Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(1): 1345-1348

Received: 16-11-2018
Accepted: 19-12-2018

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Sunflower defoliator population influenced by long term climatic trends and extreme weather conditions

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Abstract
An experiment to study incidence of defoliators on sunflower and their relation to weather parameter was carried out in non replicated design during *Kharif* 2001 to 2012, observations on pest incidence were recorded in the experiment as per the standards, weather parameter recorded in meteorological observatory at oilseeds research station, Latur, were used. Year wise data on pest incidence and weather parameter recorded on weekly basis was averaged for entire period. The weather - pest interaction in sunflower for defoliators was analysed by adopting correlation and regression studies.
Results of correlation studies revealed that, overall mean population of defoliators was significant and positively correlated with relative humidity-II. It is also evident from data that mean peak incidence of pest that the population of defoliators was at peak in38th MW. When the mean weather parameters of 37th week were maximum temperature (29.3 ^{0}C), minimum temperature (20.25 ^{0}C), precipitation (46mm), relative humidity I (81.95%) & humidity II (73.62%). Therefore it can be concluded that increase in relative humidity is causing significant increase in defoliators population and highest population density of the defoliators were observed during 37th SMW which means the weather parameters during this period were most conducive for pest population.

Keywords: Pest incidence, defoliators, weather parameter

Introduction

Sunflower (*Helianthus annuus* L., Family: Compositae) is usually tall annual, that grow to a height of 50–390 cm. The rough and hairy stem is branched in the upper part in wild plants but is usually unbranched in domesticated cultivars. The petiolate leaves are dentate and often sticky. The lower leaves are opposite, ovate or often heart-shaped. The upper leaves are alternate and narrower. They bear one or several too many wide, terminal capitula (flower heads), with bright yellow ray florets at the outside and yellow or maroon (also known as a brown/red) disc florets inside. Sunflower is one of the four most important annual crops in the world grown for oil along with soybean, rapeseed and groundnut. It is an important addition to the list of edible oilseed crops in India in the last four decades (Satyagopal, *et. al*, 2015) [8]. Sunflower was introduced in India during 1969 and to begin with four Russian varieties and one Canadian variety were evaluated in different parts of the country. The commercial cultivation of sunflower began in 1972. From a modest beginning of 15,000 hectares during 1972-73, the area under sunflower has witnessed phenomenal increase in the last two decades, although there has been a setback in its production in last few years. Until late 1980's, the crop was mainly confined to southern parts of the country- The country had been facing acute shortage of vegetable oils and its availability at very high cost, resulting in an import of 3.7 lac tonnes of edible oil in 1988-89, at a cost of about Rs. 1300 crores to the exchequer (Vasudevan, 1990) [10], due to low productivity of the oilseeds crop including Sunflower, this may be due to the attack of several pest on the sunflower crop.
An array of insect-pests cause damage to sunflower crop in different crop growth stages (Rajamohan *et ah*, 1974, Rangarajan *et al*,, 1975; Ayyanna *et ah*, 1978; Rohilla *et al*, 1980 and Arya, 1993) [4, 5, 2, 6, 1]. In India, more than fifty insect species have been found feeding on sunflower, of which seedling pests, sucking pests, defoliators and capitulum borer are of economic importance. (Basappa, 1995) [3]. Control of the insect pests mainly depends upon the use of chemicals but cultural and biological control is more useful than chemical control. The main benefit of bio-control is its safety to human health and environment. Unlike chemical control, it does not cause the secondary pest out break (Flint and Dreistadt, 1998). z

In order to develop an ecologically sound, economically feasible and socially acceptable pest management system, detailed information is required on insect-pest complex and their natural enemies in relation to crop phenology, population dynamics, losses or damage caused and tactics to minimize the pest population below economic threshold levels without affecting adversely the population of natural enemies, honey bees and other pollinators. Therefore present study was designed to asses long term effects of abiotic factors on defoliators and to study the interrelation between these two.

Materials and Methods

A field experiment in Randomized Block Design (RBD) with three replications with a plot size of 9.6 X 9.9 m^2 was laid out at Oilseeds Research Station, Latur during 2001 to 2012 using Sunflower, variety Morden. The row to row and plant to plant distance was kept at 60 cm and 30 cm, respectively. Fertilizer applications and agronomic practices were used according to standard recommendations. After fifteen days of germinations, data for the defoliators were recorded on weekly basis till harvest of the crop. Defoliators population count was made by actually counting the number of young and grown up larvae on each plant .Total of different fifteen observation plants were observed at each time.

Information pertaining to the abiotic factors or weather parameters was obtained from the Automatic weather station, Oilseeds Research Station, Latur, Maharashtra, India. Then by adopting Simple correlation analysis relation between mean defoliators population and weather factors (Temperature min and maximum, Relative humidity morning and evening and Rainfall) was worked out. After observing contribution of each weather variable in abundance of defoliators population data was subjected to further multiple regression analysis so as to formulate different equation which will be useful for forewarning defoliators infestation in advance.

Results and Discussion

Weather based pest forewarning systems can act as an effective tool in developing suitable control measures against pest incidence in crops. Information on abundance and distribution of pest in relation to meteorological parameters is the basic requirement for developing pest management program for a specific agro ecosystem. Both maximum and minimum temperatures, total rainfall, and relative humidity are the major weather parameters that largely control the dynamics of a given insect species.

Dynamics of defoliators population

Defoliators maximum population 1.20, 1.30, 2.13, 3.80, 4.20, 4.50, 5.00, 5.60, 5.45, 0.57, 1.10 and 2.40 larvae/plant were recorded during 38, 38, 37, 35, 37, 38, 37, 37, 38, 36,36 and 37 standered metrological week during 2001-2012 respectively. Hence the overall incidence of pests was moderate to high during 2001-2012. Peak period of maximum number of 5.60 larvae /plant were recorded during 37th SMW in the year 2008 and mean peak infestation i.e. 2.54 larvae /plant was observed in 37th SMW. Over the years 38th SMW week was found most congenial for the defoliators. (Table 1 and 2).

Correlation matrix

The correlation matrix revealed that the whitefly population, has a significant and negative correlation of population with maximum temperature. Weather parameters as minimum temperature, rainfall, relative humidity morning and relative humidity evening exhibited positive correlation with whitefly population but was non-significant (Table 3).

Cumulative effect of abiotic factors on defoliators population

From the correlation study, it was apparent that among the meteorological parameters no single parameter was responsible for multiplication and growth of the defoliators in sunflower crop but all parameter contributed in growth and development of defoliators . This could be expected because under natural conditions, no environmental factor acts/reacts in isolation, rather it acts in combination with other environmental factors. So, stepwise regression analysis between defoliators populations and meteorological parameters was performed to evaluate the cumulative effect of different meteorological parameters on defoliators multiplication and development (Table 4). It was evident that maximum temperature exerted 49.5 per cent effect on the population fluctuation of defoliators. The effect increased to 51.3,64.7,79.7 and 99.3 per cent when the effect of minimum temperature, relative humidity morning, relative humidity evening and rainfall was included.

Our findings are in partial agreement with those of Rangarajan *et at.* (1975) [5] during the study on pest complex of sunflower reported that while the leafiiopper, *A. biguUitla biguttula* was found associated with the crop throughout the year, other pests like *A.gossypii, N. viridula, D. indicus, S. dorsaUs* and *S. UttoraUs* were noticed in both winter and summer crops. Others like *B. tabaci, Oxycetonia versicolor* K, *P. orichalcea* and^. *armigera* were active in winter season. Panchbhavi *et al,* (1977) [7] reported that average number *of H. armigera* larvae varied from 3.85 to 7.64 per 30 plants on variety EC-68414. Dubey *et al.* (1995) [3] studied the population dynamics *ofH. Armigera* on various crops and recorded its peak activity in February and March during two years in Madhya Pradesh. Ramesh babu (2017) [9] find out the effect of various weather parameters on the occurrence of major defoliators in soybean crop. Semilooper larval population was recorded late July/early August and their peak activity observed during 33-34, 33-36 and 37-39 standard weeks, in 2012, 2013 and 2014, respectively. Among the weather factors, morning relative humidity showed significant (r=0.954) and positively, highly influence on the larval population per mrl whereas evening humidity (r=-0.644) and sunshine hrs (r=-0.367) negatively and significantly influence the larval population per mrl. The various weather parameters significantly caused 92 per cent variations in larval population per mrl. The mothcatches of *Spodoptera litura* increased from late-August to late-September and this trend was almost similar in different *kharif* seasons observed. Larval population of *S. litura* positively correlated with pheromone trap catches during 2014.

Table 1: Mean population of defoliators and corresponding weather parameters, 2001-2012.

SMW	Mean defoliators Population												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	1.00	0.00	0.36	**3.80**	2.60	0.2	4.10	1.80	0.45	0.40	0.80	1.00	1.38
36	1.10	0.00	0.73	1.80	3.60	0.6	4.60	2.20	0.75	0.57	1.10	2.00	1.59
37	1.10	1.20	2.13	1.80	4.20	4.2	5.00	5.60	2.55	0.33	0.00	2.40	2.54
38	1.20	1.30	2.00	1.40	3.80	4.5	3.30	4.20	5.45	0.47	0.07	1.00	2.39
39	0.8	0.90	1.30	0.60	2.20	1.4	0.80	4.20	1.35	0.60	0.33	1.20	1.31
40	0.4	0.80	0.40	0.00	0.00	0.4	0.20	3.20	3.15	0.00	0.13	1.20	0.82
41	0.20	1.10	0.30	0.00	0.00	0.2	0.40	3.60	2.24	0.00	0.20	1.40	0.80
SMW	**Temperature Maximum**												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	30.6	28.8	29.4	28.9	29	30.28	33.71	33.2	27.4	27.5	27.2	29.50	29.5
36	31.5	28.4	29.1	29.5	30.2	31.75	33.57	32.9	27.2	28.2	26.8	26.20	29.4
37	32.3	28.7	29.8	28.9	30.5	32	32.42	31.2	27.1	27.4	27.8	26.00	29.3
38	32.7	30.2	30.4	29.6	30.1	30.35	33.21	31.4	32	27.8	28	27.40	30.0
39	33.4	30.6	31.6	30.6	27.8	28.5	35.92	31.7	32.7	28	28	28.10	30.3
40	31.5	32.4	29.5	30.3	28.8	30.5	35.5	31.2	31.8	28.5	29.3	29.60	30.7
41	30.3	33.7	33.3	31.3	31.6	30.7	30.7	31.9	27.7	30.5	29.9	27.50	30.8
SMW	**Temperature Minimum**												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	19.8	20.1	21.6	22.9	22.1	20.71	20.42	18.8	19.4	15.3	20.7	21.20	20.29
36	19.4	20.3	20.2	21.6	21.8	20.2	22.07	19.7	19.9	17.7	20.4	20.30	20.38
37	21.2	20.1	19.9	21.5	21.8	21	19.35	21	21	14.7	21.3	21.10	20.25
38	20	19	19.1	22.4	21.9	21.7	20.78	22.3	21.6	14.6	21	20.90	20.48
39	19.8	20	19.3	23.1	20.9	21.7	20.92	22.2	20.3	14.7	20.9	20.40	20.40
40	20	20.2	20.5	22.4	20.7	21	20.42	22.3	20.6	14.7	21.3	20.60	20.43
41	19.9	18.5	18.8	22.4	21.3	20.2	18.42	18.7	20.5	14.1	20.3	20.40	19.42
SMW	**Relative humidity Morning**												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	92	88	81.1	82	89.5	84.28	71.71	70	80	91	88	71	81.51
36	93	84.9	77.7	86.9	90.4	83.85	80.85	80	86	86	87	87	84.60
37	91	87	67.8	79.1	90.7	77.14	77.71	82	87	86	81	86	81.95
38	91	81	77.6	64.7	88.1	89.57	79.85	89	82	84	79	80	81.35
39	92	85	72.8	75	89.42	85.28	85.71	84	79	85	79	74	81.29
40	93	76	81.7	77.3	91	85.7	86.57	79	80	80	79	70	80.57
41	95	69	73.3	73.8	87.2	86.8	58	59	86	69	71	86	74.46
SMW	**Relative humidity evening**												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	91	64	59.8	71	84.7	74.85	72.28	70	76	76	75	65	71.69
36	89	61	64.5	76.3	85.7	74.71	81.14	80	69	79	78	70	74.49
37	89	63	62.5	72.7	85.2	76.7	77.7	82	67	76	70	77	73.62
38	89	57	55.4	65.7	85	86.8	78.42	87	75	70	70	74	73.12
39	76	56	57.7	71.3	88.8	80.4	85.57	84	51	76	61	61	70.25
40	91	44	42.7	76.4	87.2	71.5	85.85	78	55	58	55	50	63.97
41	91	33	33.4	73.7	87.1	71.8	59.472	59	74	49	54	73	60.68
SMW	**Rainfall**												
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
35	5.1	88.30	182.40	21.10	38.00	0.20	20.00	0.00	108.5	176.5	181.40	9.00	75.04
36	0.8	30.80	0.00	58.70	21.60	0.00	112.20	80.00	36.00	29.60	62.10	59.00	44.55
37	0	25.60	0.00	49.50	6.00	73.60	28.00	81.8	108.00	41.90	3.60	88.00	46.00
38	18.4	0.00	6.10	6.30	89.20	21.00	87.00	299	0.00	23.60	0.00	21.00	50.36
39	4.6	20.00	45.00	35.50	18.00	117.0	185.8	47.6	0.00	54.60	9.50	2.00	48.64
40	58.2	18.50	49.00	123.50	122.20	22.20	93.00	7.10	35.00	14.00	34.50	0.00	47.18
41	55.6	0.00	0.00	47.50	0.00	51.30	0.00	0.00	92.50	0.00	0.00	153.20	31.32

Table 2: Peak incidence of defoliators in Sunflower (2001-2012)

Sr. No.	Parameter	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Mean
1	Peak Population	1.20	1.30	2.13	3.80	4.20	4.50	5.00	5.60	5.45	0.57	1.10	2.40	3.11
2	First app (SMW)	35	37	34.0	32.0	32.0	34.0	33.0	33.0	35.0	32.0	38.0	32.0	34
3	peak (SMW)	38	38	37.0	35.0	37.0	38.0	37.0	37.0	38.0	36.0	44.0	37.0	38
4	sowing week (SMW)	32	32	30.0	28.0	29.0	31.0	31.0	30.0	29.0	30.0	35.0	29.0	31
5	crop age at First	21	35	28.0	28.0	21.0	21.0	14.0	21.0	42.0	14.0	21.0	21.0	24
6	Crop age at peak	42.0	42.0	49.0	49.0	56.0	49.0	42.0	49.0	63.0	42.0	63.0	56.0	50

Table 3: Correlation between, defoliators population and various meteorological parameters (Pooled data over 2001 and 2012).

Weather parameter	Defoliators	Significance at 5%
Maximum temperature (°C)	2.213	Non-Significant
Minimum temperature (°C)	1.044	Non-Significant
Morning relative humidity (%)	1.302	Non-Significant
Evening relative humidity (%)	2.905	Significant
Rainfall (mm)	0.344	Non-Significant
T table Value at 5% 2.571		

Table 4: Regression equations for defoliators population and meteorological parameters (pooled data over 2001 and 2012).

Regression equation							Multiple correlation coefficient
Y = 22.74 +	(-1.71) **x** X_1+	(3.49) **x** X_2+	(-0.54) **x** X_3+	(0.08) **x** X_4+	(-0.04) **x** X_5+	0.14	0.993
Y=1.352 +	(-0.301) **x** X_1+	(1.040) **x** X_2+	(-0.292) **x** X_3+	(0.169) **x** X_4+	0.539		0.797
Y=27.042 +	(-1.381) **x** X_1+	(1.988) **x** X_2+	(-0.301) **x** X_3+	0.581			0.647
Y=17.280 +	(-0.712) **x** var2+	(0.278) **x** var3+	0.591				0.513
Y= 25.017 +	(-0.782) **x** var2+	0.538					0.495

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