

Cover Crops in Rice Systems

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Background Information

- Advisors have been approached by growers (and industry) asking for cover crop variety recommendations (increased in 2020-2021)
- Data from California rice systems is almost 20 years old, and only utilized vetch and bell beans (Pettygrove and Williams, 1996)
- Many legume species do not survive the wet, waterlogged soils
 - Growers have difficulty with varietal selection
- Growers need data on rice yields in rice when compared to cover crops
- Effects on soil carbon and nitrogen cycles?



Cover Crops

- Possible benefits:
 - Adding nitrogen to the system
 - Nitrogen fixation (leguminous cover crop)
 - OR taking up nitrogen that would be lost from the system by leaching or denitrification
 - Improving subsequent rice yields
 - Long-term soil quality changes:
 - Increased organic matter
 - Improved soil tilth
- Challenges:
 - Difficulty with residue management can delay rice planting
 - Increased greenhouse gas production in waterlogged soils
 - Increased management costs



Table 2.—Effect of wheat and purple vetch as winter green manure on the production of Colusa rice.

Treatment	1954				1955			
	Green manure crop			Rice yield	Green manure crop			Rice yield
	Yield	Nitrogen			Yield	Nitrogen		
	lbs./A.	%	lbs./A.	lbs./A.	lbs./A.	%	lbs./A.	lbs./A.
No fertilizer								
Fallow	—	—	—	2340	—	—	—	2060
Wheat	900	1.00	9	2710	530	1.65	9	2100
Vetch	910	2.82	26	3340	1250	3.50	44	3040
30 lbs. N/A.								
Fallow	—	—	—	2640	—	—	—	2370
Wheat	900	1.00	9	2890	350	1.54	5	2320
Vetch	910	2.82	26	3670	1260	3.42	43	3350
LSD 5%								
Fertilizer				310				380
Green manure				430				360

Table 3.—Effect of vetch green manure and the placement of inorganic nitrogen on Caloro rice production.

Nitrogen source and placement lbs./A.	Rice yield lbs./A.
Check	3050
30 N as ammonium sulfate broadcast on surface	3440
30 N as ammonium sulfate drilled 4 inches deep	4050
30 N in vetch tops (4.24% N) disked once	4320
30 N in vetch tops (4.24% N) disked twice	4030
LSD 5%	850

“Current” Data for Varieties (1996)

- Woollypod vetch
- Purple vetch
- Fava bean (bell bean)



Table 2. Purple vetch N content and equivalent fertilizer N value in a continuous rice rotation.

Rice crop year	Straw burned in fall		Straw disced in fall	
	Vetch N content	N fertilizer replacement	Vetch N content	N fertilizer replacement
-----lb N/acre -----				
1990	38	74	16	88
1991	105	108	86	90
1992	57	90	47	60
1993	6	0	10	0
1994	37	70	34	60
5-yr average	49	68	39	60

Data from Sills Farm, Sutter Co. (Rice Research Board annual reports, Project RM-6, 1990-94)

Rice grain yield, cwt/acre

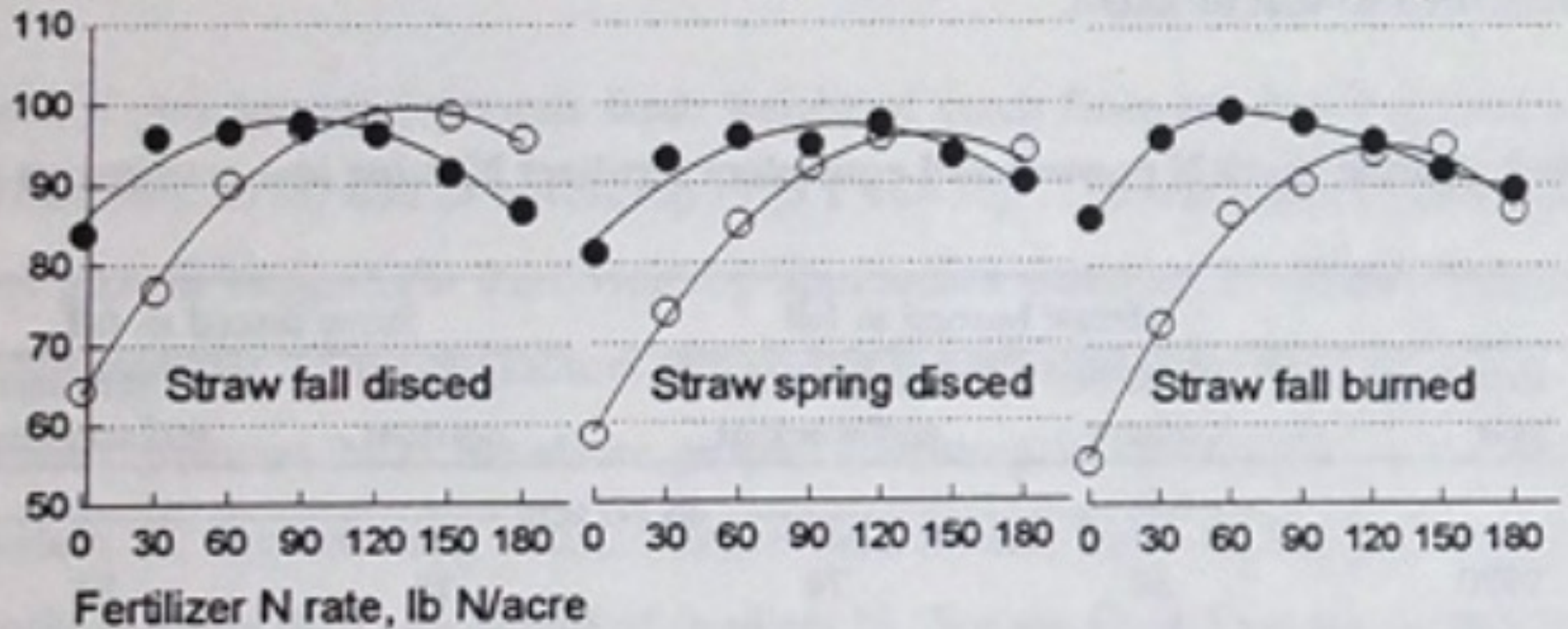


Figure 1. Five-year average yields as influenced by covercropping and rice straw management at the Sills Farms experiment in Sutter County, 1990-94. Straw management and covercropping treatments were repeated annually on the same 0.5-acre plots with six replicates.

Table 3. Effect of covercropping on rice grain N response in Butte Co., Skinner Ranch, 1989.

N fertilizer rate	No covercrop	Purple vetch	Lana vetch	Bell bean
lb N/acre	-----grain yield, cwt/acre, 13% moisture-----			
0	67.6	<u>82.8</u>	<u>80.2</u>	<u>83.3</u>
30	73.2	78.1	76.7	79.7
60	<u>78.2</u>	67.2	73.5	77.6
90	70.4	63.1	52.7	59.2

Covercrop treatment means LSD.05 = 2.9 cwt/acre; within N=0 treatment LSD.05 = 7.9 cwt.
Maximum yields for each covercrop treatment are highlighted.

Table 4. Effect of covercropping with purple vetch on rice grain yield averaged over five years and across straw-burned and straw-incorporated treatments.

N applied to rice	Purple vetch	No covercrop
lb/acre	----- cwt/acre, 14% moisture -----	
0	43	27
40	51	41
80	56	52
120	54	57

Maximum yields for each treatment are highlighted.

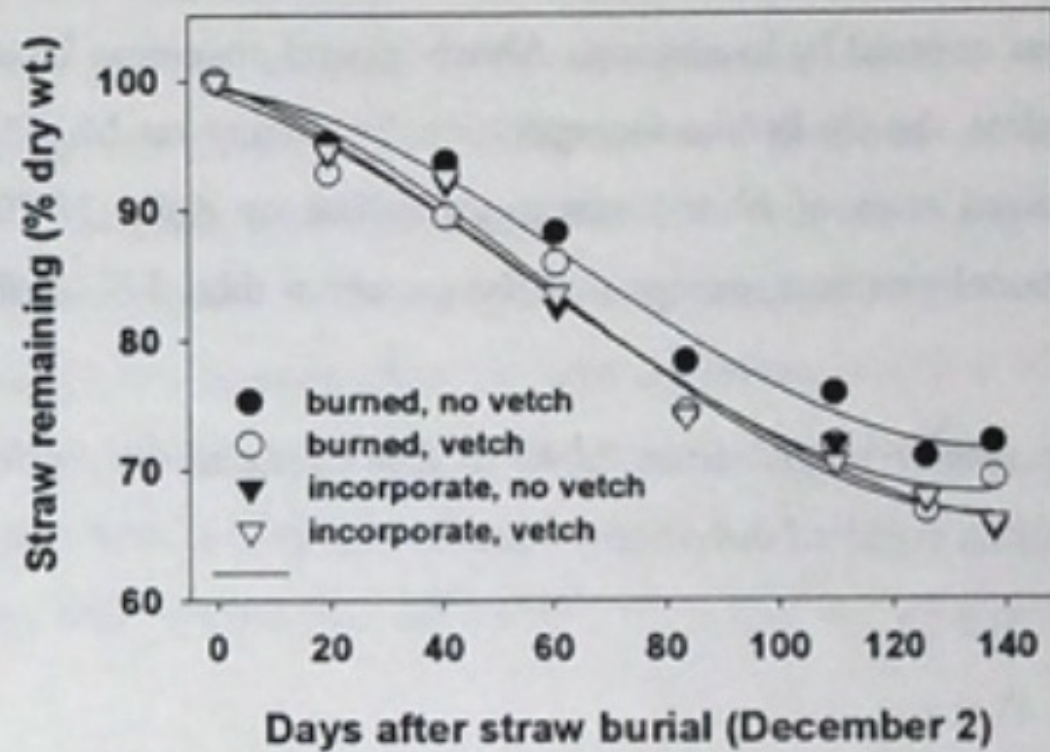


Figure 2. Effect of covercropping and rice straw disposal method on disappearance of straw buried in nylon mesh bags (Unpublished data, D. Bossio). Rice straw disposal methods and covercropping had been in effect for five years before bags were buried.

Cover Crop Variety Trial

California Rice Research Board

Project team: W. Brim-DeForest, M. Leinfelder-Miles, S. Rosenberg, B. Linguist, L. Espino, S. Light, C. Pittelkow



OBJECTIVES OF PROPOSED RESEARCH:

1. Evaluate winter cover crop varieties for agronomic performance
2. Assess site characteristics and soil properties and relate to agronomic performance of cover crops

Methods (started in fall 2022) :

- Rice Experiment Station: *field was in rice prior season (2022)*
 - Soil sampling 10/28
 - Field was disked three times prior to seeding
 - Seeding date: 10/31
 - Rice straw cover ratings taken prior to seeding
 - Seed was not rolled in
- Colusa County: *field not tilled since fall 2021*
 - Soil sampling date: 10/12
 - Seeding date: 10/26
 - Seeded by broadcast method (by hand)
 - Seed was harrowed in
- San Joaquin County : *field not tilled since fall 2021*
 - Soil sampling 11/8
 - Seeding date: 11/30 and set up dat loggers.
 - Large basin flown on and harrowed in
 - VT was hand seeded and raked in by hand



Evaluating:

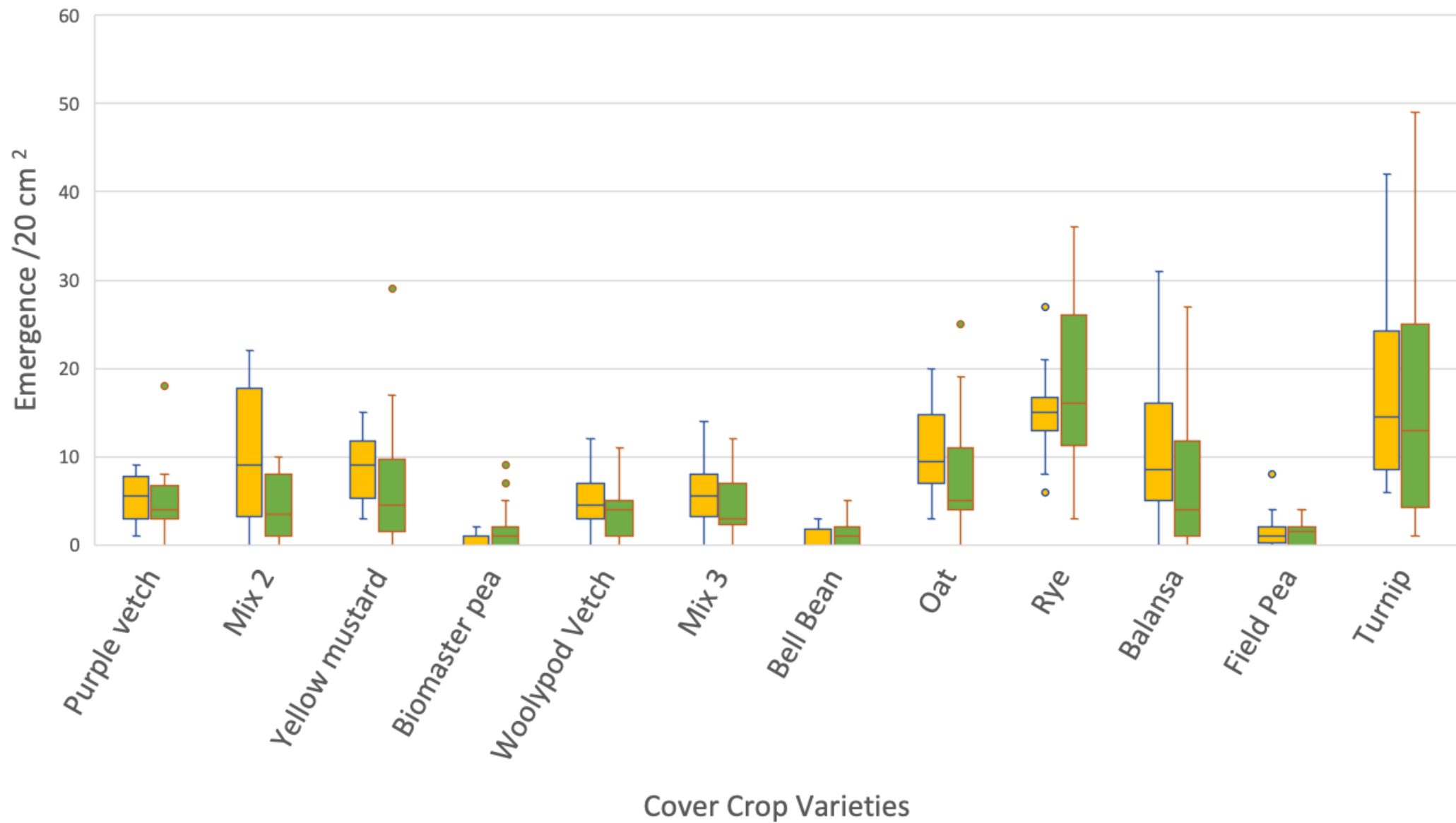
- Cover crop performance
 - Does it survive over the winter?
 - Carbon/nitrogen content
 - Biomass production
- Relation to soil moisture/location
 - Provide specific recommendations based on soil properties
 - What cover crops perform well in waterlogged soil?



Species/Mix	Lbs/ac
Purple vetch	60
Woolypod vetch	60
Bell Bean	160
Balansa Clover	8
field pea	90
yellow mustard	10
turnip (purple top)	15
Rye (ceareal)	90
Oats (white)	100
Biomaster pea	60
Mix 1 (purple vetch, bell bean, field pea, rye)	121.67
Mix 2 (purple vetch, balansa, field pea, oats, radish)	93.5

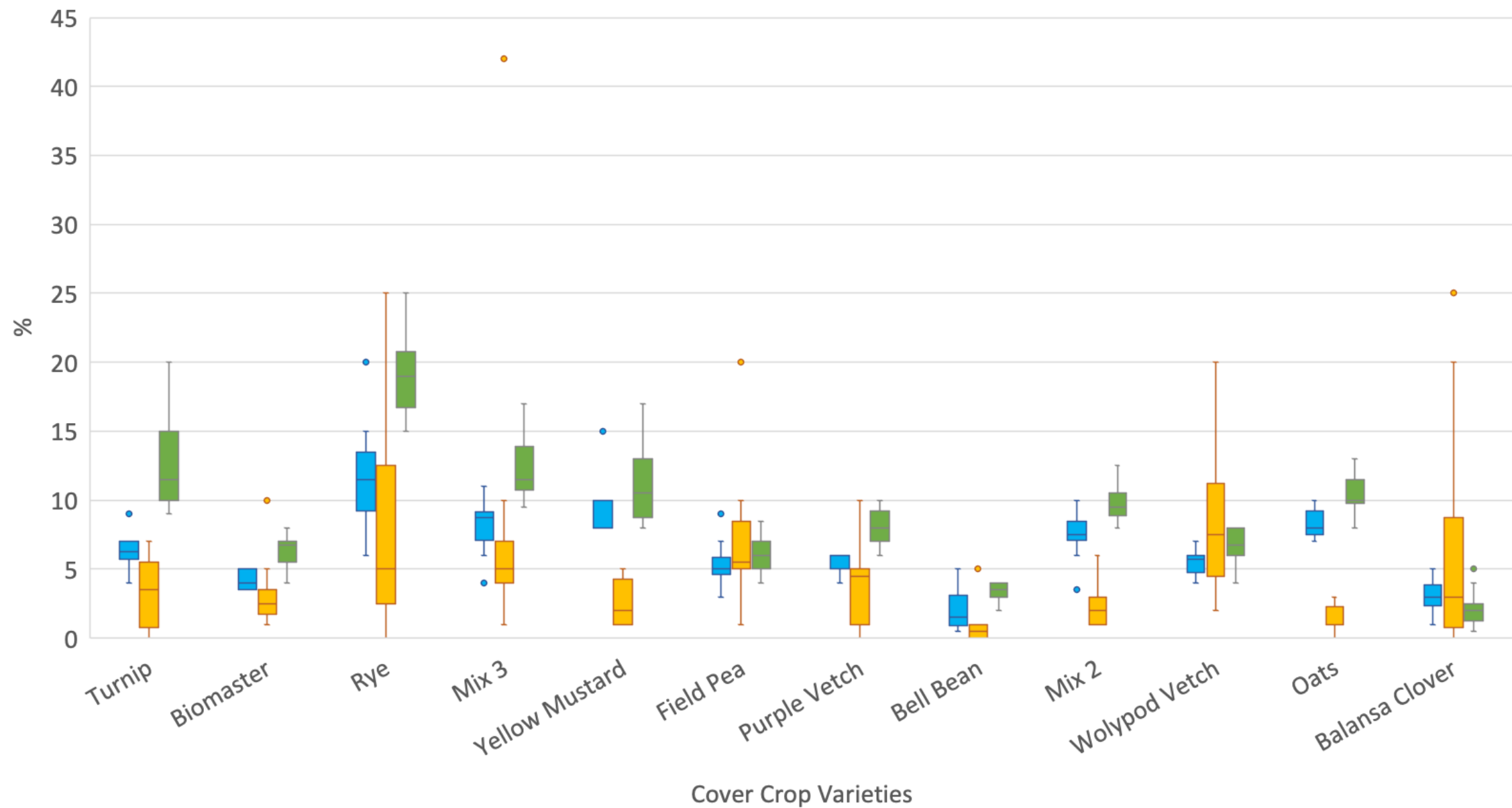
Emergence Counts of Different Cover Crop Varieties

Colusa- Germination count RES - Germination Count



Percent Cover of Different Cover Crop Varieties

RES December % cover RES January % cover Colusa December % Cover



Due to wet winter...

- Standing water at Colusa site made it difficult to conduct Month 2 assessment of cover crop percent cover
- San Joaquin trial has not yet been evaluated for emergence and percent cover (planted at end of November)



Evaluation of carbon and nitrogen cycling in CA rice cover crop systems

CA Department of Food and Agriculture Healthy Soils Program (CDFA-HSP) Demonstration Project

Project team: W. Brim-DeForest, M. Leinfelder-Miles, S. Rosenberg, B. Linqvist, L. Espino, S. Light, C. Pittelkow



Project background

- In CA rice systems, the typical winter practice is for fields to be either dry- or flood-fallowed.
- Cover cropping is not widely implemented, particularly on soils with high clay content and/or limited drainage.
- Potential benefits of cover cropping include:
 - Introduces crop rotation into the rice system
 - Increases soil organic matter
 - Reduces nitrogen losses and inputs
 - May improve rice straw decomposition



Project objectives

- The objective of this trial is to evaluate whether winter cover cropping improves soil health and/or rice yield.
- Project is being implemented on three sites in Butte, Colusa, and San Joaquin counties from 2022-2025:
 - Same locations as variety trial
- Two basins at each site (same size at each site):
 - One cover cropped
 - One fallowed

CDFA Grant: cover cropping

- RRB conducted in tandem with CDFA grant (3 years)
- CDFA grant proposes:
 - To evaluate cover cropping (mix) versus fallow
 - Cover crop biomass/stand
 - Rice yield in the following crop
 - Emergence data/stand counts in rice (impact of cover crop biomass?)
 - Soil nitrogen and organic matter
 - Mix:
 - Purple vetch (13.3 lbs/ac)
 - Bell beans (33.3 lbs/ac)
 - Field peas (30 lbs/ac)
 - Rye (45 lbs/ac)
 - *With the mix*: evaluating what species do best/survive the winters, especially at different locations and with variable soil moisture

Acknowledgements

- Rice Research Board
- California Department of Food and Agriculture
- Grower collaborators
- Rice Experiment Station
- Troy Clark, UCCE Jr Specialist
- Taiyu Guan, UCCE Assistant Specialist
- Consuelo Baez-Vega, UCCE Jr Specialist
- Kayla Minehan, UCCE Student Assistant
- Marco Giron, UCCE Jr Specialist
- Ignacio Macedo, UCD PhD Student
- Zhang Zhenglin, UCD PhD Student
- Daniel Rivers, UCCE Laboratory Assistant II
- Ray Stogsdill, UCD Staff Research Associate



Thank you—Questions?