# DETERMINING FERTILIZER NUTRIENT USE EFFICIENCY WITH ONION

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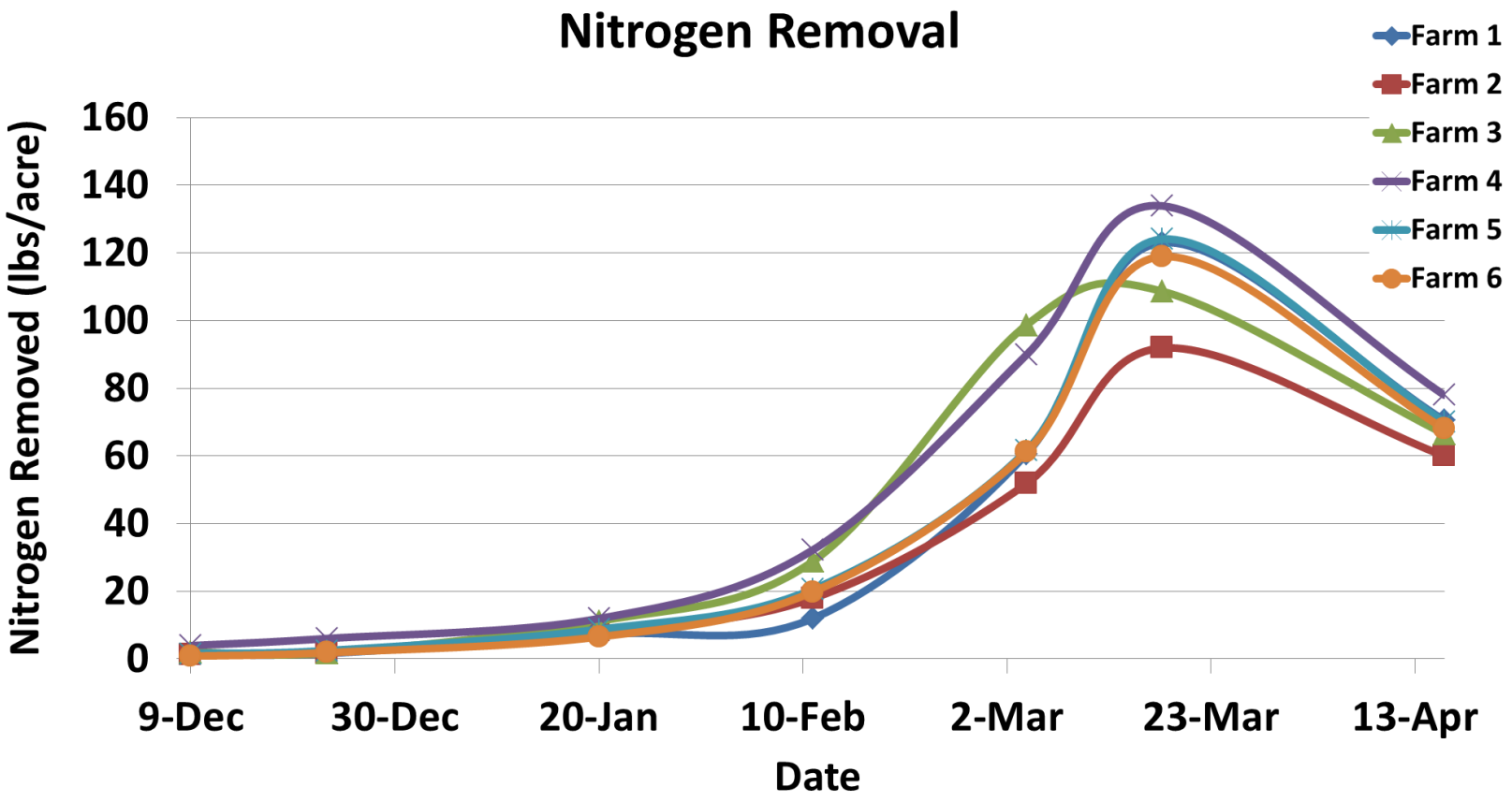
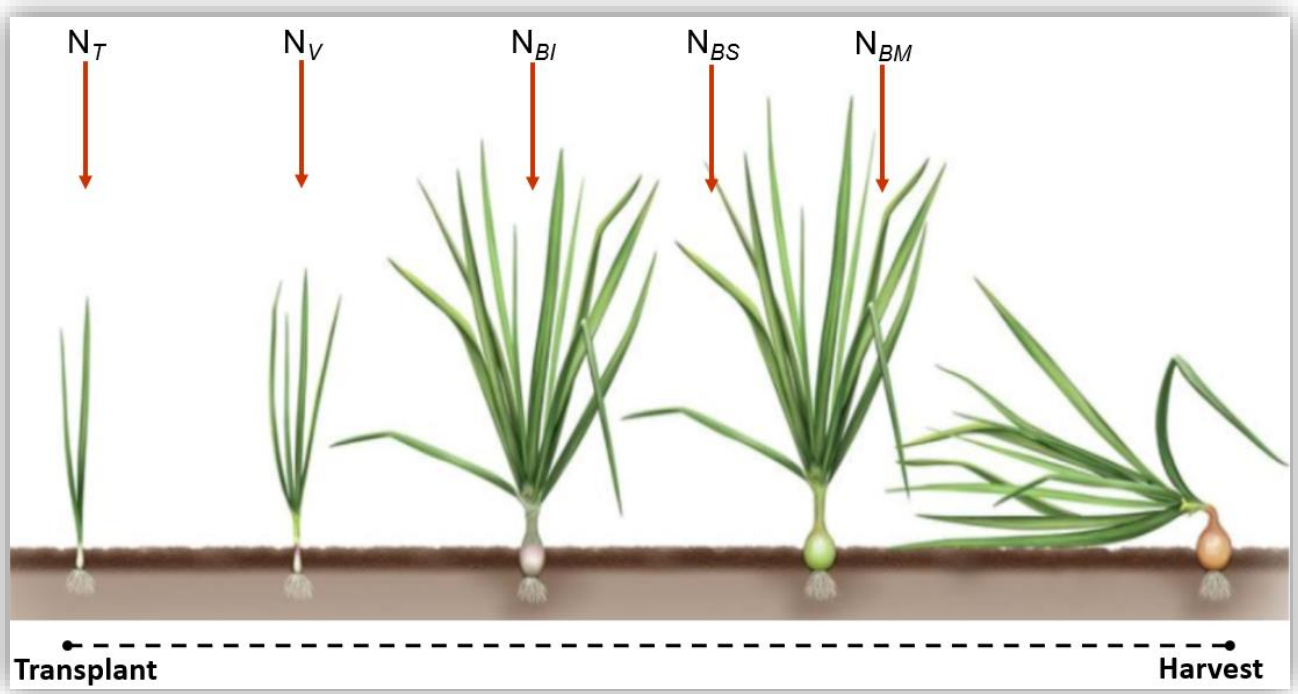
# Objective

Determine the FNUE across different fertilizer application times and investigate the application timing that most contributes to bulb yield in the production of Vidalia onions.

# Nutrient Removal - N



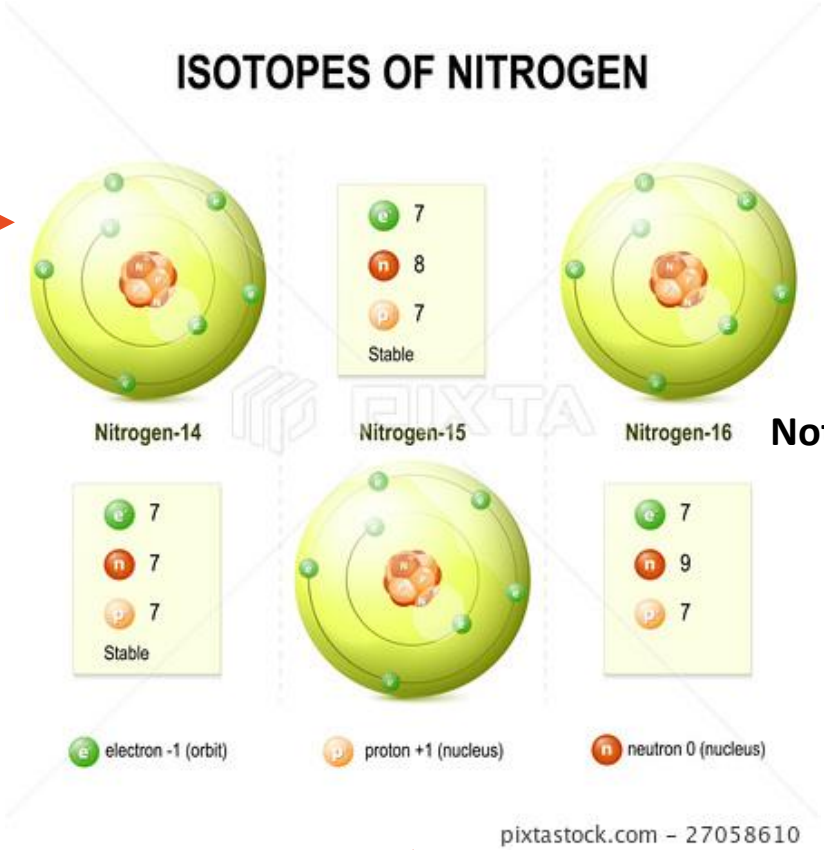
**Total fertilizer N rate:** 112 bl/acre N




Timing of application must be synchronized with plant N requirement to optimize the FNUE of onions and reduce total fertilizer N rate

# What is N15?

**99.63%**




**Not stable in environment**

**0.36%**

https://www.pixtastock.com/illustration/27058610

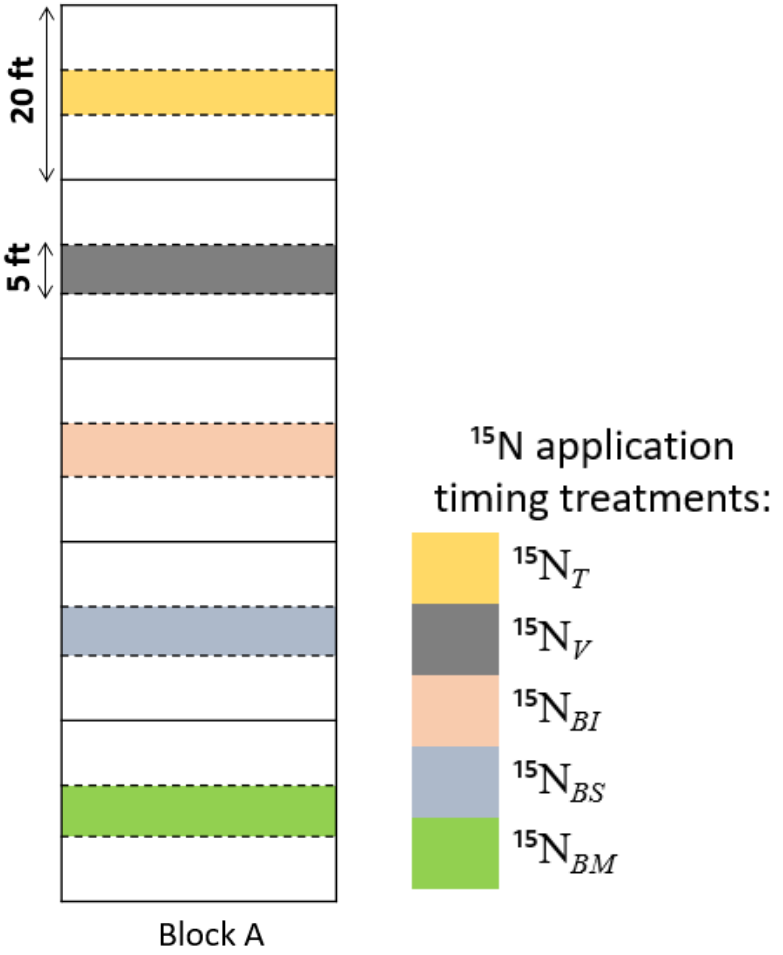
# Materials and Methods

- **Location:** Vidalia Onion and Vegetable Research Center (Lions, GA)
- **Years of study**: 2020-21 and 2021-22 onion seasons
- **Treatments:** Five $^{15}N$ isotope labeled fertilizer (ammonium nitrate) application timings x 4 replications, in a randomized complete block design

| Treatments | N rate (lb./acre) | | | | | |
|---|---|---|---|---|---|---|
| | $N_T$ | $N_V$ | $N_{BI}$ | $N_{BS}$ | $N_{BM}$ | Total N |
| $^{15}N_T$ | 22.4[i] | 22.4 | 22.4 | 22.4 | 22.4 | 112 |
| $^{15}N_V$ | 22.4 | 22.4[i] | 22.4 | 22.4 | 22.4 | 112 |
| $^{15}N_{BI}$ | 22.4 | 22.4 | 22.4[i] | 22.4 | 22.4 | 112 |
| $^{15}N_{BS}$ | 22.4 | 22.4 | 22.4 | 22.4[i] | 22.4 | 112 |
| $^{15}N_{BM}$ | 22.4 | 22.4 | 22.4 | 22.4 | 22.4[i] | 112 |

[i]The time **$^{15}N$** fertilizer is being applied; NT = N applied at transplanting; NV = N applied at vegetative stage; NBI = N applied at bulb initiation; NBS = N applied bulb swelling; NBM = N applied at pre-maturation.

# Material and methods



# Materials and Methods

**FNUE and Ndff evaluation**

- The FNUE was evaluated at harvest in each plot receiving the $^{15}N$ treatments.

$$\boldsymbol{Ndff} = \frac{\%15N\ at.excess\ of\ the\ plant\ sample}{\%15N\ at.excess\ of\ the\ fertilizer\ applied} \times Plant\ uptake\ (kg/ha)$$

$$\boldsymbol{FNUE} = \frac{Ndff}{Rate\ of\ N\ fertilizer\ applied\ (kg/ha)} \times 100$$

# RESULTS

# Results

Table 3. Marketable yield, bulb size distribution, percentage culls, and nitrogen harvest index (NHI) of onions (Allium cepa L.) harvested in 2021 and 2022.

| Year | Marketable | Colossal | Jumbo | Medium | Culls |
|---|---|---|---|---|---|
| | kg ha$^{-1(\%)}$ | | | | (%) |
| 2021 | 1102 b[i] | 2 b | 933 b | 167 a | 2.69 b |
| 2022 | 1303 a | 229 a | 1028 a | 46 b | 7.30 a |

[i]Values followed by the same letters indicate no significant difference by the Tukey test ($p<0.05$).

Table 4. Effects of fertilizer N application timing treatments on N derived from fertilizer (Ndff) at onion bulbs, leaves, roots and total plant, and fertilizer N use efficiency (FNUE) measured at harvest

| Treatment | Bulbs | Leaves | Roots | Total plant | FNUE (%) |
|---|---|---|---|---|---|
| | Ndff ($kg \cdot ha^{-1}$ $^{15}N$) | | | | |
| 2021 | | | | | |
| $^{15}NT^{i}$ | 1.16 c[ii] | 0.91 d | 0.02 c | 2.09 c | 8.87 c |
| $^{15}NV$ | 3.37 bc | 2.80 c | 0.04 bc | 6.21 b | 26.38 b |
| $^{15}NBI$ | 4.67 b | 3.59 c | 0.05 bc | 8.30 b | 35.28 b |
| $^{15}NBS$ | 11.75 a | 12.93 a | 0.08 a | 24.76 a | 105.16 a |
| $^{15}NBM$ | 12.76 a | 10.00 b | 0.05 ab | 22.81 a | 96.87 a |
| 2022 | | | | | |
| $^{15}NT$ | 4.62 b | 1.28 b | 0.04 a | 5.94 b | 25.22 b |
| $^{15}NV$ | 14.16 ab | 3.57 a | 0.10 a | 17.83 ab | 75.74 ab |
| $^{15}NBI$ | 20.22 a | 3.95 a | 0.08 a | 24.25 a | 103.02 a |
| $^{15}NBS$ | 15.38 ab | 2.84 ab | 0.06 a | 18.28 ab | 77.64 ab |
| $^{15}NBM$ | 10.97 ab | 1.54 b | 0.05 a | 12.56 ab | 53.34 ab |

[i]The time $^{15}N$ fertilizer is being applied; NT = N applied at transplanting; NV = N applied at vegetative stage; NBI = N applied at bulb initiation; NBS = N applied bulb swelling; NBM = N applied at pre-maturation.

# Results

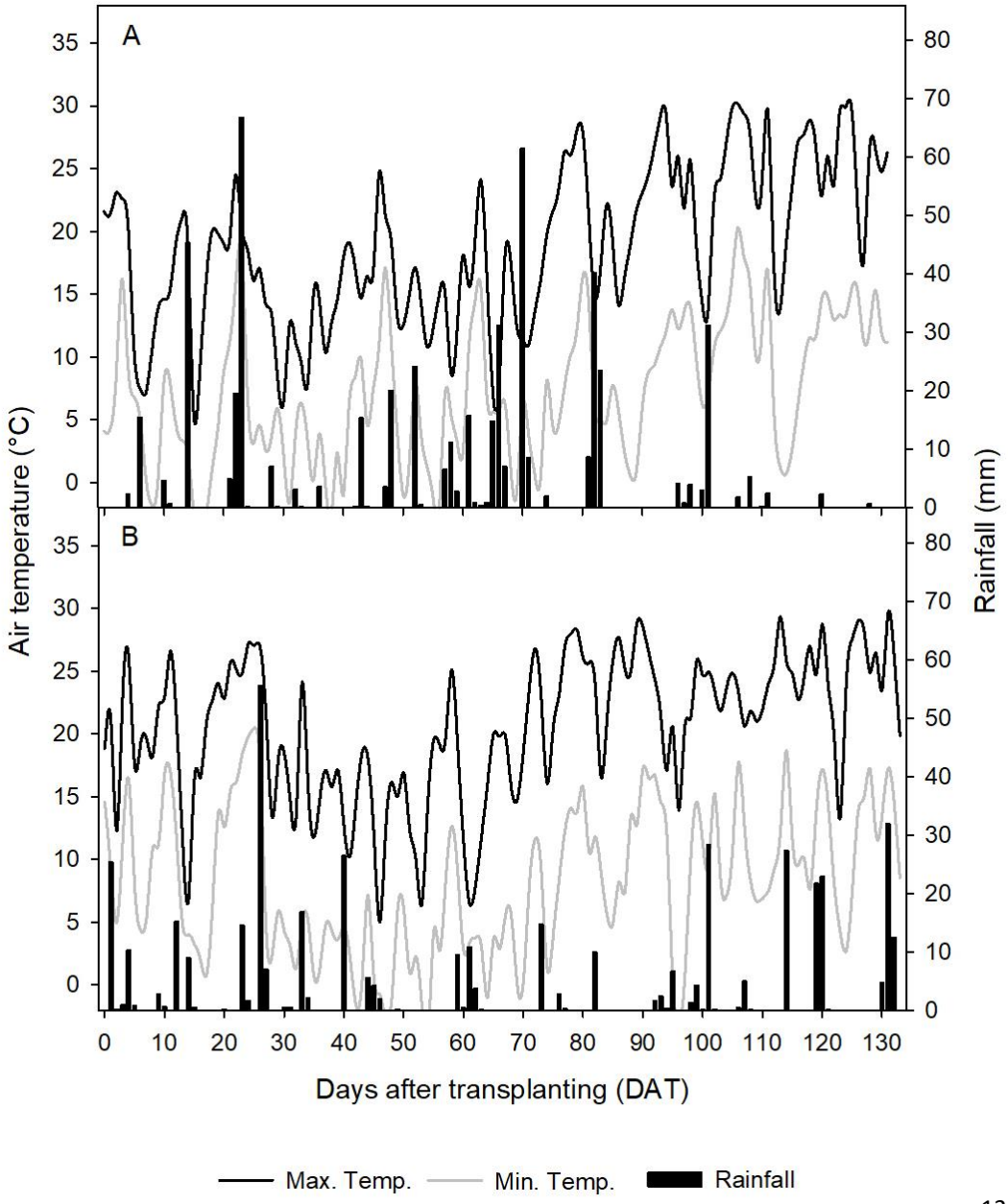
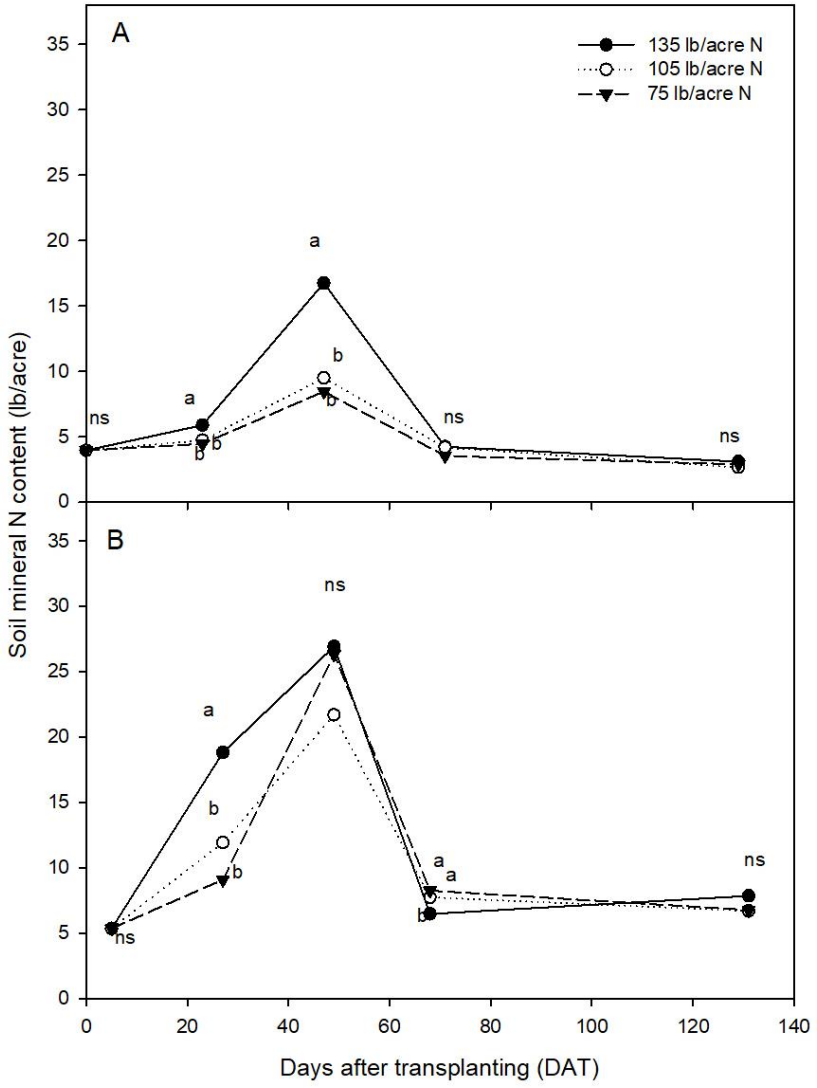



Figure 1. Daily maximum (max.) and minimum (min.) air temperatures (°C) and rainfall (mm) for onion (*Allium cepa* L.) grown during 2021 (a) and 2022 (b) in Georgia, USA. Data averages estimated using the University of Georgia Weather Network.

# Rainfall

- 2021 and 2022 were similar at the start of the season (6.3 & 5.7 inches) in 21 and 22 from planting until about 30 days after planting
- But bigger differences in rainfall in between 30 and 80 days of growth - 9.5 inches in 2020 and 3.9 inches in 2022 -

# How much to add early in the season?

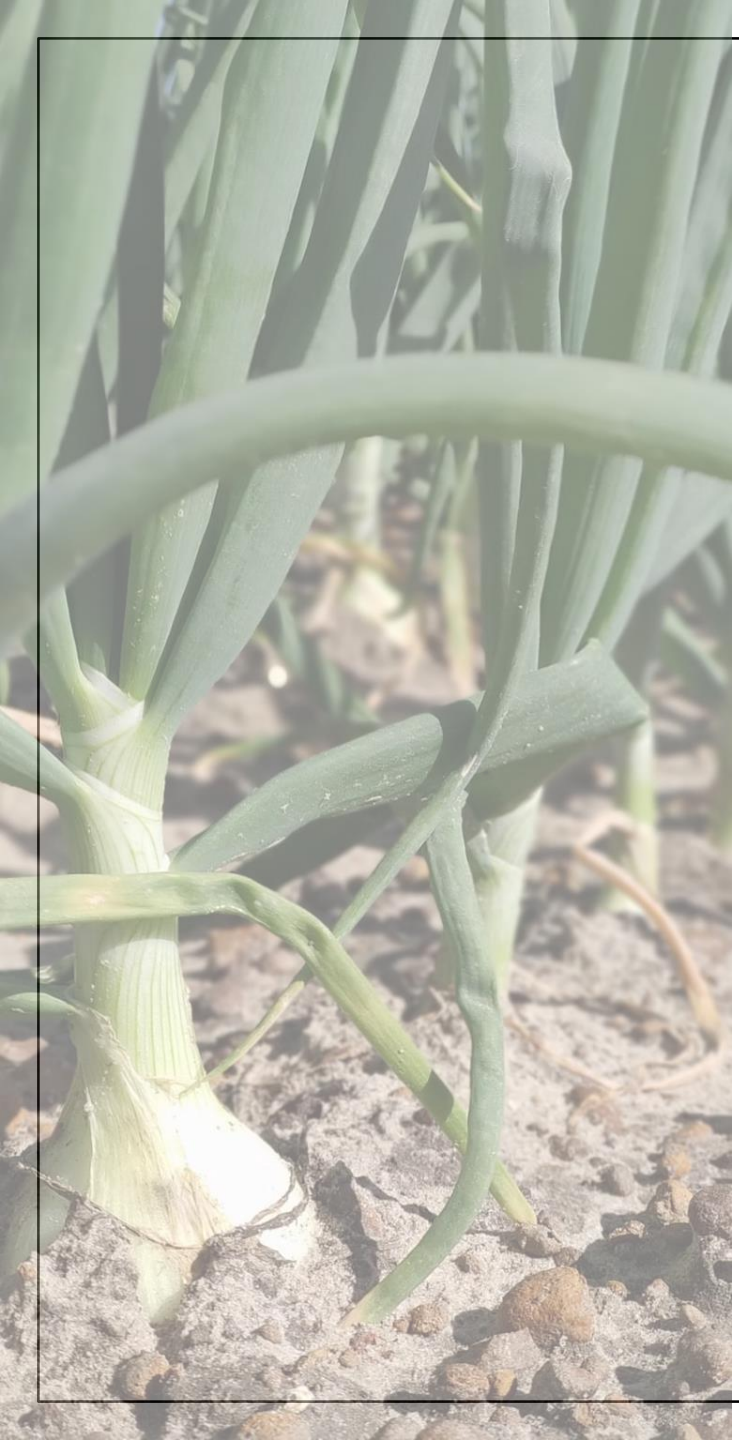


# Nitrogen harvest index

- Percentage of N found in bulbs vs. leaves
  - 2021 – it was 54% at harvest
  - 2022 it was 81% at harvest
- This suggests that in 2022 the plants had allocated more resources to the bulbs ……makes sense given that they used more N earlier in the year.

**Effect of timing of last N application on yield – Candy Ann (2021 and 2022)**

| Stage | Date | Total Yield | Col | Jumbo |
|---|---|---|---|---|
| Bulb initiation | Feb 10-12 | 1118a | 32a | 915a |
| Bulb growth | Feb 20-22 | 1079b | 30a | 851ab |
| Bulb maturation | March 7-10 | 1038b | 25a | 792a |



# THANK YOU!