Evaluating carbon and nitrogen cycling in CA rice cover crop systems

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With funding from the CDFA Healthy Soils Program, we are evaluating winter cover crops to better understand whether winter cover cropping improves soil carbon and nitrogen dynamics in the rice system and whether cover cropping impacts rice yields. In CA rice systems, rice may be grown over multiple seasons without rotation. Cover crops may provide an opportunity to introduce plant diversity, including nitrogen-fixing legumes.

Typical winter management in CA rice systems is to winter flood. Some of the benefits of winter flooding include helping with straw decomposition and pest management, and providing waterfowl habitat. Cover cropping is not widely implemented in rice systems, particularly on soils with high clay content and/or limited drainage because these conditions can make it challenging to terminate and incorporate cover crop biomass in time to prepare fields for rice production. However, the potential benefits of cover crops include:

- Crop rotation
- Increase soil organic matter
- Reduce nitrogen losses and/or inputs
- Improve rice straw decomposition

Trial locations

This is a three-year trial which began in Fall 2022 and runs through 2025. The Delta site is one of three locations, along with sister sites on a commercial farm in Colusa County and the Rice Experiment Station in Butte County. At all three sites, the following cover crop mix is planted.

Cover crop species	lb/ac	% Mixture
Purple vetch	13	11
Bell bean	33	27
Field pea	30	25
Rye	45	37

Data collection includes soil sampling for organic matter, total nitrogen, and nitrate-nitrogen; cover crop stand establishment and seasonal ground cover; cover crop biomass carbon and nitrogen inputs, and rice yield. At each location, cover cropping is done in place of winter flooding and is compared to a flooded untreated control.

The Delta location is unique among the three locations because of the high organic matter soil (approx. 28%). Rice production in the Sacramento-San Joaquin Delta region has been steadily increasing in recent years. While Delta acreage is only a fraction of that in the Sacramento Valley, Delta yields are consistent with statewide averages. Production practices differ between the Delta and Sacramento Valley because of varying climate and soil conditions. However, the regions are similar in that rice is often grown back-to-back (without rotation), and the typical winter season management is for fields to be either dry or flood-fallowed.

Observations

The 2022-2023 winter season presented a number of challenges for cover cropping at all three locations, and data collection was limited. Seasonal rainfall started early in the fall, which challenged cover crop establishment. At the Delta location, cover crop seed was flown onto the field on November 30th, and the field was immediately harrowed. Despite harrowing, large seeded species were not well incorporated, and bird predation was severe (Fig. 1). Additionally, in the ten days after planting, the site received nearly 3.5 inches of rain and seasonal rainfall exceeded 25 inches.

Figure 1. Large seeded varieties were not well incorporated into the soil. Bird pressure was heavy.

Preliminary data

The 2023-2024 winter season started off fairly dry. The cover crop was drill-seeded on November 13th, and all four species of the mix germinated (Fig. 2).

Figure 2. Successful stand establishment with drill-seeding and with drier fall conditions.

We estimated percent cover of the cover crop species in mid-December and mid-January (Fig. 3).

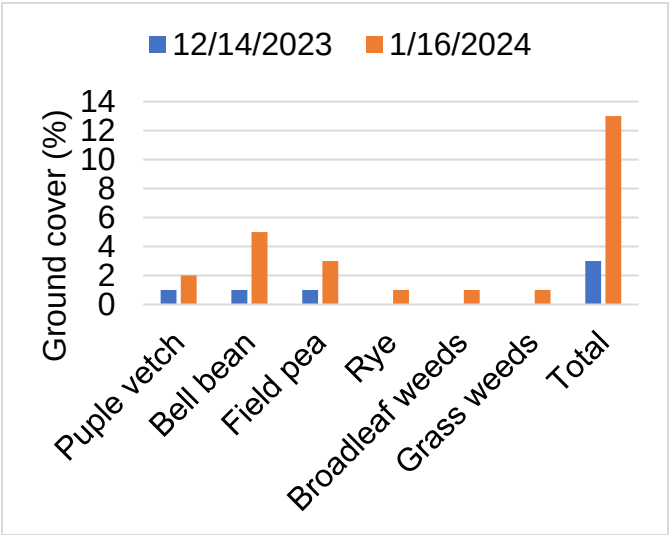

Figure 3. Percent cover of cover crop species.

Lesson learned

- Timing of operations is critical. Earlier planting makes a difference.
- Stand establishment is impacted by conditions outside of our/the grower's control (i.e. weather, predation).
- Factors that could limited long-term adoption: 1) the potential benefits of cover-cropping may not be realized in the short-term, and 2) cover cropping incurs costs (e.g. seed, equipment operations) and potential risks (e.g. delay to rice operations).
- Long-term benefits will depend on cover crop biomass obtained and other site-specific factors.

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