Delta Rice Production – Challenges and Opportunities

The Delta region of California is located at the confluence of the Sacramento and San Joaquin rivers. The Delta spans approximately 738,000 acres, where over 400,000 acres are in agricultural production. While the region is defined by its waterways, the Delta is also unique for its fertile soils which range from mineral to organic. The mineral soils are the result of alluvial deposits from waterways. The organic soils formed from decomposed plant matter. Delta soils were reclaimed in the mid- to late-1800's when levees were constructed to contain water within channels, allowing Delta "islands" to be farmed.

Over time, some areas of the Delta with organic soils have experienced carbon oxidation, resulting in land subsidence. Land subsidence threatens levee stability, water quality, and water distribution within the Delta and to other parts of California. Keeping soils flooded mitigates soil carbon loss and land subsidence, but most crops cannot grow under flooded conditions. Rice is one exception because of its unique cellular structure that allows gas diffusion through the plant, even under flooded conditions. Research has demonstrated that the flooded conditions of rice cultivation can greatly reduce, if not stop, carbon oxidation and land subsidence in the Delta.

The predominant rice-growing region in California is the Sacramento Valley, but rice acreage in the Delta is growing, and yields are comparable with statewide averages (Table 1). Rice establishment practices differ between the Sacramento Valley and the Delta due to varying environmental conditions, like soils and climate. In the Sacramento Valley, rice is grown on mineral soils with a high clay content. In the Delta, rice is grown on soils with a high organic matter content (approximately 20-40%) and low bulk density (i.e. mass per unit of volume, approximately 0.5-0.8 g/cm^3). Sacramento Valley fields are planted by flying soaked seed onto flooded fields (i.e. water-seeding). This planting practice presents challenges in the Delta because the lightweight, organic soil can go into suspension and then bury the seed when it settles, resulting in a reduced stand. Additionally, winds can affect crop establishment in a water-seeded system by preventing root anchoring into the soil or by dislodging seedlings. To overcome these challenges, Delta rice is drill-seeded into moist soil, as growers would plant wheat (Fig. 1).

Table 1. Delta and statewide rice acreage and yield (as hundredweight per acre, cwt/ac).

California Rice Production						
	2022	2021	2020	2019	2018	2017
SJC* Acreage	8930	7070	4990	4360	3620	3060
Proportion of statewide acreage in the Delta	N/A	2%	1%	0.9%	0.7%	0.7%
Average SJC* Yield (cwt/ac)	101	95	88	81	86	82
Average Statewide Yield (cwt/ac)	N/A	92	89	86	88	86

**Rice acreage and yield according to the San Joaquin County (SJC) Agricultural Commissioner's Crop Reports. Rice acreage in SJC is primarily in the Delta region. Delta acreage in other counties is not included in these statistics. At the time of publishing, 2022 CDFA statewide data were not yet available (N/A).*

The San Francisco Bay is a strong influence on weather patterns in the Delta. Cool tempera-

tures affect how fast the crop develops and may delay flowering and harvest, which can impact yield (Fig. 2). Also, cold nighttime temperatures between panicle initiation (i.e. when the grain head begins to form at the base of the stem) and flowering can result in blanking. Blanking is a term used to describe when individual grains do not fill, which lowers yield. Nighttime temperatures peak in late-July, and a nighttime temperature less than 58°F (depending on variety) is considered cold for rice grain development. To overcome the cool conditions, Delta growers plant early in the season (April or May) so that panicle development and flowering occur ahead of nighttime temperatures decreasing. Growers also plant very-early and early maturing varieties, which mature roughly 15 days ahead of intermediate and late-maturing varieties in the Delta region. Variety options are limited but may expand with continued variety selection for cold tolerance.

Figure 1. Delta rice is drill-seeded, in contrast to the water-seeding done in the Sacramento Valley.

Windy conditions in the Delta can interfere with pesticide applications since pesticides cannot be sprayed when winds are high. Delta growers adapt to these challenges by making applications before dawn, when winds are calm.

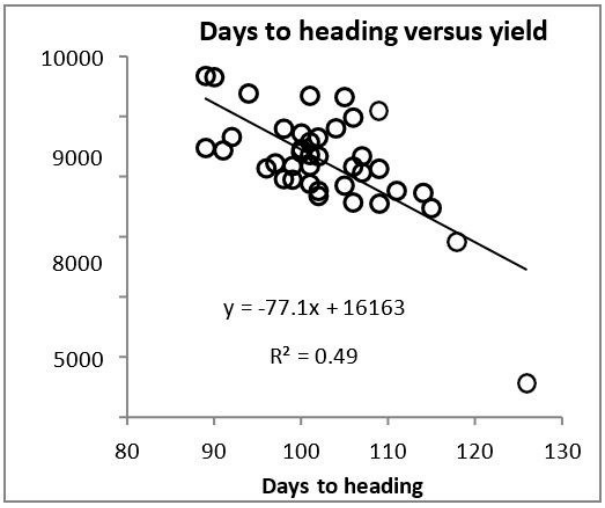

Figure 2. Relationship between days to 50% heading and grain yield. Data are from the Delta variety trial (2010-2014).

For more on this topic:

- ✓ CA Department of Food and Agriculture. CA Agricultural Production Statistics. https://www.cdfa.ca.gov/Statistics/.
- ✓ Deverel, S. J., Dore, S., and Schmutte, C. 2020. Solutions for subsidence in the California Delta, USA, an extreme example of organic-soil drainage gone awry, Proc. IAHS, 382, 837–842, https://doi.org/10.5194/piahs-382-837-2020.
- ✓ San Joaquin County Agricultural Commissioner. Annual Crop Report. https://www.sjgov.org/department/agcomm/general-info/crop-reports.

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Delta Rice Production – Planting and Fertility Practices

Rice production practices in the Delta are uniquely adapted to the local conditions, including cooler temperatures and soils with high organic matter. Variety selection, planting practices, and fertility management that are suitable for the region help ensure successful production.

Variety selection

UC Cooperative Extension evaluates varieties in the Delta for cold-tolerance and adaptability (Fig. 1). Very-early and early maturing varieties, like M-105, M-206, and CM-101 have performed well in trials. They have good agronomic characteristics and consistent quality across different harvest moistures. The most widely planted variety in the Delta and across the state is M-206. While CM-101 is a very good variety for the Delta, a contract is required, so it is not widely planted. Among the newer varieties, M-210 is early maturing, blast resistant, and may be a good option for the Delta. M-209 and M-211 are not suitable for the Delta because they are late to mature and susceptible to cold temperatures.

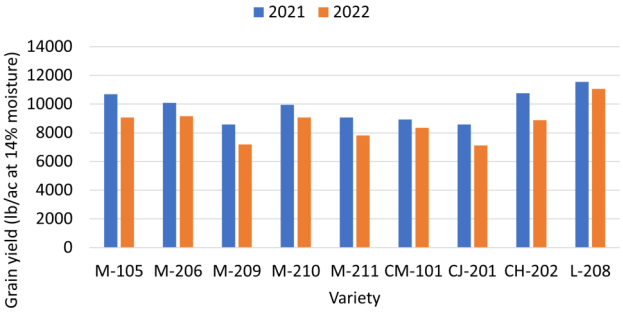

Figure 1. Yield from UCCE Delta variety trials.

Planting practices

Delta rice is planted in either April or May, depending on seasonal rainfall and when growers can start bringing equipment onto the fields. Rice is drill-seeded into moist soil, as growers would plant wheat, where row spacing is about 6 inches and seeding rate is around 150 pounds per acre. When employing drill-seeding, growers must be mindful of planting depth and soil moisture. Typical seeding depth is about 1.5-2 inches. Research has shown that rice seedlings do not emerge well and may come up twisted and bent when planted too deep. Rice emergence is most successful when growers "plant to moisture", which means that seed is planted at the interface of dry and moist soil. Some growers may drill-seed into dry soil and then irrigate with a brief flush of water to help germinate seed. This practice, however, can result in an uneven stand and may make weeds more problematic by giving them a head-start to grow before the rice has emerged. A better practice if a grower "misses the moisture" would be to flush the field ahead of planting, allow some time for the soil surface to dry, and then plant to moisture.

Fertility management

For rice grown on high organic matter soil, research indicates that there is no benefit to applying nitrogen (N), phosphorus (P), or potassium (K) fertilizer at planting. While some growers may apply starter fertilizer at planting through the grain drill, all fertilizer could be applied just be-

fore the permanent flood is established (roughly the 3-4 leaf stage, or about 3-5 weeks after planting).

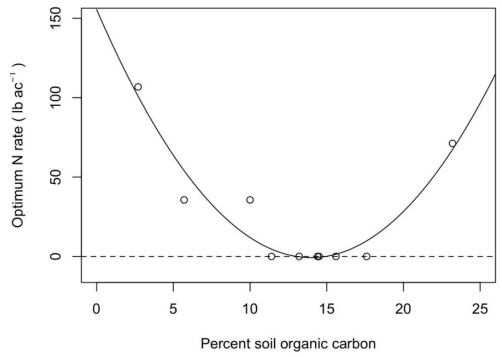

Figure 2. Relationship between soil organic carbon and optimum N fertility rate. (Data from Espe et al., 2015. Soil Science Society of America Journal).

Determining the correct N fertilizer rate is important. Applying too little N results in poor crop yields. Too much N results in delayed crop maturity, lodging (which lowers grain quality and slows harvest operations), and blanking. Research has indicated that soils with 12 to 18% carbon (roughly 24 to 36% organic matter) do not require N fertilizer; however, soils with lower or higher organic carbon contents do require N fertilizer (Fig. 2). Rice yields did not improve in trials where P fertilizer was applied, indicating that P fertilizer may not be necessary in the Delta (Fig. 3). In contrast, K fertilizer will be needed under some circumstances. Soils in the Delta may be low in K, and K is removed from the system in large quantities after harvest, especially in fields where the straw is baled. In trials, yields were reduced when no K was applied in one of two fields (Fig. 3). The data show that K could either be applied at planting or just before permanent flood with similar yield results. Trial results may not apply to all areas of the Delta, and growers should use soil and leaf sampling to guide their fertilizer decisions. Evaluate leaf samples at panicle initiation to determine if topdressing fertilizer is necessary.

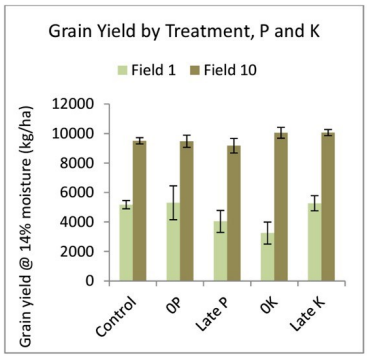

Figure 3. Yield response to P and K fertilizer. The control received both P and K fertilizer at planting. The late P and K received P and K fertilizer just before permanent flood.

For more on this topic:

- ✓ Espe et al. 2015. Indigenous Nitrogen Supply of Rice is Predicted by Soil Organic Carbon. Soil Science Society of America Journal. doi: 10.2136/sssaj2014.08.0328.
- ✓ Leinfelder-Miles, M. et al. 2022. Sample Costs to Produce Rice, Delta Region. UC Cooperative Extension and UC Davis Department of Agricultural and Resource Economics. https://coststudies.ucdavis.edu/en/current/commodity/rice/.
- ✓ UC Agronomy Fact Sheets. https://agric.ucdavis.edu/fact-sheets.

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Delta Rice Production – Pest Management

Rice pest management practices in the Delta reflect the conditions and pest pressures of the region. Operations described below are typical for the Delta drill-seeded system but will vary across farms and seasons.

Weed management

Weeds are the most problematic pests in Delta rice fields. Grasses – like barnyardgrass and watergrasses (*Echinochloa* spp.) and sprangletop (*Leptochloa fascicularis*) – are the most challenging weeds (Fig. 1), but broadleaf weeds and sedges must also be managed. The Delta system also has weeds that are not found in other regions, like nutsedges (*Cyperus* spp.). In the drill-seeded system, growers manage weeds with pre-plant cultivation and ground application of herbicides before the permanent flood is established. Herbicides are applied when the rice has about three to four leaves. The flood should be applied within a few days after herbicide application to avoid impacts to the rice. Later in the season, an aerial herbicide application may be applied to manage weeds that escape the ground application, but often this application is not needed.

Figure 1. Early watergrass (top panicle) and barnyardgrass (center panicle) are two typical weeds in the Delta system.

Wetland plants like cattails (e.g. *Typha* L.) can become weedy in the Delta system, particularly if they emerge ahead of the rice crop and outcompete the rice. Cattails are difficult to control because they propagate by seed and underground rhizomes that become new plants if divided, as from tillage. Herbicide application can help to manage cattail pressure, but application timing is critical. Research has shown that control can be achieved if cattails are small (i.e. less than three feet tall).

Figure 2. Weedy rice is a significant pest because it reduces crop yield and quality. Weedy rice may be observed as light-green patches of plants that stand taller than the cultivated variety.

Weedy rice is rice with undesirable characteristics, like grain shattering and seed dormancy (Fig. 2). It is sometimes called red rice because some types have a red pericarp. Weedy rice has been identified in the Delta region and should be managed with cultural practices, like using certified seed, rogueing plants, and equipment sanitation. Reductions in the weed seed bank have been observed where post-harvest management included mowing but no tillage, followed by winter flooding. These

practices keep seed on the soil surface where it may be eaten by migratory waterfowl or deteriorate in the water. Herbicide spot spraying for in-season management is possible, but there are limited products registered for use.

Arthropod management

Among the arthropod pests, true armyworms (*Mythimna unipuncta*) may present serious problems in some years by feeding on vegetation or damaging grain panicles. UC Cooperative Extension has been monitoring populations in the Delta since 2016 (Fig. 3). While armyworm populations may undergo two generations during the season in the Sacramento Valley, only one generation has been observed in the Delta system. Scouting is an important part of management, and insecticides are registered for use. See the armyworm fact sheet for more information on this pest. Other insect and arthropod pests are generally not problematic in the Delta.

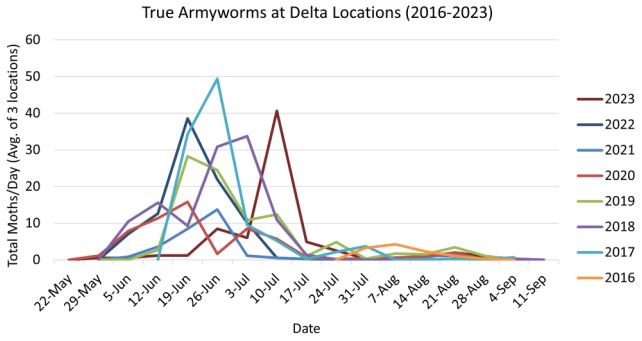

Figure 3. UCCE monitors true armyworms in Delta rice fields. Pest pressure varies from year to year.

Disease management

Diseases that have been observed in the Delta include stem rot (*Sclerotium oryzae*), aggregate sheath spot (*Rhizoctonia oryzae-sativae*), and rice blast (*Magnaporthe oryzae*); though, disease pressure is highly variable across the region and over time. Stem rot will manifest as black lesions along the water line at late-tillering. Aggregate sheath spot will manifest as gray or green lesions on the lower leaf sheaths at the water line. Both diseases that can be more problematic on low potassium soils, which occur in the Delta. Rice blast will often appear as diamond-shaped lesions on the leaves mid-season and may present as lesions on the node below the panicle later in the season. It is important to scout for both of these diseases at late-tillering. Fungicides are registered and are most effective when applied between late-boot and early-heading. There is no varietal resistance for stem rot, but M-210 is blast resistant and has performed well in Delta variety trials. The biology and management of these diseases is described in more detail in separate fact sheets.

For more on this topic:

- ✓ California Weedy Rice. https://caweedyrice.com/.
- ✓ Delta Crops Resource Management, Rice. https://ucanr.edu/sites/deltacrops/Rice/.
- ✓ UC Agronomy Fact Sheets agric.ucdavis.edu/fact-sheets.
- ✓ UC Integrated Pest Management: Rice. https://ipm.ucanr.edu/agriculture/rice/.

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