Exploring Winter Pea and Winter Lentil Pulse Production for the Northeast

Solveig Hanson[1], Kristen Loria[2], and Virginia Moore [1]

[1] Plant Breeding and Genetics Section [2] Crop and Soil Sciences Section, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853.

Figure 1. Winter-hardy pea (left) and lentil (right) growing at Peter & Hanna Martens Farm in Penn Yan, NY

Background

Due to high demand for Northeast-grown pulses for regional feed and food markets, a collaborative experiment was conducted to assess potential of winter-hardy grain pea and lentil production in the New York State. Production of winter pulses on Northeastern farms would support cropping system diversification and offer potential soil health benefits as fall-planted legume crops providing soil cover over winter. Sustainable production in this region, however, is dependent on identification of material adapted to regional climate and identification of best agronomic practices. This information is currently lacking, with few commercial producers of winter pulse crops in the Northeast. Preliminary variety trials and seeding rate trials were initiated in partnership with an organic grain farmer collaborator to open the door to increased production of winter lentil and winter pea in the Northeast, as well as inform future efforts to screen and develop winter pulse varieties adapted to the Northeast.

Methods

A winter pea variety trial and winter lentil seeding rate trial were conducted at two sites in both the 2022-2023 and 2023-2024 growing seasons. At a Cornell research farm site each year, a spatially balanced randomized complete block design with all entries was conducted. At the on-farm location, a single replicate of the same trials was conducted using the mother-daughter participatory trial method, with only a subset of entries included for the winter pea variety trial and all seeding rates included for the lentil seeding rate trial. Management was conducted in accordance with National Organic Program standards, and on-farm trials occurred on certified organic land.

Winter Grain Pea Variety Trials

To identify regionally adapted winter grain pea cultivars, we compared performance of ten commercially available cultivars in two years of trials. All cultivars possess yellow or green seedcoats suitable for food or feed markets. Replicated trials on Cornell University Research Farms (Ithaca, NY area) were complemented by unreplicated trials at the Peter & Hanna Martens Farm in Penn Yan, NY. Pea plots were planted in mixture with triticale or winter oat; seeding rates were 175,000 pure live seeds (PLS)/ac for peas and 480,000 PLS/ac for triticale. Triticale (cv. 'Chief') was used as the companion crop at the research station trial both years, while an oat population selected on-farm for winter hardiness was used in Year 2 at the Martens Farm, sown at 60 lbs/ac. Pea varieties (Table 1) and 'Chief' triticale were sourced from ProGene. Keystone winter pea was identified by farmer-collaborator Martens as a commonly used variety in New York State, and these trials were designed to identify varieties that might outperform Keystone.

Table 1: Varieties included in winter pea variety trials

Species	Variety	Replicated Year 1	Replicated Year 2	On-Farm Year 1	On-Farm Year 2
Winter Pea	Blaze	X	X	X	X
Winter Pea	FP6101	X	X	X	
Winter Pea	Goldenwood	X	X	X	X
Winter Pea	Icicle	X	X	X	X
Winter Pea	Keystone	X	X	X	X
Winter Pea	Keystone/Icicle Mixture	X	X	X	
Winter Pea	KurtWood	X	X	X	X
Winter Pea	Vail	X	X	X	X
Winter Pea	Windham	X	X		
Winter Pea	Payback		X		X

Stand count and vigor were rated in both fall and spring; plant height, lodging, and disease were rated in early summer. Grain yield and biomass were harvested in mid-late summer, and crude protein analysis was performed after harvest. For yield data collection in the replicated trial , in Year 1 we hand harvested an 0.5 m^2 quadrat sample from each 15' x 4.5' plot, but in Year 2 we used a mechanical plot harvester due to the plots' high biomass. On-farm plots (approx. 0.2 ac each) were combine harvested using a flex header.

Results: Replicated Winter Pea Variety Trial

Year 1 (2022-23) was a normal-to-dry year, and we found significant differences among varieties for all traits ($p<0.05$ to $p<0.001$) except weed biomass (NS) in replicated trials. For most traits, analysis identified one or two lower-performing varieties but did not show much difference among the top-ranking 7 or 8 varieties. Shorter varieties with more stems – like Blaze, Vail, and Goldenwood – ranked higher for grain yield in both replicated and on-farm trials (Table 2).

Table 2: Year 1 replicated winter pea variety trial results, ranked by yield. ***, **, and * indicate fixed-effect ANOVA tests significant at $p<0.001$, $p < 0.01$, and $p < 0.05$, respectively. For leaf type, S = Semileafless and N = Normal Leaf.

	Leaf Type †	Mean Plant Height (cm) ***	Pea Grain Yield (lb/ac) ***	Percent Crude Protein (%) **
Blaze	S	75.8	2199	26.1
Vail	S	77.7	1774	26.4
Goldenwood	S	68.2	1770	26.2
Kurtwood	S	92.6	1698	23.2
KeystoneIcicle	N/S	108.1	1479	24.7
Keystone	S	99.9	1267	25.4
Icicle	N	108.9	1058	23.9
Windham	S	59.1	743	25.8
FP6101	N	97.2	444	22.4

The Year 2 replicated trial was in a high-moisture field and showed very consistent stands. We saw no significant difference among varieties for spring stand, total biomass, or triticale yield (NS), indicating that we succeeded in establishing consistent stands across the field (Table 3). However, we did see significant differences in plant height, lodging, disease severity, pea grain yield, and percent crude protein ($p<0.01$ to $p<0.001$). Top yielding varieties were the Keystone/Icicle mixture and Icicle. Icicle is a vining and indeterminate cultivar that had mid-range to low yields in Year 1 in both monoculture and biculture with Keystone. In short, wet field conditions favored indeterminate, normal-leaf, vining varieties that could outgrow disease pressure but that were prone to lodging.

Table 3: Year 2 replicated winter pea variety trial results, sorted by yield. ***, **, and * indicate fixed-effect ANOVA tests significant at p<0.001, p < 0.01, and p < 0.05, respectively. For leaf type, S = Semileafless and N = Normal Leaf.

	Leaf Type †	Mean Plant Height (cm) ***	Percent Standing 100 = no lodging 0 = all lodged ***	Pea Grain Yield (lbs/ac) **	Percent Crude Protein (%) ***
KeystoneIcicle	**N/S**	152.9	25	2197	26.5
Icicle	**N**	165.3	25	1449	26.7
Windham	**S**	96.2	100	1257	27.9
Kurtwood	**S**	120.6	95	1254	24.9
Goldenwood	**S**	105.4	97.5	1184	26.4
FP6101	**N**	166.1	35	1141	28.4
Vail	**S**	102.6	95	920	28.4
Keystone	**S**	120.6	90	871	26.4
Payback	**S**	105.7	100	841	24.9
Blaze	**S**	102.1	100	615	26

To analyze grain yield over both years, we calculated Standardized Grain Pea Yield for each variety, as a percentage of the average same-year yield. A combined two-year analysis identified two varieties – Kurtwood and Goldenwood – that provided above-average yield (about 117% of same-year yield) in two very different growing seasons (Figure 1). Blaze and Vail – two semi-leafless, compact varieties – yielded much better in Year 1's drier conditions, while the Keystone/Icicle mixture and Icicle – Icicle being a normal-leaf, tall variety – excelled in Year 2's high-moisture conditions. Keystone, a commonly used variety in New York State, showed relatively stable performance over seasons but only about 84% of same-year yield. Interestingly, the Keystone/Icicle mixture produced higher yields than either individual variety in both years. While we can't conclude that variety mixtures are always advantageous based on this evidence, it suggests that further study of grain pea variety mixtures could be helpful.

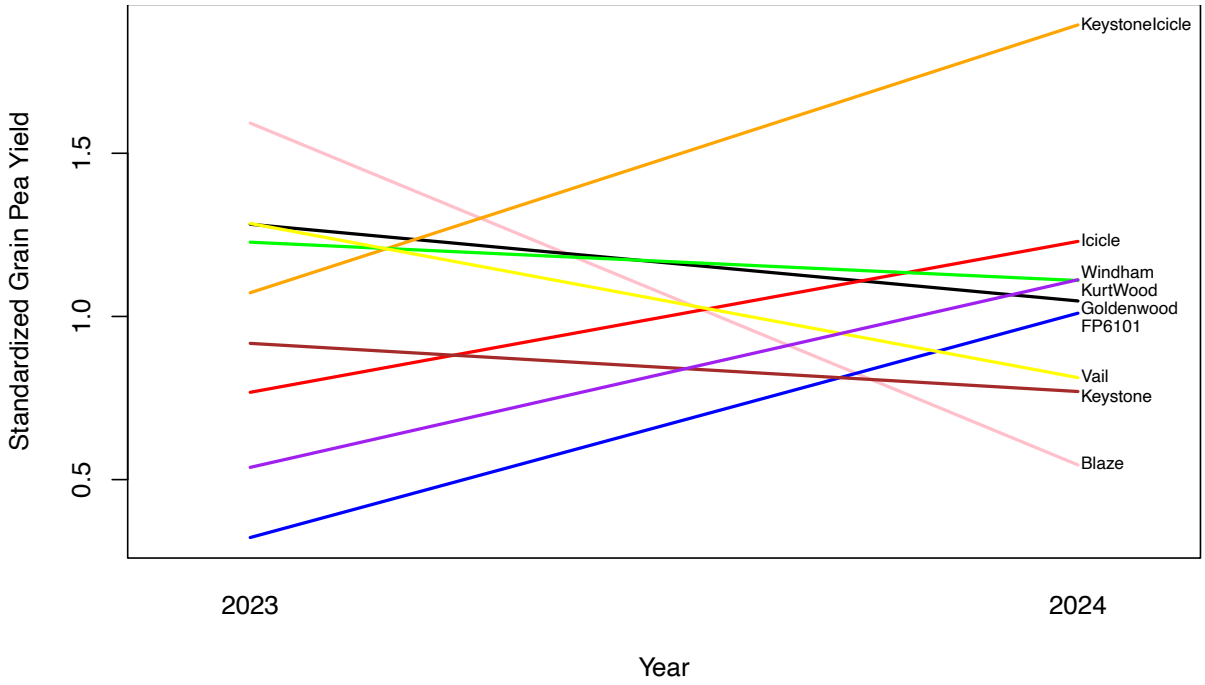

Figure 2: Standardized grain pea yield in Year 1 and Year 2, calculated as the percent of mean same-year yield.

Results: On-Farm Winter Pea Variety Trial

In Year 1, on-farm yield rankings were very similar to those in the replicated trial. In Year 2, on-farm yield rankings were quite different from the replicated trial, but they were similar to Year 1 on-farm rankings (Table 4). That is, over two years of trials on a single farm, it was possible to identify varieties that performed consistently.

Absolute yields were roughly 20x higher on the Martens Farm in Year 2 than Year 1. This difference is partially explained by an improved spring stand in Year 2; average stand counts were 83% higher in Year 2 than in Year 1, which in turn led to lower weed pressure in Year 2. In addition, the use of winter oat as a biculture crop in place of triticale, and/or the use of a newly acquired flex combine header to more effectively harvest grain from lodged plants, may have contributed to improved yields in Year 2.

The success of winter oat as a biculture crop for winter grain pea was notable. Not only did winter oat facilitate effective winter pea production, its grain maturity aligned better with winter pea than did triticale, allowing for a higher quality dual crop. In addition, oats offer food-grade market opportunities, which are more profitable than the triticale feed market. USDA average grain pea yields from 6 Western and Great Plains States range from 1000-2000 lbs/ac (USDA-NASS, 2024), aligning with yields from the more productive varieties in Year 2 on-farm trial, plus both years' replicated trials.

Table 4: Year 1 and Year 2 on-farm winter pea variety trial results, ranked by yield.

On-Farm Trial: Year 1

	Cleaned Pea Yield (lb / ac)
Blaze	91
Goldenwood	73
Vail	68
Kurtwood	59
Keystone	59
Icicle	27
FP6101	18

On-Farm Trial: Year 2

	Cleaned Pea Yield (lb / ac)
Blaze	2027
Vail	1993
Keystone	1814
Kurtwood	1732
Goldenwood	1713
Payback	1626
Windham	1616
Icicle	1093

Winter Pea Trial Conclusions

Two-year analysis identified two winter grain pea varieties – Kurtwood and Goldenwood – that provided above-average yield in two very different growing seasons at both research and on-farm plots. Notably, these two varieties provided higher yields than Keystone, the commonly used regional variety, along with similarly stable yield in different environmental conditions. We identified Blaze and Vail as varieties that performed well in drier conditions and the Keystone / Icicle mixture as excelling in a wet, disease-prone environment.

While vining, indeterminate pea cultivars performed well in higher-moisture conditions, harvest was only feasible with equipment capable of picking up large, lodged plants. Both triticale and winter oat were viable companions for pulse-cereal biculture. According to USDA reports, conventionally-grown Western state dry pea yields averaged between 1025 and 1922 lbs/ac in crop years 2021-2023. This study showed that Northeast farms are capable of producing dry pea yields competitive with Western and Great Plains states.

Winter Lentil Seeding Rate Trial

There is currently one commercially available cultivar of winter-hardy lentil, “Morton”, released by the USDA-ARS and belonging to the red market class, is typically consumed as a dehulled whole or split red lentil. “Morton” has been shown to consistently overwinter in zone 5b, with temperatures below -25 Fahrenheit (Green Cover Seeds).

Table 5. Winter Lentil Trial Management

	Research Station	On-Farm
Site	Freeville, NY	Penn Yan, NY
Plot Size	4.5’ x 15’	30’ x 300’ (~0.20 ac)
Replicates	4	1
Seeding Rates	25, 32.5, 40, 47.5, and 55 pounds per acre	
Biculture/Nurse Crop	Year 1: None Year 2: Oat 70 pounds per acre	

In both research station and on-farm trials in Year 1, plots suffered from high weed competition as well as inconsistent winter survival in the on-farm trial, and showed no difference among treatments in stand count, grain yield, or biomass (NS, results not shown).

Table 6. Research station trial results: Year 2

Seeding Rate	Spring Stand (plants/a) ***	Weed Biomass (lbs/a) NS	Lentil Yield (lbs/a) NS	Oat Yield (lbs/a) NS
55 lbs/a	1019844	708	841	2404
40 lbs/a	501828	774	815	2052
32.5 lbs/a	420888	725	799	2012
47.5 lbs/a	715510	724	774	1970
25 lbs/a	288146	720	528	2022

In Year 2, in which lentil was co-seeded with 70 pounds per acre of oat, establishment, weed suppression and winter survival was much improved, with significant differences in spring stand observed between the highest and lowest seeding rates in the research station trial ($p<0.001$) as well as observed differences in the on-farm trial. However, differences in lentil plant density among seeding rate treatments did not result in significant differences in weed biomass or lentil yield (NS) in the research station trial (Table 6). In Year 2, characterized by an exceptionally mild winter, overwintering was observed in the oat nurse crop both on-farm and

in the research station trial. As a result, yields are reported for oat grain as well as lentil grain in the research station trial. Research trial results reflect hand-harvested yield, which does not account for expected yield loss during combine harvest. All on-farm plots were combine harvested using a flex header.

Table 7. On-farm winter lentil seeding rate trial results: Year 2

Seeding Rate	Fall Stand (plants/a)	Spring Stand (plants/a)	Lentil Yield (lbs/a)
55 lbs/a	577,372	501,828	1006
40 lbs/a	453,264	453,264	866
32.5 lbs/a	302,176	226,632	677
47.5 lbs/a	442,472	437,076	629
25 lbs/a	183,464	161,880	576

On-farm and replicated results suggested that modest-to-no yield is gained from plant populations greater than approximately 486,000 plants per acre. This approximate stand count was achieved with 40 pounds per acre in both replicated and unreplicated trials in Year 2, and additional plant density in the replicated trials did not produce substantially greater yield (Table 7).

Notably, use of an oat nurse crop facilitated successful establishment of winter lentil and reduced winter annual weed pressure, as well as possibly contributing to better winter survival. USDA reports lentil yield from 4 western states (likely predominantly spring-planted), and conventionally-grown yields averaged between 600 and 1100 lbs/ac for 2021-2023. This indicates that Northeast-grown fall-planted organic lentils can yield comparably to Western production regions.

Winter Pulse Profitability

Below is a partial budget analysis for winter pea and winter lentil, taking into account variable costs associated with production as represented by the on-farm trials conducted. Custom operation and post-harvest handling rates are taken from Ohio Farm Custom Rates 2024 (Ward et al.) or in personal communication with the farmer collaborator. Land rent value used was New York state average for 2024 (NASS). Income is calculated using these prices and average yields from the on-farm trials in Year 2.

A per acre yield value of 866 pounds reflects the on-farm trial average in 2023 for the 40 pounds per acre seeding rate. Price reflects an estimated value of food-grade NYS-grown certified organic lentil of $1.05 per pound when markets move beyond initial exploratory production (Martens, personal communication). Grain drying values reflect 5 percentage points of moisture removed (to 10% moisture), and on-farm storage for 6 months.

Table 8. Winter lentil partial budget analysis

Input Type	Operation	Input	$/unit	Units/ac	Per Acre $
Fieldwork	Disc		-		-$20.00
Fieldwork	Rolling Cultivator & Drill		-		-$42.00
Fieldwork	Field Rolling		-		-$4.00
Seed		oat seed	-$0.35	70	-$24.50
Seed		lentil seed	-$1.10	40	-$44.00
Fieldwork	Combine and transport		-		-$38.00
Storage	Grain drying, per bu/point		-$0.05	72.2	-$3.61
Storage	Grain storage per bu/month		-$0.07	86.6	-$6.06
land rent			-		-$83.50
Grain Income			$1.05	866	**$909.30**
				Net Partial Return Per Acre:	**$643.63**

With relatively few inputs and field preparation, winter lentil has potential for favorable partial returns given the high value of the crop being sold in regional marketplaces, with our analysis showing a net partial return of $643.63 per acre. However, as differences in year-to-year trial results indicates, managing weeds, efficiently harvesting this small-statured crop, effectively separating a cereal-pulse biculture, and ensuring access to markets for your harvested crop are all important considerations when considering this new specialty crop.

For the winter pea profitability analysis, the per acre yield used was 30.1 bushels (or .928 tons), the mean yield of the top 5 performing entries from the 2023 on-farm trial. A price of $700 per ton for organic feed-grade yellow pea in New York state was used. Grain drying was calculated at 4 percentage points moisture removed, with grain storage time of 6 months. Winter pea also showed favorable net partial returns at $412.04 per acre, and feed-grade organic yellow pea markets are more firmly established in the Northeast region, though most product is currently sourced from other production regions.

Table 9. Winter pea partial budget analysis

Input Type	Operation	Input	$ / Unit	Units/ac	Per Acre $
Fieldwork	Disc harrow		-		-$20.00
Fieldwork	Rolling Cultivator & Drill		-		-$41.00
Fieldwork	Field Rolling		-		-$4.00
Seed		Pea seed	-$0.35	65	-$22.75
Seed		Triticale seed	-$0.53	37	-$19.61
Fieldwork	Combine and transport		-		-$38.00
Storage	Grain drying, per bushel per degree		-$0.05	123.7	-$6.18
Storage	Grain storage, per bushel per month		-$0.07	30.9	-$2.16
land rent			-		-$83.50
Grain Income			$700.00	0.928	**$649.25**
				Net Partial Return Per Acre	**$412.04**

Winter Pulse Trial Conclusions

Preliminary results indicate that both winter grain pea and winter-hardy lentil can produce viable yields in the Northeast region. However, variable crop establishment and weed suppression resulted in variable crop yields between Year 1 and Year 2 of the trials in both species. This variability indicates that agronomic management as well as environmental conditions, especially winter conditions affecting survival and precipitation affecting disease infestation and seed quality, is likely to affect crop yield, ease of harvest and ultimate profitability. Results from these trials indicate that a companion or nurse crop for both winter pea and lentil may be important to controlling weeds in organic systems, due to the poor weed competitiveness of the legume species when fall-planted. A companion crop may also facilitate ease of harvest and disease control. However, when using a companion crop consideration is required of how the two crops will be separated after harvest. In the case of winter pea, the large pea grain is easily sieve separated from a winter cereal due to size difference. However, 'Morton' lentil was difficult to separate fully from triticale due to similar seed size. In Year 2 when intercropped with an overwintering oat crop, seed density was sufficiently different to facilitate separation using a gravity table. Overall, winter pulse crops hold promise for diversifying food and feed production in the Northeast and offering farmers new options for crop rotation and markets.

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