

Title: Participatory research to test red onion varieties for diversified and local food systems in Ohio

Production challenge addressed by this project: Onion (*Allium cepa* L.) is a popular bulb vegetable that belongs to the family Alliaceae and is one of the cultivated species in the genus *Allium*. The demand for locally grown onions in Ohio has been increasing, in part due to their nutritive and medicinal effects. While most onion varieties grown in Ohio are adapted to either northern or southern climates, southeast Ohio, is located in the threshold between short and long-day onion production. Additionally, frequent extreme weather events and unpredictable weather conditions pose challenges for growing northern-adapted onion varieties. Early warm spells, often followed by late spring frosts (e.g. false springs) have led to delayed growth and even entire crop loss. Summer heat waves and frequent rain events have made proper curing for storage more difficult, leading to rot, waste, and a need to quickly sell the crop at a reduced price. Early season growth timing is particularly important for onions, as the crop begins to bulb at a certain day length, in addition to variety selection that will cure, and store reliably given variable weather conditions.

Objective: This project aims to evaluate plant growth, establishment, yield, and postharvest shelf life of five red onion varieties grown in Ohio's Appalachian region.

Rationale: The project is focused on *red onions* for three main reasons: 1) red onions are versatile, visually appealing, and exceptionally nutritious, attracting a higher market demand and price, 2) few climate-adapted open-pollinated red onion varieties are available, leading to a gap in the market and high potential to sell bulk seed, and 3) many growers in the region relies on onions for early season income, as seed crops have a much longer cash cycle.

Study Design: Experiments were performed in randomized complete block design with 4 replications. A total of five varieties of red onion ('Transylvanian Red', 'Rose de Roscoff Keravel', 'Rossa di Toscana', 'Rossa di Milano', and 'Karmen') were included in this trial. All varieties were sown on March 6, 2024 and transplanted on May 3, 2024. For *Rossa di Milano* an additional early sowing date (on February 13) was included on the trial. For reporting purposes, early (February 13) and late (March 6) indicate *Rossa di Milano's* sowing dates.

In Spring 2024, experimental beds were mowed and power-harrowed before transplant using a Grillo walking-behind tractor. Details on plot layout, study information, production operations, and crop growth and postharvest parameters are summarized in Figure and Table 1 below.



market onion	aisle	BLOCK 1	aisle	BLOCK 2	aisle	BLOCK 3	aisle	BLOCK 4	aisle	market onion
		buffer		buffer		buffer		buffer		
		TR1		RM-L2		RT3		RK4		
		buffer		buffer		buffer		buffer		
		RK1		KN2		TR3		RT4		
		buffer		buffer		buffer		buffer		
		RT1		RM-E2		RM-L3		KN4		
		buffer		buffer		buffer		buffer		
		RM-E1		TR2		KN3		RM-L4		
		buffer		buffer		buffer		buffer		
		RM-L1		RT2		RK3		RM-E4		
		buffer		buffer		buffer		buffer		
		KN1		RK2		RM-E3		TR4		
		buffer		buffer		buffer		buffer		

- Translyvanian Red (TR)
- Rose de Roscoff Keravel (RK)
- Rossa di Toscana (RT)
- Rossa di Milano – early (RM-E)
- Rossa di Milano – late (RM-L)
- Karmen (KN)

Figure 1. Experimental plot layout applied to this trial. Trial size detail: 30” bed width, 24” aisle width, 2 onion rows per bed with 14” between rows and 12” within rows. Buffer zone: 24” between plots and 48” at the end of each block. Plant population: total of 60 plants per variety per block (3 plants per hole times 20 holes, on stagger), 360 plants per block, and 1440 plants across all experiment.

Table 1. Study information, production operations, and crop growth and postharvest parameters for the 2024 growing season.

Study information and field operation	Description
Varieties	‘Translyvanian Red’, ‘Rose de Roscoff Keravel’, ‘Rossa di Toscana’, ‘Rossa di Milano’, and ‘Karmen’
Treatments	6
Replication	4
System	Open field
Study type	Randomized complete block design
System	Organic in practice
Soil type	Silt loam soil texture, classified as Guernsey-Upshur complex with 8 to 15 percent slopes (NRCS Soil Survey)
Sowing date	13 Feb (early - Rossa di Milano only) and 6 Mar (all varieties)
Transplanting	3 May (hand transplanted)
Field scout for pest/disease and vigor	3 May, June 26, and 11 July
Weeding	15-17 May (by hand around plants, with shuffle hoe and collinear hoe between rows)
Fertilizer application date	May 18
Fertilizer type and rate	Neptune's Harvest Hydrolyzed Fish Fertilizer 2-4-1 (2oz per gallon of water on each plot)

Harvest	July 11
Length of growing season	70 days
Storage quality	July 11, 6 Sept, 29 Oct, 28 Dec
Sensory evaluation	6 Sept

Observations:

- **Weather data.** A mini weather station was installed next to the plot to collect data on weather conditions that onion plants experienced during growing conditions. Data collected include temperature (°F), relative humidity (%), dew point temperature (°F), and vapor-pressure deficit (kPa).
- **Yield data.** At maturity, each 30"x 120" plot was harvested. The final number of plants for each plot was recorded and total yields were computed. Heat spike at the end of the growing season in late June (Figure 2) led to crop harvest in early July and the removal of the field curing process, which was initially planned for this experiment. Harvested onion bulbs were transferred to storage conditions immediately after harvest.
- **Storage weight loss.** Onion bulbs were stored in cold room space. The observation of physiological loss in weight (PLW) was recorded on July 11 (T0 at harvest), September 6 (T1 at 57-day storage), October 29 (T2 at 110-day storage), and December 28 (T3 at 170-day storage) until 5.5 months of storage. PLW included loss in weight of onion due to the drying effect of the atmosphere and due to rotting. Sprouted bulbs were also considered unsuitable for consumption and were taken for PLW count. PLW (%) was estimated on a weight basis.
- **Sensory evaluation.** A pilot sensory evaluation was conducted on September 6 (57 days of storage condition) with five trained assessors based on their interest in sensory evaluation and familiarity with the onion project. Onion bulb quality attributes selected for sensory evaluation were appearance (both, raw and cooked onion), sweetness, pungency, aroma, texture, and taste (cooked onion only).
Judges were familiarized with the definitions of quality attributes, scorecards, and the method of scoring. Judging was done between 1 p.m. and 3:30 p.m. They were advised to rinse their mouth with sparkling water and plain crackers between tasting two consecutive samples. Scorecards were prepared to assess the sensory attributes of onion samples using quality parameters. Five-point sensory scales, "Dislike extremely", "Dislike slightly", "Neither like nor dislike", "Like slightly", and "Like extremely", were used for the evaluation of quality attributes of onion samples.

Statistical analysis. Data analysis from this report was conducted in R version 4.0.4 (R Core Team, 2020). Mean values for each onion variety were separated using Tukey's HSD (honest significant difference) test. Statistical analysis was conducted by members of the Urban Food Innovations Team led by Dr. Krupek followed by data interpretation and summary with collaborator farmer Lindsay Klaunig.

Summary:

- Average temperature during the experiment was 69.6 °F. Total rain or irrigation over 0.1 inches (2.54 mm) throughout the experiment was 5.6 inches (143 mm), with approximately 3.3 inches (85 mm) of rain and 2.3 inches (58 mm) of irrigation by hose (Figure 2).
- There was a significant variation in bulb total yield due to varieties (Table 2). Across all varieties, total yield ranged from 24,045 to 32,887 lbs/acre. Rossa de Milano sowed early (February 13) yielded the highest and Karmen yielded the lowest (Figure 3).
- There was a significant variation in physiological loss in weight due to varieties (Table 2). Such differences were observed primarily at 27-day and 170-day of storage (Figure 4). After 57 and 170 days of storage, bulbs from Rossa di Toscana had the highest cumulative weight loss of 59.6 and 92.2%, respectively. Similarly, bulbs from Rossa di Milano (both early and late planted) had the lowest cumulative weight loss (Figure 4).
- Looking at Table 3, it can be said that appearance (both raw and cooked samples) was highly appreciated for Karmen and Translyvanian Red. Taste was the best for Rossa di Milano. Karmen ranked the highest in aroma and lowest in pungency, while both Rose de Roscoff Keravel and Rossa di Toscana ranked the highest in texture preferences. It can be perceived that “Appearance” was given the highest preference by the consumer.

Results:

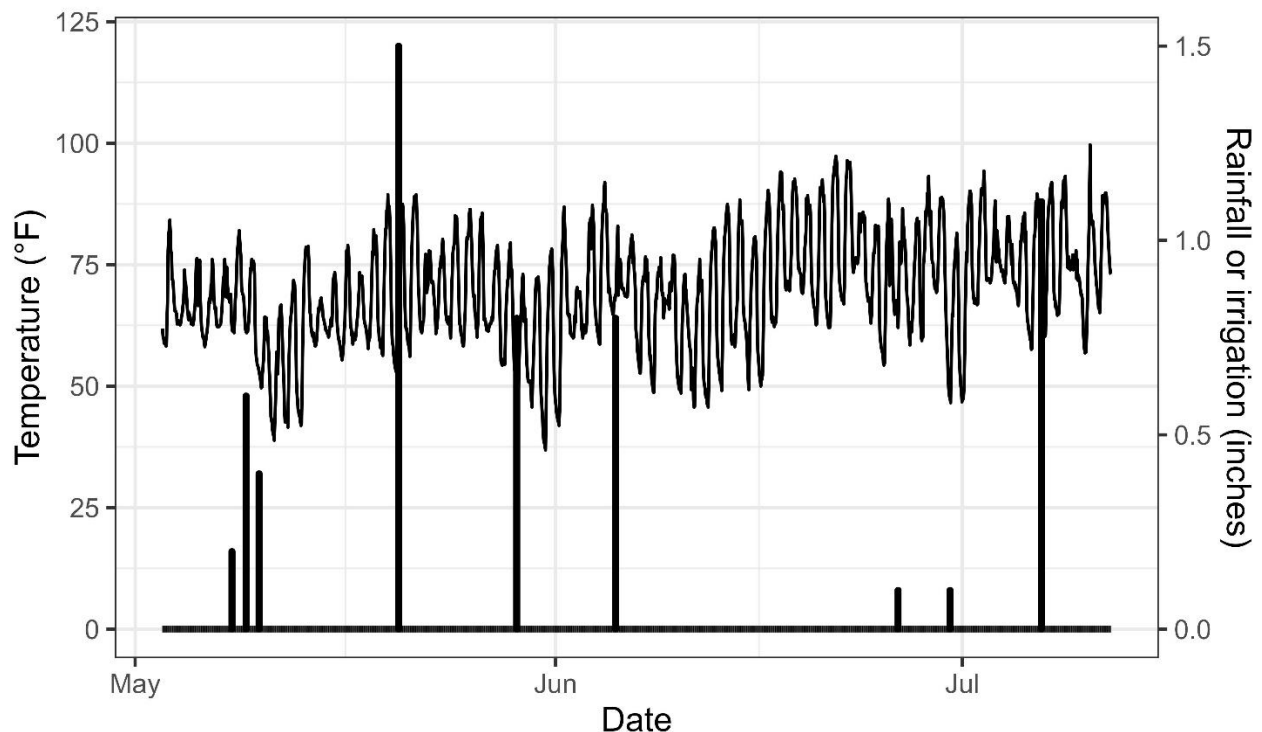


Figure 2. Daily temperature and rainfall of irrigation over 0.1 inches during field trial.

Table 2. Summary of ANOVA for yield and postharvest characteristics significance of source of variation.

Source of Variation	d.f.	Total yield		Weight loss (T1)		Weight loss (T2)		Weight loss (T3)	
		Mean Square (MS)	F-test	MS	F-test	MS	F-test	MS	F-test
Treatment	5	46969307.16	6.01***	500.6	22.8***	220.18	4.46*	227.09	9.71**
Replication	3	12042633.64	1.54	46.5	2.1	30.64	0.620	0.03	0.001
Error	15	7809496.12		21.9		49.40		23.38	

*, **, *** and ns are significant at $p \leq 0.1$, $p \leq 0.05$, $p \leq 0.01$ and non-significant, respectively,

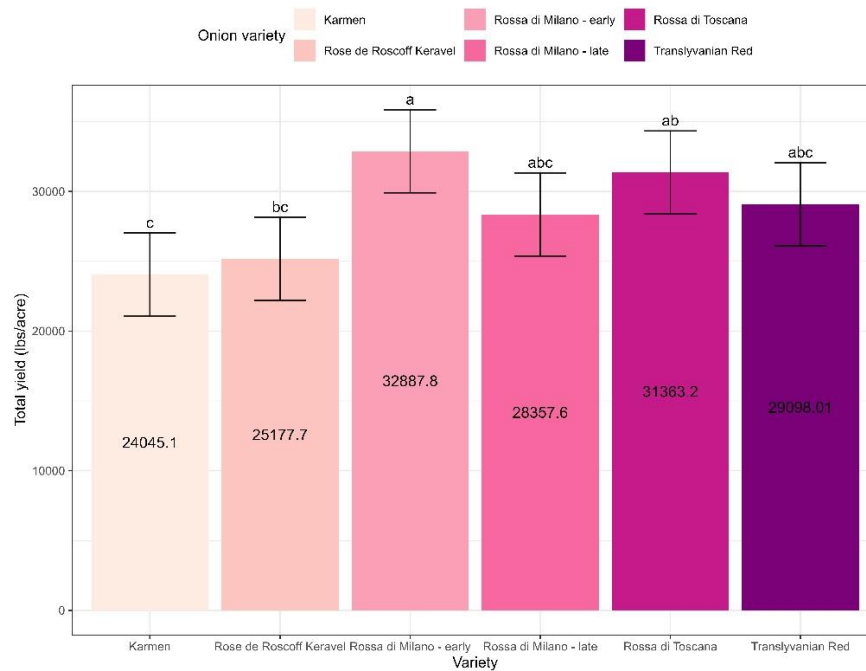


Figure 3. Effect of variety on onion total yield for Translyvanian Red, Rose de Roscoff Keravel, Rossa di Toscana, Rossa di Milano, and Karmen in Athen, OH. Error bars represent standard error of the mean at the 95% confidence interval. Letters indicate significant differences ($p < 0.05$) among varieties according to Tukey test.

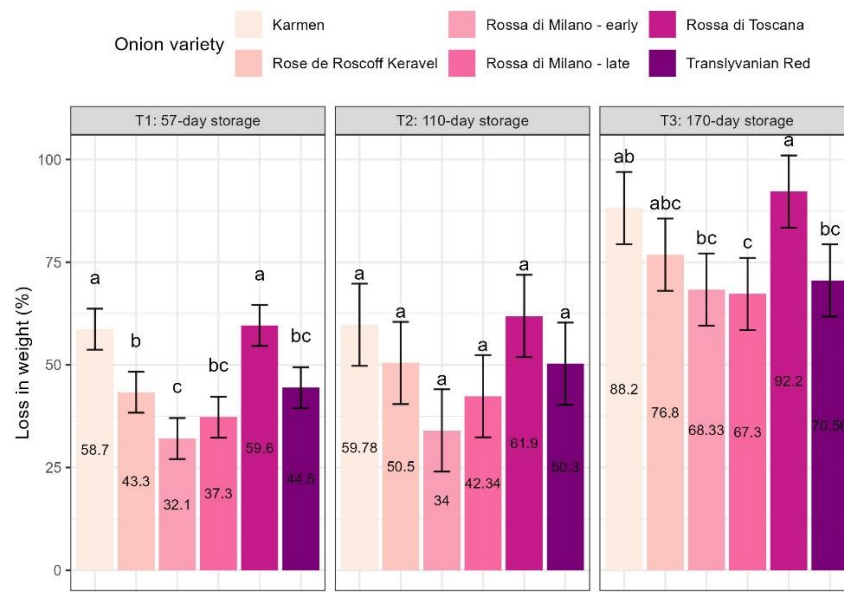


Figure 4. Effect of variety on cumulative fresh weight loss of Translyvanian Red, Rose de Roscoff Keravel, Rossa di Toscana, Rossa di Milano, and Karmen bulbs measured at 57, 110, and 170 days of storage. Error bars represent standard error of the mean at the 95% confidence interval. Letters within each storage period (T1, T2 and T3) indicate significant differences ($p < 0.05$) among varieties according to Tukey test.

Table 3. Sensory scores for quality attributes of Translyvanian Red, Rose de Roscoff Keravel, Rossa di Toscana, Rossa di Milano, and Karmen bulbs assessed at 57 days of storage.

Sensory quality attributes	Sensory scale scores				
	Karmen	Rose de Roscoff Keravel	Rossa di Milano	Rossa di Toscana	Translyvanian Red
Appearance (whole, raw) ¹	4.2	3.0	3.0	3.4	4.4
Appearance (cut, raw) ¹	4.8	3.4	3.3	3.0	3.6
Appearance (cooked) ¹	4.6	3.2	2.5	2.8	4.6
Aroma ¹	4.3	2.4	3.8	3.0	3.2
Texture ¹	3.8	4.2	4.0	4.2	3.6
Taste ¹	3.4	3.4	4.3	3.5	2.8
Sweetness ²	3.0	4.2	3.3	2.4	2.8
Pungency ³	2.0	3.4	2.5	2.6	2.8

¹Five-point Likert scale (1=dislike extremely, 2= dislike slightly, 3= neither like nor dislike, 4= like slightly, 5=like extremely)

²Five-point scale for sweetness (1= sweetness is almost undetectable and 5= sweet as a cooked apple)

³Five-point scale for pungency, or sharpness (1= pungency is almost undetectable and 5=pungency is the dominant attribute and almost overpowering)

Photos:



Figure 5. Summer Seed Saving outreach event held at Trouville Farm which highlighted the onion trail and participatory research described in this report. Photo by Love'Yah Stewart.



Figure 6. Outreach event demonstrating varieties' performance held during the Ohio State Extension Ag and Natural Resources (ANR) annual retreat on June 5, 2024.



Figure 7. Harvest yield data collection and sample preparation for storage.



Figure 8. Storage quality assessment (fresh weight loss and sensory evaluation) held during the [Summer Seed Saving](#) outreach event on September 6, 2024.



Figure 9. Onion preparation for sensory evaluation analysis held on September 6, 2024. Samples of five raw onions per variety, with two bulbs cut in half, were provided to participants with scoring rubrics and guidance on how to evaluate for visual appearance (both, whole and cut samples).



Figure 10. Onion preparation for sensory evaluation analysis held on September 6, 2024. Samples of 150 g of onion per variety were slightly cooked in a pan with 5 g of neutral oil, and 1 g of salt, sautéed on heat level five for 90 seconds and allowed to cool at room temperature before serving to sensory panel participants. Participants were provided with palette cleansers (sparkling water and plain crackers) and scoring rubrics with guidance on how to evaluate for sensory parameters (sweetness, pungency, appearance, aroma, texture, taste). Photo by Love'Yah Stewart.

About Trouvaille Farm:

In the hills of Southeastern Ohio, you will find Lindsay Klaunig on her farm: Trouvaille Farm. While she has been a grower for more than 20 years, this is her seventh season as owner and operator of Trouvaille Farm, something that the name itself acknowledges (Trouvaille means lucky find).

The farm landscape is a patchwork of diversity. There are grass-fed beef and goats on pasture, heirloom crops on the ridge tops, and fruit trees throughout the farm. Lindsay grows on erosive hilltops and is committed to using low input, organic-acceptable methods, such as low till, cover cropping, integrated animal fertility, natural mulches, and integrated pest management (IPM). Many of the open-pollinated varieties are being grown to maturity and processed as seed crops, to be sold through small regional seed companies. Lindsay and farm partner Michael Barnes are both first-generation farmers who work full time on the farm and rely on it for their family's livelihood.

Acknowledgments:

We thank Lindsay Klaunig, with Trouvaille Farm, for making this work possible by managing the on-farm trial, allowing our research team to visit her field, and sharing the trial data. We also thank our project partner, Rural Action, for supporting farm field days and outreach activities and Love'Yah Stewart for the professional photos taken during the sensory evaluation activity.

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To learn more about Wagner Grants, visit <https://amp.osu.edu/research/funding-opportunities-warner-grants-sustainable-agriculture>

To learn more about Trouvaille Farm, visit <https://www.trouvaillefarm.com/>

To learn more about Love'Yah Stewart, visit <https://thkluvltr.com/>

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