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Do Russia and Eastern Europe need GM plants?

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Russia, Ukraine and Kazakhstan are the leading agricultural producers, especially for potato, sugar beet and sunflower. The cumulative effect of adverse climatic conditions, high weediness and losses related to viruses and pests (without any insecticide and herbicide treatments) led to losses amounting to 40–80% of potential production in the Russian Federation and other mentioned countries. We have used new biotechnology methods to obtain several crops (potato, sugar beet, sunflower and others) tolerant to abiotic and biotic stresses. For the first time – on the basis of domestic varieties bred by Russian scientists – GM potato varieties have been obtained, resistant to Colorado beetle. These GM potato varieties were recognised as being as safe as traditional ones and have been registered for food use. Using this technology, new biotechnological sugar beet lines tolerant to herbicides were also obtained.

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Russia and two neighbouring Eastern Europe countries – Ukraine and Kazakhstan represent one of the leading regions of the world for the agricultural production, especially for potato, sugar beet and sunflower

According to the Ministry of Agriculture of the Russian Federation, potatoes were grown on an area of approximately 3.3 million hectares at Russian farms of all categories (2008). In 2008 Russia produced an annual potato yield equal to 30.0 million tons (exceeding 10% of world potato production), Ukraine – about 19.5 million tons, and Kazakhstan – 2.4 million tons. Yields and yield stability were influenced by continental weather-related environmental factors in this region: cold winters, and dry and hot weather which is usual for the first half of the vegetation period. The resulting average level of potato productivity in Russia consists of about 9.4–10 tons/ha. The cumulative effect of these adverse growing conditions, high weediness and losses related to viruses and pests, lead to the fact that the total potato losses in the Russian Federation are about 48%.

After 20 years when Colorado beetle was detected in Russia (1949–1969), it has occupied its permanent habitat in the basic zones of agriculture manufacture and was found in many territories of Russia. By 1990 (when the reforming of agriculture of Russia began) the pest was found in 40 areas, 2 territories and 12 Autonomous Socialist Republics (ASSR).

Potato production in Russia is practically everywhere concentrated in the private (individual) farm sector, which has become the main production system: the share of their potato production remains at a level of 95%. Owing to the absence of any insecticide

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and herbicide treatments, the losses amount to 40–80% of potential production and some experts estimate the real annual losses from the Colorado potato beetle alone to be 2–2.5 billion $ US.

It is obvious that development protective measures should be planned on the basis of expansion of existing chemical and biological plant protection methods, and also include the use of new opportunities offered by genetically modified crops.

Biotechnological methods can be seen as the summation of genetic engineering technology and traditional plant breeding. These methods were developed to obtain several crops (potato, sugar beet and other crops [1,2]) tolerant to abiotic and biotic stresses. The technology scheme includes the introduction of original plant lines to *in vitro* culture, the insertion of target gene sequences into the plant cells, the selection of plant lines with the target gene sequences, micropropagation and breeding of modified plant lines.

This advanced technology allows us not only to considerably reduce the time needed for breeding, but also to insert agriculturally important traits which cannot be done in the traditional way. Using this technology, we have obtained biotechnological potato varieties resistant to Colorado beetle and biotechnological sugar beet lines tolerant to herbicides.

The application of the potato varieties and sugar beet lines obtained allows improving reliability, profitability and simplicity of plant cultivation. It will also provide considerable, positive ecological effects and will reduce health risks of both producers and consumers.

Development of the Russian GM potato varieties resistant to Colorado beetle

Scientific work during the past 15 years has led to the creation of GM potato varieties resistant to herbicides, pests, fungal and viral diseases in Russia [3]. For the first time – on the basis of domestic varieties bred by Russian scientists – GM potato varieties have been transformed. Integration of novel trait, resistance to Colorado beetle, was performed with the method essentially new to the Russian selection process, namely, genetic engineering.

Colorado beetle resistant potato varieties have passed all field and biosafety trials (Fig. 1) and were recognised by the Russian state authorities as being as safe as traditional ones and have been registered for food use:

- BT potato 'Elizaveta' Centre 'Bioengineering' RAS, Russia (2005, for an unlimited period).
- BT potato 'Lugovskoy' Centre 'Bioengineering' RAS, Russia (2006, for an unlimited period).

Three GM potato lines have received approvals by the Russian State Seed Committee (the date of priorities November 2004).

Development of Russian sugar beet varieties, resistant to viral infection

Sugar beet (*Beta vulgaris* L.) is another important cultivar of present day Russian agriculture. It is used as raw material, and its gross crop in 2008 was about 29.0 million tons for Russia; about 13.7 million tons for Ukraine, and for Kazakhstan – 0.3 million tons. It is also a traditional and basic domestic source for the production of sugar in the Russian Federation.

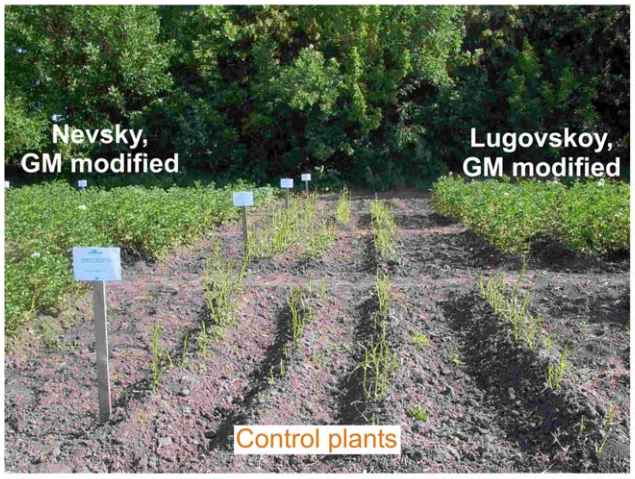

FIGURE 1

Field tests of transgenic potato, resistant to Colorado beetle.

Over half of sugar beet cultivation costs are caused by weed control, but weediness still leads to a 25–30% average yield. In addition, losses of up to 10–11% in sugar beet yield (in Russia) are associated with the infection of beet yellows virus and beet necrotic yellow vein virus. Recently, a group of scientists of the Centre 'Bioengineering' of the Russian Academy of Sciences have created GM sugar beet lines tolerant to herbicides on the basis of phosphinotricine [4] (Fig. 2). Another major research direction is development of new virus resistant sugar beet lines.

These new crops – GM potatoes with their unique border identifiers and all GM sugar beet lines – are protected by 22 patents.

FIGURE 2

Control plants (*on the left*) and transgenic plants (*on the right*) of sugar beet after treatment with herbicide 'Basta'.

References

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