EFAO
ECOLOGICAL FARMERS ASSOCIATION OF ONTARIO

2022

Screening of quinoa transplant date and viability

FARMER-RESEARCHERS
Dean Orr, Mill Valley Farm

FUNDING
Brian and Joannah Lawson Family Foundation

The Arrell Family Foundation

IN A NUTSHELL

In a continuation of his 2021 quinoa variety screening trial, Dean screened the viability of transplanting quinoa for five seeding dates and two transplant dates.

- Quinoa can be successfully grown from transplants and this method offers excellent weed control under organic management
- The efforts and cost of transplanting labour appears to be feasible with the high price of organic quinoa
- Dean believes that with no difference in germination and transplant survivability, earlier transplanted quinoa would be easier to manage with a longer harvest window and less possibility of head sprouting in the fall

MOTIVATION

As continuation of Dean's 2021 quinoa variety screening trial (1), the goal of this trial was to examine direct seeding dates for quinoa, and their effects on competitiveness, weed suppression and yield. More specifically, Dean wanted to see if earlier seeded quinoa was going to be more successful. After the plots had been laid out, and the first planting was completed, the experiment had to be abandoned due to some capacity concerns on the farm. Dean pivoted the experiment to a smaller, more manageable one, looking at the efficacy of transplanted quinoa.

Given the high price of organic quinoa, Dean hypothesized that the extra labour required to transplant will still likely lead to a good net return and allow the plants a significant head start on weed pressure, which was found to be the main issue with last year's direct-seeded quinoa experiment. Anecdotally, this year's abandoned experimental plot still appeared to be suffering poor germination and heavy weed pressure, and would likely have resulted in poor yield.

To assess the viability of transplanting quinoa in his system, Dean evaluated five seeding dates and two transplant dates, and measured germination, transplant survivability, and harvest yield.

METHODS

The area chosen for the 2022 quinoa transplant plots was a sandy loam with good fertility, making it an excellent site for transplanting. Dean used no additional fertilizer. The previous year's crop was green beans and corn. Weed pressure was high from the weed seed bank. The land was not certified organic, however the quinoa was managed organically.

Transplants in plug trays

Height difference between a 72 cell tray and 200 cell Tray.

CELL PLANTING

Dean started transplants in plug trays of various sizes, and planted into a commercial seed starting soil mix. He used Buffy, the best performing variety from the 2021 trial from Wild Garden Seed Ltd. in Philomath Oregon, purchased in 2021. This seed was labeled as having a 93% germination rate at the time of purchase.

Dean planted one seed per cell, to get an accurate calculation of germination rates. He kept all plug trays outside the entire time, in partial shade, to prevent seed trays from drying out too quickly. Trays were kept constantly moist with use of a mister on a garden hose. He evaluated five planting dates approximately two weeks apart from each other: April 27, May 12, May 28, June 10, and June 25.

FIELD PLANTING

Dean observed that for optimal transplant hardiness, quinoa should be transplanted four to five weeks post cell seeding. He transplanted the quinoa seedlings into rows 198' long. He transplanted the first two seeding dates on June 5-6, with the seedlings at ages 5.7 and 3.9 weeks, respectively. The last three seeding dates were transplanted on July 22-23 with the seedlings at ages 8, 6, and 4 weeks, respectively.

Dean transplanted five rows of quinoa total, each row with a different seeding date.

Rows three and four were the seeding dates of May 28 and June 10 and did not have enough surviving seedlings to fill the 198' row, and so were only partial rows.

Dean irrigated all quinoa post-transplanting. A rain event watered in the first transplanting and Dean used a small irrigation reel to water in the second transplanting. He used no other irrigation thereafter.

Dean transplanted all the quinoa by hand into rows spaced 5' apart, with plants spaced 6" apart in-row. He purposely set the row spacing wide to observe how wide the quinoa would naturally want to grow and branch. Dean chose the in-row spacing based on work by Buckland et al. 2020, and it appeared satisfactory to allow the quinoa space to grow while also shading out in-row weed pressure. Dean observed that the transplanted quinoa appeared to naturally grow to a width of about 15" in this spacing configuration.

Dean conducted a later season plot (outside of this experiment) which was planted 4 rows wide, on 15" centers, with the same 6" in-row spacing. Dean noted that this configuration appeared to offer excellent in-row and between-row weed control, did not seem to crowd the plants, and seemed to offer additional stem support to reduce lodging during heavy rains.

WEED CONTROL

Prior to transplanting, Dean cultivated the area with a field cultivator to start with a blank slate for weed control. For post-transplant weed control he used hand hoes and wheel hoes. Both worked well for him and he only needed to weed once in-row. The quinoa was successfully able to shade out the weeds within the row after that. Weed control between rows required two or more passes.

In his side experiment plot, with quinoa transplanted on 15" centers, Dean only needed to weed once for effective control, as shading was much more effective.

With transplanted quinoa, it was extremely easy to tell the crop from weeds — even the look-alike lambs quarters.

First row of quinoa at transplanting

Quinoa at 16 days post-transplant, showing the distinct sway present in a noticeable number of transplants. This plant is quite a severe example, others were not as pronounced.

Quinoa plot on Sept 17, 2022. Row 1 is on the right, Row 5 on the left. Row 1 is about ready to harvest. Row 2 is about 10 days away. Row 3 and 4 are visibly stunted and not complete rows. Row 5 is lodged due to weak stalk strength in combination with rain. Rows planted closer together in a separate plot behind the camera, on 15" centres, did not lodge as badly.

Quinoa at approximate harvest readiness. Overall plant height is approximately 75-85 cm.

DATA ANALYSIS

To evaluate the effect of quinoa planting date on germination we used an analysis of variance (ANOVA) to calculate a probability value (p-value) based on the difference we observed among treatments. We used a cut-off value of 0.05, meaning we wanted to have 95% confidence in any difference we observed. If the p-value was less than the cut-off value, we had confidence to say the treatment produced differences. If the p-value was more than the cut-off value, we concluded there was no statistical difference. If we detected a difference among treatments, we conducted another test (i.e. a post-hoc test called the least significant difference, LSD) to determine where the differences occurred between treatments.

FINDINGS

SEEDING DATE GERMINATION

For each planting, Dean evaluated the total number of seeds that germinated two weeks after the seeding date and found no significant difference in germination among varieties (P=0.21). As seen in **Figure 1**, he observed that trays seeded on June 25 had the most variation in germination.

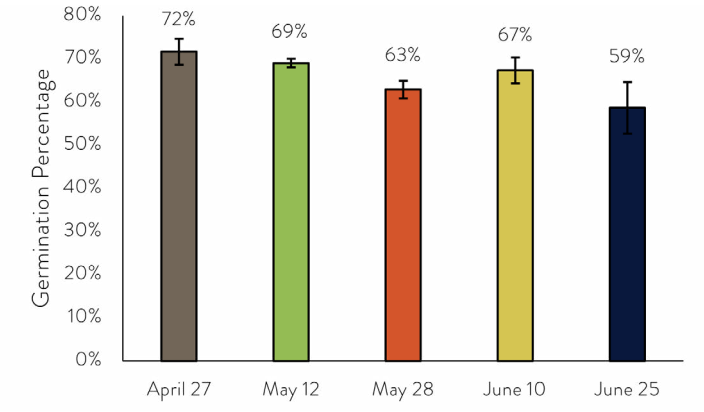

Figure 1. Germination percentage ±SE of seeded quinoa by date.

TRANSPLANT SURVIVAL RATE

Dean evaluated transplant survival two weeks post transplant by counting the number of surviving transplants and comparing that to the expected number of transplants. Overall, Dean noted that transplant survival was excellent for both transplant dates and among seeding dates (**Figure 2**).

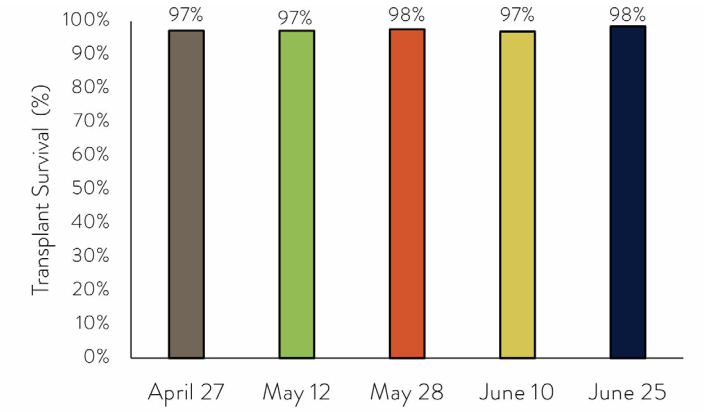

Figure 2. Transplant survival by seeding date of quinoa.

Dean noted that seedlings sowed on May 28 and June 10 were extremely stunted and appeared to produce seed before/during transplant. He was unsure if this was an effect of the heat stress in the cell trays or day-length sensitivity. Regardless, the transplants did not appear to suffer dramatically different survival rates, as the vast majority survived, although they did not grow much taller than they were at time of transplant.

Dean observed that although transplant survivability was high, many transplants ended up having a crooked stem right near the ground. This wasn't a huge issue, but did make weeding a little more difficult as plants would lay out of the row.

While Dean noticed plant height differences, dependent on cell size, in the seedling trays,the difference disappeared after several weeks post transplant, and did not seem to affect plant survivability, vigor, or overall height.

Another observation Dean made was that quinoa seems to be severely impacted by the allelopathy of black walnut trees. The quinoa planted closer to the field edge did worse the closer it got to the black walnut trees.

Threshed and mostly cleaned quinoa. There are still some aborted seeds present.

HARVEST AND YIELD ESTIMATES

Dean planned to determine yield as quinoa was harvested. Due to time constraints, however, he was only able to harvest and weigh the first row of quinoa, which was the first quinoa to be seeded and transplanted.

Dean harvested the plants by hand, by clipping them at the base and stripping the heads into clean garbage pails. He harvested the quinoa on September 17 and 22, and noted that it was noticeably drier and easier to strip on September 22. With the approximate maturity of 148-155 days, Dean noted that the plants could have likely dried down another week past September 22.

A side experiment of quinoa transplanted on 15" centres at 29 days post transplant. The rows have only been weeded once with a hand hoe and ended up being very clean and weed-free.

Table 1. Harvest and yield estimates based on one row of harvested quinoa

SAMPLE	WEIGHT (G)	WEIGHT/YIELD PER PLANT (G)	YIELD PER ACRE ON GIVEN ROW AND PLANT SPACING (17,424 PLANTS PER ACRE) (KG)
15 PLANTS YIELD	263.8	17.6	306.5
15 PLANTS FOR SELECTION	275.4	18.4	319.9
221 PLANTS FOR SEED	1992.7	9.0	157.2
251 PLANTS, ALL COMBINED	2531.9	10.1	175.8
No statistical analysis was conducted on this data.			

Dean took a sample of 15 plants, (roughly 1 plant every 15) as a measure of yield per plant. He took a second sample of 15 plants with straight stems and good upright growth for plant breeding selection in future years. He put the rest of the plants in the third container. As Dean knew the number of plants harvested, he was able to combine the sample weights to get a rough estimate of yield per plant, and a rough estimate of yield per acre (**Table 1**).

Dean noted that during harvest no head sprouting was noticeable on the plants. While threshing, however he did notice head sprouting.

He threshed all of the quinoa by hand, which was extremely labour intensive, and cleaned it with an old clipper seed cleaner. Dean noted that while threshing by hand was fairly difficult, he was able to get the samples fairly clean with this simple seed cleaning system, except for what he is assuming was aborted seed, which maintained a similar size and shape to the grain.

CONTENT AND CAVEATS

Dean noted that keeping plug trays constantly moist was harder on later planting dates, as temperatures and daylight increased. The older seedlings from the second transplant date (May 28 and June 10) suffered more significant heat stress in the trays, given the warmer temperatures they were growing in.

Dean has recently learned that quinoa seed may be mature 2-3 weeks before measured plant maturity at dry down. Swathing the quinoa at seed maturity while the stems are still green may lead to an earlier harvest and more consistent threshing.

A side experiment of quinoa transplanted on 15" centres, at time of transplant (28 days after seeding).

A side experiment of quinoa transplanted on 15" centres 57 days post transplant

A side experiment of quinoa transplanted on 15" centres 57 days post transplant, with one hand hoeing for weed control. The understory is very clean of weeds. This is also a good view of transplanted quinoa stalks. Most are fairly straight and strong, while still showing some varying severity of sway.

NEXT STEPS

Future explorations include selecting for transplanted varieties that grow straighter and more upright after planting; selecting for varieties that establish more quickly under direct-seeded conditions; utilizing better row spacings and examining effects on yield; and expanding plot size to examine efficacy of mechanical transplanting and harvesting.

Dean notes that it would also be interesting to look at the effectiveness of a tine weeder in transplanted quinoa.

Lodged quinoa after a medium intensity rain. Most of the quinoa stood back up, while some did not. The quinoa transplanted in close, 15" rows, did not lodge as badly.

TAKE HOME MESSAGE

Overall Dean was happy with this year's quinoa. He was able to successfully grow transplanted quinoa, and harvest a crop with a reasonable yield.

Transplanting offered excellent weed control and, aside from the extra labour of transplanting, it did not have many downsides. The extra labour required to seed the cell trays and transplant was likely a similar amount of time as the labour required for extra weeding passes needed in direct seeded quinoa. Dean believes with the right spacing, you may only have to do one or two weeding passes throughout the season on transplanted quinoa.

REFERENCES

1. https://efao.ca/wp-content/uploads/EFAO-Dean-Orr-Research-Report-2021-FINAL-audio-17Dec21.pdf
2. Buckland, K., Rasmussen, A., and Smith, E. 2020. Quinoa Production for the Willamette Valley. Oregon State Extension EM 9300. https://catalog.extension.oregonstate.edu/em9300/html

ACKNOWLEDGEMENTS

FLRP Staff for their expertise and flexibility, and Dean's parents for their continued support.