

Perla and MI 48 (between 224 and 347% more than the control at 7 d and 273 and 302% at 21 d). Pokkali and IR42 showed proline values of 179-189% more than the control at 7 d and 177-237% at 21 d.

The trials indicated that the salt-tolerant varieties do not necessarily accumulate large amounts of free-proline relative to salt-sensitive varieties. In general, free-proline content increased in salt-sensitive

varieties compared with that in salt-tolerant varieties and thus may not always be a suitable marker in examining salt resistance in rice. ■

Photosynthetic rate and respiration of some F₁ hybrid rices

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We studied the photosynthetic rate (Pn) and maintenance respiration (MR) of 11 hybrids developed from five cytoplasmic male sterile (CMS) lines (IR64 A, PMS3 A, V20 A, Deepa A, and PMS 10 A) and their corresponding pollen parents under field conditions during the 1992 wet season.

The experiment was laid out in a randomized complete block design with three replications. Seedlings were transplanted at a spacing of 15 × 15 cm in 3-m² plots in the main field. Sixty kg N/ha were applied. We measured the Pn of the second

(n-1) leaf 35 d after planting (DAP) and that of the flag leaf (n leaf) at flowering with a LI-6000 photosynthesis system at near saturated light (1,000 µE/m² per s).

Maintenance respiration was measured directly from the CO₂ evolution rate using a differential respirometer (Gilson, USA). Leaves were excised in the evening and kept in the dark for 12 h. A weighed quantity without the midrib was cut into 1-2 mm pieces and suspended in 1.8 ml of 0.2 M phosphate buffer at pH 7.0 in a Warburg flask. Twenty percent KOH (0.2 ml) was poured into a center well and a filter paper strip was added to the alkali to increase the surface area for rapid CO₂ absorption. After greasing the upper rim, the flask was attached to the manometer, and the side arm of the flask was closed with a plug. The flask was then immersed in a water bath at a

constant 30 °C. The system was shaken to promote rapid gas exchange between the fluid and the gas phase.

The manometer fluid fell, indicating the rapid consumption of oxygen in the chamber by the tissue. The rate of respiration was calculated by subtracting the initial reading from the final reading. At each growth stage, four measurements for both Pn and MR were taken per sample for all three replications. The yield and biomass were assessed at harvest (see table).

Significant variations in Pn, MR, and Pn/MR among the hybrids and parents were observed at both 35 DAP and at flowering. However, the means of these three parameters were generally higher at flowering than at 35 DAP and in hybrids than in male parents at flowering stage. Hybrid IR64 A/Rasi showed high Pn at 35 DAP while IR64

Photosynthetic rate (Pn) and maintenance respiration (MR) in relation to yield and biomass production in rice hybrids. Cuttack, India. 1992 wet season.

Hybrid/restorer	35 DAP ^a			Flowering			TDM ^b (g/m ²)	Yield (g/m ²)
	Pn (μmol CO ₂ /m ²)	MR/s	Pn/MR	Pn (μmol CO ₂ /m ²)	MR/s	Pn/MR		
<i>Hybrids</i>								
IR64 A/Savitri	14.8	3.9	3.8	26.0	2.3	11.1	981	401
PMS3A/IR9828-91-2-3	16.2	2.4	6.7	20.2	2.0	10.3	798	396
PMS3A/Saruchina	21.0	2.0	10.6	28.9	2.4	12.1	1035	538
V20 A/IET11057	19.9	2.1	9.3	21.7	2.8	7.7	816	361
Deepa A/IET11057	22.5	2.8	8.1	21.1	2.6	8.1	916	312
V20 A/IET10463	15.3	2.1	7.5	17.2	2.5	6.9	676	263
PMS10A/ARC10339	16.0	2.3	7.0	27.6	3.7	7.4	865	463
IR64 A/Rasi	26.5	2.5	10.6	20.0	2.5	7.9	616	246
IR64 A/Miz. 51	16.7	1.8	9.2	29.7	3.2	9.2	1001	436
IR64 A/IR25560-109-3-1-3-2	16.2	2.3	7.2	17.0	2.3	7.5	694	212
IR64 A/IR1846-300-1	23.8	2.3	10.3	20.8	2.8	7.5	814	316
<i>Restorers</i>								
Savitri	22.7	2.3	9.7	29.0	3.3	8.8	1121	412
IR9828-91-2-3	18.9	2.4	7.8	31.6	2.3	13.7	863	346
Saruchina	14.1	4.5	3.2	18.6	2.0	9.4	912	402
IET11057	16.6	2.1	8.0	17.6	2.6	6.7	921	342
IET10463	21.0	2.7	7.7	12.8	1.6	7.7	729	240
ARC10339	8.1	2.0	4.1	9.5	1.8	5.2	961	424
Rasi	21.1	2.3	8.4	16.8	3.0	5.6	693	262
Miz. 51	17.1	2.0	9.1	19.8	2.7	7.4	942	421
IR25560-109-3-1-3-2	30.2	2.9	10.4	25.1	3.2	7.9	746	242
IR1846-300-1	18.1	1.9	9.5	20.1	2.7	7.6	964	341
Grand mean	18.9	2.5	8.0	21.5	2.7	8.4	860	359
Mean of hybrids	19.0	2.4	8.2	22.7	2.8	8.7	837	343
Mean of restorers	18.9	2.3	7.8	20.1	2.5	7.3	885	351
CD at 5%	3.6	0.8	1.5	1.5	0.3	0.8	29	14

^a DAP = days after planting. ^b TDM = total dry matter.

A/Miz.51 and PMS3 A/Saruchina were more efficient at flowering. PMS3 A/Saruchina recorded the highest total dry matter (12.1 t/ha) and grain yield (538 g/m²)

Fertilizer management

Integrated effect of deeply placed urea and *Gliricidia* green manure on grain yield of transplanted rice

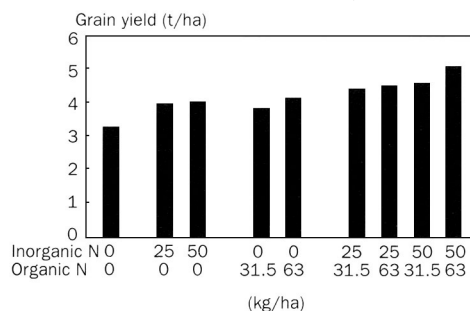
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We studied the integrated effect of organic and inorganic sources of N on grain yield of rice variety PLG-1 (130 d duration) during 1991-93 wet seasons. We compared how deeply placing urea behind the plow and applying *Gliricidia sepium* leaves as a green manure—individually and in combination—affected rainfed transplanted rice.

Each of the nine treatments in the experiment was laid out in a 50-m² plot on the RARS farm in a randomized block design with three replications. The soil was clay loam with pH 7.4 (1:2.5 soil:water) and a cation exchange capacity of 35 meq/100 g soil. All of the plots received 21 kg P/ha as single superphosphate and 41 kg K/ha as potassium chloride.

Prilled urea (PU) (25 kg N and 50 kg N/ha) was applied behind the plow, about 5-6 cm deep, at the time of puddling. *Gliricidia* was spread uniformly over newly puddled soil as fresh green manure at 5 and 10 t/ha (containing 2.7% N on an oven-dry basis)

Effect of integrated use of inorganic and organic N on grain yield of rice. Maharashtra, India.



followed by IR64 A/Miz.51. Photosynthesis at flowering, however, was positively correlated with total dry matter ($r = 0.430^*$) and grain yield ($r = 0.446^*$) at harvest.

Unlike PMS3 A/Saruchina, high Pn coupled with low MR and high Pn/MR are desirable for high photosynthetic productivity, which ultimately leads to more grain. ■

Effect of deeply placed urea behind the plow and *Gliricidia* green manure on grain yield of transplanted rice. Maharashtra, India. 1991-93 wet seasons.

Treatment			Mean grain yield (t/ha)			
Urea N (kg/ha)	Green manure (t/ha)	Green manure (kg N/ha)	1991	1992	1993	Pooled mean
0	0	0	4.0	2.2	3.7	3.3
25	0	0	4.9	2.8	4.4	4.0
50	0	0	4.5	3.9	3.9	4.1
0	5	31.5	5.0	2.5	4.2	3.9
0	10	63.0	4.8	3.0	4.8	4.2
25	5	31.5	5.2	3.5	4.8	4.5
25	10	63.0	4.9	3.9	5.1	4.6
50	5	31.5	5.0	4.6	4.7	4.8
50	10	63.0	5.4	4.8	5.5	5.2
LSD (0.05)			ns ^a	0.4	0.4	0.1

^ans = not significant.

and pressed below the surface by hand. Three-week-old rice seedlings were planted at 20- × 15-cm² spacing during the wet season on 24 Jul 1991, 20 Jul 1992, and 19 Jul 1993 and harvested on 10 Nov 1991, 5 Nov 1992, and 3 Nov 1993.

The response of the rice crop to the different treatments varied significantly with the season (see table). Applying *Gliricidia* at 5 or 10 t/ha coupled with the deep placement of urea at 25 or 50 kg N/ha

increased rice grain yield significantly over applying *Gliricidia* alone. The maximum yield of 5.2 t/ha, which was significantly higher than the rest, was obtained by applying *Gliricidia* at 10 t/ha and urea at 50 kg N/ha (see table, figure). Thus, the integrated use of inorganic and organic nitrogen can make important contributions to increasing and sustaining rice production. ■

Effect of rice hull, biofertilizer, and chemical fertilizers on growth and nitrogen economy of wetland rice

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We studied the effects on rice yield of using leucaena (*Leucaena leucifera*), a common leguminous plant in northern India; blue-green algae (BGA); and urea—individually and in combination—in a mild alkaline soil with and without rice hull amendment.

The soil was sandy loam (mixed, Isohyperthermic Typic Ustocrypt) with pH 8.0, EC 4.2 dS/m, 22 kg ESP, CEC 15 cmol_c/kg, and 0.46% organic C. Rice hull (0.56% N on an oven-dry basis) was incorporated at 5 t/ha (about 22 kg N)

Effect of integrated use of biofertilizer and chemical fertilizer N on yield of Pusa Basmati 1. IARI, New Delhi, India. 1992 wet season.

Treatment	Grain yield (t/ha)	
	Rice hull-amended field	Untreated field
Control	3.5	3.4
Blue-green algae (BGA)	3.9	3.8
Leucaena	4.9	4.7
Urea (30 kg N/ha)	3.8	4.0
Urea (60 kg N/ha)	4.4	4.1
Urea (120 kg N/ha)	5.1	5.0
Leucaena + BGA	4.9	4.7
Urea (30 kg N/ha) + BGA	4.6	3.9
Urea (60 kg N/ha) + BGA	5.0	4.8
1/2 Leucaena + urea (60 kg N/ha)	5.2	4.7
1/2 Leucaena + urea (90 kg N/ha)	5.4	5.0
CD (0.05)	0.4	0.5
Pooled mean	4.6	4.3
CD (0.05)	(0.7)	