

ANNOTATION

dissertation work Argynbayeva Assel Mukhtarkyzy on the topic “Current phytosanitary status of major viral diseases of potato in Kazakhstan”, submitted for the degree of Doctor of Philosophy (PhD) on specialty 6D081100 - Plant Protection and Quarantine

Relevance of the research topic. This study focuses on assessing the phytosanitary status of potato production in Kazakhstan by identifying major viral diseases and mapping the distribution of potato viruses.

Potato is a vital part of the global food system and plays a crucial role in strengthening world food security. Continuous potato production can contribute to all four pillars of food security: availability, accessibility, consumption and stability. Because of the high genetic diversity of this tuber, as well as its large cultivation and demand, potato research and innovation can contribute to the achieve the Sustainable Development Goals “Zero Hunger” (SDG02) and “Responsible Consumption and Production” (SDG12). The year 2008 has been declared the International Year of the Potato by the United Nations, noting that the potato is one of the staple foods of the world's population and reaffirming the need to sensitize the world to the role that the potato can play in food security and poverty eradication. In today's world, potatoes are grown on every arable continent (including at high altitudes in tropical countries) and are regularly consumed by billions of people. Potato is also one of the most widely cultivated technical and fodder crops in the world. In terms of area planted worldwide, potato ranks fourth after rice, wheat, corn and is the first non-grain crop.

This study aims to assess the current spread of viral diseases in seed potato farms across Kazakhstan.

Purpose of the research

The primary objective of this study is to evaluate the prevalence of viral diseases in potatoes in Kazakhstan, map the distribution of major potato viruses, and develop a quality control system for seed potatoes.

Research objectives

1. Collect plant and seed material from commercial and seed potato farms across Kazakhstan;
2. Isolate viral RNA from the collected samples;
3. Identify potato viruses M, S, Y, X, and PLRV using RT-PCR and PCR methods;
4. Create a distribution map of major potato viruses in Kazakhstan and analyze their prevalence;
5. Develop a quality control system for seed potatoes.

Research methods:

Plant material was collected in the field according to the methodology of the Nederlandse Algemene Keuringsdienst (NAK) Seed Inspection Service.

Tuber collection in storage facilities followed the methodology of the NAK Seed Inspection Service.

RNA extraction from plant material was performed according to the method described in [1].

Reverse transcription polymerase chain reaction (RT-PCR) was conducted using commercial kits following the manufacturer's instructions.

PCR analysis for virus detection was performed using commercial kits according to the manufacturer's instructions.

Mapping the distribution of potato viral diseases across various regions of Kazakhstan was conducted using ArcGIS software.

Comparative analysis methods were used to develop a quality control system for potato seeds, based on a comparison with systems used in leading potato seed-producing countries.

Main provisions submitted for defense:

1. Monitoring of major viral diseases (Y, X, M, S, PLRV) in potatoes across Kazakhstan was conducted.

2. A multiplex PCR system for detecting four potato viruses (Y, X, M, S) was developed.

3. A distribution map of major potato viruses in Kazakhstan was compiled.

4. A system for monitoring the quality of seed potatoes was developed.

Description of main research results.

As part of the dissertation research, the following key results were obtained:

– Monitoring of viral diseases was conducted in 27 seed and commercial potato farms across eight regions of Kazakhstan, covering both field and storage conditions.

– A multiplex PCR system was developed for the simultaneous detection of four potato viruses (Y, X, M, S), improving diagnostic efficiency.

– A distribution map of major potato viral diseases was created to assess the current epidemiological situation in Kazakhstan.

– A quality control system for seed potatoes was developed to improve the standards of seed production.

Practical significance

The study's findings are of high practical importance for understanding the spread of potato viral diseases in Kazakhstan. The developed virus detection methods can be widely applied in agriculture for the rapid and accurate identification of potato viruses. The proposed seed quality control system, once implemented, will significantly contribute to the development of the country's potato seed production sector.

Justification of scientific novelty:

Due to the impact of viral diseases, crop yields can drop by up to 90% in production crops. This necessitated large-scale monitoring of viral diseases in major seed farms, which import elite planting material from abroad (up to 95%) and domestically (5%).

The primary viral diseases affecting potatoes in Kazakhstan include: Potato Virus Y (PVY), Potato Virus X (PVX), Potato Virus M (PVM), Potato Virus S (PVS), and Leaf Roll Virus (PLRV).

For the first time in Kazakhstan, we conducted monitoring of seed and large potato farms and enterprises for potato viral diseases. This effort resulted in

compiling a map showing the spread of these diseases across various regions of Kazakhstan. Additionally, we developed a quality control system for potato seeds, which is expected to significantly enhance potato seed production in Kazakhstan, thereby increasing yields and attracting investments.

Correspondence with scientific development directions or state programs:

The relevance of this research aligns with the socio-economic development goals outlined in several key state strategic and program documents:

1. Message of the President of the Republic of Kazakhstan, December 2012. "Strategy "Kazakhstan-2050": a new political course of an established state" (The third challenge is the threat to global food security; the sixth challenge is the depletion of natural resources; large-scale modernization of agriculture in the context of growing global demand for agricultural products);

2. The Concept of Development of the Agro-Industrial Complex of the Republic of Kazakhstan for 2021-2030 (as amended on March 28, 2023) (Clause 5. Basic principles and approaches to development 5.1. Crop production);

3. The Message of the Head of State K.K. Tokayev to the People of Kazakhstan "Constructive public dialogue is the basis for stability and prosperity of Kazakhstan" dated September 2, 2019 (III. Developed and inclusive economy. Fifth point: Developed agro-industrial complex)

This research was conducted under the framework of scientific and technical programs:

- R11465424 "Development and Implementation of Highly Effective Diagnostic Systems" (2021-2022), specifically Task 07 focusing on studying the phytosanitary state of potato crops for major viral diseases in Kazakhstan using genomic technologies.

- BP10765038 "Development of Methodology and Implementation of a System for Certification and Inspection of Seed Potatoes" (2021-2023), aimed at enhancing certification processes for seed potatoes and fruit crop planting material in Kazakhstan.

Theoretical and practical significance:

Theoretical significance lies in the development of new methodological foundations for isolating total RNA from plant material, significantly advancing molecular genetic research methodologies. Regulations for RNA isolation from plant and planting material were refined, expanding diagnostic capabilities for viral diseases. An important theoretical achievement was the introduction of an innovative multiplex amplification system for simultaneous virus detection. Furthermore, a GIS map illustrating the distribution of major potato viruses in Kazakhstan was created, providing a theoretical basis for disease monitoring.

Practically, this research contributes directly to regulating viral infections and enhancing potato yields in Kazakhstan. The developed virus detection methods have broad applications in agriculture for monitoring seed material phytosanitary conditions. Maps of viral disease distribution enable assessment of the problem's scale and informed decision-making for disease control. Notably, these results

improve the potato seed production system and reduce reliance on imported seed materials.

Description of the Doctoral student's contribution to the preparation of each publication:

On the topic of the dissertation, 4 (four) scientific articles were published, including 1 (one) article in a journal indexed in the SCOPUS database and 3 (three) articles in publications recommended by the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (SHEQAC MSHE)

In the article published in the SCOPUS-indexed journal, the doctoral student conducted all experimental studies, including the collection and analysis of field data, laboratory studies using RT-PCR methods, statistical processing of results, and manuscript preparation. The doctoral student also developed a multiplex PCR system for identifying four potato viruses and ensured the manuscript met the journal's requirements.

In the publications published in journals recommended by the SHEQAC MSHE, the doctoral student developed the research methodology, monitored seed farms, conducted molecular genetic analyses, compiled maps of viral disease spread using GIS technologies, and prepared and designed the articles according to the publication requirements.

All publications were prepared with the doctoral student's direct participation, and the results were either obtained personally by the student or under their lead role.

Contribution of the Doctoral Student to the preparation of the Dissertation:

The doctoral student personally formulated the research goals and objectives, conducted field studies and laboratory tests to assess the phytosanitary condition of potatoes in seed and commercial farms across Kazakhstan, and performed viral disease detection using RT-PCR and PCR analyses. The results were visualized using agarose gel electrophoresis, and maps of the distribution of the main potato viruses were created using GIS technologies. The doctoral student processed and interpreted the obtained data.

Also, the doctoral student contributed to the development of a seed quality control system, conducting a comparative analysis of various systems used in different countries. She participated in the development of an algorithm for inspection services, particularly for field inspections and warehouse activities.

Volume and structure of the Dissertation:

The dissertation is presented on 100 pages and includes 15 tables, 36 figures, and 3 appendices. It is structured with an introduction, three chapters, and a conclusion. The reference list includes 159 sources.