VARIATIONS IN POPULATION DYNAMICS OF BEET ARMYWORM ON CABBAGE IN PUNJAB, PAKISTAN

Sumaira Maqsood[1], Amna Shoaib[2*], Muhammad Ali[3], Shahbaz Ahmad[3] Asim Abbasi[1]

ABSTRACT
Spodoptera exigua Hübner (Lepidoptera: Noctuidae) is a multi-host serious global pest around the world. In the current study, cabbage (*Brassica oleracea* L.) field populations of *S*. *exigua* were monitored in five different localities (Okara, Lahore, Faisalabad, Chiniot, and Sargodha) of Punjab, Pakistan through regular 10 days intervals on cabbage crop during 2018-2019. Results revealed an extensive distribution of *S. exigua* across Punjab, especially at a higher rate in Lahore, Sargodha, and Faisalabad. Weather conditions (temperature and moisture) during the month of September in Punjab, Pakistan facilitate the local population of insects. Therefore, insect management protocol should be applied in the month of July, before the onset of the larval population.

Keywords: Beet armyworm, Cabbage, Insecticides, Pakistan, Population.

INTRODUCTION

During recent decades, the agriculture sector's vulnerability to climate change has been well documented in Asian and the Pacific regions, though Pakistan is on 5th position in this list (Chaudhry, 2017). Ever-rising temperatures and infrequent rainfall patterns are among the most predicted effects of climate change on herbivore insect pest populations (Maqsood *et al*., 2016). High-temperature threshold has been regarded as the main factor governing population dynamics (Régnière *et al*., 2012), genetic potential, mortality, and fecundity in insects (Finlay-Doney and Walter, 2012). Likewise, wet conditions also affect the growth, development, migratory capabilities, and wide distribution of insect pest (Macfadyen *et al*., 2018).
Beet armyworm *Spodoptera exigua* (Lepidoptera: Noctuidae) native to Southeast Asia, is alarming agricultural pest species being able to attack 130 host plants belonging to 30 families (Robinson *et al*., 2010). It has been regarded as a major pest of important crops including vegetables e.g. tomato, cabbage, eggplant, okra, etc. in adjoining plains, and sub-mountainous areas of Pakistan as well (Ahmed *et al*., 2018). Larvae feed on both foliage and fruit. All stages of this insect prevail throughout the year, which has also raised its migratory potential from one crop to the other both in winter and summer, while field failures of insecticides against *S. exigua* are becoming common (Ahmed *et al*., 2018; Saeed *et al*., 2019). Among its various hosts, cabbage (*Brassica oleracea* L.) is a suitable nutritious food for *S. exigua*. Cabbage is an extensively cultivated vegetable in more than 90 countries of the world during the cool season at 15-20 °C. It is rich in health-associated compounds including protein, carbohydrate, vitamins (A, B, C, E, K etc.), minerals (calcium, iron, magnesium, zinc, phosphorus, potassium, sodium, selenium etc.), and phenolics (Sanlier and Guler, 2018). Its high nutritional profile helps to prevent

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[1] Department of Environmental Sciences, Kohsar University, Murree, Pakistan
[2] Department of Plant Pathology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan
[*] *Correspondence to:* amna.iags@pu.edu.pk
[3] Department of Entomology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan

cancer, scurvy, constipation, digestive ailments, blood pressure, and premature aging, besides, it reduces joint pain, irritation, fever, allergies, and promotes good eyesight, brain, and bone health (Hallmann *et al*., 2017). China is the world leader in cabbage production and produced 34,223,156 metric tons in 2019, while Pakistan is at 53rd position, producing 80770 tons, and the province of Punjab shares 50% of production. Keeping in mind the importance of cabbage and the damages done by *S. exigua*, the present research was carried out to study the population dynamics of this pest in cabbage.

MATERIAL AND METHODS

The study was conducted in 5 cabbage-growing areas of Punjab (Sargodha, Chiniot, Okara, Faisalabad, and Lahore) from August-October (2018 and 2019). After nursery transplanting, cabbage fields were surveyed regularly at fixed intervals to check the presence or absence of *S. exigua* larvae. The schedule consisted of periods [period I (15 to 25 August), period II (27 August to 07 September), period III (09 to 19 September), period IV (21 September to 01 October), and period V (03 to 13 October)]. Randomly 25 plants were selected to record the data of larvae per plant from each replication at 11 days intervals. The data of selected cities on weather factors (temperature, relative humidity, rainfall) were taken from the Pakistan Meteorological Department.

RESULTS AND DISCUSSION

Cabbage is cultivated throughout the year in Pakistan but is susceptible to insect pests including *S. litura*, which is one of the alarming pests and may cause 100% yield losses (Lingappa *et al*., 2004). The data revealed significant variations in larval population on cabbage after every 10 days of fixed intervals from five selected areas of Punjab, Pakistan during 2018 and 2019. During the first year (2018) of 1st period (15th-25th August), a statistically similar population of larvae was recorded in Lahore, Okara, Sargodha, and Faisalabad (8-10 larvae per 25 plants), while, a significantly less number (6 larvae per 25 plants) was recorded in

Chiniot. During the 2nd period (27th August-7th September), a significantly greater number of larvae was reported in Faisalabad (18 larvae per 25 plants) followed by Lahore (15 larvae per 25 plants), while in the other three cities number of larvae was statistically similar (11-12 larvae per 25 plants). The number of larvae increased during the 3rd (8th-19^{h} September) and 4th (21st September-1st October) periods as compared to previous periods, while these were statistically insignificantly different in all five cities. During the 5th period (3rd-13th October), the same trend in the number of larvae was observed in different cities as was recorded during the initial two periods (Table 1). During 2019, the identical pattern in the population rise of the insect was noticed from the 1st to 5th periods as was observed during 2018, accordingly, the larval population emerged at the start of August and reached peak value at the mid-September and then started decreasing in October. Moreover, a significantly greater number of larval populations was recorded in Faisalabad, Lahore, Sargodha, Okara, and Chiniot (Table 2).

According to the present study, the attack and infestation rate of the larval population of *S. exigua* was minimum during the month of August, while peak population was reported in mid-September to end-September; finally, it started decreasing in October. The presently reported population dynamics were due to the variations in the weather factors as rainfall and relative humidity can turn on and off massive outbreaks of insect pests (Maqsood *et al*., 2016). In September (9th-30th), average temperature (34/25 ºC) and humidity (70%) were probably the optimum for larval proliferation as compared to the larval population in August (34/27 ºC; humidity 97%) and October (32/20 ºC; humidity $\leq$ 50%). Likewise, Rao *et al*. (2014) sated an increase in the larval population of *Spodoptera* species in September due to temperature fall with the increase in humidity rate and rainfall. Punithavalli *et al*. (2014) summarized that the larval population of different species of *Spodoptera* along with their egg masses appear during the month of August and stay in the field on host plants till the

month of October. Their finding also negatively correlated the effect of temperature with larval population and, positively related the humidity with plant infestation of *Spodoptera* species. Babu *et al*. (2015) have confirmed the total *Spodoptera s*pecies population existence period from August-October, and the peak population in September in the humid Southern Plain Zone of Rajasthan, India.

Moreover, cabbage growing areas in Faisalabad (31.4504° N, 73.1350° E), Sargodha (32.0740° N, 72.6861° E) and Lahore (31.5204° N, 74.3587° E) cities of Punjab were possibly ideal for *S. exigua* due to prevalence of suitable conditions of moisture, light, humidity, rainfall, and other indirect factors (Zhend *et al*., 2012) which favoring the build-up of high larval population.

Table 1. Variations on population dynamics of beet armyworm on cabbage in Punjab, Pakistan during 2018-2019

	Cities	**Sargodha**	**Chiniot**	**Faislabad**	**Okara**	**Lahore**
2018	**Coordinate/Time period**	32.0740° N, 72.6861° E	31.7292° N, 72.9822° E	31.4504° N, 73.1350° E	30.8138° N, 73.4534° E	31.5204° N, 74.3587° E
1st	**15 Aug - 25 Aug**	8ab± 0.90	6b± 0.60	8ab±0.60	9a± 0.60	10a± 0.60
2nd	**27 Aug - 07 Sep**	11bc±0.35	10c±1.01	18a±0.59	12b±1.01	15ab±1.20
3rd	**09 Sep - 19 Sep**	23a±0.78	20ab±1.6	21ab±1.0	18b±0.6	20ab±0.61
4th	**21 Sep - 01 Oct**	21a±1.27	18a±1.23	22a±1.22	19a±1.01	19a±1.40
5th	**03 Oct - 13 Oct**	15b±0.80	12c±0.30	18a±0.90	12c±1.01	16b±1.20
2019						
1st	**15 Aug - 25 Aug**	9a±1.20	5b±1.01	8a±1.01	7a±0.60	9a±0.60
2nd	**27 Aug - 07 Sep**	7ab±1.60	3c±1.20	11a±1.20	6b±0.61	5b±1.20
3rd	**09 Sep - 19 Sep**	22ab±1.20	20b±0.60	26a±1.61	21b±0.68	21b±1.71
4th	**21 Sep - 01 Oct**	19b±1.01	18b±1.20	25a±1.20	15c±0.70	20b±1.01
5th	**03 Oct - 13 Oct**	16b±1.51	11c±1.10	21a±1.01	13bc±1.70	17ab±1.50

Alphabets in each row show significant differences (p < 0.05) as determined by the LSD test.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this study clearly demonstrated that *S. exigua* is widely distributed across different cities of Punjab, especially in Lahore Sargodha, and Faisalabad. Weather conditions during the month of September in Pakistan support optimum conditions for *S. exigua* population rate and activities. Therefore, insect management protocol should be applied in the month of July, before the onset of the insect population.

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