International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 29/06/2013 | Accepted on : 07/07/2014 | Published : 13/10/2015

Imaging Process Technique to Evaluate the Incidences of Insect Pests

Sehsah, E.M.
Associate Prof., Agric. Eng. Dept Fac, of Agriculture,
Kafr El Sheikh Univ.33516, Egypt

H. M. Hassan
Lecturer of Ent. Dept Fac., of Agriculture,
Kafr El-Sheikh Univ.33516, Egypt

Abstract – **The aim of the current study was to develop an accurate, practical and inexpensive method to estimate the consumed leaf area (CLA) due to the insect pests' herbivores. This technique is depending on a digital camera and public domain software for measuring existing leaf area and the consumed leaf area. The research was conducted in the both laboratory of agriculture engineering and economic entomology department, faculty of agriculture, kafr el Sheikh University, Egypt. The accuracy and precision of this method was compared to that of a digital mechanical drawing planimeter method. All methods were used to measure metal disks of a known area. As well as measured the natural leaves damage by using the imaging process and mechanical method. The digital camera accurately estimated the consumed leaf area from the low, medium, or high degree of simulated leaf feeding. The leaf surface area with a digital camera requires two steps (creating a digital image file and calculating the area represented by that image), the overall time required to measure leaf injury is shorter than with a planimeter. This method is accurate, relatively simple and inexpensive for estimating the consumed leaf area. Such method of estimating insect consumption could be applicable to numerous herbivores. The maximum increment different of initial leaves area by using the planimeter and image processing method was 7.3% for Broad bean (Vicia faba L.) leaves. The consumed leaf area percent by using the imaging process were 2.2 %, 1.4% and 4.9% for the following insects herbivores the beet fly (Pegomyia mixta Vill), the leaf Leafminer (liriomyza trifolii Burgess), and the Citrus leafminer (Phylloconstis citrella Stainton) respectively.**

Keywords – **Image Process, Leaf Area, Incidences of Insect.**

I. INTRODUCTION

Image processing has grown into a particularly active area of research in the last decade, due to advances in computing technology. There are relatively few industrial uses of image processing and very few within the agricultural industry. Many biological studies require measurement of leaf area and defoliation, Wheeler and Isman 2001, Mesbah, I.I.2000), and plant-insect interactions (Peterson et al. 1993, Hammond et al. 2000). Prior studies measuring herbivore (leaf area removed) have used visual estimates (Stotz et al. 2000), hand tracings of injured leaves or a comparison of treated leaves to an appropriate control (Gonzalez et al. 1992, Wheeler and Isman 2001). Much image processing research is done using standard video cameras (Gunasekaran et al. 1987; Keefe and Draper 1988). These are relatively cheap because of the large market for surveillance cameras (Salyani et al. 1994). They operate in the visual spectrum and are more or less matched to the sensitivity of the human eye. A black and white camera output would typically be digitized to give eight bits of grey level information per pixel, i.e. a grey level between 0 (black) and 255 (white). A color camera output can be decoded into three images to represent the red, green and blue components of the full image. Therefore more memory is required to store a color image and it is available now in the markt. The three components of the color image can be recombined in software or hardware to produce the intensity, saturation and the images which can be more convenient for subsequent processing. (Gagliardi et al 1985). Images from these cameras are very like a human's view of the object. The latter methods use a leaf area meter or a sampling grid to estimate leaf area (Vigneault C. et al 1998). Though useful, each of these methods has significant drawbacks; leaf area meters are expensive and measuring leaf area by hand with a sampling grid is time consuming. Recently, digital cameras have been used to measure infection by plant pathogens (Lindow and Webb 1983), insect feeding (Alchanatis et al. 2000, Su and Messenger 2000), and to capture insect images (Mitchell and Lasswell 2000). James and Newcombe (2000) used the Adobe Photoshop (version 3.0, Mountain View, CA) software package to measure leaf feeding of Phratora califonrica Brown (Coleoptera: Chrysomelidae) on hybrid poplars (Populus spp.). These estimates of leaf feeding were used to train personnel to visually estimate percentage of damage in leaf samples. Using public domain software (Scion Image) and a digital-imaging system, Wheeler and Isman (2001) measured area of untreated and treated leaf discs. Sehsah and Belal (2012) used The Image J software Version 1.52 to count the BT spores cells by capturing and detecting the BT cells with microscope PC camera. The result indicated that it could be able to use the Image J program to count the BT and it will be easy method.

II. OBJECTIVES

The aims of this current paper were developed a related easy method imaging processing using a digital camera and public domain software image J V.1.46 program to measure existing leaf area and damage area by insect herbivorous. We validated this method by comparing it with the mechanical planimeter standard leaf area. As well as, to investigate different types of the insect incidences such as leaf miners, mine blotches and chewing holes and its effect in leaves damage by using the imaging processing method.

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

III. MATERIALS AND METHODS

Two different techniques types mechanical and imaging process method were used to measure the consumed leaf area and initial leaf area in these types of host plants (namely broad beans, cabbage, orange and sugar beet which expressed to the natural infestation by different pests such as .

Mechanical method

The Roller-Type Electronic Digital Planimeter made by Placom is an instrument was used to measure the surface area of an arbitrary two-dimensional shape as shown in figure 1. The leaves of the different plant were drawn as a contour. The planimeter contains a measuring wheel that rolls along the drawing as the operator traces the contour. The planimeter ' measuring wheel moves perpendicular to its axis, it rolls, and this movement is recorded. The measuring wheel moves parallel to its axis, the wheel skids without rolling, so this movement is ignored. That means the planimeter measures the distance that it's measuring wheel travels, projected to the measuring wheel's axis of rotation. By counting the number of turns through which the measuring wheel rotates, the turns count is proportional to the area inside the contour or the leaf area. Also the elapsed time to measure the leaf area with mechanical method was recorded from the first step to the calculated of the leaf area.

The imaging processing method

Digital Camera

The digital cannon power-shot 45S is Compact Digital Still Camera with Built-in Flash and 3x Optical/4.1x Digital/12x Combined Zoom Lens. Lens and Flash accessories are available and used in image processing method. The imaging processing method consisted of from the above digital camera, Laptop HP with 2.4 GH and the Image J v1.52 soft ware program as free available imaging processing program as shown in figure 2-a.

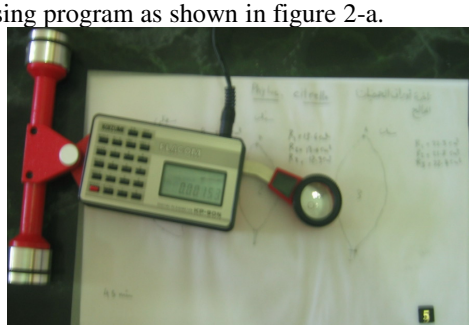

Fig.1. The mechanical planmeter to measure the different leaves are.

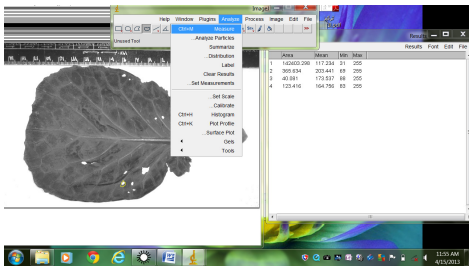

Fig 2a . The soft ware Image J V. 1.52 program which imaging the leaf area

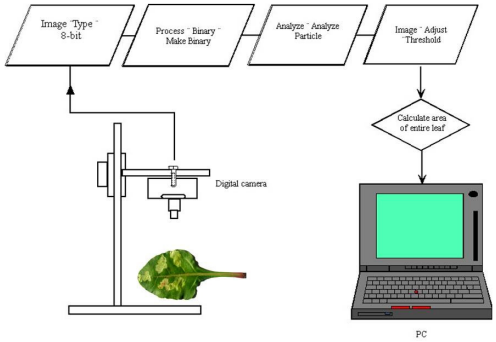

Fig.2-b. The analysis of the leaf area using ImageJ V. 1.52 program

Software program

ImageJ is a public domain Java image processing program inspired by National Institutes of Health. It runs, either as an online applet or as a downloadable application, on any computer with a Java 1.52 or later virtual machine. It is multithreaded, so time-consuming operations such as image file reading can be performed in parallel with other operations. The ImageJ program can calculate area and pixel value statistics of user-defined selections as shown in figure 2-b. It can measure distances and angles. All analysis and processing functions are available at any magnification factor. ImageJ was designed with an open architecture that provides extensibility via Java plug-in. Custom acquisition, analysis and processing plug-in can be developed using ImageJ's built in editor and Java compiler. User-written plug-in make it possible to solve almost any image processing or analysis problem. With the object outlined, the surface area was calculated by selecting the measure option (selected from the analyze menu). It was also measured the removed amount of leaf area. While the leaf was selected, the damaged area was highlighted after inverting the colors of the image (inverse selected from the edit menu). The amount of leaf area removed was measured from this inverted image within the boundaries of the original selection.

Experimental design and data analysis

It is compared the accuracy and precision of leaf area estimates from the imaging processing with estimates from a planimeter. Three separate tests were conducted using metal disks of a known area, a single leaf, and multiple leaves. In the first test, metal disks were used to evaluate the precision and accuracy of both methods to estimate a known area (13.6 cm2, 21.6 cm2, 91.2 cm2 and 170.16 cm2 disk). Each disk was scanned three separate times with the Planimeter and the digital camera. Descriptive statistics were used to compare the accuracy (mean) and precision (standard error of the mean, SEM) of each method. In the field test, it was compared the planimeter also with the image processing to estimate the initial leaf area and the damage of leaf area due to the insect herbivorous from a single leaf. A single leaf was harvested from different field conditions. The different crops Sugar Beet (Beta vulgaris L,), Orange (Citrus sinensis Osbeck L.), Broad bean (Vicia faba L.) and Cabbage (Brassica

oleracea L.) were collected from the experimental field in the faculty of agriculture kafr el-sheikh. The insects herbivores Pegomyia mixta Vill, Pieris rapae L., Liriomyza trifolii (Burgess Leafminer), Cassida vittata Vill., and Phyllocnistis citrella Citrus (leafminer Stainton) were collected from the third leaf from the Sugar Beet (Beta vulgaris L,), Orange (Citrus sinensis Osbeck L.), Broad bean (Vicia faba L.), Sugar Beet (Beta vulgaris L,) and Cabbage (Brassica oleracea L.) crops respectively. The leaves damage due to the above insects herbivores were measured by using the two different techniques of leaves area imaging process and digital mechanical planimeter.

Table 1: Indicate the tests using metal disks of a known area compared to planimeter area.

Standard. area, cm2	Planimeter area, cm2	Increment, cm2
13.6	13.3	0.3
21.6	21.4	0.2
91.2	89.8	1.4
170.16	165.1	5.1

Table 2: Indicate the tests using metal disks of a known area compared to Image processing area

Standard. area, cm2	Image processing area, cm2	Increment, cm2
13.6	13.4	0.2
21.6	21.5	0.1
91.2	90.5	0.7
170.16	166.5	3.6

Time elapsed to measure leaf area

The total time was measured to scan a single leaf three times with the planimeter leaf area, per the method described above. Three different leaves were measured in this way and a mean time calculated. For the digital camera, the time was measured to convert three sets of images with three leaves each to a single digital image. We then measured the time to calculate leaf area and injury (leaf area removed) from these digital files. All time estimates assumed that a user was familiar with the software and hardware and that the hardware was on longer enough to begin working immediately. Consumed leaf area percentage due to insect herbivorous was calculated by difference between the remaining and initial leaf areas. The following equation was used to simulate the consumed leaf area due to the insects herbivorous.

$$A_c = \left(\frac{A_r - A_i}{A_i} \right) \times 100$$

Where as:

Ac consumed leaf area, cm
Ai Initial leaf area, cm
Ar remained leaf area, cm

IV. Results and Discussions

The result of the current research presented that there are a non significant different between two technique methods of consumed leaf area as shown in figure 3 to measure the leaf surface area. As well as, it could be able to measure the consumed leaves area with high accuracy by using the imaging process technique. This method need only to capture the image for the leaf that damage by the insects herbivores. Table 1 and 2 indicated that there are no significant different between the imaging process and planimeter compared to standard method. The imaging process technique was an easy method to measure the leaves area and consumed leaves area due to the different insect herbivores.

Figure 4 illustrated that the consumed leaves area percent for different crops and insects herbivores. The consumed leaf area percent due to insects herbivores Pegomyiack mixta Vill, (Burgess Leafminer), and Citrus (leafminer Stainton) may able to measure with highly accuracy by imaging process compared to digital mechanical planimeter.

On the other hand, the digital mechanical planimeter could be able to measure the consumed leaves area after bigger damage of the leaves due to the insect's herbivores. It may be late to control the pests because the digital mechanical planimeter depending on the drawing of the traces' contour.

The consumed leaf area percent by using the imaging process were 2.2 %, 1.4% and 4.9% for insects herbivores Pegomyiack mixta Vill, (Burgess Leafminer), and Citrus (leafminer Stainton) respectively. The consumed leaf area percent by using the mechanical planimeter was not able to measure for pesticide activity Pegomyiack mixta Vill, (Burgess Leafminer), and Citrus (leafminer Stainton) respectively.

The consumed leaf area percent by using the imaging process were 2.8 % and 6% for insects' herbivores Pieris rapae and Cassida vittata Vill respectively. The consumed leaf area percent by using the mechanical planimeter were 2 % and 3.6 % for insects herbivores Pieris rapae and Cassida vittata Vill respectively. The above result indicated that it is easy to measure the consumed leaves area percentage by using the imaging process technique.

In addition to, the elapsed time to measure the leaf area for all leaves' crops were taken no longer time by using the imaging process compared to the mechanical planimeter method as shown in table 3. The imaging process taken a few minutes compared to the mechanical planimeter. In the other hand, it may be taken more time if the leaf has a bigger size by using the mechanical planimeter. The maximum elapsed time to measure the leaf area was 5 minutes by using imaging process compared to 36 minutes for mechanical planimeter at insect herbivores Cassida vittata Vill in Sugar Beet (Beta vulgaris L,). Table 4 presented that no significant different between the two different methods the planimeter and image processing to measure the initial leaves area without damage. The maximum increment different of initial leaves area by using the planimeter and image processing method was 7.3% for Broad bean (Vicia faba L.) leaves.

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

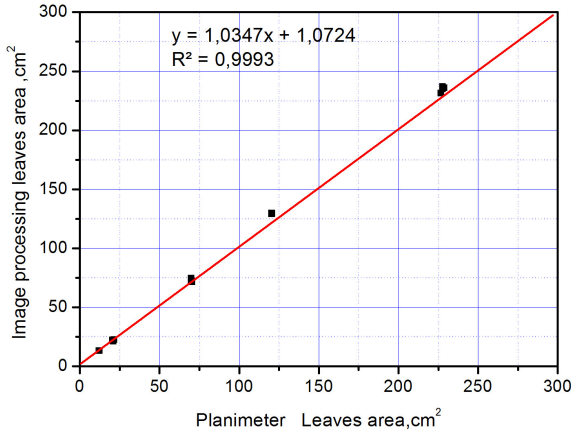

Fig.3. Indicate the fitting curve between the two different measuring leaves area planimeter and image processing method.

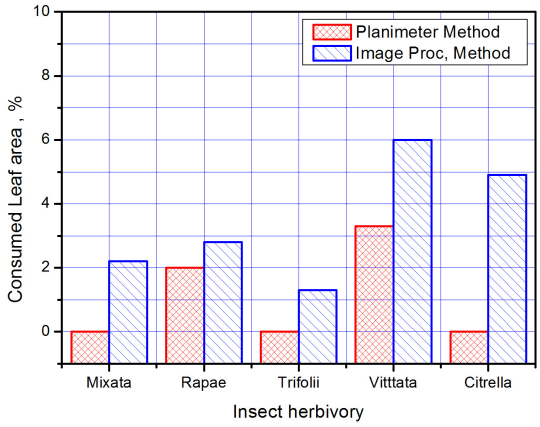

Fig.4. Display the percent of consumed leaves area by using the two different laves area planimeter and image processing method for different insect herbivores.

Table 3: Display the Time elapsed to measure leaves area with and without damage using the two different methods planimeter and image processing.

Insect herbivores	Leaves of crops	Time elapsed, min	
		Planimeter	Image proc.
Liriomyza trifolii Burgess	Broad bean (Vicia faba L.)	15	2
Pieris rapae L.	Cabbage (Brassica oleracea L.)	29	3
Phyllocnistis citrella Stainton)	Orange (Citrus sinensis Osbeck L.)	16	2
Pegomyia mixta Vill.	Sugar Beet (Beta vulgaris L,)	34	5
Cassida vittata Vill.	Sugar Beet (Beta vulgaris L,)	36	5

Table 4: Illustrate the initial leaves area without damage using the two different methods planimeter and image processing for different crops.

Leaves of crops	Planimeter Leaf area, cm2	Image proc. Leaf area, cm2	Increment percent, %
Broad bean (Vicia faba L.)	13.2	12.2	-7.3
Cabbage (Brassica oleracea L.)	129.6	120.4	-7.0
Orange (Citrus sinensis Osbeck L.)	22.0	21.0	-4.7
Sugar Beet (Beta vulgaris L,)	72.7	70.1	-3.5
Sugar Beet (Beta vulgaris L,)	234.9	227.6	-3.1

V. Summary and Conclusion

The result indicated that, the imaging process technique was an easy method to measure the leaves area and consumed leaves area due to the different insect herbivores. Measuring leaf area removed as a result of insect herbivore can be useful for evaluating host plant resistance and pesticide activity. The consumed leaf area percent by using the mechanical planimeter was not able to measure for some insects herbivores such as Pegomyiack mixta Vill, (Burgess Leafminer), and Citrus (leafminer Stainton. This results depending on the type of crops and insects herbivores. The pesticides activity may be know and measured by using the imaging process and giving the indicator to control the insect's herbivore. We recommended that measuring the insect consumption as a function of time and of leaf age class (leaves were partitioned into five age classes according to the order of leaf emergence along the twig).Time consuming bio-energetic should be studying for all herbivore populations.

References

[1] Alchanatis, V., A. Navon, I. Glazer, and S. Levski. 2000. An image analysis system for measuring insect feeding effects caused by biopesticides. J. Agric. Engng. Res. 77: 289-296.

[2] Gagliardi, G., G. F Hatch and N. Sarkar. 1985 Machine vision applications in the food industry, Proceedings of Vision '85, Society of Manufacturing Engineers, Detroit, March: 6-40-6-54

[3] Gonzalez, A. G., I. A. Jimenez, A. G. Ravelo, X. Belles, and M. D. Piulachs. 1992. Antifeedent activity of dihydro-B-agarofuran sesquiterpenes from Celastraceae against Spodoptera littoralis. Biochem. Syst. Ecol. 20: 311-315.

[4] Gunasekaran, S., T. M. Cooper, A. G, Bedage,and P. Klishnan. 1987. Image processing for stress cracks in corn kernels. Transactions of the American Society of Agricultural Engineers, 30(1): 266-271.

[5] Hammond, R. B., L. G. Higley, L. P. Pedigo, L. Bledsoe, S. M. Spomer, and T. A. Degooyer. 2000. Simulated insect defoliation on soybean: inßuence of row width. J. Econ. Entomol. 93: 1429-1436.

[6] James, R. R., and G. Newcombe. 2000. Defoliation patterns and genetics of insect resistance in cottonwoods. Canadian J. Forest Research30: 85-90.

[7] Jansky, S., S. Austin-Phillips, and C. McCathy. 1999. Colorado potato beetle resistance in somatic hybrids of diploid interspeciÞc Solanum clones. Hortic. Sci. 34: 922-927.

[8] Jasiobedzki, P. and W. J. Martin 1989 Processing of bacterial colony images for automatic isolation and transfer. Journal of Physics E: Scientific Instrumentation, 22:364-367

[9] Keefe, P. D; and S. R. Draper. 1988. An automated machine vision system for the morphometry of new cultivars and plant genebank accessions. Plant Varieties and Seeds, 1:1-11

[10] Lindow, S. E., and R. R. Webb. 1983. QuantiÞcation of foliar plant disease symptoms by microcomputer-digitized video image analysis. Phytopathology 73: 520-524.

[11] Mesbah, I.I. 2000. Economic threshold of infestation with the beet fly, Pegomyia mixta Vill., in sugar-beet fields at Kafr El-Sheikh region.1. A method for estimating sugar-beet leaf area consumed by Pegomyia mixta larvae. J. Agric. Res. Tanta Univ., 26(3) 508-514.

[12] Mitchell, F. L., and J. L. Lasswell. 2000. Digital dragonßies. Am. Entomol. 46: 110-116.

[13] Peterson, R.K.D., S. D. Danielson, and L. G. Higley. 1993. Yield responses of alfalfa to simulated alfalfa weevil injury and development of economic injury levels. Agron. J. 85: 595-601.

[14] Salyani, M., Fox, R.D., 1994. Performance of image analysis for assessment of simu- lated spray droplet distribution. Trans. ASAE 37 (4), 1083–1089. Salyani, M., Fox, R.D., 1999. Evaluation of spray quality by oil and water-sensitive papers. Trans. ASAE 42 (1), 37–43.

[15] Sehsah, E.M. and E.B.Belal. 2012. Direct injection technique for bio-pesticide spray. Misr J. Ag. Eng., 29 (3): 875 - 892

[16] Stotz, H. U., B. R. Pittendrigh, J. Kroymann, K. Weniger, J. Fritsche, A. Bauke, T. Mitchell-Olds. 2000. Induced plant defense responses against chewing insects: ethylene signaling reduces resistance of Arabidopsis against Egyptian cotton worm but not diamondback moth. Plant Physiol. 124: 1007Ð1019.

[17] Su, N. Y., and M. T. Messenger. 2000. Measuring wood consumption by subterranean termites (Isoptera: Rhinotermitidae) withdigitized images. J. Econ. Entomol. 93: 412Ð414.

[18] Vigneault C, C, Roger, K. P. C. Hui and G. Boivin. 1998. An image analysis system developed for evaluation of Coleomegilla maculata larvae's behavior. Canadian Agricultural Engineering, 40, 55-60

[19] Wheeler, D. A., and M. B. Isman. 2001. Antifeedant and toxic activity of Trichilia americana extract against the larvae of Spodoptera litura. Entomol. Exp. Appl. 98: 9Ð16. Received for publication 19 February 2002; accepted 26 June 2002.