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Relationship between NDVI and Canopy Cover Sensed by Small UAV under Different Ground Resolution

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Introduction

Canopy Cover (CC) indicates the proportion of the ground area covered by green canopy.
It can describe the development crops, and estimate the evapotranspiration volume of crop leave within crop simulation models such as AquaCrop (Steduto P, et al., 2009). Previous studies have related CC to spectral indeices such as normalized difference vegetation index (NDVI), which usually increases as the canopy develops, reachinf a maximun when the canopy fully developed, and declines as the crop starts to defoliate.
Traditional remote sensing studies have shown the wide application of satellite imagary for monitoring crop CC using NDVI data.
In recent years, with the rapid development and popularity of unmanned aerail vehicles (UAVs), which can provide much higher spatial and temporal resolutions of the farming field than satellite, it become necessary to verify if the NDVI valueremains the same relationship with CC under high resolutions, to prove the interchangeability of UAV and satellite imagery of monitoring CC.

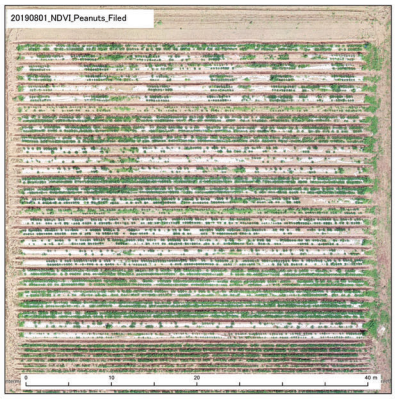

Photo.1 Orthomosaic of Peanuts Field (1st August, 2019)

Methodology

① Field Survey

Study Site:
Expirimental peanuts field in Obihiro University of Agriculture and Veterinary Medicine, Hokkaido, Japan
Survey date:
31th July to 1st August, 2019
Equipment:
Phantom 4 Pro (DJI) for RGB imagery
Inspire 1 (DJI) and Sequoia (Parrot) for multispectral imgaery
Flight Height:
50m (Phantom 4 pro),
30m (Inspire & Sequoia)
Overlap:
Top 80%, Side 80%

② Data Processing

A. Constructing orthomosaic and reflectance map (Pix4D mapper, Pix4D)
B. Calculating CC using a supervised image classification tool (ArcGIS Pro, Esri)

C. Calculation NDVI using the Raster Calculation tool
D. Dividing the study site into small grids with the size of 0.50 m, 1.0 m, 3.0 m, 5.0 m and 10 m (e.g. Ground Resolution)
E. Extracting NDVI and CC value from each size of grids
F. Regression analysis of NDVI and CC from each size of grids
G. ANOVA of NDVI, CC, and the ground resolution

Results & Discussion

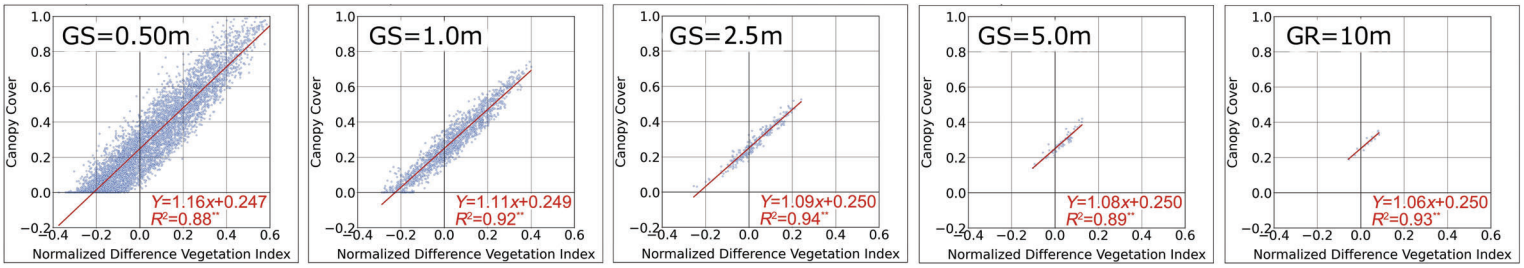

Fig.1 Relationship between NDVI and Canopy Cover under each grid size (GS)

NDVI showed highly correlated linear relationship (y=ax+b) with CC under each ground resolution from 0.10 m to 10 m. The shapes of the regression equations of NDVI and CC closely resembled to each other. Therefore, ANOVA (Analysis of covariance) was made with NDVI value as the explanatory variable, CC value as the objective variable, and ground resolution as the covariance.

As the result,
all 5 kinds of ground resolution has no significant effect on the fluctuation of CC, which means the ground resolution should be removed from the precdicting model. This result shows that CC could be predicted by NDVI with the quation of
Y=1.16x+0.248
However, because the amount of samples various between each kind of grid size,
The equation derived from the data of 10m GS was used to predict CC using NDVI. The RMSE of each grid size from 0.50 m to 10 m was 0.081, 0.089, 0.048, 0.025, 0.020, 0.014, respectively.

Table 1 Modal Parameters of ANCOVA

Factor	Regression coefficient	Standard deviation	t	$Pr > \|t\|$
Intercept	0.248	1.981	12.507	**<0.0001**
NDVI	1.16	0.469	246.767	**<0.0001**
Ground Resolution 0.5m	-0.003	1.983	-0.001	0.999
Ground Resolution 1m	-0.003	1.991	-0.002	0.999
Ground Resolution 3m	0.043	2.074	0.021	0.983
Ground Resolution 5m	-0.006	2.218	-0.003	0.998
Ground Resolution 10m	0.000	0.000		

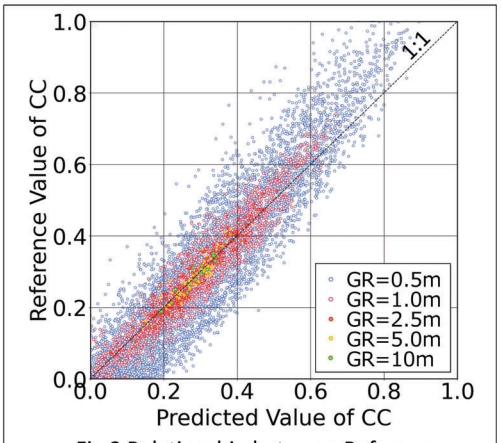

Fig.2 Relationship between Reference and Predicted Value of Canopy Cover

Conclusion

With the increasing of the ground resolution, despite of the inclusion of the irrelevant factors, such as soil and mulch sheets (plastic films used to modify soil temporature and prevent moisture loss), the value of NDVI and CC stays the same corrected and linear relationship. This result demonstrated the possibility of using UAV multispectral imagery for CC monitoring with the same regression equations as satellite multispectral imagery.

Reference
Steduto P, Hsiao T C, Raes D, et al. AquaCrop- The FAO crop model to simulate yield response to water: I. Concepts and underlying principles[J]. Agronomy Journal,2009,101(3):426-437.