Benefits of weevil resistant sweetpotato varieties

SASHA
Sweetpotato Action for Security and Health in Africa

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Sweetpotato damaged roots by weevils (credit N. Smit)

What is the problem and potential solution?

Weevil is a major threat to sweetpotato, which plays a vital role in food security and income generation for both the urban and rural poor in Sub-Saharan Africa. Weevils can devastate sweetpotato production, and even cause total crop loss. A socio-economic study undertaken by CIP and national partners in Burundi, DR Congo (Kivu province only), Rwanda, and Uganda revealed that weevils cause an average annual yield loss of 20%, or 198 kg per hectare. In Uganda alone, total losses were estimated at 530,000 tons out of an annual production of 2,650,000 tons. The costs in terms of food supply, access to healthy food and lost income can be considerable.

Weevil resistant varieties are the most sustainable solution to this problem. They could potentially increase food production by 25% for populations threatened by malnutrition in Sub-Saharan Africa. However, decades of research and breeding efforts have failed to develop weevil-resistant varieties. Faced with this challenge, we are applying advances in biotechnology, by using genes tailored to resist insect pests, to provide the solution.

Why sweetpotato?

In Sub-Saharan Africa, sweetpotato is a staple crop grown primarily by low-income earners, most of whom are women. During seasons of low rainfall, when there is insufficient food, sweetpotato is often the only food available locally. It is a good source of carbohydrates and micronutrients, and it produces higher yields per unit area than any other crop.

Why are weevils such a threat?

Weevils cannot dig but they are a particular threat during dry periods, when cracks form in the soil, facilitating their access to the sweetpotato roots. The principal weevil species in Africa are *Cylas puncticollis* and *Cylas brunneus*, both of which are widespread. Larvae emerge from eggs deposited in cavities in the vines or under the root skin. They create feeding tunnels leaving behind microbes that cause rotting of the sweetpotato root. In response to this microbial infection, the root produces highly toxic compounds that render the whole root, even those parts that appear unaffected, unsafe for consumption. Adult weevils emerging from pupae near the root surface can quickly infest neighboring fields, even up to 120 m away.

What have past efforts revealed?

To date, decades of efforts to develop methods for controlling this pest in Sub-Saharan Africa have not succeeded. A method using pheromones to mass-trap males of a different type of weevil showed promise in Cuba, but failed to reduce root infestation when applied in Uganda. Moreover, the cost of pheromones would be prohibitively high for African farmers producing sweetpotatoes. Field sanitation, the most effective way of controlling weevils, is too labor intensive for small-scale farmers practicing piecemeal harvesting.

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Small-scale farmers in SSA producing sweetpotato (credit S. Tumwegamire)

Detecting weevil infestation is difficult. Adult weevils are nocturnal and the larvae's feeding habits unpredictable. Attacking the weevils directly is difficult as well. Most of the weevil population is distributed below the soil surface, limiting the effectiveness of insecticides.

There has been substantial research on components that could offer resistance, including the recent identification of periderm compounds in the latex of sweetpotato that could be active against weevils. However, no complete resistance to weevils from the crop's germplasm is yet available for use in breeding.

A promising approach

Biotechnology offers the potential to develop resistant varieties that could be rapidly adopted and contribute to food security and income for African population threatened by malnutrition.

Insect resistance, specifically to Lepidopteran and Coleopteran pests, has been successfully achieved in several crops using genetically engineered plants that express insecticidal proteins similar to the crystal (Cry) proteins from *Bacillus thuringiensis* (Bt). Use of Bt crops has resulted in a significant reduction in insecticide use as well as in yield increases. This has resulted in enhanced grower profitability and increased diversity of non-target insects. The lack of success in integrated pest management and conventional breeding makes exploring the Bt option particularly attractive.

Other benefits of biotechnology include no negative impacts on human health or the environment. Farmers and their families would not consume partially damaged roots suspected to contain trace amounts of toxic compounds. The absence of intellectual property rights on the sweetpotato weevil resistance technology for use in African countries also means that there will be no limitation to transfer it to other partners should it turn into a success.

Undamaged roots suitable for human consumption (credit R. Mwanga)

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