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# Quinoa production in Colorado

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## Quick Facts

- Quinoa grows only at elevations ranging from 7,000 feet to 10,000 feet in Colorado. It responds to additional nitrogen but is less responsive to irrigation.
- Quinoa germinates within 24 hours after planting. Planting, tillage and harvesting are done by conventional equipment.
- Pesticides have not been cleared for use on quinoa.

Quinoa (pronounced keen-a-wa), *Chenopodium quinoa*, is a grain crop that comes from the high Andes of Peru, Bolivia and Chile. It has been called vegetable caviar or Inca rice. It is closely related to common lambsquarter and we have observed what appears to be hybrids between the two species. Cultivated quinoa grows at high elevations in Colorado and is limited by temperature to locations between 7,000 and 10,000 feet. Temperatures exceeding 95° F tend to cause the vegetative plant to become dormant or cause pollen sterility.

## Crop Requirements

Total water requirements are minimal; between 10 and 15 inches (precipitation and irrigation combined on sandy-loam to loamy-sand soils). Quinoa responds well to nitrogen. In our first year trials, we observed the following in the variety lineares:

Nitrogen Lbs/A	Yield Lbs/A
15	949.9
65	991.4
125	1377.8

Plants have a wide range of maturity from 90 to 125 days under Colorado conditions. The early maturity types are recommended because of the short season at high elevations. Once the grain has reached the soft dough stage, plants are not



affected by temperatures down to 20° F. A killing frost (24° F) at Gunnison in early August, 1985 found the CSU research plots in mid-bloom. We estimate a 70 to 80 percent loss at this site. Generally a light frost (30 to 32° F) will not harm quinoa.

## Harvest

At maturity, plants have a sorghum-like head. Drydown is very satisfactory and plants are easily combined. A sorghum header attachment is suggested for quinoa. Seed size is similar to millet in diameter (1/16 inch) with two flat surfaces giving it the appearance of a miniature aspirin tablet.

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To simplify technical terminology, trade names of products and equipment occasionally will be used. No endorsement of products named is intended nor is criticism implied of products not mentioned.

Seed color is variable from black, red, orange, yellow to white. The seed coat coloring is caused by a coating of saponin. This bitter-tasting compound has several industrial uses, but it may be toxic to fish. For human consumption, the grain is processed to remove the saponin coating. With the coating removed, the marketable grain is generally white.

One of the problems of quinoa harvest is fall rain. Quinoa seed will germinate within 24 hours after exposure to moisture. This occurs from the point of maximum drydown, which means you could see heads sprouting if it rains and warms up just prior to harvest.

Quinoa insect pests include flea beetles and a wide range of caterpillars. They find quinoa to be very tasty. No pesticides have been cleared for use on quinoa. This fact is important since the value of quinoa is in the health food market where pesticides are not acceptable.

Experiments with quinoa in the San Luis Valley have given consistent yields of 1200 lbs/A for the past two years. Currently, only one numbered variety, D407, is available for experimental production. D407 has early maturity, a semidwarf growth habit, yellow compact heads and medium-small kernels.

## Planting of Quinoa

Quinoa prefers cool soil conditions (45 to 50° F) at 1 inch below the surface for germination. Planting should be at a depth of ½ to 1 inch depending on soil type and available soil moisture. Row width can be variable with a minimum of 14 inches between rows. Germination occurs within 24 hours and emergence occurs in three to five days. A stand of 130,000 plants per acre appears optimal. A stand of this density would require between ½ and ¾ pound per acre. It is a common practice to double seeding rates when conditions are less than optimum.

## Weed Control

Quinoa is slow growing for the first two weeks in the spring. Weed control is difficult because there are no registered herbicides. Plant quinoa in fields as weed free as possible and cultivation and hand hoeing are recommended for weed control.

## Water Requirements

Late April to mid-May plantings may not need irrigation until mid-June, provided the soil profile was near field capacity at planting. July rainfall has generally been sufficient in our trials to carry the crop to August. Over-irrigation after establishment tends to produce tall lanky plants and yields are not improved. Over-irrigation in the seedling stages causes damping off and severe stunting.

## Nutrition

Quinoa is called one of the world's most perfect foods. The United Nations Food and Agriculture Organization (FAO) states its quality is "equal to . . . the protein of whole dried milk." Table 1a illustrates nutritional value and Table 1b shows the composition of proteins in quinoa.

**Table 1a: Nutritional analysis comparisons of various grains.**

Crop	% Water	% Crude Protein	% Fat	% Carbohydrate	% Fiber	% Ash
Barley*	9.0	14.7	1.1	67.8	2.0	5.5
Buckwheat*	10.7	18.5	4.9	43.5	18.2	4.2
Corn*	13.5	8.7	3.9	70.9	1.7	1.2
Millet (Pearl)*	11.0	11.9	4.0	68.6	2.0	2.0
Oats*	13.5	11.1	4.6	57.6	10.3	2.9
<b>Quinoa**</b>	<b>12.6</b>	<b>13.8</b>	<b>5.0</b>	<b>59.7</b>	<b>4.1</b>	<b>3.4</b>
Rice*	11.0	7.3	.4	80.4	.4	.5
Rye*	13.5	11.5	1.2	69.6	2.6	1.5
Wheat (HRW)*	10.9	13.0	1.6	70.0	2.7	1.8

\*Crampton, E. W. and L. E. Harris. 1969. *Applied Animal Nutrition, Second Edition*, San Francisco, W.H. Freeman and Company. 753 pp.

\*\*Cardoza, A. and M. Tapia. 1979. *Valor nutritiva. In Quinoa y Kaniva. M. Tapia, ed. Serie Libros y Materiales Educativos No. 49. As cited by J. Risi and H.W. Galway. 1984. The Chenipodium Grains of the Andes. Adv. Appl. Biol. (10):145-207.*

**Table 1b: Essential amino acid patterns (g/16g N) of quinoa compared to wheat, soy and FAO reference pattern for evaluating proteins.**

	Quinoa	Wheat	Soy	FAO (1973)
Isoleucine	4.0	3.8	4.7	4.0
Leucine	6.8	6.6	7.0	7.0
Lysine	5.1	2.5	6.3	5.5
Phenylalanine	4.6	4.5	4.6	—
Tyrosine	3.8	3.0	3.6	—
Phen plus Tyr*	8.4	7.5	8.2	6.0
Cystine	2.4	2.2	1.4	—
Methionine	2.2	1.7	1.4	—
Cys plus Met**	4.6	3.9	2.8	3.5
Threonine	3.7	2.9	3.9	4.0
Tryptophan	1.2	1.3	1.2	1.0
Valine	4.8	4.7	4.9	5.0

\*Phenylalanine plus Tyrosine.

\*\*Cystine plus Methionine.

Source: Johnson and Aguilera. 1980. *Processing Varieties of Oilseeds (Lupine and Quinoa). Report to Natural Fibers and Foods Commission of Texas, 1979-80.*

## Marketing

Currently, the only locally available marketing is done by Quinoa Corporation (P.O. Box 7114, Boulder, Colorado, 80306 (303) 444-9462). It is suggested that you contact a marketing group concerning contracts for quinoa grain prior to production of the crop.