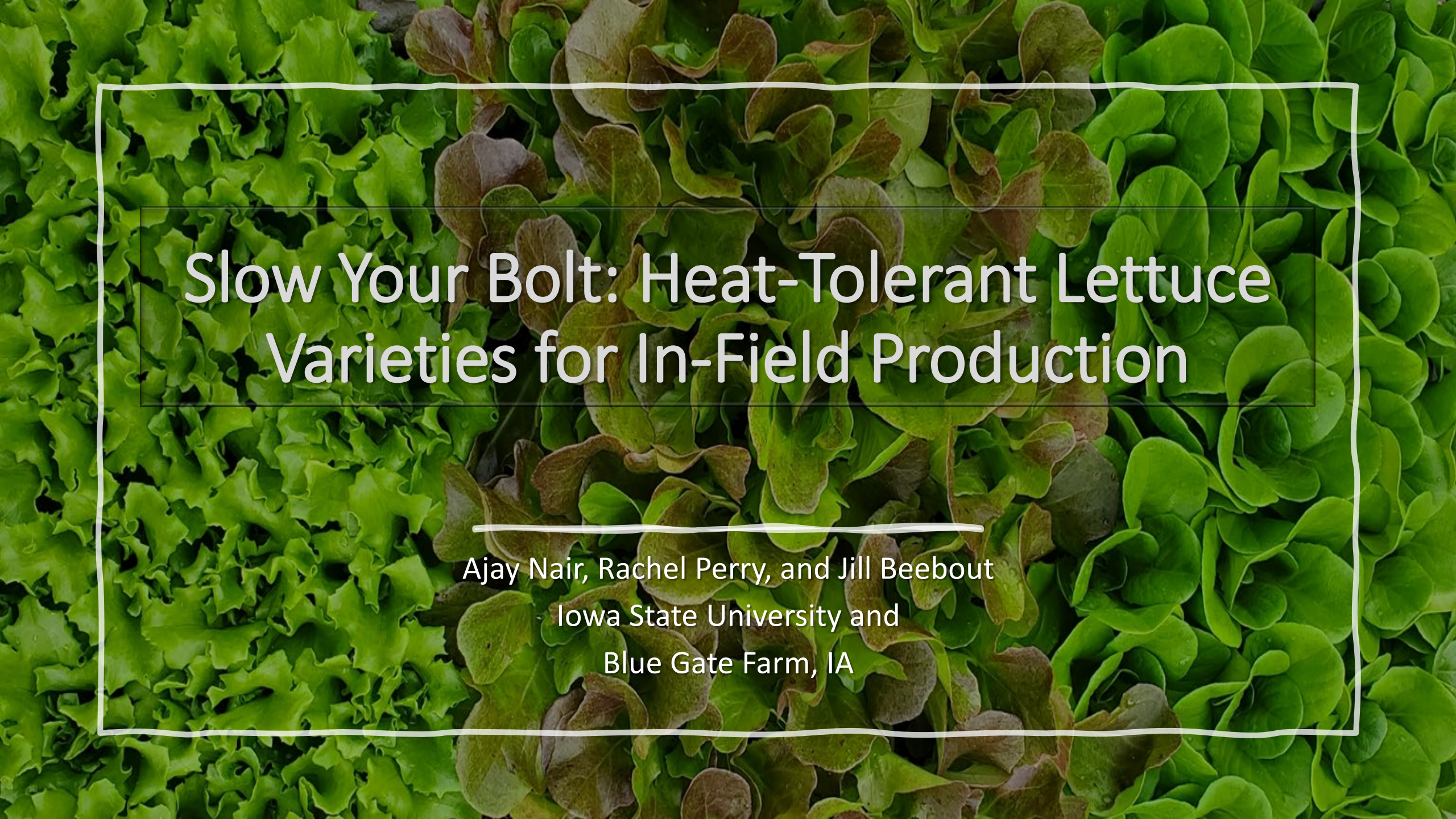


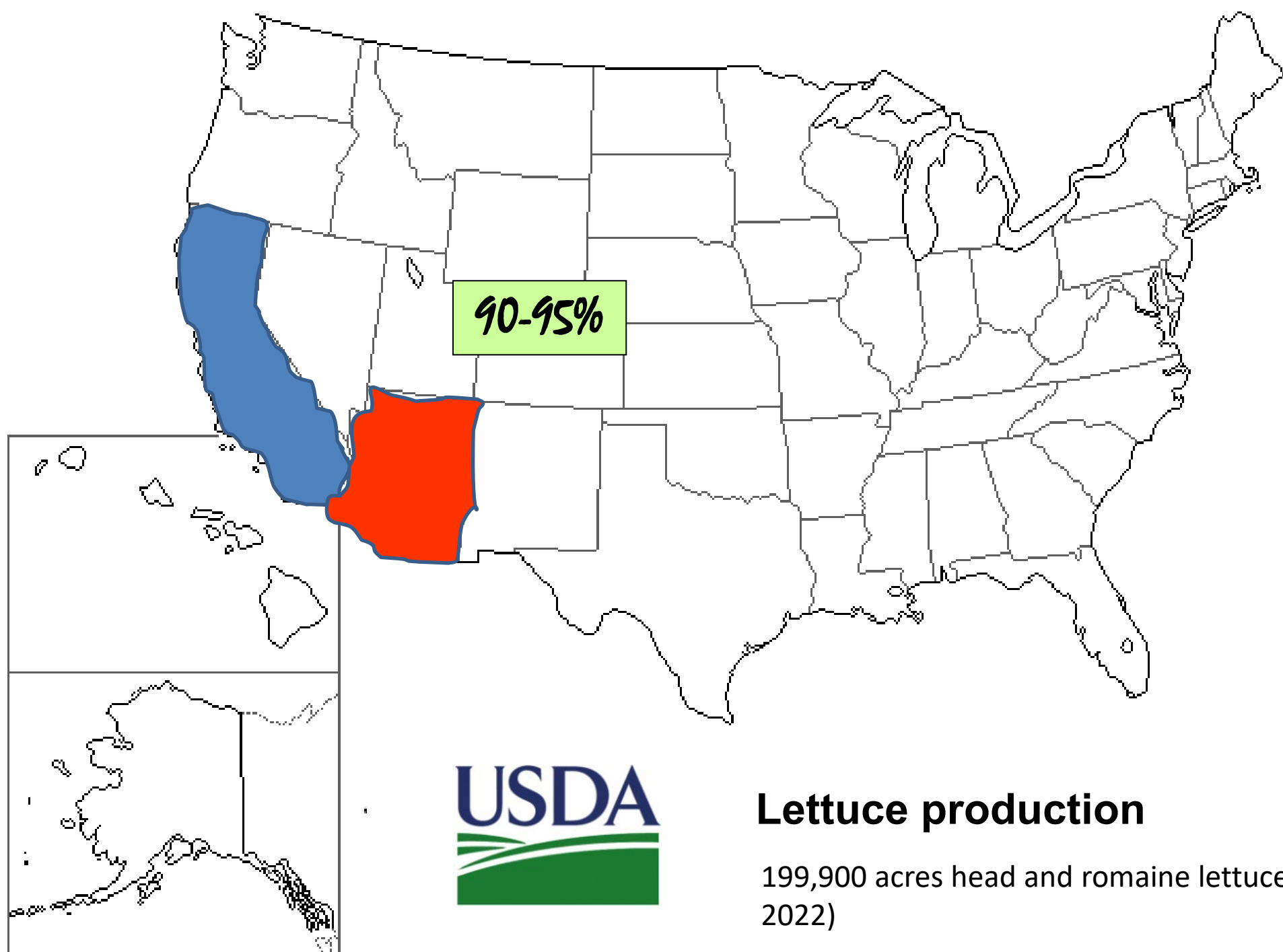


# Slow Your Bolt: Heat-Tolerant Lettuce Varieties for In-Field Production

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Ajay Nair, Rachel Perry, and Jill Beebout  
Iowa State University and  
Blue Gate Farm, IA







## Lettuce in Midwest High Tunnels

**In a recent survey of growers at the Great Plains Growers Conference (IA, KS, MO, and NE) who used high tunnels, 58% had grown lettuce in the last four years, second only to tomatoes (90%).**







# Lettuce Types

- Romaine/Cos (var. *longifolia*)
- Butterhead (var. *capitata*)
  - Boston
  - Bib
- Summer Crisp/Batavia (var. *capitata*)
- Salanova<sup>®</sup>/Easyleaf/Multi-leaf lettuce(var. *capitata*)





# Evaluating lettuce cultivars for summer production in Iowa



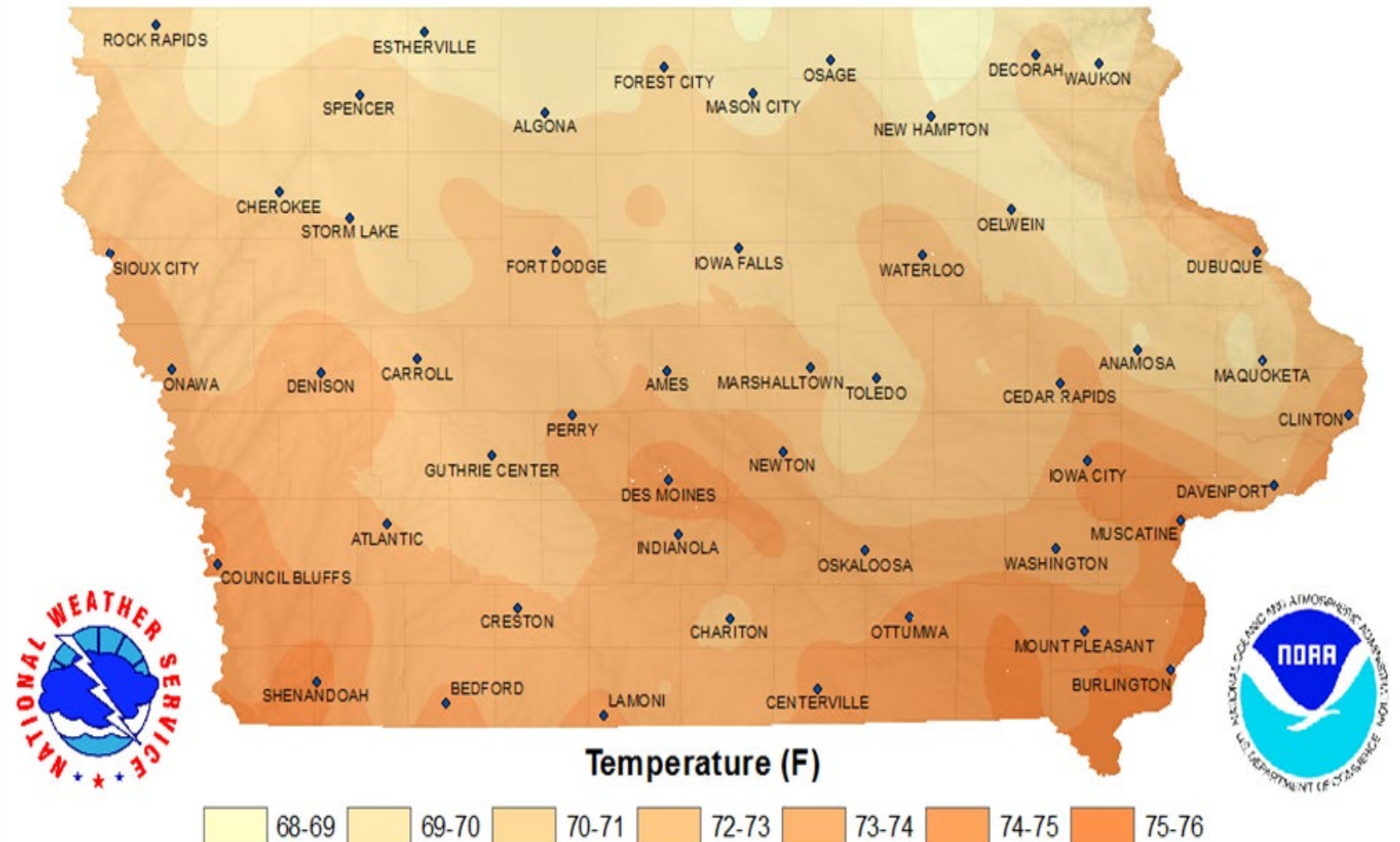
# Objectives

- 1) Assess the quality of various types and cultivars of lettuce in the summer months for Iowa production
- 2) Explore opportunities for extended lettuce production into the summer months



# Wet spring conditions

## Summer Average Temperature Normals (1981-2010)





# Challenges of growing lettuce during summer months

- Lettuce is a cool-season vegetable
- Heat stress
- Bolting and bitter taste
- Increased pest pressure
- Higher water demand





# Bolting

- **Bolting is the term used for flower stalk formation in vegetables.**
- **Bolting in spinach, lettuce, and some radishes (oriental types) will occur naturally as days get longer (daylength effect), higher temperatures, or a combination**
- **High temperatures will accelerate bolting in spinach and lettuce.**
- **Bitter taste and poor quality**



**Head becomes tight  
and moves upwards**





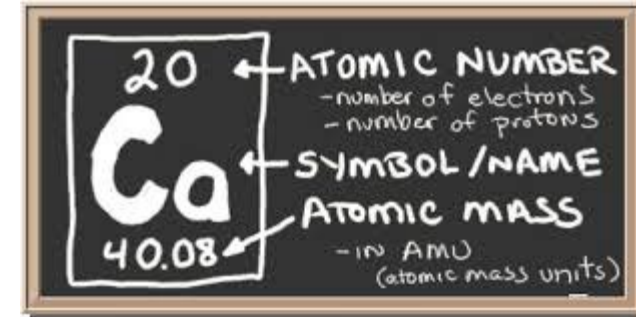




- 
- The background of the slide is a close-up photograph of several layers of green lettuce leaves. The leaves are vibrant green with prominent veins and a slightly ruffled texture. A semi-transparent white rectangular box is centered over the middle of the image, containing a bulleted list of four items.
- **Fast growth rates**
  - **High humidity, temperature, and light**
  - **Low Calcium**
  - **Genetics**



# Calcium

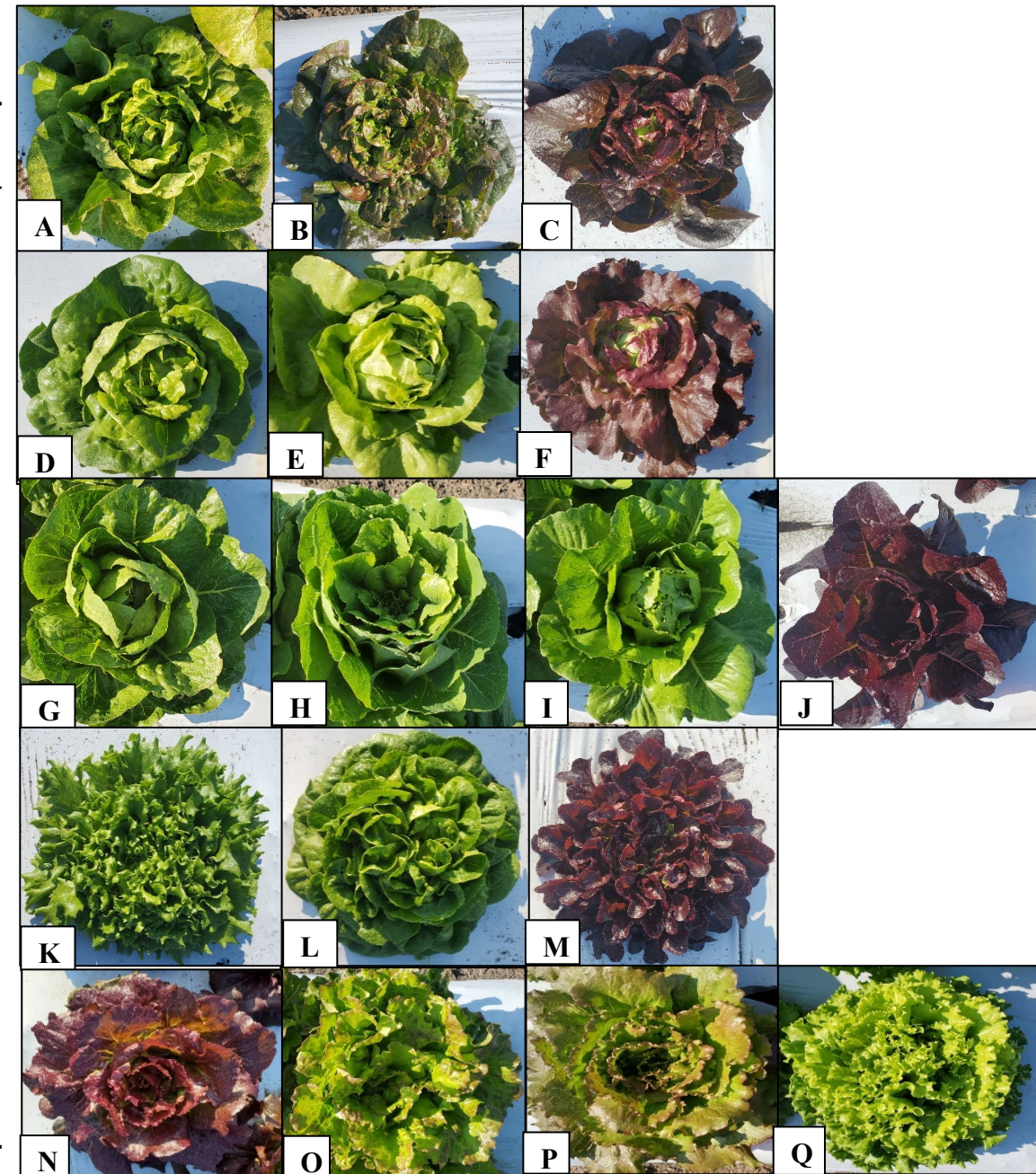


- **Highly immobile in plants**
- Symptoms first seen in young leaves
- Calcium is necessary for cell elongation and division, protein synthesis, root and leaf development, and plant vigor



# Cultivar Evaluation

| Type              | Cultivar         | Seed Provider             | Days to Full Maturity |
|-------------------|------------------|---------------------------|-----------------------|
| Butterhead Bib    | A) Buttercrunch  | Johnny's Selected Seeds   | 46 days               |
|                   | B) Cegolaine     | Johnny's Selected Seeds   | 50 days               |
|                   | C) Rosaine       | Johnny's Selected Seeds   | 52 days               |
| Butterhead Boston | D) Adriana       | Johnny's Selected Seeds   | 48 days               |
|                   | E) Nancy         | Johnny's Selected Seeds   | 52 days               |
|                   | F) Skyphos       | Johnny's Selected Seeds   | 47 days               |
| Romaine           | G) Aerostar      | High Mowing Organic Seeds | 55 days               |
|                   | H) Coastal Star  | Johnny's Selected Seeds   | 57 days               |
|                   | I) Thurinus      | Johnny's Selected Seeds   | 56 days               |
|                   | J) Sparx         | Johnny's Selected Seeds   | 58 days               |
| Salanova®         | K) Green Batavia | Johnny's Selected Seeds   | 55 days               |
|                   | L) Green Butter  | Johnny's Selected Seeds   | 55 days               |
|                   | M) Red Oakleaf   | Johnny's Selected Seeds   | 57 days               |
| Summer Crisp      | N) Cherokee      | Johnny's Selected Seeds   | 48 days               |
|                   | O) Lovelock      | High Mowing Organic Seeds | 48 days               |
|                   | P) Magenta       | Johnny's Selected Seeds   | 48 days               |
|                   | Q) Muir          | Johnny's Selected Seeds   | 50 days               |







**Batavian/Crisphead or Summer  
Crisp Lettuce**



# Salanova® Lettuce —

INTRODUCING the newest innovation in lettuce. Grow like a head lettuce, but sell as a salad mix.

Compared to traditional baby leaf:

- More than 40% greater yield
- Better flavor, texture, shelf life
- Less labor to grow and harvest
- Modern package of disease resistance to DM and *Nasonovia ribisnigri* aphid.

See more growing information, videos, and technical brochures on Salanova® on our website at [Johnnysseeds.com](http://Johnnysseeds.com)



Grow like a head lettuce



Prepare in one cut

**Incised Leaf Types** — Use as a flavorfull base for structure, loft and weight. Prepare with knife.



GREEN INCISED LEAF



RED INCISED LEAF



GREEN SWEET CRISP  
FRISEE



RED SWEET CRISP FRISEE

## 3072JP SALANOVA® FOUNDATION COLLECTION: 0

53 days (M10-30)

**Building block for a high-value salad mix.** This collection will add not only great flavor, but increase loft and weight to a salad mix. It can be used as a stand-alone mix, but is recommended to be combined with the Salanova® Premier Collection to create a more dramatic offering. The collection includes 25% each of the four incised leaf types in individual packages. Suitable for mechanical harvesting or preparing with a knife. Seed is pelleted using NOP-compliant pellets to make planting easier. Utility Patent 5,977,443.

100 Seeds \$15.95; 500 Seeds \$24.95; 1,000 Seeds \$30.95;  
5M @ \$26.50/M; 10M @ \$24.95/M.







Nutrie

120 lb

75 lbs

100 lb

White-on-black raised beds

Transplanted: June 7, 2021 & 2022





**Within row spacing:**

- **Butterhead types: 9-12"**
- **Romaine, Crisphead**

- **Randomized Complete Block Design**
- **Five replications**





## Harvested

- July 1 & July 13, 2021
- July 6, 2022





# Data collection

## Quality assessment

Marketability

Diameter

Leaf Number and Leaf Area

Dry Weight

Plant Nutrient Content

Bolting (%)





Table 1. Lettuce (*Lactuca sativa*) yield and quality in summer 2021 at the Iowa State University Horticulture Research Station, Ames, IA.

| Type                  | Cultivar      | Plant dry<br>weight (g) <sup>i</sup> | Marketable number <sup>ii</sup> | Marketable<br>weight (kg) | Head diameter<br>(cm) <sup>iii</sup> | Unmarketable<br>number <sup>iv</sup> | Unmarketable<br>weight (kg) |
|-----------------------|---------------|--------------------------------------|---------------------------------|---------------------------|--------------------------------------|--------------------------------------|-----------------------------|
| Butterhead Bib        | Buttercrunch  | 9.08 <sup>NS,v</sup>                 | 10 <sup>NS</sup>                | 1.93 <sup>NS</sup>        | 10.10 <sup>NS</sup>                  | 2 <sup>NS</sup>                      | 0.14 <sup>NS</sup>          |
|                       | Cegolaine     | 8.26                                 | 11                              | 1.94                      | 10.20                                | 1                                    | 0.02                        |
|                       | Rosaine       | 7.38                                 | 11                              | 1.57                      | 9.90                                 | 1                                    | 0.04                        |
| Butterhead Boston     | Adriana       | 11.78 a                              | 11 <sup>NS</sup>                | 1.99 b                    | 12.90 a                              | 1 <sup>NS</sup>                      | 0.03 <sup>NS</sup>          |
|                       | Nancy         | 11.77 a                              | 12                              | 2.66 a                    | 13.10 a                              | 0                                    | 0.00                        |
|                       | Skyphos       | 7.13 b                               | 11                              | 1.36 c                    | 9.70 b                               | 1                                    | 0.08                        |
| Romaine               | Aerostar      | 15.29 a                              | 12 a                            | 2.86 b                    | 12.30 b                              | 0 b                                  | 0.00 b                      |
|                       | Coastal Star  | 16.76 a                              | 11 a                            | 3.92 a                    | 16.80 a                              | 1 b                                  | 0.06 ab                     |
|                       | Sparx         | 16.21 a                              | 12 a                            | 4.19 a                    | 15.60 a                              | 0 b                                  | 0.00 b                      |
|                       | Thurinus      | 6.25 b                               | 9 b                             | 0.98 c                    | 6.50 c                               | 3 a                                  | 0.20 a                      |
| Salanova <sup>®</sup> | Green Batavia | 8.22 a                               | 11 <sup>NS</sup>                | 1.49 <sup>NS</sup>        | 12.20 a                              | 1 <sup>NS</sup>                      | 0.01 <sup>NS</sup>          |
|                       | Green Butter  | 5.63 b                               | 11                              | 1.08                      | 5.80 b                               | 1                                    | 0.04                        |
|                       | Red Oakleaf   | 6.77 ab                              | 11                              | 1.40                      | 10.50 ab                             | 1                                    | 0.09                        |
| Summer Crisp          | Cherokee      | 7.61 b                               | 11 <sup>NS</sup>                | 1.52 b                    | 9.00 b                               | 1 <sup>NS</sup>                      | 0.01 <sup>NS</sup>          |
|                       | Lovelock      | 11.96 a                              | 11                              | 2.87 a                    | 14.60 a                              | 1                                    | 0.01                        |
|                       | Magenta       | 11.16 a                              | 10                              | 2.73 a                    | 12.00 a                              | 2                                    | 0.24                        |
|                       | Muir          | 13.02 a                              | 10                              | 2.13 ab                   | 13.33 a                              | 2                                    | 0.14                        |



Table 3. Leaf Number and leaf area of lettuce (*Lactuca sativa*) grown in summer 2021 and 2022 at the Iowa State University Horticulture Research Station, Ames, IA.

| Type                  | Cultivar      | 2021                |                             | 2022             |                              |
|-----------------------|---------------|---------------------|-----------------------------|------------------|------------------------------|
|                       |               | Leaf Number         | Leaf Area(cm <sup>2</sup> ) | Leaf Number      | Leaf Area (cm <sup>2</sup> ) |
| Butterhead Bib        | Buttercrunch  | 13 <sup>NS,ii</sup> | 1462.53 <sup>NS</sup>       | 13 b             | 1714.61 b                    |
|                       | Cegolaine     | 14                  | 1314.65                     | 19 a             | 2723.99 a                    |
|                       | Rosaine       | 17                  | 1251.76                     | 19 a             | 1610.63 b                    |
| Butterhead Boston     | Adriana       | 16 ab               | 2422.37 a                   | 16 ab            | 4728.53 a                    |
|                       | Nancy         | 17 a                | 2828.58 a                   | 20 a             | 3994.28 a                    |
|                       | Skyphos       | 13 b                | 1658.49 b                   | 14 b             | 2720.23 b                    |
| Romaine               | Aerostar      | 23 a                | 2960.81 <sup>NS</sup>       | 22 <sup>NS</sup> | 5099.20 a                    |
|                       | Coastal Star  | 20 ab               | 3683.93                     | 23               | 5149.14 a                    |
|                       | Sparx         | 21 a                | 3089.47                     | 23               | 4960.07 a                    |
|                       | Thurinus      | 15 b                | 2777.58                     | 23               | 3390.83 b                    |
| Salanova <sup>®</sup> | Green Batavia | 38 ab               | 1838.71 <sup>NS</sup>       | 48 <sup>NS</sup> | 2723.89 <sup>NS</sup>        |
|                       | Green Butter  | 27 b                | 1471.47                     | 44               | 2916.65                      |
|                       | Red Oakleaf   | 46 a                | 1794.87                     | 45               | 2558.99                      |
| Summer Crisp          | Cherokee      | 12 <sup>NS</sup>    | 1675.52 b                   | 18 <sup>NS</sup> | 3225.77 b                    |
|                       | Lovelock      | 16                  | 2419.37 ab                  | 17               | 4160.65 a                    |
|                       | Magenta       | 17                  | 2536.16 a                   | 16               | 4156.37 a                    |
|                       | Muir          | 17                  | 2380.27 ab                  | 19               | 3461.59 ab                   |



Table 4. Summer field trial air and soil temperatures in 2021 and 2022 at the Iowa State University Horticulture Research Station, Ames, IA.

|                    | Air temperature (°C) <sup>i</sup> |      |      |                             | Soil temperature (°C) <sup>ii</sup> |      |      |
|--------------------|-----------------------------------|------|------|-----------------------------|-------------------------------------|------|------|
|                    | Mean                              | Max  | Min  | 30-year Mean <sup>iii</sup> | Mean                                | Max  | Min  |
| 2021 <sup>iv</sup> |                                   |      |      |                             |                                     |      |      |
| June               | 24.0                              | 36.8 | 8.7  | 20.5                        | 26.8                                | 34.3 | 19.0 |
| July               | 22.8                              | 32.8 | 13.5 | 22.3                        | 25.6                                | 32.2 | 20.1 |
| 2022 <sup>v</sup>  |                                   |      |      |                             |                                     |      |      |
| June               | 29.0                              | 46.1 | 8.0  | 20.5                        | 23.3                                | 27.9 | 17.2 |
| July               | 28.3                              | 49.0 | 11.7 | 22.3                        | 24.1                                | 29.1 | 20.0 |



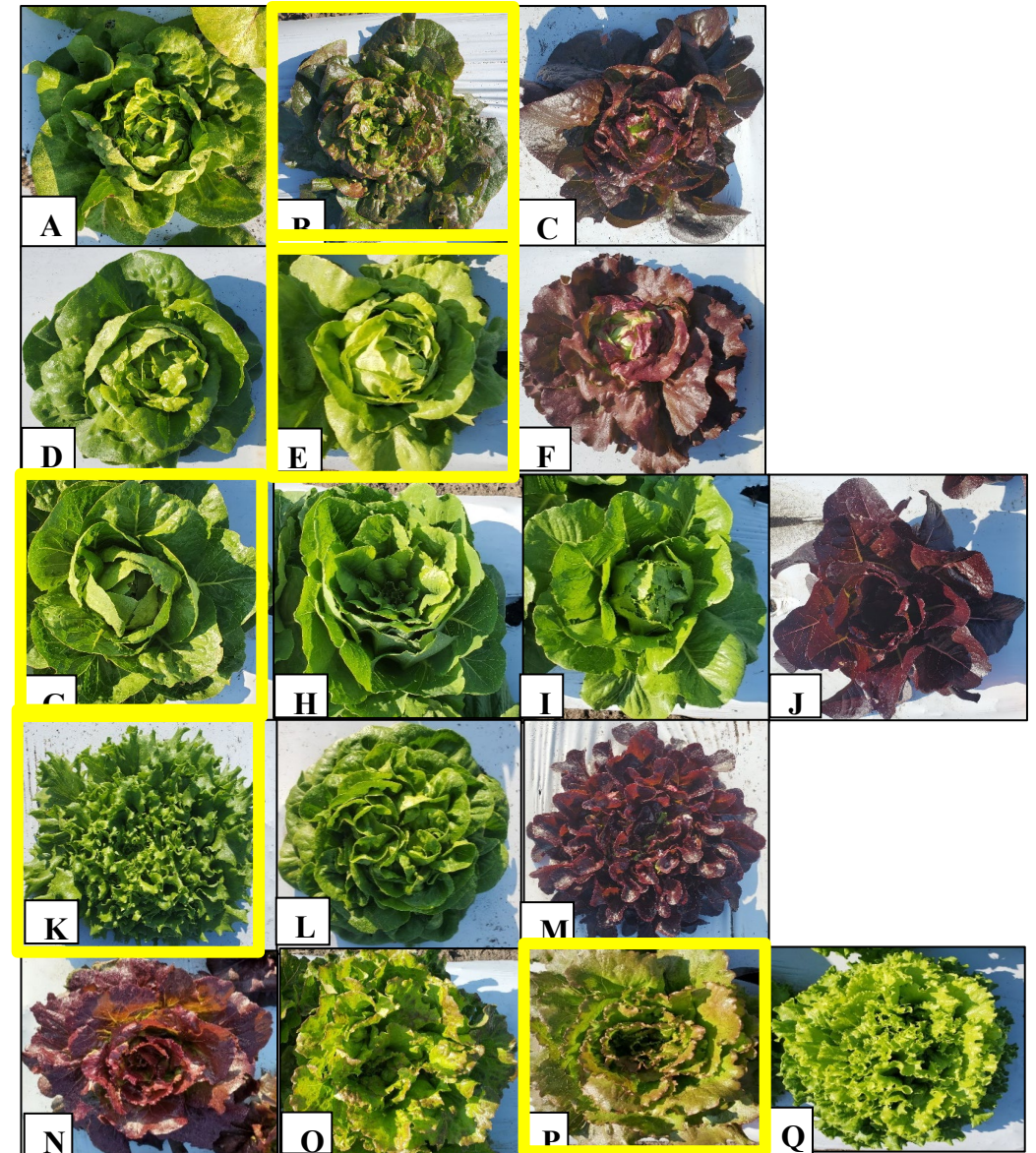
Table 5. Percentage of bolting lettuce (*Lactuca Sativa*) at the Iowa State University Horticulture Research Station Ames, IA in summer 2021 and 2022.

| Type                  | Cultivar      | 2021                           | 2022              |
|-----------------------|---------------|--------------------------------|-------------------|
|                       |               | Heads bolting (%) <sup>i</sup> | Heads bolting (%) |
| Butterhead Bib        | Buttercrunch  | 20 <sup>NS,ii</sup>            | 35 b              |
|                       | Cegolaine     | 0                              | 100 a             |
|                       | Rosaine       | 20                             | 95 a              |
| Butterhead Boston     | Adriana       | 0 <sup>NS</sup>                | 100 a             |
|                       | Nancy         | 40                             | 95 a              |
|                       | Skyphos       | 0                              | 30 b              |
| Romaine               | Aerostar      | 30 b                           | 10 c              |
|                       | Coastal Star  | 100 a                          | 90 a              |
|                       | Sparx         | 100 a                          | 75 ab             |
|                       | Thurinus      | 0 b                            | 55 b              |
| Salanova <sup>®</sup> | Green Batavia | 0 <sup>NS</sup>                | 15 b              |
|                       | Green Butter  | 0                              | 100 a             |
|                       | Red Oakleaf   | 0                              | 100 a             |
| Summer Crisp          | Cherokee      | 20 ab                          | 30 a              |
|                       | Lovelock      | 20 a                           | 35 a              |
|                       | Magenta       | 0 b                            | 15 b              |
|                       | Muir          | 50 a                           | 35 a              |



# Cultivar Conclusions

| Type              | Cultivar         | Seed Provider             | Days to Full Maturity |
|-------------------|------------------|---------------------------|-----------------------|
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|                   | Q) Muir          | Johnny's Selected Seeds   | 50 days               |





# **Bolting mitigation**

- **Cultivar selection**
- **Healthy transplants**
- **Proper fertility management**
- **Monitoring weather conditions**
- **Hard....but avoiding the ‘perfectionist’**







4-week-old lettuce plug





# Aphid infestation of lettuce





- 
- **Neem-based insecticide**
  - **Spinosad**
  - ***Beauveria bassiana* (Mycotrol®)**
  - **Interplant with quick flowering annuals e.g. sweet alyssum (*Lobularia maritima*)**







# Many THANKS

Rachel Perry, Anne Carey  
Taylor Mauch, Carly Strauser, and  
Undergraduate students



SCAN ME



<http://extension.iastate.edu/vegetablelab>



# LETTUCE DISCUSS...

