Identification Spectral Signature of Weed Species in Rice using Spectroradiometer Handheld Sensor

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Abstract. Productions of rice in Malaysia is less compared to other rice producers such as Thailand. One of the reasons is lack of management in weeds. Losses due to weeds must be solved in rice production system, they interfere with the activities involved in the field throughout crop growing period. The main problem in rice field is to detect the presence of weeds among the paddy plant. It is hard to detect from plain sight for weeds in the green field by farmers. This research developed a technique to detect and control the weeds in the rice field. Spectral signature of weeds was collected and stored in the mobile apps for weed management application. The spectral signature of weeds species is unique and has their own characteristics. It can be used as a reference on how to detect weeds in the rice field using remote sensing. In this study, the result outcomes are mainly targeting to help all the paddy farmers in Malaysia to increase their production numbers of paddy. In addition, paddy farmers will be introduced with much advance technique to spot on the weeds that have been infesting in their paddy field and can prepare with what strategy to control on different kind of weeds. Different weed species has different physiological characteristics and it requires different type of strategy to counter the growth in the paddy field. Every weed in the paddy field need to be recognized in order to plan a control strategy. By using only naked eyes of a human and the limited view through the side view of the paddy field contributes to the problem of recognizing type of weeds that infesting the area.

Keywords: Spectral signature, weed species, rice management

1. Introduction

Rice were hugely planted in northern and eastern side of Malaysia especially in Kedah and Kelantan. This is because that two states due to the availability of huge low and flat land. As Malaysia is a tropical country, rice can be cultivated throughout the year because the rainfall distribution is high. Rice need a lot amount of water throughout its lifecycle.
Figure 1. Plant height and the timing of field hyperspectral (HS) measurements at different growth stages in a paddy field [1].

Figure 1 shows the Plant height and the timing of field hyperspectral (HS) measurements at different growth stages in a paddy field. Different varieties of rice may be having a different growth period. Generally, rice varieties will undergo three growth stages which are vegetative, reproductive and maturative. During vegetative period, rice will have active tillering process, plant height will increase gradually and the emergence of leaf at regular intervals. Reproductive period is where the culm elongation is evaluated while get declining in tiller number and the emergence of last leaf which is flag leaf. Maturative period is the ripening of colour and changes texture of the rice grain [1].

1.1 Weed in rice
A survey on weed diversity have been made in coastal rice fields of Seberang Perak in Peninsular Malaysia in 2013 [2]. A total of 40 different weed species including 22 were annuals and 18 perennials. Comprising 12 grasses, 10 sedges and 18 broadleaved weeds were recognized across the rice field [2].

1.2 Common weeds in rice field
Table 1 shows the common weeds in rice field, adaptation from the manual book “Buku Panduan Perosak Kada”. This manual book was written by Bahagian Industri Padi Lembaga Kemajuan Pertanian Kemubu (KADA) in 2011 [3].

| Weeds                  | Description                                                                                                                                 |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Saromacca grass        | An erect or ascending annual or perennial; up to 100 cm tall.                                                                                |
| (Ischaemum rugosum)    | Stem: often purplish, usually has hairs at nodes, cylindrical.                                                                              |
|                        | Leaf: blades 10–30 cm long, glabrous or with scattered hairs on both surfaces; compressed sheaths rather loose and green or purplish, with hairs on margins; ligule membranous and fused with auricles. |
Inflorescence: paired terminal spikes that are often strongly pressed against one another, thus appearing like a single spike. At maturity, it separates into two spike-like racemes. Spikelets paired, one is sessile, the other pedicelled; sessile spikelet yellowish green, up to 6 mm long, first glume prominently transversely wrinkled; awns spiral at base, dark colored.

| Lesser fimbristylis  
| (*Fimbristylis miliacea*) |
|---|
| Annual or perennial, without hairs, strongly tillering, with fibrous roots and up to 80–90 cm high. |
| Stem: slender, erect, densely tufted, compressed, and smooth; strongly angled at the top and flattened at the base; 20–70 cm tall. |
| Leaf: stiff and thread-like; on flowerless stems: in 2 rows and with flattened sheaths; no prominent midribs; on flowering stems: only linear leaf sheaths; basal leaves have overlapping leaf sheaths; ligule absent. |
| Inflorescence: 6–10 cm long, compound umbel with 6–50 spikelets; spikelets reddish brown, 2–4 mm long and either round or acute at apex. |
| Fruit: straw-colored or pale ivory nut, 0.2–0.3 mm long. |

| Red sparangletop  
| (*Leptochloa chinensis*) |
|---|
| A tufted and smooth annual or perennial; up to 120 cm tall. |
| Stem: slender, hollow, erect or ascending from a branching base, rooting at lower nodes, smooth and without hair, typically 10–20 nodes, and can reach as high as 50–100 cm. |
| Leaf: smooth, linear, 10–30 cm long; ligule an inconspicuous membrane 1–2 mm long and deeply divided into hairlike segments. |
| Inflorescence: narrowly ovate, loose panicle, main axis 10–40 cm long, and with many spike-like slender branches; racemes slender, each with two... |
rows of spikelets, spikelets 2−3.2 mm long, purplish or green and 4−6 flowered.

| Weedy rice (*Oryza sativa* L.) | A variable, erect, stout or slender annual rice with varying height and form. Stem: tufted, erect, hollow and slender or stout, smooth and hairless, 80−120 cm tall. Leaf: blade flat with parallel veins, 15−30 cm long; ligule and auricle present; ligule usually 10−20 mm long. Inflorescence: an erect or nodding loose panicle, spikelet about 7 mm long, flat, one-flowered, with or without awns of varying length. |
|---------------------------------|---------------------------------------------------------------------------------------------------|
| Jungle rice (*Echinochloa* spp.) | A tufted annual grass, up to 60 cm tall. Stem: reddish purple or green, ascending to erect, without hairs. Leaf: linear, 10−15 cm long, basal portion often tinged with red; ligule absent. Inflorescence: simple, ascending racemes, green to purple, about 5−15 cm long; spikelets subsessile 1−3 mm long. |

2. Methodology

2.1 Study Area
The study area was located at Ladang Merdeka, Kampung Lundang Paku, Ketereh, Kelantan. The area is a well-organized plot and the variety of the paddy seed was PadiU Putra. This is a new variety that is resistant to leaf blight disease discovered by UPM researchers [5]. The experimental period was conducted from January 2018 to May 2018.

2.2 Data collection
Hyperspectral reflectance data was collected using a FieldSpec® HandHeld 2 Spectroradiometer (Analytical Spectral Device Corporation (ASD), Inc., Boulder, CO, USA). The benefits of using FieldSpec® HandHeld 2 spectroradiometer is that it is cost effective, user friendly, versatile and durable [4,6]. It has a highly sensitive detector array with a low stray light grating, a built-in shutter, DriftLock dark current compensation and second-order filtering that produces a high signal-to-noise spectrum in under a second [6].
2.3 Data analysis
Pre-processing All the raw data were transferred into the computer using the USB cable. The data were saved in the Microsoft Excel. Then, the data were binned into 10 nm spectral band each compared to 1 nm originally [4]. This process is to eliminate the noise from the reflectance [4]. Spectral signature was visualized the spectral reflectance graph for each species using Microsoft Excel. Spectral reflectance were visualized graphically using Microsoft Excel.

3. Results and Discussion
Spectral reflectance profile for weed species is shown graphically for each type of weed. Basically, the spectral profile showed a low reflectance in visible region with small peak in the green region, an increase begins at 690 nm reaching the static line in the near-infrared region [3]. This is an ordinary green plant spectral reflectance. There is a huge difference in the percentage level of reflectance between weeds at certain wavelengths compared to the other wavelengths [3].

Species differences show up at specific wavelengths. In the visible spectrum (450 nm - 680 nm), all weed spectral signatures were very similar and many overlapped one another, while infrared region (680 nm – 990 nm) the spectra of different species separated from each other wavelengths [3]. Red sprangletop (*Leptochloa chinensis*) had the highest NIR reflectance compared to other weed species in the late season (Figure 2). The second highest reflectance was saromacca grass (*Ischaemum rugosum*) (Figure 3) and followed by Lesser fimbristylis (*Fimbristylis miliacea*) (Figure 4).

Figure 2. Spectral reflectance graph of Red spangletop (*Leptochloa chinensis*).
4. Conclusion
Detecting weeds visually in a large rice field area is hard and time consuming to farmers. In such a way, the application of spectral signature can assist us to detect weeds in easily. This research project proves that the spectral signature could be a potential use of modern technology to manage weeds in the field. The correlation between the spectral signature information and ground data can display the rate of weed infestation in the rice field. Other than that, methods of control can be determine through the unique spectral signature in order to assist the farmers on how to overcome the problems of weeds. The application of spectral signature allows the detection of weeds in the field in a shorter period instead of practicing conventional method that requires more time usage to make a thorough detection throughout the rice field. However, statistical analysis needs to be done to clarify and test the spectral reflectance. More research and analysis will be continued in the next season.
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