Mulches for Controlling Erosion and Establishing Grass on Slopes: What Works

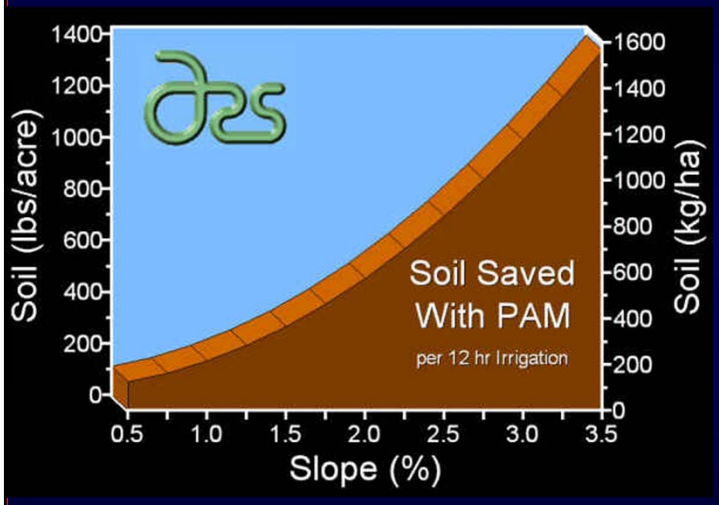
Ground Covers: Many Varieties

But can they be improved with polyacrylamide (PAM)?

USDA Promotes PAM

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Furrow Irrigation Application



Up to 94% Reduction In Furrow Erosion!

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

PAM and Erosion: Published Results

- PAM usually reduced erosion, but there appeared to be a minimum application rate for reliable results.
- PAM also usually reduced runoff volume, but there is some evidence that surface sealing can occur.
  - Depends on rate, concentration, and soil

Mulch Effects

Authors	Year	Material	Slope (%)	Erosion Reduction (%)
Mannering et al.	1963	Wheat straw	5	≥2,400 kg/ha = 0 ≤1,100 kg/ha = 75-90
Bautista et al.	1996	Straw		50-94
Dougherty et al.	2010	Blankets Hydromulch Straw	?	58 53 66
Hayes et al.	2005	Straw	50	83
Faucette et al.	2005	Compost, hydroseed	10	95-99
Sutherland & Zielger	2007	Coir blanket Coir mesh	9	>99 92-99

- Insert splash video

Additional Mulch Benefits

Cover (%)	Soil Loss	Clay (<2 um)	Silt (2-50 um)	Sand (>50 um)
	(% of 0 cover)	Particle Size Ratio: Eroded/Soil		
0	100	0.9	0.9	2
15	50	0.9	1	2.5
30	43	0.8	0.9	3.3
50	40	0.7	1	3.6
70	10	0.7	1	5
90	4	0.6	1	5.5

Shi et al., 2012: Effects of Mulch Cover Rate on Interrill Erosion Processes and the Size Selectivity of Eroded Sediment on Steep Slopes. doi:10.2136/sssaj2012.0273

Results of Our Tests




NCSU Study

Site	Time	Bare	Straw	Reduction
	(month/date)	Soil Loss, kg/ha		%
Piedmont 1	6/24-7/25	7,300	390	95
Piedmont 2	9/24-12/17	11,700	1,200	90
Coastal Plain	12/17-2/8	10,500	500	95

Hayes et al., 2005. J. Soil Water Cons.

Small Plot, Low Slope Tests
Averages First 5 Storms

Cover	Runoff		Turbidiity (NTU)		Erosion (t/ha)	
	No PAM	PAM#	No PAM	PAM	No PAM	PAM
Bare	6.5a	5.2a	2,279a	1,950a	4.4a	2.3a
Blanket	3.2b	2.1b	1,350ab*	570b*	1.7ab	0.5b
Straw	1.7b	1.9b	763b	371b	0.8b	0.6b
Hydromulch	1.7b	1.4b	349b	142b	0.6b	1.4ab

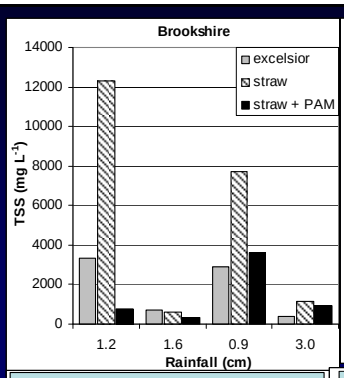
#APS 705, 19 kg/ha
*PAM significantly reduced turbidity for that mulch

Small Plot, Low Slope Tests
Grass Cover (%)

Cover	October 30		November 13	
	No PAM	PAM*	No PAM	PAM
Bare	24c	23c	38c	44b
Blanket	39b*	48a*	50ab	55ab
Straw	48a	50a	56a	65a
Hydromulch	25c*	30b*	39bc	51b

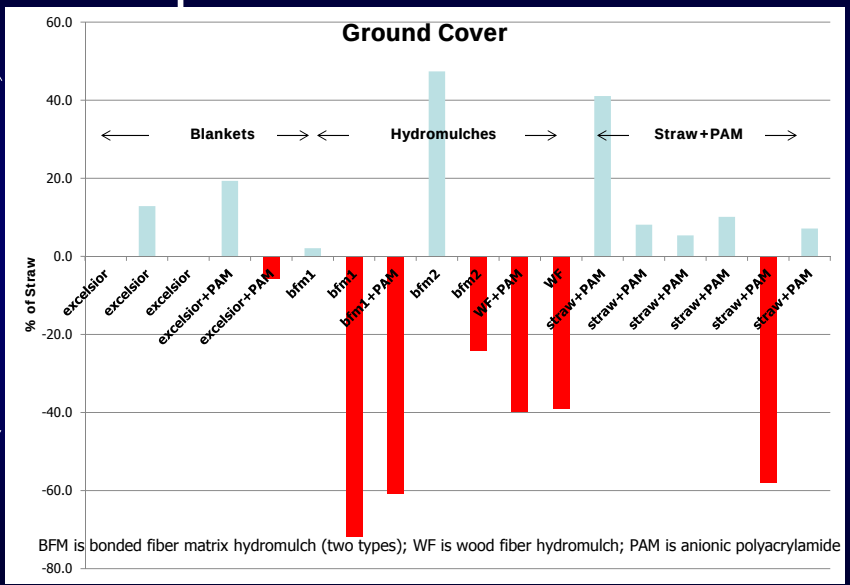
*PAM significantly improved grass cover for that mulch

Sediment Losses: ECB, Straw, Straw+PAM



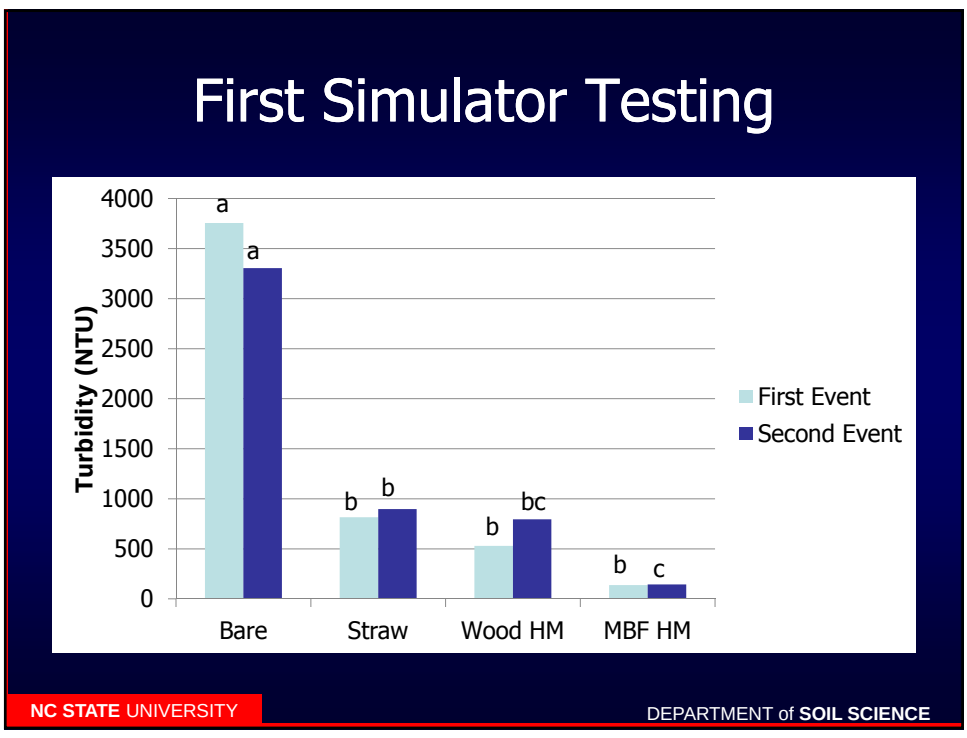
NC STATE UNIVERSITY

Compared to Straw Alone...

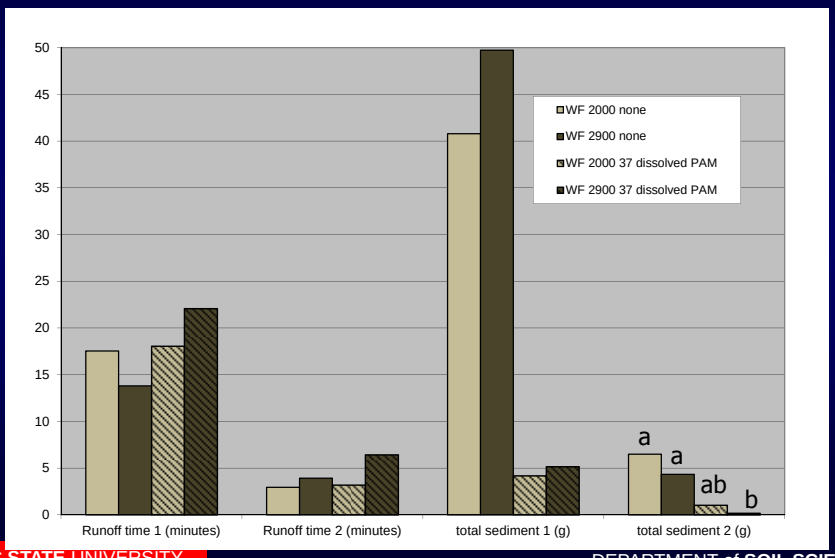


NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE


Rainfall Simulator – basic design

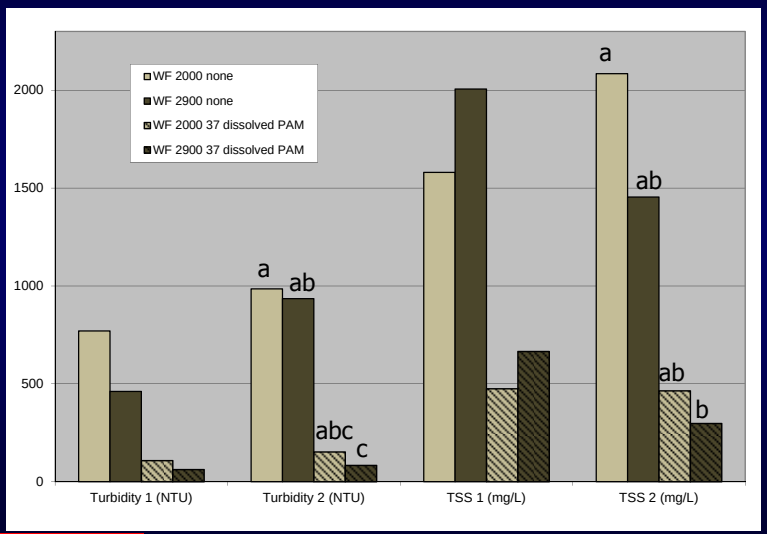

First Simulator Testing
Turbidity (NTU)
4000
3500
3000
2500
2000
1500
1000
500
0
a
a
b
b
b
bc
b
c
Bare
Straw
Wood HM
MBF HM
First Event
Second Event
NC STATE UNIVERSITY
DEPARTMENT of SOIL SCIENCE

Wood Fiber Hydromulch
Rate and PAM Effects



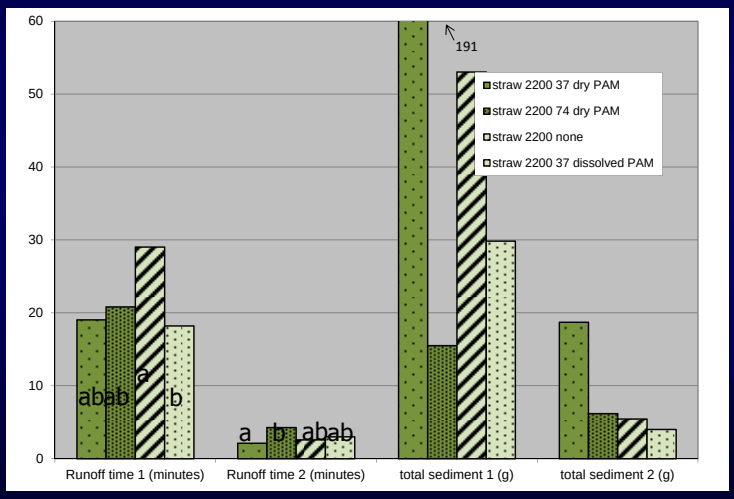
NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Wood Fiber Hydromulch
Rate and PAM Effects



NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Straw
Rate and PAM Effects

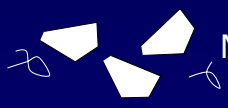


NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

PAM Dissolution Process

Powder

Initially



Mostly solids, some free but not fully active

Hour or Two

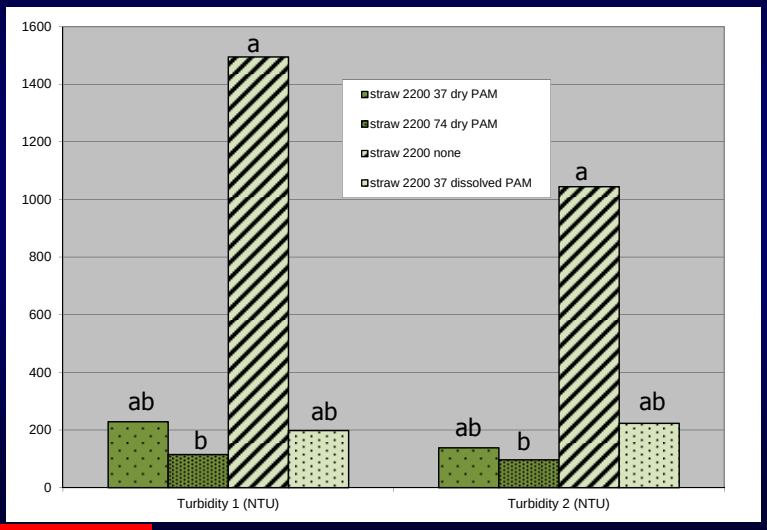
Some fully active, Some free but folded, Still solids present

Many Hours

Mostly free and fully active, still some folded

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Straw
Rate and PAM Effects



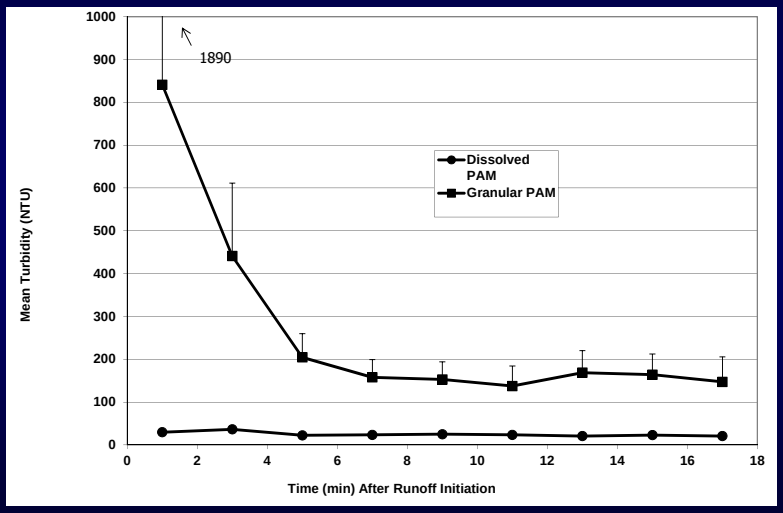
Rainfall Simulator: PAM effects

Mulch Type	Mulch Rate (kg/ha)	% Reduction in Turbidity 1	% Reduction in TSS 1
C	2000	80.5	63.2
C	3000	52.9	28.1
WF	2000	86.0	70.0
WF	3000	86.5	66.8
S	2200	86.8	81.5

C = Cotton Prototype Hydromulch; WF = Wood Fiber Hydromulch; S = Straw

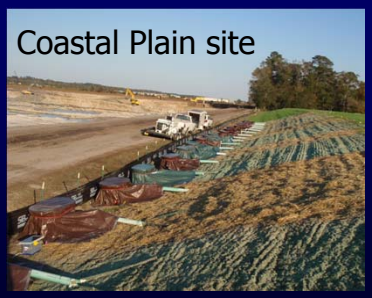
Adding 37 kg/ha dissolved PAM reduced turbidity and TSS, but differences were not always significant.

Rainfall Simulator Tests: Granular vs Dissolved PAM



Recent Study Results

Recent Project to Evaluate Hydromulches and PAM



NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

6th Site: Catastrophe!

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Final Results: Erosion

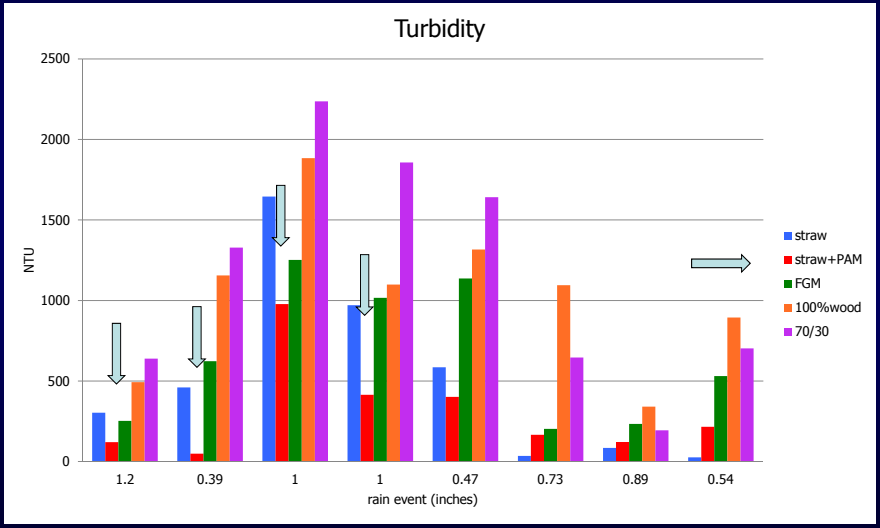
Treatment	Site 1, Kinston	Site 2, West Jefferson	Site 3, Garner	Site 4, Apex	Site 5, Holly Springs
			Total sediment loss (kg ha^{-1})		
Straw			3,685a	51bc	36b
Straw+PAM			1,261ab	29c	29b
SMM			959bc	N/A	35b
BFM			1,930ab	N/A	N/A
FGM			333c	164ab	N/A
WFM			N/A	237a	120ab
WCB			N/A	221ab	210a

PAM=Polyacrylamide. FGM=flexible growth media. SMM=stabilized mulch matrix. BFM=bonded fiber matrix. WFM=wood fiber mulch. WCB=70:30 wood fiber/cellulose blend.

Summary: Erosion

- For 2 sites, all mulches performed similarly.
- For 1 site, 2 of 3 hydromulches were better than straw; 1 hydromulch was better than straw+PAM; straw+PAM was as good as the BFM.
- For 1 site, straw+PAM was better than all 3 hydromulches; straw alone was better than WFM.
- Last site, straw = straw+PAM = SMM; WCB worse than all three.

Straw + PAM vs. Hydromulch(Piedmont, winter 2012)



Vegetative Cover

Treatment	Site 1, Kinston	Site 2, West Jefferson	Site 3, Garner	Site 4, Apex	Site 5, Holly Springs
			Cover (%)		
Straw				56a	75b
Straw+PAM				54a	67b
SMM				N/A	93a
BFM				N/A	N/A
FGM				28b	N/A
WFM				34b	94a
WCB				32b	96a

Summary: Vegetation

- For 3 sites, there were no differences in cover for any mulch treatment.
- For 1 site, straw and straw+PAM had significantly more cover than FGM, WFM, and WCB.
- Last site, SMM=WFM=WCB and all were better than either straw treatment. However, high tackifier application was likely the cause.

Careful with the Tackifier…

Hydroseeder Diving

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Greenhouse Study: Hydromulches

Mulch:

1)Straw -2240 kg ha^{-1}

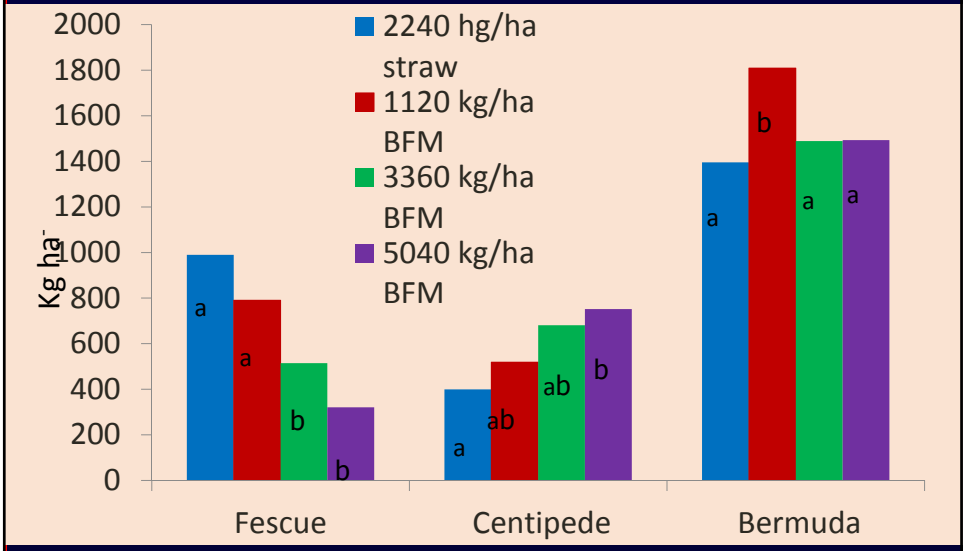
2)BFM (bonded fiber matrix) and FGM (flexible growth media) - 1120 kg ha^{-1} (low rate)

3)BFM (bonded fiber matrix) and FGM (flexible growth media) - 3360 kg ha^{-1} (recommended rate)

4)BFM (bonded fiber matrix) and FGM (flexible growth media) - 5040 kg ha^{-1} (high rate)

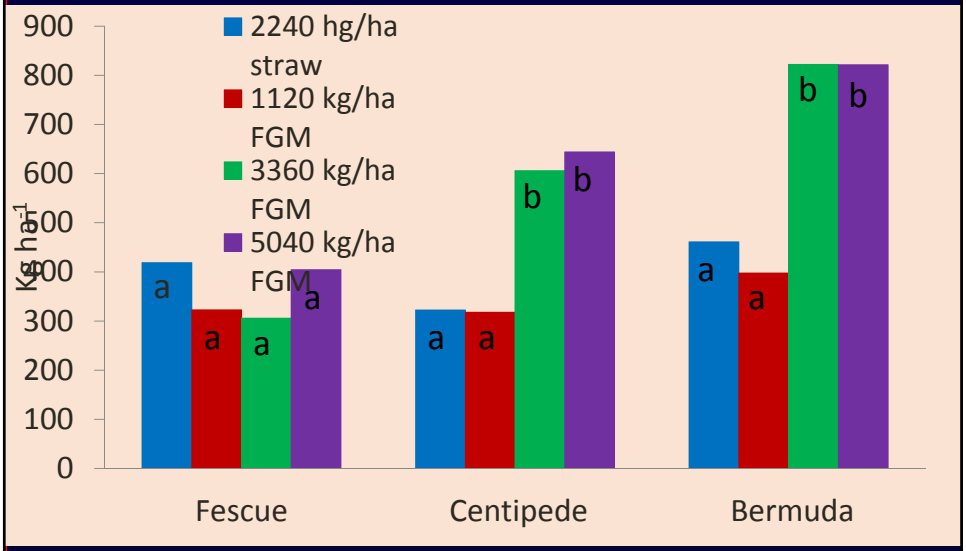
NC STATE UNIVERSITY

BIOMASS FOR BFM



NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

BIOMASS FOR FGM



NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Does PAM Reduce Erosion?

- PAM usually reduced erosion rates for typical ground covers.
- Straw + PAM (30 lb/ac) can outperform blankets and hydromulch.
- But poor ground coverage by mulch may reduce or eliminate PAM benefits.

Does PAM Improve Vegetation Cover?

- We have not found clear evidence of improved grass stands when PAM was applied.
- Previous work showed small but significant increases in early grass coverage (McLaughlin and Brown, 2006).

Conclusions

- Any ground cover is better than none (>90% reduction rule).
- Hydromulches and blankets alone *may* be more effective than straw alone.
- PAM may improve straw performance to hydromulch or blanket level.
- Minimum PAM application rate of **20 lb/acre** is needed to be effective, 20-30 lbs/ac best.
- The application of PAM to bare soil is not a substitute for mulch.

Careful About Plastic Netting!

Careful with the PAM Mixing!

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

Questions

NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE