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A Study on Increasing Yield and Profitability Through the Use of Smart Systems in the Management of Almond Orchards

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Abstract

In agricultural production, almond cultivation is a fruit-farming sector gaining prominence in Türkiye and worldwide, owing to its greater tolerance of soil types compared to other fruit crops and its high economic value. Therefore, optimizing almond orchard management is vital for promoting sustainable agriculture and ensuring food security. In recent years, almond orchard management has been implemented using smart fertilization and irrigation systems based on microclimatic meteorological data and automated, precise drip irrigation and fertilization programs based on IoT and Evapotranspiration (ET) data. Furthermore, tree health and plant water stress index (CWSI) monitoring can be performed using NDVI (Normalized Difference Vegetation Index) obtained from drone or satellite imagery. In addition, AI-based early warning systems against early spring frosts, one of the biggest risks in almond orchards, and the integration of broad-spectrum cameras and smart sensors against biotic and abiotic stresses that cause significant economic damage to almond orchards, such as disease prediction, create a digital protective shield that enables the detection of biotic and abiotic stress factors at the cellular level before they are perceived by the human eye. Then, advanced cameras placed on unmanned aerial vehicles or fixed stations map the micro-changes in chlorophyll content, cell structure, and leaf temperature in the leaves via NDVI and CWSI. After this mapping process, moisture, leaf wetness, and trunk diameter sensors pre-placed underground and on tree trunks provide a 24/7 real-time physiological data stream from the orchard. By combining these two technologies with AI-based predictive models, wind turbines are automatically triggered in response to frost risk, fungal disease spores are predicted while still in the germination stage, and drought stress is prevented before it turns into damages. The aim of this study is to detect biotic and abiotic stress factors and increasing input costs related to the climate crisis in almond cultivation at an early stage using smart technologies.

Keywords: *almond, yield, smart systems, profitability, almond breeding*