Texas Rice Special Section
Highlighting Research

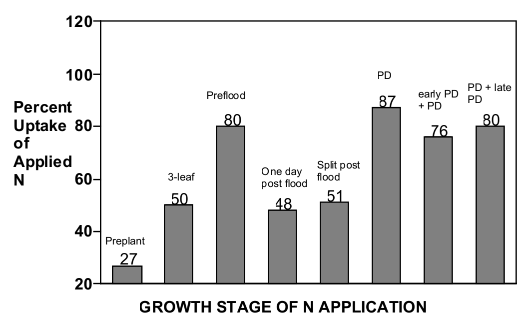
Agronomic Management

Dr. Fred Turner

Rice Plant Recovery of Urea-N Applied at Specific Growth Stages

To obtain the most income from each dollar invested in N fertilizer, it becomes important to know which N application time is most efficiently used by rice plants. To measure N efficiency at a given application time, 50 lbs N enriched with ^{15}N ("tagged N") were applied at the following growth stages: 1) preplant, 2) three-leaf, 3) preflood on dry soil, 4) one-day post flood, 5) one-day and ten-day post flood, 6) PD, 7) early PD and PD, and 8) PD and late PD. In addition, 100 lbs of "non-tagged" N/A were applied at other times to achieve a total of 150 lbs N/A on Gulfmont at Beaumont (2 years) and Eagle Lake (1 year). Figure 1 shows N uptake efficiencies for the application times described above and indicates that: a) Applying N at the 3-leaf stage rather than at preplant may reduce total N rate under some conditions; b) Preflood N on dry soil was 1.6 times more efficient than postflood N applied within 10 days after flooding even if the postflood was applied in two applications; and c) One N application at PD, after roots have entered the floodwater, was more efficient than early or late split application near PD stage.

Fig.1: Plant Recovery of 50 lbs urea applied at specific growth stages



Percent N uptake varies with year, soil type and water management. The values in the figure represent the average for three years and two soil types. For more details or to request a copy of an annual research report contact Dr. Fred Turner at 409-752-2741 ext. 2223 or email f-turner@tamu.edu.

Screening Rice Varieties from Other States for Main and Ratoon Crop Yield and Quality In Texas

We evaluate main and ratoon crop yield and quality of potential rice varieties from Texas, Louisiana, Arkansas and Mississippi at two locations, with different soil types and multiple plant populations. The data helps producers and consultants make variety-specific management decisions for main and ratoon yields in Texas. For each of the 10 to 12 varieties evaluated, the following data are collected: seed/lb, targeted seeding rates and achieved seedling/ft^2, maximum tillering capacity, minimum nitrogen rates, lodging potential, strengths and weaknesses of each variety and an economic ranking for main, ratoon and total crop yield based on the combination of yield and milling data.

Last year the highest economic ranking varieties for total crop at Eagle Lake were: Cocodrie, Cypress, La2128, Dixiebelle and Wells. At Beaumont the highest economic ranking varieties for main crop were: Cocodrie, Jefferson, La2128, Gulfmont and Wells. For more details, or to request a copy of an annual research report, contact Dr. Fred Turner at 409-752-2741 ext. 2223 or email f-turner@tamu.edu.

Can Total Non-structural Carbohydrates (TNC) in Stems at Main Crop Harvest Serve as a Tool to Adjust Ratoon Crop Inputs?

In research plots where most other ratoon yield influencing factors were held constant, 66 to 90% of the ratoon crop yield variability was attributed to TNC in stems at main crop harvest. Variability in stem TNC may cause variability in ratoon tillering and ratoon yield. This will be the second year of providing farmers, consultants and extension agents with "TNC Sampling Kits". Main crop stem samples submitted for TNC analysis 3 to 5 days prior to main crop harvest allow for TNC analysis data to be returned to farmers within 3 days for use in predicting ratoon yield potential and management level of individual fields. Data from the past 3 years suggest:

1) Within certain restrictions, the relationship between stem TNC at main crop (MC) harvest and ratoon crop (RC) yields is relatively strong across the Texas Rice Belt. TNC levels less than 350 lbs/A, when ratoon tillers are not visible, are strong indicators that ratoon yield potential is less than 1200 lbs/A even under very high input levels. TNC levels of 1000 or more lbs/A typically produce ratoon yields of 3000 or more lbs/A.

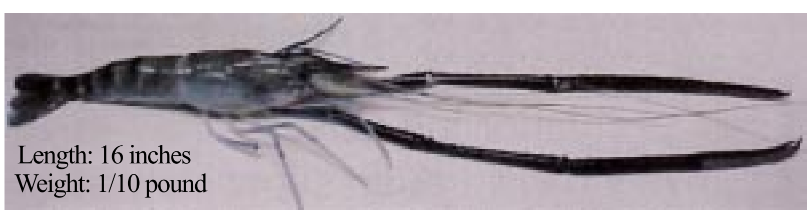
2) Excellent ratoon yields (2800 to 3800 lbs/A) were achieved when Jefferson MC was harvested the 3rd week of July 2000, even though MC TNC levels were low. These data suggest that good ratoon yields are possible even though TNC levels are low if the MC is harvested before August and disease pressure is low.

3) Lowering the MC cutting height from 18 to 8 inches tended to slightly increase RC yield in 1998 when RC yield potential was low. With higher RC yield potential in 1999, the 8" cutting height increased RC yield up to 1000 lbs/A under the highest level of management. In 2000 the lower MC cutting height increased RC yield 500 to 800 lbs/A. Lower MC cutting height appears to be the quickest route to improved RC yields in Texas. Low cutting could impact N management and water quality. Benefits of the 8" cutting height tended to increase as RC yield potential increased.

For these reasons we will test most of our ratoon crop treatments at the low main crop cutting height. For more details contact Dr. Fred Turner at 409-752-2741 ext. 2223 or email f-turner@tamu.edu.

Can We Produce Fresh Water Prawns in Rotation with Rice Somewhat Like Crawfish?

Since the U.S. consumes 82% more shrimp than it catches or produces, we want to find out if Texas rice fields can produce fresh water prawns (*Macrobrachium Rosenbergii*) for the shrimp market. Fresh water prawns are currently being "grown-out" in intensely managed 3 to 5 ft deep ponds stocked with juvenile prawns. Juvenile prawns must be purchased from a hatchery/nursery because they will not reproduce in our climate or survive our winters (60ºF or less are fatal to young fresh water prawns). We hope to develop practices for growing-out the 20-day old juvenile prawns in 18" deep water producing 1000 lbs prawns/A of the 10 per pound size in 150 days valued at roughly $2500/A. Given estimated production costs (including stocking, feed, labor, water, land, and harvest) there is a possible return of $1,000/A.

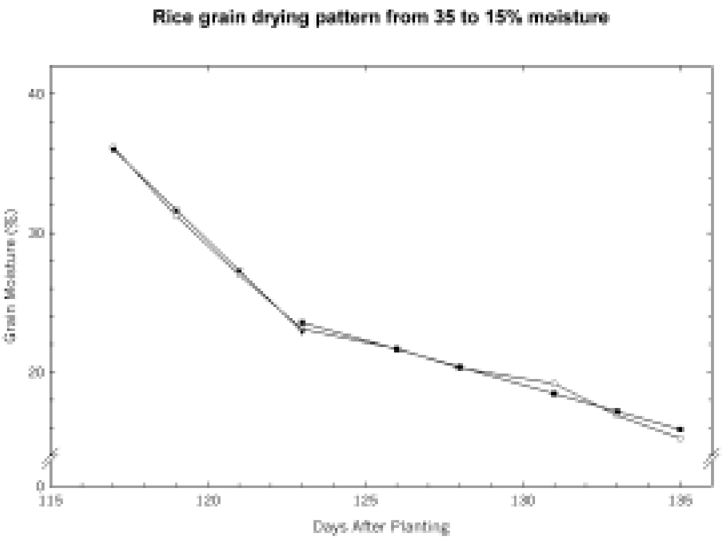


Initial results indicate that oxygen levels in the flooded fields containing decaying vegetation are lower than acceptable, while flooded fields of young rice plants have acceptable oxygen levels for prawns. Even though the fresh water prawns seem to be more sensitive to our climate than crawfish, they have possibilities that warrant further evaluation. For more information contact Dr. Fred Turner at 409-752-2741 ext. 2223 or email f-turner@tamu.edu.

Impact of MC Drain Times on MC Milling and Grain Drying Patterns

Dr. Garry N. McCauley

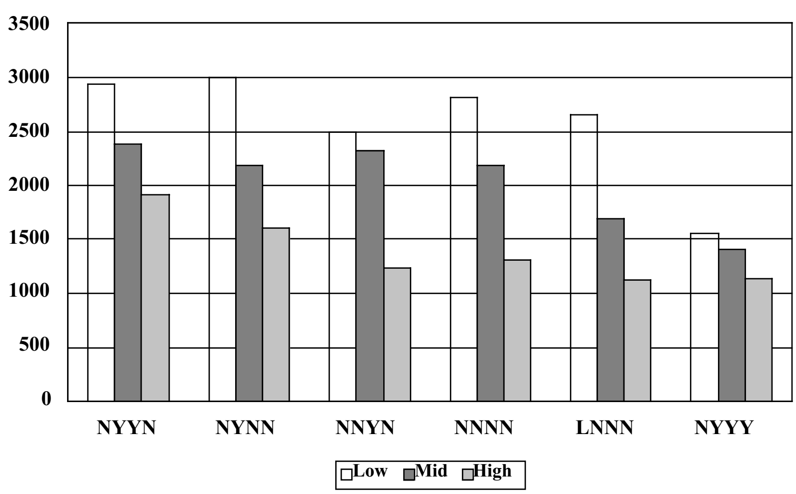
Research was conducted for 5-years at the Beaumont Research and Extension Center to evaluate the impact of MC drain time on grain drying patterns and milling quality. Lemont rice was uniformly drill seeded in large blocks. Management followed best management practices for Lemont except for drain time. Blocks were drained at 4-day intervals from 7 days after heading to 27 days after heading. A 4-row by 20-foot sample was harvested at about 2-day intervals between 35% and 15% grain moisture. Harvest grain moisture was determined then the sample was dried to 12%. Total and whole milled grain was determined using standard milling procedures. Rice drained between 15 and 27 followed the same drying pattern and was never significantly different in grain moisture. The figure shows the rice-drying pattern averaged across drain times with the same drying pattern. Only when rice was drained at 7 days after heading was there a reduction in percent whole milled grain. It has been long assumed that rice lost 1% grain moisture per day but the figure shows that this is not the case. Rice will lose 2.2 % per day above 23% grain moisture. Then the grain drying characteristics changes and moisture loss was 0.6% per day between 23 to 15% grain moisture. Using the old 1% rule would over or under estimate moisture loss depending on the stage of the rice. The cause of the drying rate change needs further investigation. For more information contact Dr. Garry McCauley at 979-234-3578 or email gmccaule@elc.net.



Integrated Rice Management for Ratoon Production

Impact of MC management on RC production has been evaluated for the past three years in Cypress, Cocodrie, and Jefferson rice at Eagle Lake. Input variables included nitrogen, fungicide, late season phosphorus, shading, and MC cutting height. Results are presented in the figure. Cutting heights evaluated were high - just below the head, mid – mid straw, and low – 4 inches above the ground. Cutting height is clustered together by management input. Labels are defined as: first letter reflects nitrogen level normal (180) or low (120), second letter is yes or no fungicide, third letter indicates yes or no for late season phosphorus, the last let-

Impact of nitrogen, fungicide, phosphorus, and shading on ratoon crop yield forCypress



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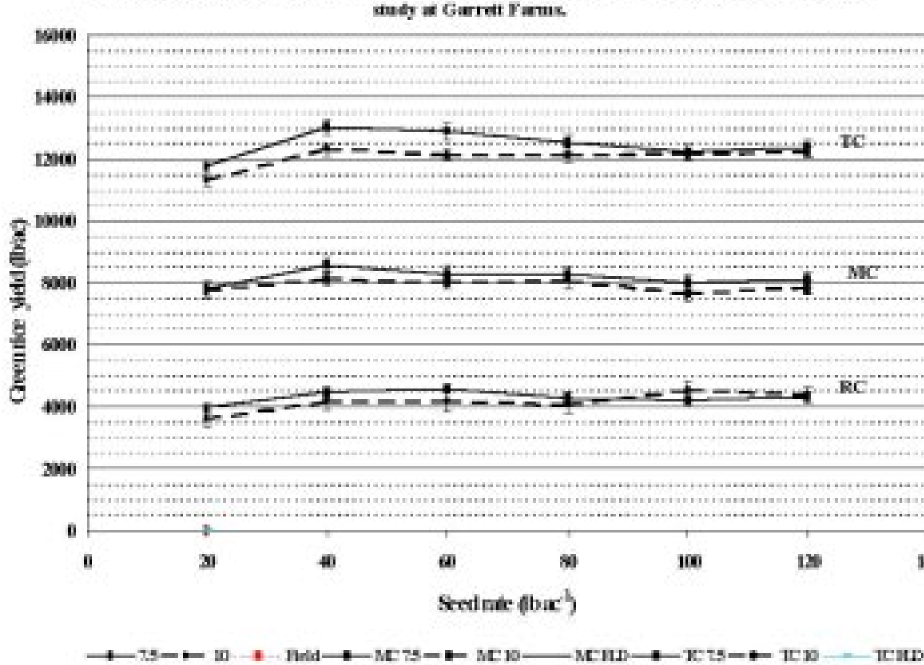
ter indicates yes or no shade for 2-weeks post flowering. A fungicide treatment consisted of tilt at the 2-inch panicle followed by Quadris 14 days later. Late season phosphorus was 40 pounds per acre of 0-60-0 applied at the soft dough stage of the rice. Shade post flowering in the MC drastically reduces the RC yield and reduces the impact of the other management inputs even with fungicide (NYYY). Cutting height was the only MC management variable that consistently impacted RC yield. The lower the MC was cut the higher the RC yield. Late season phosphorus tended to reduce RC yield (NNYN versus NYNN or NNNN). Two MC fungicide applications did not consistently nor significantly increase RC yield (NNNN versus NYYN or NYNN). Reducing the MC nitrogen from 180 to 120 pounds per acre only reduced the RC yield by about 200 pounds per acre. The only producer-controlled variable that consistently increased RC yield was cutting height. For more information contact Dr. Garry McCauley at 979-234-3578 or email gmccaule@elc.net.

Large Field Evaluation of Row Spacing and Seeding Rate in Cypress Rice

Row spacing and seeding rates in Cypress rice was evaluated in large field test on Garrett Farms in Brazoria County. Main and ratoon crop yield and yield components have been measured for 1998-2000. MC, RC, and TC rice yields are shown in the attached figure. Row spacing was 7.5 and 10 inch and seeding rates were 20, 40, 60, 80, 100, and 120 pounds per acre. The producer used a fall stale seedbed cultural system. Management and crop development were recorded. MC and RC yields with 7.5-inch row spacing were always equal to or better than the 10-inch row spacing. Optimum seeding rate was 40 to 60 pounds per acre. Yield declined severely from 40 to 20 pounds per acre. The yield penalty was not as great as seeding rate increased from 60 to 100 pounds per acre.

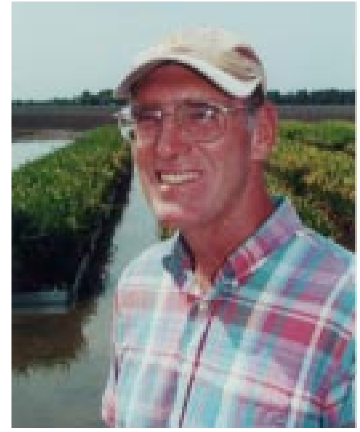
Thus producers should select a seeding rate that allows some error to the higher rate. Seed stacking does appear to be a problem as seeding rate increases. For 7.5-inch row spacing, productive seed declined linearly from a high of 90% at 20 pounds per acre to 70% at 80 pounds per acre. Productive seed remained constant at 70% as seeding rate increased to 120 pounds per acre.

Figure Cy F 7.0. Green rice yield from Summary 1998-2000 Cypress row spacing by seeding rate study at Garrett Farms.



The most important yield component appeared to be panicles per seedling, as panicles per seedling declined from 5 to 2 as seeding increased from 20 to 120 pounds per acre. Panicles per seedling were nearly asymptotic from 80 to 120 pounds per acre. In the ratoon crop, panicles per seedling declined from 6.5 at 20 pounds per acre to near 2 at 120 pounds per acre. Sterility was a constant 28% and would appear to be a limiting factor in the RC. Plot yield – yield component correlation indicated grain weight to be a significant factor in RC yield, but it varied less than 1% with seeding rate. For more information contact Dr. Garry McCauley at 979-234-3578 or email gmccaule@elc.net.

Rice Water Weevil Research – New Chemistry


Dr. M.O. Way

Every year we evaluate novel insecticides to try to increase the number of pest management tools available to Texas rice farmers. More tools means less chance of resistance build-up, insurance against withdrawal of an insecticide by EPA, and greater competition among basic manufacturers which theoretically reduces pesticide costs. This year we are evaluating the following new insecticides at different rates and timings: Danitol 2.4EC – early postflood; Adage 5FS – seed treatment; Gaucho 480 – seed treatment; V-10101 2.25EC – early postflood; F0570 0.8EC – early postflood; Experimental – preflood and early postflood. For more information contact M.O. Way at 409-752-2741ext. 2231 or email moway@aesrg.tamu.edu.

Rice Water Weevil Research – Storage Study

If rice seed is treated with Icon 6.2FS in the winter, stored, then planted in the spring, will the treatment remain effective? We answered this question with an experiment conducted at the Beaumont Center this year. XL-6 and Cocodrie were treated with Icon 6.2FS at 0.0375 lb (AI)/acre in Dec 2000 (then stored in a rice bin) or treated in Apr 2001 (just before planting). Plots were planted at 80 lb seed/acre in April. Results of the test, showed that storage of treated seed overwinter did not reduce efficacy of Icon 6.2FS (Table 5). For more information contact M.O. Way at 409-752-2741ext. 2231 or email moway@aesrg.tamu.edu.

Table 5. Storage Study at Beaumont, TX. 2000/2001.

		No. immature RWW / 5 cores				
Variety	Treatment	I	II	III	IV	0
XL6	Untreated	63	76	59	83	70.3
XL6	Treat, Plant	15	8	6	4	8.3
XL6	Treat, Store, Plant	4	3	3	3	3.3
Cocodrie	Untreated	86	65	64	84	74.8
Cocodrie	Treat, Plant	16	9	11	19	13.8
Cocodrie	Treat, Store, Plant	14	5	10	10	9.8

Stem Borer Research – Pheromone Trapping

Stem borers, primarily Mexican rice borer (MRB), are becoming increasingly abundant and damaging in the southern portion of the Texas Rice Belt (Jackson and Matagorda Counties). The MRB was introduced from Mexico into the Lower Rio Grande Valley of Texas in 1980 and was first detected in the Texas Rice Belt in 1987. In 2000, MRB pheromone traps were placed in most counties of the TRB to determine the current range of this insect. Adult moths were collected in five new counties (Fort Bend, Brazoria, Wharton, Waller and Colorado) (Fig. 1) and (Table 1). However, none

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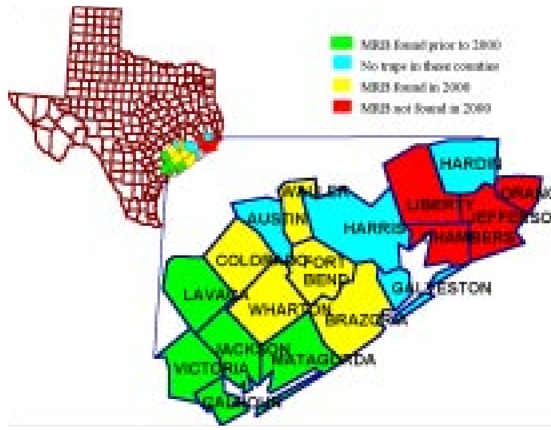
Table 1. Mexican rice borer (MRB) pheromone trap collections in the Texas Rice Belt. 2000.

		Month of collection						
County	Trapper	May	Jun	Jul	Aug	Sept	Oct	Nov
Calhoun[1]	Havlak	-	-	110	307	385	560	107
Jackson[1]	Lesikar	263	350	275	276	98	102	34
Matagorda[1]	Batchelor	846	832	462	1175	1096	435	-
	Burnside	-	-	-	483	196	-	-
Brazoria[2]	Garrett	6	39	23	31	6	-	6
Colorado[2]	Vawter	75	192	203	305	432	712	113
Fort Bend[2]	Avriett	56	210	85	135	43	-	-
Waller[2]	McGee	0	4	10	16	18	23	9
Wharton[2]	Jahn	109	228	232	325	393	638	132
Chambers	Nunez/Way	0	0	0	0	0	0	0
Jefferson	Nunez/Way	0	0	0	0	0	0	0
Liberty	Holcomb	0	0	0	0	0	0	0
Orange	Chiarello	0	0	0	0	0	0	0

[1]MRB found prior to 2000
[2]MRB found in 2000

were collected in counties east of Harris. Trap counts suggest that populations gradually build during the summer and peak in early fall when ratoon rice is maturing.

This research is being continued and expanded in 2001 and is partially funded by TRRF. Lead researcher on this project is Dr. M.O. Way with cooperation from Dr. Gene Reagan, sugarcane entomologist at LSU. Technical support staff include R. G. Wallace and M. S. Nunez, Derick Beach, Ryan Martin, Lucas Moore, Matt Vaglica, Matt Heiner, Adam Blackwelder and Travis Aldrich. For more information contact M.O. Way at 409-752-2741ext. 2231 or email moway@aesrg.tamu.edu.



Stem Borer Research - Insecticide Evaluations

Experiments conducted in 1999 and 2000 at Ganado, TX showed that stem borers, primarily Mexican rice borer (MRB), did not attack rice until about panicle differentiation, even though adult MRB were collected in pheromone traps much earlier (before the permanent flood). This suggests that moths are actively choosing to lay eggs in rice at a certain stage of development of the crop. Information such as this can help pinpoint the best time to apply insecticides for maximum effectiveness. Research last year showed that Icon 6.2FS as a seed treatment at the rate commonly used by growers significantly reduced whiteheads compared to the untreated (Table 2). Intrepid 240SC and Confirm 2F also reduced whiteheads. In another experiment, Karate Z applied at the first sign of stem borer damage (about panicle differentiation) significantly reduced whiteheads (Table 3). This research is being expanded in 2001 to include evaluation of the insecticides, rates and timings. (Table 4) We thank TRRF for partially funding these studies. For more information contact M.O. Way at 409-752-2741ext. 2231 or email moway@aesrg.tamu.edu.

Table 2. Evaluation of selected insecticides for stem borer control. Ganado, TX. 2000.

Treatment	Rate [lb (AI)/acre]	Timing	RWW per 3 cores	Whiteheads per 4 rows[4]	Yield (lb/acre)[b]
Icon 6.2FS	0.0375	st[1]	3.0	33.0 b	8932 a
Icon 6.2FS	0.05	st	3.0	29.0 b	8445 a
Intrepid 240SC	0.06	1st sign[2]	-	43.8 b	7080 b
Intrepid 240SC	0.06 + 0.06	1st sign + 3 wks	-	46.3 ab	7249 b
Intrepid 240SC	0.06	boot	-	37.0 b	7448 b
Intrepid 240SC	0.06	1 wk after 1st sign	-	45.3 ab	7577 b
Confirm 2F	0.125	boot	-	40.3 b	7133 b
Confirm 2F	0.25	boot	-	34.5 b	7141 b
Karate Z	0.03	2 bpf[3]	0.5	48.5 ab	8535 a
Untreated	-	-	23.3	64.5 a	7015 b

[1]st = seed treatment [2]1st sign = 1st sign of damage (1 in. panicle) [3]bpf = before permanent flood [4]Means in a column followed by the same letter are not significantly different at 6% level for whiteheads and 5% level for yield (ANOVA, DMRT).

Table 3. Evaluation of Karate Z for stem borer control. Ganado, TX. 2000.

Treatment	Rate [lb (AI)/acre]	Timing	Whiteheads per 4 rows[2]
Karate Z	0.04	1st sign[1]	21.3 b
Karate Z	0.03	1st sign	25.5 b
Untreated	-	-	68.8 a

[1]1st sign = 1st sign of damage (1 in. panicle) [2]Means in a column followed by the same letter are not significantly different at 5% level (ANOVA, DMRT).

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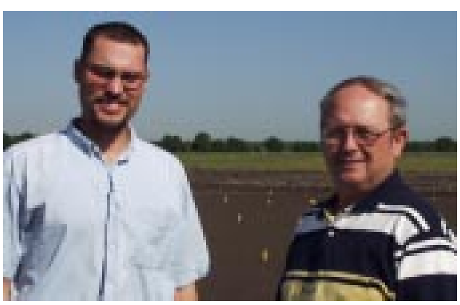
Table 4. Stem borer insecticide screening in Ganado, TX. 2001.

Trt. #	Treatment	Rate [lb (AI)/acre]	Timing
1	Intrepid 2F	0.06 lb (AI)/acre	pd[1]
2	Intrepid 2F	0.09 lb (AI)/acre	pd
3	Intrepid 2F	0.09 lb (AI)/acre	boot
4	Icon 6.2FS + Intrepid 2F	0.0375 + 0.09 lb(AI)/acre	st[2] + pd
5	Icon 6.2FS	0.0375 lb (AI)/acre	st
6	Orthene 75S	0.5 lb (AI)/acre	heading
7	Orthene 75S	1.0 lb (AI)/acre	heading
8	Karate Z	0.03 lb (AI)/acre	heading
9	Icon 6.2FS + Karate Z	0.0375 + 0.03 lb (AI)/acre	st + pd
10	Dimilin 2L	0.1875 or 0.125 lb(AI)/acre	boot
11	Dimilin 2L	0.1875 lb (AI)/acre	9 dapf [3]
12	Dimilin 2L	0.1875 lb (AI)/acre	16 dapf
13	Dimilin 2L	0.1875 lb (AI)/acre	26 dapf = pd
14	Sevin XLR Plus	1.5 lb (AI)/acre	pd
15	Tracer	0.089 lb (AI)/acre	pd
16	Steward SC	0.09 lb (AI)/acre	pd
17	Compound X	-	pd
18	Compound X	-	pd
19	Karate Z	0.03 lb (AI)/acre	1 dbpf [4]
20	Untreated	-	-

[1]pd = panicle differentiation
[2]st = seed treatment
[3]dapf = days after permanent flood
[4]dbpf = days before permanent flood

Impact of Newpath Herbicide for Weed Control in Clearfield Rice



Brian Ottis and Dr. Mike Chandler

For the past two years, studies have been conducted in Beaumont and Eagle Lake, TX to evaluate Newpath herbicide (imazethapyr) for weed control in CLEARFIELD rice. Application timings evaluated were single and sequential applications made preplant incorporated (PPI), preemergence (PRE), early postemergence (EPOST), and late postemergence (LPOST). Rates PPI and PRE included 2, 3, 4, 5, and 6 oz/A. EPOST and LPOST rates being evaluated were 1, 1.5, 2, 3, and 4 oz/A. Lower rates were applied at Eagle Lake due to a coarse soil. Weeds evaluated were red rice and barnyardgrass at Beaumont and broadleaf signalgrass at Eagle Lake. Red rice control at Beaumont 21 days after treatment (DAT) with sequential applications at all rates was greater than 92%, while less than 70% control was observed with a single PPI or PRE application, regardless of rate. Adequate red rice control is best achieved with sequential applications of Newpath. Broadleaf signalgrass control was greater than 87% with a sequential application of Newpath regardless of rate. Crop injury following PRE and PPI applications was less than 5% at both locations regardless of rate. Injury 7 DAT of EPOST applications at Beaumont was greater than 20% with sequential applications of Newpath. In Eagle Lake, injury was higher following EPOST applications at lower rates of Newpath. However, once permanent flood was established, no visible differences in crop injury were observed. Rice yields in all treatments were greater than 6000 lb/A. Lower rates of Newpath are essential on lighter soils to minimize crop injury. Studies are currently in progress to evaluate red rice control and crop response on lighter soils to determine the most effective rate combinations for this area. CLEARFIELD rice will be a useful tool in red rice control. However, other herbicides will be needed for control of leguminous weeds such as hemp sesbania and jointvetch. Research on this project was conducted by Brian Ottis, Garry McCauley and Mike Chandler. For mor information contact Dr. Mike Chandler at 979-845-8736 or email jm-chandler@tamu.edu.

Entomology/Plant Pathology/Weed Management continued...

Weed Management Systems in Rice

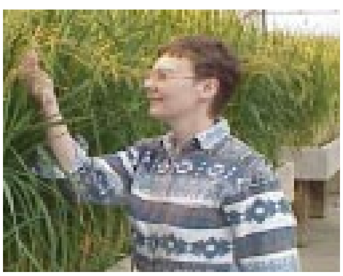
Dr. Arlen Klosterboer

In addition to traditional Extension Activities, an extensive weed control research program is conducted annually in rice and soybeans. The objectives of the program include 1) to screen and develop herbicides for utilization in rice and soybeans, 2) to develop new and improved technology of present commercial herbicides for more effective and economical weed management and 3) to provide necessary research information to agricultural chemical industry for the development and registration of experimental herbicides in weed control systems, and for expansion of uses of presently labeled herbicides. The research has played a major role in the development and introduction of Arrosolo, Basagran, Command, Facet, Grandstand R, Londax, Permit, Storm, Whip 360 and conservation tillage. Herbicides presently being researched include Aura, Clincher, Regiment, Ricestar and Liberty Linked and Clearfifeld/New Path weed control systems.

The results are used extensively in rice and soybean weed control educational programs to provide farmers current information regarding weed management. This research program is presently being supported by the agricultural chemical industry. For more information contact Dr. Arlen Klosterboer at 979-845-146 or email a-klosterboer@tamu.edu.

Genetics

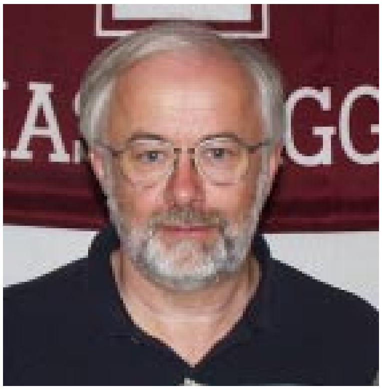
Incorporating Seedling Vigor Genes into U.S. Germplasm



Dr. Shannon Pinson

In the 1980's, when the U.S. rice industry switched from growing tall rices to growing semidwarf varieties, it was apparent that the semidwarfs had less seedling vigor and cold tolerance than the taller varieties. It is now known that the *sd1* gene, used worldwide to produce semidwarf rices, is genetically linked to reduced vigor from shortened mesocotyls and coleoptiles. Rather than "fixing" the problem genetically with the release of vigorous semidwarf varieties, production practices have been altered to accommodate this reduced vigor - one example of which is seed treatment with gibberelic acid to enhance seedling elongation. The development of vigorous semidwarf varieties would benefit rice producers in many ways, including 1) early planting under relatively cool temperatures, which would lengthen the growing season and increase opportunity for ratoon cropping; 2) earlier flooding which would save water and suppress weeds; and 3) deep planting to take advantage of soil moisture reserves, a practice which would protect seed from bird feeding and further save water and suppress weeds. Dr. Shannon Pinson has identified three genes that, when combined, produce mesocotyls four times longer than those of present semidwarf varieties. One of these genes is in U.S. semidwarfs, but long mesocotyls only result when combined with two genes from foreign germplasm, one of which is genetically linked to *sd1*. Dr. Pinson has identified 17 lines containing all three of the desired seedling vigor genes and the *sd1* semidwarf gene. These lines emerge and tiller extremely well even when drill-planted 2-inches under heavy clay soils, and exhibit some cold tolerance. The vigor of these lines exceeds that of 'Cypress'. Although these have undesirable grain quality, they are significantly improved sources from which breeders can extract seedling vigor for incorporation into improved semidwarf rice varieties. After collecting additional 2001 field-plot data, Dr. Pinson will identify one to three lines with the most desirable traits for formal release to public U.S. rice breeders. For more information contact Dr. Shannon Pinson at 409-752-5221 or email sr-pinson@tamu.edu.

The increased vigor of one of the identified progeny lines (two right rows in photo) is readily apparent when compared with Lemont (two left rows)



Dr. Bill Park

Molecular Markers for Blast Resistance Genes

Our work involves the practical application of biotechnology in breeding programs. In previous work, we identified molecular markers linked to the blast resistance genes Pi-k^h, Pi-ta^2 and Pi-b. Recently we were also able to obtain markers tightly linked to Pi-Z. Unlike many DNA markers that only are useful in specially constructed "mapping populations", these markers give useful polymorphism in the narrow crosses most often used in breeding programs.

When incorporating several resistance genes in a variety, it can often be difficult to detect individual genes if their resistance spectra overlap. The presence of one gene, in essence, "masks" the presence of another. Use of molecular markers, instead of a phenotypic evaluation, circumvents this problem. Using DNA markers also allows selection to be done year-round, and to be done on early generation seedlings which makes it more cost effective than traditional methods.

All of our markers have been transferred to the USDA-ARS DNA marker laboratory in Beaumont, Texas and are being used in the breeding program. All of our markers were identified using public DNA databases, thus they can be used by breeders without having to pay royalties. Researchers working on this project include Connie Bormans, Anna McClung, Toni Marchetti, Carl Johnson and William Park. For more information contact Dr. Bill Park at 979-845-8868 or email wdpark@tamu.edu or Dr. Anna McClung at 409-752-5221 ext. 2234 or email a-mcclung@tamu.edu.

DNA Markers for Blast Disease Resistance

Dr. Bob Fjellstrom

Rice blast (caused by *Pyricularia grisea*) is a constant disease threat throughout rice growing regions of the world. Using genetic resistance to blast is a cost-effective and environmentally friendly means to control crop losses due to blast. There are several races of the blast fungus present in Texas. Unfortunately, genes controlling resistance to blast confer resistance to one or more races of blast, but not all. Several resistance genes, therefore, must be combined to obtain broad-spectrum blast resistance. DNA markers indicating the presence of disease resistance genes provide a means to effectively combine several resistance genes together without laborious progeny testing.

The USDA/TAMU rice varietal development program in Texas has been developing DNA markers associated with several major blast resistance genes to make breeding for disease resistance more efficient and effective. Markers initially identified in the lab of Dr. Bill Park at TAMU-College Station were evaluated in independent laboratory tests to confirm their association with blast resistance genes along with new markers developed at USDA/TAMU-Beaumont, analyzing markers and race-specific resistance reactions in progeny from genetic crosses. High correlations (greater than 98%) were found between the presence of markers and disease resistance. The markers identified are linked to the Pi-b, Pi-k^h, and the Pi-ta^2 resistance genes which confer resistance to all blast races presently found in the U.S.

These results confirm that these genetic markers are reliable in predicting the presence of blast resistance genes in breeding materials that are important in developing disease resistant varieties for Texas. Researchers on this project include R. Fjellstrom, W.D. Park, C. Conaway, A.M. McClung, R. Shank, and M.A. Marchetti, with technical support from R. Boyd, J. Cammack, P. Carre, J. Cockrell, P.M. Frank, G. Gipson, C. McCormick, and A. Menard. For more information contact Dr. Bob Fjellstrom at 409-752-2741 ext. 2225 or email r-fjellstrom@tamu.edu.

Red Rice is Not Just One Weed Species

All red rice found in production fields has traditionally been classified as *Oryza sativa* – the same species as commercial rice. As a result, red rice has generally been viewed as a single generic problem. Using DNA markers, we found that red rice is much more divergent than previously realized. Most red rice is similar to Asian cultivars of commercial rice. Other red rice is very similar to US commercial cultivars – perhaps due to natural crossing between red rice and US cultivars. However, some red rice from across the US rice belt is distinctly different from commercial rice. Instead it is closely related to the noxious weed *Oryza rufipogon*. Generally speaking, black-hulled types of red rice are closely related to *O. rufipogon,* while straw-hulled types are more related to *O. sativa*, but this is not always the case. Almost all of the previous work on red rice control used straw hulled accessions.

Whether the results of these studies will also apply to the O. *rufipogon*-like red rice is not completely clear. There is already evidence of substantial natural herbicide tolerance in some *O. rufipogon*-like red rice that needs to be carefully considered in designing red rice control strategies for Texas. Researchers working on this project include Kelly Vaughan, Brian Ottis, Mike Chandler and William Park. For more information contact Dr. Bill Park at 979-845-8868 or email wdpark@tamu.edu.

Plant Physiology

Physiology Research to Improve Combined First and Second Crop Yield

Dr. Lee Tarpley

The principal scientist, Lee Tarpley, started in January 2001 as an Assistant Professor and Whole Plant Physiologist at the TAMU Center in Beaumont. He will be researching the physiology of the rice plant in support of both production and varietal improvement. This project has two parts: (1) identify management practices to make ratoon tiller establishment more consistent, and (2) figure out the details of how the rice plant stores, and then later uses, temporary reserves of carbohydrates (sugars and starch) and nitrogen-containing compounds (such as protein). The plant naturally uses these reserves to help fill the grain, to help the new ratoon tillers to get established, and to help fill the ratoon grain. We would like to be able to use Plant Growth Regulators (PGRs) and other management choices to direct the processes of ratoon establishment and grain filling. Field sites are in Beaumont and Eagle Lake. Selected PGR treatments are to be applied after flowering of the main crop or ratoon crop of Cocodrie. The plants are being sampled periodically for physiological and biochemical change as they develop and in response to PGR treatments.

Fred Turner and Mike Jund are cooperating scientists and Ronnie Porter is providing technical assistance. Alicia Delgado, a TAMU student, is helping for the summer and Dr. Tarpley is currently seeking a TAMU graduate student to work on the physiology project full time. Research on this project is being conducted thanks to sponsorship by TRRF. For more information contact Dr. Lee Tarpley at 409-752-2741 ext. 2235 or email ltarpley@tamu.edu.

Physiological Evaluation of Rice Main Crop and Second Crop Response to Messenger™

The Eden Bioscience product, Messenger, is being marketed for rice as a Plant Growth Regulator (PGR) that when applied early can increase the resistance or tolerance of the plant to disease, and possibly insects and poor environmental conditions. This could indirectly increase yield by keeping the plants healthier. The

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Plant Physiology continued...

Texas rice growers have a unique advantage in being able to support a ratoon crop, but have to battle more than their share of pests and diseases. The focus of this research is to evaluate Messenger for its ability to increase ratoon crop yield. We are also investigating the impact of Messenger on the mechanisms of the temporary storage and use of reserves of carbohydrates (sugars and starch) and nitrogen-containing compounds (such as protein) because these mechanisms are important for maintaining yield when the plant is exposed to poor conditions for photosynthesis, such as exposure to environmental stress or particular pests.

We are also measuring the amount of accumulated oxidative stress by the plant. This helps us to quantify how well the growing plant is resisting (in a general sense) diseases, pests, and poor environmental conditions. These field plots are at Beaumont and Eden Bioscience is sponsoring the research.

The principal investigator, Lee Tarpley, is the new plant physiologist at the TAMU Center. Jonathan Bevil of Eden Bioscience, and Dr. Fred Turner and Mike Jund of the TAMU Beaumont Center are cooperating in the research. For more information contact Dr. Lee Tarpley at 409-752-2741 ext. 2235 or email ltarpley@tamu.edu.

Physiology of Recently Introduced Hybrids

RiceTec recently released several hybrids and the yield potentials of these hybrids are very good. The milling quality, however, is lower than conventional releases. The plants seem to senesce before grain filling is complete. This project seeks to identify management schemes that can be used to delay senescence, at least until grain filling is complete.

We are investigating the mechanisms of the temporary storage of reserves of carbohydrates (sugars and starch) and nitrogen-containing compounds (such as protein) because these mechanisms can interact with processes in the leaf and delay senescence. We are also measuring the amount of accumulated oxidative stress by the parts of the plant. This helps us to figure out which comes first: the events triggering senescence in the plant (possibly the stem) or the loss of productivity (such as the leaves' ability to photosynthesize).

This project primarily considers the use of Plant Growth Regulator (PGR) applications to hold off the senescence. This would allow us to take advantage of the yield potential of XL-6. Another experimental hybrid is also being characterized, although the early senescence is not anticipated to be a problem. RiceTec is sponsoring the research for which Lee Tarpley is the principal investigator. Steve Malone and Jim Stroike of RiceTec, and Fred Turner and Mike Jund of the TAMU Beaumont Center are cooperating scientists. For more information contact Dr. Lee Tarpley at 409-752-2741 ext. 2235 or email ltarpley@tamu.edu.

The Physiological Basis for Superior Yield Performance in Texas Rice

Dr. Ted Wilson

The focus of this research is to estimate primary plant traits, for each of six varieties (Cocodrie, Cypress, Jefferson, Lemont, Saber, and Wells), for use in predicting the performance of varieties for different areas and environments, across the Texas rice belt. Each of the varieties was planted at the Bay City, Beaumont, Eagle Lake, and Ganado uniform nursery trials. Samples were taken for each rice variety once a week, with up to 48 rice growth parameters recorded for each. Before planting, five soil samples were taken from each field. Clay, silt, and sand contents, pH, organic matter, bulk density, nitrate (NO_3), ammonium (NH_4), and total N were measured. Soil samples were taken from the center of the sampling area to a depth of 45 cm representing soil from 0-5, 6-15, 16-25, 26-35, and 36-45 cm.

Each variety differed significantly in how many leaves the main plant produced prior to producing a

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Plant Physiology continued...

panicle (Fig. 1A). Saber produced the greatest number of leaves prior to producing a panicle (16.9), followed by Cypress (16.5), Lemont (16.3), Wells and Cocodrie (16.2), and Jefferson (15.2). A small difference in the number of leaves produced by a variety can have a tremendous impact on the number of tillers and the amount of vegetative mass produced by a main plant or tiller (Fig 1B).

In general, the greater the number of leaves produced by a variety, the greater the number of tillers produced. The high panicle node for Saber is largely responsible for its high total biomass. In contrast, the high biomass for Wells is largely a result of its unusually large main plants and tillers. The lower panicle node and lower tillering ability are largely responsible for Jefferson's early maturity.

Researchers on this project include Lloyd.T. Wilson, Guowei Wu and Jim Medley. For more information contact Dr. Ted Wilson at 409-752-2741 or email lt-wilson@aesrg.tamu.edu.

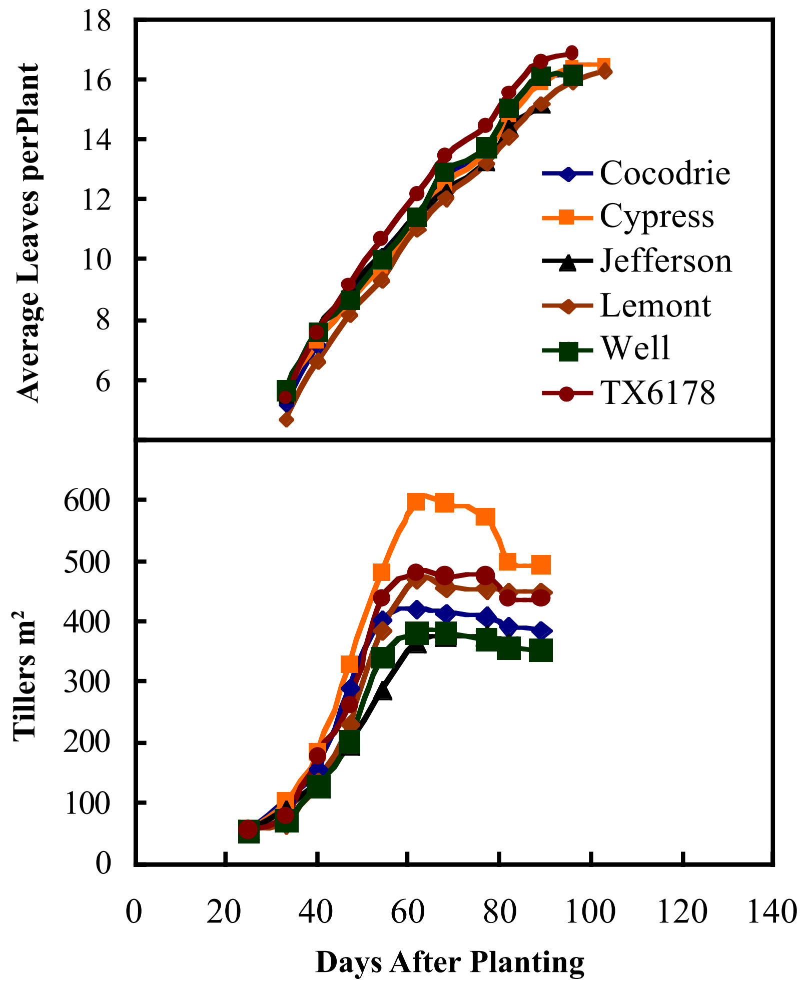

Fig. 1. A) Average number of leaves (nodes) produced per plant for each variety, and B) Number of tillers per m^2.

Table 1. Yield comparison for the Beaumont Eagle Lake Nitrogen Study in 2000

Locations	Nitrogen (lbs. N/ac)	Yield (lbs./ac)*
Beaumont	0	2078.4 g
Beaumont	80	5854.3 f
Beaumont	160	8113.8 abc
Beaumont	240	8962.8 a
Beaumont	320	8471.1 ab
Eagle Lake	0	7118.7 de
Eagle Lake	80	7551.8 bcd
Eagle Lake	160	8447.5 ab
Eagle Lake	240**	7136.3 cde
Eagle Lake	320***	6258.2 ef

* Values followed by the same letter are not significantly different at P=0.05

** Moderate lodging

*** Heavy lodging

The Uptake and Distribution of Nitrogen in Rice

The objective for this research is to establish a detailed database on the movement of total nitrogen and nitrate nitrogen throughout the season, both for the soil and within the rice plant. The variety Cypress was planted on April 20 at both the Beaumont and Eagle Lake sites. Five levels of nitrogen were applied (0, 80,160,240, and 320 lbs./ac). The high levels of nitrogen were intentional and were intended to identify the level at which nitrogen begins to cause fertilizer burn to the rice.

Several conclusions can be drawn from the results of this study. Heavy clay soils, such as are found at Beaumont, limit the movement of ammonia and nitrate-nitrogen in the soil. This result supports earlier lab studies by Turner and Trostle. This restriction results in a greater amount of nitrogen having to be applied with the heavier soils to obtain higher yields. The lighter soils are more forgiving under conditions of nitrogen stress. This is illustrated in Table 1, by comparing the 0 and

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Plant Physiology continued...

80 lbs./ac applied N treatments for Beaumont versus Eagle Lake. These treatments resulted in an ca. 7000 lbs./ac and 3000 lbs./ac yield reductions for the respective treatments at Beaumont. The same treatments at Eagle Lake had an ca. 1500 and 1000 lbs./ac reduction, respectively. The difference comparing these two locations is largely a result of the proximity of the growing roots to the ammonia and nitrate-N in the soil. For lighter soils, such as those at Eagle Lake, as the roots remove nitrogen from the soil, the remaining nitrogen readily diffuses to the roots. For heavier soils, such as those at Beaumont, as the roots remove nitrogen from the soil, the remaining nitrogen is to a large degree prevented from diffusing to the roots due to the small particle size of the heavy clay soils. Researchers on this project include Lloyd T. Wilson, Guowei Wu, Jim Medley, Christina Fernandez, Fred Turner and Mike Jund. For more information contact Dr. Ted Wilson at 409-752-2741 or email lt-wilson@aesrg.tamu.edu.

Rice Physiological Modeling

The focus of this research is to estimate the impact of primary plant traits on the yield performance of rice. The approach taken involves the development and use of a physiologically complex rice simulation model, and field trials to determine how well the model is able to predict the performance of model selected rice phenotypes. Table 1 summarizes the yield performance of model-selected lines, Lemont and Teqing parent varieties, and six commercial varieties. Averaged across 1999 and 2000, all 10 of the lines that were predicted to yield better than the Lemont parent variety did so. Three of the four lines that were predicted to yield worse than Lemont variety did so, with the fourth "low-yielding" line producing only 74 lbs./ac more than Lemont. These results were very similar for both 1999 and 2000.

The accuracy of the model at selecting lines that should produce superior yields is particularly encouraging. Three of the model-selected lines out-yielded all of the tested commercial varieties. These lines (LQ243, LQ39, LQ158) are more resistant to lodging than the Teqing parent type whose yield performance is reduced by both heavy late-season winds and rains. The best performing line, LQ243, out-yielded Cocodrie by 494 lbs./A. Overall, this plant type out-performed Lemont by 40%. Researchers on this project include Lloyd T. Wilson, Guowei Wu, Shannon Pinson, and Anna McClung. For more information contact Dr. Ted Wilson at 409-752-2741 or email lt-wilson@aesrg.tamu.edu.

Table 1. Yield (lb/A) from the 1999 and 2000 Crop Physiology-RiceModeling Experiment.

1999-2000 Yields

Variety	**Selection***	**Bay City**	**Beaumont**	**Eagle Lake**	**Ganado**	**1999 Mean**	**2000 Mean**	**Grand Mean**
LQ:243	H	7895	8093	8139	8500	7784	8529	8157
LQ:39	H	7921	8664	7405	7639	7392	8422	7907
LQ:158	H	7039	9053	7936	7370	7955	7744	7850
Cocodrie	-	6583	9706	7075	7288	6833	8492	7663
Teqing	Parent	9138	8496	6902	5961	6830	8417	7624
Wells	-	7050	9735	7072	6612	7061	8173	7617
LQ:314	H	7733	7571	8079	7063	7374	7849	7612
LQ:60	H	7828	8501	6166	7384	7338	7601	7470
LQ:190	H	6632	8623	7711	6890	7043	7884	7464
Jefferson	-	7052	8148	7249	7092	6947	7823	7385
TX6178	-	6268	8989	7196	6496	-	7237	7237
LQ:300	H	5932	7161	6621	7829	6612	7159	6886
LQ:201	H	6232	8145	6561	6543	6901	6839	6870
LQ:220	H	6210	6862	7448	6894	6876	6830	6853
LQ:242	H	6395	7113	6911	6488	6297	7156	6727
LQ:19	L	7032	7340	5430	6652	5904	7323	6614
Cypress	-	5810	7649	6090	6805	5940	7236	6588
Lemont	Parent	6017	8038	5959	6147	6005	7075	6540
LQ:217	L	6486	7853	5466	5173	6120	6369	6245
LQ:347	L	6424	8287	5450	4751	5918	6538	6228
LQ:3	L	5556	5894	5195	5647	5307	5839	5573
Average	**-**	**6821**	**8058**	**6743**	**6730**	**6722**	**7454**	**7088**

Tocol and Gamma-oryzanol Contents of Southern U.S. Rice

Dr. Christine Bergman

Rice bran is primarily considered a by-product of the milling process and thus little value is obtained from its sale. Yet, rice bran contains phytonutrients such as the tocols and the gamma-oryzanol fraction that act as antioxidants and reportedly have positive effects on human health. Rice bran or its extracts are therefore attractive candidates for use in the development of functional (health-beneficial) foods.

The objectives of this research were to quantify the levels of tocols and gamma-oryzanol in currently grown U.S. rice cultivars and to determine the effects of the production area. Eleven Southern U.S. rice cultivars were grown in Texas, Louisiana, Mississippi and Arkansas, during 1999. Reverse-phase HPLC with UV and florescent detectors were used to quantify the tocol and gamma-oryzanol contents of the samples. The levels of these phytonutrients varied significantly due to genetics and area of production. Across environments, the cultivars varied in total tocol content by 40% (0.20 to 0.29 mg/g) and in gamma-oryzanol content by 63% (3.40 to 5.37 mg/g). Tocol and gamma-oryzanol contents were correlated, but at a low level.

Consequently, it appears that to obtain rice bran with elevated levels of both phytonutrient fractions, new cultivars will need to be developed. These results will be compared to the levels of antioxidants in the same cultivars grown in 2000 and in internationally sourced germplasm. This initial study indicates there is enough genetic variation in rice bran phytonutrient content to warrant selecting specific cultivars or developing new ones for use in functional foods. Researchers on this project are C. Bergman, J. Delgado and Z. Xu. For more information contact Dr. Christine Bergman at 409-752-5221 ext. 2260 or email c-bergman@tamu.edu.

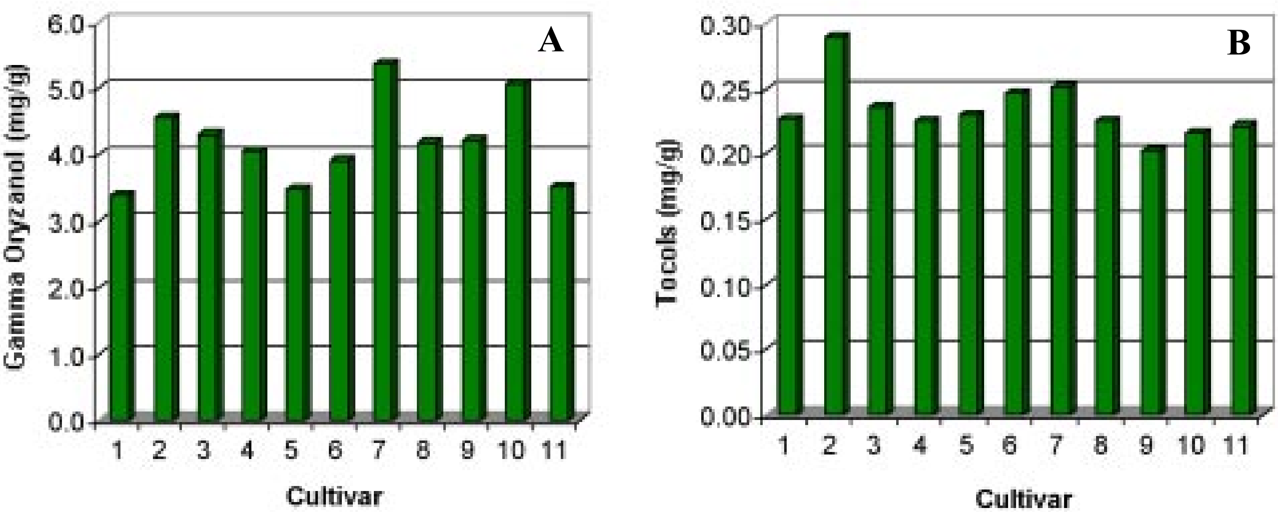

Fig. 1. Mean gamma-oryzanol (A) and tocol (B) contents of 11 cultivars grown in Arkansas, Louisiana, Mississippi, and Texas in 1999.

A Rapid Method for Determining Carbohydrates at Different Stages of Rice Development

Total non-structural carbohydrates (TNC) are significant contributors to rice grain production. All research related to the genetics and physiology of TNC metabolism requires that large numbers of samples be analyzed. The wet-chemistry method for TNC is a very time consuming analytical procedure. Consequently, the rate at which physiology and genetic studies related to TNC can proceed is severely constrained. An instrument that holds promise as a rapid measure of TNC is the near-infrared (NIR) spectrophotometer.

The objective of this research was to develop NIR calibration equations (NIR-CE) for TNC that would be effective either across or within season, genotype, crop growth stage, and plant structure type. Nearly 700

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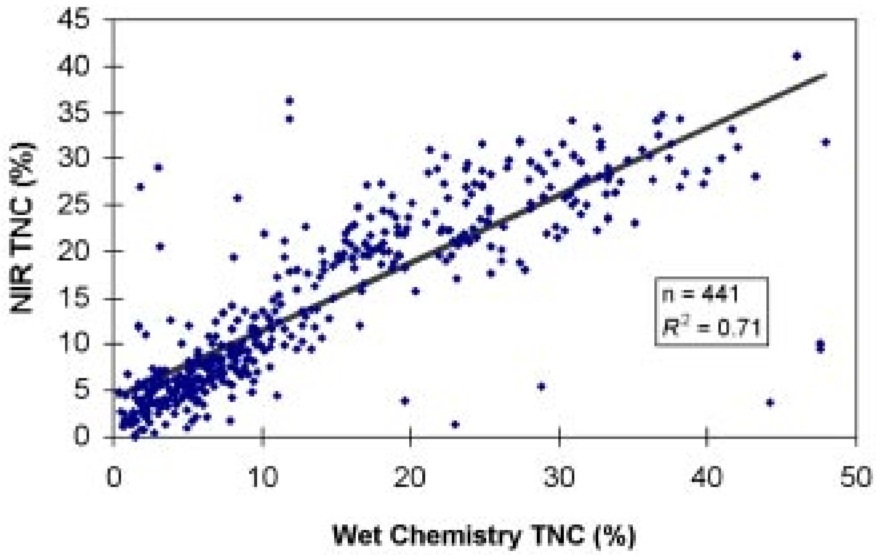
Rice Quality continued...

samples from the Lemont x Teqing population were used for the preliminary development and evaluation of NIR-CE. Samples were from 16 genotypes, main leaf and stem, 1st and 2nd tiller leaf and stem grown in Beaumont. Samples (253) that would spectrally represent all the samples were identified and their associated TNC values (wet chemistry) were used to develop a NIR-CE. TNC for the remaining samples were predicted using this NIR-CE. Figure 1 displays the relationship between the NIR-CE predicted TNC values and those obtained using a wet chemistry method. Of the variation in wet chemistry TNC values for these samples, 71% was explained by the NIR-CE generated values. The NIR-CE would have provided TNC values in approximately 60% less time than the wet chemistry method if categorization of samples according to their TNC levels (e.g., low, medium or high) was required. However, the NIR-CE developed thus far is not as robust as required of analytical tools used for research. This is not surprising considering the tremendous plant matrix diversity contained in the set of samples. Future work to improve the performance of the NIR-Cs for TNC will focus on using samples from within a season, genotype, plant structure and within a development stage. Researchers on this project include C. Bergman, N. Gipson, S. Pinson and T. Wilson. For more information contact Dr. Christine Bergman at 409-752-5221 ext. 2260 or email c-bergman@tamu.edu.

Fig. 1. Linear relationship between TNC values obtained using a wet chemistry method and NIR predicted values. Samples consisted of 16 genotypes, main leaf and stem, 1st and 2nd tiller leaf and stem from two growing seasons.



DNA Markers Associated with Aromatic Rice End-Use Quality Traits

U.S. rice imports consist primarily of aromatic types that have unique end-use quality traits desired by several ethnic groups and a growing number of other consumers. Aromatic rices include the Jasmine- and Basmati-types which have an aroma that is considered to be "popcorn-like." Basmati-type's kernels also elongate after cooking to a greater degree than conventional rice. U.S. rice breeding programs are working to bring these end-use quality traits into genetic backgrounds that would be suitable for U.S. production.

These efforts are hindered due to the confounding impact of the growing environment on both the aroma and kernel elongation of breeding lines. DNA markers enable breeders to know the true genetic potential of a breeding line regardless of the environment in which it was grown. The objective of this research was to develop and evaluate DNA markers for selecting breeding lines for aroma and kernel elongation. A breeding population derived from a cross between Dellmont (scented,

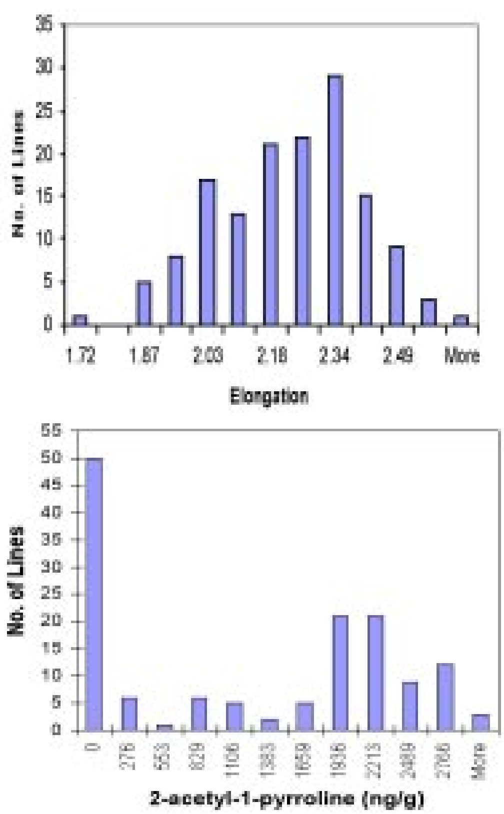


Fig. 1. Histogram of kernel elongation and 2 acetyl-1-pyrroline content of breeding lines from a cross between Dellmont and B8462T3-710 B.

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Rice Quality continued...

non-elongating) and B8462T3-710 B (non-scented, elongating) was evaluated for kernel elongation and 2-acetyl-1-pyrroline content (2AP), the compound most responsible for aromatic rice scent. The population was deemed to be suitable for use in DNA marker evaluation as it showed a large degree of variation for both traits (Fig. 1).

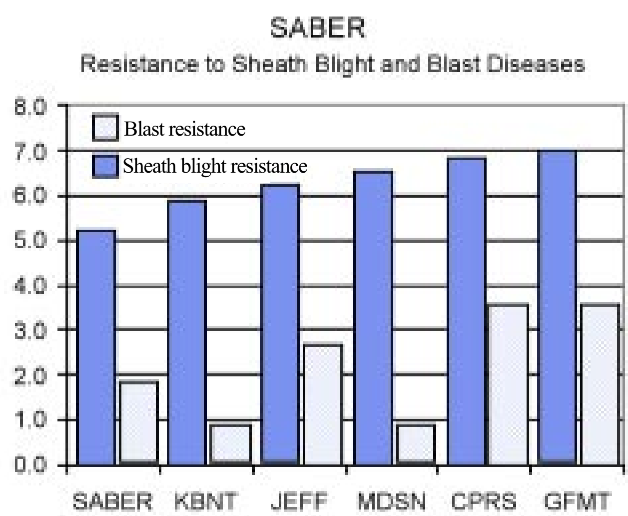
The DNA markers explained 68 and 25% of the variation in 2AP and elongation, respectively. The association between 2AP and our DNA marker appears high enough to make it a suitable tool for marker assisted selection. Prior to adopting this marker for routine end-use quality evaluation we plan to further evaluate it using another breeding population. More development work is underway to find a suitable marker for the elongation trait. Our plan is to study other markers on chromosome 8 and to evaluate more lines of the Dellmont x B8462T3-710 B population. Researchers on this project include C. Bergman, A. McClung and R. Fjellstrom. For more information contact Dr. Christine Bergman at 409-752-5221 ext. 2260 or email c-bergman@tamu.edu.

Varietal Improvement

The Newest Texas Release "SABER"

Robert Weatherton

Saber is an early maturing long-grain rice cultivar with improved blast and sheath blight resistance. It was developed at the Texas A&M University System Agricultural Research and Extension Center at Beaumont, by the USDA-ARS and the Texas Agricultural Experiment Station in cooperation with the Texas Rice Improvement Association and the Texas Rice Research Foundation. Saber was developed from the cross Gulfmont/RU8703186/Teqing (cross number B8910A11), made at the Experiment Station in Beaumont, TX in 1989. Saber is a early maturing semidwarf cultivar with excellent main and ratoon yield and milling quality. The objective of the cross was to develop cultivars similar to Gulfmont but having improved resistance to blast and sheath blight diseases. In 28 Texas trials, the average flowering date of Saber was 2 days earlier than Gulfmont and Cypress, and 6 days later than Jefferson. Seedling vigor is somewhat better than Gulfmont and more similar to Cypress. In 2000, Texas Rice Improvement Association grew Foundation Seed in a nine-acre field. The planting rate was 39 lbs/A and planted on April 1, 2000. The source of the seed was Headrow seed supplied by the plant breeder Dr. Anna McClung. The field yielded 6,628 lbs/A at 12% moisture. The milling yield was excellent at 67/73 and produced a seed germination of over 95%. Saber appears to have a very high and stable milling yield like Cypress. Milling integrity is similar to that of Cypress at lower harvest moistures.



The unique feature of Saber is its combination of superior resistance to both blast and sheath blight. Sheath blight resistance is slightly better to that of Jefferson and blast resistance is likely adequate to preclude the use of fungicide for the control of blast in most situations. Saber is also very resistant to narrow brown leaf spot, and appears to have levels of tolerance to the physiological disorder "straighthead". For more information contact Robert Weatherton at 409-752-2741 ext. 2230.