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WAYS OF OPTIMIZATION OF PHYTOSANITARY CONDITIONS IN POTATO IN BELARUS

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Abstract

Phytosanitary situation in potato in Belarus has recently deteriorated as a result of changing role of particular harmful organisms and their proportion in the agrophytocenosis. Harmfulness of many widely spread diseases (late blight, early blight, all species of scab, stem nematode, blackleg) has increased. Diseases earlier belonged to the group of limited occurrence and only potentially dangerous (rubbery rot, dry rot, pink rot, black dot, watery wound rot, ring rot of tubers) began to cause more and more damage, so it required re-examination of strategy and tactics of crop protection against diseases.

Conception of management for potato phytocenosis phytosanitary stability based on the use of agrotechnical, breeding and seed-growing, biological and chemical protection methods was proposed.

Key words: potato, disease, fungus, bacterial disease, virus, stem nematode, protection, agrophytocoenosis.

Introduction

Phytosanitary situation in Belarus in most of the agricultural crops including potato has recently become noticeably worse. It was favoured by crop rotation reduction, filling it with cereal crops, slowdown of cultivar replacement and introduction of cultivars with complex resistance to diseases, use of uncertified seeds, narrow choice of efficient pesticides, and reduction of volumes of protective measures application. Moreover, the role of particular pathogen species and their ratio in the agrophytocenosis have changed. In potato crop harmfulness of many widely spread diseases (late blight, early blight, all species of scab, blackleg) has increased. Diseases that earlier belonged to the group of limited occurrence and only potentially dangerous – rubbery rot, dry rot, pink rot, black dot, watery wound rot started to cause more and more damage. After long-term absence, cases of ring rot occurrence on crop were recorded. All this required re-examination of present points of view on strategy and tactics of crop protection against a number of fungi, bacterial and virus pathogens /Иванюк, 2005; Иванюк, Банадысев, 2005 a, 2005 b/.

Materials and Methods

To reveal the specific composition of potato tops and tuber disease agents, the infectious material collected in registered, perspective and introduced varieties grown in different agroclimatic zones of Belarus was used. The pathogen pure culture was obtained by way of isolation on acidulous potato-glucose agar. The species of phytopathogenic micro-organisms were determined by artificial infection of potato leaves and tubers method and their subsequent re-isolation on natural and artificial nutritive media. *Phytophtora infestans* (Mont.) de Bary was determined with the help of Shick and Black varieties-differentiators set. The identification of late blight agent compatibility types was done under laboratory conditions by combined cultivation of the studied strain with the standard isolate A_1 in vegetable nutritive agar.

Records of the disease severity during potato vegetation and storage were done by the methods common in phytopathology /Методика исследований..., 1967; Методика исследований..., 1995/.

Results and Discussion

Many years' observations on phytopathological situation development in potato in Belarus allowed us to determine that the main reasons of its worsening are the changes taking place in the biology of many disease agents, their high adaptability and plasticity, strengthening of phytopathogenic features. They make new forms much faster than resistant varieties or synthesized new fungitoxic combinations are created.

Late blight (causal agent – *Phytophtora infestans* (Mont.) de Bary), in spite of the long history of its study has not become less dangerous. Phytopathologists indicate that for the last 150 years the danger of epidemic development of the disease practically has not reduced. In Belarus, 25 years out of the last 44, have been with epidemic development of the disease. The second migration of the causal agent of late blight has begun.

Now *P. infestans* affects potato during all vegetation period, beginning from the seedling emergence till natural death of tops. In the year 2002 in Grodno region, the disease was found as early as on the 24th of May – the earliest date in the history of late blight study in the country /Иванюк, Калач, 2006/. Initial disease symptoms more often appear on upper leaves and stems and only then – on middle and lower leaves. Damage of tops and stems of many widely registered cultivars of potato in Belarus was recorded at high level.

Our experiments showed significant changes in relation to causal agent response to environmental factors, especially temperature and humidity. Epidemic development of late blight is registered nearly every year, although weather conditions of vegetation periods significantly differ: from warm and dry to cold and wet.

The main reason of the sudden strengthening of late blight harmfulness is significant changes in the causal agent population structure. At present, we have differentiated pathogen races, including 11 genes of virulence. In Belarus during all years of investigation 481 races have been identified, both types of compatibility of *P. infestance* – A_1 and A_2 and self-fertile type A_1A_2 have been found. This essentially complicated phytopathological situation on potato, as A_2 is characterized by higher aggressiveness and virulence. Moreover, early disease appearance is also connected with possibility of

A_2 type to affect seed tubers, keep safe inside them, and on combined development together with type A_1 form sexual structure – oospores, which may remain in the soil for 4–5 years, and according to some data – to 30–35 years.

In some years early blight, caused by 2 fungus species of *Alternaria* spp. – *Alternaria solani* (Ell et Mart.) J. et G. and *Alternaria alternata* (Fr.) Keissler, causes damage not less than late blight. In the years of epidemic development of this disease (1991, 1992, 1994, 1999, 2002, 2006, 2007) the tops of all registered cultivars of potato in Belarus were affected for more than 50%, and tuber yield reduced by 25–30%. Middle-ripening and middle-late-ripening cultivars are especially heavily affected by early blight.

A serious threat to potato seed production is posed by rhizoctoniosis (*Rhizoctonia solani* Kühn). The lack of resistant cultivars and effective seed treaters results in 50% death of plants before seedling emergence on heavy damp soils in the years with cool spring. "White leg" during vegetation period is found almost on all plants, and sclerotia – on most of the tubers. As a result, the elite potatoes grown in Belarus in most cases do not meet the requirements for seed potato.

Pink rot (pink late blight) caused by fungus *Phytophthora erytroseptica* Pethyb is encountered more seldom in the conditions of Belarus. Single tubers with the symptoms of this disease are identified almost annually. The disease is favoured by oxygen lack in the soil because of moisture excess and overcompactness.

In separate years on low places with the development of thick tops, especially after applying high rates of nitrogenous fertilisers at air temperatures not exceeding $+24^{o}$ C during the second half of summer, a considerable incidence (up to 20%) of stem white mould (sclerotinia), caused by fungus *Sclerotinia sclerocearum* Lib is observed.

For the last decade, common scab (species of *Streptomyces* spp.) has had epidemic development on potato tubers everywhere, independently of weather conditions, cultivars, technology of production. Such disease development, first of all, is favoured by constantly changing causal agent's structure. Now *S. chromofuscus*, *S. violaceoruber*, *S. melanosporofacie* never met before in the country have become the main *Streptomyces* species able to cause common scab.

Favourable conditions for potato tuber infection by common scab are created by the farming system accepted in Belarus. Even average level of soil pH exceeds 6.0, and as is well known, fields with the soil acidity above 5.5 should not be used for potato growing, especially seed potato.

Rubbery rot – *Geotrichum candidum Link et Pers*., watery wound rot – *Pythium ultimum* Trow., black dot – *Colletotrichum coccodes* (Wallr) Hughes, dry rot – *Fusarium* spp. were the main pathogens identified on tubers during storage. These diseases in Belarus have been identified for the first time only during the last decade. At present these diseases are widely spread. In the years, favourable for development of their casual agents, in some lots of potato up to 15–20% tubers with rot symptoms are registered. The main factors favourable for tuber infection and the further disease development are warm weather with frequent rainfall during final period of vegetation, herbicide application resulting in overcompactness and soil aeration worsening due to the reduction of number of inter-row cultivations, the high rate of nitrogenous fertilisers.

The harmfulness of bacterial diseases – blackleg and ring rot – has increased. Bacterial and miscellaneous diseases cause the greatest damage to potato in the northern parts of the country. Ring rot is registered only sporadically, and the presence of this disease in seed potato is not allowed.

In Belarus potato virus and phytoplasm diseases are widely spread and harmful. Now more than 30 causal agents of this type of diseases are known. The greatest economic damage to the republic's potato growing is caused by diseases, causal agents of which are XBK, YBK, MBK, SBK, ABK, leaf roll virus. X and S viruses reduce potato yield, on the average, by 10–20%, severe forms of disease (YBK, leaf roll virus, PSTV) by 70–85%, and sometimes up to 100%.

Particular feature of virology situation in Belarus is that for the last years the area of distribution of high-pathogenous virus strains has been extended, which results in increasing damage caused to potato.

At present potato stem nematode, caused by two stem nematode species – *Ditylenchus destructor* Thorne and *Ditylenchus dipsaci* (Kuhn) Filipjev – has become widespread. Tuber infection by the nematodes sharply decreases seed and food potato quality. Moreover, yield losses because of potato infection by nematode can be as high as 30–80%.

Altered phytopathological situation considerably influences the efficiency of protective measures applied on potato in Belarus.

For reduction of tuber infection by late blight, first of all, just before tops closing, deep hilling of potato crop should be done. Tubers at the depth of 10–12 cm are affected by late blight 5–10 times less, and at the depth of 15 cm almost are not affected. It is very important to form ridges correctly. Wide ridges with flat tops keep water and together with it spores of late blight and other causal agents at the bottom of plants, which creates good conditions for pathogen penetration into the soil and tuber infection. On narrow ridges with pointed tops water and infection of *P. infestance* together with it quickly flow down into inter-row spacing.

When organizing disease control management difficulties appear in connection with the establishment of dates of first potato preventive treatments with fungicides against late blight and early blight and determination of place and role of forecast in the management. At present forecast in most cases does not substantially effect the determination of optimal dates and number of fungicide application, as in most cases it does not take into account the changes taken place in relations between pathogens and host-plants, and also biology of disease causal agents, time of their appearance on potato.

Late blight and early blight control on potato should be directed to preventive measures rather than to treatments, so that diseases during growing season appear as late as possible. In connection with this we consider that at this stage dates of beginning of "critical" days for *P. infestance* development and phenological forecast should be used as main indicators for the application of protective measures, as the first preventive spraying on all cultivars regardless of the group of their maturity at the time of tops closing in the rows. At later time treatments of food potato should be made based on a short-term forecast; seed potato – by standard plan every 8–9 days, i. e. taking into account only duration of toxic action of used preparation independently of forecasted degree of disease development.

Long-term observations suggest that the longer tops remain green on seed plots the greater danger of tubers affection by late blight is created. Thus in the epidemic years of this disease, when potato tops completely die during a short period of time, tuber affection does not exceed 2–7%. In the cases when after disease appearance its development with the help of fungicides was held at the level 15–20%, the infection reached up to 15–20%, and on separate plots – 40% and more. In the former case together with tops the pathogen are eradicated; in the latter – in the field the fixed level of infection on the growing tops was kept constant for a long time. This way of tubers re-infection can be removed only by timely and qualitative tops destruction on seed plots. The optimum date of tops destruction is its late blight affection at 15–20% level and already formed seed fraction, but not later than 7–8 days after the last fungicide treatment. Desiccants do not affect directly the causal agent of the disease. They deprive it of nutrients, on the green parts of plants after desiccation (stems, stalks) the fungus keeps viable and can infect tubers.

For potato protection against tuber rot, first of all, crop rotation should be followed, as causal agents of many diseases keep in soil and develop on other plant species. As rubbery rot and pink rot more often occur on heavy damp soils with oxygen lack, especially during tuber formation period, all agrotechnical measures, designed to improve plough layer's aeration should be used. Special attention should be given to potato storage conditions. They must be optimal. High humidity level in storages is not allowed, as high humidity favours the spread of diseases, especially bacterial. In spring, careful sorting of seed material should be carried out, in order to prevent tubers with disease symptoms getting into field as this can result in heavy losses.

In spite of the achievements in the sphere of chemical potato protection, an important method of disease control on this crop is cultivation of resistant cultivars. However, solving this problem became more and more difficult. Potato breeders and immunologists have long since recognized pointless developing of new cultivars only with vertical (racial specific) resistance. The most reliable is horizontal (long) resistance, however, and in this direction progress proved to be short-lived. There are no satisfactory donors of potato resistance to pathogens, mechanisms and conditions of horizontal resistance are insufficiently studied. To present day the role of environmental factors in the manifestation of this trait has been underestimated. But their importance is much greater than it has been supposed before. Results of many-years observation showed that this type of resistance manifests itself only under conditions favourable for growth and development of plants of particular cultivar. At all deviations from optimum it decreases. From our point of view, potato selection for resistance to fungus diseases can become effective only when clear methods of control and forecast of intraspecific variability of pathogens and appropriate periods of cultivar replacement are worked out.

Conclusions

1. Among the potato fungal diseases that occur during the vegetation period under Belarus conditions, the most common and harmful are late blight, early blight, rhizoctoniosis and common scab. In epiphytoty years these diseases can cause a tuber yield decrease of more than 25%.

2. During storage, the greatest damage to potato is done by rubbery and dry Fusarium tuber rots, the losses from which can make up 15–20%.

3. White and pink tuber rots belong to potentially dangerous potato diseases. In the years favourable for their occurrence, their severity can range from 1.5 to 20%.

4. Timely application of the complex of protective measures for potato production in Belarus even in the years of epidemic development allows to reduce tops' damage by late blight and early blight from 80–90% to 5–10%; tubers with rots from 15–20 to 1.0–1.5%, which gives an opportunity to save up to 10–12 t ha^{-1} high-quality production.

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REFERENCES

1. Иванюк В. Г. Мониторинг фитопатологической ситуации на картофеле в условиях Беларуси // Фитосанитарное оздоровление экосистем: материалы съезда: Второй Всероссийский съезд по защите растений. Санкт-Петербург, 5–10 декабря 2005 г. – Санкт-Петербург, 2005, т. 1, с. 38–40

2. Иванюк В. Г., Банадысев С. А. Биологические и организационные принципы управления фитосанитарным состояниеем агроценозов в Беларуси // Земляробства і ахова раслін. – 2005 a, № 6, с. 32–33

3. Иванюк В. Г., Банадысев С. А. Проблемы фитосантарии и пути их решения // Актуальные проблемы защиты картофеля, плодовых и овощных культур от болезней, вредителей и сорняков: материалы международной научно-практической конференции, посвященной 100-летию со дня рождения академика НАН Беларуси Н. А. Дорожкина, Самохваловичи, 9–12 августа 2005 г. – Минск, 2005 b, с. 8–13

4. Иванюк В. Г., Калач В. И. Видовой состав и структура популяций возбудителей грибных болезней картофеля на приусадебных и дачных участках в Беларуси // Вопросы картофелеводства: актуальные проблемы науки и практики: научные труды. Всероссийский НИИ картофельного хозяйства. – Москва, 2006, с. 307–314

5. Методика исследований по защите картофеля от болезней, вредителей, сорняков и иммунитету – Москва: ВНИИКХ, 1995. – 105 с.

6. Методика исследований по культуре картофеля. – Москва, 1967. – 262 с.