



ABUNDANCE OF MAJOR INSECT-PESTS OF INDIAN BEAN IN RELATION TO MAJOR WEATHER FACTORS

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ABSTRACT

Abundance of major insect-pests of Indian bean cv. Gujarat Papdi was studied at standard week wise interval during 2011-12 at Navsari Agricultural University, Navsari. Whitefly, *Bemisia tabaci* (Gennadius) population commenced from 41 standard week (SW) attaining peak (8.28/leaf) during 4 SW. It indicated significant negative correlation with temperature (maximum, minimum and average) ($r' = -0.6463, -0.5697$ and -0.6162). Total contribution of all the weather factors was 31.62 per cent indicating significant multiple correlation coefficient ($R = 0.5623$). Leaf miner, *Liriomyza trifoli* (Burgess) oriented leaf damage commenced from 41 SW attaining peak status (34.86 %) on 5 SW exhibiting significant positive correlation with wind velocity ($r' = 0.6270$) and negative correlation with temperature (maximum, minimum and average) ($r' = -0.6157, -0.4958$ and -0.5562). Total impact of all the weather factors was 41.54 per cent indicating significant multiple correlation coefficient ($R = 0.6445$). Appearance of Aphid, *Aphis craccivora* (Koch) colony commenced from 48 SW attaining peak (3.65 aphid index) on 3 SW indicating significant positive correlation with wind velocity ($r' = 0.5160$) but significant negative correlation with temperature (maximum, minimum and average) ($r' = -0.7219, -0.5619$ and -0.6398). The multiple correlation coefficient ($R = 0.7014$) was significant explaining 49.16 per cent variation due to all the weather factors. Pod borer, *Helicoverpa armigera* (Hubner) population commenced on 49 SW attaining peak (6.21 larvae/plant) on 4th SW. It indicated significant positive correlation with wind velocity ($r' = 0.4590$) and significant negative correlation with temperature (maximum, minimum and average) ($r' = -0.6992, -0.5701$ and -0.6376). The multiple correlation coefficient ($R = 0.6333$) explained 40.11 per cent variation due to all the weather factors.

Key words: Correlation, Indian bean, standard week

INTRODUCTION

Indian bean (*Dolichos lablab* L.) Syn. *Lablab purpureus* L., *Lablab niger* Medik is a group of important pulse cum vegetable crops having great potentiality for protein and yield. In south Gujarat, Indian bean is the most important pulse vegetable crop grown particularly in Navsari, Surat and Valsad districts. In India, it is cultivated in an area of 23.86 million hectares (Anonymous, 2009) while in Gujarat, it occupies an area of 8901 million hectares with production of 7218 million tones. The major constraints affecting yield of Indian bean are insect-pests which act either as a vector of many diseases or cause direct injury to different parts from seedling to maturity stage. Thirty species of insect pests have been recorded on Indian bean (Srivastava and Butani, 1998). Aphid, jassid, whitefly, pod borer, spotted pod borer and pod bug (*Clavigralla*) are serious pests which attack buds, flowers and pods. Amongst them, *Bemisia tabaci* (Gennadius), *Liriomyza trifoli* (Burgess), *Aphis craccivora* (Koch) and *Helicoverpa armigera* (Hubner)

are the potential insect pests of Indian bean. Of late, there have been major changes in the status of several pests under the influence of changing environment. Information available of their seasonal fluctuation in relation to major abiotic factors in the country and under south Gujarat agro-climatic conditions is stant. So, the present study was proposed and undertaken with the objective of studying seasonal cycle of major insect-pests of Indian bean in relation to major abiotic factors.

MATERIALS AND METHODS

The experimental trial was conducted at Regional Horticultural Research Station, Navsari Agricultural University, Navsari on Indian bean cv. Gujarat Papdi during *Rabi* 2011-2012 to study seasonal abundance of major insect-pests of Indian bean in relation to major abiotic factors. Observations were recorded throughout the crop season at standard week wise interval (October 2011-till harvest). For recording observations, twenty plants were selected and tagged. Plants were kept free from insecticide spray during the observation period.

Total number of white fly adults was counted on leaves and pods of top, middle and bottom part of each tagged plant. For recording leaf miner, total number of leaves and mined leaves were observed on top, middle and bottom portion of each tagged plant and based on these per cent damage was worked out. Aphid was recorded as per the method given by Siroli *et al.* (1966) and El-

Defrawi and Rizk (2002). The pest observations were counted on leaves, flowers and pods on top, middle and bottom part of each selected plant and degree of infestation level was categorized as 1,2,3,4 and 5 according to visual counts and its symptoms were given as per the methodology of Hafez (1964) and El-Defrawi *et al.* (1991).

Aphid infestation ratings

Rating scale	Designation
1	Up to 20 aphids/plant shoot, there is no obvious symptom of attack.
2	21-50 aphids/plant shoot, aphid colonies present on the 1/3 plant height, plant damage showing less than the untreated control.
3	51-100 aphids/plant shoot, aphids are not in recognizable colonies but diffused to infest large proportion of leaves and stems and more than one shoot infested.
4	101-500 aphids/plant shoot, present in very dense numbers infesting all plant parts on 2/3 plant height.
5	>500 aphids/plant shoot. Plant severely infested by aphids and covers nearly all the plant surfaces.

The infestation index was calculated as:

$$\text{Infestation index} = \frac{1xa + 2xb + 3xc + 4xd}{a+b+c+d}$$

Where, 1, 2, 3, 4 and 5 are the grades (scale) and a, b, c and d are the numbers of plants falling in each grade.

Pod borer *Helicoverpa armigera* was observed at all the stage of crop growth on the basis of number of larvae in five randomly selected pods on top, middle and bottom part of each tagged plant. Weather data based on temperature (maximum, minimum and average), relative humidity (morning, evening and average), rainfall, rainy days, sunshine, wind velocity and sky position were recorded at standard week wise interval to study the effect of weather parameters on population of various insect pests. Thereafter, relationship between pest population and or damage and weather factors was studied using correlation analysis.

RESULTS AND DISCUSSION

(a) Whitefly, *Bemisia tabaci* (Gennadius). The results presented in table 1 and graphically depicted in fig.1 indicate commencement of whitefly population during 41 standard week (SW) (8-14 October) which indicated as high as 1.03 white flies per leaf. The white fly population multiplied further and attained peak (8.28/leaf) during 4 SW (22-28 January, 2012). Thereafter, it declined gradually attaining the lowest level (0.98) during 9 SW (26 February – 4 March) at harvest.

The white fly population could not establish significant positive correlation with any weather factor taken into consideration however, the population exhibited highly significant negative correlation with maximum temperature ($r' = -0.6463$), minimum

temperature ($r' = -0.5697$) and average temperature ($r' = -0.6162$). Total contribution of all the weather factors on abundance of white fly population was 31.62 per cent indicating significant multiple correlation ($R = 0.5623$) (Table 2). The regression equation of white fly population with weather factors is:

$$\hat{Y} = 28.3602 + 0.1294(X_1) + 0.9133(X_2) - 1.7741(X_3)$$

Where

Y = Mean white fly population/leaf

X₁ = Maximum temperature (°C)

X₂ = Minimum temperature (°C)

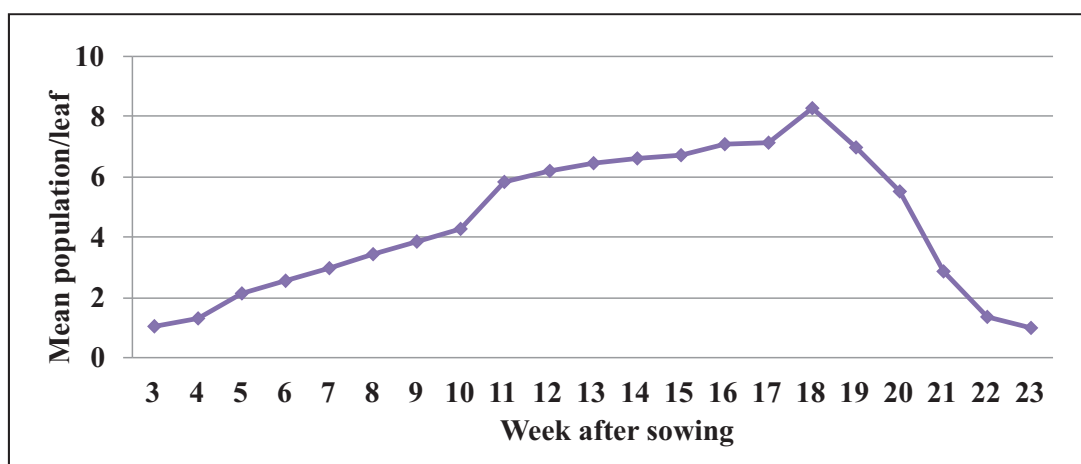
X₃ = Average temperature (°C)

So, it is evident that relationship between white fly population and temperature was significant but negative implying that with every unit decrease in temperature, there was corresponding rise in the pest population and vice-versa.

Patel and Jhala (1992) observed that Indian bean was the most preferred host for *B. tabaci* and November and January were the most favourable months for reproduction and survival. Similarly, Chaudhary *et al.* (2001) found temperature, relative humidity and rainfall negatively correlated with *B. tabaci* population on tomato. Gurjar (2005) reported that whitefly population had highly significant positive correlation with average temperature, while, remaining factors *viz*: minimum temperature, maximum temperature evening, average relative humidity, wind velocity and sunshine hours had non-significant positive correlation with white fly population while, morning relative humidity had non-significant negative correlation with white fly population on cowpea.

Table 1. Seasonal abundance of major insect-pests of Indian bean during 2011-12

Standard Week	Met. Period	Whitefly/leaf	Leaf miner % mined leaves	Aphid infestation index	<i>Helicoverpa armigera</i> larvae/plant
41	8-14 Oct.	1.03	3.09	0	0
42	15-21 Oct.	1.28	3.41	0	0
43	22-28 Oct.	2.13	3.97	0	0
44	29-4 Nov.	2.57	4.24	0	0
45	5-11 Nov.	2.98	5.09	0	0
46	12-18 Nov.	3.42	6.67	0	0
47	19-25 Nov.	3.87	7.60	0	0
48	26-2 Dec.	4.27	8.45	0.90	0
49	3-9 Dec.	5.83	9.19	1.20	0.89
50	10-16 Dec	6.17	10.03	1.75	1.95
51	17-23 Dec.	6.47	10.78	1.90	2.63
52	24-31 Dec.	6.58	14.97	1.15	2.95
1	1-7 Jan.	6.73	17.94	1.70	3.15
2	8-14 Jan.	7.08	19.88	2.30	3.95
3	15-21 Jan.	7.13	22.41	3.65	4.75
4	22-28 Jan.	8.28	28.86	3.40	6.21
5	29-4 Feb.	6.97	34.86	2.90	4.45
6	5-11 Feb.	5.53	34.30	2.45	2.53
7	12-18 Feb.	2.85	33.83	2.20	2.00
8	19-25 Feb.	1.33	33.56	1.60	1.74
9	26-4 March	0.98	33.37	0.85	0.68

**Figure 1. Seasonal abundance of whitefly on Indian bean**

In the earlier reports, high pest population was recorded during November – January or winter months. In the present findings, the white fly population remained highest (8.28/leaf) during 4 SW (22-28^h January) followed by another active period of the pest during 50-5 SW (10 December – 4 February) recording 7.13, 7.08, 6.97, 6.73, 6.58, 6.47 and 6.17 white flies per leaf. This was the coolest period of the year which indicated significant negative correlation of pest

population with temperature. So, the present finding is more or the less same as reported in the earlier reports and is in close agreement with them.

(b) Leaf miner, *Liriomyza trifoli* (Burgess). The results revealed that leaf miner infestation (% mined leaves) started appearing from 41 SW (8-14 October) recording 3.09 per cent mined leaves. The pest damage escalated further indicating peak damage to the tune of 34.86 per cent at 5 SW (29 January – 5 February) (Table 1).

Table 2. Correlation and regression coefficients of major insect-pests of Indian bean with major weather factors

Abiotic factors	Correlation coefficient (r)				Regression Coefficient			
	White fly (Y ₁)	Leaf miner (Y ₂)	Aphid (Y ₃)	<i>Helicoverpa armigera</i> (Y ₄)	White fly (Y ₁)	Leaf miner (Y ₂)	Aphid (Y ₃)	<i>Helicoverpa armigera</i> (Y ₄)
Max. temp. (X ₁)	-0.6463**	-0.6157**	-0.7219**	-0.6992**	0.1294	-11.2411	-1.8375	-0.0633
Min. temp. (X ₂)	-0.5697**	-0.4958*	-0.5619**	-0.5701**	0.9133	-7.4153	-1.1958	0.8204
Av. temp. (X ₃)	-0.6162**	-0.5562**	-0.6398**	-0.6376**	-1.7741	16.1132	2.6410	-1.3657
Mor. RH (X ₄)	0.2778	-0.0685	0.2895	0.2675	-	-	-	-
Even. RH (X ₅)	0.1814	-0.2526	0.1469	0.2233	-	-	-	-
Av. RH (X ₆)	0.2547	-0.1581	0.2472	0.2700	-	-	-	-
Wind velocity(X ₇)	0.1948	0.6270**	0.5160**	0.4590*	-	10.837	0.5173	0.6199
Sun Shine (X ₈)	-0.3029	-0.1114	-0.2539	-0.2339	-	-	-	-
R ²					0.3162	0.4154	0.4916	0.4011
Variation (%)					31.62	41.54	49.16	40.11
R					0.5623*	0.6445*	0.7014**	0.6333*
Constant (A value)					28.3602	97.7781	15.4058	22.9382

* Significant at 5 per cent level ** Significant at 1 per cent level

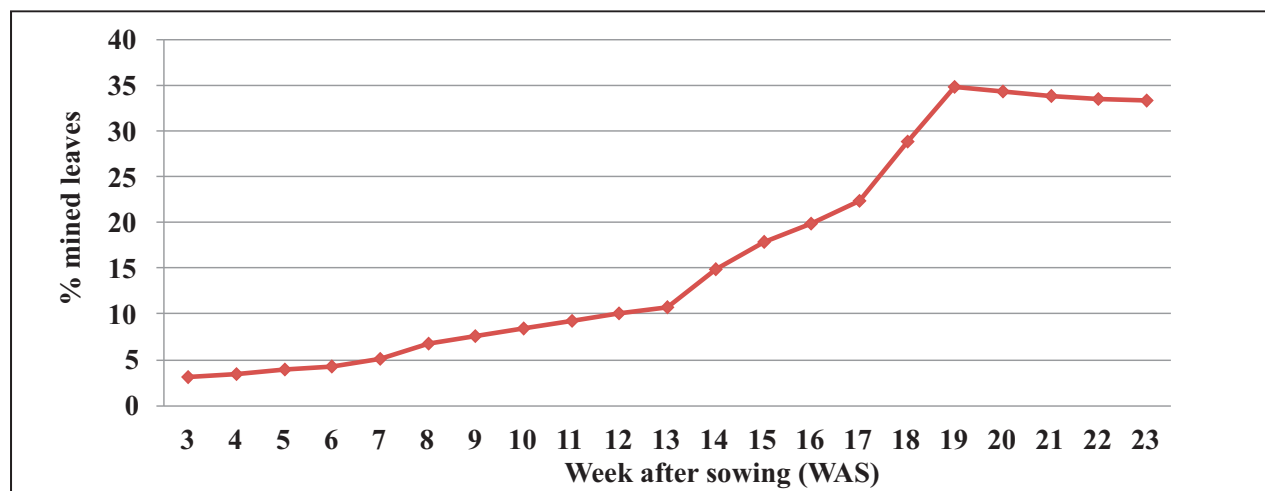


Figure 2. Seasonal abundance of leaf miner on Indian bean

The results based on per cent mined leaves in table 2 indicated significant positive correlation with wind velocity ($r' = 0.6270$) and negative correlation with maximum temperature ($r' = -0.6157$), minimum temperature ($r' = -0.4958$), average temperature ($r' = -0.5562$). The remaining factors *viz.*, relative humidity (morning, evening and average) and sun shine could not indicate any significant on abundance of the pest. The total impact of all the weather factors considered in this investigation on leaf miner oriented damage was 41.54 per cent indicating highly significant correlation coefficient ($R = 0.6445$) (Table 2). The regression equation involving leaf miner damage and weather factors is:

$$\hat{Y} = 97.7781 - 11.2411 (X_1) - 7.4153 (X_2) - 16.1132 (X_3) + 10.837 (X_7)$$

Where,

Y = Mean leaf miner damage (% mined leaves)

X_1 = Maximum temperature ($^{\circ}\text{C}$)

X_2 = Minimum temperature ($^{\circ}\text{C}$)

X_3 = Average temperature ($^{\circ}\text{C}$)

X_7 = Wind velocity (Kms/hour)

Leaf miner damage increased with unit increase in wind velocity and decreased with increase of temperature to a significant extent. The damage remained highest (34.86 % mined leaves) during 5 SW (29 January – 4 February) followed by active period during 6-9 SW indicating damage to the tune of 34.30, 33.83, 33.56 and 33.37 per cent, respectively. This period witnessed lowest temperature of the year and comparatively higher wind velocity which coincided with higher damage and peak status of the pest exhibiting significant negative and positive correlations, respectively. The period of 41 to 49 SW witnessed lower pest damage (< 10 % mined leaves) when temperature was comparatively higher and wind velocity was lower.

Though immature stages of the pest remained inside the serpentine feeding galleries on dorsal side of the leaf

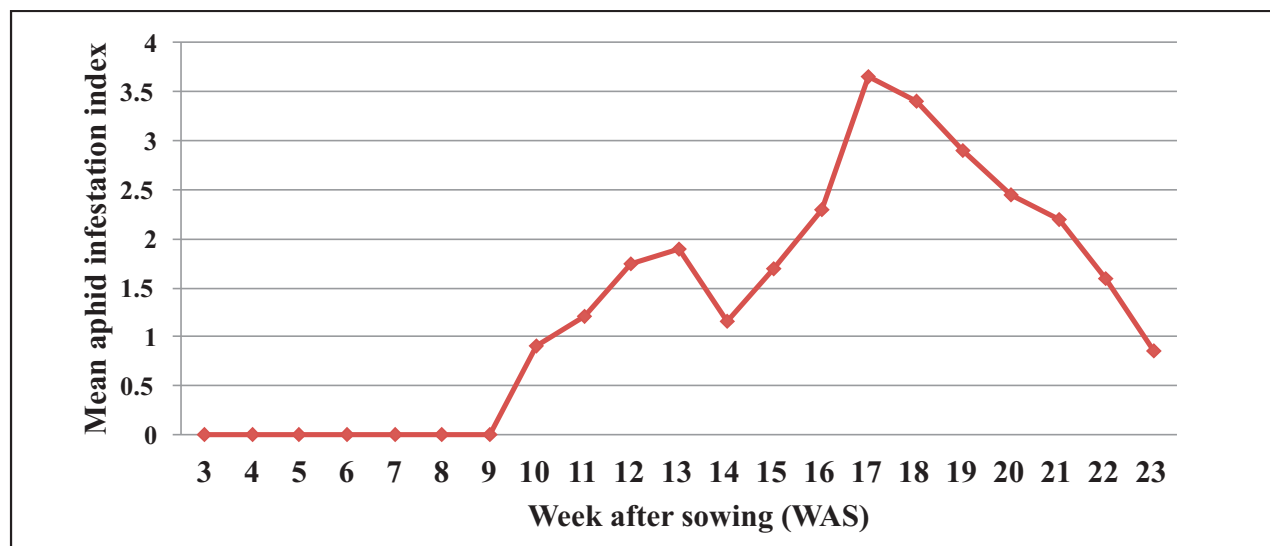


Figure 3. Seasonal abundance of aphid on Indian bean

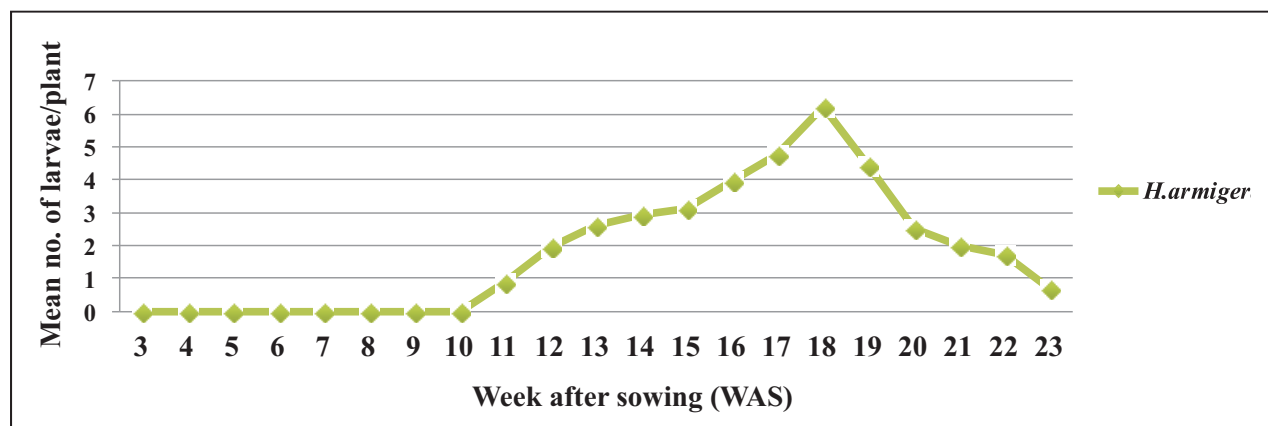


Figure 4. Seasonal abundance of pod borer, *Helicoverpa armigera* on Indian bean

lamina, yet its female adult remain outside the gallery so due to high winds, there could be a possibility of sweeping the adult pest from damaged plants to the healthy plants being higher during 4-9 SW i.e. 22 January – 4 March inflicting higher damage as compared to period of 41-49 SW when temperature remained higher and wind velocity being lower.

Srinivasan *et al.* (1995) carried out survey of *L. trifoli* on its host plants in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu wherein 70 host plants like fiber crops, pulses, vegetables, green manure crops, fodder crops were observed. They further reported relatively severe incidence of *L. trifoli* on tomato, field bean, okra, potato, etc. Highest population of tomato leaf miner larvae (*L. trifolii*) (3.08/leaf) was observed in first week of January, while it remained lowest (2.80) in fourth week of November. Salah and Wad Medani (2008) reported that faba bean plots (cv. Shambat and SML) were heavily infested by the leaf miners, which ultimately resulted in yield losses of 42.25 per cent for Shambat and 29.16 per cent for SML, respectively. Ganapathy *et al.* (2010) reported lower incidence (9.0%) of leaf miner in cowpea in November wherein it was maximum (32.5%) in March. Hemalatha *et al.* (2002) carried out field experiment at Andhra Pradesh and found that high relative humidity (69.77%) exhibited positive correlation with the leaf miner (*L. trifolii*) population. Krishnakumar *et al.* (2004) at IIHR, Bangalore reported that relative humidity had significant negative correlation with leaf miner (*L. trifolii*) oriented damage in tomato crop. As no authentic information is available on relationship of abundance of leaf miner oriented damage in relation to weather factors in Indian bean, so it may be concluded that prevalence of lower temperature and high wind velocity during 4-9 SW coincided with higher damage of the pest and vice-versa

(c) **Aphid, *Aphis craccivora* (Koch).** Initiation of pest population and infestation (0.90 index) commenced from 48 SW (26 November – 2 December). The aphid infestation index increased steadily and attained peak

(3.65) at 3 SW (15-21 January) thereafter, it declined gradually indicating lowest level (0.85) at 9 SW (26 February-4 March) (Table 1 and Fig. 3).

Aphid population/index on Indian bean exhibited significant positive correlation with wind velocity ($r = 0.5160$) and significant negative correlation with maximum temperature ($r' = -0.7219$), minimum temperature ($r' = -0.5619$) and average temperature ($r' = -0.6398$). The relative humidity (morning, evening and average) had no significant effect on population fluctuation of the aphid. The multiple correlation coefficient ($R = 0.7014$) was highly significant explaining 49.16 per cent variation due to all the weather factors taken into consideration (Table 2).

The regression equation of aphid population/index and weather factors is:

$$\hat{Y} = 15.4058 - 1.8375 (X_1) - 1.1958 (X_2) + 2.6410 (X_3) + 0.5173 (X_7)$$

Where,

Y = Mean aphid infestation index

X_1 = Maximum temperature ($^{\circ}\text{C}$)

X_2 = Minimum temperature ($^{\circ}\text{C}$)

X_3 = Average temperature ($^{\circ}\text{C}$)

X_7 = Wind velocity (Kms/hour)

Positive correlation between aphid population and wind velocity indicate that with every unit increase in wind velocity there was corresponding increase in pest infestation index and vice-versa. It implied that pest peaked (3.65 index) during 3 SW (15-21 January) when wind velocity was comparatively higher. This was followed by an active period of 4-6 (22 January – 11 February), 2 (8-14 January) SW when aphid infestation indices were 3.40, 2.90, 2.45 and 2.30, respectively. On the other hand, either there was no pest infestation or a very low level of pest indices (< 2) during 41-47 SW (8 October – 25 November) or 48-1 SW (26 November-7 January), respectively when temperature was high and

wind velocity being lower. As male aphids are winged (alate form), there might be a possibility of their sweeping from damaged plants to healthy plants during the active period when wind velocity was comparatively higher.

Faleiro *et al.* (1990) reported that population of *A. craccivora* on cowpea was negatively correlated with maximum daily temperature, wind speed and sunshine and positively correlated with minimum temperature, wind speed, sunshine, relative humidity and rainfall at New Delhi. EL-Defrawi (2000) reported that *A. craccivora* had two main periods of activity in faba bean wherein highest count was observed during third week of December and February. Reza and Ahmed (2000) concluded that aphid incidence (*A. craccivora*) had significant positive association with rainfall. Salman and Mohamed (2000) observed negative correlation between aphid population on faba bean and maximum as well as minimum temperature in Egypt.

In the ongoing discussion, peak aphid infestation (3.65 index) has been reported at 3 SW (15-21 January) followed by active periods during 4-7 SW (22 January – 18 February) and 2 SW (8-14 January) when temperature was comparative lower. This trend of aphid incidence was also reported by EL-Defrawi (2000), Salman and Mohamed (2000).

(d) Pod borer, *Helicoverpa armigera* (Hubner). The results presented in table 1 and graphically depicted in fig. 4 showed that larval population of pod borer (0.89 larva/plant) started appearing from 49 SW (3-9 December) which attained peak (6.21) at 4 SW (22-28 January) thereafter, it declined steadily reaching to the lowest (0.68) at harvest which coincided with 9 SW (26-4 March) (Table 1).

The larval population of *H. armigera* indicated significant positive correlation with wind velocity ('r' = 0.4590) and significant negative correlation with maximum temperature ('r' = -0.6992), minimum temperature ('r' = -0.5701) and average temperature ('r' = -0.6376). The remaining weather factors failed to exhibit any significant correlation with pest population. Multiple correlation coefficient (R = 0.6333) was significant explaining 40.11 per cent due to all the weather factors taken into consideration. The regression equation of *H. armigera* larval population and weather factors is:

$$\hat{Y} = 22.9382 - 0.0633 (X_1) + 0.8204 (X_2) - 1.3657 (X_3) + 0.6199 (X_7)$$

Where

Y = Mean larval population

X₁ = Maximum temperature (°C)

X₂ = Minimum temperature (°C)

X₃ = Average temperature (°C)

X₇ = Wind velocity (Kms/hour)

This type of correlation trend implies that with increase in wind velocity there was corresponding increase in larval population of the pest and vice-versa. This could be due to migration of adult pest from damaged plants to the healthy plants by high velocity wind thereby inflicting higher damage (2.00-6.21 larvae/plant). Migration was more prominent during 51-7 SW (17 December – 18 February) indicating peak status (6.21 larvae/plant) during 22-28 January (4 SW) when temperature was almost lowest exhibiting significant negative correlation with temperature.

Gurjar (2005) reported that maximum temperature, minimum temperature and average temperature had highly significant negative correlation with *H. armigera* population on tomato. Mallikarjuna *et al.* (2012) reported eight pod borers on field bean from Bengaluru. Amongst them, *H. armigera* was prominent and its incidence was as high as 80.50 larvae per 10 plants during third week of November.

In the present investigation, active period of the pest commenced from 17th December (51 SW) which is slightly different from the results obtained in the earlier reports. This could be due to difference in agro-climatic conditions, date of sowing and crop and its variety. So, it may be concluded that the pest under consideration (*H. armigera*) peaked (6.21 larvae/plant) during 4th SW (22-28 January) when wind velocity was comparatively higher and temperature being lower.

CONCLUSION

The current investigation based on seasonal abundance of major insect-pests of Indian bean in relation to major abiotic factors is concluded as under:

- Population of white fly reached peak at 4 SW. Relationship between white fly population and temperature was significant but negative.
- Incidence of leaf miner attained peak leaf damage at 5 SW. Correlation between leaf miner damage and wind velocity was positive and it was negative with temperature.
- Abundance of aphid population attained peak at 3 SW. The population indicated highly significant and positive correlation with wind velocity and negative with temperature.
- The incidence of pod borer *Helicoverpa armigera* reached to its peak during 4 SW. Highly significant and positive correlation was observed between pod borer larval population and wind velocity while, it was negative with temperature.



Population of white fly *Bemisia tabaci* on Indian bean (G.)



Mined leaves of Indian bean due to incidence of leaf miner *Liriomyza trifoli* (Burgess)



Plate 2. Shoot and pod infested by Bean aphid *Aphis craccivora* (Koch)



Plate 3. Bored pods of Indian bean by pod borer *Helicoverpa armigera* (Hubner)

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