REMOTE SENSING OF NITROGEN AND WATER STATUS ON BOSTON LETTUCE TRANSPLANTS IN A GREENHOUSE ENVIRONMENT

M. Tempesta and G.P. Gianquinto

Horticultural Science, University of Bologna, Faculty of Agriculture
Bologna, Italy

N. Tremblay*, P. Vigneault, M.Y. Bouroubi and M. Dorais

Horticultural R&D Center
Agriculture and Agri-Food Canada
St-Jean-sur-Richelieu, Quebec, Canada

INTRODUCTION

Remote sensing applied as a warning tool in plant stock production is expected to help in the achievement of more uniform and more productive greenhouse cropping systems. Remote sensing of vegetation targets can be achieved from their reflectance or fluorescence properties. Both approaches are based on indices that combine certain spectral bands known for the diagnostic information they provide on vegetation condition.

MATERIALS AND METHODS

In this study, the spectroradiometer FieldSpec® Pro (350-2500 nm), the fluorescence sensor Multiplex®, and the multispectral Camera MiniMCA® (450-850 nm) were used to analyze the nitrogen and water spatial variability of Boston lettuce transplants in a series of experiments conducted in growth cabinets or in a commercial greenhouse. For each experiment, lettuce transplants were provided by the participating grower about 25 days after sowing and were treated with two nitrogen levels. Prior to remote sensing assessment, they were let to dry for different times or watered differently in order to change their water status. Several vegetation indices were tested to statistically assess their relationships with nitrogen and water status.

RESULTS AND DISCUSSION

Indices were selected based on: 1) the significance of the F test on treatment effects; 2) the size of the F ratio; 3) the stability of the effects among sampling dates; 4) the absence of a N x water interaction and; 5) a high dynamic range of the index (amplitude).

The Multiplex parameters FLAV (flavonols) was found to be the best for discriminating N status while SFR-G or SFR-R (Simple Fluorescence Ratio under green (or red) excitation) were strongly significant for the water status (Table 1).

Table 1. Best Multiplex parameters for the determination of nitrogen or water status in a lettuce transplant crop

VI	Experiment #	Pr > F	F Value	Amplitude
	For nitrogen status			
FLAV	4	<0.0001	1021	71%
NBIG	4	<0.0001	643	62%
NBIR	4	<0.0001	555	63%
BRRFRF	4	<0.0001	522	61%
	For water status			
SFRG	2	< 0.0001	23	25%
SFRR	2	< 0.0001	21	24%

For nitrogen, the best FieldSpec Pro indices were: PSRI (Plant Senescence Reflectance index), DCNI (Double Peak Canopy Nitrogen index) ARI2 (Anthocyanin reflectance index 2), and NIR/R660. For water status: NDWI (Normalized Difference Water index), NPCI (Normalized Pigments Chlorophyll Ratio index), and NDLI (Normalized Difference Lignin index).

Table 2. Best MiniMCA parameters for the determination of nitrogen status in a lettuce transplant crop

VI	Experiment #	Pr > F	F Value	Amplitude
VI_{opt}	4	< 0.0001	101	46%
RDVI	4	< 0.0001	72	24%

The camera MiniMCA was used to produce a map of N crop status within a greenhouse with the optimal vegetation index (VI_{opt}). None of the indices tested with the MiniMCA was able to assess water spatial variability.

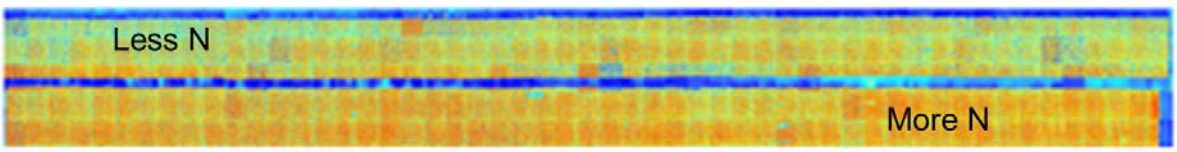

Figure 1. Mosaic image of the VI_{opt} index of a lettuce transplant crop in a greenhouse made with the MiniMCA multispectral camera. Colour gradation is related to differences in N status.