Stormwater runoff management from plastic tunnels.

Oleg Daugovish, Ben Faber, Eta Takele, Anna Howell, Camille Garcia and Gina Ferrari (UC-ANR), Jamie Whiteford (and Ventura County Resource Conservation District staff), Laosheng Wu (UC-Riverside, and his lab staff).

SB County: Hoop Structures Ordinance Amendment (Project) Environmental Impact Report (EIR)

“If multiple hoop structures are arranged together in rows, the covers will direct runoff to the narrow portions of ground surface located in between the individual rows (i.e., “anchor row” or “post row” gutters). Over time, the concentration of runoff into these newly channelized gutters can create a scouring effect that would result in increased soil erosion, exacerbated by increased runoff velocities within the gutters. Increased soil erosion can lead to greater silt and sediment levels in the runoff, which could adversely affect surface water quality.”

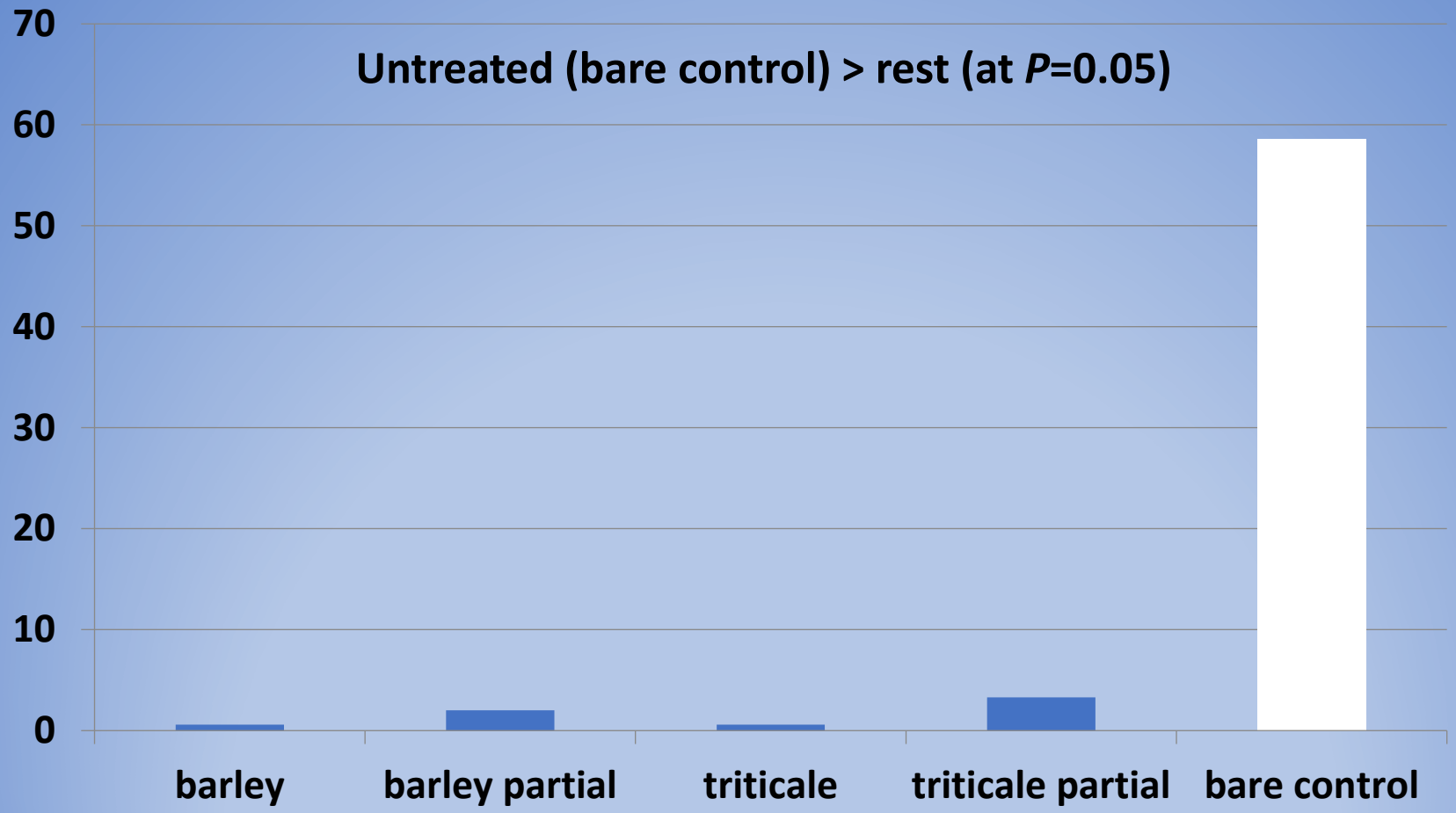
SB County: Hoop Structures Ordinance Amendment (Project) Environmental Impact Report (EIR)

“..agricultural operators are subject to the Ag Order 3.0, which includes a number of requirements to reduce storm water runoff and velocity and hold fine particles in place”

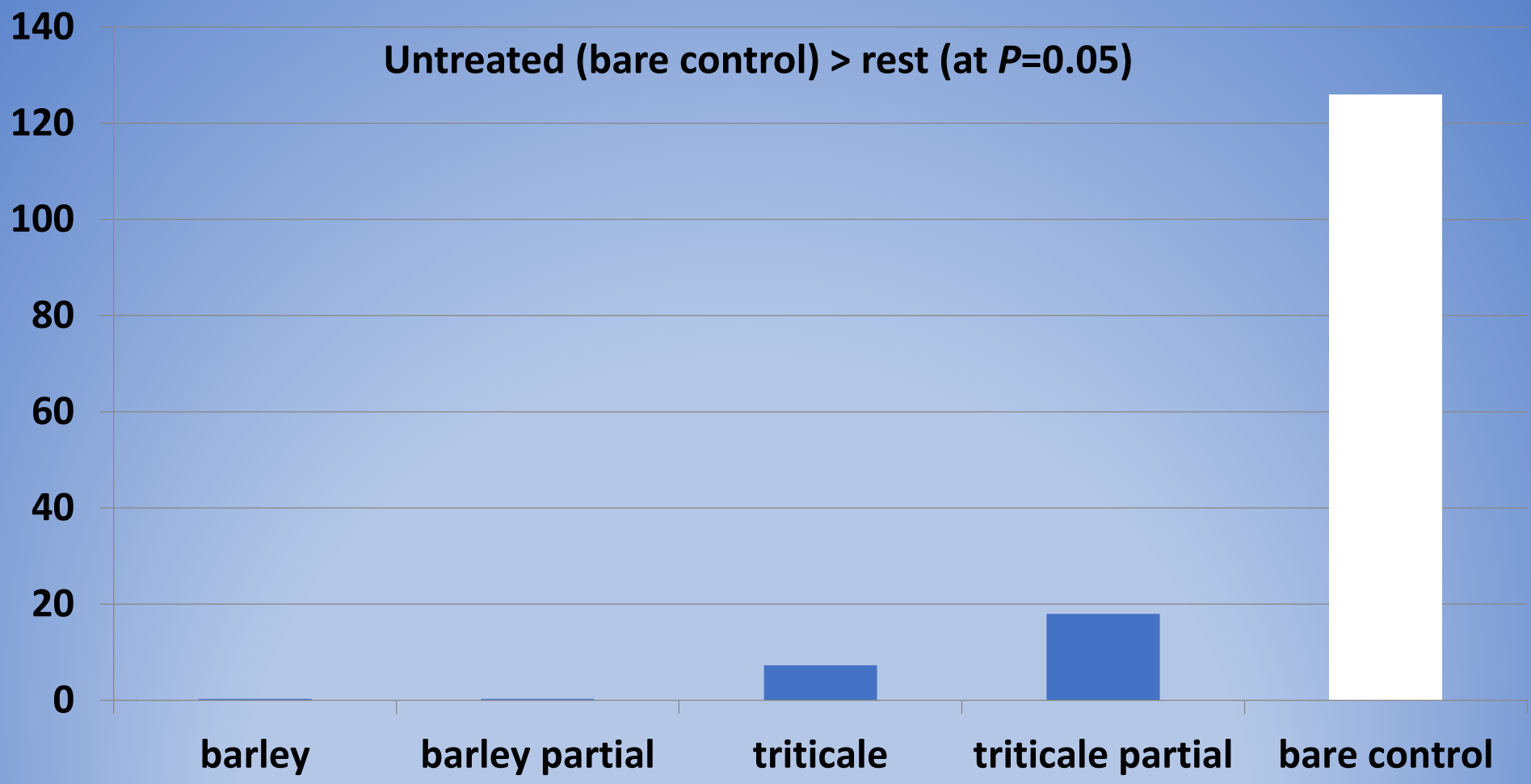

B 14

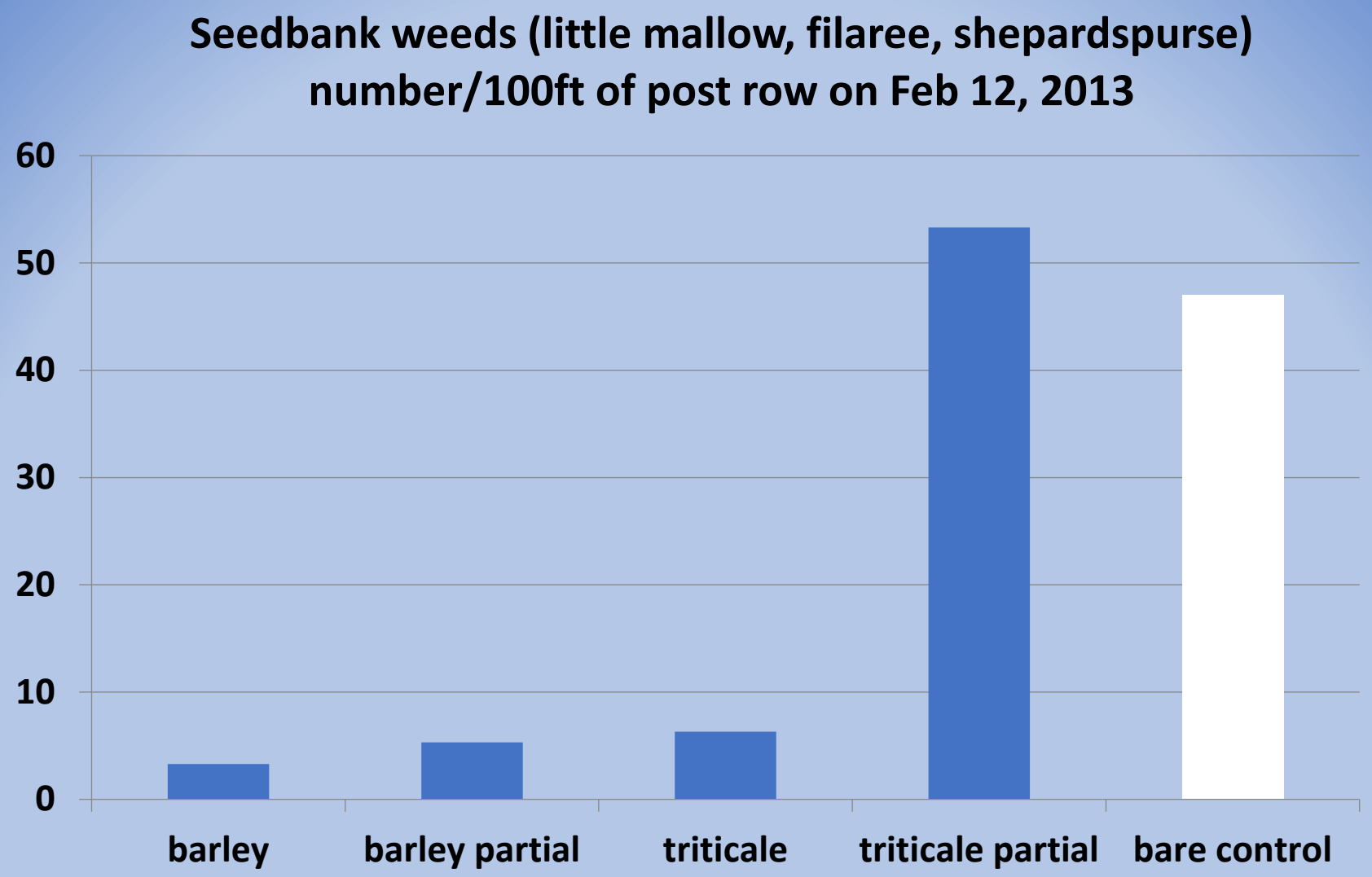
Untreated post row

Sowthistle weed number/100ft of post row on Feb 12, 2013



Horseweed (Conyza app.) weed number/100ft of post row on Feb 12, 2013




Seedbank weeds (little mallow, filaree, shepardspurse)
number/100ft of post row on Feb 12, 2013
60
50
40
30
20
10
0
barley
barley partial
triticale
triticale partial
bare control

2016-2018 SCBG project: Ventura and SB counties

Untreated (standard)

Barley cover crop
planted at 500lbs/A, terminated at heading with sethoxydim and mowing, as needed

Yardwaste mulch
(1-4 inch particles) applied 2-3 inches thick






<u>Weed barrier</u>
fabric placed on soil surface and pinned

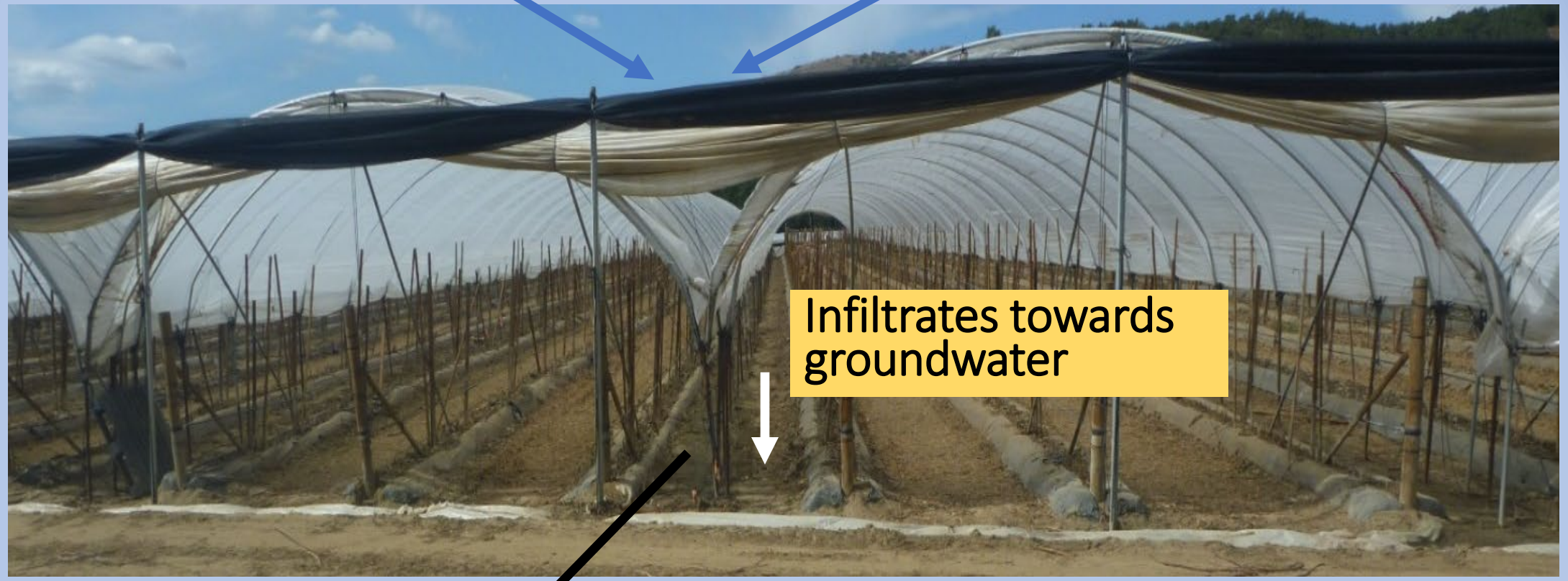
<u>Polyacrylamide</u>
(PAM, 'Simplot Soilbuilder')
applied at ~2lbs/A before rain events

Polyacrylamide (PAM)

- Synthetic Organic Polymer, breaks down to monomers by physical degradation, used >1mln acres in US
- PAM itself does not pose any environmental threat, as long as acrylamide (breakdown monomer) is kept away from food. Use anionic PAM, with <0.05% acrylamide
- Require clay particles in soil (not pure sand)
- Stabilizes soil aggregates

Image by Mike Cahn

Rainwater



Surface runoff

Barley

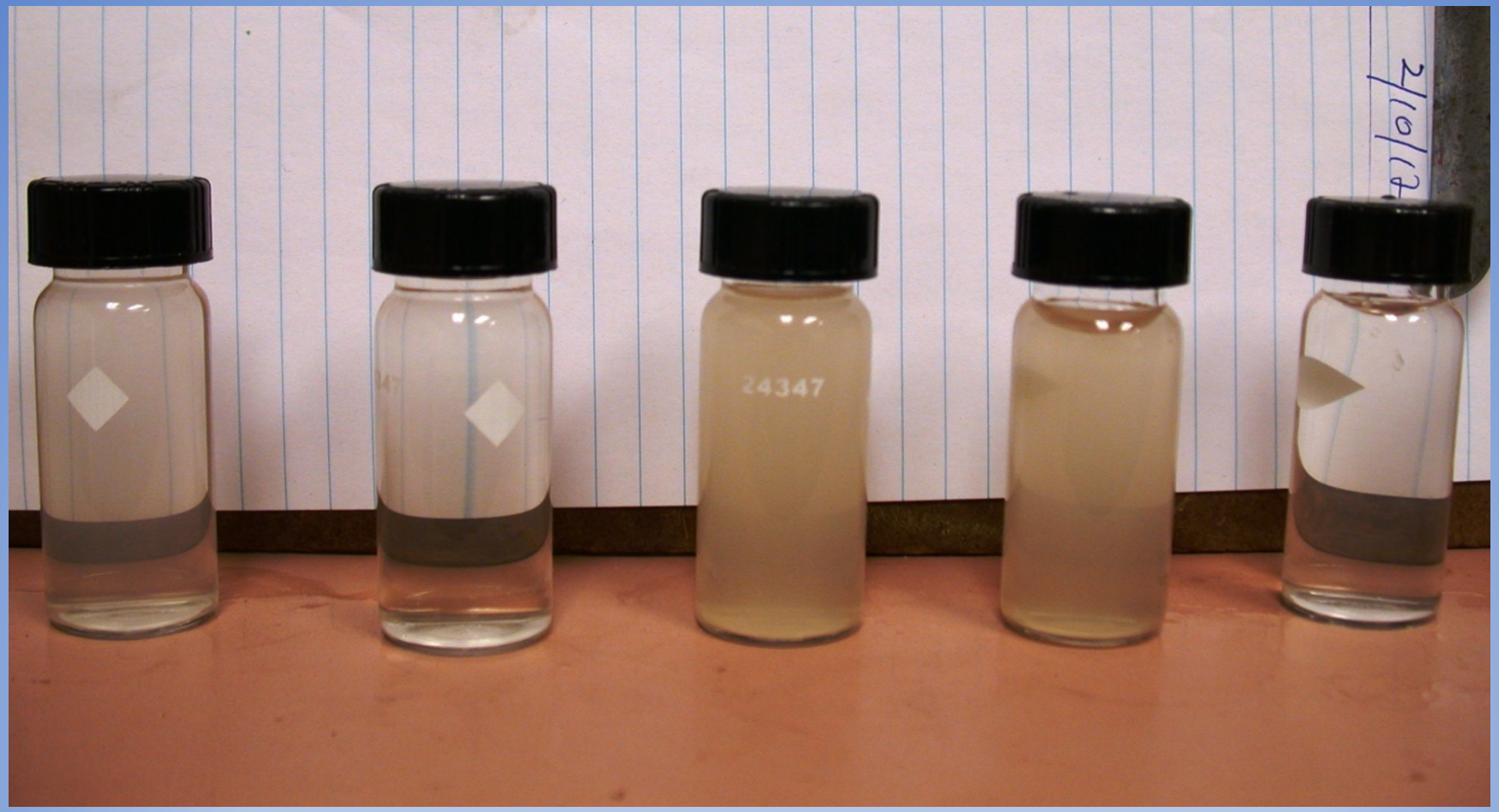
Mulch

PAM

Fabric

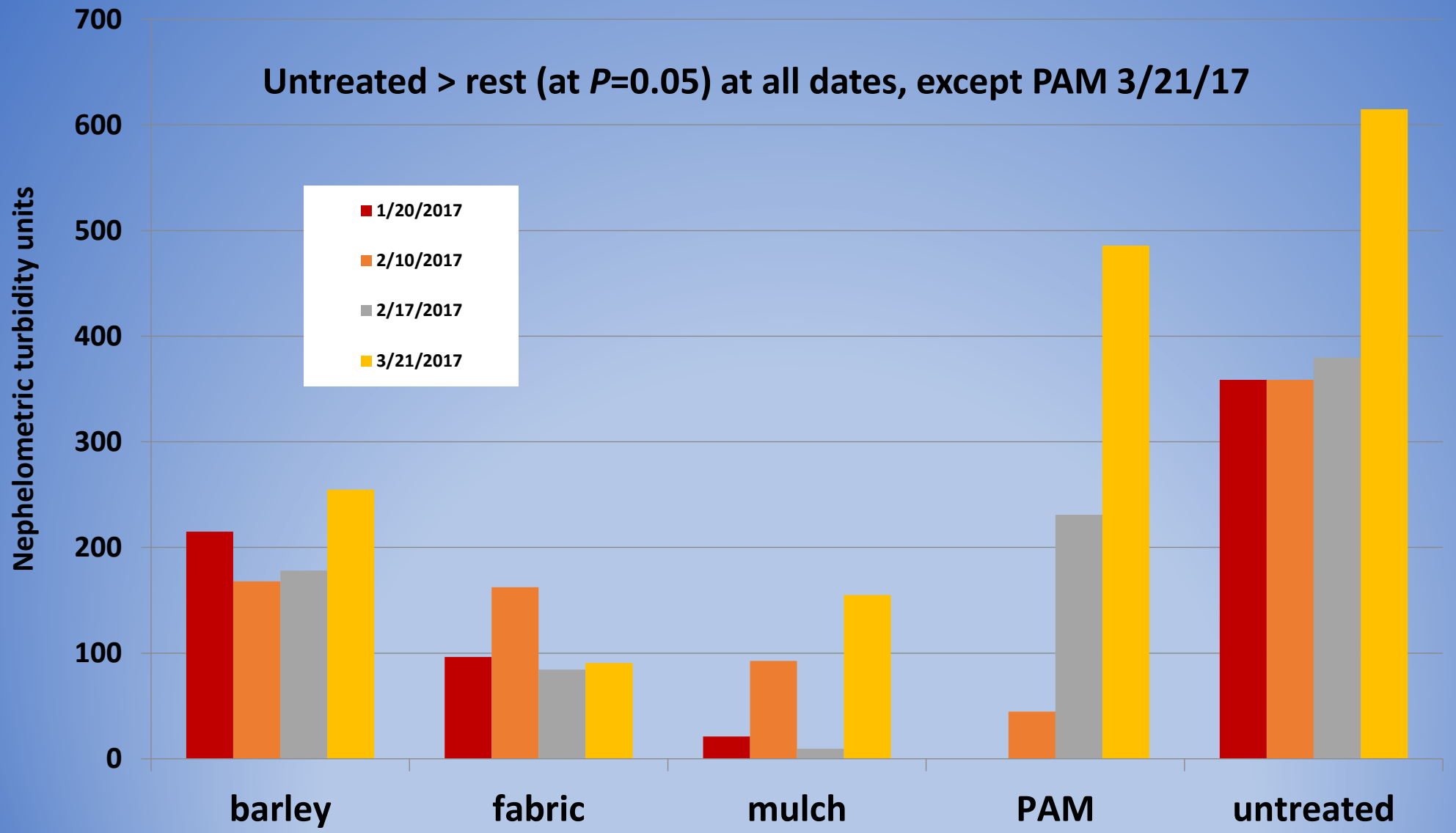
Untreated

Turbidity of runoff

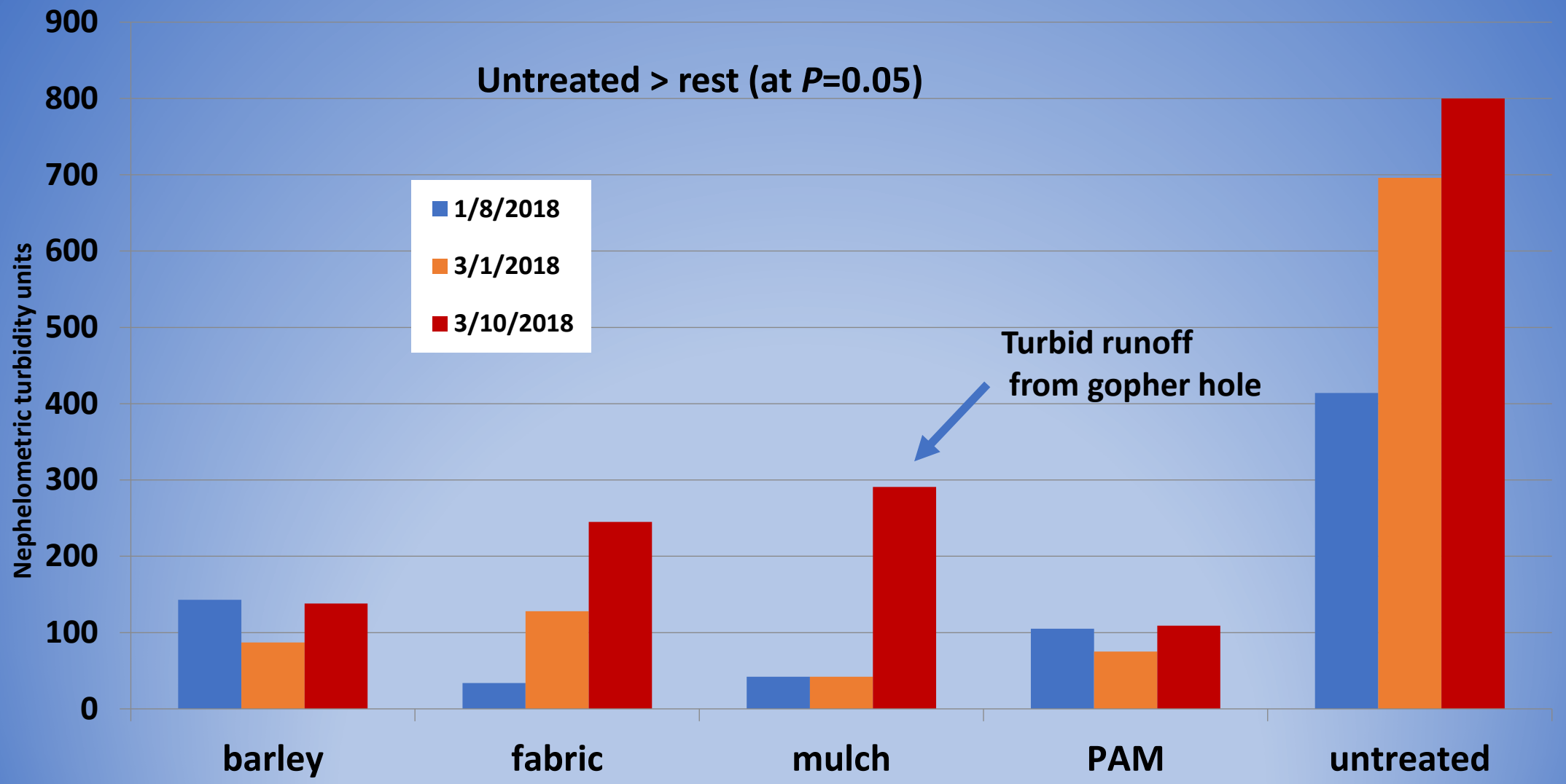


Weed barrier | Barley | Untreated | Mulch | PAM

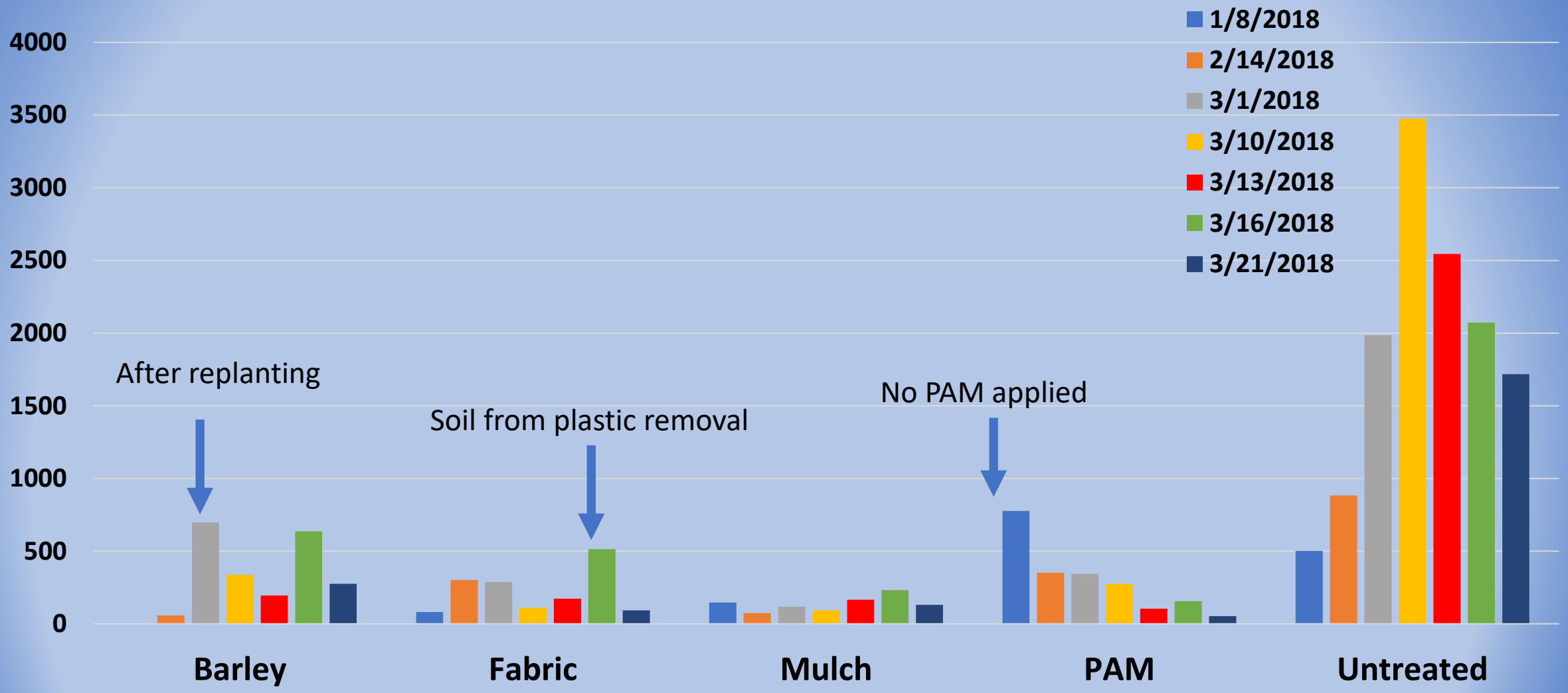
Turbidity in 2017 (grab samples, Somis)



Turbidity in 2018 (grab samples, Somis)

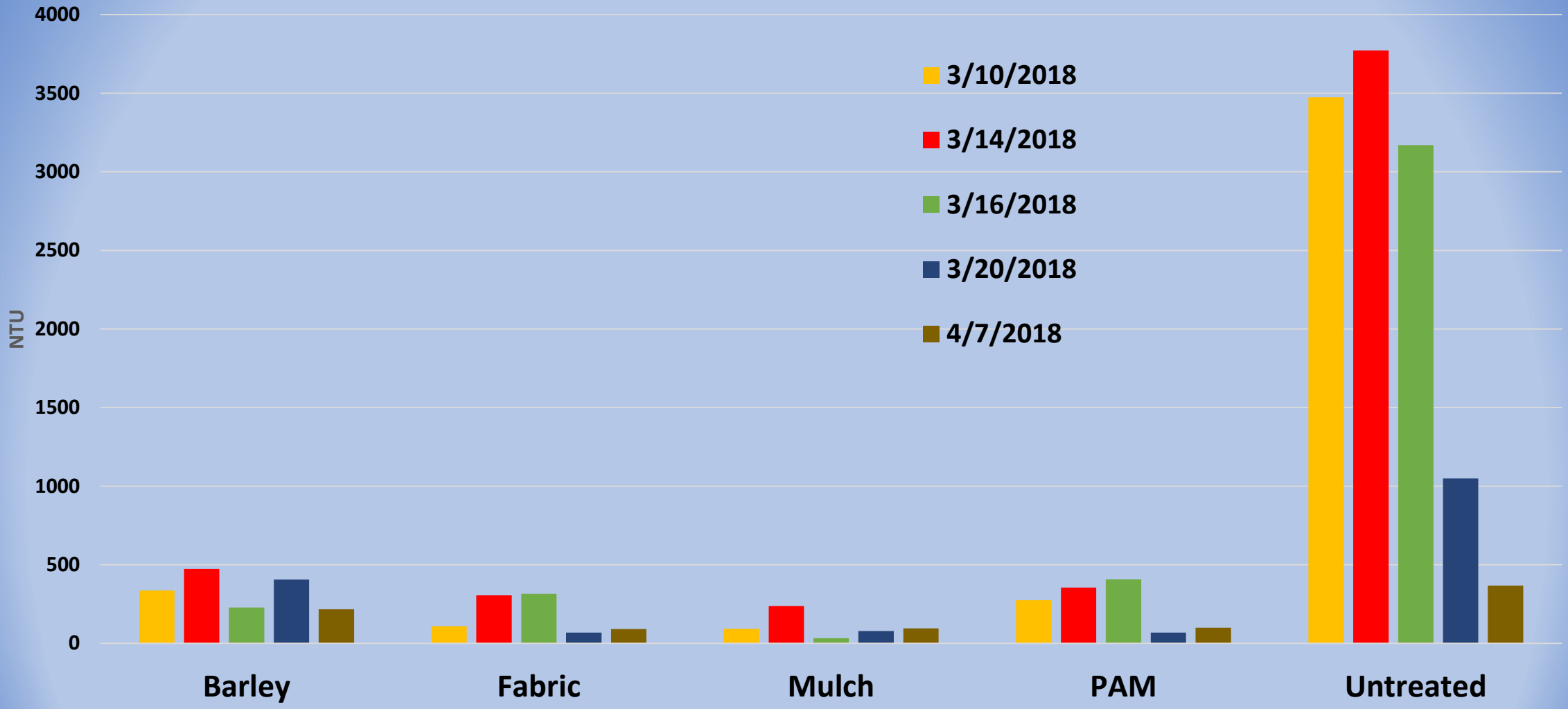


Turbidity in 2018 (first flush): Somis



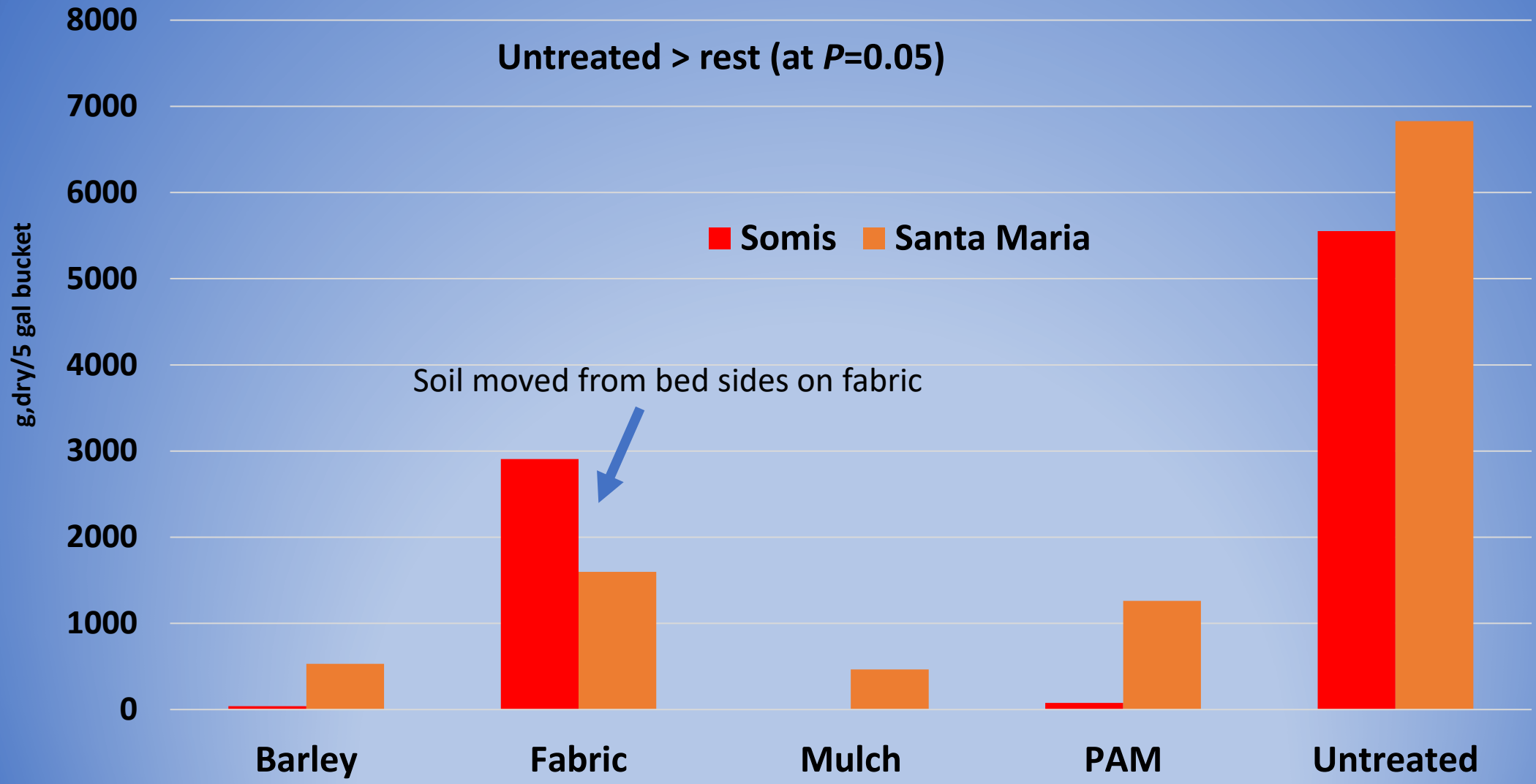
Untreated > rest (at *P*=0.05)

Turbidity at 5 dates in 2018 (first flush): S. Maria

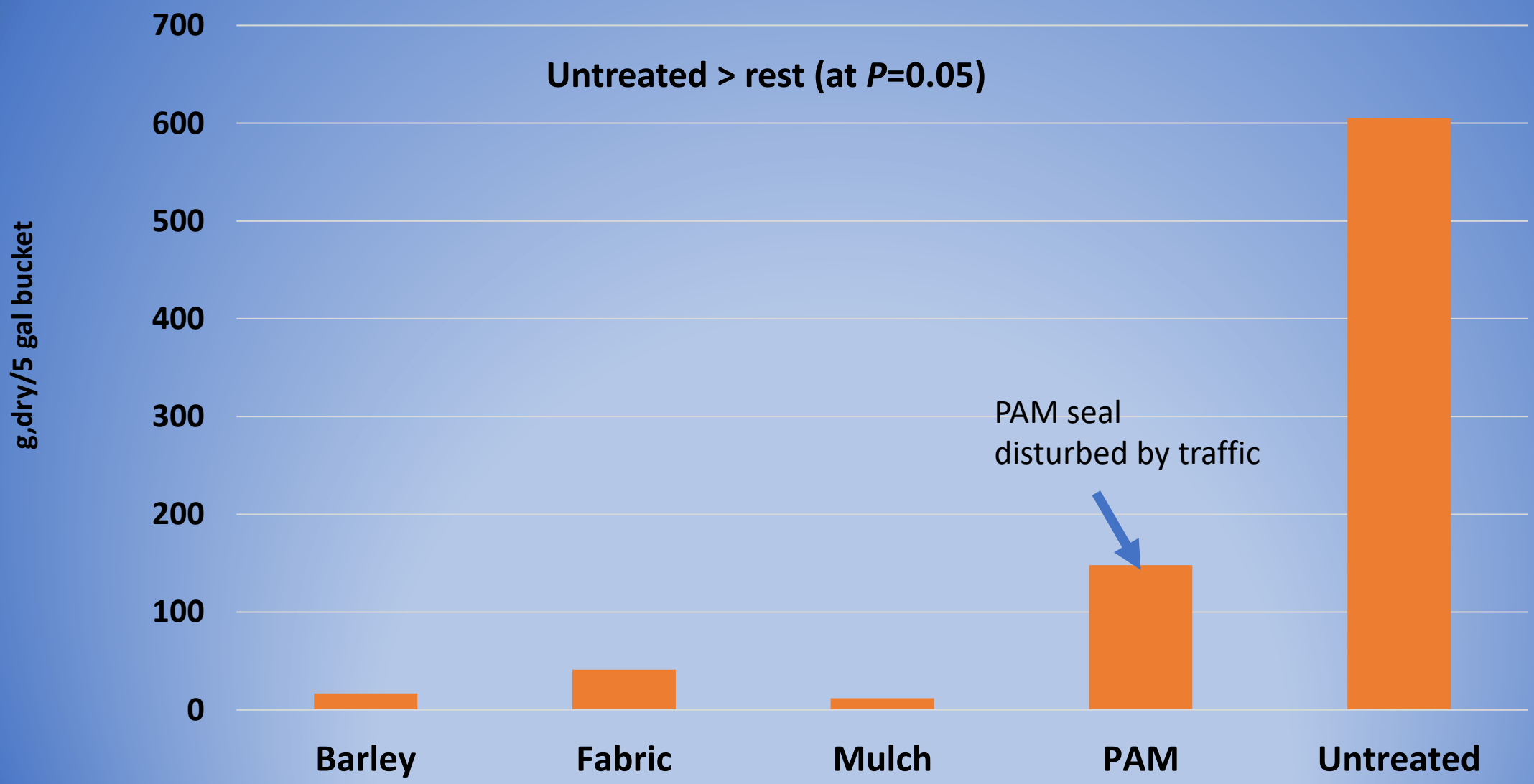


Untreated > rest (at *P*=0.05) at most dates

Sediment in 2018 (after 3.25”rain)



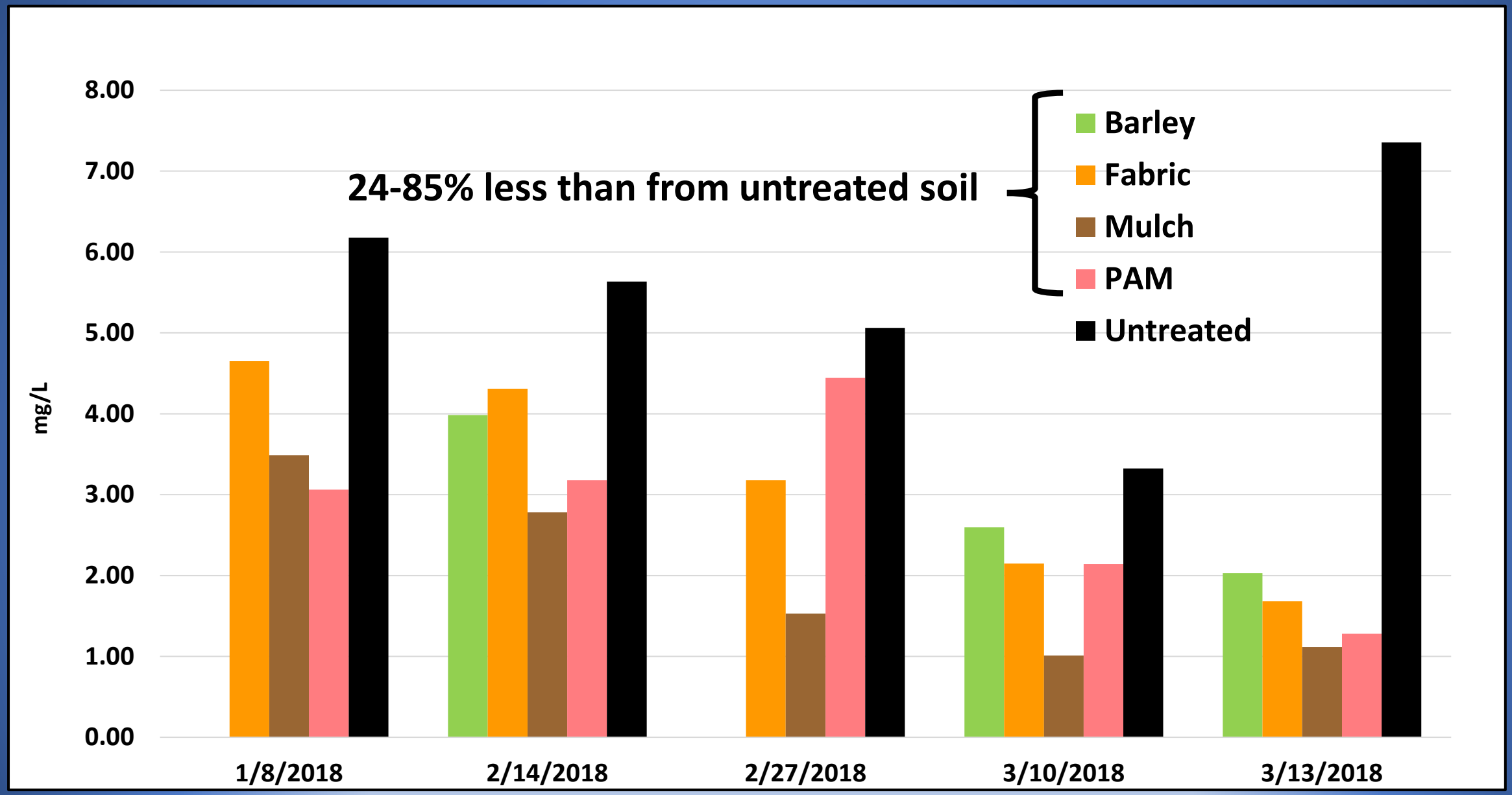
Sediment in 2018 (after 0.1”rain, S. Maria)



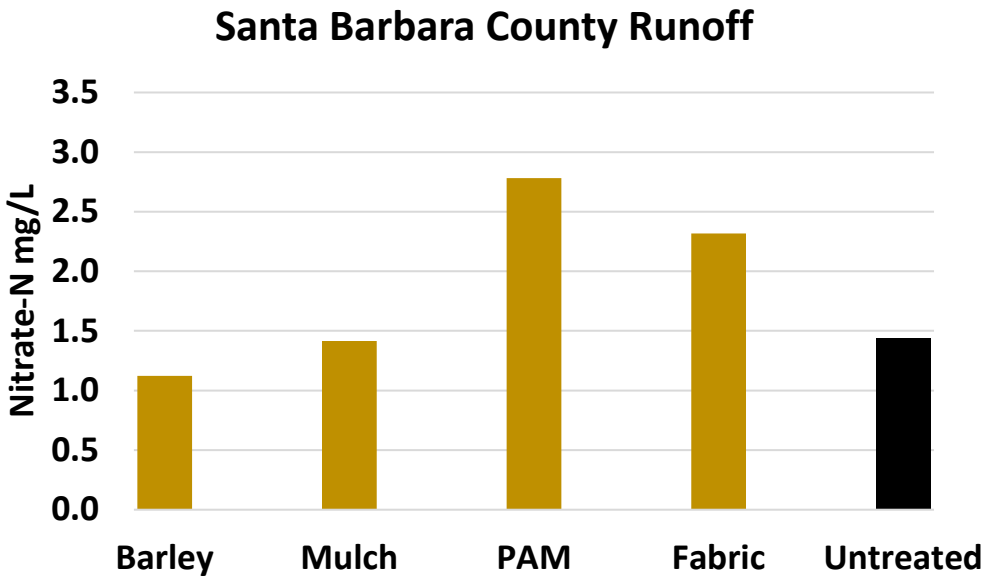
Mangiafico et al. 2009- Hort Technology (work from Ventura county)

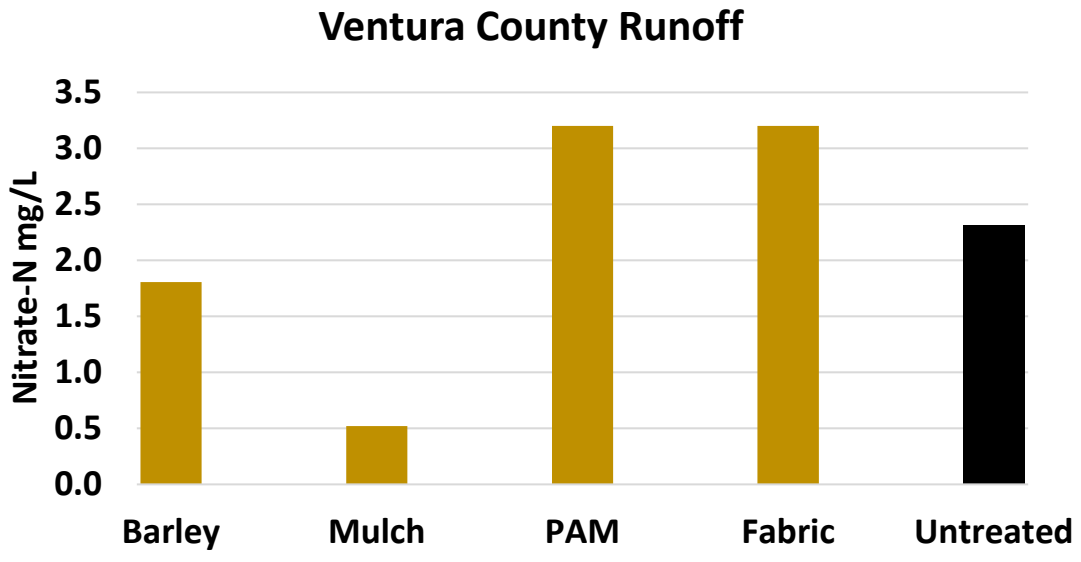
- Constituents in runoff exceeding benchmarks for surface waters included turbidity, chlorpyrifos, and some organochlorine pesticides. When detected, chlorpyrifos concentration was linearly related to sample turbidity ($P = 0.0025$, $r^2 = 0.49$). This suggests that the retention of waterborne sediments on-site may be an effective method for mitigating runoff of this pesticide.

Phosphorus in first flush of runoff, Somis



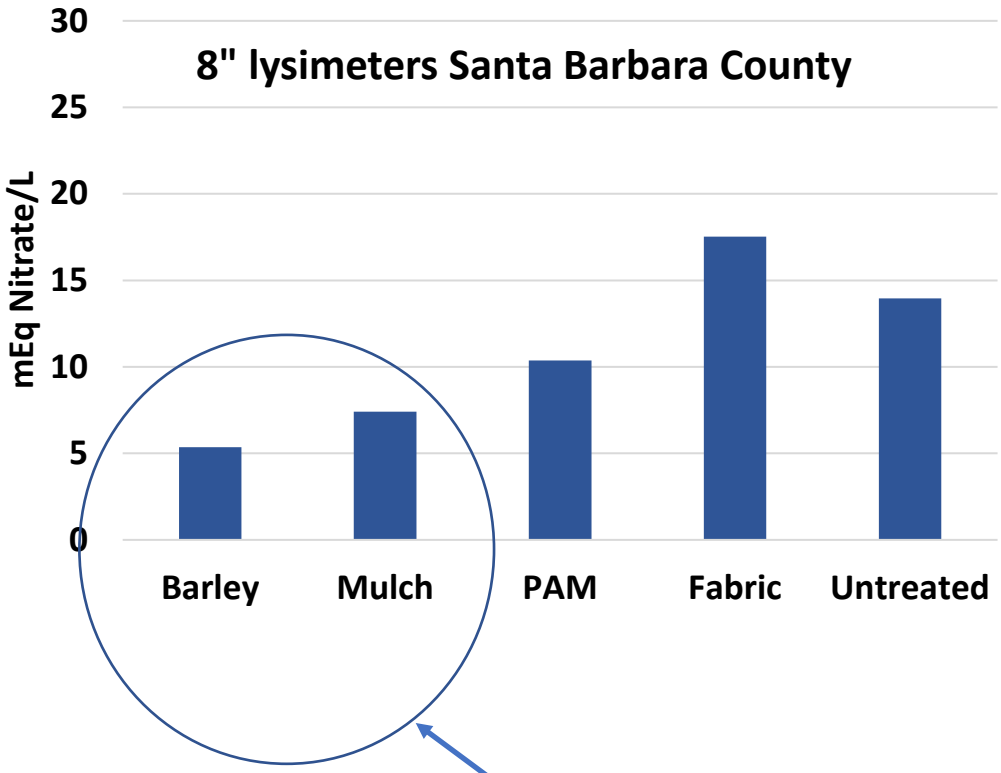
NO_3-N in runoff (first flush), averaged of 5 sampling events

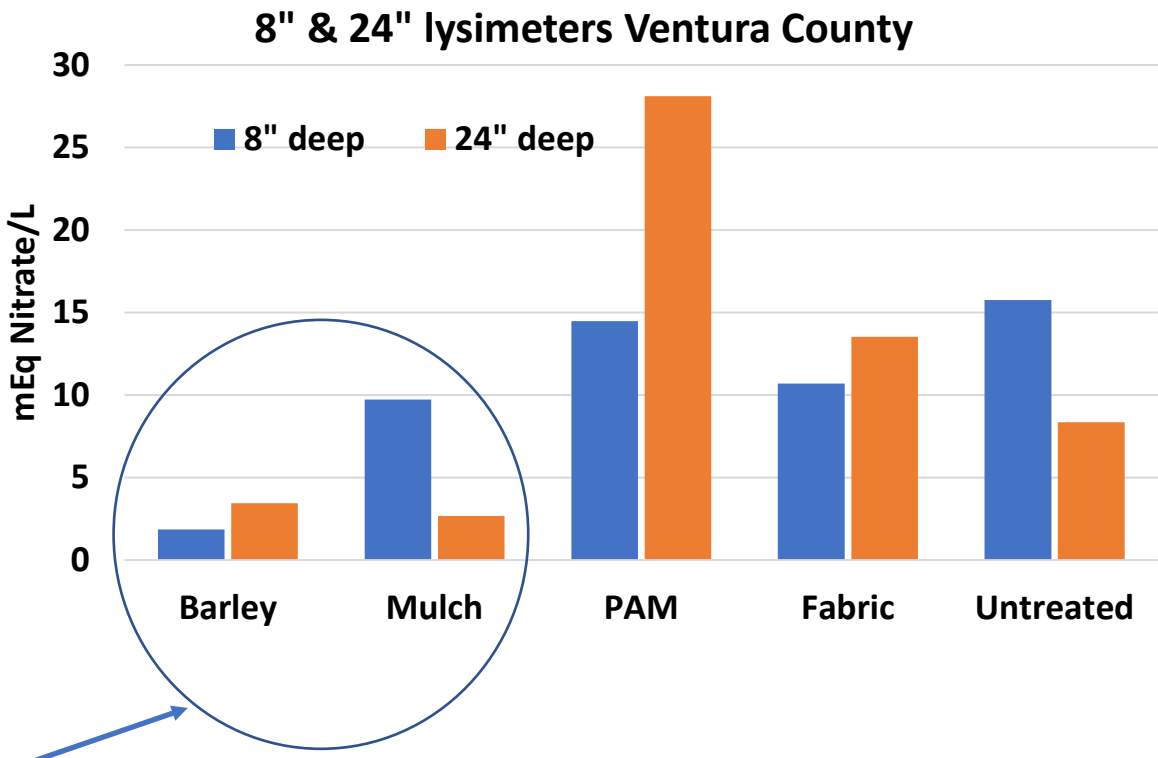




Significantly < than untreated (*P*=0.05) during 1 (barley) or 2 (mulch) out of 5 rain events,
<u>BUT</u>
Reduced flow in mulch and barley during light rain = lower or no runoff compared to other

NO_3-N in leachate, averaged of 5 sampling events





Significantly (P<0.05) < than untreated

Soil analyses under treatments, Somis, Apr 2018

	Moisture, %	At P=0.05	NO3-N, ppm	At P=0.05
Untreated	18.5	b	28	a
Fabric	18.4	b	22	a
Mulch	20.8	a	7.8	b
Barley	19.6	ab	4.4	b
PAM	18.3	b	35	a

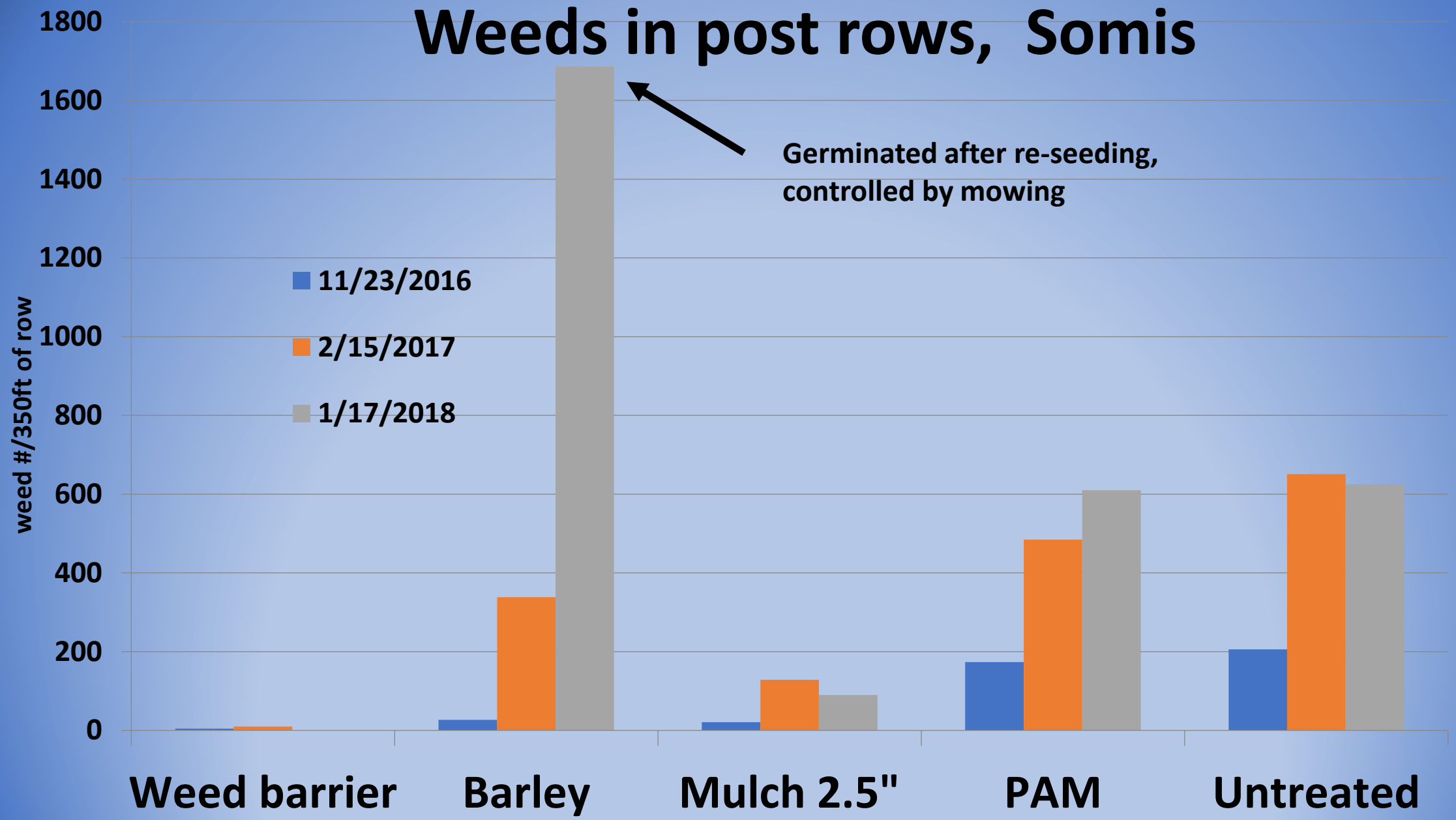
No differences in phosphorus among treatments or among soil depths (0-6” and 6-12”)

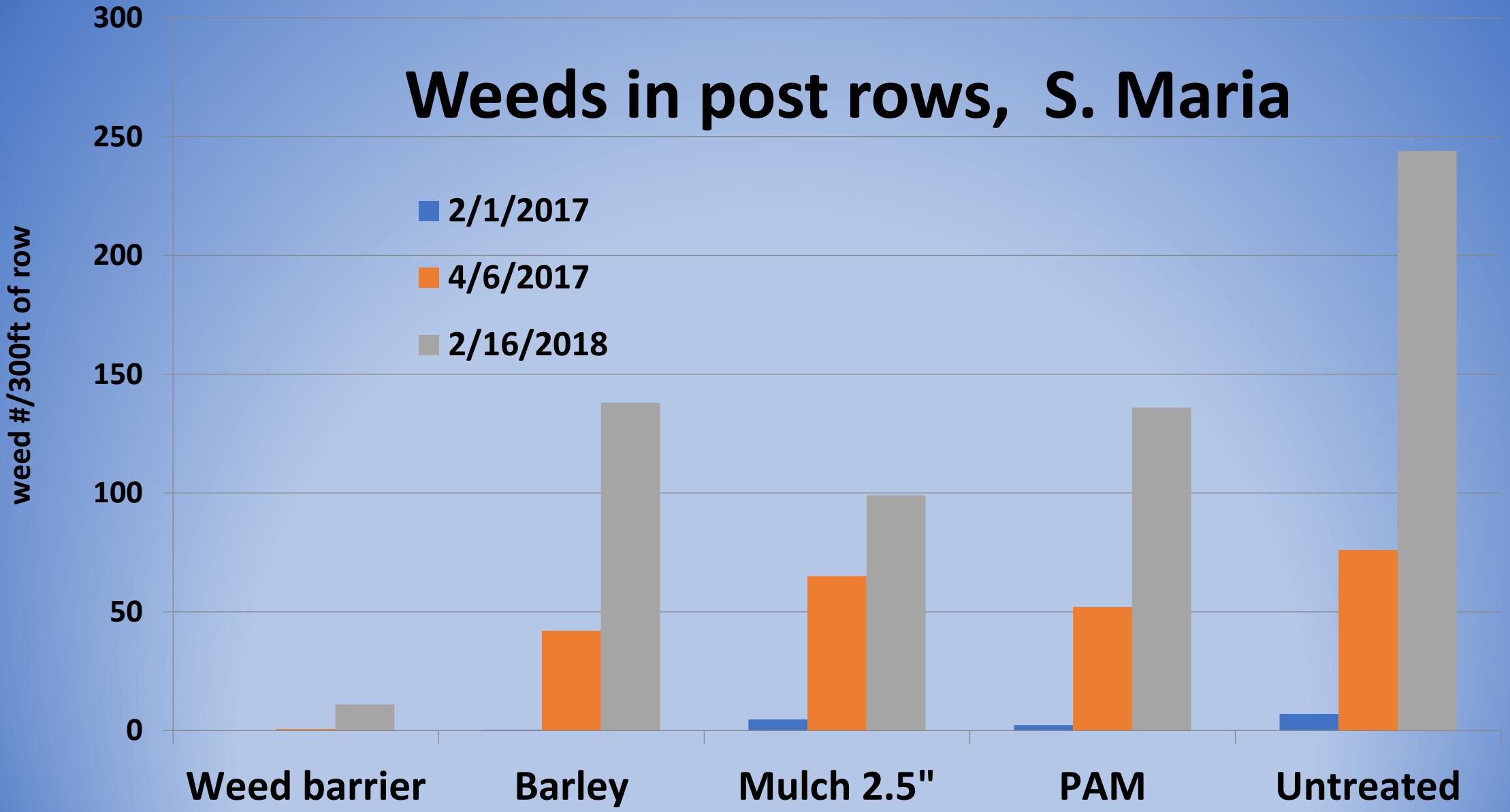
Soil analyses under treatments, S. Maria, Apr 2018

	NO3-N, ppm	At P=0.05
Untreated	11.2	a
Fabric	2.3	b
Mulch	9.8	ab
Barley	4.7	b
PAM	8.4	b

No differences in moisture or phosphorus levels among treatments or soil depths (0-6” and 6-12”)

Raspberry shoots in post rows, Somis


Weeds in post rows, Somis
Germinated after re-seeding, controlled by mowing
11/23/2016
2/15/2017
1/17/2018
weed #/350ft of row
1800
1600
1400
1200
1000
800
600
400
200
0
Weed barrier
Barley
Mulch 2.5"
PAM
Untreated


Weeds in post rows, S. Maria
weed #/300ft of row
300
250
200
150
100
50
0
2/1/2017
4/6/2017
2/16/2018
Weed barrier
Barley
Mulch 2.5"
PAM
Untreated

Key points

- **<u>All treatments can have beneficial impact on soil and nutrient retention and weed control (except PAM) if maintained/properly managed:</u>**

Barley: dense stands control weeds, but poor stands and scarce residue do not. If stand is poor and residue after mowing/herbicide use is lacking- consider reseeding. 600 lbs/a rototilled in moist soil or before rain works best.

PAM: spread before rain and minimize soil disturbance. If not disturbed can benefit during multiple rain events. If disturbed – re-apply. Will not affect weeds.

Mulch: Controls annual weeds only when persists at ~2.5-3 in thickness. Can float out of the ends of tunnel at high runoff velocity. If thin layer/breaks down rapidly - minimizes efficacy

Fabric: Best weed control; minimize soil on top of fabric . It can be rolled up at the end and reused.

Key points

Barley and mulch retain moisture and reduce N moving to groundwater better than other treatments or untreated.

This N is likely used by barley crop, and for residue and mulch decomposition (cellulose and lignin degrading m/o)

Mulch promotes caneberry shoot growth in it, likely by retaining moisture.

All BMPs reduced development of erosion channels compared to untreated.

For workers in tunnels: no issues with any BMPs , barley in the center or/and cut to <6" from ground.

Sample costs of post row treatments

Summary of Costs of Treatments		
Treatment: Fabric		
Materials and Labor	Costs/Tunnel Cycle/ Treatment area : 1 post row =1800 ft² 1 tunnel cycle =3 years life	Costs/Tunnel Cycle/ Per Acre (5.5 post rows) 1 tunnel cycle =3 years
Fabric Cost (1 role covers 8,071 ft²) at $349.31/roll	77.90	428.47
Pins: 90 for treatment area (1800 ft² =1 post row) at $0.12/pin	10.80	59.40
Labor (2 people at 0.5 hour each) at $15.00/hour	15.00	82.50
Total cost for fabric treatment	103.70	570.37
Reuse of Fabric for another planting		
Unpinning cost (2 people 0.5 hour each)	15.00	82.50
Pinning back for the planting (2 people 0.5 hour each)	15.00	82.50
Total cost with fabric reuse (2 tunnel cycle)	133.70	735.37
Total cost per tunnel cycle	66.85	367.68
Less weed control cost in post rows at $300/acre/year (100% weed control)	-37.19	-204.55
Total fabric treatment cost	**29.66**	**163.14**
Treatment: Mulch		
Mulch Cost (90 cu.ft for 1800 ft²) at $15/cu.yard ($0.56/cu.ft): 495 cu.ft/Acre	50.00	275.00
Delivery and spreading for 1800 ft²--0.74 hours at $15/hour	11.10	61.05
Total cost for mulch treatment	61.10	336.05
Less weed control in post rows at $300/acre/year (70% weed control)	-26.03	-143.18
Total treatment cost	**35.07**	**192.87**
Treatment: Cover Crop		
Cover crop planting:		
500 lbs/Acre (43,560 sq. ft) at $20/50lbs (2X)	8.26	45.45
Labor hours for light tilling with hand rototiller:		
2 people (20 min each) at $15 per hour wage rate (2x for 2 seeding)	10.00	55.00
Mowing (2x): 2 people (20 min/each) (2X for 2 seeding)	10.00	55.00
Machine cost: mowing at $14/acre (from cost studies)	0.58	3.18
Weedwacker (same as mowing)	0.58	3.18
Less weed control in post rows at $300/acre/year (50% control)	-18.60	-102.27
Total cover crop treatment cost	**10.83**	**59.55**
Treatment: Polyacrylamide (PAM)		
PAM cost (application at 2 lbs/acres at a price of $4/lb; 6 X application	1.98	10.91
Labor @250 min/acre and wage rate $15/hour: 6x application	15.50	85.23
Total PAM cost	17.48	96.14
Less weed control cost in the post rows	0.00	0.00
Total PAM cost	**34.96**	**192.27**

Treatment	Cost/Tunnel cycle (3 yrs) Per Acre (5.5 post rows)
Fabric (weed barrier)	$ 163
Mulch	$ 193
Cover crop (barley 500lbs/A)	$ 59
PAM	$ 192

Benefits?

- Reduce Costs of sediment management 60-90%
- Reduce or eliminate penalties for non-compliance if runoff is polluted (phosphorus, sediment, chlorpyrifos /other soil-adsorbed pesticides)
- Keeping soil in your field and reducing erosion, especially on slopes
- Barley and mulch reduced nitrate leaching to groundwater
- Opportunity to market your product as from ‘farm that practices soil conservation’ , CDFA ‘Healthy Soils’ Program has funding for growers

ACKNOWLEDGEMENTS

We greatly acknowledge help and contributions from Driscoll/Reiter AC, AGQ lab and funding from Cal Dept of Food and Agriculture.