Mississippi Corn Promotion Board
2018 Progress Report

Project Title: Evalution of In-Field Crop Sensors for Variable Rate Nitrogen Application and Yield Prediction in Corn — Year 2

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Project Summary (Issue/Response)

Unmanned aircraft system (UAS) mounted hyperspectral sensor and field sensors such as the GreenSeeker were used to collect normalized difference vegetation index (NDVI) which is indicator of greenness or vegetative index of corn. It is directly related to nitrogen and plays a key role in developing phenological stages (V6 and VT stages) of corn. It aids to make decision regarding the amount of fertilization that is needed for each phenological stages of corn. Georeferenced NDVI data were collected by UAS and field sensors from the 2 ac field located at 33.470 N and 88.763 W, North Farm at MSU for the second year. The field is divided to 16 blocks, in which every block includes 12 rows corn planted. There are 4 treatments in 4 different amounts of Nitrogen were applied at random and data were collected for two years to build the reliable algorithm for N application. In addition to spectral signatures for NDVI for near real time nitrogen applications; the leaf weight, SPAD readings and yield at 15.5% moisture content were also computed. A web based data processing tool has been initiated and will be fully developed for farmers'access. Data will be used to develop the algorithm to assist the farmer to make decision, whether they would need the third application of N at pre-tassel stage and use for VR application.

The UAS aerial images and statistical analysis (like ANOVA, min, max and mean of NDVI for each plot) would be accessible in this website: www.msstatecorn.ml/ABE. This website will be fully developed in order to assist the farmers to make a better decision in choosing N consumption level.

Project Results/Outcomes

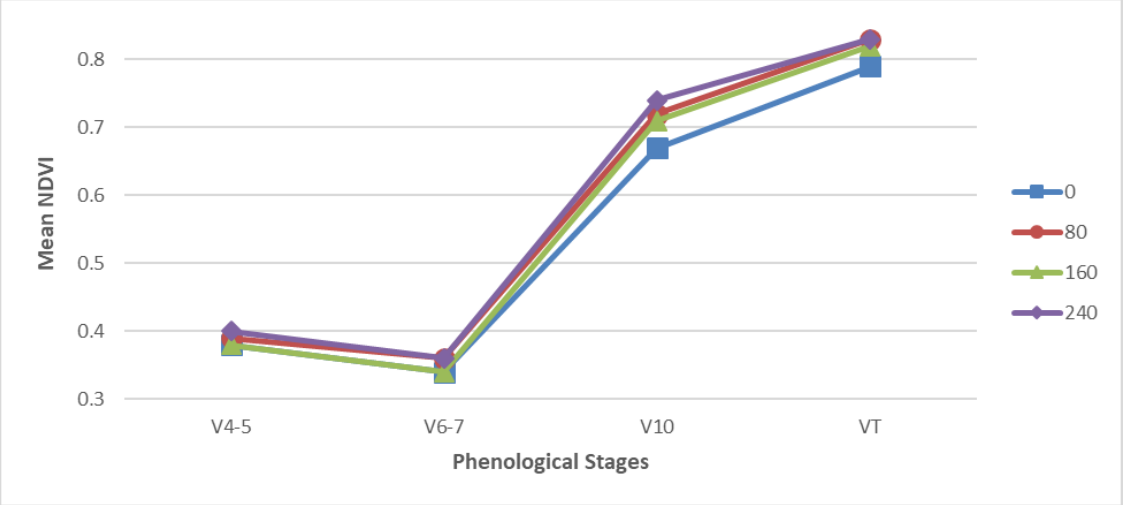
NDVI data were collected by the hyperspectral red edge band sensor mounted on the UAS that was flown at 200ft height at V4-5, V6-7, V10 and VT stages. Field sensor data were collected at ten random points for each plot (160 points for each phenological stage) by GreenSeeker from 2 to 4 ft above the corn (based on the device's manual). High precision hand-held GPS (Yuma2) was used to record geolocation of each point. Data were analyzed (such as georeferencing and reflectance correction of UAS images) using ANOVA and the significant relationship between different application rates including control in 4 different dates has been recorded. As it can be seen in table 1 and Figure 1, the mean NDVI extracted from aerial images, decreased at V6-7 stage as it was expected because the plants were growing rapidly and need to take high amount of N. In addition to spectral signatures for NDVI for near real time N applications, plant N%, leaf weight, SPAD readings and yield at 15.5% moisture content were also computed as shown in table 2. These results would be used for developing the algorithm in year-3. NDVI was increasing at V10 and VT, if the NDVI was similar in these stages, then applying fertilizer was not necessary, and if it was decreasing, we should apply based on that algorithm that will be developed. So, fertilization was not needed for this year. A developed web portal (www.msstatecorn.ml/ABE) will enable the farmers to upload the data and imagery and receive the processed data in useful format. A screen shot of the web portal is shown in figure 2. Data collection dates is selected from the left menu and then data analysis would be done automatically, and then results would be shown in the right side. The web based tool will be fully developed (in year 3) in order to assist the farmers to make a better decision in choosing N consumption level.

Project Results

Table 1- The mean NDVI of pixels for each treatment in different phenological stages.

lb. N/acre	V4-5	V6-7	V10	VT
0	0.38	0.34	0.67	0.79
80	0.39	0.36	0.72	0.83
160	0.38	0.34	0.71	0.82
240	0.4	0.36	0.74	0.83

Figure 1- The mean NDVI for each treatment in different phenological stages



Project Impacts/Benefits

The conventional N management practices for corn production can result in potential N fertilizer losses and have an impact on the environment along with economic loss. Applying excess N fertilizer than what is needed can cause potential problem of unused N being moved to groundwater or surface water bodies or lost to the atmosphere due to denitrification process. In recent years, various platforms of remote sensing have been used as a tool to develop N management strategies and improve N use efficiency (NUE). The active optical sensors include hand-held sensors and crop sensors mounted on tractor to assess corn N status and direct on-the-go variable rate in-season N applications. The UAS system has also been used as a successful platform for evaluating N variability in corn at different stages including pre-tassel so that proper N management can be implemented for maximum yield. The hyperspectral sensor and RGB camera mounted on UAS are becoming viable source of information for real time or near real time variable rate fertilization based on the data transfer and processing time. Initial results from previous studies as well as data from first two years have shown encouraging outcomes. Overall, this research would be able to provide information about the usefulness of UAS based remote sensing techniques for site specific N management in corn crop. The developed web based data processing tool will give the farmers an efficient platform for data management to make proper decision to apply N in one, two or three splits. Results of this work will be published in referred and extension journals, presented at conferences, grower meetings and field day tours and help farmers to know the suitable amount of N and necessity of applying fertilizer at pre-tassel stage by building algorithm.

Project Deliverables

Publication:

Pathak, R., Barzin, R., & Bora, G. C. (2018). Data-driven precision agricultural applications using field sensors and Unmanned Aerial Vehicle. *International Journal of Precision Agricultural Aviation*, *1*(1).

Bora, G. C. 2018. Digital and Data-Driven Precision Agricultural Applications Using Unmanned Aircraft Systems (UAS). Presented at NASA Academy of Aerospace Quality workshop at Glen Research Center, Cleveland, OH; September 07, 2018.

Web based data processing:

www.msstatecorn.ml/ABE

MISSISSIPPI STATE UNIVERSITY
MS AGRICULTURAL AND FORESTRY EXPERIMENT STATION

MISSISSIPPI STATE UNIVERSITY
EXTENSION

	V4-5			V5-6			V6-7			VT			
lb. N/ac	Whole plant N%	Whole plant Weigh t (g)	SPAD Chloro-phyll	Whole plant N%	Whole plant Weight (g)	SPAD Chloro-phyll	Leaf N%	Leaf Weigh t (g)	SPAD Chloro-phyll	Leaf N%	Leaf Weight (g)	SPAD Chloro-phyll	**Yield 15.5% bu/ac**
0	3.35	7.80	34.56	2.93	12.95	38.33	3.24	4.80	44.46	1.91	13.33	34.53	125.34
80	3.67	7.59	37.48	3.49	13.87	40.06	4.12	5.72	51.95	2.85	16.25	45.95	214.89
160	3.71	7.57	37.55	3.49	13.90	42.21	4.26	5.74	53.99	3.03	16.10	47.49	244.07
240	3.76	8.82	38.04	3.46	15.35	42.09	4.19	5.64	53.38	3.13	16.80	48.31	254.17

Table 2- Summary of average output for each treatment at different phenological stages gathering by UAS

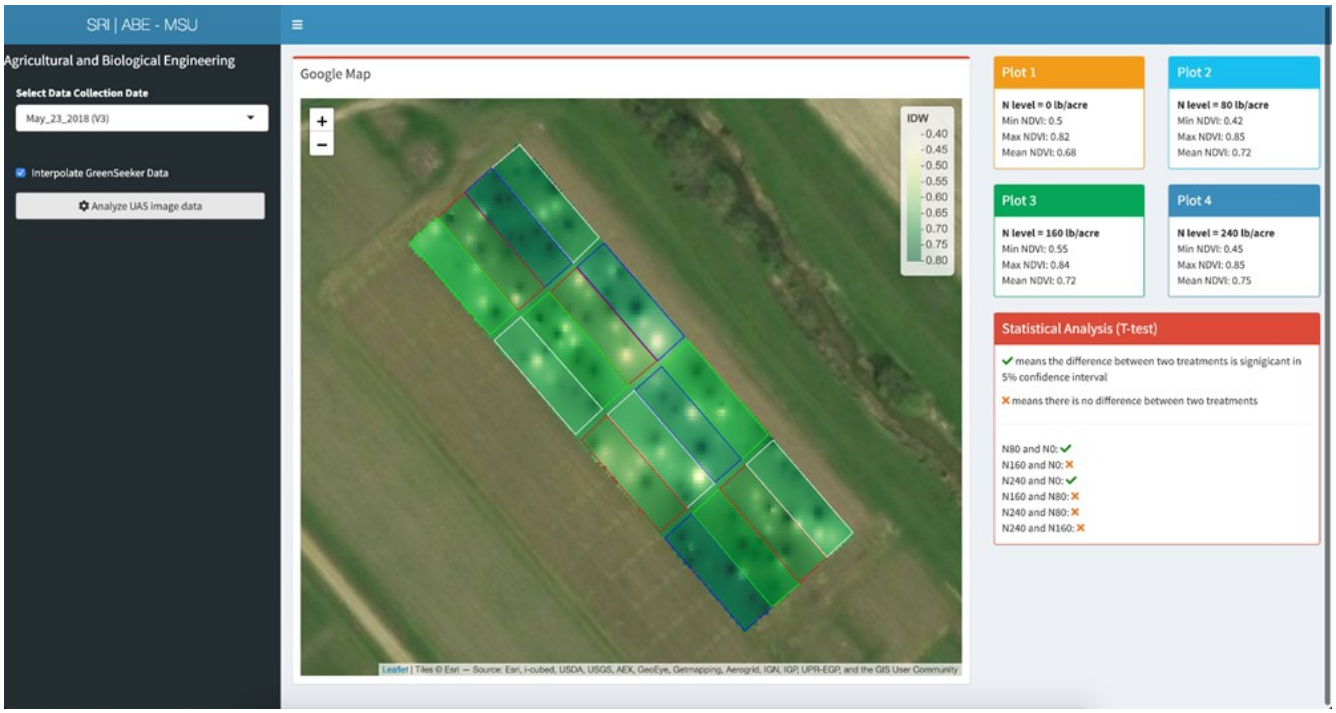


Figure 2: A screen shot of the web to show the data analysis