Dry Organic Fertilizers: Types, Placement and N Release Curves

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Dry Organic Fertilizers

- **Organic fertilizers are primarily made from animal byproducts: meat, blood, feather & bone meals as well as fishery wastes**
- **Seed meals, kelp and alfalfa are also sources**
- **The nitrogen in these materials are converted to plant-available forms of N by microbial conversion**
- **This process depends on the C:N ratio of the material, soil moisture and temperature and fertilizer placement**

Dry Organic Fertilizers

- **Commercially available dry fertilizers are now pelletized for use with mechanical applicators**

Analysis and Carbon Content of Various Fertilizers

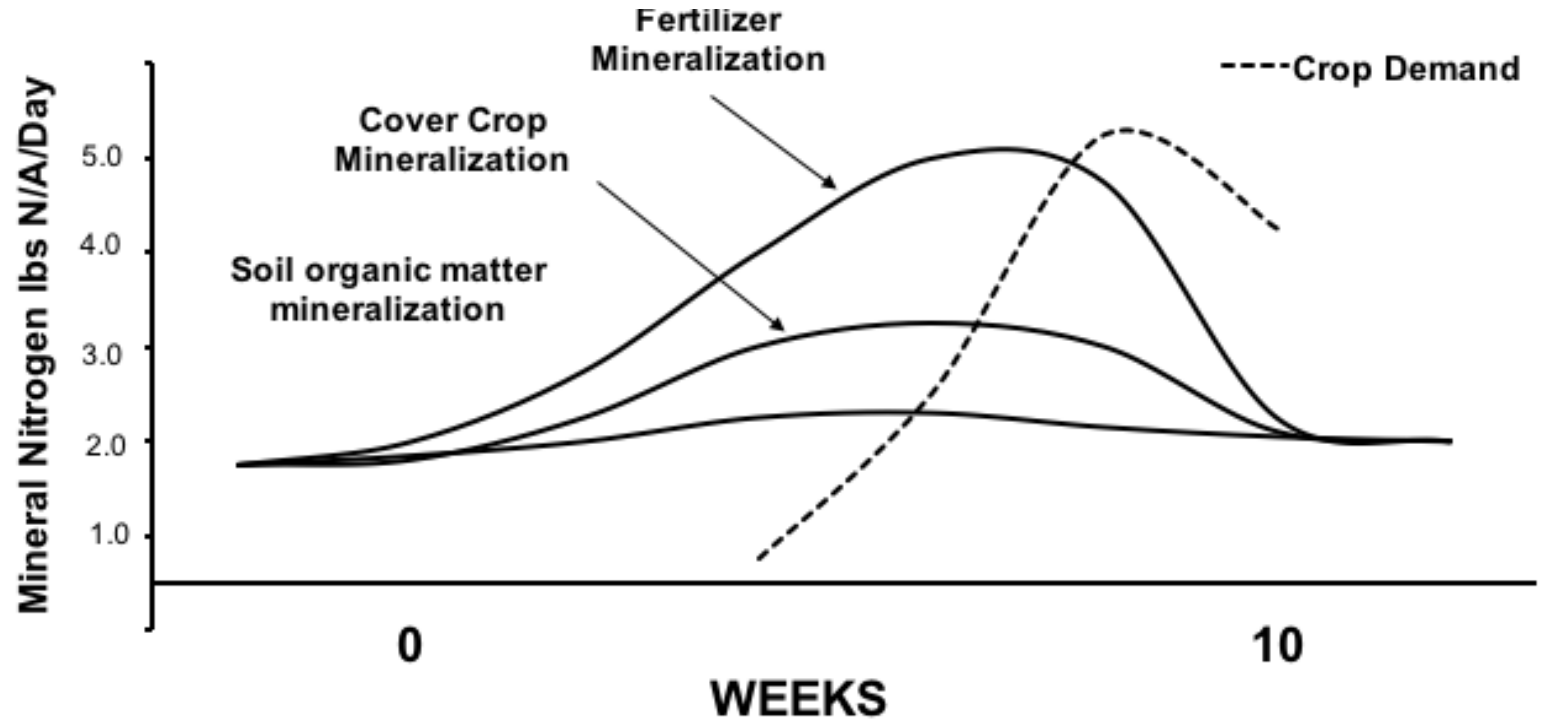
Fertilizer	% Carbon	C:N	Source
4-1-1	±40	10	Seed meals
14-0-0	43	3	Hydrolyzed soybean meal
2.5-2-2.5	25	10	Poultry
4-4-2	28	7	Poultry Manure + Meat and Bone Meals
9 to 12	---	---	Guano
12-0-0	46	4	Feather
8-5-1	37	5	Meat and Bone

Dry Organic Fertilizers

- **One of the great challenges is achieving synchrony between the release of mineral N from the organic fertilizers and crop demand**
- **Given that the materials must be physically applied, there are set numbers of times that the materials can be applied:**
  - **Preplant, post planting, top/sidedressing**

Dry Organic Fertilizers

- **The timing of the fertilizer applications must be done far enough in advance of demand curve of the crop, but not so far in advance that the resulting pool of nitrate would be at risk for nitrate leaching**



Laboratory Incubations of Fertilizer Materials

Percent N Mineralized

Material	2 weeks	4 weeks	8 weeks
2.5-2.0-2.5	4.0	5.8	13.6
4-4-2	28.8	30.5	37.5
8-5-1	47.2	43.5	58.5
10-5-2	43.8	49.3	58.8
12-0-0	48.7	56.5	59.3

In-vitro evaluations

Two Phase Release of Mineral Nitrogen from Organic Fertilizers

- **There is a rapid phase that occurs in the first 7-14 days after application of the organic fertilizer to the soil – due to the breakdown of easily decomposed materials (amino acids, simple proteins)**
- **The second phase is the result of the slow steady breakdown of recalcitrant materials that act like soil organic matter**

In-field Fertilizer Mineralization Studies

Polypropylene Pouches with Fertilizer

- Pouches with fertilizer were placed into the soil at the beginning of the crop cycle
- 4-4-2 (blend of chicken manure, bone and meat meals) & 12-0-0 (feather meal)
- Pouches were buried & placed on soil surface to simulate application methods

In-field Fertilizer Mineralization Studies

Buried in soil

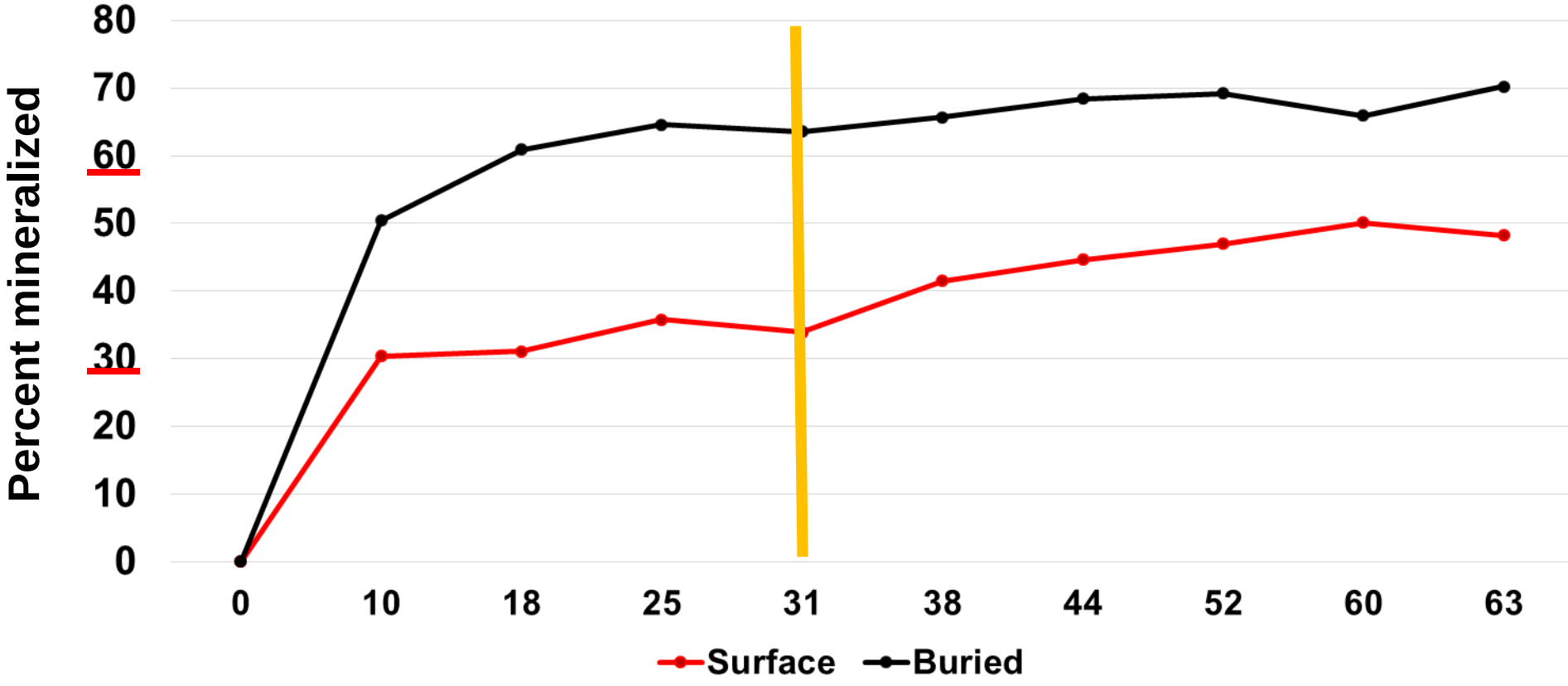
Place on top of soil

4 pouches collected weekly and analyzed for N, P & K over the crop cycle

4-4-2

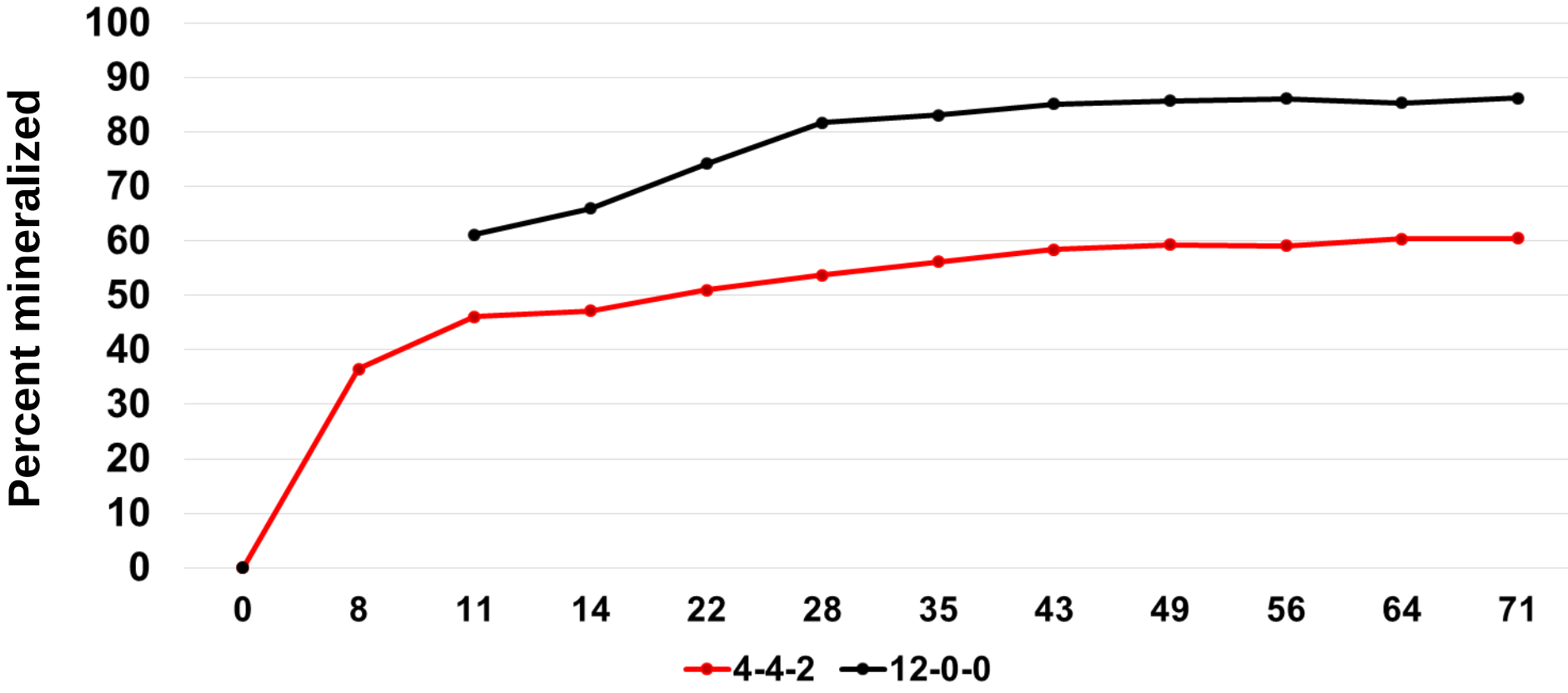
Percent N Mineralized from Pouches

Buried vs Surface 2016



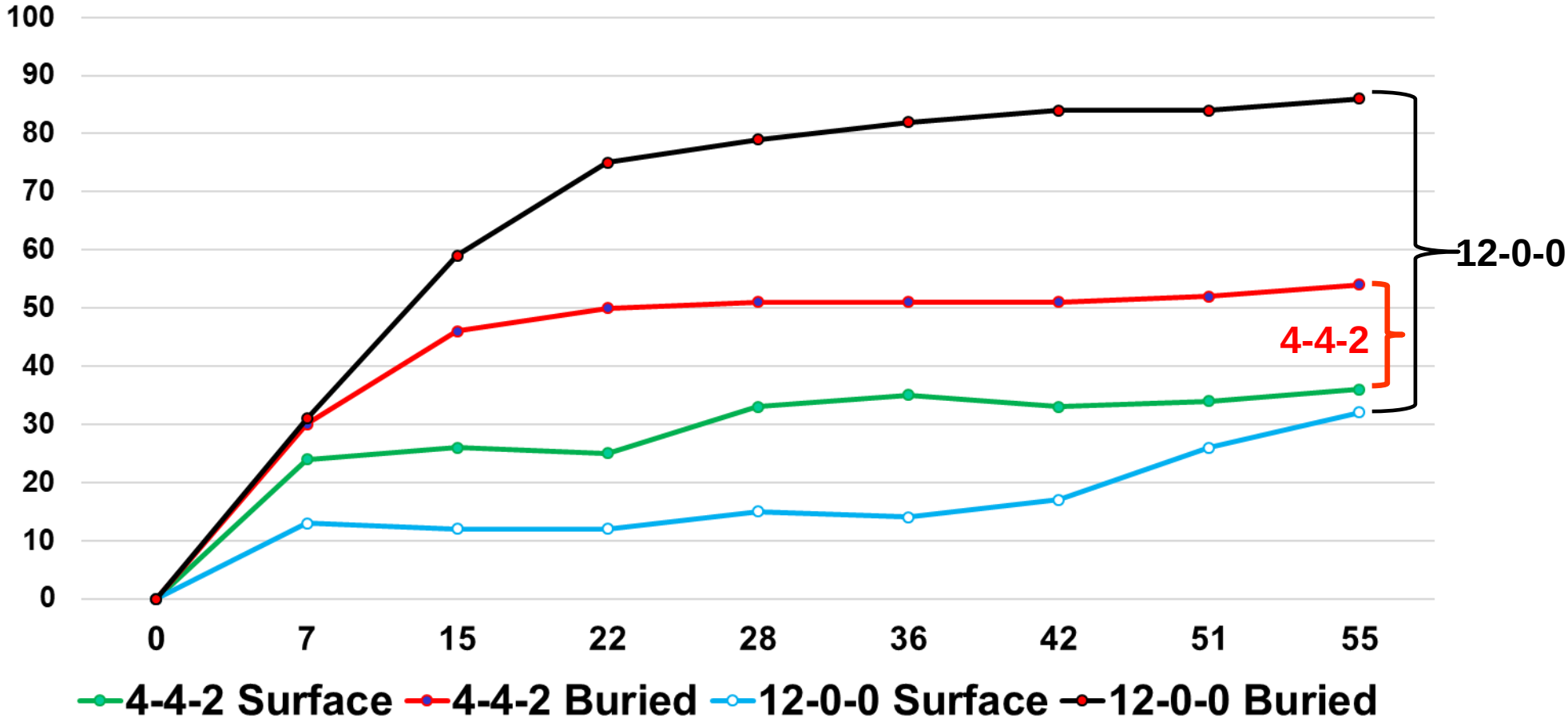
Days after Planting Lettuce

Buried 4-4-2 vs 12-0-0
Percent N Mineralized from Pouches



Days after Planting Lettuce

Difference N Release Between 4-4-2 & 12-0-0 in Surface and Buried Placement



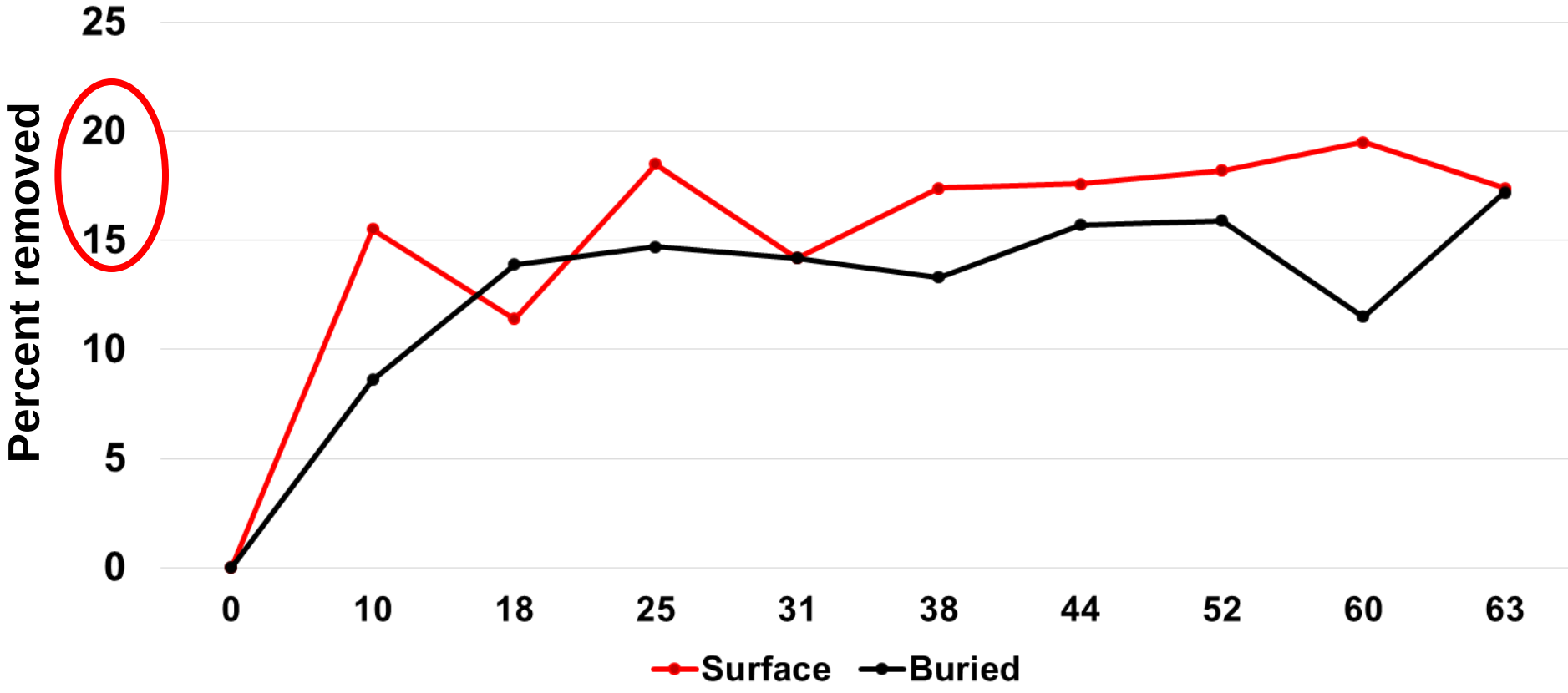
Differences Between Laboratory vs In-Field Mineralization Evaluations

- The in-field evaluations resulted in about 20-30% greater estimate of mineralization
- There may be differences in moisture and temperatures
- The there may be some inaccuracy in the in-field evaluation due to losses of material from the pouches

4-4-2

Percent Phosphorus Removed from Pouches

Buried vs Surface 2016

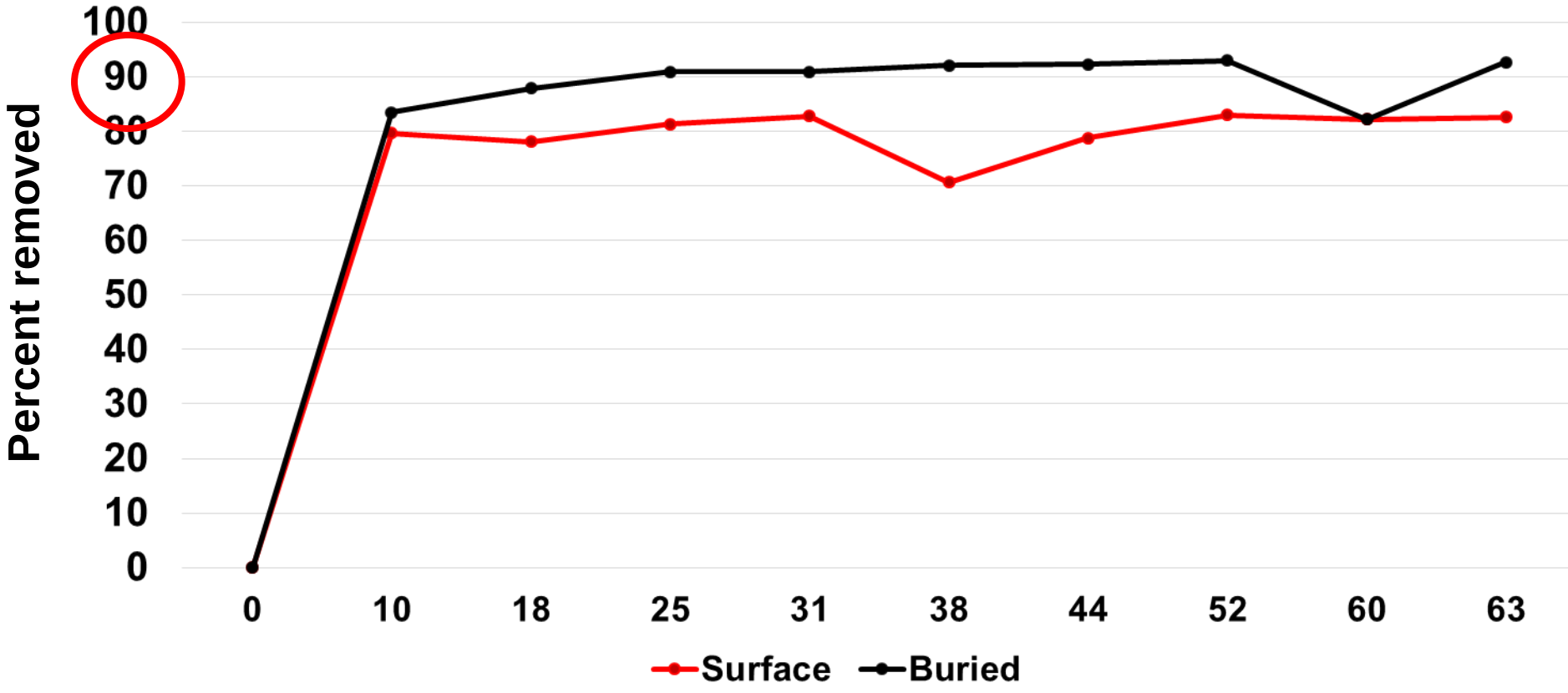


Days after Planting Lettuce

4-4-2

Percent Potassium Removed from Pouches

Buried vs Surface 2016



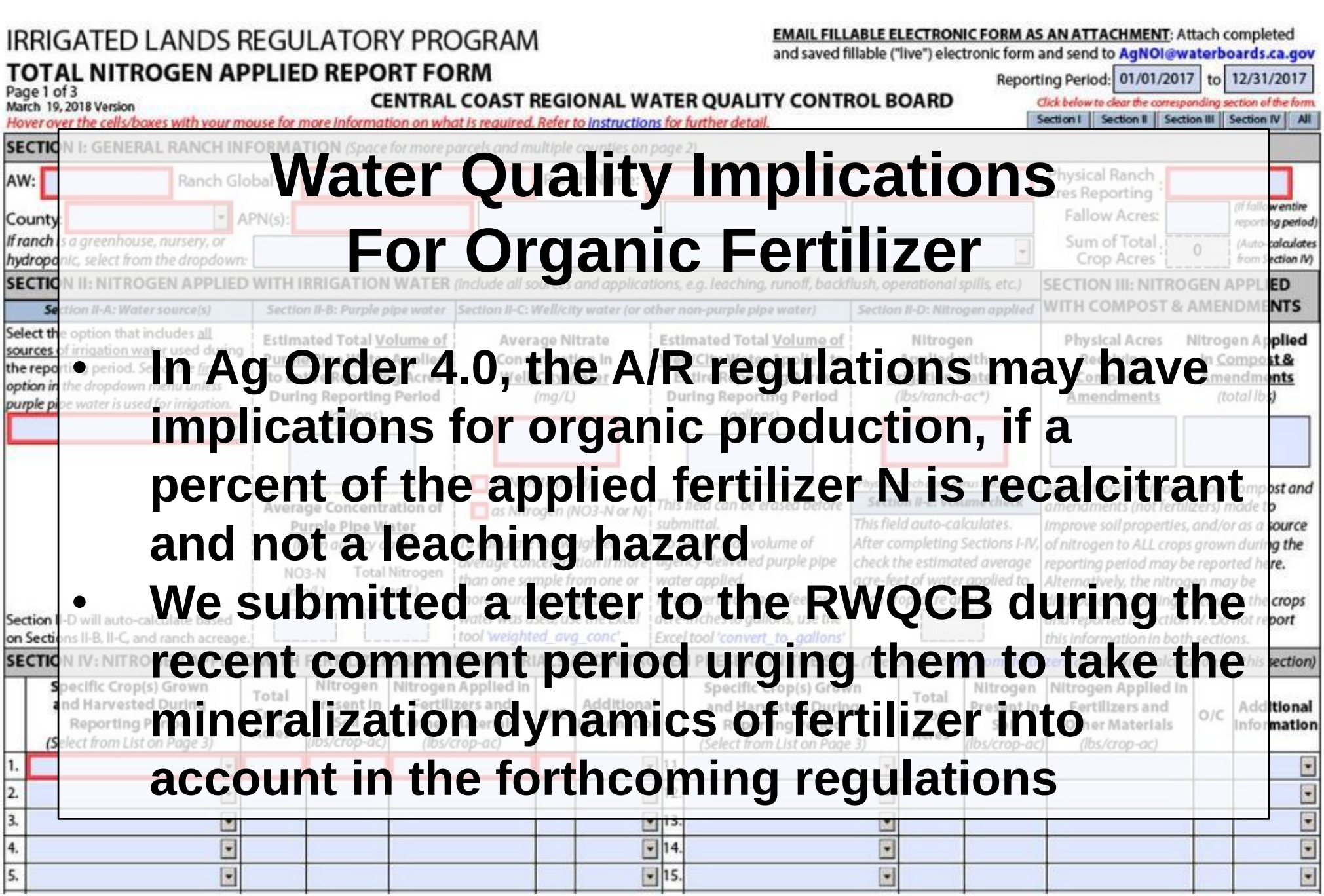
Days after Planting Lettuce

Summary of Pouch Evaluations Buried vs Surface

- **Placement of the material affects the speed of mineralization of N and may affect the rate of material needed for optimal growth**
- **Given the pH's of the soil, the phosphorus in 4-4-2 that comes from bone meal, is not available to the crop and remains in the soil as an insoluble mineral**
- **Potassium is rapidly released**

Fate of Unused Applied N

- **What is the fate of the fertilizer N that is not mineralized during the crop cycle?**
- **Presumably it adds to total N in the soil and continues to slowly mineralize similar to nitrogen in soil organic matter**
- **It is not at risk for rapidly mineralizing and contributing to nitrate leaching**



Water Quality Implications For Organic Fertilizer

- In Ag Order 4.0, the A/R regulations may have implications for organic production, if a percent of the applied fertilizer N is recalcitrant and not a leaching hazard
- We submitted a letter to the RWQCB during the recent comment period urging them to take the mineralization dynamics of fertilizer into account in the forthcoming regulations

Organic Fertilizer Programs

- **The amount of N applied to the crops ranged from 1.2 to 5.7 times N uptake**
  - **A:U (crop uptake, not R – removal)**
- **Taking into account N mineralized from organic fertilizer over the crop cycle, the amount applied to crop uptake ranged from 0.4 to 2.8 times N uptake**

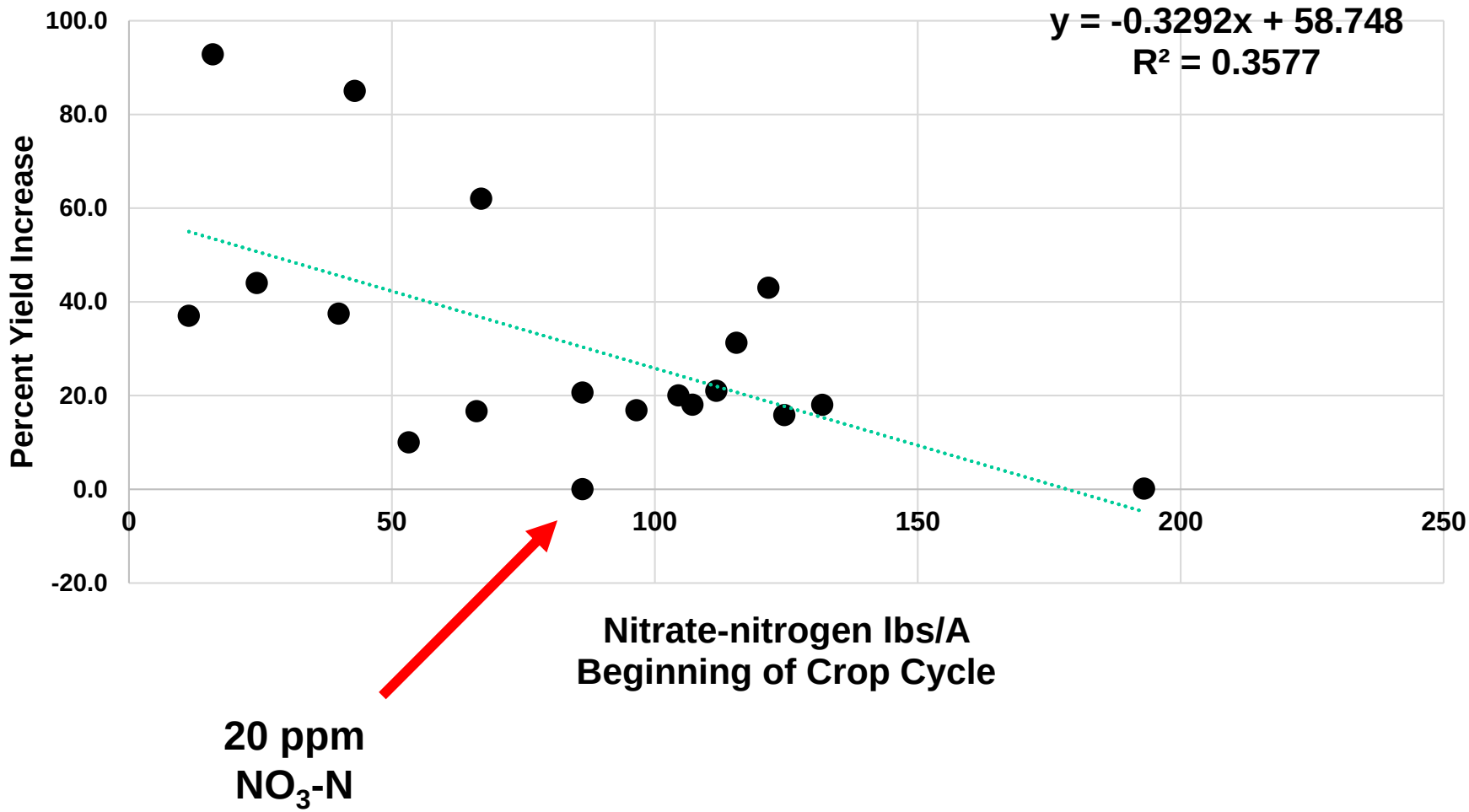
Challenges in Improving Nitrogen Use Efficiency of Dry Organic Fertilizers

- **In conventional production, the use of nitrate quick tests is a key practice for improving nitrogen use efficiency**
- **In double cropped leafy green vegetable production systems, there are often large pool of nitrate that build up following the 1st crop**
- **These pools of nitrate can be measured and accounted for in fertilizer decisions**

Challenges in Improving Nitrogen Use Efficiency of Dry Organic Fertilizers

- **The time of testing needs to mesh with fertilizer timing and crop uptake**
- **Testing also needs to allow sufficient time for the fertilizers to be applied and to release useful amounts of N for the crop to use**
- **This can be tricky for short season vegetables such as spinach and baby lettuces – some week(s) prior to planting**

Initial Nitrate-N and Percent Yield Increase with Fertilization



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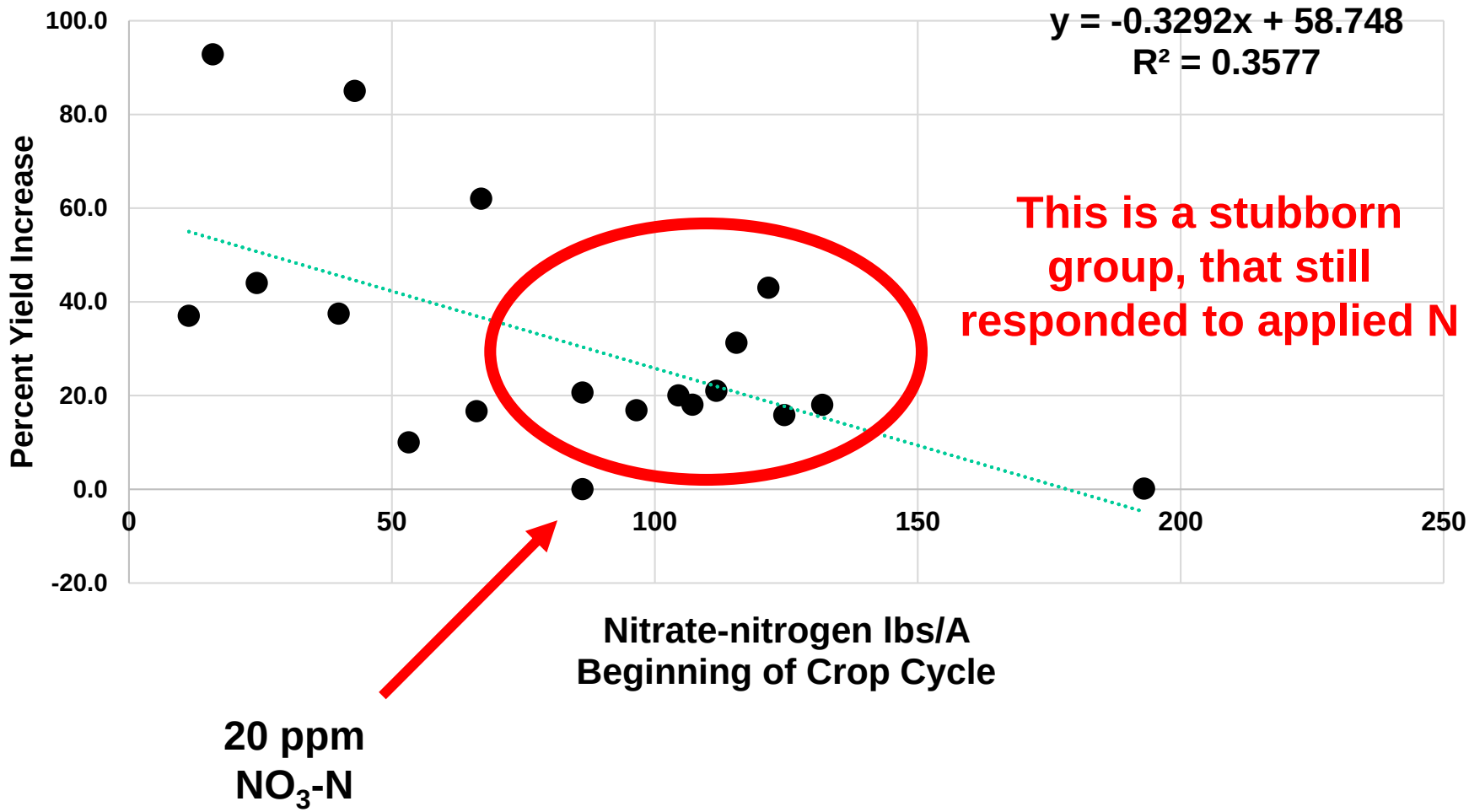


Nitrogen Fertility Trial 1

Planting lbs N/A	Topdress lbs N/A	Total lbs N/A	Initial NO_3-N	Fresh wt tons/A
80	80	160	21	6.9
40	80	120	21	6.9
0	0	0	21	6.4

Clay loam soil

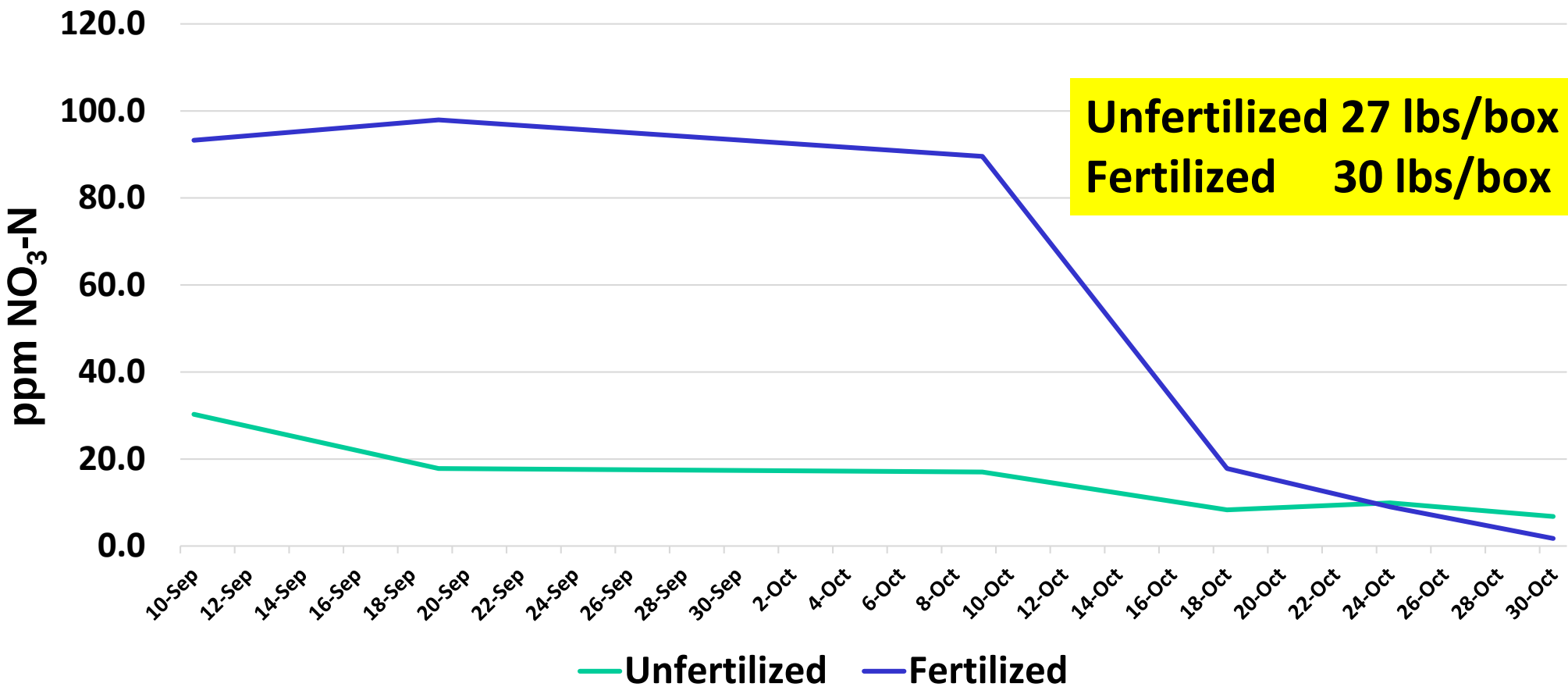
Nitrogen Fertility Trial 2

Planting lbs N/A	Topdress lbs N/A	Total lbs N/A	Initial NO_3-N	Fresh wt tons/A
160	0	160	27	7.7
120	0	120	27	6.8
0	120	120	27	5.7

Sandy loam soil

Romaine Lettuce Fertility Trial
Long-term Organic Farm

400 lbs 12-0-0 (48 lbs N/A); Preplant application



Utilizing Soil Tests to Improve Nitrogen Use Efficiency

- **We need more research on using nitrate testing in organic vegetable systems**
- **At this point, we see some evidence that nitrate testing can be helpful**
- **However, even with good amounts of nitrate, in some cases, fertilization still improved yields**
- **The amount of N needed to achieve full yields was modest – 40 lbs N/A**

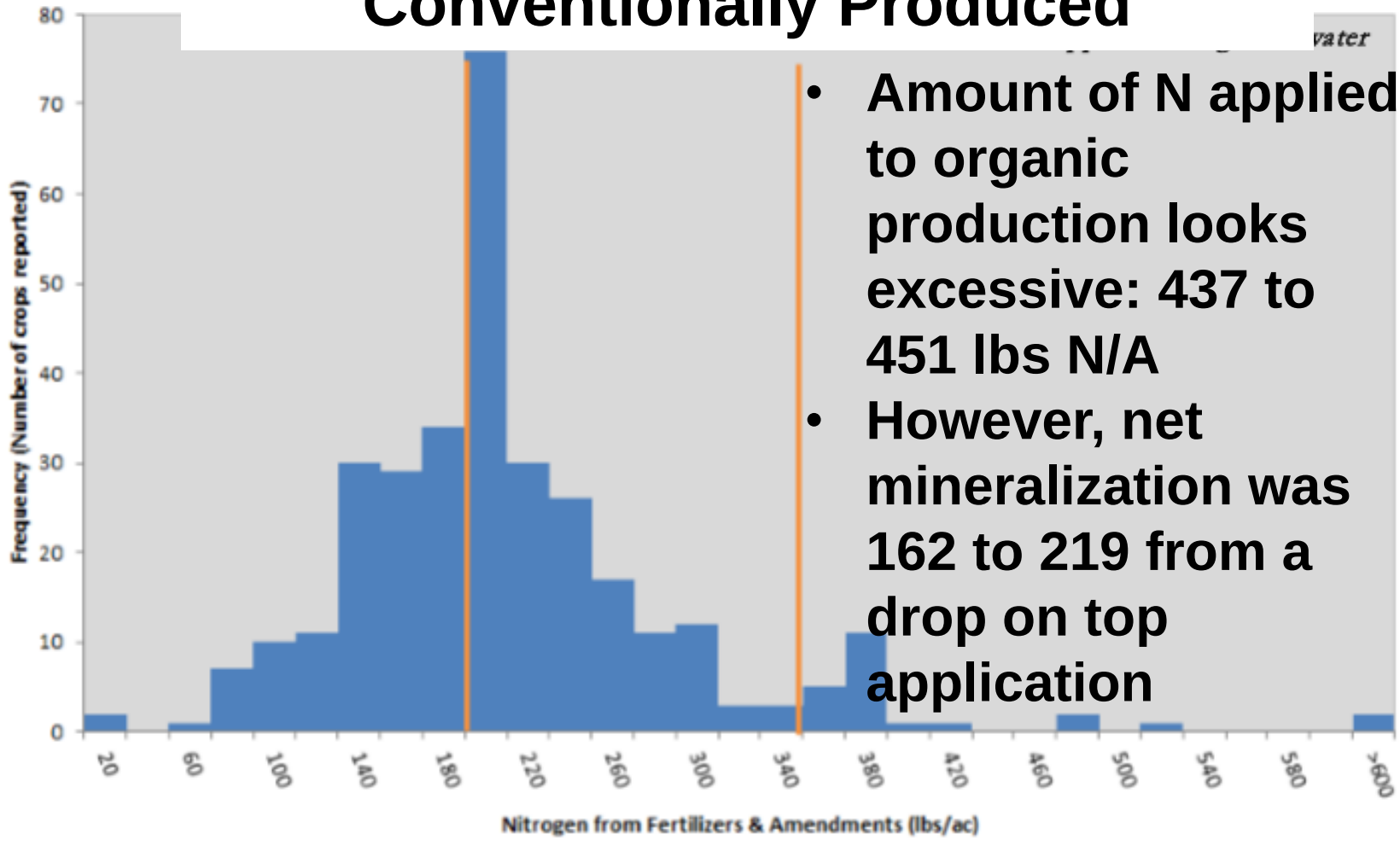
Fertilization of Broccoli

- **Broccoli is a tricky crop because it scavenges N from deeper in the soil profile during the 2nd half of the crop cycle**
- **Broccoli following lettuce can take advantage of the residual N**
- **<u>Incorporating the fertilizer can increase available N</u>**

Grower Reported N from Fertilizers

(325 Crop Records) Compared to Specific Crop Nitrogen Uptake

Broccoli Fertilizer N Applications Conventionally Produced



- Amount of N applied to organic production looks excessive: 437 to 451 lbs N/A
- However, net mineralization was 162 to 219 from a drop on top application

Input of Carbon

Material	Biomass lbs/A	Carbon content percent	Total carbon lbs/A
Compost	10,000[1]	29%	2,146
Cover crop	6,000	44%	2,640
4-4-2 2 baby crops @ 3000 each	5,400[2]	29%	1,566
8-5-1 1 broccoli crop	5,000[3]	41%	2,050

1 – 10,000 lbs/A @ 74% oven dry weight
2 – 6000 lbs/A (2 baby crops @ 3000 lbs/A each) @ 90% oven dry weight;
3 – 5650 lbs/A @ 90% oven dry weight

Thank You for Your Attention

Thank you to cooperating growers, research assistants and to the Fertilizer Research and Education Program for Funding