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ABOUT FEATURES REMOTE CROPS OF WHEAT, WITH USE OF THE UAV, ON A CONDITION OF A FLAG LEAF

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ПРО ОСОБЛИВОСТІ ВІДДАЛЕНОГО ПОСІВУ ПШЕНИЦІ, З ВИКОРИСТАННЯМ UAV, ЗА УМОВИ ПРАПОРЦЕВОГО ЛИСТКА

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Question of use of local resources for ensuring energy needs and in particular production of biogas remains relevant. Grain crops which condition at initial stages of vegetation is inadmissible for receiving a qualitative harvest can become a prospect of raw materials for creation of biogas. The optimum tool for monitoring of a condition of vegetable cultures is considered UAV which use does not depend on the existence of clouds. The purpose of this research is an assessment by results of the use of the UAV of potential quality of winter wheat in the phrase "exit in a tube" about the expediency of its use for the production of biogas. Measurements of intensity of components of the color of wheat were taken in the conditions of a research hospital, the condition of a flag leaf was estimated visually at land researches. By results of work it was offered the indicator stressful index, it is constructed on the definition of a condition of a flag leaf which is the indicator of the formation of grain yield in wheat. It was shown expediency of account on monitoring of wheat, except the average value of intensity, the brightness of the channel of color and size of semi-distribution. This size can be considered as an additional parameter during the creation of stressful indexes, and also to testify about a condition of transition between stages of growth and development of plants. It is experimentally proved that color portraits of wheat have to be created under concrete stages of organogenesis. Taking into account that the duration of stages is several days, namely the UAV that can directly be used by agricultural producers, is the optimum tool for requirements of exact agriculture..

Keywords: *UAV, biogas, stress index, yield programming, digital camera, nitrogen nutrition level, the vegetation index.*

Introduction

Considering a trend of current issues of food and energy security of the countries of Europe and, in particular, Ukraine, is extremely important. On increase of needs in energy the accurate trend on attempts to reduce dependence on supplying countries and transistors of gas is observed.

Diversification of suppliers of gas improves a situation in the market, however causes new risks, in particular terrorist threats that it is specified by A. Rezazadeh et all. (2018) [1] for pipelines and also environmental safety of their construction and operation, R. Lidskog et all. (2012) [2]. Orientation to renewables with use of local resources, in particular biogas, becomes relevant even for the countries of exporters of oil and gas, such as Azerbaijan of N. Vidadili et all. (2012)[3]. In comparison with wind generation and solar photo cells, biogas has the powerful advantages caused by a possibility of accumulation of energy and management of its power. It is extremely relevant for the agricultural enterprises having rather small power consumption at estimated peak loadings that was shown in the works devoted to development of biogas technologies in the rural areas of China by Z. Song et all. (2012) [4].

Use of biogas reactors commercially demands attraction of considerable volumes of raw materials. A perspective source of raw materials in EU countries of P. Schroder et all. (2018) [5] consider use of grounds with a difficult relief or low fertility for cultivation of power cultures. However, their area can be insufficient. It is possible to provide necessary amount of raw materials for biogas reactors when using waste of crop production, for example, at cultivation of corn on grain as it is specified in works of M. Narra et all. (2018) and Sergej Ustak et all. (2018) [7] where after harvesting there are considerable volumes of the vegetable remains. As raw materials for creation of biogas it is potentially possible to use also low-quality products of crop production and also its surplus for which storage there are no refinery capacities and elevators. Under such circumstances for management of a harvest and, in particular, the choice of plantings, will be used for biogas production, landowners are interested to obtain ob-

jective information about a condition of plants as soon as possible. Among winter crops as raw materials for biogas, most often use wheat straw. Technological aspects of this process Gabriele Mancini et all. (2018) [8] and Asad Ayub Rajput et all. (2018) [9] is described. In program work of Colin Wrigley et all. (2017) [10] it is proved that the maximum profit on cultivation of grain it will be reached when processing all available biomaterial what both cultures, and technical and technological means have to be at the same time adapted to. Considering a winter wheat as a raw materials source for biogas reactors, the best from the point of view of agronomists, the period for monitoring is the vegetation phase "an exit in a tube". This circumstance is explained by the following circumstances: plants are already rather created, to change culture already late.

Specifics of monitoring is the limited term of making decision on carrying out technological operations and therefore tools for implementation of monitoring is optimum unmanned aerial vehicles (UAVs) V. Lysenko et all. (2017) [11]. The choice of the UAV, in comparison with satellites, is caused essentially smaller dependence on overcast, provides high distributive ability in comparison with low to the cost of pictures.

Assessment of a condition of flag and sub flag leaves as indicators of a condition of a winter wheat, it is caused by their role for formation of a grain yield. By the generalized results of researches about a half from the lump of grain provide assimilates which were formed in a flag leaf, and about a third - formed in a sub flag leaf.

The purpose of work is assessment by results of use of the UAV of a potential winter wheat of quality in the phase "exit in a tube" about expediency of its use for production of biogas.

Condition of a question. Methodical questions of use of mobile robots are presented in many works, such as Nevliudov et all. (2018) [12], G. Ponomaryova et all. (2018). However, approaches to the choice of the spectral touch equipment for monitoring remain debatable as it is presented in survey work of David R. Green et all. (2019) is relative to use for monitoring, in particular wheat, specialized and universal spectral devices. The equipment from various producers with various spectral parameters leads to emergence of stressful indexes under concrete brands of sensors even for monitoring of one culture. In work of V. Lysenko et all. (2016) [15] the technique of calibration of spectral data, suitable for UAV sensors is presented , however it is calculated first of all on optical range, and for the specialized equipment it is possible to use also NIR spectrum range.

Use of stressful indexes for monitoring of conditions of vegetable plantings with use of the UAV is carried out in the way:

- loan of indexes from satellite technologies, such as NDVI;
- creation of own indexes on the basis of use of the regression analysis.

The stressful indexes constructed on the concept of "the line of the soil" such as NDVI, SAVI etc., submitted in works of F. Rodriguez-Moreno et all. (2016) [16], Qiang Cao et all. (2014) [17] and M.A. Hassan et all. (2018) [18] vulnerable to accuracy, selectivity and problems arising with lighting change. The indexes constructed on the basis of the regression analysis, submitted in works of M.M. Saberioona et all. (2014) [19] and Cao Q. et all. (2014) [20] more convenient for technologies of exact agriculture, however are adapted for a concrete grade or a hybrid of a plant and touch the equipment.

For the choice of sites of plants which are expedient for choosing as a raw materials source for biogas reactors it is desirable for operator to have extreme criterion by which it is possible to distinguish high-quality crops from the others. Based on the experience described of use of stressful indexes, the spectral criterion has to be steady against lighting changes. Such criterion of definition of a stressful state in the conditions of monitoring from a board of the UAV used assessment of a flag leaf as it was shown on the example of barley in work of R. Vicente et all. (2018) [21].

High efficiency of monitoring of a flag leaf for a winter wheat by spectral methods from a board of the land platform it is presented in work of S. Kipp et all. (2014) [22].

Thus, the analysis of references allows to draw a conclusion on a possibility of use as extreme criterion of indicator assessment of quality of crops of a winter wheat a condition of a flag leaf which can be determined by results of the spectral analysis with use of the UAV.

Experiment Methodology

Organization of measurements and pilot sections. Pilot studies were conducted on the oP NUBIP fields of Ukraine "Agronomical experimental station" in a long field hospital of department of agrochemistry and quality of products of crop production (GPS of coordinate: 50°4’28 "N, 30°13'20"). For monitoring used the RGB PHANTOM VISION FC200 camera which is the regular equipment for the DGI Phantom 3 UAV. Researches were conducted on uniform lighting in cloudless weather (the Light Source setup in the manual mode - Fine Weather). Flight altitude of the UAV is 100 meters. Before the research’s crops were visually checked for lack of drops of water on upper leaves of plants.

For experience with a winter wheat, Colonia sort, the following options of application of fertilizers were used: 1) without fertilizers (control); 2) P; 3) RK; 4) NPK (the recommend norm) 5) NPK (1.5 recommend norms) (fig. 1).

Fig. 1. Photos of crops of a winter wheat, Colonia grade, on a research hospital (sites with various application of fertilizers - the growing norm from left to right (03.05.2018). Photographing was carried out at different stages of an organogenesis (fig. 2)

Fig. 2a. Picture of pilot sites of a winter wheat taken during the separate periods of vegetation (organogenesis stages on EPA)
Date of shooting: 03.05.2018
37 stage: there is a flag leaf which is still twisted.39 stage: ligula stage (sheet uvula): the ligula of a flag leaf is noticeable, the flag leaf is completely developed

Fig. 2b. Picture of pilot sites of a winter wheat taken during the separate periods of vegetation (organogenesis stages on EPA)
Date of shooting: 11.05.2018
41 stages: sheet the vagina of a flag leaf is extended.
43 stage: the sheet vagina of a flag leaf begins to flow

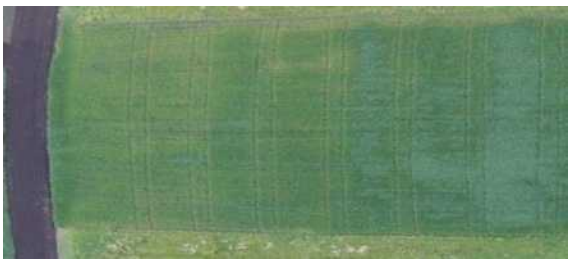

Fig. 2c. Picture of pilot sites of a winter wheat taken during the separate periods of vegetation (organogenesis stages on EPA)
Date of shooting: 18.05.2018
45 stage: the sheet vagina of a flag leaf bulk up47 stage: the sheet vagina of a flag leaf opens

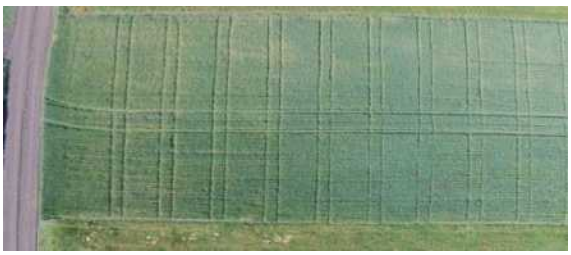

Fig. 2d. Picture of pilot sites of a winter wheat taken during the separate periods of vegetation (organogenesis stages on EPA)
Date of shooting: 29.05.2018
49 stage: the last sheet vagina opens, over a uvula of the top leaf there are noticeable awns

Fig. 2e. Picture of pilot sites of a winter wheat taken during the separate periods of vegetation (organogenesis stages on EPA)
Date of shooting: 08.06.2018 50-51 stages: beginning of emergence of an inflorescence (sprouting): it is visible the top part of a whisk or a cone 52 stage: emergence of 20% inflorescence

Obtained results and discussion

Data processing received from digital photographing. At assessment of color space of plants, proceeding from digital pictures, instead of the RGB format the model of appearance of CIECAM02 color presented in works of H. Ali et all. (2017) [23] and Asim Kumar Roy Choudhury (2014) [24] can be used. CIECAM02 model is more convenient in view of the fact that instead of three separate channels RGB the only channel which changes in the range 0-360° is used and describes all color space. For a transfer of data with RGB in CIECAM02 the free software BreedPix (USA) described in work of B. Zhou et all. (2015) [25] on researches of diseases of wheat and work of R. Vicente et all. (2018) [26] for carrying out researches of a nitric stress can be used. Despite convenience of perception and ease of work only with one channel instead of three, the transfer from one color space in another demands considerable computational capabilities that needs to be considered at orientation to industrial production. Therefore in researches processed experimental graphic data of the RGB format with use of the software of mAtHCAD that is suitable for graphic data processing of the JPEG format. Advantages of such approach were shown in work of J. Agrisuelas et all. (2017) [27]. At calculation of data according to the technique used in the BreedPix program distribution of number of pixels concerning values of intensity of each of three components of color was considered. The algorithm and the program in the environment of MathCAD was for this purpose developed for calculation of number of pixels with the corresponding intensity of RGB, for each component of color, for selected in the manual mode picture sections. For statistical processing of data retrieved they were exported to the Origin Pro SR4 v8.0951 software package of the OriginLab Corporation company intended for numerical data analysis and scientific graphics.

The received results and discussion. Assessment of nature of distribution and the choice of the equation for approximation of experimental data. In fig. 3 typical distribution of number of pixels in size of intensity of a component of color is presented.

Along with studying directly of sites of the field, were considered also the site of the dirt road (B_gt), for establishment of a possibility of influence of existence of the soil on results of assessment of spectral parameters of crops. By results of the received estimates, the conclusion was drawn on lack of need of preliminary data filtering as influence of the pixels caused by the soil will be insignificant. The dependence of number of pixels on value of intensity of a component of color is described by normal distribution and can be approximated typical by the equations. For approximation the equation of Amplitude version of Gaussian peak function (Gauss Amp) and Lorentzian peak function (Lorentz) was chosen.

Apparently from the provided data, a certain value of a maximum of distribution (I) is approximately identical to both used approximation equations. The Lorentz function gives the best the similarity for the maximum value of distribution, however determines value worse on the half-width of distribution (w) which is defined as one-half-amplitude width. Accuracy of determination of half-width of distribution, in comparison with establishment of its amplitude, more relevant as the quantity of points can change over a wide range. Besides, the coefficient of determination (R2) at approximation of experimental data for the equation of Gauss Amp was above, then in Lorentz therefore in researches for approximation selected Gauss Amp equations.

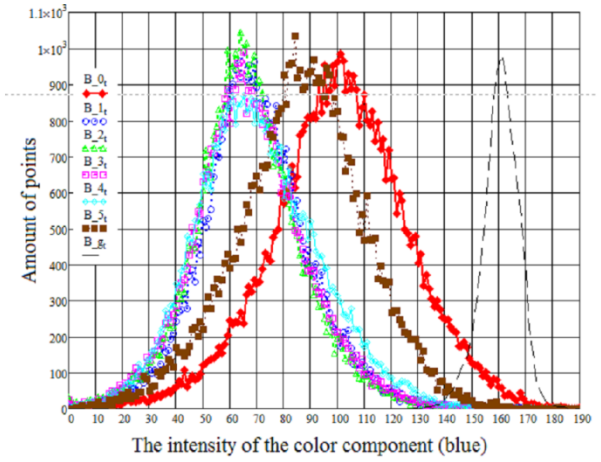

Fig. 3. Distribution of Number of Pixels for a blue component of color for research sites with a winter wheat with various doses of mineral fertilizers (2018.05.11)

The received results of approximation of experimental data on determination of parameters of color portraits of crops of a winter wheat of a sort of Colonia are presented in table.

Notes:

- sites where it was recorded are highlighted with gray color the flag leaf is well developed;
- with underlining data where the nature of distribution of intensity of the plants making colors differed from the general are highlighted in bold type (fig.5).

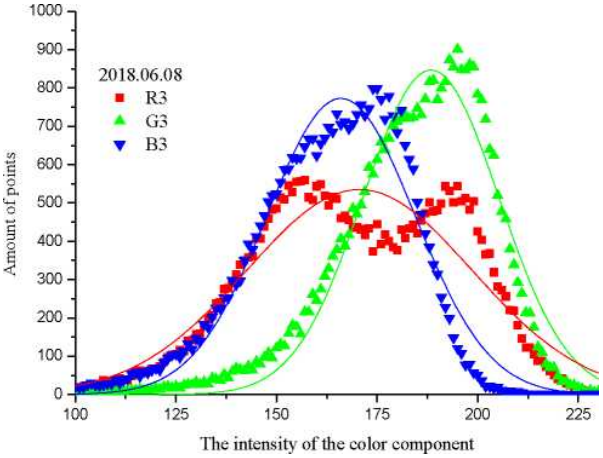

Fig.5. Dependence of number of pixels for the relevant channels of components of color from the size of their intensity for the third the pilot site (the beginning of emergence of an inflorescence), 2018.06.08 are recorded

Table

Results of approximation of color portraits of sites of a winter wheat

№	R			G			B			
	I	w	R^2	I	w	R^2	I	w	R^2	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	2017.05.03									
5	95	12,3	0,996	139	11,9	0,994	110	11,8	0,995	1,7
4	92	13,8	0,991	135	13,4	0,989	103	13,1	0,990	1,6
3	92	15,4	0,994	135	14,4	0,988	102	14	0,989	1,6
2	96	18,1	0,995	134	16,0	0,997	99	14,2	0,996	1,4
1	95	17,5	0,996	134	15,4	0,997	99	13,9	0,996	1,5
0	108	20,5	0,995	140	16,7	0,997	104	15,7	0,995	1,3
	2018.05.11									
5	71	22,0	0,983	115	22,0	0,985	88	22,3	0,987	2,0
4	58	20,0	0,989	99	21,0	0,988	69	21,8	0,985	2,0
3	58	18,0	0,987	97	18,9	0,990	67	18,9	0,989	1,9
2	63	17,2	0,986	100	17,5	0,988	66	17,2	0,986	1,7
1	65	17,8	0,986	103	17,0	0,987	69	17,7	0,986	1,7
0	111	27,5	0,990	140	23,0	0,991	102	23,8	0,991	1,2
	2018.05.18									
5	92	11,0	0,996	131	11,2	0,996	108	12,3	0,995	1,7
4	85	10,7	0,998	125	10,5	0,997	94	11,8	0,991	1,6
3	87	11,3	0,998	126	10,6	0,997	95	11,1	0,996	1,6
2	92	12,7	0,992	129	10,8	0,995	91	9,8	0,993	1,4
1	94	11,5	0,995	132	9,8	0,995	94	9	0,993	1,4
0	106	14,4	0,990	138	11,5	0,991	98	10,5	0,989	1,2
1	2	3	4	5	6	7	8	9	10	11
	2018.05.29									
5	123	26,3	0,976	153	24,0	0,974	133	24	0,973	1,4
4	119	25,7	0,977	148	24,0	0,977	124	23,8	0,975	1,3
3	117	27,5	0,970	145	24,1	0,968	121	24,6	0,963	1,3
2	118	29,6	0,969	143	26,1	0,964	114	26,0	0,967	1,2
1	116	26,4	0,970	141	23,8	0,967	112	23,5	0,970	1,2
0	122	25,2	0,970	143	22,6	0,969	112	22,4	0,970	1,1
	2018.06.08									
5	160	23,0	0,989	182	17,1	0,994	165	17,2	0,990	1,2
4	162	20,8	0,990	184	15,2	0,980	162	15,1	0,983	1,1
3	**170**	**28.0**	**0.930**	**187**	**16.9**	**0.973**	**166**	**18.4**	**0.972**	**1.1**
2	179	21,0	0,970	189	14,3	0,970	165	17	0,980	1,0
1	176	18,4	0,977	189	14,3	0,970	163	14,8	0,982	1,0
0	183	15,8	0,974	191	12,9	0,960	166	13,8	0,977	1,0

Apparently from the data provided in the drawing, the nature of dependence for a red component of color significantly differs from green and blue - instead of one maximum there are two. A probable explanation of it is that fixing took place for transition state - upon transition from one stage of an organogenesis to another. Starting from this, it is possible to assume that the size of half-width of distribution by a peculiar indicator of a transitional growth phase and development of plants of a winter wheat. This indicator can be perspective at creation of stressful indexes as in experiences from 2018.05.03 it was recorded dependence between a condition of half-width of distribution and a condition of application of fertilizers for the considered channels.

Analyzing dependences of spectral channels of plants on providing them with batteries, by us it is recorded that such dependences have to be under construction under concrete phases of vegetation or stages of an organogenesis. So, 05.11, 05.18 and 06.08 dependence were recorded for red and green, and 05.29 - for is green also blue channels. Proceeding from it it is offered to use the indicator index for a flag leaf:

$$F = \frac{G \times B}{R^2} ,$$

where F – is the stressful index for indication of a flag leaf, R, G, B – are red, green and blue channels.

Such indicator index allows estimating quickly crops which have the potential of receiving a qualitative harvest that is extremely relevant when choosing raw materials for biogas rectors.

Directions of further researches. In work it is shown that stressful indexes need to be created under the corresponding stages of an organogenesis or a phase of vegetation, however it is expedient to study a possibility of remote assessment of a stage of vegetation. Use of additional information from farms on grades of culture and real terms of crops and also data of meteorological stations can become the possible decision that will allow counting a phase of vegetation and a stage of an organogenesis with certain accuracy.

Flag leaves have specific coloring therefore we consider expedient for creation of the indicator index of establishment of a condition of a flag leaf of use of the infrared channel of monitoring.

Conclusions

It is offered the indicator stressful index constructed on certain conditions of a flag leaf which is the indicator of formation of a grain yield in wheat;

The expediency of account on monitoring of wheat, except average value of intensity, brightness of the channel of color and size of half-width of distribution is shown. This size can be considered as additional parameter during creation of stressful indexes and also to confirm a condition of transition between stages of growth and development of plants.

It is experimentally proved that color portraits of wheat have to be created under concrete stages of an organogenesis. Taking into account that duration of stages is several days, the UAV, can directly be used by agricultural producers, is a best tool for needs of exact agriculture.

References

1. AmiraliRezazadeh (2018) Applying game theory for securing oil and gas pipelines against terrorism / Amirali Rezazadeh, Luca Talarico, GenserikReniers, Valerio cozzani, Laobing Zhang // Reliability Engineering & system safety, In press, corrected proof, Available online, 30 April 2018.
2. Rolf Lidskog (2012) Sweden and the Baltic Sea pipeline: Between ecology and economy / Rolf LidskogIngemarElander // Marine Policy. Vol. 36, Issue 2, March 2012, pp. 333-338.
3. Nurtaj Vidadili (2017) Transition to renewable energy and sustainable energy development in Azerbaijan / Nurtaj Vidadili, Elchin Suleymanov, Cihan Bulut, Ceyhun

Mahmudlu // Renewable and Sustainable Energy Reviews. Vol. 80, pp. 1153¬1161.
4. Zilin Song (2014) Comparison of biogas development from households and medium and large-scale biogas plants in rural China / Zilin Song, Chao Zhang, Gaihe Yang, YongzhongFeng, GuangxinRen, Xinhui Han // Renewable and Sustainable Energy Reviews. Vol. 33, pp. 204-213;
5. P. Schroder (2018) Intensify production, transform biomass to energy and novel goods and protect soils in Europe—A vision how to mobilize marginal lands / P.Schroder, B.Beckers, S.Daniels, Gnadinger, E.Maestri, N.Marmiroli, M.Mench, R.Millan, M.Obermeier, N.Oustriere, T.Persson, C.Poschenrieder, F.Rineau, B.Rutkowska, T.Schmid, W.Szulc, N.Witters, A.Ssb0 // Science of The Total Environment. Vol. 616-617, pp. 1101-1123;
6. MadhuriNarra (2018) A bio-refinery concept for production of bio-methane and bio-ethanol from nitric acid pre-treated corncob and recovery of a high value fuel from a waste stream / MadhuriNarra, KumudMacwan, BipinVyas, ManishaR.Harijan, Disha Shah, Velmurugan Balasubramanian, Anil Prajapati // Renewable Energy. Vol.127, pp. 1-10.
7. Sergej Ustak (2018) Cup-plant potential for biogas production compared to reference maize in relation to the balance needs of nutrients and some microelements for their cultivation / SergejUstak, Jakub Munoz // Journal of Environmental Management. Vol. 228, pp. 260-266.
8. Gabriele Mancini (2018) Increased biogas production from wheat straw by chemical pretreatments / Gabriele Mancini, Stefano Papirio, Piet N. L. Lens, Giovanni Esposito // Renewable Energy, Vol. 119, pp. 608-614.
9. Asad Ayub Rajput (2018) Effect of thermal pretreatment on chemical composition, physical structure and biogas production kinetics of wheat straw / AsadAyub Rajput, Zeshan, ChettiyappanVisvanathan // Journal of Environmental Management, Vol. 221, pp. 45-52.
10. Colin Wrigley (2017) Chapter 25 - Grain Quality: The Future is With the Consumer, the Scientist and the Technologist /Colin Wrigley, Ian Batey, Diane Miskelly // Cereal Grains (Second Edition) Assessing and Managing Quality Woodhead Publishing Series in Food Science, Technology and Nutrition, pp. 691-725.
11. V.Lysenko (2017) Usage of Flying Robots for Monitoring Nitrogen in Wheat Crops / V.Lysenko, 0pryshko, D.Komarchuk, N.Pasichnyk, N.Zaets, A.Dudnyk // The 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications 21-23 September, 2017, Bucharest, Romania. Vol.1. pp.30-34.
12. I.Nevliudov (2018) MEMS Accelerometer in Hexapod Intellectual Control / I.Nevliudov, Ponomaryova, V.Bortnikova, S.Maksymova, K.Kolesnyk, //2018 14th International Conference on Perspective Technologies and Methods in MEMS Design, MEMSTECH - pp. 146-15.
13. G.Ponomaryova (2018) Mems-based inertial sensor signal and machine learning methods for classifying robot motion / G.Ponomaryova, Nevlydov, O.Filipenko, M.Volkova. // 2018 IEEE Second International Conference on Data Stream Mining & Processing (DSMP 2018) - pp. 13-16.
14. David R. Green (2019) Chapter 21: Using Low- Cost UAVs for Environmental Monitoring, Mapping, and Modelling: Examples From the Coastal Zone / David R. Green, Jason J. Hagon, Cristina Gomez, Billy J. Gregory // Coastal Management. pp. 465-501.
15. V.Lysenko, (2016) Drones camera calibration for the leaf research / V.Lysenko, O.Opryshko, D.Komarchyk, N.Pasichnyk. // Scientific Bulletin of the National University of Life and Environmental Sciences of Ukraine. 2016. №252. pp.61-65.
16. F. Rodriguez-Moreno (2016) Spectral monitoring of wheat canopy under uncontrolled conditions for decision making purposes / F. Rodriguez-Moreno, F. Zemek, J. Kren, M. Pikl, V. Lukas, J. Novak // Computers and Electronics in Agriculture. Vol.125, pp. 81-88.
17. Qiang Cao (2014) Active canopy sensing of winter wheat nitrogen status: An evaluation of two sensor systems / Qiang Cao, Yuxin Miao, GuohuiFeng, XiaoweiGao, Fei Li, Bin Liu, ShanchaoYue, Shanshan Cheng, Susan L. Ustine, R. Khosla // Computers and Electronics in Agriculture
18. Muhammad Adeel Hassan (2018) A rapid monitoring of NDVI across the wheat growth cycle for grain yield prediction using a multi-spectral UAV platform / Muhammad Adeel Hassan, Mengjiao Yang, AwaisRasheed, Guijun Yang, Matthew Reynolds, Xianchun Xia, Yonggui Xiao, Zhonghu He // Plant Science,;
19. M.M.Saberioona (2014) Assessment of rice leaf chlorophyll content using visible bands atdifferent growth stages at both the leaf and canopy scale // M.M. Saberioona, M.S.M. Amina, A.R. Anuarb, A. Gholizadehc, A. Wayayokd, S. Khairunniza-BejodaSmart. International Journal of Applied Earth Observation and Geoinformation. Vol.32 P.35-45
20. Cao Q., (2014) Active canopy sensing of winter wheat nitrogen status: An evaluation of two sensor systems / Qiang Cao, Yuxin Miao, GuohuiFeng, XiaoweiGao, Fei Li, Bin Liu, ShanchaoYue, Shanshan Cheng, Susan L. Ustin, R. Khosla. Computers and Electronics in Agriculture
21. Vicente R (2018) Identification of traits associated with barley yield performance using contrasting nitrogen fertilizations and genotypes / Vicente R, Vergara-D'iaz O, Kerfal S, Lopez A, Melichar 'J, Bort J, Serret MD, Araus JL, Kefauver SC, Plant Science, https://doi.org/10.1016/j.plantsci.2018.10.002
22. Kipp, S. (2014). Identification of stay-green and early senescence phenotypes in high-yielding winter wheat, and their relationship to grain yield and grain protein concentration using high- throughput phenotyping techniques / Kipp, S., Mistele, B., Schmidhalter, U. // Functional Plant Biology. Vol.41, pp. 227-235
23. H.Ali (2017) Symptom based automated detection of citrus diseases using color histogram and textural descriptors. / H.Ali, M.I.Lali, M.Z.Nawaz, M.Sharif, B.A.Saleem // Computers and Electronics in Agriculture. Vol.138, pp. 92-104.
24. Asim Kumar Roy Choudhury (2014) Principles of Colour and Appearance Measurement. Object Appearance, Colour Perception and Instrumental Measurement pp.1-52. https://doi.org/10.1533/9780857099242.1
25. B. Zhou (2015) Low-cost assessment of wheat resistance to yellow rust through conventional RGB images / B.Zhou, A.Elazab, J.Bort, O.Vergara, M.D.Serret, J.L.Araus // Computers and Electronics in Agriculture. Vol.116, pp. 20-29.
26. Ruben Vicente () Identification of traits associated with barley yield performance using contrasting nitrogen fertilizations and genotypes / R.Vicente, O.Vergara^az, S.Kerfal, A.Lopez, J.Melichar, J.Bort, M.D.Serret,

J.L.Araus, S.C.Kefauver // Plant Science. Available online, 6 October 2018
27. J.Agrisuelas (2017) Use of RGB digital video analysis to study electrochemical processes involving color changes / J.Agrisuelas, J.J.Garda- Jareno, E.Perianes, F.Vicente // Electrochemistry Communications. Vol.78, pp. 38-42.

Лисенко В.П., Опришко О.О., Комарчук Д.С., Марцифей А.І., Пасічник Н.А., Лукін В.Є. Про особливості віддаленого посіву пшениці, з використанням UAV, за умови прапорцевого листка

Питання використання місцевих ресурсів для забезпечення енергетичних потреб і, зокрема, виробництва біогазу залишається актуальним. Перспективою сировини для створення біогазу може стати зернова культура, стан якої на початкових етапах вегетації неприпустимо для отримання якісного врожаю. Оптимальним інструментом для моніторингу стану овочевих культур вважається UAV, використання якого не залежить від наявності хмар. Метою даного дослідження є оцінка за результатами використання UAV потенційного якості озимої пшениці в фразі «вихід в трубу» про доцільність його використання для виробництва біогазу. Вимірювання інтенсивності компонентів кольору пшениці проводилися в умовах дослідницької лікарні, стан прапорцевого листка оцінювалося візуально при наземних дослідженнях. За результатами роботи було запропоновано індикатор стресового індексу, побудований на визначенні стану прапорцевого листка, який є індикатором формування врожайності зерна в пшениці. Була показана доцільність обліку по пшениці, крім середнього значення інтенсивності, яскравості колірного каналу і величини напіврозподілу. Цю величину можна розглядати як додатковий параметр при створенні стресових показників, а також свідчити про стан переходу між етапами зростання і розвитку рослин. Експериментально доведено, що кольорові портрети пшениці повинні створюватися під конкретні стадії органогенезу. Беручи до уваги, що тривалість етапів становить кілька днів, а саме UAV, який може безпосередньо використовуватися сільськогосподарськими виробниками, є оптимальним інструментом для вимог точного землеробства.

Ключові слова: *UAV, біогаз, індекс стресу, програмування врожайності, цифрова камера, рівень азотного живлення, вегетаційний індекс.*

Лысенко В.П., Опрышко А.А., Комарчук Д.С., Марцыфей А.И., Пасичник Н.А., Лукин В.Е. Об особенностях удаленного посева пшеницы, с использованием UAV, при условии флагового листа

Вопрос использования местных ресурсов для обеспечения энергетических потребностей и, в частности, производства биогаза остается актуальным. Перспективой сырья для создания биогаза может стать зерновая культура, состояние которой на начальных этапах вегетации недопустимо для получения качественного урожая. Оптимальным инструментом для мониторинга состояния овощных культур считается UAV, использование которого не зависит от наличия облаков. Целью данного исследования является оценка по результатам использования UAV потенциального качества озимой пшеницы в фразе «выход в трубу» о целесообразности его использования для производства биогаза. Измерения интенсивности компонентов цвета пшеницы проводились в условиях исследовательской больницы, состояние флагового листа оценивалось визуально при наземных исследованиях. По результатам работы был предложен индикатор стрессового индекса, построенный на определении состояния флагового листа, который является индикатором формирования урожайности зерна в пшенице. Была показана целесообразность учета по пшенице, кроме среднего значения интенсивности, яркости цветового канала и величины полураспределения. Эту величину можно рассматривать как дополнительный параметр при создании стрессовых показателей, а также свидетельствовать о состоянии перехода между этапами роста и развития растений. Экспериментально доказано, что цветные портреты пшеницы должны создаваться под конкретные стадии органогенеза. Принимая во внимание, что продолжительность этапов составляет несколько дней, а именно UAV, который может непосредственно использоваться сельскохозяйственными производителями, является оптимальным инструментом для требований точного земледелия.

Ключевые слова: *UAV, биогаз, индекс стресса, программирование урожайности, цифровая камера, уровень азотного питания, вегетационный индекс.*

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