Can Peanut Agronomic Characteristics Be Estimated from an UAV Platform?

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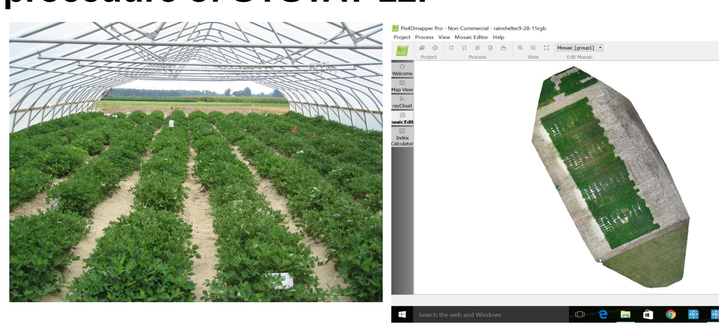
- **Peanut (*Arachis hypogaea* L.) is an important crop for Virginia and the US, but its current improvement through direct selection for yield, is slow. Breeding for targeted physiological indices was superior to breeding for yield alone (Nigam et al., 2005), but phenotyping for these indices is slow too. Low-level aerial imaging platforms can benefit modern field evaluations through alternatives to old evaluations.**

- **<u>The objective</u> was to assess the efficacy of RGB-derived indices from a UAV platform for estimating peanut yield.**

- **<u>Materials and methods</u> included peanut genotypes grown in 1.6 m^2 RCBD replicated plots under rainout shelters at Holland, VA, in 2015 and 2016. Soil moisture was maintained at 0.08 m^3m^{-3} water at 30 cm depth by irrigation for the drought regime. After shelters' removal, an octocopter UAV equipped with a Sony Alpha 6000 camera was used to collect red-green-blue (RGB) images in waypoint navigation at 10 m above the ground. Pix4D, ArcGIS, and Image J software were further used to derive Green Area (% pixels between 60°<Hue>120°) and Greener Area (% pixels 80°<Hue>120°) from the HSL color model. Ground-RGB, Normalized Difference Vegetation Index (NDVI), and Canopy Temperature Depression (CTD) were also assessed with a Samsung NX300 camera, handheld GreenSeeker and Agri-Therm IR thermometer. ANOVA, Tukey HSD, and regression were further used in GLM procedure of SYSTAT 12.**



- **Figure 1. Peanut plots exposed to drought (left) and the orthomosaic (right) after rain shelter removal and aerial imaging.**

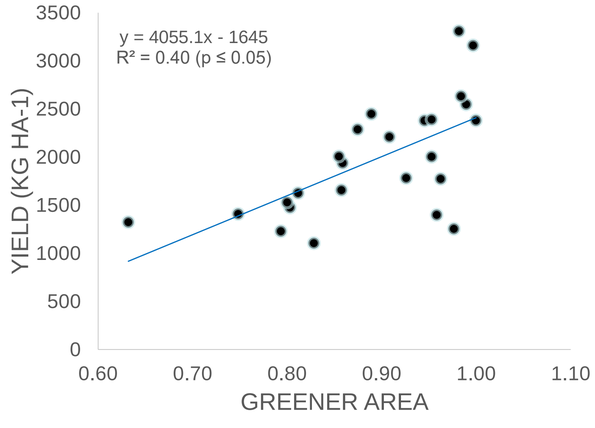
<u>Results</u> showed significant genotypic differences for yield under drought in both years (Table 1&2). These yields were well predicted by RGB indices taken from an UAV platform in 2015 and from the ground in 2016 (Figs 2&3). While UAV RGB indices were also taken in 2016, this data is under analysis.

Table 1. Pod yield of 26 genotypes under drought stress imposed by rainout shelters in 2015

Genotype	Pod yield (kg ha^{-1})	Genotype	Pod yield (kg ha^{-1})
GP-NC WS 17	3308 a	**Georgia-13M**	1938 c-f
08X09-3-14-1	3160 ab	**Sugg**	1782 c-f
07030-1-10-1	2631 a-c	**Florida-07**	1773 c-f
Tifrunner	2547 a-d	**Sullivan**	1656 c-f
Georgia-09B	2448 a-e	**N10046ol**	1625 c-f
Wynne	2390 a-e	**SPT 06-06**	1528 c-f
Bailey	2380 a-e	**N08082olJCT**	1475 c-f
N05006	2379 a-e	**Georgia Green**	1409 d-f
OLin	2294 a-e	**N04074FCT**	1398 d-f
07036-1-2-1	2287 a-f	**NM Valencia A**	1323 ef
TUFRun297	2209 a-f	**NC 3033**	1254 ef
Florunner	2006 b-f	**Georgia-06G**	1229 ef
C76-16	2003 b-f	**SSD 6**	1105 e
Mean			1982
P value			*0.039**

* Based on Tukey HSD at $p < 0.05$.

Figure 2. Relationship UAV-taken Greener Area and peanut yield under field induced drought stress in 2015.



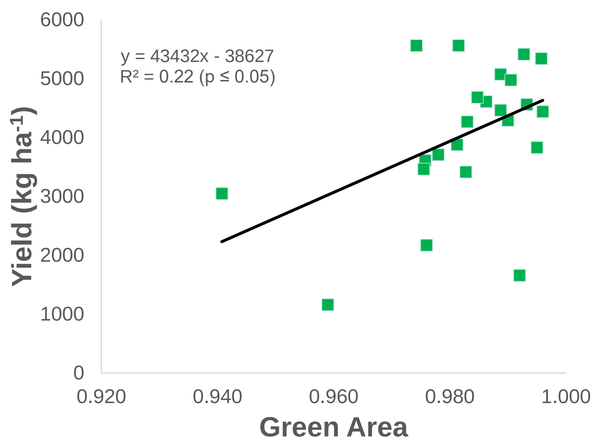
When yield was compared with ground-taken NDVI and CTD in 2015, correlation with yield was insignificant; R^2 was 0.17 for CTD and 0.01 for NDVI. Similar comparisons will be performed for the 2016 collected data.

Table 2. Pod yield of 23 genotypes under drought stress imposed by rainout shelters in 2016

Genotype	Pod yield (kg ha^{-1})	Genotype	Pod yield (kg ha^{-1})
C76-16	5562 a	**SPT06-06**	4269 a-d
TUFRun297	5562 a	**N08082ol**	3879 a-e
Sugg	5415 ab	**Wynne**	3830 a-e
Florunner	5342 ab	**Florida-07**	3708 a-e
GP-NC WS 17	5074 a-c	**N10046ol**	3610 b-e
Tifrunner	4976 a-c	**OLin**	3464 c-f
N05006	4684 a-d	**Bailey**	3415 c-f
Gaorgia-09B	4610 a-d	**NM Valencia A**	3049 d-f
FloRun107	4562 a-d	**NC3033**	2171 d-g
TUFRunner511	4464 a-d	**N04074FCT**	1659 fg
08X09-3-14-1	4440 a-d	**SSD6**	1161 g
Sullivan	4293 a-d		
Mean			4052
P value			*0.001**

* Based on Tukey HSD at $p < 0.05$.

Figure 3. Relationship of ground-taken Green Area and yield under field induced drought in 2016.



In this study, remote sensing from a UAV platform used less time than traditional field sensing with handheld NDVI and CTD devices; and RGB indices were better predictors of peanut yield than NDVI and CTD.

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References:

Nigam, S.N., S. Chandra, K. Rupa Sridevi, Mahonar Bhukta, A.G.S. Reddy, R. Nageswara Rao, G.S. Wright, P.V. Reddy, M.P. Deshmukh, R.K. Mathur, M.S. Basu, V. Vasundhara, P. Vindhiya Varman, and A.K. Nagda. 2005. Efficiency of physiological trait-based selection approaches for drought tolerance in groundnut. Annals Appl. Biol. 146:433-439.

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