***Araştırma Makalesi***
*(Research Article)*

Ayşenur YILMAZ[1]
Abdulkadir ÇAKIR[1]
Ozan DEMİRÖZER[2]

[1] Suleyman Demirel University, Technology Faculty, Departmant of Electrical and Electronic Engineering, E14 Block, West Campus, 3226, Isparta/Turkey
[2] Suleyman Demirel University, Agricultural Faculty, Departmant of Plant Protection, East Campus, 3226, Isparta/Turkey
corresponding author: aysenrylmaz357@gmail.com

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# Counts of rose soft scale (*Rhodococcus perornatus* Cockerell & Parrott) (Hemiptera: Coccidae) by using image processing methods

Gül koşnili (*Rhodococcus perornatus* Cockerell & Parrott) (Hemiptera: Coccidae)'un Görüntü İşleme Yöntemleri Kullanılarak Sayılması

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**ABSTRACT**

**The rose soft scale (*Rhodococcus perornatus* Cockerell & Parrott) (Hemiptera: Coccidae) is the main pest of oil-bearing rose in Isparta (Turkey). It spends all periods of the life on oil-bearing rose (*Rosa damascena* Miller) and damage rose plants by sucking the sap. Population density, which is the first step of the struggle with pests, is estimated by regular sampling and counting. However, in case of insects that can reach an overly dense population level, as in Coccidae, census errors are frequently caused by different conditions in census studies. In this study, infested rose twigs infested by different life stages of the pest (1st nymph instar, 2nd nymph instar, female(adult)) were provided from different oil-bearing orchards in Isparta at different time stages in the seasons and the twig samples were cut as 1.5 cm pieces for the purpose of image taking and counting. İmaging were done by Leica (Z16 APO; 40X Magnification). Acquired images were processed in the Leica las 4.50 microscope software platform by performing the necessary image quality enhancement operations. Images from the macroscope are converted into countable form by Matlab program (R2016b version) and Matlab software language using morphological image processing methods. An algorithm has been created to determinate female(adult), 1st and 2nd nymphs of rose soft scale and calculate average size of the different life stages. Counting was done and tables were arranged according to the created algorithm.**

Anahtar Sözcükler:

Görüntü işleme, zararlı, Isparta, Yağ gülü, Türkiye

**ÖZET**

**Yağ güllerinin ana zararlısı gül koşnili (*Rhodococcus perornatus* Cockerell & Parrott) (Hemiptera: Coccidae)'dir. Hayatının tüm evrelerini yağ gülü bitkisi (*Rosa damascena* Miller) üzerinde geçirir ve bitki öz suyunu emerek zararlı olmaktadır. Zararlılarla mücadelenin ilk basamağı olan popülasyon yoğunluğunun tahmin edilmesi yapılan düzenli örnekleme ve sayımlarla mümkün olmaktadır. Ancak, Coccidae'de olduğu gibi aşırı yoğun popülasyon düzeyine ulaşabilen böceklerde sayım çalışmalarında farklı koşulların sıkça etkili olması sayım hatalarına neden olmaktadır. Bu çalışmada, Isparta'da bulunan yağ gülü üretim alanlarından farklı zamanlarda temin edilen ve zararlının farklı yaşam dönemleriyle bulaşık (1. nimf, 2. nimf dönemleri ve ergin(dişi)) dal örnekleri 1.5 cm'lik parçalara ayrılıp sayıma hazır hale getirilmiştir. Leica marka (Z16 APO; 40X büyütme) makroskop kullanılarak örnek dal görüntüleri alınmıştır. Alınan görüntüler Leica las 4.50 mikroskop yazılım platformunda gerekli görüntü kalitesi arttırma işlemleri yapılarak işlenebilir hale getirilmiştir. Daha sonra görüntüler Matlab yazılım programı (R2016b sürümü) ve Matlab yazılım dili ile morfolojik görüntü işleme yöntemleri kullanılarak sayılabilir forma dönüştürülmüştür. Yapılan bu çalışmayla zararlıya ait 1. nimf, 2. nimf ve ergin(dişi) dönemlerinin belirlenmesi ve her bir dönemin ortalama vücut boylarının çıkartılması için bir algoritma oluşturulmuştur. Sayımlar ve tablolar bu çalışmada yazılan algoritmaya bağlı kalınarak düzenlenmiştir.**

## INTRODUCTION

Image processing is manipulation and analysis of pictorial information as general term (Castelman, 1996). It can be defined, images that get on varied shapes are saved, evaluated and viewed on special computer it contains analog digital convertor (Ayata et al., 1997).

Digital image processing has two principal aims: enhancement of image for humans and processing of image data for autonomous machine perception, for storage, transmission, and representation (Gonzalez and Woods, 2002).

First image processing application was implemented for disposed stains that send from circumlunar satellite image's deviation and electronic noise released by computer in US at 1964. Now days, commonly used technique of image proccessing is utilized on varied implementation as industry, military, security, robotic, geological, medicine and agriculture.

Image proccessing techniques were used on purpose of measurement leaf size's, analysis color and classification for fruit, varied operations of disinfection, monitoring of root growing, finding out weed, determined rate of milling etc. (Ayata et al., 1997; Dursun and Göknur-Dursun, 2000-2005). Agricultural products features as height's, weights, thickness, circumference, projection, some coefficient of forms are determined by image proccessing technique. Thus, difficult measurements are ensured that it gets done qua easier, shorter time and accurate measurement. In this study, the presence of the *Rhodococcus perornatus* (Cockerell & Parrot) was detected in the images taken using by macroscope on rose twigs.

**Rose Soft Scale *Rhodococcus perornatus* (Cockerell & Parrot)**

Rose oil is an important component of essential oils and it is extracted from flowers of *Rosa damascena* Miller in Isparta, Turkey. Also it has great economic importance in this region. It is mainly used in cosmetics and pharmaceuticals. The majority of the plantations are located in the center of Isparta: Keçiborlu, Gönen, Atabey, Eğirdir and Aksu districts (Altınok and Ulusoy, 2004). Rose soft scale *Rhodococcus perornatus* (Cockerell & Parrot) is the main pest of *R. damascena* and is widely distributed in the province. *R. perornatus* has one generation per year in Isparta and overwinters as the 2nd nymph (Altınok and Ulusoy, 2004). Due to the infestation of this pest the rose plants can become defoliated and accumulation of sooty molds growing on the honeydew. Additionally, the heavy infestation of this pest can be completely destroyed a rose orchard in three or four years (Acatay, 1970).

**MATERIAL and METHODS**

**Count directly on stereomicroscope and retrieving images from Leica macroscope**

In this study, twig samples which are provided from different oil-bearing production areas on Isparta at different times and infested with pest (different life cycles; 1st nymph instar 2nd nymph instar, adult) were separated 1.5 cm pieces and prepared for counting. Each twig was directly counted by the stereomicroscope. Counts were written on schedule. Images were taken by Leica brand (Z16 APO; 40X Magnification) macroscope and acquired images were processed in the Leica las 4.50 microscope software platform by performing the necessary image quality enhancement operations. Retrieving images from macroscope was seen on Figure 1.

**Figure 1.** Retrieving images of different life stages of rose soft scale from by Leica Z16 macroscope

**Image processing on Matlab**

Taken images from the Leica Las 4.50 interface were converted into countable form by Matlab program (R2016b version) and the Matlab software language using morphological image processing methods. An algorithm has been created to calculate average soft scale dimensions for determinate life periods of soft scale (1st, 2nd nymph instar and adult(female)). Firstly, manual counting was performed while adhering to created algorithm. Matlab interface was shown in Figure 2.

Created algorithm was shown Figure 3. This algorithm is symbolic of the logical computation to be used in the study.

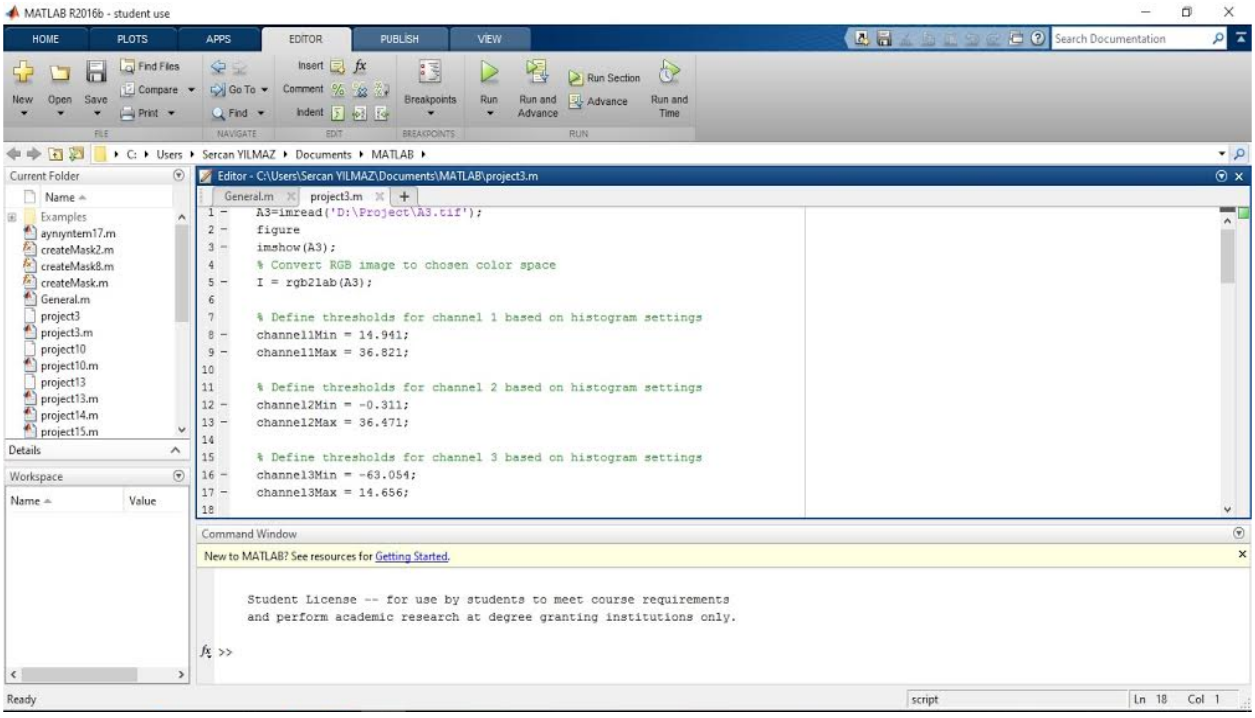



**Figure 2.** Matlab software programme interface

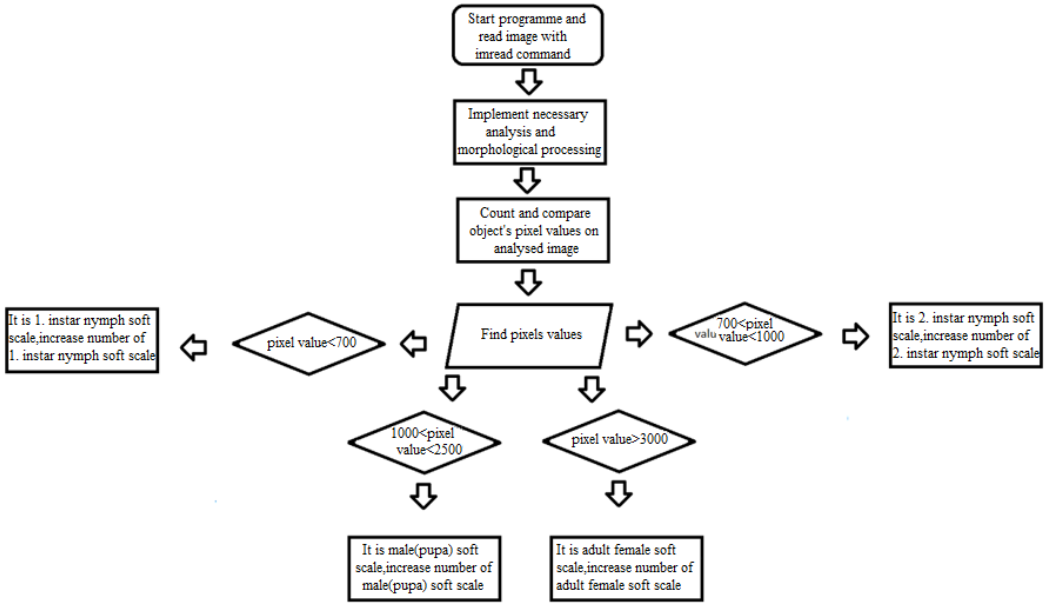
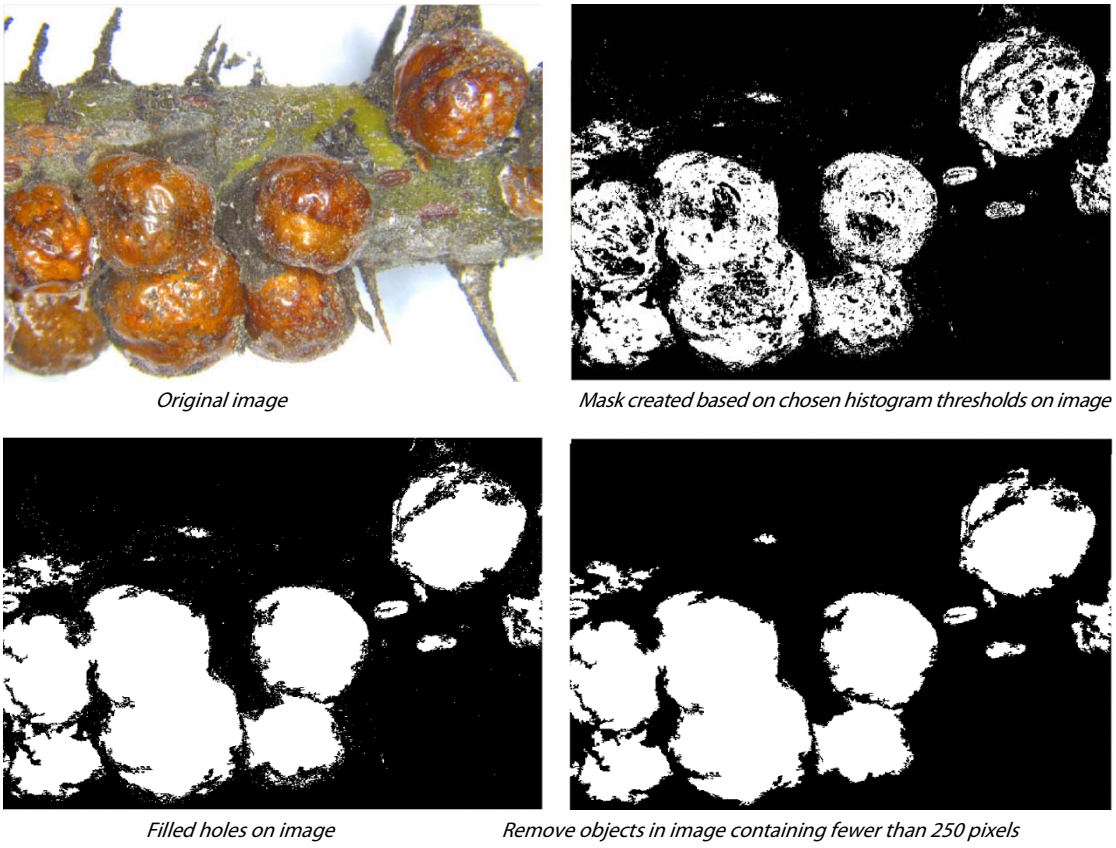



**Figure 3.** Created operating logic algorithm of the counting rose soft scale system

## RESULTS

### Analysis on infested rose twigs by adult female and pre-adult stages of rose soft scale

On this step, seven adults(female) and five 2nd nymph soft scales were investigated by direct counting method with stereomicroscope. Except that fractional result found on MATLAB (R2016b) because there are color fluctuations on twig similar to rose soft scale colors. Image was converted black and white color space with determined threshold values thereby image color's converted Lab color space. Color noises were occurred on image because of fluctuations on twig similar to rose soft scale colors. Median filter and 'bwareaopen' command's were implemented for remove color noises. Object's pixel values were determined for algorithm by 'cellfun(@numel,cc.PixelIdxList)' command's. Number of rose soft scale and average size of rose soft scale were found by algorithm. Implemented algorithm on image, it was seen on Figure 4 and result of calculate was seen on Figure 5.



*Original image* *Mask created based on chosen histogram thresholds on image*

*Filled holes on image* *Remove objects in image containing fewer than 250 pixels*

**Figure 4.** Analysed on infested rose twigs by adult(female) and 2. nymph instar rose soft scale

```
2. nymph female(adult):
           1      120032
           2        2963
           3       19716
           4       33368
           5       33030
           6        4392
           7        4030

2.nymph instar:
           1         298
           2         311
           3         271
           4         413
           5         500

2.nymph instar:
           5

2. nymph female(adult):
           7

Average size of 2.nymph instar:
    358.6000

Average size of 2.nymph female(adult):
    3.1076e+04
```

**Figure 5.** Command Window Screen (Result of calculate)

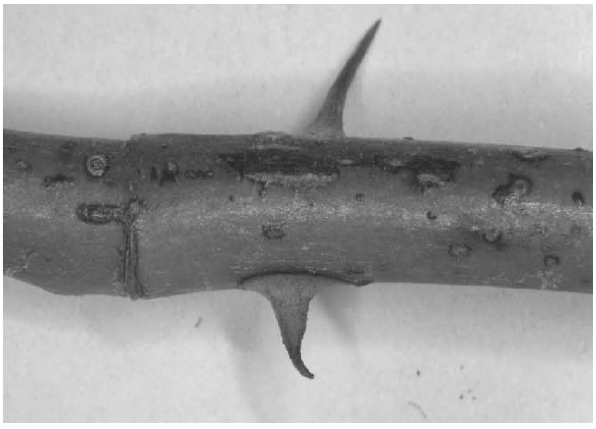
**Analysis on un-infested rose twigs purpose of controlling of created program**

The correctness of algorithm was checked thereby determined algorithm was implemented on rose twig, it didn't have any rose soft scale. Used of all algorithm was worked %100 rightly. Implemented algorithm on image and result of calculate were seen on Figure 6.

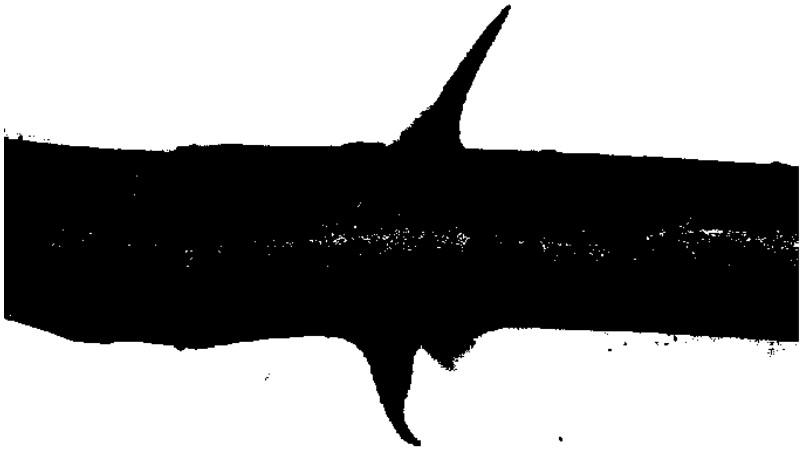
**Analysis on rose twigs were infested by the 2nd nymphs of rose soft scale**

In this this stage of the study, forty-six 2nd nymph instar soft scales were investigated by direct counting method with stereomicroscope. Different way analysis were tried on sample image, that has just 2nd nymph rose soft scale. Received image was converted to Lab color space from RGB. Thresholds were defined for color channels on histogram setting. Color mask was created based on chosen histogram thresholds. Created mask was implemented on input image. Morphological operations (dilate, bwareaopen, imfill ('holes')) were implemented on image for cleanse noise after color masked image. Optimum algorithm was wrote for find number of rose soft scale and average size of rose soft scale. Implemented algorithm on image was seen on Figure 7 and result of calculation was seen on Figure 8.

*Original image*



*Gray threshold image*



Implemented algorithm on image

```
1. nymph instar:
2.nymph instar:
1. nymph instar:
     0

2.nymph instar:
     0

Average size of 1.nymph instar:
   NaN

Average size of 2.nymph instar:
   NaN
```

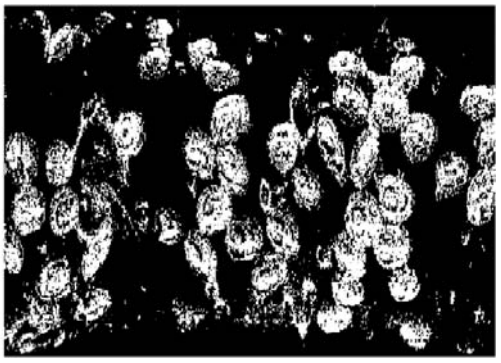
*Command Window Screen (Result of calculate)*

**Figure 6.** Analysed on un-infested rose twig purpose of controlling of created program

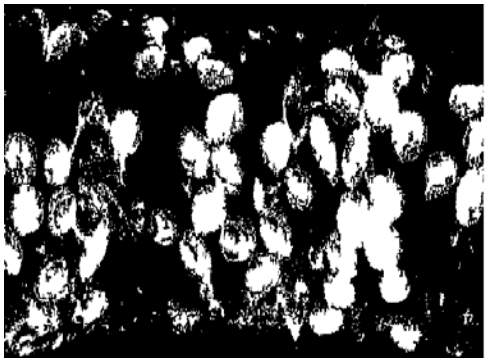
*Original image*

*Converted Lab image chosen color space*

*Created mask image based on chosen histogram thresholds*



*Cropped and converted binary image*



*Filled holes and reductioned noise on image*

*Removed small objects on image*

*Dilated image with strel structuring element*

**Figure 7.** Analysed on rose twigs were infested by the 2nd nymph instar of rose soft scale

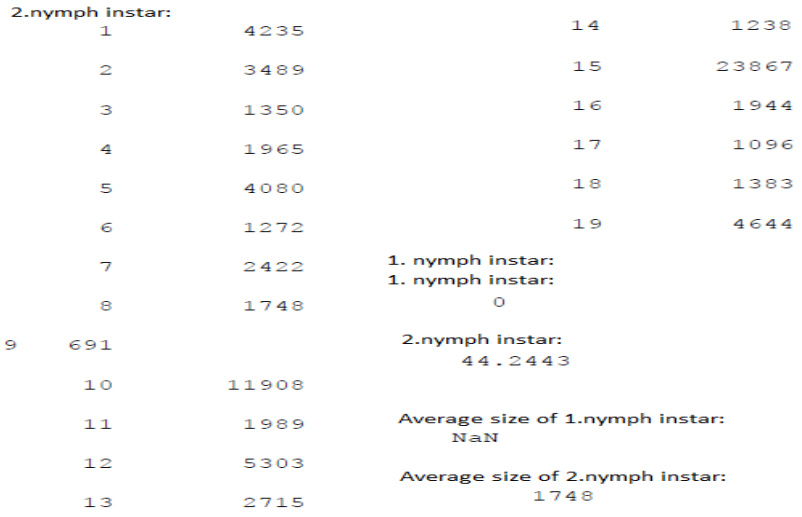



**Figure 8.** Command Window Screen (Result of calculate)

## CONCLUSION

In the study, investigations were completed succesfully that carried out on the 13 twig samples which were infested with rose soft scale. The colors of twigs and different life stages of the pets were found very close to each other, and so it caused undesirable color fluctuations and noises on the images. Some of the rose soft scale were shown in larger sizes than their actual sizes, which were located in the nearest color frequencies. It was also caused errors and fractional conclusion on counting phase. These type of problems can be eliminated by improving the used of image processing methods. According to analysis results 16.879 2nd nymph instar and 7.8333 1st nymph instar of rose soft scale, and 6.0803 adult females were counted study of the twigs (Table 1). And average number of 8.838 2nd nymph instar male (pupa) of rose soft scale were counted on only two rose twig. This obtained results were shown that to counting of rose soft scale can be done easily using image processing methods.

**Table 1.** Result of MATLAB operation process

| Analysed rose twig | 1. nymph | 2. nymph | female adult | male(pupa) |
|---|---|---|---|---|
| 1. | 0 | 5 | 7 | 0 |
| 2. | 0 | 0 | 9,2409 | 0 |
| 3. | 0 | 0 | 0 | 17,6760 |
| 4. | 0 | 0 | 0 | 0 |
| 5. | 0 | 1 | 0 | 0 |
| 6. | 5 | 12 | 0 | 0 |
| 7. | 15 | 27 | 0 | 1 |
| 8. | 5 | 18 | 0 | 0 |
| 9. | 4 | 19,5494 | 2 | 0 |
| 10. | 0 | 12 | 0 | 0 |
| 11. | 0 | 44,2443 | 0 | 0 |
| 12. | 8 | 15 | 0 | 0 |
| 13. | 10 | 15 | 0 | 0 |

In the present study, detection of rose soft scale on oil-bearing rose twigs using by image processing methods was succesfully performed. By the method used counting of different life stages of the pest can be realized in a shorter time and without errors. Pourdarbani and Rezaei (2011) designed a similar method based on automatic image analysis to control the whitefly pest on study of detected greenhouse pests by image analysis. Examples of contaminated leaf samples were collected and analyzed by Matlab

software. Their used algorithm was consisted of back ground removing and pest selection. They used different imaging device (Sony NO.DSC-P100). Also they used different filters on Matlab software (low-pass filter, laplacian filter). They studied on 50 sample whitefly and their proposed system could detect the mature whiteflies.

Huddar et al. (2012) aimed at pest segmentation, detection pest automatically, reduction in pest counting error on plants using image processing methods in their work. Also they aimed detection pest not only greenhouse environment but also in a farm environment. Whitefly was selected as pest to be detected.

In this study, faults arising from the human factors removed and working efficiency was increased. There are some studies in the literature to detect some pest by image processing methods. It is thought that, timesink and workforce costs can be reduced on studies of observation and population, which are had an important role on entomology, through obtained results of this study. It is aimed to contribute of investigating of different pests and pest control studies.

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