SEASONAL DYNAMIC CHANGE IN SPECTRUM OF TWO INVASIVE PLANTS IN TAIWAN: *MIKANIA MICRANTHA* AND *CHROMOLAENA ODORATA*

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Abstract: As an island country, Taiwan has unique ecosystem and abundant natural resources. However, invasive plants impact the forest ecosystem in Taiwan in both economy and biodiversity aspects. In order to assess the possibility of remote sensing monitoring for invasive herb species through utilising GER1500 ground handheld spectroradiometer, this research regularly measured the reflectance spectrum of *Mikania micrantha* and *Chromolaena odorata*. Seasonally dynamic variations of the reflectance spectrum were observed, and the plant phenological characteristics also were recorded. The observation period is 10 months, and the observation frequency is 2-3 weeks. Results indicated that the visible light reflectance rate of *Mikania micrantha* and *Chromolaena odorata* rises with fading; whereas the near-infrared light reflectance rate decreases with it. For *Mikania micrantha*, the lowest visible light reflectance rate happened in January, and the highest visible light reflectance rate was detected in February. The highest near-infrared light reflectance rate was detected in July. The reflection peak in green light is 553-554 nm. The absorption valley in red light is 670 nm. Red edge position (REP) was 718 nm regardless seasons, but would blue shift to 716 nm in February. As for *Chromolaena odorata*, February and March present the lowest visible and near-infrared light reflectance rate. December had the highest visible light reflectance rate. October had the highest near-infrared light reflectance rate. The reflection peak in green light is 551-553 nm. The absorption valley in red light is 667-674 nm. REP was 716-718 nm. However, it would blue shift to 700-701 nm from January to March, and would red shift to 718 nm in April. In this study, through intensive ground spectral observations, to establish detailed seasonal reflectance spectral characteristics, and it provides the reference for remote sensing mapping of invasive plants of *Mikania micrantha* and *Chromolaena odorata*.

INTRODUCTION

Taiwan has unique ecosystem and abundant natural resources. However, invasive plants impact the forest ecosystem in Taiwan in both economy and biodiversity aspects. Invasions can be facilitated by land-use change and other human activities (Vitousek et al. 1997; Hobbs, 2000). The *Mikania micrantha* and *Chromolaena odorat* are the most common herbal invasive plants in Taiwan. *Mikania micrantha and Chromolaena odorat* are widespread weeds in the tropics. *Mikania micrantha* grows very quickly and covers other plants. *Chromolaena odorat also* grows very quickly and soon replace by other plant species. Monitoring the distribution of invasive plants dynamic is very important.

Remote sensing can extract information about the land cover type. Using remote sensing technology to monitor the distribution of invasive plants is an efficient method. But, the phenology of different vegetation types are often similar, it affect the image classification accuracy of remote sensing image. If we can really grasp the seasonal dynamic of plant spectral, it is possible to substantially increase the ability to identify vegetation by remote sensing information (Cochrane, 2000; Dennison and Roberts, 2003; Armitage et al., 2004). Therefore, the ground spectral observation is the basic work of remote sensing.

METHODS

1. Ground spectral observation

In order to assess the possibility of remote sensing monitoring for invasive herb species through utilising GER1500 ground handheld spectroradiometer, this research regularly measured the reflectance spectrum of *Mikania micrantha* and *Chromolaena odorata*. Study plots of *Mikania micrantha* and *Chromolaena odorata* is in Pingtung County of Taiwan (**Figure 1).**

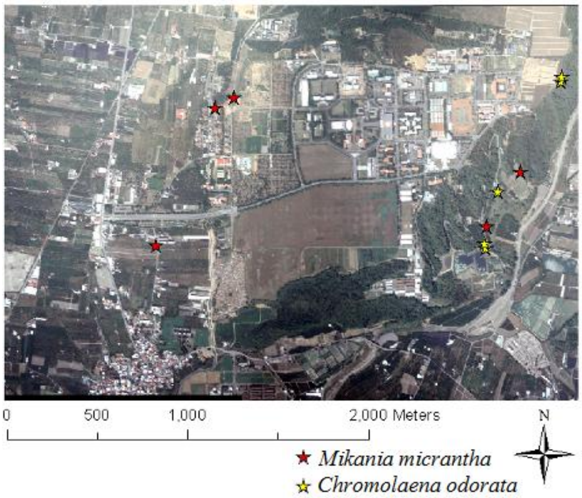

Figure 1: Study plots of *Mikania micrantha* and *Chromolaena odorata* in Pingtung County of Taiwan

Seasonally dynamic variations of the reflectance spectrum were observed, and the plant phenological characteristics also were recorded. The observation period is 10 months, and the observation frequency is 2-3 weeks. The total 17 times of observation date is in **Table 1**.

Table 1: The observation dates

Observation Times	Date
1	2010/07/08
2	2010/08/04
3	2010/08/24
4	2010/09/14
5	2010/09/28
6	2010/10/25
7	2010/11/16
8	2010/11/30
9	2010/12/14
10	2010/12/29
11	2011/01/17
12	2011/01/30
13	2011/02/16
14	2011/03/05
15	2011/03/20
16	2011/04/10
17	2011/04/28

2. Reflectance calculation

After spectral reflectance observation, the object reflectance was calculated by Equation 1.

$$R(\%) = \frac{rad}{irrad} \times 100\,\% \qquad (1)$$

R(%)=Reflectance
rad= Target Radiance
irrad= Incident Radiance

3. Reflectance data analysis
After reflectance calculation, we calculated average reflectance of the sample area, and it was the reflectivity of the current date. Subsequent to calculated the First Derivative Differential, in order to facilitate comparison of the two species in the leaf spectral reflectance difference. In order to understand the relationship between spectra reflectance and vegetation index, and the NDVI was calculated by Equation 2.

$$NDVI=(R_{NIR}-R_{Red})/(R_{NIR}+R_{Red}) \qquad (2)$$

NIR is Near-infrared reflectance.
Red is Red reflectance.

In this study, we also calculated Red Edge Slope (RES) and Red Edge Position (REP). The RES is the max reflectance value between 680~760 nm after First Derivative Differential calculation, and the REP is the corresponding wavelength of RES.

RESULTS AND DISCUSSION

1. Seasonal dynamics change in spectrum of *Mikania micrantha*
Results indicated that the visible light reflectance rate of *Mikania micrantha* rises with fading; whereas the near-infrared light reflectance rate decreases with it (see **Figure 2 and Figure 3**).

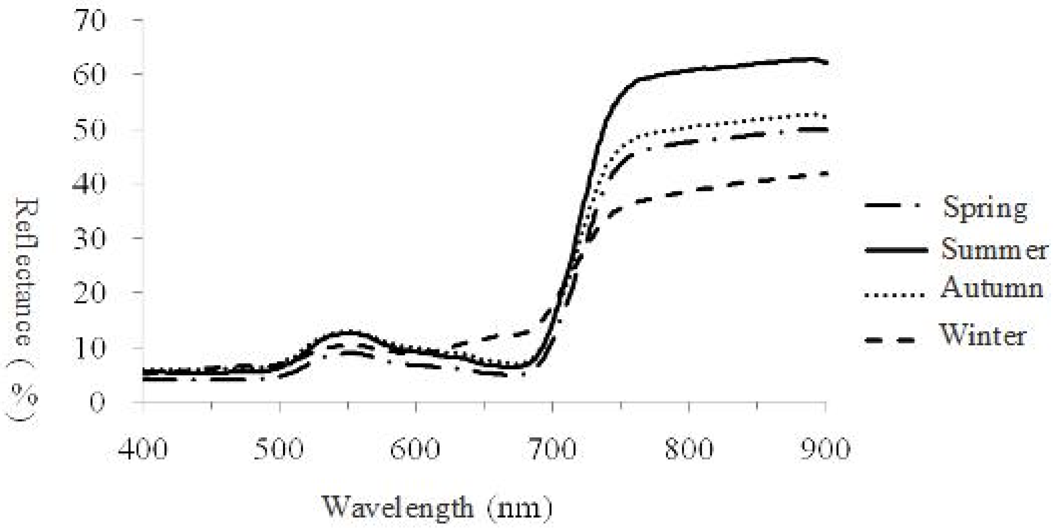

Figure 2: Seasonal dynamics change in spectrum of *Mikania micrantha*

Figure 3: Seasonal dynamics change of *Mikania micrantha*

For *Mikania micrantha*, the lowest visible light reflectance rate happened in January, and the highest visible light reflectance rate was detected in February. The highest near-infrared light reflectance rate was detected in July. The reflection peak in green light is 553-554 nm. The absorption valley in red light is 670 nm. Red edge position (REP) was 718 nm regardless seasons, but would blue shift to 716 nm in February (**Table 2**).

Table 2 The change of REP, RES, NDVI for *Mikania micrantha,*

Yeay	2010	2010	2010	2010	2010	2010	2011	2011	2011	2011
Mouths	7	8	9	10	11	12	1	2	3	4
REP (nm)	718	718	718	718	718	718	718	716	718	718
RES	1.346	1.266	1.156	0.962	0.822	0.649	0.486	0.307	0.930	1.014
NDVI	0.799	0.797	0.789	0.789	0.678	0.625	0.636	0.205	0.801	0.791

2. Seasonal dynamics change in spectrum of *Chromolaena odorata*

Results indicated that the visible light reflectance rate of *Chromolaena odorata* rises with fading; whereas the near-infrared light reflectance rate decreases with it(see **Figure 4 and Figure 5**)..

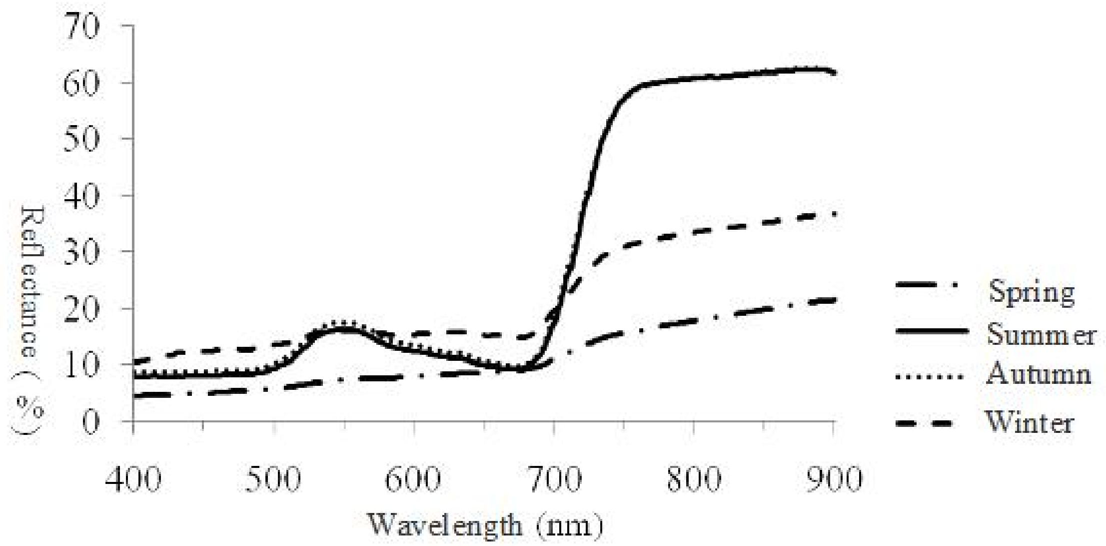

Figure 4: Seasonal dynamics change in spectrum of *Chromolaena odorata*

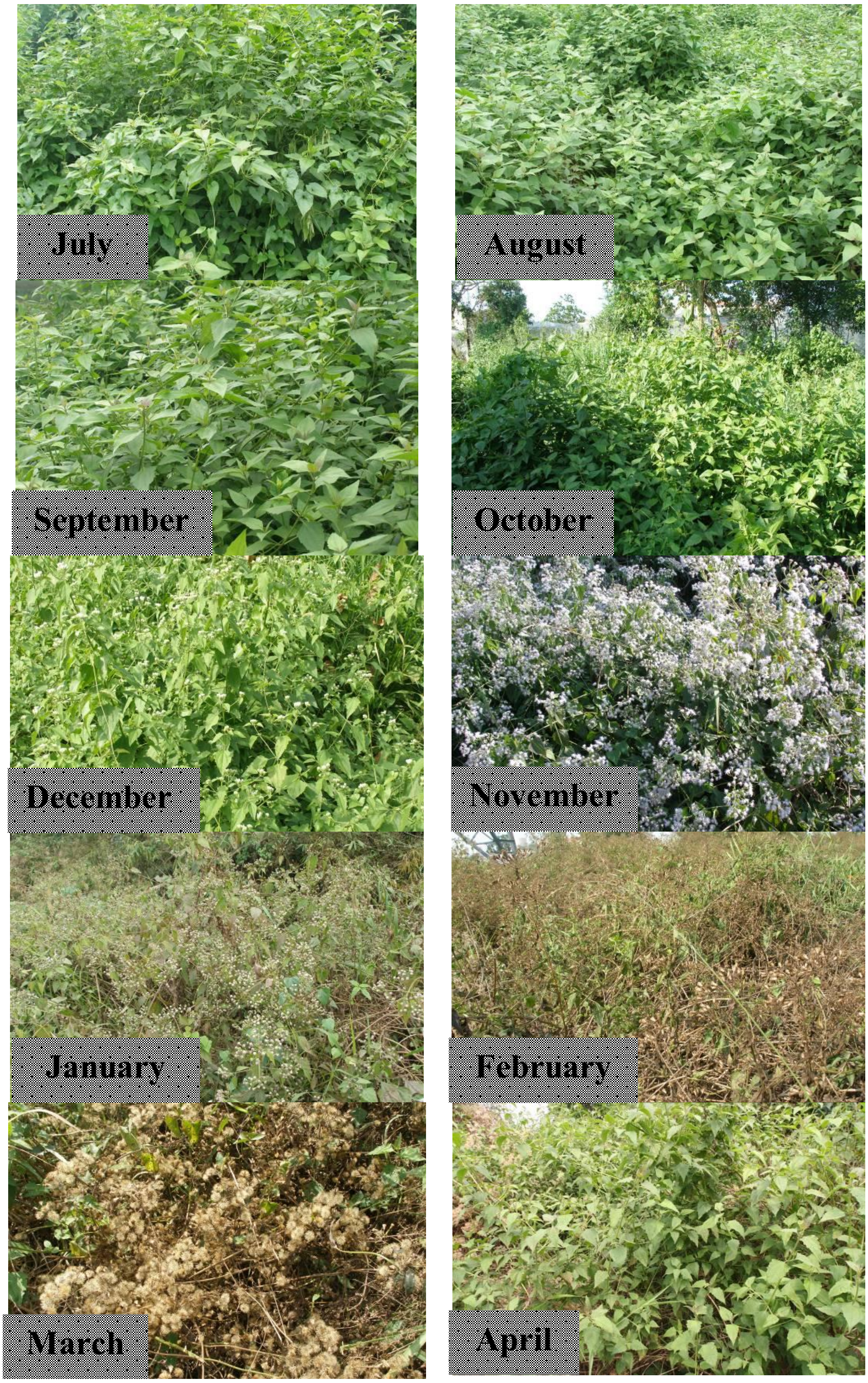

Figure 5: Seasonal dynamics change of *Chromolaena odorata*

As for *Chromolaena odorata*, February and March present the lowest visible and near-infrared light reflectance rate. December had the highest visible light reflectance rate. October had the highest near-infrared light reflectance rate. The reflection peak in green light is 551-553 nm. The absorption valley in red light is 667-674 nm. REP was 716-718 nm. However, it would blue shift to 700-701 nm from January to March, and would red shift to 718 nm in April (**Table 3**).

Table 3 The change of REP, RES, NDVI for *Chromolaena odorata*

Yeay	2010	2010	2010	2010	2010	2010	2011	2011	2011	2011
Mouths	7	8	9	10	11	12	1	2	3	4
REP (nm)	718	718	718	717	718	718	700	700	701	718
RES	1.147	1.283	1.155	1.185	1.145	0.546	0.267	0.142	0.132	0.798
NDVI	0.770	0.708	0.720	0.643	0.760	0.456	0.301	0.331	0.318	0.654

CONCLUSIONS & RECOMMENDATIONS

In this study, through intensive ground spectral observations, to establish detailed seasonal reflectance spectral characteristics, and it provides the reference for remote sensing mapping of invasive plants of *Mikania micrantha* and *Chromolaena odorata*.

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