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KUFRI SADABAHAR: A POTATO VARIETY FOR UTTAR PRADESH

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ABSTRACT: Kufri Sadabahar is a medium maturing, main season, high yielding potato variety suitable for cultivation in Uttar Pradesh. It is a clonal selection from a cross between MS/81-145 and PH/F-1545. Its plants are tall and vigorous with field resistance to late blight. Its tubers are white, oblong with shallow eyes and white flesh. It possesses good keeping quality and high tuber dry matter (20%). It is capable of yielding 350 to 400 q/ha under optimum agronomical practices.

INTRODUCTION

In India, nearly 85 to 90% of the potato area and production is confined to sub-tropical north Indian plains, where the potato crop is raised during short days in winter season. Uttar Pradesh accounts for nearly 33% (4,40,000 ha) of the total area and 42% (9.82 million t) of the total potato production in the country with yield level of 223 q/ha (5). Varieties with early or medium maturity, fast bulking, insensitive to photoperiod, slow rate of degeneration, high productivity, good storability at ambient temperature and resistant to late blight are suitable for cultivation in Uttar Pradesh (2, 3, 6). In the past, several high yielding potato varieties like Kufri Chamatkar (1968), Kufri Bahar (1980), Kufri Lalima (1982) and Kufri Anand (1999) were developed by the Central Potato Research Institute at its Modipuram campus but all except Kufri Anand are susceptible to late blight, which now appears more frequently in the region and causes extensive yield losses. The new variety Kufri Sadabahar (MS/93-1344) has been bred with the objective to replace the late blight susceptible popular variety Kufri Bahar and to meet the growing demand of farmers to increase potato productivity in the region.

BACKGROUND

The clone (MS/93-1344) was derived from the cross between late blight resistant advance hybrid MS/81-145 (female), having white oval-round tubers with shallow eye and a meiotic tetraploid PH/F-1545 (male), having white, oval tubers with medium deep eyes and good resistance to late blight. The cross was made at the Central Potato Research Station, Kufri, Himachal Pradesh (32^{o} N and 77^{o} E, 2501 m asl) in 1991. The pedigree of Kufri Sadabahar is presented in **Fig. 1**. The seedling and further clonal stages were raised and evaluated (1, 4) at the Central Potato Research Institute, Campus, Modipuram (29^{o} N and 76^{o} E; 222 m asl), Meerut, Uttar Pradesh. The selection MS/93-1344 was introduced to All India Coordinated Research Project (AICRP) on Potato in 2000. Under AICRP-Potato, it was evaluated at 10 locations across the country for four years during 2000-01 to 2004-05. Based on recommendations of the 25th Group Meeting (September 8-10, 2005, Udaipur) of AICRP, the hybrid MS/93-1344 was evaluated in regional on-farm trials in Uttar Pradesh and Haryana during 2005-06 (4 locations) and 2006-07 (10 locations). In these trials, it showed wider adaptability and higher yield than the controls. Based on its performance, the hybrid MS/93-1344 was recommended for release in

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Uttar Pradesh by Uttar Pradesh State Variety Release Committee meeting held on 20th July 2007 in Lucknow. Subsequently, it was released and notified as variety under the name Kufri Sadabahar by the Central Sub-Committee on Crop Standards Notification and Release of Varieties for Horticultural Crops, Ministry of Agriculture, Department of Agriculture and Co-operation, Government of India, New Delhi in 2008.

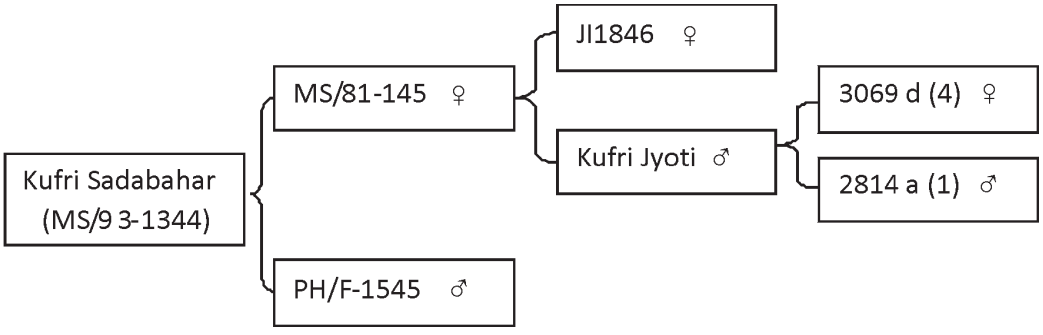

Fig. 1. Pedigree of Kufri Sadabahar

VARIETY DESCRIPTION

Plant

Growth habit: Plant medium-tall, erect, semi-compact, vigorous. *Stems*: Medium, thick, predominantly green with red-brown pigment scattered throughout, wings slightly developed and straight. *Leaves*: Dark grey green, open, rachis green. *Leaflets*: Weakly dissected, leaflet width medium, ovate-lanceolate, leaflet coalescence absent, midrib green, smooth glossy surface with entire margin. *Folioles*: Medium.

Inflorescence

Flowering: Profuse **(Fig. 2)**, inflorescence simple, floral stalk light purple, floral stalk-pedicle articulation clearly visible and located above the middle. *Calyx*: Partially pigmented. *Corolla*: White, semi-stellate. *Stigma:* Single, stylar length longer than stamen column, pale green. *Anthers:* Pale yellow, anther cone normally developed, pollen quantity abundant and stainability high. *Fruit set*: Low under field conditions.

Tubers

Size: Medium to large, 7-8 tubers per plant, *Shape*: Oblong. *Skin:* Smooth, white. *Eyes*: Shallow, with a mean of 12 eyes per tuber (range 10-14), predominantly apical. *Flesh*: White, texture mealy.

Sprout

Red purple, cylindrical, base slightly hairy, sprout tip closed, frequency of sprout root initials medium, protrusions of lenticels weak and lateral shoots short.

YIELD PERFORMANCE

Kufri Sadabahar out-yielded the control cv. Kufri Bahar which is the most popular variety of the region by a margin of 60 and 89% at 75 and 90 days crop durations, respectively, in advance stage trials at Modipuram during 1997-98 to 1999-2000 **(Table 1)**. The low yields of Kufri Bahar during 1997-98 was due to late blight infection. Kufri Sadabahar also out-yielded Kufri Pukhraj and Kufri Sutlej by a margin of 4 and 22%, respectively, at 90 days crop duration and remained at par with Kufri Anand.

In multi-location trials conducted under AICRP from 2000-01 to 2004-05 at 10 locations,

Table 1. Performance of variety Kufri Sadabahar in advance stage trials at Modipuram.

Hybrid/Variety	Total tuber yield q/ha							
	1997-98		1998-99		1999-2000		Mean yield	
	75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days
Kufri Sadabahar	266	307	261	307	265	399	264	338
Kufri Anand	-	-	244	262	294	410	269	336
Kufri Bahar	124*	149*	205	208	-	-	165	179
Kufri Pukhraj	-	-	239	243	322	407	280	325
Kufri Sutlej	233	231	257	278	310	362	258	290
CD (P ≤ 0.05)	22	33	40	57	38	39	29	43

*Tuber yields were low due to late blight infection in the crop.

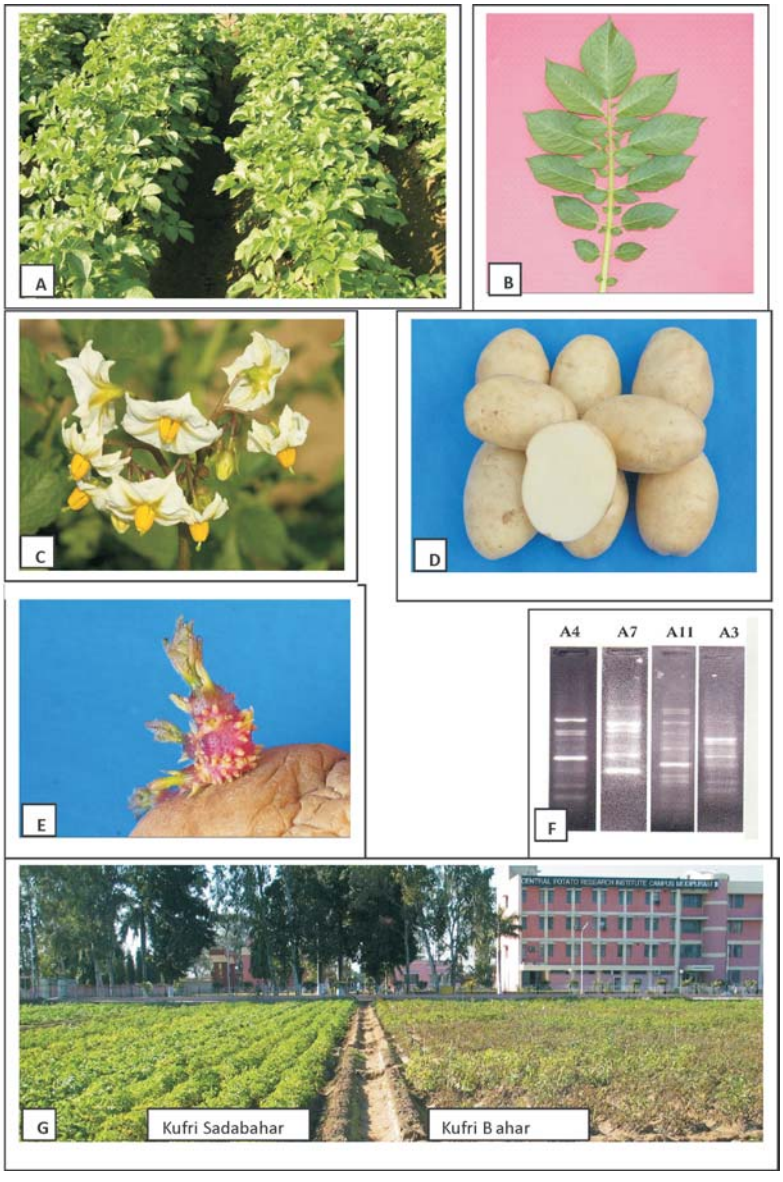

Fig. 2. Morphological characteristics of Kufri Sadabahar (A) Crop, (B) Leaf, (C) Flowers, (D) Tubers, (E) Sprout , (F) Fingerprints and (G) Late blight host response

Kufri Sadabahar produced 4 and 6% higher total and marketable tuber yield, respectively, than the best control Kufri Ashoka **(Table 2)** at 75 days crop duration. However, at 90 days Kufri Sadabahar produced 2 and 5% higher total and marketable tuber yield, respectively, than the best control Kufri Pukhraj **(Table 3)**. Kufri Sadabahar performed better than the best control at 6 and 4 locations at 75 and 90 days, respectively. It yielded higher than the control Kufri Pukhraj at Bhubneshwar (39%), Hissar (12%), Modipuram (6%) and Chhindwara (7%). However, it remained at par with Kufri Pukhraj at Kalyani, Deesa and Jorhat **(Table 3)**.

In regional on-farm trial conducted at 4 locations during 2005-06, Kufri Sadabahar out-yielded Kufri Bahar by a margin of 32, 4, 3% at Koopa (Agra), Jasoda (Kannauj) and Modipuram (Meerut), respectively in Uttar

Table 2. Performance of Kufri Sadabahar at 75 DAP in AICRP multi-location trials (pooled over 2000-01 to 2004-05).

Locations	Total tuber yield (q/ha)			Marketable tuber yield (q/ha)		
	Kufri Sadabahar	KufriAshoka	Kufri Jawahar	Kufri Sadabahar	Kufri Ashoka	Kufri Jawahar
Bhubneshwar	226	172	183	213	161	162
Kalyani	228	260	230	218	247	207
Hissar	256	219	192	246	204	175
Deesa	313	290	202	307	273	185
Jalandhar	339	344	240	315	319	220
Modipuram	274	252	262	256	221	226
Patna	251	273	155	239	255	139
Chhindwara	213	191	178	194	172	150
Jorhat	168	157	160	142	134	138
Hassan	162	176	150	148	162	135
Mean	243	233	195	228	215	174

Table 3. Performance of Kufri Sadabahar at 90 DAP in AICRP multi-location trials (pooled over 2000-01 to 2004-05.

Locations	Total tuber yield (q/ha)			Marketable tuber yield (q/ha)		
	Kufri Sadabahar	Kufri Sutlej	Kufri Pukhraj	Kufri Sadabahar	Kufri Sutlej	Kufri Pukhraj
Bhubneshwar	230	163	165	223	156	157
Kalyani	260	240	268	250	226	253
Hissar	315	316	282	309	291	256
Deesa	411	329	419	405	318	404
Jalandhar	440	457	466	422	433	445
Modipuram	333	302	313	312	274	287
Patna	335	342	354	356	307	340
Chhindwara	247	225	230	229	208	213
Jorhat	182	188	187	158	165	161
Hassan	196	239	221	216	215	224
Mean	295	280	291	288	259	274

best control Kufri Ashoka at Bhubneshwar (31%), Hissar (17%), Deesa (8%), Modipuram (9%), Chhindwara (12%) and Jorhat (7%) and remained at par at Jalandhar **(Table 2)** at 75 days crop duration. At 90 days, Kufri Sadabahar yielded higher than the best Pradesh and remained at par with it at Uchani (Karnal) in Haryana at 90 days **(Table 4)**. For marketable yield Kufri Sadabahar performed better than the best control Kufri Pushkar at most of the locations. It also produced tubers with higher dry matter content than the

standard varieties Kufri Bahar and Kufri Pushkar. The tuber dry matter yield from Kufri Sadabahar was also higher than from any other varieties **(Table 4)**.

Kufri Sadabahar was evaluated at 10 locations under regional on-farm trials during 2006-07 and it surpassed Kufri Bahar at all the locations at 75 and 90 days, except at Rasoolpur (Karnal) at 75 days **(Table 5)**. Kufri Sadabahar yielded higher than regional control Kufri Bahar at Shyamnagar (48%), Jasoda (16%), Sherpur (44%), Koopa (80%), Modipuram (53%), Daurala (13%), Pantnagar (16%) and Uchani (13%) at 75 days. At 90 days, Kufri Sadabahar yielded higher than regional control Kufri Bahar at Shyamnagar (38%), Jasoda (23%), Sherpur (46%), Koopa (37%), Modipuram (46%), Daurala (24%), Pantnagar (10%), Rasoolpur (11%), Uchani (21%) and Gwalior (22%). On an average, Kufri Sadabahar out yielded the best control Kufri Pushkar by a margin of 10 and 12% for total tuber yield and marketable tuber yield, respectively, at 90 days; however at 75 days it

Table 4. Performance of Kufri Sadabahar in regional on-farm trials at 90 DAP (2005-06).

Total and marketable tuber yield

Location	Total tuber yield (q/ha)			Marketable tuber yield (q/ha)		
	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar
Koopa Sadabad (Agra)	516.7	390.0	421.7	491.7	368.3	351.7
Jasoda (Kannauj)	431.7	415.0.	465.0	381.7	370.0	373.3
Modipuram (Meerut)	319.3	309.4	273.6	290.0	259.0	245.4
Uchani (Karnal)	356.7	366.7	335.0	331.7	331.7	295.0
Mean	406.1	370.3	373.8	373.8	332.3	316.4

Tuber dry matter content (%)

Location	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar
Koopa Sadabad (Agra)	18.59	17.71	15.61
Jasoda (Kannauj)	20.78	19.93	17.55
Modipuram (Meerut)	19.90	15.86	17.47
Uchani (Karnal)	18.52	17.94	17.25
Mean dry matter (%)	19.45	17.86	16.97
Dry matter yield (q/ha)	78.99	66.32	63.43

Table 5. Performance of Kufri Sadabahar in regional on-farm trials during 2006-07.

Location	75 days after planting			90 days after planting					
	Total tuber yield (q/ha)			Total tuber yield (q/ha)			Marketable tuber yield (q/ha)		
	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar	Kufri Sadabahar	Kufri Bahar	Kufri Pushkar
Shyamnagar (Kannauj)	350.0	236.6	311.7	450.0	326.7	386.7	366.7	268.3	318.3
Jasoda (Kannauj)	363.3	313.3	316.7	433.3	353.3	401.7	354.9	291.7	321.7
Sherpur- Sadabad (Agra)	335.6	232.6	290.4	462.9	316.5	425.9	453.5	305.6	411.3
Koopa- Sadabad (Agra)	391.5	217.6	315.9	529.6	386.6	457.7	520.4	375.3	438.2
Modipuram (Meerut)	299.4	195.3	240.8	383.0	262.9	349.0	364.4	249.1	324.0
Daurala (Meerut)	264.2	233.9	259.8	353.1	285.7	316.5	340.9	275.4	297.1
Pant Nagar	229.2	197.9	254.1	234.8	213.2	281.9	151.5	147.1	205.8
Rasoolpur (Karnal)	229.1	261.8	232.7	320.0	287.3	298.2	311.4	270.1	286.4
Uchani (Karnal)	287.3	254.5	210.9	341.8	283.6	309.1	332.2	264.1	293.4
Gwalior	-	-	-	337.0	276.7	262.9	315.6	234.8	230.6
Mean tuber yield	305.5	238.2	270.3	384.6	299.3	349.0	351.2	268.2	312.7

surpassed the Kufri Pushkar by margin of 13% for total tuber yield. Kufri Sadabahar out yielded the most popular variety of the region (Kufri Bahar) by a margin of 28% for total tuber yield at 75 and 90 days; however it surpassed Kufri Bahar by a margin of 31% for marketable tuber yield at 90 days **(Table 5)**. Kufri Sadabahar has the ability to produce more than 90% tubers of marketable size at both the dates of lifting. Kufri Sadabahar possessed high tuber dry matter (20%) as compared to Kufri Bahar (16%) and Kufri Pushkar (17.5%).

In early trials during 2006-07 at CPRI Campus, Modipuram, Kufri Sadabahar out yielded the best control Kufri Bahar by margins of 9% and 19% for total tuber yield and marketable tuber yield, respectively at 75 days. However, it remained at par with Kufri Bahar for total tuber yield, and produced 7% higher marketable tuber yield than Kufri Bahar at 90 days **(Table 6)**.

DISEASE RESISTANCE: Kufri Sadabahar showed moderate field resistance to late blight at Kufri in hills (7) and good field resistance under short day sub-tropical conditions in the plains **(Table 7)**. Thus Kufri Sadabahar can be apt replacement for the current popular variety Kufri Bahar which is highly susceptible to late blight. Also, the tubers of this variety seldom exhibit external or internal defects and are not susceptible to skin damage at harvest. Kufri Sadabahar showed moderate tolerance to frost during January 2006.

KEEPING QUALITY: Kufri Sadabahar possesses long tuber dormancy (> 8 weeks), at par weight loss with Kufri Bahar and firm tuber appearance after 90 days a storage under ambient conditions **(Table 8)**, therefore adjudged to be of good keeper. This will benefit small or marginal farmers who are unable to store potato in cold store and have to sell their produce in the market. It possesses 20% dry matter **(Table 4 and 8)** and therefore, will provide better nutrition to the consumers at similar cost.

AGRONOMIC MANAGEMENT: Normal agronomical schedule recommended for medium maturing varieties is required for production of optimum tuber yield of Kufri Sadabahar. *Planting time*: 15th October-5th November. *Seed rate*: 35-40 q/ha. *Seed size*: 40-50 gram. *Spacing:* Plants spaced at 20 cm in

Table 6. Performance of Kufri Sadabahar in early planting at Modipuram during 2006-07.

Hybrid/ Variety	75 days after planting		90 days after planting		Per cent marketable yield	
	Total yield	Marketable yield	Total yield	Marketable yield	75 days after planting	90 days after planting
Kufri Sadabahar	260.6	238.3	302.7	288.2	91.4	95.1
Kufri Bahar	238.9	199.9	301.3	270.5	83.7	89.8
Kufri Pukhraj	187.4	152.6	230.6	207.6	81.4	90.1
Kufri Surya	213.4	181.8	244.7	222.5	85.2	91.0
CD ($P \leq 0.05$)	20	24	33	28	7.3	NS

Table 7. Late blight reaction of advance hybrids and varieties evaluated in regional trials during 2006-07.

Hybrid/Variety	Meerut (Modipuram)	Meerut (Daurala)	Agra Sadabad (Koopa)	Karnal (Uchani)	Kannauj (Jasoda)
Kufri Sadabahar	6	7	Did not appear	6	Did not appear
Kufri Bahar	1	1	Did not appear	2	Did not appear
Kufri Pushkar	1	2	Did not appear	2	Did not appear

Late blight reactions on 1-9 scale, 1-susceptible, 9-resistant.

Table 8. Keeping quality and dry matter (pooled over years 1998, 1999 and 2000) at CPRI Campus Modipuram, Meerut.

Hybrid/Variety	Sprouting (%) (days)					Total weight loss (%) (days)			Tuber firmness at 90 days	Dry matter (%)
	30	45	60	75	90	30	60	90		
Kufri Sadabahar	3.3	7.0	45.0	91.3	100.0	6.7	10.3	13.7	good	19.9
Kufri Bahar	0.0	0.0	34.5	86.5	100.0	3.5	4.5	13.0	good	17.4
Kufri Sutlej	8.7	31.3	66.7	98.7	100.0	5.3	9.3	17.7	good	17.0
Kufri Anand	0.0	1.0	24.5	98.5	100.0	5.5	9.0	14.5	good	18.8
Kufri Pukhraj	1.5	13.5	56.0	100.0	100.0	4.0	7.5	14.0	good	17.8
CD (P ≤ 0.05)	1.1	5.4	7.2	8.7	-	1.5	2.9	3.7	-	1.1

rows drawn apart 60 cm. F*ertilizer:* Recommended doses of NPK (180 kg N, 80 kg P, 100 kg K) with 50% N at the time of planting and 50% at earthing up. However, nutrient management for different environment needs to be worked out for obtaining optimum productivity of Kufri Sadabahar. *Plant Protection Measures (for seed crop only)*: Thimet @10 kg/ha at earthing up and foliar spray of Oxy-demeton methyl @ 1.5ml/litre after 75 days of planting.

USAGE: Kufri Sadabahar is likely to be preferred by consumers for its oblong tubers and shallow eyes resulting in lower peeling losses compared to Kufri Bahar, which has oval tubers with medium deep eyes. It is easy to cook (15-20 minutes), and cooked/boiled potatoes are free from discolouration. It possesses pleasant flavour, mealy texture and good palatability. The desirable tuber characters, good keeping and culinary quality of Kufri Sadabahar will favour its acceptance.

ADAPTABILITY: Kufri Sadabahar has performed well in multi-location/ regional on-farm trials conducted under AICRP in Uttar Pradesh and adjoining areas and has been recommended for cultivation in Uttar Pradesh; however it can be grown in adjoining areas of Uttar Pradesh as well. Kufri Sadabahar can aptly replace the late blight susceptible variety Kufri Bahar in Uttar Pradesh and can meet the long felt demand of farmers for a variety with white skin oblong tubers, white flesh, resistance to late blight and higher yield.

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