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Efficiency of potato and garlic virus control by interferon use

O. Melnyk, I. Mytenko, N. Dukhina, O.Semenchenko, O. Vitanov, S. Shcherbina, S. Datsenko, Y. Zelendin, N. Chefonova, D. Ivanin

Institute of Vegetables and Melons of NAAS, st. Institutska 1, Village Selecciyne of Kharkiv Region, 62478, Ukraine, Dnipro State Agrarian and Economic University, Dnipro, st. S. Efremov, 25, 49027

Corresponding author E-mail: melnik.matilda@gmail.com

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The antiviral action of interferon on the virus-infected biotechnological methods of potato and garlic was investigated. The dynamics of accumulation of latent viral infection in potato plants with successive reproduction for the imposition of cascade (every 7-10 days) cultivation was determined and the influence on its yield and seed productivity was determined. According to the results of serological analysis, treatment with 0.025% interferon solution ensures the absence of viruses X, S and B in plants, and also increases the number of tubers of the seed fraction. Reduction of visual symptoms of defeat of different categories of seed material of potato varieties Tiras is 46-56%. Mainly by reducing the occurrence of such mild viral diseases as common and folded mosaic, aucuba-mosaic, and to a lesser extent by severe viral diseases, namely, wrinkled mosaic, twisting and mosaic twisting and mosaic . This provides a yield increase of 3.3-11.0 t/ha depending on the seed category. The corresponding increase in the output of tubers of the seed fraction by successive cascade treatment with interferon in the process of reproduction allows to obtain additional seed material of potato, which can be planted up to 198 hectares of field. An increase in the elite's profitability of growing the elite by 71% through the use of interferon is associated with lower production costs and resource savings. The high antiviral effect of interferon at a concentration of 0.01 to 0.10% for cascade cultivation of winter garlic crops provides for a 22% increase in its yield. In this case, there is also a decrease in the visual symptoms of viral mosaics and other diseases, including complex ones. Thus, the use of cascade interferon treatments during vegetative propagation of vegetative plants allows to restrain the reinfection of seed material and to reduce the rate of its degeneration with consistent propagation.

Keywords: Viruses; Interferon; Potato; Garlic; Degeneration; Seed material

Introduction

Due to the vegetative method of propagation of potatoes and garlic plants in the planting material accumulate a large amount of infection, in particular - viral. The main way to prevent the vertical spread of a viral infection is to create resistant varieties or regenerate apical meristems that are free of infection. However, the transition from *in vitro* cultivation to *in vivo* conditions is accompanied by the gradual reinfection of the recovered material. Its intensity depends on the variety of features, weather conditions and elements of technology. It is possible to prevent the horizontal spread of viruses by technological measures - spatial isolation, removal of weeds and diseased plants, destruction of virus-carrying insects. But the symptoms of viral diseases can appear as a result of both repeated defeat and as a result of the manifestation of a latent infection that could not be eliminated by biotechnological methods.

With each new reproduction of plants their productivity decreases, morphological and physiological-biochemical parameters change (Durnikin D.A., 2019). The speed and degree of deterioration of productive qualities depends, first of all, on the soil and climatic conditions of the growing zone, and especially on the spread in them of viral and other diseases. (Zykin, 1970; Romanova et al., 1989). There are theories that explain differently the causes of potato degeneration (environmental, temperature, viral, immune, genetic, theory of toxins and physiological aging) and provide different ways to toil against them (Blotckaia, 1995; Kononuchenko, 2000). Viral theory is dominant today. According to this theory, degeneration is a pathological phenomenon that occurs under the action of viruses and virus-like organisms (Sukhov, 1960, 1965; Fom'juk, 1960). Currently, more than 30 such pathogens are known to infect potatoes (Podgajec'kyj, 2000 ; Chesnokov, 1961). Various data on the harmfulness of viral diseases are found in the literature depending on the types and strains of viruses. The most significant effect on the symptoms of viral diseases are viruses L, X, S, M, Y, A, F, R.

Pathogens cause diseases that lead to changes in physiological processes - respiration, photosynthesis, the formation of amino acids, proteins, carbohydrates, nucleic acids, vitamins and many other substances (Ilina, 1975; Kuchko, Myc'ko, 1997; Tcoglin, 1987). Different diseases are characterized by different pathological changes. Thus, mosaic type infections are characterized by the destruction of chlorophyll in the parenchyma of leaves and growth deformation; in case of other infections there is defeat of a conducting system - a blockage and a necrosis of vessels. In the affected plants, as a rule, transpiration increases, the absorption capacity of the roots decreases. As a result of these changes, plants lose the ability to effectively utilize moisture and mineral nutrition.As a result the harmfulness of the viral infection is manifested in the reduction in the bush of the diseased plant the number and size of tubers. Reducing the yield of potatoes when planting the most common viruses tubers is: B - 20-90%, L - 28-64, M (K) - 9-48, X - 10-28, R - 10-30, S - 10- 20, A - 10-15, F - up to 10%; the potato fusiform viroid is 20-85%; mycoplasma - up to 10% (Zykin, 1970; Smit, 1960). There often may be signs of two or more viral diseases per plant. Viruses that cause only a slight decrease in yield (mild viral diseases), such as S, X, A with mixed infection with other viruses (L, Y) as a result of the synergistic effect can significantly increase their harmfulness and sharply reduce the yield of tubers. In these cases, the affected plants have symptoms of severe forms of viruses and reduce the yield to 50% or more (Dubovyk, 2000; Zykin, 1970; Ped'ko, 1994; Tereshhenko et al., 1974; Chesnokov, 1961).

Almost all garlic varieties are more or less affected by viral diseases through vegetative propagation. This leads to a significant decrease in yields, which can be 80-90% with severe damage. Garlic is more likely to affect 6-7 viruses, but there are a lot more of them. Moreover, not only viruses typical of this crop, but also those that affect other onion plants, including onions, leeks, shallots, and representatives of other botanical families are also a significant threat to garlic (Bobyr, 1960; Demidov, Shulman, 2007). The most common are Garlic Mosaic Virus (GMV), one in the Carlavirus group and the other in the Potyvirus Group, Yellow Dwarf Onion Virus (OYDV), Garlic Yellow Striped Virus (GYSV), Shallot Virus (SLV), Cucumber Virus (CMV), Tobacco Mosaic Virus (TMV) and Tobacco Curl Virus (Messiaen, 1965, 1981; Mohamed, 1981).

Most authors who have studied viral diseases think that garlic is a carrier of mixed infection.Healthy seed when grown in the field is largely prone to virus recurrence due to the high infectious natural background and the large number of carriers of potato viruses (mainly aphids), and in some cases the intense effect of natural factors on the development of hidden viral infection., 1975; Kupriianov, 1978). The seedlings of such plants, due to their biological characteristics are long, time remain physiologically young and largely prone to viral pathogens. In the first year the shortage of potato crop is 13-20% as a result of repeated infection with a viral infection (Majshhuk, 1997).

A forward-looking method of protection against viruses and viral diseases is inoculation of plants with low pathogenic strains (Postnikov, 1990). Although 5-10% of the crop is lost even when the plants are affected by weak strains of viruses, infected plants are a potential source of infection. The response of the varieties to a weak strain of a virus remains unknown and there is a threat of aggressive mutants (Reifman et al., 1996).

Long-term protection against viruses is provided by the treatment of plants with the biological preparation BioClay, which is a mixture of RNA with clay nanoparticles. The principle of action of this biological product is based on the RNA silencing mechanism (Killmer, 2017). Significantly reduce viral load in plant regeneration *in vitro* and subsequent reproduction allows the use of synthetic chemicals. Antiviral effects of such substances as ribonuclease (Zeiruk, 1986), camposan (Postnikov, 1990), tour (chlorocholine chloride), sorbic acid, phenolic compounds, antibiotic imatin (Gaiduk, 1983), potassium permanganate, virazole (Blotckaia, 1995) have been established. TB drugs (Pavlov, 1973), DHT (2,4-dioxohexo-1,3,5-triazine) (Shmyglia et al., 1991), cyanoguanidine, natrialkanmonosulfate, 2-anilino-5-adamantyl-1,3,4 -thiadiazole, glycosides (nicotianoside, somelangoside, tomatoside, phytonic), 2,5-oligoadenylate and other organic and inorganic compounds (Vlasov, Larina, 1982).

But in most cases their use was limited to the addition of nutrient media to the composition, which had no long-lasting effect in reproducing healthy material in the field. Therefore, there is a need to create ways of deterring the reinfection of potatoes and garlic throughout the seed production process. Previous studies have identified the antiviral effect of cascade treatments with pyridine derivatives and a mixture of Brovades 20 with dimethyl sulfoxide. The effect of interferon after effect on the successive reproduction of the super-superlite (extra seed) of potatoes was noted (Muravjov et al., 2014, 2016).

The presented material covers the data on the imposition of cascade treatments with interferon for the sequential propagation of both supplementary and basic seed of potatoes, as well as garlic.

Materials and Methods

Field studies were conducted under conditions of the eastern forest-steppe of Ukraine during 2007-2010 on potatoes of the Tiras cultivar, which was improved by the method of apical meristem, and during 2016-2018 - on garlic varieties Duchess and Merefyansky white. Processing of potatoes with interferon at a concentration of 0.025% was carried out after the plants reached a height of 10-15 cm, garlic - at a concentration of 0.01-0.10%, starting from phase 7 leaves in a cascade way (every 7-10 days) by spraying. Five cascade treatments were performed by spraying the plants with an aqueous interferon solution. The control is without processing.

Field experiment with potatoes was performed according to the “Methodological Recommendations for conducting research with potatoes” (Nemishaevo, 2002): repeat of 4-fold, sections of 4-row, planting scheme – 70x35 cm, (40.8 thousand pieces/ha), the area of the accounting plots is 25 m^2. Garlic was planted according to the "Methodology of Experimental Business in Vegetables and Melon" (2001) in three rows with an area of 10 m^2 in four times the standard method. Accounting for plant damage by viral diseases was carried out visually. The accounting for the damage of potato plants by viruses X, S and B in the latent form was performed by serological method "Methodical recommendations for conducting research with potatoes" (Nemishayev, 2002) drip agglutination using monovalent sera produced by the Institute of Microbiology of the National Academy of Sciences.

Results and Discussion

Dry human interferon leukocyte (Interferonum Leucocyticum Humanum) refers to cytokines and consists of a mixture of different subtypes of natural interferon alpha from human leukocytes. The mechanism of antiviral action is to create protective mechanisms in uninfected cells: change the properties of cell membranes that prevent the entry of the virus into the cell; initiation of the synthesis of a number of specific enzymes that prevent the replication of the virus RNA and the synthesis of its proteins. There is evidence of the ability of plant viruses to initiate the production of endogenous interferon in animals and humans, which may be evidence of the affinity of plant and animal interferon in origin and principle of action. But the phenomenon of interference is a relatively long process, so the introduction of plants into the body at the initial stages of infection with exogenous interferon viruses, which lasts for 5-7 days, is practiced (Vavilenkova, 2012). That is why the studies used a cascade method of crop treatment - every 7-10 days to maintain a constant concentration of it in the cellular juice of plants.

In the course of the researches, the disease of plants by diseases on visual signs was kept. Tiras varieties were affected mainly by mild viral diseases (common and folded mosaic, aukuba-mosaic), and to a lesser extent (mainly by the elite), by severe viral diseases (wrinkled mosaic, twisting and mosaic twist) and mosaic twist (Table 1).

Table 1. Potato viral infections during sequential reproduction depending on interferon treatment (average 2007-2010),%.

№	Variants	Seed potatoes category Super superelite (extra seeds)	superelite (basic seed)	Elite (basic seed)
1	Without treatment (control)	2,8	9,3	12,0
2	Interferon	1,3	4,1	6,5

The incidence of viral diseases for the use of interferon in sequential reproduction compared to controls (2.8%) was 1.5%, indicating that the virus is inhibited by its effects. The prevalence of potato superelite with viral diseases in the control variant increased by 6.5%, whereas when using interferon - only by 2.8%. In the control variant, lesions of potato elite in the control variant had 12.0% of plants, which was 5.5% higher than with interferon. Thus, the use of interferon-affected plants was 46-56% less than in the control variant.
The results of serological analysis indicate the absence of viruses X, S and B in plants by the use of interferon, while 3.4% of plants super control superalites were infected, superelite and elite - 5.2 and 17.5%, respectively (Table 2).

Table 2. The susceptibility of potato plants to viruses in a latent form by sequential reproduction depending on interferon treatment (average for 2007-2010), %.

№	Variants	Seed potatoes category Super superelite (extra seeds)	superelite (basic seed)	Elite (basic seed)
1	Without treatment (control)	3,4	5,2	17,5
2	Interferon	0	0	0

Thus, there should be noted the pronounced antiviral effect of interferon on the manifestation of viral diseases, which is confirmed by serological analysis. Reducing the virus infection resulted in a corresponding increase in the yield of the super-superelite by 11.0 t/ha compared to the control (18.5 t/ha), the super-superlite by 6.5, and the elite by 3.3 t/ha (Figure 1).

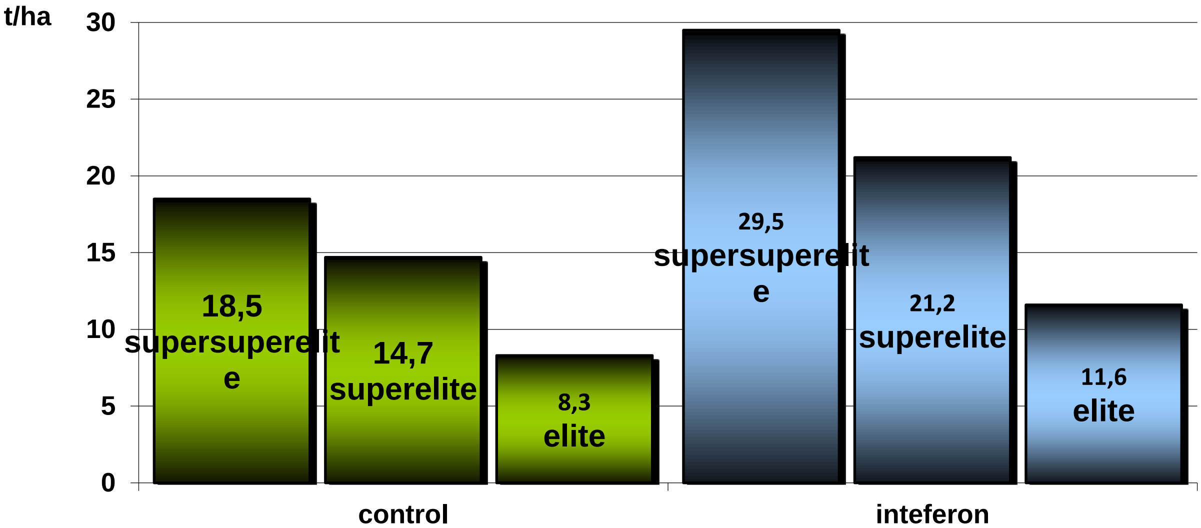

Figure 1. Yield of potatoes in successive reproduction depending on the overlay of interferon treatments (average for 2007-2010), t/ha.

The increase in the yield of potatoes in the variants of the experiment was due to the increase in the number of tubers in the bush and their average weight. However, no significant changes in the ratio of potato fractions were observed. The increase in the number of tubers of each fraction occurred in proportion to their share in the structure of the crop. Particular attention should be paid in this case to increasing the number of tubers of the seed fraction (Table 3). The significant increase in the number of seed tubers of the super-superelite when using interferon by 2.1 pcs/bush compared to the control led to an increase in their yield by 86 thousand pcs/ha; the increase in the number of seed tubers superelite by 2.0 pcs/bush provided 81 thousand pcs/ha; in the case of the elite - 0.6 pcs/bush, which allowed to obtain an additional 24 thousand pcs. from 1 ha. Thus, due to the use of interferon, the number of tubers of the seed fraction is significantly increased, which allows the additional planting of 198 hectares of crops.

Table 3. Number of tubers of seed fraction in successive propagation of potatoes depending on interferon treatment (average for 2007-2010), pcs/bush.

№	Variant	Seed potatoes category super superelite (extra seeds)	superelite (basic seed)	elite (basic seed)
1	Without treatment (control)	5,2	5,8	6,2
2	Interferon	7,3	7,8	6,8

Increased yields and seed productivity contributed to a reduction in the cost of seed by 861 UAH/ton and a 71% increase in production profitability. High efficiency of the cascade method of interferon use was observed in the cultivation of winter garlic planting material. Virus-infected garlic plants had symptoms of chlorosis and mosaics, leaves and peduncles were deformed, seeds (air bulbs) were not formed (Figure 2).

Figure 2. Winter garlic plants damage by viral diseases.

The use of the interferon provided no symptoms of viral diseases in both tested variants of winter garlic (Table 4). Growth of garlic yield in this case was 1.9-2.0 t/ha. The proposed method obtained a patent of Ukraine for utility model for No. 123806 dated 12/03/2018.

Table 4. The interferon effect on viral diseases and yield of winter garlic (average for 2017-2018).

№	Variant	Winter garlic variety	Viral diseases,%	Yield, t/ha
1	Without treatment (control)	Duchess	2,0	7,6
		Merephianskiy white	10,0	6,6
2	Interferon	Duchess	0	9,6
		Merephianskiy white	0	8,5

Conclusion

There is suggested consistent treatment of healthy potatoes with interferon use by way of overlay reproduction. The visual symptoms of viral diseases in plants of super-superlite are reduced by 2.2 times, superelite rate - by 2.3, elite - by 1.8 times. This is accompanied by a reduction in the latency of X, S and B viruses. Potato yield increase with consistent use of interferon, depending on the seed category, is 3.3-11.0 t/ha. The corresponding increase in the yield of tubers of the seed fraction is 24-86 thousand units/ha, which by sequential application of cascade treatments with interferon in the process of reproduction allows to obtain additional seed potato, which can be planted up to 198 hectares of field. An increase in the elite's profitability of growing the elite by 71% due to the use of interferon is associated with a reduction in production costs and a decrease in its cost. The absence of visual symptoms of viral diseases of garlic winter with the use of interferon, which provided a corresponding increase in yield up to 22%.

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