The IR-4 Project
Pest Management Solutions for Specialty Crops and Minor Uses

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Quin-Whaaat?

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Quinoa (keen wah) is a nutritious and potential new high value crop in the US. Development of new varieties suitable for US climatic conditions and sufficient pest control products may be necessary for quinoa to reach its full potential.

Quinoa (*Chenopodium quinoa* Willd.) is a pseudocereal in the Chenopodiaceae family. Quinoa will be proposed for inclusion in the revised Cereal Grains crop group 15. A gynomonoecious plant (both female and hermaphrodite flowers on the same plant), quinoa has an erect stem that may be branched or unbranched with alternate leaves. Planting to seed maturation varies from five to seven months depending on variety and the environment. The small, flat circular shaped seed varies in color from black, brown, red, gray, yellow, orange to purple. Quinoa has a high level of resistance to frost, drought, hail, wind, salinity and pests. Most quinoa is grown in Peru and Bolivia on the altiplano (high plain), a vast cold, windswept and barren 14,000 foot Andean plateau. More recently, quinoa crops have been successfully adapted to the coastal plains of Peru. Archeological evidence indicates that quinoa was important in the diet of the Inca civilization, with cultivation in Peru originating some 3,000 years ago. Quinoa, revered by the Incas as sacred, was considered as *chisiya mama* or "mother grain".

Small Farm in Huacho, near Lima, Peru with grain ready for threshing

Quinoa is a highly nutritious gluten-free food with higher protein content than most cereals and a better balance of amino acids that is similar to casein, the protein of milk. Quinoa is rich in lysine, a limiting essential amino acid in most cereals. Calcium, magnesium and potassium are also found in quinoa in sufficient quantities for a balanced human diet. However, quinoa also contains saponins (detergent-like properties) which can give a bitter taste to quinoa products. Saponin content ranges from high to low (sweet quinoa varieties). Traditionally saponins have been removed by washing before cooking and recently by abrasive mechanical dehulling. Quinoa can be processed into flour, flakes, breakfast cereals, bread, cookies, cakes, porridge, beer, soups, fermented drinks, vegetable milk, pasta, livestock feed, colorants and industrial uses. Leaves and sprouts can also be eaten raw or cooked.

The United Nations declared 2013 as the "International Year of Quinoa" in recognition of the ancestral practices of the Andean people and its role in promoting food security and eradication of hunger, malnutrition and poverty. Based on FAO data, the major producing Andean countries include Bolivia, Peru and Ecuador. Farms vary in size from small growers to large organic producers. Production (tons) increased 57% in Peru and 92% in Bolivia from 2000 to 2012. Peruvian quinoa exports have increased from $15 million USD in 2010 to $83 million in 2013. In 2014, conventional quinoa prices at farm gate ranged from $4000 and $4500 per MT(metric ton) while organic quinoa was $5,200 per MT. There is also production of quinoa in Brazil, Chile, Colombia, Argentina, India, Canada (Saskatchewan and Ontario) and Europe. While climatic conditions and pests are barriers to production in many areas of the US, there is small acreage of quinoa production in Colorado,

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Important pests encountered in the Andes include downy mildew (*Peronospora variabilis* Göum) *Rhizoctonia* damping off, *Fusarium* wilt, leaf spot, seed rot and brown

Downy mildew of quinoa

stalk rot. Andean insect pests include quinoa moths (*Eurysacca melanocampta* (Meyrick) and *E. quinoae* Povolný), armyworms, leafminers, cutworms, aphids, cucumber beetles, thrips and various Hemipteran species. Production of quinoa has been promoted by the Peruvian government in the dry coastal plains for water and soil conservation purposes. Quinoa requires only 30 percent of the water needed by rice and avoids salinization of soil. Quinoa grown in the coast also has higher yields (5 MT per hectare) than quinoa grown in the altiplano (1.2 MT per hectare). The expansion of production to coastal regions has resulted in new pests not observed in the cold altiplano region, increasing the

urgency of having pest management tools available to growers.

Major insect pests in Canada include stem borers, tarnished plant bugs, flea beetles and aphids. Diseases of concern are downy mildew, Ascochyta leaf spot and damping off (Pythium). Weeds in general also need control materials.

The main pest problems in the US are weeds, including the closely related and similar in appearance, common lamb's-quarter (*Chenopodium album* L.). This weed is more aggressive than quinoa and can adversely impact the growth of quinoa early in the season and also contaminate seed lots. Downy mildew has been reported in Oregon and in experimental plots of quinoa in Centre and Lancaster counties of Pennsylvania. Insect pests reported in the US include cucumber beetles, Lygus bugs, flea beetles and leaf hoppers. In Peru registered products for the control of downy mildew include numerous fungicides including metalaxyl, fluopicolide, mancozeb, cymoxanil, propamocarb, dimethomorph, chlorothalonil, *Bacillus subtilis*, extract of *Reynoutria sachalinensis* and *Trichoderma* species. Insecticides registered in Peru include phenthoate and *Bacillus thuringiensis* products. In the U.S. there are no registered products for direct application on quinoa with the sole exception of the herbicide glyphosate.

In addition to a lack of pesticide registrations in the US, the other challenges for growing quinoa are environmental conditions. Quinoa requires short daylengths and cool temperatures for good growth. Cultivated quinoa has been known to flower and produce seed at elevations between 7,000 and 10,000 feet in Colorado. Quinoa is tolerant of light frosts and is not affected by even cooler temperatures down to 20 °F after the grain has reached the soft dough stage. Temperatures which exceed 95 °F cause plant dormancy or pollen sterility.

The increasing popularity of quinoa has not been without controversy. An article in the J. Agron. Crop Sci. (Jacobsen, S.-E., 2011) focused on Bolivia and the impact of boom-like consumer demand for quinoa around the world. With the price increase of quinoa tripling from 1999 to 2008, 90% of quinoa produced in Bolivia is now exported. Jacobsen reported negative effects on the environment including degradation of soil fertility, displacement of llama production and increased erosion. Due to the high value of quinoa, Jacobsen indicated that farmers preferred to sell quinoa and bought less nutritious food for consumption. This was disputed by Winkel et al. (2012) in the same journal citing yield data that did not support the negative environmental effects of increased quinoa production and also disputed the decrease in home consumption of quinoa. Several press articles (The Guardian, NPR, AP, and NY Times) also presented stories about the negative effects of buying quinoa in that poorer people in Bolivia could no longer afford to eat a nourishing staple food because of high prices. However the impact of higher quinoa prices is complex and conflicted by sovereignty and food security issues. Bolivia and Peru have recently incorporated quinoa into school breakfast and new mothers' subsidies and growers in these countries have become economically successful, yet still set aside quinoa for personal use.