Pak. J. Agri. Sci., Vol. 56(2),401-405; 2019
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/19.6979
http://www.pakjas.com.pk

INFESTATION OF *Helicoverpa armigera* Hübner (Noctuidae: Lepidoptera) ON SOYBEAN CULTIVARS IN POTHWAR REGION AND RELATIONSHIP WITH PHYSICO-MORPHIC CHARACTERS

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In the present study, the infestation of *Helicoverpa armigera* Hübner (Noctuidae: Lepidoptera) was evaluated on five soybean cultivars in Pothwar region of Pakistan. The data regarding egg population revealed that Desi cultivar had the maximum number of eggs (0.32/leaf) while the minimum number of eggs (0.11/leaf) was recorded on NARC-2 and was found comparatively resistant. The rest of the cultivars (Ajmeri, Rawal and William-82) were found statistically similar with each other having 0.14, 0.15 and 0.14 eggs per leaf respectively. The larval population of *H. armigera* on five soybean cultivars showed significant variations. The minimum larval population (0.16 larvae/leaf) was observed on NARC-2 while it was the maximum on Desi with 0.35 larvae per leaf. The larval population on the remaining cultivars Ajmeri, Rawal and William-82 was found significantly similar with each other with an average of 0.21, 0.23 and 0.22 larvae per leaf respectively. Similarly, pod infestation of *H. armigera* on five soybean cultivars was also found statistically variable. The minimum pod infestation was recorded on NARC-2 (10.47%) while Desi cultivar showed the maximum infestation of 20.75%. The infestation on Ajmeri and Rawal cultivars found statistically similar each other showing 16.31 and 15.82% infestations respectively. Maximum yield was obtained for NARC-2 while the lowest yield was observed for Desi cultivar. The physico-morphic characters were found to be the maximum on NARC-2. As NARC-2 was found comparatively resistant cultivar and suffered less damage by *H. armigera* and recommended for cultivation in the Pothwar region.
Keywords: Soybean, *Helicoverpa armigera*, physico-morphic characters, host plant resistance.

INTRODUCTION

Soybean (*Glycine max* L.) is one of the important legume crops of the world. It is believed to be among the oldest cultivated plants by man. It was originated from East Asia specifically from North China but now this crop is adapted to tropical, subtropical and temperate areas of the world, and it can be grown in spring and summer seasons. Major producers of soybean in the world are United States, Brazil, Argentina, China, India, Paraguay and Canada. It is an important source of fats, minerals, proteins, vitamins and energy for human and livestock. Its seeds contain 40-42% protein and 18-22% oil, based on its genetic and environmental aspects (Karishnan, 2000). It can provide 60% vegetable protein and 30% edible oil. Its waste products are used as a fodder for domestic animals (Ali, 2010). Pakistan is one of the largest importers of soy meal and soybean oil from Argentina and USA for the growth of its poultry and livestock industry. Pakistan has imported about 2.2 million metric tons of soybeans in 2016-2017 (GOP, 2017).

The profitable production of soybean is affected by many biotic and abiotic factors. Among biotic factors diseases (Hussain *et al*., 2016; Ashfaq *et al*., 2017; Aslam *et al*., 2017a,b, 2018; Fateh *et al*., 2017; Kayani and Mukhtar, 2018; Kayani *et al*., 2017, 2018; Khan *et al*., 2017; Mukhtar, 2018; Mukhtar *et al*., 2017a,b, 2018; Tariq-Khan *et al*., 2017) and particularly the insect pests (Iftikhar *et al*., 2018; Javed *et al*., 2017a,b; Kassi *et al*., 2018; Nabeel *et al*., 2018) have been reported to cause reduction in yield. Losses in soybean production may reach up to 15-20% every year by the attack of insect pests only (Biswas, 2008).

Among insect pests, the cotton bollworm, *Helicoverpa armigera*, is a destructive polyphagous pest causing severe damage to soybean in the world (Reddy *et al*., 2004). It feeds on different plant parts at different stages (Garcia, 2006).

The pest is mainly controlled by chemicals and their use has caused several issues (Kranthi *et al*., 2002). Therefore, alternative strategies like cultural practices (fallow, crop rotation, ploughing, removing crop residues, planting time etc), crop hygiene, use of resistant varieties, biological control and sex pheromone etc are advocated (Rahoo *et al*., 2017, 2018a,b,c). However, the most productive and cheapest way to manage *H. armigera* is the use of resistant cultivars. The implementation of host plant resistance (HPR)

is environmentally safe technique and can play an important role in integrated pest management programs (Green *et al*., 2002).

Soybean cultivation in Pakistan remained limited to a very small area and therefore has not been able to attain a respectable position among the oilseed crops of the country. However, rapid soybean growth took place at global level due to its by-product (soybean cake) after oil extraction, which is used as a high-protein animal feed and poultry sector in many countries. In recent years, the government and non-governmental bodies have helped to create awareness to small scale farmers about the importance of soybean not only as a crop for improving their economic status but also as an important high protein food (Rahim *et al*., 2015). Keeping in view the importance of soybean crop, the present research was conducted to screen different soybean cultivars for resistance against *Helicoverpa armigera* Hübner (Noctuidae: Lepidoptera) in Pothwar region and to study the relationship with physico-morphic characters.

MATERIALS AND METHODS

***Research area*:** The research was conducted at University Research Farm Koont, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi during 2017 in a Randomized Complete Block Design with four replicates. Five soybean cultivars viz. Ajmeri, Rawal, Desi, NARC-2 and William-82 were assessed for their resistance to the insect pest and morphological parameters. The experimental area is characterized by diverse kind of environment with dry and cold conditions in winter having maximum and minimum temperatures of 24.4°C and 3.4°C respectively.

***Screening of soybean cultivars*:** The land was prepared by ploughing, laddering and fertilized at the time of sowing. The plot size of 20 m×25 m was maintained. The seeds were sown at a depth of 3-5 cm, keeping row to row and the plant to plant distances of 45 cm and 30 cm respectively. Irrigation was done as per crop requirement. Data regarding pest infestation were recorded weekly from the five randomly selected plants of soybean from each replication 30 days after sowing till harvesting.

***Egg population*:** The number of eggs of *H. armigera* was recorded from the five randomly selected plants from each experimental unit. Three leaves were selected from upper, lower and middle of the plants. The numbers of eggs were examined carefully with the help of magnifying lens, data were collected at weekly interval and the average was calculated by using the following formula.

$$\text{Number of eggs/leaf} = \frac{\text{Total number of eggs counted}}{\text{Total number of leaves observed}} \times 100$$

***Larval population*:** Larval population was also recorded at weekly interval from each replication from the five randomly selected plants. The larvae were recorded from upper, middle and lower portion of plants and the average was calculated by the following formula.

$$\text{Number of larvae/leaf} = \frac{\text{Total number of larvae collected}}{\text{Total number of leaves observed}} \times 100$$

***Pod infestation*:** The percentage pod infestation of *H. armigera* on five randomly selected plants of soybean cultivars in each replication was calculated by counting total number of pods and damaged pods by using the following formula.

$$\text{Pod infestation (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

***Physico-morphic characters*:** The physico-morphic characters of soybean cultivars such as hairs on midrib, leaf lamina and pods, plant height and stem girth were also studied during the experimentation to evaluate their role in the resistance of cultivars.

***Yield*:** Yield of five soybean plants of each cultivars from each replication was calculated at the time of harvesting.

***Correlation with environmental factors*:** *H. armigera* larval population and pod infestation on different soybean cultivars were correlated with environmental factors. The data regarding weather were collected from the Meteorological Research Station Rawalpindi.

***Statistical analysis*:** The data regarding the population of pod borer on various soybean cultivars and physico-morphic characters of cultivars were statistically analyzed using Co STAT version 6.3.1.1 software and their means were analyzed with DMR Test at 5% level of probability.

RESULTS

***Egg population*:** The data regarding egg population revealed that Desi cultivar had the maximum number of eggs (0.32/leaf) while the minimum number of eggs (0.11/leaf) was recorded on NARC-2 and was found comparatively resistant. The rest of the cultivars (Ajmeri, Rawal and William-82) were statistically similar with each other having 0.14, 0.15 and 0.14 eggs per leaf respectively (Table 1).

Table 1. Number of eggs, larval and pod infestation of *H. armigera* on five soybean cultivars.

Cultivars	Number of Eggs	Larval Population	Pod Infestation
Ajmeri	0.14 b	0.21 b	16.31 b
Rawal	0.15 b	0.23 b	15.82 b
Desi	0.32 a	0.35 a	20.75 a
NARC-2	0.11 b	0.16 c	10.47 c
William-82	0.14 b	0.22 b	16.61 ab
LSD	0.068	0.032	4.241
Analysis	F4, 199 = 0.72 *P*<0.8711	F4, 199 = 2.65 *p*<0.0000	F4, 79 = 5.92 *P*<0.0004

Mean sharing similar letters in each column are not significantly different by DMR Test at P=0.05.

***Larval population*:** The larval population of *H. armigera* on five soybean cultivars showed significant variations. The minimum larval population (0.16 larvae/leaf) was observed on NARC-2 while it was the maximum on Desi with 0.35 larvae per leaf. The larval population on the remaining cultivars viz. Ajmeri, Rawal and William-82 was found significantly similar with each other with an average of 0.21, 0.23 and 0.22 larvae per leaf respectively (Table 1).

***Pod infestation*:** Pod infestation of *H. armigera* on five soybean cultivars was also found statistically variable. The minimum pod infestation was recorded on NARC-2 (10.47%) while Desi cultivar showed the maximum infestation of 20.75%. The infestation on Ajmeri and Rawal cultivars was found statistically similar with each other showing 16.31 and 15.82% (Table 1).

The present findings are similar with the study of Biswas (2013) who reported larval population density of 0.35 larvae per leaf while the pod infestation results contradicted with those reported by the same researcher. The findings of Kumar *et al*. (2012) are also different from the larval population of current research which might be due to different environmental factors. Likewise, the findings reported in this paper also differ from those of Kalyan and Ameta (2017). Contrarily, Clark *et al*. (1972) reported pod infestation similar to the current findings.

***Plant height and stem girth*:** The maximum plant height and stem girth was recorded with NARC-2 followed by William-82 while Desi cultivar showed the minimum values in these parameters. On the other hand, Ajmeri and Rawal have shown significantly different values as compared to NARC-2 and Desi but were at par with each other's (Table 2).

***Hairs density on leaf midrib, lamina and pods*:** Maximum hair density on leaf midrib, lamina and pods was observed on NARC-2 followed by William-82 while the minimum values in these parameters were recorded in case of Desi cultivars. The hair density on the remaining cultivars was statistically at par with NARC-2. On the other hand, hairs density on leaf lamina and pods in case of Ajmeri and Rawal was significantly different from NARC-2 as shown in Table 2.

***Yield*:** The results showed that average yield of cultivars were statistically different from each other. The highest yield was recorded for NARC-2 followed by William-82. On the other hand, the lowest yield was observed for Desi cultivar followed by Ajmeri and Rawal as given in Table 2.

***Correlation between larval population and different environmental factors*:** The data indicated that minimum temperature had positive and significant correlation with the number of larvae on all cultivars of soybean. Similarly, the maximum temperature showed positive and significant correlation for Ajmeri, Rawal and William-82 while Desi and NARC-2 showed positive but non-significant correlation with the numbers of larvae. Average temperature revealed positive and significant correlation with numbers of larvae on all cultivars while average relative humidity and average rainfall showed negative and non-significant correlation between number of larvae and all the cultivars (Table 3).

***Correlation between pod infestation and different environmental factors*:** The data regarding correlation between the minimum temperature and average relative humidity and *H. armigera* infestation on pods of five soybean cultivars showed negative and non-significant

Table 2. Comparison of data regarding different physico-morphic characters on soybean cultivars.

Cultivars	Plant Height (cm)	Stem Girth (mm)	Hairs on Midrib	Hairs on Leaf Lamina per cm^2	Hairs on Pods per cm^2	Yield in (g) per 5 plants
Ajmeri	31.67 c	18.6 c	246 a	115.4 b	112.78 c	140.72 b
Rawal	31.58 c	19.55 bc	245.75 a	116.49 ab	119.68 bc	137.12 b
Desi	23.95 d	17.25 d	191.25 b	92.88 c	84.03 d	97.15 c
NARC-2	41.35 a	20.88 a	271.25 a	128.53 a	133.38 a	153.94 a
William-82	38.97 b	19.95 ab	249.5 a	118.25 ab	123.58 b	140.89 b
LSD	1.447	1.157	35.151	12.996	9.55	6.601
Analysis	F4, 19 = 214.98	F4, 19 = 13.56	F4, 19 = 6.74	F4, 19 = 9.64	F4, 19 = 36.31	F4, 19 = 101.18
	P< 0.0000	*P*< 0.0002	*P*< 0.0044	*P*< 0.0010	*P*< 0.0000	*P*< 0.0000

Mean sharing similar letters in each column are not significantly different by DMR Test at P=0.05.

Table 3. Correlation of larval population of *H. armigera* on five soybean cultivars with different weather factors.

Cultivar	Minimum Temperature °C	Maximum Temperature °C	Average Temperature °C	Average Relative Humidity %	Average Rainfall (mm)
Ajmeri	0.721*	0.676*	0.767**	-0.487ns	-0.566ns
Rawal	0.687*	0.670*	0.744*	-0.505ns	-0.543ns
Desi	0.639*	0.601ns	0.680*	-0.430ns	-0.541ns
NARC-2	0.718*	0.554ns	0.699*	-0.408ns	-0.557ns
William-82	0.663*	0.632*	0.710*	-0.485ns	-0.523ns

* = Significant ns = Non Significantly at 0.05.

Table 4. Correlation of pod infestation of *H. armigera* on five soybean cultivars with different weather factors.

Cultivar	Minimum Temperature °C	Maximum Temperature °C	Average. Temperature °C	Average Relative Humidity %	Average Rainfall (mm)
Ajmeri	-0.489 ns	0.632 ns	-0.877 ns	-0.759 ns	0.448 ns
Rawal	-0.561 ns	0.564 ns	-0.874 ns	-0.811 ns	0.434 ns
Desi	-0.257 ns	0.788 ns	-0.801 ns	-0.592 ns	0.548 ns
NARC-2	-0.400 ns	0.710 ns	-0.962*	-0.635 ns	0.230 ns
William-82	-0.469 ns	0.584 ns	-0.742 ns	-0.776 ns	0.637 ns

* = Significant ns = Non Significantly at 0.05.

correlation. On the other hand, maximum temperature and average rainfall showed positive and non-significant correlation for all cultivars. The average temperature showed negative and non-significant correlation for all cultivars except NARC-2 which showed negative but significant correlation (Table 4). The present findings were also inconformity with those of Lokesh and Singh (2005), who reported that hair densities on leaves of the plants had strong correlation with the oviposition. However, the findings of Iqbal *et al*. (2011) are in line with our findings in which hairs length on the leaves, plant height showed negative and significant interaction with the insect pest density.

***Conclusion*:** It is concluded from the present studies that NARC-2 was found comparatively resistant cultivar harboring the minimum eggs population, larval population and pod infestation by *H. armigera*. The highest yield was also recorded on NARC-2, as compared to other tested cultivars and recommended for cultivation in the Pothwar region to enhance economic returns of farmers.

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