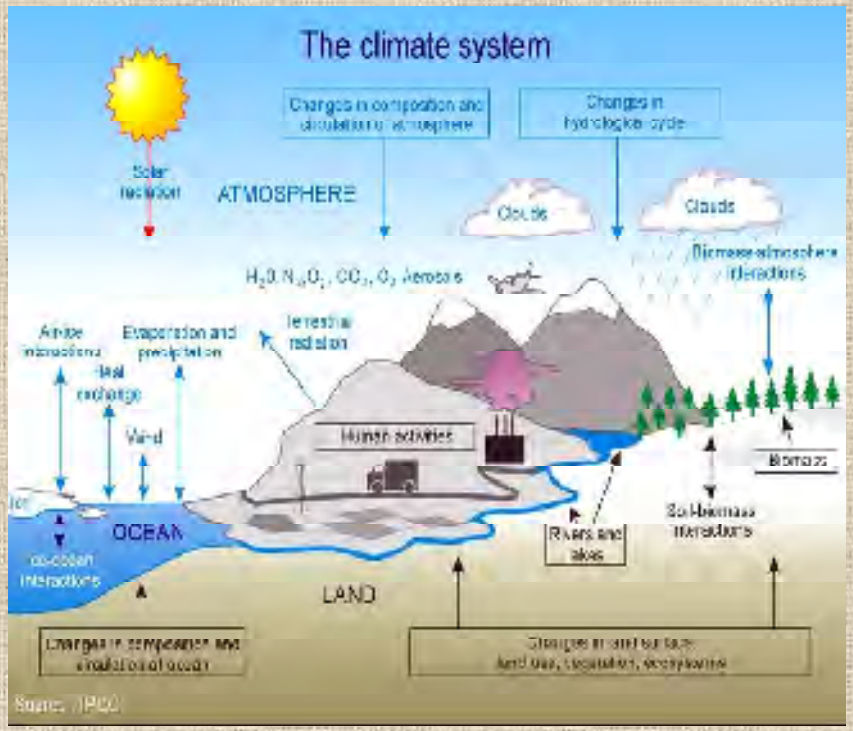

DEVELOPING HEAT TOLERANCE AND N EFFICIENT RICE HYBRIDS FOR CHANGING CLIMATE

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6th International Hybrid Rice Symposium 10-12th 2012

NUE

Field

N low Plot

N Rec Plot

NUE :Soil properties monitored season wise

Initial Soil Properties of the experimental field (Mean of 10 samples)

S.No	Soil property	N low Plot	N Rec Plot
1.	pH	6.62	6.29
2.	E.C (d S/m)	0.22	0.24
3.	Organic Carbon (%)	0.58	0.69
4.	Available N (kg/ha)	**143**	**122**
5.	Available P_2O_5(kg/ha)	109	126
6.	Available K_2O(kg/ha)	628	682

Soil pH and EC are normal; organic carbon content is medium; available N is low; P_2O_5 and K_2O are high.

Morphological features Mostly resembled Maintainer parent in Hybrids except plant height
(% change due to N application)

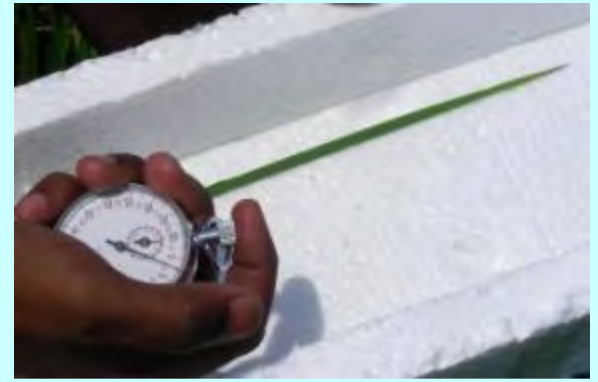
Character	Restorer	CMS	Maintainer	Hybrids
Pl.Ht	23	24	24	12
Tiller No	18	21	54	56
EBT	36		56	56
Straw	33	33	45	41
TDM	42.6	33.9	45.2	41

* Indicates N application had significant influence

IRRI Method

Symptom	No roll					
Score	0	1	2	3	4	5

Measurement of Leaf Rolling Time
DRR method (In field condition)



Short term Escape Helped by

Leat Temp at Veg and Rep stages, Leaf rolling behaviour at Veg and LA at rep stage are superior in hybrids

Character	Restorer	CMS	Maintainer	Hybrid
LT(veg)	-12	-11	-15	-22*
LT (Rep)	0.35	-9.2	-12	-13*
LR (Veg)	32	-16	2.2	-28*
LR(Rep)	81	0.1	13	38*
LA (Veg)	12	26	28	3*
LA (Rep)	16	12	27	27*

LA at veg stage inferior in hybrids at veg stage indicates relative slow growth responses

* Indicates N application had significant influence

Yield components in parents and hybrids

Character	RES	CMS	Maintainer	Hybrid
Pan.Wt	51	35	59	43
Pan No	29	27	46	20
FGW	50		62	39*
GY	48	-	62	40*
Chaff	42	-	76	73

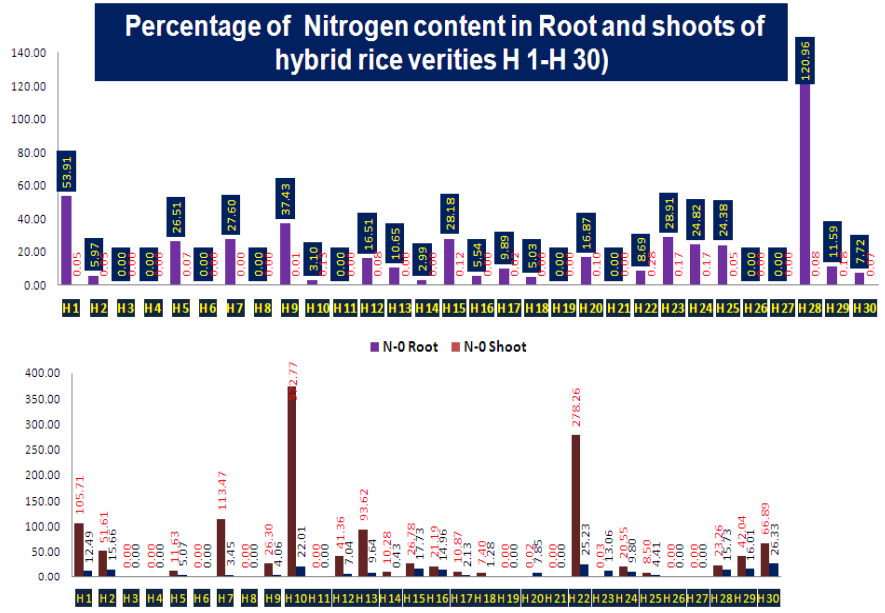
FGW and GY are relatively lower than their respective parents in hybrids

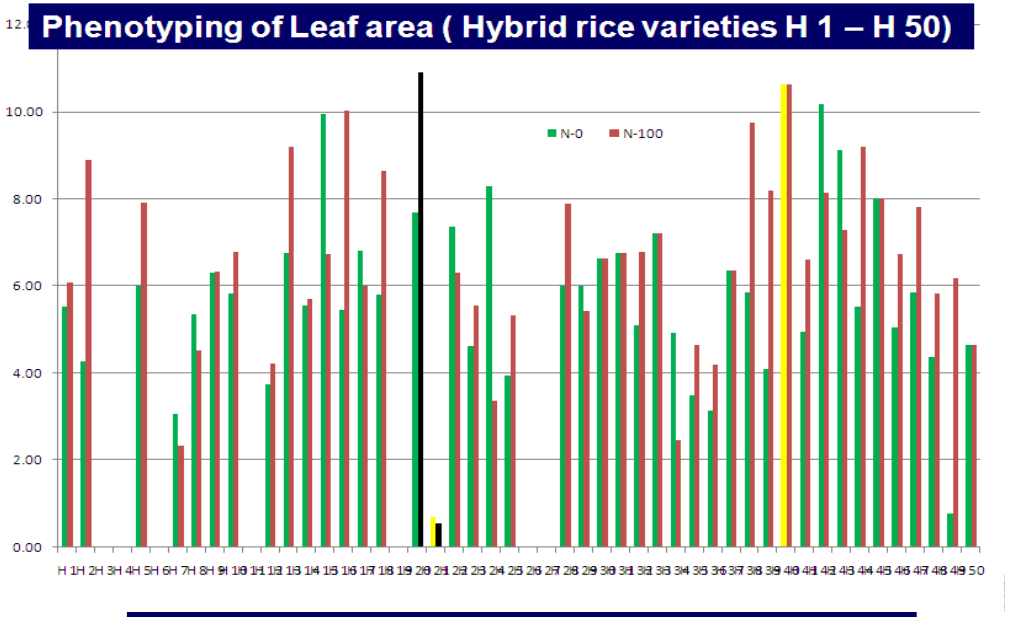
It is possible to bring the yield response similar to levels of RES and Maintainers

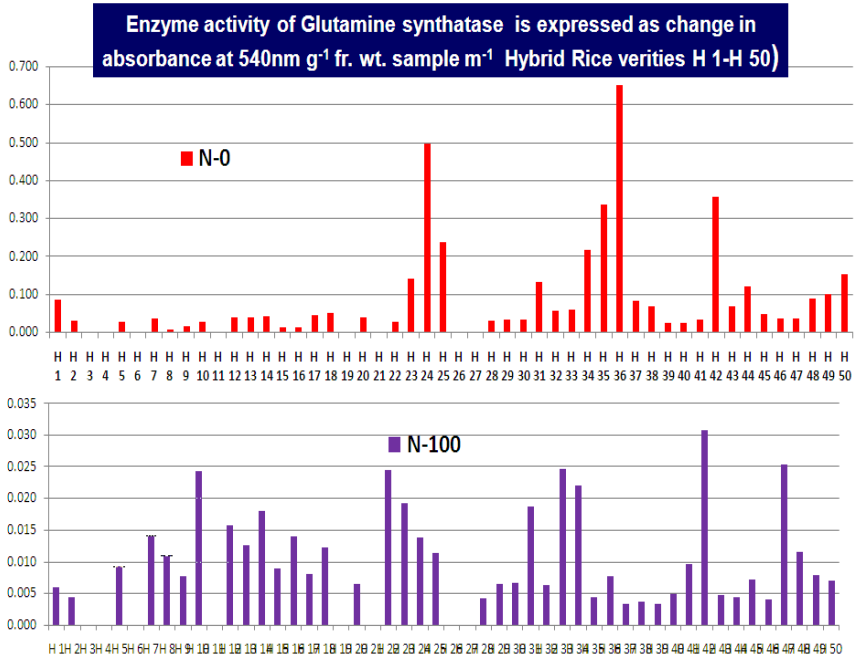
* Indicates N application had significant influence

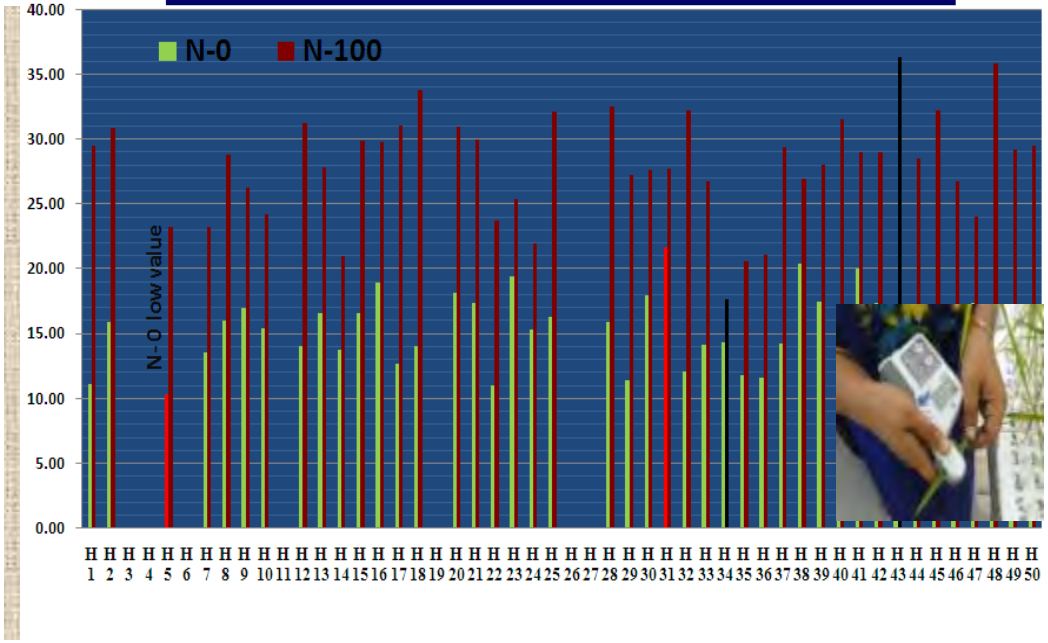
Leaf thickness

NUE Variation is very high for various physiological characteristics:







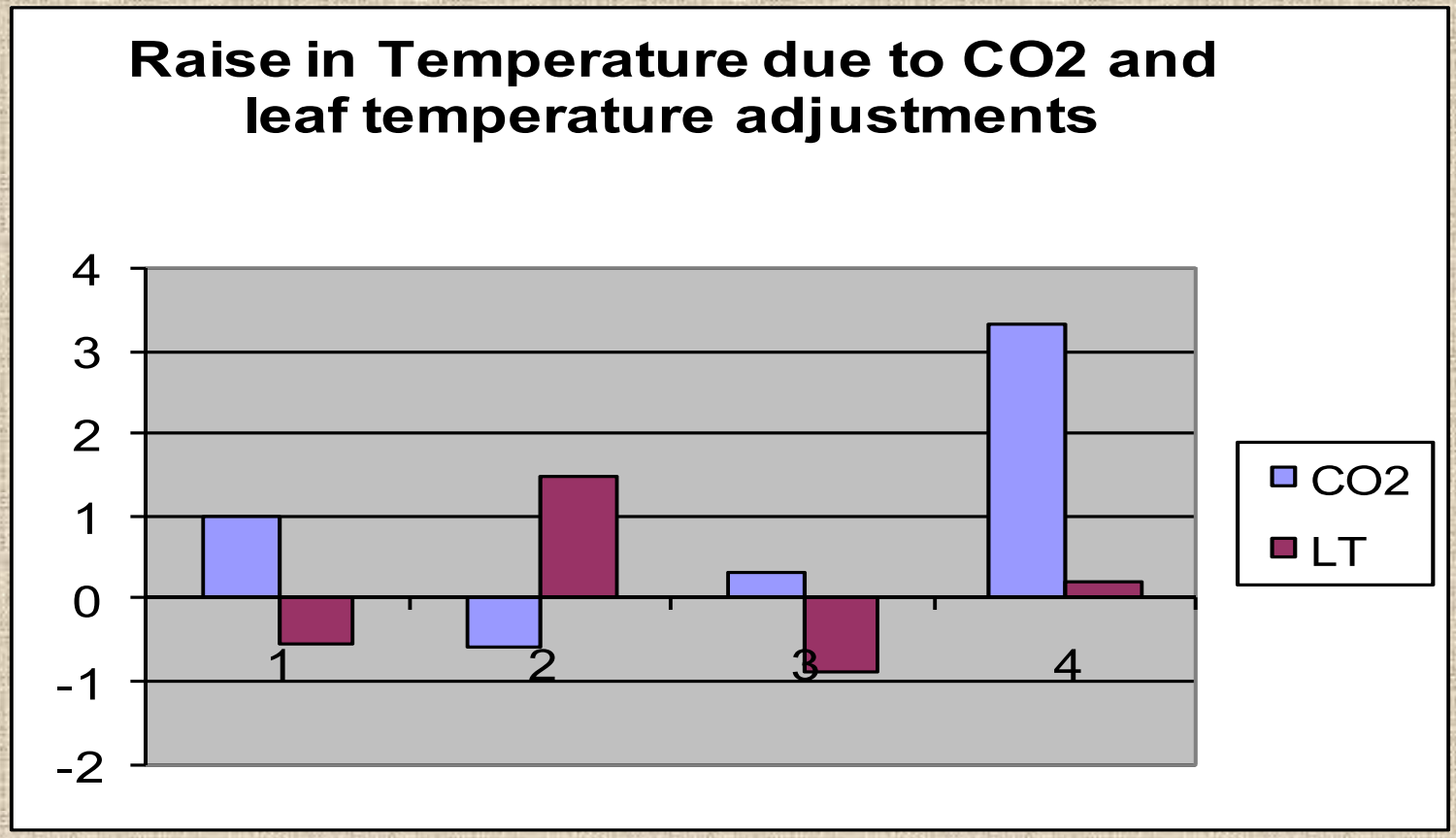


Enzyme activity of Glutamine synthatase (Hybrid Rice verities H 1-H 50

	N-0	N-100		N-0	N-100
H 1	0.087	0.006	H 26	0.000	0.000
H 2	0.032	0.004	H 27	0.000	0.000
H 3	0.000	0.000	H 28	*0.033*	0.004
H 4	0.000	0.000	H 29	0.036	0.007
H 5	0.028	0.009	H 30	0.035	0.007
H 6	0.000	0.000	H 31	0.135	0.019
H 7	0.037	0.014	H 32	0.058	0.006
H 8	0.009	0.011	H 33	0.060	0.025
H 9	0.017	0.008	H 34	0.219	0.022
H 10	0.028	0.024	H 35	0.335	0.004
H 11	0.000	0.000	H 36	0.650	0.008
H 12	0.040	0.016	H 37	0.085	0.003
H 13	0.040	0.013	H 38	0.070	0.004
H 14	0.043	0.018	H 39	0.026	0.003
H 15	0.014	0.009	H 40	0.028	0.005
H 16	0.014	0.014	H 41	0.034	0.010
H 17	0.047	0.008	H 42	0.358	0.031
H 18	0.051	0.012	H 43	0.069	0.005
H 19	0.000	0.000	H 44	0.121	0.004
H 20	0.039	0.007	H 45	0.048	0.007
H 21	0.000	0.000	H 46	0.038	0.004
H 22	0.029	0.024	H 47	0.037	0.025
H 23	0.143	0.019	H 48	0.090	0.011
H 24	0.495	0.014	H 49	0.103	0.008
H 25	0.238	0.011	H 50	0.155	0.007

Phenotyping of Temperature (Hybrid rice verities H 1-H 50)

	N-0	N-100		N-0	N-100
H 1	31.50	29.6	H 26	0.00	0.00
H 2	31.25	29.55	H 27	0.00	0.00
H 3	0.00	0.00	H 28	29.45	30.85
H 4	0.00	0.00	H 29	29.50	30.30
H 5	31.30	29.25	H 30	29.30	29.85
H 6	0.00	0.00	H 31	29.45	30.85
H 7	30.10	28.80	H 32	29.45	30.90
H 8	30.25	29.00	H 33	28.90	30.15
H 9	29.60	29.60	H 34	29.35	30.85
H 10	29.90	28.35	H 35	28.80	30.25
H 11	0.00	0.00	H 36	29.25	30.05
H 12	29.95	28.85	H 37	29.20	30.70
H 13	29.65	28.55	H 38	29.25	30.55
H 14	29.95	28.65	H 39	39.20	30.60
H 15	29.65	28.90	H 40	28.75	31.70
H 16	30.00	29.35	H 41	29.00	31.65
H 17	31.00	30.55	H 42	29.00	30.90
H 18	30.80	29.45	H 43	29.30	31.50
H 19	0.00	0.00	H 44	29.00	32.45
H 20	30.60	29.45	H 45	29.20	30.95
H 21	30.10	28.30	H 46	29.30	30.70
H 22	29.85	29.45	H 47	29.25	30.95
H 23	29.80	29.85	H 48	29.20	31.05
H 24	26.75	29.05	H 49	29.25	30.50
H 25	29.70	29.40	H 50	28.90	30.45



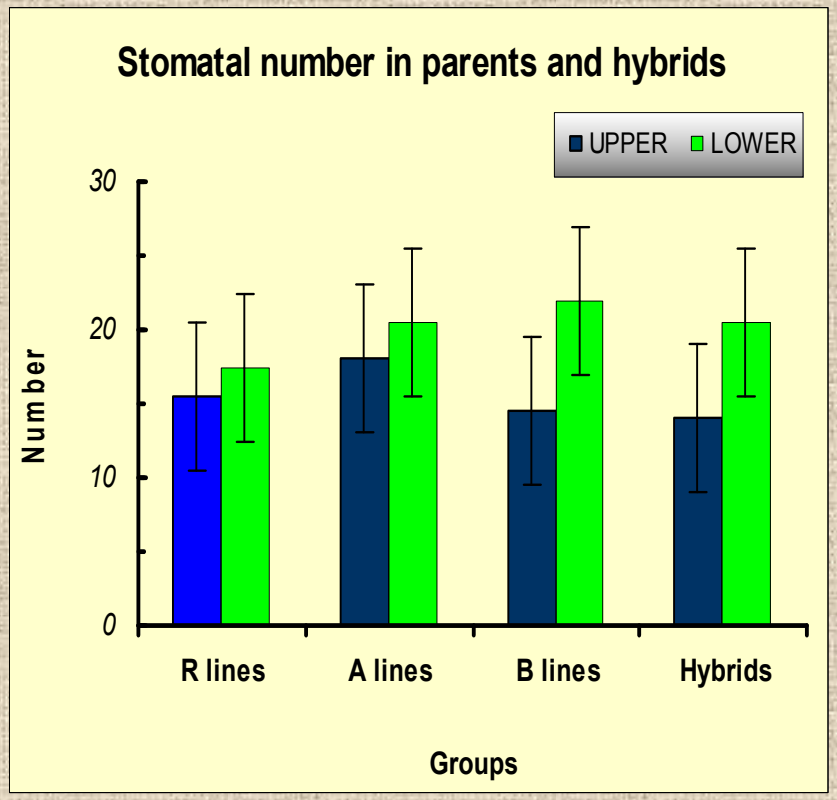
Temp differences between the chambers and LT of genotypes indicated adaptation. DRRH and its female parent have relatively adjusted better by reducing leaf temperature under elevated condition than of male parent and KH.

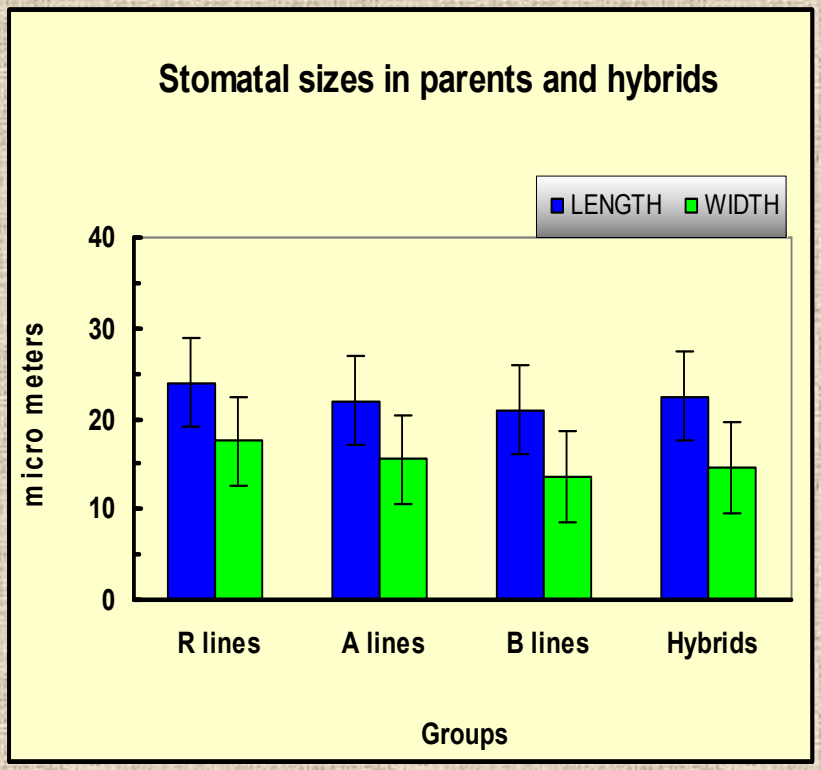
Avoidance by> Transpiration efficiency and LT

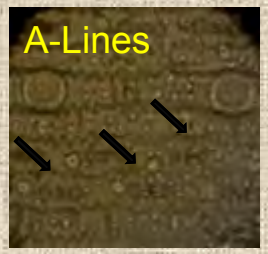
Stomates the rice genotypes belonging to different categories

S.No	Category of the Variety	Adaxial side	Abaxial side
1	Aromatic scented germplasm (Basmati 370)		
2	Germplasm lines (IC-463622)		
3	Upland rice varieties (IR-83750-B-B103-4)		
4	Arobic rice varieties (IR 82310-B-B-67-2)		
5	Heat tolerant lines from PAU (NCR-599)		

S.No	Category of the Variety	Adaxial side	Abaxial side
6	IRHTN 2009-2010 (IR-19746-28-2-2)		
7	DRR & Others released varieties (Akshayadhan)		
8	Restorers (BCW-56)		
9	A-lines (APMS 6A)		
10	B-lines (APMS-6A)		
11	Hybrids (PA6129)		

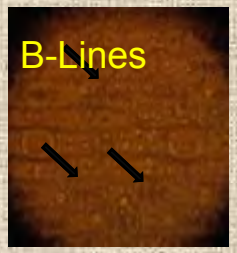

Stomatal number in parents and hybrids
UPPER
LOWER
30
20
10
0
Number
R lines
A lines
B lines
Hybrids
Groups

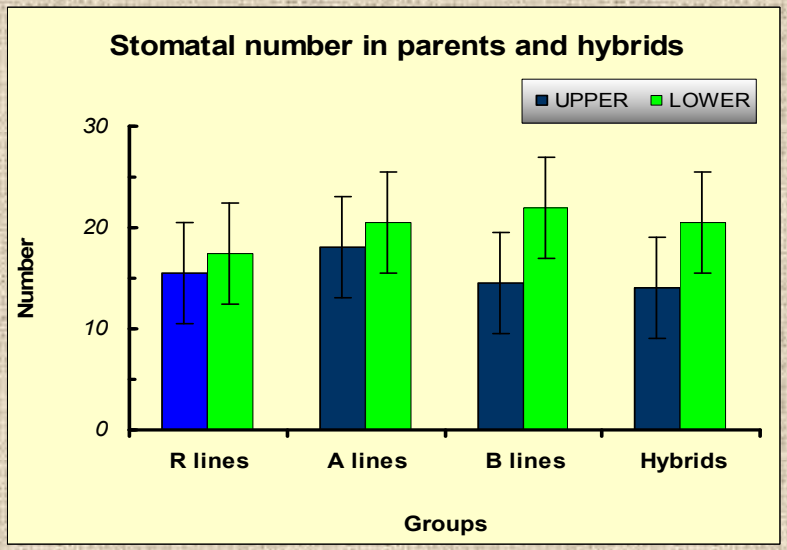

Stomatal sizes in parents and hybrids
LENGTH
WIDTH
40
30
20
10
0
micro meters
R lines
A lines
B lines
Hybrids
Groups


A-Lines


PA-6129

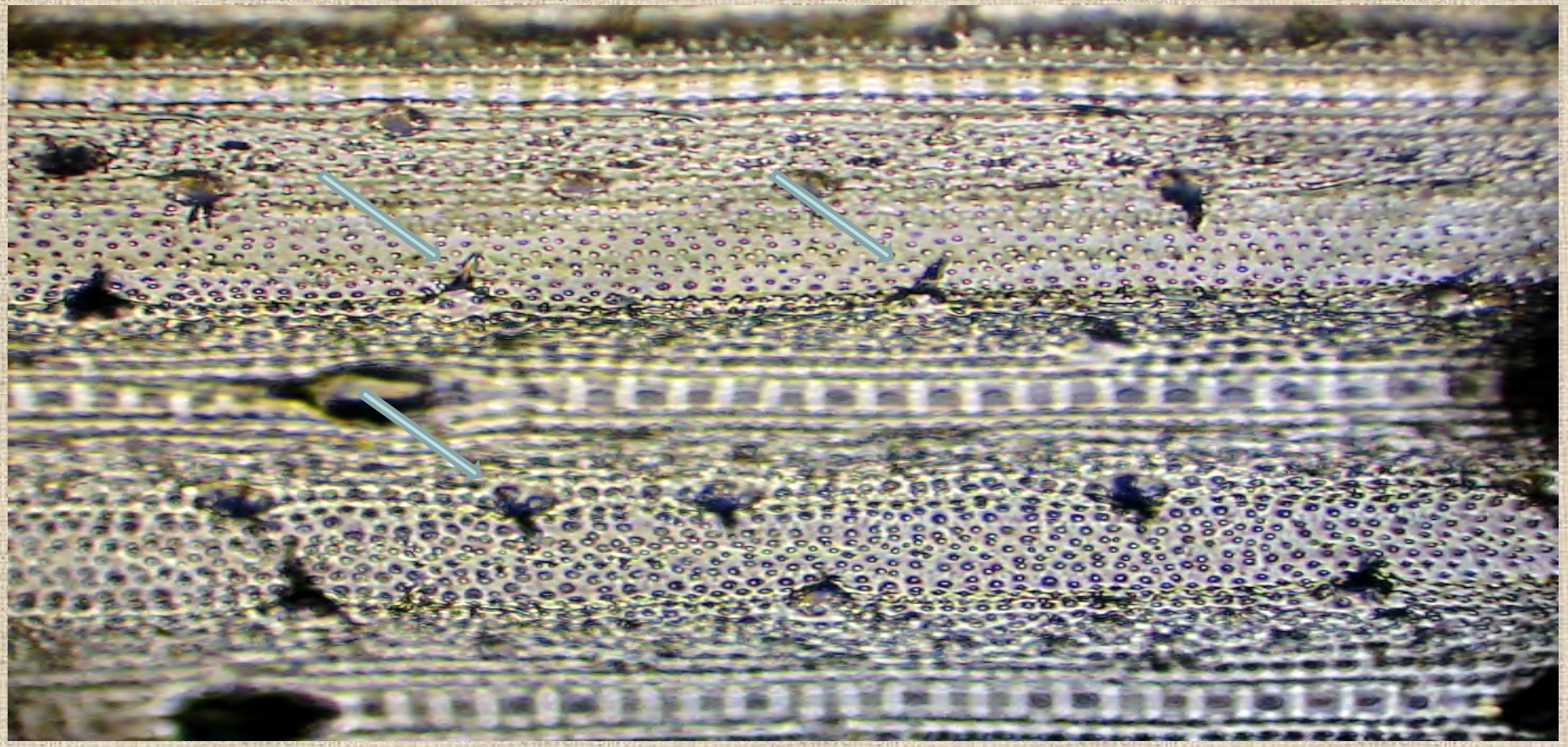

Hybrids


B-Lines


Stomatal number in parents and hybrids
UPPER
LOWER
30
20
10
0
Number
R lines
A lines
B lines
Hybrids
Groups

PA-6129

Adaxial leaf surface showing trichomes
Conserve heat flux during dry weather



NUE : After harvest of 1st season

Soil parameters measured during *kharif* 2011

S.No	Parameter	N Low Plot	N Rec Plot
KCl-N(mg N/kg soil) Mean of 10 samples			
1.	15 DAT (days after transplanting)	2.92	4.17
2.	30 DAT	3.42	5.28
3.	50 DAT	4.00	5.79
4.	At maturity	4.30	5.20
Urease enzyme activity (µg NH_4-N/g soil/2h) Mean of 10 samples			
5.	Soil Urease activity at harvest	35.7	46.2

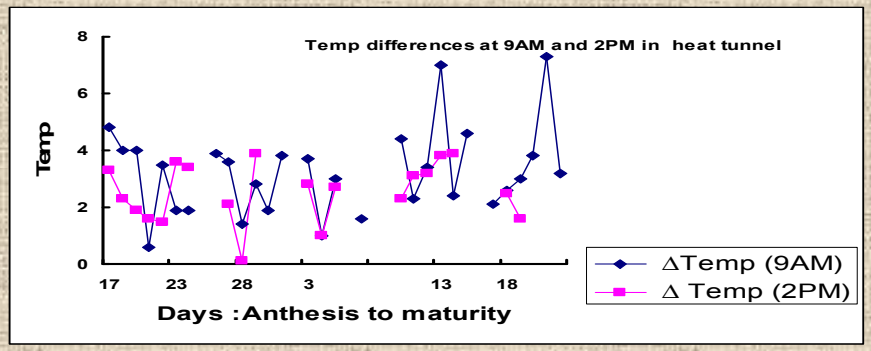
- The available N (KCl-N) during crop growth was higher by 21-54% at different stages in N Rec plot compared to N low plot
- Soil urease enzyme activity was 29% higher in N Rec plot over N low plot at harvest

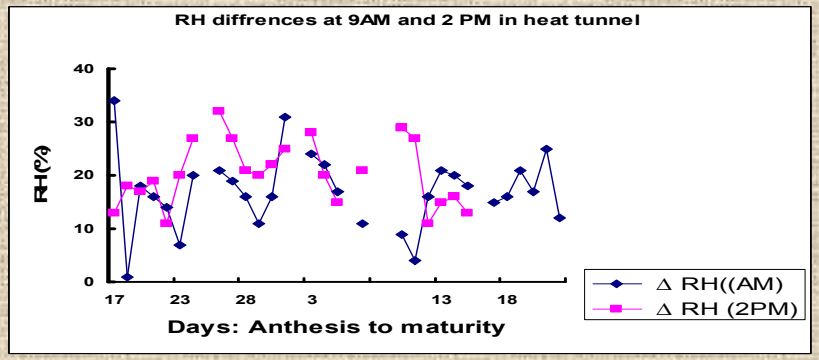
Stigma receptivity and Pollen fertility under normal and heat tunnel-DRR

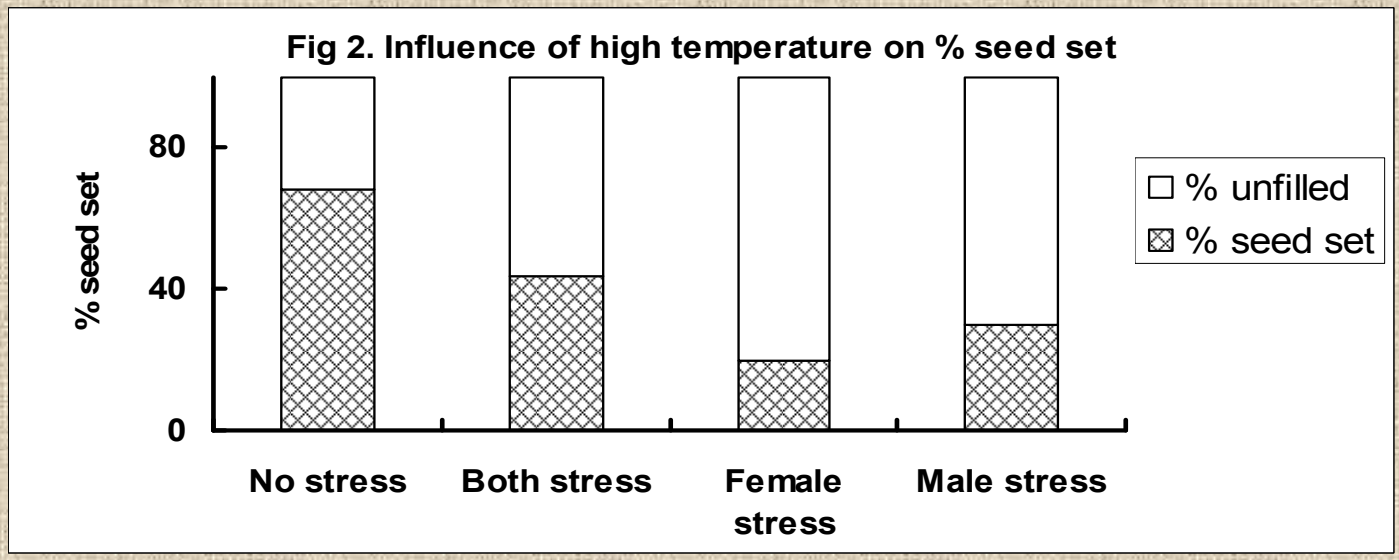
Pollen mother cells if exposed to HT, has an effect on grain filling. After the pollen Shedding, relative management of Pollen viability is possible under hypo/hyper tonic Solutions as it happens on reaching a receptive stigma and or application of B.

And their corresponding effects on grain filling -DRR

EXTENT OF SEED SET FACTORS POLLEN 8%: STIGMA 16%







Indirect Evidence boron improves only 1-8%

Stigma receptivity due to exposure to HT causes irreversible grain yield loss
Thus, under climate change, efforts to mechanisms on megagametogenesis needed.

Megagametogenesis is more sensitive than microgametogenesis to temp

Relatively superior Indian rice genotypes some physiological- characters

- Lower Thermal Injury: PSD-1, KRH-2, DRRH-44,
- Fast Leaf Rolling: DRRH-2, JKRH-2000, DRRH-44, CRHR-9.
- Stomatal Conductance : hybrids,
- High Grain Yield: PSD-3, CRHR-5 and JKRH 2000 .

Conclusions:

1) Leaf rolling and leaf temperature were superior in Hybrids.

2) Hybrids physiologically responded well to N application.

3) In yet another independent study with out N but under elevated Carbon dioxide conditions through an independent study superior maintenance of leaf stomatal characters confirms the relative tolerance of hybrids.

4) TDM and grain yields are moderate in hybrids compared to the maintainer and restorer lines indicates that further increase in grain yield is possible by improving the parental selection.

DRR TEAM

DR BC VIraktamath(**Overall supervision**)

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Thanks to all for the Kind attention