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Spectroscopic Characterization of Plant Cover in El-Fayoum Governorate, Egypt

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EL- FAYOUM region is the unique Egyptian western desert depression provided by surface Nile water. It's one of the global oldest agricultural provinces. Hyperspectral remote sensing plays an important role in assessing the biophysical characters of plant. The current investigation is one of the early attempts to study the hyperspectral characteristics of cultivated crops and wild plants in El-Fayoum Governorate. The work assists in understanding the status of the vegetation structure responding to water scarcity in the study area. Spectral reflectance of cultivated & wild plants was recorded ASD field spec spectroradiometer device and integrated with lab analyses using statistical analyses of SPSS and JMP Software. Optimal waveband and optimal wavelength were calculated by ANOVA and Tukey's analysis for discriminating of plants in the study area. Remotely sensed hyperspectral data were processed to produce spectral indices of plants to estimate the plant's vitality. Results indicated that Near Infrared (NIR) and Short Wave Infrared II (SWIR II) spectral regions were optimal to discriminate investigated taxa. In the Blue spectral zone no significant reflection was noticed. Spectral characteristics for the *Mangifera indica* (infected plant) indicated water stress. Spectral Reflectance analysis for *Ablmoschus esculentus* indicated plant suffered chlorophyll decrease. Plant Senescence Reflectance Index (PSRI) and Moisture Stress Index (MSI) for *Mangifera indica* (infected plant) and *Abelmoschus esculentus* (infected plant) were high and indicated that two plants suffer canopy stress. Also, results showed that *Citrus sinensis* has the highest value of NDVI (0.82) and CRII (7.99) between other plants. It could be concluded that the study of spectral signature is rather valuable in characterizing vegetation cover. Also, growth conditions and the environment can be predicted via spectral characterization curves.

Keywords: Spectroscopic Characterization, Plant Cover, El-Fayoum Governorate, Remote Sensing.

Introduction

El-Fayoum Governorate is the only western desert green oasis irrigated by surface Nile River freshwater, transferred from the Nile stream to the east to El- Fayoum depression by Bahr Yousef canal. It is located, 90 km southwest of Cairo. It is considered one of Middle Egypt Governorates, endowed with beautiful nature and a moderate climate throughout the year. The total cultivated area of the governorate is 1633.86 km^2, widely grown various fruits including (figs, grapes) and other typical crops including (rice, wheat, maize, cotton, sunflowers and sugar beets (El-Zeiny and Effat, 2017). For its irrigation El- Fayoum obtains water from the Nile, where the soil is mainly Nilotic silt. El- Fayoum is considered one of the most productive and fertile areas in Egypt since ancient times, there are currently no publications available on the study area's weed flora. Meanwhile, there have been significant changes in types of crops typically mature in this area, as well as changes in tillage methods of, application of fertilizers and methods of weed control (Al-Sherif et al., 2018).

Remote sensing technology application in the management of agriculture has become increasingly prevalent among farmers due to its capability to improve the status of crops by

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facilitating sound monitoring of crop (Pei et al., 2014; El-Zeiny and Effat, 2019). The development of crop canopy sensors in recent decades has enabled precision farming to be used for the non-destructive assessment of crop biophysical attributes in fields or even on a regional scale (Diacono et al., 2013). Hyperspectral remote sensing is the most widely considered technique nowadays for studying vegetation. Because of the environmental challenge, the yield of crops faces severe problems. Remote sensing may produce valuable spectral reflectance data that supply quick means of tracking growth status across different physiological, biophysical or biochemical parameters of crops. For dynamic tracking of the crop, appropriate evaluation of plant biophysical properties and physiological environmental state, for example leaf area, ability to use light, chlorophyll, and nitrogen content, are critical to enhancing nutrition and improving yields for global haven food and sustainable development (Zhao et al., 2013). The canopy spectral signature from the diffusely reflected radiation is defined by the ratio of reflected light intensity to that of incoming light for each wavelength in the spectral regions visible (400–750 nm), near-infrared (750–1200 nm) and shortwave infrared (1200–2500 nm). Electromagnetic radiation deals with pigment content, the composition of the leaves and the content of water. Photosynthetic pigments, chlorophyll and carotenoids in particular, absorb electromagnetic radiation in the visible region , resulting in less reflection. Alfadhl et al. 2012 addressed that there is also a loss of reflection in short-wave near-infrared region due to structural discontinuities in the leaf. Another important factor is Carotenoids that absorb energy and protects chlorophyll from photo-damage. One of the main carotenoids is a xanthophyll, which also protects the plant from unnecessary energy from sunlight and avoids more damage by plants. Canopy is a third factor in plant health, and equally important. This is a row of trees or roots to the peak or end. Carotenoids and chlorophyll are added together to mitigate the effect of variable canopy structure that ultimately contributes to good plant safety. Number of studies have been done on applications of remote sensing in studying and solving agriculture and environmental problems in Egypt governorates (*e.g.*, Gad and Abdel-Samie 2000, Gad, and Yehia 2003, Abdel Rahman et al., 2017, Saleh et al., 2018, Moghanm and Belal 2018 and Elbana et al., 2019, Ibrahim et al., 2019, El-Zeiny and Effat, 2019, Khdery et al., 2019, El-Hefni et al., 2020, Gamal et al. 2020 a, b).

The main objectives of this work are to collect data of hyperspectral measurements of crop and wild plants to perform spectral and numerical analyses of these data, also, to study Vegetation Indices and to study its relation with pigmentation and plant health and to discriminate between healthy and infected plants by hyperspectral technology.

Materials and Methods

Study area

El-Fayoum Governorate is the only natural green oasis in the Egyptian Western Desert, 90 km southwest of Cairo Governorate, linked to the Nile River. It is considered one of the Middle Egypt Governorates of, that is endowed with beautiful nature and a moderate climate throughout the year. It lies between 28^o 55’ N and 29^o 40’ N latitudes, 29^o 55’ E longitude and 31^o 5’ E longitude (Fig. 1). The total cultivated area of the governorate consists of 1633.86 km^2 widely grown various fruits including grapes, figs, and other typical crops including wheat, cotton, rice, maize, sugar beets and sunflowers (El-Zeiny and Effat, 2019). Fayoum obtains water from the Nile for its irrigation and its soil is mainly Nilotic silt. El-Fayoum region is considered one of the most productive and fertile areas in Egypt since ancient times, there are currently no publications available on the study area’s weed flora. Meanwhile, there have been significant changes in the types of crops typically matured in this area, as well as changes in agronomic (*i.e.*, tillage, fertilization and weed control).

Data collection

Two field trips during september 2018 and March 2019 were conducted to El-fayioum governorate to collect data for satellite image processing, plants and soil spectral radiometry measurements. Practically, the field visits aimed to identify crop problems in the governorate define factors affecting infected crops and wild plants, spectroscopic measurements of collecting plant samples for further analyses, identify seasonal crop diversity and finally define main indicators of plant problems. A total number of 11 different locations (Fig. 1) were surveyed and investigated. Each investigated stand was used for the collection of plant samples (wild or cultivated).

Spectroscopic measurements

Spectral reflectance data, within the wavelength range 350–2500 nm, recorded for representative leaves using an ASD field spec spectroradiometer using a contact probe to reduce

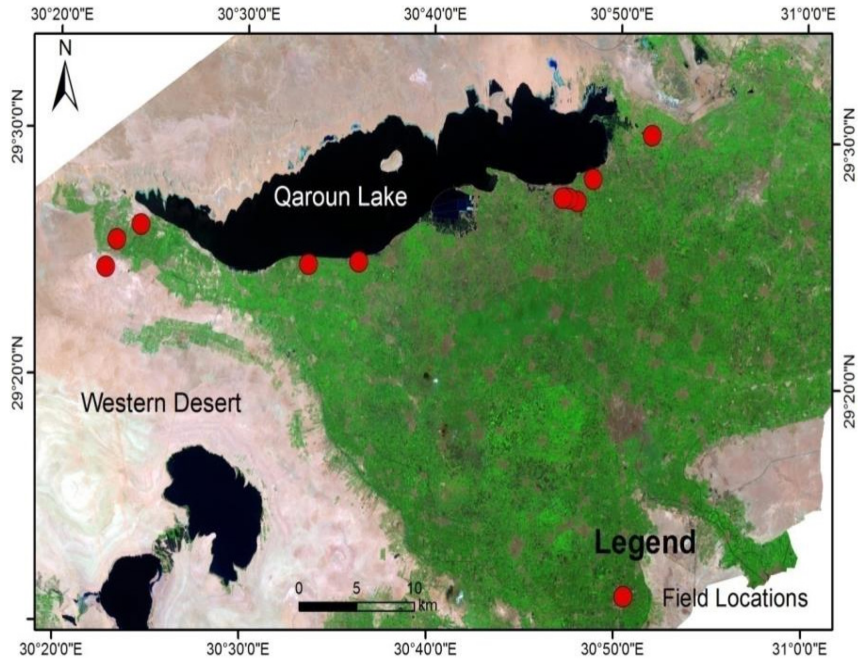

Fig. 1. Surveyed Sites in El-Fayoum Depression

atmospheric interference. The instrument was calibrated using a spectral on the white reference panel immediately prior to the first measurement and was repeated frequently and periodically during the measurement process to account for any variations in the sensitivity of the instrument that might occur during the measurement process. The statistical analyzes in JMP and SPSS were then used to identify the optimum wavelength for each plant (healthy and infected) for further analyses. Linear Discriminant Analysis (LDA) was employed to distinguish between healthy and infected plants. The techniques of this work rely on spectroradiometer measurements and statistical analyzes for spectroscopic performance measurements to first determine the optimum spectral region for differentiating between different studied plants and then choose the optimal wavelength in each spectral region that can be used to discriminate between each plant.

Five of the vegetation indices were used to quantify the plant vitality, resulting from spectroscopic measurements. The (VIS) have been represented in mathematical calculations, as seen in Table 1.

TABLE 1. Summary of vegetation indices, algorithms and sources for vegetation indices

Name	Equation	Explanation	Source
Normalized Difference Vegetation Index (NDVI)	NDVI = $\frac{R800-R680}{R800+R680}$	Content of Biomass	(Xu et al., 2013)
Carotenoid Reflectance Index 1 (CRI1)	CRI1 = 1 /R510 – 1 /R550	Carotenoids/ chlorophyll ratio	(Gitelson et al., 2002)
Leaf Chlorophyll Index (LCI)	LCI = (R7850-R710)/ (R850+R680)	Chlorophyll content	(Datt 1999)
Plant Senescence Reflectance Index (PSRI)	PSRI = (R680-R500)/R750	Chlorophyll/ carotenoids ratio	(Gitelson et al., 2001)
Moisture Stress Index(MSI)	ARI2 = R800 * (1/ R550 – 1 /R700)	Water content	(Gitelson et al., (2001)

Results and Discussions

Spectroscopic characteristics

Figure 2 shows the general spectral signature for 22 plant species cultivated and commonly naturally grown in the study. The results showed that all different plants are highly consistent with the overall spectral signature type in different spectral regions, in particular in visible and infrared light (Aboelghar and Khdery, 2017, Khdery, et al., 2014 & 2019 and Gamal et al., 2020). The analysis of reflectance value at different spectral regions generally indicates that the plant leaf normally has a low reflection. In the visible spectral region, due to strong chlorophyll absorption, relatively high near-infrared reflectivity occurs due to internal leaf dispersion. Also, relative low reflectivity is observed in the shortwave ranges due to strong waters absorption. In all spectral regions, the spectral reflection of *Olea europaea, Phragmites australis* and *Eichhornia diversifolia* was higher in its reflection than other species. In NIR and SWIRI, the small reflectance is given by *Zygopphyllum simplex*. Lastly, *Phragmites australis*, *Phoenix dactylifera* and *Zilla spinosa* recorded higher reflection values in the visible zone than other plant species' spectral reflectance.

In order to highlight the possibility of spectral reflectance measurement in differentiating between healthy and stressed vegetation type, samples were collected from Abshway administrative center, El- Fayoum governorate (Fig. 3) demonstrates the difference in spectral pattern between healthy and infected *Mangifera indica,* collected from analysis of spectral characteristics for the *Mangifera indica* indicated water stress (Fig. 3), clearly obvious at 950, 1150 and 1450 nm, in agreement with (Yones *et al* 2019) and (El-Shirbeny, 2012) findings. Also, an indication of chlorophyll stress is remarkably found at 550 nm, this, coinciding with (Yones et al. 2019) and (Onillon, 1990). The findings show that spectral signature in the visible zone is characterized by high reflectivity, while low reflectivity is clear in the infrared zone for plants affected by water stress, coinciding with Del Tio et al. (2001).

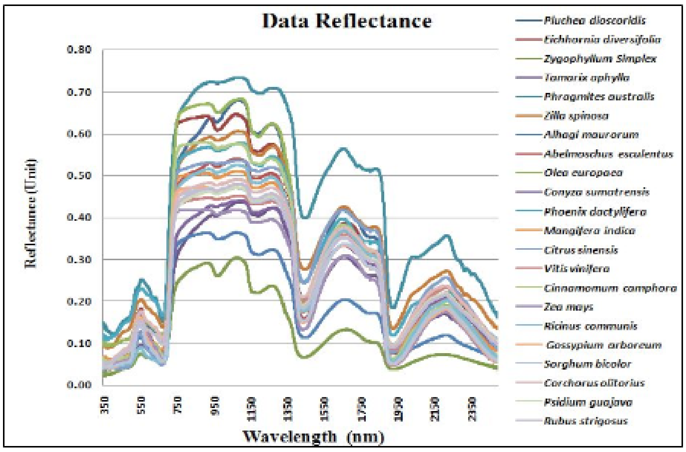

Fig. 2. General spectral pattern for various plant species

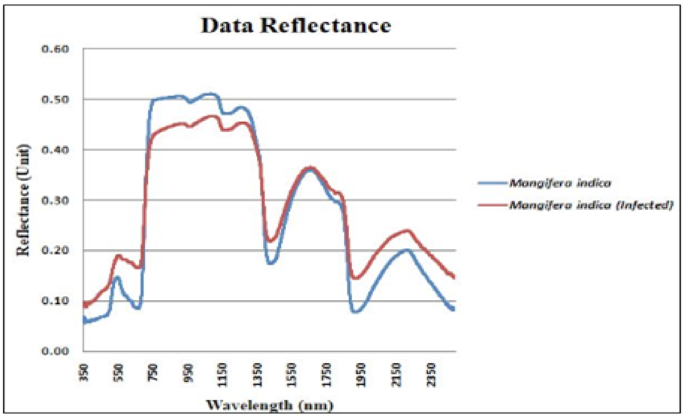

Fig. 3. Spectral reflectance pattern for healthy and infected Mangifera indica

Ablmoschus esculentus is wild (natural) plant located near to the village of Shakshouk in El- Fayoum Governorate. This area is a fallow land and adjacent to a residential area with wild and crop plants. Spectral Reflectance analysis for *Ablmoschus esculentus* (Fig. 4) indicates chlorophyll decrease at 550 nm and 770 nm, in agreement with (Yones, 2019, Kalinka, 2018 and Elkins et al., 2002). In stressed plants, the total amount of chlorophyll in the leaves decreases, leading to a proportional increase of light-absorbing pigments, and lower overall absorption, as a result of lower concentrations of Chl a and Chl b in the leaves. The specific wavelength pattern which it absorbs from VIs light will determine the type of pigment (Kalinka, 2018).

Sorghum bicolor is located in the center of EL Gharq –EL Fayoum Governorate. This area is agricultural land adjacent to a residential area, where salt accumulation is common on the soil surface. Spectral analysis for the sorghum bicolor indicates the occurrence of water stress at 950, 1150 and 1450 nm (Fig. 5), in agreement with (El-Shirbeny, 2012). There is an indication of chlorophyll stress found at 550 nm, this result agreed with (Yones et al., 2019 and Onillon, 1990).

Spectral pattern and spectral discrimination

The results of analysis of ANOVA and Tukey's procedure are presented in Fig. 6 & 7. The results indicated that Green and Red zones were not sufficient for the spectral discrimination between samples. At the same time, NIR and SWIRII spectral regions were the optimal to discriminate among investigated plants in the study area when blue and SWIR I spectral regions showed appropriate results for discrimination. Four plant species (*Phragmites australis, Olea europaea, Eichhornia diversifolia, Tamarix aphylla* show effective reflectance form in NIR zone. The species *Phragmites australis*, *Alhagi maurorum*, *Zygophyllum sipmplex* and *Zilla spinosa* give noticeable reflection in SWIRI1 zone.

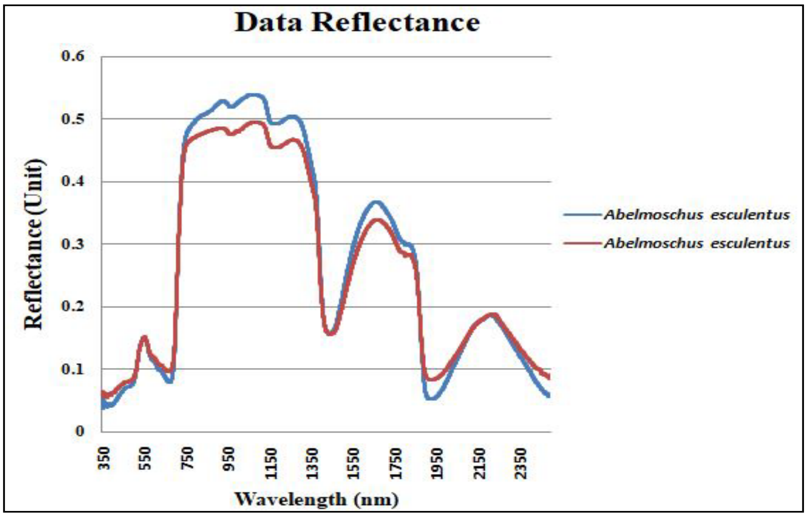

Fig. 4. The Spectral reflectance pattern to healthy and infected plant

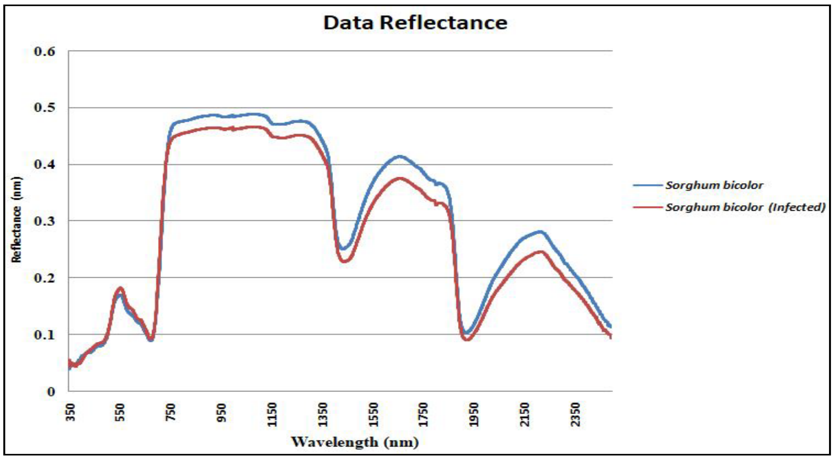

Fig. 5. The spectral reflectance pattern to healthy and infected plant

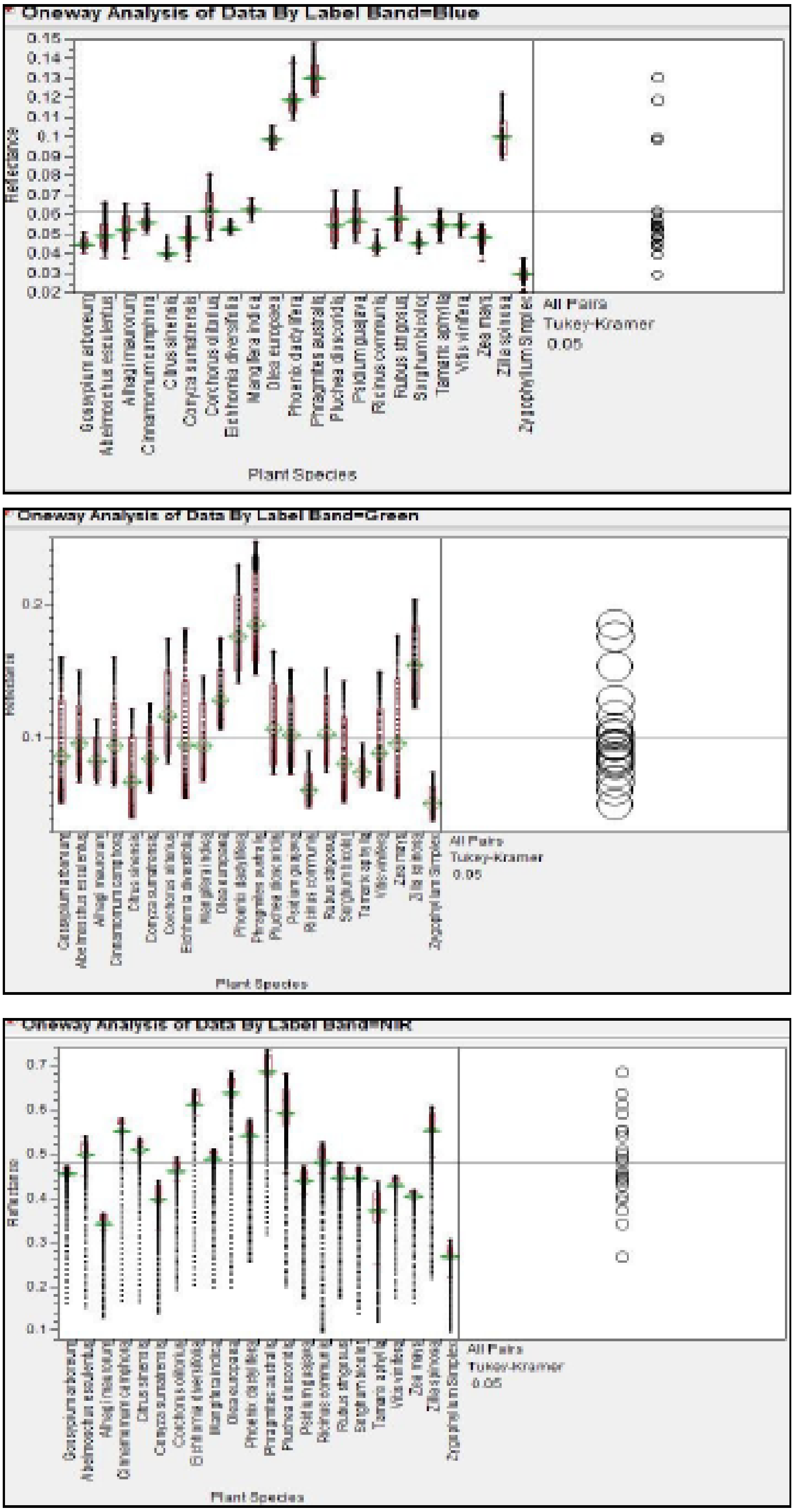

Fig. 6. ANOVA and Tukey's analyses to discriminate the studied taxa (Blue, Green, NIR Zones)

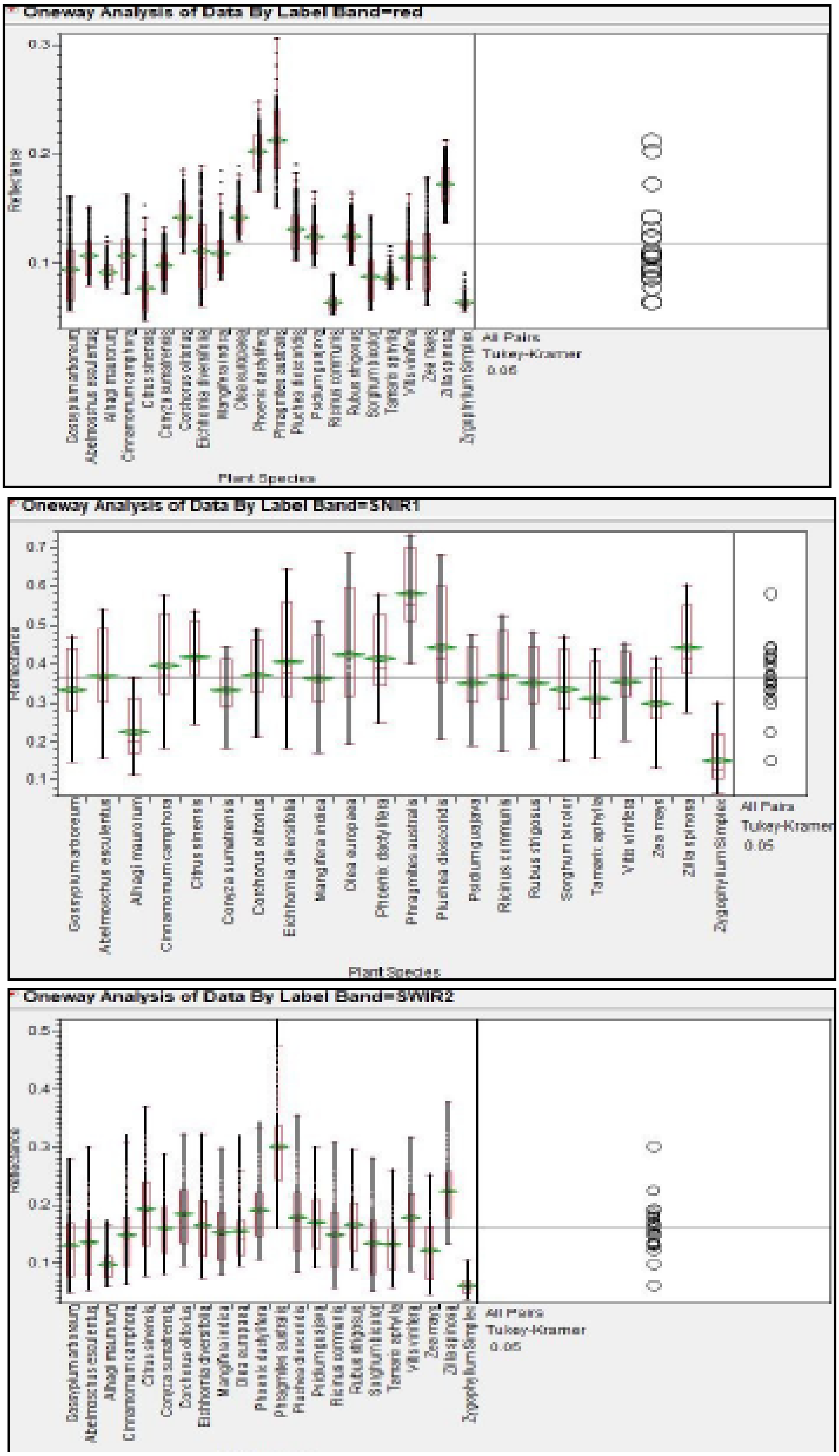

Fig.7. ANOVA and Tukey's analyses to discriminate the studied taxa (Red, SWIRI and SWIRII zones)

Identification of optimal wavelength for different plants

Linear Discriminate Analysis (LDA) results showed in Table 2. The findings revealed the optimum wavebands which have been proven to be used to differentiate among different plants. The results demonstrated that there are wide spectral unique zones of the plant species (*Citrus sinensis* and *Olea europaea*, *Phoenix dactylifera* and *Phragmites australis*). Such plants can be easily differentiated and isolated from other plant species by specific sensors as well as having high reflectance values. Finally, only one distinct wavelength had found for two plants (*Pluchea dioscoridis* and *Vitis vinifera*).

TABLE 2. The Optimum wavelength for differentiation between studied plants

Plant Species	Wavelength (nm)
Abelmoschus esculentus	1460- 1482- 1504-1526
Alhagi maurorum	1129- 1151- 1173-1261
Cinnamomum camphora	675- 697- 1643-1665- 1687- 1709
Citrus sinensis	651-673-695- 717- 793- 761- 783- 805- 827- 849- 871- 893- 915- 937- 959 981- 1003- 1025- 1047- 1069- 1091- 1113- 1135- 1157- 1179- 1201- 1223- 1245- 1267- 1289- 1311- 1333- 1355- 1377- 1399- 1421- 1443- 1465- 1487- 1509- 1531- 1553- 1575- 1597- 1619- 1641- 1663- 1685- 1707- 1729- 1751- 1773- 1795- 1817- 1839- 1861- 1883- 1905- 1927- 1949- 1971- 1993- 2015- 2037- 2059- 2081- 2103- 2125- 2147- 2169- 2191- 2213-
Conyza sumatrensis	1110-1132-1154- 1176- 1198- 12220- 1242- 1264
Corchorus olitorius	1098-1120-1142-1164- 1186
Eichhornia diversifolia	354-376-442- 596- 684- 706- 728- 750 772- 904- 1058- 1080-1168- 1190-1916- 1938- 1960- 1982- 2004- 2026- 2048- 2070
Gossypium arboreum	458- 480- 502- 568- 1492- 1536- 1580- 1646
Mangifera indica	1134- 1200- 1222- 1322- 1442- 1464- 1486- 1530- 1552- 1574- 1596- 1618- 1640- 1662- 1684- 1706- 1728- 1750- 1772- 1794-0 1816- 1838- 1860- 1882- 1904- 1926- 1948- 1970- 1992- 2014- 2036- 2058- 2080- 2102- 2124- 2168- 2190- 2212
Olea europaea	361- 383- 405- 427- 449- 471- 493- 515- 537- 559- 581- 603- 625- 647- 669- 691- 713- 735- 757- 779- 801- 823- 845- 867- 889- 911- 933- 955- 977- 999- 1021- 1043- 1065- 1087- 1109- 1131- 1153- 1175- 1197- 1219- 1241- 1263- 1285- 1307- 1329- 1351- 1373- 1395- 1417- 1439- 1461- 1483- 1505- 1527- 1549- 1571
Phoenix dactylifera	363- 407-429- 451- 473- 495- 539- 561- 583- 605- 627- 649- 671- 693- 715- 737- 759- 781- 803- 825- 847- 869- 891- 913- 935- 957- 979- 1001- 1023- 1045- 1067- 1089- 1111- 1133- 1155- 1177- 1199- 1221- 1243- 1265- 1287- 1309- 1331- 1354- 1375- 1397- 1419- 1441- 1463- 1485- 1529- 1551- 1573- 1595- 1617- 1639- 1661- 1683- 1705
Phragmites australis	357- 379- 401- 423- 445- 467- 489- 511- 533- 555- 577- 599- 621- 643- 665- 687- 709- 731- 819- 841- 1567- 1589- 1611- 1633- 1655- 1677- 1699- 1721- 1743- 1765- 1787- 1809- 1831- 1853- 1875- 1897- 1919- 1941- 1963- 1985- 2007- 2029- 2051- 2073- 2095- 2117- 2139- 2161- 2183- 2205
Pluchea dioscoridis	1233
Psidium guajava	1209- 1231- 1253- 1275- 1297
Ricinus communis	479- 567- 589- 611- 633- 655- 677- 721- 743- 765- 787- 809- 897- 919- 1139- 1227- 1447- 1469- 1491- 15`3- 1535- 1557- 1579- 1601- 1623- 1645- 1667- 1689-
Rubus strigosus	1210- 1298- 1320- 1342- 1408
Sorghum bicolor	1229- 1449- 1471- 1493- 1515- 1537- 1559- 1581- 1647
Tamarix aphylla	1126- 1148- 1258-1280- 1412
Vitis vinifera	1532
Zea mays	1072- 1094
Zilla spinosa	1436- 1458- 1480- 1502- 1524- 1546- 1568- 1590- 1612- 1634- 1656- 1678- 1700
Zygophyllum Simplex	355- 377

Calculated Vegetation Indices (VI) derived from ASD field spec

Descriptions and VI's formulas used in research are listed in Table 3. The Normalized difference of Vegetation Index (NDVI) is perhaps the most well-known and often used vegetation monitoring. The value the NDVI ranges between -1 and 1 where healthy vegetation generally falls between the values of 0.20 to 0.80. In the present study, the interpretations of the calculated hyperspectral vegetation indices data show that, most plant species under investigation are in good condition and with high values of NDVI except *Phoenix dactylifera* and *Zygophyllum Simplex*, which are coinciding with (Barryet et al., 2009). The Plant Senescence Reflectance Index (PSRI) is designed to maximize sensitivity of the index to the ratio of bulk carotenoids to chlorophyll. An increase in PSRI indicates to the increased canopy stress (carotenoid pigment). The common range of values for green vegetation is categorized between - 0.1 to 0.2. In the present study, PSRI for *Mangifera indica* (Infected one) and *Abelmoschus esculentus* (infected) was high which indicates a canopy stress. The Moisture Stress Index (MSI) is a reflectance measurement that is sensitive to the increases in leaf water content. Higher values indicate greater water stress and less water content so the result showed that *Mangifera indica* (infected plant) and *Abelmoschus esculentus*, *Sorghum bicolor* (infected plant) and *Conyza sumatrensis* have high value of MSI so these species suffer from the problem of water stress. The CRI2 is a reflectance measurement that is sensitive to carotenoid pigments in plant foliage. Higher CRI2 values mean greater concentration of carotenoid relative to chlorophyll. The common range for green vegetation is between values of 1 to 11. The results indicate that *Citrus sinensis* and *Vitis vinifera* (infected plant) have the higher values than other species. The results of leaf Chlorophhyll index indicate that all plant species in good condition except *Abelmoschus esculentus* (infected plant), *Mangifera indica* (infected plant) and *Phragmites australis*. The field survey confirmed the obtained results where water scarcity represents one of the main problems of the agricultural lands of El-Fayoum which impacted the grown plants showing the problem of water stress in most of the sampled plants.

TABLE 3. Calculated vegetation indices derived from ASD Field Spec

No.	Plant	MSI	NDVI	CRI1	LCI	PSRI
1	*pluchea dioscoridis*	0.673515	0.682413	3.511939	0.387874	0.031147
2	*Eichhornia diversifolia*	0.552837	0.809467	6.409110	0.418077	0.016207
3	*Phoenix dactylifera*	0.389576	0.809950	4.675627	0.535264	-0.010248
4	*Zygophyllum Simplex*	0.436267	0.640548	6.861640	0.375089	0.059189
5	*Tamarix aphylla*	0.79579	0.634949	3.237221	0.377377	0.029278
6	*Phragmites australis*	0.751815	0.619653	2.019457	0.226771	-0.002402
7	*Zilla spinosa*	0.710659	0.597869	1.558418	0.346972	-0.003587
8	*Zea mays*	0.846561	0.619067	3.350293	0.255975	0.013522
9	*Alhagi maurorum*	0.528164	0.630633	3.596543	0.379272	0.016650
10	*Abelmoschus esculentus*	0.876260	0.718938	4.513209	0.426880	0.004715
11	*Abelmoschus esculentus (Infected plant)*	0.678099	0.505799	2.634467	0.129010	0.073418
12	*Olea europaea*	0.529020	0.681733	2.380292	0.455213	0.016678
13	*Mangifera indica (Infected plant)*	0.784785	0.447855	1.826267	0.235380	0.085645
14	*Citrus sinensis*	0.767537	0.825431	7.992850	0.407634	0.009150
15	*Vitis vinifera*	0.775367	0.814185	5.615458	0.408998	0.025492
16	*Vitis vinifera (Infected plant)*	0.691323	0.773672	7.419561	0.344543	0.004968
17	*Cinnamomum camphora*	0.623998	0.774212	5.502310	0.446853	-0.000582
18	*Ricinus communis*	0.691429	0.798477	6.521971	0.579639	0.005940
19	*Gossypium barbadense*	0.664652	0.777445	7.059525	0.382755	-0.002217
20	*Gossypium barbadense (Infected plant)*	0.613375	0.671994	3.499126	0.444019	0.026661
21	*Sorghum bicolor*	0.829937	0.677443	3.090615	0.407421	-0.005398
22	*Sorghum bicolor (Infected plant)*	0.783941	0.656425	3.340420	0.353074	-0.006539
23	*Corchorus olitorius*	0.704390	0.769944	5.717226	0.502417	0.008946
24	*Rubus strigosus*	0.551590	0.678222	3.418835	0.234394	-0.024030
25	*Psidium guajava*	0.671068	0.708648	2.669922	0.336262	-0.026892
26	*Conyza sumatrensis*	0.803328	0.601795	3.615449	0.349419	0.044696

Conclusion

The present study is the first of series that observe the spectroscopic characteristics of the vegetation in governorates in Egypt. The present study is carried out on the spectroscopic signature of wild (natural) and cultivated plants growing in El-Fayoum depression and affected by wastewater drained from high land. Furthermore, the study was carried out to test the benefits gained from spectral data in detecting impacts of water scarcity, salinity and stress of plant diseases. It could be confirmed that the spectral reflectance patterns of plants are specific characteristics to identify and distinguish each type individually. Each plant has its spectral reflectance behavior which differs according to the status of the plant itself (e.g., healthy, infected and so on). Spectral reflectance analysis for infected plants indicated plants suffered water stress and chlorophyll decrease. The main approach of this system will be a regular based of field hyperspectral measurements during the growing crop seasons especially during the period of the maximum vegetative growth.

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التوصيف الطيفي للغطاء النباتي بمحافظة الفيوم، مصر

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الهيئة القومية للإستشعار من البعد وعلوم الفضاء- القاهرة - مصر

منطقة الفيوم هي منخفض الصحراء الغربية المصرية الفريدة من نوعها المزودة بمياه النيل السطحية وتعد واحدة من أقدم المقاطعات الزراعية في العالم. يلعب الاستشعار من البعد فائق التعدد الطيفي دورًا مهمًا في تقييم الخصائص البيوفيزيائية للنبات. يعد البحث الحالي إحد المحاولات المبكرة لدراسة الخصائص الطيفية للمحاصيل المزروعة و النباتات البرية في محافظة الفيوم. يساعد العمل في فهم حالة بنية الغطاء النباتي التي تستجيب لندرة المياه في منطقة الدراسة. تم تسجيل الانعكاس الطيفي للنباتات (المزروعة والبرية) بواسطة جهاز قياس الطيف (سبكتروراديوميتر) ودمجها مع التحليلات المختبرية باستخدام التحليلات الإحصائية لبرنامج SPSS و JMP . تم تحديد النطاق الموجي الأمثل أولا ثم الطول الموجي الأمثل للتمييز بين النباتات المدروسة باستخدام تحليل ANOVAو Tukey ايضا تمت معالجة بيانات التحليل الطيفي لإنتاج مؤشرات طيفية للنبات لتقدير حيوية النبات. أشارت النتائج إلى أن المناطق الطيفية تحت الحمراء NIR و والأشعة تحت الحمراء القصيرةSWIR االكانت الأمثل للتمييز بين النباتات المدروسة. لم يلاحظ أي انعكاس كبير في المنطقة الطيفية الزرقاء. أشارت الخصائص الطيفية لنبات Mangifera indica (نبات مصاب) إلى وجود اجهاد مائي. أشار تحليل الانعكاس الطيفي لنبات Ablmoschus esculentus إلى أن النبات يعاني من انخفاض الكلوروفيل. ايضا كانت نتائج تحليل PSRI و MSI لنبات Mangifera indica (نبات مصاب) ونبات Abelmoschus esculentus (نبات مصاب) عالية، وأشارت النتائج إلى أن النباتين يعانيان من إجهاد المظلة. كما أظهرت النتائج أن نبات Citrus sinensis له أعلى قيمة من (0.82) NDVI و (7.99) CRII بين النباتات الأخرى. يمكن استنتاج أن دراسة التوقيع الطيفي قيمة إلى حد كبير في وصف الغطاء النباتي، كما يمكن التنبؤ بظروف النمو والبيئة من خلال منحنيات التوصيف الطيفي.