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APPLICATION OF REMOTE SENSING TECHNOLOGIES FOR MONITORING THE PHYTOSANITARY CONDITION OF CROPS GRAIN SORGHUM

Remote sensing technologies for monitoring the phytosanitary condition of grain sorghum crops allow to effectively detect diseases, pests and stress factors. The use of satellite images allows to quickly assess the condition of crops over large areas. This helps to take timely measures to maintain yields and reduce the cost of protection.
Key words: grain sorghum, remote sensing, monitoring, pests.

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ЗАСТОСУВАННЯ ТЕХНОЛОГІЙ ДИСТАНЦІЙНОГО ЗОНДУВАННЯ ДЛЯ МОНІТОРИНГУ ФІТОСАНІТАРНОГО СТАНУ ПОСІВІВ СОРГО ЗЕРНОВОГО

Технології дистанційного зондування для моніторингу фітосанітарного стану посівів сорго зернового дозволяють ефективно виявляти хвороби, шкідників та стресові фактори. Використання супутникових знімків дає змогу швидко оцінювати стан посівів на великих площах. Це допомагає своєчасно вживати заходи для збереження врожайності та зниження витрат на засоби захисту.
Ключові слова: сорго зернове, дистанційне зондування, моніторинг, шкідливі організми.

In today's context of global climate change, rising costs of plant protection products and the need to ensure food security, improving the system for monitoring the phytosanitary condition of crops is of particular importance. One of the strategically important crops is grain sorghum (*Sorghum bicolor* (L.) Moench), which is characterized by high drought tolerance, adaptability to different soil and climatic conditions, and the potential for use in sustainable agriculture [1–3].

However, sorghum phytocoenoses, like other crops, are significantly harmed by a range of pests, diseases, pests and weeds that can significantly reduce yields and product quality. Traditional methods of phytosanitary monitoring are often time-consuming, subjective, and do not provide timely detection of threats over large areas [4].

Therefore, the introduction of remote sensing technologies, in particular with the use of unmanned aerial vehicles and satellite platforms, opens up new opportunities for prompt, large-scale and objective assessment of the condition of crops. The obtained spectral indices, such as NDVI, NDRE, etc., can temporarily detect stress manifestations associated with biotic factors and influence the zonal analysis for making decisions on the use of plant protection products [5, 6].

Thus, the relevance of the study is due to the need to develop and improve high-tech approaches to phytosanitary monitoring of grain sorghum crops, which contributes to improving the efficiency of the plant protection system, reducing the environmental burden on agroecosystems and increasing the competitiveness of the agricultural sector.

The aim of the study is to evaluate the effectiveness of remote monitoring for analyzing the phytosanitary condition of grain sorghum crops in Polissya and Forest-Steppe of Ukraine.

To improve and modernize the methods of phytosanitary monitoring of phytocoenoses in

2019-2024 on the basis of agricultural enterprises of various forms of ownership: PE "Chaikovka", FG "Agroprofit" and LLC "Bel-Agro 3" in Zhytomyr region, the use of remote monitoring for analyzing the phytosanitary condition of grain sorghum crops has been introduced. Weather conditions, different types of soil, the level of anthropogenic load and the spread of pests create different scenarios for the development of the crop, which allows us to assess the potential of remote monitoring in different conditions.

Remote monitoring was carried out using Sentinel-2 satellite images and data from drones with multispectral cameras.

The main vegetation indices used were:

✓ NDVI (Normalized Difference Vegetation Index) – to assess the general condition of crops during the growing season;

✓ GNDVI (Green NDVI) – to detect changes in chlorophyll content;

✓ SAVI (Soil Adjusted Vegetation Index) – to correct the influence of soil in conditions of low vegetation.

The images were processed in ArcGIS Pro software using Spatial Analyst Tools. Maps of index distribution were created, and multilayer analysis was performed to identify changes in space and time. In addition, field surveys were conducted to verify the results of remote sensing.

The constructed NDVI index maps made it possible to identify areas with satisfactory, moderate, and critical plant condition during the growing season. The analysis showed that in the early phases of sorghum development, the indices were stable, but in the middle of the growing season, localized foci of index values decreased.

Comparison of the zones of low index values with the results of ground monitoring revealed the following: mycosis damage to plants (Fig. 1); aphid damage; and nitrogen deficiency zones.

It should be noted that due to multi-temporal monitoring, it was possible to trace the development of problem areas, in particular:

✓ expansion of areas with signs of phytostress by 18% between the tillering and panicle ejection phases;

✓ partial recovery of indices after local fertilization and/or protective measures.

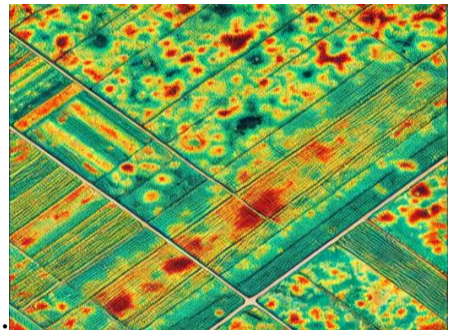

Figure 1. **Abstract NDVI map of sowing with visualization of grain sorghum mycoses**

Thus, the use of remote monitoring based on multispectral data is an effective tool for assessing the phytosanitary condition of grain sorghum crops, which allows

✓ identify risk areas in a timely manner (Fig. 2);

✓ reduce the cost of ground surveys;

✓ improve the accuracy of agronomic decision-making.

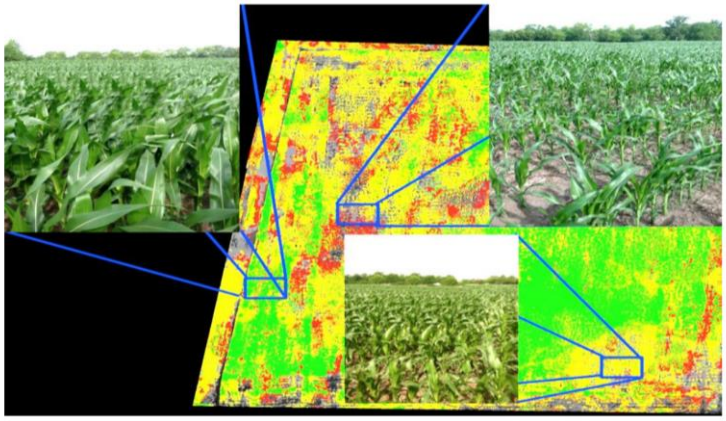

Figure 2. **Visualization of NDVI-map of grain sorghum crops: distribution of phytosanitary risks**

To summarize, here are the advantages of using remote sensing to monitor the phytosanitary condition of crops:

✓ *speed and efficiency of data collection* – remote sensing allows you to quickly obtain data from a large area. This is especially important for monitoring large agrocenoses, where traditional methods require significant time and labor costs;

✓ *contactlessness and minimization of environmental impact* – unlike traditional methods, remote sensing is created without direct contact with plants and soil, which eliminates the risk of mechanical damage to the crop or changes in their natural state;

✓ *spatial and temporal accuracy* – remote sensing makes it possible to monitor changes in crops in real time, to analyze free time periods, which allows to quickly detect changes in the phytosanitary condition and predict the possibility of threats;

✓ *the ability to analyze hard-to-reach areas* – UAVs can be used to monitor hard-to-reach areas;

✓ *integration with other technologies and data* – data obtained using remote sensing can be integrated with other data, such as weather conditions, technological maps, yield history, which allows creating complex models for forecasting and decision-making.

✓ *high accuracy and objectivity of assessment* – spectral indices obtained using remote sensing (e.g., NDVI, NDRE) make it possible to more accurately assess the condition of plants, detect stresses caused by disease or pest damage, and analyze changes in plant health over time. This reduces human subjectivity in decision-making;

✓ *reducing the cost of plant protection products* – precise identification of areas that need protection allows to reduce the cost of pesticides, the frequency of their application and increase the efficiency of plant protection;

✓ *improvement of the agro-ecological state* – due to the accuracy and timeliness of monitoring, remote sensing allows to quickly detect diseases, pests and resource shortages, which makes it possible to take preventive measures before the problem becomes a problem that can negatively affect the harvest and the environment.

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