SPATIAL DISTRIBUTION PATTERNS OF TWO COTTON BOLLWORMS, *PECTINOPHORA GOSSYPIELLA* AND *EARIAS INSULANA* IN QAULUBIA GOVERNORATE, EGYPT

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Abstract

Dispersion indices, including (k) the negative binomial distribution, Green's coefficient of dispersion (C_x), mean crowding (m*), Lloyd's (Patchiness index) (m/m*) and variance mean ratio (v/m), were calculated for the populations of two cotton bollworm male moths, *Pectinophora gossypiella* and *Earias insulana,* using pheromone traps all-over 2 years (October 95 to Sept. 97) at kaha district, Qalubia Governorate. Comparison showed that: k, C_x and m/m* as well as slopes from regression, all indicated that under the conditions of this test (at densities tested), the populations of the two pests were random. The variance / mean ratio fluctuated considerably more than other indices examined, which, by comparison, appears less reliable than previously thought.

Introduction

The cotton bollworms; pink bollworm, *Pectinophora gossypiella* (Saunders), (PBW) and spiny bollworm, *Earias insulana* (Boisduval), (SBW), considered as destructive pests in cotton fields in Egypt and many other countries, are spread world-wide. About one third of the yields lost annually are by the damage of these two pests. Under natural conditions they are spatially distributed in a non-random fashion (Waters, 1959). Sampling in such populations results in variance which is greater than the mean, indicating the insects are over-dispersed or aggregated. Behavioral responses of insects to their environment and other organisms increase the chance that if one insect is found in a sampling unit, another insect will occur in that unit (Edward and Sterling 1974).

Various attempts have made to quantitatively express the degree of aggregation in populations. Waters (1959) proposed that the exponent k of the negative binomial distribution is a valid measure of aggregation. Its value can range from zero, where aggregation is extreme to infinite where the distribution is random. Morisita (1962, 1964) described an index of dispersion (*IP*) which has the advantage of being relatively independent of distribution, the number of samples, and the size of the mean. Mollet et al. (1984) reported that the best measure of dispersion, as evaluated by Myers (1978) from computer generated patterns of egg dispersion at different population densities, was Green's coefficient (1966), $C_{x.,}$ the standardized Morisita's coefficient, *IP* (Smith-Gill 1975), the mean crowding (m*) (Lloyd 1967) and Trumble et al. (1983) used Green's coefficient of dispersion ($C_{X)}$, Lloyd's (Patchiness index) (m/m*) and the regression of m* against m to document seasonal variation in the spatial distribution patterns of aphids on strawberry. Cotton insects have been shown to be spatially distributed in a non-random manner (Allen et al. 1972, Sevacherian and Stern 1972 and Pieters and Sterling 1973). Aggregation indices for BW on cotton was reported by Allen et al. 1972, and Amin et al 1994, PBW and SBW also reported by Moawd et al. 1994 in Fayum, Egypt.

The specific objectives in this work were to determine the seasonal distribution patterns of PBW and SBW male moths in cotton and other crops using pheromone traps. The study is designed to determine the best measure of dispersion to use in investigating changes in male moth adult patterns with changes in insect density. The results are applicable to ecological situations in which changes in density and dispersion are to be investigated.

Materials and Methods

Tests were undertaken in areas where PBW and SBW are known to occur in Kaha district Qalubia Governorate Egypt, where 20 feddans adjacent to Ciba-Giegy Research Station, (45 km north Cairo in Nile Delta Valley), were chosen for this study. Mass trapping was carried out in October 1995 in a rate of one trap for each fed. Delta traps were baited by the specific pheromone of each insect; for PBW: 1:1 mixture of (Z, Z) and (Z, E)-7,11,hexadecadien 1-01 acetate, was used and: E, E, 10, 12-16: ald. for SPW. The compounds were dispersed in polyethylene vials (1 mg). The lure capsules were replaced biweekly in summer months and every four weeks in winter months. Traps were inspected daily and the catch was converted into number of moths / trap / night. The mean, variance/mean ratio, mean crowding (m); Lloyd's (Patchiness index) (m*/m), and Green's coefficient of dispersion were used in this study. Regressions were then generated to determine the relationship of each index to m. In addition, the regression equation of m* on m and log variance on log mean (Taylor, 1965) were calculated. The parameter of the negative binomial distribution, k, was used also.

Results and Discussion

Fluctuations in Population Density

Pink Bollworm

Population levels in tested areas showed that the numbers of PBW were at their highest during 1996 with three distinct population peaks, one on May 20, a second on July 20, and a third on September 26, when numbers reached almost 160 moths/trap/week. In 1997 population levels of PBW were lower, but the three peaks were still distinguished (Fig. 1).

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Spiny Bollworm

Population levels for SBW, over a two-year trial period, were generally much higher (Fig. 2) especially during 1996, peaking around 170 moths/trap/week in early October, while they reached 100 moths/ trap/night in late September 1997.

Dispersion Indices

K: The Negative Binomial Distribution

As expected, the distribution of PBW and SBW for the two years tested fit the negative binomial. The test for k resulted in a good fit using the Bilss technique (1958). The k values for PBW were -54.76 and -59.3 for 1996 and 1997 respectively (Table 1). The SBW showed negative values in years; -77.65 for 1996 and -68.45 for 1997 (Table 1). This suggests that the population is random (Waters 1959; Kogan et al 1974 and Southwood, 1978). The correlation analysis between mean and k values in the two tested years showed highly significant relationship among the two tested insects (Table 1). All means associated with k of the negative binomial were strongly correlated to the density, particularly if k values for distribution which did not statistically fit the negative binomial were excluded (Myers, 1978).

Green's Coefficient C_x

Using Green's coefficient Cx of dispersion indicated that the populations of the two insects were random (Table 1). Cx values were consistently greater than zero. Populations are considered random when Cx is equal to zero and aggregated when it is equal to 1 (Mollet et al 1984). As it appears from the table, Cx values for PBW were: 0.0023 and 0.002 for 1996 and 1997 respectively, while these values for SBW were 0.00203 for 1996 and 0.0027 for 1997. Regression of C_x on m showed a negative relationship and a significant effect in all tested trials for the two insects; while there were no significant differences on 1996 (Table 1). Therefore C_x can be considered the best candidate for use when analyzing actual changes in distribution of organisms with changes in m.

Variance/mean Ratio V/m

The variance/mean ratio showed negative relationships in 1996 and 1997 for both insects. (Table 1).

*Mean Crowding M**

The mean crowding m* (Lloyed, 1967) is highly dependent on m, for both years and insects (Table 1), and therefore is not considered useful as a measure of clumping. The regression of m* on m described by Iwao (1968) and Iwao and Kuno (1971) has been compared with other techniques (Mayers, 1978) and is considered invalid.

Patchiness Index m/m*

The Patchiness index m*/m (Lloyd, 1967) was used to document the seasonal variation in spatial dispersion patterns of PBW and SBW at Kaha, Qalubia Governorate for two years (Table 1). The conclusion was analogous to techniques, indicating that although m*/m may be influenced by density, this index nonetheless is in close agreement with C_x and Iwao's regression.

The obtained results demonstrate that C_x, m*/m, and k determined for regressions of either m* on m are all in agreement that the populations of PBW and SBW male moths at Kaha, district, Qalubia Governorate were uniformly distributed. These results agree with those of (Pieters and Sterling, 1974, Young and Price, 1975 and Moawd et al 1994). It is not easy to determine that any one index is best for all organisms under all circumstances. So, it is worthwhile to recommend the use of more than one index to determine if they agree with each other before drawing conclusions about the dispersion of populations.

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Table 1. Correlation between measures of dispersion and density of simulated population of *P. gossypiella and E. insulana*, QAULUBIA, 1996-1997.

Index	*Pectinophora gossypiella*					
	1996			**1997**		
	Mean	**r**	**P<.05**	**Mean**	**r**	**P<.05**
K	-59.3	-.9867	***	-50	-.8699	***
V	6.53	.9999	***	5.29	.9999	***
V/m	0.29	-.6536	***	0.3	-.6604	***
M*	29.3	.9999	***	23.3	.9999	***
M*/M	1.01	-.4326	***	1.01	-.4339	***
C_x	.0023	-.4399	***	.002	-.4408	***
Index	*Earias insulana*					
	1996			**1997**		
	Mean	**r**	**P<.05**	**Mean**	**r**	**P<.05**
K	-77.6	-.9968	***	-68.5	-.995	***
V	8.52	.9997	***	7.5	.9999	***
	2.91	-.6372	***	2.91	-.7207	***
M*	38.8	.9999	***	38.8	.9999	***
M*/M	1.01	-.4988	***	1.01	-.477	***
C_x	.002	-.5071	***	.002	-.4862	***

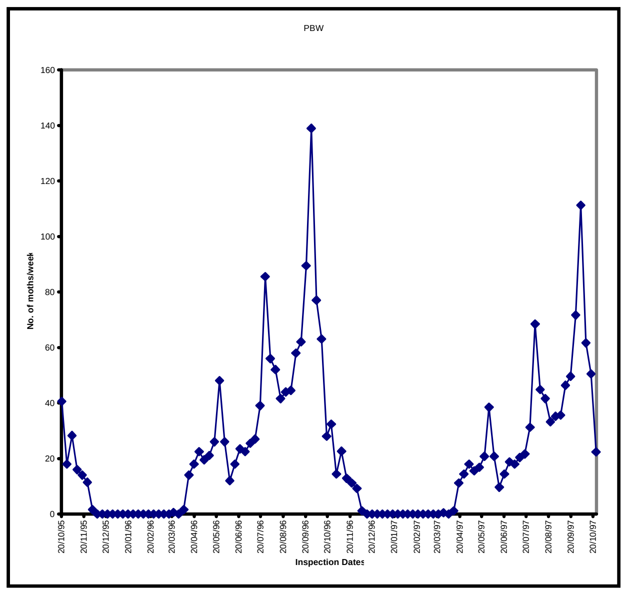

Fig. 1 The fluctuations in population density of *P. gossypiella* during two successive years, 1996-1997, in Qalubia Governorate.

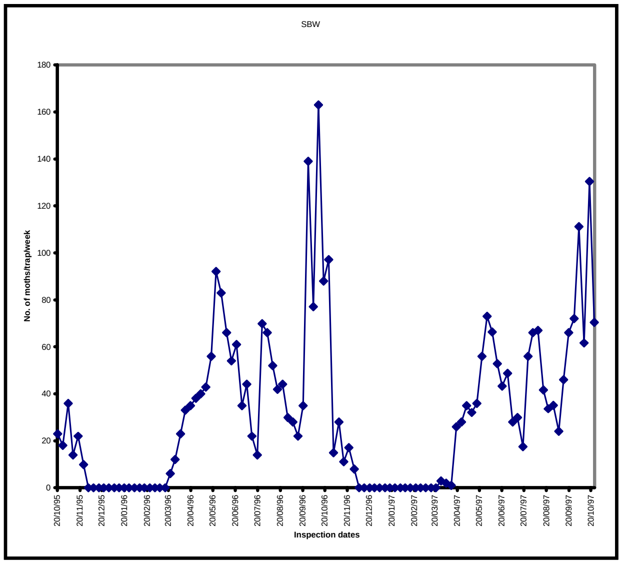

Fig. 2 The fluctuations in population density of *E. insulana* during two successive years, 1996-1997, in Qalubia Governorate.