Identification of Major Weed Types in Broadcasted Paddy Fields Using Multispectral UAV Images

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Abstract: Identification of major weeds categorized into grasses, sedges, and broad-leaf weeds, in broadcasted paddy fields using multispectral images from unmanned aerial vehicles (UAVs) was tested at the Rice Research and Development Institute, Bathalagoda, Sri Lanka, for site-specific weed management. The results from the image analysis showed that multispectral UAV images captured at 30 feet (approx. 9.1 m) height can be used to identify the three weed categories in paddy fields after generating weed maps using Pix4Dfields® software with the modified Excess Green Index. However, the grasses [e.g. *Echinochloa crus- galli* (L.) Beauv] and sedges (e.g. *Cyperus iria* L) were difficult to be differentiated from each other even though broad leaf weeds [e.g. *Monochoria vaginalis* (Sw.) Willd] could be identified separately using the maps. Therefore, further research is recommended.

Keywords: Weed species, Rice varieties, Multispectral UAV Images, PIX – 4D Field software

I. INTRODUCTION

Rice is the staple food of Sri Lankans and rice production needs to grow on par with the growing demand to safeguard food security. Weeds are one of the troublesome biotic threats to rice productivity. Different weed species and their relative densities equally contribute to the decrease in rice yields at the field level. Weeds in lowland paddy fields are traditionally controlled by adjusting the stagnant water levels. In the paddy production system, the longer presence of the weeds has resulted in a greater reduction in crop yield. Therefore, weed control becomes an important part of rice cultivation. Understanding the potential damage to a crop by weeds during the growing season is fundamental to the effective management of the crop [1].

The most common method of controlling weeds today is the application of herbicides, but this method reveals the potential risks to consumers as well as the environment especially when misused. The development of herbicide resistance in weeds is a major issue with the long-term use of herbicides with the same mode of action, making this tool ineffective and costly. Therefore, an integrated approach combining management practices, scientific knowledge, and new technological interventions like UAV multispectral drone technology may enable to reduce cost, save time, and improve the efficiency of weed control in a complex weed community found in cultivated paddy lands [2]. Recent research has shown the potential use of vegetative indices to identify weeds in paddy fields using UAV images [4]. Further strengthening such weed identification techniques will enhance the precision of site-specific and species-specific weed management programs in the paddy fields. This study was conducted to test whether multispectral UAV images could be used effectively to differentiate grasses, sedges, and broad leaf weeds in broadcasted paddy fields using a modern software platform.

II. METHODOLOGY

Field Establishment of Crops and Weeds

The study location was the Rice Research and Development Institute (RRDI), at Batalegoda, Sri Lanka, situated in the Low Country Intermediate Zone and the agro-ecological region IL1b. Location coordinates are N 7’ 31’ 47’’ E 80’ 26’ 23’’. Land preparation was done according to the recommended practices by the Department of Agriculture (DOA) and the plots at a size of 18 m^2 was established with rice-only, weed-only, and rice + weeds. Two new improved 3.5 months varieties (At362 and Bg352), and a traditional variety (Pacchaperumal) were selected for the study. Three most prominent weed species in broadcasted paddy fields namely, a grass - *Echinochloa crusgalli* (L.) Beauv, sedge - *Cyperus iria* L. and broadleaf - *Monochoria vaginalis* (Sw.) Willd was used as the test weed species. Each plot was planted with one rice variety, one weed species, and one combination of rice variety + weed species. The fertilizer application was done according to the DOA recommendations. Weeds emerging in each plot, other than the species tested, were removed either manually or using herbicides based on their selectivity.

A. Image Analysis and Statistical Analysis

The DJI P4 Multispectral Agricultural Drone® with six special cameras was used to collect UAV images. The multispectral camera comprised 1 RGB camera and five cameras covering blue, green, red, red-edge, and near-infrared bands - all on a 3-axis, stable gimbal with a 2 MP global shutter. Multispectral drone images were obtained from the first week after sowing to the 14th week every other day. Images were obtained from three heights: 25 feet (7.6 m), 30 feet (9.1 m), and 40 feet (12.2 m). The NDVI and Modified Excess Green Index [4] were used to generate weed maps using Pix4Dfields® version 1.10.1, a commercial software that is used to analyze UAV images using vegetative indices (NDVI, Excess Green Index, etc.).

III. RESULTS AND DISCUSSION

The results showed that images captured from 9.1 m height showed a better visualization compared to that acquired from 7.6 m. Wind effect also disturbed the image quality if obtained from the drone flown at 7.6 m height. The image quality did not differ when the drone was flown at heights of 7.6 m or 12.2 m. The thermal view provided better visualization of rice plants (verified after ground truthing) in red colour and weeds were indicated in red-yellow colour (Figure 1). *Monochoria vaginalis* (broadleaf weed) could be differentiated from its shape and red-yellow colour (Figure 2). However, grasses and sedges were difficult to be differentiated from each other even though broad leaf weeds could be identified separately using the maps. Therefore, the vegetative index-based image analysis facilitated by FiX4D software is not adequate to produce precise weed maps.

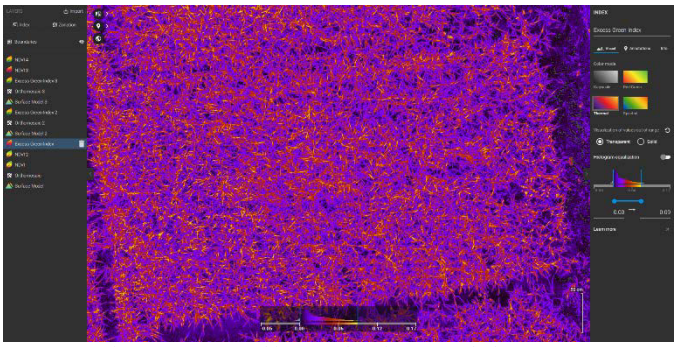

Figure 1: Processed image of a Rice + weed plot

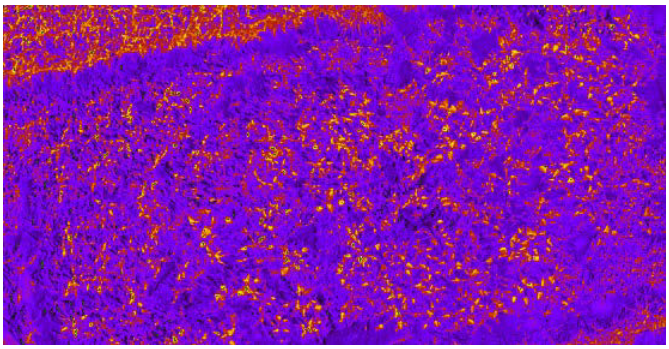

Figure 2: Processed image of Weed only plot: *Monochoria vaginalis*

IV. CONCLUSION

The use of UAVs can increase the sustainability of weed management by accurately identifying major weed types separately in the crop fields. The vegetative index-based image analysis using Fix4D commercial software was not adequate to map different weed species available in broadcasted paddy fields even though weed could be partially differentiated from rice. There is a need to have a software platform developed to suit local conditions that can be used for UAV image processing with a semantic segmentation-like deep learning approach to enhance the precision of weed identification in lowland paddy fields in Sri Lanka.

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