1893 Cluster analysis to detect principal factors affecting lepidopteron cotton plagues populations in Argentine

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Insect populations increase because reproduction or immigration and decreases because mortality or emigration. Mobility causes important changes in the spatial density and is the principal factor involved when species become important plagues in a region. In the argentine cotton land-ecosystem, the most important pests are lepidopteron caterpillars and there are no studies to develop the causes of population variations in the region. This work was done to analyse similarities in lepidopteron populations' behaviour in different localities in order to detect the principal factors affecting their size in the northeast of Argentine. Information used consist in weekly and cumulative captures in light traps of adults of *Alabama argillacea* and the complex constituted by *Heliothis virescens*, *Helicoverpa gelotopoeon* and *Spodoptera frugiperda*, in ten localities between years 1995 and 2004. An agglomerative, hierarchical average and polythetic, cluster analysis based on a Euclidean distance average for standardized variables was done. The way of clustering of weekly and accumulative Alabama and Complex captures indicates a distribution of adults in N–S direction (concordant with the predominant winds direction). Complementarily, cyclic migrations within the area in an E–W direction redistribute populations between localities. The results indicate that populations of these species in the Argentine cotton region are originated in migrations of N-S direction from warmer regions in the north and cyclical migrations of adults in E-W direction, between distant localities, redistribute the populations. However mobility of adults has great importance in its abundance and distribution.

Key words: cotton leafworm, tobacco budworm, cotton bollworm, fall armyworm, insects' mobility, migration.

Introduction

Different factors affects the abundance of species in land-ecosystems, populations increase because reproduction or immigration and decreases because mortality or emigration. Insects' mobility causes important changes in the spatial density and is the principal factor of becoming in important plagues in a region (Joyce and Lingren, 1998). In the argentine cotton land-ecosystem, the most important pests are lepidopteron caterpillars (Lepidoptera: Noctuidae), mainly cotton leafworm (*Alabama argillacea*, Hübn), tobacco budworm (*Heliothis virescens*, Fab.), cotton bollworm (*Helicoverpa gelotopoeon*, Dyar) and fall armyworm (*Spodoptera frugiperda*, Smith) (Saini, 2002). There are no studies to develop the causes of populations' size variations in the region.

Cotton leafworm is a specific pest of cotton crops, by regular invasions is now distributed from the south of Canada to the north of Argentina (Carvalho, 1981). Present during all the crop period, with increasing populations along the crops progresses, by successive infestations (Bellettini *et al.*, 1999; Carvalho, 1981). Adults are nocturnal butterflies strongly attracted by the light, have migratory habits and are able to fly long distances (Saini, 2002), characteristic which according to Botelho *et al.* (1976), originates population tips in each locality at different times. Joyce and Lingren (1998) found that mobility has great importance in their abundance and distribution and Hoffman y Frodsam (1993), Taylor

(1984) y Way (1973), indicate that migrations have most importance in the population changes than reproduction. There is reference to a hibernate stage (Calcagnolo, 1965), despite the infestations are attributed to cyclical migrations (Gaines, 1957; Glick and Graham, 1956; Hendricks *et al.*, 1975; Parencia and Rainwater, 1964; Silveira Neto, 1972). This behaviour was also found by Mazza *et al.* (2006a) in Argentinean cotton region, which observed crescent populations during the cotton crop period attributed to successive infestation.

Tobacco budworm and cotton bollworm are not specific pests of the cotton crops, they are fed on great variety of vegetal species, among them maize, linen, alfalfa, soybean and vegetables (Davies, 1991; Saini, 2002). In cotton crops its presence is cyclical and during long periods they appear limited to certain areas in reduced populations; in other circumstances the infestation expands in all the cotton area, causing economic damages of consideration (Saini, 2002). In Argentine they have not reached the same level of pest as *Alabama argillacea*, but in other cotton regions constitute the main limiting factor for the crop. Caprio and Tabashnik (1992), Caprio (1998), Fitt (1989) and Joyce and Lingren (1998), recognize the importance of high mobility of the adults in their character of pests.

Fall armyworm caterpillars are polyphagous, attack mainly gramineous, despite being in more than 80 species of 23 families, among them the cotton crop. Constitute secondary pests of cotton crops; their attack is rather sporadic, although it can be very destructive (Davies, 1991; Saini, 2002). The capacity of flight and operational range of the adults is very ample (Saini, 2002).

Mazza *et al.* (2006b), in the Argentinean cotton region have found populations of fall armyworm, tobacco budworm and cotton bollworm during all the year. The infestation tips are wide and accomplished by lower tips that indicate butterflies movements in the area.

Insect populations have heterogeneous spatial density with temporary changes of the population sizes dependent on environmental factors that constitute important elements in the analysis of population dynamics. The ability to estimate populations' density depends on understanding the population dynamics and the roll of the factors that cause changes in the populations (Clark, 1970).

The statistical analysis is used with the purpose of describing populations' behaviour or to prove some hypothesis on their characteristics. Mathematical concepts and models are introduced to define situations, structures and effects that influence, for example, in the behaviour of an insect population. The Multivariate Analysis includes a set of statistical and mathematical methods to analyze, to describe and to interpret multidimensional observations (Cuadras, 1991; Johnsson, 2002; Peña, 2002). From a set of elements, Cluster Analysis allows to obtain successive partitions reasonably homogenous (Cuadras, 1991; Infostat, 2006). This work was done to analyse similarities in lepidopteron populations' behaviour in different localities in order to detect the principal factors affecting their size in the northeast of Argentine.

Material and Methods

The use of light traps provides information about distribution, occurrence and relative intensity of stationer flies and maximum of abundance of adults of different species of insects, especially lepidopteron of Noctuidae family (Sosa, 1998; Sosa, 2002). The work was done with information of weekly and cumulative captures of adults of *Alabama argillacea* (Alabama) and the complex formed by *Heliothis virescens*, *Helicoverpa* *gelotopoeon* and *Spodoptera frugiperda* (Complex) in light traps. Includes information between years 1995 and 2004, from the localities of Reconquista (29º 11´S; 59º 42´O) (province of Santa Fe), Sáenz Peña (26º 49´S; 60º 27´O), Las Breñas (27º 05´S; 61º 07´O), Villa Ángela (27º 34´S; 60º 44´O), Tres Isletas (26º 21´S; 60º 26´O), Charata (27º 13´S; 61º 11´O), Machagay (26º 56´S; 60º 03´O), J. J. Castelli (25º 57´S, 60º 38´O), General San Martín (26º 33´S; 59º 22´O) (province of Chaco) and El Colorado (26º 19´S; 59º 22´O) (province of Formosa) (Figure 1).

Using the statistical software InfoStat (InfoStat, 2006), was done an agglomerative, hierarchical average and polythetic cluster analysis, based on Euclidean average distance for standardized variables, with the purpose of analyse the similarities between weekly and cumulative captures of adults of Alabama and Complex in the different localities and group them in sets in function to the found similarities. This analysis groups the individuals according to his proximity on the base of the calculation of similarities or dissimilarities, correlations (Pearson) or distances (Euclidean, Minkowski, Mahalanobis). Dendrograms, graphs based on a matrix of ultra metric distances that reflect the form in which the elements are grouped are constructed (Cuadras, 1991; Infostat, 2006).

With the purpose of simplifying the graphs, nomenclature indicated in Table 1 was used.

Results and Discussion

Dendrograms that appears in Figures 2 to 5, group the localities by their similarity in the weekly and accumulated captures of *Alabama argillacea* (Alabama) and the complex formed by *Heliothis virescens*, *Helicoverpa gelotopoeon* and *Spodoptera frugiperda* (Complex) and allow observing the form in which these captures are related in the different localities.

Alabama:

In Figure 2, the formation of three conglomerates is observed. The first one includes localities placed on a line in direction North – South, from Sáenz Peña (26º 49´ S) to Reconquista (29º 11´ S). The second one, the ones located on a line in direction East - West, from General San Martín (59º 22´ W) to Castelli (60º 38´ W). The third one includes Machagay and El Colorado, two neighbouring localities. Charata forms an independent cluster, with very different values respect to the other localities, reason why it was excluded from dendrogram to be able to observe in detail the other localities.

Cumulated captures present a similar grouping, the formation of four clusters can be observed (Figure 3). The first one, formed by Sáenz Peña, Villa Ángela and Reconquista and the second constituted by Las Breñas, include localities placed in direction North - South, with latitudes between 26º 49´ S and 29º 11´ S. The third one, integrated by General San Martín and El Colorado (neighbouring localities) and the quarter integrated by Tres Isletas, Charata, Machagay and Castelli.

Complex:

In dendrogram of Figure 4, four conglomerates are defined. The first one integrated by Tres Isletas, Reconquista, Villa Ángela, Las Breñas and Sáenz Peña, located on a line in direction North - South, with latitudes from 26º 21´ S to 29º 11´ S. The second one constituted by El Colorado, the third one integrated by Machagay and the quarter by Castelli. These two last ones are united to a distance superior to the unit, forming a conglomerate with localities placed in an East – West direction line, from 60º 03´ W to 60º 38´ W. Charata and General San Martín form independent clusters, with very different values respect to the other localities, reason why they were excluded from dendrogram to be able to observe in detail the other localities.

Cumulated captures of Complex generate four clusters (Figure 5). The first one formed by Tres Isletas, El Colorado and Sáenz Peña, localities geographically near. The second one integrated by Reconquista and Las Breñas, localities placed on a line with North - South direction, between 27º 05´ S and 29º 11´ S. The third one integrated by Villa Ángela and the quarter by Machagay and Castelli. Charata and General San Martín form independent clusters, with very different values respect to the other localities, reason why they were excluded from dendrogram to be able to observe in detail the other localities.

The cluster analysis generates partitions formed by disjoint classes (clusters) reasonably homogenous, grouping the observations by their similarity in the set of analyzed variables according to Cuadras (1991), Johnson (2002) and Peña (2002). It explains why it is possible to suppose that if adults of the studied species, captured in different localities represent individuals of a same population; captures in neighbouring localities must be similar. But Figures 2 to 5 shows that the weekly and cumulated captures of Alabama (*Alabama argillacea*) and Complex (*Heliothis virescens*, *Helicoverpa gelotopoeon* and *Spodoptera frugiperda*) do not group themselves by geographic proximity, therefore the adults captured in neighbouring localities would not constitute individuals of a same population.

The formation of a cluster with localities located on a line with direction N - S, between Sáenz Peña and Reconquista, indicates similarities in the captures of these localities and suggests would be a movement that originates the distribution of the adults in that direction. This leads to think that the infestations in the region can be attributed to successive migrations of adults originated in warmer regions according to the established by Bellettini *et. al* (1999), Carvalho (1981), Gaines (1957), Glick and Graham (1956), Hendricks *et. al* (1975), Parencia and Rainwater (1964) and Silveira Neto (1972), according with their migratory habits and capacity of fly long distances (Saini, 2002) and that coinciding with Botelho (1976) origins population tips in each locality in different moments. These migrations show a general direction N – S characteristic of the prevailing winds.

In agreement with the indicated by Fitt (1989) and Joyce and Lingren (1998), in the northeast of Argentina, the fly capacity and action ratio of adults of Alabama and Complex species (Saini, 2002), has great importance in its abundance and distribution and between the factors recognized by Hoffman and Frodsham (1993), Taylor (1984) and Way (1973), the migrations have greater incidence in the changes in the population sizes than the reproduction.

The existence of a second conglomerate that establishes similarities in the captures of distant localities, located on a line in direction East - West indicates, in agreement with the described by Gaines (1957), Glick and Graham (1956), Hendricks *et al.* (1975), Parencia and Rainwater (1964) and Silveira Neto (1972), that cyclical migrations in that direction redistribute the populations within the area.

In conclusion:

Cotton leafworm, tobacco budworm, cotton bollworm and fall armyworm populations in the Argentine cotton region are originated in migrations in N-S direction from warmer regions in the north.

Cyclical migrations of adults in E-W direction, between distant localities, redistribute the populations in the Argentine cotton area.

The mobility of adults has great importance in its abundance and distribution.

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Table 1. Nomenclature used in graphs to indicate weekly and cumulative captures by locality.		
Localities	Weekly Captures	Cumulative Captures
Castelli	ca	CA
Charata	ch	CH
El Colorado	ec	EC
General San Martín	sm	SM
Las Breñas	lb	LB
Machagay	ma	MA
Reconquista	rq	RQ
Sáenz Peña	sp	SP
Tres Isletas	ti	TI
Villa Ángela	va	VA

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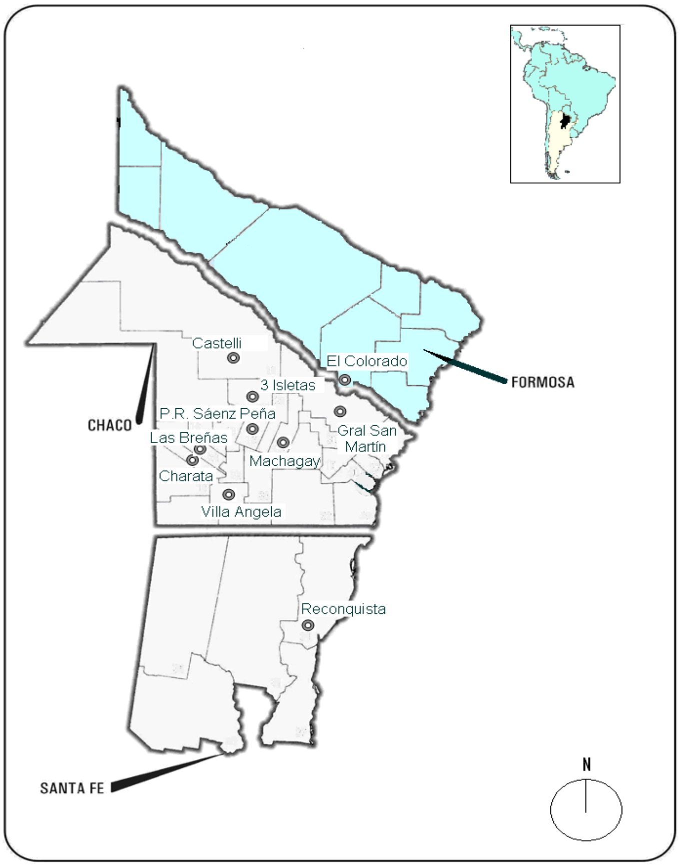
Figure 1. Geographic position of studied localities in the north of Argentina.

Figure 2. Dendrogram of weekly captures of Alabama in the different localities of the north of Argentina.

Figure 3. Dendrogram of cumulated captures of Alabama in the different localities of the north of Argentina.

Figure 4. Dendrogram of weekly captures of the Complex in the different localities of the north of Argentina.

Figure 5. Dendrogram of cumulated captures of the Complex in the different localities of the north of Argentina.



Cluster analysis...

Mazza, S.M...

Figure 1.

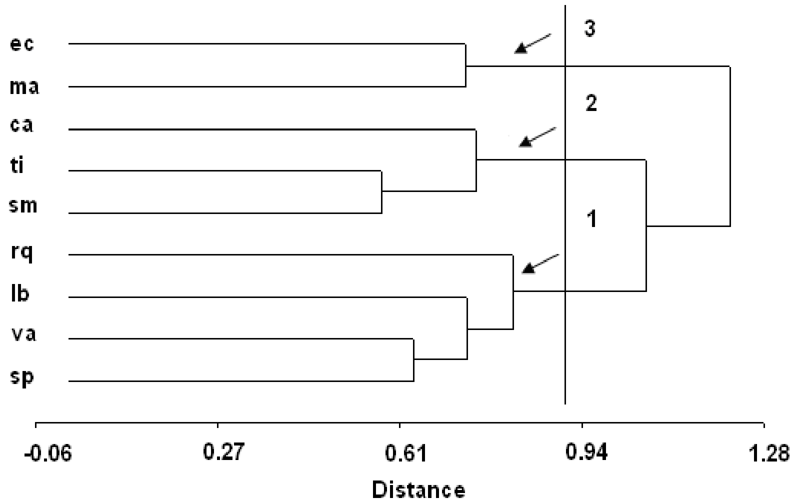


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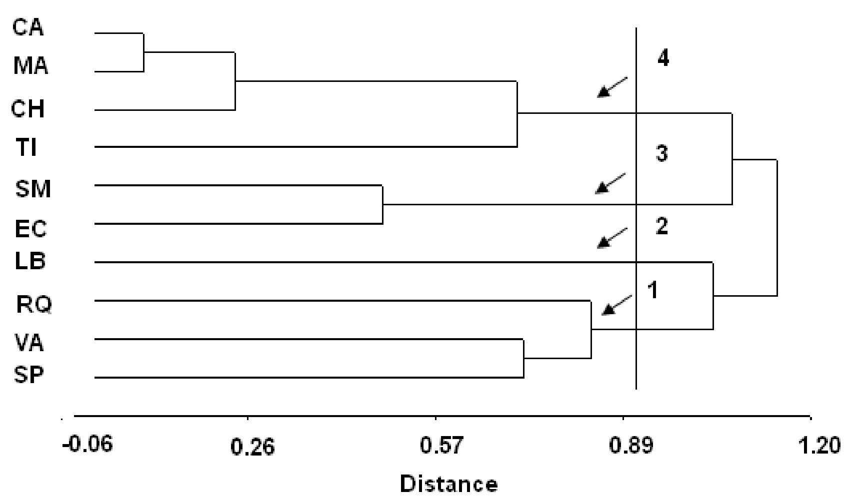
Figure 2.



Cluster analysis...

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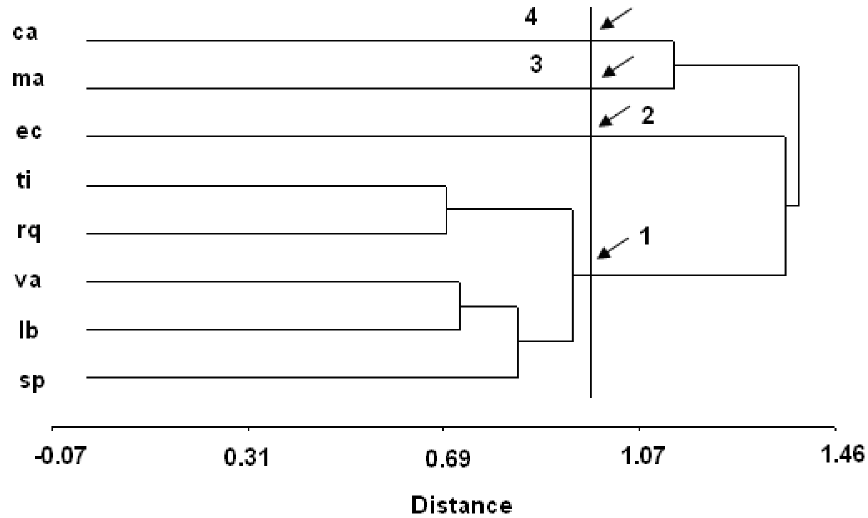
Figure 3.



Cluster analysis...

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Figure 4.

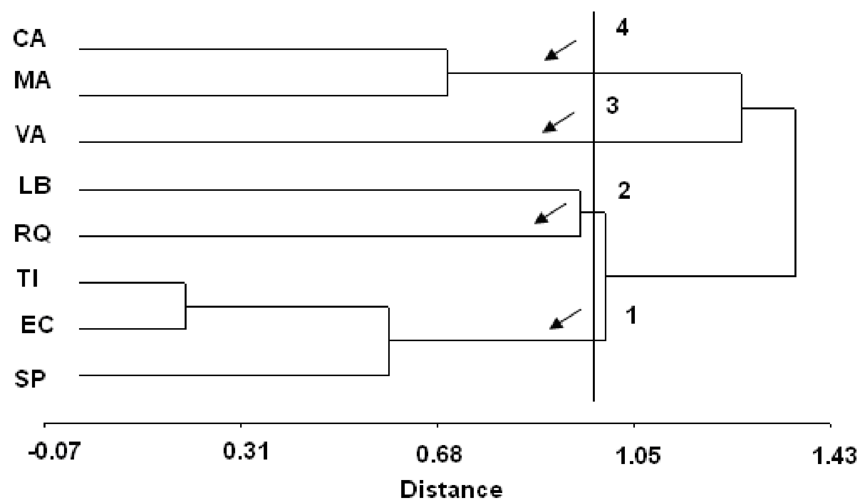

Figure 5.