

Organic Quinoa Production in the Pacific Northwest

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http://www.extension.org/organic_production



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Today's Topics

- Origin and History
- Interesting Agronomic and Nutritional Characteristics
- Variety Selection and Plant Breeding
- Growing Quinoa
- Cleaning and Marketing
- Questions

Background – What is Quinoa?



- *Chenopodium quinoa*
- Member of Amaranthaceae Family, grown primarily for its seed
- Pseudocereal – not a true 'grain'
- Closely related to beets, spinach, common lambsquarters and tumbleweed



Nutritional value of quinoa

- Excellent source of protein
 - 12-18%
 - contains high levels of 10 essential amino acids
- High concentrations of Ca, Mg, Fe, Cu and Zn
- Rich in beta carotene, niacin, riboflavin, Vitamin A, B2 and E
- High in Essential Fatty Acids, particularly linoleic acid

(Vega-Galvez et al., 2010, J Sci Food Agric)

Origin and History

- Center of origin: Lake Titicaca in Peru and Bolivia
- Evidence of cultivation as early as **5000 BC**
- From there, it spread north and southward along trade routes and via animal migration
- Cultivated in Chile by **750 BC**



Risi and Galway, 1984

Origin and History

- After conquest of Inca Empire, cultivation of quinoa was discouraged in place of introduced crops from Europe like barley and wheat
- Quinoa cultivation was reduced to areas of harsh, marginal environment and isolated areas



Adaptation

- Grown over a wide range of latitudes (2°N to 42 °S) in South America – a range of over 3,000 miles
- Wide range in altitude – from sea level to 13,000 ft
- Wide range in annual precipitation (6 inches to over 110 inches)



Five major groups

- **Sea-level:** South-Central Chile, altitude < 500m
- **Valley:** Andean Valleys, altitude range of 2000 to 4000m
- **Subtropical:** Bolivian Yungas, altitude range of 2500-3000m
- **Salar:** Bolivian Salares, altitude approximately 3700-3800m
- **Altiplano:** Lake Titicaca, 3500 to 4000m



Risi and Galway, 1984

WSU Quinoa Breeding and Agronomy Program

- **Goal:** To develop appropriate agronomic practices and quinoa varieties adapted to the PNW environment and wide range of farming systems
- **WSU Collaborators:** Jessica Goldberger (Sociology), Kefylew Desta (Irrigation and Soil Science), Chris Benedict (Extension), Carolyn Ross (Food Science), Lynne Carpenter-Boggs (Soil Science), John Reganold (Agroecology), David Crowder (Entomology), Craig Morris (Cereal Chemistry)
- **University Collaboration:** Oregon State University, Utah State University and Brigham Young University

Crop Diversity

- Washington State ranks second behind California in the number of different crops grown



Interesting Agronomic Characteristics

- Drought tolerant
- Somewhat susceptible to heat
- Grows well in saline soils



Colorado



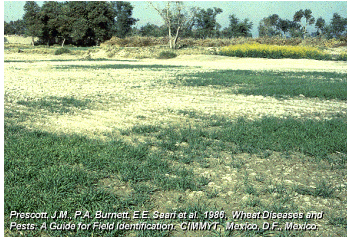
Bangladesh

Soil Salinity

Continent	Saline* Area (million hectares)
North America	6.2
Central America	2.0
South America	69.4
Africa	53.5
South Asia	83.3
North and Central Asia	91.6
Southeast Asia	20.0
Europe	7.8
Australasia	17.4
Total	351.5

Rengasamy, J Exp Bot 2006

Soil Salinity – Symptoms in Wheat



Prescott, J.M., P.A. Burnett, E.E. Sear et al.: 1989, *Wheat Diseases and Pests: A Guide for Field Identification*, CIMMYT, Mexico, D.F., Mexico.

Quinoa – Salinity Tolerance



- Saline Soils > 4 dS/m
- High yields up to 20 dS/m
- 60% of normal from 20-40 dS/m
- Sea water – 55 dS/m

Halophyte - capable of tolerating higher soil salinity while maintaining high yields

dS/m = deciSiemens per meter
(measurement of electrical conductivity)

http://jph.co.in/journal_issues/201109_sep11/paper_22.pdf

A Smattering of Available Seed Varieties

Variety	Seed Color	Source
Brightest Brilliant Rainbow	White	Wild Garden Seed, OR
Cherry Vanilla	White	Wild Garden Seed, OR
Oro de Valle	White	Wild Garden Seed, OR
Red Head	White	Wild Garden Seed, OR
Red	Red	Salt Spring Seeds, Canada
Multi-hued	White	Salt Spring Seeds, Canada
Hi-Yield	White	Salt Spring Seeds, Canada
Shelly 25 Colorado Black	Black	Sustainable Seed Company, CO
Pedro's Improved Red Faro	Red	Horizon Herbs, OR
Apelawa	White	One-Garden, MO
Pison	White/Yellow	One-Garden, MO
Temuko	White/Gold	Bountiful Gardens, CA
Linares	White	Bountiful Gardens, CA
Kaslala	Red/Brown	Bountiful Gardens, CA
Faro	White	Bountiful Gardens, CA



Organic Quinoa Variety Trials

Traits of Interest:

Maturity
Seed size / color
Lodging resistance
Salinity tolerance
Drought tolerance
Lygus resistance
Aphid resistance
Nitrogen-use efficiency
Saponin content
Sprouting resistance



Panicle Architecture



Pre-harvest Sprouting



Yield Trials

- To date, on our very small scale variety trials, the following varieties have performed well in Pullman
 - Colorado 407D (Dave 407: Adaptive Seeds)
 - Brightest Brilliant Rainbow, Cherry Vanilla, Red Head (Wild Garden Seeds)
 - Puno, Kaslaca
- 2013-2016: We will be conducting larger-scale variety and breeding line trials on five organic farms across WA, OR and UT

Washington State trial locations



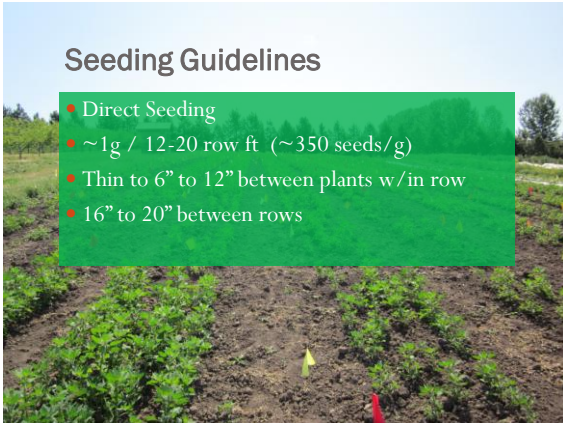
Growing Quinoa - Planting

- Mildly frost tolerant down to 28-30°F
- Germinates well in cold soil 45-60°F
- Planting date ranges on local climate and potential for hard frosts
- March – June planting dates



Seeding Guidelines

- Direct Seeding
- ~1g / 12-20 row ft (~350 seeds/g)
- Thin to 6" to 12" between plants w/in row
- 16" to 20" between rows





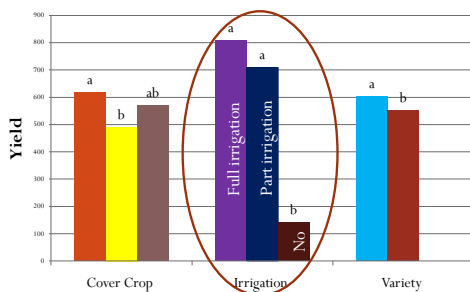


Irrigation

- Can increase yield, but also increases chance for lodging and disease (if overhead irrigation is used)
- Dryland (non-irrigated) cultivation is most common



Irrigation effect on seed yield



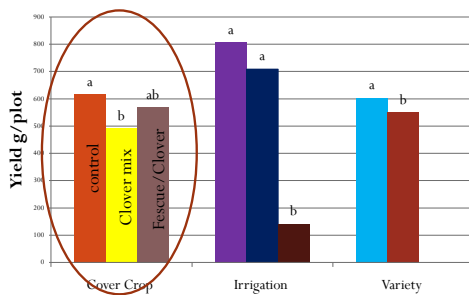
Fertility

- Quinoa grows well in marginal soils & scavenges nutrients
- Reports vary from ~40#N/acre to over 200#N/acre for optimal production
- Lodging increases with high fertility

Intercropping Trial



Intercrop effect on seed yield



Intercrop Winter Survival



Common Pests and Diseases

- **Downy mildew**
 - Prefers cool, moist climates
 - Symptoms: irregularly shaped areas of pink discoloration, chlorosis and/or necrosis, often accompanied by dense, gray sporulation on the leaves
 - Reduces the photosynthetic capacity of the plant
 - Severe downy mildew can cause complete defoliation, premature maturation and almost complete yield loss

Downy Mildew Control

- **Resistant Varieties**
 - Wild Garden Seeds, Philomath, OR
- **Seed surface sterilization**
 - 70% ethanol for 2 minutes or a quick bleach rinse







Lygus & Aphid Control



Biological Control

- Wasps of the genus *Peristenus* are parasitoids of lygus bugs; an adult wasp will inject an egg into a lygus nymph, and once the egg hatches the wasp's larva will consume the nymph from the inside out
- Mymarid wasp *Anaphes orijentatus* attacks eggs
- **Big-eyed bugs, damsel bugs, assassin bugs and crab spiders** are important natural enemies and can help control lygus bug nymphs on host plants

Seed Maturity

- Seeds should be hard and dry
- Fingernail test



Harvest









Importance of Dry Plant Matter / Seed



Tarp Drydown



Seed Cleaning









Seed Saving Basics

- **Lifecycle:** Annual
- **Pollination type:** Predominantly self-pollinated but can cross pollinate via wind up to ~300 feet
- **Isolation distance:** ~300 feet
- **Population size:** >50 for pure line varieties; >500 for landraces
- **Key concern:** Cross pollination with lambsquarters (*Chenopodium album*)

Saponins

- Found on outer seed coat / pericarp
- Benefits: Bird deterrent
- Drawbacks: Human deterrent
 - Bitter, soapy and unpalatable

<http://articles.herballejacy.com/quinoa-%E2%80%93-the-mother-of-all-grains/>

Saponin Removal

- Mechanically via abrasion
 - Mechanical dehulling involves "pearling" the grain to remove the pericarp as bran
- Washing / Rinsing



<http://www.underthelook-species.org/feature/quinoa.htm>

Saponin Removal Canada Style

Washing machine method:

- Run your washing machine through a cycle with vinegar instead of laundry detergent, to clean out any soap residue
- Place the quinoa seed in a pillow case and tie it shut
- Using just the water, run your washing machine through 2-3 cycles with the pillowcase of quinoa inside

<http://www.islandgrains.com/how-to-remove-saponin-coating-from-quinoa-seeds/>

Marketing

Whole grain quinoa bread

Gluten-free products – polenta, spaghetti, etc.

Beer / Vodka

Cereals / Grain mixtures



Quinoa Markets

- Retail
 - Farmers markets
 - CSA's
 - Bakers
- Wholesale
 - Hummingbird Wholesale (Eugene, OR)
 - Whole Foods NW
 - Earthbound Farm



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