2024 APS OIP Global Experience Program Workshop

Accurate Identification of Vegetable Diseases and Improved Plant Health in Kazakhstan

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Summary The APS workshop for accurate identification of vegetable diseases in Kazakhstan was held at the Kazakh National Agrarian Research University (KazNARU) in Almaty, from September 2nd to 5th, 2024. Vegetable production in the Almaty region has increased recently to meet local and export demand. Diseases of these crops result in significant annual losses and timely disease diagnosis would allow for improved management recommendations. This four-day workshop supported by APS OIP trained graduate students, faculty, and university specialists on the theory and practice of disease diagnosis. Using lectures, laboratory training, and field excursions participants learned many aspects of the diagnostic process. The training focused on identification of diseases of regional importance and on improving connections between growers and university specialists.

The workshop started with lectures on the disease diagnosis process, identification of fungal, bacterial, and viral diseases, and integrated pest management (IPM). There were guest lectures to further enhance knowledge of specific topic areas. Laboratory sections covered culturing fungi and bacteria from plant tissues, preservation of fungi, proper use and care of the microscope, sample preparation, incubation, and inoculation techniques. Participants received hands on training with *Phytophthroa capsici*, *Alternaria alternata*, *Fusarium* spp. and other pathogens that are annually observed in the region. Participants could immediately put what they learned from the lectures into practice.

Field trips to the towns of Shelek and Kainar to train on sampling techniques and discuss nematodes, viral diseases, and identification of diseases in the field enhanced the practical aspect of the course. Diseased plants were sampled and brought to the lab for incubation and isolation. Additional excursions on campus to laboratories and research centers, and the campus farm further improved on the learnings from the classroom. The workshop a huge success. Participants increased their knowledge of vegetable disease identification and completed the course excited for additional opportunities in diagnostics.

Acknowledgements This workshop would not have been possible without the assistance of University of Massachusetts professor Rob Wick. His advice on plant disease diagnostics and conducting international workshops, and providing material for slides was instrumental to the success of the workshop. Without the support of APS and APS OIP this workshop also would not have been possible. Many connections within APS came together providing resources and materials that proved very beneficial. I would like to thank Carmit Ziv and Elazar Fallik of the Volcani Institute, both extension professors of vegetable plant pathology who guided me during my postdoc in Israel on working with farmers in an international setting. My colleague Saltanat Mambetova gave a widely received guest lecture on vegetable extension in Michigan that was greatly appreciated by all participants. I also would like to thank my PhD advisor Mary Hausbeck for her continued support in plant pathology and extension. Locally, I am indebted to Akmaral Shokanova, who provided inspiration, organized many aspects of the workshop, and provided expert translation. She ensured the success of the workshop, and her constant positivity ensured that all participants were upbeat and ready to learn. Gulnur Suleimanova of KazNARU was essential in organizing tours of campus research centers, making sure the schedule was accurate, providing us with lab space, and coordinating with university staff. Without her active role in the workshop it would have been much more difficult to complete. I would also like to thank Maira Yesenalieva and Rabiga Daminova, for allowing us to conduct the workshop at KazNARU, and much needed help with logistics during the workshop, respectively. Bakyt Kenzhekozhaevich of the Kazakh Institute of Plant Protection and Quarantine provided initial advice on the field locations for the workshop. Finally, I would like to thank all of the participants who were engaged and interested and made this workshop a great success.

Sincerely,
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Introduction Diagnosis of plant diseases is an essential part of improving food security and reducing crop losses, and is the cornerstone of effective disease management. In Kazakhstan, vegetable growers face many challenges and plant diseases are a major economic constraint. Annual crop losses for specialty crops total in the millions of dollars each year in the country. Kazakhstan is a landlocked country and distant from global vegetable markets. Despite having a robust oil and gas industry that boosts the countries GDP, rural Kazakhstan is underdeveloped and lacks resources. Farmers face significant challenges including weak infrastructure, low government support for specialty crops research, inadequate access to fungicides, and limited knowledge surrounding disease identification. Blights are routinely observed during the growing season and losses of 15-70% to vegetables in storage have occurred (B. Kenzhekozhaevich, *Pers. obs*.). Quarantine of fresh produce due to government regulations around pathogen presence has also led to significant economic loss. The need for Western methods of disease identification are evident.

University extension is a relatively new concept in Kazakhstan, which was formerly part of the Soviet Union. The older system of extension to assist in disease management involved government approved research or receiving assistance from machine tractor stations. Many farmers in rural regions of Kazakhstan continue to follow older methods that do not meet the needs of modern day crop production. To move into a more efficient mode of production, Kazakh universities now work to train faculty and specialists. As most phytopathology research in Kazakhstan is focused on grain crops, attention to vegetable diseases is essential. This workshop provided graduate students and faculty with diagnostic techniques as well as a refresher on current best practices in diagnosing vegetable diseases. Training students and specialists in identification in the field and laboratory will allow them to provide assistance to growers during the season when timely and accurate diagnosis is necessary, and will improve integrated pest management (IPM) programs. Even relatively simple diagnostic techniques by Western standards are challenging for resource poor growers. Our goal was to provide accurate and tested methods that can be used by specialists, faculty, and growers to identify key diseases. Participants will build on this knowledge to develop management techniques that improve yields and increase profitability.

Participants The courses participants came from three different institutions and two farms. Our goal was to have diverse backgrounds represented, and participants included PhD students and faculty as well as local farmers. The majority of participants were women (88%).

	Name	Affiliation	Position
1	Gulnur Almasovna Suleimanova	KazNARU[a]	Faculty plant protection
2	Asel Serikovna Musakulova	KazNARU	Faculty Hort.
3	Yerlan Dutbayev	KazNARU	Assoc. Prof. plant protection
4	Myra Danataevna Yesenalieva	KazNARU	Faculty Hort.
5	Aidana Kharipzhanova	KazNARU	PhD Student plant protection
6	Gulzhan Salibaevna Kussainova	KazNARU	Faculty Hort.
7	Gulnur Zholdasbek	KazNARU	PhD Student plant protection
8	Rabiga Kinzhakhunovna Daminova	KazNARU	Faculty Hort.
9	Bakytzhan Zhexembi	KazNARU	PhD Student Hort.
10	Gulfaridat Kampitova	KazNARU	Faculty Hort.
11	Rabiga Abdugafarovna Iskendirova	KazNARU	Faculty plant protection
12	Ainur Asanovna Ashirbekova	NIIZKR[b]	Msc Student phytopath.
13	Arina Talapovna Maulen	NIIZKR	Bsc Student Sr. lab technician
14	Zhansaya Ziyatkhanovna Moralieva	NIIZKR	PhD Student phytopath.
15	Hasein Altyn	IMBB[c]	PhD Student
16	Zhanna Dyusenova	Farm Familytour	Farmer
17	Alma Karabaevna Tokzhumanova	Farm Ilyas	Farmer

[a] Kazakh National Agrarian Research University
[b] Kazakh Institute of Plant Protection and Quarantine
[c] Institute of Molecular Biology and Biochemistry

Figure 1: Participants filling out the first exam after an introduction and discussion on APS's mission.

Day 1 The initial day opened with a discussion of plant diagnostics, from identifying the diseased plant in the field to the laboratory diagnosis. IPM was the framework for the course participants. Without accurate diagnosis, IPM is difficult to put into practice. A useful "IPM circle" diagram was used to demonstrate this concept, showing pathogen ID, prevention, monitoring, choosing options, action, and evaluation. Next, the students were shown pictures of abiotic and biotic diseases of vegetables to help illustrate the importance of diagnosis and the spectrum of disease challenges. Comparisons of bacterial and fungal blights were especially relevant. There was a discussion on the mission of APS and benefits of our society to students and professionals internationally. After a short exam (Fig. 1) a fun game was played where pictures of diseased vegetables were identified and hung on the blackboard under the appropriate heading (Fig. 2). This game stimulated discussion on the wide range of diseases and pathogens.

Figure 2: Completed mix and match game, with diseases of fungal, oomycete, viral, bacterial, and nematode origins represented.

Then there was a lecture on disease diagnosis, working through the process in more detail, including sample submission, initial observations, incubation, isolation, Koch's Postulates, and other techniques. The lectures were given in English and translated to Russian, which is one of the official languages of Kazakhstan. The first laboratory section was on transferring fungal and bacterial cultures. Students were shown the proper techniques and then allowed to try themselves. Participants then isolated from Phytophthora infected squash and Alternaria infected tomato (Fig. 3,4). Additionally, there was an opportunity to make baits for Phytophthora using apples and infested field soil (Fig. 5).

Figure 3: Student transferring fungal cultures using sterile technique.

Figure 4: Participant isolating from diseased squash and tomato samples.

Figure 5: Participants making soil baits for *Phytophthora* using apples and infested soil.

Figure 6: Inoculation of pepper fruit with *Phytophthora*, and melon seedlings with zoospores.

Next, students inoculated pepper with *Phytophthora* and incubated the fruit in a humid chamber in order to demonstrate the third step of Koch's Postulates (Fig. 6). Finally, we had a guest lecture from Dilyara G. on virus and bacterial diseases and genetic structure in Kazakhstan. This was positively received by all (Fig. 7).

Figure 7: Guest lecture on bacterial and viral diseases by P.I. Dilyara Gritsenko from IMBB.

Day 2 The second day started with a field trip to the Kazakh Institute of Fruit and Vegetable Research. Here we received a presentation from the director, Temirzhan Aitbayev, on the new varieties introduced by the station, research into diseases, and more (Fig. 8).

Figure 8: Director Temirzhan Aitbayev presenting on new vegetable diseases and cucumber downy mildew (*peronosporosis*) in greenhouse cucumber production.

Figure 9: Researchers from the Kazakh Institute of Fruit and Vegetable Research, with course participants.

We then toured the laboratories and the seed genebank which houses much of the genetic material for vegetables in Kazakhstan. In Kazakhstan, vegetable, cucurbit, and potato production are considered separate "agricultural groupings" and all three were represented at this institute.

The work is painstaking and accurate in order to produce clean seen without the presence of diseases (Fig. 10).

Figure 10: Seed cleaning of tomato and pepper local cultivars, and tomato plants in the selection greenhouse.

We then saw the potato seed production facility (Fig. 11) and observed the process of production from micro-clonal transfers to clean production of seed tubers. On the way back to campus, we stopped at a local market and discussed with a grower his postharvest disease management for melons (Fig. 13). The cucurbit production in the region is impressive, including diverse varieties and high yields. This was also an active component of research at the institute (Fig. 12).

Figure 11: Lab workers transferring potato callus for micropropagation.

Figure 12: Diverse cucurbit production included *Momordica* spp., melon, pumpkin, and watermelon.

Figure 13: Discussion with grower on postharvest melon handling, note the diversity of cultivars typical for these markets.

Day 3 This was a long and event filled day. We started with lectures on microscopy and culturing fungi. Students were excited to start on the laboratory section, so we limited the amount of time spent on lectures. We took the majority of the morning using the microscope to look at pumpkin powdery mildew, tomato fruit infected with Alternaria, *Phytophthora capsici* on squash, *Fusarium oxysporum*, tomato anthracnose, and other diseases. Students were highly engaged in the process of making slides, staining fungal hyphae, and identifying the various fungal structures using stereo and compound microscopes (Fig. 14, 15). The books provided by APS were highly received. Western literature is expensive and limited at the university, and students were very glad to have these resources available.

Figure 14: Students using microscopes to make slides and identify fungal structures.

Figure 15: Faculty member looking at *Alternaria*, note the books from the APS OIP Library Assistance Program.

Next we toured two of the campus research centers. First was the Kaz-Japan Center, which included electron microscopy and mycotoxin and metabolite analysis. We then headed to the Agro-Hub to learn about micro-tissue propagation and clean culture (Fig. 16). These tours were a wonderful way for students to learn about the resources available on campus as many from the university had not seen these centers.

Figure 16: Touring the Agro-Hub to learn about micro-tissue propagation.

Finally, we had a virtual seminar from Saltanat Mambetova of Michigan State University Extension. Her presentation was excellent and introduced the students to the concept of Extension for vegetable crops, which does not exist in Kazakhstan.

Day 4 The final day was started by a long drive to the Shelek FMS Agro-Business center. This center was the former Philips Tobacco Station, and has since been converted into a vegetable research station. With the decline in tobacco production, local agronomists and Philips decided to train growers on vegetable production with great success. High quality solanaceous crops are produced in the region and many participants nodded in agreement when our guide Pavel Mikhailovich (Fig. 17) mentioned the renowned “Shelek tomatoes” that are the sweetest at the bazaar. The center has developed recent social projects, including donating 25 drying machines to women in the community to be able to dry and sell their own vegetables (Fig. 18).

Figure 17: Lecture on local agronomic practices at the FMS center by Pavel Mikhailovich.

Figure 18: Drying of pepper and tomato that will be crushed and sold locally, inset: ready to sell crushed pepper.

We next traveled to look at fields of tomato, pepper, and pumpkin. Some of the diseases and pests included Fusarium wilt, Phytophthora blight, *Tuta absoluta* (South American tomato moth), Orobanche parasitic plant, and other diseases (Fig. 21). We discussed in groups field identification of diseases (Fig. 19) and did a demonstration for growers of Agdia test strips for viral diseases (Fig. 20). This included sample selection and processing, which yielded a negative result.

Figure 19: Looking at pepper fields with growers. Note the narrow fruited variety.

Figure 20: Demonstration of Agdia test strips to growers and participants for viral disease detection.

Finally, we returned to campus and completed the final test. Then the participants were handed certificates of completion (Fig. 22). The final certificates were signed by the university rector, Primkul Ibragimov, and listed APS OIP, with successful course completion.

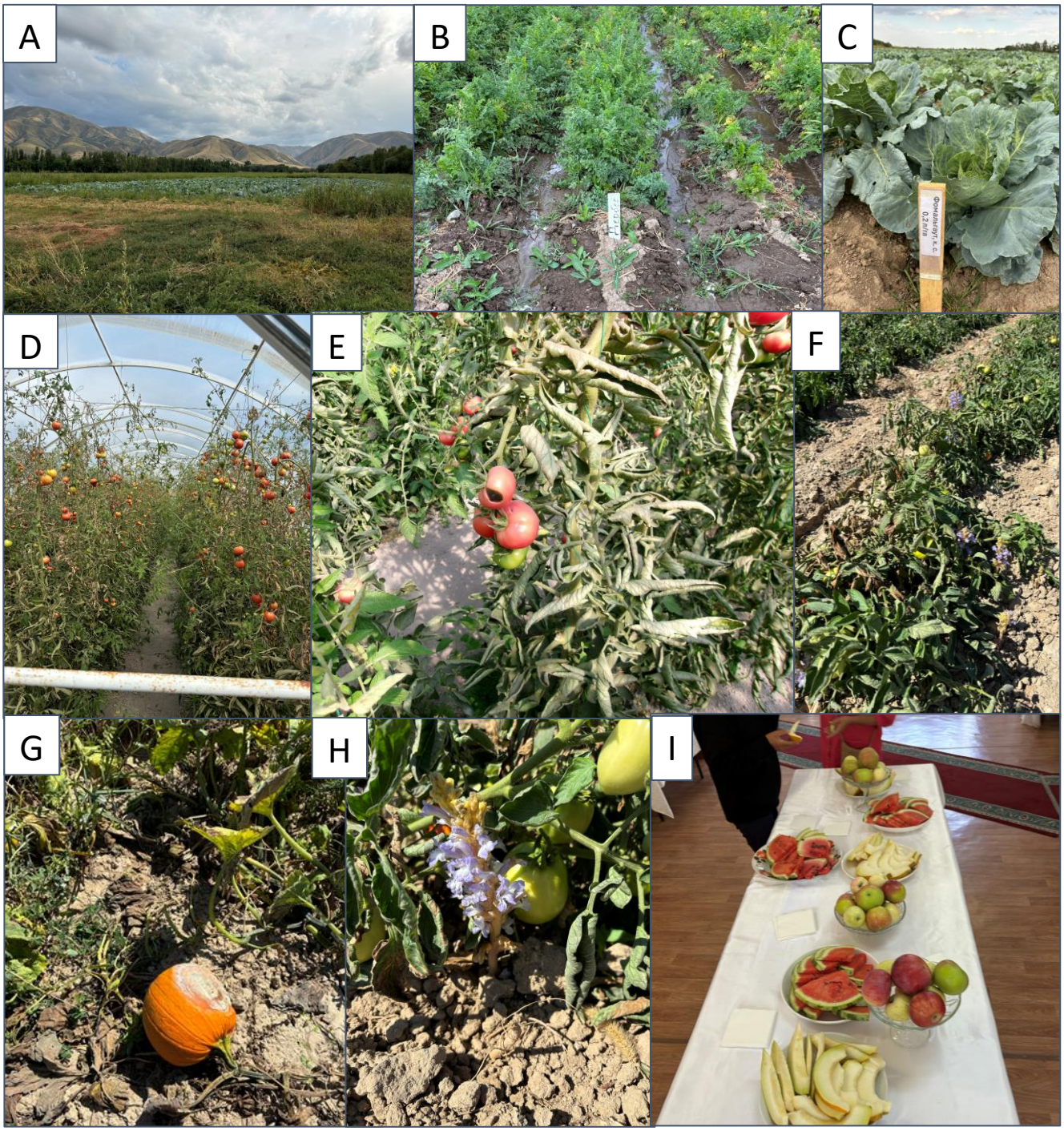

Figure 21: Diseases seen in the field at the experimental field plots in Kainar and Shelek. A) field research plots in Kainar; B) furrow irrigation of carrot; C) cabbage breeding lines; D,E) greenhouse tomato infected by Cladosporium leaf blight and Alternaria fruit rot; F) field tomato in Shelek susceptible to *Fusarium*, displaying wilt. Resistant variety (not shown) planted concurrently had no symptoms; G) Phytophthora fruit rot of pumpkin; H) Orobanche parasitic plant; I) Fresh melon and watermelon from local producers.

Figure 22: Course completion and participants with certificates.

Final Schedule

Time	Section	Location
Monday Sept 2		
9:00	Check in	Dept. Classroom
9:30	Introduction and pretest	
10:00	Disease diagnosis and IPM	
11:00	Break	
11:30	LAB: Incubation and Isolation	Dept. Laboratory
12:30	Lunch	
1:30	LAB: Baiting from soil and water	
2:00	Viral and bacterial diseases	Guest speaker: G. Dilyara, IBBR
3:00	Fungal ID	
4:00	Adjourn	
Tuesday Sept 3		
10:00	Farm discussion	KazNARU Research Station
10:30	Focus: Tomato diseases	
11:00	Focus: Cabbage diseases	
12:00	Lunch	
1:00	Diseases veg. culture	Guest speaker: T. Aitbaev, I. Hort
2:00	Seedling sanitation	
3:30	Return	
5:00	Nematode biology	
Wednesday Sept 4		
9:00	Lab components	Dept. Classroom
9:30	Microscope use	
10:30	LAB: Sample processing	Dept. Laboratory
11:30	Sanitation and plant virus	
12:00	Lunch	
1:00	LAB: Fungal and bacterial ID	
2:00	Molecular identification	
2:30	Kaz-Japan Center (in groups)	Guided
3:00	Agro-Hub tissue culture and PCR	Guided
4:00	Guest lecture	S. Mambetova, MSU Extension
5:00	Adjourn	
Thursday Sept 5		
10:00	Grower Meeting	Offsite. Shelek Station
10:15	Focus: IPM Strategies	
10:30	Focus: Postharvest challenge	
11:30	Field walk	
12:00	Lunch	
1:00	Final test	
2:30	Conclude and certificates	
3:00	Adjourn	

Budget The funding provided by APS was used almost as budgeted. However, meals cost more than planned. Laboratory material was available at the university and was also purchased prior to the workshop. Transport to field sites and locally was provided by the university. The materials

printed included a 40 page manual for each student, Phytophthora ID key, and sampling scheme that were printed in-house, significantly reducing costs (Fig. 24). Translation of the slides was initiated (Fig. 25) and will continue after the course. Students were given copies of the presentations.

Estimated cost breakdown for the Workshop

Budget Item	APS Funds	Other Funds (in-kind)[a]	Total (USD)
Lodging	640		640
Local Transport[b]	150	150	300
Flights	1,480		1,480
Extension Materials[c]	950		950
Translation service		600	600
Laboratory supplies[d]	600	600	1,200
Chilik Research Station		450	450
Meals		1,250	1,250
Total	3,820	3,050	6,870

[a] Access to the Chilik Research Station, labs, and seminar room, with support staff, provided by KazNARU as in-kind contribution. Meals for day 1, 2, 3 served by campus canteen, day 4 at local restaurant in Shelek.
[b] Farm visits, Shelek experiment station, and local transport only.
[c] Extension Materials, including workshop booklet, IPM handouts, and vegetable disease guides.
[d] PDA, Petri dishes, media components, pipette tips, and other materials for lab sections and demonstration.

Figure 23: Course materials given to each participant.

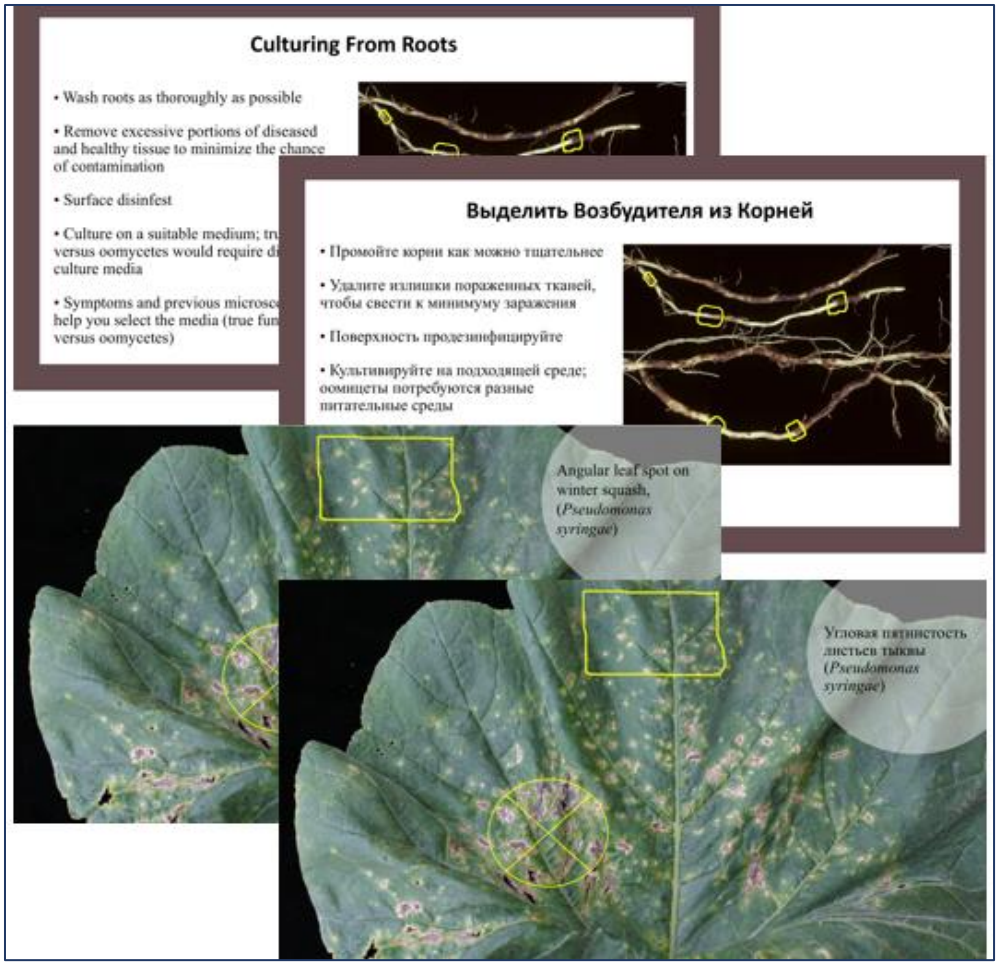

Figure 24: Sample of translated slides on isolation of fungi and bacteria.

Conclusions and future work This workshop fulfilled a number of APS goals including, dissemination of plant pathology information to Kazakhstani students and faculty, improving our reputation in Central Asia with additional scientific exchange planned, and building trust with graduate students and researchers from KazNARU of APS and the high quality resources from our society. The positive impact of our workshop was demonstrated by the initial and final quiz on plant diseases. The quizzes had 6 questions, written and multiple choice, and a question where students had to identify pictures of plant diseases. The initial quiz average score was 55% and the final average score was 78%, indicating improved recognition of the course material. Many participants gave positive feedback about the course at the conclusion, and were excited about the information gained and benefits to them as researchers. We will produce additional disease identification resources for the major diseases of the region that can be used by growers. The training that the faculty received will strengthen connections between the university and growers, leading to improved vegetable production and crop health.