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We acknowledge that there are 46 treaties, other agreements, and unceded land that cover the territory now called Ontario. We are thankful to be able to work and live in these territories and for the Indigenous, Métis, and Inuit people whom we recognize as contemporary stewards of the land.

RESEARCH REPORT 2021

In search of short season northern grain amaranth varieties: A variety trial of grain amaranth (*Amaranthus* spp)

IN A NUTSHELL

The growers' objective was to document the best short season northern grain amaranth variety for production across different farms throughout southern Ontario during the 2021 growing season.

- Golden Giant, Opopeo, and Atitlan Dorado all performed well and were overall favourites among the growers.
- The Grain Amaranth from Richters Herbs was the growers least preferred variety and didn't perform as well as the other varieties but ranked top in flavour for growers.
- Despite this, growers are interested in adapting this variety because of its good flavour, early flowering, and wide genetics which they hope means they can work with the population to create an ideal variety for their farm.
- Growers' enjoyed learning about grain amaranth production and its story but more work is needed to determine if production at the small and mid-sized scale is feasible with the harvesting and processing labour time.

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MOTIVATION

In 2020, Ronaldo Eleazar Lec Ajcot and Myriam Legault conducted a screening trial of grain amaranth (1). As a result of their work there has been a growing interest in amaranth production for grain among EFAO members in Ontario.

To continue to learn about growing grain amaranth in Ontario, a group of growers worked together to trial the three highest rated grain amaranth from the 2020 screening trial along with other choice varieties. The farmer-researchers aimed to generate a greater understanding of the cultivation of amaranth in southern Ontario in order to contribute to food sovereignty, and to support the preservation of Indigenous knowledge and native plants of the Americas.

This trial evaluated the grain of the plant and not the edible leaves. The multi-farm variety trials objective was to confirm the results of the screening trial from 2020 with replicates on-farm and across farms.

Specifically, six growers from across southern Ontario conducted randomized, replicated trials on their farms to determine the varieties of grain amaranth that are best suited to the region in terms of early maturity, grain yield, disease and pest resistance, and adaptation to ecological growing conditions.

BACKGROUND

This variety trial is a part of a larger project led by Ronaldo and Myriam to use grain amaranth as a tool for promoting sustainable cultivation, cultural significance,

and culinary use of traditional plants of the Americas, and how to incorporate them into people's daily lives.

Climate-resilient and nutrient-dense, amaranth has a potential to support food sovereignty—both locally and around the world, and help farmers to adapt to climate change. It also



Photo 1. Mature amaranth plants in the field at Norfolk Gardens.

provides a unique opportunity to learn about Indigenous knowledge, particularly Rony's Kakchiquel knowledge, and plants native to the Americas.

Amaranth species (*Amaranthus spp.*) have an important story to tell. It is a highly versatile crop—that grows prolifically and is well-known for its capacity to tolerate drastic weather changes. It has been touted as “superfood” due to its unusually high protein, fibre, and iron content, and its greens and seeds were an important staple of the many cultures in the Americas. *Amaranthus retroflexus*, commonly known as pigweed is a traditional potherb eaten by Indigenous Nations in Ontario, although its grain is not a substantial part of their diet.

There are three species of the genus *Amaranthus* that produce large seed heads of edible seeds. *A. cruentus* is native to Central America (such as Guatemala and southern Mexico), and *A. hypochondriacus* is native to Mexico (North America). *A. caudatus* is native to the Andean regions of Ecuador, Peru, and Bolivia. Rony is Kakchiquel, one of the Indigenous Maya peoples of the midwestern highlands in Guatemala who have been growing amaranth for thousands of years,

and he and Myriam have worked in Guatemala to promote the cultivation of amaranth. Amaranth was so important to Indigenous People of this area that the Spanish Crown outlawed the growing of amaranth in the 1500s. Growing these crops in Ontario adds to crop diversity here, which is important for food sovereignty and biodiversity resilience. Once harvested, amaranth seeds are dry popped over heat and made into a cereal, or ground into a flour. Its gluten-free properties give it tremendous value-added potential.

METHODS

In 2021, growers compared four varieties of grain amaranth (**Table 1**) in a randomized and replicated trial at six sites. The growers included three varieties (Atitlan Dorado, Grain Amaranth, and Opopeo) that Rony and Myriam screened in the 2020 variety trial (1), and all growers chose Golden Giant as the growers' choice variety. Rob Read also included one replicate each of Orange Giant and Juana's Orange.

Field Layout

Each grower planted two replicates of the four varieties of grain amaranth listed in **Table 1**, and Rob also planted one replicate of the two

other varieties.

Each planting consisted of one of each variety, planted in a random order. Replicate plantings consisted of 50 plants of each variety either direct-seeded or transplanted, with in-row spacing of 10-14 inches and between-row spacing of 20 inches as recommended by Ronaldo.

Growers observed the following best management practices whenever possible growers:

- Distributed in multiple side-by-side beds or planted in one long bed;
- Avoided the edge of the field and the end of the bed when finding a place for the trial, as well as any areas with known soil, shade, or irrigation differences that would affect some plots more than others;
- Whenever possible, planted the trial in a spot which had the same crop on either side;
- Used stakes to label the plots and drew a field map showing the order and location of varieties.

DATA ANALYSIS

To evaluate the effect of variety on germination, early season vigour, disease and insect resistance, yield, seed size, popping, flavour, and overall rating we used a statistical

Table 1. Species name, source, and production location of the amaranth grain varieties grown in 2021.

VARIETY NAME	SPECIES	SOURCE	SEEDS GROWN
Atitlan Dorado	<i>Amaranthus cruentus</i>	The Mesoamerican Permaculture Institute (IMAP)	IMAP, San Lucas Tolimán, Guatemala
Grain Amaranth	<i>Amaranthus hypochondriacus</i>	Richters Herbs	United States
Opopeo Amaranth	<i>Amaranthus hypochondriacus</i>	Annapolis Seeds	Yonder Hill Farm, Lunenburg County, Nova Scotia
Golden Giant Amaranth	<i>Amaranthus hypochondriacus</i>	Annapolis Seeds	Yonder Hill Farm, Lunenburg County, Nova Scotia
Orange Giant Amaranth*	<i>Amaranthus hypochondriacus</i>	Baker Creek Heirloom Seeds	Mansfield, Missouri, United States
Juana's Orange Amaranth*	<i>Amaranthus cruentus</i>	Baker Creek Heirloom Seeds	Mansfield, Missouri, United States

*Only one replication of these varieties were grown at Willow Creek Permaculture Farm.

model called analysis of variance (ANOVA) with a 90% confidence level to calculate the least significant difference (LSD) needed to call the treatments “statistically different”.

Using a 90% confidence level means that if we measure a difference between any two treatments that is greater than the calculated LSD, we expect this difference would occur 9 times out of 10 under the same conditions. In this case, we consider the difference reliable and refer to the results as statistically significant. On the other hand, if we measure a difference between any two treatments that is less than the calculated LSD, we consider these treatments unreliably different or statistically similar. We could make these statistical calculations because the growers’ experimental designs involved replication of the treatments and farm sites.

FINDINGS

Germination

Growers evaluated germination rates for each variety of grain amaranth 6 to 10 days after planting. Of the 50 plants in each variety, growers rated germination

using a scale of very low (0-19%), low (20-39%), moderate (40-59%), high (60-79%), or very high (80-100%). They found no significant differences (P=0.36) in germination among the four varieties of grain amaranth grown on all farms in this trial (**Table 2**).

Early season vigour

Growers evaluated the grain amaranth’s early season vigour around a month after planting. For each replicate they ranked seedling vigour, including seedling size, health, and growth rate, on a scale from very poor (1) to very high (5). Growers found a significant difference (P=0.02) in early season vigour of grain amaranth among varieties in the trial (**Table 2**). Using an LSD of 0.8, they found that Golden Giant and Atitlan Dorado had significantly higher early season vigour compared to Grain Amaranth.

Disease, insect, and drought resistance

In August or September, growers evaluated disease, insect, and drought resistance on a scale

of 1 (very susceptible) to 5 (very resistant), as found in **Table 3**. Growers found no significant difference (P=0.42) in their rating of disease resistance, nor did they find a significant difference (P=0.14) in their rating of insect resistance. For drought resistance, many growers acknowledged that it was difficult to rate during the 2021 growing season due to the large amount of precipitation. As such, no statistical analysis was conducted for drought resistance.

Days to flower and harvest

Growers noted the flowering date and harvest date for all varieties. They found a significant difference (P=<0.001) in days to flowering

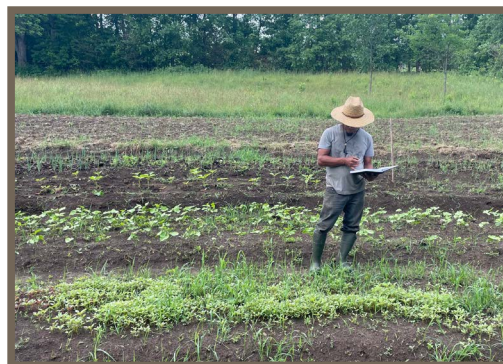


Photo 2. Rony in the field assessing early season vigour.

Table 2. Mean germination and early season vigour rating for each variety across farms.

VARIETY	GERMINATION RATING	EARLY SEASON VIGOUR RATING
Atitlan Dorado	3.8	4.5 a
Grain Amaranth	3.7	3.7 b
Opopeo Amaranth	3.3	4.3 ab
Golden Giant Amaranth	3.3	4.6 a
LSD	NS	0.8
Orange Giant Amaranth	4.0	4.0

NS - No significant difference

Table 3. Mean rating for disease, insect, and drought resistance for each variety across farms.

VARIETY	DISEASE RESISTANCE RATING	INSECT RESISTANCE RATING	DROUGHT RESISTANCE RATING
Atitlan Dorado	5.0	4.5	5.0
Grain Amaranth	5.0	4.8	5.0
Opopeo Amaranth	5.0	4.4	5.0
Golden Giant Amaranth	5.0	4.6	5.0
LSD	NS	NS	NA
Orange Giant Amaranth	5.0	3.0	No Data
Juana’s Orange Amaranth	5.0	3.0	No Data

NS - No significant difference; NA - No statistical analysis

among the grain amaranth varieties, as seen in **Table 4**. Using an LSD of 8 days, Grain Amaranth took significantly fewer days to flower than the other three varieties. They also found a significant difference ($P < 0.001$) in the days to harvest among the grain amaranth varieties (**Table 4**). Using an LSD of 5 days, Golden Giant and Atitlan Dorado took fewer days to be ready for harvest compared to Grain and Opoepo.

Ease of harvest

At the time of harvest, growers evaluated each replicate for ease of harvest on a scale of 1 (hard to harvest) to 5 (very easy to harvest). They found that there was no statistically significant difference ($P = 0.52$) in ease of harvest among varieties (**Table 4**).

Yield and yield rate

When both replicates of a variety were mature, growers harvested each replicate separately. Post-harvest, growers treated each variety grown on their farm in the same way, but methods varied across farms. Some growers dried

each variety out under a shelter for one week and then threshed and winnowed the replicates. If they did not have space to dry post harvest, other growers threshed and winnowed on the date of harvest.

Once cleaned, growers weighed each replicate and recorded the yield in grams and rated yield on a scale of 1 (poor yield) to 5 (excellent yield).

For weighted yield, growers found no statistically significant difference ($P = 0.12$) in yield among the four grain amaranth varieties tested (**Table 4**). They also found no significant difference ($P = 0.26$) in the yield rating assessed by growers (**Table 4**).

Seed size, popping rate, and flavour

After each replicate was cleaned, growers evaluated the replicates for seed size on a relative scale of 1 (very small) to 5 (very large), as well as how well each replicate popped on a dry skillet or pot on a scale of 1 (poor) to 5 (excellent) and the flavour of the popped grain on a scale of 1 (poor) to 5 (excellent). Growers evaluated these ratings on the same date.



Photo 3. Amaranth being harvested at Persephone Market Garden.

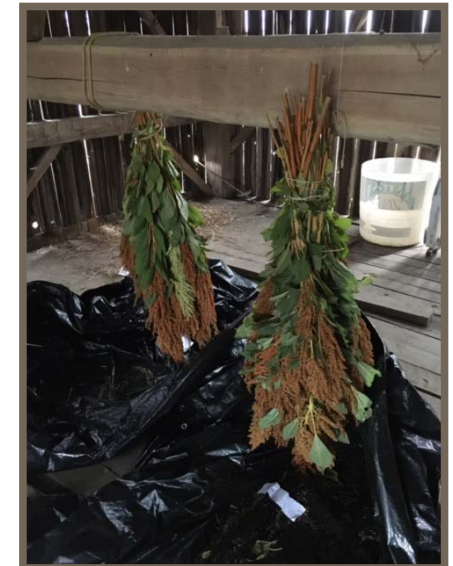


Photo 4. Amaranth hanging to dry in the barn at Willow Creek Permaculture Farm.

Table 4. Mean days to flower, days to harvest, ease of harvest rating, yield in grams, and yield rating for grain amaranth for each variety across farms.

VARIETY	DAYS TO FLOWER	DAYS TO HARVEST	EASE OF HARVEST RATING	YIELD (G)	YIELD RATING
Atitlan Dorado	63 a	119 b	4.3	958.1	3.7
Grain Amaranth	52 b	129 a	4.3	602.4	2.5
Opoepo Amaranth	63 a	129 a	4.3	742.1	2.8
Golden Giant Amaranth	64 a	119 b	4.6	874.2	3.6
LSD	8	5	NS	NS	NS
Orange Giant Amaranth	54	126	5.0	360.0	3.0
Juana's Orange Amaranth	54	126	5.0	270.0	2.0

NS - No significant difference.

Table 5. Mean seed size, popping rate, flavour rating, and overall rating for each variety across farms.

VARIETY	SEED SIZE RATING	POPPING RATE	FLAVOUR RATING	OVERALL RATING
Atitlan Dorado	3.2	3.4	3.0 c	3.1 ab
Grain Amaranth	3.2	3.6	4.4 a	2.3 b
Opopeo Amaranth	3.0	3.0	4.1 ab	3.3 a
Golden Giant Amaranth	3.2	3.5	3.6 bc	3.8 a
LSD	NS	NS	0.8	0.9
Orange Giant Amaranth	No Data	5.0	4.0	4.0
Juana's Orange Amaranth	No Data	5.0	4.0	3.0

NS - No significant difference.

The growers found no significant differences among varieties $P=0.12$ and $P=0.72$ for seed size and popping rate, respectively (**Table 5**). Growers did find a significant difference ($P<0.001$) in flavour rating (**Table 5**). Using an LSD of 0.8, they rated Grain Amaranth and Opopeo with the best flavour followed by Golden Giant and Atitlan Dorado with the least preferred flavour.

Overall rating

Finally, growers provided an overall evaluation for each replicate on a scale of 1 (poor) to 5 (excellent). They found a significant difference ($P=0.003$) in the overall rating among varieties. Using an LSD of 0.9, Golden Giant and Opopeo were the top rated varieties overall followed by Atitlan Dorado and finally Grain Amaranth which had the lowest overall rating (**Table 5**).

Table 6 shows the growers' notes from the trial. Growers observed that the Grain amaranth variety displayed off-types and varied forms within the variety during growth, flowering, and maturity. **Table 7** shows growers' answer to the question "Would you grow this grain

amaranth variety again?". These comments corroborated other findings that Golden Giant, Opopeo, and Atitlan Dorado were the top varieties in the grain amaranth variety trial.

CAVEATS

- Direct seeded amaranth was easily disturbed by heavy precipitation, which led to poor germination.
- A wet fall season interfered with plant drydown and harvest.
- Space to hang the grain after harvest is significant.
- Threshing and seed cleaning was very time consuming and took a lot of labour. Some growers found it challenging to get the amaranth dry enough for good threshing without using artificial drying, such as a food dehydrator. Fully dry plants led to much faster threshing.
- Moisture level in grain might have had an affect on popping quality.

NEXT STEPS

Farmer-researchers from this multi-farm trial will use this data set to help inform grain amaranth variety selection moving forward. They will

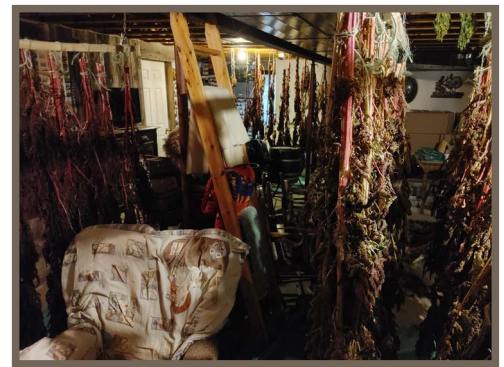


Photo 5. Amaranth being dried at Flat Earth Farm.



Photo 6. A bowl of popped Atitlan Dorado amaranth.

also use what they have learned this year to help inform the types of data to collect and the ways in which to record it moving forward. For example, moving away from a rating system and towards quantitative numbers and measurements where possible—like exact percent germination over a rating for germination, etc. More research into production at a larger, more mechanized scale would also be useful. Because the Grain Amaranth variety from Richters Herbs matured early and also seemed to have broad genetics, some growers have decided to work on selecting a locally-adapted strain of grain amaranth out of this population by selecting seed only from the Grain Amaranth plants that perform best in their gardens, while others are interested in growing multiple varieties of amaranth and then saving seed from the ones that perform well in their location, thus creating a new landrace variety.

Table 6. Growers notes on flavour and overall ranking of each variety in the trial.

VARIETY	KH	PM	RR	RELA & ML	TY	JVB
Atitlan Dorado	Lodging in late August with heavy rain and wind.	Poor germination, but fastest to mature, least drying/most mature seed at harvest, okay yield and flavour. Ambivalent.	Didn't perform as well as Orange Giant or Juana's Orange.	Poor germination but due to external factors and not seed quality.	No Data	Plant is great with good yield and seed maturity. Flavour and popping is not there.
Grain Amaranth	No Data	Best germination, plant size, and yield (by far); okay flavour; slow to mature, immature seeds made it very difficult to thresh. Needs to be planted earlier, crazy yields.	This variety seemed to have off types and varied forms, this variety might be good for breeding and doesn't seem finished yet. Much 'spikier' and other types.	Off type which had crossed with wild relatives.	Unsure if true to type.	Short plant, easily toppled by its top dense flower. Not true to type. Popping and flavour is good, I was surprised by this.
Opopeo Amaranth	Lodging in September with heavy rains and wind.	Strong germination, beautiful plant!, but slow to mature and difficult to thresh, poor yield but exceptional flavour. I'd try again with this one, worth the effort.	Such beauty, and definite potential for yield if all plants matured.	This was the only 'red' variety and performed as well as the 'golden' varieties. Very productive.	Doesn't mature fast enough.	Too bad that they didn't have enough time to mature. It had a good popping rate and flavour. Optimistic about this variety.
Golden Giant Amaranth	Lodging in late August with heavy rain and wind.	Poor germination, relatively quick to mature, easy to thresh but poor yield and okay flavour. Meh.	Didn't perform as well as Orange Giant or Juana's Orange	High productivity, the only variety to dry down completely.	No Data	Overall the best in seed maturity, high yield, popping rate, and flavour.
Orange Giant Amaranth	No Data	No Data	Performed better on my farm than the other 'golden' types in the trial.	No Data	No Data	No Data
Juana's Orange Amaranth	No Data	No Data	Performed better on my farm than the other 'golden' types in the trial.	No Data	No Data	No Data

KH- Kristine Hammel; PM- Phil Mount; RR- Rob Read; RELA & ML- Ronaldo Eleazar Lec Ajcot and Myriam Legault; TY- Tarrah Young; & JVB- Janna Van Blyderveen.

Table 7. Growers were asked “Would you grow this grain amaranth variety again?”

VARIETY	KH	PM	RR	RELA & ML	TY	JVB
Atitlan Dorado	Maybe	Yes	No	Yes	Yes	Yes
Grain Amaranth	Maybe	Yes	Yes	No	No	No
Opopeo Amaranth	Maybe	Yes	Yes	Yes	No	Yes
Golden Giant Amaranth	Maybe	Yes	No	Yes	Yes	Yes
Orange Giant Amaranth	No Data	No Data	Yes	No Data	No Data	No Data
Juana’s Orange Amaranth	No Data	No Data	Yes	No Data	No Data	No Data

KH- Kristine Hammel; PM- Phil Mount; RR- Rob Read; RELA & ML- Ronaldo Eleazar Lec Ajcot and Myriam Legault; TY- Tarrah Young; & JVB- Janna Van Blyderveen.

TAKE HOME MESSAGE

Even with some challenges with growing and drying conditions, this trial offers insights into the most viable grain amaranth varieties for ecological farms in southern Ontario.

Giant Golden, Opopeo, and Atitlan Dorado all performed similarly and were the growers favourite varieties overall. Grain Amaranth did not perform as well as the other varieties and was the least favourite variety overall, but scored high in flavour rating.

Although growers had mixed feelings about continued production of grain amaranth at small-mid scale, the trial resulted in a lot of learning, sharing, and community building around amaranth production in the region.

“I have gotten to know amaranth as a much closer plant friend, which I really appreciate. What a beautiful plant that shares with us so readily. I spent a lot of time with the plants, and seeing them from across the yard was always exciting. I’m so grateful for amaranth, and the opportunity to work with it. On the other hand, I am disappointed with the trade-off of labour compared to yield, and don’t expect I will grow amaranth as a serious grain crop again. I imagine I will always make space for it in the garden though, as harvesting a few ounces per season for a special treat of popping it in winter, and making it into a traditional sweet with honey. I came to appreciate it more as a sacred plant, well suited to consume as part of a gratitude ceremony.” - Rob Read

“Growing the amaranth brought a lot of joy, and I expect I will grow it again on a smaller scale for its beauty and cultural significance, but the labour requirements to harvest such a quantity of amaranth (by hand that is), were far more than I would have expected. A neighbour has offered up the use of his combine and seed cleaning equipment, [if] we want to grow more in the future, and I think that any future trials should explore mechanical harvests.” - Tarrah Young

ACKNOWLEDGEMENTS

The growers would like to acknowledge the great support from Ronaldo Eleazar Lec Ajcot in championing this project and providing guidance throughout the process.