Potato Virus Y (PVY) stands as a formidable and pervasive threat to global potato crops, inflicting substantial harm and presenting significant challenges. PVY, a member of the Potyvirus genus, is spread by aphids, contaminated seeds, and mechanical tools like pruners. Depending on the severity of the infection and the particular potato variety, yield losses attributed to PVY might range from 10% to a startling 80%. Several symptoms, including stunted growth, foliar mosaic patterns, leaf curling, and discoloration of both leaves and tubers, are brought on by PVY in potato plants. Some potato types suffer from severe foliar damage that ultimately results in plant death. Novel necrotic PVY strains have emerged, and they cause modest foliar signs that make it harder to identify infected plants. Notable PVY strains include the typical PVYO, which induces mosaic symptoms in most potato varieties, and the necrotic strains PVYNO and PVYNTN, resulting in vein necrosis in potato leaves. A pressing demand exists for innovative solutions aiding growers in pinpointing PVY-infected potato plants. Previous research has demonstrated the efficacy of deep learning-based convolutional neural networks (CNNs) in distinguishing between diverse plants, weeds, and diseases. This study further explores and expands upon the application of these models for PVY-infected plant detection. Various deep learning models are trained using imagery datasets comprising healthy and PVY-infected potato plants cultivated in greenhouse conditions. Optimal models are subsequently fine-tuned using field images collected by a custom-developed robot equipped with three RGB cameras, covering three rows of potato plants at a time. The robot employs an RTK system for geotagging captured images, enabling the precise localization of infected plants in the field. Evaluation metrics encompass accuracy, precision, recall, and F1-score. Through 10-fold cross-validation, the trained models achieve classification accuracy scores exceeding 80% in discerning between healthy and PVY-infected potato plants. Significantly, the models demonstrate a capacity to reliably detect PVY-infected plants, even when symptoms are subtle, crucial for early intervention and curbing virus proliferation.