IDENTIFICATION OF NITROGEN STATUS IN *Brassica juncea* L. USING COLOR MOMENT, GLCM AND BACKPROPAGATION NEURAL NETWORK

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Abstract

Vegetables cultivation using hydroponic is becoming popular now days because of its irrigation and fertilizer efficiency. One type of vegetable which can be cultivated using hydroponic is green mustard (*Brassica juncea* L.) tosan variety. This vegetable is harvested in the vegetative phase, approximately aged of 30 days after planting. In addition, during the vegetative phase, this plant requires more nitrogen for growth of vegetative organs. The lack of nitrogen will lead to slow growth and the leaves turn yellow. In this study, non-destructive technology was developed to identify nitrogen status through the image of green mustard leaf by using digital image processing and artificial neural network. The image processing method used was the color moment for color feature extraction, gray level co-occurrence matrix (GLCM) for texture feature extraction and back propagation neural network to identify nitrogen status from the image of leaf. The input image data resulted from acquisition process was RGB color image which was converted to HSV. Prior to the color and texture feature extraction and texture, acquisition image was segmented and cropped to get the leaf image only. Next Step was to conduct training using back propagation neural network with two hidden layer combinations, 20,000 iteration epoch. Accuracy of the test results using those methods was 97.82%. The result indicates those three methods is reliable to identify nitrogen status in the leaf of green mustard.

Keywords: nitrogen, image processing, back propagation Neural Network.

Introduction

Green mustard plant (*Brassica juncea* L) Tosakan variety is a commodity that has commercial value and favored in Indonesian society. Green mustard can be planted in hydroponic or non hydroponic, hydroponic is a plant growing method using controlled mineral nutrient solution without soil (Lingga, 1999). Nitrogen nutrient is a major nutrient that green mustard need especially in the vegetative phase. Green mustard that lack of Nitrogen, the leaf will turn yellow because lack of chlorophyll, so leaf color and texture can be indicator of plant nitrogen status especially nitrogen. Nitrogen nutrient status can be measured using chemical test, SPAD meter and leaf color chart, but chemical test method takes too much time, leaf color chart method is not accurate enough and subjective depending on observer's eyes, SPAD meter is hard to use because to measure leaf sample using SPAD meter, it is need at least 5 times to find the average value (Auearunyawat, P et al.2012).

The purposes of this study is to develop system for identifying Nitrogen nutrient on green mustard (*Brassica juncea* L.) Tosakan variety use image processing and artificial neural network that captured using conventional digital camera. By using vision technology, Nitrogen

identification will not requiring direct contact to plant leaf and nondestructively, so will minimize error caused by human visual subjectivity.

Materials and Methods

Materials

This research was conducted using 249 green mustard (*Brassica juncea* L.) Tosakan variety. The source of Nitrogen nutrient in this research was ZA fertilizer. The dosage of ZA varied from 0, 1, 2, 3 grams mix in one liter of water. Image acquisition was conducted at green house, to capture leaf images aged 15 days after planting.

Figure 1. Algorithm flow chart

Image Acquisition

Green mustard (*Brassica juncea* L) Tosakan variety images were acquired using *Canon Digital Camera PowerShot A1200*. The images were obtained with 4000 x 3000 pixels and saved using the Joint Pictures Expert Group (JPEG) format. No flash light was used in capturing proses. All photographs were taken using dark box, with 5 watt 6500 K cool day light lamp, in order to ensure the same light condition for image acquisition (figure 2).

Figure 2. Image Acquisition box for Green mustard leaves

Pre-processing

The captured images were resize to 800 x 600 pixels to speed up the computation process. The segmentation process were obtained using modified excess green (MExg) of RGB color channel (Woebbecke et al., 1995) then continued using Otsu thresholding, Opening morphology, RLE labeling and bounding box to crop the leaf part.

Figure 3. Image obtained before and after pre-processing

Color Moments Method

Color moments are effective because this method based on dominant feature from color probabilities distribution. Color moments are appropriate for color based image analysis, especially for image that contains plant leaf (Man, Q-K et al. 2008). The RGB images were converted into Hue Saturation Value (HSV), because Hue color based on human perception (Gonzales, 2002).

Figure 4. RGB and HSV leaf color

The three color moments can be defined as :

Mean :

Mean of Hue, Saturation and Value are calculated using following formula :

$$\mu_{H,S,V} = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N p_{ij}^c \dots\dots\dots (1)$$

Standard Deviation :

Standard deviation of Hue, Saturation and Value are calculated using following formula :

$$\sigma_{H,S,V} = \left[\frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (p_{ij}^c - \mu_c)^2 \right]^{1/2} \dots\dots\dots (2)$$

Skewness :

Skewness of Hue, Saturation and Value are calculated using following formula :

$$\theta_{H,S,V} = \left[\frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (p_{ij}^c - \mu_c)^3 \right]^{1/3} \dots\dots\dots (3)$$

HSV		RGB	
	Mean	Standar Deviasi	Skewness
H	0.20067	0.12125	-1.0289
S	0.434	0.28791	-0.52027
V	0.39481	0.25437	-0.61267

Figure 5. Result of Color moments extraction feature

GLCM Method

Texture feature extraction were obtained using GLCM (*Gray Level Co-occurrence Matrix*) from four directions (0°, 45°, 90°, dan 135°) with 1 pixel distance. The GLCM method is suitable for estimating image properties related to second-order statistic (Metre V, 2013). The five GLCM metode can be defined as :

$$Entropy = - \sum_i \sum_j P[i,j] \log P[i,j] \dots\dots\dots (4)$$

$$Energy = \sum_i \sum_j P^2[i, j] \dots\dots\dots (5)$$

$$Contrast = \sum_i \sum_j (i - j)^2 P[i, j] \dots\dots\dots (6)$$

$$Homogeneity = \sum_i \sum_j \frac{P[i, j]}{1 + [i - j]} \dots\dots\dots (7)$$

$$Correlation = \frac{\sum_{i=1}^L \sum_{j=1}^L (ij)(GLCM(i, j) - \mu_i \mu_j)}{\sigma_i \sigma_j} \dots\dots\dots (8)$$

Figure 6. Result of GLCM extraction feature

Backpropagation Neural Network Method

Backpropagation artificial neural network method was employed in this research. Inputs for backpropagation neural network were obtained from 29 features, 9 color moments features and 20 features of GLCM. The architecture of backpropagation neural network for training and testing were using 2 hidden layers combination. Training and testing were obtained using Matlab software.

Figure 7. Architecture of backpropagation neural network

The following parameter that used for the backpropagation training :

```
net.trainParam.epochs= 20000
net.trainParam.goal=0.000001
net.trainParam.lr=0.001;
net.trainParam.show=100
net.trainParam.mc=0.5
```

Results and discussion

Table 1 illustrate the result of Backpropagation neural network MSE and Accuracy using 2 hidden layers model with 40, 60, 80 and 100 neurons,

Table 1. Result of Backpropagation neural network testing

Hidden Layer	Neuron	MSE	Accuracy (%)
1	40	0,0000163	93,47
	60	0,0000105	90,21
	80	0,00000349	93,47
	100	0,0000339	85,86
2	40-20	0,00000235	97,82
	60-20	0,0000047	96,73
	80-20	0,00000211	93,47
	100-20	0,00000171	96,73

Figure 8 shows the performance accuracy of different neuron in 1 hidden layer. From the graph the best accuracy is using 40 and 80 neurons.

Figure 8. Accuracy from different neurons with 1 hidden layer

Figure 9 shows the performance accuracy of different neuron in 2 hidden layer. From the graph the best accuracy is using 40-20 neurons

Figure 9. Accuracy from different neurons with 2 hidden layer

Next, from figure 10 shows the MSE result with different number of neurons in 1 hidden layer, the closest MSE to goal setting is 80 neurons.

Figure 10. MSE vs number of neuron in 1 hidden layer

the MSE result with different number of neurons in 2 hidden layer depicted in figure 11, the closest MSE to goal setting is 100-20 neurons

Figure 11. MSE vs number of neuron in 2 hidden layer

Conclusion

In conclusion, image processing and artificial neural network techniques can be utilized to identify Nitrogen nutrient content on green mustard (*Brassica juncea* L.) Tosakan variety. Result showed that the best configuration was using 29 features vector 2 hidden layers and 40-20 neurons since it obtain the highest accuracy percentage with 97,82%.

References

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