Influence of climate change on *Helicoverpa armigera* (Hubner) in pigeonpea

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Abstract

Annual monitoring of the population dynamics of *Helicoverpa armigera* in unprotected pigeonpea crop during *kharif* seasons of 2011 to 2014 for 4 years at the farmers field North Gujarat, India. Temperature, rainfall and host-plant species were analyzed with respect to population fluctuation of the insect pest. The observations revealed that, the average number of larval population per plant in the season (from 27th to 3rd standard weeks) was 0.97, 0.32, 0.30 and 0.38 larvae/plant during 2011, 2012, 2013 and 2014 respectively. Population of *Helicoverpa armigera* had significant and negative correlation with maximum temperature ($r = -0.524$), rainfall ($r = 0.079$) and relative humidity ($r = -0.827$, $r = -0.595$ morning and evening, respectively).

Key words: Population dynamics, *Helicoverpa armigera*, weather parameters.

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is one of the most important legume crops of the tropics and subtropics of Asia and Africa. Pigeonpea, also known by names such as arhar and

tur in India, offers nutritional security due to its richness in protein (21%) along with mineral supplements viz., iron and iodine. India is the world's largest producer and consumer of pulses including pigeonpea. Pigeonpea has a unique place in Indian farming and accounts for about 90% of the global area and 93% of the global production. Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Bihar are the major growing States of our country. Chhattisgarh, Rajasthan, Odisha, Punjab and Haryana also grow the crop but in lesser area. India ranks second in area and production (3.81 M ha area with production 3.02 Mt., Anonymous 2014). The productivity levels range from 360 to 1145 kg/ha owing to the cultivation of the crop on a wide range of soils in different cropping systems across varied agro climatic regions. A number of factors are responsible for the lower productivity, which mainly includes biotic as well as abiotic factors.

Among biotic stresses diseases viz., wilt, sterility mosaic and foliar diseases and insect pests feeding on pods lead to significant yield losses. Climate change is expected to trigger changes in diversity and abundance of arthropods, geographical and temporal distribution of insect pests, insect biotypes, herbivore plant interactions, activity and abundance of natural enemies, and efficacy of crop protection technologies. We expect both the crop in terms of phenology and physiology and the pests in their occurrence and abundance likely to change. Pigeonpea crop is infested by more than 300 species of insect pests. Among these, the maximum yield losses is caused by pod borer's complex and pod fly and the gram pod borer *Helicoverpa armigera* (Hubner.) is a major pest causing 20–30% yield losses (Gaur et al. 2010; Sreekanth et al. 2015). The pod borers damage the developing flowers and pods making holes in the pods. Hence, study of impact of climate change on pigeonpea crop-pest interactions requires carefully collected data on long term basis. While already available historical data could form an approach for partial study of climate change impacts, formulation and implementation of a robust research strategy combining the present scenario of cropping patterns, cultivars, and production and protection practices across heterogeneous locations over time would yield improved and holistic understanding. Considering the importance of the pigeonpea grown across Indian cropping systems as a pulse crop and assessment of the changing pest dynamics in relation to climate, and through development of forewarning models. A plan to study of dynamics of pigeonpea pests in multiple locations over seasons along with other system components including weather was formulated to be implemented through surveillance integrating geographical, field, crop, agronomical and pest management practices.

Materials and methods

Surveillance plan and procedures

Two pigeonpea fields each at the pulse research station and in ten selected villages of the

North Gujarat region are to be fixed for pest surveillance. Fixed fields are those fields grown with pigeonpea, that once selected should be continuously monitored year round on weekly basis for pests and diseases using the specified data sheet formats. Observations in all the designated fixed fields should be made on weekly basis. Pigeonpea fields should be fixed field surveillance.

Selection of fixed fields

Fixed fields of farmers in villages

Ten villages of pigeonpea growing from the three nearby districts of North Gujarat were selected. In each village, two farmer fields were selected with a area near to one acre for surveillance during the season. Assigning fields of farmers as Fixed 1 and Fixed 2 should be made during the first observation of surveillance and the same were maintained till the end of season.

Observations

The recording of observations on insect pests and diseases in the selected fixed fields was initiated with the sowing of the crop and continued till the end of the crop season. In each selected field, select five spots randomly such that four are from four corners and one from the centre of the field. Five feet distance alongside of boundary in all directions of the field should be left out as buffer space to avoid border effects during pest observations. The spot selection for pest observations during each weekly visit was random and it is not the fixed spots in a pigeopea field. All insect and disease recordings at each spot should be completed before moving on to next spot. Further weather parameters viz., rainfall, maximum and minimum temperature, maximum and minimum relative humidity were gathered from metrological department and averaged for every metrological standard week. Also the population data were correlated with weather parameters.

Statistical analysis: Correlation analysis of data obtained from pod borers population, rainfall, maximum and minimum temperature, maximum and minimum relative humidity at every metrological standard week from 2011 to 2014 were analyzed.

Results and Discussion

The population dynamics of *Helicoverpa armigera* was recorded from cropping season of pigeonpea during 26th standard metrological weeks (SMW) to 3rd SMW for four years from 2011, 2012, 2013 and 2014 years data was recorded. During 2011, the pest incidence started in 40th SMW with 0.95 larvae/plant and peak incidence of 1.75 larvae/plant in 43th SMW (Table 1) there after its population started declining and was nil on 51th week. Over all that season mean incidence of *Helicoverpa armigera* was 0.97 larvae/plant.

The pest incidence during 2012 was initiated on 39th SMW (0.19larvae/plant) and started raising with two peaks one on 44th SMW and second on 50th SMW with 056 larvae/plant and there was drastic decline in the pest population (Table-1). During 2013, the incidence started from 43rd SMW and continued upto 2nd SMW. Maximum incidence of pest was noticed during 52nd SMW to 1st SMW were recorded 0.45 and 0.52 larvae/plant, respectively. During 2014 also the pest incidence was similar to that of 2013 with little more numbers. Peak and severe larval population 0.58 larvae/plant found on 50th SMW (Table 1) and onwards drastically declined.

Table1. *Helicoverpa armigera* population on pigeonpea at farmer's field

MSW	2011-12	2012-13	2013-14	2014-15
30	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.0
38	0.0	0.0	0.0	0.0
39	0.0	0.19	0.0	0.0
40	0.95	0.24	0.0	0.0
41	0.73	0.33	0.0	0.0
42	1.66	0.26	0.0	0.13
43	1.75	0.33	0.21	0.23
44	0.93	0.41	0.12	0.28
45	1.08	0.19	0.23	0.4
46	1.14	0.21	0.24	0.38
47	1.01	0.31	0.24	0.38
48	0.73	0.31	0.37	0.39
49	0.48	0.36	0.33	0.45
50	0.26	0.51	0.30	0.58
51	0.0	0.56	0.28	0.55
52	0.0	0.35	0.45	0.0
1	0.0	0.26	0.52	0.0
2	0.0	0.0	0.26	0.0
3	0.0	0.0	0.0	0.0

MSW- Meteorological Standard Week

Fig. 1. Temporal variation of *Helicoverpa armigera* population on pigeonpea.

The *Helicoverpa* population was decreasing trend over the years. Pest population was range from 0.26-1.75 larvae/leaf and mean of 0.97 larvae/leaf during 2011 in short period of 41st to 50th SMW (Fig. 2). Average *Helicoverpa* population 0.32 larvae/plant with range between 0.19-0.56 larvae/plant on 39th to 1st SMW during 2012. During 2013, it was 0.30 larvae/plant with range of 0.12 to 0.52 larvae/plant on 43rd to 2nd SMW. *Helicoverpa* population was range between 0.13 -0.58 larvae/plant with average of 0.38 larvae/leaf during 2014. During first years, the pest population was higher and thereafter during 2012, 2013 and 2014 pest population was started declining every year. In all four years observations, peak population was observed between 50th SMW to 2nd SMW and the *Helicoverpa* population was greatly influenced by abiotic factors such as temperature and humidity. Hence, pest population was correlated with abiotic factors and presented here.

Population of *Helicoverpa* had significant and negative correlation with maximum temperature ($r = -0.524$) and non-significant and negatively correlated with minimum temperature ($r = -0.710$) shown in Table 2. However, significant and positively correlated with rainfall ($r = 0.079$). Similarly, Relative humidity (morning and evening) had significant and negative correlation to *Helicoverpa* population ($r = -0.827$, $r = -0.595$, respectively). Present studies were in partially in line with the Singh et al. (1990) reported that *E. kerri* had a negative association with the rainfall, minimum daily temperature, relative humidity. Jayasimha et al. (2012) reported that leafhopper population had a significant negative correlation with rainfall. However, RH was non significant and negative with population. Similarly Sutaria et al (2010) who observed rainy days were negatively correlated. Haldhar et al. (2010) reported that the relationship between lemon butterfly egg, larval population and maximum temperature was (-0.53 & -0.55) negatively correlated whereas the maximum

relative humidity was (0.44 & 0.53) positively correlated. Singh et al. (2013) who reported negative correlation between cotton leaf hopper population and relative humidity. Yadav et al. (2015) who showed that leafhopper population was negatively correlated with minimum temperature.

Table 2. Correlation matrix of *Helicoverpa armigera* population with environmental factors at farmer's field

Year	Rainfall	Weather factors			
		Temperature		Relative humidity	
		Maximum	Minimum	Morning	Evening
2011-12	-0.376 ^{**}	-0.683 ^{**}	-0.035 ^{NS}	-0.467 [*]	-0.539 ^{**}
2012-13	-0.094 ^{NS}	-0.640 ^{**}	-0.343 ^{NS}	-0.691 ^{**}	-0.373 [*]
2013-14	-0.587 ^{**}	-0.847 ^{**}	-0.075 ^{NS}	-0.631 ^{**}	-0.278 ^{NS}
2014-15	-0.225 ^{NS}	-0.567 ^{**}	-0.328 ^{NS}	-0.637 ^{**}	-0.334 ^{NS}
Cumulative	0.079	-0.524	-0.710	-0.827	-0.595

Fig. 2. Larval population of *Helicoverpa armigera* on pigeonpea

Conclusion

Helicoverpa on pigeonpea is at decreasing trend from year to year and causing less damage to crop. During last four years (2011 to 2014) there was a lot of variation in prevalence of abiotic factors viz., rainfall, temperature and relative humidity in this region

might have unfavoured the pest buildup from year to year at decreasing trend and near future if the similar variation continued with abiotic factor particularly rainfall, maximum temperature and relative humidity will play a major role to decline to this pest status.

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