A Gift from Georgia for Northeast Wheat Growers

Integrated Fusarium Management using Resistant Landrace Wheat

Eli Rogosa, Northeast Organic Wheat – Funded by SARE <growseed.org>

Biodiversity is the organic farmers' best defense against disease and pests. However the power of biodiversity to protect against the ravages of Fusarium Head Blight (aka Fusarium or scab) is yet untapped in the Northeast. Although landrace (aka heritage) wheats from European lands with similar climates to ours have evolved the resistance to fusarium that organic growers seek, these wheats are today on the verge of extinction.

Fusarium causes serious crop damage to Northeast wheats due to our typical rainy weather, susceptible cultivars and crop residues that host Fusarium. When moisture is high at wheat's flowering and grain filling stage, the tiny spores of Fusarium infect the spike. Fusarium contaminates the grain with deoxynivalenol (also known as DON or vomitoxin) that reduces grain quality, flavor[1] and yield. According to Ben Gleason, an organic wheat grower in Vermont, 'Fusarium is the greatest pressure faced by New England's organic wheat growers.' To prevent contamination of wheat food products with vomitoxin, flour mills test wheat and will reject grain with more than 2 parts per million of DON.

bleached-out fusarium-infected wheat spikes

Growers recognize fusarium in the field by the bleached-out, white spikes oozing orange-pinkish spores. During wet weather, there may also be white or pink fluffy mold on infected heads. Infected grain heads produce shriveled, discolored, lighter weight kernels.

[1] 'Pigs can detect as little as 1 ppm of DON and refuse to feed on contaminated grain if given a choice of clean grain.' Dr. Gary Bergstrom

Integrated Strategies to Control Fusarium include:

1. **Cultural Practices**:

a. Crop Rotation – Fusarium can survive on crop residues of previously infected crops. A three year roration between cereal crops will assure complete decomposition of infected residues. Even a single year non-host crop between cereals helps to reduce Fusarium inoculum potential.[2] Incorporate cover crops and diverse crops that are not hosts for fusarium and that build soil life.

b. Disease Suppressive Soil - Manage compost at lower temperatures with minimal turning over longer periods to encourage earthworm activity. Earthworm castings contain complex microbial communities that suppress fungal pathogens, and help decompose and decontaminate infected grain stalks that host fusarium. Apply disease-suppressive compost generously.

c. Residue Management - Avoid overwintering grain residues that can host fusarium. Contamination is common when wheat follows corn, especially if residues remain on the soil surface. Fine chopping and tilling-under residues enhances decomposition and decreases contamination.[3]

d. Stagger planting dates or plant varieties with different days to maturity. This reduces the risk of the entire crop being infected during flowering or grain fill, the vulnerable periods for infection.[4]

2. Post Harvest – Since Fusarium infected kernels are lighter than healthy kernels, they can be removed using a gravity table to separate out the light weight kernels.[5] A home-made gravity table can be fashioned simply by placing grain in a hand-held box and shaking it in small vigorous motions so the lighter seeds are vibrated to the lower section to be removed.

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[2] Dr. Gary Bergstrom, Cornell University, a plant pathologist and Fusarium specialist, our region's disease management expert - from his workshop and editorial contributions.

[3] Fusarium head blight and mycotoxins in cereals – potential strategies to control contamination under conservation tillage. Susanne Vogelgsang, Andreas Hecker and Hans-Rudolf Forrer. Research Station Agroscope Reckenholz-Tänikon ART, Reckenholzstrasse 191, 8046 Zurich, Switzerland, susanne.vogelgsang@art.admin.ch

[4] Dr. Gary Bergstrom ibid

[5] Dr. Gary Bergstrom ibid

3 . Fungicides - Organic growers have few fungicides to choose from[6], and even when used, fungicides do not guarantee protection from infection, since fusarium infection can occur at grain maturity past the time when fungicides may be applied.

Jack Lazor, Butterworks Farm, VT, observes: 'Spraying the biodynamic silica prep on wheats reduces Fusarium.' Silica is used to supress fungal diseases, to stimulate leaf growth and to enhance ripening, however it may cause burning if the weather is very dry. Contact <jpibiodynamics.org> to order.

4. Grow and Breed Fusarium-Resistant Varieties - Growing resistant varieties is the most effective solution and a key for organic growers. To enhance Fusarium-resistance in your favorite varieties, harvest the healthiest wheat spikes on disease-free plants by hand. Rogue out fusarium-infected plants and discard. This method works best with genetically diverse heritage varieties.

Where can we find fusarium resistant wheats? Progress in breeding fusarium-resistant wheat has been slow, not only due to lack of effective sources of resistance, but to the lack of hard red wheat breeding programs in the Northeast. Modern wheat is bred for genetic uniformity and yield in high-input industrial farming systems. The narrow genetic base of modern wheat has resulted in the loss of the robust survival mechanisms that enabled Europe's landrace wheats to survive disease pressures in their regions of origin[7]. Modern wheat bred in conventional Midwest farms in climates and soils vastly different from the Northeast lack sufficient fusarium resistances for our rainy region. European countries with climates similar to the Northeast bring experiences more relevant to ours.[8]

Searching for Fusarium Resistant Bread Wheat for the Northeast

What exactly is a landrace? Landrace wheats are populations that evolved over generations of natural and human selection to be well adapted to their local conditions, survivors of adversity with durable resistances to the complex of local diseases. Landrace wheat is typically composed of mixtures of genotypes and natural hybrids, reflecting generations of natural and on-farm selection.[9i]

In the Fertile Crescent, where the first wheats, einkorn and emmer, were domesticated and durum wheat evolved, wild wheat still grows on field edges, quietly providing a gene flow of about 3% to 5% outcrossing of resilient wild traits.[ii] Bread wheat evolved in the Transcaucasus region, one of the most ecologically diverse regions in the world. Wild grasses crossed with emmer, einkorn and durum wheat to create a vast diversity of bread wheat species each with diverse populations.

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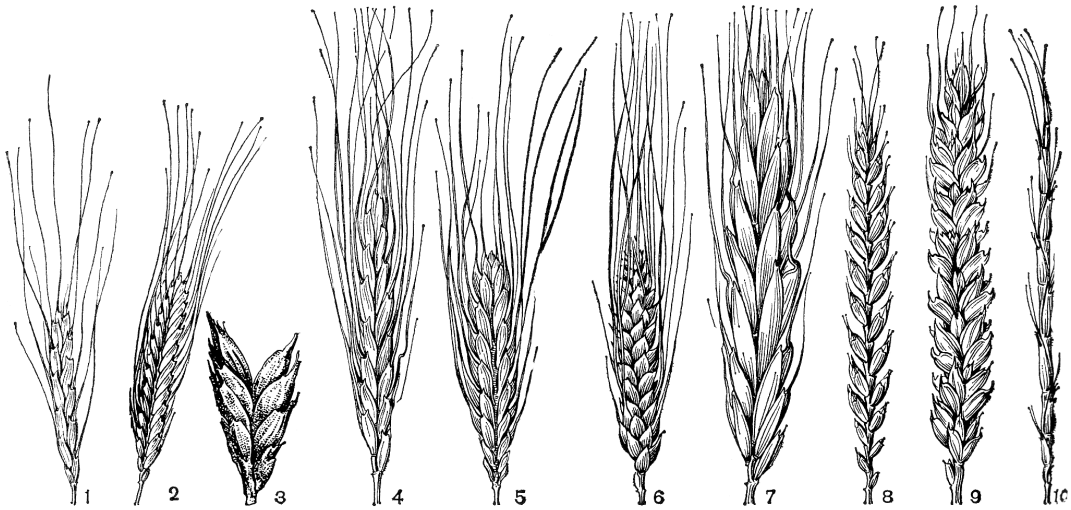
[6] ***None*** of EPA listed products on the ScabSmart site can be used organic production.

[7] Raul Robinson, Breeding For Resistance

[8] Fusarium Diseases in Cereals – potential impact from sustainable cropping systems - Proceedings http://cost860.dk/publications/doc/SUSVAR_Fusarium_proc_final_06dec07.pdf

[9] Jaradat, A. 1992, Euphytica 52: 155-174



Wheat Species: wild wheat, einkorn, emmer (3,4), timopheevii, durum, polanicum, spelt, bread and aegilops

Genetically diverse landrace populations, infused with genes from wild wheat, adapt through self-regulating, evolutionary systems that mimic natural interactions.[10] The variable genepools of ancient Transcaucasus landrace bread wheats evolved dynamic mechanisms to survive in the rainy local seaside and mountain environments with climates similar to New England. To this day, the Transcaucasus region, especially Georgia, is renowned for its delicious ancient bread wheat species that are almost unknown to the rest of the world. Rare Georgian wheats[iii], evaluated for disease resistances by US researchers, have been found to be *the most fusarium-resistant wheats in the world.*[11]

Unfortunately in the past century, Georgia suffered under 70 years of Russian domination, which amongst other oppressions, struck at the heart of Georgia's deep love of their land by forbidding cultivation of landrace wheat. Russia legislated that Georgia would be the fruit basket for the Soviet Union by exporting its luscious grapes, apples, peaches and citrus. Georgian landrace wheat production ceased. Only imported 'green revolution' seeds were allowed to touch their soil. Wheat was shipped into Georgia from the Ukraine. A tiny handful of seeds of the world's most ancient landrace bread wheat were saved in Georgian institutions[12] and in Nikolai Vavilov's collection in St Petersburg. Today, at the core of Georgia's rebuilding after Soviet dominion is her recovery of the Georgian heritage of diversified traditional agriculture and indigenous food crops.

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[10]The structure of wild and domesticated emmer wheat populations, gene flow and emmer domestication. Luo MC, Yang ZL, You FM, Kawahara T, Waines JG, Dvorak J PS, UC Davis CA, 95616, USA

[11]Evaluation of Fusarium Head Blight Resistance in Tetraploid Wheat. R. E. Oliver[a], X. Cai[a], T. L. Friesen[c], S. Halley[d], R. W. Stack[b] and S. S. Xu[c,*a] Dep. of Plant Sciences, ND State Univ., USDA-ARS, Northern Crop Science Lab., P.O. Box 5677, Fargo, ND 58105 [d] Langdon Research Extension Center, North Dakota State Univ., Langdon, ND 58249.
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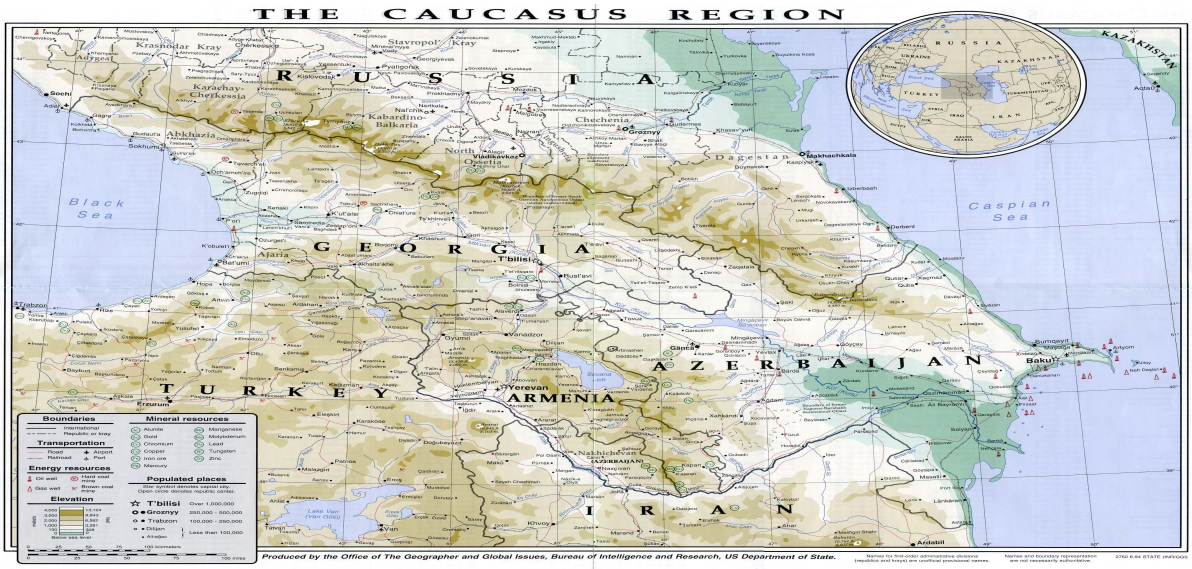
[12] Collections were preserved in the Tbilisi Institute of Botany and the Institute of Arable Farming.



Elkana, the Georgian Organic Farming Association, is single-handedly working to restore the Georgian heritage of wheat and bread traditions. They are working with their national genebank to grow-out Georgian landrace wheats and have restored enough to cover 28 hectares[13] of Tsiteli Doli landrace bread wheat (*T. aestivum*) and 2 hectares of Dika (*T. carthlicum*).

In the SARE-funded Northeast Organic Wheat trials, Georgian wheats not only were totally free of Fusarium, even in the rainiest seasons when other varieties were smitten[14], but have a rich flavor that artisan bakers search for. Following a year of conversations, Eli Rogosa met with Elkana at a European-wide biodiversity conference in Austria held March, 2010. The Georgian organic farmers generously gave Eli a precious bag overflowing with their rare landrace wheats. The satchel of seeds bears a Noah's ark of fusarium resistances for Northeast growers, especially rare species known as:

'Dika' (*T. carthlicum),* believed to be a cross between emmer and bread wheat, has no hulls and easy to thresh. The Georgian organic farmers proudly report that when Dika is baked in a village today, the fragrance wafts through the street and people come running to taste the delicious traditional bread.

Dika

[13] 28 hectares = 69 acres, 2 hectares = 4.9 acres

[14] Georgian wheats have been exploited for resistant genes by breeders for decades, but forgotten as a foodcrop.

Black Zanduri Wheat

'Zanduri' (*T. timopheevii),* known as 'King's Wheat', is a not only source for Fusarium resistance but is cherished for its rich flavor and robust health in Georgia. Thank you Elkana for your generous gift!

photo by Eli Rogosa

Mariam Jorjadze and Elene Shatberashvili of Elkana <elkana.org.ge> share Georgian landrace wheats with Eli Rogosa, Dr. Geza Kovacs, Hungarian Cereal Genebank and Dr. Anders Borgen <agrocologia.dk> at the 'Liberate Diversity' Conference in Austria, March, 2010

Kachapuri, a traditional Georgian savory bread filled with fragrant cheese <georgiancookery.com.ge>

Contact Eli <growseed@yahoo.com> to request Georgian landrace wheat and guidelines to restore them to build a community seed supply.

Visit 'Scab Smart' for Fusarium management updates: ag.ndsu.edu/scabsmart/index.html

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