

KSK111H: FIRST EVER BASMATI RICE HYBRID, A FINE GRAIN HIGH YIELDING, EARLY MATURING AROMATIC RICE (*ORYZA SATIVA*) HYBRID IN PAKISTAN FOR TOMORROW'S FOOD SECURITY

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Abstract

Hybrid rice is the marketable crop acquired by growing F1 seeds of a cross between heritably divergent parents. Best hybrids combinations show the 15-20% more potential than traditional varieties sown under parallel circumstances. Rice demand has recently been amplified in state due to rising and falling cereal prices and global food security concerns. To manage with these matters there is an opportunity to practice heterosis for hybrid development in rice. KSK111H was first ever approved basmati rice hybrid from Punjab in Pakistan's rice history. It is a high yielding aromatic rice hybrid with tolerance to moderate salinity levels in soil. It is developed by scientists of Rice Research Institute, Kala Shah Kaku through germplasm i.e., KSK1301A and KSK1301R lines through hybridization. KSK111H was fine grain rice hybrid which has good cooking quality with mild aroma and expected to fetches good market price in future. The paddy yield of KSK111H is 51% higher as compare to indigenous Super Basmati. Main features are: an early maturing (almost 3 weeks prior than Super Basmati), tolerant to salinity upto EC 5, same basmati aroma like other basmati varieties, good yield (sown in mid-June to mid-July), outstanding yield potential (11.5 t/ha) and average yield (7.2 t/ha). It is developed to break the yield barriers of basmati rice grown by the local farmers of southern Punjab especially.

Keyword: Rice; Basmati hybrid; Punjab; Pakistan; High Yielding; Early maturing; aroma

Introduction

Partial population of world consume rice grain. For economic development and growing population 1% annually rise in yield is demand of the era (Normile 2010). Rice is the chief cereal as well as cash commodity of Pakistan. It is the second main staple food crop after wheat whiles the subsequent major exportable item earning more than US\$ 2.00 billion foreign exchange annually (Muthayya et al. 2014). The overall objective of the agriculture sector is increasing productivity of various crops in the country. In Pakistan, rice as a food and cash crop holds an important position. Besides the local consumption, it earns a lot of foreign exchange through exports in raw form and as raw material for starch paper industry. (Mushtaq et al. 2005). It accounts for 10 % of the entire agricultural area and 18% under grain crops.

Rice is sown on about 3.38 million ha area with 8.2 million metric tons yield of milled rice as reported by Ministry of National Food Security and Research Pakistan. In 2020-21, Pakistan's rice exports fetched \$2.04 billion (Ministry of Commerce 2020-21).

Province Punjab is the chief producer of basmati rice because of its exceptional soil and climatic conditions. It shares 70% in total state rice production. Gujranwala, Hafizabad, Nankana Sab, Narrowal, Sheikhpura and Sialkot districts are major basmati areas. Recently, imported hybrid rice cultivars had beaten the basmati production owing its short maturity duration (105 days) and high yields (115 mounds/acres). (Abedullah et al 2007). Furthermore, rice stakeholders i.e., growers and traders has dissimilar securities. Farm community need quick maturing and greater yielding cultivars for all-out

profit and sufficient sowing time for succeeding crops. (Ghasal et al. 2015) Traders choose quality grains in terms of shape, aroma, color, size and texture. (Khan et al. 2010).

Super basmati dominates in traditional rice track of Punjab and people prefer basmati rice due to its long grain length, two-fold elongation ratio, intermediate amylose content and nutty aroma. It is the specialty rice sown in Pakistan and India. Due to its gastronomic quality traits, internationally considered as super rice. (Akhter et al. 2014). Seeing its distinctiveness, uniqueness, varying dietary pattern, the demand is amassed globally. Hybrid production is a verified and efficacious technology for rice production too. When equated with inherited lines, it has an average of about 20% more yield due to the additional biomass before flowering stage with greater harvest index (Taillebois et al., 2017). In a male sterility system, a male sterile line is incapable of setting seeds through selfing. Therefore, it can be used as the female parent to produce hybrids by receiving pollens from a normal fertile line. (Cui et al., 2020)

During 1920's, the basmati rice improvement programme was initiated at Rice Research Institute Kala Shah Kaku (RRI KSK), Pakistan. (Ahmed et al; 2011). As basmati varieties have yield barriers and considering the increasing demand of rice due to population increase on one hand and decreasing land and water resources available for rice cultivation on the other, it is critical to develop and use these technologies that will result in higher yield. Half of the area of rice in China is under adoption of hybrid rice due to yield improvement in rice. (Li et al. 2010). Hybrid rice varieties confirmed a 1-1.5 t ha⁻¹ yield advantage over semi-dwarf inbred varieties (HYVs) at farmer fields in China and other

countries. Future of Pakistan's basmati lies in the development of basmati rice hybrid along with other basmati varieties. The increase in rice yields can promote food security for probably 60 million surplus people per year (Li et al. 2010). So there is dire need to exploit heterosis through utilization of hybrid vigor in rice. Objective of this study was to develop hybrid rice with Basmati parent. Moreover, analysis regarding yield parameters and quality traits on different locations was determined and compared with existing inbred basmati variety.

Materials and methods

Experimental design and Plant material

Three field experiments were piloted in Rice Research Institute, Kala Shah Kaku from 2018-2021. The plant material was composed of KSK1301A/KSK1301R in three line systems. KSK1301R is a local variety with high yield and good cooking quality and KSK1301A is a wild abortive CMS line with good cooking quality. Individually hybrids were planted in a four-row plot with six lines in each row at a spacing of 20 cm.

Replicated complete block design (RCBD) was followed in all different station yield trial and national uniform replicated yield trials during rice growing season May/June. Afterwards this combination was retested in re-testcross nursery and evaluated in test hybrid trials at micro level trials, and station yield trials in three consecutive years. Standard agronomic production technology was used. Insect pest infestation was also recorded during the trials.

Data Collection

Agronomic traits were probed in field as yield (YD), plant height (PH), heading days (HD), panicle number per plant (PN), panicle length (PL), grain weight per 1000 grains (KGW), grain number per panicle (GN), seed setting rate (SSR), grain width (GW) and grain

length (GL). After harvesting, milling was done. Cooking and quality data was recorded for and after cooking.

Data Analysis

Analysis of variance technique was applied to study the traits using Statistix computer software (SPSS 13.0 software). Statistical analysis was studied at 5% Level of Significance).

RESULTS & DISCUSSION

Results showed that the rice hybrid KSK111H was higher yielder than existing super basmati rice variety. Super basmati is an existing commercial variety cultivated on maximum area of Punjab. KSK111H is also an early maturing hybrid which is 10 days earlier than super basmati as depicted in Fig.1 and data presented in Fig.1.



Figure 1: Field view of KSK111H and Super Basmati

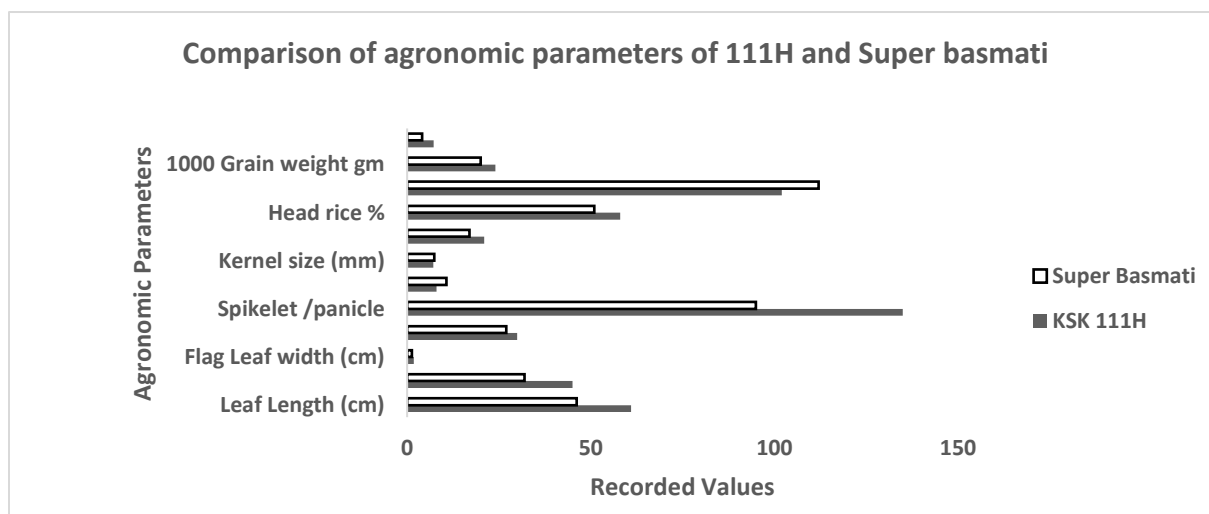


Fig.2: Agronomic parameters of Basmati Hybrid and Super Basmati

The new candidate hybrid KSK111H along with Super Basmati (C) was tested in 10 trials of different locations of Punjab in two consecutive years. The yield data are given in table 1. Table-2 indicates that in Micro plot yield Trials, KSK111H gave 15% higher yield than Super Basmati (C).

The new candidate fine rice hybrid KSK111H along with three checks was tested in 16 trials in three consecutive years. The yield data are given below in table 2.

Table 1: Yield comparison of hybrid and commercial variety in micro plot trials

Year	Location	Varieties / paddy yield (t/ha)	
		KSK111H	Super Basmati
2020	Gujranwala	5.06	5.38
	Faisalabad	5.30	5.55
	Kala Shah Kaku	4.63	3.60
	Bahawalnagar	3.22	2.94
	Average	4.55	4.37
2021	Gujranwala	5.33	5.73
	Sheikhupura	5.67	4.87
	Faisalabad	6.47	5.40
	Sargodha	5.33	3.47
	Kala Shah Kaku	4.81	4.04
	Bahawalnagar	4.70	2.20
	Average	5.39	4.29
Average of 2 years		4.97	4.33
% Increase over check		15%	

Table 2: Yield data of National uniform yield trials Punjab locations

Year	Punjab Location	Varieties / paddy yield (kg/ha)		
		KSK111H	Check (Fine rice)	Check (Coarse rice)
2019	Sheikhupura	11535	-	8600
	Kala Shah Kaku	6200	2462	5268
	Multan	6637	-	8923
	PARC, KSK	3104	2471	5109
	Vehari	6803	-	9400
	Average	6856	2467	7460
2020	Multan	9729	-	11362
	Kala Shah Kaku	6982	3255	7040

	PARC, KSK	3639	3111	5403
	Farooqabad	4925	3369	8710
	Average	6319	3245	8129
2021	Bhawalnagar	4853	4429	-
	PARC, KSK	4716	2846	-
	Sialkot	3637	3317	-
	RRI, KSK	3607	3105	-
	NIAB Faisalabad	3862	3590	-
	NIBGE Faisalabad	4472	3997	-
	Pindi Bhattian	2105	2330	-
	Average	3893	3373	-
Average (3 years - Punjab)		5689	3028	7795
% increase over Check - Fine grain		51%		

The above table indicated that in National uniform rice yield trials, KSK111H gave 51% higher paddy yield than Basmati varieties (Check) in Punjab. Yield data

revealed that “KSK111H” is well adapted in Punjab province.

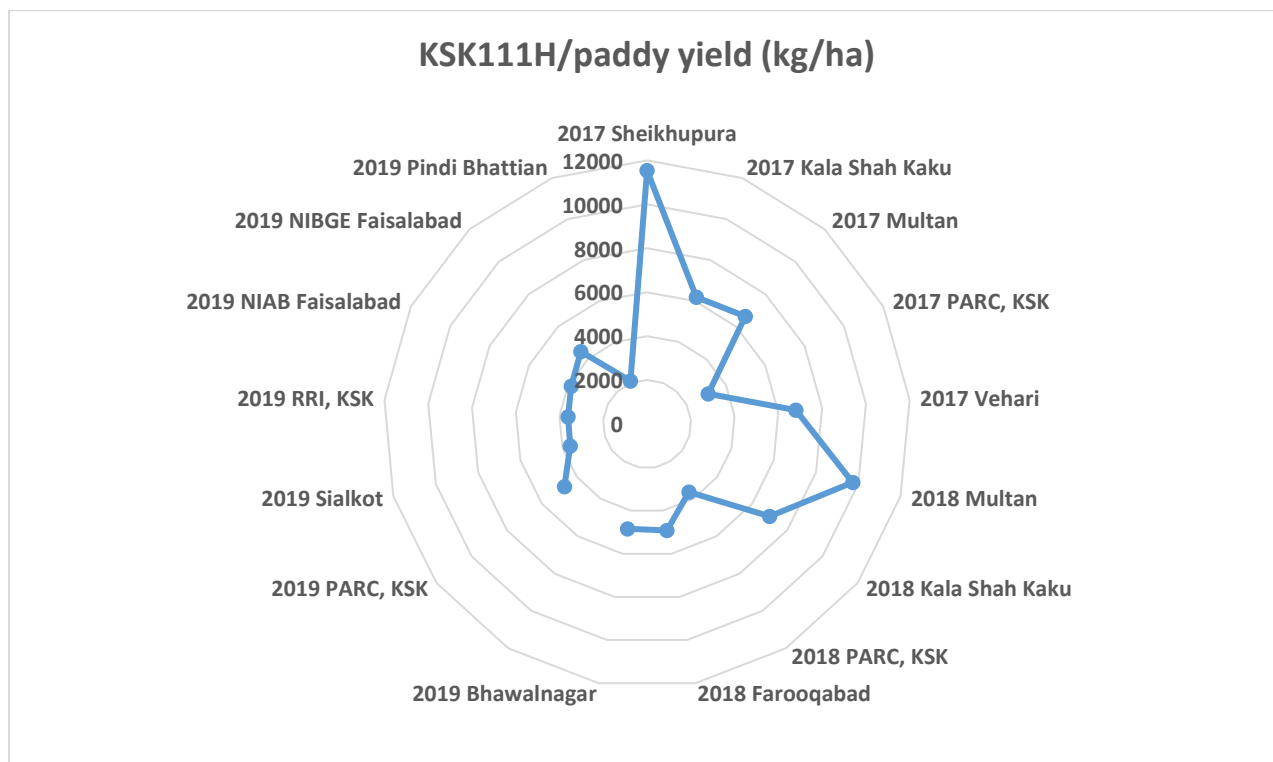


Fig 3: Graphical presentation of KSK111H in Punjab locations.

Yield data of transplanting trials on “KSK111H” and Super Basmati conducted at Rice Research Institute, Kala Shah Kaku are summarized in Table-3:

It is relatively strong from the data that on average of two years, KSK111H gave utmost yield 4.41 t/ha at 1st July transplanting date. Therefore, it is obvious that the maximum yield of KSK111H can be obtained by transplanting rice nurseries from 1st July to 20th July.

“KSK111H” was tested during 2019 and 2019 against insect pests including White Back Plant Hopper (WBPH), Brown Plant Hopper (BPH) and pathological infections viz., Bacterial Leaf Blight (BLB), Brown Leaf Spot (BLS) & Stem rot at Rice Research Institute, Kala Shah Kaku under no spray conditions. The results are summarized below in Table-4:

Table 3: Yield data along with average of sowing date trials

Year / Variety	Transplanting dates / paddy yield (t/ha)					
	1/6	16/6	1/7	16/7	1/8	Average
2019-20						
KSK111H	2.61	3.49	4.54	3.45	2.88	3.39
Super Basmati	3.07	3.12	3.53	4.11	2.57	3.28
2020-21						
KSK111H	4.23	4.27	4.27	3.17	2.12	3.61
Super Basmati	2.19	2.45	2.82	2.78	2.00	2.45
Average of 2 years						
KSK111H	3.42	3.88	4.41	3.31	2.50	3.50
Super Basmati	2.63	2.79	3.18	3.45	2.29	2.86
% increase over Super Basmati						+39%

Table 4: Insect pest reaction at Rice Research Institute, Kala Shah Kaku

Designation	Insect Reaction		Disease Reaction		
	WBPH	BPH	BLB	BLS	Stem rot
KSK 111H	MR	R	MR	MR	-
Super Basmati	R	MR	HS	S	S
KSK 111H	R	R	MS	MS	R
Super Basmati	R	MR	HS	S	S

R = Resistant, S = Susceptible, HR = Highly Resistant, MR = Moderately Resistant, MS= Moderately Susceptible.

The studies regarding the physical characters of grain, milling recovery, cooking quality and chemical tests carried out at Rice Research Institute farm area, Kala Shah Kaku and in national uniform yield trials are presented below in Table-7.

As the good rice variety in Pakistan is with excellent cooking quality for local consumer Khan et al. (2010), millers and exporters, it was enhanced in Basmati rice hybrids as compared to other rice hybrids with poor cooking quality.

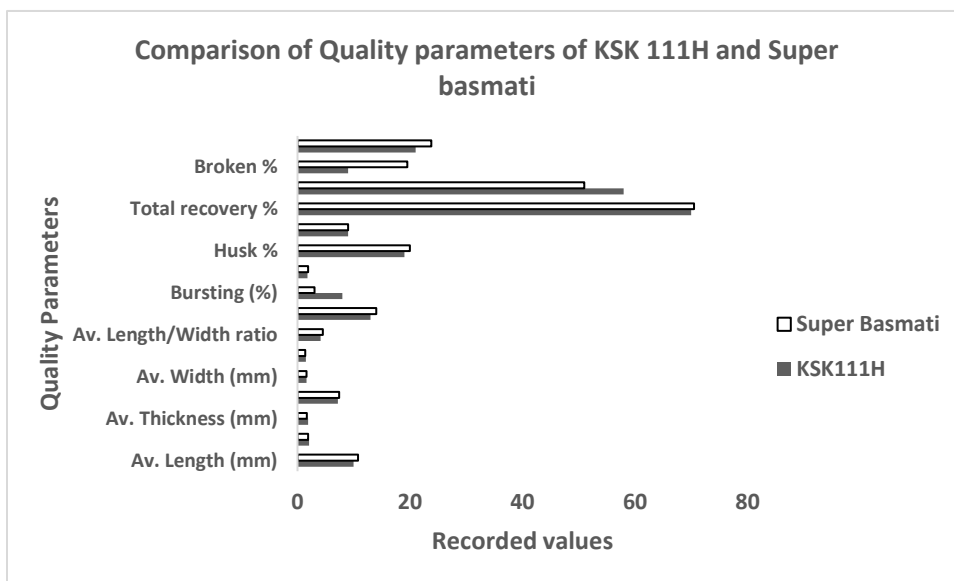


Fig.4: Cooking quality traits of Basmati hybrid in comparison with Super Basmati



Fig.5: Pictorial view of raw and cooked rice grain of Basmati Hybrid

Conclusion

The newly developed basmati rice hybrid, KSK111H gave 51% yield in all the in-station and outstation yield trials, on the average basis. It gave 58% head rice recovery for rice millers and good aroma for basmati rice consumers as compared to all rice hybrid being imported with inferior rice quality this hybrid had solved the farmers concern of inferior grain quality. KSK111H is two weeks earlier than other basmati varieties so farmers of rice can be profited. The rice hybrid showed adequate potential to be used as rice hybrid for yield augmentation and income returns to farmers and rice exporters.

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Conflict of Interest

There is no conflict of interest.

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