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**THE DEGREE OF ACCUMULATION OF X, M, S-POTATO
VIRUSES IN VARIOUS PARTS OF PLANTS**

The article deals with the potato used to solve some problems of the implementation of sustainable development goals in our republic. Ways of virus damage to potato, which is widely used in crop production, are provided. Materials on the localization of X, M, S viruses mainly in the apical part of the tubers, including their sprouts, have been carried out; in the light sprouts from the umbilical part of the tuber, these viruses are found by 10–15 % less frequently than in the apical ones. In vegetative potato plants of the studied varieties, in various organs and parts of X, M, S, viruses have different serological titers, it is highest in the leaves of the upper tier, and lower in the reproductive organs. Damage to the reproductive organs of the plant is directly related to the environment and abiotic factors. Unfavorable factors have a negative effect on the reproductive organs of the plant and reduce the quality of the product. The degree of accumulation and concentration of viruses, in turn, is decisively reflected in the clarity of the course of serological reactions carried out with certain parts and organs of potato plants.

These indicators are practically important information for potato production centers. It is urgent to find ways to fight viruses in potato cultivation in our country. These studies are important for increasing the quality and quantity of the product. Increasing the quality of products for the purposes of sustainable development is a solid step in strategic development. In this regard, it is true that researches on damage and quality production of important species in agriculture are relevant.

Keywords: concentration, titer, serology, layer, mosaic, crop production, potato, virus.

Introduction

Development of agriculture in our country is one of the ways of economic growth. Cultivation of species with high demand in the development of agriculture is being undertaken. The cultivation and harvesting of oilseeds is costly. The average annual yield of oilseeds is 9.5 c/he. The introduction of new agronomic technologies by agricultural producers and the use of new varieties ensure the stabilization of the level of yield, its quality, and increase profitability. Currently, the price of oilseeds is the highest in the region. The average yield of vegetables and potatoes annually is within 187 and 373 c/he, respectively. The use of modern technology and the involvement of seasonal workers in vegetable growing make it possible to create jobs and harvest in the shortest possible time with minimal losses [1, p.102672]. In 2019, to increase crop yields and preserve soil fertility, 57.5 thousand tons of mineral fertilizers were applied, which is 30.7 thousand tons more than in 2013. This made it possible to increase grain yields in the fields where precision farming systems and the method of differentiated fertilization is used [2, p. 77]. Therefore, it is important to study the ways of growing unfamiliar cultures and their damage by viruses. Our study focused on the culture of *Solanum tuberosum* L.

Materials and methods

Potato – *Solanum tuberosum* L. (Fig. 1) belongs to the Solanaceae family of nightshades. Potato, as a food, technical and fodder crop, is one of the most widespread in the world.



Figure 1 – Potato – *Solanum tuberosum* L.

In the world practice of agriculture, in terms of planting area, potatoes rank fifth after wheat, rice, corn and sorghum, and fourth in terms of gross production, yielding to the first three. The largest number of potatoes is grown abroad [3, p. 394]. However, today more than 40 % of the world potato production is confined to China, Russia and India [4, p. 16].

Due to biological characteristics, potatoes are more prone to viral and viroid diseases than other agricultural crops [5, p. 12].

Based on the average statistical data for the Republic of potato yield, which is in the range of 11–13 t/he, with the yield potential of the varieties used, equal to 30–40 t/he, the problem of combating viral diseases in Kazakhstan is still truly relevant [6, p. 260].

The intensity of the reproduction of plant viruses and their accumulation depend, as is known, on a number of biological and abiotic factors and causes: the conditions for growing varietal and age characteristics, the location of the organ on plants. Of no small importance here are the natural and climatic features of the zone of cultivation of plants [7, p. 15].

Currently, in many countries of the world, much attention is paid to studying the potential of potatoes. At the same time, the main goal of research is to obtain even higher and more stable yields from this valuable agricultural crop [8, p. 16; 9, p. 147].

It is one of the significant cultures. In the context of social growth of the population and the problems of the Center for Sustainable Development. Based

on the opinion of scientists, the UN General Assembly draws the attention of the world community to the potato, believing that some problem solving Center for Sustainable Development, this development of the potato industry has a very important strategic knowledge [10, p. 18; 11, p. 10; 12, p. 272].

The degree of accumulation and concentration of viruses, in turn, is decisively reflected in the clarity of the course of serological reactions carried out with certain parts and organs of potato plants.

We were interested in this question not so much from the point of view of its theoretical interpretation, but rather in terms of its use for practical purposes – to obtain potato seeds that are as free as possible from infection with X, M, S-viruses.

For this purpose, during 2018–2021, we studied the degree of accumulation of X, M, S-viruses in the sprouts of the apical and umbilical parts of potato tubers, as well as in various plant organs, including its fruits (berries). We needed to identify not only the degree of accumulation of viruses here, but also to determine the conditions for setting up the clearest serological reactions for a correct assessment of virus infection in potato plants that produce berries and seeds.

In parallel with this, the dependence of the clarity of serological reactions on the conditions of germination of tubers in the dark and in the light was studied. For the analysis, sprouts of the apical and umbilical parts of the tuber were used. For experiments, 100 tubers were taken from model plants that showed a clear serological reaction during the growing season for the presence of latent infection of complexes X, M, S-viruses. Before analysis, one half of the tubers was kept in the light at a temperature of 18 °C to 20 °C and an air humidity of 70–80 % for 20 days; the second halves of the same tubers were kept in the dark under a similar hydrothermal regime. two centimeters, they were subjected to serological analysis. After the same period of time, the sprouts of halves of tubers kept in the dark were checked serologically [13, p. 165].

Results and discussion

Studies have shown that dark potato sprouts of both varieties did not give clear reactions to X, M, S-viruses. In our opinion, the detection of viruses by the serological method in the sprouts of potato tubers formed in the dark was difficult due to their low concentration, which lies beyond the sensitivity of this method. This can be confirmed by the fact that X, M, S-viruses from the juice of dark sprouts were found by us on test plants. The indicator method is known to be more sensitive. At the same time, serological analysis carried out with light shoots of tubers of both varieties showed clear results (Table 1).

Table 1 – Results of serological analyzes of potato light sprouts (2018–2021)

Viruses	Number of sprouts (%) of virus-infected varieties			
	Priekulskyearly		Penzaprecocity	
	Apical	Umbilical	Apical	Umbilical
X	100	85	100	96
M	80	73	94	89
S	75	56	91	96

As can be seen from these data, most often X, M, S-viruses were found in apical sprouts, much less often in sprouts located in the umbilical part of potato tubers (Fig. 2).

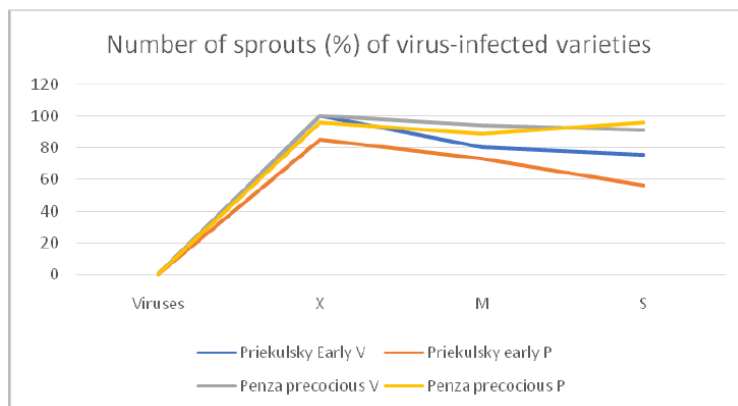


Figure 2 – Number of sprouts (in%) of virus-infected varieties

The apical sprouts of the Priekulsky early variety were infected with X-virus by 100 %, M-virus by 85, S-virus by 75 %, and in the sprouts of the umbilical part, respectively, S-virus 85, M-virus 73, S-virus 56 % [13, p. 8].

The infection of sprouts in the variety Penza early ripening was somewhat higher than in the variety Priekulsky early. Comparing the results of analyzes of light sprouts of tubers and vegetative plants from which these tubers were taken, it can be concluded that the infection of tubers was lower. During the formation of tubers, as is known, mosaic viruses are transported from the surface organs along with the flow of nutrients to tubers, however, some viruses obviously lingers in the tops before reaching them.

According to V.A. Shmyglya (1963), during the period of storage of tubers, the movement of viruses in parts of the tubers is not observed. Judging by our

data, we can assume that during the period of tuber formation, the infection of X, M, S-viruses was more intensively localized in their apical part, which was found in serological analyzes carried out at the end of the storage period.

According to our observations, the symptoms of some viral potato diseases are masked in favorable mountain climatic conditions. However, being in a potato plant, even in a latent state, viruses adversely affect the yield and quality of seed material, as discussed above.

Until now, researchers have no consensus on the dynamics of the concentration of potato viruses during the growing season.

The results of the experiment V.G. Reifmanai V.D. Kostina (1960) convinced that the concentration of the X-virus in different parts of plants and in different varieties depends on the phase of development, leaf layer and characteristics of the potato variety [4, p. 18].

M. Goldin and Z. Eliseeva (1969), studying the content of X, S-viruses in plants of varieties Lorch and Berlichingen in the mountainous conditions of the south-east of Kazakhstan, came to the conclusion that the concentration of these viruses can change dramatically depending on the phase of plant development, leaf tiers, varieties and growth conditions [15, p. 7–8].

The effect of accelerators on the growth process of plants is high [16, p. 890].

To study the prerequisites for infection with X, M, S-viruses of potato seeds, we carried out the following work. We studied the concentration of X, M, S-viruses in the leaves of the lower, middle and upper layers of potatoes, as well as in flower stalks, corolla, and then in the walls and juice of berries at different degrees of maturity. To perform this work, at the beginning of the budding phase, twenty-five model plants were serologically selected and labeled, latently affected by the complex of X, M, S-viruses. Courses with symptoms of a clear lesion of wrinkled mosaic were selected in the same number. The prevalence of X, M, S-viruses was determined by serological tests. The analysis of the leaves of each tested bush was performed in three terms: at the time of budding, flowering and at the end of flowering. The selection of leaves for analysis was carried out as follows. On the main stem of each bush, the number of leaves was counted, the resulting number was divided by three, then the average leaf was taken in each tier. The juice squeezed from the leaves was diluted 2, 4, 8, 16, 32, 64, 128, 256 times. With each dilution, a drip-serological reaction was made, noting the final dilution in which the reaction was still read. For analysis of peduncles and corollas, one organ from each model plant was used (Table 2) [6, p. 264].

Table 2 – Serological titer of mosaic viruses in various organs affected by wrinkled mosaic of Priekulsky early potato plants (2019–2021)

Developmentphase	Organs	Virustiter (averagedata)		
		X	M	S
1	2	3	4	5
Budding	beaters	14,4	8,8	8,0
	peduncles	65,4	32,0	38,4
	toplayerleaves	166,4	123,0	115,2
	middletierleaves	128,9	115,2	108,8
	lowerlayerleaves	102,4	81,8	102,4
Beginningofflowering	beaters	14,4	8,0	8,2
	peduncles	65,4	28,8	32,0
	toplayerleaves	128,0	115,2	89,6
	middletierleaves	108,8	102,4	80,3
	lowerlayerleaves	76,8	68,4	64,6
Endofflowering	beaters	4,0	2,0	2,2
	peduncles	19,2	17,6	11,2
	toplayerleaves	68,8	65,4	57,6
	middletierleaves	57,6	51,2	44,8
	lowerlayerleaves	57,6	44,8	32,0
Fruiting	Berrywalls	11,2	10,4	8,0
	Berryjuice	8,0	4,2	4,0

During the growing season, their highest serological titer was observed in the leaves of the upper layer during the budding period. This trend was noted both in outwardly healthy plants and in plants clearly affected by wrinkled mosaic.

Conclusions

The considered materials allow us to conclude the following: in order to reliably assess the state of infection of potatoes with X, M, S-viruses in our conditions, a serological assessment of plants should be carried out during the period of budding or the beginning of flowering. At the same time, for analysis, it is better to take the leaves of the upper than the middle or lower tiers of the bush.

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ӨСІМДІКТЕРДІҢ ӘРТҮРЛІ БӨЛІКТЕРІНДЕ КАРТОПТЫҢ Х, М, S ВИРУСТАРЫНЫҢ ЖИНАҚТАЛУ ДӘРЕЖЕСІ

Мақала біздің республиканың тұрақты даму мақсаттарын жүзеге асыруда картопты пайдалану мәселелеріне арналған. Егістік өндірісінде кеңінен қолданылатын картоптың вируспен зақымдануының жолдары көрсетілген. Түйнектердің апикальды бөлігінде, оның ішінде өскіндерінде Х, М, S вирустарының локализациясы жөнінде материалдар келтірілген; түйнектің омыртқалық бөлігіндегі өскіндерде бұл вирустар апикальды бөліктермен салыстырғанда 10–15 %-ға аз жиілікте кездеседі. Зерттелген сорттардың өсімдік картоптарының әртүрлі органдарында және бөліктерінде Х, М, S вирустарының серологиялық титрлері әртүрлі болады, ең жоғарысы жоғарғы деңгейдегі жаспырақтарда, ал төменгісі репродуктивті органдарда байқалады. Өсімдіктің репродуктивті органдарына зиян келтіру тікелей қоршаған орта мен абиотикалық факторларға байланысты. Қолайсыз факторлар өсімдіктің репродуктивті органдарына теріс әсер етіп, өнім сапасын төмендетеді. Вирустардың жиналу және шоғырлану деңгейі, өз кезегінде, картоп өсімдіктерінің белгілі бір органдары мен бөліктерімен жүргізілген серологиялық реакциялардың өткізілуінде анық көрінеді.

Бұл көрсеткіштер картоп өндірісінің орталықтары үшін практикалық маңызы бар ақпарат болып табылады. Біздің елде картоп өсіруде вирустармен күресудің жолдарын табу өте маңызды. Бұл зерттеулер өнімнің сапасы мен санын арттыру үшін маңызды. Тұрақты даму мақсатында өнімнің сапасын арттыру стратегиялық дамудың берік қадамы болып табылады. Осыған байланысты ауыл шаруашылығында маңызды түрлердің зақымдануы мен сапалы өндірісі бойынша зерттеулер өзекті болып табылады.

Кілтті сөздер: концентрация, титр, серология, қабат, мозаика, егістік өндірісі, картоп, вирус.

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СТЕПЕНЬ НАКОПЛЕНИЯ X, M, S-ВИРУСОВ КАРТОФЕЛЯ В РАЗЛИЧНЫХ ЧАСТЯХ РАСТЕНИЙ

В статье рассматривается картофель, используемый для решения некоторых проблем реализации целей устойчивого развития в нашей республике. Приведены пути вирусного поражения картофеля, широко используемого в растениеводстве. Проведены материалы по локализации вирусов X, M, S преимущественно в апикальной части клубней, включая их ростки; в светлых ростках из пупочной части клубня эти вирусы встречаются на 10–15 % реже, чем в апикальных. В вегетирующих растениях картофеля изученных сортов, в различных органах и частях X, M, S, вирусы имеют разный серологический титр, он наиболее высок в листьях верхнего яруса, и ниже в репродуктивных органах. Повреждение репродуктивных органов растения находится в прямой зависимости от окружающей среды и абиотических факторов. Неблагоприятные

факторы отрицательно влияют на репродуктивные органы растения и снижают качество продукции. Степень накопления и концентрации вирусов, в свою очередь, находит решающее отражение в четкости хода серологических реакций, проводимых с определенными частями и органами растений картофеля.

Эти показатели являются практически важной информацией для центров картофелеводства. В нашей стране назрела необходимость поиска путей борьбы с вирусами при возделывании картофеля. Эти исследования важны для повышения качества и количества продукции. Повышение качества продукции в целях устойчивого развития – это серьезный шаг в стратегическом развитии. В связи с этим актуальными являются исследования по изучению повреждаемости и качества продукции важных для сельского хозяйства видов.

Ключевые слова: концентрация, титр, серология, слой, мозаика, растениеводство, картофель, вирус.

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