A Novel Approach for Quantification of Population Density of Rice Brown Plant Hopper (RBPH) Using On-Field Images Based On Image Processing

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Abstract: **Rice covers about 69% of the cultivated area and is the major crop, covering about 63% of the total area under food grains. It is the staple food of almost the entire population of Odisha. Therefore, the state economy is directly link with improvements in production and productivity of rice in this state. Almost 1.10 lakh acres of farmland across the state of Odisha affected due to brown plant hoppers year 2018-19. Therefore, it is necessity to quantifying the population density of rice brown plant hopper (RBPH) and make decisions for its treatment. Manually it is time-consuming and unreliable. Here we propose a methodology where a smartphone mounted in selfie stick used to capture planthopper images on rice stems and by application of image processing technique the population density of RBPH scaled. The methodology includes image enhancement, median filtering and k-means clustering for segmentation.**

***Index Terms* - Rice planthopper; median filter; k-means clustering; image processing technique.**

1. Introduction

Pest attack is one of the major cause in the reduction of quality and quantity of paddy crops. In Odisha, rice is grown under highly diverse ecosystem and a wide range of climatic conditions [1]. 70% of Indian economy depends on agriculture but paddy diseases causes the major loss in crop as well as economic loss. Rice planthopper are one major group of rice pests, BRPH is one of them. In the month of April 2019, many farmers are attempted suicide for paddy crop loss, which is due RBPH attack in western Odisha. The RBPH locally known as Chakada. To avoid losses of rice crop due to RBPH it is essential to monitor the rice field time to time. For insect pest control, application of chemical insecticides is still the favorite method for farmers which causes environmental pollution and reduces population of the natural enemies of herbivores [2]. Although, chemical pesticides play crucial roles in the management of crop diseases and pests [3], its disadvantages are also evident in the environment. Knowledge and information are key to correct pest management decisions [4]. The point of Integrated pest management (IPM) is to apply pesticide only when and where it is needed [5]. IPM as a system which provides intensive information for appropriate decision making for field practitioners [4]. Technology can help farmers monitor crops efficiently and potentially detect destructive insects or pest and prevent their relevant disease in early stage [6]. Advance computing technology can help farmer take decision about many aspects of crop development. Suitable diagnosis of crop disease in the field is critical in increasing production [7]. However, in the field of agriculture, there were little application reported in using intelligent materials as compared to other fields such as medical, aerospace, construction, etc. It is still a challenge for the scientific community the improvement and application of pest and disease models to analyze and predict yield losses [8]. In most cases, humans perform diagnosis about diseases visually. Trained raters may be efficient in recognizing plant diseases however some associated disadvantages may harm the efforts of recognizing diseases [9]. Implementation of disease detection application in agricultural sector will help farmers get the information about the diseases of the leafy vegetables and the necessary management techniques that can be used to prevent the diseases without depending on the experts [10]. Computer vision and image processing technology have been widely used in many fields and have many potential applications in modern agriculture [11]. Moreover, the techniques of machine vision are extensively applied to agricultural science and have great perspective especially in the plant protection fields [12]. Moreover, machine vision and digital image processing are extensively applied to agricultural science, which leads to crops management [13]. Automatic detection of plant disease takes less time and effort, and more accurate as compared to visual way of detecting [14]. It is important to develop agricultural pest identification system based on computer vision technology to correctly identify and target control measures to prevent damage caused by pests [15]. Automatic technique of plant disease detection reduces large work of monitoring big farms and at early stage; symptoms of diseases are detected [14]. Several approaches based on automation and image processing have come to light to address early detection of pest infestation. Most of the algorithms concentrate on pest identification limited to a greenhouse environment [16]. Cheng et.al. suggested a pest identification method that uses deep residual learning to achieve pest identification with complex farmland background [15]. In the study of Kawasaki et. al., a novel plant disease detection system based on convolutional neural network was presented. Using only training images, CNN can achieve high classification performance [17]. In the study of Sladojevic et. al., deep convolutional network was used in the development of plant disease recognition model based on leaf image classification. Convolutional neural networks(CNN) has achieved impressive result in the field of image classification [18]. Yao et. al. proposed in their study a three-layer detection method to detect and identify White-backed planthoppers using image processing. The proposed method was found to be feasible and effective for the identification of different developmental stages of planthopper on rice plants [19].

2. METHODOLOGY

The images are collected from different parts of Sambalpur and Burla, Odisha, India. The RBPH has been detected using on-field images through execution of following steps and illustrated in flow chart1.

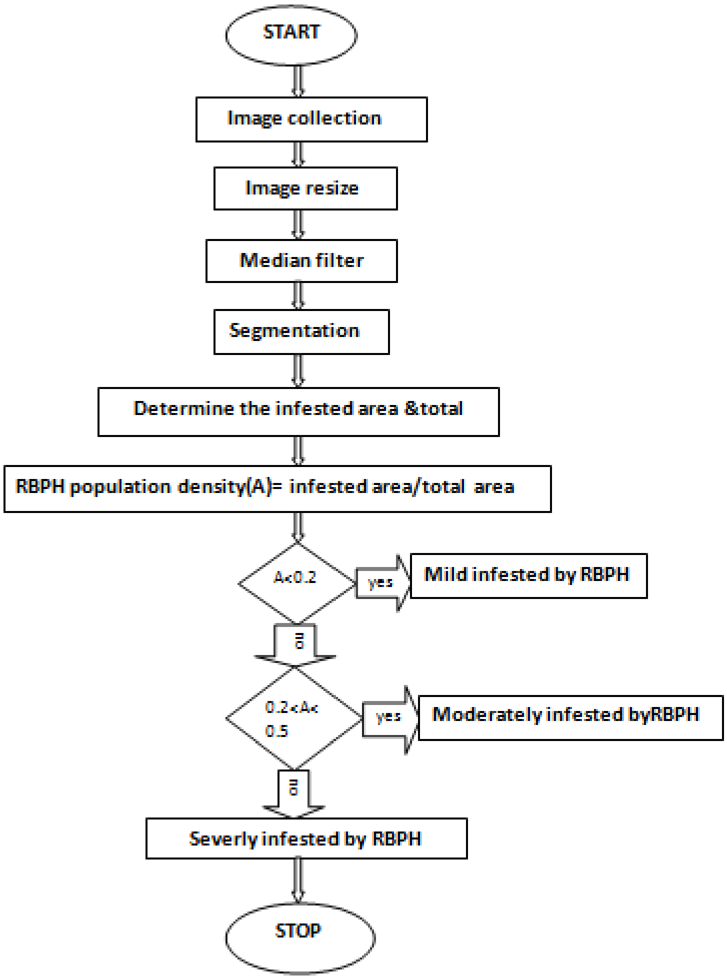


Fig.1. procedural steps for quantifying population density of RBPH.

2.1 Image collection

The images were captured using smartphones with the help of selfie stick from different part of Sambalpur and Burla, Odisha. The samples of RBPH on-field images are shown in figure 2. Some images are also collected from internet.

(a) (b)

Fig.2. Rice Brown planthopper on-field Images (a) capture image using smart phone mounted in selfie stick (b) sample captured image.

2.2 Image Resize

Around 50 number of images are collected on 29 April 2019 in between 9AM to 3PM with smart phone of 12-megapixel camera mounted in selfie stick. All images transformed to a size of 250x250 pixel for further processing.

2.3 Median Filtering

The sample images collected in the month of April 2019 from paddy field. The image contain glare due to water logging in the paddy field. To eliminate the glare from the image, median filter is use.

2.4 Segmentation

Here k-means clustering is used for segmentation. Here k- value is 3 to extract the RBPH only from the back ground and fore ground. So three clusters are form i.e. cluster1 contain background, cluster2 contain foreground and cluster3 contain the RBPH. The flow chart of K-means clustering is illustrated in figure 3.

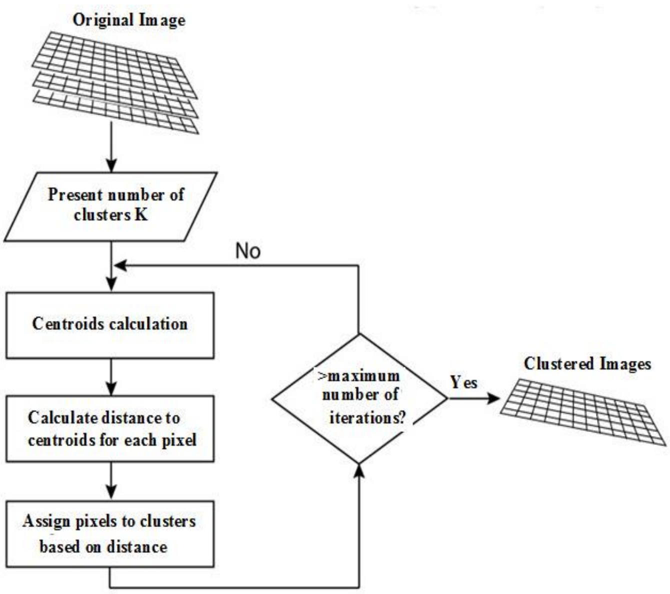
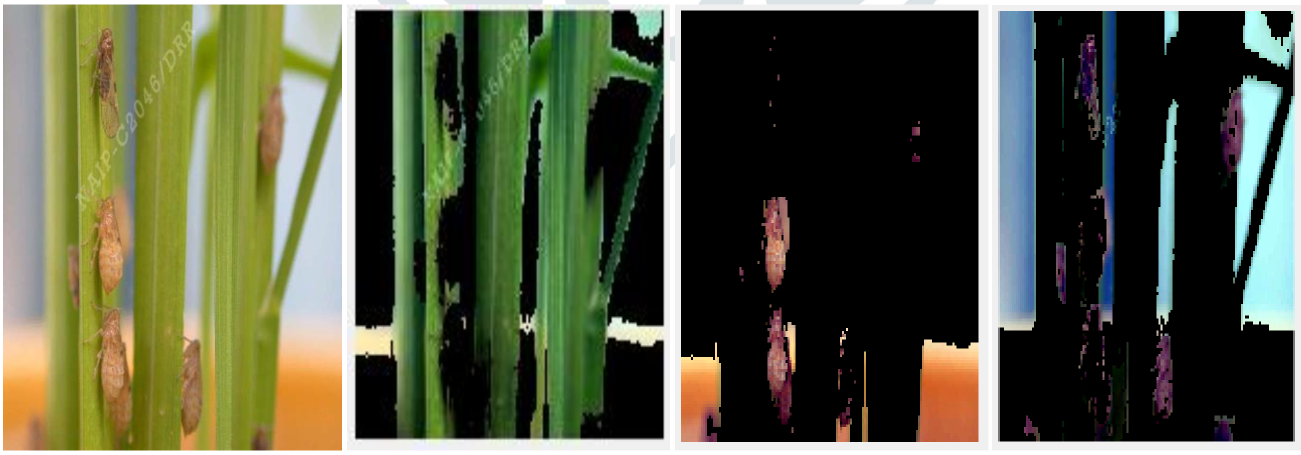


Fig. 3. K-means Clustering Algorithm.

2.5 Quantification of RBPH

After segmentation, the area of infested RBPH on rice plant and the total captured image is calculated. Then a population density is determined, which is the ratio of infested RBPH area and the total area. If the RBPH population density is less than 20% it is mild infested, within 20% to 50% is moderate infested and above 50% severely infested.

3. RESULTS AND DISCUSSION

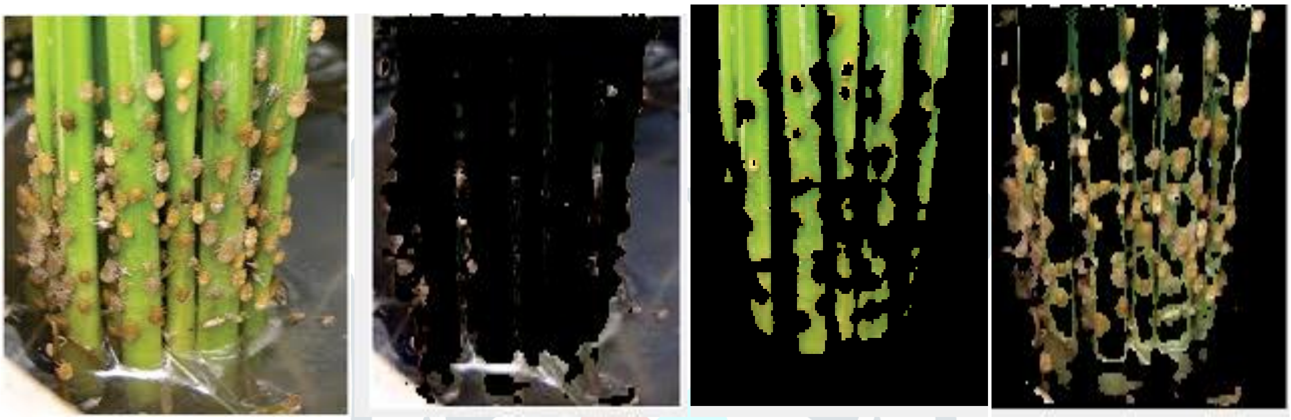


(a) (b) (c) (d)

Fig.4. Mild infested by RBPH (a)original image(b)cluster1(c)cluster2(d)cluster3

(a) (b) (c) (d)

Fig.5. moderate infested by RBPH (a)original image(b)cluster1(c)cluster2(d)cluster3



(a) (b) (c) (d)

Fig.6. Severely infested by RBPH (a)original image(b)cluster1(c)cluster2(d)cluster3

The proposed methodology is examined using three Varity images i.e. mild infested, moderate infested and severely infested. In fig.4 (a) is original image collected from internet, then (b), (c), (d) are the three clustered image of original one. The RBPH region is shown in fig.4(c) and result show it is mild infested by RBPH. Then fig.5 is the sample of moderately infested collected by using smartphone camera from paddy field. Fig.5 (a) is the original image, (b),(c),(d) are the different cluster and cluster (b) shown the RBPH infested region and result also implies moderate infested by RBPH. Similarly, Fig. 6 is the sample of severely infested RBPH. Fig. 6(a) is the original image, (b), (c), (d) are the different cluster. Here cluster (d) shown the RBPH infested region and result implies severely infested by RBPH.

4. CONCLUSION

This paper describe a simple, reliable, economic and easy handling method to quantify the RBPH infestation. This developed application can be recommended to farmers in its android version with smartphone to aid them in controlling rice pest infestation. These will also help staff of Department of Agriculture to assist farmers once pests are quantified.

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