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Basmati CSR 30 (Yamini)

- the first salt tolerant basmati variety is a boon to the farmers

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Gurbachan Singh, Y.P. Singh, S.K. Sharma and Ram Ajore

CENTRAL SOIL SALINITY RESEARCH INSTITUTE
KARNAL-132 001, HARYANA, INDIA

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Director, Central Soil Salinity Research Institute,
Zarifa Farm, Kachhwa Road, Karnal-132001 (Haryana), India
Telephone: +91-184-2290501; Fax: +91-184-2290480,2292489
E-mail: director@cssri.ernet.in
Website : www.cssri.org

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C S S R I

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Historical perspective

The aroma of basmati rice symbolizes the emotions and exuberance of Indian heritage. It is perceived that basmati is the nature's exclusive bounty bestowed upon the Indian sub-continent. The Hindi word basmati comprises of two syllables: *'Bas'* rooted in Sanskrit means 'aroma' and *'mati'* means 'already ingrained'. There are several historical accounts of basmati rice in the Indian context. Several agro-morphological and quality traits characterize the basmati types. Among quality traits, grain length, grain length/breadth ratio, grain elongation upon cooking, aroma, amylose content, gelatinizing temperature and gel softness etc determine the worth of this crop commodity. Often the traditional tall, beak-grained and photoperiod sensitive types that need short days for induction of flowering are considered true basmati types.

Basmati rice is generally unable to grow in salt affected lands which cover about 6.73 million ha agricultural landscape in India. Since most of the country's present day basmati growing regions had initially sodicity problems, it was imperative to have basmati cultivar which was fitting in the sodic and reclaimed sodic agro-ecology. In its quest to rehabilitate and reclaim such adverse environments and to popularize basmati cultivation in sodic areas, Central Soil Salinity Research Institute, Karnal developed the first ever sodicity tolerant basmati rice variety CSR 30 which is popularly named as "Yamini". CSR 30 variety was identified and recommended by Central Variety Release Committee, Ministry of Agriculture, Govt. of India in 2001 for growing in the salt affected areas of Uttar Pradesh, Haryana and Punjab. This variety was developed by Dr. B. Mishra and Dr. R.K. Singh from the cross Pak.Bas1/BR4-10 and therefore, combines the higher salt tolerance of BR4-10 in the genetic background of Pakistani Basmati. BR4-10 is an old salt tolerant rice variety developed from Agriculture Research Station, Panvel (Raigad), Maharasthra and is locally known as Bhura Rata. The basmati parent Pakistan Basmati is one of the popular local basmati cultures in the traditional basmati areas with superior grain quality. Pakistan Basmati is also recently named as Basmati 386 in the Indian Punjab state. Besides its domestic consumption, basmati rice grown in India and Pakistan commands lot of demand in the international market.

Adaptation, yield and area under cultivation

Almost all the basmati varieties of rice are sensitive to sodicity stress. A large basmati rice growing belt of Haryana is either under moderate to reclaimed sodic soils or has poor quality ground water which is used for irrigation. Due to these stresses, farmers are unable to harvest the potential yield, though they opt for basmati rice as it is the best profitable crop. Due to the continuous injudicious use of poor quality water (sodic water) in some areas, yield of basmati varieties have started declining appreciably. Realizing this problem, research efforts at CSSRI were intensified to develop basmati rice variety with better tolerance to sodicity and poor quality waters.

The experience shows that CSR 30 not only performs better in salt stressed soils but also gives about 20 per cent higher paddy yield than the national check variety Taraori Basmati (Table 1).

Table 1: Yield performance (kg ha^{-1}) of CSR 30 in traditional basmati areas in the national trials

State/location	Varieties	
	CSR 30 (IET 14720)	HBC19 (Taraori Basmati) National check
Haryana		
Kaul	2,514	1,869
Karnal	4,566	3,733
Mean	3,540	2,801
Rajasthan		
Kota	3,257	1,529
Banswara	2,416	1,555
Mean	2,837	1,542
Jammu and Kashmir		
RS Pura	2,819	2,305
Uttar Pradash		
Modipuram	2,916	2,916
New Delhi		
IARI	2,098	3,024
Punjab		
Kapurthala	2,014	1,790
Rauni (Patiala)	2,942	2,394
Mean	2,478	2,092
Overall mean	**2,838**	**2,346**

Source: Progress Report, 1996, DRR, Hyderabad.

Due to its higher yielding ability, sodicity tolerance and better resilience to different biotic and abiotic stresses, CSR 30 has gained lot of popularity among farmers in the basmati growing areas. It tolerates soil sodicity up to pH 9.5 and salinity up to 7.0 dS m^{-1}. It is also found moderately tolerant to blast, sheath rot, rice tungro virus (RTV) and white backed plant hoppers (WBPH) with an average score of 4.6, 4.8, 4.75 and 4.36, respectively.

Basmati is primarily grown in the states of Haryana, Punjab, Uttarakhand and Uttar Pradesh. Haryana state with about 43 per cent of its total rice area under basmati rice has the highest basmati area among these four states. Especially in Haryana, CSR 30 occupied 1.1 lakh ha premium basmati area as against only 7.0 thousand ha under HBC19 (Taraori Basmati) as shown in Table 2. This shows that CSR 30 has occupied considerable area in normal soils also.

Grain quality and morphological attributes

CSR 30 has long slender and highly scented grains with good head rice recovery (59%), high kernel elongation on cooking, intermediate gelatinizing temperature and intermediate amylose content (23%). It is at par with the national check Taraori Basmati (HBC19) in quality traits (Table 3). In the panel test, IET 14720 (CSR 30) was identified as a good culture on account of its attractive flakiness, aroma and fine elongation of cooked rice.

Table 2: District-wise area (in ha) under Basmati varieties in Haryana during 2005*

District	Varieties		
	CSR 30	HBC 19	Bas. 370
Kaithal	26006	1208	763
Panipat	15821	456	0
Sonepat	16183	1035	0
Jind	9683	1028	0
Karnal	7602	0	0
Ambala	16897	861	0
Kurukshetra	10806	375	0
Yamunanagar	0	600	0
Hisar	4961	341	0
Fatehabad	570	0	0
Sirsa	200	0	0
Rohtak	951	1000	163
Faridabad	1075	0	0
Total	**110755**	**6904**	**926**

*Source: Ahuja *et.al.* (2007)

Table 3: Grain quality analysis of CSR 30*

Quality parameter	Varieties	
	CSR 30 (IET 14720)	HBC 19 (National Check)
Hulling (%)	73.7	77.3
Milling (%)	64.8	63.6
Head rice recovery (%)	58.6	53.1
Brown rice		
Kernel length (L) in mm	7.22	6.91
Kernel breadth (B) in mm	1.80	1.80
L / B ratio	4.01	3.84
Grain type	LS	LS
Milled rice		
Kernel length (L) in mm	5.70	5.70
Kernel breadth (B) in mm	1.60	1.70
L / B ratio	3.56	3.35
Cooked rice		
Kernel length (L) on cooking in mm	12.17	12.07
Kernel breadth (B) on cooking in mm	2.40	2.10
Elongation ratio	2.14	2.12
Volume expansion ratio	4.10	3.83
Alkali value	4.88	5.48
Amylose content (%)	23.30	28.80
Aroma	Strong scent	Strong scent

* Based on the mean values of results from three national laboratories (DRR, Hyderabad, CRRI, Cuttack and IARI, New Delhi)

Grain quality characteristics of Basmati CSR30

Regarding other morphological traits, CSR 30 has erect flag leaf, well exserted awned panicles with white stigma and takes about 125 days for flowering. Its plant height is about 155 cm which gets reduced under salt stress conditions thus, enabling it to prevent lodging. Like traditional basmati, it has also photoperiod sensitivity inducing its flowering under shorter day length but has unique "stay green" trait enabling its timely harvest when its stem is even yellow green. The "stay green" trait at maturity enables its higher photosynthetic efficiency thus possibly contributing to yield superiority. Basmati CSR 30 also possesses better strength against lodging than other traditional basmati varieties. Basmati variety CSR 30 has shown better performance both in terms of grain quality and yield superiority. It also fetches more price as well as gives about 20 per cent more yield over Taraori Basmati (HBC19).

Molecular markers are now capable of detecting the precise inter-varietal similarity. Among different molecular markers, simple sequence repeat (SSR) markers are efficient as well as cost effective to detect precise genetic similarities in rice. Therefore, among evolved basmati varieties, Basmati CSR 30 has shown highest molecular genetic intimacy of 96 % with traditional basmati types (Basmati 370, Dehraduni Basmati, Ranbir Basmati, Basmati 386 and Taraori Basmati) through dendrogram derived from UPGMA cluster analysis using SSR markers (Nagaraju *et al*, 2002).

Performance of basmati rice varieties under sodic soils

During *Kharif* 2001, seven basmati rice varieties were grown under two different soil environments. One of the locations was the reclaimed sodic soils of main Institute farm Karnal with soil pH around 9.0 which is almost normal for rice. Another location had moderate sodic soil (pH 9.5-9.6) at CSSRI Regional Research Station, Shivri Farm, Lucknow. Though, the rice varieties did not differ significantly at Karnal location for grain yield, soil stress at Lucknow could unravel the significant hidden variability among the varieties for grain yield under sodicity stress (Table 4). Highest yield reduction (88 %) was noticed in Pusa Basmati 1 followed by Desi Hansraj, Basmati 370 and Kasturi indicating their higher sensitivity to sodicity stress. Least yield reduction was observed in case of CSR 30 (26%). Based on the absolute yield at both the locations, only CSR 30 could yield more than 2000 kg ha^{-1}.

Table 4: Grain yield of basmati rice varieties under salt-stress conditions

Variety	Grain yield (kg ha^{-1})		Yield reduction under sodic stress (%)
	Reclaimed sodic soils at Karnal (pH_2 9.0)	Sodic soils at Lucknow (pH_2 9.5-9.6)	
CSR 30	3537	2611	26.2
Super Basmati	3655	1556	57.4
Basmati 370	3556	1222	65.6
HBC 19	2787	1778	36.2
Desi Hansraj	3395	1055	69.9
Pusa Basmati 1	3617	455	87.7
Kasturi	2163	833	61.5
Location mean	**3244**	**1358**	**57.7**
CD (P=0.05)	NS	899	

Adaptive trials and demonstrations

CSR 30 was tested at farmers' fields by Krishi Vigyan Kendra, Jind (Haryana) before its release and it yielded 3737 kg ha^{-1} at pH_2 9.3. Before the release, it was suggested to conduct a large area demonstrations of CSR 30 during Kharif 2000 at CSSRI outreach farm at Bhaini Majra, Kaithal [soil pH_2 9.3-9.4 with poor quality water of high RSC (Residual Sodium Carbonate) of more than 10 meq l^{-1}; the safe limit for irrigation being less than 2.5 meq l^{-1}]. Until maturity, both CSR 30 and HBC 19 varieties behaved almost similar but at the time of panicle initiation/flowering, HBC 19 experienced heavy damage of about more than 75 per cent while CSR 30 had hardly 20-25 per cent damage. This damage was in terms of the almost burnt or chaffy panicles either due to higher soil pH or higher RSC of irrigation water. This demonstration clearly brought out the potential of CSR 30 over the traditional basmati variety HBC19 and was a breakthrough to the farmers and seed producers in favour of CSR 30. After the release of CSR 30, Front Line Demonstrations (FLDs) were also conducted during 2002-03 in Uttar Pradesh, Uttarakhand and Haryana states. At all the locations, CSR 30 performed better than check variety. The yield advantage was recorded from 15-37 per cent over the local check HBC 19 (Table 5).

Institute's QRT visiting CSR 30 demonstrations at Kaithal Farm

A farmer appreciating the salt tolerance of CSR 30

Farmers evincing keen interest in the cultivation of CSR 30

Table 5: Performance of CSR 30 under FLDs under farmers' field conditions

State/District	Year	Grain yield (kg ha^{-1})		Increase in mean yield (%)
		CSR 30	HBC 19	
Haryana				
Panipat	2002	3,654	2,700	35.3
Karnal	2003	2,160	1,723	25.4
Jind	2003	3,025	2,620	15.5
Uttarakhand				
Kashipur	2002	3,230	Not reported	–
Uttar Pardesh				
Aligarh	2002	2,375	1,725	37.7

Source: Compact Block of Frontline Demonstrations-DRR, Hyderabad for 2003 and 2004

Seed production of CSR 30

Since the release of CSR 30, CSSRI, Karnal has been producing the seed of this variety. The chain of seed production like other varieties is Nucleus Seed-Breeder Seed-Labelled or Foundation Seed-Certified Seed. Nucleus and Breeder seed are produced at CSSRI, Karnal. Besides, Seed Production Unit at CSSRI also produces its labeled seed to meet greater demand. Since the advent of CSR 30, CSSRI, Karnal alone has sold more than 500 quintals of its Breeder and Labelled seed (Table 6). The seed demand of this variety is growing every year.

Besides, to meet the huge seed production demand other organizations like CCS HAU, Rice Research Station, Kaul , Distt. Kaithal, Haryana also produces Breeder seed of CSR 30. Significant to mention, Haryana Seed Development Corporation right from 2001 targeted about 500 quintals seed production of CSR 30 every year. It has again enhanced the seed production target of 750 quintals of CSR 30 every year starting from 2008 to 2010. In addition, several other public/private agencies including National Seed Corporation and HAFED in Haryana are engaged in the seed production of CSR 30. U.P. Bhumi Sudhar Nigam at Lucknow often gives huge indent

Breeder Seed Production at CSSRI, Karnal

for its seed. It has been observed that many seed companies are directly requesting for getting the Breeder seed of CSR 30. Ideally, the demand for Breeder seed should come through Seed Association of India at least one year in advance to plan the Breeder seed production and to meet the demand accordingly. The address is given below:

Seed Association of India,
1119-1120, Vishal Towers
District Centre, Janakpuri, New Delhi-110058
Tel.: 011-25612990, Website: seedassociationofindia.com

Table 6 : Year-wise sale of seed (Breeder/labelled) of CSR30 by CSSRI, Karnal

Year	Quantity of sale (qtls)
2000	6.80
2001	37.55
2002	8.35
2003	81.54
2004	93.47
2005	19.23
2006	23.20
2007	33.00
2008	53.00
2009	84.00
2010	60.00
Total	**500.14**

Basmati CSR 30 has got indent for a huge quantity of 20 quintals Breeder seed for the year 2008 as against only 6.7 quintals of HBC19 (Taraori Basmati) from Department of Agriculture and Co-operation which shows the growing popularity of CSR 30 only during 4-5 years of its advent (Table 7). The trend also shows growing demand and acceptability of CSR 30 in non-traditional basmati states like U.P., Bihar and M.P.

Seed production and distribution

Table 7: Breeder seed indent (qtls) through Department of Agriculture and Co-operation, Government of India for CSR 30 *vis-a-vis* Taraori Basmati (HBC 19) for the year 2008

Indented by	CSR 30	HBC 19
SFCI/NSC	0.30	0.15
Haryana	0.08	0.08
U.P.	1.30	0.00
M.P.	11.00	0.00
Bihar	3.00	0.00
Private	4.04	6.50
Total	**20.00**	**6.73**

Source: Proceedings of All India Rice Group Meetings held at DRR, Hyderabad, 2007.

Agro-technology

Normally, same agronomic practices and plant protection measures as recommended for other traditional basmati types should be followed for CSR 30 in a particular agro-climatic area. However, some additional practices are recommended for its cultivation in sodic soils (Table 8). Besides, chemical treatment of seed prior to sowing is recommended. For this, Amisan (0.5%) @ 5 g in 10 litre of water+Streptocycline (0.1 %) @ 1 g in 10 litre of water are enough to soak about 10 kg seed for 24 hours before sowing. Recently, foot rot/*bakanae* disease is appearing in basmati types. The disease is characterized by few abnormally elongated pale yellow and lanky plants than others. For this disease management, seed treatment consisting of 10 g bavistin /10 litre of water for soaking 10 kg seed is advised. For its prevention, seedlings for plantation should be uprooted in the standing water. Uprooting seedlings from dry field for nursery should be avoided. The affected taller plants should also be rogued out and isolated.

Both farmers and industry thank Basmati CSR 30

Table 8 : Agronomic practices for cultivation of CSR 30

Agronomic practice	Non-stress soils	Salt-stress soils
Seed rate	20-25 kg/ha	30-40 kg/ha
Nursery sowing	1st -15th June	20th May - 5th June
Seedling age	25-30 days	35-40 days
Transplanting time	1st -15th July	1st -15th July
Seedlings per hill	2-3 seedlings	3-4 seedlings
Spacing	15x15 cm	15x15 cm
Fertilizer requirement - N	60 kg N/ha in 3 splits (transplanting, after 3 and 6 weeks)	70-75 kg N/ha in 3 splits (transplanting, after 3 and 6 weeks)
Phosphorus	As per soil test value	No need of P for initial 3-5 years of reclamation
Zinc	20-25 kg/ha depending upon the Zn deficiency symptoms	20-25 kg/ha Zn is a must in sodic soils

With the continuous rice-wheat cropping sequence, new problems of soil health and ground water depletion are arising. Basmati types also mature later than semi-dwarf rice varieties which sometimes delays wheat sowing in the rice-wheat rotation. To meet these challenges, studies on resource conservation technologies have been conducted at CSSRI, Karnal. The experiment consisted of different tillage and crop establishment techniques in rice-wheat cropping system. The results proved that direct seeded rice (CSR 30 variety) with Sesbania co-culture as a *brown manuring* yielded at par with conventional transplanting besides, offering a water saving of more than 40 per cent. In addition, other agronomic practices like SRI (System on Rice Intensification)

technique popular in southern states and double transplanting or two step transplanting practiced in eastern states may also prove a boon for basmati rice cultivation.

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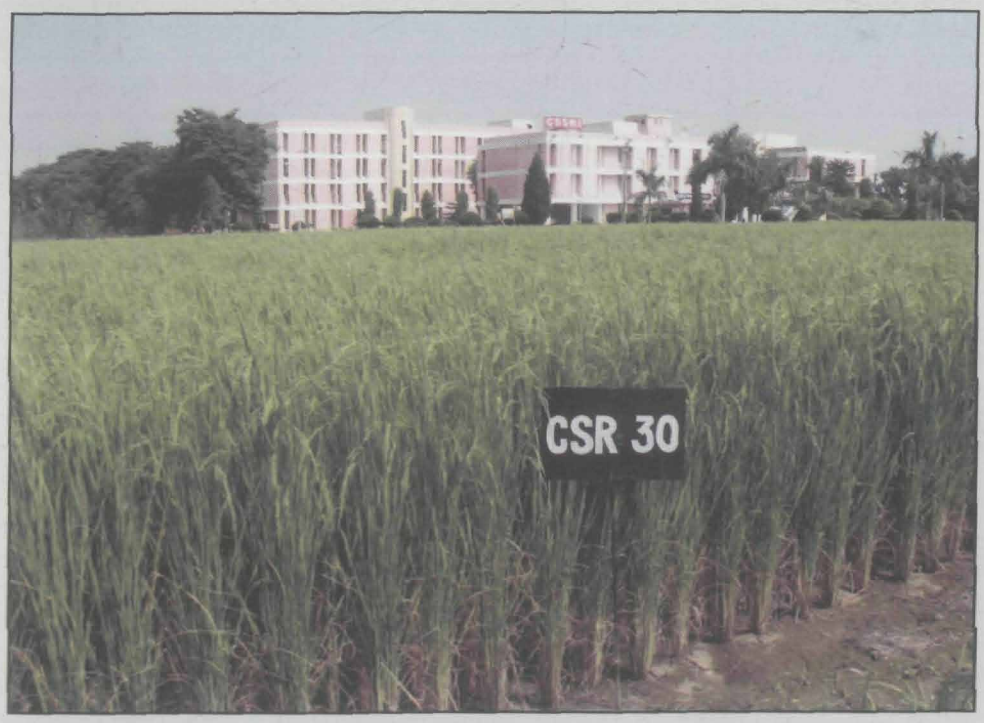


CSR 30


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CSR 30


CSR 30

CENTRAL SOIL SALINITY RESEARCH INSTITUTE
KARNAL-132 001, HARYANA, INDIA
Telephone: +91-184-2290501; Fax: +91-184-2290480,2292489
E-mail: director@cssri.ernet.in
Website : www.cssri.org