ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 07, pp.21656-21662, July, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

SCREENING OF AVAILABLE CHICKPEA GENOTYPES FOR RESISTANCE POTENTIAL AGAINST GRAM POD BORER, *HELICOVERPA ARMIGERA* (HUBNER) IN SINDH, PAKISTAN

[1]Hafeez-U-Rahman Jamro, [1*]M. Ibrahim Khaskheli, [1]Jan M. Mari and [2]Maqsood A. Rustamani

[1]Department of Plant Protection, Sindh Agriculture University, Tando Jam, Pakistan
[2]Department of Entomology, Sindh Agriculture University, Tando Jam, Pakistan

ARTICLE INFO

Article History:
Received 20th April, 2018
Received in revised form
19th May, 2018
Accepted 26th June, 2018
Published online 30th July, 2018

Key Words:
Chickpea genotype,
H. armigera,
Locations.

ABSTRACT

Gram pod borer, *H. armigera* (Hub.) is one of the voracious pests of chickpea that needs considerable attention for the management. Thus, present studies were conducted to find out the elite genotype from the existing materials. Ten different genotypes were tested in two different locations; Upper zone (Dokri, Larkana) and Lower zone (Tandojam) of Sindh province of Pakistan. The results regarding the pod infestation revealed significant ($P < 0.05 = 0.0000$) difference among ten tested genotypes. Significantly, lowest percent pod infestation was recorded for NIFA- 2005 followed by DG-89 and DG-92. Significantly higher percent pod infestation was observed for Choola followed by Tamman-2013 and Sanyasi before and after harvesting during 2015 and 2016, respectively, when experiments were conducted at Upper zone. In lower zone, significantly, lowest percent pod infestation was recorded for DG-89 followed by NIFA- 2005 and DG-92. However, there was no significant difference between DG-89 and NIFA- 2005 for pod infestation. Significantly higher percent pod infestation was observed for Choola followed by Sanyasi and Dasht. During both years of trials, it was moderate in Balkassar- 2000 followed by Wanahar- 2000, Dasht and Tamman- 2013. Based on pod infestation percent, DG-89 (3) was rated as Moderate Resistance (MR) and Resistance (R) at RRI, Dokri and Tandojam, respectively. However, NIFA- 2005 (2) was rated as R at both locations; whereas, DG-92 (3), Wanahar- 2000 (3) and Balkassar-2000 (3) were rated as MR at both locations. Three varieties; Punjab- 2008 (4), Tamman- 2013 (4), and Dasht (4) were found MS at both observed locations. The variety Sanyasi (5) was rated as Susceptible (S), Choola (6) as high susceptible (HS) at Dokri, while susceptible at Tandojam. Present studies confirmed elite genotypes for Upper and lower zones of Sindh province of Pakistan that maybe used for sustainable chickpea production.

Citation: Hafeez-U-Rahman Jamro, M. Ibrahim Khaskheli, Jan M. Mari and Maqsood A. Rustamani, 2018. "Screening of available chickpea genotypes for resistance potential against gram pod borer, helicoverpa armigera (hubner) in Sindh, Pakistan", *International Journal of Development Research*, 8, (07), 21656-21662.

INTRODUCTION

Chickpea, *Cicer arietinum* L. is an important grain of legume crops of Pakistan, normally grown in the post rainy season. Based on the cultivated area, it is ranked on 19th number among the crops, and is grown in 34 countries of the world. The cultivated acreage under pulses in India, Pakistan, Nepal, and Bangladesh covers about 90% of the world (Saxena *et al.,* 2001). However, Pakistan is the 2nd largest chickpea producer with an annual production of 673 thousand tons (Anonymous, 2013). In Pakistan, it is grown on an area of 972 thousand hectares as winter crop (during Rabi season) with 581 kg hectare^{-1} of yield which is very low as compared to many chickpea growing countries (FAO, 2000). Chickpea is known as with various names such as gram, or Bengal gram, garbanzo or garbanzo bean, as well as the Egyptian pea (Baynes and Smith, 1880; Agricultural Research Service, 2014). Besides its economic importance, numbers of pests are found infesting chickpea from seedling stage to maturity, which are attacking on roots, foliage and pods. The major insect pest species associated with the chickpea crop are belonging to the insect orders Lepidoptera, Hemiptera, Diptera and Thysanoptera (Avalos, 2010; Fichetti, 2009). About 60 different insect pest species are known to feed on chickpea; however, *Helicoverpa armigera* (Hub.) is considered as major pest (Sharma, 2014; Ahmed, 1990), that cause severe losses every year in standing

***Corresponding author:* M. Ibrahim Khaskheli,**
Department of Plant Protection, Sindh Agriculture University, Tando Jam, Pakistan.

crops. Some recent studies also revealed that a gram pod borer is the major constraints to chickpea (Mulwa, 2010). Pod borer causes yield losses of up to 80% especially in ASALs areas where insect severity is high, but can be as low as 30- 50% in cooler areas. It is also mentioned by Ahmed and Awan (2013) that the gram pod borer is one of the major insect pests of chickpea and has great economic importance. Though, screening for resistance to insects under natural conditions is a long- term process because of the variation in insect density across seasons and locations, and staggered flowering of the test material; however, from time to time, there is also need to find the elite germplasm from the available material to accomplish the need to growers. Knowledge concerning the periods of maximum insect abundance and hot-spots is the first step to initiate work on screening and breeding for resistance to *H. armigera*. Delayed plantings of the crop and use of infester rows of a susceptible cultivar of the same or of a different species can be used to increase *H. armigera* infestations under natural conditions (Sharma, 2005). Moreover, no any fruitful protective measures were implemented to control insect pest spreading on crop. Though, some studies on screening for resistance have been documented in the literature from various countries like as India (Choudhary *et al*., 2014; Rehman *et al*., 2017; Mantesh *et al*., 2017), Pakistan (Nadeem *et al*., 2010; Sarwar *et al*., 2011; Abro *et al*., 2017), Bangladesh (Altaf, 2009). However, still there are several genotypes/germplasm that posses great yield potential as well as nutritive values. In Pakistan, especially in Sindh province there is diversity of agro-ecological conditions that categorized this province in different zones like upper, middle and lower. Because of climatic variation the crop varieties are not producing the actual potential. So such kind genotypes need to be evaluated from time to time as the suitable one could be find out for better and quality production for particular zone. Keeping these facts present studies were conducted to screen out the available chickpea genotypes for resistance potential against gram pod borer, *Helicoverpa armigera* (Hubner) in Sindh, Pakistan.

MATERIALS AND METHODS

Study location: Present studies were conducted on screening of available chickpea genotypes for resistance potential against gram pod borer, *Helicoverpa armigera* (Hubner) at different agro- ecological zones of Sindh, Pakistan i. e Upper Zone (Dokri, Larkana) and Lower zone (Tandojam). The experiments were conducted during 2014-15 and 2015-16 at Rice Research Institute (RRI), Dokri, Larkana and Plus Research Sub-Station, Agriculture Research Institute (ARI), Tandojam, Pakistan.

Plant Materials: Ten different commercial chickpea genotypes viz; Choola (control/check), Punjab- 2008, Dasht, Balkasar-2000, Wanhar-2000, Tamman-2013, NIFA-2005, Sanyasi, DG- 92 and DG- 89 were selected based on the yield and quality potential. It is important to know that varieties DG-89 and DG-92 are quite famous and are shown on regular basis in these areas and also these variety were released from Rice Research Institute, Dokri. Therefore these varieties have been particularly included in the current studies. The certified seeds/ breeders nucleic seed (BNS) of chickpea cultivars were obtained from different breeders of research institutes.

Experimental layout and growing conditions: All varieties were sown under field conditions without any control measures of pest, with three replications in Randomized Complete Block Design (RCBD). Each plot size was 7.2 sq m and between row to row 30 cm space was maintained. There were 06 rows (lines)/per plot in each replication. The rows length was 04 meters in every block and 01 meter gap between the rows was maintained each replication, respectively. About 80 gram seed per replication of each treatment was sown through drilling methods. The seeds were drilled into the furrows and then covered with a 5 cm soil layer over them. All other standard agronomic practices like weeding, hoeing, tillage practices were applied. Irrigation applications were applied according to the crop recommendations. No irrigations were applied to all the genotypes as per local circumstance and recommendations, because some locations were paddy growing areas of Sindh, so soil conserve enough moisture, thus, no need of further irrigation for chickpea crop in these areas. The crop was kept free from weeds/ unwanted plants manually. All the cultural practices were performed uniformly in each replicate.

Resistance screening: In the current studies, resistance screening of chickpea genotypes was assessed based on pre- and post-harvest pod infestation. All the experiments were strictly monitored for pest appearance at weekly interval beginning from the germination to harvest. Data on pod infestation was recorded on weekly basis from the date of sowing to harvest. Infestation of gram pod borer was recorded from 20 plants randomly selected from each replication. Total number of pods and number of damaged pods per plant infested by pod borer were counted. At the end crop was harvested and threshed manually. Then post harvest damage/ infestation percentage was also recorded. Randomly 500 pods per replication of each variety were selected and then healthy and infested pods were counted. Percent infestation pod was calculated by using the formula mentioned below:

$$\text{Percentage of Pod infestation} = \frac{Number\ of\ Infected\ Pods}{Total\ Number\ of\ Observed\ Pods} \times 100$$

Rating of resistance for each tested genotype was conducted based on rating scale of chickpea cultivars mentioned in Table 1. Resistance/susceptibility of each examined variety of chickpea were determined by using our modified pest susceptibility ratings (PSR) scale (Table 1) based on the scale suggested by Jackai (1981).

Statistical analysis: Data were statistically analyzed using computer software package Statistix 8.1 (Analytical Software 2005). The data were analyzed of variance (ANOVA) and to test the superiority of mean values LSD test was applied and all differences described in the text were considered significant at the 5 % level of probability.

Table 1. Pest susceptibility ratings (PSR) scale used for the host screening of chickpea varieties in current studies

Ratting Scale	Percent pods damaged	Reaction	
0	0	Immunity	I
1	1-10%	High Resistance	HR
2	11-20%	Resistance	R
3	21-30%	Moderately Resistance	MR
4	31-40%	Moderately Susceptible	MS
5	41-50%	Susceptible	S
6	= >51%	Highly Susceptible	HS

Table 2. Percent infested pods observed under field conditions of RRI, Dokri during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Variety	2015								2016								Overall Mean	
	Jan		Feb		March		April		Jan		Feb		March		April			
DG-89	0	y	0	y	13.916	v	20.96	p - s	0	y	0	y	13.52	W	21.962	p - s	8.795	f
NIFA- 2005	0	y	0	y	15.595	uv	16.65	t - v	0	y	0	y	15.57	uv	22.523	o -r	8.79	f
DG-92	0	y	2.94	y	19.605	r- t	23.38	m - r	0	y	0	y	18.57	s-u	31.13	f - i	11.95	e
Dasht	0	y	0	y	22.736	n - r	28.96	h - k	0	y	0	y	23.69	m-q	33.943	f	13.658	d
Balkassar-2000	0	y	8.139	x	22.967	m-r	20.316	q - t	0	y	0	y	20.37	q-t	31.45	f - i	12.904	de
Wanahar- 2000	0	y	3.333	y	25.833	k - o	26.46	j - n	0	y	0	y	23.26	m-r	32.723	f-h	13.945	d
Punjab- 2008	0	y	0	y	26.629	j-m	28.18	i - k	0	y	0	y	29.72	g-j	39.255	d	15.473	c
Sanyasi	0	y	10	wx	27.659	i-l	33.48	fg	0	y	0	y	40.49	cd	43.839	bc	19.431	b
Tamman- 2013	0	y	0	y	28.171	i-k	34.22	ef	0	y	0	y	24.21	l - p	37.839	de	15.554	c
Choola	0	y	0	y	32.444	f-h	51.58	a	0	y	0	y	46.45	B	51.05	a	22.688	a
SE								1.9491									0.6891	
LSD ($P < 0.05$)								3.8274									1.3532	

*Mean of 20 Plants/Replication

Note: The alphabetical letter showing the homogenous grouping in column are not significant with each other.

Table 3. Percent infested pods observed under field conditions of Tandojam during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Variety	2015								2016								Overall Mean	
	Jan		Feb		March		April		Jan		Feb		March		April			
DG-89	0	q	0	q	15.337	o-p	15.078	p	0	q	0	q	14.051	p	15.062	p	7.441	e
NIFA- 2005	0	q	0	q	18.441	o	15.085	p	0	q	0	q	14.638	p	15.067	p	7.904	e
DG-92	0	q	0	q	26.014	m-n	28.282	k-m	0	q	0	q	30.606	i- k	28.25	k-m	14.767	d
Balkassar-2000	0	q	0	q	24.273	n	30.404	i-k	0	q	0	q	32.082	h -j	30.368	i-k	14.456	d
Wanahar- 2000	0	q	0	q	24.623	n	30.06	j-l	0	q	0	q	32.844	g- j	30.021	j-l	14.693	d
Punjab- 2008	0	q	0	q	32.578	g-j	33.408	g- i	0	q	0	q	42.979	C	33.371	g- i	17.792	c
Tamman- 2013	0	q	0	q	37.339	d-f	34.716	e-h	0	q	0	q	35.592	d - g	34.672	f- h	17.351	c
Dasht	0	q	0	q	26.853	l- n	38.03	d	0	q	0	q	34.575	f- h	37.965	de	17.178	c
Sanyasi	0	q	0	q	41.655	c	48.318	b	0	q	0	q	35.728	d - g	48.259	b	21.745	b
Choola	0	q	0	q	58.113	a	49.596	b	0	q	0	q	44.024	c	49.543	b	25.159	a
SE								1.664									0.5883	
LSD ($P < 0.05$)								3.2676									1.1553	

*Mean of 20 Plants/Replication

Note: The alphabetical letter showing the homogenous grouping in column are not significant with each other.

RESULTS

Pod infestation by gram pod borer under field conditions: The results regarding the pod infestation by gram pod borer, *H. armigera* (Hub.) in chickpea observed in two different location, Upper zone (Dokri, Larkana) and Lower zone (Tandojam) of Sindh province of Pakistan revealed significant ($P < 0.05 = 0.0000$) (Supporting Table 1 and 2) difference among ten tested verities. The data was recorded from 20 randomly selected plants and mean of 20 plants was statistically analyzed and is presented in all parameters of the results.

Upper Zone (Dokri, Larkana): The percent infested pods observed under field conditions of RRI, Dokri during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *H. armigera* showed no significant difference between the two years of observation. The data for pod infestation by gram pod borer was recorded from the first week of January and continued upto the month of April during the year, 2015 and 2016, respectively. No infestation was recorded in the month of January of both years; however, it was noticed in some varieties during the month of February, 2015. In the month of March 2015 and 2016, all tested varieties exhibited the infestation of gram pod borer. The performance of tested genotype become obvious in the month of April and based on the mean percent of April months of 2015 and 2016, all genotypes were ranked for resistance reaction. Significantly, lowest percent pod infestation was recorded for NIFA-2005(16.65 and 22.523%) followed by DG-89 (20.96 and 21.962%) and DG-92(23.38 and 31.13%) during 2015 and 2016, respectively. Though the percent pod infestation of NIFA- 2005 (22.523%) was little higher compared to DG-89 (21.962%) for 2016; however, no significant difference was observed among these two varieties for both years (Table 2). The percent pod infestation was observed moderate in Balkassar-2000 (20.316 and 31.45%) followed by Wanahar- 2000 (26.46 and 32.723%), Punjab-2008 (28.18 and 39.255%) and Dasht (28.96 and 33.943%). Significantly higher percent pod infestation was observed for Choola (51.58 and 51.05%) followed by Tamman-2013 (34.22 and 37.839%) and Sanyasi (33.48 and 43.839%) during 2015 and 2016, respectively. There was no significant difference observed during 2015 for Sanyasi (33.48 %) and Tamman-2013 (34.22%); However, percent pod infestation in Sanyasi (43.839%) was significantly higher compared to Tamman-2013 (37.839%) during 2016, when experiments were conducted at Upper zone of Sindh (RRI, Dokri, Larkana) (Table 2).

Lower zone (Tandojam): The percent pod infestation by gram pod borer, *H. armigera* (Hub.) in chickpea observed in Lower zone (Tandojam) also revealed significant ($P < 0.05 = 0.0000$) difference among tested verities. The percent infested pods observed under field conditions of Tandojam during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *H. armigera* showed no significant difference between the two years of observation and presented in Table 3. The data for pod infestation by gram pod borer was recorded similarly from the first week of January and continued upto the

Table 4. Percent infested pods observed after harvesting at RRI, Dokri during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Variety	Pod Infestation Percent*					
	2014-15		2015-16		Overall Mean	
DG -89	21.467	f - h	18.8	h	20.133	e
NIFA- 2005	20.867	gh	21.667	f-h	21.267	e
DG- 92	28.533	e-h	34.333	d-f	31.433	d
Balkassar- 2000	36	c-e	30.8	e-h	33.4	d
Wanahar- 2000	32.8	d-g	34.8	c-e	33.8	d
Dasht	35.133	c-e	34.733	c- e	34.933	cd
Tamman- 2013	41.267	c-e	38.267	c-e	39.767	b-d
Punjab-2008	47.4	bc	40.467	c-e	43.933	bc
Sanyasi	47.267	bc	45.133	b-d	46.2	b
Choola	60.467	a	57.133	ab	58.8	a
SE	6.3777				4.5097	
LSD ($P < 0.05$)	12.911				9.1294	

*Mean of 20 Plants/Replication

Note: The alphabetical letter showing the homogenous grouping in column are not significant with each other.

Table 5. Percent infested pods observed after harvesting at Tandojam during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Variety	Pod Infestation Percent*					
	2014-15		2015-16		Overall Mean	
DG- 89	16.133	jk	13.533	k	14.833	g
NIFA- 2005	16.8	i-k	14.2	jk	15.5	g
DG- 92	22.4	hi	19.8	ij	21.1	f
Wanahar- 2000	29	fg	26.4	gh	27.7	e
Balkassar- 2000	29.6	fg	31	e-g	30.3	de
Punjab-2008	33.733	d-f	31.133	e-g	32.433	cd
Tamman- 2013	34.4	d-f	35.733	de	35.067	c
Dasht	33.133	d-f	38.8	d	35.967	c
Sanyasi	51.267	bc	48.667	c	49.967	b
Choola	59.2	a	56.6	ab	57.9	a
SE	3.0108				2.1290	
LSD ($P < 0.05$)	6.0951				4.3099	

*Mean of 20 Plants/Replication

Note: The alphabetical letter showing the homogenous grouping in column are not significant with each other.

Table 6. Resistance reaction of different genotypes against gram pod borer, *Helicoverpa armigera* under field conditions of RRI, Dokri and Tandojam during 2015 and 2016

Variety	Pod Infestation Percent*									
	RRI, Dokri		Mean	Rating Scale	Reaction	Tandojam		Mean	Rating Scale	Reaction
	2015	2016				2015	2016			
DG-89	20.96	21.962	21.46	3	MR	15.078	15.062	15.07	2	R
NIFA- 2005	16.65	22.523	19.59	2	R	15.085	15.067	15.08	2	R
DG-92	23.38	31.13	27.26	3	MR	28.282	28.25	28.27	3	MR
Wanahar- 2000	26.46	32.723	29.59	3	MR	30.06	30.021	30.04	3	MR
Balkassar-2000	20.316	31.45	25.88	3	MR	30.404	30.368	30.39	3	MR
Punjab- 2008	28.18	39.255	33.72	4	MS	33.408	33.371	33.39	4	MS
Tamman- 2013	34.22	37.839	36.03	4	MS	34.716	34.672	34.69	4	MS
Dasht	28.96	33.943	31.45	4	MS	38.03	37.965	38.00	4	MS
Sanyasi	33.48	43.839	38.66	5	S	48.318	48.259	48.29	5	S
Choola	51.58	51.05	51.32	6	HS	49.596	49.543	49.57	6	S

*Mean of 20 Plants Per Replication

month of April during the year, 2015 and 2016 respectively, as explained earlier. No infestation was recorded in the month of January of both years; however, in the month of March 2015 and 2016, all tested varieties showed the infestation of gram pod borer. Moreover, there was variability in the percent pod infestation for the months March and April, 2016. In some tested varieties like as DG-92, Balkassar-2000, Wanahar-2000, Punjab- 2008 and Tamman- 2013, little higher infestation percent was recorded during the month of March and then it was reduced in April, 2016. Furthermore, the performance of tested genotype becomes obvious in the month of April of 2015 and 2016. Significantly, lowest percent pod infestation was recorded for DG-89 (15.078 and 15.062%) followed by NIFA- 2005 (15.085 and 15.067%) and DG-92 (28.282 and 28.25%) during 2015 and 2016, respectively. However, there was no significant difference between DG-89 and NIFA- 2005 for pod infestation (Table 3). Similar to Upper zone, the percent pod infestation at Lower zone was observed moderate in Balkassar-2000 (30.404 and 30.368%) followed by Wanahar- 2000 (30.06 and 30.021%), Punjab-2008 (33.408 and 33.371%) and Tamman- 2013 (34.716 and 34.672 %). Significantly higher percent pod infestation was observed for Choola (49.596 and 49.543%) followed by Sanyasi (48.318 and 48.259%) and Dasht (38.03 and 37.965%) during 2015 and 2016, respectively. The performance of all tested varieties showed great variability for damage percent caused by gram pod borer when experiments were conducted at Lowe zone of Sindh (Tandpjam). Some varieties showed higher infestation percent at Upper zone while lower percent at Lower zone of Sindh Province; however, it was vice versa for other varieties observed during 2015 and 2016 (Table 3).

Pod infestation after harvesting: The performances of all tested genotypes were further confirmed by assessing the harvested pods per replications. Randomly 500 pods were selected and then healthy and infested pods were counted. The performance of all genotypes become obvious when significantly lowest percent pod infestation was recorded for DG -89 (21.467 and 18.8%) followed by NIFA- 2005 (20.867 and 21.667%) and DG- 92 (28.533 and 34.333%) However, DG- 92 (34%) showed higher percent than Balkassar- 2000 (30%) during 2016. During both year of trials, it was moderate in Balkassar- 2000 (36 and 30.8%) followed by Wanahar- 2000 (32.8 and 34.8%), Dasht (35.133 and 34.733%) and Tamman- 2013 (41.267 and 38.267%). The highest pod infestation after harvesting was noticed in Choola (60.467 and 57.133%) followed by Sanyasi (47.267 and 45.133%) and Punjab-2008 (47.4 and 40.467%) from the genotypes tested at Upper Zone (RRI, Dokri) during 2015 and 2016, respectively (Table 4). The performance of genotypes at Lower zone (Tandojam) significantly depicted lowest percent of pod infestation for DG- 89 (16.133 and 13.533%) followed by NIFA- 2005 (16.8 and 14.2 %) and DG- 92 (22.4 and 19.8 %). During both years of trials, it was moderate in Wanahar- 2000 (29 and 26.4 %), Balkassar- 2000 (29.6 and 31 %), Punjab-2008 (33.733 and 31.133 %), Tamman- 2013 (34.4 and 35.733%). The highest pod infestation after harvesting was noticed in Choola (59.2 and 56.6 %) followed by Sanyasi (51.267 and 48.667 %) and Dasht (33.133 and 38.8 %) from the genotypes tested at Lower Zone (Tandojam) during 2015 and 2016, respectively (Table 5).

Rating of genotypes: All genotypes tested at Upper (RRI, Dokri) and Lower zone (Tandojam) of Sindh, Pakistan were rated based on our modified scale. Mean percent of highest pod infestation that was recorded in the month of April during 2015 and 2016 at both locations, RRI, Dokri and Tandojam was used for the rating of resistance against gram pod borer. According to rating scale the reaction of varieties DG-89 (3) was rated as Moderate Resistance (MR) and Resistance (R) at RRI, Dokri and Tandojam, respectively. However, variety and NIFA- 2005 (2) was rated as R at both locations. Whereas DG-92 (3), Wanahar- 2000 (3) and Balkassar-2000 (3) were rated as MR at both locations. Three varieties such as Punjab- 2008 (4), Tamman- 2013 (4), and Dasht (4) were found MS at both observed locations. The variety Sanyasi (5) was rated as S based on higher pod infestation percent and rating scale. The performance of Choola (6), check variety, showed the highest susceptibility (HS) at Dokri, while susceptibility (S) at Tandojam based on highest pod infestation percent and rating scale (Table 6).

DISCUSSION

The pod infestation by gram pod borer, *H. armigera* (Hub.) in chickpea depicted the voracious nature of this pest that needs considerable attention. Thus, a present study has been conducted to find out the elite genotype from the existing varieties. Present studies have tested 10 different genotypes in two different location; Upper zone (Dokri, Larkana) and Lower zone (Tandojam) of Sindh province of Pakistan. The data of all field experiments was recorded from 20 randomly selected plants and mean of 20 plants was statistically analyzed and is presented in all parameters of current studies. Though, there are several studies has already been conducted for the screening of genotypes (Altaf, 2009; Nadeem *et al*., 2010; Sarwar *et al*., 2011; Choudhary *et al*., 2014; Rehman *et al*., 2017; Mantesh *et al*., 2017; Abro *et al*., 2017). However, their selected varieties and locations were quite different than the current study. Simultaneously, in the recent past, no any work has been reported in the literature that focusing the screening of elite genotypes. This situation created the gap to screen out the existing genotype for the need of growers, researcher and scientists. The data for pod infestation by gram pod borer was recorded from the first week of January and continued upto the month of April during the year, 2015 and 2016, respectively, at RRI, Dokri. No infestation was recorded in the month of January of both years; however, it was noticed in some varieties during the month of February, 2015. This might be due to the availability of conducive environment for pest infestation. In the month of March 2015 and 2016, all tested varieties showed the infestation of gram pod borer. However, the performance of tested genotype become obvious in the month of April and based on the mean percent of April months of 2015 and 2016 all genotypes were ranked for their reaction. Significantly, lowest percent pod infestation was recorded for NIFA- 2005 (16.65 and 22.523%) followed by DG-89 (20.96 and 21.962%) and DG-92 (23.38 and 31.13%) during 2015 and 2016, respectively. Though the percent pod infestation of NIFA- 2005 (22.523%) was little higher compared to DG-89 (21.962%) for 2016; however, no significant difference was observed among these two varieties for both years. Significantly higher percent pod infestation was observed for Choola (51.58 and 51.05%) followed by Tamman-2013 (34.22 and 37.839%) and Sanyasi (33.48 and 43.839%) during 2015 and 2016, respectively, when experiments were conducted at Upper zone of Sindh (RRI, Dokri, Larkana).

In Lower Zone (Tandojam) the performance of all genotypes was observed similar except some varieties that showed different response than Upper Zone. No infestation was recorded in the month of January of both years; however, in the month of March 2015 and 2016, all tested varieties showed the infestation of gram pod borer. Moreover, there was variability in the percent pod infestation for the months March and April, 2016. In some tested varieties like as DG-92, Balkassar-2000, Wanahar- 2000, Punjab- 2008 and Tamman-2013, little higher infestation percent was recorded during the month of March and then it was reduced in April, 2016. Significantly, lowest percent pod infestation was recorded for DG-89 (15.078 and 15.062%) followed by NIFA- 2005 (15.085 and 15.067%) and DG-92 (28.282 and 28.25%) during 2015 and 2016, respectively. Significantly higher percent pod infestation was observed for Choola (49.596 and 49.543%) followed by Sanyasi (48.318 and 48.259%) and Dasht (38.03 and 37.965%) during 2015 and 2016, respectively, when experiments were conducted at Lowe Zone of Sindh (Tandojam). Some varieties showed higher infestation percent at Upper Zone while lower percent at Lower Zone of Sindh Province; however, it was vice versa for other varieties observed during 2015 and 2016. This variation was because of environmental condition of the area as well as adoptability of the genotype to that specific location. Nadeem *et al*., (2010) conducted field studies to assess the thirteen advanced desi chickpea genotypes against chickpea pod borer, *Helicoverpa armigera* (Hübner) during 2007-2008. Similar to our studies, weekly observations were taken and data showed that mean larval population of chickpea pod borer in different genotypes ranged from 0.33 to 4.33 per meter row from 1st week of March to 3rd week of April, where the pod damage varied from 7.4 to14.2%. In our studies, the moths of March and

April were remained critical for the infestation of chickpea pod borer. Similar type of field screening was also conducted by Sarwar *et al*., (2011); however, they used different genotypes in their studies. In the present studies, the performances of all tested genotypes were further confirmed by assessing the harvested pods per replications. The performance of all genotypes become obvious when significantly lowest percent pod infestation was recorded for DG -89 followed by NIFA-2005 and DG- 92. During both years of trials, it was moderate in Balkassar- 2000 followed by Wanahar- 2000, Dasht and Tamman- 2013. The highest pod infestation after harvesting was noticed in Choola followed by Sanyasi and Punjab-2008 from the genotypes tested at Upper Zone (RRI, Dokri) and Lower Zone (Tandojam) during 2015 and 2016, respectively. Moreover, the response of Punjab-2008 and Dasht showed variability, from moderate to highest in both locations, respectively. All genotypes were rated based on our modified scale for resistance reaction against gram pod borer. DG-89 (3) was rated as Moderate Resistance (MR) and Resistance (R) at RRI, Dokri and Tandojam, respectively. However, NIFA-2005 (2) was rated as R at both locations, whereas, DG-92 (3), Wanahar- 2000 (3) and Balkassar-2000 (3) were rated as MR at both locations. Three varieties; Punjab- 2008 (4), Tamman-2013 (4), and Dasht (4) were found MS at both observed locations. The variety Sanyasi (5) was rated as S based on higher pod infestation percent and rating scale. The performance of Choola (6), check variety, showed the highest susceptibility (HS) at Dokri, while susceptibility (S) at Tandojam based on highest pod infestation percent and rating scale. In the literature some studies on screening for resistance have been documented from various countries like as India (Choudhary *et al*., 2014; Rehman *et al*., 2017; Mantesh *et al*., 2017;), Pakistan (Nadeem *et al*. 2010; Sarwar *et al*., 2011; Abro *et al*., 2017), Bangladesh (Altaf, 2009). However, they fulfill the need of that particular area/country and times. Our studies confirmed elite genotypes for Upper and lower zones of Sindh province of Pakistan that maybe used for sustainable chickpea production.

REFERENCES

Abro, N.A. Abro, M.A. Khatri, I. Jatoi, G.H. Mazari, S.N. Kandhro, R. Mangi N. 2017. Screening of different chickpea varieties against gram pod borer *Helicoverpa armigera* (Hub.) and its laboratory rearing on chickpea, B.T cotton and conventional cotton. *Pak. J. Biotechnol.*, 14 (3) 443-447.

Ahmed, K. and Awan, M.S. 2013. Integerated management of insect pests of chickpea *Cicernarietinum* (L.) Walp in South Asian Countries: Present status and future strategies - a review. *Pak. J. Zool.,* 45: 1125- 1145.

Ahmed, K., Lal, S.S., Morris, S.S., Khalique, F., and Malik, B.A. 1990. Insect pest problems and recent approaches to solving them on chickpea in South Asia. Pages 165-168, In: Chickpea in the Nineties: proceedings of the Second International Workshop on Chickpea Improvement, 4-8 Dec 1989, ICRISAT Center, India. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Altaf, H. 2009. Field screening of chickpea genotypes against pod borer Bangladesh *J. Agril. Res.*, 34(3): 517-521. (Short Communication)

Analytical Software, 2005. Statistix 8.1 user's manual, Tallahassee, FL.

Anonymous, 2013. Economic survey of Pakistan, Islamabad, Pakistan.

ARS, 2014. *Cicer arietinum,* Germplasm Resources Information Network (GRIN). Agricultural Research Service (ARS), United States Department of Agriculture (USDA).

Avalos, S., Mazzuferi, V., Fichetti, P., Berta, C. and Carreras, J. 2010. Entomofauna asociada a garbanzo en el noroeste de Córdoba (Argentina). *Hortic Argent,* 29:5-11.

Baynes, T.S.; Smith, W.R., eds. 1880. Gram. Encyclopædia Britannica. 11 (9th ed.). New York: Charles Scribner's Sons. pp. 36–37.

Choudhary, O.M., Anwala, R. and Sharma, M.M. 2014. Studies on varietal screening and date of sowing of *Helicoverpa armigera* (Hub.) on chickpea [*Cicer arietiinum* (L.)]. *Adv. Res. J. Crop Improv.,* 5 (2) : 149-153.

FAO, 2000. FAO Production Yearbook. Vol. 54. Food and Agriculture Organization of the United Nations, Rome, Italy. pp. 113.

Fichetti, P., Avalos, S., Mazzuferi, V. and Carreras, C. 2009. Lepidópteros asociados al cultivode garbanzo (*Cicer arietinum* L.) en Córdoba, Argentina. *Bol Sanid Veget"Plagas*“,35:49-58.

Mantesh, S. Devika Rani, D. Jagadesh, K.S. and Naik, S. M. 2017. Relative Efficacy of Selective Insecticides and Screening of Germ Plasm against Gram Pod Borer in Cow Pea (*Vigna unguiculata* L.). *Int. J. Curr. Microbiol. App. Sci.,* 6(12): 2332-2339.

Mulwa, R.M.S., Kimurto, P.K. and Towett, B.K. 2010 Evaluation and selection of drought and pod borer *(Helicoverpa armigera*) tolerant chickpea genotypes for introduction in semi-arid areas of Kenya. Proceedings, Second RUFORUM Biennial Meeting, Entebbe, Uganda, 20-24 September 2010, 34.

Nadeem. S. Shafique, M. Hamed, M. Atta, B.M. and Shah, T. M. 2010. Evaluation of advanced chickpea genotypes for resistance to pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae). *Pak. J. Agri. Sci.*, 47(2), 132-135.

Rehman, S. Waqar, M. Jamil1, M. and Akram, M. 2017. Screening of some chickpea (*Cicer arietinum* L.) varieties against *Helicoverpa armigera* under semi arid climatic conditions. *Legume Research*, 40 (2) : 379-383

Sarwar, M. Ahmad, M. and Toufiq, M. 2011. Identification and susceptible and tolerant gram (*Cicer artenium* L.) genotypes against gram pod borer (*Helicoverpa armigera*) (Hubner), *Pak. J. Bot*., 43(2): 1265-1270.

Saxena, M. P., R. Goldworthy and N. M. Righer, 2001. Chickpea. The Physiology of Tropical Field Crops. John Willey and Sons. 419-452.

Sharma, H.C. 2005. *Heliothis/Helicoverpa* Management: Emerging Trends and Strategies. Future Research. Oxford and IBH Publishers, New Delhi.

Sharma, H.C. Gaur, P. M. Srinivasan, S and Gowda, C. L.2014. *Exploiting host plant resistance for pest management in chickpea. Legume Perspectives*. (3): 25-28.

Supporting Tables

Table 1. Analysis of variance for percent infested pods observed under field conditions at RRI, Dokri and Tandojam during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Source	DF	SS	MS	F	P
RRI, Dokri					
Variety	9	16159.00	1795.40	78.77	0.00000
Replication	2	163.00	81.60	3.58	0.02840
Year	1	494.00	494.00	21.67	0.00000
Month	3	186370.00	62123.20	2725.50	0.00000
Week	3	10380.00	3460.10	151.80	0.00000
Variety*Year	9	466.00	51.80	2.27	0.01650
Variety*Month	27	16549.00	612.90	26.89	0.00000
Variety*Week	27	2463.00	91.20	4.00	0.00000
Variety*Year*Month	30	5727.00	190.90	8.38	0.00000
Variety*Year*Week	30	2346.00	78.20	3.43	0.00000
Variety*Year*Month*Week	180	37777.00	209.90	9.21	0.00000
Error	638	14542.00	22.80		
Total	959	293435.00			
CV	33.34				
Tandojam					
Variety	9	25681.00	2853.50	171.76	0.00000
Replication	2	197.00	98.40	5.92	0.00280
Year	1	20.00	19.80	1.19	0.27510
Month	3	241296.00	80432.10	4841.44	0.00000
Week	3	1101.00	367.10	22.10	0.00000
Variety*Year	9	946.00	105.10	6.33	0.00000
Variety*Month	27	27749.00	1027.70	61.86	0.00000
Variety*Week	27	1160.00	43.00	2.59	0.00000
Variety*Year*Month	30	2902.00	96.70	5.82	0.00000
Variety*Year*Week	30	1860.00	62.00	3.73	0.00000
Variety*Year*Month*Week	180	15636.00	86.90	5.23	0.00000
Error	638	10599.00	16.60		
Total	959	329148.00			
CV	25.72				

Table 2. Analysis of variance for percent infested pods observed after harvesting at RRI, Dokri and Tandojam during 2015 and 2016 for the screening of resistance genotype against gram pod borer, *Helicoverpa armigera*

Source	DF	SS	MS	F	P
RRI, Dokri					
Varieties	9	7212.45	801.384	13.13	0.0000
Replication	2	45.18	22.589	0.37	0.6930
Year	1	34.05	34.051	0.56	0.4596
Varieties*Year	9	183.94	20.437	0.33	0.9576
Error	38	2318.48	61.013		
Total	59	9794.09			
CV	21.48				
Tandojam					
Varieties	9	10356.1	1150.68	84.62	0.0000
Replication	2	130.4	65.19	4.79	0.0139
Year	1	14.4	14.41	1.06	0.3099
Varieties*Year	9	110.3	12.26	0.9	0.5335
Error	38	516.7	13.6		
Total	59	11127.9			
CV	11.50				

****