0.05 probabilities was used to separate the means with significant differences. All the analysis was done using Statistix 8.1.

Results and Discussion

Population of white backed planthopper S. furcifera (H.) in three districts of Sindh province

The population of white backed planthopper, *S. furcifera* (H.) was surveyed from three districts of Sindh province. These districts were Larkana, Jacoabad and Badin locating upper and lower regions of Sindh province. The data were collected for two rice growing seasons 2012 to 2013, respectively. The results regarding fortnightly mean population of *S. furcifera* (H.) showed significant difference as shown in Figure 1, 2 & 3 ($p<0.05$). The maximum mean population of 15.25 WBPH/25 hills at 38 ^{0}C with 50 % relative humidity was observed in district Badin. Such planthopper's population was recorded in the first week of August, 2012. The temperature and relative humidity were also observed fluctuated; meanwhile the highest population of WBPH was observed at optimum temperature of 35 ^{0}C to 40 ^{0}C, respectively.

The second highest mean population of WBPH was recorded in Jacobabad after Badin districts. The mean population was started to decrease with 8.57

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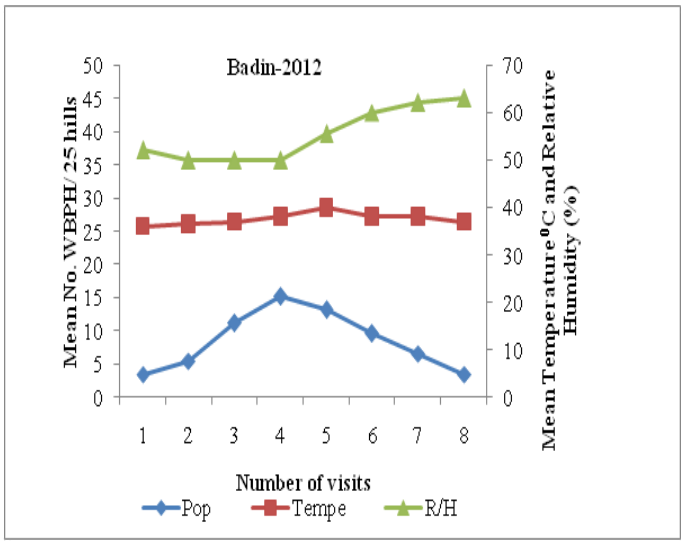

Figure 1: *Mean population of S. furcifera (H.) in district Badin 2012.*

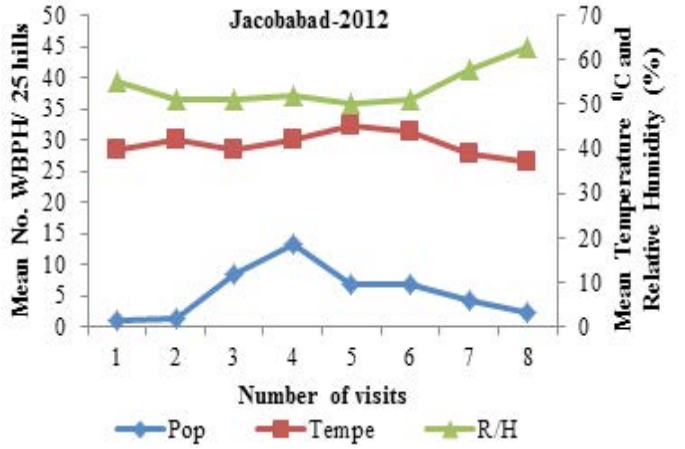

Figure 2: *Mean population of S. furcifera (H.) in district Jacobabad 2012.p;*

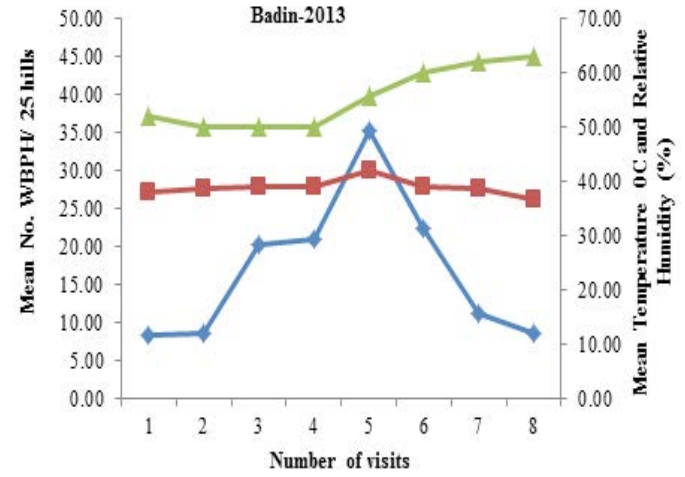

Figure 3: *Mean population of S. furcifera (H.) in district Larkana 2012.*

WBPH/25 hills in the month of July. However, the highest mean population of 13.25 WBPH/25 hills was observed in the month of August at 42 ^{0}C and relative humidity of 52 %. Such population was observed to reduce (6.65 WBPH/25 hills) from month of September. A similar trend of WBPH population was recorded in Larkana with highest mean population of 11 WBPH/25 hills was recorded in the month of August and started to decline (7.77 WBPH/25 hills) from last week of August. The temperature also played a significant role in building population of pest whereas the trend of WBPH in accordance to reach at peak was same. The temperature of 43 ^{0}C and relative humidity of 51 % observed when maximum population of WBPH was observed in Larkana district.

The correlation results regarding mean population of WBPH also indicated effect of temperature and relative humidity in all selected districts (Table 1). There was a positive relationship between humidity and mean population of WBPH in all three districts (r= 0.51, 0.63 and 0.85, respectively in Larkana, Jacobabd and Badin at p< 0.05). However, the relationship between temperature and mean population was negative but significant different (r= -0.55, -0.66 and -0.32, respectively at Larkana, Jacobabad and Badin at p< 0.05). The population of *S. furcifera* (H.) in the next consecutive rice growing season (2013) in selected three districts found increased (Figure 4, 5 & 6). Although, the maximum population was found in district Badin such as 35.1 WBPH/ 25 hills at temperature of 42 ^{0}C and relative humidity of 55.5 % same like as in year 2012 but it was observed increased or jumped in overall population of pest from 2012 to 2013. Such population was recorded to build from 15th July to the end of August. Similarly, the population was found increased in other selected districts but comparatively in 2013 the overall mean population of WBPH was observed higher in district Larkana as compared to district Jacobabad. The highest mean population of 20.55 WBPH/25 hills at temperature of 44 ^{0}C and relative humidity of 55 %. Furthermore, the results in district Jacobabad presented that the maximum mean population of WBPH was 15.26 WBPH/25 hills in the first week of August and such population started to decline in first week of September. Such change in mean population of WBPH in all observed districts could the results of variation in abiotic factors however humidity strongly favored in building up the pest population. In addition, the correlation results also showed similar trend as it was observed in 2012.

The correlation results regarding mean population of WBPH also indicated that the effect of temperature

and relative humidity in all selected districts (Table 2). There was a positive relationship between humidity and mean population of WBPH in all three districts (r= 0.61, 0.53 and 0.85, respectively in Larkana, Jacobabd and Badin at p< 0.05). However, the relationship between temperature and mean population was negative but significant different (r= -0.65, -0.76 and -0.55, respectively at Larkana, Jacobabad and Badin at p< 0.05). Initially it was observed during the survey of rice crop in all selected districts that the trend of white backed planthopper population was varied at different stages of rice. Thus, three prominent stages of rice was selected to collect the data and results showed that in both selected years (2012 and 2013), the maximum population of WBPH was observed in booting stages of rice and such population was particularly highest in district Badin 11.21 ± 0.45 followed by 8.26 ± 0.51 in district Larkana and 7.54 ± 0.70 in district Jacobabad, respectively in year 2012. However, planthoppers population was also higher at tillering stage than milking stage of crop. Meanwhile, in three rice stages (Tillering, Booting and Milking), the overall population was found higher in district Badin as compared to other areas (Figure 7 and 8).

Table 1: *Correlation matric between mean population of S. furcifera (H.) in three districts of Sindh and abiotic factors (2012).*

Locations	Factors	R	R^2	S.E	p value
Larkana	Temp	-0.55	0.55	0.21	<0.05
	Humidity	0.51	0.54	0.11	<0.05
Jacobabad	Temp	-0.66	0.64	0.01	<0.05
	Humidity	0.63	0.54	0.11	<0.05
Badin	Temp	-0.32	0.46	0.21	<0.05
	Humidity	0.85	0.69	0.12	<0.05

In next growing year, the population trend on selected rice stages was observed similar. The highest mean population of 12.56 ± 0.41 WBPH/25 tillers was observed in district Badin followed by 11.21 ± 0.61 and 9.69 ± 0.73 in districts Larkaran and district Jacobabad, respectively. Overall population was found higher as compared to last year data (2012), whereas the maximum jump of population found increased particularly in district Larkana in 2013 as compared to rest of other districts and also in comparison to year 2012. Therefore, it was observed after these findings that although tillering stage of

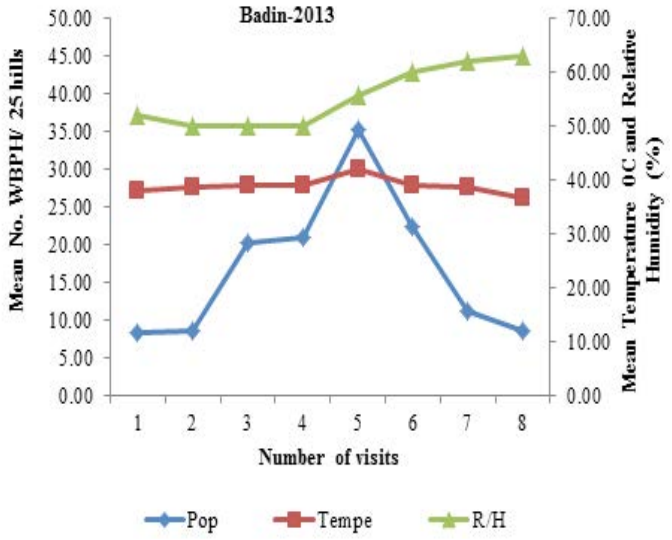

Figure 4: *Mean population of S. furcifera (H.) in district Badin 2013.*

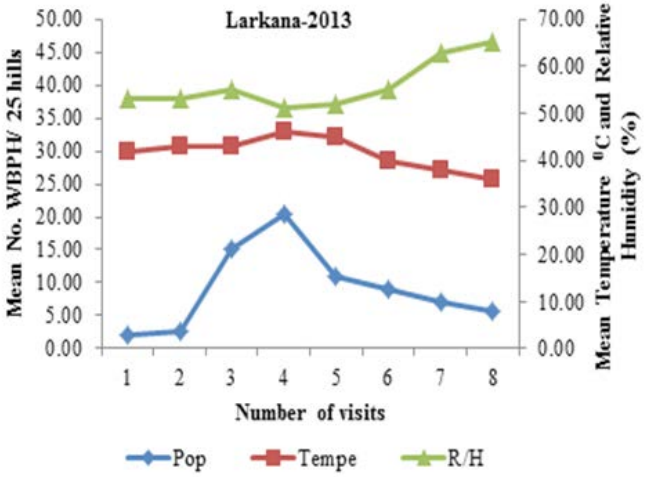

Figure 5: *Mean population of S. furcifera (H.) in district Larkana 2013.*

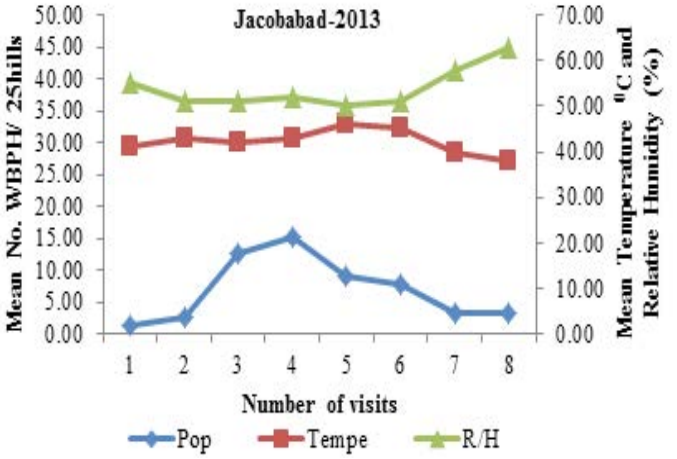

Figure 6: *Mean population of S. furcifera (H.) in Jacobabad Larkana 2013.*

rice invited most of planthoppers through their lush green colour but building of maximum population of planthoppers were recorded in booting stage of rice. It could be due to application of nitrogenous fertiliz

Table 2: *Correlation matric between mean population of S. furcifera (H.) in three districts of Sindh and abiotic factors (2013).*

Locations	Factors	R	R^2	S.E	P value
Larkana	Temp	-0.65	0.65	0.11	<0.05
	Humidity	0.61	0.64	0.21	<0.05
Jacobabad	Temp	-0.76	0.61	0.13	<0.05
	Humidity	0.53	0.59	0.01	<0.05
Badin	Temp	-0.55	0.52	0.05	<0.05
	Humidity	0.85	0.49	0.14	<0.05

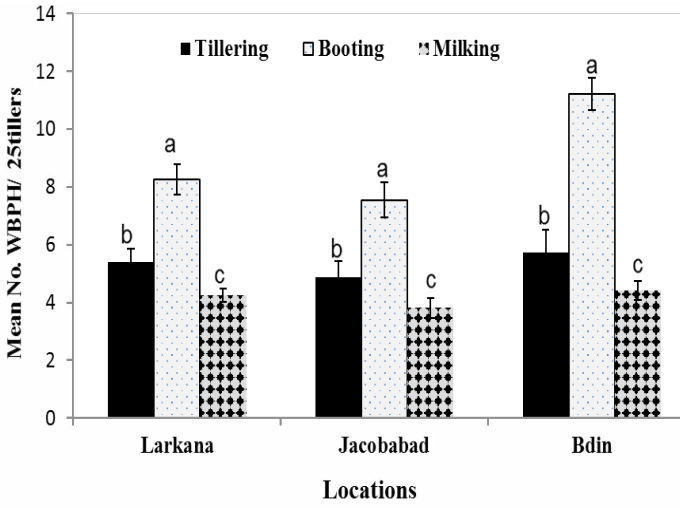

Figure 7: *Mean population of S. furcifera (H.) at variable stage of rice in three selected districts of Sindh province year 2012.*

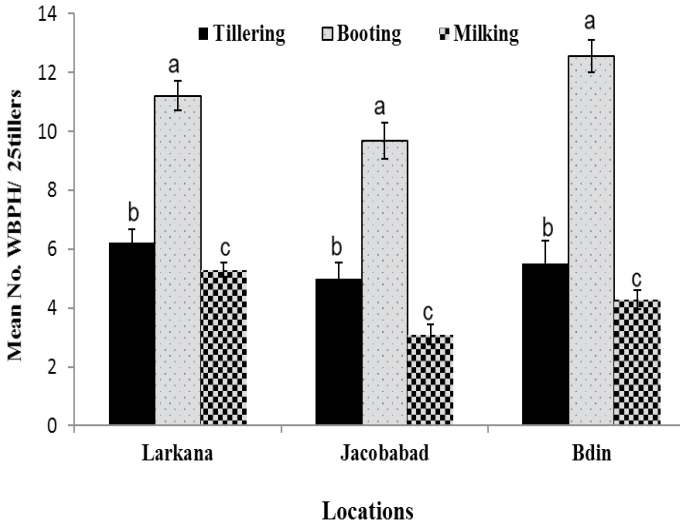

Figure 8: *Mean population of S. furcifera (H.) at variable stage of rice in three selected districts of Sindh province year 2013.*

er which promoted the population of white backed plant hopper in these selected districts of Sindh province. Rice is attacked by various number of pests but whitebacked plant hopper is one of the most dangerous among other pest. Plant hoppers always create a major threat to rice grown areas of the world including Pakistan (Ahmad et al., 2002). The number of different pest outbreaks have been reported in various areas of South Asia affiliated with these small sized insect pests. These plant hoppers varied according to plant growth and temperature with relative humidity and also paly an imperative role to build their population in rice gorwing area of the world (Claridge et al., 1982; Ahmad et al., 2002).

Varietal resistance of rice against BPH S. furcifera (Horvath)

The results in Table 3 showed that the population of WBPH *S. furcifera* observed on different varieties was varied significantly (P <0.005) in both years 2012 and 2013. In 2012, the maximum mean population of 3.87±0.49 was recorded on IR-8 followed by DR- 61 (3.53±0.40) and the lowest on RH-302 (0.87±0.26) followed by RH-300 (0.53±0.07), respectively. However, the results in 2013 were recorded with the maximum mean population of 3.58±0.77 on DR-57 followed by L-2 (3.56±0.98) and the lowest on IR-8 (2.03±0.33) followed by Kangni 27 (1.93±.096) per plant respectively (Table 4). Meanwhile, the infestation percentage was in worth condition in term of damage but different varieties performed differently in both consecutive years against white backed planthopper. Bentur et al. (2003) worked on screening rice varieties against white backed planthopper under field conditions. Kalode et al. (2005) also developed a varietal screening method in green houses conditions. Vaidya (2008) adopted 18 methods for mass screening of rice varieties and similar research work had been conducted before on different rice cultivars to know the response of rice varieties against these planthoppers (Kalode et al., 1985). The literature is full of references for conductiong varietal test of rice varieties against WBPH such as Vaidya and Kalode (1979) screened 536 new germplasm, Sidhu and Khush (1988) screened 20 rice cultivars. Thus, all these findings displayed that with times and growing stage of rice crop, the attack these planthoppers increased. Moreover, these pests also acquired excellent resistance against pesticides and similarly against various rice cultivars or varities.

Conclusion

The population of white backed planthopper, *S. furcifera* (Horvath) was surveyed from three districts of Sindh province (Larkana, Jacoabad and Badin) for two rice growing seasons 2012 to 2013. The maximum mean population of 15.25 WBPH/25 hills at 38 ^{0}C

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Table 3: *Mean population of S. frucifera (H.) on different selected varieties of rice at Rice Research Institute Dokri, 2012.*

Dates of observations											
Varieties	17/9 /12	24 /9/12	01/10/12	08/10/12	15/10/12	29/10/12	05/11/12	12/11/12	19/11/12	22/11/12	Mean±S.E
IR-6	0.95	3.04	2.04	1.95	2.96	4.40	2.56	2.83	2.79	3.08	2.66±0.25efghij
IR-8	3.53	3.05	3.04	1.50	3.56	9.40	4.01	4.09	4.27	2.28	3.87±0.49cdefg
SADAHAYAT	1.75	1.50	1.60	0.80	3.28	4.40	2.22	2.30	2.43	2.39	2.27±0.34a
DR-51	2.20	2.44	1.40	1.79	3.44	1.80	2.18	2.18	2.13	3.64	2.32±0.38defghij
DR-52	2.62	3.12	2.32	1.40	4.96	3.20	2.94	2.99	2.97	1.96	2.85±0.42defghi
DR-57	2.74	2.92	1.60	1.17	1.17	7.00	2.77	2.77	2.74	5.08	3.00±0.43bcde
DR-58	2.92	2.68	1.92	1.25	3.52	6.60	3.15	3.19	3.27	4.28	3.28±0.44bcd
DR-61	2.38	3.12	2.48	1.00	3.68	7.60	3.38	2.39`	3.61	4.48	3.53±0.40abc
DR-82	2.40	2.06	1.84	1.00	2.58	3.80	2.28	2.26	2.29	3.09	2.36±0.40ab
DR-83	3.28	2.24	1.40	0.67	4.60	5.80	3.00	2.95	3.07	6.50	3.35±0.47defghi
DR-92	1.96	1.32	1.55	1.00	2.44	3.40	1.94	1.94	2.05	5.00	2.26±0.36abc
L-2	2.16	2.40	1.56	0.80	4.12	4.40	2.57	2.64	2.68	4.96	2.83±0.38defghij
SHAHKAR AGRO	2.00	2.21	1.68	0.83	0.80	3.20	1.79	1.75	1.68	1.42	1.74±0.37bcdef
LATIFY	1.44	1.57	1.00	0.67	3.20	1.00	1.48	1.49	1.47	1.25	1.46±0.38hijkl
SUPER BAS-MATI	1.00	1.57	0.00	0.00	0.80	1.33	0.78	0.75	0.61	2.44	0.93±0.26jklm
BASMATI	0.67	0.00	1.00	0.00	3.68	1.50	1.14	1.22	1.42	2.32	1.30±0.21lmn
R-H-300	0.00	1.00	0.00	0.00	1.45	0.00	0.41	0.48	0.39	1.60	0.53±0.07klmn
R-H-301	1.00	1.00	1.00	0.00	0.80	1.60	0.90	0.88	0.86	1.76	0.98±0.26n
R-H-302	1.00	0.00	1.00	0.00	3.04	1.40	0.00	0.00	0.91	1.39	0.87±0.26lmn
R-H-303	2.28	1.32	1.44	0.50	2.56	0.00	1.35	1.20	1.17	1.00	1.28±0.39mn
R-H-304	2.84	1.48	1.84	1.92	0.80	3.00	1.98	1.84	1.90	2.32	1.99±0.44klmn
R-H-305	2.20	1.32	1.76	1.84	3.64	3.60	2.39	2.43	2.61	1.30	2.31±0.23ghijk
R-H-306	1.92	1.32	1.64	1.80	2.48	1.00	1.69	1.66	1.71	0.75	1.60±0.36defghi
KANGNI-27	1.00	0.00	1.33	1.33	3.20	1.00	0.00	0.00	0.00	0.89	0.88±0.28ijklm
SONAHRI KANGNI	0.00	1.00	1.57	1.79	2.84	3.40	0.00	0.00	0.00	1.92	1.25±0.23mn
KANGNI TROH	1.96	1.00	1.36	1.36	3.48	2.00	1.86	1.84	1.98	3.84	2.07±0.36klmn
JEERA SHAHI	2.56	1.84	1.64	1.68	3.00	1.20	1.99	1.89	1.90	2.40	2.01±0.41efghijk
RATRIA	2.20	2.76	1.44	1.52	2.28	2.60	2.13	2.12	2.02	2.88	2.20±0.38fghik
JAIJAI-77	2.20	2.44	1.20	1.24	7.56	1.00	2.61	2.67	2.71	0.77	2.44±0.38defghij
SONHARI SOGDASI	2.48	2.28	1.00	1.00	3.96	1.00	1.95	1.87	1.80	1.11	1.84±0.41defgh
Mean ± S.E	1.92± 0.6 c	1.80± 0.1bcd	1.48± 0.1 de	1.06± 0.1 f	2.99± 1.4 ab	3.05± 0.4 a	1.91± 0.1 c	1.92± 0.1 c	1.98± 0.1 de	2.60± 0.2 cd	

The mean values represented by different letters in coloumn (date wise) and rows (variety wise) are significant different at P<0.05.

with 50 % relative humidity was observed in district Badin in the first week of August, 2012. The correlation results regarding mean population of WBPH also indicated the effect of temperature and relative humidity in all selected districts with positive relationship (r= 0.51, 0.63 and 0.85, respectively in Larkana, Jacobabd and Badin). At different rice stages, the maximum-population of WBPH was observed in booting stages of rice and highest in district Badin in year 2012. However, planthoppers population was also higher at tillering stage than milking stage of crop. In varietal screeing, the population of *S. furcifera* observed maximum on IR-8 and the lowest on RH-302 in 2012.

Table 4: *Mean population of S. frucifera (H.) on different selected varieties of rice at Rice Research Institute , Dokri 2013.*

Varieties	17/ 8/13	24/8/13	01/9/13	08/9/13	15/9/13	29/9/13	05/10/13	12/10/13	19/10/13	22/10/13	Mean ± S.E
IR-6	2.98	2.25	2.23	2.13	3.12	6.34	3.45	3.75	2.76	1.34	3.04±0.33^{ab}
IR-8	0.54	2.19	1.08	2.09	2.34	2.78	1.08	2.76	2.56	2.90	2.03±0.33^{cde}
SADA-HAYAT	2.56	4.11	2.22	1.09	2.34	3.45	2.12	2.09	2.08	2.09	2.42±1.03^{bcde}
DR-51	4.23	3.12	2.76	2.98	2.14	5.23	2.77	1.89	1.42	3.45	3.00±1.19^{ab}
DR-52	3.45	2.97	2.67	3.87	2.78	4.98	2.67	2.18	2.90	3.01	3.15±1.05^{ab}
DR-57	2.10	4.09	3.88	2.08	2.98	3.78	4.01	3.98	4.87	3.98	3.58±0.77^{a}
DR-58	2.40	1.98	2.34	3.00	4.09	4.60	3.56	2.98	2.34	2.09	2.94±0.90^{abc}
DR-61	2.34	2.23	2.68	0.83	2.00	4.00	1.79	5.00	1.68	2.45	2.50±0.97^{bcd}
DR-82	3.53	3.15	2.11	2.13	3.22	2.14	3.12	1.09	1.98	2.87	2.53±1.18^{bcde}
DR-83	2.00	1.32	2.56	2.00	4.56	2.09	5.87	2.98	3.78	2.00	2.92±0.83^{abc}
DR-92	3.14	2.87	2.90	2.18	2.76	2.70	3.23	3.14	2.76	2.98	2.87±1.05^{abc}
L-2	3.45	3.09	3.89	1.98	2.45	6.70	4.00	5.00	2.00	3.01	3.56±0.98^{a}
SHAHKAR AGRO	3.06	3.40	2.56	2.00	2.12	5.20	2.57	4.64	2.68	3.96	3.22±0.97^{ab}
LATIFY	4.32	1.57	4.00	2.00	3.20	2.98	3.78	1.49	2.67	3.24	2.92±1.22^{abc}
SUPER BAS-MATI	3.00	3.00	2.50	1.09	0.80	1.33	4.00	0.75	5.00	2.44	2.39±1.12^{bcde}
BASMATI	0.67	4.23	1.00	3.90	3.68	5.00	1.14	5.00	1.42	2.32	2.84±0.48^{abcd}
R-H-300	3.96	2.87	3.85	3.78	2.00	4.00	2.00	0.48	3.00	2.00	2.79±1.19^{abcd}
R-H-301	4.23	1.00	2.00	3.14	2.15	3.12	4.24	3.43	2.45	2.00	2.78±1.23^{abcd}
R-H-302	3.07	2.50	1.00	3.50	3.04	2.00	5.00	6.00	2.97	2.15	3.12±0.99^{ab}
R-H-303	4.32	2.09	4.50	3.23	2.56	3.21	3.26	1.20	2.13	3.09	2.96±1.21^{abc}
R-H-304	5.00	1.48	5.00	1.45	4.32	2.67	2.09	1.23	3.09	0.67	2.70±1.36^{abc}
R-H-305	2.70	1.62	1.56	1.54	2.64	4.00	4.39	5.43	2.65	2.30	2.88±0.42^{abcde}
R-H-306	2.92	3.32	2.62	2.80	3.41	2.34	2.65	2.64	3.00	2.75	2.84±1.01^{abcd}
KANGNI-27	1.78	1.56	2.33	1.89	2.20	1.65	2.00	5.00	0.00	0.89	1.93±.096de
SONAHRI KANGNI	0.00	1.00	1.57	1.79	2.84	3.40	1.98	1.90	1.45	2.00	1.79±0.01^{e}
KANGNI TROH	2.96	3.00	1.36	1.78	2.48	4.54	2.86	3.84	2.00	3.33	2.81±1.03^{abcd}
JEERA SHAHI	2.56	2.00	2.98	2.33	3.00	2.17	1.99	3.00	1.34	2.74	2.41±1.03^{bcde}
RATRIA	3.00	2.73	2.44	2.12	2.78	2.69	2.19	3.12	2.01	2.68	2.58±1.08^{bcde}
JAIJAI-77	3.90	1.46	3.12	2.00	3.00	1.89	3.13	1.56	2.71	4.00	2.68±1.21^{abcde}
SONHARI SOGDASI	3.00	2.28	2.18	2.10	4.96	2.33	2.95	1.45	1.70	2.00	2.50±1.10^{bcde}
Mean ± S.E	2.90±0.2 b	2.49±0.1 cd	2.60±0.1 c	2.29±0.1 e	2.85±0.1 c	3.34±0.2 a	2.98±0.2 b	2.93±0.2 b	2.43±0.1 cd	2.59±0.1 c	

The mean values represented by different letters in coloumn (date wise) and rows (variety wise) are significant different at P<0.05.

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Author's Contribution

All authors contributed equally in the present manuscript. The research was conducted under kind supervision of Dr. Abdul Ghani Lanjar and Dr Imran Khattri who guided the first author throughout his study. Mr. Haroon Hullio worked all the experiment

by himself and gained the data which was statistically analyzed and interpreted with the help of Dr. Agha M. Ahmed. However, Dr. Abdul Rahman Dhuyo helped the first author in setting all the experimental layout and also provided field facilities for conducting all experiment throughout the study.

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