Northern NY Agricultural Development Program
2022 Project Final Report

Exploring Winter Greens Production and Marketing Potential In Northern New York

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Background
Winter greens are among the traditional crops grown in high tunnels in northern New York with significant potential financial return to growers. High tunnel production provides growers with opportunities to extend their growing and sales seasons. The objective of this variety trial was to compare yields, regrowth ability, cold tolerance, and taste of leafy greens for baby leaf production in "deep fall" (October through November) and winter northern New York high tunnel growing conditions.

Methods: Winter Salad Mix Variety Evaluation
We focused this trial in 2022 on species in the Brassicaceae (mustards) family, which offers a great diversity of leaf colors and textures for salad mixes. For comparison, we included two "control" treatments to the brassica species: spinach, the most commonly grown winter green, and lettuce, preferred by consumers. The 20 varieties tested were sourced from Johnny's Selected Seeds (Appendix: Table 1).

Elisabeth Hodgdon conducted the winter salad mix variety trial in the 20'x48' unheated high tunnel at the Cornell Willsboro Research Farm in Willsboro (Essex County), NY. The soil was amended according to soil test results, receiving 1 ton/ac of lime, 150 lbs/ac of K2O in the form of potassium sulfate (0-0-52), and 130 lbs N/ac using Pro Booster (10-0-0). Additionally, we applied compost to the tunnel at a rate of 50 tons/ac.

The varieties were direct seeded into the tunnel on September 22, 2022, according to winter greens production scheduling recommendations from Johnny's Selected Seeds. Using a randomized complete block design, we planted four replicates of each variety in 2' x 2.5'-wide plots (Appendix: Figures 1, 2). Each plot contained 12 rows of plants spaced 1" apart, following thinning, within rows, and 2.25" apart between rows. This spacing was selected because it is commonly used in the Northeast and is based on recommendations from The Winter Harvest Handbook author Eliot Coleman.

Figure 1, left: Winter greens plots arranged in a randomized complete block design at the Willsboro Research Farm in October 2022; NNYADP 2022 project: Exploring Winter Greens Production and Marketing Potential in Northern New York. Photo: Elisabeth Hodgdon.

Figure 2, right: Winter greens varieties evaluated at Willsboro Research Farm in 2022-2023; NNYADP 2022 project: Exploring Winter Greens Production and Marketing Potential in Northern New York. Photo: Elisabeth Hodgdon.

We harvested the greens with a serrated knife as they reached baby leaf size, cutting the plants approximately 1" from the base to obtain leaves that were 3-4" long. The fall harvest season in northern New York spanned from October 19 through December 5, 2022, and greens were harvested once in late winter on March 16, 2023. Due to abnormally warm temperatures in October and November, we harvested most plots 2-4 times during this period, whereas brassica baby leaf greens would not typically regrow as quickly under more "normal" conditions. Between December 5 and March 16, the greens were covered in heavy row cover for cold protection.

We terminated the trial in mid-March after our late winter harvest because a majority of the plants were bolting, and animal intrusion had damaged several plots at the end of March. We analyzed our yield data to determine whether there were statistically significant differences between varieties using one-way Analysis of Variance (ANOVA) tests with Tukey pairwise comparisons in JMP statistical software.

Results
Number of harvests: We harvested most plots three times (Appendix: Table 2). Several of the mustards ('Golden Frills,' 'Green Wave,' 'Red Giant', 'Ruby Streaks,' and 'Scarlet Frills') were harvested four times on average. The lettuce and 'Red Cloud' tatsoi were the slowest growing and were harvested only once in the fall. Second, third, and fourth harvests were of marketable quality for most crops. If leaves were hairy, coarse textured, or off-colored and exhibiting signs of disease, we characterized them as unmarketable.

Pest and disease pressure: Few pests and disease issues were observed in the tunnel, except that we identified symptoms of bacterial blight in 'Esme' arugula that reduced marketable yield of this variety only.

Yield: In the fall, marketable leaf yield varied significantly by variety according to the ANOVA test (F_{19}=4.32, P<0.0001). 'Astro' and standard arugula ('Arugula'), 'Green Giant,' 'Tokyo Bekana,' and 'Red Giant,' mustards were the highest yielding varieties, each yielding 1.90 lbs or greater marketable leaves per 5 sq ft plot. 'Space' spinach, 'Red Cloud' tatsoi and 'KX-1' kale were the lowest yielding (< 0.90 lbs marketable leaves per 5 sq ft plot). 'Central Red' mizuna was the least cold tolerant variety in the trial, with plots dying in November due to cold nighttime temperatures. 'Esme' was the lowest yielding arugula due to bacterial blight damage reducing marketable leaves harvested.

In mid-March, not all varieties were harvested, due to bolting, winterkill, and/or poor quality regrowth. Spinach, which was among the lowest yielding in the fall, was the highest yielding in March. The kales and 'Golden Frills,' 'Green Wave,' 'Red Giant,' 'Ruby Streaks, and 'Scarlet Frills' mustards were the only varieties harvested in the spring. Most lettuce died over the winter due to cold. March yield varied significantly by variety according to our ANOVA model: (F_{19}=1.80, P=0.0439). However, when combining fall and March harvests for total yields by variety, there were no significant differences in yield: (F_{19}=1.14, P>0.05). We harvested greater yields in the spring from varieties that were lower yielding in the fall, resulting in similar yields between all varieties.

Taste: Most mustards included in the trial were "spicy" with varying degrees of pungency (Table 2). 'Tokyo Bekana' was the most lettuce-like mustard, with a mild flavor and light green leaves. 'Green Wave' and 'Golden Frills' green mustards were the most pungent. Spinach, kale, and lettuce were mild compared to most mustards.

Conclusions
The yield and quality results from the salad mix variety trial can be used by vegetable growers to select varieties for a bagged salad mix. We observed that some varieties of greens produced heavily in the fall, but yielded less in the late winter/spring, and vice versa. We harvested little from the plots overall after they had overwintered. In our grower interviews (see next Methods section and Appendix), some producers prefer to grow greens until December for holiday markets and late fall CSA shares, and then terminate most or all greens before January.

The fall harvest's highest yielding varieties: 'Astro' and standard arugula ('Arugula'), 'Green Giant,' 'Tokyo Bekana,' and 'Red Giant' could be mixed with a frilly purple mustard such as 'Scarlet Frills' or 'Ruby Streaks' for an additional texture component to create an attractive salad mix. Depending on consumer preferences, spinach and lettuce

could be included. Due to the slow growth of lettuce and spinach, these should be seeded at least two to three weeks prior to the faster growing mustards, or transplanted to be harvested at the same time. For a direct comparison, we planted all varieties at the same time in our trial.

While most varieties performed well in this trial, 'Central Red' and 'Esme' are not recommended due to poor cold tolerance and disease susceptibility, respectively. Additionally, growers may be cautious when growing 'Golden Frills' and 'Green Wave' due to its very pungent flavor, which may be off putting to some consumers. Conversations with customers at CSA pick ups, farmers markets, and retail stores, and restaurant chefs can aid a grower in understanding which varieties their customers prefer according to taste.

Methods: Interviews of Winter Green Growers in NNY

Lindsey Pashow conducted interviews with eight NNY-based winter greens growers. These growers provided valuable information for future winter greens growers. The main topic areas were:
1) Key characteristics of northern New York farms successfully growing winter greens, e.g.. high tunnel growing capacity, labor requirements, facility infrastructure, and management strategies;
2) Effective marketing strategies for winter greens in NNY; and
3) Advice for prospective winter greens growers.

A two-page survey summary document, Winter Greens Production in Northern New York (Appendix. Figure 3a-b) highlights the information gathered from eight growers participating in the interviews regarding their growing practices, varieties, challenges, pricing, markets, and success.

Extension and Outreach
Workshops
- Good Agricultural Practices (GAPs) Training via Zoom: Presenters Elisabeth Hodgdon and Lindsey Pashow; March 23, 2022; 23 participants.

- High Tunnel Winter Greens Virtual Workshop: Presenters Elisabeth Hodgdon, Lindsey Pashow, and NNY winter greens growers Lissa Goldstein; topics: identifying and managing diseases of winter greens, biological control of aphids, leafy greens food safety, wash/pack design and postharvest efficiency, results from NNY winter greens grower interviews, advice for packaging and marketing winter greens. January 9, 2023. 45 participants.

Podcasts
- March 17, 2022, Elisabeth Hodgdon and Judson Reid recorded a podcast titled, "Winter Greens Research Review" with Ethan Grundberg and vegetable grower Leon Vehaba re: research-driven winter spinach planting date and soil fertility recommendations, and results from an economic analysis of high tunnel heating during winter months. Episode is posted on the Eastern NY Commercial Horticulture Program's SoundCloud site, and has been listened to at least 256 times.

- October 23, 2022, Elisabeth Hodgdon and Lindsey Pashow recorded a podcast

titled, "Winter Greens Grower Interviews in Northern New York," discussing results from Lindsey's series of interviews with NNY winter greens growers. Episode is posted on the Eastern NY Commercial Horticulture Program's SoundCloud site, with at least 124 listens.

Farm Visits
Elisabeth Hodgdon, Lindsey Pashow and Judson Reid visits to provide technical assistance to high tunnel winter crop growers by county: Clinton: 3, Essex: 16, Franklin: 4, Jefferson: 4, Lewis: 4, St Lawrence: 6.

Next Steps
In 2023, the project team will continue to look at opportunities for winter green production and best variety options and to assemble a typical winter greens production budget. Continued research will provide northern New York growers with valuable information for making their operations production, efficient, and with the best opportunities for extended season profitability.

For More Information
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NNYADP 2022 Project: Exploring Winter Greens Production and Marketing Potential in Northern New York
APPENDIX

Table 1. Winter greens varieties evaluated in 2022-2023 at the Cornell Willsboro Research Farm in Willsboro, NY, and their characteristics.

Crop type	Species	Variety	Leaf Color	Leaf Texture
Arugula	*Eruca sativa*	'Arugula'	Green	Smooth
Arugula	*Eruca sativa*	'Astro'	Green	Smooth
Arugula	*Eruca sativa*	'Esmee'	Green	Frilly
Kale	*Brassica oleraceae*	'KX-1'	Red	Frilly
Kale	*Brassica napus*	'Red Russian'	Red	Frilly
Lettuce	*Lactuca sativa*	'Five Star'	Mix	Mix
Mizuna	*Brassica rapa*	'Central Red'	Green	Frilly
Mizuna	*Brassica rapa*	'Mizuna'	Green	Frilly
Mustard	*Brassica juncea*	'Golden Frills'	Green	Frilly
Mustard	*Brassica rapa*	'Green Giant'	Green	Smooth
Mustard	*Brassica juncea*	'Green Wave'	Green	Smooth
Mustard	*Brassica juncea*	'Red Giant'	Red	Smooth
Mustard	*Brassica rapa*	'Red Kingdom'	Red	Smooth
Mustard	*Brassica juncea*	'Ruby Streaks'	Red	Frilly
Mustard	*Brassica juncea*	'Scarlet Frills'	Red	Frilly
Mustard	*Brassica rapa*	'Tokyo Bekana'	Green	Smooth
Spinach	*Spinacea oleracea*	'Space'	Green	Smooth
Tatsoi	*Brassica rapa*	'Koji'	Green	Smooth
Tatsoi	*Brassica rapa*	'Red Cloud'	Red	Smooth
Tatsoi	*Brassica rapa*	'Tatsoi'	Green	Smooth

Table 2. Mean number of harvests, total yield, and pungency of winter greens harvested at the Cornell Willsboro Research Farm, October 2022–March 2023.

Crop Type	Variety	Mean No. Harvests per Plot	Fall[z] Yield (lbs/5 sq ft)	Late winter[y] Yield (lbs/5 sq ft)	Total Yield (lbs/5 sq ft)	Pungency
Mustard	'Green Giant'	2	1.99 a[x]	0 b	1.99	Medium
Mustard	'Tokyo Bekana'	3	1.96 ab	0 b	1.96	Mild
Mustard	'Red Giant'	4	1.90 ab	0.25 ab	2.15	Medium/Strong
Tatsoi	'Koji'	2	1.87 abc	0 b	1.87	Mild/Medium
Arugula	'Arugula'	3	1.77 abc	0 b	1.77	Medium/Strong
Arugula	'Astro'	3	1.76 abcde	0 b	1.76	Medium
Mizuna	'Mizuna'	3	1.51 abcde	0 b	1.51	Medium
Mustard	'Green Wave'	4	1.41 abcde	0.28 ab	1.69	Very Strong
Mustard	'Golden Frills'	4	1.39 abcde	0.12 ab	1.52	Very Strong
Tatsoi	'Tatsoi'	2	1.33 abcde	0 b	1.33	Mild
Arugula	'Esme'	2	1.26 abcde	0 b	1.26	Medium
Kale	'Red Russian'	3	1.24 abcde	0.26 ab	1.50	Mild
Mustard	'Scarlet Frills'	4	1.15 abcde	0.41 ab	1.56	Medium
Mustard	'Ruby Streaks	4	1.13 abcde	0.24 ab	1.37	Medium
Lettuce	'Five Star'	1	1.11 abcde	0 b	1.11	Mild
Mustard	'Red Kingdom'	3	1.07 abcde	0 b	1.07	Mild
Mizuna	'Central Red'	3	0.99 bcde	0 b	0.99	Medium
Kale	'KX-1'	3	0.89 cde	0 b	1.13	Mild
Tatsoi	'Red Cloud'	1	0.79 de	0 b	0.79	Medium
Spinach	'Space'	2	0.77 e	0.89 a	1.67	Mild

[z]Fall harvests occurred in late October through early December 2022.
[y]The late winter harvest occurred in mid-March 2023, after greens resumed growth following winter dormancy.
[z]Mean yields with the same letter within the same column are not significantly different based on Tukey-Kramer HSD pairwise comparison tests.

Winter Greens Production in Northern New York:

Summary of Interviews with NNY Growers

During 2022, Cornell Cooperative Extension vegetable production and agricultural business specialists interviewed eight winter green growers to learn about their growing practices, varieties, challenges, pricing, markets, and packaging. The growers included at least one from each of the six northern NY counties: Clinton, Essex, Franklin, Jefferson, Lewis, and St. Lawrence.

Grower Information

Overall interview grower information:

- 8 Growers
- Represented 6 counties NNY
- Certified Organic or Organic Practices
- 1-15 High Tunnels (1-2 per farm)
- 2 to 10 years farming
- Growing Season: November to May

Growing Practices

Growers used a variety of growing practices to protect their winter greens:

- Single and Double Plastic High Tunnel
- Unheated or Unheated Tunnels
- Minimum Tunnel Temperature: Below Freezing
- Row Cover
- Heating Source: Coal, Waste Oil, and Propane

Varieties Planted

- Spinach: Most Popular
- Arugula
- Asian Greens
- Chard
- Kale
- Baby Kale
- Mustards
- Lettuce
- Parsley
- Cilantro
- Early Spring

Challenges

Growers identified as the most common challenges for winter greens production:

- Aphids
- Army Worms
- Voles: eat seedlings
- Lack Markets
- Unprofitable
- Poor Germination

Grower Reason to Grow Winter Greens

Growers were very supportive towards winter green production but a market must be determined prior to planting.

- Main: Growers want to support their own diet during the winter
- Extend Growing Season
- Additional Revenue
- Support Labor
- Sustain Wholesale Markets

Figure 3a. Winter Greens Farmer Survey Summary, page 1. Credit: Lindsey Pashow.

Stopped Growing Winter Greens

Two growers stopped growing winter greens due to these reasons:

- Grower needs a break from growing
- Unprofitable
- Lack of Labor

Pricing

Pricing was very variable for growers across northern NY. It is important to track all labor (pre-planting, planting, harvesting, row cover maintenance, etc.) seed, row cover, high tunnel use space, etc.

- Wholesale: $4 to $16 lb.
- Retail: $8 to $14

Grower Insight

- One grower said that customers were surprised that they could purchase spinach in the winter. The customer thought that it was a mistake and that the sign in front of the farm stand just hadn't been taken down from the Fall.
- The majority of growers were very positive about winter green production in northern NY.
- Customers were very excited to find local greens.

Grower Tips

- Plant early (September) and don't wait till late fall.
- Make sure you have a market for your product.

Typical Markets

It is important to have a market for winter greens before planting. These are the typical markets that growers are using in Northern NY:

- Extended CSA
- Farmers Markets
- Sustain Wholesale Markets
- Restaurants
- Local Stores
- Farmstand

Packaging

- Bag and Clam Shell (Food Grade Packaging)
- Make sure to wash and remove water. Spinner or a Screen can help remove extra water.

Winter greens production offers NNY growers another option for season extension. Contact Cornell Cooperative Extension for assisting in identifying and building markets before planting.

Figure 3b. Winter Greens Farmer Survey Summary, page 2. Credit: Lindsey Pashow.