COMPREHENSIVE RICE RESEARCH

ANNUAL REPORT
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PROJECT TITLE: Weed Control in Rice

PROJECT LEADER AND PRINCIPAL INVESTIGATORS:

Project Leader:
Albert Fischer, Weed Science Program, Dept. of Plant Sciences, UC Davis

Principal Investigators:
James W. Eckert, Dept. of Plant Sciences, UC Davis
Louis Boddy, PhD student with A. Fischer, Dept. of Plant Sciences, UC Davis
Claudia Marchesi, PhD student with A. Fischer and R. Plant, Dept. of Plant Sciences, UC Davis
Aldo Merotto, PhD student with A. Fischer, Dept. of Plant Sciences, UC Davis
Maria Dolores Osuna, Postdoctoral Researcher with A. Fischer, Dept. of Plant Sciences, UC Davis
Hagai Yasuor, Postdoctoral Researcher with A. Fischer, Dept. of Plant Sciences, UC Davis

Collaborating UC Scientists:
J.E. Hill, Cooperative Specialist, Dept. of Plant Sciences, UC Davis
R. Tjerdeema, Environmental Toxicology Dept., UC Davis
C. Greer, Farm Advisor, Colusa-Glenn Co.
W.M. Canevari, Farm Advisor, San Joaquin Co.
R.G. Mutters, Farm Advisor, Butte Co.

Visiting Scientists:
Prof. Aida Ortiz, visiting scientist with A. Fischer, Dept. of Plant Sciences, UC Davis
Marco Milan, PhD student, University of Turin, visiting scientist with A. Fischer, Dept. of Plant Sciences, UC Davis

Grower Cooperators:
Thad Rodgers, Glenn Co.

Field Operations:
Steve Johnson, Research associate, Dept. of Plant Sciences, UC Davis

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OBJECTIVES OF PROPOSED RESEARCH:

1. To test and screen herbicides for efficacy, safety and compatibility for tank mixtures or sequential treatments in order to develop, in integration with agronomic practices, weed control packages for the main rice production systems in California.

2. To continue searching and testing new compounds with potential for addressing critical weed control issues to establish their suitability and proper fit into the rice

management systems of California. Encourage introduction of promising new chemicals to the California market.

3. To develop new alternatives to weed control through the exploration of agronomic opportunities, rice/weed competition to minimize herbicide costs and environmental impacts. To measure rice yield impact of specific weed species and develop a predictive approach.

4. To develop an understanding of herbicide resistance in weeds, provide diagnosis, test herbicides, and develop effective alternatives to manage this problem.

OBJECTIVE 1. *To test and screen herbicides for efficacy, safety and compatibility for tank mixtures or sequential treatments in order to develop, in integration with agronomic practices, weed control packages for the main rice production systems in California.*

Herbicide test plots were located at two different sites at the Rice Experiment Station (RES) in Butte County, and one off-station site in Glenn County. One of the sites has Londax (bensulfuron-methyl)-resistant smallflower umbrellasedge. The off-station site has resistant late watergrass as the main weed problem, and the continuously flooded trial at that site (Glen County) was planted May 8 and the stale seedbed field was planted May 30, while planting at the RES occurred May 15 and May 22. This season as in the past two seasons, we have used M-205 and M-206 at the two on station sites. This has led to reduced lodging of the rice which translates to greater reliability of the combine harvest yield.

Continuously flooded experiments have water applied and not drained throughout the duration of the season, while pinpoint experiments have flood water at time of seeding then water drained for foliar applications of herbicides at specific stages of rice growth. Dry seeded experiments were drilled into the soil followed by flushes of water to establish the rice, then permanent flood was established with rice at the 3-4 leaf stage of growth. All sprayed herbicide applications were made with a CO_2-pressurized (207 kPa) hand-held sprayer equipped with a ten-foot boom and 8003 nozzles, calibrated to apply 20 gallons of spray volume per acre. Applications with solid formulations were performed by evenly broadcasting the product over the plots.

In recognizing the need for developing herbicides to meet the cultural needs of growers throughout the state, our herbicide testing system was designed around the various types of irrigation schemes that growers use. These include: Continuous flood, pin-point flood and dry/drill seeding with establishment flush irrigation. The first month after seeding corresponds to the “critical” period of competition (30 days after seeding) between weeds and rice. In the continuously flooded trial best yields were obtained when herbicide programs provided at least 95% of broad-spectrum weed control during this period and can recover about 30-40% of potential yield losses (Figure 1a). Good weed control in continuously flooded rice can be achieved with early treatments, which generally provide excellent yield (Figure 1b). Treatments that consist of an early application followed by a late-season treatment (4 lsr to 1 tiller) generally were no better than early treatments, however they can be useful to prevent growth and seed production by late-emerging weeds and improve ease of harvest. When only late treatments were applied, yields were generally 10% lower and less consistent. Several of the ALS inhibiting herbicides caused early stand reduction of rice and yield loss in spite of good weed control (Figure 1b). We are currently conducting a detailed study of herbicide phytotoxicity impact on common California varieties.

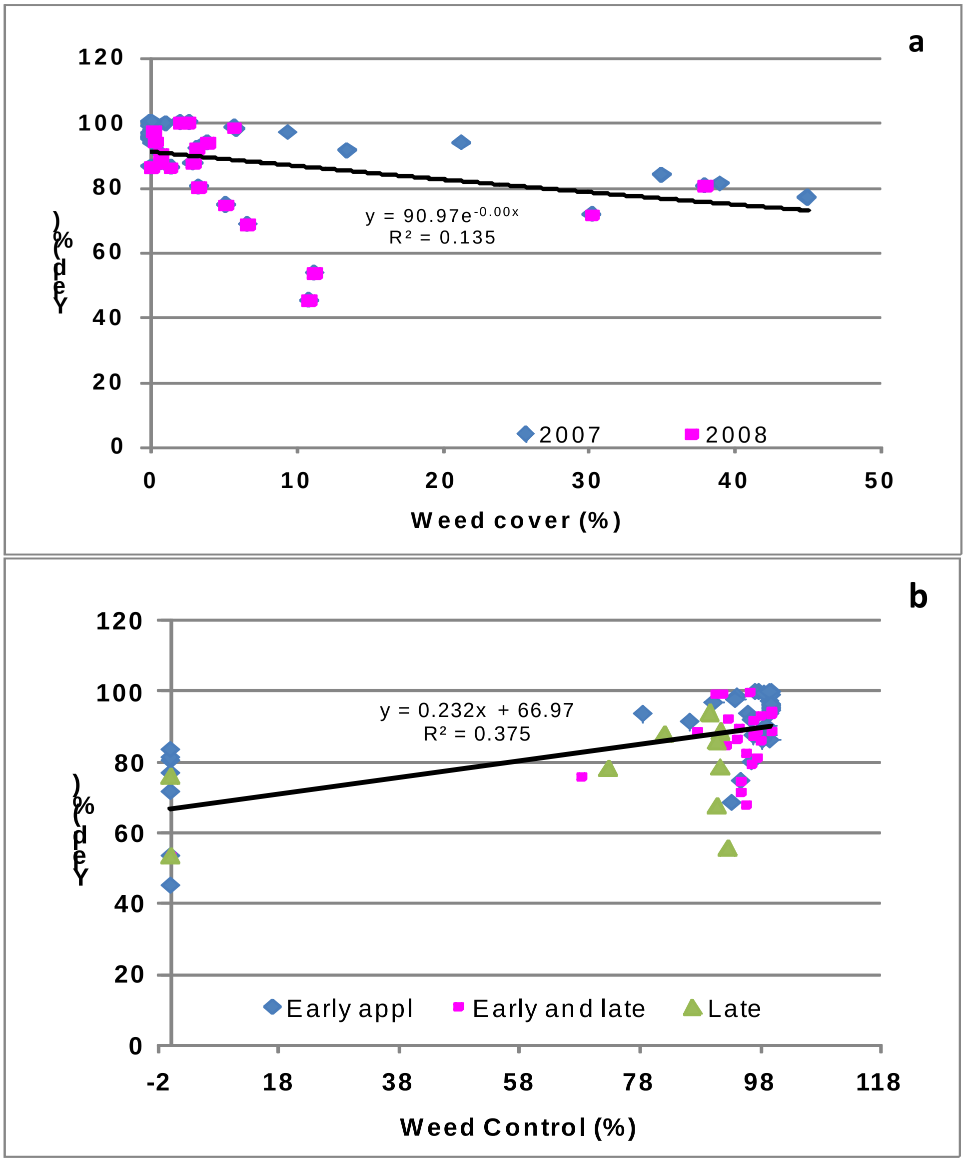

Figure 1. Weed competition and efficacy of weed control in continuously flooded rice; evaluations of weed infestation and control were conducted 40 days after seeding rice. a. Rice yields (percent of the maximum yield) as affected by weed cover (a measure of the intensity of weed infestation); b. Rice yields (percent of the maximum yield) as affected by weed control efficacy expressed as percent of untreated plots (= 0% weed control). Data are combined for the 2007 and 2008 continuously flooded experiments at the RES.

Weed infestations in our pinpoint system have a stronger impact on yields compared with the continuously flooded system, because of the temporary elimination of flooding. This promotes emergence of competitive weeds and eliminates temporarily the weed suppressive effect of flood; thus the steeper slope of the significant weed cover-yield relationship illustrated in Figure 2a. The same comments made earlier regarding the continuously flooded system apply here as well.

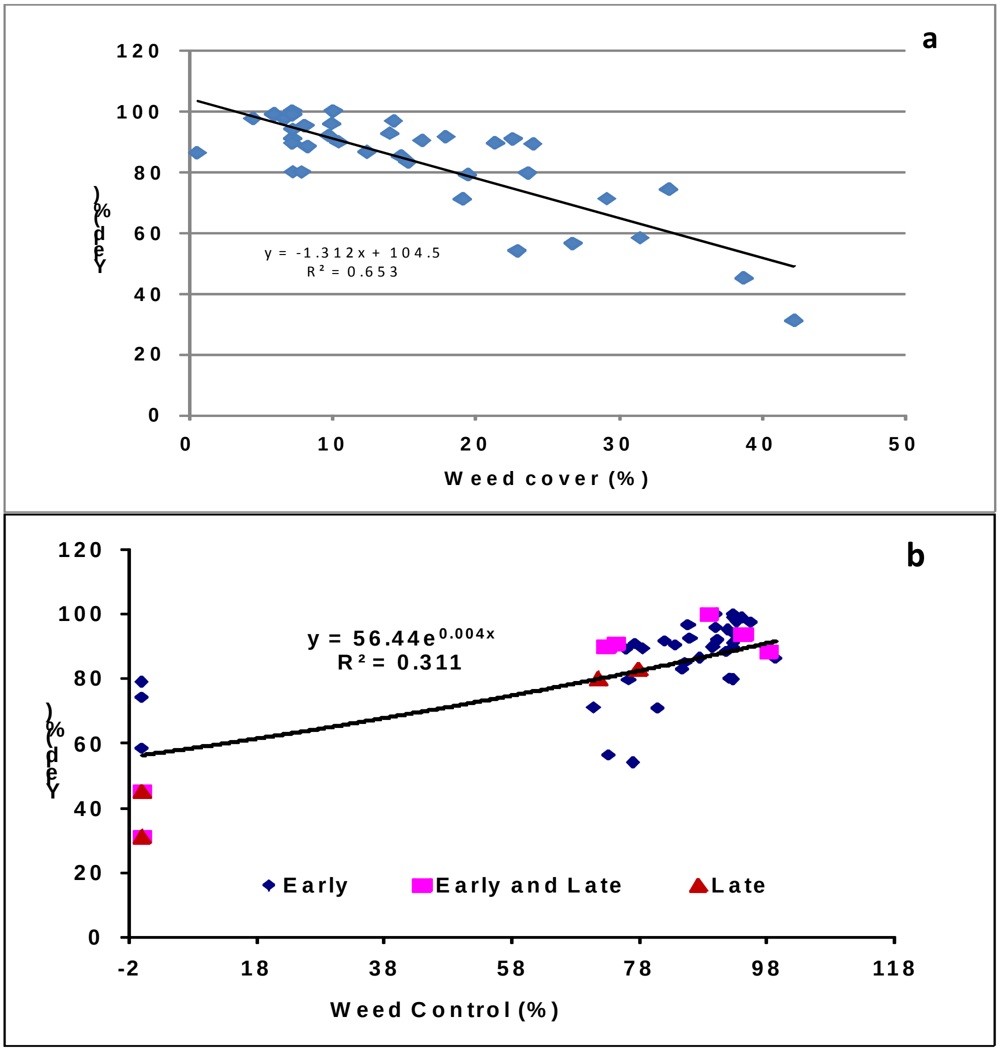

Figure 2. Weed competition and efficacy of weed control in pinpoint flooded rice; evaluations of weed infestation and control were conducted 40 days after seeding rice. a. Rice yields (percent of the maximum yield) as affected by weed cover (a measure of the intensity of weed infestation); b. Rice yields (percent of the maximum yield) as affected by weed control efficacy expressed as percent of untreated plots (= 0% weed control). Data are combined for the 2007 and 2008 pinpoint flooded experiments at the RES.

Good (greater than 95%) control during the first critical month of weed competition (Figure 2a) is essential to obtain best yields. This is best achieved with early applications (Figure 2b). Split early and late applications give similar results when weed control was high, and assisted in suppressing the ability of late emerging weeds to produce seed and re-infest the seedbank (Figure 2b). Late applications were not as successful or were not broad-spectrum treatments and yielded less than other treatments. Two treatments with the ALS inhibitor halosulfuron (active ingredient) were associated with yield losses greater than expected (Figure 2b), suggesting crop injury. Weed competition caused significant yield loss in the drill seeded experiment, and early treatments providing greater than 95 percent weed control were necessary for optimum yields (Figure 3a & b).

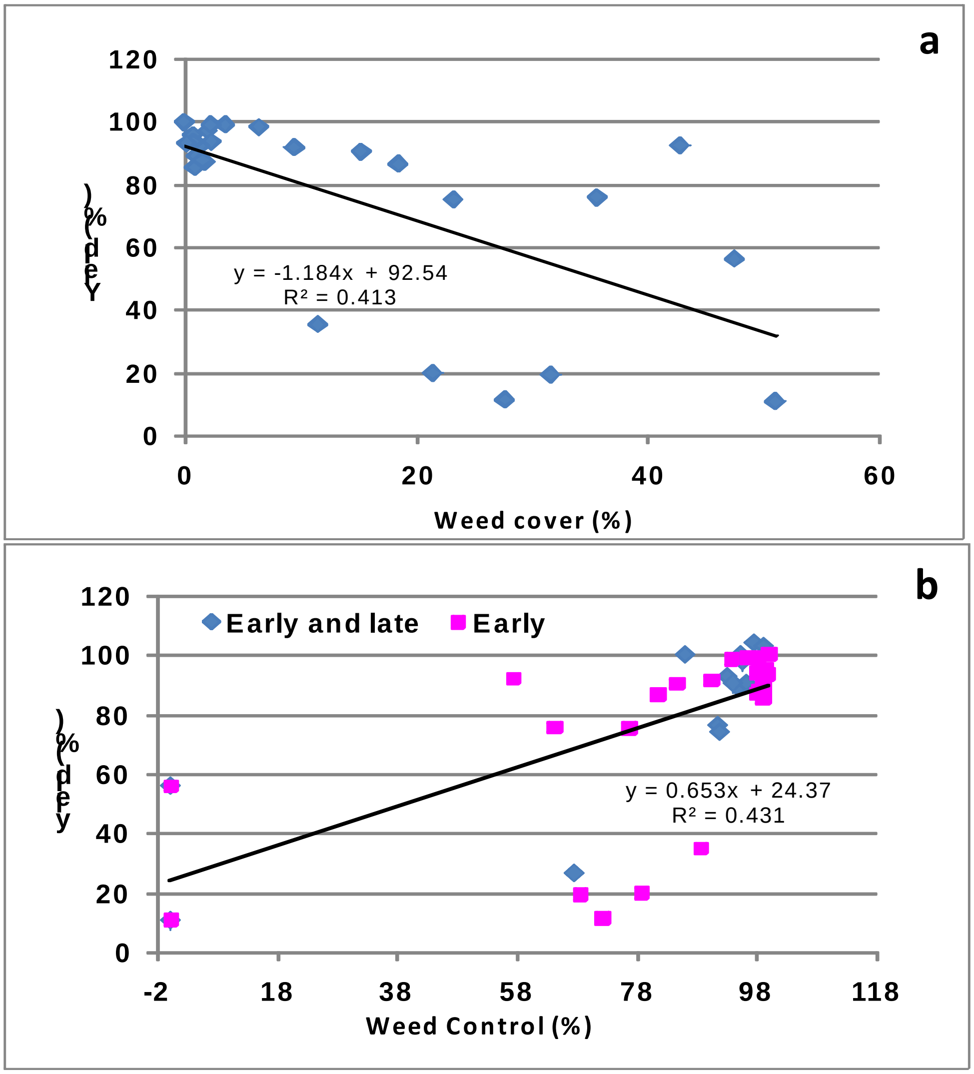

Figure 2. Weed competition and efficacy of weed control in drill seeded rice; evaluations of weed infestation and control were conducted 40 days after seeding rice. a. Rice yields (percent of the maximum yield) as affected by weed cover (a measure of the intensity of weed infestation); b. Rice yields (percent of the maximum yield) as affected by weed control efficacy expressed as percent of untreated plots (= 0% weed control). Data are combined for the 2007 and 2008 drill seeded experiments at the RES.

This year, several treatments whose low yields were not consistent with the weed control level achieved suggested these treatments were injurious to rice (low data points in Figure 3b). This was the case of Prowl H2O (1120 g ai/ha; DPRE or at the 2-3 lsr) Abolish (4484 g ai/ha; DPRE) and the mixture of Super Wham plus Whip (4484 + 32 g ai/ha respectively) at the 3-4 lsr (Table 7). Stand reduction was observed in those treatments.

Continuous flood system combinations

The continuous flood trials conducted at the Hamilton road site have herbicide-susceptible weed species. In most cases, the applications were sequential comprising an initial application of Cerano, Granite GR, or Bolero/Abolish for watergrass control followed by an application of either Shark, Londax, Super Wham, or Regiment at various timings (Table 1) to control broadleaves, sedges, and in some cases late-emerging watergrass plants or those missed by the early treatment. Granite GR is a recently available granular herbicide that was tested alongside other standard herbicides used by growers. Rice yields for most of the treatments were not statistically different. Statistically lowest yields were stand alone reference treatments to demonstrate the value of sequential applications and not expected to control all weed species.

The best treatments for weed control and yield were: V-10219 (2800 + 120 g ai/ha, 2 lsr); Cerano (673 g ai/ha, DOS) fb. Granite GR (40 g ai/ha, 2-3 lsr); Granite GR (40 g ai/ha, 2-3 lsr) fb. Propanil (6726 g ai/ha, 1-3 Till); Granite GR (40 g ai/ha, 2-3 lsr) fb. Clincher (315 g ai/ha, 1-3 Till); Abolish (4480 g ai/ha, as a pre-flood application on soil surface, PFS) fb. Regiment (37 g ai/ha, 1-3 Till) had very good yield, but weed control was not a good as other treatments; Regiment (37 g ai/ha, 1-3 Till). Other good treatments were: Shark (224 g ai/ha) and Granite GR (40 g ai/ha) applied at 2-3 lsr; Cerano (673 g ai/ha, DOS) fb. Propanil (6726 g ai/ha, 1-3 Till); Shark (224 g ai/ha, 2-3 lsr) fb. Clincher (315 g ai/ha, 1-3 Till); Shark (224 g ai/ha, 2-3 lsr) fb. Super Wham (6726 g ai/ha, 1-3 Till); and Cerano (336 g ai/ha, DOS) fb. V-10142 (336 g ai/ha) plus propanil (4484 g ai/ ha) at the 4-5 leaf stage of rice. When Cerano was followed by Regiment (37 g ai/ha; 1-3 Till) ricefield bulrush was not satisfactory (Table 1). Treatments in other continuously flooded trials at the RES that provided good weed control and yields were: Shark H_2O (224 g ai/ha) plus Londax (70 g ai/ha) both applied at the 2 lsr fb. Clincher (271 g ai/ha, 30 days later); Cerano (448 g ai/ha, DOS) fb. Shark H_2O (224 g ai/ha) plus Granite GR (40 g ai/ha) applied at 2 lsr; Cerano (448 g ai/ha, DOS) fb. Shark H_2O (224 g ai/ha) plus Londax (70 g ai/ha) applied at 2 lsr; Cerano (448 g ai/ha, DOS) fb. Shark H_2O (224 g ai/ha) plus Strada GR (74.5 g ai/ha) applied at 2 lsr (Tables 2 & 3); Cerano (448 g ai/ha, DOS) fb. Strada GR (74.5 g ai/ha, 3-4 days after Cerano) fb. Propanil (6726 g ai/ha, 1-3 Till.); Cerano (448 g ai/ha, DOS) fb. Propanil (3363 g ai/ha, 2-4 lsr) (Table 4); Cerano (448 g ai/ha, DOS) fb. Propanil (4484 g ai/ha, 5-6 lsr); Cerano (448 g ai/ha, DOS) fb. Strada WG (73.5 g ai/ha) plus propanil (4484 g ai/ha) tank mixed and applied at 2-4 lsr; Cerano (448 g ai/ha, DOS) fb. Strada WG (73.5 g ai/ha, 2-4 lsr) fb.propanil (4484 g ai/ha, 5-6 lsr) (Table 5).

Pin-point system combinations

In the water seeded pin-point flood trial with herbicide susceptible weeds conducted at the RES, plots were drained four days prior to initial application (June 14) and then re-flooded two days after application. Follow-up applications of foliar herbicides require lowering of water to achieve 70% weed exposure for effective coverage of weed foliage.

Main weeds this year were late watergrass, ricefield bulrush, ducksalad, and monochoria. Weed interference is often more intense in a system where water is drained for even a brief period , which encourages germination and growth of certain species. Smallflower umbrellasedge and sprangletop are usually typical weed problems in this system. However, since the drainage period was rather short, these species failed to establish this season. Control of watergrass and ricefield bulrush was the main determinant of final yields in this trial. Most of the treatments tested had statistically similar yields (Table 6). The following treatment combinations provided best weed control and yield: Granite SC (35 g ai/ha) tank mixed with Clincher (280 g ai/ha) applied at the 2-4 lsr followed by propanil (6726 g ai/ha, 1-2 Till); Granite SC (35g ai/ha) tank mixed with propanil (6726 g ai/ha) applied at 3-4 lsr followed by Clincher 9315 g ai/ha, 1-2 Till); Stam 4 SC (4484 g ai/ha, 3-4 lsr); Clincher (315 g ai/ha, 3-4 lsr) followed by propanil (6726 g ai/ha, 1-2 Till); and Clincher (315 g ai/ha, 3-4 lsr) followed by Regiment (37 g ai/ha, 1-2 Till), although this treatment failed to control ricefield bulrush. Lowest yields in this experiment were generally stand alone treatments that were used to compare the efficacy of the combination treatments.

Drill seeded system

Rice seed was drilled into dry ground, then flush-irrigated for establishment. Additional flush irrigations were applied to insure good crop establishment. Standing water inhibits establishment of the rice that is drilled into the soil. The main weeds in this system are generally watergrass, ricefield bulrush, smallflower umbrellasedge and sprangletop, however, this season this experiment was dominated by watergrass with low levels of sprangletop and smallflower umbrellasedge.

Herbicide timing included delayed pre-emergent (DPRE) applications after the first irrigation flush, applications at the 2-3 lsr, 3-4 lsr and post permanent flood (PPF) applications (Table 7). Early control of watergrass and sprangletop that lasted through the season generally led to the highest yields in this trial. For the second year the best yielding treatment was achieved with a tank mix of Regiment and Abolish (25 g ai/ha plus 3360 g ai/ha respectively, 2-3 lsr) followed by Clincher (315 g ai/ha, PPF). Other high yielding treatments were: Granite SC (35 g ai/ha, 2-3 lsr) followed by Clincher (315 g ai/ha, PPF); Granite SC tank mixed with Prowl H2O and Clincher (35 g ai/ha plus 1120 g ai/ha, plus 315 g ai/ha respectively, 2-3 lsr); and a tank mix of Prowl H2O, Regiment plus Whip (1120, 37 and 32 g ai/ha respectively, 2-3 lsr).

OBJECTIVE 2. *To continue searching and testing new compounds with potential for addressing critical weed control issues to establish their suitability and proper fit into the rice management systems of California. Encourage introduction of promising new chemicals to the California market.*

Prowl H_2O (pendimethalin)

Prowl is a selective herbicide for controlling annual grass (watergrass, barnyardgrass, sprangletop) and certain broadleaf weeds (smallflower umbrellasedge) as they germinate and emerge. As a meristematic inhibitor, it interferes with the plant's cellular division and early growth. Prowl H_2O has substituted Prowl EC on the supplemental label for drilled and dry seeded rice in California. Prowl H_2O is a recently released water based capsule suspension (CS) formulation. Wet/dry cycles cause the capsule wall to rupture and release the pendimethalin. Prowl H_2O needs to be applied to moist soil without any standing water. Flooding causes the chemical to degrade and loose efficacy; also volatility losses are more rapid when this herbicide is applied to wet soil surfaces. Prowl H_2O was tested in a drill seeded rice culture at the RES (Table 7). Prowl H_2O applied alone (1120 g ai/ha) as delayed pre-emergent (DPRE) provided 46% watergrass/barnyardgrass control and 33% sprangletop control at 40 DAS. Improved control of watergrass/barnyardgrass was achieved by following the Prowl H2O treatment with Super Wham (4484 g ai/ha) at 2-3 lsr. Since it does not have post-emergence activity, Prowl (1120 g ai/ha) applied alone at the 2-3 lsr provided poor control of watergrass/barnyardgrass and poor control of sprangletop. In both DPRE and 2-3 lsr there were emerged watergrass/barnyardgrass plants that are not expected to be controlled foliarly by this herbicide, therefore, weed control ratings reflect the ability of the herbicide to control non-emerged weeds; best performance with this compound is obtained when applied prior to weed emergence. When weeds were already emerging at the time of application, tank mixes of Prowl H_2O with Clincher (315 g ai/ha), or with Regiment (37 g ai/ha) plus Whip (32 g ai/ha) or with Super Wham (4484 g ai/ha), or Super Wham (4484 g ai/ha) plus Whip (32 g ai/ha) improved the late season grass control and yield (Table 7). Super Wham, Regiment and Clincher in these tank mixes provide control of established grasses while Prowl prevents establishment of germinating grasses; Super Wham and Regiment do not control sprangletop. Control of sprangletop was best with post-emergent applications at the 3-4 leaf stage of rice of Super Wham plus Whip (4484 plus 32 g ai/ha, respectively) or Clincher (280 g ai/ha) fb. Super Wham (4484 g ai/ha), earlier applications were not successful since sprangletop was not fully emerged at that timing. However, the combination of Granite SC, Prowl H20, and Clincher (35, 1120 and 315 g ai/ha, respectively) applied at the 2-3 leaf stage of rice provided outstanding grass control. Another excellent overall treatment was the tank mixture of Regiment and Abolish (25 and 3360 g ai ha, respectively, 2-3 lsr) followed by a post-permanent flood tank mixture of Super Wham and Whip (4484 and 32 g ai/ha, respectively, 3-4 lsr). Prowl generally works better in dry/drill seeded and aerobic conditions than in water saturated soils where it gets rapidly broken down. Thus in water seeded rice, Prowl works better when fields are drained and re-flood is slow or delayed.

Harbinger (pendimethalin**) alone and in combinations**

Harbinger is an EC formulation of pendimethalin designed to be used in dry seeded rice in mixture with a safening agent (Safeguard). It is applied to the dry soil surface after seed has been lightly incorporated. Flush irrigation is utilized for germination and establishment of the rice prior to permanent flood and to move the herbicide into the region of weed seed germination. Grass weed control was generally poor this season for all pendimethalin treated plots (table 8). The herbicide was safe to rice, and the added safener apparently reduced the efficacy on watergrass when Harbinger was applied to the dry soil surface prior to the establishment flood. Follow-up post-emergent applications were not successful on the large (2 tillered) watergrass plants. Yields were poor for all treatment combinations in this trial and the high level of overall weediness made harvest difficult and resulted in highly variable yields.

Overall, pendimethalin did not perform at the RES as well as it has in prior seasons.

Strada WG (orthosulfamuron, water-dispersible granule)

Orthosulfamuron is an ALS inhibitor for broad-spectrum activity on susceptible watergrass and smallflower umbrellasedge, and other sedges and broadleaf weeds. It has shown very little phytotoxicity to rice at all stages of growth. We tested a WG formulation for pinpoint applications and a GR for into the water treatments in continuously flooded rice culture. Both formulations appear to very safe on rice. Londax-resistant smallflower umbrellasedge is usually resistant to this herbicide.

Strada WG was tested as pinpoint applications in a basin that had been previously treated with Cerano at the day of seeding. Strada WG was applied at the 2-4 lsr timing or at the 5-6 lsr timing (Table 5). All applications of Strada in combination with propanil following Cerano provided excellent grass and ricefield bulrush control.

Strada GR (granular formulation)

Strada GR was tested in a continuously flooded experiment (Table 4). All treatments included an application of Cerano (448 g ai/ha, DOS). All Strada GR (74.5 g ai/ha) treatments followed by propanil (7626 g ai/ha) provided better weed control than Cerano (448 g ai/ha, DOS) followed by propanil (7626 g ai/ha) alone and had statistically similar yields.

Granite GR (penoxsulam, granular formulation) alone and in combinations

Granite GR is an ALS inhibiting post-flood, post-emergence herbicide for selective control of susceptible watergrass/barnyardgrass (not active on sprangletop), broadleaf and sedge weeds in California rice. The granular formulation, Granite GR, was first available commercially during the 2005 season. This product was applied into the water at 40 g ai/ha 7-14 days after seeding. It was tested in combination with Cerano, propanil, Clincher and Shark (Table 1). Most treatments provided good to excellent weed control. Rice plants at the 3 leaf stage exhibited noticeable root stunting by Granite at the suggested field rate. This effect was short lived and the plants recovered. Good treatments were: Cerano (673 g ai/ha, DOS) fb. Granite GR (40 g ai/ha, 2-3 lsr), Granite GR (40 g ai/ha, 2-3 lsr) fb. Clincher (315 g ai/ha, 1-3 Till), Granite GR (40 g ai/ha, 2-3 lsr) fb. Stam (6726 g ai/ha, 1-3 Till), and Shark applied same day as Granite GR (224 g ai/ha and 40 g ai/ha, respectively, 2-3 lsr).

Granite SC (penoxsulam) alone and in combinations

Granite SC is a fluid formulation of penoxsulam for foliar application. It was labeled for California in 2006 and was in good supply in 2007 and 2008. It was tested in a pinpoint flood system with flood water dropped for an application at the 3-4 lsr (Table 6). High yielding treatments that included Granite SC were: Clincher tank mixed with Granite SC (280 g ai/ha and 35 g ai/ha respectively, 3-4 lsr) fb. Stam (6726 g ai/ha, 1-2 Till), a tank mix of Granite SC and Stam (35 g ai/ha and 6726 g ai/ha respectively, 3-4 lsr) fb. Clincher (315 g ai/ha, 1-2 Till.), and Granite SC (35 g ai/ha, 3-4 lsr) as the only herbicide. Granite SC will not control sprangletop, therefore, Clincher is generally needed for control of this weed.

V-10142 (75% imazosulfuron water dispersible granule)

V-10142 75 WDG is a Valent Corporation dispersible granule. Valent is pursuing registration of this formulation in California. It is intended as a tank mix partner for follow-up spray treatments after an into-the-water herbicide (Table 1). Cerano (336 g ai/ha, DOS) was followed by V-10142 75 WDG (336 f ai/ha) plus propanil (4484 g ai/ha) at the 4-5 lsr. A second combination of V-10142 75 WDG (168 g ai/ha) plus Regiment (22.4 g ai/ha) was applied at 5 lsr following Bolero Ultramax (3923 g ai/ha, 2 lsr). Both treatment combinations provided good weed control and yield although the first combination had slightly higher yield. This compound is in the same class as other ALS (acetolactate synthase enzyme) inhibiting herbicides, so we would highly recommend not using it in combination with other ALS herbicides (Londax, Granite, Regiment, halosulfuron, etc.).

V-10219 (formulated mixture of thiobencarb and imazosulfuron)

V-10219 is a Valent corporation combination granule being tested for into-the-water application. This granule may not be the final formulation used for seeking registration. It was tested at three rates of application (1870 + 79, 2800 + 120 and 3203 + 134 g ai/ha) at the 2 leaf stage of rice. The best weed control and yield was realized with the 2800 + 120 g ai/ha rate (Table 1). Precautions listed above would also apply to this material.

Halomax 75 (halosulfuron)

Halomax 75 is a 75% active ingredient halosulfuron formulation (similar to Sempra CA and Permit) made by Aceto agricultural Chemicals Corporation. It is in the final stages of EPA approval and is anticipated to be available in California in April 2009. It was tested in a pinpoint flood system and compared to Permit herbicide. It has identical weed control spectrum as Permit and similar yield (Table 6). It was only tested as a stand-alone treatment, but would work better in a program that would address the weeds not controlled (mainly sprangletop and watergrass). It is another ALS herbicide that needs the same precautions addressed with all ALS herbicides.

Stam 4SC (propanil)

Stam 4SC is a liquid suspension of propanil that is owned by UPI (United Phosphorus Inc.) and was available in 2008 in limited supply. It was tested in a pinpoint system as a stand-alone treatment compared to Stam 80 EDF. It was applied at 4484 g ai/ha at 3-4 leaf stage rice (Table 6). Both formulations provided good control of weeds and were among the better yielding treatments in the trial.

OBJECTIVE 3. *To develop new alternatives to weed control through the exploration of agronomic opportunities, rice/weed competition to minimize herbicide costs and environmental impacts. To measure rice yield impact of specific weed species and develop a predictive approach.*

Herbicide resistant weed management systems in rice using alternative stand establishment techniques:

Five alternative stand establishment techniques were employed for four consecutive years. These systems highlighted the advantages of each in the shift of the weed seedbanks throughout the years. This season, the techniques were switched to take advantage of the impact the new system would have on weed recruitment and the established seedbank. Water seeded systems tend to favor aquatic weeds while dry or drill seeded systems tend to favor aerobic/dryland weeds. Added to the two basic techniques is the use of a stale seedbed where weeds are encouraged to germinate prior to seeding the crop then eliminated with a total herbicide like glyphosate (“stale seedbed” technique). This dramatically reduces the weed pressure on the crop as long as the soil surface is not disturbed after the stale seedbed glyphosate application.

This year, plots from this experiments received alternative treatments to validate the potential of shifting aerobic and anaerobic stand establishment, and the value of implementing a stale seedbed with glyphosate to deplete fields from all kinds of herbicide resistant weeds. Thus, plots where rice had been conventionally water seeded were heavily infested with aquatic weeds. Weeds almost disappeared from these plots when rice was drill seeded (no-till) following a stale seedbed with Roundup. Plots with heavy barnyardgrass and sprangletop infestations after 4 years of drill seeding rice were switched to water seeding after a stale seedbed with Roundup without any spring tillage and again, weeds were almost absent from these plots as a result of the change in rice establishment method. All this was achieved without any additional herbicide applied besides the Roundup. Herbicides can still be applied if 100% weed control is desired and to prevent seed set by late emerging weeds. Alternating rice establishment systems from aerobic (dry seeding) to anaerobic (water seeding) regimes (and vice versa) combined with the use prior to seeding of a total non-selective herbicide for which resistance does not yet exist in weeds of rice (such as Roundup or other) allows for a major reduction of herbicide resistant weed infestations in rice and of the overall herbicide use and associated costs.

A predictive yield-loss model for infestations of herbicide-resistant and -susceptible *Echinochloa phyllopogon* in cultivated rice fields.

Late Watergrass *(Echinochloa phyllopogon)* is one of the most important weeds in California rice fields, and has evolved resistance to most available herbicides, thus severely limiting control options. Accurately predicting rice yield-loss based on simple early-season measurements can reduce guesswork involved in deciding among weed control options, and will allow for projecting the economic impact to a farm of a weed infestation. A series of competition experiments were conducted between rice and four late watergrass (LWG) biotypes, two of which are resistant to thiobencarb and two that are susceptible. A simple process-based type model was created to predict yield-loss resulting from different levels of LWG infestation. Resistant biotypes had a slightly smaller effect on yields than susceptible ones, but produced more seed.

OBJECTIVE 4. *To develop an understanding of herbicide resistance in weeds, provide diagnosis, test herbicides, and develop effective alternatives to manage this problem.*

Diagnostic and detection of herbicide resistance.

We continue to screen potentially resistant grass samples (late watergrass, early watergrass and barnyardgrass) submitted by growers and PCAs against known susceptible and resistant lines. Testing this past season included Cerano, Regiment, Clincher, Bolero, Ordram, Granite and propanil applied at the standard field rate and ½ the standard rate. The past three seasons we have reported results of testing by including a picture showing the individual treatment effects on their sample compared with the known susceptible and resistant lines. The percent control (i.e. control referred as percent of the mean of untreated plants for the same biotype) and standard error was labeled below each treatment. Response from growers and PCA's continues to be positive. They comment that they like seeing the effect on the grass along with the level of control by the different herbicides. Various resistance patterns were observed in all submitted samples, which included barnyardgrass, early, and late watergrass accessions.

Late watergrass resistance to Penoxsulam

Echinochloa phyllopogon is a major weed of California rice that has evolved resistance to multiple herbicides. Cross-resistance to penoxsulam was evaluated in a resistant (R) accession collected in a rice field of the northern Sacramento Valley. Ratios (R/S) of the GR_{50} values varying from five to 8 were observed in whole-plant and seedling dose-response assays. The ALS enzyme was similarly sensitive to penoxsulam in plants of R and S, but specific ALS activity was higher in the former. Addition of malathion (P450 inhibitor) enhanced herbicide phytotoxicity, while pre-treatment with thiobencarb (P450 substrate) antagonized penoxsulam. Faster rates of ^{14}C-penoxsualm biotransformation to 5-OH penoxsulam and to BSTCA-methyl were observed in R *vs*. S plants. Penoxsulam metabolism in R plants pre-treated with malathion was as in S plants treated with penoxsulam alone. These results suggest *E. phyllopogon* resistance to penoxsulam is mostly due to P450-mediated enhanced metabolism, and higher specific ALS activity may contribute to reduce penoxsulam toxicity in these plants

Late watergrass resistance to clomazone

Late watergrass [Echinochloa phyllopogon (Stapf.) Koss.] is a major weed of Californian rice that has evolved P450-mediated metabolic resistance to multiple herbicides. Resistant (R) populations are also poorly controlled by the recently introduced herbicide clomazone. The authors assessed whether this cross-resistance was also P450 mediated, and whether R plants also had reduced sensitivity to photooxidation. Understanding mechanism(s) of resistance facilitates the design of herbicide management strategies to delay resistance evolution. Ratios (R/S) of R to susceptible (S) GR50 were near 2.0. [14C]Clomazone uptake was similar in R and S plants. Clomazone and its metabolite 5-ketoclomazone reduced chlorophyll and carotenoids in S more than in R plants. The P450 inhibitors disulfoton and 1-aminobenzo-triazole (ABT) safened clomazone in R and S plants. Disulfoton safened 5-ketoclomazone only in S plants, while ABT synergized 5-ketoclomazone mostly against S plants. Paraquat was more toxic in S than in R plants. Cross-resistance to clomazone explains failures to control R plants in rice fields, and safening by P450 inhibitors suggests that oxidative activation of clomazone is needed for toxicity to E. phyllopogon. Clomazone resistance requires mitigation of 5-ketoclomazone toxicity, but P450 detoxification may not significantly confer resistance, as P450 inhibitors poorly synergized 5-ketoclopmazone in R plants. Responses to paraquat suggest
research on mechanisms to mitigate photooxidation in R and S plants is needed.

Distribution and origin of herbicide-resistant *Echinochloa oryzoides* in rice fields of California

Echinochloa oryzoides (early watergrass) is an aggressive weed in California rice that has evolved resistance to several herbicides. To provide insight into the origins and spread of resistance, 434 individuals from 23 populations (12 resistant, 11 susceptible) in rice fields across California were genotyped at seven microsatellite loci. The total number of alleles detected was 47, ranging from 3 to 11 alleles per locus. Genetic diversity within populations, as measured by the Shannon-Weaver diversity index (H_{SW}), indicated that susceptible populations, with H_{SW} ranging from 0.17 to 0.58, were more genetically diverse than resistant populations, with H_{SW} ranging from 0.04 to 0.38. Mean allelic richness (A), which ranged from 1.71 to 2.99 among populations, was also higher in susceptible (A = 1.27) than resistant (A = 1.13) populations. No isolation by distance was detected within resistant or susceptible populations or across all populations, indicating little gene flow via pollen. Clustering analysis using UPGMA revealed one satellite cluster, consisting of a single population, and one main cluster consisting of resistant and susceptible populations from different geographic regions in California. The lack of geographic and population structuring suggests resistant biotypes in California have spread by seed dispersal and by independent mutation events.

Herbicide programs for resistance management

The “ mimic” site in Glenn County. At this resistant late watergrass site, two main treatment basins were set up. Each had one baseline into-the-water application of Cerano or Granite GR. All follow-up treatments were foliar sprays at the 4-5 lsr with water lowered (not drained) for weed foliage exposure (Table 9). The best weed control and yield were achieved with the sequence of Cerano (673 g ai/ha, DOS) fb. propanil (6726 g ai/ha, 4-5 lsr) and Cerano (673 g ai/ha, DOS) fb. Granite SC (40 g ai/ha, 4-5 lsr). Other good treatments were the base application of Cerano (673 g ai/ha, DOS) fb. Shark (112 g ai/ha, 4-5 lsr) or Regiment (44.5 g ai/ha, 4-5 lsr), although this last treatment yielded significantly less than the others. Best results in the Granite basin were obtained with Granite GR (40 g ai/ha, 2-3 lsr) followed by a tank mix of Super Wham (6720 g ai/ha) and Clincher (315 g ai/ha) at the 4-5 lsr. Another good treatment was Granite GR (40 g ai/ha, 2-3 lsr) fb. Super Wham (6720 g ai/ha, 4-5 lsr). Granite GR (40 g ai/ha, 2-3 lsr) applied alone does not completely control the highly resistant watergrass at this site and the yield is dramatically lower. Cerano can cause some stand reduction and bleaching while Granite GR causes stunting of rice. Rice appeared to recover in all cases and produces good yields.

Spring tilled stale seedbed system

This is a system that we have been utilizing in a large plot experiment at the Rice Experiment Station for several years. It was designed to help control resistant late watergrass (mimic) although the experiment station currently does not have this problem weed. It has been very effective in controlling many rice weeds and we needed to take it out to a real world rice field where resistant watergrass is prevalent. We have been doing traditional resistance management plot trials in a growers' field that has highly resistant late watergrass. This rice grower agreed to try this new technique on an eight acre check. Within this area we also established a test plot to test herbicide combinations for their fit into this new system. The stale seedbed process entails normal spring tillage followed by a period of ten or more days of flushing and/or shallow flooding the field in order to encourage germination of the common rice weeds. The flushing method tends to encourage weeds that need moisture, but also need an aerobic environment to germinate. This includes weeds like sprangletop and smallflower umbrellasedge. A period of continuous flood encourages weeds that tend to need an anaerobic period for germination. This includes ricefield bulrush, late watergrass, ducksalad, arrowhead and waterhyssop. The length of time that the flushing/flooding continues is crucial and dependent on obtaining sufficient germination of the problem weeds. Variables that could affect this are: time of year, air temperature, water temperature and amount of sunlight during this period. Once sufficient germination has occurred the field is drained and allowed to dry down to the point where a ground rig sprayer can be used. This drying period also exposes the soil to oxygen for improved establishment of the eventual rice crop. Glyphosate (Roundup or other total herbicide product) is applied to the field. After 24 hours the field is re-flooded without any tillage or soil disturbance, then air seeded. Minimal soil disturbance is crucial to prevent non-germinated weed seed from being moved into a soil depth where germination is encouraged. Fertility is different with this system. Nitrogen will need to be applied after the glyphosate treatment without disturbing the soil. Additional top dress nitrogen treatments will likely be necessary throughout the season. Follow-up herbicides will need to be tailored to the weed spectrum that germinates after seeding.

In our trial plots the glyphosate treatment completely controlled the resistant late watergrass and initially controlled sprangletop (Table 10). Some sprangletop did germinate and establish later in these plots. Other problem weeds in this field were: bulrush, smallflower umbrellasedge and ducksalad. These weeds were initially controlled by the glyphosate treatment, but additional germination after flooding occurred. Follow-up herbicides generally controlled these weeds and provided respectable yields. The best treatment combination at this site was glyphosate plus UAN (both at 2%v/v applied at 20 gallons/a post flush) followed by propanil (4484 g ai/ha, 3-4 lsr), which yielded 8000 tons/ha. Other good treatments included the same post flush glyphosate treatment mentioned above followed by Regiment (44.5 g ai/ha, 3-4 lsr); Granite SC plus Clincher (35 + 315 g ai/ha respectively, 3-4 lsr) or Granite SC (35 g ai/ha, 3-4 lsr). The glyphosate plus UAN treatment without follow-up treatments provided 100 percent control of watergrass and initially 100 percent control of sprangletop, however, some sprangletop did germinate after this treatment along with bulrush, smallflower umbrellasedge and ducksalad. This treatment still provided a respectable yield. The grower used the treatment described above of glyphosate followed by Granite SC plus Clincher on the remainder of the field. However, the second herbicide application was made too late when weeds were already considerably large and yields in his field averaged 6000 tons/ha.

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CONCISE GENERAL SUMMARY OF RELEVANT RESULTS OF THIS YEAR'S RESEARCH

Our field and lab program seeks to assist California rice growers in their critical weed control issues of preventing and managing herbicide-resistant weeds, achieve economic and timely broad-spectrum control and comply with personal and environmental safety requirements. Thus we test in the field at the RES, and in a cooperator's field heavily infested with *mimic* (multiple-herbicide-resistant late watergrass biotypes), herbicides, their mixtures and sequential combinations for the rice growing systems that currently prevail in California. We continued work on a long-term field experiment with new alternative rice stand establishment systems in order to develop novel but feasible solutions for controlling herbicide-resistant weeds. Advantages of the Continuous Flooded rice system include the suppression of watergrass by deeper water, which is particularly relevant when there is resistant watergrass, and the elimination of Sprangletop as a problem, provided a uniform 4-inch water depth can be maintained. We had heavy early and late watergrass infestations, but also ricefield bulrush and the complex of ducksalad/monochoria were present. Granular formulations applied early into-the-water are excellent non-drift tools for this system. Thus sequences with Cerano followed by (fb.) either Granite GR, or propanil gave excellent broad-spectrum control. Some stunting and dark green color of rice could be noticed after the Granite GR treatment. Other treatments that worked well following Cerano were Strada GR followed by propanil, Strada WG plus propanil, Shark plus Granite GR, and Shark plus Londax.

Another combination is Cerano followed by a tank mix of a new Valent Corporation herbicide (V-10142) and propanil. This Valent herbicide is imazosulfuron and may be available in the near future. Sequences can also start with Granite GR applied into the water followed by either propanil (also protects Granite from the evolution of resistance to ALS inhibitors) or Clincher. Shark (also protects Granite from ALS-resistance) followed by Granite GR improved ricefield bulrush control and provided good broad-leaf and sedge control. Regiment alone and Abolish followed by Regiment provided good weed control and yield. Shark plus Londax followed by Clincher also was efficacious and provided good yield. A new into-the-water granular herbicide (V-10219) is being developed by Valent Corporation that is a combination of Bolero and imazosulfuron. It performed very well this season and Valent is pursuing registration. This combination granule will hopefully be available in the near future. Rice yields for these treatments were in the range of 5200-7250 pounds per acre of paddy rice (14% moisture). The <u>Pinpoint System</u> in California rice requires draining at the 2-4 leaf stage to expose weed foliage to foliar herbicides. However, this exposure of the soil surface to air also favors the establishment of weeds like sprangletop, barnyardgrass and smallflower. For this reason it is important that fields are rapidly re-flooded beginning 48 hours after application. Follow-up applications can be made at 1-2 tiller stage after lowered (draining not needed) to expose 70% of weed foliage to the spray. The best broad-spectrum treatments were: Clincher tank mixed with Granite SC and propanil, Granite SC plus propanil fb. Clincher, Granite SC plus Clincher fb. propanil, propanil alone, Clincher fb. propanil and Clincher fb. Regiment. Our <u>Drill-Seeded rice</u> (M206) was flushed with water three times for establishment (June 9, June 13, June 16, and June 25), then a final permanent flood (3-4 inches) was applied when rice was at the 5 leaf stage (July 2). The main weeds in this system were watergrass and sprangletop. Residual herbicides (Prowl H_2O and Abolish) applied in delayed pre-emergence (DPRE, this is right after the germination flush before rice emerges) have typically been efficacious. However, this season these treatments were ineffectual. Treatments that worked well in this system were: Regiment plus Abolish followed by Clincher (PPF, post permanent flood) Granite SC followed by Clincher, a tank mix of Granite SC, Prowl H2O and Clincher, Prowl H_2O Regiment and Whip. <u>*Mimic*</u> is resistant to all available herbicides for grass control, except propanil. In a <u>continuously flooded system,</u> Granite GR (2-3 lsr) applied into-the-water followed by a tank mix of Clincher plus propanil or a follow up of propanil alone provided substantially greater weed control and yield as compared to Granite GR alone. Combinations of Cerano followed by Granite SC or propanil at the 4-5 lsr were also very good treatments in this system, where *mimic* has also resistance to Cerano. Shark following Cerano did not control late watergrass but still had respectable yields. Yields of treatments with good weed control ranged between 7300-10600 Lb/acre paddy rice (14%). The <u>spring tilled stale seedbed</u> trial located in a field with highly resistant *mimic* was particularly interesting. The long flush/flooding treatment (prior to applying glyphosate followed by rice seeding into the water) recruited large numbers of weeds that were eliminated by the glyphosate treatment. This treatment alone eliminated the late watergrass from this field and dramatically reduced the sprangletop that would have normally established. Follow-up herbicides were needed for broadleaf and sedge weeds. They included: propanil, Regiment, Granite SC plus Clincher, or Granite SC alone. <u>The alternative rice establishment systems</u> that have been developed throughout a long-term field experiment involve: drill seeding, water seeding, no-till options, and the use of the stale-seedbed technique (promotion of weed emergence with irrigation flushes, followed by pre-plant burn-down application of glyphosate prior to seeding rice). After four years of maintaining the same establishment technique on a large plot experiment at the Rice Experiment Station treatments were swapped to determine the usefulness of this strategy. All drill seeding was replaced by water seeding and vice-versa to offset weed adaptations and all treatments, except a conventional water seeded control, were preceded by a stale-seedbed technique. Thus, only three of the original treatments were implemented this season: Water seeded conventional, water seeded stale seedbed and drill seeded stale seedbed. In addition, the two stale seedbed treatments were also no spring till. Evaluations of weed cover and yield indicate that the drill seeded treatments needed follow up herbicide applications, while the water seeded no-till stale seedbeds did not need the follow up herbicide treatments this year and were harvestable with only the glyphosate application prior to seeding rice. This suggests that switching establishment systems is effective in controlling weeds associated with one or the other systems (aerobic or anaerobic seedbed).

Table 1. Continuous flood trial at Hamilton Road.

					Phytotoxicity[1]												Weed Control[2]												
					1st						2nd																		
Treatment	**Rate**	**Timing[3]**	**Application date**		% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	ECHPH	SCPMU	HETLI	BAORO	ECHPH	HETLI	MOOVA	BAORO	ECHPH	SCPMU	HETLI	MOOVA	Yield (kg/ha)
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			7 DAT			14 DAT			11-Jun				1-Jul				21-Jul				1-Oct
Untreated[4]	---	---															5	2	5	2	3	4	2	2	6	1	4	1	4147
Cerano fb. Superwham + COC	673 fb. 6726 + 1.25% v/v	DOS fb. 1-3 Til	23-May		0	3	5	0	2	5	0	0	0	0	0	0	91	27	66	0	99	88	86	52	99	75	97	83	6671
Cerano fb. Granite GR	673 fb. 40	DOS fb. 2-3 lsr	23-May	9-Jun	0	2	5	0	2	5	0	5	0	3	1	0	92	62	88	100	100	100	100	95	100	100	100	100	6990
Cerano fb. Regiment + NIS	673 fb. 37 + .125% v/v	DOS fb. 1-3 Til	23-May	24-Jun	0	3	5	0	2	5	3	0	0	1	0	0	95	79	77	0	97	95	91	0	100	25	81	83	6292
Granite GR fb. Stam 80 EDF + COC	40 fb. 6726 + 2.5% v/v	2-3 lsr fb. 1-3Til	9-Jun	24-Jun	0	5	0	3	1	0	6	0	0	0	0	0	97	55	78	100	100	100	100	100	100	100	100	100	6869
Granite GR fb. Clincher + COC	40 fb. 315 + 2.5% v/v	2-3 lsr fb. 1-3 Til	9-Jun	24-Jun	0	4	0	5	0	0	6	0	0	4	0	0	93	74	48	94	100	93	0	100	100	75	72	100	6881
Shark H_2O fb. Granite GR (fb. Foliar if needed)	224 fb. 40	2-3 lsr	9-Jun		0	4	0	5	0	0							79	72	83	100	98	100	100	100	100	100	100	100	6674
Shark H_2O fb. SuperWham + COC	224 fb. 6726 + 1.25% v/v	2-3 lsr fb. 1-3 Til	9-Jun	24-Jun	0	0	0	0	0	0	0	0	0	0	0	0	24	47	11	85	74	93	0	100	81	75	100	100	6136
Shark H_2O fb. Clincher + COC	224 fb. 315 + 2.5% v/v	2-3 lsr fb. 1-3 Til	9-Jun	24-Jun	0	0	0	0	0	0	0	0	0	0	0	0	5	69	38	97	77	65	0	100	95	50	97	100	6399
Abolish fb. Regiment + NIS	4480 fb. 37 + .125% v/v	PFS bf. 1-3 til	20-May	24-Jun							0	0	0	0	0	0	52	0	0	100	88	74	79	100	95	75	44	58	7214
Untreated																	5	4	6	1	8	2	1	1	7	1	1	1	3487
Abolish	4480	PFS	20-May														58	36	0	92	70	8	0	97	49	100	0	33	5309
Abolish fb. SuperWham + COC	4480 fb. 6726 + 1.25% v/v	PFS bf. 1-3 til	20-May	24-Jun							0	0	0	0	0	0	50	0	7	92	85	28	25	94	77	100	0	42	5543
Bolero Ultramax fb. Superwham + COC	4480 fb. 6726 + 1.25% v/v	1-2 lsr fb. 1-3 Til	6-Jun	24-Jun	0	0	0	0	0	0	0	0	0	0	0	0	31	20	0	100	89	40	42	97	84	100	21	58	5246
SuperWham + COC	6726 + 1.25% v/v	1-3 Til	24-Jun		0	0	0	0	0	0							19	31	16	0	80	90	83	88	70	100	8	67	5239
Superwham + Grandstand + COC	6726 + 280 + 1.25% v/v	1-3 Til	24-Jun		0	0	0	0	0	0							32	32	35	0	80	68	92	63	84	100	50	67	6096
Grandstand	280	1-3 Til	24-Jun		0	0	0	0	0	0							58	22	63	0	18	42	0	28	22	100	17	58	4304
Regiment + NIS	37 + .125% v/v	1-3 Til	24-Jun		0	0	0	0	0	0							20	32	43	0	59	58	33	46	95	100	50	100	6858
V-10219 (Thiobencarb + imazsulfuron)	2800 + 120	2 lsr	6-Jun		0	1	0	0	0	0							86	97	74	100	99	53	0	100	96	100	88	100	7251
V-10219 (Thiobencarb + imazsulfuron)	1870 + 79	2 lsr	6-Jun		0	0	0	0	0	0							94	91	87	100	96	70	0	100	96	100	71	100	6196
V-10219 (Thiobencarb + imazsulfuron)	3203 + 134	2 lsr	6-Jun		0	4	0	0	1	0							98	78	72	100	95	90	92	100	96	75	63	100	6765
Cerano fb. V-10142 + Wham 60 DF	336 fb. 336 + 4484	DOS fb. 4-5 lsr	23-May	24-Jun							0	0	0	0	0	0	74	71	68	70	93	83	0	98	98	50	75	100	6756
Bolero Ultramax fb. V10142 + Regiment	3923 fb. 168 + 22.4	2 lsr fb. 5 lf	6-Jun	24-Jun	0	4	1	0	1	0	0	7	0	0	1	0	34	0	0	100	73	38	8	100	96	75	100	100	5764
LSD (P=0.05)																													1150

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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] PFS (pre-flood surface), PPI (pre-plant incorporated), fb. (followed by), lsr (leaf stage of rice), Til (tillers of rice).

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

Trial Information

1. Abolish applied May 20 to dry soil prior to flood
2. Trial seeded May 22, 2008 with 150 lbs per acre of M206
3. Trial managed as a permanent flood with flood water at 4-5 inches.
4. No weeds were visible when Cerano was applied on day of seeding May 23.
   Watergrass was 1-2 leaf, ricefield bulrush was 1-2 leaf, and ducksalad was 1 leaf on June 6.
   Watergrass was 2 leaf, ricefield bulrush was 2 leaf, and ducksalad was 1 leaf on June 9.
   Watergrass was 1-2 tiller, ricefield bulrush was tillered, ducksalad was 6-7" on June 24
5. Spray applications made with 20 gallons/acre using 8003 nozzles.
6. Weather conditions on May 20: Air temperature 66o F, wind 1-3 MPH from the Southeast.
   Weather conditions on May 23: Air temperature 65o F, wind 2-6 MPH from the West.
   Weather conditions on June 6: Air temperature 67o F, wind 2-4 MPH from the North.
   Weather conditions on June 9: Air temperature 76o F, wind 0-1 MPH from the North.
   Weather conditions on June 24: Air temperature 78o F, wind 0-1 MPH from the southeast.

Table 2. FMC - HR

					Phytotoxicity[1]																		
					1st						2nd						Weed Control[2]						
Treatment	**Rate**	**Timing[3]**	**Date**		% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	ECHPH	SCPMU	HETLI	ECHPH	SCPMU	HETLI	**Yield (kg/ha)**
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			7 DAT			14 DAT			11-Jun			1-Jul			1-Oct
Untreated[4]	--	--															7	13	9	25	2	8	5625
Cerano fb. Shark H_2O 40 DF	673 fb. 224	DOS fb. 2 lsr	23-May	6-Jun	1	3	3	0	3	3	1	1	6	0	0	1	93	96	96	96	92	97	6018
Cerano fb. Shark H_2O 40 DF + Londax	673 fb. 224 + 70	DOS fb. 2 lsr	23-May	6-Jun	4	3	0	0	5	3	3	1	8	0	0	3	96	98	93	95	100	88	6436
Cerano fb. Shark H_2O 40 DF + Strada GR	673 fb. 224 + 74.5	DOS fb. 2 lsr	23-May	6-Jun	1	1	3	0	4	0	0	1	0	0	0	0	87	100	100	97	100	100	6311
Cerano fb. Shark H_2O 40 DF	673 fb. 112	DOS fb. 20-45 DAS	23-May	6-Jun	3	1	1	0	5	3	0	18	0	4	13	0	91	77	80	88	75	92	5941
Cerano fb. Shark H_2O 40 DF + Granite GR	448 fb. 224 fb. 40	DOS fb. 2 lsr	23-May	6-Jun	3	4	5	0	5	13	1	3	20	1	5	1	90	98	100	99	100	100	6811
Shark H_2O 40 DF + Londax fb. Clincher + COC	224 + 70 fb. 271 + 2.5% v/v	2 lsr fb.30 days after shark	6-Jun	20-Jun	1	0	8	1	0	1	0	0	0	0	0	0	100	87	90	93	75	100	6994
LSD (P=0.05)																							1635

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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)

[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 May 22, 2008 with 150 lbs per acre of M206
2. Trial managed as a continuous flood with 4-5 inches.
3. No weeds visible on May 23.
   Watergrass was 1-2 leaf, bulrush was 2 leaf, and ducksalad was 1-2 leaf on June 6.
   Watergrass was 5 leaf, bulrush was 4 leaf, and ducksalad was 2-3 leaf on June 20.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 23: Air temperature 65^o F, wind 2-6 MPH from the west.
   Weather conditions on June 6: Air temperature 67^o F, wind 3-5 MPH from the north.
   Weather conditions on June 20: Air temperature 98^o F, wind 0-1 MPH from the west.

Table 3. FMC - J-9

Treatment	Rate	Timing[3]	Date		Phytotoxicity[1]												Weed Control[2]								Yield (kg/ha)
					1st						2nd														
					% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	ECHPH	SCPMU	ECHPH	SCPMU	HETLI	ECHPH	SCPMU	HETLI	
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			7 DAT			14 DAT			4-Jun		24-Jun			14-Jul			22-Sep
Untreated[4]	--	--															1	6	4	13	3	7	21	6	5027
Cerano fb. Shark H_2O 40 DF	673 fb. 224	DOS fb. 2 lsr	15-May	28-May	0	0	4	0	0	0	0	3	0	0	5	0	50	54	75	0	55	100	0	75	6685
Cerano fb. Shark H_2O 40 DF + Londax	673 fb. 224 + 70	DOS fb. 2 lsr	15-May	28-May	0	0	1	0	0	3	0	6	0	0	10	0	88	73	52	19	28	83	0	85	7730
Cerano fb. Shark H_2O 40 DF + Strada GR	673 fb. 224 + 74.5	DOS fb. 2 lsr	15-May	28-May	0	0	0	0	5	0	0	6	0	0	8	0	75	81	100	34	100	92	15	44	7437
Cerano fb. Shark H_2O 40 DF	673 fb. 112	DOS fb. 20-45 DAS	15-May	28-May	0	0	4	0	0	0	0	0	0	0	0	0	50	19	76	0	35	85	0	95	5457
Cerano fb. Shark H_2O 40 DF + Granite GR	448 fb. 224 fb. 40	DOS fb. 2 lsr	15-May	28-May	0	0	0	0	3	0	0	0	4	0	9	5	63	71	100	63	100	100	52	100	7583
Shark H_2O 40 DF + Londax fb. Clincher + COC	224 + 70 fb. 271 + 2.5% v/v	2 lsr fb.30 days after shark	28-May	17-Jun	0	5	0	0	6	1	0	1	0	0	1	0	75	76	96	55	70	80	0	29	7412
LSD (P=0.05)																									1377

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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)

[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 May 15, 2008 with 150 lbs per acre of M205
2. Trial managed as a continuous flood with 4-5 inches.
3. No weeds visible on May 15.
   Watergrass was 1-2 leaf, ricefield bulrush was 1 leaf, and ducksalad was 1 leaf on May 28.
   Watergrass was 5 leaf, ricefield bulrush was 1 tiller, smallflower was 5 leaf, ducksalad was 5 leaf, and waterhyssop was 2-3 leaf on June 17.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 15: Air temperature 83° F, wind 8-9 MPH from the Northwest.
   Weather conditions on May 28: Air temperature 77° F, wind 6-8 MPH from the south southeast.
   Weather conditions on June 17: Air temperature 76° F, wind 1 MPH from the west.

Table 4. Isagro Continuous Flood

						Phytotoxicity[1]																		% Weed Control[2]									
						1st						2nd						3rd															
Treatment	**Rate**	**Timing**[3]	**Date**			% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	ECHPH	SCPMU	HETLI	BAORO	ECHPH	SCPMU	MOOVA	HETLI	BAORO	Yield (kg/ha)
	(g ai/ha)		1st	2nd	3rd	7 DAT			14 DAT			7 DAT			14 DAT			7 DAT			14 DAT			11-Jun				1-Jul					1-Oct
Untreated	--	--																						3	5	2	3	21	1	2	5	3	5140
Cerano fb. Strada fb. Wham + COC	448 fb. 74.5 fb. 6726 + 1.25% v/v	DOS fb. 1-2 leaf sedge fb. 1-3 Tiller	23-May	6-Jun	24-Jun	0	0	4	0	3	6	4	0	0	2	1	0	0	0	0	0	0	0	71	46	100	75	99	100	100	100	95	6749
Cerano fb. Strada fb. Wham + COC	448 fb. 74.5 fb. 6726 + 1.25% v/v	DOS fb. 3-4 DAC fb. 1-3 Tiller	23-May	26-May	24-Jun	5	8	5	1	10	0	6	8	5	0	1	5	0	1	0	0	0	0	92	0	75	46	92	100	100	100	62	7188
Cerano fb. Strada fb. Wham + COC	448 fb. 74.5 fb. 6726 + 1.25% v/v	DOS fb. 6-7 DAC fb. 1-3 Tiller	23-May	28-May	24-Jun	3	3	0	0	14	0	3	3	0	3	0	0	0	0	0	0	0	0	92	11	88	75	86	100	25	100	37	7076
Cerano fb. Wham + COC	448 fb. 6726 + 1.25% v/v	DOS fb. 1-3 Tiller	23-May	24-Jun		1	3	4	0	8	5	0	0	0	1	0	0							71	NA	0	0	71	100	67	47	0	7450
LSD (P=0.05)																																	1492

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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), lsr (leaf stage of rice), Til (tillers of rice), DPRE (pre emergent), EPE (early post emergent), PPF (post permanent flood).

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

Trial Information

1. Trial seeded May 22, 2008 with 150 lbs per acre of M206
2. Trial managed as a continuous flood.
3. No weeds visible on May 23.
   Watergrass was 1 leaf, ricefield bulrush was 1 leaf, and ducksalad was 1 leaf on May 26.
   Watergrass was 1 leaf, ricefield bulrush was 1 leaf, and ducksalad was 1 leaf on May 28.
   Watergrass was 1-2 tiller, ricefield bulrush was tillered, ducksalad was 6-7" on June 24
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 23: Air temperature 65^{o} F, wind 2-6 MPH from the west.
   Weather conditions on May 26: Air temperature 61^{o} F, wind 6-8 MPH from the southeast.
   Weather conditions on May 28: Air temperature 79^{o} F, wind 2 MPH from the south.
   Weather conditions on June 24: Air temperature 76o F, wind 2-3 MPH from the south.

Table 5. Isagro Strada WG as pinpoint following Cerano

Treatment	Rate	Timing[3]	Date			Phytotoxicity[1]																		% Weed Control[5]							Yield (kg/ha)
						1st						2nd						3rd													
						% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	ECHPH	SCPMU	HETLI	BAORO	ECHPH	SCPMU	HETLI	
	(g ai/ha)		1st	2nd	3rd	7 DAT			14 DAT			7 DAT			14 DAT			7 DAT			14 DAT			1-Jul				21-Jul			1-Oct
Untreated[4]	--	--																						41	2	6	6	29	2	5	
Cerano fb. Wham + COC	448 fb. 3363	DOS fb. 2-4 lsr	23-May	13-Jun		0	0	0	0	4	0	0	0	0	0	0	0							95	25	0	37	99	100	36	7836
Cerano fb. Wham + COC	448 fb. 4484 + 1.25% v/v	DOS fb. 5-6 lsr	23-May	20-Jun		0	0	0	0	4	0	0	0	0	0	0	0							99	50	61	88	100	100	75	7758
Cerano fb. Strada + Wham + COC	448 fb. 73.5 + 4484 + 1.25% v/v	DOS fb. 2-4 lsr	23-May	13-Jun		0	0	0	0	5	0	5	4	1	0	8	1							98	75	40	98	99	100	36	7563
Cerano fb. IRPROP + COC	448 fb. 3433 + 1.25% v/v	DOS fb. 2-4 lsr	23-May	13-Jun		0	0	0	0	0	0	5	1	1	13	13	2							100	75	98	100	100	100	48	7162
Cerano fb. Strada + SIL fb. Wham + COC	448 fb. 73.5 + 0.125% v/v fb. 4484 + 1.25% v/v	DOS fb. 2-4 lsr fb. 5-6 lsr	23-May	13-Jun	20-Jun	0	0	0	0	1	0	8	4	1	3	8	1	0	5	0	0	4	0	95	75	31	88	100	100	48	7556
Cerano fb. Strada + Wham + COC	448 fb. 73.5 + 4484 + 1.25% v/v	DOS fb. 5-6 lsr	23-May	20-Jun		0	0	0	0	0	0	4	1	1	0	1	0							96	25	43	100	100	100	50	7137
Cerano fb. Strada + Wham + COC	448 fb. 73.5 + 6726 + 1.25% v/v	DOS fb. 5-6 lsr	23-May	20-Jun		0	0	0	0	0	0	1	3	1	0	0	0							100	75	35	98	100	100	36	7107
Cerano fb. IRPROP + COC	448 fb. 3433 + 1.25% v/v	DOS fb. 5-6 lsr	23-May	20-Jun		0	0	0	0	0	0	0	0	0	0	0	0							91	100	0	0	97	100	50	7493
LSD (P=0.05)																															664

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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), lsr (leaf stage of rice), Til (tillers of rice), DPRE (pre emergent), EPE (early post emergent), PPF (post permanent flood).

[4] Untreated weed control values represent % cover by the respective weed species in an adjacent experiment

Trial Information

1. Trial seeded May 22, 2008 with 150 lbs per acre of M206
2. Trial managed as a pinpoint flood after initial water hold for Cerano. Water drained June 11 and final flood on June 14.
3. No weeds visible on May 23.
   Watergrass was 4 leaf, ricefield bulrush was 2-4 leaf, ducksalad was 5-6 leaf on June 13.
   Watergrass was 1-2 tiller, ricefield bulrush was 5 leaf, bulrush was 4 leaf, ducksalad was 2 leaf, waterhyssop was 4 leaf on June 20.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 23: Air temperature 65o F, wind 2-6 MPH from the West.
   Weather conditions on June 13: Air temperature 93o F, wind 2-3 MPH from the southeast.
   Weather conditions on June 20: Air temperature 98o F, wind 0.5 MPH from the west.

Table 6. Pinpoint Trial at Hamilton Road

					Phytotoxicity[1]												Weed Control[2]								
					1st						2nd														
Treatment	Rate	Timing[3]	Date		% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	% Stunting	% Stand	% Injury	ECHPH	SCPMU	HETLI	BAORO	ECHPH	LEEFA	SCPMU	MOOVA	Yield (kg/ha)
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			7 DAT			14 DAT			1-Jul				21-Jul				2-Oct
Untreated[4]																	15	6	14	8	58	1	2	3	2314
Granite SC + COC	35 + 2.5% v/v	3-4 lsr	17-Jun		0	3	0	0	5	0							100	0	68	38	97	0	100	74	6362
Clincher + Granite SC + COC fb. Stam + COC	280 + 35 + 2.5% v/v fb. 6726 + 2.5% v/v	3-4 lsr fb. 1-2 Til	17-Jun	23-Jun	0	3	0	1	3	0	0	1	0	0	0	0	100	0	79	67	98	75	92	0	7494
Granite SC + Stam + COC fb. Clincher + COC	35 + 6726 + 2.5% v/v fb. 315 + 2.5% v/v	3-4 lsr fb. 1-2 Til	17-Jun	23-Jun	0	0	0	1	1	0	3	0	0	0	1	0	100	0	98	100	98	33	100	0	7031
Clincher + COC	315 + 2.5% v/v	3-4 lsr	17-Jun		0	0	0	1	0	0							87	0	0	0	96	50	0	0	5330
Clincher + COC fb. Stam + COC	315 + 2.5% v/v fb. 6726 + 2.5% v/v	3-4 lsr fb. 1-2 Til	17-Jun	23-Jun	0	0	0	3	4	0	0	4	0	0	4	0	95	19	8	0	98	75	17	0	6804
Super Wham + Clincher + COC	4484 + 315 + 2.5% v/v	3-4 lsr	17-Jun		0	6	1	1	0	0							80	83	0	56	91	75	88	44	6698
SuperWham + Whip + COC	4484 + 32 + 1.25% v/v	3-4 lsr	17-Jun		0	0	1	1	0	0							59	100	18	83	77	100	92	54	5315
Super Wham + Abolish + COC	4484 + 4484 + 1.25% v/v	3-4 lsr	17-Jun		0	9	3	1	3	0							93	100	0	100	93	25	100	0	6222
Regiment + NIS	30 + 0.125% v/v	3-4 lsr	17-Jun		0	0	3	1	1	3							78	84	78	100	86	75	25	0	5984
Untreated																	9	6	10	6	46	1	2	9	3365
Regiment + NIS fb. Super Wham + COC	30 + .125% v/v fb. 6726 + 1.25% v/v	3-4 lsr fb. 1-2 Til	17-Jun	23-Jun	0	6	1	1	9	0	0	6	0	0	4	0	100	100	87	100	95	58	75	4	6622
Clincher + COC fb. Regiment + NIS	315 + 2.5% v/v fb. 37 + .125% v/v	3-4 lsr fb. 1-2 Til	17-Jun	23-Jun	0	0	0	3	3	0	1	1	0	0	3	0	100	0	0	0	98	100	0	0	6748
Regiment + Abolish	30 + 3363	3-4 lsr	17-Jun		0	10	1	1	8	0							79	83	62	60	94	50	0	0	6481
Regiment + MCPA + NIS	37 + 560 + .125% v/v	1-2 Til	23-Jun		0	0	0	0	1	0							40	0	55	0	92	75	0	0	5987
Regiment + NIS	37 + 0.125% v/v	1-2 Til	23-Jun		1	0	0	0	1	0							47	0	67	48	97	50	0	0	6202
Halomax 75 + NIS	70 + 0.5% v/v	3-4 lsr	17-Jun		0	0	0	0	1	0							25	100	0	100	60	17	100	87	4225
Permit 75DG + NIS	70 + 0.5% v/v	3-4 lsr	17-Jun		0	0	0	0	0	0							25	100	18	100	59	58	100	77	4049
Stam 4SC + COC	4484 + 1.25% v/v	3-4 lsr	17-Jun		0	0	0	0	0	0							56	0	34	85	77	100	100	37	6806
Stam 80 EDF + COC	4484 + 1.25% v/v	3-4 lsr	17-Jun		0	1	0	0	0	0							61	0	29	66	86	100	100	58	6679
LSD (P=0.05)																									1272

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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] PFS (pre-flood surface), PPI (pre-plant incorporated), fb. (followed by), 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 May 22, 2008 with 150 lbs per acre of M206
2. Trial managed as a pinpoint flood with flood water drained June 13 reflood June 19.
3. Watergrass was 4-5 leaf, bulrush was 2-4 leaf, 5-6" on June 17.
   Watergrass was 1-3 tiller, ricefield bulrush was 1-2 tller and ducksalad was 6-8 inches on June 23.
5. Spray applications made with 20 gallons/acre using 8003 nozzles.
6. Weather conditions on June 17: Air temperature 76° F, wind 0-1 MPH from the west.
   Weather conditions on June 23: Air temperature 78° F, wind 0 MPH.

Table 7. Drill seeded trial

Treatment	Rate	Timing[3]	Date		Phytotoxicity[1]												Weed Control[2]			
					1st						2nd									
					% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	ECHPH	ECHPH	LEFFA	Yield (kg/ha)
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			7 DAT			14 DAT			29-Jun	19-Jul		6-Oct
Untreated[4]	---	---															38	50	2	652
Prowl H2O	1120	DPRE	16-Jun		0	0	0	0	0	0							20	46	33	691
Prowl H2O fb. Super Wham + COC	1120 fb. 6726 + 1.25 % v/v	DPRE fb. 2-3 lsr	16-Jun	27-Jun	0	0	0	0	1	0	0	0	0	0	0	0	61	100	50	5199
Prowl H2O	1120	2-3 lsr (AFF)	27-Jun		0	0	0	0	0	0							25	37	58	1178
Prowl H2O + Super Wham + Whip + COC	1120 + 4484 + 32 + 1.25 % v/v	2-3 lsr (AFF)	27-Jun		0	0	0	0	3	0							68	98	33	5306
Prowl H2O + Regiment + Whip + NIS	1120 + 37 + 32 + 0.125 % v/v	2-3 lsr (AFF)	27-Jun		0	8	0	0	0	0							51	100	50	5819
Prowl H2O + Clincher + COC	1120 + 315 + 2.5 % v/v	2-3 lsr (AFF)	27-Jun		0	4	0	0	0	0							55	15	50	5617
Abolish	4480	DPRE	16-Jun		0	0	0	0	4	0							45	59	8	1201
Abolish fb. Super Wham + COC	4480 fb. 6726 + 1.25 % v/v	DPRE fb. 2-3 lsr	16-Jun	27-Jun	0	0	0	0	0	0	1	1	0	0	0	0	86	99	67	5417
Abolish fb. Regiment + NIS	4480 fb. 12.5 + 0.125% v/v	DPRE fb. 2-3 lsr	16-Jun	27-Jun	0	0	0	0	0	0	0	3	0	0	0	0	50	98	75	5332
Abolish fb. Regiment + Abolish + NIS	4480 fb. 30 + 3360 + 0.125% v/v	DPRE fb. 2-3 lsr	16-Jun	27-Jun	0	0	0	0	0	0	0	0	0	0	0	0	68	82	50	5583
Regiment + Abolish fb. Clincher + COC	25 + 3360 fb. 315 + 2.5 % v/v	2-3 lsr fb. PPF	27-Jun	11-Jul	0	0	1	0	0	0	0	0	0	0	0	0	68	92	50	6075
Regiment + Abolish fb. Super Wham + Whip + COC	25 + 3360 fb. 6726 + 32 + 1.25 % v/v	2-3 lsr fb. PPF	27-Jun	11-Jul	0	0	0	0	1	0	0	0	6	0	0	0	8	90	92	5395
Shark fb. Clincher + COC	168 fb. 315 + 2.5% v/v	3-4 lsr fb. PPF	30-Jun	11-Jul	0	0	0	1	3	0	0	1	1	1	21	0	24	37	8	1606
Super Wham + Whip + COC	4484 + 32 + 1.25 % v/v	3-4 lsr	30-Jun		0	25	0	1	30	0							1	77	100	2150
Clincher + COC fb. Superwham + COC	280 + 2.5% v/v fb. 6726 + 1.25% v/v	3-4 lsr fb. PPF	30-Jun	11-Jul	0	1	0	0	0	3	0	1	6	0	1	0	33	83	100	4643
Granite SC + COC fb. Clincher + COC	35 + 2.5% fb. 315 + 2.5% v/v	2-3 lsr fb. PPF	27-Jun	11-Jul	0	3	0	0	0	0	1	3	1	0	3	0	31	92	75	5938
Granite SC + Prowl H2O + Clincher + COC	35 + 1120 + 315 + 2.5 % v/v	2-3 lsr	27-Jun		0	0	0	0	0	0							59	96	92	5909
Granite SC + Clincher + COC fb. Super Wham + COC	35 + 280 + 2.5% v/v fb. 6726 + 1.25 % v/v	2-3 lsr fb. PPF	27-Jun	11-Jul	0	0	0	0	0	0	0	0	3	0	0	0	34	89	0	5648

LSD (P=0.05)

DPRE applications are tank mix with foliar herbicide if weeds are emerging at time of application
DPRE is after establishment flush when rice seed has fully imbibed

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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), lsr (leaf stage of rice), Til (tillers of rice), DPRE (pre emergent), EPE (early post emergent), AFF (after final flush), PPF (post permanent flood).

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

Trial Information

1. Trial seeded June 9, 2008 with 120 lbs per acre of M206
2. Trial managed as a drill seeded with initial flush on June 9, additional flushes on June 13, June 16 and June 25 with final flood on July 2.
3. Watergrass was 1 leaf on June 16.
   Watergrass was 3-4 leaf, sprangletop was 1 leaf on June 27.
   Watergrass was 3-4 leaf on June 30.
   Watergrass was 1-2 tiller, sprangletop was 3 leaf on July 11.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on June 16: Air temperature 63^o F, wind 1-3 MPH from the south.
   Weather conditions on June 27: Air temperature 83^o F, wind 2 MPH from the south.
   Weather conditions on June 30: Air temperature 74^o F, wind 2 MPH from the southeast.
   Weather conditions on July 11: Air temperature 75o F, wind 1-2 MPH from the southeast.

Table 8. Western Farm Service dry seeded trial

					Phytotoxicity[1]								
					1st						Weed Control[2]		
Treatment	**Rate**	**Timing[3]**	**Date**		% Stunt	% Stand	% Injury	% Stunt	% Stand	% Injury	ECHPH	ECHPH	Yield (kg/ha)
	(g ai/ha)		1st	2nd	7 DAT			14 DAT			29-Jun	19-Jul	30-Sep
Untreated[4]	---	---									46	30	1827
Prowl 3.3 (Harbinger)	897	prior to estab. flush	30-May		0	0	0	0.0	0.0	0.0	55	0	2300
Harbinger + SafeGuard	897 + 1% v/v	prior to estab. flush	30-May		0	0	0	0.0	0.0	0.0	0	0	1038
Harbinger + SafeGuard fb. Regiment + Breakthru + UAN 32	897 + 1% fb. 28 + 0.25% v/v +2% v/v	prior to estab. flush fb. 5 lsr	30-May	1-Jul	0	0	0	0.0	0.0	0.0	0	0	3368
Harbinger + SafeGuard fb. Granite SC + COC	897 + 1% v/v fb. 35 + 2.5% v/v	prior to estab. flush fb. 5 lsr	30-May	1-Jul	0	0	0	0.0	0.0	0.0	0	27	3290
Harbinger + Safeguard fb. Stam + COC + Hi-Wett	897 + 1% v/v fb. 6726 + 1.25% v/v + 0.39% v/v	prior to estab. flush fb. 5 lsr	30-May	1-Jul	0	0	0	0.0	0.0	0.0	8	31	4403
Prowl 3.3 (Harbinger)	897	After estab. flush (seed fully imbibed)	5-Jun		0	1.25	0	0.0	2.5	0.0	13	0	1886
Harbinger + SafeGuard	897 + 1% v/v	After estab. flush (seed fully imbibed)	5-Jun		0	1.25	0	0.0	0.0	0.0	40	12	2689
Prowl 3.3 (Harbinger) + Stam + COC	897 + 3363 + 1.25% v/v	2-3 lsr	13-Jun		1.25	0	2.5	1.3	0.0	0.0	64	5	2272
LSD (P=0.05)													2364

[1] % stunting (percent stunting of Crop), % stand (percent stand reduction), % 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), lsr (leaf stage of rice), Til (tillers of rice), DPRE (pre emergent), EPE (early post emergent), AFF (after final flush), PPF (post permanent flood).

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

Trial Information

1. Trial dry seeded May 30, 2008 with 200 lbs per acre of M206 then rolled twice for partial seed incorporation.
   Pre-flush herbicide applications made to dry seedbed.
2. Trial managed as a dry seeded with initial flush on May 30, additional flushes on June 9 and 16 with final flood on June 24.
3. No weeds visible on June 6.
   Watergrass was 1-2 tiller on July 1.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 30: Air temperature 79^o F, wind 3 MPH from the southwest.
   Weather conditions on June 5: Air temperature 72o F, wind 2-4 MPH from the northwest.
   Weather conditions on June 13: Air temperature 85o F, wind 2-4 MPH from the southwest.
   Weather conditions on July 1: Air temperature 63o F, wind 2 MPH from the south.

Table 9. Continuous flood trial at resistant site.

Treatment	Rate		Timing[2]	Dates		% Weed Control[1]					
						ECHPH	SCPMU	HETLI	ECHPH	SCPMU	Yield (kg/ha)
	(g ai/ha)	Prod./a		1st	2nd	7-Jul			13-Aug		9-Sep
Untreated											2183
Cerano[3]	673	12lb	DOS	9-May		2	71	7	6	68	1404
Cerano fb. Granite SC + COC	673 fb. 40 + 2.5% v/v	12lb fb. 2.4oz + 2.5% v/v	DOS fb. 4-5 lsr	9-May	13-Jun	44	98	93	77	99	10678
Cerano fb. Superwham + COC	673 fb. 6726 + 1.25% v/v	12lb fb. 6qt + 1.25% v/v	DOS fb. 4-5 lsr	9-May	13-Jun	56	99	90	95	98	10659
Cerano fb. Regiment + NIS	673 fb. 44.5 + 0.125% v/v	12lb fb. 0.79oz + 0.125% v/v	DOS fb. 4-5 lsr	9-May	13-Jun	63	82	88	79	93	7298
Cerano fb. Shark	673 fb. 112	12lb fb. 4oz	DOS fb. 4-5 lsr	9-May	13-Jun	0	87	0	0	94	9275
LSD (P=0.05)											1333
Granite GR[3]	40	15lb	2-3 lsr	20-May	13-Jun	3	21	4	6	23	5227
Granite GR fb. SuperWham + COC	40 fb 6726 + 1.25% v/v	15lb fb. 6qt + 1.25% v/v	2-3 lsr fb. 4-5 lsr	20-May	13-Jun	96	100	67	96	100	9042
Granite GR fb. Clincher + SuperWham + COC	40 fb 315 + 6726 + 2.5% v/v	15lb fb. 15oz + 6qt + 2.5% v/v	2-3 lsr fb. 4-5 lsr	20-May	13-Jun	100	96	70	92	99	9601
LSD (P=0.05)											2298

[1] 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)

[2] fb. (followed by), lsr (leaf stage of rice), Til (tillers of rice), PFS (pre-flood surface), PPI (pre-plant incorporated).

[3] Base herbicide weed control values represent % cover by the respective weed species

Trial Information

1. Trial seeded May 8, 2008 with 150 lbs per acre of M104.
2. Trial managed as a continuous flood.
3. No weeds on May 9.
   Watergrass was 2 leaf, bulrush was 1 inch, ducksalad was 1 inch, smallflower was 0.5 inch on May 20.
   Watergrass was 4 leaf, bulrush was 3 tiller, smallflower was 3 inchs, ducksalad was ready to flower June 13.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 9: Air temperature 79o F, wind 2-4 MPH from the north.
   Weather conditions on May 20: Air temperature 65o F, wind 1-2 MPH from the southeast.
   Weather conditions on June 13: Air temperature 80o F, wind 1-2 MPH from the north.

Main field treatment

65 gal aqua ammonia plus 2 gal/a Hydrahume, 200 lb/a ammonium sulfate starter
May 8 seeded with 180 lb per acre M104
May 19 Warrior + Dimilin + Strikeforce around borders of field
June 14 Riceshot @ 6 qt/a + Grandstand @ 2 oz/a + Agridex
July 7 Riceshot @ 6 qt/a + Regiment @ 5 oz/a + Agridex

Table 10. Stale seedbed - resistant site

					Phytotoxicity[1]	Weed Control[2]														
					2nd															
Treatment	**Rate**	**Timing[3]**	**Date**		% Stunting	ECHPH	LEEFA	SCPMU	CYPDI	HETLI	ECHPH	LEEFA	SCPMU	CYPDI	HETLI	ECHPH	LEEFA	SCPMU	CYPDI	HETLI
	(g ai/ha)				7 DAT	9-Jul					5-Aug					13-Aug				
Untreated[4]						8	10	8	1	14	8	10	6	1	1	5	8	3	1	1
Roundup + UAN	2% v/v + 2% v/v	After flush	27-May		NA	100	100	0	0	0	100	100	0	0	0	100	95	0	8	0
Roundup + UAN fb. Super Wham + COC	2% v/v + 2% v/v fb. 4484 + 1.25% v/v	After flush fb. 3-4lsr	27-May	9-Jul	0	100	100	0	0	0	100	99	70	95	88	100	94	75	67	0
Roundup + UAN fb. Granite SC + COC	2% v/v + 2% UAN fb. 35 + 2.5% v/v	After flush fb. 3-4lsr	27-May	9-Jul	3	100	100	0	0	0	100	99	100	0	67	100	99	75	58	0
Roundup + UAN fb. Granite SC + Clincher + COC	2% v/v + 2% UAN fb. 35 + 315 + 2.5% v/v	After flush fb. 3-4lsr	27-May	9-Jul	3	100	100	0	0	0	100	100	75	100	79	100	100	88	0	0
Roundup + UAN fb. Regiment + NIS + UAN	2% v/v + 2% v/v fb. 44.5 + 0.25% v/v + 2.0% v/v	After flush fb. 3-4lsr	27-May	9-Jul	5	100	100	0	0	0	100	100	75	100	79	100	100	100	0	0
LSD (P=0.05)																				

[1] % Stunting (Percent stunting of 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), lsr (leaf stage of rice), Til (tillers of rice), PFS (pre-flood surface), PPI (pre-plant incorporated).

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

Trial Information

1. Trial timeline
May 2 Plot layout, apply mustard meal and rake in, flush and drain
May 5 Flood field and hold shallow water to keep soil wet
May 14 Begin drain of field
May 15 Water off stale seedbed
May 20 West half of field sprayed with 2% glyphosate plus triclopyr using ground rig
May 25 East half of field sprayed with 1.5% glyphosate plus MCPA plus ammonium sulfate
May 27 Burn down treatments applied to test plots

May 28 Field flooded
May 30 Seed applied at 150lb/a, M104
June 6 Urea applied at 100 units of N/a
June 25 Rice stand thin and ducksalad and bulrush establishing
July 3 Flood water lost due to water delivery issue
July 8 Drain field
July 9 Apply Granite SC plus Clincher to main field, follow up treatments applied to test plots
July 10 Flood field
July 25 Fertilize topdress with 50 units N as ammonium sulfate
August 6 Fertilize topdress with 20 units N as ammonium sulfate (early heading)
2. Trial managed as a stale seedbed with pinpoint drain for foliar herbicide applications.
3. Watergrass and sprangletop were 2-3 leaf, bulrush was 1-2 leaf, smallflower ws 1-2 leaf, ducksalad was 1-2 leaf on May 27.
Watergrass was 5-6 leaf, sprangletop was flowering, bulrush tillering, ducksalad was early flower, redstem 4 leaf on July 9.
4. Spray applications made with 20 gallons/acre using 8003 nozzles.
5. Weather conditions on May 27: Air temperature 75° F, wind 0-1 MPH from the northeast.
Weather conditions on July 9: Air temperature 80° F, wind 1-2 MPH from the north.