行政院及所屬各機關出國報告

(出國類別: 其他(國際性研討會))

(出席第三屆歐洲精準農業會議並發表論文)

論文題目

ESTIMATION OF *DIGITARIA DECUMBENS* STENT. GROWTH FROM SPECTRAL CHARACTERISTICS AND VEGETATION INDEX

(利用光譜特徵及植被指數估測盤固草之生長)

服務機關: **行政院農業委員會**
農業試驗所

出國人　職稱: **副研究員**
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出國地區:**法國** Montpellier

出國期間:2001 **年** 06 **月** 16 **日至** 06 **月** 22 **日**

報告日期:2001 **年** 07 **月** 30 **日**

摘要

報告人經行政院農業委員會農業試驗所派遣及經費補助，出席於 2001 年 06 月 18-20 日在法國 Montpellier 市國際會議暨戲劇中心(LE CORUM Conference Center-Opera House)舉行之「第三屆歐洲精準農業會議 The 3rd European Conference on Precision Agriculture」並發表論文，口頭宣讀之論文名稱為"Estimation of *Digitaria decumbens* Stent. Growth from spectral characteristics and vegetation index"(附錄四)。本項國際會議係由位於法國 Montpellier 之國立農業專業研究所(AGRO Montpellier, Ecole Nationale Superieure Agronomique)和法國 ENITA de Bordeaux 機構邀集歐洲地區學者專家及業界共同籌辦，參與會議之國家達 29 個，註冊人數 294 人，景況熱烈。會議除了開幕式及大會安排專題演講之外, 計有 25 節口頭論文宣讀及 2 節壁報論文展示，出版之論文輯內包括八大主題計 162 篇論文。由於精準農業為二十一世紀農業生產體系的必然發展方向，報告人參與此一大型國際精準農業會議，將可以充分瞭解精準農業科技的國際發展現況及未來趨勢，會議心得亦將助益於協助調整與改進農業試驗所現行精準農業之研究與關鍵技術之研發。

關鍵詞: 盤固草、植被光譜、光譜特徵、生長、遙感探測

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ESTIMATION OF *DIGITARIA DECUMBENS* STENT. GROWTH FROM SPECTRAL CHARACTERISTICS AND VEGETATION INDEX

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一、目的

歐洲精準農業會議(European Conference on Precision Agriculture)為一項大型國際會議，每隔二年選擇不同歐洲國家舉辦一次，1997年第一屆會議地點設於英國 Warwick，1999 年第二屆會議地點設於丹麥 Odense，2001 年第三屆會議地點則位於法國 Montpellier。會議乃由歐洲地區各國家科學界人士籌辦，本(第三)屆係由位於法國 Montpellier 之國立農業專業研究所(AGRO Montpellier, Ecole Nationale Superieure Agronomique)和法國 ENITA de Bordeaux 機構邀集各國專家學者組成籌備委員會(參見附錄五)共同籌辦。會議目的旨在提供一個容納多元科學與技術領域的學術論壇，讓與會從事精準農業之學者、專家、研究人員、產業人士和農民等相互討論及交換意見、知識與經驗等，以促進精準農業相關科技之應用、研究與發展。

此類結合各相關學界與產業領域之綜合性會議，對於融合生物與技術專長、更新農業生產系統、及改進遙感探測、地理資訊系統、全球定位技術、感測計技術與先進農機具等助益甚大，並對提升精準農業體系之運作及有關領域之發展亦有正面而積極的促進作用。報告人參與此一會議之目的即在收集各種相關資訊作為改進現行試驗研究方向與內容之依據，同時瞭解精準農業科技的國際發展現況及未來趨勢，提供農業試驗所規劃與研擬未來研究重點之參考。

二、過程

報告人參加本項國際會議期間係自 2001 **年** 6 **月** 16 **日起至** 2001 **年** 6 **月** 22 **日止，主要行程及活動摘要如下列**:

日期	項次	行程及活動內容
2001/06/16	1	抵達法國巴黎
2001/06/17	1	抵達法國 Montpellier，會議地點所在城市
	2	前往會場辦理報到手續
2001/06/18	1	參加開幕式
	2	參加第一場大會專題演講
	3	參與主題一、二、三各項研討
	4	參觀第一節璧報論文展示
	5	參觀現場儀器設備展示及操作
2001/06/19	1	參加第二場大會專題演講
	2	參與主題二、三、四、八各項研討
	3	參觀第二節璧報論文展示
	4	參觀現場儀器設備展示及操作
2001/06/20	1	參加第三場大會專題演講
	2	參與主題五、六、七各項研討
2001/06/21	1	搭機返國，自 Montpellier 經巴黎至桃園中正機場
	2	返抵桃園中正機場

三、會議議程及主題

本次會議之議程如附錄一，計分成大會專題演講(plenary session)**、口頭論文宣讀**(parrallel session, oral presentation)**及壁報論文展示**(poster session)**等三大類別，後二類別融入於八項主題。**

本次會議之八項主題分別為: (1)**精準農業之作物與產量層面**(Crops and Yields Aspects in Precision Agriculture)**、**(2)**遙測技術在精準農業上之應用**(Application of Remote Sensing to Precision Agriculture)**、**(3)**精準農業之新工具與方法**(New Tools and Methods for Precision Agriculture)**、**(4)**變異率之管理-工具、方法與軟體**(Managing Variability-Tools, Methods and Software)**、** (5)**土壤與精準農業**(Soil and Precision Agriculture)**、** (6)**精準農業之運作與經濟層面**(Economical Aspects and Adoption of Precision Agriculture)**、** (7)**精準農業之雜草防除層面**(Weed Control Aspects of Precision Agriculture)**、及**(8)**氮素管理與精準農業**(Nitrogen Control and Precision Agriculture)**等。**

報告人參與"**遙測技術在精準農業上之應用**(Application of Remote Sensing to Precision Agriculture)"**主題之口頭論文宣讀**(2001 **年** 6 **月** 19 **日** 14:40-15:00)**，論文內容如附錄四。**

四、參加會議人員及論文篇數(論文輯)

第三屆歐洲精準農業會議(The third European Conference on Precision Agriculture)於 2001 年 06 月 18-20 日在法國 Montpellier 市國際會議暨戲劇中心(LE CORUM Conference Center-Opera House)舉行(參見附錄五)，會議採開放型式，計有來自世界二十九國的學者、專家、研究人員和產業界人士參加，盛況空前。經正式註冊報名者，統計有 294 人(參見附錄三)；其中，屬於歐洲地區者有 13 國 213 人，亞洲地區者 8 國 28 人，美洲地區者 3 國 42 人，大洋洲地區者 2 國 8 人，非洲地區者 2 國 3 人(附錄二)。

國內計有二篇論文參與此次大會之論文發表，除了報告人之外，另一篇由來自國家太空計畫室的 Dr. Chih-Li Chang 和成功大學測量系的 Dr. Yih-Hsing Tseng 共同署名，篇名為"Application of satellite images for automatic recognition of paddy fields in Taiwan"。惜此篇作者因故並未出席口頭論文宣讀。

本屆大會出版論文輯二卷(冊)，於會議當天發放。第一卷包括主題(三)精準農業之新工具與方法(New Tools and Methods for Precision Agriculture)24 篇、主題(二)遙測技術在精準農業上之應用(Application of Remote Sensing to Precision Agriculture)34 篇、及主題(五)土壤與精準農業(Soil and Precision Agriculture)27 篇，合計 85 篇。第二卷包括主題(六)精準農業之運作與經濟層面(Economical Aspects and Adoption of Precision Agriculture)11 篇、主題(七)精準農業之雜草防除層面(Weed Control Aspects of Precision Agriculture)9 篇、主題(四)變異率之管理-工具、方法與軟體(Managing Variability-Tools, Methods and Software)21 篇、主題(一)精準農業之作物與產量層面(Crops and Yields Aspects in Precision Agriculture)22 篇、及主題(八)氮素管理與精準農業(Nitrogen Control and Precision Agriculture)14 篇，合計 77 篇。總計二卷共 162 篇論文，970 頁篇幅。

五、心得

2001 年第三屆歐洲精準農業會議計有來自世界二十九國的學者、專家、研究人員和產業界人士共 294 人報名參加，本次會議分成(1)精準農業之作物與產量層面、(2)遙測技術在精準農業上之應用、(3)精準農業之新工具與方法、(4)變異率之管理-工具、方法與軟體、(5)土壤與精準農業、(6)精準農業之運作與經濟層面、(7)精準農業之雜草防除層面、及(8)氮素管理與精準農業等八大主題進行論文宣讀與研討，並有專題演講及壁報論文展示穿插其中。同時，產業界另展示精準農業有關之儀器設備及操作系統，提供研究人員和農民等參考、選購。

報告人在參與會議各項活動後，綜合各主題之主要重點如下列，這些重點反映目前及未來精準農業之研發方向，將可提供農業試驗所現行精準農業計畫執行團隊參考、引用。在主題(1)精準農業之作物與產量層面，主要重點有: (A)產量追蹤系統之研發與操作、(B)降低產量追蹤系統之產量估算誤差、(C)蛋白質感測器附掛於穀物收穫機上之研發、(D)利用產量追蹤系統估算產量及分佈變異、(E)土壤與作物(品種)種類對產量時空變異分佈之影響、(F)光輻射模式在精準農業上之應用、及(G)利用遙測資料調整植被覆蓋以獲取最佳產量等七項。

在主題(2)遙測技術在精準農業上之應用，主要重點有: (A)利用遙測技術於特定地點土壤資源套疊與管理、(B)利用遙測技術於土壤和農作物生育與農產品質變異追蹤及管理、(C)利用遙測技術於農作物生產管理以降低生產成本、(D)衛星與航空遙測在精準農業上之應用、(E)利用遙測資料製作農作物生育與產量變異分佈圖、(F)利用遙測追蹤與管理農作物病蟲害、(G)利用遙測資料辨識作物栽植密度及雜草混植、(H)以附掛於農機具上影像感測器估測稻株氮素含量、(I)估測牧草生質量之電子影像分析技術、(J)利用二維及三維數位資料辨別農作物與雜草、(K)果樹樹形與葉片分佈之自動擷取及分析系統、(L)利用植被光譜特徵估測農作物之生長、及(M)利用行植作物內葉片溫度變異之模擬提高水分使用效率等十三項。

在主題(3)精準農業之新工具與方法，主要重點有: (A)利用遙測影

像區分(辨識)農業生產區及農作物種類、(B)利用遙測影像進行農作物變異管理、(C)研發精確與有效的土壤調查技術以應用於精準農業、(D)多年產量資料之套疊與展示、(E)利用 GIS 及 GPS 於農田空間變異資料收集與管理、(F)利用農機具附掛之感測系統分析農田變異、(G)適用農業之商業型精準定位系統研發、(H)差分定位之曳引機及農機具研發、及(I)農業活動用自動機器人研發等九項。

在主題(4)變異率之管理-工具、方法與軟體，主要重點有: (A)精準農業資訊系統之研發、(B)以成本效益分析精準農之空間變異資料、(C)特定地點氮肥管理方法之研發與評估、(D)特定地點播種率決策系統之研發、(E)改進適用於精準農業之肥料施用機、(F)變異率肥料施用決策系統之研發、(G)土壤元素及作物空間變異之管理、(H)特定地點施用氮肥對農田氮素流失之模擬、及(I)綜合農田感測及遙測資料決定特定地點農藥施用等九項。

在主題(5)土壤與精準農業，主要重點有: (A)土壤特性變異分佈之瞭解、(B)利用土壤電導度分類農地、估測土壤含水量分佈之技術、研發附掛於農機上之土壤特性感測器、(C)研發土壤光譜儀(光電比色計)進行土壤特性即時偵測、(D)利用擴散性反射比光譜技術於土壤酸鹼值及石灰含量估測、(E)土壤緊密度分佈之偵測技術、(F)土質結構及土壤元素空間變異分佈、(G)利用土壤傳導度從事土壤特性調查、及(H)不同耕犛方式對土壤特性變異分佈及產量之影響等八項。

在主題(6)精準農業之運作與經濟層面，主要重點有: (A)農作物實施精準農耕之資源投入模擬與分析、(B)精準農業與環境經濟、(C)空間變異及天氣之環境與經濟效應、(D)利用產量回應模式決定最佳資源投入、(E)精準農業之經濟面評估(資源投入經濟效益)、(F)特定地點雜草管理之經濟與環境衝擊、(G)農家和操作者之特性影響精準農業運作及成效之分析、及(H)是否採行精準農業之經濟分析等八項。

在主題(7)精準農業之雜草防除層面，主要重點有: (A)雜草種類之分類技術、(B)利用高解析光譜區別作物與雜草、(C)農作物族群中雜草群落之辨識、(D)利用遙測影像區分作物與雜草、(E)農藥噴施機具之精準施用技術、及(F)農藥噴施機之即時感測及操作等六項。

在主題(8)**氮素管理與精準農業，主要重點有**： (A)**利用光譜特徵估測農作物植體氮素狀態、**(B)**利用即時感測施用氮素追肥、**(C)**利用葉率素螢光測計估測作物氮素狀態、**(D)**利用氮素感測施用氮肥對品質之影響**、(E)**土壤氮素空間之分佈及可供作物利用氮素之評估**、**及**(F)**評估氮素變異之限制因子等六項。**

六、建議

報告人參與此一國際性精準農業會議，不僅個人因此獲益匪淺，亦希望藉由本件出國報告對從事精準農業相關領域或工作之人員有所幫助。因為精準農業制度及精準農業體系乃二十一世紀的農業發展方向和願景，兼顧生產穩定、環境保護與生態維護，將可協助於改善農業結構與體質，改進農業生產與經營管理，並促使農業朝向高科技和高效能時代邁進。也唯有藉助精準農業的施行，才能開創臺灣農業的第二春，創造農業新風貌，達到農業永續經營終極目標。

由參與此一會議的國家和人員資料發現，全世界至少有 29 個國家進行精準農業有關研究發展，尤以歐洲地區 13 國最多，亞洲地區 9 國其次，再次為美洲 3 國、大洋洲 2 國及非洲 2 國。顯然的，精準農業風潮已擴展至全球，我國現在若不加強研究以求迎頭趕上，以提升農業競爭力，不久未來將遠遠落在其後而遭致淘汰命運。又就單一國家參與人數而言，地主國法國 66 人最多，其次為鄰近德國 55 人，再次為美國 35 人，接著為丹麥 20 人、西班牙 17 人、英國 13 人、瑞典 12 人、日本 10 人、比利時 9 人、義大利 8 人、澳洲 7 人、荷蘭 6 人、加拿大 5 人等，以上國家都是積極發展精準農業的科技大國。國內目前已由行政院農業委員會農業試驗所執行一項精準農業統籌性計畫，作為精準農業先驅性研究計畫，相信將可為我國在此一領域之研究奠定良好基礎，助益於未來更深入、更積極的研究發展。

為提昇國內研究人員之國際觀及宏遠視野，掌握國際研發現況及趨勢，建議政府有關部門應鼓勵具有潛力者參與類似大型國際會議。因為藉著聆聽大師級學者專家之演講，參加專題研討與觀摩，以及發表研究論文，將可大幅開拓專業視界、增進專業知識、並提高個人和國家學術知名度，對於個人或整體學術水準及研究品質的向上提升絕對具有正面作用。

附錄一: **大會議程**

Program for the 3rd European Conference on Precision Agriculture

The Corum, Montpellier, France

June 18-20, 2001

3ECPA						
		Pasteur	Joffre 1	Joffre A/B	Joffre C/D	Barthez
Monday 18 0930-1030	Plenary Session	Plenary				
1030-1100	Morning Break					
1100-1240	Parrallel Sessions 5		Crops and Yields Aspects in PA 1	Application of Remote Sensing to PA 1	New Tools and Methods for PA 1	
1240-1340	Lunch Break					
1340-1420	Poster Session					
1420-1600	Parrallel Sessions 5		Crops and Yields Aspects in PA 2	Application of Remote Sensing to PA 2	New Tools and Methods for PA 2	
1600-1630	Afternoon Break					
1630-1830	Parrallel Sessions 6		Crops and Yields Aspects in PA 3	Application of Remote Sensing to PA 3	New Tools and Methods for PA 3	
Tuesday 19 0830-0930	Plenary Session	Plenary				
0930-1030	Poster Session					
1030-1100						
1100-1300	Parrallel Sessions 6		Managing Variability-Tools, Mehtods and Software 1	Application of Remote Sensing to PA 4	New Tools and Methods for PA 4	
1300-1400	Lunch Break					
1400-1600	Parrallel Sessions 6		Managing Variability-Tools, Mehtods and Software 2	Application of Remote Sensing to PA 5	Nitrogen Control and PA 1	
1600-1630	Afternoon Break					
1630-1830	Parrallel Sessions 6		Managing Variability-Tools, Mehtods and Software 3	Application of Remote Sensing to PA 6	Nitrogen Control and PA 2	
Wednesday 20 0830-1030	Parrallel Sessions 6		Soil and PA 1	Weeds Control Aspects of PA 1		Adoption of PA 1
1030-1100	Morning Break					
1100-1230	Parrallel Sessions 6		Soil and PA 2	Weeds Control Aspects of PA 2		Adoption of PA 2
1230-1330	Plenary Session	Plenary				
1330-1430	Lunch Break					
1430-1600	Parrallel Sessions 6		Soil and PA 3			

附錄二: 參加會議之國家及人數

參加 2001 年第三屆歐洲精準農業會議之國家及人數

No.	Country	Participant
1	Australia	7
2	Belgium	9
3	Brazil	2
4	Cameroun	2
5	Canada	5
6	Czech Republic	5
7	China, Mainland	1
8	Denmark	20
9	Finland	2
10	France	66
11	Germany	55
12	Hongrie	1
13	Israel	2
14	Italy	8
15	Japan	10
16	La Reunion	1
17	Latvia	1
18	Moldavie	3
19	Netherlands	6
20	New Zealand	1
21	Norway	1
22	Poland	2
23	Republic Dem Congo	1
24	Slovenia	3
25	Spain	17
26	Sweden	12
27	Taiwan	2
27	United Kindom	13
29	United States	35
Total		294

附錄四: 論文

ESTIMATION OF *DIGITARIA DECUMBENS* STENT. GROWTH FROM SPECTRAL CHARACTERISTICS AND VEGETATION INDEX

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ABSTRACT

Field experiments were conducted to measure and analyze ground-based remotely sensed hyperspectral data of Pangola grass (*Digitaria decumbens* Stent.) during the growing seasons in 1999-2000. After cut of each growing season, reflectance spectrum was found changed with the growth of plants. The correlation intensity of spectral reflectance to growth traits varied in different wavelengths, and the wavelengths in the near-infrared region (740-1300 nm) mostly had positive correlation coefficients. Changes in the normalized difference vegetation index followed the trends of growth traits during the growing seasons. 15 major transition points were selected and grouped from the reflectance spectra as characteristic wavebands (CW) during the growing seasons. The simplified feature connecting the center wavelengths of characteristic wavebands may be considered as the spectral signature, which changed as the plants developed and differed in different growing seasons.

INTRODUCTION

Spectroradiometry is a technique commonly used in modern remote sensing for a wide range of industrial applications nowadays. In agriculture, the technique has been adopted to study canopy optical nature, to analyze canopy spectral characteristics, and to estimate growth status of crop plants (Su and Yang, 1999;Yang and Su, 1999). It can also be used to assess and monitor changes in temporal and spatial variations of a crop canopy under various environmental stresses (Clarke, 1977; Kanemasu *et al*., 1985; Yang and Su, 2000; Yang and Cheng, 2001). Such information may be linked to a determining system for decision-making, and to an agricultural machinery system for timely field operation.

Before the practical use in site-specific farming, it is necessary to fully understand the change of canopy spectral characteristics during plant growth. The mathematical relationships between spectral parameters and physical growth traits should be established and modeled, and the differences among different growing seasons and cultural practices should be clarified. The information is required to the development of application algorithm for improving of cultural management. This study was to measure and analyze changes in reflectance spectrum of Pangola grass from the near-ground measurements during the experimental periods, and to identify and model spectral characteristics in associated with growth.

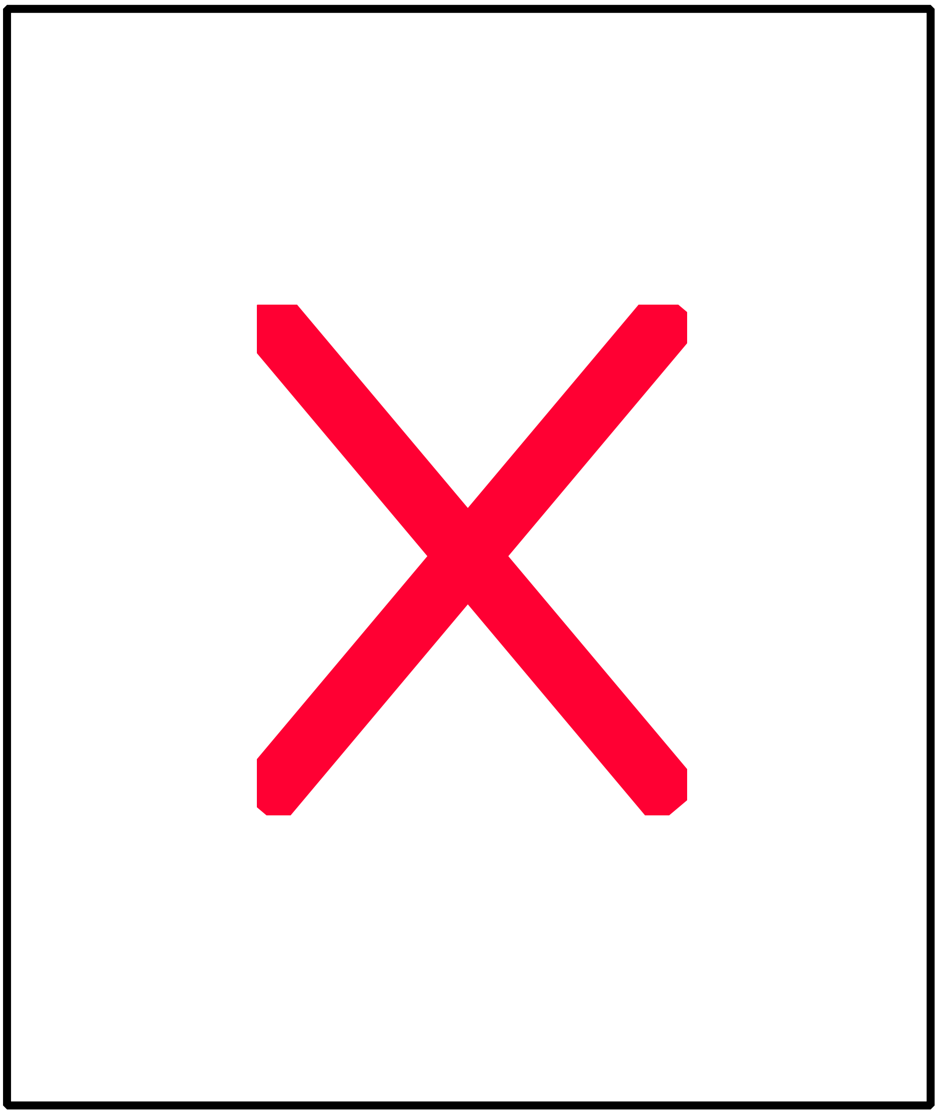
MATERIALS AND METHODS

Field experiments were conducted at both Hsinchu branch station (24º 45' N, 120º 54' E, elevation of 60 m) and Hsinhua headquarters (23º 3' N, 120º 19' N, elevation of 31 m) of TLRI in the growing seasons of 1999-2000 (Table 1). It was a 3-year-old Pangola grass (line-A254) pasture in Hsinchu, and was a 10-year-old pasture in Hsinhua. The soil was a sandy loam with pH of 5.1 and 4.8 for Hsinchu and Hsinhua, respectively. The experimental plots were divided into 4 square subplots, 5 m × 5 m of each at Hsinchu and 1.2 ha of each at Hsinhua. The fertilizers were applied as recommended. No pesticides were applied to the pasture and the experimental plots received no irrigation, except precipitation. Hand weeding was applied randomly to reduce weed interference.

TABLE 1. The growing seasons of Pangola grass (*Digitaria decumbens* Stent.) at Hsinchu branch station and Hsinhua headquarters of Taiwan Livestock Research Institute during the experimental periods in 1999-2000.

GROWING SEASON	**EXPERIMENTAL PERIOD**	
	HSINCHU	**HSINHUA**
SPRING	03/02/1999-05/18/1999	Not available
SUMMER	05/18/1999-07/21/1999	06/18/1999-09/08/1999
FALL	07/21/1999-09/14/1999	09/08/1999-12/22/1999
WINTER REMAIN	09/14/1999-03/17/2000	12/22/1999-03/06/2000
SPRING	03/17/2000-05/23/2000	03/06/2000-05/16/2000
SUMMER	05/23/2000-07/12/2000	05/16/2000-08/19/2000
FALL	07/12/2000-09/07/2000	08/19/2000-12/08/2000

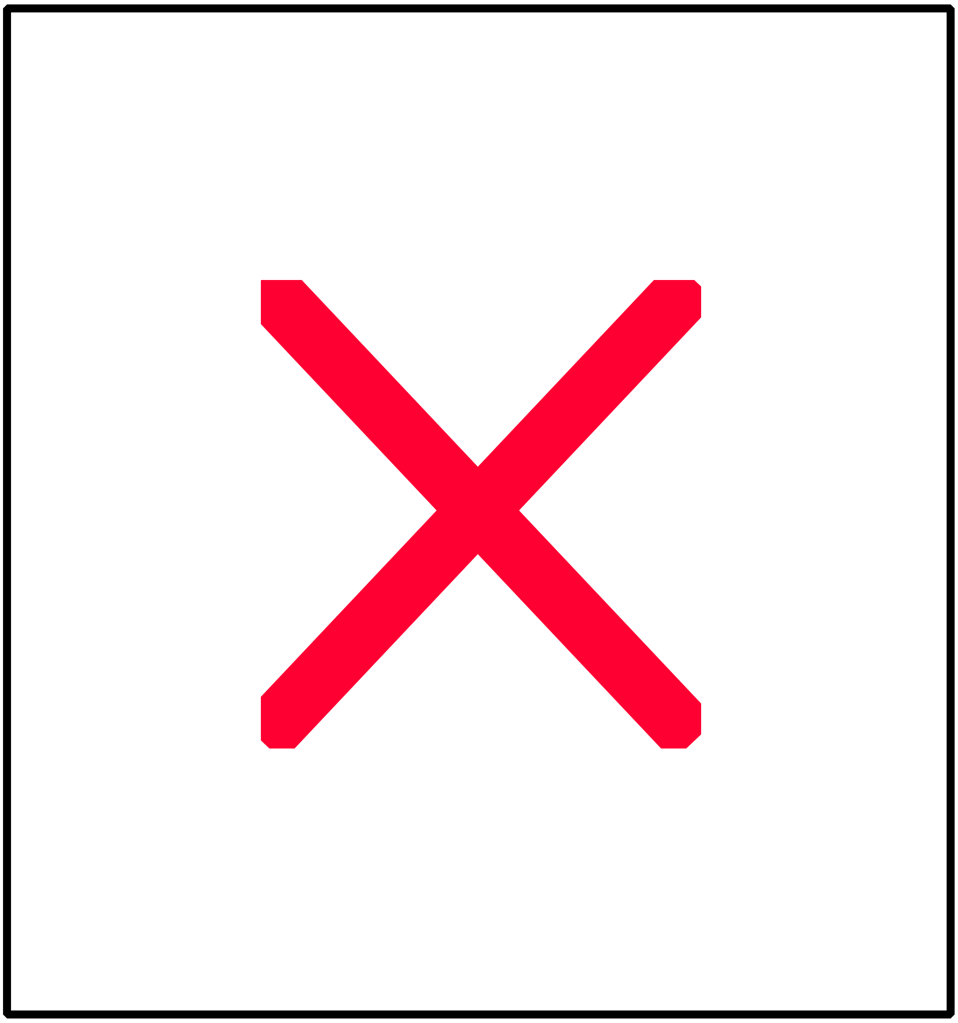
Reflectance spectrum was taken and monitored by a portable spectroradiometer (model GER-2600, Geophysical & Environmental Research Corp., New York, USA) periodically after cut. At least 12 spots of measurements per subplot were taken and each measurement was set as a mean of 3 individual full-range (350-2500 nm) spectral scans. The average reflectance spectrum was calculated from those of 12 measurements per subplot and the mean reflectance spectrum was resulted from 4 subplots. Reflectance spectrum was obtained by comparing radiance of the target vegetation to radiance of the reference.



Three approaches were employed to study spectral characteristics. Firstly, 15 wavelengths were determined from the first order differentiation in accord with the apparent peaks and valleys appeared in the mean reflectance spectrum. These wavelength intervals grouped from the experimental periods were named the characteristic wavebands (CW), and the bandwidths and the center wavelengths were calculated. The mean reflectance and standard deviation of the individual center wavelengths were also computed. The 2nd approach was to run the correlation intensity analyses of spectral reflectance to growth traits, and the wavelengths with the maximum correlation coefficient were acquired. Finally, correlation between the normalized difference vegetation index (NDVI) and growth trait was determined. The NDVI was calculated by the formula: (NIR-RED)/(NIR+RED), where NIR is the reflectance of the near infrared peak, and RED is the reflectance of the red light minimum.

RESULTS AND DISCUSSION

As shown in Fig.1 during the spring season of 1999, reflectance spectrum of Pangola grass vegetation changed as the plants developed. Reflectance spectrum was closely related to the external physical characters and the growing environment. There were 15 major transition points selected from the mean reflectance spectrum on each measuring days. These 15 wavelengths had different reflectance during the growth, and may be grouped as CW (Table 2). By connecting the center wavelengths of these CWs, the derived simplified feature may be considered as the spectral signature of the spring season (Fig.1). However, spectral signature was not constant among the growing seasons due to the environmental effects.



The correlation intensity curves of spectral reflectance to different growth traits in the range of 350-2500 nm, at both sites, were graphed in Fig.2. It showed that a variety of correlation coefficients exist along the spectral domain. The curves give a whole picture of the correlation profile for Pangola grass. At Hsinchu, most wavelengths in the visible (400-740 nm), shortwave infrared (1300-1800 nm) and middle infrared (1800-2500 nm) regions exhibited a negative correlation to growth traits, while wavelengths in the ultraviolet (350-400 nm) and near infrared (740-1300 nm) regions were mostly positively correlated. At Hsinhua, most wavelengths in the near infrared region had positive values of coefficients while wavelengths in other regions had negative coefficients. Wavelengths with the maximum correlation coefficients in various wavebands can also be identified from Fig.2.

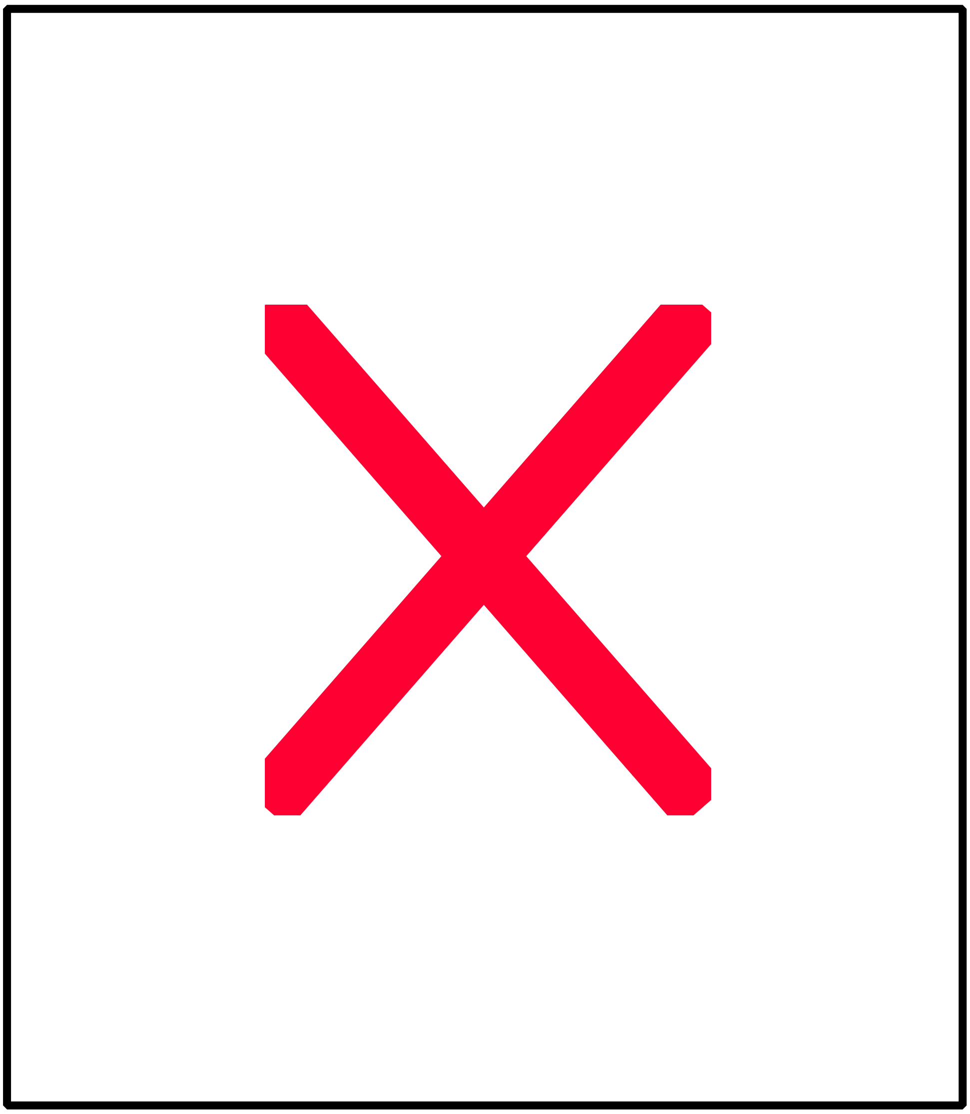
TABLE 2. Spectral characteristics of reflectance spectra in Pangola grass (*Digitaria decumbens* Stent.) grown at Hsinchu branch station of Taiwan Livestock Research Institute during the spring growing season of 1999.

CW	**BAND INTERVAL (nm)**	**BAND WIDTH (nm)**	**CENTER WAVELENGTH(nm)**	**MEAN REFLECTANCE(%)**	**S.D. (%)**
1	367- 409	42	388	2.8	0.5
2	550- 559	10	555	8.1	0.8
3	657- 666	9	662	5.4	2.7
4	882- 921	39	901	48.1	12.6
5	1177-1193	16	1185	35.9	4.8
6	1271-1286	15	1278	37.8	4.7
7	1377	0	1377	15.5	2.3
8	1391-1406	15	1399	19.3	2.0
9	1450	0	1450	13.2	3.4
10	1663-1677	14	1670	23.7	3.4
11	1784-1824	40	1804	20.2	3.9
12	1850	0	1850	22.9	4.3
13	1965	0	1965	5.6	5.2
14	2222	0	2222	12.8	4.3
15	2385-2465	80	2425	7.1	4.4

During the experimental periods from 1999-2000, changes of NDVI were similar to the trends of growth traits (plant height, aboveground fresh weight and dry weight) at both sites (data not shown), indicating a close relationship between the two variables. As the data from two sites were not significantly different by the t-test (data not shown), two groups of data were pooled for analysis. The relationships were found best fitted to an exponential function (Fig. 3). Changes of growth traits to NDVI can be estimated from the relationships.

CONCLUSION

As shown in this study, spectroradiometry is a feasible and effective technique for monitoring and characterizing changes of spectral property of crop vegetation. However, spectral measurements are found affected by not only pigment composition, cellular structure, canopy architecture and sun angle but also regional effects (climate, cultivation practice, etc.). With the normalization technique to establish the mathematical relationships between growth traits and NDVI, growth of Pangola grass may be estimated and monitored temporally and spatially.



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公務出國報告提要

頁數　　含附件:□是■否

報告名稱: **出席第三屆歐洲精準農業會議並發表論文**

主辦機關: **行政院農業委員會農業試驗所**

聯絡人: **楊純明**　　　　　**電話**: (04)2330-2301 **轉** 135

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出國類別: **其他**

出國地區: **法國**

出國期間: **民國** 90 **年** 06 **月** 16 **日** - **民國** 90 **年** 06 **月** 22 **日**

報告日期: **民國** 90 **年** 07 **月** 30 **日**

分類號/目: F1/**農技**(**耕作方法**)

關鍵詞: **盤固草、植被光譜、光譜特徵、生長、遙感探測**

內容摘要: **報告人經行政院農業委員會農業試驗所派遣及經費補助，出席於** 2001 **年** 06 **月** 18-20 **日在法國** Montpellier **市國際會議暨戲劇中心**(LE CORUM Conference Center-Opera House)**舉行之「第三屆歐洲精準農業會議** The 3rd European Conference on Precision Agriculture**」並發表論文，口頭宣讀之論文名稱為**“Estimation of *Digitaria decumbens* Stent. Growth from spectral characteristics and vegetation index”(**附錄四**)**。本項國際會議係由位於法國** Montpellier **之國立農業專業研究所**(AGRO Montpellier, Ecole Nationale Superieure Agronomique)**和法國** ENITA de Bordeaux **機構邀集歐洲地區學者專家及業界共同籌辦，參與會議之國家達** 29 **個，註冊人數** 294 **人，景況熱烈。會議除了開幕式及大會安排專題演講之外，計有** 25 **節口頭論文宣讀及** 2 **節壁報論文展示，出版之論文輯內包括** 162 **篇論文。由於精準農業為二十一世紀農業生產體系的必然發展方向，報告人參與此一大型國際精準農業會議，將可以充分瞭解精準農業科技的國際發展現況及未來趨勢，會議心得亦將助益於協助調整與改進農業試驗所現行精準農業之研究與關鍵技術之研發。**

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