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Economic Threshold Level of Aphid on Mustard crop at Pundibari (A part of Coochbehar district): It's determination by application of probability and statistics

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Abstract

Mustard is one of the major oilseed crops grown all over India. The mustard aphid, *Lipaphis erysimi* (Kalt.), is one of the important pests in Terai region of West Bengal, which causes severe yield loss. The quantum of damage is determined by finding out the values ofthe economic injury level (EIL) and economic threshold level (ETL) respectively (Weersink *et al*., 1991).In fact, the knowledge of the value of the parameter, ETL helps to reduce the crop loss (and ensure less pesticide application), and as a sequel, the profit is increased. Contextually, substantial knowledge is required on the dynamics of the pest population in order to determine the density of the pest infestation (imbibed under the concept of economic injury level (EIL)) and the knowledge of the value of EIL is an important input which monitors the quantum of pest damage resulting in crop loss. This communication is devoted to the development of a systematic statistical method (not based on the economic parameters as in Weersink *et al*., 1991) for the determination of ETL (defined explicitly in the Introduction section) of the pest, aphid in case of the oilseed crop, mustard plant based on a real-life data set on the pest (aphid) incidence on mustard crop from a special type of experiment designed for this purpose.

Keywords: economic threshold level (ETL), mustard aphid infestation, probability distributions, kolmogorov-smirnov (K-S) test, occurrence probability

1. Introduction

Rapeseed-Mustard is one of the important oilseed crops in India [1]. Among the insects and pests related to the rapeseed-mustard, mustard aphid is considered as one of the most important one in the Terai region of West Bengal [2]. The mustard aphid (*Lipaphis erysimi* (Kalt.)) has been reported to cause yield loss to the extent of 9% -95% [3]. The twin concepts of EIL and ETL address the above task towards determination of ETL [4]. Indeed, the information on the actual time of control of the infestation due to any pest is imperative (so as to make the crop production economically viable)as it provides the timely information and guidance to the farmer (Pal *et al*., 2013). In the paper [5] the concepts of EIL and ETL are defined respectively as the "lowest population of pests that will cause economic damage", and as the "population density (number of pests) at which control measures should be determined to prevent an increasing pest population from reaching the economic injury level". A search in literature on the available information on the values of EIL and ETL with respect to the pest Aphid on rapeseed-mustard crop confirms that such values are widely variable along different parts of the country [6]. Hence the present investigation has been carried out with the objective to determine the economic threshold level (ETL) for *Lipaphis erysimi* (Kalt.) in case of the Indian mustard (variety B-9) crop in the Terai region of West Bengal.

2. Material and Methods

The present study area falls in the *Terai* Agro-climatic zone of North Bengal, where the mustard crop is a widely grown oilseed crop in winter season. For studying the occurrence pattern (dynamics) of the pest, Aphid on the mustard crop a field experiment is conducted and its details are presented as follows: "The field experiment was conducted at the Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, where the initiation of sowing of mustard (var. B-9) was done on the 25th December, 2014 and the weekly observations on infestation were recorded". As regards the detailed procedure, it is stated that for the collection of the data, the field is divided into 4 strata and from each stratum the co-ordinates are randomly chosen (using random number table) for the selection of one sq. m. area. Thus, 10 such co-ordinates are chosen per stratum for the year 2015 for the collection of the data on the pest population. From each of the co-ordinates 5 plants are selected by employing "W" pattern. For each plant the occurrence of the number of Aphids/10cm of the terminal shoot are counted. Indeed, the pest infestation data are recorded at 7 days interval throughout the season and no pesticides are applied during the whole season of the crop, the total number of data, thus obtained, is 280.

As indicated earlier that the number of pests (Aphids) appearing on the mustard plant is recorded throughout the growing season of the crop. The collection of the number of Aphids (recorded weekly) feeding and thriving on the mustard plants over a season constitute the pest population. It is possible to obtain the empirical distribution from the above data collected on the pest population. The best fitting theoretical distributions can be selected using the Kolmogorov-Smironov (KS) statistic. After identification of the best distribution the occurrence probabilities (cumulative probabilities) are obtained using the best fitting distributions. It is proposed in the paper [4] that the ETL corresponds to the number of pests whose cumulative probability (or benchmark probability) of occurrence lies in the range 0.3 to 0.5, ETL values vary with pests and with crops, besides, ETL values for a pest vary in case of different locations even for the same crop.

The statistical distributions considered in the paper are Normal, Lognormal, Exponential, Beta, Gamma, Logistic and Weibull respectively. The reader may visit any standard textbook for the expressions of the probability density functions of the above distributions (also on the details of KS test).

3. Results

The referred pest infestation data from the experiment (described above)are fitted using the seven probability (parametric) distributions, viz., Normal, Lognormal, Exponential, Beta, Gamma, Logistic and Weibull. Among the above fitted distributions on the experimental data-set, Beta and Weibull distributions are found to be statistically significant (at 1%, 5% and 10%) employing the K-S statistics. Table – I contains the K-S test results on the seven distributions. Table – II contains the values of the occurrence probabilities (calculated on the best-fitting distributions only) corresponding to different numbers of pest (Aphid) incidences.

Table 1: K-S test results on seven distributions.

Type of distribution Goodness of fit test (Kolmogorov-Smirnov)	**Test is both sided:n=280**						
	Normal	**Lognormal**	**Exponential**	**Beta**	**Gamma**	**Logistic**	**Weibull**
Calculated value	0.087	0.110	0.180	0.053	0.093	0.109	0.069
Tabulated value(α=0.10)	0.073	0.073	0.073	0.073	0.073	0.073	0.073
Tabulated value(α =0.05)	0.081	0.081	0.081	0.081	0.081	0.081	0.081
Tabulated value(α =0.01)	0.097	0.097	0.097	0.097	0.097	0.097	0.097

From the above Table 1, it is seen that the Beta and Weibull distributions provide good fits at all levels (1%, 5% and 10%) as the calculated values of K-S statistics (in cases of Weibull and Beta) are less than the tabulated values indicating that the null hypothesis is not rejected. Among these, the Beta distribution imbibes a little more precision because it gives the lowest K-S statistic value. It is also noted that between the Beta and Weibull distributions, the cumulative probabilities differ in the range 0 to 0.04 only. As the absolute differences (judged on the KS test statistic) are very small, either of the two distributions can be regarded as a best-fit probability distribution. Therefore, the table of occurrence probabilities is constructed in respect of the above Beta and Weibull distributions (Table 2). The observed values of the variable (number of pests), X, are first arranged in ascending order, and the corresponding cumulative probabilities are listed in the next column.

Table 2: Occurrence probability of number of pests (aphid) in 10cm terminal shoot.

No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P (X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)		No. of pests (x) (avg. Per leaf)	Cum.Prob. P(X≤x)	
	B	W		B	W		B	W		B	W		B	W		B	W		B	W
15.2	0.00	0.03	34.4	0.14	0.11	52.8	0.26	0.23	82.4	0.46	0.44	106.8	0.60	0.60	134	0.73	0.75	168.4	0.86	0.88
18	0.02	0.04	34.4	0.14	0.11	53.2	0.27	0.23	83.2	0.46	0.44	108	0.60	0.61	134.4	0.73	0.76	171.2	0.87	0.89
18.4	0.02	0.04	34.8	0.14	0.11	54	0.27	0.23	84.4	0.47	0.45	108	0.60	0.61	135.2	0.74	0.76	171.6	0.87	0.89
18.8	0.03	0.04	34.8	0.14	0.11	54.4	0.28	0.24	85.2	0.47	0.46	108	0.60	0.61	136	0.74	0.76	172.4	0.87	0.89
19.2	0.03	0.04	34.8	0.14	0.11	57.6	0.30	0.26	85.6	0.48	0.46	108	0.60	0.61	136.8	0.74	0.77	174	0.88	0.90
20	0.03	0.04	36	0.15	0.12	57.6	0.30	0.26	86	0.48	0.46	108	0.60	0.61	139.2	0.75	0.78	175.6	0.88	0.90
20.4	0.04	0.04	36	0.15	0.12	60.4	0.32	0.28	86.4	0.48	0.47	108.4	0.61	0.61	139.2	0.75	0.78	177.2	0.89	0.90
21.2	0.04	0.05	36.4	0.15	0.12	62	0.33	0.29	86.4	0.48	0.47	108.4	0.61	0.61	139.6	0.75	0.78	178.8	0.89	0.91
22	0.05	0.05	36.8	0.15	0.12	62	0.33	0.29	86.8	0.48	0.47	108.4	0.61	0.61	140	0.76	0.78	180	0.90	0.91
23.6	0.06	0.06	37.6	0.16	0.13	62.4	0.33	0.29	86.8	0.48	0.47	109.6	0.61	0.62	140.4	0.76	0.78	180.4	0.90	0.91
23.6	0.06	0.06	38	0.16	0.13	63.2	0.33	0.30	87.6	0.49	0.48	111.2	0.62	0.63	140.8	0.76	0.78	181.2	0.90	0.91
24.4	0.06	0.06	39.2	0.17	0.14	63.2	0.33	0.30	88.8	0.50	0.48	111.6	0.62	0.63	142.4	0.77	0.79	181.2	0.90	0.91
24.8	0.07	0.06	39.2	0.17	0.14	64.4	0.34	0.31	88.8	0.50	0.48	115.2	0.64	0.66	142.8	0.77	0.79	182	0.90	0.91
25.6	0.07	0.07	40	0.18	0.14	64.8	0.34	0.31	92.4	0.52	0.51	116	0.64	0.66	142.8	0.77	0.79	184	0.91	0.92
26	0.08	0.07	40.4	0.18	0.14	65.2	0.35	0.31	92.4	0.52	0.51	116	0.64	0.66	143.2	0.77	0.80	184	0.91	0.92
26	0.08	0.07	40.4	0.18	0.14	65.2	0.35	0.31	94.4	0.53	0.52	118	0.65	0.67	144	0.77	0.80	185.6	0.91	0.92
26	0.08	0.07	41.2	0.18	0.15	66.4	0.36	0.32	94.8	0.53	0.53	118	0.65	0.67	144.4	0.77	0.80	185.6	0.91	0.92
26.4	0.08	0.07	41.6	0.19	0.15	66.8	0.36	0.32	95.2	0.53	0.53	118.8	0.66	0.68	145.2	0.78	0.80	188.8	0.92	0.93
26.4	0.08	0.07	41.6	0.19	0.15	66.8	0.36	0.32	96	0.54	0.53	119.2	0.66	0.68	145.2	0.78	0.80	194.4	0.93	0.94
26.8	0.08	0.07	42	0.19	0.15	67.47	0.36	0.33	96.4	0.54	0.54	119.6	0.66	0.68	145.6	0.78	0.80	194.8	0.93	0.94
26.8	0.08	0.07	42	0.19	0.15	68	0.37	0.33	98.4	0.55	0.55	119.6	0.66	0.68	146	0.78	0.81	196	0.94	0.94
28	0.09	0.08	42.4	0.19	0.16	69.2	0.37	0.34	99.2	0.56	0.56	120	0.66	0.68	146.8	0.78	0.81	196	0.94	0.94
28	0.09	0.08	42.53	0.19	0.16	69.6	0.38	0.35	100	0.56	0.56	120	0.66	0.68	146.8	0.78	0.81	197.6	0.94	0.94
28.8	0.10	0.08	42.8	0.19	0.16	70.4	0.38	0.35	100	0.56	0.56	120.4	0.67	0.68	148	0.79	0.81	198	0.94	0.94
28.8	0.10	0.08	43.6	0.20	0.16	70.8	0.38	0.35	100	0.56	0.56	120.4	0.67	0.68	148	0.79	0.81	198	0.94	0.94
29.2	0.10	0.08	44.8	0.21	0.17	72.4	0.39	0.37	100	0.56	0.56	120.4	0.67	0.68	149.2	0.79	0.82	198.8	0.94	0.94
29.6	0.10	0.08	45.2	0.21	0.17	74.4	0.41	0.38	101.2	0.57	0.57	122	0.67	0.69	149.6	0.80	0.82	200	0.94	0.95
30	0.10	0.09	45.6	0.21	0.18	75.6	0.41	0.39	102	0.57	0.57	122	0.67	0.69	150	0.80	0.82	203.2	0.95	0.95
31.2	0.11	0.09	46	0.22	0.18	75.6	0.41	0.39	102	0.57	0.57	122	0.67	0.69	151.2	0.80	0.83	206	0.96	0.95
31.2	0.11	0.09	47.2	0.23	0.19	78	0.43	0.41	102.4	0.57	0.58	125.2	0.69	0.71	152.4	0.81	0.83	206.8	0.96	0.96
31.6	0.12	0.10	47.6	0.23	0.19	78	0.43	0.41	102.8	0.58	0.58	125.6	0.69	0.71	152.8	0.81	0.83	211.2	0.96	0.96
31.6	0.12	0.10	48	0.23	0.19	78	0.43	0.41	103.6	0.58	0.58	126	0.69	0.71	154.8	0.81	0.84	212	0.97	0.96
32	0.12	0.10	49.2	0.24	0.20	78.4	0.43	0.41	103.6	0.58	0.58	127.2	0.70	0.72	154.8	0.81	0.84	215.6	0.97	0.96
32	0.12	0.10	49.6	0.24	0.20	79.6	0.44	0.42	104	0.58	0.59	129.2	0.71	0.73	156	0.82	0.84	218.4	0.98	0.97
32.4	0.12	0.10	50	0.24	0.21	79.6	0.44	0.42	104.4	0.58	0.59	129.6	0.71	0.73	156	0.82	0.84	223.2	0.98	0.97
32.4	0.12	0.10	50.27	0.25	0.21	80	0.44	0.42	104.4	0.58	0.59	130	0.71	0.73	159.6	0.83	0.86	226.8	0.99	0.97
33.2	0.13	0.10	50.4	0.25	0.21	80.8	0.45	0.43	104.8	0.59	0.59	131.6	0.72	0.74	160	0.83	0.86	229.2	0.99	0.98
33.6	0.13	0.11	51.73	0.26	0.22	81.6	0.45	0.43	105.6	0.59	0.60	132	0.72	0.74	160.4	0.83	0.86	232.4	0.99	0.98
34	0.13	0.11	52	0.26	0.22	82	0.45	0.44	106	0.59	0.60	132.4	0.72	0.75	162	0.84	0.86	246.8	1.00	0.99
34.4	0.14	0.11	52.4	0.26	0.22	82.4	0.46	0.44	106.4	0.59	0.60	133.2	0.73	0.75	166.8	0.86	0.88	256.4	1.00	0.99

B=beta, W = Weibull; X represents the variable (no. of pests); x represents a value of X. Cumulative probabilities (0.3 and 0.5) and the corresponding values of the incidences are shown in bold.

4. Discussion

According to ICAR-NCIPM on oilseed, the ETL value for mustard aphid is around 50-60/plant. On the other hand, Dubey *et al*., 1998 have observed ETL value of around 87/plant. It is recalled that the ETL values for the pest populations whose cumulative probability (or benchmark probability) of occurrence lies in the range 0.3 to 0.5 (Pal *et al*., 2013), and the value (ETL) varies over different crops grown at different locations also. It is found that at the cumulative probability 0.3 the aphid population is around 57-58 and at 0.5 (cumulative probability) the aphid population is around 88. So the present study establishes that the ETL value for aphid population lies within the range of cumulative probability level, 0.3-0.5 (and the corresponding ETL values lie in the range, 55 – 90).

5. Conclusion

The findings of the paper conclusively establish that the ETL level of Aphid on the spice mustard (var. B-9) at Pundibari (a part of Cooch Behar district) lies in the range 55 to 90. Also the method of finding the value of ETL through statistical approach [4] can be regarded as precise (based on actual experimentation without the application of fertilizer at site) towards the determination of ETL level of the pest, Aphid on mustard crop.

6. References

1. Singh P, Premchand K. Yield loss due to mustard aphid, Lipaphis erysimi (Kalt.) in Eastern Bihar Plateau. Journal of Applied Zoological Research. 1995; 6:97-100.
2. Karmakar K. Effect of date of sowing on the incidence of insect pests of rape and mustard. Journal of Interacademicia. 2003; 7(4):420-425.
3. Bakhetia DRC, Arora R. Changing scenario of insect pests and pest management in rapeseed mustard. In Pests and Pest Management in India-The Changing Scenario.(Ed. HC Sharma and MV Rao). Lead Paper of the National Seminar on Changing Scenario in Pest and Pest Management in India. 1993; 31:56-69.
4. Pal S, Ghosh A, Dhar T. On determination of ETL–a distributional approach. Biometrical letters. 2013; 50(2):107-116.
5. Weersink A, Deen W, Weaver S. Defining and Measuring Economic Threshold levels. Canadian Journal of Agricultural Economics. 1991; 39(4):619-625.
6. Jana K, Pal S. Assesment of Loss in Yield of Braccica Juncea by *Lipaphis erysimi* (KALT.) Under Terai Agro-Ecological Condition of West Bengal. Ann. Entomol. 2005; 23(1-2):5-11.
7. Dubey VK, Yadu YK. Determination of economic threshold level of aphid (Lipaphis erysimi Kalt.) on mustard crop. Journal-of-Soils-and-Crops. 1998; 8(2):123-126.