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Seasonal incidence and distribution pattern of insect pest infesting onion ecosystem in the red lateritic zone of West Bengal

Koushik Garai

Abstract
Seasonal incidence and distribution pattern of insect pest of onion ecosystem was studied at Horticulture Research farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal during *rabi* season of 2021-22. The result of field experiment revealed that the highest population of thrips was 18.86 thrips per plant on fourth week of December (52nd SMW). Thereafter the nymph and adult population gradually declined and no population found since 1st week of February (5th SMW) till harvesting. The population of flea beetle was highest (6.43 adult /plant) on first week of January (1st SMW) and the maximum population of grasshopper (2.14/ plant) was observed in the second week of January (2nd SMW). Different indices of dispersion i.e mean, variance, variance-mean radio, dispersion parameter 'K', David and Moore's index, Lexis Index, Charlier coefficient, Index of dispersion, Lloyd mean crowding index showed aggregative, clumped and contagious nature of distributionof thrips, flea beetle and grasshopper in crop growing season. But it was found that majority of the calculated "K" values for standard weeks slightly different from the negative binomial aggregative kind of dispersion.

Keywords: Distribution, binomial, David and Moore's index, Charlier coefficient, clumped

Introduction
Onion (*Allium cepa* L) is one of the most important vegetable crops among the various bulb producing vegetables in the Indian ecosystem. The crop belongs to the Liliaceae family, which is commercially grown in tropical and subtropical countries. It is grown for consumption as a vegetable crop in the green immature stage and also as mature bulbs. It is a popular salad crop and is consumed in different preparations in every household. It also has certain nutritional and therapeutic qualities. It is used as a remedy for various diseases like dysentery, infantile convulsions, headaches, hysteria fits, rheumatic pain and malarial fever as a fine demulcent to give relief in piles. Onion bulbs are rich sources of minerals like phosphorus, iron, calcium and also contains carbohydrates, proteins, vitamin 'C', fibers.
Insect pests, *viz.*, thrips, *Thrips tabaci* (Lindeman); maggot fly, *Delia Antigua* (Meigen); caliothrips, *Caliothrips indicus* (Bangall) and tabacco caterpillar, *Spodoptera litura* (Fabricius) are the main limiting factors for the production of good quality onion bulbs as well as seeds. Among them, thrips, *T. tabaci* was reported as a regular and major pest in West Bengal and other parts of the country. Thrips cause both quantitative and qualitative losses about 34-43 percent. Thrips puncture the tender leaves and suck the sap. As a result of continuous feeding by such a large population the plant leaves become curl, wrinkle and gradually dry up, resulting in shriveled bulb and seed formation.
Pattern of distribution is one of the most important ecological attributes that follows a characteristic pattern depending upon their inherent properties and habitat conditions. Understanding the interactions that might take place between random populationChange the processes and the overall insect population is aided by research on dispersion patterns. The aggregation degree of a population spatial pattern can be used to define various aspects of population ecology and density-related regulating mechanisms, including feeding and reproduction under specific conditions, territorial behavior, diffusion behavior, communication behavior, etc.As the distribution pattern of insect pest on onion is much wanting in the red lateritic zone so an attempt was made to provide the spatial distribution of major insect pest during *rabi* season.

Materials and Methods
A field experiment was conducted to work out the seasonal incidence and distribution pattern of insect pest of onion during the rabi season of 2021-22 at Horticulture Research farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal which is situated between 23.24º North latitude and 87.42º East longitudes having an altitude of 40 m above the mean sea level. All the recommended cultural practices were followed in the crop growing season excluding plant protection managements. One month old seedlings of Sukhsagar variety were planted during second fortnight of November for raising the crop in plots of 40 cm row to row and 30 cm plant to plant spacing.Insitu observation of population build up of thrips, flea beetle and grasshopper were recorded following random sampling technique by taking 10 plants randomly from each plot out of 21 plots. The observation was recorded from three leaves *viz.*, one each from top, middle and bottom canopies of the plant. Observations were recorded at weekly interval starting from 51st standard meteorological week to 11th standard meteorological week with respect to certain weather parameters during the crop growing season.

The data thus obtained was organised into a frequency distribution with several indexes like mean ($\bar{X}$),variance (S^2),variance-mean ratio ($S^2/\bar{X}$), dispersion parameter 'K'[{ $\bar{X}^2/(S^2-\bar{X})$}], David and Moore's index {$(S^2/\bar{X}) - 1$}, Lexis Index [$\sqrt{(S^2/\bar{X})}$], Charlier coefficient [{$\sqrt{(S^2-\bar{X})}$}/ $\bar{X}$], Index of dispersion [$(n-1)*(S^2/\bar{X})$], Lloyd mean crowding index [$\bar{X}+\{(S^2/\bar{X})-1\}$], were calculated as per the procedure suggested by Elliot (1977). The degree of crowdingexperienced by an individual was worked out for all the standard work by following Llyod's method (1967) and designated as Lloyd index of mean crowding [$\bar{X}+\{(S^2/\bar{X})-1\}$] and Lloyd index of patchiness[$\bar{X}+\{(S^2-1)/\bar{X}\}$].

i) Ratio of variance to mean (VMR)
The variance to mean ratio, proposed by Patil and Stiteler, was the simplest method for estimating insect dispersion (1974).

VMR= ($S^2/\bar{X}$) where S^2 denotes variance and $\bar{X}$ denotes mean.

VMR is one for a "Poisson" distribution, less than one for a positive binomial distribution, and greater than one for a negative binomial distribution.

VMR also provides information about population dispersion, with the number >1 indicating contagiousness, 1 indicating regularity, and =1 indicating random distribution.

ii) David and Moore's clumping index (IDM)
The index of clumping (IDM) calculated by David and Moore (1954) was also used to confirm the following distribution:

IDM= {$(S^2/\bar{X}) - 1$}

The IDM yields a value of zero for the Poisson distribution, positive for the negative binomial distribution, and negative for the positive binomial distribution.

iii) The Lewis index
To determine the dispersion of T. tabaci, the Lewis index was calculated using the formula below: $\sqrt{(S^2/\bar{X})}$

This index has a value of >1 for contagious, 1 for regular, and =1 for random distribution.

iv) Dispersion index (ID)
The "Index of Dispersion," calculated as suggested by Patil and Stiteler, confirmed the distribution pattern (1974).

I_D= $(n-1)*(S^2/\bar{X})$ where I_D is the dispersion index and n is the number of samples drawn.

v) Mean crowding index (X*) according to Lloyd's
As recommended by Lloyd, mean crowding (X*) was determined to illustrate the likely influence of mutual interference or rivalry among individuals (1967). The sample estimate of mean crowding (X*) was derived as, X *= $\bar{X}+\{(S^2/\bar{X})-1\}$, with values greater than zero indicating an over dispersed or regular distribution and less than one indicating an under dispersed distribution. Mean crowding is strongly reliant on both clumping degree and population density as an index.

Result and Discussion
Seasonal activity of Thrips
The population of Thrips (*Thrips tabaci* L.) (Table-1) first appeared on the third week of December (51st SMW) and the population was about 16.57 thrips per plant. The population of Thrips was found highest on fourth week of December (52nd SMW), about 18.86 thrips per plant when the maximum temperature was 24.53 ºC, minimum temperature 13.74 ºC, relative humidity 89.14%, rainfall 0.34mm and sunshine 2.64 hours. The next highest Thrips population was found on 1st week of January (1st SMW). Here the thrips population was 17.14 thrips per plant when the maximum temperature 23.27 ºC, minimum temperature 10.47 ºC, relative humidity 93%, rainfall 0.00 mm and sunshine hours 5.74 was prevalent. The population of thrips was present in the field to varying tunes until the month of January. Thereafter the population of thrips was gradually declined during the last week of January (4th SMW) and no population was found during 1st week of February (5th SMW) to till harvesting.

Hameed and Hussein (2014) [8] decided to study the seasonal abundance of onion thrips in Iraq and estimated that the percentage of adults remained low (less than 5 thrips per plant) until the beginning of February, when the number increased to 13 adults per plant, then to 32 thrips per plant, and finally to 72 thrips per plant in March. By the first week of May, the thrips population had dropped to about 5 thrips per plant after March. Present findings are in confirmation with Thakur *et al.* (2016) [6] and Kumar *et al.* (2015) [9] through out the crop growing season.

Seasonal activity of Flea beetle
The population of Flea beetle (*Phyllotreta striolata* F.) (Table-2) first appeared on 3rd week of December (51st SMW) and the population was about 3.29 Flea beetle per plant. The abiotic conditions at that time were; maximum temperature 23.67 ºC, minimum temperature 10.33 ºC, relative humidity 79%, rainfall 0.00 mm and sunshine hours 6.24. Highest flea beetle population was found during the first week of January (1st SMW), about 6.43 flea beetles per plant, during the bulb initiation stage. At this time, abiotic conditions were maximum temperature 23.27 ºC, minimum temperature 10.47 ºC, relative humidity 93%, rainfall at the rate of 0 mm and sunshine hours 5.74. Second highest flea beetle population was found during the second week of January (2nd SMW) about 5.71 flea beetle per plant found when the maximum temperature 24.24 ºC, minimum temperature 14.56 ºC, relative humidity 92.14%, rainfall 2.7 mm and sunshine hours 2.04. The Flea beetle population declined from second week of February (6th SMW) up to harvesting.

Simillar findings were observed by Patel *et al.* (2015) [10], Singh *et al.* (2015) [11] & Yadav *et al.* (2012) [12] revealed that flea beetle activity began in December, infesting the early vegetative stage, but decreased later in January, most likely due to the lower temperatures and hardening of the leaf tissues. Later increases in population coincided with the crop's pod formation stage and rising temperatures, and the population gradually climbed until it peaked during the last week of February.

Seasonal activity of grasshopper

The population of Grasshopper (Table-3) first appeared on 4thweek of December (52nd SMW) and the population was about 1.57 Grasshopper per plant. The abiotic conditions at that time were; maximum temperature 24.53 ºC, minimum temperature 13.74 ºC, relative humidity 89.14%, rainfall 0.34 mm and sunshine hours 2.64. Highest Grasshopper population was found during the 2nd week of January (2nd SMW), about 2.14 Grasshoppers per plant, during the vegetative stage. At this time, abiotic conditions were maximum temperature 24.24 ºC, minimum temperature 14.56 ºC, relative humidity 92.14%, rainfall at the rate of 2.7 mm and sunshine hours 2.04. Second highest Grasshopper population was found during the third week of January (3rd SMW) about 2 grasshoppers per plant found when the maximum temperature 22.43 ºC, minimum temperature 10.77 ºC, relative humidity 87.14%, rainfall 0.00 mm and sunshine hours 6.11. Lowest population was found during the second week of February (6th SMW), about 1.14 per plant.

Shah *et al.* (2015) [13], Nisar *et al.* (2015) [14], Ahmed *et al.* (2015) [15] reported on spinach that from the emergence of the plant to the maturity of the crop, grasshopper populations were monitored. In single spinach, the second week had the highest mean percent damage of 36 percent, while the third week had the lowest (21 percent). The mean percent damage observed in week one was 29 percent, followed by 27, 28, and 28 percent in weeks four, five, and six, respectively.

Spatial distribution pattern of insect pest

Variance mean ratio or index of dispersion(Id) value generally depart from unity and if it tends to zero signifies regular distribution but in the experiment the same was observed more than one in all the standard weeks, which again substantiate aggregative distribution. 'K' of the negative binomial is an index of aggregation in the population and the present observed values for most of the week’s found to be either below 8 or slightly exceeding 8 indicating clumping behaviour of individuals. However, the findings were not truly in accordance with the statement of Southwood (1978) wherein he proposed that 'K' value always remains <8 in aggregative distribution. Reciprocal of ‘K’ were found to be more than zero with positive sign for all the weeks ranging from 0.02 to 0.41, 0.11 to 0.77 and 0.08 to 0.37 for thrips, flea beetle and grasshopper respectively which implied contagious nature of distribution.

David and Moore’s index signifies regularity in distribution when the values lies below zero but in the above experiment the calculated values always found to be more than zero so the distribution was supposed to be clumped or non-random one. In addition, Lexis index calculated was more than one in all the weeks i.e. all values departed towards positive side from the unity, that again signifies that the flea beetles followed a contagious distribution and not a random one (only possible when the value equals to unity).

In case of regular distribution Charlier coefficient would be imaginary but in the present investigation it was found significantly more than zero suggesting contagious nature. The Lloid patchiness indexes showing the degree of aggreqativeness varied from 1.02 to 1.41, 1.16 to 3.61 and 1.42 to 2.16 for thrips, flea beetle and grasshopper respectively supported that the distribution was agqregative in nature.

Table 1: Seasonal incidence of Thrips infesting onion with respect to certain abiotic parameters during the year 2021-22

SMW	Population of Thrips/ Plants	Important Weather Parameters As Recorded During The Respective Standard Week				
		Maximum Temperature (ºC)	Minimum Temperature (ºC)	Relative Humidity (%)	Rain Fall (mm)	Sunshine Hours
51st	16.57	23.67	10.33	79	0.0	6.24
52nd	18.86	24.53	13.74	89.14	0.34	2.64
1st	17.14	23.27	10.47	93	0	5.74
2nd	8.43	24.24	14.56	92.14	2.7	2.04
3rd	2	22.43	10.77	87.14	0	6.11
4th	1.71	22.26	13.8	86.29	0.77	2.79
5th	0	21.31	8.9	71.86	0	4.84
6th	0	21.99	12.94	85.86	6.8	5.44
7th	0	24.5	11.67	77.86	3.22	8.69
8th	0	27.69	13.76	74.29	0	7.27
9th	0	28.65	17.33	84.75	5.53	7.25

Table 2: Seasonal incidence of Flea beetle infesting onion with respect to certain abiotic parameters from the year 2021 and 2022

SMW	Population of Flea beetle/ Plants	Important Weather Parameters As Recorded During The Respective Standard Week				
		Maximum Temperature (°C)	Minimum Temperature (°C)	Relative Humidity (%)	Rain Fall (mm)	Sunshine Hours
51st	3.29	23.67	10.33	79	0.0	6.24
52nd	4.14	24.53	13.74	89.14	0.34	2.64
1st	6.43	23.27	10.47	93	0	5.74
2nd	5.71	24.24	14.56	92.14	2.7	2.04
3rd	4	22.43	10.77	87.14	0	6.11
4th	2.29	22.26	13.8	86.29	0.77	2.79
5th	1.57	21.31	8.9	71.86	0	4.84
6th	1.29	21.99	12.94	85.86	6.8	5.44
7th	0.86	24.5	11.67	77.86	3.22	8.69
8th	0	27.69	13.76	74.29	0	7.27
9th	0	28.65	17.33	84.75	5.53	7.25

Table 3: Seasonal incidence of Grasshopper infesting onion with respect to certain abiotic parameters from the year 2021 and 2022

SMW	Population of Grasshopper/ Plants	Important Weather Parameters As Recorded During The Respective Standard Week				
		Maximum Temperature (°C)	Minimum Temperature (°C)	Relative Humidity (%)	Rain Fall (mm)	Sunshine Hours
51st	0	23.67	10.33	79	0.0	6.24
52nd	1.57	24.53	13.74	89.14	0.34	2.64
1st	1.85	23.27	10.47	93	0	5.74
2nd	2.14	24.24	14.56	92.14	2.7	2.04
3rd	2	22.43	10.77	87.14	0	6.11
4th	1.57	22.26	13.8	86.29	0.77	2.79
5th	1.86	21.31	8.9	71.86	0	4.84
6th	1.14	21.99	12.94	85.86	6.8	5.44
7th	1.29	24.5	11.67	77.86	3.22	8.69
8th	1.43	27.69	13.76	74.29	0	7.27
9th	1.29	28.65	17.33	84.75	5.53	7.25

Table 4: Distribution pattern of Thrips (*Thrips tabaci* Lindeman) in Onion ecosystem (based on pooled mean from the year 2021 and 2022)

Sr. No.	SMW	Mean ($\bar{X}$)	Variance (S^2)	Variance-mean ratio ($S^2/\bar{X}$)	Dispersion parameter 'K' $\{\bar{X}^2/(S^2-\bar{X})\}$	Reciprocal of K(=1/K)	David Moore's index $\{(S^2/\bar{X})-1\}$	Lexis index $\sqrt{(S^2/\bar{X})}$	Index of dispersion $\{(n-1)(S^2/\bar{X})\}$	Charlier coefficient $[100\{\sqrt{(S^2-\bar{X})}\}/\bar{X}]$	Lloyd mean crowding index $[(\bar{X})+\{(S^2/\bar{X})-1\}]$	Llyod patchiness index $[\bar{X}+\{(S^2/\bar{X})-1\}]/\bar{X}$
1	51st	16.57	23.62	1.43	38.95	0.03	0.43	1.19	8.55	16.02	17.00	1.03
2	52nd	18.86	27.48	1.46	41.26	0.02	0.46	1.21	8.74	15.57	19.32	1.02
3	1st	17.14	35.14	2.05	16.32	0.06	1.05	1.43	12.30	24.75	18.19	1.06
4	2nd	8.43	11.95	1.42	20.19	0.05	0.42	1.19	8.51	22.26	8.85	1.05
5	3rd	2	2.33	1.17	12.12	0.08	0.17	1.08	6.99	28.72	2.17	1.08
6	4th	1.71	2.9	1.70	2.46	0.41	0.70	1.30	10.18	63.79	2.41	1.41

Table 5: Distribution pattern of Flea beetle (*Phyllotreta striolata* F.) in Onion ecosystem (based on pooled mean from the year 2021 and 2022)

Sr. No.	SMW	Mean ($\bar{X}$)	Variance (S^2)	Variance-mean ratio ($S^2/\bar{X}$)	Dispersion parameter 'K' $\{\bar{X}^2/(S^2-\bar{X})\}$	Reciprocal of K (=1/K)	David Moore's index $\{(S^2/\bar{X})-1\}$	Lexis index $\sqrt{(S^2/\bar{X})}$	Index of dispersion $\{(n-1)(S^2/\bar{X})\}$	Charlier coefficient $[100\{\sqrt{(S^2-\bar{X})}\}/\bar{X}]$	Lloyd mean crowding index $[(\bar{X})+\{(S^2/\bar{X})-1\}]$	Llyod patchiness index $[\bar{X}+\{(S^2/\bar{X})-1\}]/\bar{X}$
1	51st	3.29	7.57	2.30	2.53	0.40	1.30	1.52	13.81	62.88	4.59	3.00
2	52nd	4.14	11.81	2.85	2.23	0.45	1.85	1.69	17.12	66.90	5.99	3.61
3	1st	6.43	16.29	2.53	4.19	0.24	1.53	1.59	15.20	48.83	7.96	3.38
4	2nd	5.71	9.24	1.62	9.24	0.11	0.62	1.27	9.71	32.90	6.33	2.44
5	3rd	4	11.33	2.83	2.18	0.46	1.83	1.68	17.00	67.68	5.83	3.58
6	4th	2.29	3.24	1.41	5.52	0.18	0.41	1.19	8.49	42.56	2.70	1.98
7	5th	1.57	2.28	1.45	3.47	0.29	0.45	1.21	8.71	53.67	2.02	1.82
8	6th	1.29	2.57	1.99	1.30	0.77	0.99	1.41	11.95	87.70	2.28	2.22
9	7th	0.86	1.14	1.33	2.64	0.38	0.33	1.15	7.95	61.53	1.19	1.16

Table 6: Distribution pattern of Grasshopper in Onion ecosystem (based on pooled mean from the year 2021 and 2022)

Sr. No.	SMW	Mean ($\bar{X}$)	Variance (S^2)	Variance-mean ratio ($S^2/\bar{X}$)	Dispersion parameter 'K' $\{\bar{X}^2/(S^2-\bar{X})\}$	Reciprocal of K (=1/K)	David Moore's index $\{(S^2/\bar{X})-1\}$	Lexis index $\sqrt{(S^2/\bar{X})}$	Index of dispersion $\{(n-1)(S^2/\bar{X})\}$	Charlier coefficient $[100\{\sqrt{(S^2-\bar{X})}\}/\bar{X}]$	Lloyd mean crowding index $[(\bar{X})+\{(S^2/\bar{X})-1\}]$	Llyod patchiness index $[\bar{X}+\{(S^2/\bar{X})-1\}]/\bar{X}$
1	51st	1.57	2.29	1.46	3.42	0.29	0.46	1.21	8.75	54.05	2.03	1.82
2	52nd	1.85	3.14	1.70	2.65	0.38	0.70	1.30	10.18	61.39	2.55	2.16
3	1st	2.14	3.14	1.47	4.58	0.22	0.47	1.21	8.80	46.73	2.61	2.00
4	2nd	2	2.33	1.17	12.12	0.08	0.17	1.08	6.99	28.72	2.17	1.67
5	3rd	1.57	2.29	1.46	3.42	0.29	0.46	1.21	8.75	54.05	2.03	1.82
6	4th	1.86	2.48	1.33	5.58	0.18	0.33	1.15	8.00	42.33	2.19	1.80
7	5th	1.14	1.48	1.30	3.82	0.26	0.30	1.14	7.79	51.15	1.44	1.42
8	6th	1.29	1.57	1.22	5.94	0.17	0.22	1.10	7.30	41.02	1.51	1.44
9	7th	1.43	1.62	1.13	10.76	0.09	0.13	1.06	6.80	30.48	1.56	1.43
10	8th	1.29	1.9	1.47	2.73	0.37	0.47	1.21	8.84	60.54	1.76	1.70
11	9th	1.43	1.62	1.13	10.76	0.09	0.13	1.06	6.80	30.48	1.56	1.43

Conclusion

Based on this study, it is concluded that in the ecosystem pest were found after the transplanting of seedling of onion crop and continue their infestation till the harvesting. The field experiment revealed that the different indices of dispersion i.e mean, variance, variance-mean radio, dispersion parameter 'K', David and Moore's index, Lexis Index, Charlier coefficient, Index of dispersion, Lloyd mean crowding index showed aggregative, clumped and contagious nature of distribution of thrips, flea beetle and grasshopper in crop growing season. But it was found that majority of the calculated "K" values for standard weeks slightly different from the negative binomial aggregative kind of dispersion. So it is concluded that the pattern of distribution of insect pest in onion ecosystem of red lateritic zone of West Bengal was negative binomial or clumped or aggregative in nature.

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