СЕКЦІЯ IX.
АГРАРНІ НАУКИ ТА ПРОДОВОЛЬСТВО

EARLY PREDICTION OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) GRAIN YIELD USING SPATIAL NORMALIZED DIFFERENCE VEGETATION INDEX

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Early yield prediction is an important task of modern agriculture, providing great opportunities for better crop management and enhancing the advantages of the systems of precision agriculture. Yield prediction is possible based on simulation models (e.g., CERES, APSIM and other modeling systems), or empirical models (mathematical models developed using true experimental data received in the field conditions and processed using various statistical and mathematical algorithms, mainly regression analysis, artificial neural networks, etc.) [1–3]. Currently, among numerous empirical models those based on the data of remote sensing (utilizing various vegetation, meteorological, soil indicators computed using satellite imagery) are of a growing importance and demand.

Winter wheat (*Triticum aestivum* L.) is the major cereal crop in Ukraine [4]. Yield prediction of this crop is an important task for solving the problems of efficient technological management in the systems of climate-smart and precision agriculture, while the information and consultative basis at the moment is insufficient in Ukraine. In order to predict irrigated winter wheat grain yields in the South of Ukraine we developed prediction models on the basis of remotely sensed normalized difference vegetation index at the stages of the crop tillering (stage 5 or BBCH 31-39) and heading (stage 10.1 or BBCH 51-59) combined with true yielding data collected during 2017-2018 in the field experiments conducted at the irrigated lands of the Institute of Climate-Smart Agriculture (former Institute of irrigated Agriculture). The yields were harvested and accounted using self-propelled grain harvester at every experimental plot and further calculated to standard moisture content in grain (14%). Normalized difference vegetation index for each experimental plot at the fixed stages of the crop development was taken at the platform OneSoil AI, which uses Sentinel ½ combined imagery to assess the spatial vegetation index [5]. Phenological stages were assessed using national and international methodologies [6, 7]. The regression models for two stages of the crop development were created by the means of polynomial regression analysis (second-grade polynomic), performed using BioStat v7 software. Statistical procedures were performed at p=0.05.

The results of the study revealed the possibility of early (up to 60-70 days in advance in case of use the index values at the tillering stage) winter wheat grain yield prediction by linking the values of normalized difference vegetation index to the crop's productivity. Approximation of the developed polynomial regression models has proved that their accuracy is enough to provide reliable yielding forecasts: the mean absolute percentage error of the models fluctuates within 7.76-8.53% [8]; fitting quality, estimated by the R^2 values, is good – 0.9331-0.9454 (the fluctuations depend on the stage of the spatial index assessment). The models could be improved through adding more inputs or changing mathematical algorithm (however, the change should be reasonable), and in their current state they are useful in educational and theoretical studies, while the productivity scale for winter wheat depending on the values of normalized difference vegetation index could be applied in farming practices.

The developed polynomial regression models allow early prediction of winter wheat grain yield, and could be used "as they are", or integrated in the decision support systems for agriculture to enhance crop simulation quality.

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