Department of Agriculture
PHILRICE
PHILIPPINE RICE RESEARCH INSTITUTE

2014 NATIONAL RICE R&D HIGHLIGHTS

SEED TECHNOLOGY DIVISION

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Seed Technology Division

Division Head: SR Brena

Executive Summary

Seed quality assurance is one of the essential components of seed production since this activity raises the quality of the seed produced. Thus, seed quality assurance in rice always begins in the field. This comprises various operations in which seed passes before it reaches the clients. STD 002 is composed of studies on Seed Quality Assurance in PhilRice Seed Stock.

Internal field inspection is being conducted by the division following set of rules as prescribed by several Administrative Orders issued by the Department of Agriculture in order to examine the purity status of breeder (BS), foundation (FS), registered (RS) and nucleus seed production areas of the Plant Breeding and Biotechnology Division and the Business Development Division of the Philippine Rice Research Institute. Breeder, FS and RS seed production area were inspected during the dry season (DS) of 2014 while inspection during wet season (WS) of 2014 was on the nucleus and breeder seed production areas only. A total of 94, 15 and 11 varieties of BS, FS and RS were inspected on DS 2014, respectively and 56 BS varieties on WS 2014. However, 96% of the BS and the rest of the FS and RS passed the inspection.

Seed purity and viability testing are routine activities of the division which serve as the internal seed quality control of the institute in order to determine and monitor the over-all quality of the seed produce after harvest and the stored seed stocks. Out of the 75 BS of WS 2013 tested for varietal purity in the division, only 7 varieties matched the result obtained by the BP1-NSQCS. On the other hand, out of the 34 BS varieties of DS2014, none of which passed as BS; 15 varieties were rejected; 3 passed as FS; 1 as RS and the rest were classified under certified seeds (CS). The division also studied the purity status of the seeds after passing specific postharvest operations: after threshing, drying and cleaning. On WS2014, 58 BS varieties were examined. After threshing, only 23 varieties failed to pass as BS. After drying and cleaning, increasing number of varieties did not pass the standards for BS (32 and 44 varieties, respectively). Thus, downgrading of BS seed lots are mainly affected by the quality of work employed during the postharvest operations. Viability testing is being conducted to assure high quality seeds with 85% and higher be procured by seed growers. Nucleus and BS seed stocks were tested. In DS and WS 2013, 66% (42 of 64) and 99% (61 of 62) of nucleus seed varieties, respectively had + 85% germination rate. TGMS parentals and hybrid seed lots from Mindanao and Dupax, Nueva Viscaya were also tested and found out having high germination rate. Thus, Mestiso 19, Mestiso 20 and PRUP TG101 have

high seed quality despite of the long distance transport and ordinary room storage. To ensure the stored seed lot performance in the field, seed vigor test is also conducted.

Grow-out test (GOT) is being carried out by the division to assess the seed lot's genetic purity of hybrid parental lines before distributed for trials and commercialization. Samples from PhilRice- Bukidnon, CES, Isabela, Los Banos which were produced in WS 2013 and Negros were evaluated in DS 2014. Generally, seed lots for distribution should have a genetic purity of 97% and up in GOT. However, GOT requires 3 to 4 months before the final purity of the seed lot is assessed. Thus, the use of molecular marker assay to assess the genetic purity will be fast and accurate. SSR markers were utilized since it has more polymorphism, co-dominant and large in quantity than most of the other DNA markers. Out of 36 SSR markers, only 7 markers differentiated genotypes for both parental lines and hybrid.

Two-line hybrid rice (Mestiso 19 and 20) is a product of a new breeding program that utilizes two parents: a thermo-sensitive genic male-sterile (TGMS) line that serves as a seed parent and a male-fertile line as pollen parent. This breeding system is considered as economically feasible over cytoplasmic male sterile (CMS) system not only because of the absence of maintainer and restorer lines but also because of impressive yields. Mestiso 19 and 20 in large-scale demonstration and commercial production showed an average yield of 8±1 ton/ha across all regions in the Philippines conveying a pragmatic solution to rice insufficiency problem in the country.

However, the adoption of TGMS hybrids among small-scale farmers is hindered by the low seed supply. Over the past five years of TGMS hybrid seed production since its release in 2009, seed yields remain less than 1 ton/ha which discourages seed growers to continue or expand their production. Yield component data from multi-location seed production experiments showed that percentage seed set appears to be the limiting factor. Thus, improving seed set to increase hybrid seed yield was the main focus of studies under STD-003.

On one hand, microscopy analysis reveals that the large pollen size of male-fertile parents of Mestiso 19 limits the width of pollen dispersion and thus, affects seed setting in male-sterile lines. One implication of this result is that the ratio between male and female parent can be adjusted to optimize cross pollination. These findings were further supported by results on increasing pollen row ratio. It appears that with 3 pollen: 8 seed parent ratio improvements in seed set were achieved consistently for two seasons in Negros. Similar findings were observed for Mestiso 20. Application of phyotohormones in combination with gibberellic acid resulted in significant improvements of floral traits that favor cross-pollination. In Midsayap, timing and frequency of GA3 proves to be important. Results showed that the best time to apply GA3 is at 20 to 30% heading stage that resulted to over 1 ton/ha seed yields across two seasons.

Concerning seed quality, the use of improvised hermetic storage (or 'Saklob') discourages insect pest to thrive which consequently resulted in less insect- damaged seeds. Seed viability and vigor were also significantly higher in 'Saklob' storage compared to ordinary sacks. Mechanical harvesting using combine harvester resulted in higher seed vigor and viability compared to manually harvested seeds.

Utilization of hybrids significantly increased rice yields in the Philippines and other countries. However, the success of hybrid rice technology depends on the hybrid seed production in order to produce high quantity and quality seeds. STD 004 is composed of studies on Hybrid Basic Seed Production and Hybrid Seed Research.

Characterization of Cytoplasmic Male Sterility (CMS) lines for stability in pollen sterility is being done at PhilRice-Los Baños (LB). IR58025A, IR68897A and IR73328A, the 3 commercially used CMS lines were established for the study. Monthly planting of these CMS lines was conducted to observe stability of pollen sterility with reference to the month it was established. Important agronomic and flowering characteristics were also evaluated.

Nucleus and breeder seed production of existing and new recommended hybrid varieties are also done at PhilRice-LB. The study aimed to characterize, check the purity and genetic identity of hybrids and parental lines, develop protocols on the basic and nucleus seed production and initial seed increase for popularization and commercialization of hybrids.

Identification of the best location and time of the year or season optimum for seed production and quality is also being conducted initially in Mindoro. In order to have a successful hybrid seed production, flowering behavior of the parental lines should be well established locations favorable for seed production. Hence, flowering behavior and seed production capacity of hybrid parental lines in Sta. Cruz, Mindoro Oriental was tried. Five Restorer -lines, 2 pollen parents, and 2 CMS lines and 2 TGMS lines were planted. Flowering of S-lines was extended until after 5 P.M but P-lines lasted only until 1 PM. S xP seed production of M19 and M20 was possible under Mindoro condition in DS 2014, however, the quality of the F1 produced was not good due to late dying.

I. Seed Quality Assurance in PhilRice Seed Stock

Project Leader: SR Brena

Internal Field Inspection of Seed Production Areas

SRBrena, JManagkil, RHadcan

Seed quality assurance in rice seed begins in the field. As prescribed by several Administrative Orders issued by the Department of Agriculture, inbred and hybrid seed production areas follow set of rules on field inspection. Generally, field inspection starts 20 days after transplanting, at maximum tillering, onset of flowering (most important period to remove off-types), and two weeks before harvest. Although these are prescribed period for inspection, rouging should be done for as long as there are off-types observed in the field. This routine activity is done to assure PhilRice-clients of seeds with the high purity. However, despite efforts for seed quality assurance in the field by the Seed Technology division, threshing and the rest of the postharvest operations are controlled by the staff of Business Development Office. Moreover, laboratory certification, one particular aspect of the entire system of seed certification is under an agency outside of PhilRice.

The study was conducted by inspecting breeder (BS), foundation (FS) and registered (RS) production areas of PBBD and BDO. The field under each seed class planted per variety was inspected in three replications. For FSP and RSP, 32 x 32 hills were pegged with bamboo sticks. Total number of plants in a pegged area was 1,024. Three pegged areas per variety were inspected. Off-types considered were plants that exhibited early and late flowering; short and tall plants; and volunteer plants.

Highlights:

- Field inspection was done in DS 2014 in breeder seed production (BSP); foundation seed production (FSP); and registered seed production (RSP) areas. In WS 2014, field inspection was concentrated in basic and BS seed production plots.

- There were 94 BS varieties inspected in DS 2014. Inspection was done several times during crop growth and last inspection was done two weeks before harvest. During last inspection, all BS varieties passed field inspection (no off-types), except for IR 64; NSIC Rc120, NSIC Rc130 and NSIC Rc184.

- There were 15 and 11 varieties inspected under the foundation seed production (FSP) and registered seed production (RSP), respectively in DS 2014. Percentage purity of varieties planted in FSP during last field inspection ranged from 97.95% to 99.45%. NSIC Rc298 had the lowest purity while NSIC Rc238 had the highest purity (Table 1).

- Percentage purity of varieties planted under RSP during last inspection ranged from 98.43 to 99.34%. Highest purity was noted in NSIC Rc240 planted in block 14 and lowest in NSIC Rc17.

- In WS 2014, 56 breeder varieties were inspected. Few off-types were noted during the early stages of crop growth, however, during flowering high percentage number of off-types were observed in NSIC Rc280; NSIC Rc334; NSIC Rc348; PSB Rc82; NSIC Rc344; and NSIC Rc238 (Table 2). Moreover, four varieties were rejected in field due off-types. The varieties rejected were NSIC Rc348; NSIC Rc280; NSIC Rc324; and NSIC Rc334.

- Early field inspection of seed production areas is recommended for ease of determining off-types. Late inspection particularly after flowering is difficult because the plants had attained its maximum height and the overlapping canopy hindered the detection of other off-types left during the previous inspection.

- Despite the high percentage purity in the field, all postharvest operations should be done properly to assure high percentage passing of the seed lots produced during seed certification by BPI-NSQCS.

Table 1. Percent purity of varieties planted under FS and RS production during final field inspection in DS 2014.

FS Varieties Inspected	% Purity (final inspection)	RS Varieties Inspected	% Purity (final inspection)
PSB Rc82	99.23	NSIC Rc17	98.43
NSIC Rc160	98.48	NSIC Rc194	99.30
NSIC Rc214	99.05	NSIC Rc222	98.49
NSIC Rc218	99.17	NSIC Rc222	99.07
NSIC Rc222	99.11	NSIC RC238	98.49
NSIC Rc238	99.45	NSIC Rc240	99.31
NSIC Rc240	98.81	NSIC Rc240	99.34
NSIC Rc274	98.22	NSIC Rc292	99.25
NSIC Rc282	98.83	NSIC Rc298	98.57
NSIC Rc288	99.18	NSIC Rc300	98.67
NSIC Rc290	98.94	NSIC Rc302	98.88
NSIC Rc292	99.27		
NSIC Rc298	97.95		
NSIC Rc300	98.69		
NSIC Rc302	99.23		

Table 2. Varieties with high percentage off-types observed in breeder seed production plots in WS 2014 during field inspection at the flowering stage.

Variety	Percent Off-types	Percent Purity
NSIC Rc280	7.95	92.05
NSIC Rc324	4.76	95.24
NSIC Rc348	3.19	96.81
PSB Rc82	3.00	97.00

Seed Purity and Seed Viability Testing

SRBrena, JManagkil, MCSalamanca

Varietal purity is a quality parameter used to determine the over-all quality of the seeds produced at PhilRice after harvest while seed viability testing is done to monitor the quality of the stored seed stocks. This may include carry over seed lots of previous cropping and buffer stocks. This routine study is done as part of the internal seed quality control of PhilRice spearheaded by the Seed Technology division. For varietal purity, 400gm sample taken at random in one particular seed lot is used to assess the presence of seeds of other rice varieties in one particular variety. The seed analyst assessed the seed sample on top of a diaphanoscope. Determinants of off-types in rice seed are grain shape, color, width, and presence or absence of awn. Varietal purity testing in 2014 was done for breeder seeds produced in WS 2013 and those produced in DS/WS 2014. The reported number of off-type becomes the basis for a seed lot to be classified as BS, FS, RS, or CS. This is also the basis for downgrading seed lots produced to lower seed class in case the number of off-types exceeded the maximum number allowable in the expected seed class after harvest.

Viability testing measured in the laboratory through germination test was done in carry over seed lots of hybrids and inbred varieties. The test was done using 400 seeds taken from the pure seed component of the physical purity test. These seeds are divided into 4 sets of 100 seeds. Each set was considered a replicate. Newly harvested seeds and old seed stocks must have at least 85% germination rate to be considered eligible for distribution or disposal to seed growers and farmers. After testing, all varieties with germination rate below 85% will be discarded for commercial purposes.

Highlights:

- Seventy five breeder seed varieties produced in WS 2013 were tested for varietal purity in 2014. Only seven varieties tested for varietal purity by SeedTech analysts matched the result obtained from BPI-NSQCS (Table 3). All other varieties evaluated in SeedTech laboratory had lower seed classes than those obtained from BPI-NSQCS certification results.

- Varietal purity test was conducted in 34 breeder seed varieties produced in DS 2014. There was no variety tested that passed as BS. Forty four percent (15 varieties) were rejected; 3 passed as FS; 1 passed as RS and the rest were classified as CS Table 4).

- To determine in what specific postharvest operation off-types are incurred, varietal purity determination was made in WS 2014 in all 58 breeder seeds produced after threshing, drying, and seed cleaning. Varietal purity determination revealed that 23 varieties after threshing did not pass as BS. After drying, 32 varieties did not pass as BS. After cleaning, 44 varieties failed to meet the standards for BS (Table 5).

- Based on the data obtained in varietal purity determination of BS varieties produced in PhilRice, the high percentage of BS seed lots downgraded to lower seed classes was affected by the quality of work employed in different postharvest operations. The production field always passed final field inspection but the varieties get contaminated after harvest.

- Remaining seed stocks in storage need to be tested for viability to assure seed growers of the quality of the seed they will procure. There were 64 and 62 basic seed varieties produced in DS and WS 2013 which were tested for seed viability. Almost 66% (42) of the varieties tested in DS 2013 had germination rate higher than 85%. Sixty-one (61) varieties produced in WS 2013 had germination equal to or higher than 85%. Only NSIC Rc304 had 76% germination.

- Breeder seed stock produced in DS and WS 2013 were tested for seed viability. Average germination of 85 and 89% was observed in 61 and 69 varieties tested from DS and WS 2013 remaining seed stock (Table 6). Germination declined after the second test. Average germination rate was only 59 and 86% in 35 and 15 breeder seed varieties produced in DS and WS 2013, respectively.

- There were 19 and 38 seed lots of Mestiso 19 and Mestiso 20 from Mindanao representing 941 and 2,230 bags, respectively which were tested for seed germination three to four months after harvest (WS 2013 production). The average germination value observed was 95 and 96% for Mestiso 19 and 20, respectively. High seed quality was observed in TGMS hybrids produced by PhilRice through partnership with seed contractors even after long distance transport and storage in ordinary storage rooms in BDO warehouse for 3 months (Table 7).

- PRUPTG101 or the S-lines of Mestiso 19 produced by PhilRice-Isabela in Dupax, Nueva Viscaya in DS 2013 which were transported to CES in November 2013 were stored in BDD warehouse. Bulk of the produce was distributed for commercial planting in DS 2014. There were 148 bags in 6 seed lots left in the warehouse which were tested for germination in May 2014. Only one lot consisting of 49 bags (1 bag = 15kg) had 59% germination. All other seed lots tested had 87% to 97% germination rates.

Table 3. Breeder seed varieties produce in WS 2013 tested for varietal purity.

Variety	Result of Varietal Purity Test Conducted by	
	Seed Technology Division	BPI-NSQCS
PSB Rc54	FS	FS
NSIC Rc15	BS	BS
NSIC Rc122	BS	BS
NSIC Rc148	CS	CS
NSIC Rc152	CS	CS
NSIC Rc154	CS	CS
NSIC Rc218	RS	RS

The test was done in January 2014

Table 4. Number of off-types counted in some BS varieties produced in DS 2014.

Variety	Number of off-types	Resulting seed class
IR 42	2	FS
PSB Rc18	15	CS
PSB Rc74	29	Rejected
PSB Rc96	9	CS
NSIC Rc13	206	Rejected
NSIC Rc17	51	Rejected
NSIC Rc19	15	CS
NSIC Rc148	26	Rejected
NSIC Rc152	9	CS
NSIC Rc188	15	CS
NSIC Rc190	11	CS
NSIC Rc192	36	Rejected
NSIC Rc220	16	CS
NSIC Rc224	70	Rejected
NSIC Rc272	23	Rejected
NSIC Rc278	14	CS
NSIC Rc280	28	Rejected
NSIC Rc282	54	Rejected
NSIC Rc286	9	CS
NSIC Rc290	35	Rejected
NSIC Rc294	6	RS
NSIC Rc296	30	Rejected
NSIC Rc300	1	FS
NSIC Rc302	52	Rejected
NSIC Rc304	91	Rejected
NSIC Rc326	2	FS
NSIC Rc328	16	CS
NSIC Rc334	15	CS
NSIC Rc336	44	Rejected
NSIC Rc334	11	CS
NSIC Rc346	14	CS
NSIC Rc348	50	Rejected

Table 5. Number of breeder seed varieties produced in WS 2014 with observed off-types after each specific postharvest operation.

Postharvest Operation	Number of varieties with off-types
After Threshing	23
After Drying	32
After Cleaning	44

Table 6. Percentage seed germination of breeder seed stock produced in DS and WS 2013.

Production season	First test (January 2014)			Second test (June 2014)		
	No. of Varieties tested	Ave. Germination (%)	Ave. Moisture Content (%)	No. of Varieties tested	Ave. Germination (%)	Ave. Moisture Content (%)
DS 2013	61	85	12	35	59	
WS 2013	69	89	11	15	86	

Table 7. Percentage seed germination of carry over seed lots of TGMS hybrids produced in WS 2013.

Variety	Number of Seed Lots	Total number of Bags	Average Germination (%)	% Moisture Content
Mestiso 19	19	941	95	11.5
Mestiso 20	38	2230	96	11.3

Seed Vigor Testing of Buffer Stock and Carry Over Seed Lots

SRBrena , MCSalamaca

Seed vigor generally declines ahead of seed viability and is often said to be a better measure of seed quality. The test gives an indication of the most likely performance of the seed lot when planted in field; gives an idea of the seedling emergence; storage potential; and the ability to stand the rigors of long distance transport. The decline in seed quality is affected greatly by three factors, high temperature, moisture content and relative humidity. The most commonly used method to assess seed vigor is accelerated ageing test (AAT). Two hundred seeds from a seed lot were divided into 4 sets of 50 seeds per set. Each set was placed in an improvised accelerated ageing wide-mouthed bottle with water inside. The seeds are placed on top of fine wire mesh located inside the bottle. The sealed bottles were placed in an oven set at 400C for 3 days. After 3 days, moisture content of the seeds was measured and seed germination conducted. The result of germination of aged seeds and the control was compared. Lower germination values noted in the aged seeds indicate lower vigor seed lots. When there is no change in the germination rates after the aging seeds, then the seed lots are considered high vigor seed lots.

Highlights:

- Breeder seed stock produced in DS and WS 2013 were tested for vigor in January and May 2014. There were 61 and 69 varieties of BS in DS and WS 2013 tested. For DS 2013 varieties tested, percent germination after accelerated ageing test (AAT) was still 81% whereas varieties produced in WS had only 85% (Table 8). In terms of storage duration, DS varieties have been stored for almost 9 months while WS varieties have been stored for 3 months only.

- Generally, seed vigor declined ahead than seed viability. In 8 BS varieties produced in DS 2013, control samples (no AAT) had 95% germination value while counterpart seeds subjected to AAT had only 88% in the first test. In the second test, almost the same pattern was observed. Those samples produced in WS had 91 and 84% germination in the control and those aged seeds, respectively (Table 9)

- The TGMS seed lots tested for seed vigor were transported from Davao to PhilRice-Central Experiment Station in December 2013. These seeds remained in storage for almost four months before the vigor test was conducted.

- TGMS hybrids tested for vigor showed very high values both for Mestiso 19 and Mestiso 20. After ageing, moisture content of TGMS hybrids increased by 5% (Table 10). Despite the increase in % MC of aged seeds of Mestiso 19 and Mestiso 20, germination of the seeds remained almost the same as those of the control (not aged). Seed lots of TGMS hybrids stored were considered high.

- Retrieved TGMS hybrids from RFO 3 tested showed high vigor values (94 to 99%) in Mestiso 20 in all seed lots except in seed lot with only 86% germination rate after accelerated ageing test. Three seed lots of Mestiso 19 were considered poor quality seed lots with seed vigor values ranging from 62 to 65%.

- Two seed lots of S-lines of Mestiso 19 (PRUPTG101) produced in Dupax, Nueva Viscaya were considered high vigor seed lots even after one year. The germination values after ageing the seeds remained 96%. However, one seed lot had low vigor with only 66% germination after ageing the seeds.

Table 8. Percent germination of BS varieties after accelerated ageing test.

Production season	First test (January 2014)			Second test (June 2014)		
	No. of Varieties tested	Ave. Germination (%)		No. of Varieties tested	Ave. Germination (%)	
		Control samples	After AAT		Control samples	After AAT
DS 2013	61	85	81	35	59	58
WS 2013	69	89	85	15	86	88

Table 9. Seed germination rates before and after ageing breeder seed samples produced in two seasons during the first test in January 2014.

Production Season	Variety Tested	% Germination			
		January 2014		June 2014	
		Control	Samples after AAT	Control	Samples after AAT
DS 2013	NSIC Rc17	96	86	92	83
	NSIC Rc154	97	87	95	93
	NSIC Rc160	99	90	98	95
	NSIC Rc182	94	82	90	85
	NSIC Rc184	92	80	90	84
	NSIC Rc218	95	94	94	93
	NSIC Rc274	95	95	98	98
	NSIC Rc282	97	92	90	86
WS 2013	PSB Rc14	96	90	92	83
	PSB Rc28	93	89	88	89
	NSIC Rc15	88	73	57	77
	NSIC Rc122	90	87	85	86
	NSIC Rc128	91	85	94	93
	NSIC Rc142	94	86	84	86
	NSIC Rc288	88	81	92	89

Table 10. Changes in seed vigor of carry over seed lots of TGMS hybrids evaluated.

Variety	Germination (%)		Moisture Content (%)	
	Control	After AAT	% MC	% MC
Mestiso 19	95	94	11.5	16.6
Mestiso 20	96	96	11.3	16.3

Assessing the Seed Quality, Purity, and Genetic Identity of Hybrid Parental Lines of Public Hybrids Produced at Philrice
SR Brena, LV Guittap, R Hadcan, RAG Saludares

All hybrid parental lines produced by the Nucleus and Breeder seed group at PhilRice-Los Baños are stored and will not be distributed for trials and commercial production until the result of grow-out test (GOT) is available. The test is a reliable in assessing the genetic purity of any parental line, however, it requires almost 3 months before the result becomes available. Despite the long period required for the test, the result provides good basis for discarding seed lots with low genetic purity preventing its distribution s thereby minimizing production problems.

Samples of parental lines produced in WS 2013 from PhilRice-Bukodnon; CES; Isabela; Los Baños; and Negros were sent to STD for GOT in DS 2014. Each sample was planted in three replications of at least 500 hills per replicate. The first GOT was planted in December 2014 which consisted of 6 seed lots of S-lines of PRUP TG101 from PhilRice-Isabela; 4 seed lots of TGMS hybrids; and control plot yield of Mestiso 20 from PhilRice-Agusan. The second GOT consisted of 12 seed lots of Mestiso 20 and 7 seed lots of Mestiso 19. The third batch of GOT consisted of 21 entries. There were 2 seed lots of IR58025A; 2 seed lots of IR34686R; 14 seed lots of PRUPTG102 from Bukidnon; 2 seed lots of PRUPTG102 and 1 seed lot of PRUPTG101 from PhilRice-Negros. The fourth batch of GOT consisted of 5 seed lots of F1 seeds of Mestiso 20; 1 seed lot of F1 seed of Mestiso 19; and 1 seed lot of TG101M from CES. The last GOT done consisted of 20 seed lots of F1 seeds of Mestiso 20.

All GOT plots were assessed for off-types from the vegetative stage until two weeks before harvest. All off-types noted were consolidated per replication and the total off-types observed was expressed in percentages. Generally, parental lines for distribution either for trials or commercial production should have genetic purity in GOT of 97%.

Highlights:

- Percentage genetic purity of PRUPTG101 grown in Dupax, Nueva Viscaya WS 2013 by PhilRice-Isabela ranged from 97.25% to 99.75% (Table 11). Four seed lots evaluated had more than 99% genetic purity. All of these seed lots were distributed for commercial S X P seed production of TGMS hybrid, Mestiso 19.

- The high demand for Mestiso 20 prompted the TGMS hybrid seed production group to expand the seed multiplication area (male fertile environment) for S-lines of Mestiso 20 (PRUPTG102). Areas identified included Don Salvador Benedicto (DSB) in Negros Occidental and Bukidnon. Fourteen seed lots of PRUPTG102 produced in Bukidnon had genetic purity ranged from 97.56 to 99.36%. The two seed lots grown in DSB had 98.36% and 99.10%, respectively. The lone S-line of PRUPTG101 produced in DSB had 98.48% genetic purity (Table 12)

- Other than the S-lines, PhilRice satellite station in Bukidnon also produced A-line of Mestizo 1 and the required restorer lines (IR34686R). Two seed lots each of these parental lines were also tested for genetic purity. Purity obtained in IR5025A was 99.4% and 99.3% for IR34686R. These seed lots were used for commercial seed production in DS 2014 with positive acceptance of the TGMS hybrid seed contractors and with high seed yield obtained.

- The parental lines produced in DS 2014 were tested for genetic purity in WS 2014. Very high genetic purity was noted in all seed lots of IR68897A and PRUPTG101 which were harvested in April 2014 (Table 13). The last GOT conducted on parental lines produced in May 2014 showed 7 seed lots with low genetic purity (Table 14). These parental lines were discarded and were not eligible for use in commercial hybrid rice seed production.

- The conduct of GOT for parental lines proved effective in providing hybrid seed growers of seeds with high genetic purity. Based on many commercial hybrid seed production, distribution of parental lines with 97% or higher genetic purity after GOT minimized rouging, thus less cost on labor.

Table 11. Percent genetic purity of PRUPTG101 produced from Dupax, Nueva Viscaya.

Parental line/Variety	% Genetic Purity
PRUPTG101 (S-lines of M19)	
F1L1	99.60 a
F1L2	99.23 a
F2L1	99.28 a
F2L2	99.75 a
F2L3	98.18 a
F2L4	97.45 b
F3L1	97.25 b

Table 12. Percent genetic purity of parental lines produced in Bukidnon and Don Salvador Benedicto in WS 2013.

Parental line/Variety	% Genetic Purity
PRUPTG102	
S-1 (Bkdn)	99.36
S-2 (Bkdn)	98.34
S-3 (Bkdn)	99.09
S-4(Bkdn)	98.53
S-5 (Bkdn)	98.51
S-6 (Bkdn)	98.65
S-7 (Bkdn)	98.17
S-8 (Bkdn)	98.30
S-9 (Bkdn)	97.56
S-10 (Bkdn)	98.74
S-11 (Bkdn)	98.67
S-12 (Bkdn)	98.52
S-13 (Bkdn)	98.73
S-14 (Bkdn)	98.58
S-1A (M19; DSB)	98.48
S-1A (M20; DSB)	99.10
S-1B (M20; DSB)	98.36
IR58025A	
G-14-1	99.51
G-14-2	99.36
IR34686R	
D16-1	99.45
D16-2	99.18

Table 13. Percent genetic purity of parental lines harvested in April 2014.

Parental Lines/Seed Lot		Ave. plant population/rep	Number of off-types	Off-types based on heading		% Genetic Purity
				Early	Late	
IR68897A	Lot 1	468	0	5	5	98
	Lot 2	467	0	6	7	97
	Lot 3	453	0	4	6	98
	Lot 4	452	0	4	6	98
	Lot 5	413	1	6	6	97
	Lot 6	442	0	7	6	97
	Lot 7	464	0	7	4	98
	Lot 8	427	0	4	5	98
	Lot 9	440	2	4	8	97
PRUPTG101	Lot 1	434	3	8	4	97
	Lot 2	415	3	7	5	97
	Lot 3	433	1	3	5	98

Table 14. Percent genetic purity of parental lines harvested in May 2014.

Parental Lines/Seed Lot		Ave. plant population/rep	Number of off-types	Off-types based on heading		% Genetic Purity
				Early	Late	
IR58025A	Lot 1	405	1	5	27	92 d
	Lot 2	423	0	4	24	93 cd
	Lot 3	445	0	4	24	94 bcd
	Lot 4	270	1	2	15	92 d
	Lot 5	323	0	8	14	93 d
PRUPTG102*	Lot 1	436	5	12	6	95 abcd
	Lot 2	486	1	8	4	98 a
	Lot 3	484	5	9	2	97 ab
	Lot 4	464	2	8	23	93 d
	Lot 5	478	1	10	6	97 ab
PRUPTG102**	Lot 1	483	2	7	2	98 a
	Lot 2	490	1	15	0	97 a
	Lot 3	470	0	7	2	98 a
	Lot 4	465	1	9	2	97 a

* Seed lots harvested on May 16, 2014

**Seed lots harvested on May 8, 2014

Utilization of SSR Markers for Seed Purity Testing in TGMS Hybrids of Mestiso 19 and Mestiso 20
RAG Saludares, SR Brena

With the burgeoning population in the Philippines and decreasing natural resources, rice production needs to step up to achieve rice self-sufficiency. However, high genetic purity is an essential prerequisite for commercialization of any hybrid seeds. There is 1kg production decrease in every 1% decrease in seed purity. Conventionally, hybrid seed purity is assayed by a grow-out test (GOT) which requires three to four months before the final purity of the materials is assessed. Yet, there is a need for molecular marker assay to assess genetic purity of hybrid seeds that is both fast and accurate. DNA markers are neutral, less environmentally conditioned and well reproducible. Simple Sequence Repeats (SSRs) has much more polymorphism, co-dominant and large in quantity than most of the other DNA markers. Molecular marker technology in rice has been applied widely in the identification and registration of plant variety and monitoring of the seed purity and the authenticity with high accuracy, high reliability and low cost. The objectives of the study are to investigate microsatellite markers or SSR markers capable of distinguishing rice hybrids and their parental lines and to identify specific primers which can be used for genetic purity testing with the final goal to develop a low-cost, fast, accurate, sensitive and effective DNA fingerprinting method for purity testing of hybrid rice.

Highlights:

- Three seed lots of PRUP TG102 (S-line 12Apr2012 CNE2, S-line 22Jun2012 BTB4 and problematic S-line 10May2013 FSP11) and two Mestiso 20 F1 hybrids (NSIC Rc204H 27 Oct 2012 and NSIC Rc204 H 7June2012) were planted in the basins replicated thrice.

- Leaf samples were collected from each treatment of Mestiso 20 S-lines and F1 16 days after seeding at Philippine Rice Research Institute- Seed Technology Division and were partly processed (DNA extraction) at PhilRice- Molecular Genetics Laboratory.

- DNA quantification, DNA amplification via Polymerase Chain Reaction (PCR) and SSR analysis via Polyacrylamide Gel Electrophoresis (PAGE) was conducted at the International Rice Research Institute, Plant Breeding, Genetics and Biotechnology Division, Genotyping Services Laboratory (IRRI, PBGB-GSL).

- Thirty-six SSR markers previously identified to be associated with the seed purity tests of both the parentals and its hybrids were initially used (Table 15). However, only 7 polymorphic markers were included (RM493, RM71, RM7, RM455, RM149, RM424 and RM511) that successfully detected and differentiated the genotypes.

- Parental polymorphism survey identified 5 informative markers (RM493, RM455, RM511, RM149 and RM71) [Figure 1 to 5]. However, 4 markers (RM7, RM424, RM71 and RM511) were found useful for identification of Mestiso 20 (Figure 6 to 9).

Table 15. Simple Sequence Repeats utilized for marker polymorphism test.

SSR Marker	Chromosome No.	Base pair
RM 493	1	211
RM 104	1	222
RM 490	1	101
RM 154	2	199
RM 71	2	149
RM 7	3	180
RM 223	3	165
RM 168	3	116
RM 471	4	106
RM 280	4	155
RM 119	4	172
RM 335	4	155
RM 413	5	79
RM 13	5	141
RM 163	5	124
RM 161	5	183
RM 592	5	400
RM 136	6	104
RM 111	6	126
RM 276	6	153
RM 204	6	194
RM 455	7	131
RM 152	8	151
RM 149	8	303

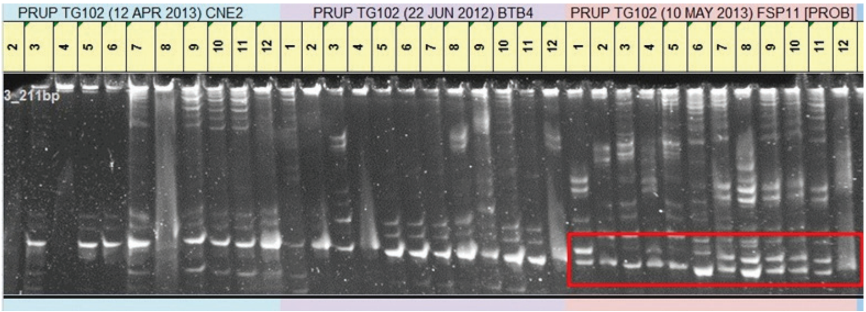


Figure 1. RM493

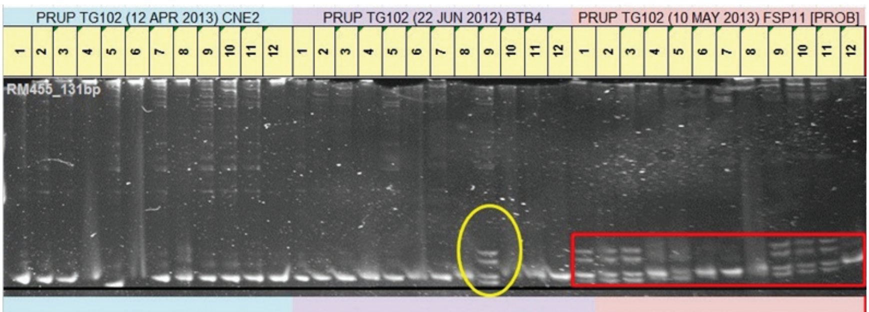


Figure 2. RM455

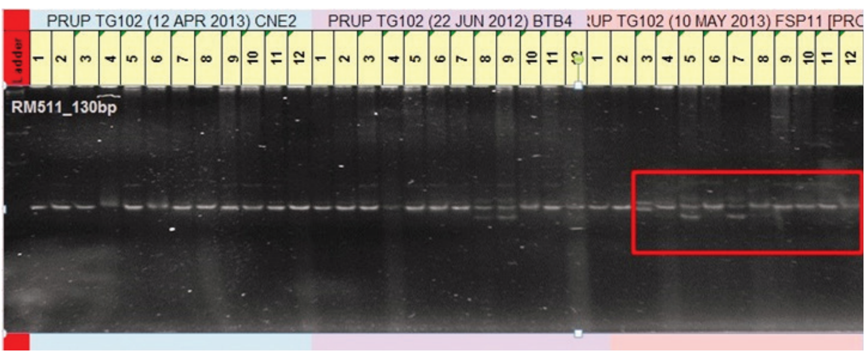


Figure 3. RM511

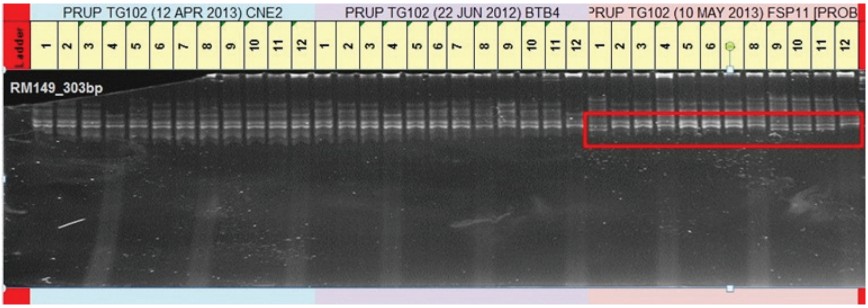


Figure 4. RM149

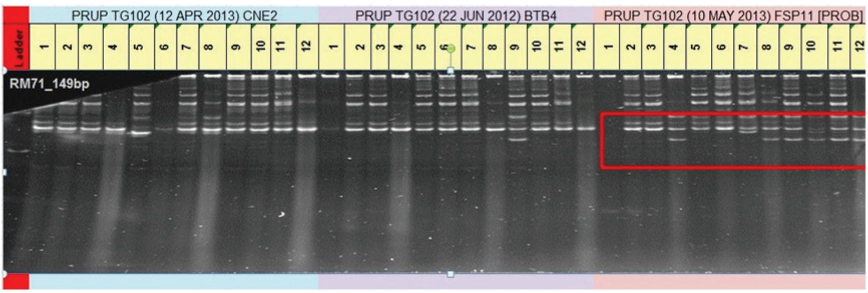


Figure 5. RM71

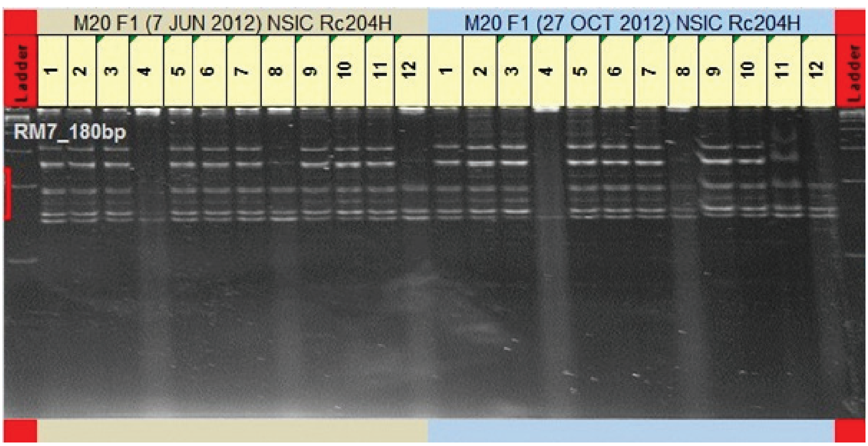


Figure 6. RM7

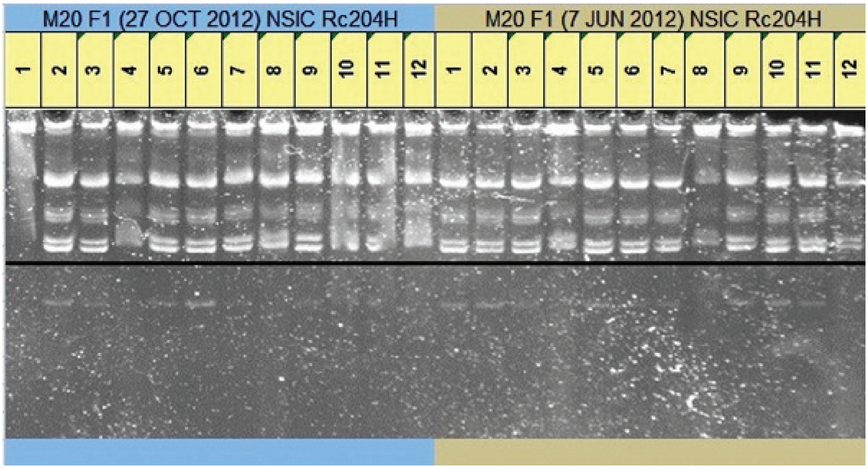


Figure 7. RM424

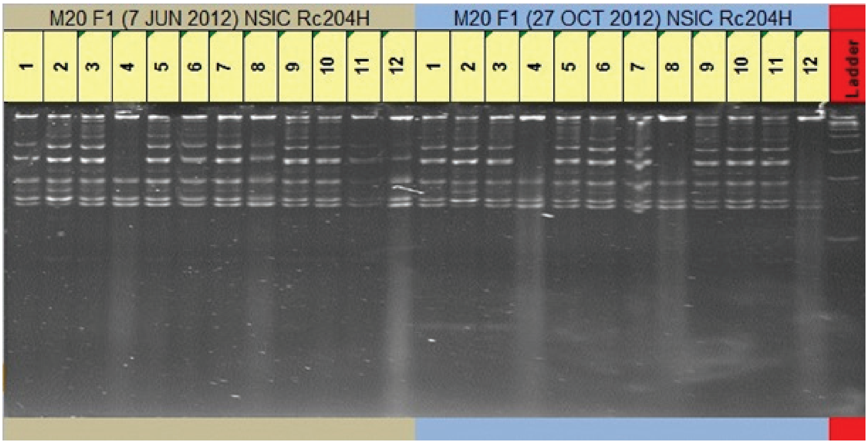


Figure 8. RM71

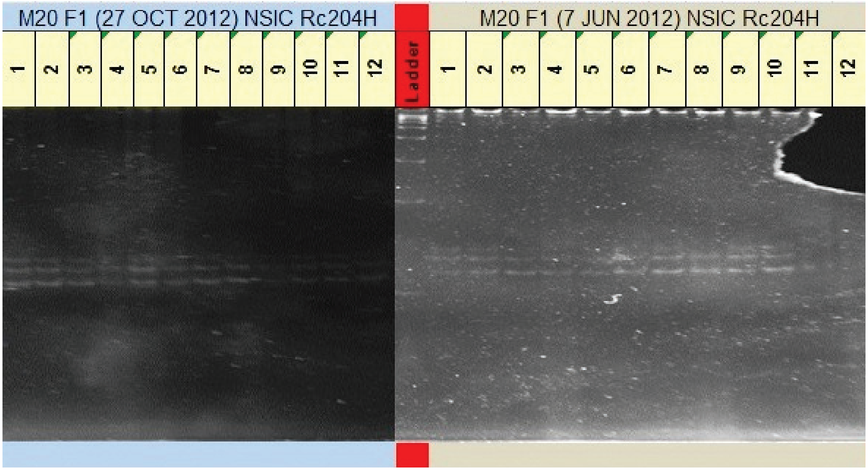


Figure 9. RM511

II. Development/Improvement of Pre-harvest and Postharvest Technologies for Commercial Seed Production

Project Leader: SR Brena

Reducing Storage Insect Pest Damage Through Appropriate Seed Storage Treatment

SRBrena, JManangkil, MCSalamanca

Low temperature storage proved effective in maintaining seed quality and minimizing storage insect pest damaged. However, its use is hindered by the high operational costs required. Seed growers including PhilRice resort to using ordinary sacks and or laminated plastic sacks as seed packaging materials. Moisture content of seeds inside these packaging materials are highly susceptible to the changes in the relative humidity of the storage rooms and damage due to storage insect pests is also high. These problems are reduced with the use of hermetic storage whose primary objective is to maintain low oxygen level inside the seed package. Hermetic storage also minimizes the use of insecticide during seed storage. Misuse of insecticide by farmers is common and can cause health and environmental problems (Baritbutsa et al., 2010).

Plastic laminated sacks are now used for seed storage, however, problem of storage insect pests persists. To minimize decline in seed quality particularly of hybrid parental lines which has higher price compared to inbred seeds, hermetic storage using `Saklob' was tried for short term storage under ambient conditions. The study was conducted to determine changes in seed quality; assess damaged caused by storage insect pests; and fungal pathogens.

Highlights:

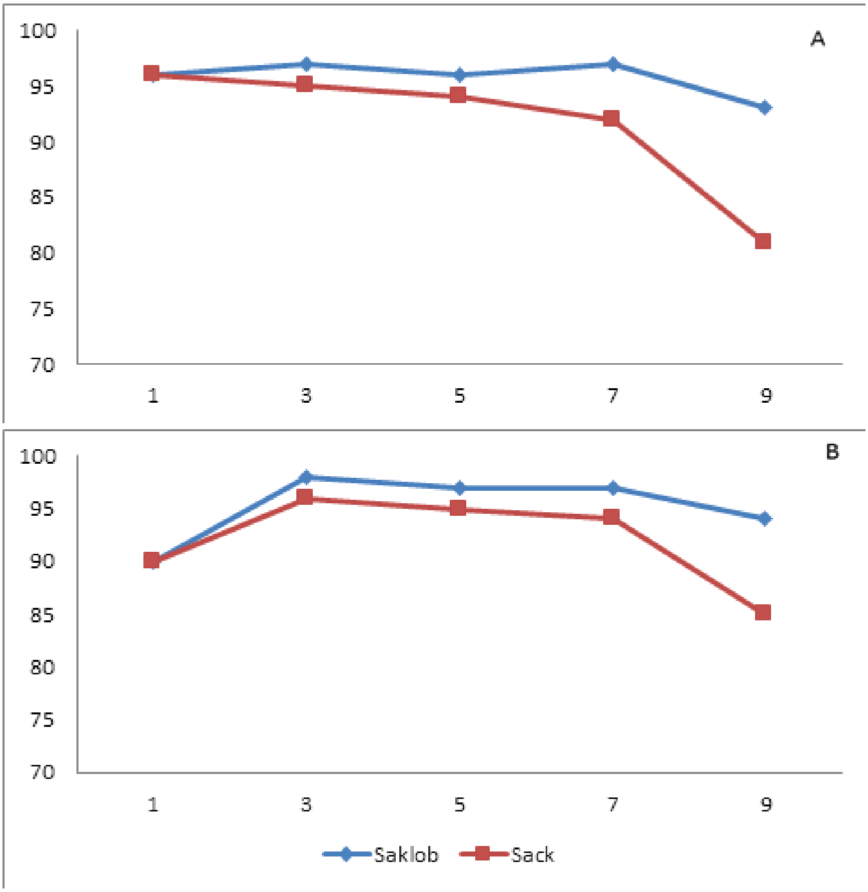
- Pollen parent seeds of TG101M produced in DS 2013 were packed in 5kg laminated plastic sacks then piled in 3 separate Saklob. Control samples were also packed in 5kg capacity laminated sacks but were stored big ordinary sacks. Both samples were kept in the same room with average temperature of 28.40C in 9 months. The storage experiment was started one month after harvest. Data gathering in this experiment lasted until February 2014.

- There were minimal changes in seed viability and vigor for 5 months. Seed viability and vigor of seeds stored in Saklob remained high (97%) after 7 months while control samples had only 92 and 94% seed viability and vigor, respectively. Both viability and vigor decreased after 9 months in both seeds stored in Saklob and in ordinary sacks. However, seed viability and vigor of seeds in Saklob remained higher than 90% while those in sacks have only 81 and 85% (Figure 10A and 10B). Moisture content of seeds remained below 14%.

- Storage insect pest population and damaged seeds were lower in Saklob than in ordinary sack during the entire duration of storage. The population increase of storage insect pest in the control samples was observed throughout the storage duration. An increase in the population of storage insect pest was observed in Saklob only after 9 months (Figure 11A).

- The development of storage fungus Aspergillus sp.was controlled in seeds kept in Saklob. Increased percentage occurrence of the fungus was noted after 3 months and the increase was observed until 9 months. The fungus was also observed in seeds under hermetic storage but the occurrence was lower than those in ordinary sacks (Figure 12).

- Similar experimental set up was made using seeds of TG102M (pollen parent of Mestiso 20) harvested in DS 2014. Seed viability and seed vigor measured through seed germination did not differ after 8 months (Figure 13). Seed vigor which is a better quality measure than viability because the seeds were subjected to accelerated ageing test before germination test is conducted remained high. However, seeds kept in Saklob had higher percentage seedling emergence when grown in soil.



Months in Storage

Figure 10. Changes in seed viability (A) and vigor (B) in TG101M stored at indicated treatments for 9 months. Each data point represents the average of 3 replications.

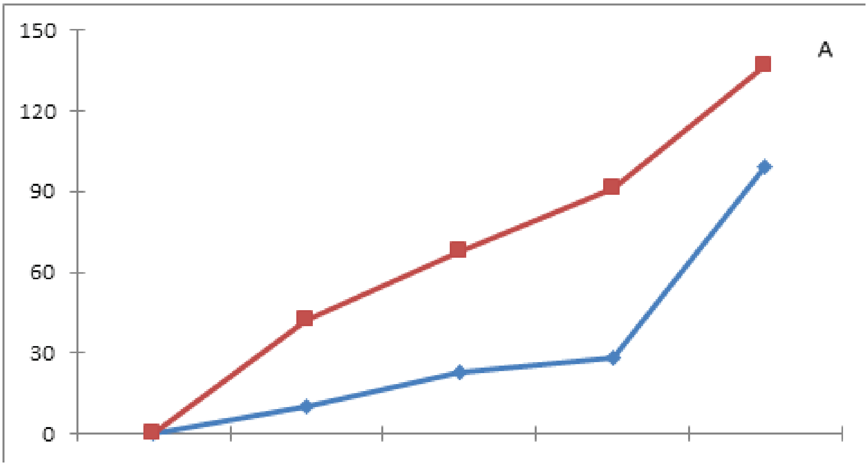


Figure 11. Storage insect pest population (A) and damaged seeds (% by weight) (B) in TG101M stored at indicated treatments for 9 months. Each data point represents the average of 3 replications.

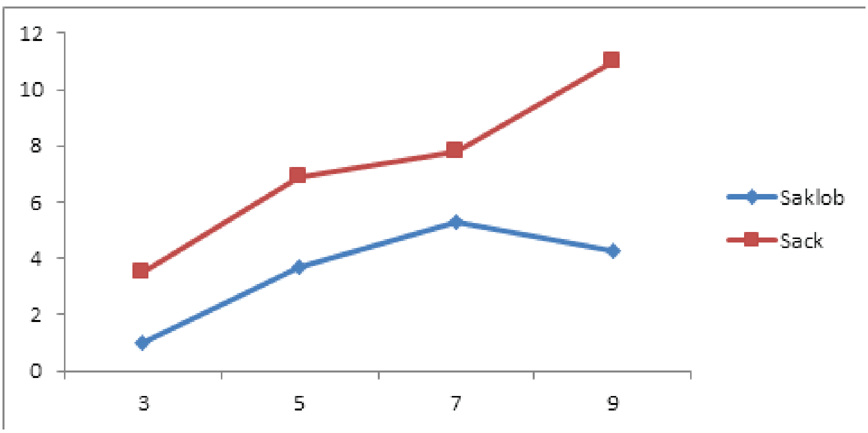


Figure 12. Percent occurrence of storage fungus, Aspergillus sp. in seeds stored at indicated treatments. Each data point represents the mean of 3 replications.

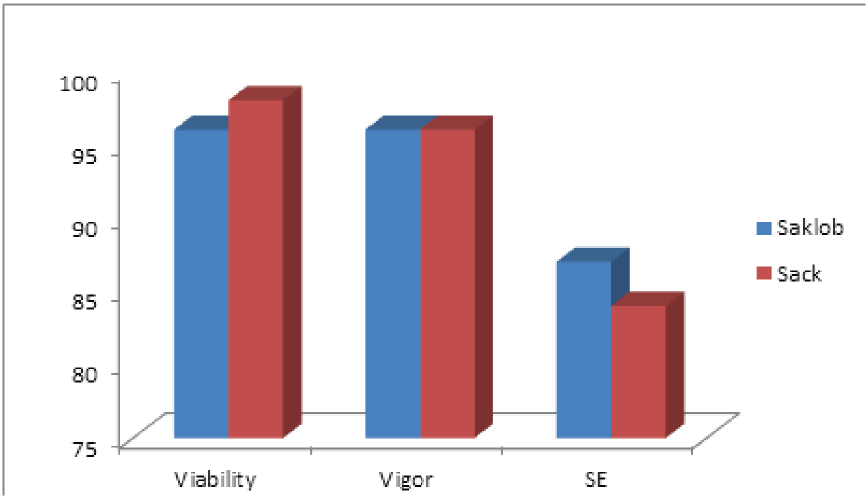


Figure 13. Seed viability, vigor, and seedling emergence after 8 months in PRUPTG102 produced in DS 2014 then kept in Saklob.

Postharvest Mechanization and its Effect on Seed Quality
SR Brena, J Manangkil, and MC Salamanca

Farm labor in rice producing areas decreases continuously which poses problems in field operations such as transplanting and harvesting. During transplanting, migrant workers come to employ as transplanters. The same thing happens during peak harvest season. Farm operations done manually require more time whereas, mechanization can do the same kind of work with more area accomplished in a day.

With the current global trend to mechanize farm operation including seed production areas, it is necessary to document possible effects of mechanized harvesting on seed quality during subsequent seed storage. The study was conducted in DS 2013 using TG101M (pollen parent of Mestiso 19). Three big paddies measuring 0.2ha each were planted manually with TG101M. During harvest, each paddy was divided into half. One half was harvested manually while the other half was harvested using combine. Seeds were sun-dried, cleaned, packed in 5kg laminated plastic sack, and then stored. Seeds were evaluated for seed quality bi-monthly which lasted until February 2014.

Highlights:

- After 7 months of storage, seed viability and seed vigor in seeds harvested using combine remained higher than 95% compared to seeds manually harvested. After 9 months, seed viability and vigor declined but the values remained higher than 90%.

- Manually harvested seeds of TG101M had slightly lower seed viability and vigor values than seeds harvested using combine. A sharp decline in both seed quality parameters was observed after 9 months with 81% seed viability and 85% seed vigor, respectively (Figure 14).

- Moisture content of the seeds did not change much from the initial MC of 12%.

- PRUPTG102M harvested mechanically using combine harvester had higher viability and seed vigor than seeds manually harvested. No difference in the percent seedling emergence was observed in both harvesting methods used (Figure 15).

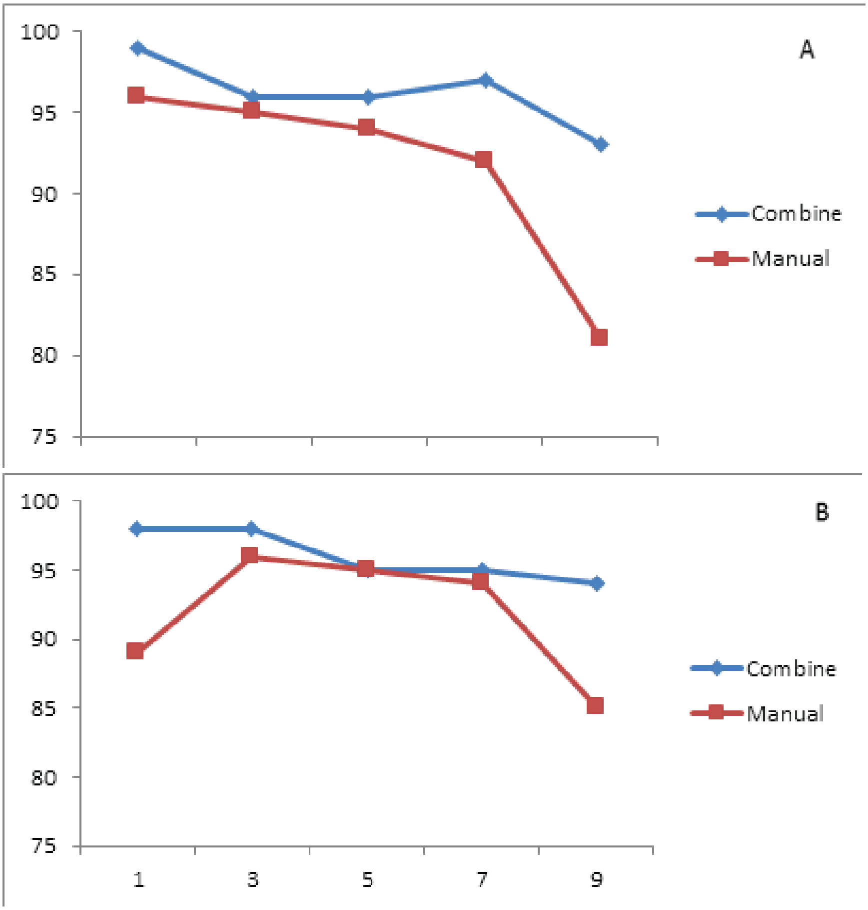


Figure 14. Changes in seed viability (A) and vigor (B) in TG101M harvested either manually or mechanically using combine. Each data point represents the average of 3 replications.

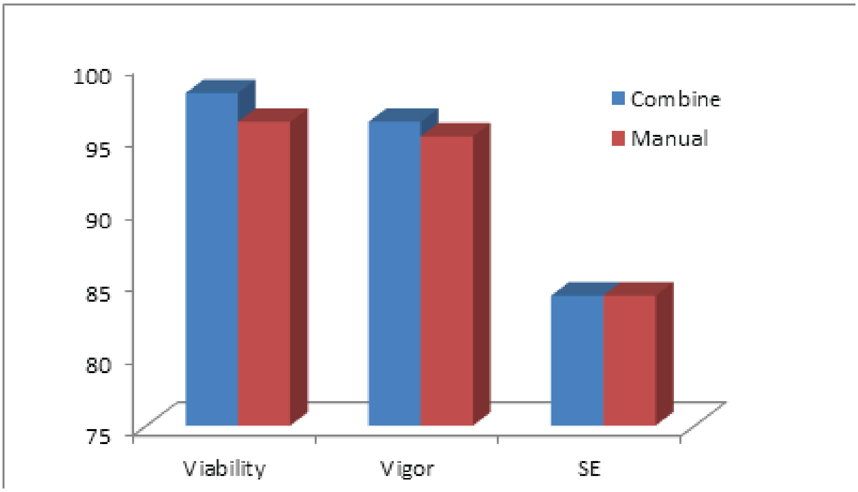


Figure 15. Seed viability, vigor, and seedling emergence in seeds of PRUPTG102M harvested mechanically. Each data point represents the average of three replications after 8 months.

Enhancing Pollen-Stigma Interaction to Improve Synchrony of Pollination: Strategy to Break Low SxP Seed Yield of Mestiso 19

REG Ragas, SR Brena, IV Boholano, M Palanog, V Luciano

Yield component data from multi-location seed production experiments (Ragas, et al., 2014, manuscript in preparation) showed that percentage seed set appears to be the limiting factor in achieving high yields in SxP of Mestiso 19. Seed setting in thermosensitive genic male sterile (TGMS) line depends upon the extent of outcrossing which is a function of the floral morphology and flowering behavior of TGMS and the male parents (Rahman et al., 2013). Stigma exsertion is especially emphasized as an effective floral characteristic that enhances outcrossing. However, TGMS line or male sterility, in general, often shows incomplete panicle exsertion, which prevents access to about 40% of the spikelets (Yan and Li, 1987; Tian 1991). Because spikelet houses the stigma, the failure of the spikelets to open creates a barrier for stigma exsertion. By reforming these floral characteristics to fit natural outcrossing, improvement of TGMS hybrid seed production may be possible.

There are important phytohormones that control floral characteristic improvement and are naturally present in a rice plant. Gibberellic acid has an important role in fertility, in addition to allowing panicle exsertion, stamen elongation, and stigma exsertion. They are necessary for the development, release and germination of pollen. Boric acid is required for normal reproductive processes especially in pollen germination and pollen tube growth. Glycine is important in plant growth and development, and is also associated with thermo tolerance in rice spikelets. Methyl jasmonate induces floret opening and stimulates the expansion of floret cells.

The objective of this study are: (a) to investigate floral traits of parent component lines of Mestiso 19 and (b) determine yield components and their contributions to seed set as affected by exogenous application of phytohormones.

Highlights:

- Longer anther length and bigger pollens were observed from TG 101M (pollen parent of Mestiso 19) compared to TG102 M (pollen parent of Mestiso 20). The heaviness of the rice pollen will limit the maximum width of dispersion during cross-pollination (Table 17).

- Angle of spikelet opening is improved by application of phytohormones. A treatment combination of glycine+boric acid+methyl jasmonate gave the widest angle (23.87o). Water as control treatment only had 7o (Table 18).

- Flowering longevity as determined by daily rating of percent flowering of male and female parents shows that flowering time and duration are extended through application of phytohormones (Figure 16). Significant effect is seen in all plots treated with gibberellic acid, glycine, boric acid, and methyl jasmonate.

- Dual stigma exsertion is common in plants that received methyl jasmonate (MeJa). As a plant hormone, MeJa induces floret opening and stimulate expansion of floret cells resulting to pistils with larger stigma.

- Seed set of female plants in rows vary. Female plants near the pollen source appear to have higher seed set than those in the middle rows (4, 5, and 6) (Figure 17). One implication of this result is that the ratio between male and parent can be adjusted to optimize cross pollination.

- After one year observation, wet season hybrid seed production gave higher seed set than dry season. Seed set among all yields components contributed to the improvement on yields. In wet season, seed set in plots treated with GA3 had the highest (26%) while control plots had the lowest (19%).

- In both seasons, the highest yield was consistently observed in plots treated with GA3+Gly+BA+Meja combination with yields of 225.97 and 1201.93 kg·ha-1 in dry and wet season, respectively (Table 19).

Table 17. Floral traits of parent lines of NSIC RC 202H or Mestiso 19 in comparison with NSIC RC 204H or Mestiso 20.

	TGMS parent	
Parameters	PRUP TG101	PRUP TG102
Pistil part		
Stigma size		
Brush-part (mm)	1.52 ± 0.02	1.44 ± 0.03
Non-brush part (mm)	0.61 ± 0.01	0.68 ± 0.02
Total stigma length (mm)	2.13 ± 0.02	2.12 ± 0.04
Stigma width (mm)	0.57 ± 0.01	0.55 ± 0.01
Stigma exsertion		
Single (%)	59.00 ± 5.60	38.00 ± 1.80
Double (%)	34.00 ± 8.80	48.00 ± 3.80
No exsertion (%)	7.30 ± 6.40	14.00 ± 2.00
Style length (mm)	0.29 ± 0.01	0.26 ± 0.01
	Pollen parent	
	TG 101M	TG 102M
Anther length (mm)	2.56 ± 0.04	2.41 ± 0.03
Pollen diameter (µm)	58.84 ± 0.58	51.37 ± 0.43

Table 18. Angle of spikelet opening as affected by different phytohormones[1].

Treatment	Angle of opening				
	Mean	Std.Error	Median	Max	Min
Water	7.00	4.24	7.00	10.00	4.00
Gibberellic acid (GA_3)	17.08	5.89	17.19	32.43	4.85
Glycine (Gly)	17.90	4.38	18.28	27.58	11.79
Boric acid (BA)	18.69	4.81	17.45	31.91	9.85
Methyl jasmonate	17.83	4.59	17.03	25.62	11.24
GA_3+Gly+BA+Meja	19.71	4.92	19.93	29.09	10.51
Gly+BA+Meja	23.87	7.16	26.54	32.27	10.42

[1]Values are means of 140 samples analyzed per treatment

Table 19. Seed yield and yield components of Mestiso 19 for two seasons at PhilRice CES.

Treatment/ Season (2014)	Productive tiller ($plant^{-1}$)	Total number of spikelets	Seed set (%)	Panicle exsertion rate (%)	1000 grain weight (g)	Yield ($kg \cdot ha^{-1}$)
Dry season						
Control	7.97	163	1.42	75.24	22.38	127.76
GA3	8.07	185	2.08	75.29	22.76	198.25
GA_3+Gly+BA+Meja	6.80	167	2.94	77.87	22.54	225.97
Gly+BA+Meja	7.87	166	2.08	75.22	21.36	176.20
Wet season						
Control	7.57	98	19.12	77.46	24.28	997.04
GA3	6.53	97	26.03	82.77	24.04	1138.74
GA_3+Gly+BA+Meja	7.06	97	24.01	79.57	23.52	1201.93
Gly+BA+Meja	6.58	99	21.58	78.13	23.53	983.30

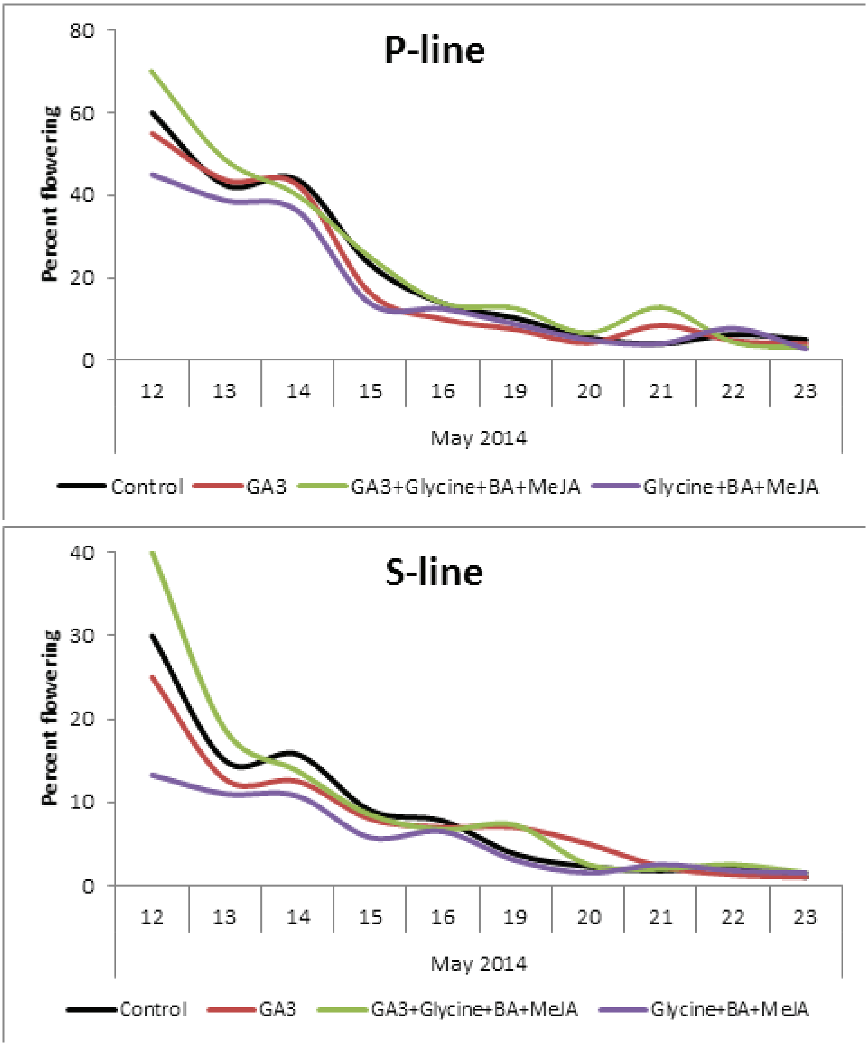


Figure 16. Flowering longevity of parental lines as affected by different phytohormones.

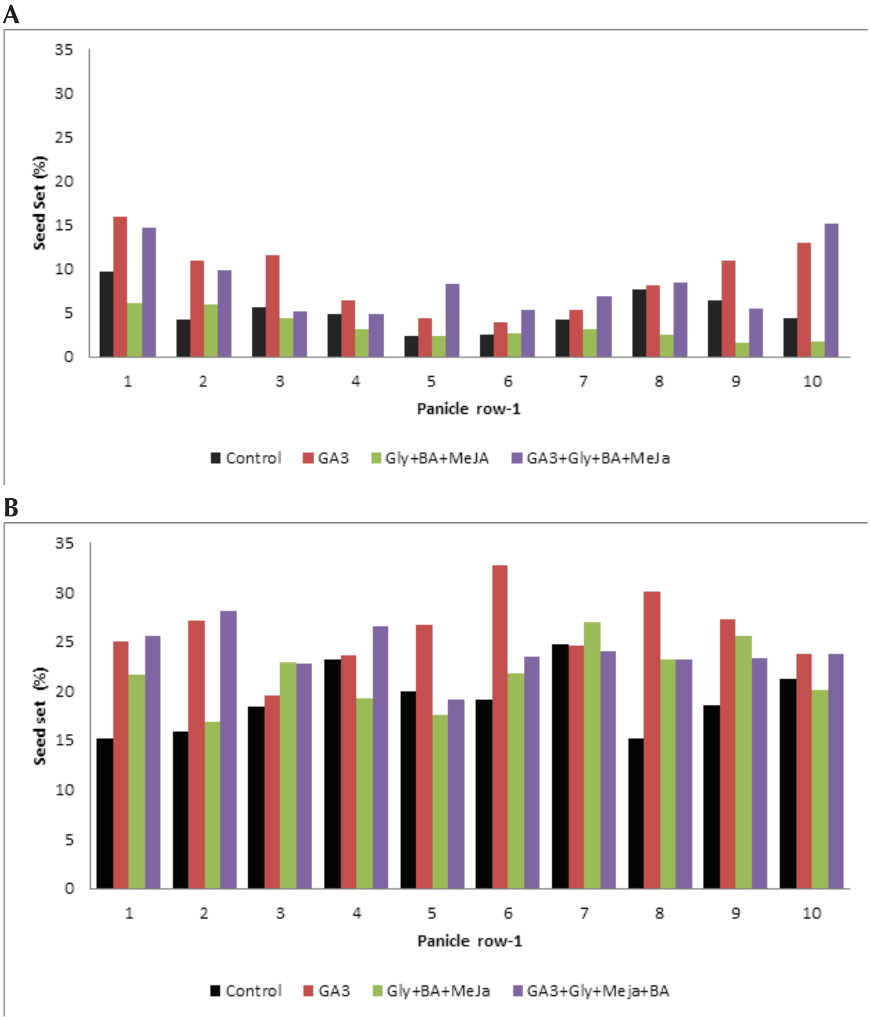


Figure 17. Seed set of panicle per row as affected by different phytohormones in (A) dry (B) wet season of 2014 at PhilRice CES.

Increasing Seed Yield in SxP Seed Production by Increasing the Row Ratio and Plant Density of P Line

SR Brena, M Osano-Palanog

To supply the growing demand for rice in the Philippines, research about hybrids and the release of promising hybrid rice for commercial cultivation were intensified (IRRI, 1998). To date 42 hybrids have been released by the National Seed Industry council (NSIC). Out of 42 released hybrids, 16 are public hybrids developed by IRRI, PhilRice and UPLB and two are TGMS based hybrids NSIC Rc202H (Mestiso 19) and NSIC Rc204H (Mestiso 20).

During the initial commercialization phase of TGMS hybrids in 2012, only NSIC Rc202H was planted. This variety became popular to farmers because of its high yield potential, short maturity period of just 110 days, moderate resistant to some pest and diseases and good eating quality. In 2012 and 2013, more than 20 ha S x P seed production of Mestiso 19 were planted in PhilRice-Negros, however, seed yield ranged from 400 to 700kg/ha only. In Davao Oriental, the average seed yield obtained in SxP seed production of M19 was 707kg/ha in WS 2012; 1,048k/ha in DS 2013; and 935 kg/ha in DS 2014. Although the original plan to commercial TGMS hybrid Mestiso 20 was in 2014, commercial seed production was launched earlier because of the good performance of the Mestiso 20 hybrids in farmers' field. From then on, there was clamor from the DA Regional Field Offices for PhilRice to supply F1 seeds of Mestiso 20. Thus, in WS 2012, parental lines of NSIC Rc204H became commercially available to hybrid seed growers in Davao provinces. In DS 2014, the average seed yield obtained in SxP seed production of Mestiso 20 was 1,885kg/ha. This seed yield level was never achieved in Mestiso 19.

The low seed yield in S x P seed production of Mestiso 19 discourages hybrid seed growers to expand their seed production areas. The current 3:10 row ratio in S x P seed production (three rows of pollen parent to 10 rows of S-lines) resulted in more number of unfilled spikelets. Moreover, the problem is further aggravated by the low tillering behavior of the PRUPTG101M (P-lines of M19) which might have caused the low pollen load available to pollinate the S-lines during supplementary pollination. One possible solution to solve the problem of low seed yield is to increase the number of P-lines planted through closer planting distance and to reduce the number of S-line rows being used in SxP seed production relative to the P-lines. Thus, more pollen will be available during pollination, hence, this study.

Highlights:

- SxP seed production of Mestiso 19 was set up in PhilRice-Negros in DS and WS 2014. Row ratios used were 3:10 and 3:8. For each row ratio used, the pollen parent was planted using three planting distances; 20 x 20; 20 x 15cm; and 15 x 15cm. Each row ratio and planting distance used was planted in three plots and each plot was considered a replicate.

- Plant height of P and S –lines, percentage spikelet fertility and panicle exsertion rate were monitored. Highest P-line height was attained in 3:8 row ratio with 20x20cm planting distance followed by 20x15 under the same row ratio. Despite the increase in plant height of P-lines in 3x8 row ratio and 20x20cm planting distance, spikelet fertility was only 37.7%, though there was 98.8% panicle exsertion rate (Table 20).

- The target yield of 1t/ha in SxP seed production following the row ratio and planting distance in the P-lines used was not attained despite highly synchronized flowering of both parental lines because the prevailing temperature in PhilRice –Negros during flowering was very high (Figure 18A).

- Higher percentage seed set was observed during WS. However, highest percentage seed set was observed in 3:8 row ration using 15 x15cm planting in P-lines. Reducing the number of S-line rows in M19 SxP with closer planting distance in P-lines may compensate for the low tillering capacity of the P-lines of Mestiso 19. Moreover, temperature during pollination in WS was lower than in DS (Figure 18B).

Table 20. Plant height (before harvest), productive tillers, and spikelet fertility observed in S and P-lines planted in S x P plots of Mestiso 19 in PhilRice-Negros in DS 2014 using different row ratio and planting distance of P-lines.

Row Ratio	Planting Distance in P-lines (cm)	Plant height (cm)		% Seed Set		% Panicle Exsertion	
		S-lines	P-lines	S-lines	P-lines	S-lines	P-lines
3 :10	20 x 20	101.3	128.1	7.2	52.9	78.1	94.6
	20 x 15	87.5	117.7	3.7	47.6	74.3	86.1
	15 x 15	91.4	119.1	6.7	55.1	75.2	100.0
3:8	20 x 20	99.8	135.5	6.3	37.7	74.7	98.8
	20 x 15	95.0	137.2	9.9	50.9	73.6	100.0
	15 x 15	96.1	127.9	5.4	44.8	75.1	93.5

Plant height (before harvest), productive tillers, and spikelet fertility observed in S and P-lines planted in S x P plots of Mestiso 19 in PhilRice-Negros in WS 2014 using different row ratio and planting distance of P-lines.

Row Ratio	P-lines planting distance (cm)	Plant height (cm)		Tiller Number in S-lines			Tiller Number in S-lines			% Seed Set	
		S-lines	P-lines	Productive	Non-P	Total	Productive	Non-P	Total	S-lines	P-lines
3:10	20 x 20	89.8	127.9	6	3	9	12	2	10	35.5	43.3
	20 x 15	84.9	111.3	8	1	9	11	2	9	73.6	80.1
	15 x15	84.7	115.8	5	2	7	13	3	16	50.3	79.3
3:8	20 x 20	88.0	122.5	6	3	9	10	3	13	34.6	73.5
	20 x 15	87.1	115.2	6	3	9	8	1	9	48.8	78.9
	15 x 15	89.6	124.0	6	3	9	10	1	11	61.2	96.5

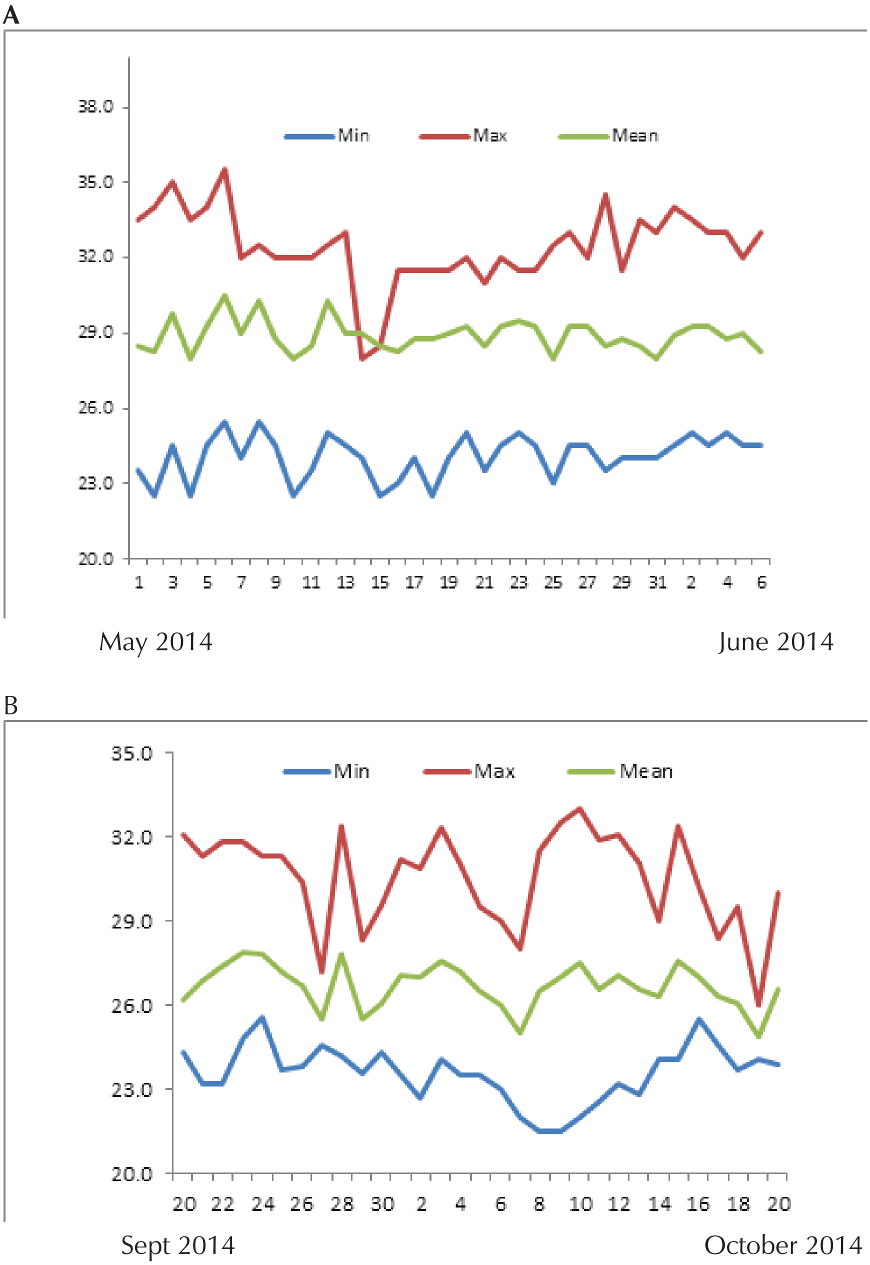


Figure 18. Temperature profile in DS 2014 (A) and WS 2014 (B) during supplementary pollination in SxP seed production of Mestiso 19 in PhilRice-Negros.

Effect Of Temperature on Growth, Grain Yield, Pollen Development and Grain Quality of Selected Restorer Lines and Pollen Parents
LV Guittap and SR Brena

One of the most effective ways of mitigating the effect of climate change is the deployment of high temperature-tolerant cultivars. In breeding stress tolerant crops, information on the effect of temperature on rice growth and development is necessary. It is important to look at other aspects on how temperature affects rice such as the pollen behavior, spikelet sterility and fertility and grain quality to further understand the mechanism of heat stress. Conducting field experiment to determine the effect of temperature would provide a broader understanding of the complex nature of temperature effect on growth performance. Furthermore, it is also important to determine what specific stage or stages are most vulnerable to the stress. This would be helpful in recommending cultural management practices to reduce if not eliminate the effect of heat stress. In hybrid seed production for example, flowering behavior and agro-morphological characteristics are important. Quantifying the effect of temperature on pollen sterility and days to flowering for synchronization would be helpful in attaining high seed yield. This would also aid in understanding pollen behavior.

The study was conducted mainly to identify the influence of temperature on flowering behavior and pollen growth and development of different restorer lines and pollen lines. Also other important agro-morphological characteristics will be identified.

Highlights:

- During the season six (6) restorer lines (R-lines) and two (2) pollen parents (P-lines) were tested in Los Baños (LB) and Central Experiment Station at Maligaya (CES). The R-lines lines include IR34686R, IR60819R, and IR71604R, the restorer lines of three popular hybrids Mestizo 1, Mestiso 3 and Mestiso 7. Other R-lines were IR60912R, SRT3R, and IR73385R, the male parents of Mestiso 21, Mestiso 25, and Mestiso 26 respectively. Pollen parents tested in the study were TG101M and TG102M which are the P-lines of two popular TGMS-based hybrids Mestiso 19 and Mestiso 20. Restorer lines with their respective hybrids are summarized in Table 21.

- Temperature data at Los Banos during the experiment was requested from PAG-ASA Agromet Station at UPLB. As expected, maximum temperature did not reach more than 35 C. Flowering (50% heading) of the genotypes occurred from 2nd week of April to 1st week of May. The average temperature during April is 29.1 C. Data for May and June will be requested. On the other hand, the male parents planted at

CES flowered from 1st week to 3rd week of May. Temperature data is not yet available but initial observation in the area showed that during flowering, the temperature is around 35 C.

- Most of the lines tested flowered earlier at CES as compared to LB. In the case of IR34686R, similar number of days to 50% heading was recorded for both locations at 105 days. IR60819R and IR6091R both flowered 95 days from soaking at LB and 2 days earlier at CES. For IR71604R and SRT3R, flowering was recorded at 87 days at CES and 89 days and 90 days at LB respectively. About 3 days difference in number of days to flowering was observed for IR73885R on two locations. The two pollen parents of TGMS-based hybrids also flowered 2 days earlier at CES compared to LB.

- Pollen samples were also collected on the onset of flowering. Evaluation for pollen fertility and other pollen characteristics under a microscope using IKI solution as stain to determine the effect of temperature to pollen is currently being done. The samples will be observed in three fields and will be scored using the SES published by IRRI.

- Grain samples for testing selected grain quality parameters are being done in collaboration with the Rice Chemistry and Quality Laboratory in PhilRice Los Baños.

Table 21. List of restorer lines tested with respective hybrids and days to 50% heading.

Lines	Hybrid Involved	Days to 50% heading	
		LB	CES
IR34686R	PSB Rc72H	105	105
IR60819R	NSIC Rc116H	95	93
IR71604R	NSIC Rc136H	89	87
IR73385R	NSIC Rc230H	95	92
SRT3R	NSIC Rc232H	90	87
IR60912R	NSIC Rc206H	95	93
TG101M	NSIC Rc202H	86	88
TG102M	NSIC Rc204H	96	98

Evaluation of Proper Timing and Frequency of GA3 Application in Increasing Seed Yield of S X P Seed Production in PhilRice Midsayap

IV Boholano, SR Brena, REG Ragas

Hybrid seed production experiment was carried out during dry and wet seasons of 2014 at PhilRice Midsayap in a split-plot design with four replications. Heading stage served as main treatment plot while split applications of gibberellic acid (GA3) as sub-plot treatments. Four heading stages were determined as follows: (T1 or control) 5 to 10% heading; (T2) 2 days before heading; (T3) 20 to 30% heading; (T4) 50% . For sub-plot factor, a total of 180 g/ha GA3 was used in different ratios: (G1or control) no GA3 applied for S-line but P-line had two splits of GA3 application, (G2) three splits of application with a ratio of 2:6:2; (G3) three split of application with a ratio of 2.5:5:2.5; (G4) two split of application with a ratio of 2:8; and (G5) four split of application with a ratio of 2:4:3:1 of total GA3. The parental lines used were PRUP TG101 (S-line) and TG101M (P-line). P-lines were sown three (P1) and five days (P2) after S-line to allow flowering synchrony. The study aimed to identify the optimum timing and frequency of GA3 application based on different heading stages. Yield component data were analyzed using MegaStat and treatment differences were further subjected to post-hoc analysis.

Highlights:

- The interaction between GA3 applications and different heading stages was significant for all yield parameters tested except for 1,000 grain weight in dry and wet seasons; and plant height difference between parent lines in dry season (Table 22).

- At 20 to 30% heading stage, highest yields were consistently achieved among treatments tested and across two seasons. The yields were 0.9t/ha and 1.1t/ha for dry and wet seasons, respectively. Consequently, at 20 to 30% heading (82 to 85 DAS), high outcrossing rate, high panicle exsertion rate, and plant height difference of 25 to 30cm between parent lines were obtained that contributed largely to the said yields.

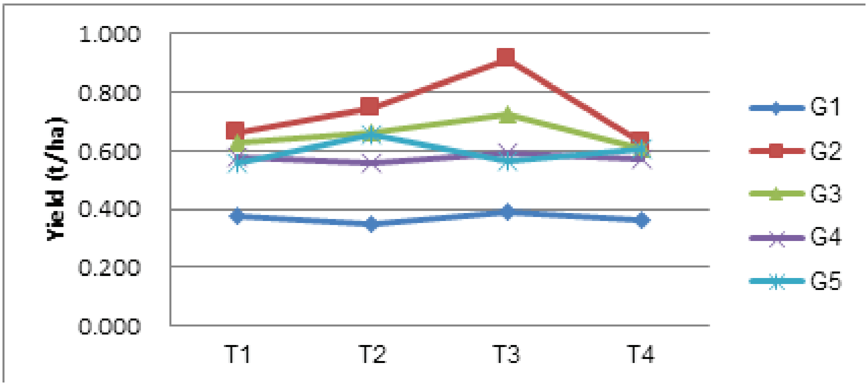
- Results suggest that the best time for GA3 application in Midsayap environment is when P-line is at two days before heading (74-76 DAS) and S-line is at 20 to 30% heading stage (82-83 DAS). To accommodate this heading interval and achieve ideal flowering synchronization, seeding interval should be adjusted accordingly.

Table 22. Calculated P value of different parameters in two-way analysis of variance for two cropping season, CY 2014.

	Parameters									
Source	**Yield (t/ha)**		**Outcrossing rate (%)**		**Panicle exertion rate (%)**		**Plant height difference (cm)**		**1000, grain weigh**	
Cropping Season	**DS'14**	**WS'14**	**DS'14**	**WS'14**	**DS'14**	**WS'14**	**DS'14**	**WS'14**	**DS'14**	**WS'1**
Heading Stage	0.0012**	3.78E-06**	.0011**	5.77E-10**	.0739	6.46E-07**	3.77E-07**	9.24E-14**	.2265^{ns}	.8197
GA3 Application	8.84E-21**	1.32E-37**	2.61E-21**	9.73E-28**	1.79E-20**	2.12E-39**	1.01E-13**	8.72E-21**	.7281^{ns}	.5873
Interaction	0.0033**	1.18E-11**	.0062**	2.71E-09**	.0403*	.0003**	0.11	2.33E-06**	.7026^{ns}	.6601

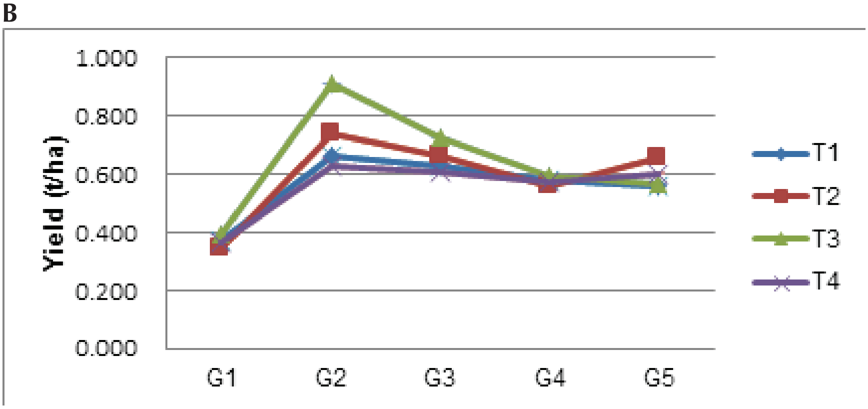
*** – statistically highly significant at P< 0.001; * – statistically significant at < 0.05 ; ns – not significant*

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

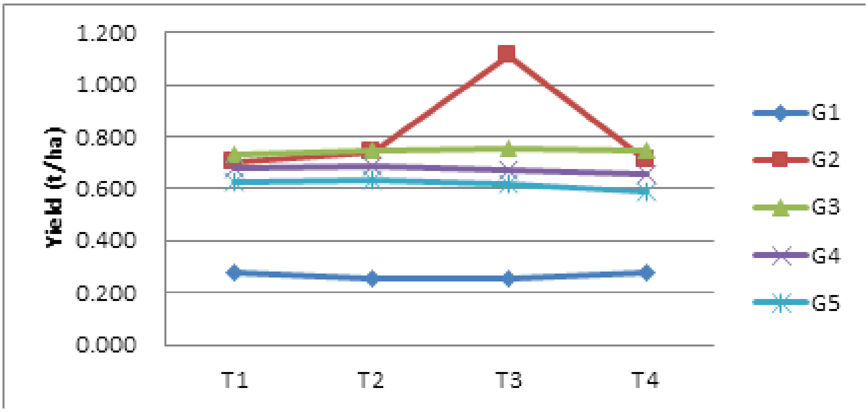
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

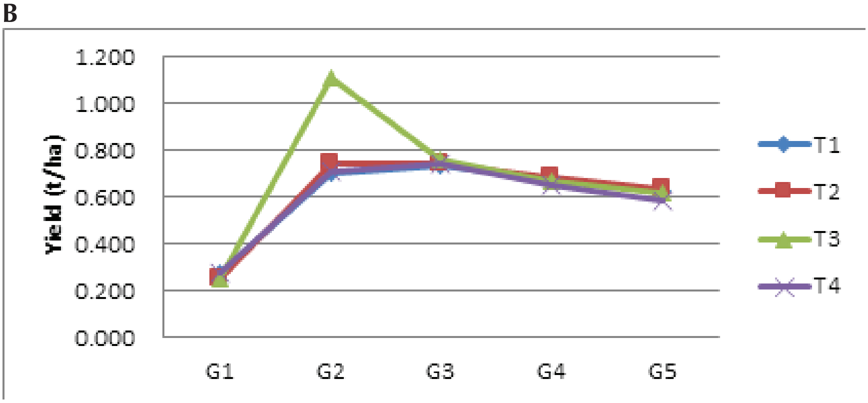
Figure 19. A) Interaction on grain yield (t/ha) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), DS'14; B) Interaction on grain yield (t/ha) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36 g/ha)
G3 (45:90:45 g/ha)
G4 (36:144 g/ha)
G5 (36:72:54:18 g/ha)

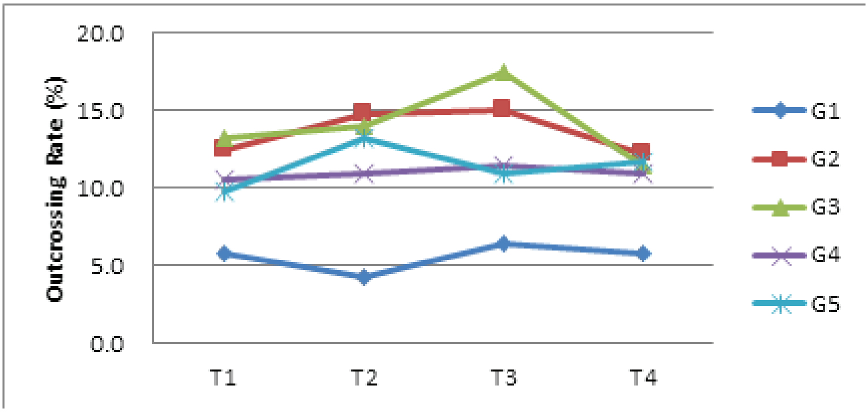
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

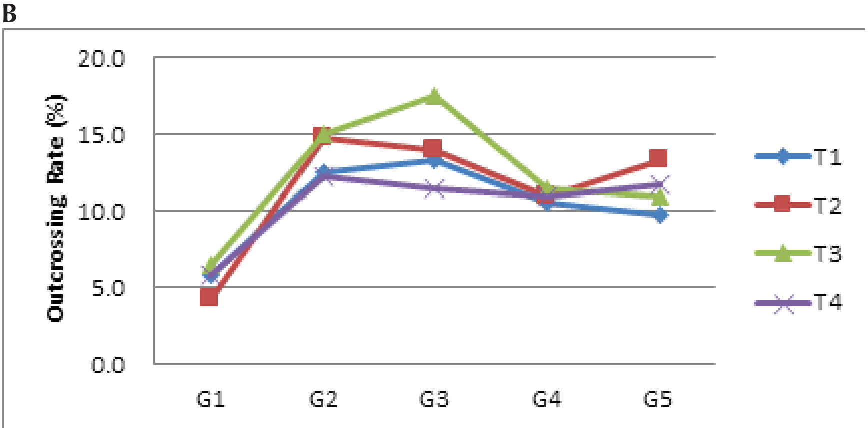
Figure 20. A) Interaction on grain yield (t/ha) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), WS'14; B) Interaction on grain yield (t/ha) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

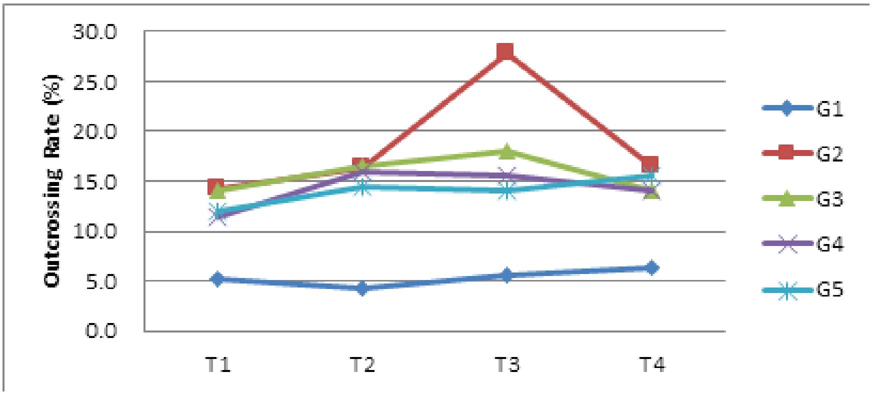
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

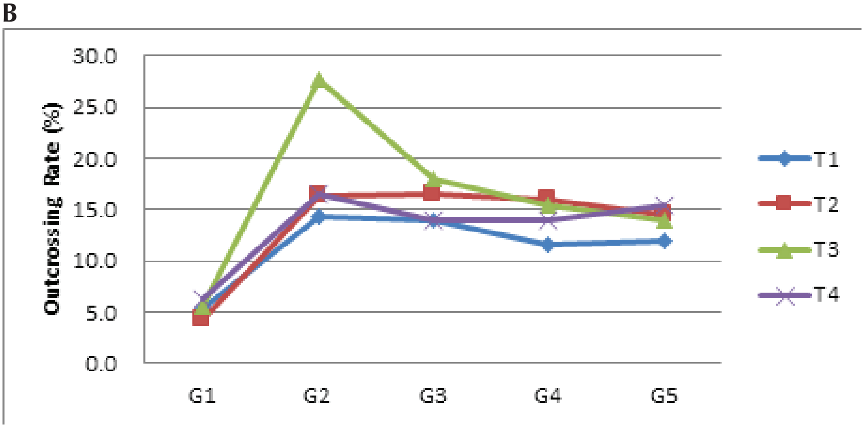
Figure 21. A) Interaction on Outcrossing rate (%) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), DS'14; B) Interaction on Outcrossing rate (%) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

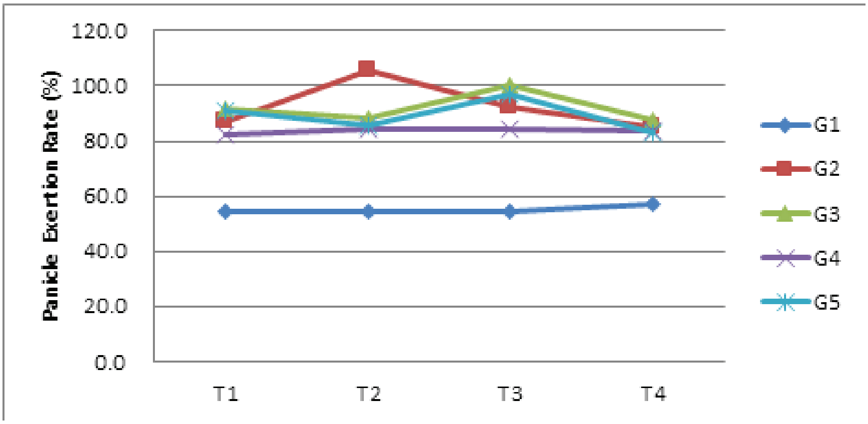
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

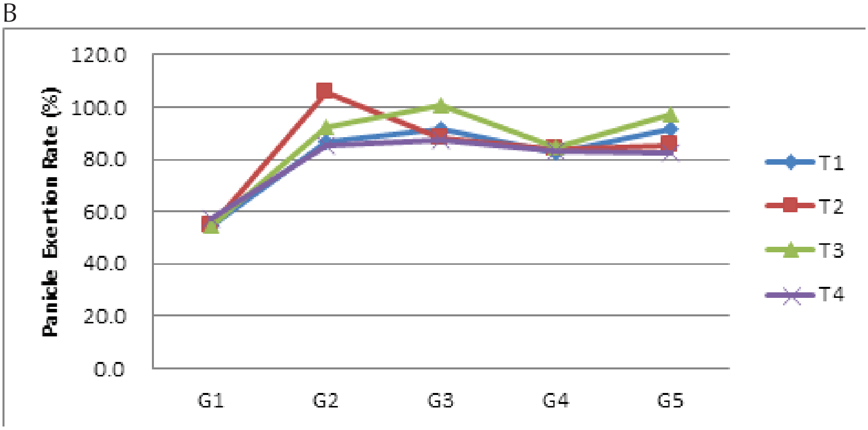
Figure 22. A) Interaction on Outcrossing rate (%) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), WS'14; B) Interaction on Outcrossing rate (%) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

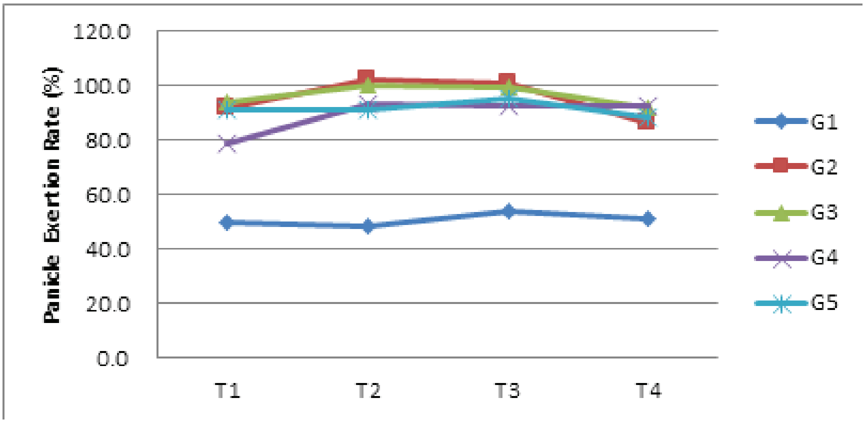
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

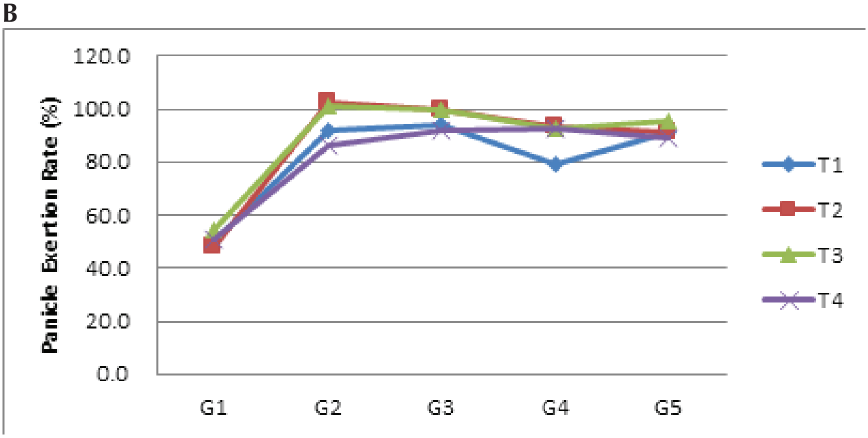
Figure 23. A) Interaction on Panicle exertion rate (%) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), DS'14; B) Interaction on panicle exertion rate (%) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

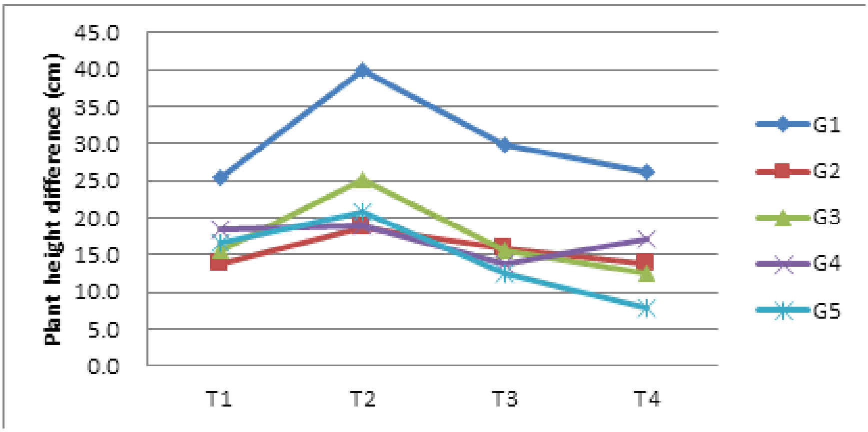
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

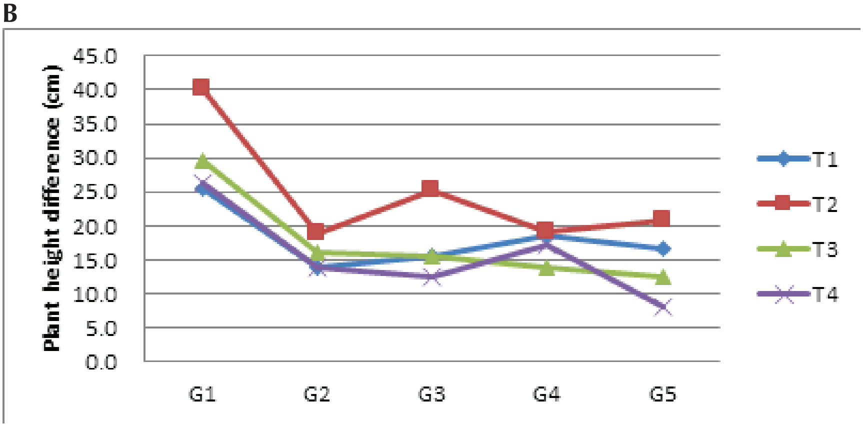
Figure 24 A) Interaction on Panicle exertion rate (%) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), WS'14; B) Interaction on panicle exertion rate (%) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

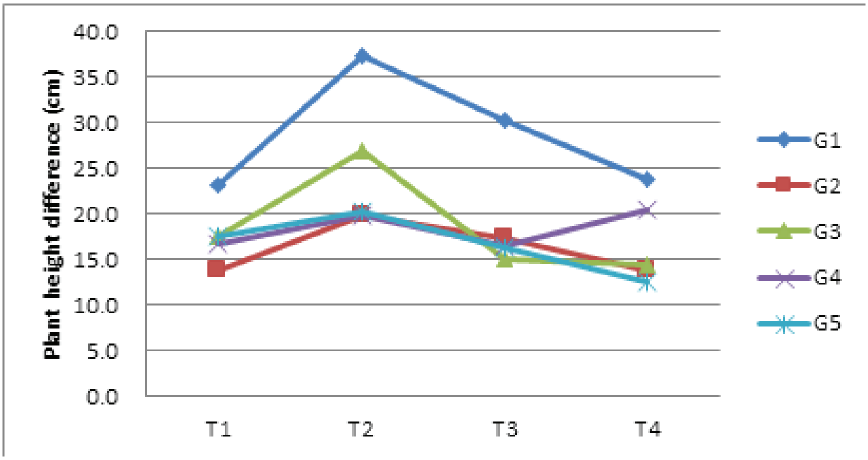
B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

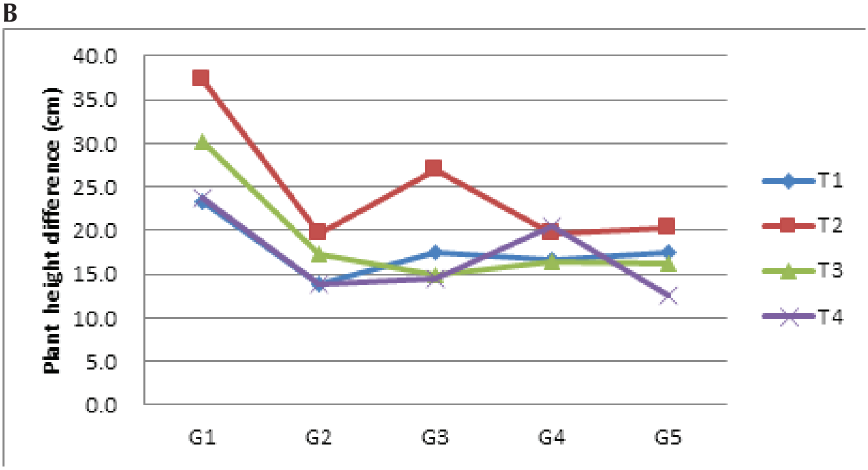
Figure 25. A) Interaction on Plant height difference between P and S line of Mestiso 19 (cm) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), DS'14; B) Interaction on Plant height difference between P and S line of Mestiso 19 (cm) by application of Gibberellic acid (GA3) in different heading stage.

A



Legend:
G1 (no GA3 for S-Line)
G2 (36:108:36g/ha)
G3 (45:90:45g/ha)
G4 (36:144g/ha)
G5 (36:72:54:18g/ha)

B



Legend:
T1 (10-15% heading)
T2 (two days before heading)
T3 (20-30% heading)
T4 (50% heading)

Figure 26. A) Interaction on Plant height difference between P and S line of Mestiso 19 (cm) on the different heading stage (Factor 1) applied with different ratio of Gibberellic acid (GA3), WS'14; B) Interaction on Plant height difference between P and S line of Mestiso 19 (cm) by application of Gibberellic acid (GA3) in different heading stage.

Optimizing Seeding Interval, Row Ratio, and Timing of GA3 Application for Increased Seed Yield of M20 in PhilRice Negros

BU Tizon-Salazar

Seed production in two-line hybrids is faster since maintainer line is no longer required compared with three-line hybrids (Virmani et al., 2003). In other countries like China, two-line hybrids have 10% more yields compared to three-lines. In the Philippines, PhilRice Negros (having favorable temperature for two-line hybrid seed production) has been producing F1 seeds of M20, a major two-line hybrid variety commercially released in the country, yet increasing the seed yield to 1t/ha remains a major challenge. Initial data gathered from the station's seed production area WS 2012 and 2013 showed that average spikelet fertility ranged from 25 to 30%. Though this is very close to the ideal seed setting rate (during the fertile phase) of >30% (Virmani et al., 2003), seed yield was only 0.43 t ha-1 and 0.30 tha-1, respectively. These figures are far from China's 2.5-3.0t/ha average seed yield for two-line hybrids (Yuan, et al. _; Lu et al., 1998). Though it is inappropriate to compare seed yields from two countries considering the differences in the parentals, agro-climatic conditions, and cultural management practices, among other factors, it is worthwhile to identify which factors influenced the seed yield obtained in the station. Through this, improvements on the practices can be done.

Generally, this study aims to increase seed yield of M20 in PhilRice Negros by 10% by 2016 through optimization of seeding interval, the row ratio and timing of GA3 application. The study has 3 substudies; sub-study 1. Synchronizing flowering of NSIC Rc204H parentals through optimum seeding interval; sub-study 2. Determining the appropriate row ratio for increased seed yield of M20 at PhilRice Negros; and sub-study 3. Determining the optimum timing of GA3 application for increased seed yield of M20 at PhilRice Negros. Sub-studies 2 and 3 started WS 2014 while sub-study 1 will start DS 2015. Ongoing data processing and analysis for sub-study 3.

Highlights:

- Generally, plant height, tiller number, panicle length, panicle exerted, filled grains, spikelet fertility, and 1000-grain weight did not differ significantly among treatments across parentals and growth stages (Tables 1- 5). Compared to S lines, P1, P2, and P3 lines are generally taller by 34-37cm and developed 3-6 more tillers at maturity (Table 23 and 24). On the other hand, significant differences were recorded in plant height of P2 and S lines at maximum tillering (60 DAT), but they showed different trends. While S lines planted in 2:4 row ratio resulted to 5.63cm-shorter plants, P2 lines planted in the same row ratio led to 8 cm-taller plants compared to those planted in

3:10 row ratio. Compared to panicle length, the length of exerted panicle is shorter by at most 6cm across treatments and parentals (Table 25). Across parentals, S lines manifested generally shorter panicles.

- On the average, 90 more filled grains was observed in S lines following 3:10 row ratio compared to the other treatments, though differences were considered not significant (Table 26). However, the same plants recorded higher unfilled grains, 80 on the average, compared to the other treatments. This increased number of filled and unfilled grains observed led to 83-202 more total grains in 3:10 row ratio (Table 27). With this, spikelet fertility in S lines planted in 3:10 row ratio is generally higher by 13, 6, and 11%, respectively, at maturity (Table 5). The combined effect of additional tillers and filled grains could have contributed to the increased yield observed in 3:10 row ratio. These results will be verified DS 2015 set-up.

Table 23. Plant height of P1, P2, P3 and S lines 30, 60 and 120 days after transplanting, WS 2014.

Treatment	Plant Height (cm), days after transplanting											
	P1			P2			P3			S		
	30	60	120	30	60	120	30	60	120	30	60	120
2:04	68.06	84.83	114.00	65.73	86.38	121.56				53.89	76.72a	76.74
2:06	67.86	86.33	110.35	68.33	84.44	114.58				54.90	74.77ab	76.60
3:08	68.66	89.11	109.73	71.33	89.22	120.90	67.96	87.00	116.37	53.32	73.47ab	78.78
3:10	71.00	86.22	118.73	69.80	85.99	123.60	70.46	83.89	122.63	50.28	71.09b	87.04
ANOVA	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	*	ns
C.V. (%)	5.84	3.02	9.04	9.46	3.06	5.8	5.66	2.11	10.7	5.29	2.02	5.42

ns– not significant; *significant at 5%; **significant at 1%.

Table 24. Tiller number of P1, P2, P3, and S lines 30, 60, and 120 days after transplanting, WS 2014.

Treatment	Tiller number, days after transplanting											
	P1			P2			P3			S		
	30^{ns}	60^{ns}	120^{ns}	30^{ns}	60*	120^{ns}	30^{ns}	60^{ns}	120^{ns}	30^{ns}	60^{ns}	120*
2:04	21	20	11	22	26a	14				11	12	6b
2:06	22	16	9	19	26a	11				12	13	6b
3:08	20	23	9	21	20ab	10	23	25	9	11	14	7ab
3:10	21	19	10	18	18b	9	18	19	11	10	14	8a
ANOVA	ns	Ns	ns	ns	*	ns	ns	ns	ns	ns	ns	*
C.V. (%)	13.5	19.03	24.8	23.27	13.43	28.8	31.79	34.62	3.83	13.2	16.93	9.2

ns– not significant; *significant at 5%; **significant at 1%.

Table 25. Tiller number per square meter, panicle length, and panicle exerted of P1, P2, P3, and S lines at 120 days after transplanting, WS 2014.

Treatment	Tiller no per m^2, panicle length and panicle exerted											
	P1			P2			P3			S		
	Tiller/m^2	PLength	PExerted	Tiller/m^2	PLength	PExerted	Tiller/m^2	PLength	PExerted	Tiller/m^2	PLength	PExerted
2:04	43a	26.26	23.02	54a	29	23.56				110b	19	17
2:06	27ab	21.13	21.13	32ab	25	22.30				115b	20	16
3:08	18b	22.60	22.60	20b	28	24.70	19	28	24.67	139ab	22	18
3:10	20ab	25.57	25.57	18b	28	25.06	22	28	25.15	162a	22	18
ANOVA	*	Ns	ns	**	ns	ns	ns	ns	ns	**	ns	ns
C.V. (%)	10.4	13.4	13.4	17.2	10.4	9.6	4.21	2.5	4.3	9.3	5.22	7.75

ns– not significant; *significant at 5%; **significant at 1%.

Table 26. The number of filled, unfilled, and total number of grains of P1, P2, P3, and S lines at 120 days after transplanting, WS 2014.

Treatment	Filled, unfilled and total number of grains											
	P1			P2			P3			S		
	Filled Grains	Unfilled Grains	Total	Filled Grains	Unfilled Grains	Total	Filled Grains	Unfilled Grains	Total	Filled Grains	Unfilled Grains	Total
2:04	233	656	888	342	593	935				61	432	493ab
2:06	214	339	554	432	359	792				88	346	434b
3:08	249	499	749	285	486	771	389	385	774	83	470	553ab
3:10	294	494	788	244	507	751	367	419	786	167	469	636a
ANOVA	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
C.V. (%)	6.95	16	11.5	18.1	10.2	17.6	19.6	17.6	17.4	19.8	11.1	9.85

ot significant; *significant at 5%; **significant at 1%.

Table 27. Spikelet fertility, 1000 grain weight and yield of P1, P2, P3, and S lines at 120 days after transplanting, WS 2014.

Treatment	Spikelet fertility (%), 1000 grain weight (g), and potential grain yield (t ha−1)											
	P1			P2			P3			S		
	Fertility	1000 Grain wt	Yield	Fertility	1000 Grain wt	Yield	Fertility	1000 Grain wt	Yield	Fertility	1000 Grain wt	Yield
2:04	28	25	2.56	38.67b	25	4.54a				13	25	1.93b
2:06	38	26	1.76	54.33a	23	3.10ab				20	25	2.87b
3:08	32	26	1.21	37.00b	24	1.36b	47	24	2.05	15	25	3.15b
3:10	36	27	1.61	32.33b	24	0.99b	43	26	2.20	26	25	6.56a
ANOVA	ns	ns	ns	**	ns	*	ns	ns	ns	ns	ns	*
C.V. (%)	14.2	4.9	10.1	11.1	17.7	3.91	35	16.9	10.1	13.3	2.67	16.4

ot significant; *significant at 5%; **significant at 1%.

III. Hybrid Basic Seed Production and Hybrid Seed Research

Project Leader: SR Brena

Characterization of CMS lines for stability in pollen sterility

LV Guittap, GT Sulte, EE Sajise, and TM Masajo

The use of hybrids is a proven technology in increasing rice yields in the Philippines and elsewhere. To date, over 40 hybrids have already been released by the National Seed Industry Council (NSIC) where majority are based in the cytoplasmic male sterility (CMS) system. Among these, 13 are considered public hybrids which utilize as female parents 5 different CMS or A lines. These are IR58025A (A-line of Mestizo 1 and Mestiso 38), IR68897A (A-line of Mestizo 3, 7, 26, 29 and 32), IR73328A (A-line of Mestiso 21, 25, 31 and 48), PR2A (A-line of Mestiso 16), and PR3A (A-line of Mestiso 17). However, problems on the stability of the pollen sterility trait are often being observed. Over the years, data compiled at Los Baños showed as compared to other CMS lines, low percentage of completely sterile plants in the IR58025A populations as determined by microscopic examination of the pollen using IKI stain. Such unstable pollen sterility expression is likewise observed in IR73328A, the A line of the released hybrids, Mestiso 21, 25 and 31 and 48. The purity and stability of the A-line is a very important factor in CMS-based system because of its effect on seed purity and quality of F1 commercial seed. Quantifying pollen sterility is therefore vital in measuring the stability of commercial CMS lines. Knowledge on stability of commercially used CMS lines will be very helpful in monitoring the purity and quality of the AXB and AXR seed production in the field. This can also be used as a basis in breeding and improvement of CMS lines in the future. Likewise, characterization of important agro-morphological characters and flowering behavior would yield information needed by breeders, seed producers and production specialists, and seed quality inspectors. The objectives of the study are: (a) To characterize commercially used CMS lines for stability in pollen sterility and (b) To observe and identify other important traits and behavior which can be useful in improving seed multiplication and management of the CMS lines.

Highlights:

- Populations of three commercially used CMS lines (IR58025A, IR68897A, and IR73328A) were established for the study. At the onset of flowering, each CMS line was checked for sterility through microscopic evaluation of the pollen. Stability of completely sterile (CS), sterile (S) and partially sterile (PS) CMS lines were tested by backcrossing about 20 CMS individuals to corresponding maintainer-lines. All progenies of the backcrosses will be crossed with the same B-line for the next three generations to monitor stability of pollen sterility.

- During 2014 dry season, 16 CS, 15 S and 10 PS individuals of IR73328A were made to represent three generations. The seeds harvested from BC3 will be assembled together with the materials previously generated from BC1 and BC2 for evaluation of trueness, sterility and uniformity in 2014 wet season. The crosses made per generation is summarized in Table 28.

- Monthly planting of the CMS lines was conducted to observe stability of pollen sterility with reference to the month it was established. The CMS lines were also characterized for important agronomic and flowering characteristics. On the average, the recorded days to 50% heading of IR58025A was 88 days (from April 2012 to April 2013) which ranged from 85-96 days. For IR73328A and IR68897A, the average days to 50% heading was 80 days during the one year period ranging from 75 to 91 days. The variation of recorded days to flowering for the commercially-used CMS lines was between 11 days (for IR58025A) to 15 days (IR73328A and IR68897A). Other important morphological characteristics such as days to 50% heading and plant plant height were also observed in the monthly planting (Table 29.), For the plant height, IR73328A was the tallest at 100 cm. This is one of the reasons why this line is not performing well during seed production since it is taller than its maintainer line. The plant height of IR58025A and IR68897A was recorded 92cm and 77cm respectively. Tiller number of the three CMS-lines was 15. Anthesis for all of the CMS lines was starts from 9:00 to and ends at 11:30AM. For IR58025A and IR73328A, the start of flowering is around 9:30AM while on IR68897A, begin earlier at 9:00 AM. The duration of anthesis lasted for about two hours on all the CMS lines.

- Pollen sterility and seed set evaluation was also observed from the monthly planting of the CMS-lines (Table 30). IKI staining method was used to evaluate pollen and the computation of percent pollen sterility was based from SES published by IRRI. For all of the CMS lines tested, pollen sterility ranged from 99.86 to 100% during the year of observation.

- Seed set was determined by bagging panicles on the onset of flowering. It was observed that for IR58025A, seed set occurred (0.4% to 2.2%) on the plants established during September, October and November wherein the flowering is during the mid-December, January, and February. For

IR73328A, seed set was observed only on the entries established in July (0.3 %) and February (0.19%) and none on other months.

Table 28. Number of paired crosses made and evaluated each season from 2012 dry season to 2013 wet season.

Parental line	Season											
	S0			S1 (BC1)			S2 (BC2)			S3 (BC3)		
Pollen score	CS	S	PS	CS	S	PS	CS	S	PS	CS	S	PS
IR68897A and B	20	20	20	17	19	18	9	16	15	9	16	15
IR58025A and B	20	20	20	11	13	14	11	13	14	11	13	14
IR73328A and B	20	20	20	17	16	10	16	15	10	16	15	10

Table 29. Agronomic characteristics of commercially used CMS-lines established from April 2012 to April 2013.

Parental line	Days to 50% heading		Plant height (cm)	Tiller No.
	Range	Average		
IR58025A	85-96	88	92	15
IR68897A	76-91	80	77	15
IR73328A	75-90	80	100	15

Table 30. Pollen sterility and seed set of commercially-used CMS-lines established from April 2012 to April 2013.

Parental lines	IR58025A		IR68897A		IR73328A	
Date of establishment	Pollen sterility (%)	Seed set (%)	Pollen sterility (%)	Seed set (%)	Pollen sterility (%)	Seed set (%)
Apr-12	100.00	0	100.00	0	100.00	0
May-12	100.00	0	99.98	0	99.99	0
Jun-12	100.00	0	99.99	0	100.00	0
Jul-12	100.00	0	100.00	0	99.92	0.3
Aug-12	99.86	0	100.00	0	99.97	0
Sep-12	99.98	0.4	99.97	0	100.00	0
Oct-12	99.95	0.3	99.99	0	99.96	0
Nov-12	99.98	2.2	99.93	0	100.00	0
Dec-12	100.00	0	100.00	0	100.00	0
Jan-13	100.00	0	99.94	0	100.00	0
Feb-13	100.00	0	100.00	0	99.98	0.19
Mar-13	99.98	0	99.99	0	100.00	0
Apr-13	100.00	0	100.00	0	99.99	0
Range	**99.86 - 100**	**0 - 2.2**	**99.93 - 100**	**0**	**99.92 - 100**	**0-.3**

Nucleus and Breeder Seed Production of New Recommended Hybrid Varieties

GTSulte, LVGuittap TMMasajo, SHEscamos, JLLales, and FMXie

The hybrid rice technology has proved to be effective in increasing production of rice in the country and elsewhere. To date, more than 40 hybrids have so far been released by the National Seed Industry Council (NSIC) of which about 15 were developed by IRRI, PhilRice, and UPLB, are considered public hybrids. Five of these hybrids are popular and are widely grown by farmers. Several newly released hybrids have been identified as potential replacement for the currently grown varieties. These hybrids include Mestiso 31 (NSIC Rc248H), Mestiso 32 (NSIC Rc250H) and Mestiso 38 (NSIC Rc262H). Upon release of a hybrid variety, seed production of parents and F1 should follow to popularize and commercialize the hybrid. Likewise, protocols on basic and F1 seed production methods for the new hybrids should be studied and established in order to give proper recommendations to hybrid seed growers. The project had the following objectives: a.) Check purity and genetic identity of component (parental) lines in NSIC Rc248H (Mestiso 31), NSIC Rc250H (Mestiso 32), and NSIC Rc262H (Mestiso 38), b.) Characterize the three new NSIC hybrids released and the component parents based on agro-morphological and grain characters, c.) Develop protocol on the method of basic seed production of the parents and the F1 seeds of Mestiso 31, Mestiso 32 and Mestiso 38, d.) Field test the seed production protocols developed for Mestiso 31, Mestiso 32, and Mestiso 38 and e.) Do initial seed increase of the parents of Mestiso 31, Mestiso 32, and Mestiso 38 to anticipate popularization and commercialization.

Highlights:

- Component lines of public hybrids recently approved by NSIC were included in the study. In 2013 wet season (WS), original seeds of Mestiso 31 and Mestiso 32 parentals were requested from IRRI. Since the CMS- and maintainer lines of Mestiso 31 (IR73328A and B) and Mestiso 32 (IR68897A and B) are available at PhilRice, only IR73013R the restorer line of both hybrids was requested. From the seeds received, a germplasm file was processed and packed for storage to serve as future reference and original seed stock.

- During 2013 WS, seed purification and multiplication of IR73013R was initiated. A source population was established, and from there 500 plants were selected for plant-to-row establishment. Each plant selection was harvested, processed and labelled correspondingly. Harvested seeds from each entry were divided into three parts: (a.) 5 grams were used for evaluation, (b.) 20 grams were sampled, bulked and planted for breeder seed production and (c.) the remaining seeds were stored as file.

- In 2014 dry season (DS), the 500 plant selections from the previous season were evaluated and 320 entries were selected based on days to heading, trueness, purity and uniformity. The selected entries were bulked and about 20kg were harvested and processed as nucleus seeds. Breeder seed production plot was also established during the season. A total of 90kg IR73013R were harvested, processed, packaged and submitted for NSQCS certification.

- An observation nursery was established for A, B and R-line of Mestiso 31 and 32 to observe the flowering behavior and to characterize the parentals. The information generated will be compiled and use as basis in formulating seed production protocols. Based on the dry season data (Table 31.), days to 50% heading (DTH) of IR73013R is 96 days. On the other hand, DTH of IR73328A (Mestiso 31) and IR68897A (Mestiso 32) is 79 days and 81 days respectively. According to the initial observation, the R-line of Mestiso 31 must be seeded 17 days earlier than the A-line to synchronize the flowering. In the case of Mestiso 32, A-line must be established 15 days after the restorer line. The plant height of IR7013R is 122cm, taller than IR68897A and IR73328A. Taller restorer line is favorable in AXR F1 seed production since it facilitate better cross pollination and application of GA3 could be minimized.

- Other hybrid being considered for commercialization in 2015DS is NSIC Rc262H (Mestiso 38) bred by PhilRice and PhilScat. During the season, 005-10167R (breeding code) the restorer line of Mestiso 38 was obtained from PhilSCat. The R-line was planted for the establishment of source population and about 500 plants were selected and will be evaluated in 2014 WS. IR58025A and B is the CMS- and maintainer line of the hybrid.

- Aside from the three hybrids, purification of the restorer line of Mestiso 29 was initiated in 2013 WS. About 300 panicles of true-to-type plants of PR34202R (restorer line of Mestiso 29) were evaluated in panicle-to-row arrangement. About 120kg were selected and harvested from 220 entries considered as nucleus seeds. Seed of the restorer line of Mestiso 48 was also purified and 35kg of nucleus seeds was produced.

Plans for 2014 wet season

- Plant-to-row evaluation will be done to purify 005-10167R (Mestiso 38). Breeder seed production of the restorer line will be initiated for NSQCS certification.

- Observation nursery for the parentals of Mestiso 31 and 32 will be done in 2014 WS to generate additional information and to confirm the data from DS. AXR seed production plot will also be established to evaluate synchronization data and to produce hybrid seeds for 2015 F1 trial. F1 and component lines will be further characterized based on agro-morphological and grain characters. The information that will be generated will be vital for successful hybrid seed production and also for seed certification.

Table 31. Flowering and agro-morphological characteristics of Mestiso 31 and Mestiso 32 parentals. 2014 DS.

Component lines	Days to 50% heading	A X R Synchronization	Plant height (cm
Mestiso 31			
IR73328A	79	17	110
IR73328B	79		110
IR73013R	96	1	122
Mestiso 32			
IR68897A	81	15	76
IR68897B	81		76
IR73013R	96	1	122

Hybrid and Nucleus and Breeder Seed Production (PHILRICE-UPLB-IRRI)
LV Guittap, GT Sulte, TM Masajo, SH Escamos, JE Hernandez, JL Lales, FM Xie

Successful commercial exploitation of hybrids in highly autogamous cereal crops like rice depends on the extent of superiority of hybrids over existing popular inbred varieties and the ease at which F1 seeds could be economically produced. It would take good-performing hybrids and an organized and efficient system of seed production and distribution to popularize and commercialize hybrid varieties. Like all hybrids involving inbred parental lines, genetic purity of the parents must be maintained to produce quality hybrid seeds in commercial quantities every time required. Pure, true-to-type and high quality seed is essential for the successful implementation of government's hybrid rice commercialization program. This project at PhilRice Los Baños was assigned the responsibility to produce and distribute basic seeds of released public hybrids. These are the hybrids bred by IRRI and PhilRice, tested in the NCT and released as varieties by the

National Seed Industry Council (NSIC). The project is jointly implemented by PhilRice Los Baños in collaboration with UPLB and IRRI.

Highlights:

- Evaluation nurseries were established to check the trueness, uniformity and sterility of the A-lines generated from paired crosses and S-line individuals selected at male fertile environment (MFE). A total of 492 paired crosses of IR58025A, IR68897A, and IR73328A with were evaluated during the season. On the other hand, 1000 plant selections each from PRUP TG101 and PRUP TG102 selected from source population at MFE in Tublay, Benguet were evaluated at male sterile environment (MSE) in Los Baños.

- From the evaluation nursery, about 300 entries from the CMS-lines were identified as completely sterile and true-to-type thus, they can be used to raise nucleus seeds. On the other hand, 700 entries and 600 entries of PRUP TG101 and PRUP TG102 respectively were selected to serve as source population in producing nucleus seeds.

- During the period, 1,267kg of processed A-line, 727kg of B-line, and 696kg of R-line breeder seeds of CMS-based hybrids were applied for NSQCS seed certification (Table 32). For the parents of TGMS hybrids, breeder seeds produced during the period were 1,358kg P-line; 758kg TG101M and 600kg TG102M. S-line of Mestiso 19 and 20 were also planted at MFE site in Tublay, Benguet. PRUP TG101 and PRUP TG102 will be harvested at the end of June 2014.

- An added responsibility was given to the project with the DAs TGMS hybrid commercialization program. Requirements for S- and P-line foundation seeds for the nationwide SxP seed production was produced under the management of BDD with technical assistance from the staff of NBSP. Two MFE sites located at Lucban, Quezon and Majayjay, Laguna were planted with PRUP TG101 and PRUP TG102.

- Amount of hybrid parents produced and distributed in the period from January to June 2014 for 2014 DS planting is shown in Table 1. Breeder seeds of CMS-based hybrid parentals distributed were mainly for foundation seed production while the S- and P-lines dispatched were for SxP or F1 seed production of Mestiso 19 and 20. Also F1 seeds were dispatched for research purposes

- Sufficient amount of breeder seeds of hybrid parentals of public released hybrids are kept in the cold rooms at Seed Processing and Storage Facility at Los Baños. They are distributed to accredited hybrid seed growers on request. Total hybrid parental breeder and F1 seeds in storage is as follows: 1,792kg of A-line, 936kg of B-line, and 1,017kg of R-line and 1358kg P-line. The seeds in storage consist of old stock produced from the previous seasons and the parentals harvested in 2014 dry season

Table 32. Summary of amount (kg) of breeder and F1 seeds produced, distributed and those currently in store in 2014 dry season at PhilRice Los Baños.

Hybrid/ Parental	Amount of Breeder and F1 Seeds produced (kg)	Amount of Seeds Dispatched (kg)			Amount of Breeder Seeds in Store (kg)
		AXB	AXR	Research	
Mestizo 1					
IR58025A	520	30		15	520
IR58025B	366	12			366
IR34686R	696	5	85	5	696
PSB Rc72H	0			0.5	2
Mestiso 3/7					
IR68897A	747	30			1272
IR68897B	361	12			571
IR60819R	0				21
IR71604R	0				300
NSIC Rc116H	0			0.5	2
NSIC Rc136H	0			0.5	2
Mestiso 19					
PRUP TG 101	*		1500		
TG-101M	758	5			758
NSIC Rc202H	0			2.5	
Mestiso 20					
PRUP TG 102	*			15	
TG-102M	600	30	275	5	600
NSIC Rc204H	0			0.5	
TOTAL					
A-line	**1792**				
B-line	**936**				
R-line	**1017**				
S-line					
P-line	**1358**				
F1	**6**				

*For harvest

Identification of the Best Location and Time of the Year/Season Optimum for Seed Production and Quality

SR Brena, LV Guittap, and MF Austero

The success of China in the development and expansion of hybrid rice technology has influenced other countries like the Philippines to adopt hybrid rice technology. When Chinese hybrids were planted in the Philippines, they were found not adapted in our environmental conditions and their grain quality was poor compared to the popular high-yielding inbred varieties. This leads to extensive research to develop suitable parental lines. Later, public hybrid varieties were developed, released and used commercially. These varieties were PSB Rc72H, NSIC Rc114H and NSIC Rc116H. However, initial hybrid seed production in the Philippines resulted in low seed yield. For a sustainable hybrid program, seed yield level in hybrid seed production should be at least 1t/ha. Thus, to achieve this seed yield, yield, seed production of new released hybrid varieties should be tried in different locations where it is adapted. The best location for hybrid seed production of each released hybrid should be identified for continued seed production.

With the establishment of three new PhilRice satellite stations in Mindoro, Samar, and Zamboanga, hybrid seed production trials should be tried in these areas. In this study, AxR seed production was tried only in Sta. Cruz, Occidental Mindoro for Mestizo 1; Mestiso 7; 29; 38; and SxP seed production of Mestiso 19 and 20. The trials were conducted to develop production protocols for each specific hybrid that will give 1t/ha seed yield.

Highlights:

- S x P seed production was possible in Mindoro. However, the S-lines of both M19 and M20 remained open much longer than those observed in other locations in the Philippines. Normally, the flowers opened early and then closed by 1 to 2 P.M. In Mindoro, S-lines opened between 7 to 8 AM and closed between 5 to 6 PM. The observation gives some advantage in seed production if the P-lines flowering can be extended also so there will be more spikelets that can be pollinated.

- Among the released hybrids tried for seed production in Mindoro, SxP seed production of both TGMS hybrids produced F1 seeds, however, the F1 seeds produced were not dried at once causing seeds to discolor. Harvesting of the F1 seeds coincided on rainy days which caused seed discoloration.

- The study will be conducted again but only for seed production of Mestiso 19 and 20 only because of the good performance of the F1 under farmers' field.

Table 33. Estimated seeding intervals of parentals for flowering synchronization of different hybrids under Mindoro condition in DS 2014.

Hybrid	Parental Lines		Estimated seeding interval (days)
Mestizo 1	IR58025A		25
	IR34686R	R1	21–25
		R2	28
Mestiso 38	IR58025A		12
	PhilScat R	R1	12
		R2	5
Mestiso 29	IR68897A		3
	PR34032R	R1	3
		R2	3
Mestiso 7	IR68897A		3
	IR71604R	R1	7
		R2	10–13
Mestiso 19	PRUPTG101		3–5
	TG101M	P1	3–4
		P2	3–4
Mestiso 20	PRUPTG102		3–5
	TG102M	P1	3–4
		P2	3–5

Flowering Behavior and Seed Production Capacity of Hybrid Parental in Different Locations and Seasons

SRBrena, LVGuittap, and MFAustero

Unlike inbred, where the female and male parts are found in one plant, hybrid seed production requires planting side by side of male and female plants to produce the F1 seeds. Hybrid seed set on the female line depends primarily on its flowering synchronization with the R line. Differential seeding of the female and the male plants must be established for each hybrid to achieve flowering synchronization. If the duration of the male line is 10 days more than that of the female line, the male line is sown in 2 to 3 staggered sowings to ensure continuous pollen supply. In this case, R lines are sown 13, 9, and 5 days ahead of the female line (http://www.fao/docrep/006y4751e/4751e0h.htm). Likewise, row ratio and spacing play major role in hybrid seed production. A row ratio of 6:2 seed parent to pollen parent has been proven very effective. Row ratio direction perpendicular to the prevailing wind direction at flowering stage allows easy pollen dispersal on the seed parent.

To attain the ideal production capacity of the promising hybrids, optimum synchronization of flowering must be attained. For ideal flowering synchronization, the female parent should flower 1 to 2 days earlier than the R lines. With the promising hybrid lines in the pipe line, flowering behavior of the parental should be well established in location favorable for hybrid seed production, hence, this study.

Highlights:

- Five different R lines; IR60819R; IR34686R; PR34302R; IR71604R; and PhilScatR of three - line hybrids and two pollen parents of TGMS hybrids; TG101M and TG102M were planted in Sta. Cruz, Occidental, Mindoro. Only two A lines, IR58025A and IR68897A; and two S –lines, PRUPTG101 and PRUPTG102 were also planted.

- IR58025A and IR34686R are the parental lines of Mestizo1; IR58025A and PhilScatR are Mestiso38; IR68897A and PR34302R for Mestiso29; IR68897A and IR71604R for Mestiso7. Parental lines of Mestiso 19 are PRUPTG101 and TG101M while PRUPTG102 and TG102M are for Mestiso20.

- Following standard protocol and GA3 application in Occidental Mindoro for Mestizo1, differential seeding interval required should adjusted to about 30 days and at least 12 days for Mestiso 38.

- Heading date of both parental lines of M19 and M20 was between 84 and 85 days. Duration of flowering was longer TG101M by 2days compared to TG102M but S-lines of both hybrids bloomed in 13 days.

- Flowering synchronization for Mestiso 19 and 20 was achieved, however, flowers of both S-lines remained open for 10 to 11 hrs but P-line flowers are opened for 4 to 5 hrs only.

Table 34. Flowering behavior monitored in different parental lines.

Hybrid/ Parental	Amount of Breeder and F1 Seeds produced (kg)	Amount of Seeds Dispatched (kg)			Amount of Breeder Seeds in Store (kg)
		AXB	AXR	Research	
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IR68897B	361	12			571
IR60819R	0				21
IR71604R	0				300
NSIC Rc116H	0			0.5	2
NSIC Rc136H	0			0.5	2
Mestiso 19					
PRUP TG 101	*		1500		
TG-101M	758	5			758
NSIC Rc202H	0			2.5	
Mestiso 20					
PRUP TG 102	*			15	
TG-102M	600	30	275	5	600
NSIC Rc204H	0			0.5	
TOTAL					
A-line	**1792**				
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R-line	**1017**				
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- IR58025A and IR34686R are the parental lines of Mestizo1; IR58025A and PhilScatR are Mestiso38; IR68897A and PR34302R for Mestiso29; IR68897A and IR71604R for Mestiso7. Parental lines of Mestiso 19 are PRUPTG101 and TG101M while PRUPTG102 and TG102M are for Mestiso20.

- Following standard protocol and GA3 application in Occidental Mindoro for Mestizo1, differential seeding interval required should adjusted to about 30 days and at least 12 days for Mestiso 38.

- Heading date of both parental lines of M19 and M20 was between 84 and 85 days. Duration of flowering was longer TG101M by 2days compared to TG102M but S-lines of both hybrids bloomed in 13 days.

- Flowering synchronization for Mestiso 19 and 20 was achieved, however, flowers of both S-lines remained open for 10 to 11 hrs but P-line flowers are opened for 4 to 5 hrs only.

Table 35. Flowering behavior monitored in different parental lines.

Parental Lines	Days to heading	Duration of flowering	Time of flower	
			Open	closing
IR58025A	78			
IR34686R	104			
IR58025A	86			
PhilScatR	95	10	8:14 AM	12:50 PM
IR68897A	76	8	8:02 AM	12:41 PM
PR34302R	76	7	7:58 AM	12:07 PM
IR68897A	76	8	8:02 AM	12:41 PM
IR71604R	82	12	7:51 AM	11:54 AM
PRUPTG101	85	13	7:33 AM	5:47PM
TG101M	84	12	8:14 AM	12:08PM
PRUPTG102	85	13	7:17 AM	6:42 PM
TG102M	85	10	8:24 AM	12:30 PM

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Mestiso 38	IR58025A		12
	PhilScat R	R1	12
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Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit

LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
mtha^{-1} - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

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