## High Throughput Phenotyping Methods on Peanuts Fields

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Meeting the food demand for the growing population will require an increase in crop production despite of the changing climate and the increased risk of drought. Breeding programs are using new technologies based on genetics and phenotyping through marker assisted selection. The traditional methods to evaluate agronomic and morphological plant traits in the field are cost expensive and time consuming. During the last decade, the miniaturization of new performing sensors allowed a breakthrough the phenotyping bottleneck, by remotely trait estimation using vegetation indices. The objective of this study was to compare two high throughput field phenotyping methods, one using onboard multispectral camera on an unmanned aerial vehicle (UAV) and second one using handheld equipment at ground level. The handheld sensors, GreenSeeker crop sensor (Trimble Inc., USA) and SPAD-502 (Konica-Minolta Corp, Japan), are affordable, easy-to-use and quick measurement devices to assess the health and vigor of a crop (biomass, chlorophyll content). UAV flights were performed with a hexacopter UAV (FeHexaCopterV2, MikroKopter Company, Germany). The onboard multispectral Airphen camera (Hyphen, France) included six individual cameras equipped with filters centered on 450, 530, 560, 675, 730 and 850 nm, with a spectral resolution of 10 nm.
For this study we used a randomized complete block design with 4 blocks and 21 peanut varieties. The experiment was performed at two sites in Senegal (Bambey and Nioro).
The varieties were representative to the agronomic and morphological traits observed in west Africa. The results showed a significant association between the two methods. The normalized difference vegetation index (NDVI) measured by the GreenSeeker and the NDVI from the UAV camera presented an average correlation coefficient (r) around 0.8. We observed similar good relationships between the SPAD relative chlorophyll content and green normalized vegetation index (GNDVI). These relationships were less straightforward when the plants have not yet reached full plant cover (leaf area index (LAI) ≤ 1). This is probably due to the presence of weeds during the early growth stages.
Differences were observed in the implementation of these methods. For the use of the handheld sensors, one hour was necessary to phenotype the whole experiment. With the UAV a complete overview of the experiment took 10 minutes.
The strong technological advances of the last few years give the possibility of phenotyping populations at lower cost and in narrow time windows. The different methods are largely comparable. The choice of their use depends only on the objectives and the investment desired by the research teams.