# RICE FIELD DAY

## *Rice Weed Control*

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California Cooperative Rice Research Foundation, Inc.
United States Department of Agriculture
University of California
Cooperating

August 27, 2014

**Continuous Flood**

| No. | Treatment | Rate Prod./a | Timing[3] | Application date 1st | Application date 2nd | Application date 3rd | Phytotoxicity[1] 1st 7 DAT % Stunting | 1st 7 DAT % Stand | 1st 7 DAT % Bleach | 1st 7 DAT % Injury | 1st 14 DAT % Stunting | 1st 14 DAT % Stand | 1st 14 DAT % Bleach | 1st 14 DAT % Injury | 2nd 7 DAT % Stunting | 2nd 7 DAT % Stand | 2nd 7 DAT % Bleach | 2nd 7 DAT % Injury | 2nd 14 DAT % Stunting | 2nd 14 DAT % Stand | 2nd 14 DAT % Bleach | 2nd 14 DAT % Injury | 3rd 7 DAT % Stunting | 3rd 7 DAT % Stand | 3rd 7 DAT % Bleach | 3rd 7 DAT % Injury | 3rd 14 DAT % Stunting | 3rd 14 DAT % Stand | 3rd 14 DAT % Bleach | 3rd 14 DAT % Injury | Weed Control[2] 6/20 (20 DAS) ECHPH | 6/20 SCPMU | 6/20 CYPDI | 6/20 HETLI | 6/20 BOARO | 7/10 (40 DAS) ECHPH | 7/10 SCPMU | 7/10 CYPDI | 7/10 HETLI | 7/30 (60 DAS) ECHPH | 7/30 SCPMU | 7/30 CYPDI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Untreated[4] | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 8 | 6 | 2 | 28 | 2 | 23 | 9 | 2 | 19 | | | |
| 2 | Granite GR fb. Abolish + Regiment + UAN + NIS | 15lb fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | 2-3 lsr fb. 5 lsr | 10-Jun | 18-Jun | — | 0 | 0 | 1 | 3 | 13 | 13 | 9 | 6 | 1 | 3 | 3 | 9 | 2 | 5 | 0 | 3 | — | — | — | — | — | — | — | — | 73 | 76 | 65 | 97 | 88 | 98 | 100 | 100 | 100 | | | |
| 3 | Cerano fb. Granite GR fb. Abolish + Regiment + UAN + NIS | 12 lb fb. 15lb fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DOS fb. 2-3 lsr fb. 5 lsr | 2-Jun | 10-Jun | 18-Jun | 0 | 0 | 44 | 0 | 3 | 0 | 34 | 3 | 1 | 9 | 9 | 12 | 21 | 23 | 10 | 8 | 30 | 15 | 5 | 10 | 21 | 26 | 1 | 4 | 87 | 94 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | | |
| 4 | Cerano fb. GWN-10380 (Butte) fb. Abolish + Regiment + UAN + NIS | 12 lb fb. 7.5lb fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DOS fb. 1 lsr fb. 5 lsr | 2-Jun | 6-Jun | 18-Jun | 2 | 0 | 35 | 0 | 3 | 0 | 29 | 2 | 0 | 1 | 46 | 0 | 0 | 28 | 5 | 1 | 48 | 32 | 7 | 13 | 19 | 25 | 0 | 3 | 88 | 98 | 100 | 100 | 100 | 96 | 100 | 100 | 100 | | | |
| 5 | Bolero fb. Regiment + UAN + NIS | 23 lb fb. 0.8 oz + 2.0% + 0.2% v/v | 1 lsr fb. 3-4 lsr | 6-Jun | 13-Jun | — | 13 | 13 | 0 | 0 | 0 | 35 | 0 | 0 | 0 | 23 | 7 | 4 | 5 | 26 | 3 | 8 | — | — | — | — | — | — | — | — | 87 | 90 | 100 | 85 | 92 | 94 | 94 | 100 | 96 | | | |
| 6 | Bolero fb. Granite SC + SuperWham + COC | 23 lb fb. 2oz + 6 qt + 1.25%v/v | 1 lsr fb. 3-4 lsr | 6-Jun | 13-Jun | — | 8 | 13 | 0 | 0 | 7 | 29 | 0 | 0 | 1 | 24 | 11 | 3 | 6 | 26 | 3 | 10 | — | — | — | — | — | — | — | — | 90 | 93 | 100 | 96 | 98 | 96 | 100 | 100 | 99 | | | |
| 7 | Shark H2O fb. Abolish + Regiment + UAN + NIS | 7.5oz fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | 1 lsr fb. 5 lsr | 6-Jun | 18-Jun | — | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 1 | 2 | 6 | 12 | 1 | 3 | 0 | 0 | — | — | — | — | — | — | — | — | 19 | 86 | 98 | 97 | 75 | 96 | 9 | 71 | 90 | | | |
| 8 | Granite GR + Shark H2O fb. Abolish + Regiment + UAN + NIS | 15lb + 7.5oz fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | 2.5 lsr fb. 5 lsr | 10-Jun | 18-Jun | — | 0 | 0 | 1 | 2 | 11 | 12 | 6 | 2 | 2 | 5 | 4 | 8 | 5 | 6 | 0 | 4 | — | — | — | — | — | — | — | — | 71 | 88 | 100 | 98 | 98 | 100 | 100 | 100 | 100 | | | |
| 9 | Cerano fb. Shark H2O fb. Abolish + Regiment + UAN + NIS | 12lb fb. 7.5oz fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DOS fb. 1 lsr fb. 5 lsr | 2-Jun | 6-Jun | 18-Jun | 1 | 0 | 50 | 0 | 2 | 0 | 38 | 4 | 0 | 0 | 59 | 1 | 0 | 23 | 18 | 1 | 27 | 16 | 7 | 13 | 8 | 13 | 0 | 2 | 88 | 86 | 98 | 98 | 85 | 96 | 84 | 100 | 98 | | | |
| 10 | Bolero fb. SuperWham + COC | 23 lb fb. 6qt + 1.25% v/v | 1 lsr fb. 1 Til | 6-Jun | 25-Jun | — | 9 | 3 | 0 | 0 | 9 | 21 | 0 | 1 | 4 | 11 | 1 | 11 | 3 | 11 | 0 | 6 | — | — | — | — | — | — | — | — | 90 | 91 | 100 | 95 | 100 | 94 | 94 | 100 | 91 | | | |
| 11 | Cerano fb. SuperWham + COC | 12 lb fb. 6qt + 1.25% v/v | DOS lsr fb. 1 Til | 2-Jun | 25-Jun | — | 1 | 0 | 66 | 0 | 7 | 0 | 64 | 4 | 0 | 3 | 1 | 7 | 1 | 3 | 0 | 1 | — | — | — | — | — | — | — | — | 91 | 34 | 50 | 84 | 46 | 99 | 0 | 0 | 35 | | | |
| 12 | Granite GR fb. SuperWham + COC | 15lb fb. 6qt + 1.25% v/v | 2 lsr fb. 1 Til | 10-Jun | 25-Jun | — | 0 | 0 | 2 | 2 | 11 | 12 | 6 | 4 | 1 | 4 | 1 | 9 | 3 | 5 | 0 | 7 | — | — | — | — | — | — | — | — | 81 | 85 | 91 | 95 | 88 | 96 | 100 | 100 | 100 | | | |
| 13 | Untreated | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 12 | 4 | 1 | 31 | 2 | 26 | 12 | 1 | 22 | | | |
| 14 | SuperWham + COC | 6 qt + 1.25% v/v | 20-25 DAS (5 lsr -1 Til) | 23-Jun | — | — | 0 | 0 | 6 | 5 | 0 | 0 | 0 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 49 | 20 | 92 | 50 | 0 | 66 | 97 | 100 | 52 | 71 | 86 | 100 |
| 15 | SuperWham + Wetcit | 6 qt + 1.25% v/v | 20-25 DAS (5 lsr -1 Til) | 23-Jun | — | — | 0 | 0 | 6 | 7 | 0 | 1 | 0 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 34 | 29 | 25 | 27 | 0 | 69 | 83 | 100 | 65 | 78 | 94 | 100 |
| 16 | Rice Edge + COC | 10 lb + 1.25% v/v | 20-25 DAS (5 lsr -1 Til) | 23-Jun | — | — | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 51 | 13 | 19 | 15 | 3 | 73 | 100 | 100 | 73 | 87 | 42 | 83 |
| 17 | Rice Edge + COC | 10 lb + 1.25% v/v | 40 DAS (2-3 Til) | 10-Jul | — | — | 0 | 2 | 0 | 7 | 0 | 1 | 0 | 6 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 27 | 0 | 0 | 19 | 0 | 22 | 11 | 7 | 7 | 51 | 98 | 100 |
| 18 | Cerano fb. Shark H2O + Londax fb. SuperWham +COC | 12 lb fb. 7.5oz + 1.66oz fb. 6 qt + COC | DOS fb. 2-4 lsr fb. 1-2 tiller | 2-Jun | 13-Jun | 2-Jul | 0 | 0 | 51 | 0 | 5 | 0 | 41 | 5 | 0 | 15 | 16 | 4 | 26 | 22 | 4 | 11 | 1 | 6 | 0 | 15 | 1 | 4 | 0 | 2 | 90 | 70 | 100 | 99 | 89 | 98 | 100 | 100 | 95 | | | |
| 19 | Cerano fb. Shark H2O + Halomax fb. SuperWham +COC | 12 lb fb. 7.5oz + 1.33oz fb. 6 qt + 1.25%v/v | DOS fb. 2-4 lsr fb. 1-2 tiller | 2-Jun | 13-Jun | 2-Jul | 0 | 0 | 47 | 0 | 6 | 0 | 31 | 3 | 0 | 12 | 13 | 5 | 4 | 18 | 4 | 12 | 6 | 6 | 0 | 12 | 3 | 6 | 0 | 1 | 84 | 74 | 75 | 97 | 75 | 98 | 100 | 100 | 95 | | | |
| 21 | Sonar-Q (Fluridone) | 10.7oz | 1 lsr | 6-Jun | — | — | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 27 | 59 | 44 | 53 | 0 | 0 | 69 | 83 | 7 | | | |
| 22 | Sonar-Q (Fluridone) | 21.4oz | 1 lsr | 6-Jun | — | — | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 29 | 20 | 50 | 54 | 0 | 0 | 33 | 50 | 8 | | | |
| 23 | Sonar-Q (Fluridone) | 42.8oz | 1 lsr | 6-Jun | — | — | 0 | 0 | 32 | 1 | 0 | 2 | 7 | 0 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 66 | 60 | 71 | 29 | 0 | 36 | 52 | 100 | 0 | | | |

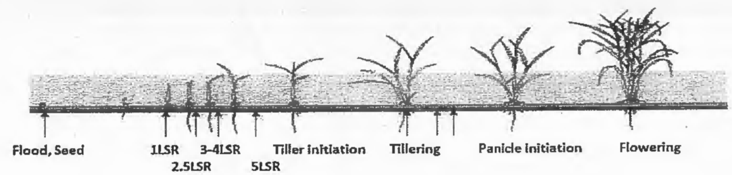
**RiceEdge is a dry flowable herbicide with 60% propanil and 0.46% halosulfuron.**
**Wetcit is a non-ionic surfactant.**

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)
[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad)
LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).
[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a continuous flood with water started May 30, 2014. For pre-flood treatments, flushed May 30, and a continuous flood was applied June 1
3. No weeds had emerged on May 31 (Pre-flood application)
   No weeds had emerged on June 2 (DOS application)
   Watergrass was 1.5 leaf, bulrush was 1 inch, and ducksalad was 2 leaf, on June 6.
   Watergrass was 2.5 leaf, bulrush was 3 inches, smallflower was 1 inch, and ducksalad was 2 inches, on June 10.
   Watergrass was 2.5 leaf, bulrush was 4 leaves, smallflower was 1 inch, water hyssop was 2 leaves, and ducksalad was 4 leaves, on June 13.
   Watergrass was 3 leaf, bulrush was 7 leaves, smallflower was 3 inches, waterhyssop was 2-3 leaves, and ducksalad was 5-6 leaves, on June 18.
   Watergrass was 1-2 tiller, bulrush was 1 tiller, smallflower was 4-5 inches, waterhyssop was 3 nodes, and ducksalad was flowering, on June 23.
   Watergrass was 1-2 tiller, bulrush was 1 tiller, smallflower was 4-5 inches, waterhyssop was 3-4 nodes, monochoria was 2 leaves, arrowhead was pre-flowering, and ducksalad was flowering, on June 25.
   Watergrass was 2-3 tiller, bulrush was 2 tiller, smallflower was 5-6 inches, waterhyssop was 4-5 nodes, monochoria was 2-3 leaves, arrowhead was flowering, and ducksalad was flowering, on July 2.
   Watergrass was 6 tiller, bulrush was 2-3 tiller, smallflower was 6-8 inches, waterhyssop was flowering, monochoria was 6 leaves, arrowhead was flowering, and ducksalad was flowering, on July 10.
4. Weather conditions on May 31: Air temperature 92° F, wind 0.6 MPH from the South.
   Weather conditions on June 2: Air temperature 84.5° F, water temperature was 80.6° F, wind 3.1 MPH from the southwest.
   Weather conditions on June 6: Air temperature 76.4° F, water temperature 80.4° F, wind 6.5 MPH from the North.
   Weather conditions on June 10: Air temperature 87.2° F, water temperature 75.2° F, wind 9.8 MPH from the Northwest.
   Weather conditions on June 13: Air temperature 81° F, water temperature 78° F, wind 4 MPH from the Northwest.
   Weather conditions on June 18: Air temperature 74° F, water temperature 71.6° F, wind 5.8 MPH from the Northwest.
   Weather conditions on June 23: Air temperature 81.4° F, water temperature 77.5° F, wind 2.2 MPH from the Southwest.
   Weather conditions on June 25: Air temperature 77° F, water temperature 78.8° F, wind 8 MPH from the Southeast.
   Weather conditions on July 2: Air temperature 82° F, water temperature 77° F, wind 2.5 MPH from the Southeast.
   Weather conditions on July 10: Air temperature 80° F, water temperature 72.9° F, wind 2.1 MPH from the Southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

# Continuous Flood




**Application timing**

**Seeded: June 1**

**Flood: June 1, 3-4" water depth**

**Day of Seeding Application: June 2**

**Post-Flood Applications: June 6, June 10, June 13, June 18, June 25, July 2, July 10**

**Continuous Flood**

| | Treatment | Rate | Timing[3] | Application date | | Phytotoxicity[1] | | | | | | | | | | | | | | | | Weed Control[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1st | | | | | | | | 2nd | | | | | | | | | | | | | | | |
| | | | | | | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | ECHPH | SCPMU | CYPDI | HETLI | ECHPH | SCPMU | CYPDI | HETLI |
| | | Prod./a | | 1st | 2nd | 7 DAT | | | | 14 DAT | | | | 7 DAT | | | | 14 DAT | | | | 6/20 (20 DAS) | | | | 7/10 (40 DAS) | | | |
| 1 | Untreated[4] | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 15 | 7 | 2 | 16 | 28 | 19 | 3 | 16 |
| 4 | V-10219 A (League MVP) fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 9 | 4 | 0 | 0 | 2 | 5 | 5 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 93 | 100 | 100 | 98 | 98 | 100 | 100 | 100 |
| 5 | V-10219 B fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 13 | 4 | 0 | 0 | 2 | 12 | 6 | 1 | 0 | 11 | 0 | 0 | 1 | 7 | 0 | 0 | 96 | 100 | 100 | 100 | 99 | 100 | 100 | 100 |
| 6 | V-10219 C fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 8 | 1 | 0 | 0 | 2 | 9 | 4 | 0 | 0 | 6 | 0 | 0 | 1 | 3 | 0 | 0 | 93 | 100 | 100 | 100 | 99 | 100 | 100 | 97 |
| 7 | V-10219 A (League MVP) fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 2 lsr fb. 1 Til | 9-Jun | 2-Jul | 0 | 7 | 3 | 2 | 0 | 7 | 4 | 3 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 92 | 96 | 100 | 87 | 98 | 100 | 100 | 92 |
| 8 | V-10219 B fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 2 lsr fb. 1 Til | 9-Jun | 2-Jul | 0 | 7 | 3 | 0 | 1 | 21 | 5 | 2 | 1 | 9 | 0 | 0 | 6 | 7 | 0 | 0 | 92 | 96 | 100 | 100 | 96 | 100 | 100 | 99 |
| 9 | V-10219 C fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 2 lsr fb. 1 Til | 9-Jun | 2-Jul | 0 | 6 | 6 | 0 | 0 | 13 | 6 | 3 | 2 | 14 | 0 | 1 | 5 | 11 | 0 | 1 | 88 | 93 | 100 | 91 | 98 | 100 | 100 | 96 |
| 10 | Bolero Ultramax fb. Regiment +Dynamic+UAN | 23.3 lb fb. 0.67oz + 2.0% + .375% v/v | 2 lsr fb. 1 Til | 10-Jun | 2-Jul | 0 | 7 | 1 | 0 | 0 | 5 | 3 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 82 | 65 | 96 | 0 | 92 | 94 | 100 | 25 |
| 11 | V-10219 A (League MVP) fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 3 lsr fb. 1 Til | 12-Jun | 2-Jul | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 86 | 73 | 92 | 40 | 98 | 100 | 100 | 59 |
| 12 | V-10219 B fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 3 lsr fb. 1 Til | 12-Jun | 2-Jul | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 71 | 72 | 83 | 42 | 98 | 99 | 90 | 66 |
| 13 | V-10219 C fb. Regiment +Dynamic+UAN | 30 lb fb. 0.67oz + 2.0% + .375% v/v | 3 lsr fb. 1 Til | 12-Jun | 2-Jul | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 85 | 81 | 92 | 46 | 97 | 99 | 100 | 58 |

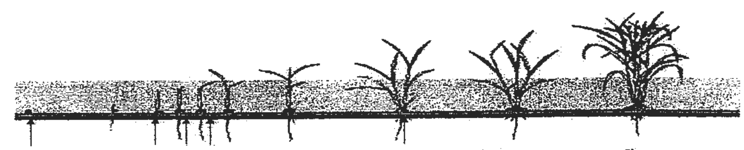
League is a wettable granule consisting of 75% imazosulfuron
V-10219 A (League MVP) is a granular formulation of 10% thiobencarb and .43% imazosulfuron (League MVP)
V-10219 B is a granular formulation of 10% thiobencarb and 1% imazosulfuron
V-10219 C is a granular formulation of 11.67% thiobencarb and 1% imazosulfuron

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)
[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad)
LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).
[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a continuous flood with water started May 30, 2014. A permanent flood was applied June 1.
3. No weeds had emerged on May 31 (Pre-flood application)
   Watergrass was 1.5 leaf, bulrush was 1 inch, and ducksalad was 2 leaf, on June 6.
   Watergrass was 2 leaf, bulrush was 4 leaf, smallflower was 3 leaf and ducksalad was 1 inch, on June 9.
   Watergrass was 2.5 leaf, bulrush was 2-4 leaf, smallflower was 1 inch, ducksalad was 2-4 leaf, and arrowhead was 2 leaf, on June 10.
   Watergrass was 2.5 leaf, bulrush was 3 inches, smallflower was 2 inch and ducksalad was 3 inch, on June 12.
   Watergrass was 2-3 tillers, bulrush was 2 tillers, waterhyssop was 4 nodes, and ducksalad was flowering, on July 2.
4. Weather conditions on May 31: Air temperature 92° F, wind 0.6 MPH from the South.
   Weather conditions on June 6: Air temperature 76.4° F, water temperature 80.4° F, wind 6.5 MPH from the North.
   Weather conditions on June 9: Air temperature 104° F, water temperature 100.4° F, wind 3.3 MPH from the Southeast.
   Weather conditions on June 10: Air temperature 93° F, water temperature 89.6° F, wind 7.5 MPH from the Northwest.
   Weather conditions on June 12: Air temperature 61° F, water temperature 55.4° F, wind 12.6 MPH from the Southeast.
   Weather conditions on July 2: Air temperature 81° F, water temperature 76.5° F, wind 2.5 MPH from the Southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

# Continuous Flood




Application timing ↑

**Seeded:** June 1

**Flood:** June 1, 3-4" water depth

**Post-Flood Applications:** June 6, June 9, June 10, June 12, July 2

**Continuous Flood**

| | Treatment | Rate | Timing[3] | Application date | | Phytotoxicity[1] | | | | | | | | | | | | | | | | Weed Control[2] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1st | | | | | | | | 2nd | | | | | | | | | | | | | | | | |
| | | | | | | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | ECHPH | SCPMU | CYPDI | HETLI | BAORO | ECHPH | SCPMU | CYPDI | AMMCO |
| | | Prod./a | | 1st | 2nd | 7 DAT | | | | 14 DAT | | | | 7 DAT | | | | 14 DAT | | | | 6/20 (20 DAS) | | | | | 7/10 (40 DAS) | | | |
| 1 | Untreated[4] | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 20 | 6 | 2 | 20 | 1 | 32 | 10 | 2 | 1 |
| 3 | GWN-10380 (Butte) | 7.5lb | 1 lsr | 6-Jun | 2-Jul | 0 | 0 | 0 | 1 | 4 | 7 | 5 | 0 | --- | --- | --- | --- | --- | --- | --- | --- | 97 | 100 | 100 | 100 | 100 | 88 | 100 | 100 | 100 |
| 4 | GWN-10380 (Butte) | 9lb | 1 lsr | 6-Jun | 2-Jul | 0 | 0 | 0 | 0 | 4 | 6 | 7 | 0 | --- | --- | --- | --- | --- | --- | --- | --- | 96 | 100 | 100 | 100 | 100 | 93 | 99 | 100 | 40 |
| 5 | GWN-10380 (Butte) fb. SuperWham + Grandstand + COC | 7.5lb fb. 6qt + 8oz + 1.25%v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 0 | 0 | 0 | 2 | 1 | 6 | 6 | 0 | 0 | 3 | 0 | 10 | 0 | 1 | 0 | 2 | 93 | 100 | 100 | 100 | 100 | 99 | 100 | 100 | 92 |
| 6 | GWN-10380 (Butte) fb. Regiment + UAN + NIS | 7.5lb fb. 0.67oz + 2.0%v/v + 0.2%v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 1 | 0 | 0 | 1 | 1 | 6 | 4 | 0 | 6 | 11 | 0 | 2 | 4 | 2 | 0 | 1 | 97 | 100 | 100 | 100 | 100 | 97 | 100 | 100 | 67 |
| 7 | GWN-10380 (Butte) fb. Clincher + COC | 7.5lb fb. 15 oz + 2.5%v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 1 | 1 | 0 | 3 | 1 | 7 | 7 | 1 | 0 | 2 | 0 | 4 | 0 | 1 | 0 | 1 | 96 | 100 | 100 | 100 | 100 | 97 | 100 | 100 | 56 |
| 8 | GWN-10380 (Butte) fb. Granite SC + COC | 7.5lb fb. 2.8 oz + 1.25% v/v | 1 lsr fb. 1 Til | 6-Jun | 2-Jul | 0 | 0 | 0 | 1 | 5 | 5 | 4 | 0 | 1 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 97 | 100 | 100 | 100 | 100 | 98 | 100 | 100 | 71 |
| 9 | Cerano fb. GWN-10380 (Butte) | 12 lb fb.7.5lb | DOS fb. 1 lsr | 2-Jun | 6-Jun | 4 | 0 | 80 | 1 | 5 | 0 | 60 | 5 | 1 | 0 | 56 | 0 | 5 | 20 | 9 | 0 | 97 | 100 | 100 | 100 | 100 | 99 | 100 | 100 | 92 |

GWN-10380 is a granular formulation of 3% benzobicyclon and .64% halosulfuron

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)

[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad) LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)

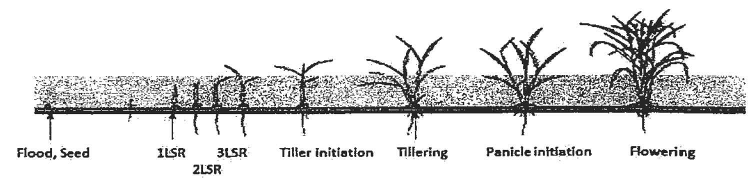
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).

[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a continuous flood with water started May 30, 2014
3. No weeds had emerged on June 2 (DOS application)
   Watergrass was 1.5 leaf, bulrush was 1 inch, and ducksalad was 2 leaf, on June 6.
   Watergrass was 2-3 tiller, bulrush was 2 tiller, water hyssop was 4 nodes and ducksalad was flowering, on July 2.
4. Weather conditions on June 2: Air temperature 84.5°F, water temperature was 80.6° F, wind 3.1 MPH from the southwest.
   Weather conditions on June 6: Air temperature 71°F, water temperature 69.8°F, wind 3.3 MPH from the south.
   Weather conditions on July 2: Air temperature 82°F, water temperature 77°F, wind 2.5 MPH from the southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

# Continuous Flood




Application timing ↑

Seeded: June 1

Flood: June 1, 3-4" water depth

Day of Seeding Application: June 2

Post-Flood Applications: June 6, July 2

**Continuous Flood**

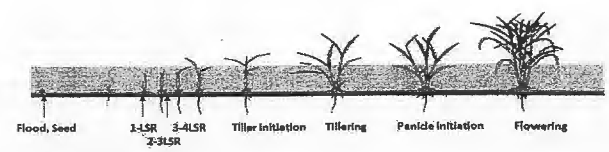
| | Treatment | Rate | Timing[3] | Application date | | Phytotoxicity[1] 1st | | | | | | | | Phytotoxicity[1] 2nd | | | | | | | | Weed Control[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | ECHPH | SCPMU | HETLI | BOARO | ECHPH | SCPMU | CYPDI | HETLI |
| | | Prod./a | | 1st | 2nd | 7 DAT | | | | 14 DAT | | | | 7 DAT | | | | 14 DAT | | | | 6/20 (20 DAS) | | | | 7/10 (40 DAS) | | | |
| 1 | Untreated[4] | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 11 | 5 | 26 | 2 | 28 | 6 | 2 | 21 |
| 2 | Cerano | 10 lb | DOS | 2-Jun | --- | 0 | 0 | 29 | 0 | 0 | 0 | 22 | 2 | --- | --- | --- | --- | --- | --- | --- | --- | 67 | 0 | 68 | 0 | 92 | 0 | 0 | 30 |
| 3 | Cerano fb. Halomax + Shark H2O | 10 lb fb. 1oz + 7oz | DOS fb. 2-3 lsr | 2-Jun | 11-Jun | 0 | 0 | 34 | 0 | 0 | 0 | 25 | 2 | 1 | 2 | 16 | 7 | 0 | 7 | 3 | 3 | 80 | 93 | 95 | 98 | 97 | 100 | 100 | 99 |
| 5 | Bolero | 23 lb | 1-2 lsr | 6-Jun | --- | 0 | 2 | 0 | 2 | 12 | 24 | 6 | 0 | --- | --- | --- | --- | --- | --- | --- | --- | 91 | 93 | 98 | 92 | 95 | 80 | 96 | 87 |
| 6 | Bolero fb. Halomax + Shark H2O | 23 lb fb. 1oz + 7oz | 1-2 lsr fb. 2-3 lsr | 6-Jun | 11-Jun | 3 | 1 | 0 | 2 | 18 | 20 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 3 | 0 | 2 | 91 | 100 | 100 | 100 | 96 | 100 | 100 | 100 |

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)
[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad)
LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).
[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a continuous flood with water started May 30, 2014.
3. No weeds had emerged on June 2 (DOS application)
   Watergrass was 1.5 leaf, bulrush was 1 inch, and ducksalad was 2 leaf, on June 6.
   Watergrass was 2.5 leaf, bulrush was 3 inches, smallflower was 1 inch, and ducksalad was 2 inches, on June 11.
4. Weather conditions on June 2: Air temperature 84.5o F, water temperature was 80.6o F, wind 3.1 MPH from the southwest.
   Weather conditions on June 6: Air temperature 76.4° F, water temperature 80.4° F, wind 6.5 MPH from the north.
   Weather conditions on June 11: Air temperature 88.5° F, water temperature 89.6° F, wind 9.8 MPH from the southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

## Continuous Flood



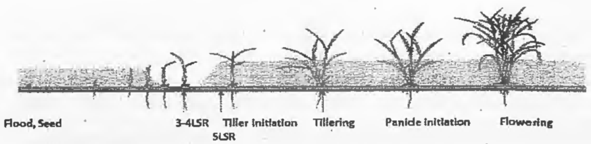

Application timing ↑
Seeded: June 1
Flood: June 1, 3-4" water depth
Day of Seeding Application: June 2
Post-Flood Applications: June 6, June 11

**Pinpoint**

| | Treatment | Rate | Timing[3] | Application date | | Phytotoxicity[1] | | | | | | | | | | | | | | | | Weed Control[2] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1st | | | | | | | | 2nd | | | | | | | | | | | | | | | | |
| | | | | | | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | ECHPH | LEFFA | SCPMU | CYPDI | HETLI | ECHPH | LEFFA | SCPMU | CYPDI |
| | | Prod./a | | 1st | 2nd | 7 DAT | | | | 14 DAT | | | | 7 DAT | | | | 14 DAT | | | | 7/10 (40 DAS) | | | | | 7/30 (60 DAS) | | | |
| 1 | Untreated[4] | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 23 | 1 | 4 | 11 | 24 | 28 | 1 | 6 | 14 |
| 2 | Rice Edge + COC | 10 lb + 1.25% v/v | 20-25 DAS (5lsr) | 23-Jun | — | 0 | 0 | 5 | 5 | 2 | 1 | 0 | 2 | — | — | — | — | — | — | — | — | 60 | 31 | 95 | 100 | 57 | 84 | 0 | 98 | 88 |
| 3 | Rice Edge + COC | 10 lb + 1.25% v/v | 40 DAS (1-2 Til) | 10-Jul | — | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 6 | — | — | — | — | — | — | — | — | 14 | 50 | 0 | 24 | 0 | 49 | 44 | 99 | 95 |
| 4 | Clincher + Granite SC + COC fb. Abolish + Regiment + UAN + NIS | 13oz + 2oz + 2.5%v/v fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | 3 lsr fb. 5 lsr | 16-Jun | 19-Jun | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 0 | 97 | 100 | 94 | 98 | 99 | | | | |
| 5 | Clincher + Granite SC + COC fb. Regiment + UAN + NIS | 13oz + 2oz + 2.5%v/v fb. 0.8oz + 2.0% + 0.2% v/v | 3 lsr fb. 1 Til | 16-Jun | 2-Jul | 0 | 4 | 0 | 1 | 0 | 3 | 0 | 2 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 99 | 100 | 97 | 98 | 99 | | | | |
| 6 | Clincher + Granite SC + Abolish + COC | 13oz + 2oz + 1.5qt + 2.5%v/v | 2-3 lsr | 16-Jun | — | 0 | 8 | 0 | 1 | 0 | 2 | 0 | 0 | — | — | — | — | — | — | — | — | 94 | 81 | 89 | 95 | 94 | | | | |
| 7 | SuperWham + COC | 6 qt. + 1.25%v/v | 4 lsr - 1 Til | 16-Jun | — | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | — | — | — | — | — | — | — | — | 77 | 31 | 99 | 98 | 34 | | | | |
| 8 | SuperWham + Clincher + COC | 6 qt. + 13oz + 2.5%v/v | 3-4 lsr | 16-Jun | — | 0 | 3 | 0 | 2 | 0 | 5 | 0 | 2 | — | — | — | — | — | — | — | — | 95 | 75 | 100 | 100 | 37 | | | | |
| 9 | Regiment + UAN + NIS fb. SuperWham + Clincher + COC | 0.67oz + 2.0%v/v + 0.2%v/v fb. 6 qt. + 13oz + 2.5%v/v | 3-4 lsr fb. 1 Til | 16-Jun | 2-Jul | 69 | 3 | 1 | 1 | 2 | 12 | 0 | 1 | 0 | 2 | 0 | 10 | 0 | 1 | 0 | 2 | 99 | 100 | 99 | 100 | 97 | | | | |
| 10 | Clincher + COC fb. SuperWham + Grandstand + COC | 13oz + 2.5%v/v fb. 6 qt. + 8oz + 1.25%v/v | 3 lsr fb. 1 Til | 16-Jun | 2-Jul | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 2 | 0 | 1 | 96 | 100 | 94 | 80 | 91 | | | | |
| 11 | Granite SC + COC fb. SuperWham + Clincher +COC | 2oz + 1.25%v/v fb. 6 qt. + 13oz + 2.5%v/v | 3 lsr fb. 1 Til | 16-Jun | 2-Jul | 0 | 4 | 0 | 1 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 2 | 99 | 100 | 97 | 100 | 98 | | | | |

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)
[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad)
LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).
[4] Untreated weed control values represent % cover by the respective weed species

# Pinpoint Flood




<u>Application timing</u> ↑

**Seeded: June 1, 2014**

**Flood: June 1, 3-4" water depth**

**Drained: June 10**

**1st Application: June 16**

**Reflood: June 18, 4" water depth**

**Post permanent flood applications: June 19, July 2**

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a pinpoint: drained June 10, and reflooded June 18.
3. Watergrass was 3-3.5 leaf, bulrush was 2 leaf, smallflower was 1-2 inches, water hyssop was 2-4 leaf, and ducksalad was 4 leaf, on June 16.
   Watergrass was 1 tiller, smallflower was 2 inches, and water hyssop was 3 inches, and ducksalad was 2 leaf, on June 19.
   Watergrass was 1-2 tiller, bulrush was 1 tiller, smallflower was 4-5 inches, water hyssop was 3 nodes, and ducksalad was flowering, on June 23.
   Watergrass was 2-3 tiller, bulrush was 1-2 tiller, smallflower was 1 tiller, water hyssop was 4 nodes, redstem was 2 nodes, and ducksalad was flowering on July 2.
   Watergrass was 6 tiller, bulrush was 2 tiller, smallflower was 1-2 tiller, water hyssop was flowering, redstem was flowering, and ducksalad was flowering on July 10.
4. Weather conditions on June 16: Air temperature 77° F, wind 6 MPH from the Southeast.
   Weather conditions on June 19: Air temperature 92° F, water temperature was 91.4° F, wind 1 MPH from the south.
   Weather conditions on June 23: Air temperature 81.4° F, water temperature 77.5° F, wind 2.2 MPH from the southwest.
   Weather conditions on July 2: Air temperature 89° F, water temperature 84° F, wind 3 MPH from the southeast.
   Weather conditions on July 10: Air temperature 80° F, water temperature 73° F, wind 2 MPH from the southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

**Shark H2O Foliar**

| # | Treatment | Rate | Timing[3] | Application date 1st | Application date 2nd | Application date 3rd |
|---|---|---|---|---|---|---|
| | | Prod./a | | 1st | 2nd | 3rd |
| 1 | Untreated[4] | --- | --- | --- | --- | --- |
| 2 | Cerano fb. Shark H2O fb. SuperWham +COC | 12 lb fb. 7.5oz fb. 6 qt + 1.25 %v/v | DOS fb. 2-4 lsr fb. 1-2 tiller | 2-Jun | 13-Jun | 2-Jul |
| 4 | Cerano fb. Londax fb. Shark H2O | 12 lb fb. 1.66 oz fb. 4 oz | DOS fb. 2-4 lsr fb. 1-2 tiller | 2-Jun | 13-Jun | 2-Jul |
| 5 | Cerano fb. Halomax fb. Shark H2O | 12 lb fb. 1.33 fb. 4 oz | DOS fb. 2-4 lsr fb. 1-2 tiller | 2-Jun | 13-Jun | 2-Jul |

Phytotoxicity[1]

| # | 1st, 7 DAT % Stunting | % Stand | % Bleach | % Injury | 1st, 14 DAT % Stunting | % Stand | % Bleach | % Injury | 2nd, 7 DAT % Stunting | % Stand | % Bleach | % Injury | 2nd, 14 DAT % Stunting | % Stand | % Bleach | % Injury |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2 | 0 | 0 | 29 | 0 | 0 | 0 | 4 | 91 | 13 | 29 | 16 | 13 | 3 | 33 | 1 | 2 |
| 4 | 0 | 0 | 41 | 0 | 0 | 0 | 56 | 4 | 3 | 4 | 14 | 4 | 1 | 3 | 0 | 2 |
| 5 | 0 | 0 | 44 | 0 | 0 | 0 | 44 | 4 | 8 | 7 | 12 | 3 | 4 | 2 | 0 | 2 |

Weed Control[2]

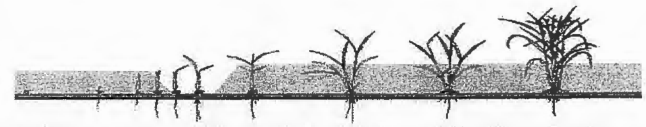
| # | 6/20 (20 DAS) ECHPH | SCPMU | CYPDI | HETLI | 7/10 (40 DAS) ECHPH | SCPMU | CYPDI | HETLI |
|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 5 | 3 | 22 | 23 | 11 | 5 | 16 |
| 2 | 99 | 95 | 94 | 100 | 94 | 97 | 100 | 97 |
| 4 | 97 | 61 | 73 | 92 | 93 | 100 | 100 | 92 |
| 5 | 94 | 64 | 74 | 88 | 95 | 98 | 97 | 75 |

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)
[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad)
LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).
[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial seeded June 1, 2014 with 120 lbs per acre of M205
2. Trial managed as a pinpoint: drained June 10, and reflooded June 15.
3. No weeds had emerged on June 2 (DOS application)
   Watergrass was 2.5 leaf, bulrush was 4 leaves, smallflower was 1 inch, and ducksalad was 2 inches, on June 13.
   Watergrass was 2-3 tiller, bulrush was 2 tiller, smallflower was 1 tiller, waterhyssop was 4 nodes, and ducksalad was flowering, on July 2.
4. Weather conditions on June 2: Air temperature 84.5o F, water temperature was 80.6o F, wind 3.1 MPH from the southwest.
   Weather conditions on June 13: Air temperature 80.4° F, wind 6 MPH from the northwest.
   Weather conditions on July 2: Air temperature 89° F, water temperature 84.4° F, wind 3 MPH from the southeast.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

# Shark H2O Foliar




Application timing

Seeded: June 1, 2014

Flood: June 1, 3-4" water depth

Drained: June 10

1st Application: June 13

Reflood: June 15, 4" water depth

Post permanent flood applications: July 2

**Drill-Seeded**

| | Treatment | Rate | Timing[3] | Application date | | | Phytotoxicity[1] 1st 7 DAT | | | | 1st 14 DAT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Prod./a | | 1st | 2nd | 3rd | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury |
| 1 | Untreated[4] | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | Prowl H2O + Super Wham + Clincher + COC | 2pt + 4qt + 13oz + 2.5%v/v | 3 lsr | 13-Jun | — | — | 8 | 0 | 0 | 1 | 12 | 1 | 0 | 1 |
| 4 | Abolish + Regiment + UAN + NIS | 1.5 qt + 0.53oz + 2.0% + 0.2% v/v | 5 lsr | 19-Jun | — | — | 0 | 0 | 7 | 17 | 0 | 0 | 4 | 1 |
| 5 | Prowl fb. Abolish + Regiment + UAN + NIS | 2 pt fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DPRE fb. 5 lsr | 29-May | 19-Jun | — | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Prowl + Clincher + Granite SC + COC | 2pt + 15oz +2oz + 2.5%v/v | 2-3 lsr | 13-Jun | — | — | 3 | 1 | 2 | 3 | 7 | 3 | 0 | 1 |
| 7 | Abolish | 1.5qt | DPRE | 29-May | — | — | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Prowl | 2pt | DPRE | 29-May | — | — | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 10 | Abolish fb. Shark H2O fb. Abolish + Regiment + UAN + NIS | 1.5qt fb. 7.5oz fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DPRE fb. 3-4 lsr fb. 5 lsr | 29-May | 13-Jun | 19-Jun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Prowl fb. Shark H2O fb. Abolish + Regiment + UAN + NIS | 2pt fb. 7.5oz fb. 1.5 qts + 0.53oz + 2.0% + 0.2% v/v | DPRE fb. 3-4 lsr fb. 5 lsr | 29-May | 13-Jun | 19-Jun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Phytotoxicity[1] 2nd 7 DAT | | | | 2nd 14 DAT | | | | 3rd 7 DAT | | | | 3rd 14 DAT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury | % Stunting | % Stand | % Bleach | % Injury |
| 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 4 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 5 | 0 | 0 | 2 | 12 | 0 | 0 | 3 | 1 | — | — | — | — | — | — | — | — |
| 6 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 7 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 8 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 10 | 3 | 1 | 8 | 12 | 59 | 5 | 8 | 36 | 26 | 0 | 7 | 29 | 4 | 3 | 1 | 2 |
| 11 | 4 | 3 | 6 | 11 | 76 | 7 | 8 | 26 | 70 | 5 | 5 | 20 | 10 | 5 | 2 | 5 |

| | Weed Control[2] 6/20 (20 DAS) | | 7/10 (40 DAS) | | | |
|---|---|---|---|---|---|---|
| | ECHPH | CYPDI | ECHPH | ECHOR | LEFFA | CYPDI |
| 1 | 33 | 3 | 57 | 3 | 3 | 2 |
| 3 | 98 | 85 | 94 | 98 | 61 | 51 |
| 4 | 0 | 35 | 88 | 100 | 0 | 0 |
| 5 | 62 | 60 | 97 | 100 | 89 | 0 |
| 6 | 85 | 47 | 99 | 100 | 82 | 47 |
| 7 | 0 | 76 | 5 | 76 | 70 | 93 |
| 8 | 15 | 57 | 24 | 37 | 75 | 85 |
| 10 | 19 | 67 | 89 | 100 | 80 | 63 |
| 11 | 77 | 88 | 94 | 100 | 75 | 54 |

[1] % Stand (Percent stand reduction), % Stunting (Percent stunting of rice), % Injury (percent injury to rice)

[2] ECHPH (Late watergrass), SCPMU (Rice field bulrush), CYPDI (Small flower Umbrellaplant), HETLI (Duck salad) LEFFA (Sprangletop), BAORO (Waterhyssop), AMMCO (Redstem), SAGMO (California arrowhead), MOOVA (Monochoria)

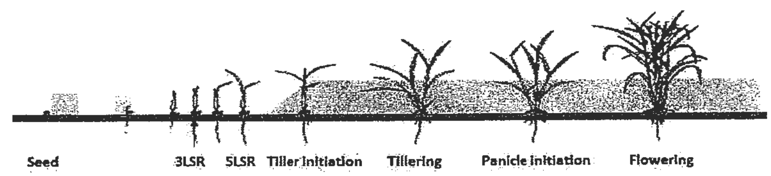
[3] fb. (followed by), PFS (pre-flood surface), PWE (pre-weed emergence), lsr (leaf stage of rice), Til (tillers of rice).

[4] Untreated weed control values represent % cover by the respective weed species

**Trial Information**

1. Trial drill-seeded May 28, 2014 with 120 lbs per acre of M205
2. Initial flush was May 29, followed by flushes June 4 and June 8. A permanent flood was applied June 15.
3. No weeds had emerged on May 29 (DPRE application)
   Watergrass was 2.5 leaf, on June 13.
   Watergrass was 2.5 leaf, smallflower was 1-2 inches, water hyssop was 2 leaf, and ducksalad was 1 tiller, on June 19.
4. Weather conditions on May 29: Air temperature 79° F, wind 0.67MPH from the South.
   Weather conditions on June 13: Air temperature 74° F, wind 4.1 MPH from the northwest.
   Weather conditions on June 19: Air temperature 92° F, water temperature 91.9° F, wind 1 MPH from the southwest.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.

# Drill Seeded




<u>Application timing</u> ↑

Seeded: May 28

Pre-Emergent Application: May 29

Flushed: May 29, June 4, June 8

Pre-Flood Application: June 13

Permanent flood: June 15, 4" water depth

Post-Permanent Flood Applications: June 19

# RICE FIELD DAY

**Wednesday, August 27, 2014**

**New Research Building**

*California Cooperative Rice Research Foundation, Inc.*
*University of California*
*United States Department of Agriculture*
*Cooperating*

Rice Experiment Station
P.O. Box 306, Biggs, CA 95917-0306

## Rice Weed Control: Herbicide Programs, New Chemicals, and Weed Management

(A.J. Fischer, W. Brim-DeForest, R. Alarcon-Reverte, R. Pedroso, B.A. Linquist, C. Greer, L. Espino, R.G. Mutters, Farm Advisor, Butte Co, J.E. Hill, S. Johnson, and J.R. Stogsdill, SRA II, UCD and UCCE)

Our field program includes the testing of herbicides, their mixtures and sequential combinations for the rice growing systems that currently prevail in California. At this years' field day we will show highlights of our weed control experiments conducted on the Rice Experiment Station's (RES) Hamilton Road field. Experiments in 2014 involved water seeded continuously flooded rice, early-drain (pinpoint) systems, and drill seeded systems. In addition, our research effort also includes areas in two cooperating grower's fields infested with multiple-herbicide resistant late watergrass ("mimic") and ALS-resistant sedges. We continue to test new products and to assist the rice industry in the registration of new herbicides as options become available. We have a strong emphasis towards the diversification and sustainability of weed management in rice, thus we continued work on the evaluation of different irrigation methods and their impact on weed communities, as well as the development of growth and emergence models, which will eventually be utilized to create prediction tools for farmers to improve the timing of herbicide applications. Our efforts seek to assist California rice growers in their critical weed control issues of preventing and managing herbicide-resistant weeds, achieving economic and timely broad-spectrum control and complying with personal and environmental safety requirements.

Here we highlight results from our 2014 field operation for the major rice growing systems used in California. Efficacy comments mostly reflect herbicide program performance by approximately 40 days after seeding (DAS) rice, thus covering the critical period for weed control in water-seeded rice determined at the RES.

**Continuously flooded rice**

This system intends to maximize weed suppression by flooding, notably the elimination of barnyardgrass and sprangletop as problems. After seeding into a flooded field, water depth is



maintained at 4 inches throughout the season. When late post-emergence applications are needed, water is lowered to expose about 70% of weed foliage to the herbicide spray, but fields are never drained. Watergrass (early and late) were the predominant weeds, followed by ricefield bulrush, smallflower and ducksalad. All weeds at our field site are susceptible, but we discuss and give herbicide options for fields with both resistant and susceptible populations.

For control of multiple-resistant watergrass in locations with susceptible sedge and broadleaf populations, an application of a tank mixture of Abolish + Regiment (1.5qt/a + 0.53oz/a + 2.0% v/v UAN + 0.2% v/v NIS) at the 5 lsr (leaf stage of rice) provides good control. Options for early sedge and susceptible grass control include Granite GR alone (15lb/a) at the 2-3 lsr, or Cerano (day of seeding at12lb/a) followed by Granite GR (15lb/a) or Butte (7.5lb/a at 1 lsr) at the 2-3 lsr. All three options provide excellent control of ricefield bulrush, smallflower and ducksalad. The combination of Cerano followed by Granite provided the best watergrass (susceptible) control (100%). Butte is a good option for sites with ALS or propanil resistant sedge populations.

Bolero is a granular into-the-water herbicide that can be used to begin an herbicide program in which it helps with sprangletop (although this weed should be uncommon in continuously flooded rice) and with ALS-inhibitor and/ or propanil-resistant smallflower umbrellasedge control. A program with Bolero applied at 23 lb/a at 1 lsr followed by Regiment (0.8oz/a at 3-4 lsr) provided good watergrass and ricefield bulrush control (93%) and excellent smallflower umbrellasedge control (100%). Regiment at the highest label rate is an option for fields with multiple-resistant watergrass. In susceptible watergrass fields, a good alternative is also to follow Bolero with Granite SC + SuperWham (2oz/a + 6 qt/a + 1/25% v/v COC) at the 3-4 lsr. Watergrass control was good (92%), while ricefield bulrush, smallflower umbrella sedge and ducksalad control were excellent (100%). When Bolero was followed by SuperWham alone (6 qt/a + 1/25% v/v COC) at the 3-4 lsr, control of ricefield bulrush was also good (96%), as was control of ducksalad (92%).

An alternative granular formulation to control susceptible sedges and watergrass is Granite GR (15lb/a) at the 1 lsr followed by SuperWham (6 qt/a + 1/25% v/v COC) at the 3-4 lsr. It provided 100% control of sedges and ducksalad, and good grass control (97%).

Shark H2O is a good herbicide for a program aimed at controlling ALS inhibitor- and/or propanil-resistant sedges (thus delaying the evolution of resistance to those herbicides. Shark H2O alone into the water (7.5oz/a) at the 1 lsr had good early control of bulrush (86%) but late-emerging bulrush was not well controlled. Smallflower control was good and lasted until 40 days after seeding (86%). Abolish + Regiment (1.5qt/a + 0.53oz/a + 2.0% v/v UAN + 0.2% v/v NIS) at the 5 lsr provided 91% control of watergrass (this mixture is also good for the control of multiple-resistant watergrass). Regiment at the 5 lsr will also suppress resistant watergrass. When Cerano was applied day of seeding (DOS) (12lb/a) followed by Shark H2O and then by an Abolish+Regiment mixture, control of watergrass increased to 96%. When Granite GR (15lb/a) and Shark H2O (7.5oz/a) were applied together at the 2.5 lsr, control of all weeds was excellent (100%).

To increase control of ricefield bulrush for sites with heavy populations, another option is to combine Shark H2O + Halomax (7.5oz/a + 1.33oz/a) for in into the water treatment at the 2-4 lsr. Control of both ricefield bulrush and smallflower was excellent (100%) and the control of watergrass by Cerano (12lb/at DOS) was enhanced by this mixture. Any escapes can be controlled with a follow-up application of SuperWham at the 1-2 tiller stage (6qt/a + 1.25% v/v) (98% watergrass control).

Bolero and Cerano are two good options for early grass (watergrass and sprangletop) control in a Shark H2O-based program in a continuous flood. Bolero (23lb/a) applied at the 1 lsr had good watergrass control (95%), as well as good ricefield bulrush and smallflower control (80% and 96%, respectively). When Bolero was followed by Shark H2O + Halomax (7.5oz/a + 1.33oz/a) at the 2-3 lsr, control of sedges increased to 98%. Cerano (10lb/a) at DOS alone controlled 92% of watergrass; when followed by Shark H2O + Halomax (7.5oz/a + 1.33oz/a) at the 2-3 lsr, watergrass control increased to 99%. Sedge and broadleaf control was excellent (100%). Stand reduction was a problem in the Bolero-based treatments.

**Early drained water-seeded rice**

Often, cold weather or windy conditions in spring require early field drainage to favor rice establishment. Also, fields are often drained for use of foliar-acting early post-emergence herbicides.



**Pinpoint flood**

In this experiment weeds were controlled by foliar herbicide treatments applied during a period of field drainage for good weed exposure to the herbicides. Prevailing weeds were early and late watergrass, ricefield bulrush, sprangletop and ducksalad.

A tank mix of Clincher + Granite SC (13oz/a + 2oz/a + 2.5% v/v COC) at the 3-4 lsr provided good control of sedges and excellent control of sprangletop (100%). For sites with multiple-resistant watergrass, a follow-up of Abolish + Regiment (1.5qt/a + 0.53oz/a + 2.0% v/v UAN + 0.2% v/v NIS) or Regiment (0.8oz/a + 2% v/v UAN + 0.2% v/v) at the 1 tiller stage of rice provides control of watergrass escapes. A 3-way tank mix of Clincher + Granite SC + Abolish (13oz/a + 2oz/a + 1.5qt/a + 2.5% v/v) showed comparatively reduced efficacy on the sedges (89% control of ricefield bulrush and 95% control of smallflower), and sprangletop (81%).

For sites with susceptible sedge and grass populations, there are several good programs. Regiment (0.67oz/a + 2% v/v UAN + 0.2% v/v NIS) at the 3-4 lsr followed by SuperWham + Clincher (6qt/a + 13oz/a + 2.5% v/v COC) at the 1 tiller stage of rice provided excellent broad-spectrum control. Clincher (13oz/a + 2.5% v/v COC) at the 3-4 lsr followed by SuperWham + Grandstand (6qt/a + 8oz/a + 1.25% v/v COC) provided excellent watergrass and sprangletop control (96% and 100%, respectively) and good ricefield bulrush and smallflower control (94% and 80%, respectively). Granite SC (2oz/a + 1.25% v/v COC) followed by SuperWham + Clincher (6qt/a + 13oz/a + 2.5% v/v COC) controlled watergrass (99%) and sprangletop (100%). Efficacy on sedge and broadleaves was excellent (greater than 97%). As in previous years, a tank mixture of Clincher and SuperWham (13oz/a + 6 qt 2.5% v/v COC) at the 3-4 lsr provided good broad-spectrum control of all weeds except for broadleaves, but the antagonism between the two herbicides lowered their efficacy slightly (control of sprangletop was only 75%).

**Drill seeded rice**

This is the system that offers flexibility for herbicide use when proximity to sensitive crops imposes restrictions to aerial applications. Drill seeding favors weeds adapted to dryland seedbeds (sprangletop is typically problematic, as are barnyardgrass and smallflower umbrella sedge) and is less favorable for aquatic species (ricefield bulrush, ducksalad, and redstem). Thus dry seeding is useful for alternation with water-seeded systems when the pressure of aquatic weeds becomes problematic. Main weeds in the experiment were the Echinochloa complex, sprangletop, and some smallflower umbrella sedge. Before heading, the Echinochloa complex is difficult to differentiate. Later weed ratings will determine the percentage of one species versus another.

For early weed control, some herbicides are applied before rice emergence. For a delayed pre-emergence application, the field is first drill seeded into dry soil. The field is flushed once, to moisten the soil and imbibe the rice seed, and then a liquid herbicide is applied onto a moist soil surface. Prowl (2 pt/a) is a pre-emergence herbicide that can protect from weed emergence after seeding rice during the period prior to the permanent flood. Abolish is another option as a pre-emergence herbicide. Both herbicides should be active against watergrass, barnyardgrass, and sprangletop; Abolish is more active on smallflower umbrellasedge than Prowl. Prowl H2O (2pt/a) applied alone at delayed pre-emergence (DPRE) provided only partial (34%) Echinochloa suppression, 75% control of sprangletop and 85% smallflower umbrellasedge control, indicating it is not a stand-alone herbicide but that it can be a useful mixing partner to limit weed emergence from soils (does not have foliar activity). Abolish (1.5 qt/a) provided poor late watergrass control (only 5%) but better early watergrass/barnyardgrass control (up to 76%) and controlled sprangletop by 70%. Abolish alone in DPRE control smallflower umbrellasedge by 93%. A follow-up application of a tank mixture of Abolish and Regiment (1.5qt/a + 0.53oz/a + 2.0% v/v UAN + 0.2% v/v NIS) provided excellent watergrass grass control (up to 95% of late watergrass).

The tank mixture of Prowl H2O (2pt/a), SuperWham (4qt/a) and Clincher (13oz/a) applied with 2.5% COC at the 2-3 lsr is a standard mixture that controlled emerged grasses (94% control of late watergrass, 61% control of sprangletop by 40 days after seeding rice, DAS) and smallflower umbrella sedge (85% control by 20 DAS) while Prowl suppressed the emergence of germinating weeds. The tank mixture of Prowl H2O (2pt/a), Granite SC (2oz/a) and Clincher (15oz/a) applied with 2.5% COC at the 2-3 lsr was another good option, providing overall best grass control (99% watergrass control, 82% sprangletop control) although control of smallflower was poor (47%) and would have required a follow-up application.



**New Compounds**

Wetcit® (crop oil based surfactant) By Oro-Agri
Under a continuous flood, SuperWham (6 qt/a) + Wetcit® (1.25% v/v) applied at the 1-2 tiller stage of rice controlled watergrass (71%), ricefield bulrush (93%), smallflower (100%) and ducksalad (74%). When applied with a generic crop oil concentrate, at the same timing and rate, control of watergrass, ricefield bulrush and ducksalad were slightly lower (66%, 90%, and 58%, respectively).

RiceEdge® (dry flowable mixture of propanil and halosulfuron) by RiceCo, LLC
RiceEdge® was tested under a continuous flood and a pinpoint flood (drained for one week at the 3-4 lsr). In both trials, it was applied at the highest label rate, of 10 lb/a (+ 1.25% v/v COC) at the 1-2 tiller stage of rice. In the continuous flood, it controlled watergrass (68%), and had excellent control of both ricefield bulrush and smallflower (99% and 100%). In the pinpoint, the same rate and timing controlled 60% of watergrass, and had excellent control of ricefield bulrush and smallflower (95% and 100%). Phytotoxicity was low (5% tip burn). The mixture did not perform well when applied at a later timing (40 DAS).

League MVP® (granular mixture of thiobencarb and imazosulfuron) By Valent
This year, we tested a new League MVP® formulation with a higher concentration of both thiobencarb and imazosulfuron (11.67% +1%) in comparison to the current commercial formulation (10% +0.43%). Under a continuous flood, League MVP® (30lb/a) of the currently commercial formulation applied into the water at the 1 leaf stage of rice (lsr) fully controlled ricefield bulrush, smallflower and ducksalad. Control of watergrass was excellent, at 98%. Applied at 30lb/a at the 2 lsr, the current commercial formulation continued to give excellent broad-spectrum control, although phytotoxicity was higher than at the 1 lsr (some stand reduction). The new formulation with 11.67% thiobencarb +1% imazosulfuron, applied at the same rate (30lb/a) had excellent control of the same weed species at both the 1 lsr and 2 lsr. Higher stand reduction was observed with the higher percentage of thiobencarb. For fields with multiple-herbicide-resistant watergrass, a follow-up application of Regiment (0.8 oz/a) at the 1-2 tiller stage of rice will improve control. At a later timing (3 lsr), both formulations provided excellent control of watergrass (over 97%), ricefield bulrush and smallflower (100%), though ducksalad control was lower than at

the earlier timings (58% in comparison to over 90%). Phytotoxicity was low at the later application timing (3 lsr).

Butte® (granular mixture of benzobicyclon and halosulfuron) By Gowan
Butte® was tested under a continuous flood, both alone and in a program. Phytotoxicity on rice was very low. The granular formulation of Butte (7.5lb/a) applied at the 1 lsr had good watergrass control (97%) early in the season and excellent ricefield bulrush, smallflower and ducksalad control. By 40 days after seeding, watergrass control was 88%. Follow-up treatments applied at the 1 tiller stage helped maintain the early high level of watergrass control. Thus SuperWham + Grandstand (6qt/a + 8oz/a+ 1.25% v/v COC), Regiment (0.67oz/a + 2.0% v/v UAN + 0.2% v/v NIS), or Granite SC (2oz/a + 1.25% v/v COC) provided 100% watergrass control. Redstem control was best when Grandstand was used. Rice bleaching was high and some stand reduction observed, but broad-spectrum weed control was best with the sequence of Cerano (12lb/a) followed by Butte (7.5 lb/a) at 1lsr.

**Weed Management**

The evolution of herbicide resistance in major weed species of California rice, including Cyperus difformis L. (smallflower umbrellasedge) and Echinochloa phyllopogon (Stapf) Koss (late watergrass), has necessitated the search for alternative management options, including alternate herbicide modes of action and tillage practices in conjunction with the use of a stale seedbed. In addition to the prevailing water seeding and continuous flooding in rice, reduced irrigation schemes are being explored for water conservation, which is expected to alter the usual weed recruitment patterns.

**Weed Germination, Emergence and Growth Models**

To establish appropriate timing of weed control interventions under variable field conditions, it is necessary to be able to predict the dynamics of weed germination and emergence under those conditions. Laboratory-generated models of germination and emergence for C. difformis and E. phyllopogon have accurately predicted timing of germination and emergence in controlled environments by incorporating information about water potential and temperature into population based threshold models (PBTM). The models use hydro- and thermal- time (accrual above a base temperature and base water potential) to predict population-level germination and emergence events. Since the ultimate use of these models is to



facilitate better management decisions in the field, we are evaluating them under field conditions. In 2013, observed values in the flooded systems varied considerably from predicted (laboratory-generated) values, particularly when comparing initiation of emergence and 90% emergence. Predicted values of 90% emergence for C. difformis under flushed conditions were 138 Growing Degree Days (GDD in °C d), whereas under field conditions, the value was 145 GDD. 90% emergence of E. phyllopogon under flushed conditions was predicted to be 227 GDD, and the actual value was 323 GDD. Differences could be due to a number of factors, including overwintering conditions in the field, which may affect seed dormancy status differently than the stratification conditions (wet-chilling) on which the laboratory models were based. Fields were not flooded over the winter, which may have resulted in the seeds not being fully imbibed at the onset of irrigation, causing an increase in GDD in the field in comparison to laboratory models. The observed differences in the flooded fields could also be explained by slow emergence due to seedling growth inhibition under anoxia. Our validation work continued in 2014.

**Weed Population Dynamics in Alternative Irrigation Systems**

Due to looming water resource issues in California, we have also been evaluating the dynamics of weed emergence in alternative irrigation systems. Since 2013, we have been evaluating three systems: i) Water-Seeded Alternate Wet and Dry (WS-AWD): Flooded for initial seeding by air, and until canopy closure of the rice, subsequently allowed to drain and then flushed again when Volumetric Water Content (VWC) reached 35%; ii) Drill-Seeded Alternate Wet And Dry (DS-AWD): Drill-seeded, then flushed again when VWC reached 35%; and iii) Water-Seeded Conventional (WS-Control): permanent flood of 10-15 cm, which was maintained until the field was drained approximately one month prior to harvest. We will continue to evaluate the system for at least 2 more years. Preliminary results confirm earlier results from other dry- versus wet-seeded systems. The dry-seeded system was dominated by grasses (particularly barnyardgrass and sprangletop) with a small population of smallflower umbrella sedge. The wet-seeded systems were dominated by aquatic weeds: primarily ducksalad, ricefield bulrush, and some watergrass. With full-control of weeds, yields were the same across all systems (10 t/ha). Without weed control, yields in the dry-seeded system were 0 t/ha. In the two water-seeded systems. yields were not significantly different from each other; the WS-AWD yielded slightly lower (5 t/ha) than the WS-Control (7 t/ha).

**Herbicide Resistance in Smallflower Umbrella Sedge**

Smallflower umbrella sedge (Cyperus difformis L.; CYPDI) is a troublesome annual weed (Cyperaceae) commonly found in rice fields worldwide. In CA, CYPDI management was complicated by the evolution of resistance to acetolactate-synthase (ALS)-inhibiting herbicides in 1993; ALS-resistant (R) CYPDI populations are now widespread throughout CA rice fields. In the wake of resistance to ALS inhibitors, the post emergent photosystem II (PSII)-inhibiting herbicide propanil (3,4-dichlopropionanilide) has been extensively used to control ALS-R CYPDI and other weeds of rice. Lack of proper control following propanil spraying was detected in 2012 suggesting resistance to this herbicide might have also evolved in rice fields. The objectives of this research were to confirm resistance to propanil, ascertain resistance levels, and establish the underlying mechanisms of resistance in CYPDI biotypes collected in rice fields of California. Our results indicate that a number of CYPDI populations collected in CA rice fields displayed a high level of resistance to propanil (R/S ratio equaled 14). When rice cv. M-206 and propanil-susceptible (S) and –R CYPDI were sprayed with propanil jointly with the insecticide carbaryl (a known propanil synergist that inhibits propanil degradation in plants), all plant species except propanil-R CYPDI experienced significant growth suppression, suggesting propanil metabolism is not the mechanism of resistance in the R biotypes used. Interestingly, propanil-R CYPDI biotypes are also cross-resistant to other PSII-inhibiting herbicides (diuron, atrazine, bromoxynil, and metribuzin), although resistance to atrazine is weak. These results suggested propanil resistance might involve the PSII-inhibitor binding site at the target protein D1 of PSII. Therefore, we sequenced the herbicide-binding region of the chloroplast psbA gene, which codes for propanil's target site (e.g. the D1 protein), where a valine to isoleucine substitution at amino acid residue 219 was identified. This mutation had already been found in Poa annua biotypes resistant to diuron and metribuzin and is not associated with resistance to atrazine in agreement with our results. Therefore, unlike resistance in grasses and selectivity in rice - at which resistance is attributed to enhanced propanil degradation, resistance to propanil in CYPDI from CA is endowed by a single mutation at the D1 protein, which affects binding of propanil at its target-site. For control of propanil-R CYPDI (and given the widespread resistance to ALS inhibitors in CA rice fields), it is thus necessary to switch herbicide modes of action away from PSII and ALS inhibitors, and prevent spread of resistant populations by preventing seed contamination by performing proper cleaning of tillage and harvest



machinery. Further research has also indicated that other herbicides used in rice are effective against propanil-R CYPDI, such as carfentrazone, benzobicyclon, and thiobencarb.

**Herbicide Resistance in Sprangletop**

Two subspecies of sprangletop (Leptochloa fusca spp. fascicularis and Leptochloa fusca spp. uninervia) are native to California. Preliminary surveys indicate that there are differences between the two subspecies in their distribution: fusca is spread throughout rice fields, and uninervia appears closer to the edges. Only a few herbicides are available to control sprangletop in California. The two active ingredients most widely used are clomazone (commercial names Cerano, Bombard) and cyhalofop-butyl (Clincher). Clomazone is a DXP synthase inhibitor, and cyhalofop-butyl is an ACC-ase inhibitor. In the past two years, we received grower field-collected samples that were tested for resistance (2012 and 2013) to these two active ingredients. We confirmed independent populations with resistance to clomazone and cyhalofop-butyl, but have no confirmed cases of multiple-resistance. All samples tested and confirmed resistant are from the spp. fusca, not spp. uninervia. Preliminary results indicate that resistance to cyhalofop-butyl also confers cross-resistance to quizalofop, but not to clethodim (also ACC-ase inhibitors). Further research is needed to determine possible mechanisms of resistance. Abolish (thiobencarb) and Prowl H2O (pendamethalin) used as pre-emergent herbicides still offer good control in dry-seeded systems, while Bolero (thiobencarb) offers control in water-seeded continuously flooded systems.

**Herbicides used and their active ingredient**

| | % ai | lb ai/gal |
|---|---|---|
| Abolish (thiobencarb) | 84 | 8.0 |
| Bolero Ultramax (thiobencarb) | 15 | NA |
| Butte (benzobicyclon + halosulfuron) | 3+0.64 | NA |
| Cerano (clomazone) | 5 | NA |
| Clincher (cyhalofop-butyl) | 29.6 | 2.4 |
| Granite SC (penoxsulam) | 24 | 2.0 |
| Granite GR (penoxsulam) | 0.24 | NA |
| Grandstand (triclopyr) | 44.4 | 3.0 |
| Halomax (halosulfuron) | 75 | NA |
| League MVP (thiobencarb+imazosulfuron) | 10+0.43 | NA |
| Londax (bensulfuron-methyl) | 60 | NA |
| Prowl H2O (pendimethalin) | 42.6 | 3.8 |
| Regiment (bispyribac-sodium) | 80 | NA |
| RiceEdge (propanil + halosulfuron) | 60+0.64 | NA |
| Sandea (halosulfuron) | 75 | NA |
| Shark H2O (carfentrazone) | 40 | NA |
| SuperWham (propanil) | 41.2 | 4.0 |

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