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4R Nutrient Stewardship

March 21, 2012

April 5, 2012

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Holden Research and Consulting

- My Experience
  - Over 900 trials in the past ten years in nutrient and pest management for fruit, nut, and vegetable production. 110 crops and counting
  - 390 plus to date in the field of nutrient management, most of which have been production trials.
  - Many of these trials have been to fine tune the rates of fertilizer we use today for local crop production.

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The Four R's
The right source, the right rate, the right time, the right place.

- Sponsored by The Fertilizer Institute, Canadian Fertilizer Institute, International Plant Nutrition Institute, and International Fertilizer Industry Association
- http://www.nutrientstewardship.com/

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The Four R's

- This is not meant to be the deffinative discussion on the correct fertilizer program for your growing situation
- It is meant to enlighten and cause you to think about how you use fertilizer and how to use it in the most efficient way
- I would use the word sustainable in this talk, but which of you don't want to sustain your operation. It is an overused politically correct word. Let's just do the right thing.

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The Right Source

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Right Fertilizer Source

- This needs to be continuously evaluated for the crop, season, weather, etc.
- Nitrogen
  - Urea
  - Ammonia
  - Nitrate
- Phosphorus
  - Ortho or poly?
  - Neutral or acid?
- Potassium
  - Anion attached to it might matter?
  - Chloride, sulfate, thiosulfate, nitrate, etc.

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Right Fertilizer Source

- Nitrogen source
  - Most crops we grow utilize some ammonia and mostly nitrate, while the urea has to convert into ammonia than nitrate.
  - Conversion in soil: Urea->Ammonia->Nitrate. This is very slow in soil temperatures below 50 F., Approximately 6 weeks in soils above 60F.
  - Urea on wet soil at 60 F will loose approximately 10% a day to the atmosphere
  - Blueberries prefer urea form over the other two, one of the exceptions to the rule.
  - Leaves will pretty much only take up nitrogen as urea, so foliar applications of potassium nitrate do you very little good in supplying nitrogen to the leaves.

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Right Fertilizer Source

- Phosphates
  - Ortho vs. Poly
  - Once in the ground no difference, but it will matter if you are injecting into an irrigation system
  - Poly better to be placed
  - Ortho better to be injected into water

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University Recommendations for Cool Season Vegetables

.Fertilize only when soil testing suggests that plants are likely to respond to fertilization. For soils with pH > 6.2, the most appropriate soil test is the Olsen (bicarbonate) procedure. Soils with Olsen P > 80 ppm contain sufficient available P for optimum vegetable crop production. Continued fertilization of these soils wastes money and increases the potential for P pollution. Soils testing in the range of 40 to 80 ppm may under some circumstances (low soil temperature, for example) respond to P applications, but only a small amount of P would be required. Small, at-planting "starter" applications would be sufficient. For summer-planted fields, no P fertilization should be necessary for soils that test > 40 ppm.

University of California, ANR Publication 8098, *Nutrient Management In Cool Season Vegetables*

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What are the Issues with Phosphorus Availability

- pH
- Temperature
- Cation inhibition
  - Calcium
  - Zinc
  - Etc.

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How Soil pH affects P_2O_5

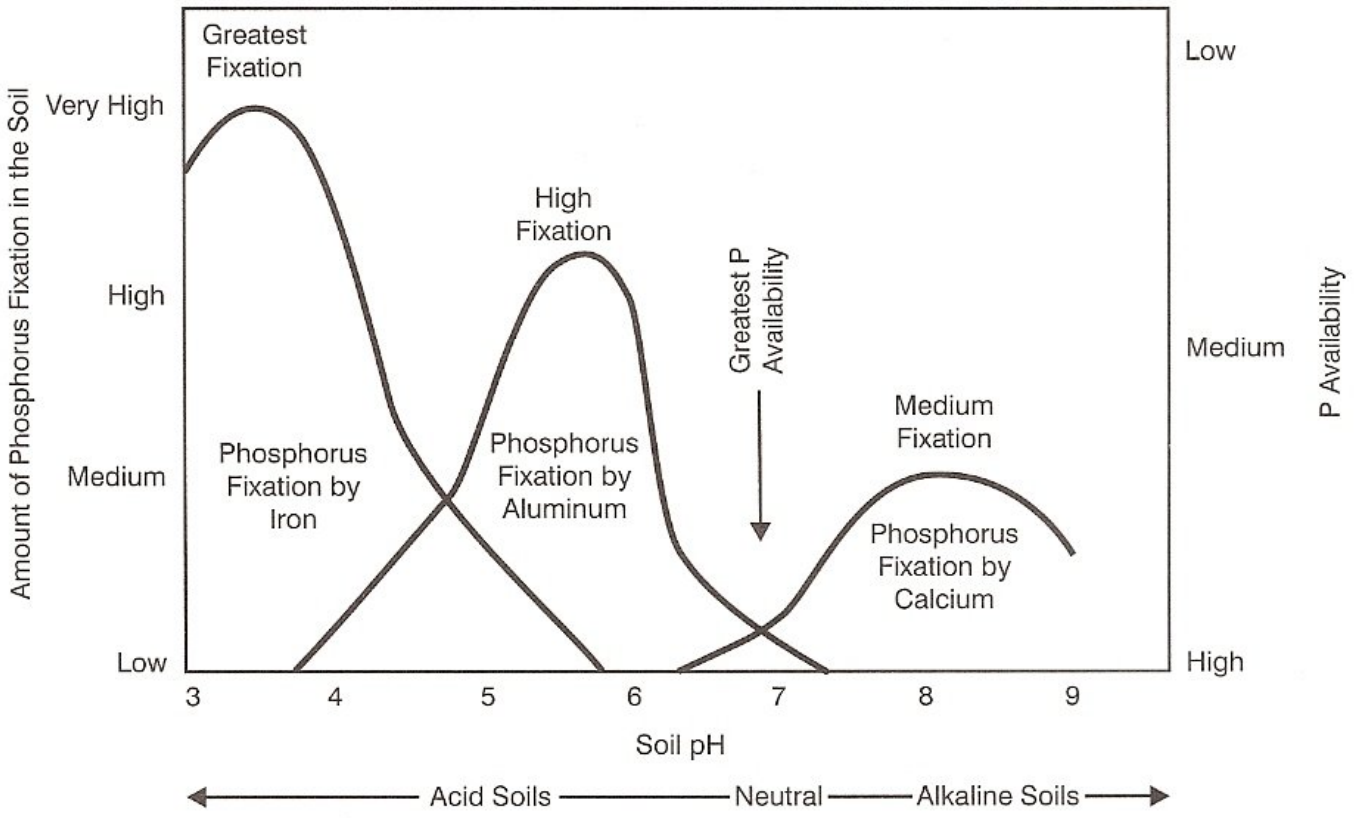

FIGURE 4–4. Phosphorus availability as influenced by soil pH.

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Cool Soils

- Cool soils may induce phosphorus deficiency
- With cool soils you have slower root growth and development
- Less opportunity for roots to come in contact with the phosphorus they need at this time
- Limiting phosphorus in cool seasons exacerbates the ability for cool season vegetables to grow.

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Cation Inhibition

- Calcium and zinc cations (and others) have an affinity for PO_4, phosphate anion.
- They form calcium and zinc phosphate precipitates which are now hard to resolubilize for root uptake.
- But this also helps reduce leaching of PO_4 from the soil solution.

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Fertilizer Calculations

- Say we have a soil reading of 15 ppm P_2O_5 and want to raise it to 40 ppm
- We want 25 ppm more of P_2O_5 in the soil
- 25 ppm in 1 acre foot is approximately 100 pounds P_2O_5 in 4 million lbs of soil (approximate weight of 1 acre foot)
- Using 11-52-0, it would take 192 lbs/ac. 10-34-0 would require 294 lbs/ac or about 25 gallons.
- Using a 0-29-26 Phosphite fertilizer would take the equivalent of 344 lb/ac or 27.3 gal (344/12.6 lb/gal)
- That is a lot more than most Phosphite labels suggest per acre per application (usually 2-3 qt/ac)
- This is not practical based on cost and could very well be detrimental based on some of the data reported in the Thao and Yamakawa paper.
- But as a foliar fertilizer the 2-3 qt/ac might be practical.

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For more on Phosphorus

- http://holdenresearch.com/wp-content/uploads/2011/08/10fbslagra02-2-16-16-for-Production-Chardonnay-2010-final-report-Holden-1-25-11.pdf
- http://holdenresearch.com/wp-content/uploads/2011/09/WPHA-Fall-2010-Phosphate-Presentation-Holden-Research.pdf
- http://holdenresearch.com/wp-content/uploads/2011/12/Phosphates-vs.-Phosphites-November-20111.pdf

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Right Fertilizer Source

- Potassium
  - The critical issue is the anion it is attached too.
  - Chloride, nitrate, sulfate, thiosulfate, hydroxide, carbonate, etc.

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The Right Rate

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The Right Fertilizer Rate

- Why Not?
- Don’t want to be wasteful
- If a little bit works, a whole lot more will work even better! Right?
- How about balance, that is more important.

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So what is the Right Rate

- That is why we have analytical laboratories
- To test our soils and plant structures.
- Will obviously vary with crops and varieties.
- History, your experience, manufacturers
- Google “Correct Fertilizer Rate for Commercial …..”
- International Plant Nutrition Institute: http://www.ipni.net/

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The Right Rate

- Examples of some crop utilizations in units per acre:
  - Cabbage (70000 lbs): N=270 lbs, P2O5=63 lbs, K2O=250 lbs.
  - Bell Peppers (36000 lbs): N=275 lbs, P2O5= 104 lbs, K2O= 432 lbs. Notice the significant increase in phosphate and potassium needs for the fruiting crop

  Oranges (54000): N=265 lbs, P2O5=55 lbs, and K2O=330 lbs

  Source: Nutrient Removal App for the iPhone from Mosaic Company

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The Right Time

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The Right Time.

- There are some standard truths to the timing of nutrients for plant demands.
- Nitrogen is utilized by plants to synthesize amino acids, chlorophyll production, and enzyme production = Leaves
- Phosphate goes to the growing points = Roots and flowers
- Generally potassium moves carbohydrates from the leaves to the fruit (and roots)

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The Right Time.

- In general the right time for:
  - Nitrogen – after thinning (or spring for trees when new leaves push) to mid-season, then maintenance levels
  - Phosphate – At planting (or early spring for trees) for early root emergence, especially in cold soils, continued into flowering period
  - Potassium – Mid season to the end of the season as carbohydrates are moved into the fruits

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The Right Time

- Four real world tests with Phosphate fertilizers during the winter, early, and late spring to demonstrate the need and timing follow.

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Four Recent Trials with Phosphates in Peppers and Strawberries.

- Phosphates generally placed in addition to the grower's standard practices which may include pre-plant and in-season phosphate applications.
- All crops grown on tape, which allows for precise in season placement of phosphate.

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Early Spring 2010 Peppers

- Pre-Plant poly phosphate applied as band under seedline on 4/27/10
- Pre-Plant Phosphorus (Olsen Method) – 41 ppm
- Treat 1 – untreated
- Treat 2 – 100 lb/ac P_2O_5 as 10-34-0
- Treat 3 – 55 lb/ac P_2O_5 as Proprietary
- Treat 4 - 30 lb/ac P_2O_5 as Proprietary
- Planted 5/5/10

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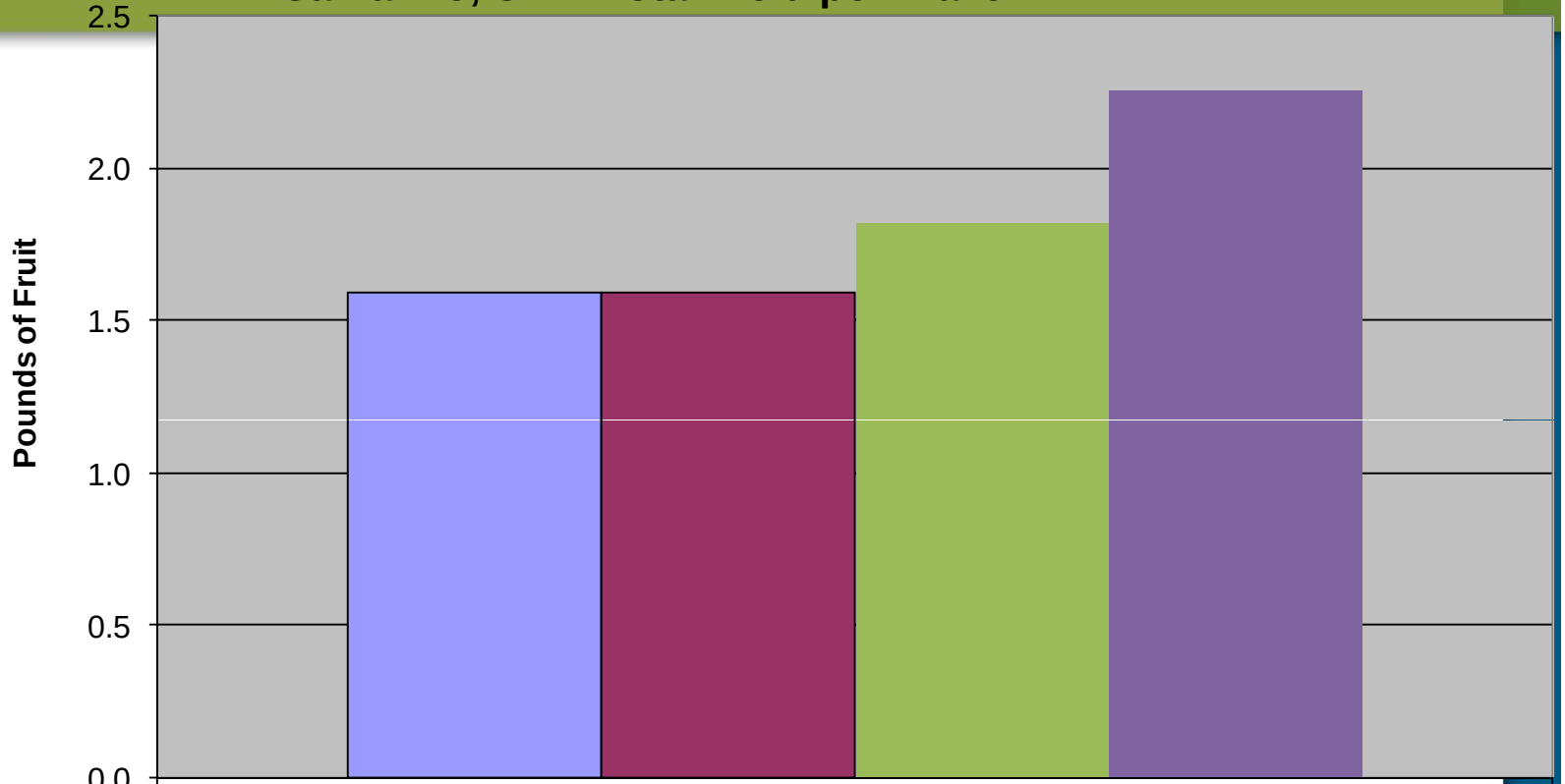
Chart 1: 2010 Spring - Summer Bell Pepper Phosphate Study - Camarillo, CA. - Total Yield per Plant



	Lbs./Plant	
UTC	1.6	b
Reduced Propietery 2	1.6	b
Reduced Propietery 1	1.8	ab
Grower Standard	2.3	a

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Post Treat Soil P_2O_5 Levels

- Treat 1 – 30 ppm
- Treat 2 – 31 ppm
- Treat 3 – 34 ppm
- Treat 4 – 27 ppm

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Late Spring 2010 Peppers

- Pre-Plant poly phosphate applied as band under seedline on 6/17/10
- Pre-Plant Phosphorus (Olsen Method) – 44 ppm
- Treat 1 – 125 lb/ac P_2O_5 as 10-34-0
- Treat 2 – 100 lb/ac P_2O_5 as 10-34-0
- Planted 6/20/10

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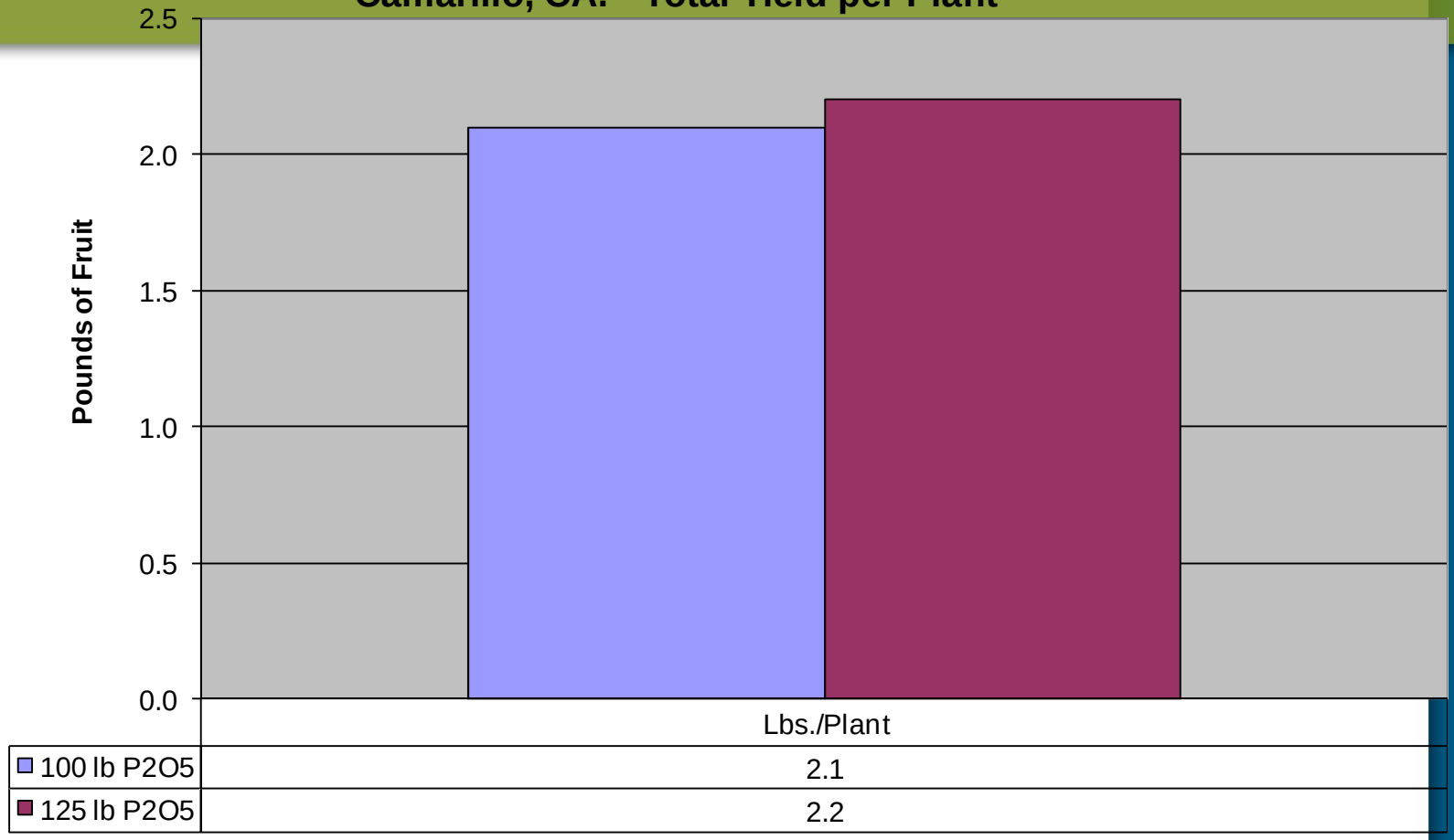
Chart 2: 2010 Late Spring - Summer Bell Pepper Phosphate Study - Camarillo, CA. - Total Yield per Plant



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Post Treat Soil and Leaf P_2O_5 Levels

- Treat 1 – 40 ppm
- Treat 2 – 49 ppm
- Leaf Treat 1 - .32%
- Leaf Treat 2 - .35%

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2008-09 Strawberries

- Planted 10/2/08
- All Received Pre-Plant and in-Season Phosphate
- 500 lb/ac 18-8-13 slow release
- Approximately 20 gal/ac Phosphoric acid in season (150 lb P_2O_5) in tape
- Experimental Treatment received another 80 lb/ac of P_2O_5 in the tape and 40 lb/ac of P_2O_5 foliar as Proprietary Product

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Plant Sizing at Nine Weeks after Planting

Grower Standard

Additional Phosphate

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Chart 6: Proprietery 2008-09 Strawberry Nutrient Study - Camarillo, CA. - Cumulative Marketable Production by Pick Day

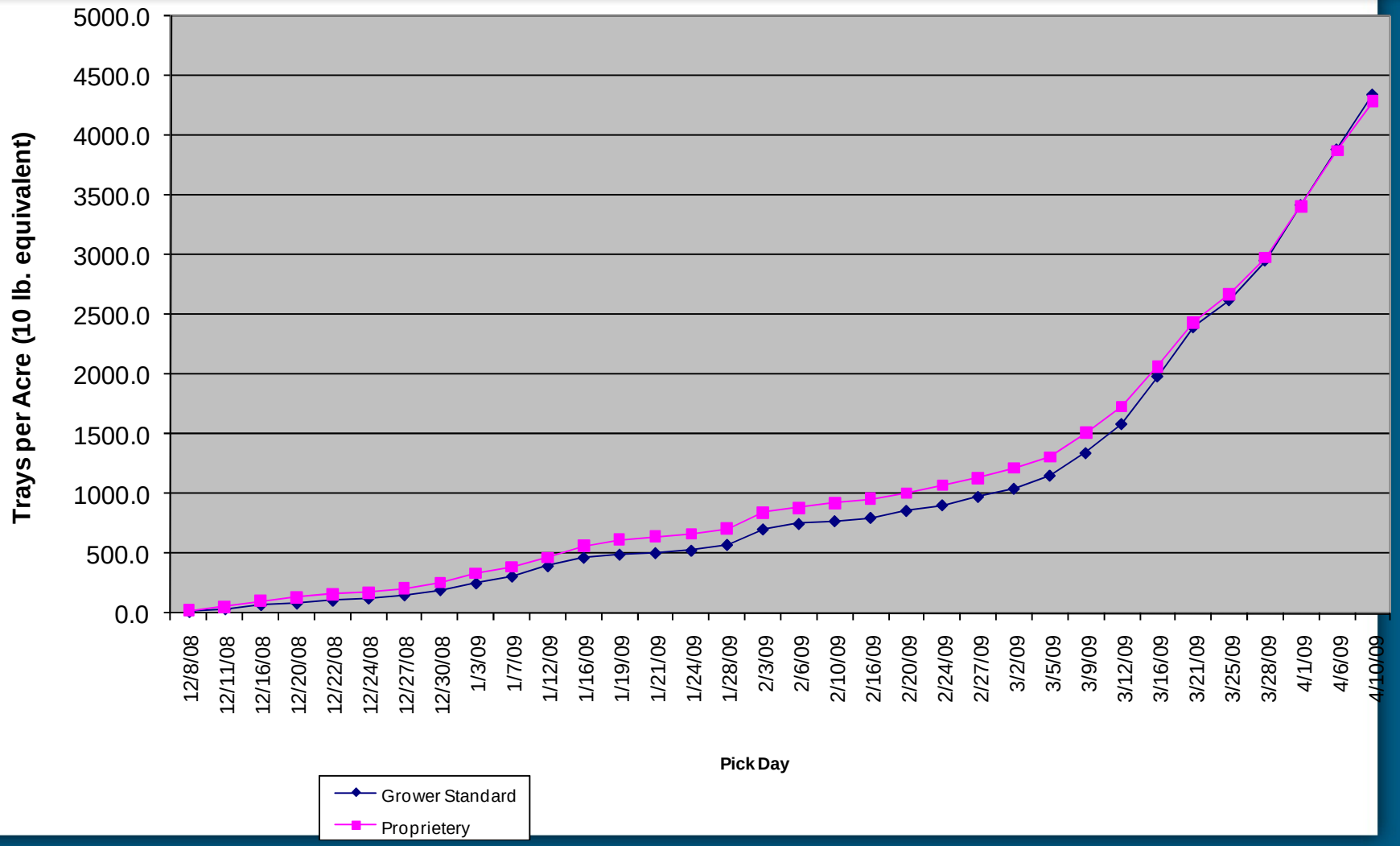

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Chart 6: Proprietery 2008-09 Strawberry Nutrient Study - Camarillo, CA. - Early Cumulative Marketable Production by Pick Day

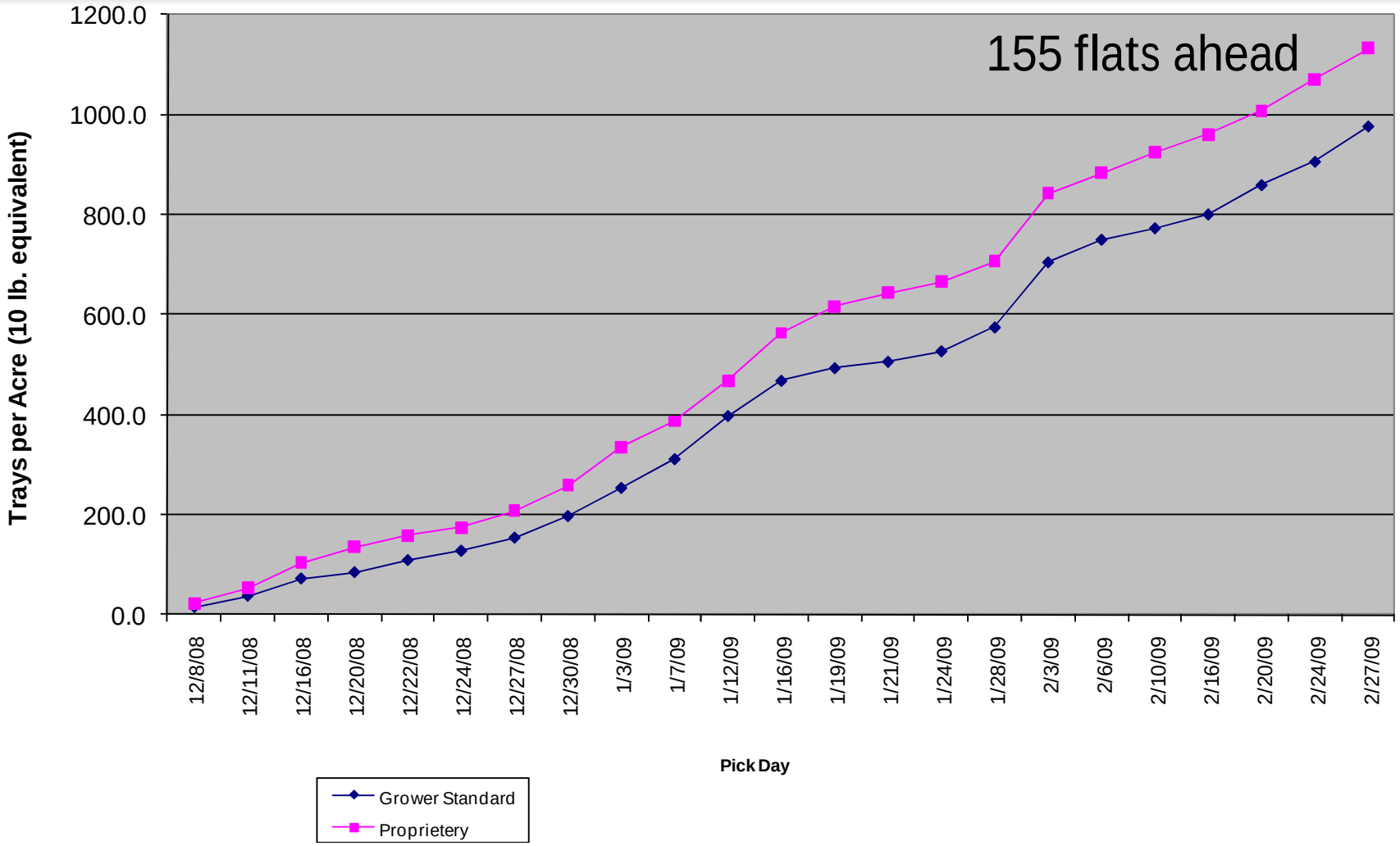

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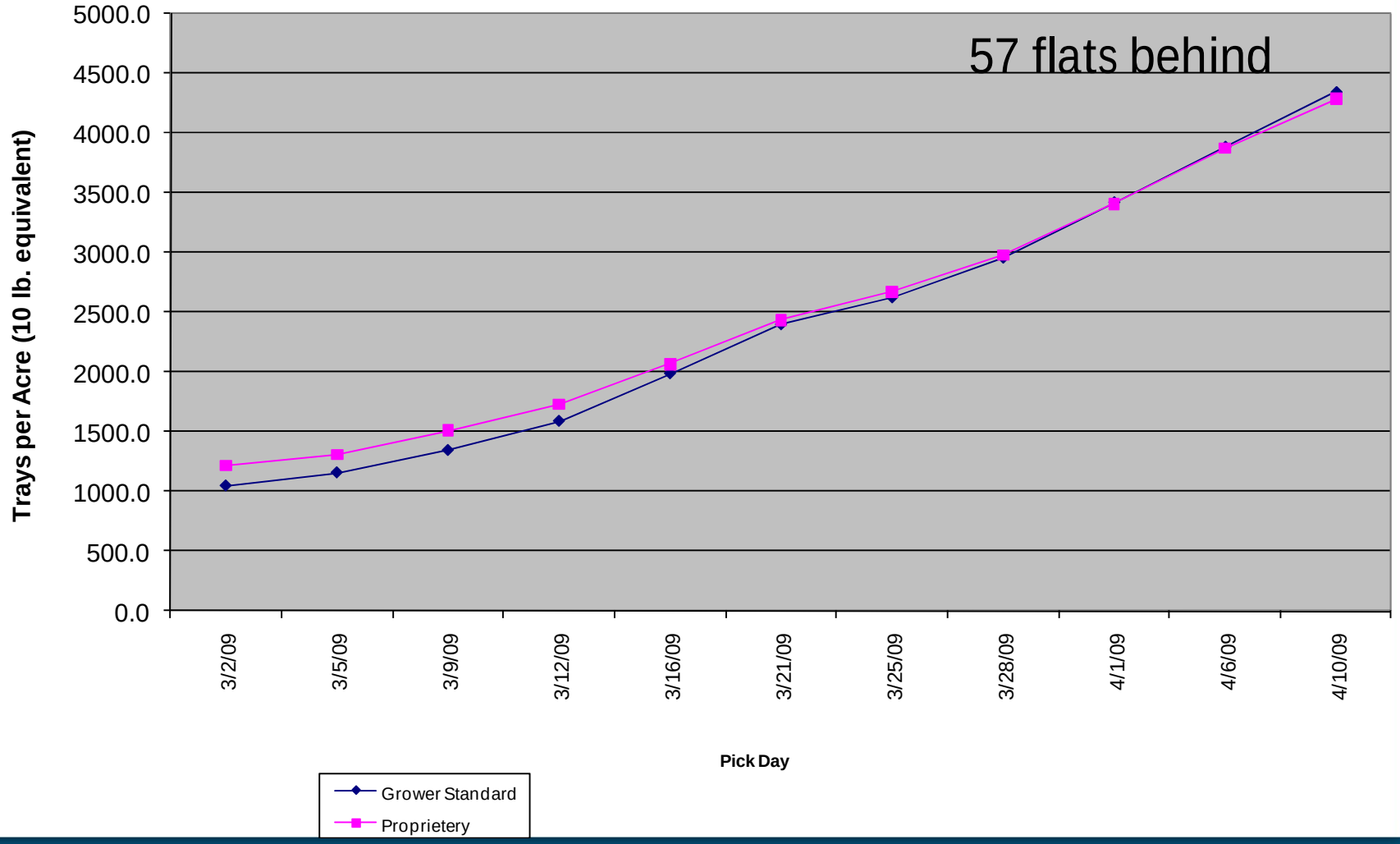
Chart 6: Proprietery 2008-09 Strawberry Nutrient Study - Camarillo, CA. - Late Cumulative Marketable Production by Pick Day



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Conclusions

- Additional Early Season applications of P2O5 did help increase early season production
- As soils warmed and crop finished out the end season differential was not as great
- Early season production does return the grower a better price per flat.

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2009-10 Strawberries

- Planted 10/3/09
- All Received Pre-Plant and in-Season Phosphate
- 500 lb/ac 18-8-13 slow release
- Approximately 20 gal/ac Phosphoric acid in season (150 lb P_2O_5) in tape
- Experimental Treatment received another 45 lb/ac of P_2O_5 in the tape as 3-18-18 (ortho phosphate) over five applications
- Also Proprietary product run alone and in combination with 3-18-18

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Plant Sizing at Nine Weeks

Grower Standard

Product A

3-18-18 / Product A

3-18-18

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Chart 8: Proprietery Trial on Strawberries - Ventura County, Fall/Winter 2009-2010 - Cumulative Marketable Production by Pick Day

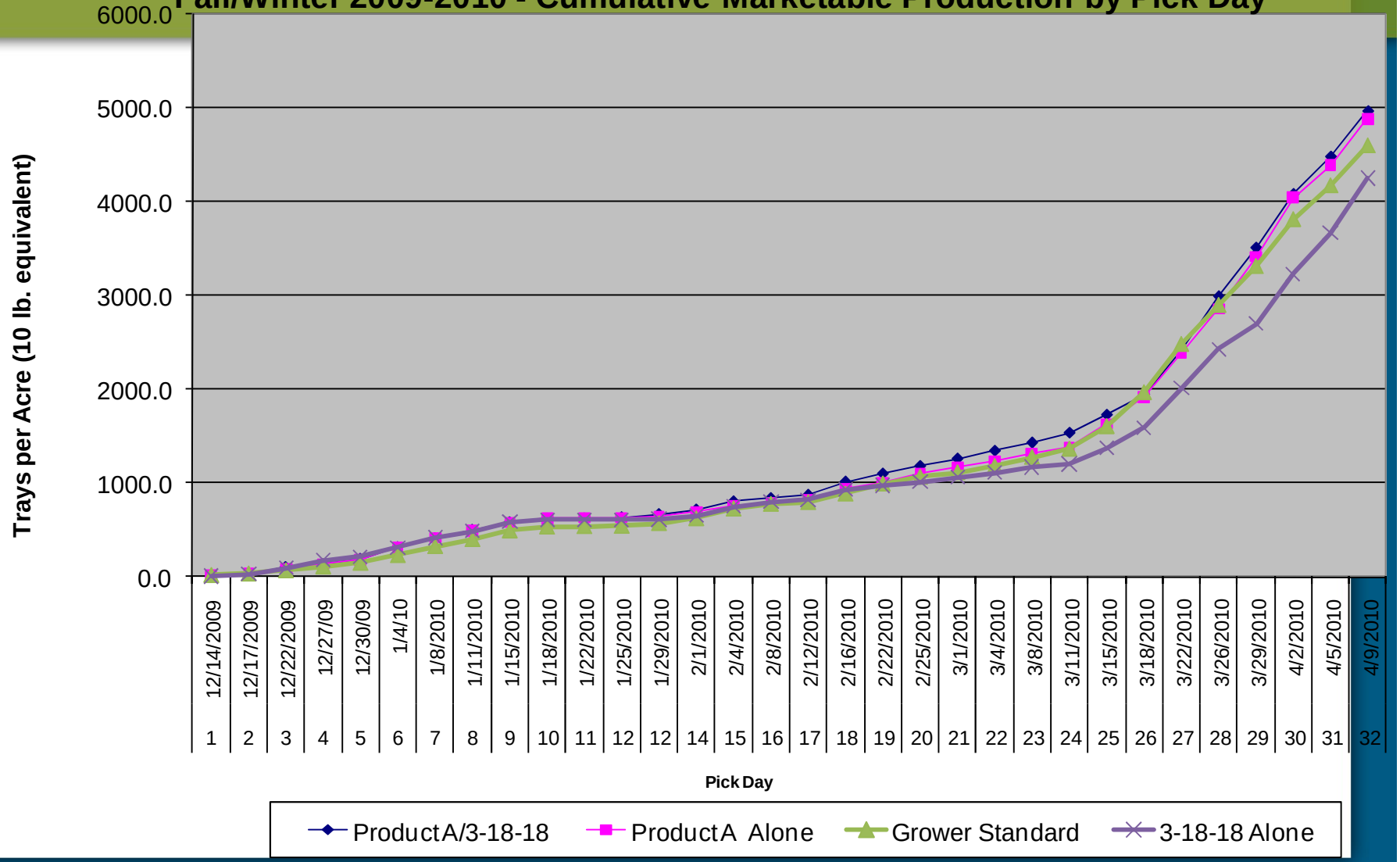

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Chart 8a: Proprietery Trial on Strawberries - Ventura County, Fall/Winter 2009-2010 - Cumulative Marketable Production by Pick Day

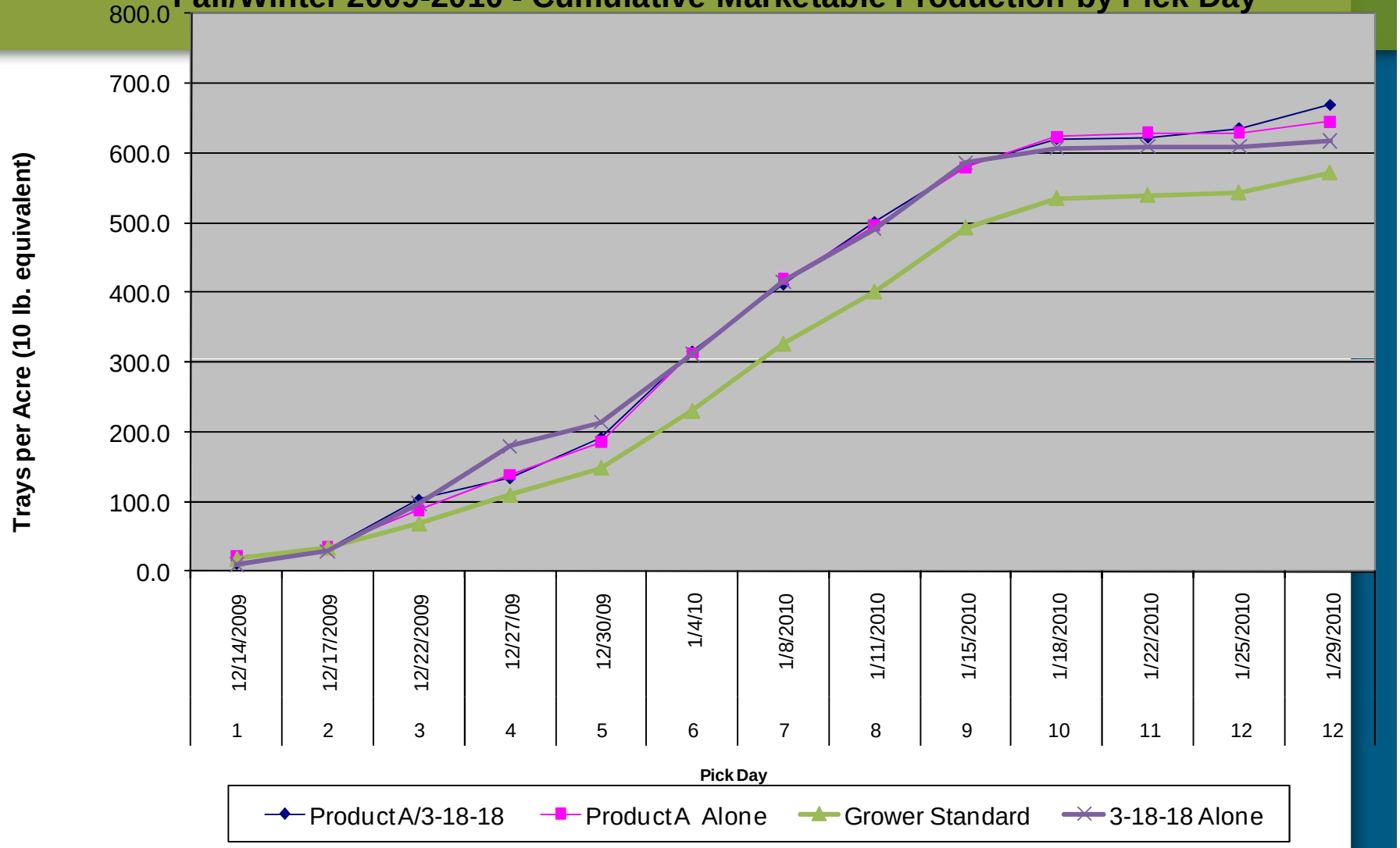

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Chart 8a: Proprietery Trial on Strawberries - Ventura County, Fall/Winter 2009-2010 - Cumulative Marketable Production by Pick Day

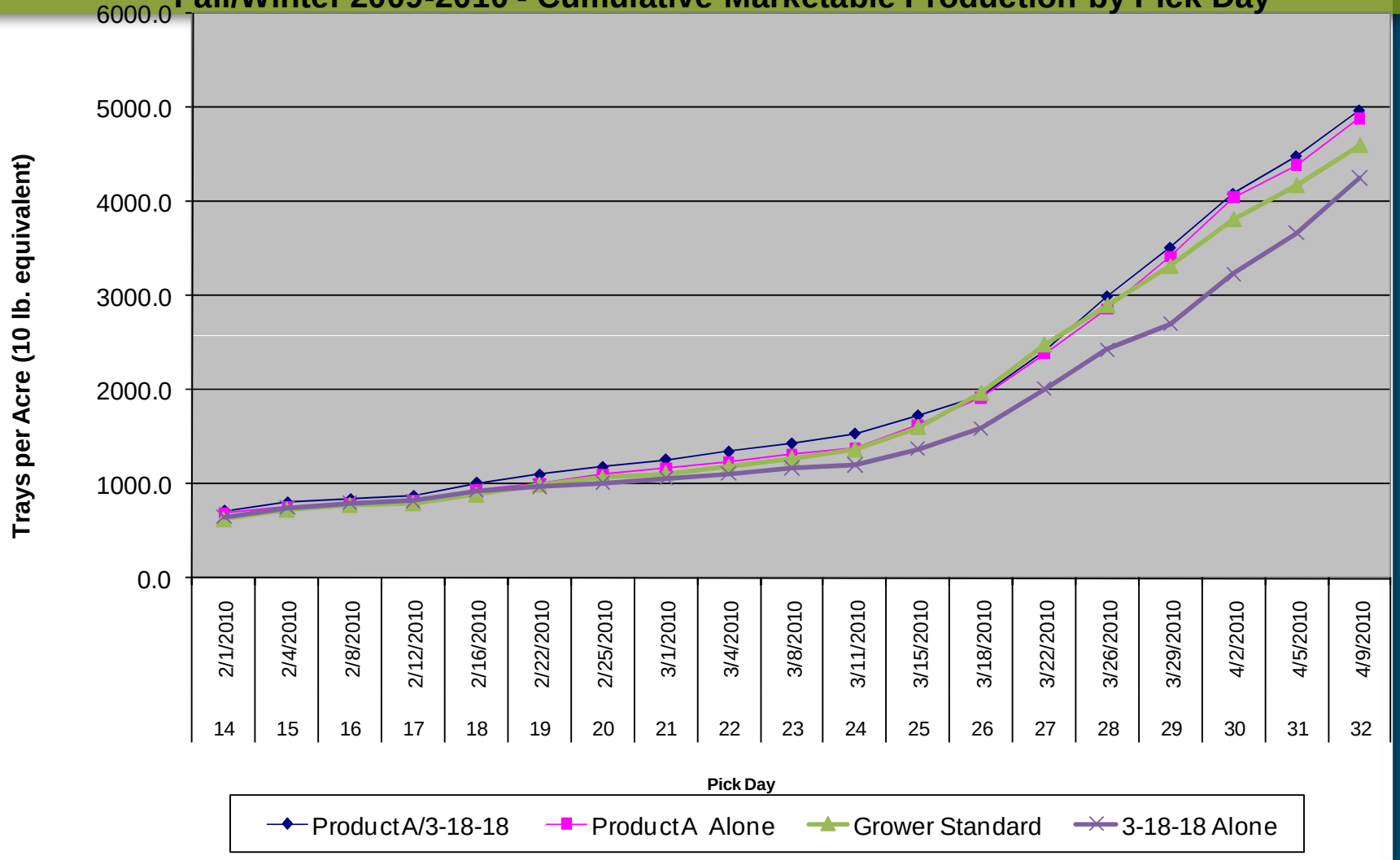

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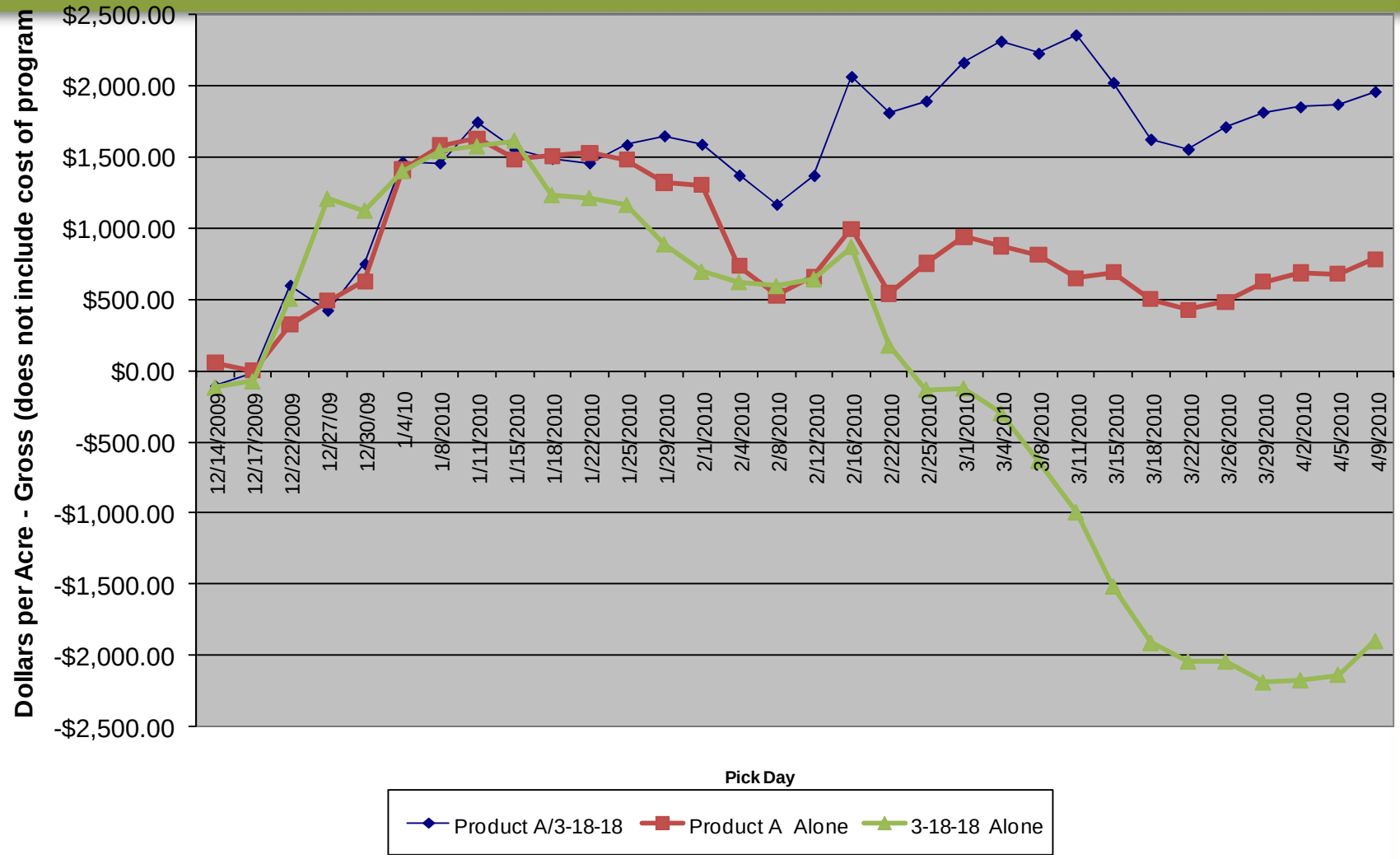
Chart 9:Proprietery Trial on Strawberries - Ventura County, Fall/Winter 2009-2010-Cumulative Differential from Grower Standard Return



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Conclusions

- Additional Early Season applications of P2O5 did help increase early season production
- Spring of 2010 was cooler than previous spring. With phosphate source removed in February, reduction in production was observed.

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The Right Place

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The Right Place

- Placement is critical!
- An old friend once told me: “Roots do not have forks and knives, all they have are straws.”
- Fertilizer needs to be were the roots can interact with it.
- One other issue: Roots are meant to take in nutrients (water and fertilizer), leaves are meant to process those accumulated nutrients, they are the factory that uses the resources. So the right place for most nutrients is in the ground, not on the leaves! But there are always exceptions to the rule.

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So What are the issues with the Right Placement?

- Roots need to intercept these nutrients:
  - Too close and you will burn the roots, too far away the roots never find the soluble elements.
- Our soils quite often inhibit nutrient uptake
  - Urea will gas off on the surface of wet soils and once converted to nitrate leaches with the water (thus the reason for these seminars)
  - Certain clays hold on to ammonium and potassium.
  - High calcium in our water and soils inhibit phosphate availability

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The Right Place

- In general it is:
  - Where the roots grow, so broadcasting fertilizer on non-irrigated ground is wasteful
  - It is where the roots will intercept it. Example is well mulched avocados and roots growing up into the mulch to intercept potassium on heavy clay
  - In the case of phosphate, it is a well placed band at 2x2 under the vegetable seed or transplant to get the crop started (Starter fertilizer)

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The Four R's

- The Right Source
- The Right Rate
- The Right Time
- The Right Place

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Thank you

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