Nitrogen Management in Organic Strawberries

Organic Soil Fertility for Vegetables and Strawberries
Feb. 12, 2019

Joji Muramoto

University of California, Santa Cruz

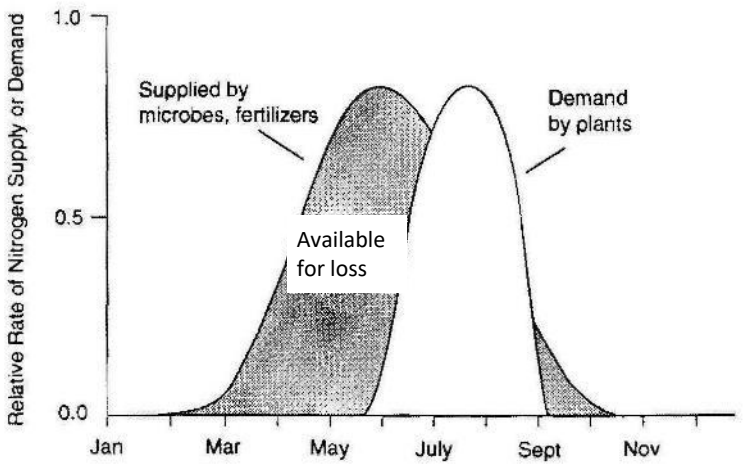
Overview

1. *Synchrony: Matching N supply with N demand*
2. *N Uptake by organic strawberries*
3. *N Supply for organic strawberries*
4. *Pre-plant and in-season N trials*
5. *Tools for N management in organic strawberries*
6. *High carbon amendment trial*

Synchrony of Nitrogen Supply and Nitrogen Demand

- *Matching N supply with N demand of strawberry plants*
  - amount and timing

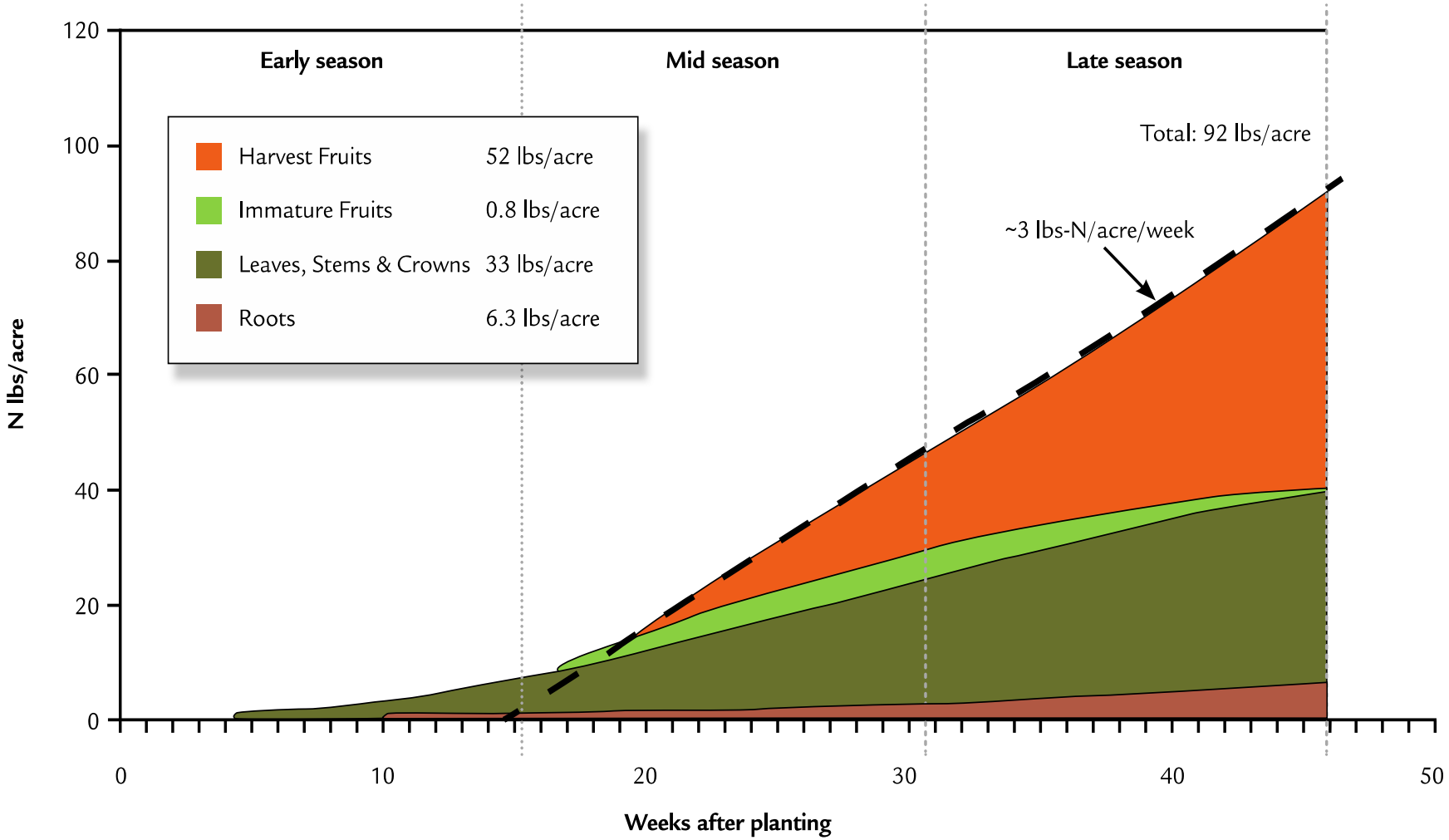
- *Important for:*
  - *Efficient use of N resources*
  - *Protecting ground and surface water from nitrate contamination*
  - *Reducing N fertilizer cost*
  - *Good fruit yield*



Asynchrony of N supply and N demand

(Robertson, 1997)

N Demand: Cumulative N Uptake by Organic Strawberry



Marketable yield: 37,800 lb/acre

Moss Landing, CA. Average of 4 seasons.
cv. Aromas

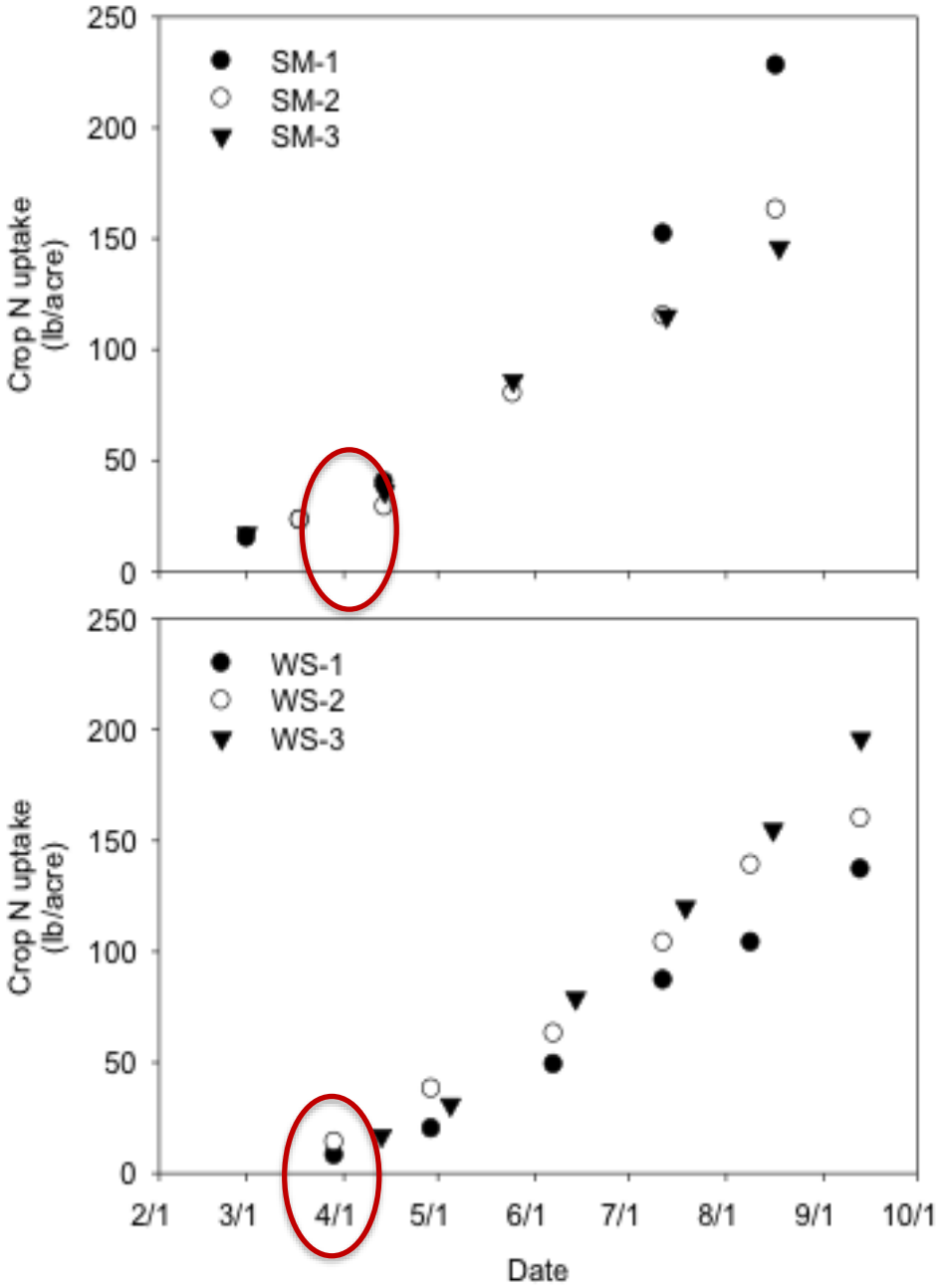
Strawberry N uptake:
Slow but constant for long period

(Muramoto and Gaskell, 2011)

N uptake by conventional strawberries in California

Santa Maria

Watsonville



Av. Yield: 73,000 lb/ac

150-220 lb-N/acre
6-8 lb-N/acre/week during the harvest season

(Bottoms et al., 2013)

N Supply: Organic N sources

- *Traditionally, organic growers concentrate on soil organic matter (SOM) management as basis for organic production program*

- *N mineralization residue, cover crop or compost lasts 8-10 weeks*
  - *does not match the N needs of the strawberry crop*

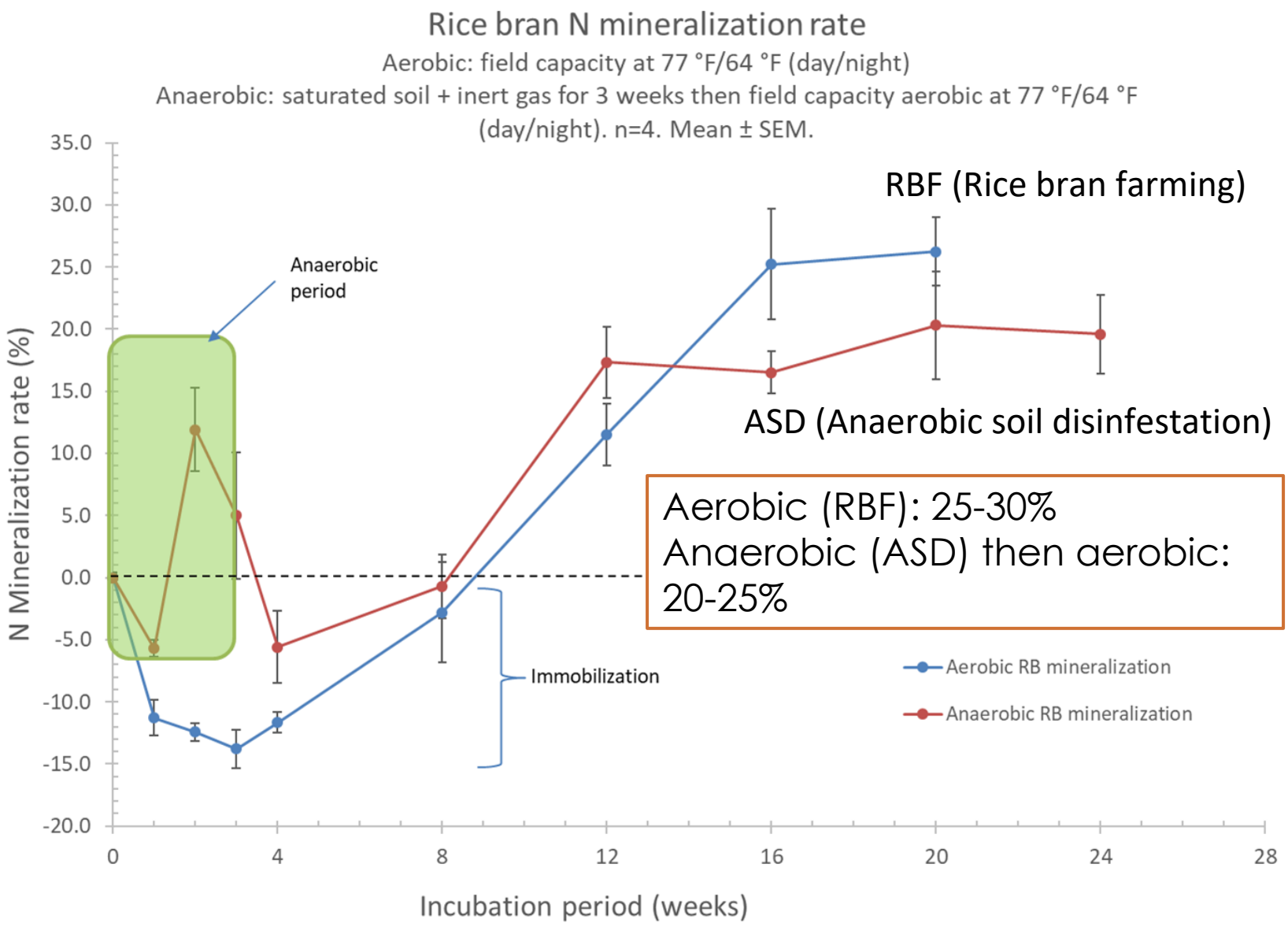
- *Cycling of N in soil organic fraction, microbial activity*
  - *Dynamic – depends on environmental factors soil temperature, moisture, pH, soil biology, etc.*

Net N mineralization (% of total N) from organic fertilizers and composts

Material	Total N %	C/N ratio	1 week	4 weeks	8 weeks	24 weeks
Blood meal	15.8	3.1	51	67	70	-
Feather meal	14.2	3.5	50	64	63	-
Fish powder	13.7	3.4	48	60	64	-
Sea bird guano	11.1	1.3	45	48	54	-
Pelletized poultry manure	2.8	8.6	10	23	36	-
Manure (poultry, feedlot)	2.7	11	-	-	-	15
Manure compost (poultry, feedlot, dairy)	1.9	9.8	-	-	-	6
Plant residue compost	1.6	14.2	-	-	-	2

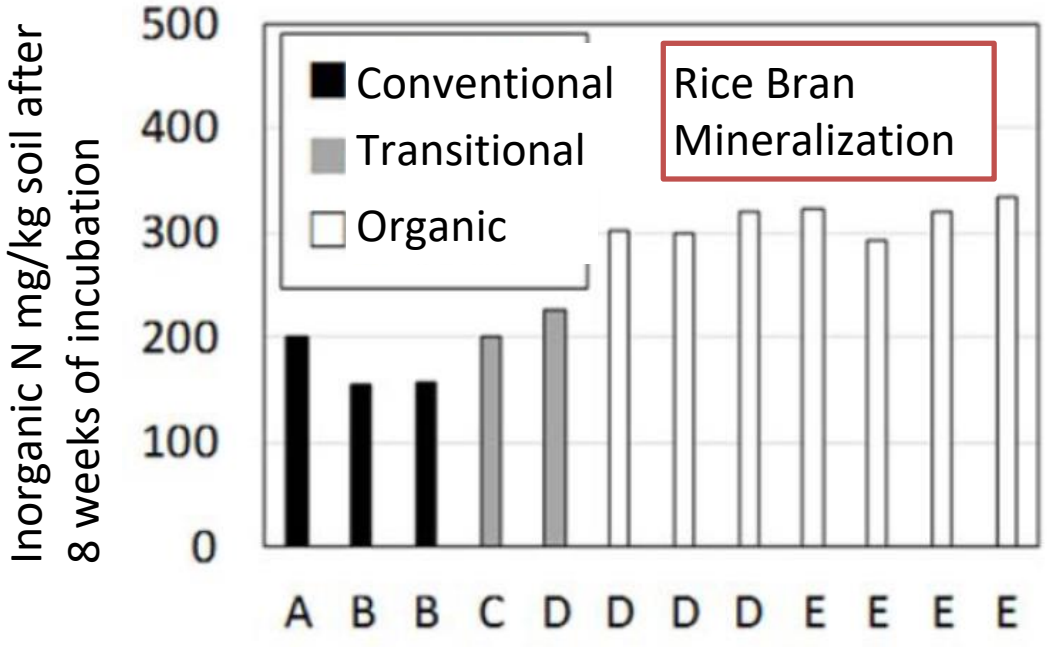
Incubated at 77 °F. (Hartz and Johnstone 2004; Hartz et al., 2000)

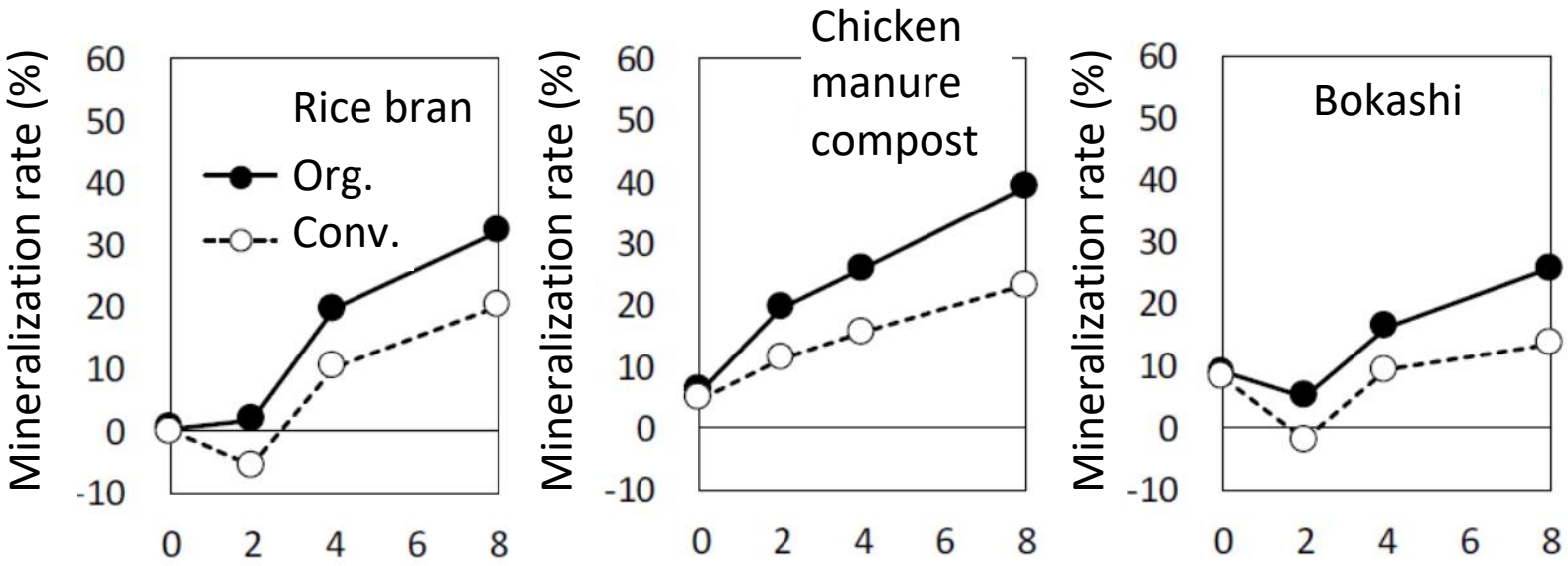
N MINERALIZATION FROM RICE BRAN



Organically managed soils mineralize organic fertilizers faster

- **Recent Japanese study**
- **8 weeks incubation, field capacity, 86 °F**

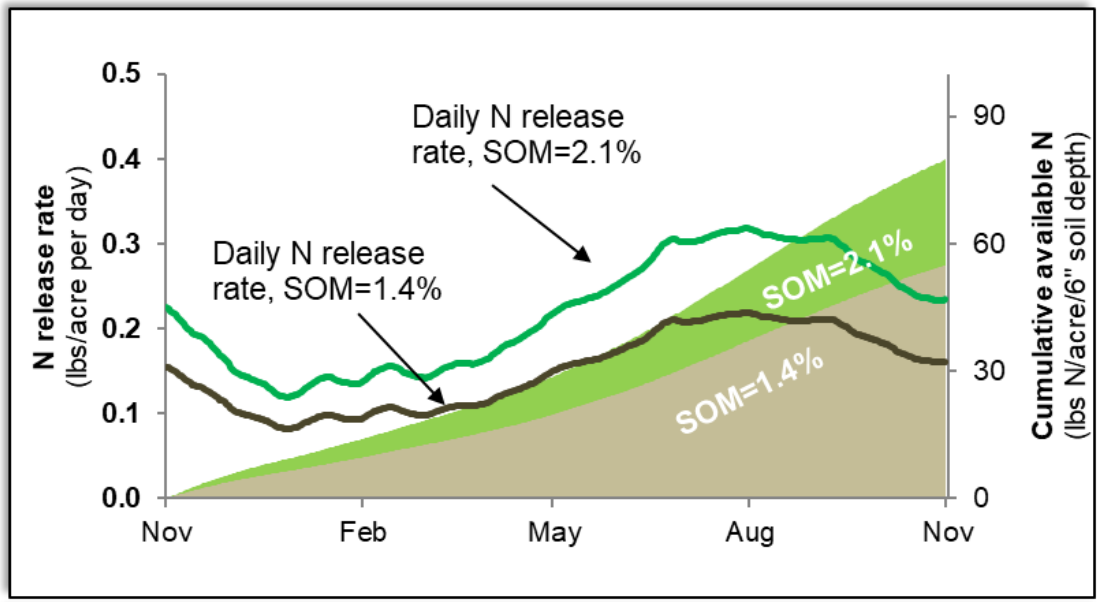


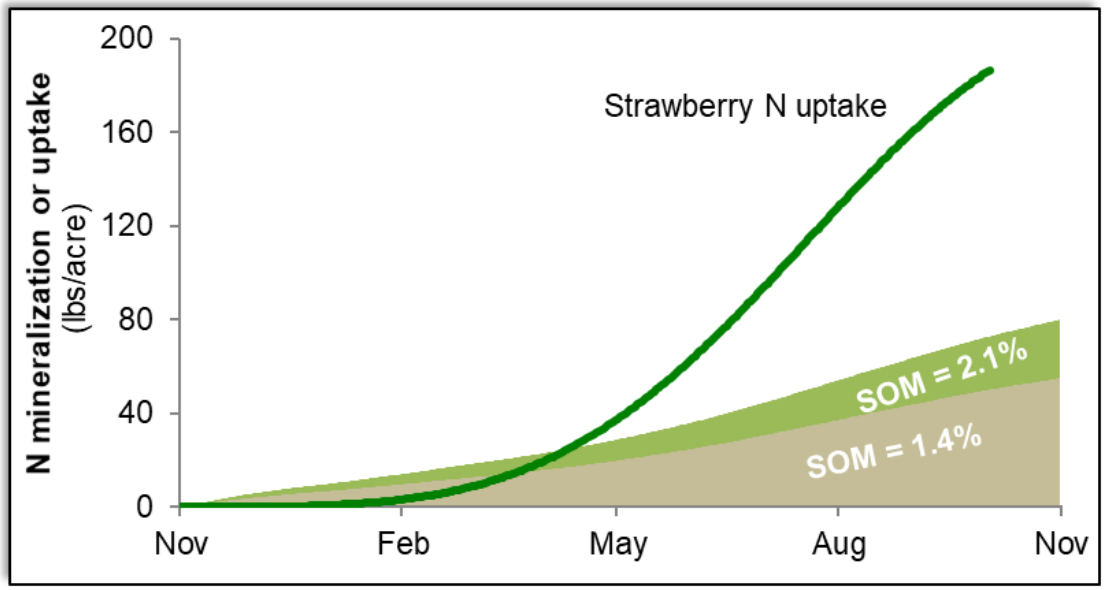


(Karasawa et al., 2018a,b)

N release from SOM

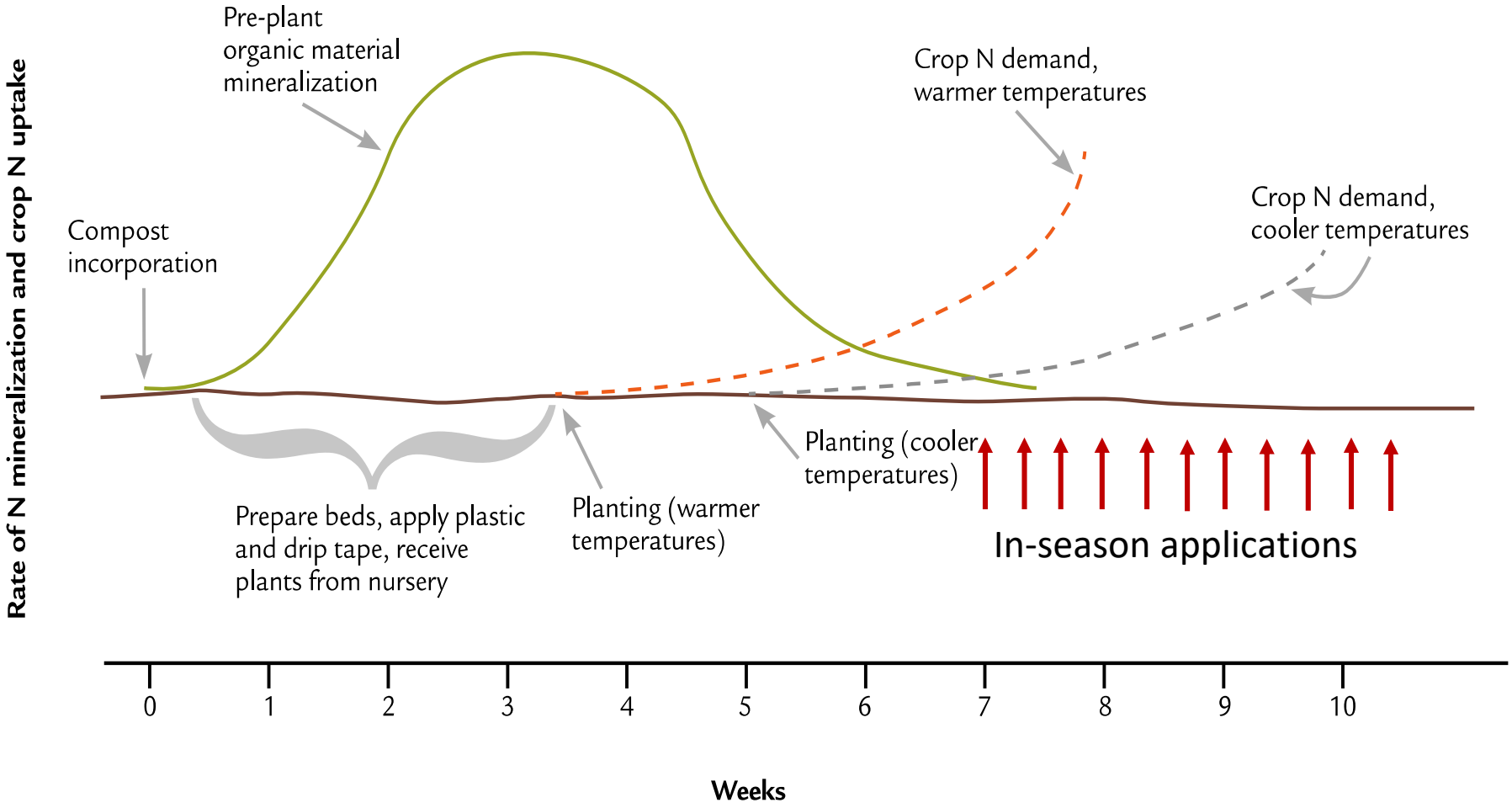
- *SOM can provide some inorganic N*
  - *Soil temp, moisture, dependent*
- *Increased SOM can reduce the needs of N input to some degree*
- *But it is not sufficient to fulfil N demand during the harvest period*





(Courtesy of Patricia Lazicki and Daniel Geisseler, UC Davis)

Asynchrony of pre-plant nitrogen release and strawberry N uptake



N Supply: In-season N applications

- *In-season band application and cultivation with organic pelleted or milled fertilizer…impractical under plasticulture CA strawberry systems*

- *Fertigation: liquid organic fertilizer applications via drip tapes are popular among organic strawberry growers in CA*

- *Clogging of drip tapes by fertigation of liquid organic fertilizers is a big issue*

- ***Use of double drip lines or use of soluble organic fertilizers***

Pre-plant/In-season N Trials in the Northern District

- *Goal: To examine effects of types and rates of pre-plant and in-season N applications to fruit yield in organic strawberry production*

- *Approach: Four seasons of randomized block split-plot on-farm trials with In-season N as main plots and pre-plant N as split plots in Watsonville, CA (4 reps)*

- *cv. Seascape*

Experimental Design

Season Site	Main plots (In-season N*)	Split plots (Pre-plant N)
2007-08 Site-3**	0, 150, 300 lb-N/ac with liquid organic fertilizer	Compost 5 t/ac (CP) CP + Blood meal 75 lb-N/ac (CP+BM75) CP + Blood meal150lb-N/ac (CP+BM150)
2008-09 Site-4**		

* Biweekly applications through Mar. to Oct.

** Managed by a large scale specialized grower

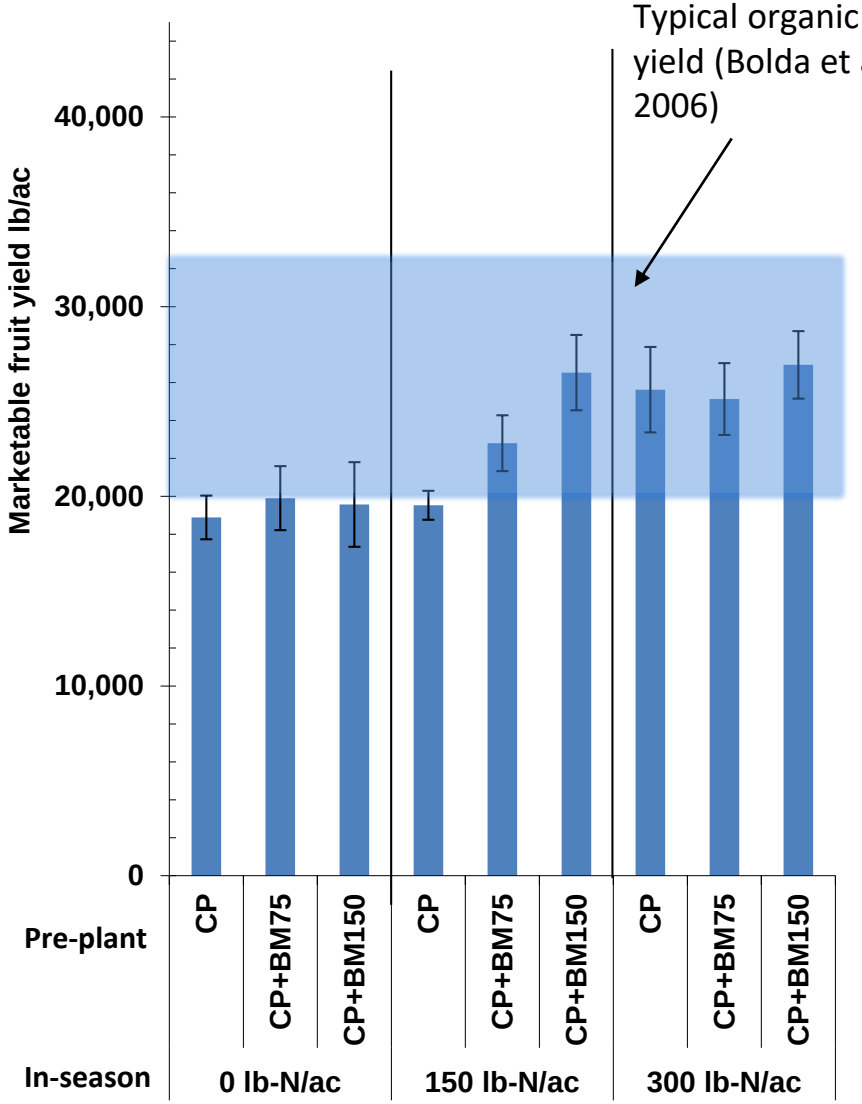
Grower's standard practice.

Marketable Fruit Yield (Mean ± SEM)

Mkt: ANOVA (*P≤0.05*)
In-season: * 0 150 300
Pre-plant: n.s.
In-season x Pre-plant: n.s.

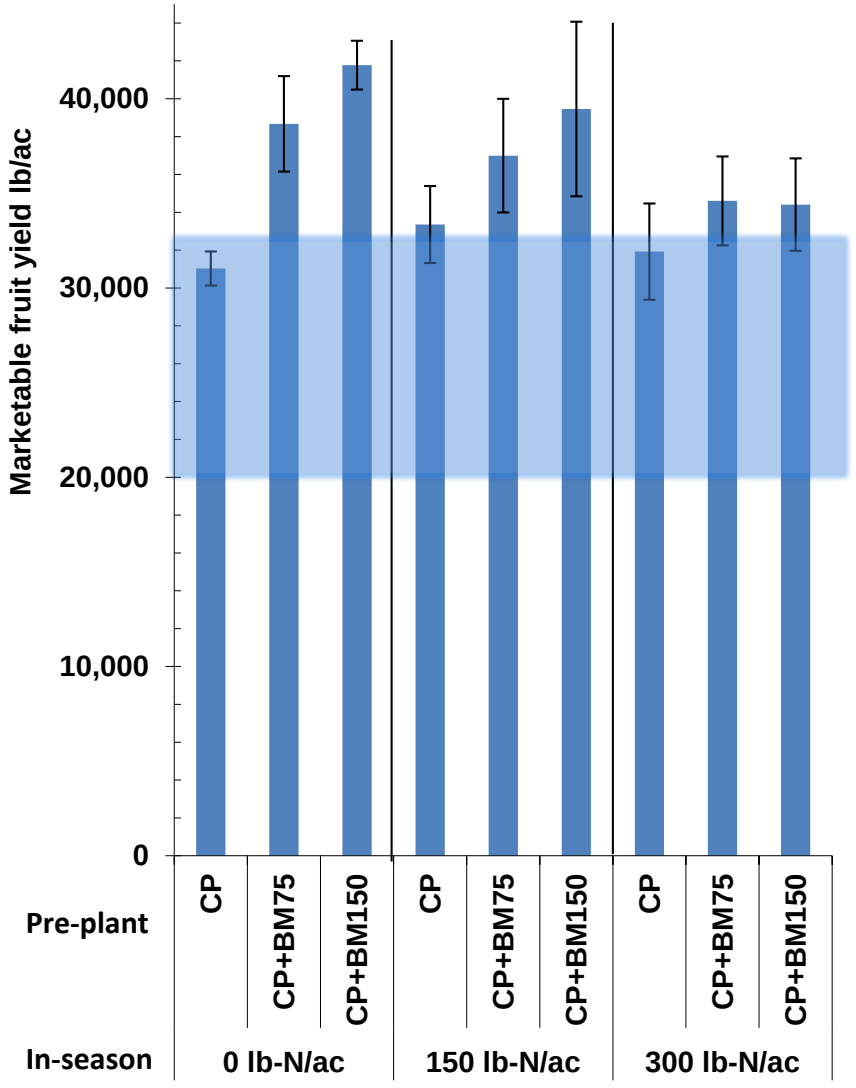
2007-08 (Site-3)

Typical organic yield (Bolda et al., 2006)



Mkt: ANOVA (*P≤0.05*)
In-season: n.s.
Pre-plant:** CP +BP75 +BP150
In-season x Pre-plant: n.s.

2008-09 (Site-4)



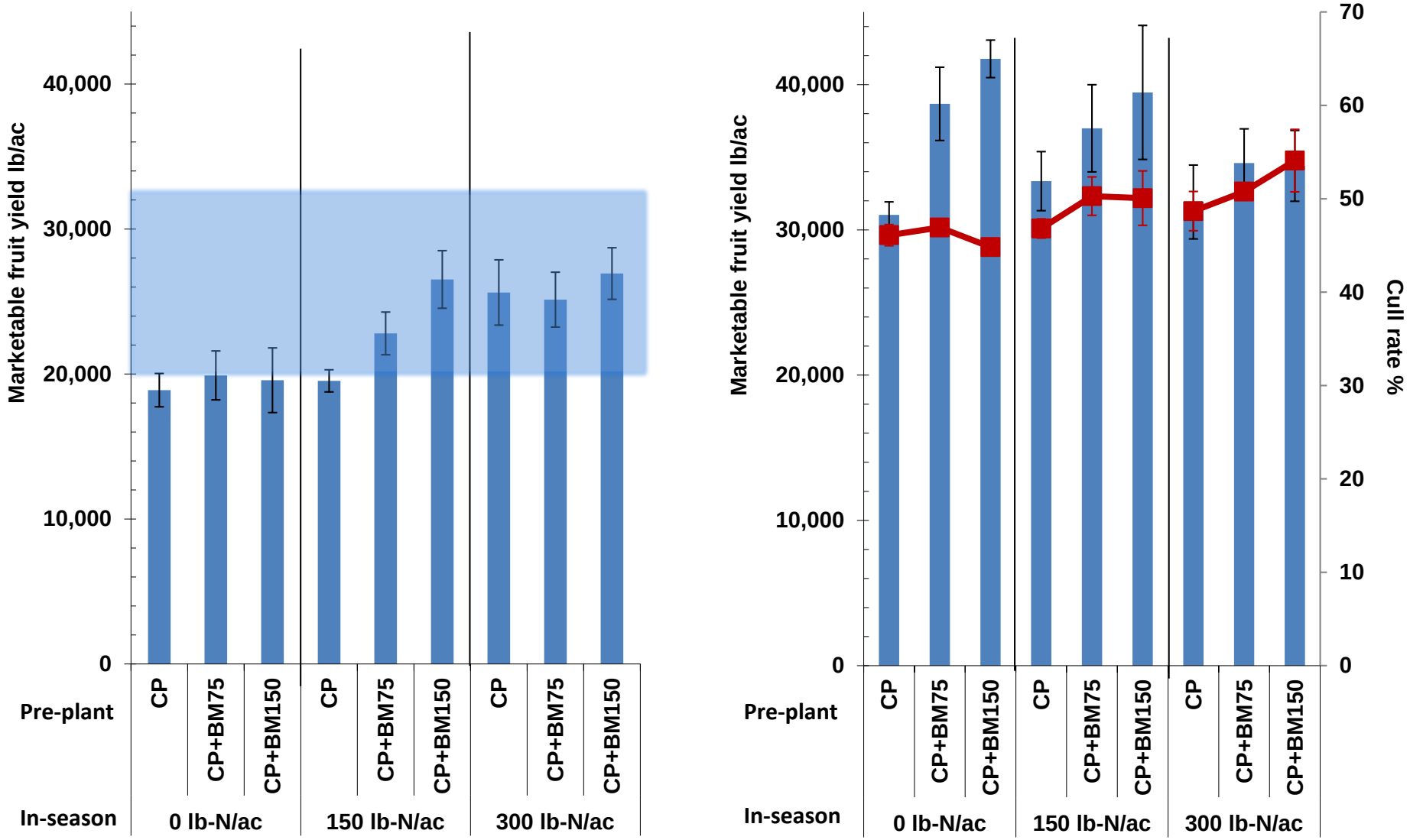
Marketable Fruit Yield (Mean ± SEM)

Mkt: ANOVA (*P≤0.05*)
In-season: * 0 150 300
Pre-plant: n.s.
In-season x Pre-plant: n.s.

2007-08 (Site-3)

Cull: ANOVA (*P≤0.05*)
In-season: * 0 150 300
Pre-plant: n.s.
In-season x Pre-plant: n.s.

2008-09 (Site-4)



N loss and Winter Weather
(Nov. 1 – Jan. 31. Watsonville, CA)

Season Site	Precip. inch	Mean Max. Air Temp ºF	Mean Min. Air Temp. ºF
2007-08 (Site-3)	10.7 (-0.9*)	61.5 (-1.1)	39.6 (-0.9)
2008-09 (Site-4)	6.1 (-5.6)	64.9 (+2.2)	41.0 (+0.5)

* Difference from the 30 yr mean (1979-2008).

N Management in Organic Strawberries: Summary (1)

- *N demand by strawberries varies depending on the region and the fruit yield*
  - *In the Southern (warmer) region, N uptake increases faster than the Northern (colder) region*
    - *Pre-plant N*
      - *more effective in the south than the north*
      - *can increase fruit yield in dry-warm winters in the north*
      - ***For the north, moderate rate (50-75 lb-N/acre) recommended***
      - ***If it is a warm/dry winter, start fertigation early (e.g. Jan-)***

N Management in Organic Strawberries: Summary (2)

- *Mineralized N from a crop residue, organic fertilizers and SOM does not match the long and steady N needs of strawberries*
  - *In-season N applications necessary (target 6-8 lb-N/acre/week during the harvest season)*

- *Fertigation of liquid organic fertilizer*
  - *Use of common organic liquid organic fertilizer without filter + double drip lines*

    or
  - *Use of soluble organic N fertilizer (expensive?)*

N Management Tools for Organic Strawberry

- Tissue test: TN of leaf blades

Stage	Early flowering	Early harvest	Main harvest
TN in blade	3.1-3.8%	2.7-3.2%	2.4-3.0%

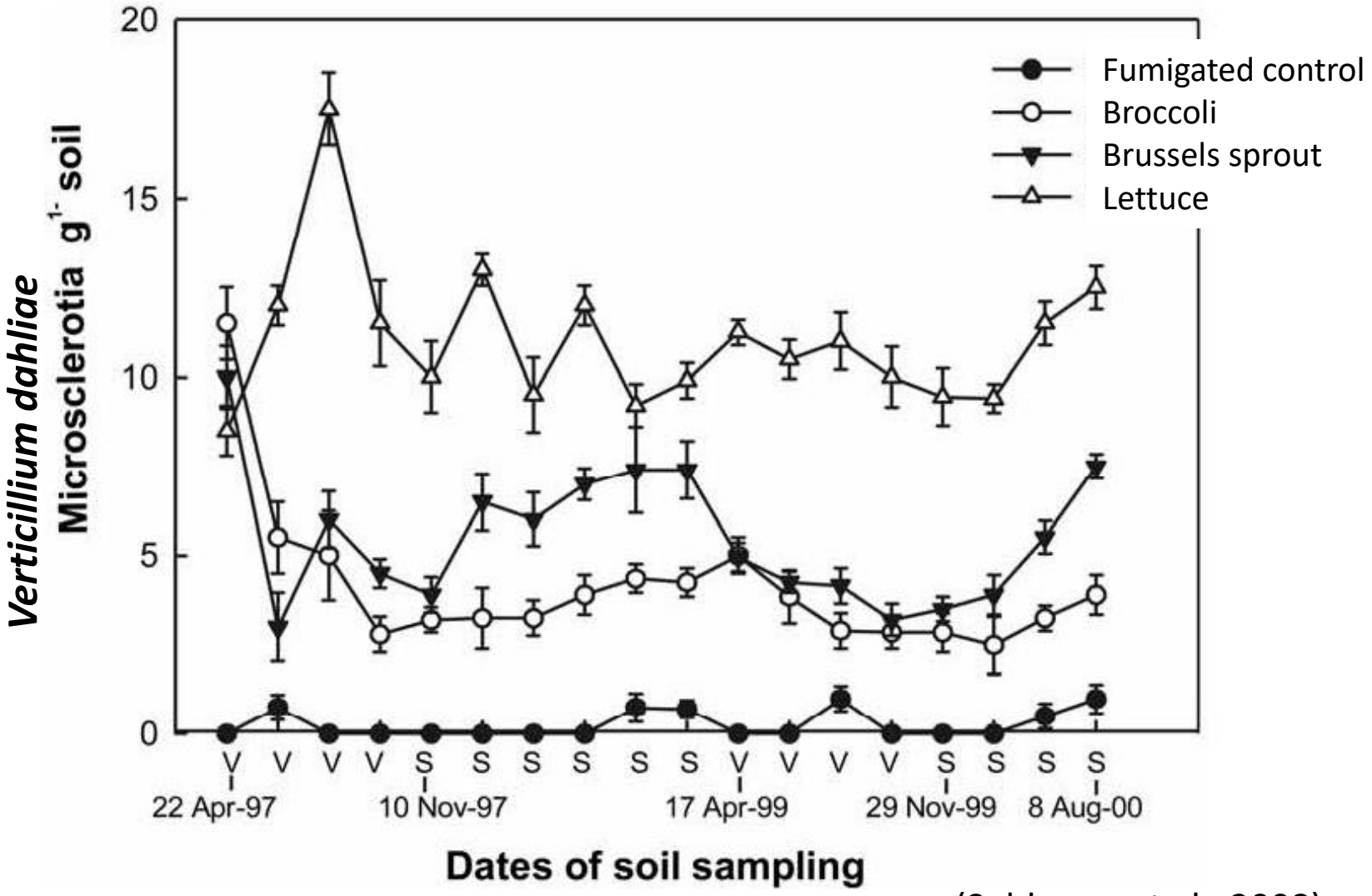
(Bottoms et al., 2013)

  - NO_3 in petioles: highly variable

- Soil nitrate test

  NO_3-N 10 - 25 p.p.m. (=mg-N/kg dry soil) in 0'-1' depth

Broccoli residue incorporation reduces *Verticillium dahliae in soil*



(Subbarao et al., 2008)

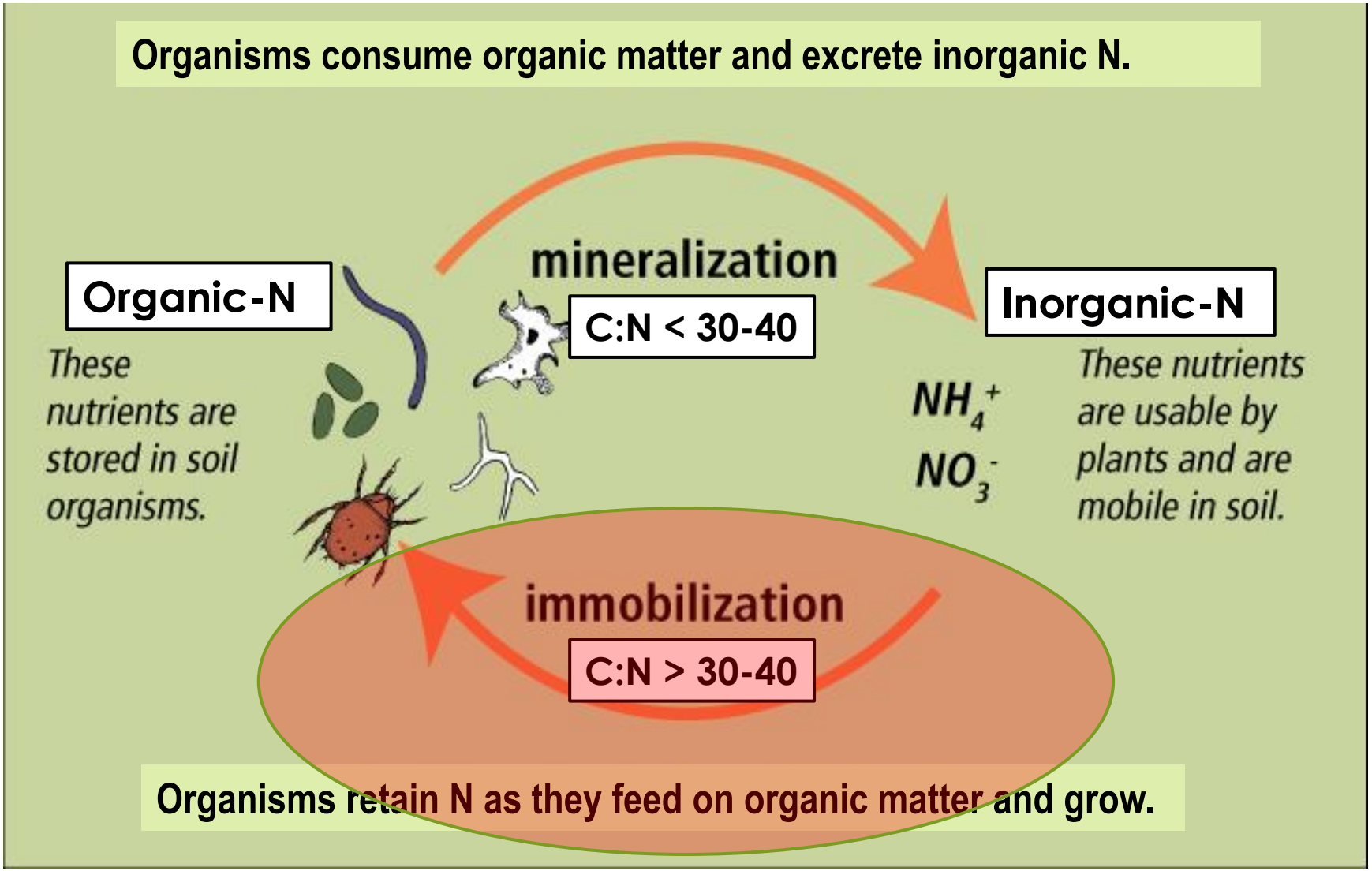
Asynchrony of N supply and N demand in an organic strawberry field in the Northern region, CA

150-250 lb-N/acre
C:N ~10

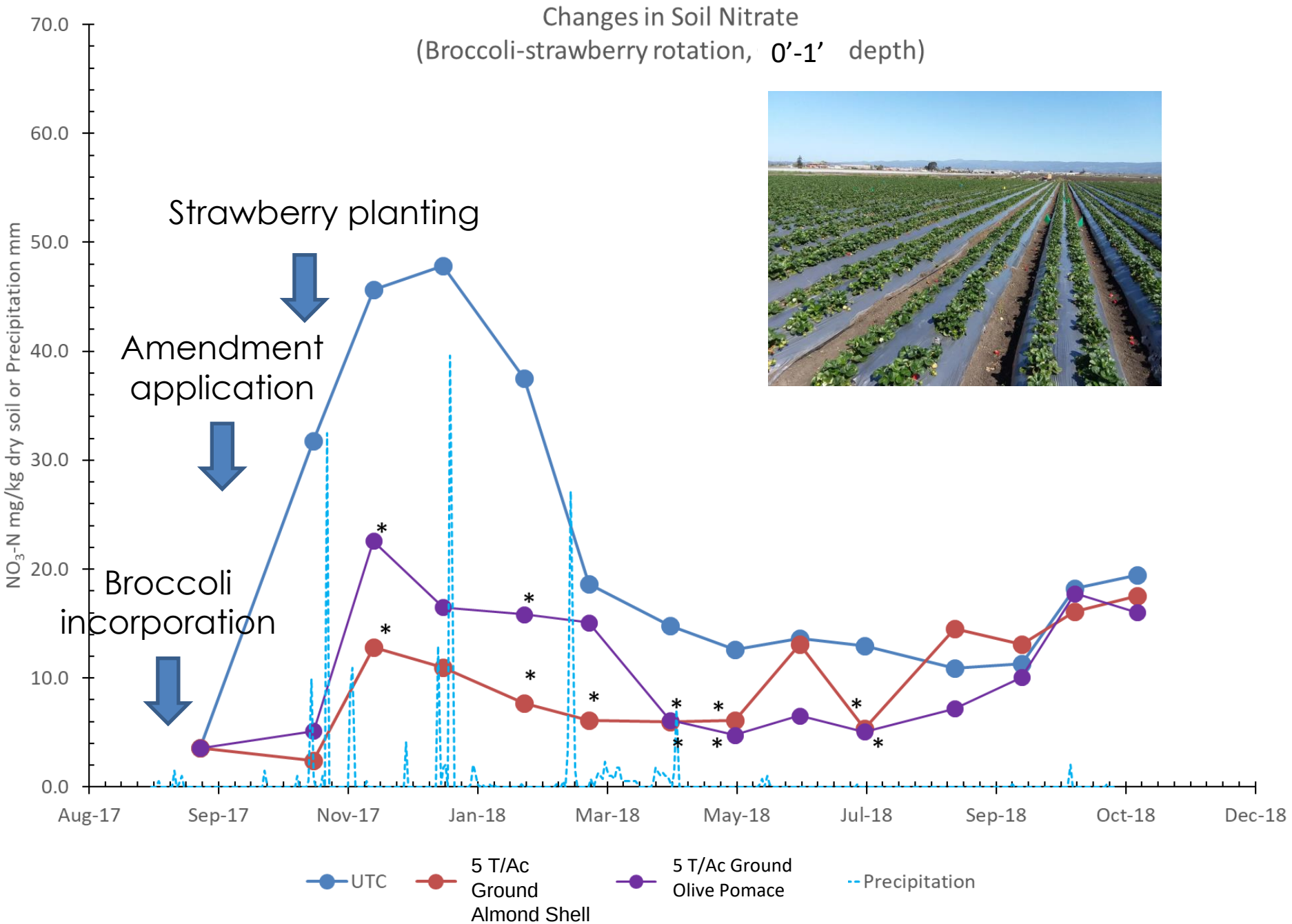
(Muramoto et al., 2004)

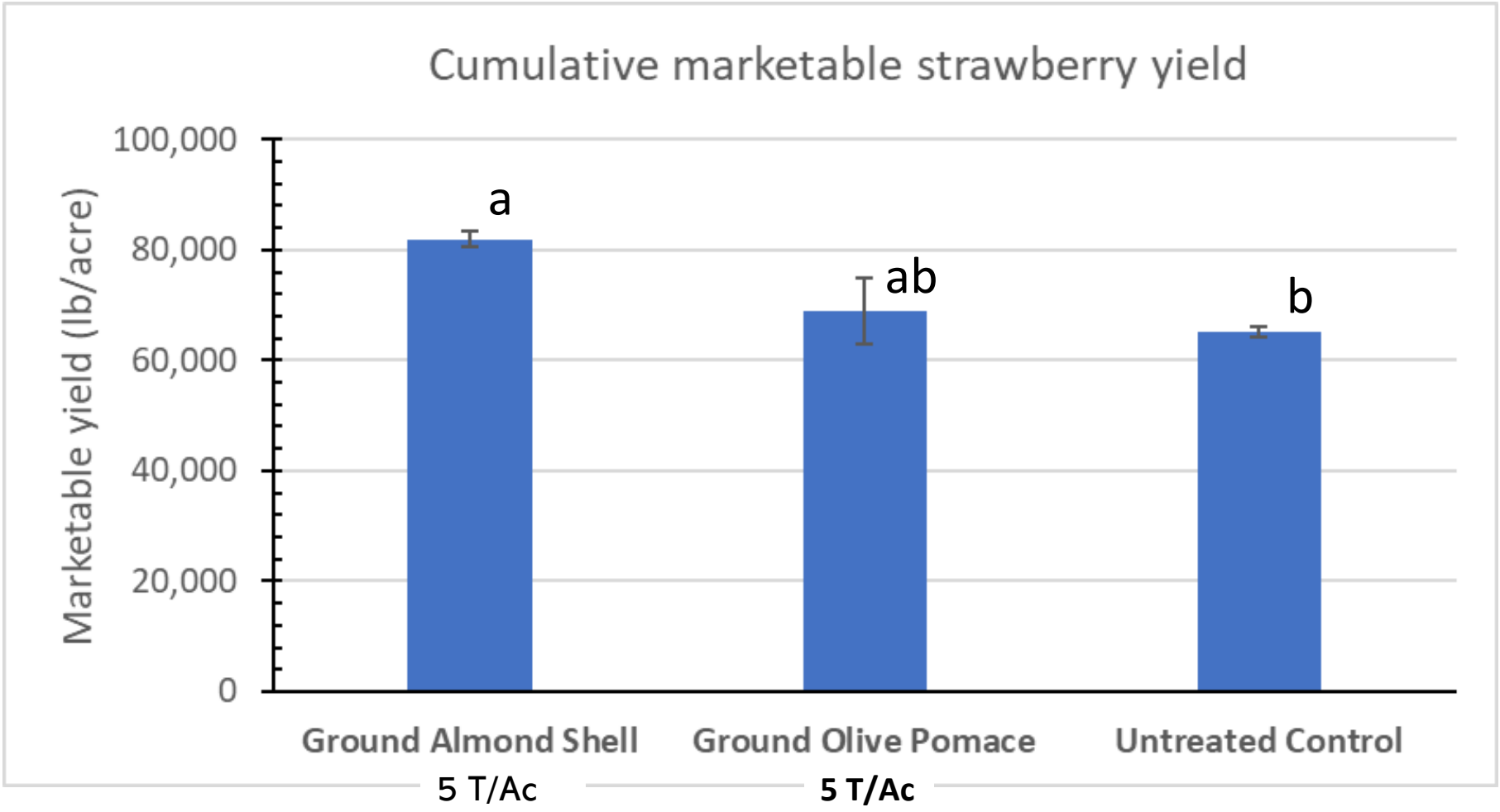
Broadcasting ground almond shell and ground olive pomace (Broccoli-Strawberry Rotation 10/20/2017)

N immobilization vs. N mineralization



(Adopted from USDA-NRCS, 2017)


Changes in Soil Nitrate
(Broccoli-strawberry rotation, 0'-1' depth)
Strawberry planting
Amendment application
Broccoli incorporation
NO_3-N mg/kg dry soil or Precipitation mm
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Aug-17
Sep-17
Nov-17
Jan-18
Mar-18
May-18
Jul-18
Sep-18
Oct-18
Dec-18
UTC
5 T/Ac Ground Almond Shell
5 T/Ac Ground Olive Pomace
Precipitation



- Very heavy soil (Vertisol)
- Tightly-coupled N supply + soil physical improvement?
- Still reduce *Verticillium dahliae* in the soil?
- Trial to be repeated in the 2019 -2020 season


Thank you!
Question?
joji@ucsc.edu