AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2016 – 2018

TITLE: Can quinoa be a reliable alternative crop in Malheur County?

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EXECUTIVE SUMMARY:

Preliminary quinoa trials were conducted in 2016 and in 2017 at the Oregon State University Malheur Experiment Station at Ontario, Oregon. The 2016 trial demonstrated that seed yields in the range of 3,000 to 3,500 lb/acre were feasible with low inputs. Varieties would need to have lower and more uniform plant heights, less lodging, and earlier maturity. Single plant selections were made from 'Temuco', 'French Vanilla', and 'Apellawa'. The plants grown from the single plant selections in 2017 had lower and more uniform stature and less lodging. Better control of lygus bugs will be required to establish quinoa as a viable alternative crop in Malheur County.

OBJECTIVES:

There is continued interest in developing alternative crops that may be successfully produced in Malheur County; one crop with potential is quinoa (*Chenopodium quinoa*). Quinoa, a member of the Amaranthaceae family, is considered a pseudo-cereal that produces a grain-like seed which can be sold as a whole grain or used in bread, soups, or other uses. In addition to its status as a gluten-free option for cereal-based products, quinoa is very high in protein compared to wheat. Quinoa is believed to be tolerant of abiotic stresses including salinity, drought, and poor soil quality (Oelke et. al 2009).

1. **Determine whether quinoa can be planted mid-summer as a second crop.**

   A goal of this trial was to explore whether quinoa may be suitable for production in Malheur County. If some lines can be selected as suitable for mid-summer planting, they would have value as a double-cropping option when used in a rotation with wheat or other early-maturing crops such as peas. Mid-season planting would also enable the plant to perhaps avoid the worst of the summer heat during flowering. Kevin Murphy of Washington State University (Pullman) has shown that high heat during flowering can greatly decrease yield, but quinoa has some cold tolerance and survival to about 28°F (email communication, March, 2014). In 2014 we planted quinoa in the spring, it bloomed in the summer heat, and the plants failed to set seed (Buhrig et al. 2015).

2. **Select plant materials that could be mechanized through enhanced uniformity and reduced plant height.**

In order for quinoa to be harvested mechanically with existing local equipment, it will be essential to have a much shorter plant stature and uniform plant size to facilitate combine harvesting. Lines that have plants that mature at the same time are also critical. The seeds will need to mature at roughly the same time so that the entire crop can be harvested by combine and have seed quality. Once the seed has matured in the field, moisture can cause the seed to sprout before harvest, which can be an issue, so producers will not want to leave mature seeds hanging unharvested while other parts of the stand are still finishing and drying.

PROCEDURES AND RESULTS:

A cultivar nursery was planted July 18, 2016 at the Malheur Experiment Station on an Owyhee silt loam soil. Some of the cultivar seed was purchased from the online catalog company Wild Garden Seed (Philomath, OR). Much of the seed was selected from a cultivar nursery grown in 2015 at the Malheur Experiment Station. This seed was taken as individual plant selections.

Many of the selections planted in 2016 were made in the fall of 2015 while some were made from the overwintered plants left standing until spring of 2016. Selection criteria were based on the need for plants that mature uniformly, do not get above an optimal harvest height and have good standing strength. These criteria were developed in part by guidelines provided by Bhargava and Srivastava (2001). The quinoa seed was planted in plots 4 double rows wide and 25 ft long on 22-inch beds with a cone planter. The planting rate was 2.7 lb/acre and many entries were replicated four times. The trial was furrow irrigated. Watermark soil moisture sensors (Irrometer Co., Inc., Riverside, CA) were placed in the field to aid in irrigation scheduling. It should be noted that there were no available data for quinoa irrigation scheduling based on Watermark soil water tension data. The Watermarks were used only to monitor the moisture trends of the soil. A program to control Lygus bug was implemented and the trial was sprayed twice (August 16 and 31) with Gladiator® at the rate of 19 oz/acre at each application.

Quinoa was harvested by hand from the middle 10 ft of the middle two rows of each four-row plot on November 2. Most of the plants were not sufficiently dry to make mechanical harvest possible. The samples were placed in a forced-air dryer in preparation for threshing; a Wintersteiger combine threshed the dried samples on November 9. Grain samples were then run through a fan to remove more of the chaff and stems.

Seeds germinated very quickly with many cultivars emerging within 5 days following irrigation. Stands appeared to self-thin as the plants grew. Vegetative production occurred rapidly (Fig. 1) with many of the entries approaching 6 ft tall.

There was a high degree of variability in plant morphology within each cultivar, with some seed heads drying to red, tan, or brown, indicating genetic variability in those seed lots. The final height measurement was September 27. Severe lodging took

place as the plants matured, making further representative plant height measurements impossible. Some of the lodged plants had broken heads and stems, making them incapable of achieving physiological maturity. There was also a large window of maturity within each cultivar. Many plants had dried down while neighboring plants were still green and immature. This prevented mechanical harvest and required adding the extra step of drying the material before threshing.

Weed control was an issue due to the lack of labeled herbicides available for growing quinoa. Weeds observed included: barnyardgrass, lambsquarter, redroot pigweed, common mallow, and tumble pigweed. One benefit of some cultivars was that they grew very aggressively, which helped them compete with weed pressure by developing a dense canopy and closing the rows quickly.

Plants with a maturity rating of less than 2.4 (scale of 1 to 5, 5 = dead) were not harvested (Table 1). These were deemed too green and the grain did not form in the seed heads. Lines that were harvested had a wide range of yields (Table 2).

Even if the plants had dried down adequately, mechanical harvest would have been difficult due to plants being too tall and lodged. Hand-harvesting the plots and drying the samples for threshing was a time-consuming and expensive task. For quinoa to be successful in Malheur County, we must determine the proper planting time and find cultivars that are shorter in height and will mature more quickly and uniformly. It is important to select for plants that can be harvested by equipment already in use in this region. Single plant selections were made from Temuco, French Vanilla, and Apellawa on November 2. 2016. These selections were based on short plant height and early maturity.

Seed from thirty single plant selections were planted on June 29, 2017 to determine if the plant characteristics will be duplicated. The quinoa was furrow irrigated and received 50 lb/acre of N as urea in late July. The Quinoa received two aerial applications of insecticide to control lygus. The first was made on August 27, 2017, with the application of Gladiator (rate of 19 oz/acre). The second was made in the week of September 18-22, 2017, with the application of Sevin XLP Plus. Harvest took place on last week of October and the first week of November (October 30, 2017- November 3, 2017). Plant heights were 25 to 40 inches tall. Most selections had reduced lodging and several had uniform height. Lygus was substantially more problematic in 2017, compromising reliable seed yield estimates.

References

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Oelke, E.A., D. Putnam, T. Teynor, and E. Oplinger. 2009. Quinoa. Alternative Field Crops Manual. 2009. Accessed via www.hort.purdue.edu/newcrop, March 21, 2014.

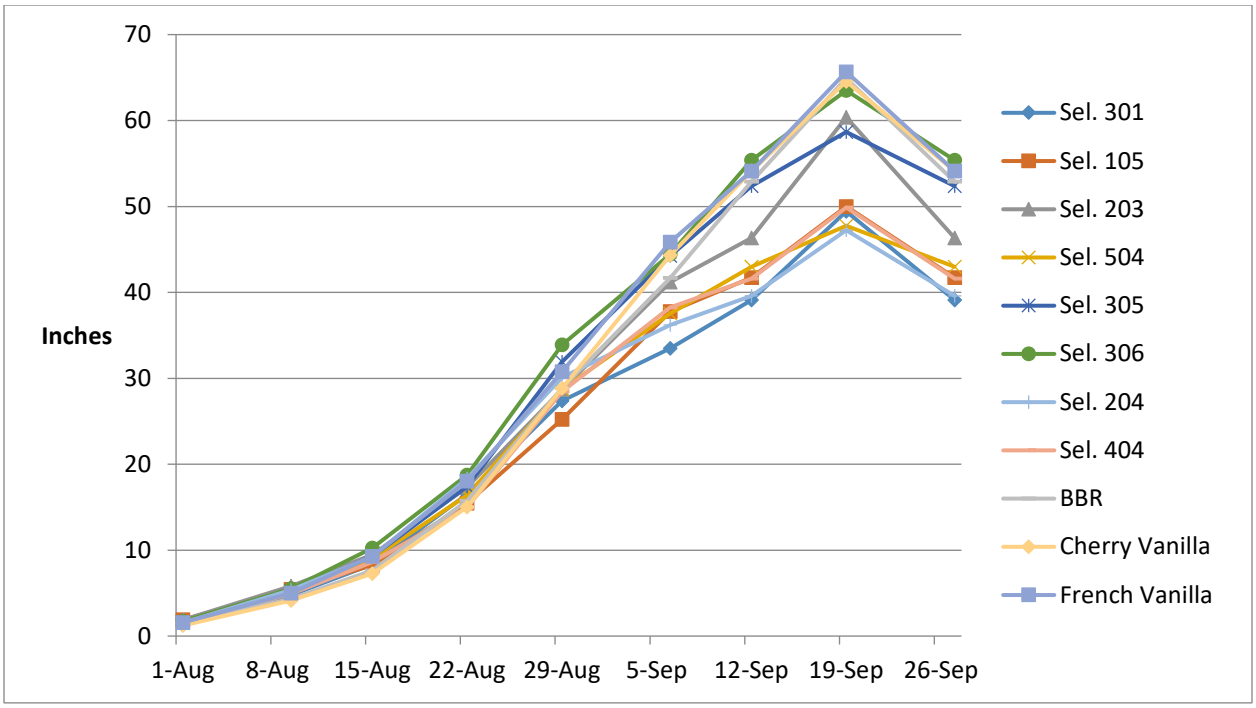

Figure 1. Weekly plant heights (inches) for quinoa planted on 18 July 2016 at the Oregon State University, Malheur Experiment Station, Ontario, OR.

Table 1. In-season ratings for a quinoa nursery grown at the Oregon State University Malheur Experiment Station, Ontario, OR in 2016.

Cultivar	Stand rating (%)(8 DAP)	Plant height (in) (68 DAP)	Harvest index* (68 DAP)	Percent lodged 11 Oct.	Plant maturity** (1-5)(5=dead) 23 Oct.
Sel. 301	47.5bc	49.4	3.1bcd	11.3d	3.8a
Sel. 105	77.5a	50.0	3.5ab	40.0bcd	4.0a
Sel. 203	60.0ab	60.4	3.4abc	70.0ab	2.4bc
Sel. 504	65.0ab	47.8	4.4a	10.0d	3.6a
Sel. 305	61.7ab	58.7	2.3cde	55.0abc	3.3ab
Sel. 306	53.3b	63.5	2.0de	81.7a	2.3c
Sel. 204	65.0ab	47.2	4.2ab	10.0d	4.2a
Sel. 404	74.0a	49.9	4.5a	26.0cd	3.7a
Br. Brilliant Rainbow	45.0bc	64.9	2.0de	55.0abc	1.8c
Cherry Vanilla	28.8c	64.6	2.3cde	73.8ab	2.3c
French Vanilla	57.5ab	65.7	1.6e	70.0ab	1.6c
LSD (0.05)	20.4	ns	1.13	30.69	0.99
F Value	0.0013	0.07	0.0001	0.0001	0.0001

*Harvest index was rated subjectively, 1-5 (5 = best) of the plant characteristics.
** Maturity was rated subjectively from 1 to 5 where 1 was very green and 5 was mature.

Table 2. Non-replicated yields for a quinoa nursery grown at the Oregon State University Malheur Experiment Station, Ontario, OR in 2016.

Selection or cultivar	Yield/acre (lb)	Selection was made from
Sel. 301	2016	Apellawa[1]
Sel. 105	1854	Red Head[2]
Sel. 203	3591	Colorado[1]
Sel. 504	3355	Temuco[1]
Sel. 305	2060	Red Head[2]
Sel. 306	------*	Brightest Brilliant Rainbow[2]
Sel. 204	3198	Temuco[1]
Sel. 404	3164	Temuco[1]
Brightest Brilliant Rainbow[2]	------*	
Cherry Vanilla[2]	------*	
French Vanilla[2]	------*	

* Not harvested due to lack of maturity
[1]Bountiful Gardens, Willits, CA.
[2]Wild Garden Seed, Philomath, Oregon

SIGNIFICANT ACCOMPLISHMENTS:

Quinoa seed yields in the range of 3000 to 3500 lb/acre can be obtained with a mid-summer planting of existing plant materials; however, the plants are not sufficiently early or uniform to permit mechanized harvest. Single plant selections hold the promise to reduce plant height and provide earlier, more uniform plantings that could be harvested mechanically.

BENEFITS & IMPACT:

Quinoa has the potential to be a highly nutritious food with potential for profitable return to growers. Plant improvement and adequate control of lygus are barriers to overcome before quinoa can be grown economically in Malheur County.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:

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FUTURE FUNDING POSSIBILITIES: none identified at this time.