Precision Agriculture in Nepal: Multiphase Evaluation of Wheat Genotypes Using Multispectral UAV Imageries

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SUMMARY

Nepal's agricultural sector, employing two-thirds of the population and contributing 26% to the national GDP, faces significant challenges from limited land resources, rapid population growth, and climate change impacts. Traditional farming practices and environmental stressors hinder wheat production, a vital crop that contributes 4.63% to the GDP. This study aimed to identify the best-performing wheat genotypes among ten varieties using multispectral UAV imagery, chlorophyll content measurements, grain yield data and plant height. The study area, approximately 900 square meters near the National Biotechnology Research Center, provided optimal conditions for monitoring plant growth and health. By monitoring the area across different phenological stages, wheat growth patterns were visualized, and correlation studies between VIs and in-situ measurements were conducted. Our findings show that VIs like NDVI effectively monitor wheat health and growth. Genotypes WK 2891 and WK 2430 consistently showed higher VI values, indicating better health and biomass production. These genotypes also exhibited the highest NDVI values at peak growth (0.805 and 0.803) and the highest grain yields (0.745 and 0.695 kg/m²). Conversely, genotypes WK 1204 and Himganga had the lowest NDVI values (0.614 and 0.705) and the lowest yields (0.598 and 0.507 kg/m²). NDVI and CIRedEdge were particularly effective for assessing health over time, with NDVI showing the highest correlation with SPAD readings (R^2=0.7451) and yield predictions (R^2=0.634). Including corrections for camera properties and sun irradiance improved the accuracy of the VI values, with the corrected datasets consistently showing higher VI values. Plant height measurements from the crop surface model (CSM) also correlated strongly with in-situ measurements (R^2=0.78), validating the use of UAV-derived data for monitoring crop growth. Time series analysis of VIs provided insights into the crop's growth stages, with peak values indicating robust growth in early April. The strong correlations between spectral indices and grain yield confirm their usefulness in precision agriculture, helping to optimize agricultural management and improve productivity. By identifying the best-performing wheat

genotypes and the most effective vegetation indices, this study contributes to enhanced crop monitoring practices, addressing the challenges posed by climate change and environmental stressors in Nepal's agricultural sector.