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Seasonal incidence of soybean defoliators and their correlation with weather parameters in *kharif* season

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Abstract
Investigation on seasonal incidence of soybean defoliators and their correlation with weather parameters was carried out at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *kharif* season of 2017. Studies on seasonal incidence of defoliators on soybean revealed that the incidence of tobacco leaf eating caterpillar, *Spodoptera litura* (Fabricius) commenced from 1st week after germination *i.e.* 3rd week of July (0.81 larvae/plant) and reached at peak level (5 larvae/plant) at 9th week after germination coinciding with 2nd week of September. All the weather parameters were non-significantly correlated with the population of *S. litura* during *kharif* season of 2017. Incidence of gram pod borer, *Helicoverpa armigera* (Hubner) (0.36 larvae/plant) commenced from 1st week after germination *i.e.* 3rd week of July and reached at peak level (2.4 larvae/plant) at 7th week after germination coinciding with 1st week of September. The correlation between the pest population and morning relative humidity and evening relative humidity was positively significant.

Keywords: Soybean, soybean defoliators, seasonal incidence, weather parameters and Junagadh

Introduction
Soybean [*Glycine max* (L.) Merrill.] Is an important leguminous crop. Native of soybean is in Asia and the first known records, indicate that soybean emerged as a domesticated crop around the eleventh century B. C. in China (Hymowitz, 1970) [5]. They named it as a "yellow jewel" which feeds China's entire population. Soybean was introduced in India in 1870-80 (Andole, 1984) [2]. The soybean crop is one of the remarkable success stories in Indian agriculture.

It is one of the most important oilseed cash crops of India. It is a fascinating crop with innumerable possibilities of not only improving agriculture, but also supporting industries. It is a unique crop with high nutritional value, providing 40 per cent protein and 20 per cent edible oil besides minerals and vitamins. Soybean oil is used as a raw material in manufacturing antibiotics, paints, varnishes, lubricants etc. Soybean meal is used as protein supplement in human diet, cattle and poultry feeds (Alexander, 1974) [1]. Soybean is a major oil seed crop of the world grown in an area of 113.01m ha with production of 283.79 mt and productivity of 2.51 t/ha (Anonymous, 2013) [4]. India contributes more than 90 per cent of the world's acreage.

In India, soybean occupies an area of 109.714 lakh ha with production potential of 114.907 lakh tons. Major production comes from Madhya Pradesh (57.168 lakh t) followed by Maharashtra (39.456 lakh t). Other soybean producing states are Andhra Pradesh, Karnataka, Chhattisgarh and Gujarat (SOPA, 2016) [13]. In India in the year 2012-13, soybean cultivation reached to 12.03 mha recording production of 12.98 mt with an average of 1079 kg/ha. In Gujarat, the area under soybean was 14,000 hectares and the yield was 714 kg per ha with total production of 10,000 tones (Anon., 2003) [3].

Soybean is mainly rich in amino acids like leucine, methionine and threonine that the human body requires. For vegetarians, it is known as "poor man's meat". It also contains good amount of potassium, sulphur and vitamin E. Due to absence of sugar content, it is considered to be very suitable diet for diabetic patients.

Soybean crop having luxuriant growth with succulent leaves attracts the number of insect pests for feeding, oviposition and shelter. About 150 insect pests cause damage to soybean in various parts of Madhya Pradesh, out of which about a dozen of insect pests cause serious damage to the crop from sowing to the harvest (Singh and Singh, 1992) [10].

Among them green semilooper, *Chrysodeixis acuta* (Walker), tobacco caterpillar, *Spodoptera litura* (Fabricius) and pod borer, *Helicoverpa armigera* are major foliage feeder insects which voraciously feeds on foliage, flower and pods causing significant yield loss.

The damage caused by this pest depends on population of damaging stage of insect, crop growth stage, cropping pattern in the area and prevailing environmental conditions. Perusal of literature reveals that insecticidal recommendation are available for protecting the crop from soybean defoliators attack. They are highly toxic to natural enemies and cause environmental pollution.

Correlation of pest population with different weather parameters provide valuable information on the basis of such data a predictive model can be developed which can be used for the forecast of pest population build-up and ultimately farmers can plan for plant protection strategies. The study of seasonal incidence will be useful to generate the information on population build-up of soybean defoliators.

Materials and Methods

In order to study the seasonal incidence of soybean defoliators, the crop was sown at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *kharif* season of 2017. The crop was grown in plot size of 18 m x 18 m keeping 45 cm x 15 cm spacing between row to row and plant to plant. Plot was divided into 20 equal quadrate of size 1.80 m × 1.50 m. All the other agronomical operations were adopted as per the scientific recommendations. The crop under the experiment was kept free from pesticides throughout the season.

Observation Recorded

The observations were recorded at weekly interval on five plants selected randomly from each quadrate, from one week after germination till the harvest of the crop. Number of larvae of leaf eating caterpillar and gram pod borer were recorded. Mean population of *S. litura* and *H. armigera* larvae per plant was worked out separately. The data thus obtained, was statistically analysed. In order to study the effect of weather parameters *viz.*, maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine hours, rainfall and rainy days on population of soybean defoliators, the simple correlation coefficients were worked out. The weekly meteorological data was obtained from Meteorological Observatory, Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh.

Results and Discussion

Tobacco leaf eating caterpillar, *Spodoptera litura* (Fabricius)

It is evident from the data (Table-1 and Fig.-1) that the population of *S. litura* was started 1st WAG *i.e.* 3rd week of July (0.81 larvae/plant) which increased during each successive weeks and reached at peak level (5 larvae/plant) at 9th WAG coinciding with 2nd week of September. Thereafter, the pest population suddenly declined at minimum level of 1.1 larvae/plant during 11th WAG and disappeared in 12th WAG.

The population of *S. litura* remained high *i.e.* 2.4 to 5 larvae/plant during 5th to 9th WAG on soybean crop at Junagadh during *kharif* season of 2017. Shrivastava and Shrivastava (1989) [9]. observed the larvae of *S. litura* were active from August to October. Singh and Singh (1990 b) [11] also observed that the *S. litura* attacks the soybean during August-October. It causes wide spread damage to soybean in September-October. Sojitra (1990) [12] showed two peaks of *S. litura* activity during the crop season. Sreenivas *et al.* (2007) [14] observed peak incidence of tobacco caterpillar during 35th MW (27th August to 2nd September, 2002).

The result presented in Table-2 indicated that non-significant positive correlation exhibited between population of *S. litura* and maximum temperature, morning relative humidity, evening relative humidity. The correlation between pest population and minimum temperature, bright sunshine hours, rainfall and rainy days was negatively non-significant. Paliwal, (2013) [8]. reported that among the different weather parameter minimum temperature was negatively correlated and evening relative humidity positively correlated with a tobacco caterpillar larval population.

Gram pod borer, *Helivoverpa armigera* (Hubner)

The data presented in Table-1 and Fig.-2 showed that the population of *H. armigera* (0.36 larvae/plant) commenced from 1st WAG *i.e.* 3rd week of July. Pest population increased constantly during each successive week and reached at peak level (2.4 larvae/plant) at 7th WAG coinciding with 1st week of September. After reaching a peak pest population declined fast and disappeared during 11th WAG at the time of maturity of the crop. Sojitra (1990) [12] studied the incidence of *H. armigera* on soybean and revealed that the pest was active during July to September. Jayaprakash (2000) [6]. reported that *H. armigera* noticed during July and September with peak incidence at 34 to 62 days after sowing.

The result presented in Table-2 revealed that correlation between pest population and rainfall and rainy days were positively non-significant in *kharif* season of 2017. The correlation between the pest population and morning relative humidity and evening relative humidity was positively significant. Whereas maximum temperature, minimum temperature and bright sunshine hours were negatively non-significant. In past, Mehto *et al.* (1985) [7] reported that the pest population had negative non-significant association with bright sunshine hours on cowpea. Sojitra (1990) [12] revealed that the population showed negative correlation with maximum temperature.

Table 1: Seasonal incidence of soybean defoliators during *kharif* season of 2017

Standard week	Week after germination	Mean no. of *S. litura* larvae/plant	Mean no. of *H. armigera* larvae/plant	Temperature (^{0}C)		Relative humidity (%)		Bright sunshine (hrs.)	Rainfall (mm)	Rainy days
				Maximum	Minimum	Morning	Evening			
29	1	0.81	0.36	30.1	25.0	95	85	0.8	197.5	6.0
30	2	1.0	1.2	28.1	25.2	93	87	0.0	34.2	4.0
31	3	1.37	1.42	30.5	25.1	90	74	1.0	7.9	2.0
32	4	1.6	1.5	32.0	24.6	90	71	1.3	25.9	3.0
33	5	2.4	1.76	31.8	24.7	90	76	2.5	11.2	1.0
34	6	2.7	2.1	31.3	24.8	93	82	2.4	71.0	2.0

35	7	3.0	2.4	29.4	23.7	92	87	0.8	185.4	4.0
36	8	4.1	1.17	31.9	24.3	90	63	5.9	2.1	0.0
37	9	5.0	0.99	34.0	25.5	85	72	5.9	13.7	1.0
38	10	3.2	0.98	31.6	24.6	91	79	1.8	12.5	2.0
39	11	1.1	0.0	33.4	23.9	82	62	9.5	0	0.0
40	12	0.0	0.0	36.0	25.3	76	41	9.4	0	0.0

Table 2: Correlation matrix of the relationship between weather parameters and population of soybean defoliators during *kharif* season of 2017

parameters	Temperature (^{0}C)		Relative Humidity (%)		Bright Sunshine (hrs)	Rainfall (mm)	Rainy days
	Maximum	Minimum	Morning	Evening			
S. litura	0.016	-0.119	0.243	0.236	-0.030	-0.080	-0.235
H. armigera	-0.543	-0.263	0.630*	0.606*	-0.646*	0.263	0.248

*Significant at 5% (r = 0.576) ** Significant at 1% (r = 0.708)

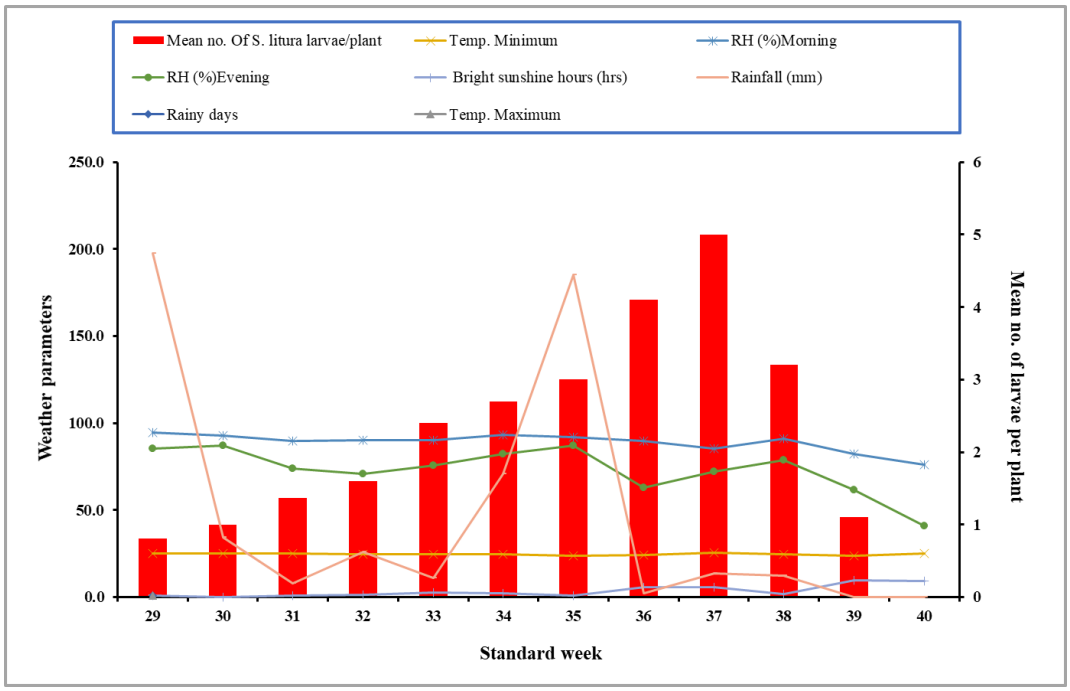

Fig 1: Seasonal incidence of tobacco leaf eating caterpillar, *S. litura* during *kharif* season of 2017

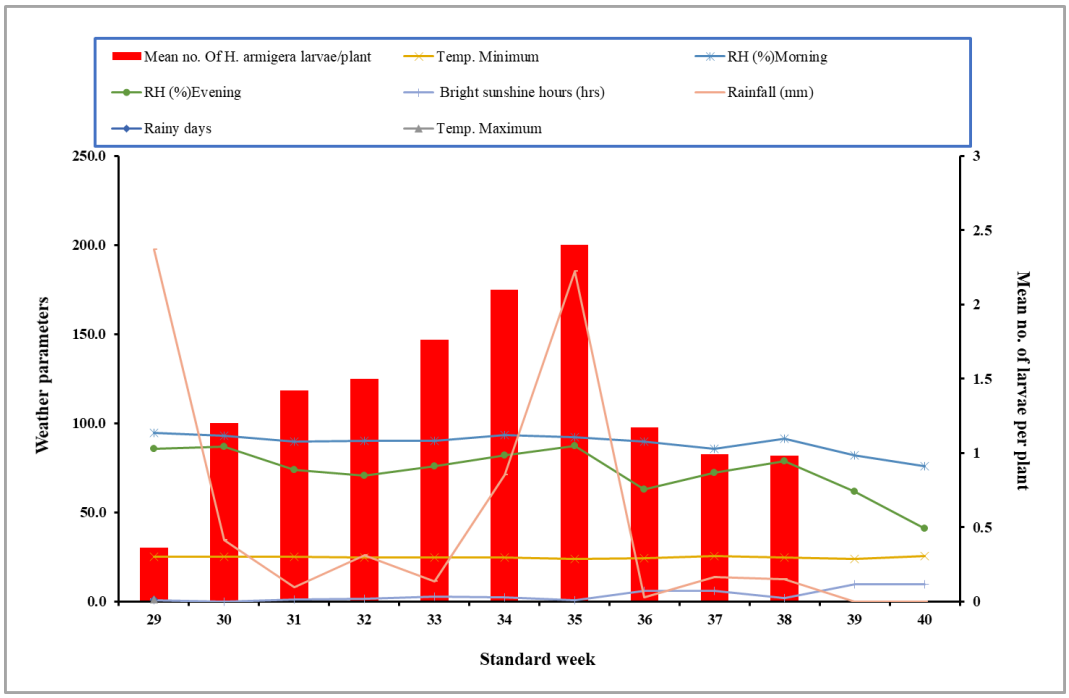

Fig 2: Seasonal incidence of pod borer, H. armigera during *kharif* season of 2017

Conclusion

The infestation of *S. litura* was initiated from 1st WAG *i.e.* 3rd week of July (0.81 larvae/plant) and reached at peak level (5 larvae/plant) at 9th WAG coinciding with 2nd week of September. Thereafter, it gradually declined and reached to zero level at the time of harvest. The correlation study indicated that population of *S. litura* and maximum temperature, morning relative humidity and evening relative humidity were positively non-significant, while minimum temperature, bright sunshine hours, rainfall and rainy days were negatively non-significant during *kharif* season of 2017.

The population of *H. armigera* was started from 3rd WAG *i.e.* 3rd week of July (0.36 larvae/plant) and reached at peak level 2.4 larvae/plant at 7th WAG coinciding with 1st week of September. Thereafter, it gradually declined and reached to zero level at the time of harvest. The correlation study indicated that the association between the pest population and rainfall and rainy days were positively non-significant during *kharif* season of 2017 while morning relative humidity and evening relative humidity was positively significant. Whereas maximum temperature, minimum temperature and bright sunshine hours were negatively non-significant.

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