LUDHIANA

Regional Rice Research Station
Punjab Agricultural University
Punjab

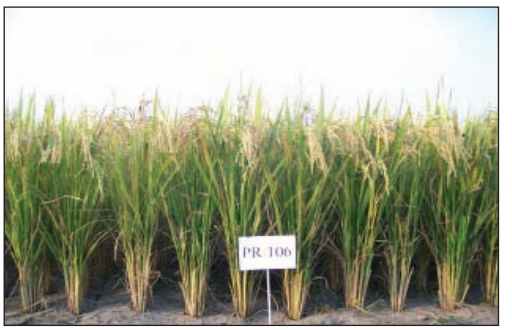
Research on rice crop was initiated in the year 1962 at Kapurthala Farm under Regional Rice Research Scheme. In 1970, the Kapurthala farm was upgraded to a Regional Rice Research Station of Punjab Agricultural University (PAU), Ludhiana. Three regional testing stations viz. Gurdaspur, Rauni and Kapurthala are involved in the multi-location evaluation of rice genotypes. The major mandate of the station is to develop short duration, high yielding non basmati and basmati varieties possessing resistance/ tolerance to biotic and abiotic stresses suitable for irrigated ecosystem.

Major contributions to AICRIP

Crop Improvement

Plant Breeding

Since inception 35 varieties (24 non-basmati and 11 basmati) have been released by PAU, Ludhiana. A very popular variety of rice PR 106 was released in 1976 which remained a predominant variety for more than three decades and covered more than 75 % area. The varieties PR 113, PR114, PR 116 and PR 118 had also found a great favor among the farmers for many years.



Basmati rice is the pride of Punjab and is being grown here since time immemorial. The traditional tall Basmati cultivars are photoperiod sensitive and low yielders, thus several Basmati varieties with semi-dwarf nature and resistance to bacterial leaf blight were developed and released viz., Super Basmati (2003), Punjab Basmati 2 (2008), Punjab Basmati 3 and dwarf version of Traditional Basmati variety Basmati 386. This is the only Basmati variety which is resistant to all the 10 pathotypes of bacterial blight prevalent in the Punjab state carrying genes xa13 and Xa21and is the first product of marker assisted technology developed by PAU. Another variety Pusa Punjab Basmati 1509 developed by PAU is finding favour among the farmers due to its shorter duration coupled with high yield potential.

Work on hybrid rice is also in progress and a set of 26 CMS lines in diverse backgrounds has been developed. Several test crosses are attempted every year to identify the heterotic combination. A very strong pre-breeding program has been initiated at the School of Agricultural Biotechnology PAU Ludhiana for mobilizing the desired genes from related wild species into cultivated backgrounds.

Variety	Parentage	Year of release	Av.yield (kg/ha)	Salient features
Coarse grain varieties				
HM 95	Jhona 349/ TN 1 (F_2 seed irradiated)	1972	4000	Very early maturing variety
PR 113	IR 8// RP 2151-173-1 8/IR8*[4]	1998	7000	First coarse grain variety resistant to bacterial blight
Non-basmati fine grain varieties				
Palman 579	IR 8/ Tadukan	1972	5200	Short duration, good quality rice variety
RP 5-3(Sona)	GEB 24/TN 1	1972	6000	Good quality fine grains, high yielding
PR 106	IR8//Peta *[5]/Belle Patna	1976	6500	Medium maturity, long slender grains, high yield
PR 103	IR 8/IR 127-2-2	1978	5500	Early maturing (125 days) long slender grains, high yielding variety
PR 4141	IR 8/BJ 1// IR 22	1982	6000	Resistant to bacterial blight
PR 108	Vijaya /Ptb21	1986	6625	Tolerant to white backed plant hopper and sheath blight

Variety	Parentage	Year of release	Av.yield (kg/ha)	Salient features
PR 109	IR 19660-73-4/IR 2415-90-90-4-3-2//IR 54	1986	6500	Resistant to bacterial blight and tolerant to white backed plant hopper
PR 110	TN1/Patong 32//PR 106*6	1992	6500	High yielding semi dwarf bacterial blight resistant, long slender grains
PR 111	IR 54/PR 106	1994	6750	High yielding semi dwarf bacterial blight resistant, long slender grains
PR 114	TN1/Patong 32//PR 106*4///IR8	1999	6875	High yielding bacterial blight resistant, long slender grains
PR 115	RP 2151-173-1-8/PR 103*3	2000	6250	Early maturing (125 days) long slender grains, erect flag leaves bacterial blight resistance
PR 116	PR108///TN1/Patong32//PR106*6////PR108	2000	7000	Long slender grains, sturdy plant bacterial blight resistant
PR 118	Pusa 44/PR 110//Pusa 44*3	2003	7250	Medium slender grains, resistant to bacterial blight
PAU 201	PR 103/PAU 1126	2007	7500	High yielding, long slender grains, bacterial blight resistant, moderately resistant to white backed plant hopper
PR 120	PAU 1196/SR817-255	2009	7133	High yielding, bacterial blight resistant, long slender grains, mid-early maturity
PR 121	PR 116///PR 108/IRRI 76//PR 106-P2	2013	7625	High yielding, resistant to all the ten pathotypes of bacterial blight

Variety	Parentage	Year of release	Av.yield (kg/ha)	Salient features
PR 122	PR 108 / IRRI-76//PR 106-P1	2013	7825	High yielding, resistant to all the ten pathotypes of bacterial blight.
PR 123	PR 116///PR 108/IRRI 76//PR 106-P2	2014	7250	High yielding, superfine grain quality, resistant to all the ten pathotypes of bacterial blight.
Basmati/aromatic rice varieties				
Punjab Basmati No.1	Sona /Basmati 370	1982	4000	First improved variety of basmati
Super Basmati	Basmati 320/IR 661	2003	3500	Extra long grains, good cooking quality with strong aroma
Punjab Basmati 2	Basmati 386/Super Basmati	2007	3152	Extra long grains, bacterial blight resistant, good cooking quality with strong aroma
Punjab Mehak 1	IR70423-170-2-3/IR 70446-85-3-2//IR70423-170-2-3	2009	4248	Extra long grains, good cooking quality with strong aroma
Punjab Basmati 3	BB resistant and dwarf version of Basmati 386	2013	4000	High yielding, only variety with BB resistance
Pusa Punjab Basmati 1509	Pusa 1301/Pusa 1121	2013	4525	High yielding, early duration, short stature.

Crop Production

Agronomy:

- To ensure response to high level of inputs, it is advisable to transplant rice at closer spacing of 15 x 15 cm^2 i.e. 44 plants m^{-2} (the normal recommendation is 20 x 15).
- Half of the nitrogen (60 kg ha^{-1}) can be saved by incorporating 6-8 weeks old green manure crop of dhaincha (*Sesbania*) or Cowpea. One third of the nitrogen (40 kg ha^{-1}) can be saved with the application of 20 t ha^{-1} FYM.
- Optimum period of transplanting for improved varieties of rice has been standardized for high crop water productivity *i.e.* 15 - 30 June.
- Optimum period of transplanting for high yield and quality characteristics for Pusa Basmati 1121 and Punjab Basmati 3 is first fortnight of July and for Pusa Basmati 1509, Basmati 386, Basmati 370, it is second fortnight of July.

- For high quality of Basmati crop, 40 kg N ha^{-1} is recommended for Pusa Basmati 1121, Punjab Basmati 3; 60 kg N ha^{-1} for Pusa Basmati 1509 and Punjab Mehak 1; and 20 kg N ha^{-1} for Basmati 386, basmati 370.
- Entire agronomic package for direct seeding of rice was given to the farmers including sowing time: first fortnight of June, seed rate :20-25 kg ha-1, sowing depth : 2-3 cm, weed control: sequential application of pre (Pendimethalin) and post emergence (Bispyribac- Na) herbicides; N dose: 150 kg N ha^{-1} in 3 equal splits (2, 5, 9 weeks after sowing).

Crop Protection

Diseases and insect pests pose a continuous threat for the sustained production of rice crop. Among diseases, bacterial blight is the most serious disease causing huge losses under the epidemic conditions. Till date 10 pathotypes of Xanthomonas oryzae pv. oryzae have been identified and characterized in Punjab. The virulence/ avirulence of the pathotypes is mentioned in Table. None of the known Xa/xa gene when deployed alone shows effectiveness against Punjab pathotypes. So the gene combinations are necessary to develop varieties possessing durable and broad spectrum resistance to all the 10 pathotypes.

Emerging and dominant pathotypes of *Xanthomonas oryzae* pv.*oryzae* showing virulence and avirulence to *Xa/xa* gene (s)/cultivars in Punja

Pathotype of *X. oryzae* pv. *oryzae*	Virulence	Avirulence
PbXo-1	*Xa4, xa5, Xa7,*	*xa8,xa13, Xa21, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118,PR 120, PAU 201, PR120, PR121, PR122, PR123, PR124
PbXo-2	*Xa7*	*Xa4, xa5, xa8,xa13, Xa21, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118,PR 120, PAU 201, PR120, PR121, PR122, PR123, PR124
PbXo-3	*xa5, Xa7, Xa21,*	*Xa4, xa8,xa13, Xa21, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118,PR 120, PAU 201, PR120, PR121, PR122, PR123, PR124
PbXo-4	*Xa4, xa5, Xa7, Xa21, Xa4+Xa21, Xa5+Xa21*	*xa8,xa13, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118,PR 120, PAU 201, PR120, PR121, PR122, PR123, PR124

PbXo-5	*Xa4, xa5, Xa7, xa8, Xa4+xa5,* PR 114, PR 116, PR 118	*xa13, Xa21, Xa38, xa13+Xa21,* IR 64, PR 111, PR 113, PR115, PAU 201, PR 120, PR121, PR122, PR123, PR124
PbXo-6	*Xa4, xa5, Xa7,*PR 114, PR 116, PR 118,	*xa8,xa13, Xa21, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 115, PR 120, PAU 201, PR120, PR121, PR122, PR123, PR124
PbXo-7	*Xa4, xa5, Xa7, xa8,* PR 114, PR 115, PR 116, PR 118	*xa13, Xa21, Xa38, xa13+Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PAU 201, PR 120, PR121, PR122, PR123, PR124
PbXo-8	*Xa7, xa8, xa13, Xa21, xa13+Xa21,* PAU 201	*Xa4, xa5, Xa38, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118, PR 120 PR121, PR122, PR123, PR124
PbXo-9	*Xa4, xa5, Xa7, xa8, , Xa21, Xa4+xa5,* IR 64, PR 111, PR 113, PR 114, PR 115, PR 116, PR 118, PR 120	*xa13, Xa38, xa13+Xa21,* PAU 201, PR121, PR122, PR123, PR124
PbXo-10	*Xa4, xa5, Xa7, xa8, Xa38, Xa4+xa5,* IR 64, PR 111, PR 114, PR 116, PR 118, PR 120	*xa13, Xa21, xa13+Xa21,* PR 113, PR 115, PAU 201, PR121, PR122, PR123, PR124

The fungicides tested and found effective against various diseases are given below:

Diseases	Management
Seed borne diseases	Soak the selected seed 8 kg in 10 litres of water containing 20g Bavistin 50WP (carbendazim) and 1g Streptocycline (streptomycin+tetracycline) for 8 to 10 hours before sowing
	Soak the selected seed 8 kg in 10 litres of water containing 5g Emisan-6 and 1g Streptocycline (streptomycin+tetracycline) for 8 to 10 hours before sowing
Sheath blight	Nativo 75 WG (trifloxystrobin + tebuconazole), @ 200 g/ha; Folicur 25 SC (Tebuconazole) @ 500 ml/ha; Tilt 25 EC (Propiconazole) @ 500 ml/ha; Monceren 250 SC (Pencycuron) @ 500 ml/ha; Bavistin 50WP (Carbendazim) @ 500 g/ha
Brown spot	Nativo 75 WG @ 200 g/ha; Folicur 25 SC (Tebuconazole) @ 500 ml/ha; Tilt 25 EC (Propiconazole) @ 500 ml/ha; Indofil Z-78 (Zineb) @ 1250 g/ha; Hinosan 50 EC (Edifenphos) @ 500ml/ha
False smut	First spray of Kocide 46% DF (copper hydroxide) @ 1250 g/ha at boot stage and second spray of Tilt 25 EC (Propiconazole) after 10-15 days of the first spray; Blitox 50 WP (Copper oxychloride) @ 1250g/ha
Sheath Rot	Tilt 25 EC (Propiconazole) @ 500 ml/ha; Bavistin 50WP (Carbendazim) @ 500 g/ha;

Blast	Indofil Z-78 (Zineb) @ 1250 g/ha; Hinosan 50 EC (Edifenphos) @ 500ml/ha
Bunt	Tilt 25 EC (Propiconazole) @ 500 ml/ha. First spray at panicle initiation stage and second after 10-15 days interval

The following insecticides were tested and found effective against various insect pests.

Stem borer & Leaf folder	Ferterra 0.4G @ 4kg/acre; Coragen 20 SC (Chlorantranilipole) @ 60 ml/acre; Sutathion 40 EC; Mortel (Regent) 0.3G @ 6 kg/acre & Marktap (Cartap hydrochloride) 4G @ 10 kg/acre; Fipronil 80% WG @ 15g/acre; Nidan 4G @ 10 kg/acre; Hostathion 40 EC (triazophos) @ 350 ml; Regent 0.3 G (fipronil) @ 6 kg and Dursban 10 G (chlorpyriphos) @ 4kg/acre; Force 20 EC, a brand of Chlorpriphos; Furadan 3 G (carbofuran) @ 10 kg/acre, twice at 30 and 70 days after transplanting;.
Planthoppers	Crocodile 17.8 SL; Confidor (imidacloprid) applied @ 40 ml/acre.
Hispa	Monocil @ 560 ml; Dursban 20EC @ 1lt and Ekalux @ 25 EC @ 800ml; Accothion 50 EC (fenitrothion)
Rice root weevil	Foratox 10 G (phorate)

Other management practices recommended for insect pest management include:

- Lopping of Basmati at half of its height at 45 days after transplanting to reduces stem borer damage.
- Economic threshold level of 10% damaged leaves recommended for leaf folder.
- PAU 201 was found moderately resistant to WBPH
- Excessive use of nitrogen encourages multiplication of insect pests particularly WBPH in PR 114.