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Application of UAV in Organically Grown Einkorn

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Abstract Organic farming is an agricultural system that is a priority in EU Mitova (2014), it shows clear environmental advantages in terms of environmental toxicity and the use of biological resources (Nemecek et al. 2006). Cereals occupy a particularly important place in organic farming. They are the main arable crops from which baby and dietary foods are produced and are very in demand on both our and international markets (Atanasova et al. 2014).
Perhaps the most common alternative cereal is the einkorn, which has already found its place in organic farms and among consumers (Konvalina 2011). The einkorn is an alternative for farmers who can incorporate another crop into their crop rotation, which guarantees them stable yield in conditions of sharp climate change. Due to its advantages, the mezza is not only an extremely valuable plant, as a healthy product of high biological value, but its cultivation does not require the use of plant protection products and mineral fertilizers (Eisele & Korke, 1997).

Aim

The aim of the present study is to establish the possibility of using UAV data to track the dynamics of biomass accumulation during the cultivation of sedge in organic farming conditions, as well as the possibilities of forecasting yields.
The experiment was conducted on a certified biological field located in the municipality of Parvomay, Plovdiv district, south-central Bulgaria. The field was planted with einkorn in October 2020.

Study Area

Ground data and drone Unmanned Aerial Vehicle (UAV) footage were collected during the agricultural year 2020-2021 on a biologically certified field with an einkorn located in central southern Bulgaria in the land of Byala Reka village, Parvomai Municipality, Plovdiv region. The boundaries of the field are determined with the help of the farmer who grows the crop in Google Earth Pro.
The field was divided into three separate parts depending on the condition and development of the harvest at the end of March 2021, when the crop was en masse entered the fraternal phase (BBCH 29). The field status was established using the EOS Crop Monitoring platform, in which a KMZ field boundary file was uploaded and the Vegetation Index (VI) NDVI was generated, on the basis of which the field was divided into three separate parts with high NDVI values, those with average NDVI values and low NDVI values. In the selected three different parts of the field, 3 GPS points were generated in the EOS Crop Monitoring platform. On the field were established three squares with sides 10 m × 10 m in the corners of which were permanent twelve permanent sites markers marked with 12 GPS points.



Field sampling

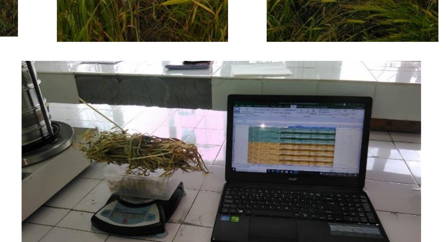
Ground data was collected in the spindle phases (BBCH 45) and milk maturity (BBCH 75), and biological yield was also taken into account when reaching technological maturity (BBCH 99). On the day of filming with UAV, all the lint plants and weed plants were counted in each of the 12 permanent test sites. All the limp plants and weeds were collected, measuring the fresh and dry biomass.
In May in phase spindle (BBCH 45) and June Milk Maturity (BBCH 75) UAV Wingtra (was used with multispectral camera Micasense and Sony RGB camera, The UAV capture data was processed with the Pix4D software. Vegetation indices EVI, MSAVI, NDVI, Chlorophyll Index Green and Chlorophyll Index RedEdge and other 29 VI were generated using the same software.







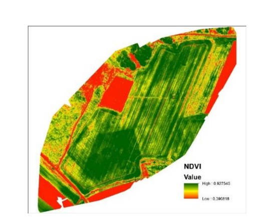


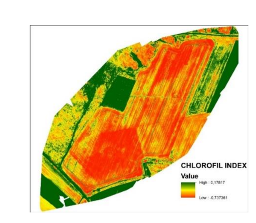
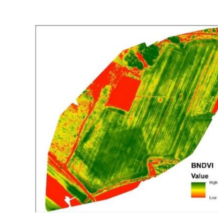
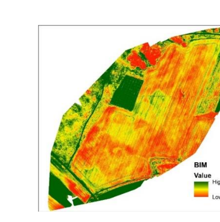



Drone data

In May and June 2021, the Wingtra unmanned aerial vehicle (UAV) was used with a Micasense multispectral camera and a Sony RGB camera, respectively to map the field. The data from the UAV acquisition were processed with the Pix4D software. The vegetation indices EVI, MSAVI, NDVI, Chlorophyll Index Green, and Chlorophyll Index RedEdge were generated with the help of the same software. The same vegetation indices were generated for Sentinel 2 using LandViewer (EOS).

Results

VI	Height of the plant	Class length	Number of plants per m	Number of grains in the class	Weight of grain of class	Weight of grain from a plant	Mass per 1000 grains	yield
CI	-0.337	-0.309	-0.319	0.038	-0.127	-0.161	-0.347	-0.654
chlorophyll_index_green	-0.684	-0.239	-0.680	-0.376	-0.391	-0.456	-0.387	**-0.848**
CIRE	0.289	0.164	0.333	0.064	0.066	0.135	0.138	0.643
CVI	-0.711	-0.139	-0.802	-0.519	-0.457	-0.497	-0.345	-0.580
DATT	-0.048	0.052	0.047	-0.161	-0.211	-0.149	-0.128	0.347
DVI	0.447	0.134	0.427	0.406	0.294	0.388	0.146	0.675
EVI	0.514	0.173	0.483	0.396	0.319	0.411	0.207	0.747
GCI	0.437	0.252	0.384	0.164	0.231	0.299	0.313	0.792
GLAI	0.666	0.251	0.668	0.357	0.376	0.442	0.385	**0.850**
GLI	0.709	0.217	0.719	0.444	0.419	0.489	0.367	**0.844**
GNDVI	0.475	0.250	0.399	0.180	0.242	0.309	0.305	0.797
GRVI	0.678	0.245	0.684	0.381	0.388	0.456	0.381	**0.852**
HI	0.653	0.251	0.636	0.312	0.360	0.420	0.397	**0.840**
hueoverallhueindex	-0.234	0.033	-0.341	-0.393	-0.203	-0.254	0.021	-0.165
MSAVI	0.503	0.161	0.478	0.411	0.319	0.413	0.192	0.733
NDRE	0.305	0.164	0.339	0.071	0.068	0.138	0.132	0.649
NDVI_RE	0.695	0.273	0.642	0.369	0.416	0.481	0.429	**0.887**
NDVI	0.621	0.246	0.578	0.301	0.337	0.404	0.359	**0.847**
NGRDI	0.678	0.245	0.684	0.381	0.388	0.456	0.381	**0.852**
OSAVI	0.587	0.199	0.537	0.395	0.349	0.436	0.265	**0.804**
RGBVI	0.722	0.194	0.729	0.467	0.432	0.501	0.360	**0.828**
RI	-0.592	-0.119	-0.520	-0.486	-0.393	-0.460	-0.205	-0.529
RSAVI	0.379	0.146	0.383	0.253	0.172	0.265	0.107	0.685
RVI	0.579	0.266	0.581	0.309	0.331	0.405	0.358	**0.861**
SAVI	0.526	0.167	0.486	0.410	0.328	0.420	0.205	0.744

VI	Height of the plant	Class length	Number of plants per m	Number of grains in the class	Weight of grain of class	Weight of grain from a plant	Mass per 1000 grains	yield
SCI	-0.678	-0.245	-0.684	-0.381	-0.388	-0.456	-0.381	**-0.852**
shpshapeindex	-0.381	-0.301	-0.336	0.025	-0.152	-0.184	-0.374	-0.682
SI	-0.352	-0.312	-0.329	0.029	-0.136	-0.171	-0.353	-0.660
TGI	0.431	-0.021	0.495	0.529	0.329	0.392	0.063	0.347
TVI	0.475	0.140	0.460	0.418	0.309	0.403	0.164	0.693
VARI	0.705	0.220	0.717	0.438	0.415	0.486	0.367	**0.844**
VVI	0.629	0.212	0.616	0.300	0.348	0.396	0.387	0.793
BSI	-0.470	-0.244	-0.432	-0.086	-0.220	-0.247	-0.371	-0.687
BNDVI	0.660	0.198	0.622	0.401	0.382	0.456	0.328	**0.846**
BIM	-0.496	-0.250	-0.475	-0.123	-0.242	-0.275	-0.382	-0.723

Conclusions

In conclusion, it can be said that in terms of indicators characterizing the state of sowing, it is appropriate to perform a filmed with UAV during the spindle phase, and not during the milk maturity phase, since during this phase much of the chlorophyll in plants has already been withdrawn and you cannot well characterize the state of the sowing.

In terms of yield and productivity elements, it is found that data obtained from the BDs during the milk maturity phase are more appropriate to characterize the elements of productivity and yield. Of all the BSI studied, only BSI was found to have a strong positive correlation with yield, and VARI was in a medium negative correlation with yield. During your milk maturity phase, which are in a strong correlation with yield are CVI, SCI and Chlorophyl index.

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