"New Trends in Agricultural Engineering": 1180- 1188. BIOLOGICAL ENGINEERING

SPATIO-TERMPORAL MONITORING OF MEDITERRANEAN FRUIT FLY Ceratitis capitita PRESENCE BY PRECISION AGRICULTURE TECHNIQUES

M.K. Abd El Wahab *, M.A. El Shazly*, M.A. El Deeb **
and M.F. Ghiyaty***

ABSTRACT

Application of Precision Agriculture aims at identifying all field parameters to adjust inputs for achieving optimum environmental and economical benefits. Ceratitis capitita infestations form great losses in different fruit orchards where field infestation records are absent which negatively affects the credibility of the Integrated Pest Management (IPM) decision. This research was carried out at Al - Mahrosa Farm - Gaber ibn Hayan village 101 Km. Cairo-Alexandria desert road. Data collected on regular weekly investigations of adult counts in a well spatially distributed pattern of pheromone traps in 15 feddans of Florida peach was examined through two successful picking seasons 2005-2006. Obtained data was demonstrated in contour maps of adult presence in the investigated area. The mentioned data showed precisely hot points which require to be treated. One of the benefits of this procedures was the significant reduction of pesticides quantities applied in the orchard from 800lit/fed to 640 lit/fed in comparison to previous seasons.

INRODUCTION

Due to the increased consumption of pesticides applied to peach orchards it was necessary to adopt procedures to keep the population of Mediterranean fruit fly, *Ceratitis capitata* below the Economic Thresholds Limits (ETL).

* Professor of Agricultural Engineering, Faculty of Agriculture, Zagazig Univ.
** Professor of Economic Entomology, Faculty of Agriculture, Zagazig Univ.
*** Assistant Lecturer- Environmental Studies and Research Institute, Minufiya Univ., Sadat city.
This research is a part of registered Ph.D at Faculty of Agriculture Zagazig University under the supervision of previously mentioned committee

Where Geographic Information System (GIS) allows tabular counts information to be georeferenced and easily converted to geographic and interpretive maps, providing the user with a visual representation of the tabular data.

Within field monitoring of *Ceratitis capitata* in peach orchard in newly reclaimed land was conducted. on the basis of conversion of printed information to digital format and integration using GIS enables Integrated Pest Management (IPM) to correlate multiple data layers to one location and manipulate the appearance of the data to visualize infestation trends and patterns.

Precision agriculture (PA) often has been defined by the technologies that enable it and is often referred to as GPS (Global Positioning System) agriculture or variable-rate farming. As important as the devices are, it only takes a little reflection to realize that information is the key ingredient for precise farming. Managers who effectively use information earn higher returns than those who don't.

PA distinguishes itself from traditional agriculture by its level of management. Instead of managing whole fields as a single unit, management is customized for small areas within fields. This increased level of management emphasizes the need for sound agronomic practices. Before considering the jump to precision agriculture management, a good farm management system must already be in place.

REVIEW OF LITERATURE

Lyons *et.al* (2002) described a network of pheromone traps for monitoring populations of the Spruce budworm, *Choristoneura fumiferana* (Clemens) (Lepidoptera: Tortricidae) has been placed, throughout the distribution of the moth, annually since the mid-1980's. Cooperators from government agencies and private forestry companies in Canada and the United States deploy traps using standardized sampling protocols. A computerized software system has been developed using geostatistics to convert the male moth counts, at point locations, to complete spatial coverage maps for use GIS . Brewster *et.al* (2005) announced that constructing maps of insect pests is much more difficult because insect populations generally are spatially dynamic (changing density and location over time) and the methods that exist for mapping their distribution tend to be complicated, labor intensive, and uneconomical. The development of maps depicting the spatial distribution of insects therefore, presents a challenge in PA.

Israely *et.al* (1996) stated that little is known about the spatial and temporal distribution of *Ceratitis capitata* populations, and to what extend it is related to host phenology and host spatial distribution. And through monitoring of medfly populations during two seasons of activity by intensively sampling a 6 km^2 with trimedlure traps area in the surroundings of Kibbutz Zova (in the Judean Hills) the spatial distribution and buildup of the population during summer and autumn were closely associated with the phenology of the different fruit hosts, and with their spatial distribution. additional factors that determine the spatial distribution of the fly population and that affect the degree of influence of the predominant environmental factors, are insecticide applications, density of the host fruits and distance between hosts. Welch (1988) stated that trap siting was found to play an important part in control and surveillance system. Israely *et.al* (2005) stated that control and eradication strategies are currently based on the assumption that populations are basically "local" and flies usually disperse only hundreds of meters throughout their life. Thus, control treatments are given individually to every orchard or group of orchards without considering the possible effect of invasion of distant populations. However, results suggest that such a strategy may be ineffective given the dispersal ability of *Ceratitis capitata* and the directional interrelation between its subpopulations. Consequently, any effective control and /or eradication strategy should focus on treatment campaigns covering large areas, which consider the change in *Ceratitis capitata* distribution in space and time. Fleischer (2000) addressed the issue of time and space using insect populations within fields as the model. Insect populations vary throughout time because of the different stages of development. Monitoring has become a critical component of this program. Adoption of IPM principles has led to a reduction in insecticides application. Presumably, there is reduced environmental impact as well. Differential application of pesticides over time creates potential areas of spray versus no spray. This, in turn, creates areas of refuge for insect and a change in the spatial variation of insects across a field or among fields. Sampling these areas over time provides a picture of insect population dynamics of these populations include spatial statistics that can be layered against temporal statistics. The application of these methods to quantifying the spatial and temporal patterns across a field may help develop better management methods. Shenk and Bajwa (2001) reported that information systems based on the widespread use of personal computers provides the basis for decision support in IPM. Geographic Information Systems (GIS) coupled with increasingly accessible Geographic Positioning System (GPS) devices help managers improve understanding of problem spots and improve IPM planning and action. PA will likely increase since it allow growers to take advantage of a wider array of pest control methods, to adjust application rates ,to apply pesticides in a timely manner, and to target areas where pest problems are most sever. GIS and GPS can be used to accurately map an orchard and its components and subcomponents, including pest and predator populations. Their software can be linked to agrochemical application equipment to precisely apply pesticides or other farm chemicals only where they are needed . this can decrease the chemical load to the environment and overall pest control costs. Mishra *et.al* (2003) demonstrated that PA is based on the philosophy of heterogeneity within homogeneity and requires precise information on the degree of variability for within field management. The aim is to vary the agricultural inputs in response to the varying conditions within the field. Gozé et al (2003) reported that field sampling plans are proposed for monitoring *Helicoverpa armigera* (Hubner) populations on cotton and for threshold insecticide treatment in sub-Saharan Africa. The geostatistical analysis of the spatial distribution of bollworms validates systematic sampling (along a diagonal for example); systematic sampling is easier to perform than random sampling. The same negative binomial distribution was observed in Burkina Faso and Cameroon under controlled conditions, with or without insecticide treatment. Krell *et.al* (2003) declared that site specific management has the potential to improve existing integrated pest management programs by implementing management tactics only where insect populations are above the ET. But, more studies considering economic problems involved in this technology are needed. The current status of technology limits SSM of been leaf beetles in soybeans until sampling costs can be reduced and map driven insecticides applications are possible.

MATERIAL AND METHODS

Mediterranean fruit fly *Ceratitis capitita* distributions were investigated during two successful picking seasons in 2005 -2006 in 15 feddans of Florida Peach orchard in newly reclaimed area in Al Mahroosa Farm which is located in Gaber Ibn Hayan village, Alexandria-Cairo desert road. Peach trees are planted in 5 x 5m square heads. Trees age is still young where the study was conducted on the second and the third fruiting season. The uniform pattern of planting enabled 18 monitoring points to be easily plotted as shown in the map which was derived from a Google® satellite image by

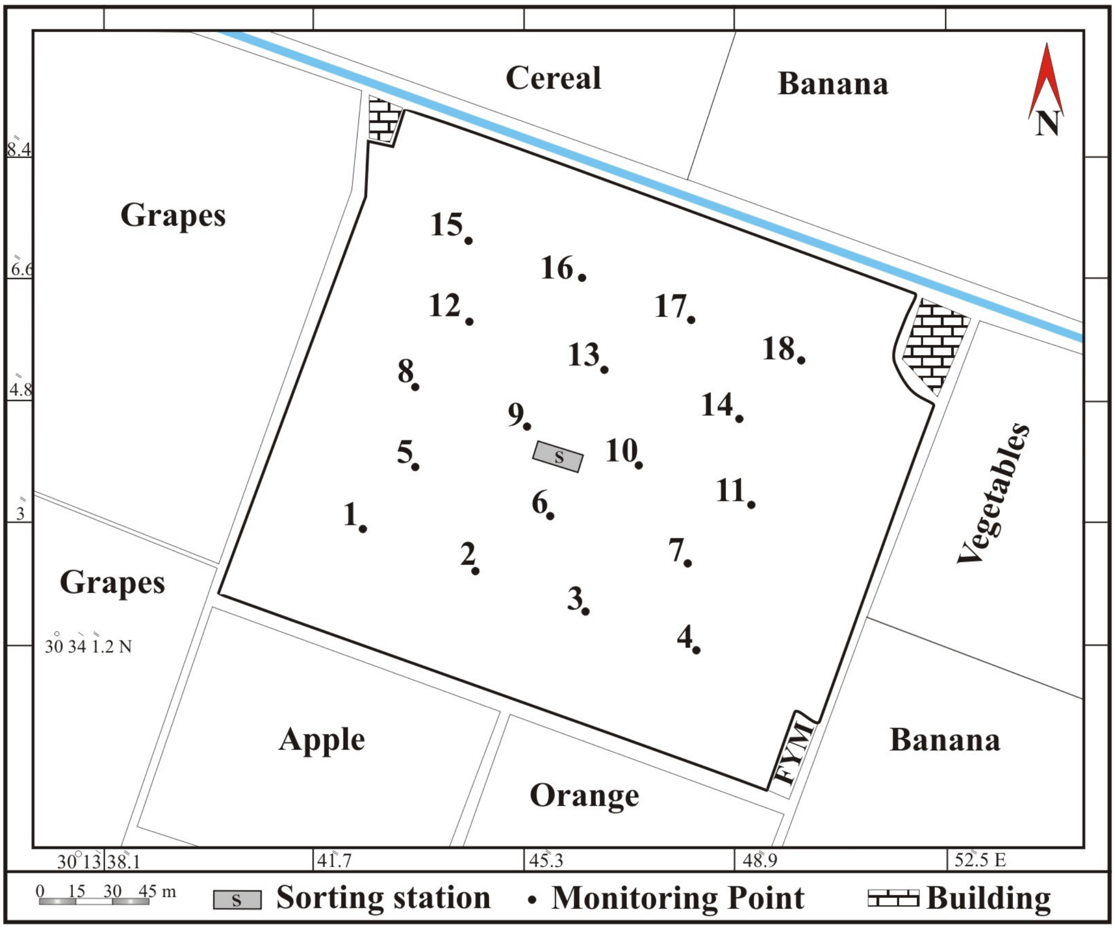

Fig. 1 Al Mahroosa Farm location map

Corel Draw11 with a field matching aid of a GPS 315 Magellan for precise field locating of the orchard position. Every monitoring point was holding a pheromone capsule for *C. capitita* fixed on a yellow sticky sheet paper which forms a major part the reinforced paper trap. These traps checked weekly in a regular pattern of recording counts and changing Yellow sticky sheets. Surfer 8 software was used for plotting monitoring point layout of a spatially distributed pattern.

Table 1. Spatial distributions of *C. capitita* counts in 2005 and 2006

Monitoring point	Investigation during picking season 2005				Investigation during picking season 2006			
	28/4	5/5	12/5	19/5	23/4	30/4	7/5	14/5
1	4	7	10	9	5	2	11	3
2	2	2	2	4	5	7	4	2
3	1	2	3	20	4	6	3	4
4	5	0	5	2	2	1	4	2
5	2	2	8	4	6	0	2	1
6	4	3	4	2	3	11	6	8
7	4	3	5	5	4	6	5	3
8	7	1	7	3	2	3	2	2
9	11	1	3	3	11	8	9	7
10	6	3	7	5	14	4	9	5
11	4	6	9	9	0	2	1	0
12	2	3	5	2	4	0	2	1
13	4	2	8	2	6	1	2	2
14	1	4	14	16	3	3	1	3
15	0	3	3	2	3	2	0	1
16	2	3	3	9	3	0	2	2
17	3	0	12	7	3	1	2	2
18	1	0	7	4	4	5	5	1
Total counts	63	45	115	108	82	62	70	49

RESULTS AND DISCUSSIONS

The weekly collected counts generate contour maps reflect the presence state of *C. capitita.*

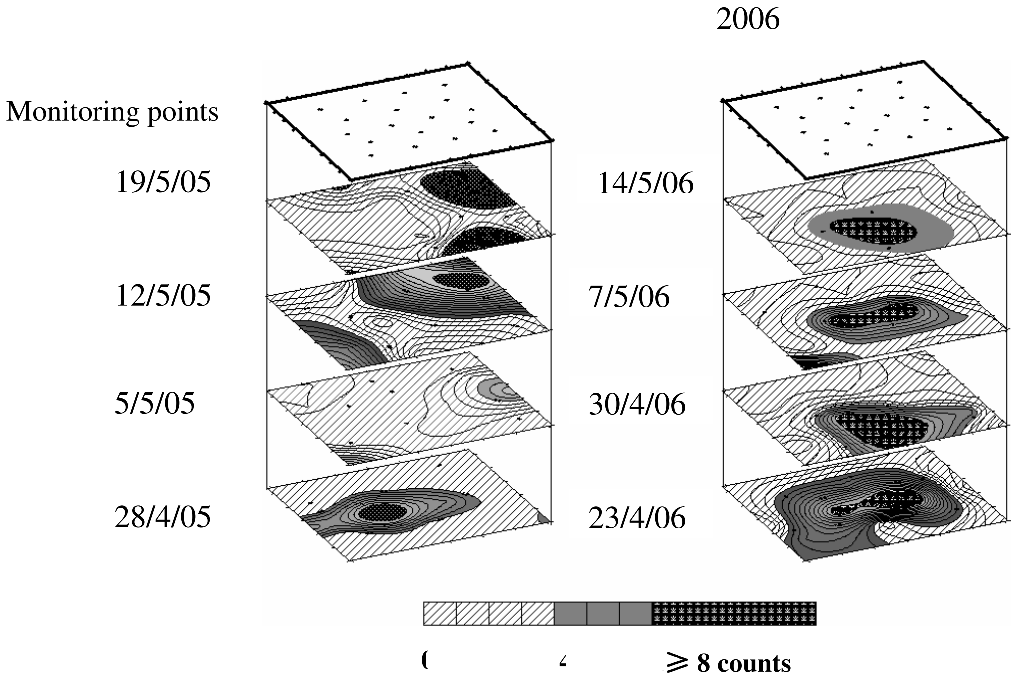

Fig.2 Visual representation of *C. capitita* counts in 2005 and 2006

These spatially maps can both be used as a rapid and precise monitoring indication for applying IPM decisions to the hot spots this result agreed with those of Goze *et. al* (2003). Also, these maps can be stored for generating accumulative temporal database providing a visual pattern of *C. capitita* presence through weeks of picking during years. Investigating the shape of contour maps of *C. capitata* counts during 28 April 2005. It was clear that the concentration of infestation counts was around the sorting station forming hot point which needed to be treated intensively with pesticides instead the whole orchard. Falled infested fruit should be collected and saved in a puriel to avoid the spread of new generation of *C. capitata.* During second week of investigation application of severe spaying of chemicals was carried out. It was clear on trees which was suffering from stresses due to strong flow of pesticide solution under very high pressure. Monitoring under open field conditions should take into consideration wrong practices of decision makers. It was obviously that *C. capitata* counts was affected. The rest of investigation weeks was somewhat domestic in the counts pattern. According to different mean of orchard management where the concept was adopted by the orchard executive manager. He applied the results of counts in his decision in 23 April 2006 where counts were relatively reduced but the contour map features had changed. According to the PIPM. These changes may be due to wind speed which was varied from 1.8 to 2.4 m/s and direction which do not affect significantly in the region. also, the temperature was around 23 ˚C to 29 ˚C where it was understood that climate factors during the two seasons were variable.

CONCLUSION

With reference to field input records during the picking season. The experimented orchard required 800 - 1120 lit/fed. This operation costs 6 – 8 skilled labor to accomplish this mission on a 600 lit sprayer. Where by the use of monitoring pheromone traps, the quantity of pesticides applied was reduced to 640 lit/fed. It was obviously that treating hot points reduced the actual time and real cost of spraying in the experimented orchard. It is hopefully to reduce applied pesticide up to 400 lit/fed.

REFERENCES

Brewster C; E. Lewis; B. Dimock and A.Herbert 2005. Precision Farming Tools Geospatial Insect Management http://filebox.vt.edu/users/rgrisso/papers/pf_spatial_tool_insects.pdf

Fleischer S.2000. Precision Agriculture and Environmental Quality: Challenges for Research and Education p.7

Gozé E; S.Nibouche and J.P. Deguine 2003 Spatial and Probability Distribution of *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) in Cotton: Systematic Sampling, Exact Confidence Intervals and Sequential Test. J. Environ. Entomol. 32(5): 1203-1210

Israely, N; B.Yuval and D. Nestel 1996. Relationship between Temporal Distribution of Mediterranean Fruit Fly Populations and Host Phenology. Abstract, The 8th conf. of the Entomological Society of Israel, procedures of meetings p.129

Israely, N; Y. Ziv and S.D. Oman 2005 Spatiotemporal Distribution Patterns of Mediterranean Fruit Fly (Diptera: Tephritidae) in the Central Region of Israel. Ann. Entomol. Soc. Am. 98(1):77-84

Krell R. K; L.A. Pedigo and B.A. Babcock 2003 Comparison of Estimated Costs and Benefits of Site Specific Versus Uniform Management for the Bean Leaf Beetle in Soybean J. Precision Agric. 4, 401-411

Lyons, D. B; C. J. Sanders and G. C. Jones 2002. The use of geostatistics and GIS as tools for analyzing pheromone trap data at a landscape level: an update. *IOBC wprs Bulletin Vol. 25(•)*

Mishra, A; K. Sundaramoorthi; C. Raj and P. Balaji 2003. Operationalization of Precision Farming in India www.gisdevelopment.net/application/agriculture/overview/pdf/127.pdf map indiea 2003

Shenk, M. and W.I. Bajwa 2001.Sustainable Agriculture News Briefs. SANB Vol.3 No.3 IPPC-UC SARE Project, Oregon State University.

Welch, J.B. 1988. Effect of trap placement on detection of *Cochliomyia hominivorax* (Diptera: Calliphoridae) J. Econ. Entom. 81, 241-245

الملخص العربي

الرصد الزمني و المكاني لتواجد ذبابة فاكهة البحر المتوسط باستخدام الزراعة الدقيقة

ا.د. محمد قدري عبد الوهاب*　　ا.د. محمود عبد الرحمن الشاذلي*

ا.د. محمد علي الديب　　م. محمد فاروق غياتي*****

يستهدف تطبيق الزراعة الدقيقة التعرف علي كافة المتغيرات الحقلية لضبط المدخلات المزرعية للحصول علي أمثل عائد بيئياً واقتصادياً. وحيث أن الإصابة بذبابة الفاكهة في مصر تشكل خسائر كبيرة في بساتين الفاكهة علي اختلاف أنواعها ويعتبر عدم توافر سجلات مزرعية لبيانات الإصابة مشكلة تهدد صحة قرار المكافحة عند استخدام نموذج المكافحة المتكاملة. تم تطبيق البحث بمزرعة المحروسة قرية جابر ابن حيان - الكيلو ١٠١ طريق القاهرة - الإسكندرية الصحراوي وجمعت البيانات بالفحص الأسبوعي لتعدادات الحشرات في المصايد الفرمونية لذبابة الفاكهة والموزعة بطريقة منتظمة مكانياً في ١٥ فدان خوخ صنف فلوريدا لموسمين جني متتاليين ٢٠٠٥-٢٠٠٦. تم عرض البيانات المتحصل عليها في صورة خرائط كنتورية للتواجد الحشري بالبستان أظهرت بدقة بؤر الإصابة المطلوب رشها بالبستان. مما قلل من كميات المبيدات المرشوشة من ٨٠٠ لتر/فدان الي ٦٤٠ لتر/فدان.

---

* أستاذ الهندسة الزراعية بكلية الزراعة جامعة الزقازيق.

** أستاذ الحشرات الاقتصادية بكلية الزراعة جامعة الزقازيق.

*** مدرس مساعد هندسة زراعية – معهد الدراسات و البحوث البيئية - جامعة المنوفية - مدينة السادات

هذا البحث جزء من رسالة دكتوراه مسجلة في قسم الهندسة الزراعية بكلية الزراعة جامعة الزقازيق تحت إشراف لجنة الإشراف المشار إليها سابقاً.