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Evaluation of different Kalanamak rice genotypes for yield and yield related traits of eastern Uttar Pradesh

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Abstract
Crop genotypes play a dominant role in crop production systems. Uttar Pradesh has been the home of some of the finest quality scented rices. Kalanamak is an important and popular scented rice variety grown in Eastern Uttar Pradesh. This variety is famous for its taste and aroma. In eastern India it is cooked in honour of guest or given as gift. It can be boon for farmers of Eastern Uttar Pradesh and Tarai area of Bihar. In present study 7+2 lines/varieties of Kalanamak, collected from IARI, New Delhi were evaluated on the basis of vital to know the effects of various characters on yield for selection criteria for high yielding genotype. The experiments laid out of two set 1st was on station and 2nd on farmers field of Maharajganj district with two block and two villages *viz*: block Siswa Bazar (Gopala & Keshrari), Meethura (Karuta & Parsauni). Yield and yield related traits were studied. Statistical analysis exhibited that rice varieties differed significantly for days to 50% flowering, plant height cm, panicle per sqm, no. of spikelet's/panicle, SRF% grain yield kg/ha, grain type and insect/pest and disease. Moreover, significantly positive genotypic correlations of grain yield with plant height and panicle/m2 were observed. Principal component analysis also classified superior varieties, shows that maximum yield was recorded for station trial and farmers field the genotypes of Pusa 1652-10-11-2-1-1-1 on station and farmers field grain yield of (3134 kg/ha & 3096 kg/ha), % increase over check Bouna Kalanamak on station and farmers field 18.4% & 19.39%, followed by Pusa 07-62-3-13 grain yield of on station and farmers field (3059 kg/ha & 3088 kg/ha), grain yield increase over check was on station and farmers field 15.21% and 18.78% have high yield stability. The investment on production by adopting improved Kalanamak line/varieties with a value of Rs. 32192/ha. Cultivation of under improved Kalanamak line/varities Pusa 1652-10-11-2-1-1-1fetch higher net return of value Rs. 95,976/- compared to check variety Bouna Kalanamak to amount of Rs. 80,383/- ha, followed by Pusa 07-62-3-13 Rs. 95,480/-, Pusa 1638-07-130-2-67-1-1-1 Rs. 92,504/- and Pusa 1652-10-11-2-2-2-3 of Rs. 90,613/-. The B:C ratio of improved Kalanamak lines/varieties of Pusa 1652-10-11-2-1-1-1was 2.98, followed by Pusa 07-62-3-13 was 2.97 compared to check variety Bouna Kalanamak was 2.50.
Pusa 1652-10-11-2-1-1-1 and Pusa 07-62-3-13 can be used as commercial cultivars in Maharajganj and other Tarai district of Eastern Uttar Pradesh area after multi- location yield test trials.

Keywords: Rice, scented Rices, Kalanamak, evaluation, yield, domestic market

Introduction
More than 90% of the world's rice is grown and consumed in Asia, where 60% of the calories are consumed by 3 billion Asians (Khush, 1997) [7, 8]. World per capita consumption is placed around the 56.9 kg (FAO, 2013) [2]. India is one of the world's largest producers of white rice, accounting for 20% of all world rice production. Aromatic rice, which has stronger aroma and kernel elongation than ordinary rice, has more in demand in different countries of the world. India is one of the largest exporter of basmati rice in world (Husaini *et al.*, 2009) [5]. The consumer demand has increased markedly to pay a premium price for fragrance (Louis *et al.*, 2005) [9]. Scented rices grow best and produce finest quality grains under cool, humid conditions, which are common in Himalayan Tarai of U.P and Uttarakhand and foot hills of Vindhya Hills. Hence Himalayan Tarai of Uttar Pradesh (U.P) and Uttarakhand is probably the place of origin of aromatic rices (Khush, 2000) [7, 8]. Among non-basmati aromatic rices, Kalanamak is the most popular scented rice variety grown in Uttar Pradesh. It is among one of the most important scented rice varieties of India. This variety is famous for its taste and aroma. It is cooking at marriages is considered auspicious and it's smoke is believed to be

purifying the atmosphere. It derives its name from its black husk. It is grown widely in Tarai area of Uttar Pradesh adjoining Nepal particularly in the districts of Siddharthnagar, Santkabirnagar and Basti and in small pockets in districts Gorakhpur, Maharajganj, Balrampur, Gonda, Bahraich, Shrawasti, Deoria and Padrauna (North Eastern Plain Zone of eastern UP). According to (H.N. Singh *et al*., 2006) [4, 10] there is no official record, but extensive discussion with farmers of its native area of cultivation revealed that Kalanamak used to be the most popular variety in this area until the 1970s. Rice is one cereal that is consumed mainly as whole milled and as boiled grain. The desired properties may vary from one ethnic group or geographical region to another and may vary from country to country (Juliano *et al.*, 1964) [6]. The farmers started fast replacing Kalanamak, particularly because of its low and unstable yields. The critical production environment (favorable rain fed lowland) that was well suited to Kalanamak also provided an ideal situation for the Mahsuri group of rice varieties. Because of yield advantages, the inclusion of these varieties on farms enhanced farmers' gross income. Thus the area under these varieties increased and Kalanamak decreased. The area income relationship became negative for Kalanamak, while it was the reverse for Mahsuri (Singh H.N. *et al*. 2005) [4, 10]. In farmers' fields, productivity ranged between 1.2 to 1.7 t/ha. In the absence of any systematic breeding program and disorganized seed production (100% farmers use their own saved seed), the level of admixtures greatly increased, thus adversely affecting its quality. Little attempt has been made in the past to improve Kalanamak with respect to quality and/or yield. A forum such as the Indigenous Aromatic Rice Export Development & Promotion Foundation needs to be established. Today such a forum exists only for Basmati *viz*. the Basmati Export Development Foundation, which largely functions in cohesion with APEDA and inputs from traders. The role of farmers and scientists in such a foundation needs to be significantly increased.

The main objectives of the present study were, to evaluate Kalanamak rice line/varieties for yield and yield related traits and study the phenotypic and genotypic correlations among various yield related traits was on station and farmers fields.

Materials and Methods

The present study was carried out by Krishi Vigyan Kendra Basuli, Maharajganj, Achrya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya for two consecutive years from 2018-19 and 2019-20. The experiments laid out of two set 1st was on station and 2nd on farmers field of Maharajganj district with two block and two villages *viz*: block Siswa Bazar (Gopala & Keshvari), Meethura (Karuta & Parsauni). To evaluate the 7+2 Kalanamak rice line/varieties. The nursery was sown 3nd week of June every year. After 25 days, seedlings transplanted in the main field in Randomized Complete Block Design (RCBD) in three replications with a spacing of 20 x 15 cm. Recommended dose of fertilizer 60:40:40:15 kg N: P: K: and ZnSo4/ha Half of the dose of N and full dose of P: K and ZnSo4 were applied basal, while remaining N were top-dressed in 2 equal splits–at tillering and panicle initiation stage. To control weeds, nomini gold @ 0.25 litre/ha was applied after 25 days old transplanting. Crop was harvested at physiological maturity and grain yield was calculated at 14% grain moisture. Single plant observations were recorded on five plants selected at random per genotype per replication for characters *viz*., plant height cm, panicle per sqm, no. of spikelet's/panicle, SRF% grain yield kg/ha, grain type and insect/pest and disease. The data on grain yield of each plot were recorded separately by threshing the harvested rice genotypes. The data so obtain were subjected to statistical analysis after necessary transformation for final statistical analysis (Gomez and Gomez, 1983) [3]. Two season data on grain yield separately recorded the mean value.

The data on seed yield, cost of cultivation and gross and net monetary return were collected from technological demonstration plot. In addition to this, data on farmer practices were also collected from the equal area. The benefit cost (B:C) ratio was calculated based on gross return. The following formulae were used to calculate the parameters as suggested by (Das *et al*. 1998) [1]:

1. Increase in grain Yield = Grain yield from Kalanamak line/variety – Grain yield from check variety plot /Grain yield from Kalanamak line/variety X 100
2. Net Return = Gross Return – Cost of cultivation
3. Benefit/Cost Ratio = Gross Return/Cost of Cultivation X 100

Results and Discussion

Yield and attributing traits

On station

Highly significant varietal differences were observed for days to 50% flowering in the varieties tested (Table 1& 1a). The days to 50% flowering ranged from 111 days Pusa 1652-0759-2-29-1-2, Pusa 1652-10-11-2-2-2-3 and Bouna Kalanamak to 121 days for Kalanamak (Treditional) variety.

Farmers field

The days to 50% flowering ranged from 109 days Pusa 1652-0759-2-29-1-2 to 121 days for Kalanamak (Treditional) variety.

Significant varietal differences were observed for number of panicle per sqm in the varieties tested (Table 1). The reason of difference in number of effective tiller per sqm is the variation in the genetic makeup of the variety. Among the various yield components productive tillers are very important as the final yield is mainly a function of the number of panicles bearing tillers per unit area (Roy *et al*. 2014). In the result of this study, Pusa 1638-07-5-3 line produced the highest number of panicle of on station & farmers field (272/m2) & farmers field Pusa 1638-07-5-3 (274/m2) followed by Pusa 1652-10-11-2-1-1-1 of on station and farmers field (257m2 & 255m2). The lowest number of panicle per sqm (152 & 169) was recorded for Kalanamak (Treditional) which was significantly lower than 272 and 274. (Table 1 &1 a).

The rice varieties exhibited highly significant differences on grain yield as shown in Table 2 & 2 (a) and Figure 1. The genotypes of Pusa 1652-10-11-2-1-1-1 on station and farmers field grain yield of (3134 kg/ha & 3096 kg/ha), % increase over check Bouna Kalanamak on station and farmers field 18.4% & 19.39%, followed by Pusa 07-62-3-13 grain yield of on station and farmers field (3059 kg/ha & 3088 kg/ha), grain yield increase over check was on station and farmers field 15.21% and 18.78% have high yield stability presented in Figure 2.

Economics

Different line/variety of Kalanamak were considered in economic analysis of farmers field demonstrations. The inputs and outputs price of commodities prevailed during the farmers field, were taken for calculating cost of cultivation, net returns and B:C ratio. (Table 3 and Figure 3). The investment on production by adopting improved Kalanamak line/varieties with a value of Rs. 32192/ha. Cultivation of under improved Kalanamak line/varities Pusa 1652-10-11-2-1-1-1fetch higher net return of value Rs. 95,976/- compared to check variety Bouna Kalanamak to amount of Rs. 80,383/- ha, followed by Pusa 07-62-3-13 Rs. 95,480/-, Pusa 1638-07-130-2-67-1-1-1 Rs. 92,504/- and Pusa 1652-10-11-2-2-2-3 of Rs. 90,613/-. The B:C ratio of improved Kalanamak lines/varieties of Pusa

1652-10-11-2-1-1-1was 2.98, followed by Pusa 07-62-3-13 was 2.97 compared to check variety Bouna Kalanamak was 2.50. The results indicated significant differences among rice varieties for plant Height, number of panicle/m2 and grain yield. The highest grain yield was obtained from the Pusa 1652-10-11-2-1-1-1 and Pusa 07-62-3-13.

Table 1: Relationship between growth traits of kalanamak line/varieties (On station)

S. No.	Strains/Varieties	Days to 50% flowering			Days to days to maturity			Plant height cm			Panicle/m2			No. of spiklets/panicle		
		2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
1	Pusa 1652-0759-2-29-1-2	110	112	111	138	141	140	126	120	123	226	230	228	334	341	338
2	Pusa 1638-07-5-3	110	113	112	138	142	140	113	117	115	268	272	270	271	289	280
3	Pusa 1638-07-130-2-67-1-1-1	113	115	114	141	144	143	107	109	108	205	209	207	289	303	296
4	Pusa 1652-10-11-2-1-1-1	112	114	113	140	143	142	97	101	99	254	260	257	211	217	214
5	Pusa 1652-10-11-2-2-2-3	112	110	111	140	139	140	92	94	93	240	243	242	241	249	245
6	Pusa 07-62-3-13	114	116	115	142	145	144	100	103	102	247	256	252	213	219	216
7	Pusa 1638-07-62-2-10	112	114	113	140	143	142	97	93	95	254	241	248	289	292	291
8	Kalanamak (Treditional)	120	121	121	148	150	149	148	152	150	147	156	152	237	241	239
9	Bauna Kalanamak (Check)	110	112	111	138	141	140	105	107	106	186	192	189	115	126	121

Table 1(a): Relationship between growth traits of kalanamak line/varieties (Farmers field)

S. No.	Strains/Varieties	Days to 50% flowering						Plant height cm						Panicle /m2					
		F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
1	Pusa 1652-0759-2-29-1-2	108	113	109	106	111	109	130	135	120	119	126	126	236	230	222	227	224	228
2	Pusa 1638-07-5-3	112	111	109	106	111	110	109	103	111	120	116	112	271	273	267	275	284	274
3	Pusa 1638-07-130-2-67-1-1-1	114	116	115	113	116	115	103	107	109	111	105	107	203	207	211	204	201	205
4	Pusa 1652-10-11-2-1-1-1	111	113	115	109	110	112	103	105	107	101	103	104	260	251	256	260	249	255
5	Pusa 1652-10-11-2-2-2-3	113	114	118	112	115	114	95	97	101	93	92	96	239	234	241	249	243	241
6	Pusa 07-62-3-13	117	118	120	116	115	117	105	109	103	101	104	104	252	259	263	241	249	253
7	Pusa 1638-07-62-2-10	113	117	109	115	112	113	93	90	96	102	105	97	241	239	249	256	249	247
8	Kalanamak (Treditional)	121	123	119	121	122	121	156	149	143	156	159	153	149	163	171	179	183	169
9	Bauna Kalanamak (Check)	109	112	115	113	111	112	101	105	109	111	107	107	192	199	201	205	207	201

Table 2: Relationship between yields and disease of kalanamak line/varieties (On station)

S. No.	Strains/Varieties	SPF %			Grain yield kg/ha			% Increase over check bauna kalanamak	Grain Type	Disease		
		2018	2019	Mean	2018	2019	Mean			FS	BS	BLB
1	Pusa 1652-0759-2-29-1-2	85	90	88	2700	2950	2825	6.40	SS	3	0	0
2	Pusa 1638-07-5-3	95	97	96	2750	2860	2805	5.34	MB	2	0	0
3	Pusa 1638-07-130-2-67-1-1-1	90	92	91	2900	3010	2955	11.29	SS	3	2	2
4	Pusa 1652-10-11-2-1-1-1	90	93	92	3100	3167	3134	18.04	MB	5	2	2
5	Pusa 1652-10-11-2-2-2-3	90	94	92	2900	3011	2956	11.33	MS	2	0	0
6	Pusa 07-62-3-13	95	98	97	2950	3167	3059	15.21	MS	5	0	0
7	Pusa 1638-07-62-2-10	85	89	87	2700	2711	2706	1.92	SS	2	1	1
8	Kalanamak (Treditional)	90	93	92	2300	2410	2355	−11.29	SB	3	0	0
9	Bauna Kalanamak (Check)	95	95	95	2600	2710	2655	—	SS	2	0	1

Table 2(a): Relationship between yields and disease of kalanamak line/varieties (Farmers fields)

S. No.	Strains/Varieties	No. of Spiklets/panicle						SPF %						Grain yield kg/ha						% Increase over check
		F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	
1	Pusa 1652-0759-2-29-1-2	336	340	323	337	340	335	97	93	81	90	85	89	2800	2650	2763	2659	2783	2731	5.32
2	Pusa 1638-07-5-3	267	275	281	267	263	271	97	89	92	86	81	89	2810	2659	2550	2690	2750	2692	3.81
3	Pusa 1638-07-130-2-67-1-1-1	291	303	274	276	267	282	92	95	87	81	83	88	2950	3010	2860	2910	3190	2984	15.07
4	Pusa 1652-10-11-2-1-1-1	209	215	213	207	212	211	92	95	97	81	83	90	2910	3150	3060	3150	3210	3096	19.39
5	Pusa 1652-10-11-2-2-2-3	243	236	231	236	230	235	91	93	87	95	96	92	2950	2800	2967	2750	3150	2923	12.72
6	Pusa 07-62-3-13	209	213	211	215	220	214	97	98	91	93	95	95	3010	3150	3090	2960	3190	3080	18.78
7	Pusa 1638-07-62-2-10	279	287	295	281	274	283	86	87	91	85	84	87	2600	2750	2800	2500	2667	2663	2.69
8	Kalanamak (Treditional)	232	236	223	231	229	230	91	87	85	92	93	90	2410	2015	2290	2310	2440	2293	−11.56
9	Bauna Kalanamak (Check)	119	117	121	123	115	119	96	95	92	94	95	94	2700	2500	2400	2750	2615	2593	—

Table 3: Economics of different kalanamak rice line/varieties of farmers field

S. No.	Strains/Varieties	Cost of cash input	Sale price (Rs./q)	Grain yield (q/ha)	Total returns Rs. (ha	Incremental benefit: Cost ratio
1	Pusa 1652-0759-2-29-1-2	32192	3100	27.31	84661	2.63
2	Pusa 1638-07-5-3	32192	3100	26.92	83452	2.59
3	Pusa 1638-07-130-2-67-1-1-1	32192	3100	29.84	92504	2.87
4	Pusa 1652-10-11-2-1-1-1	32192	3100	30.96	95976	2.98
5	Pusa 1652-10-11-2-2-2-3	32192	3100	29.23	90613	2.81
6	Pusa 07-62-3-13	32192	3100	30.8	95480	2.97
7	Pusa 1638-07-62-2-10	32192	3100	26.63	82553	2.56
8	Kalanamak (Treditional)	32192	3100	22.93	71083	2.21
9	Bauna Kalanamak (Check)	32192	3100	25.93	80383	2.50

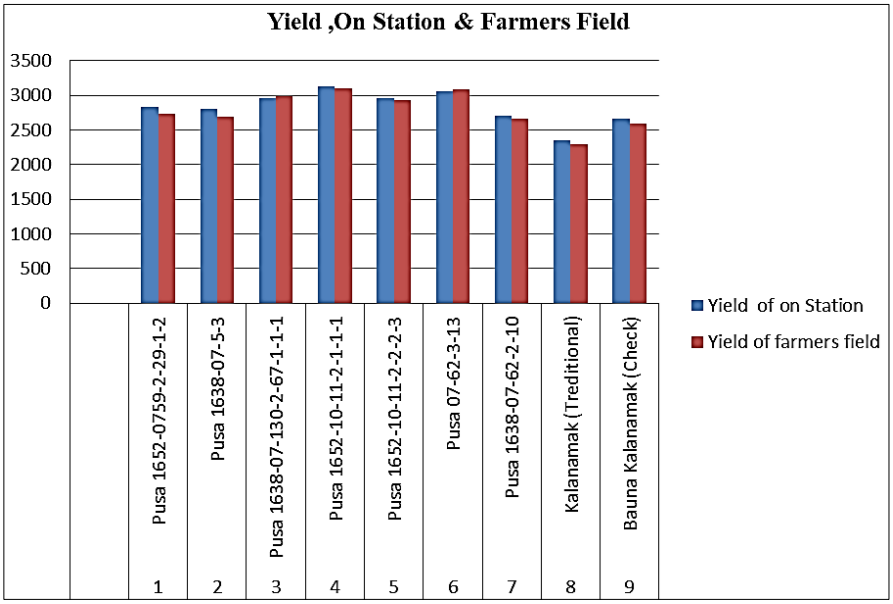

Fig 1: Grain yield of kalanamak rice line/varieties, on station and farmers field

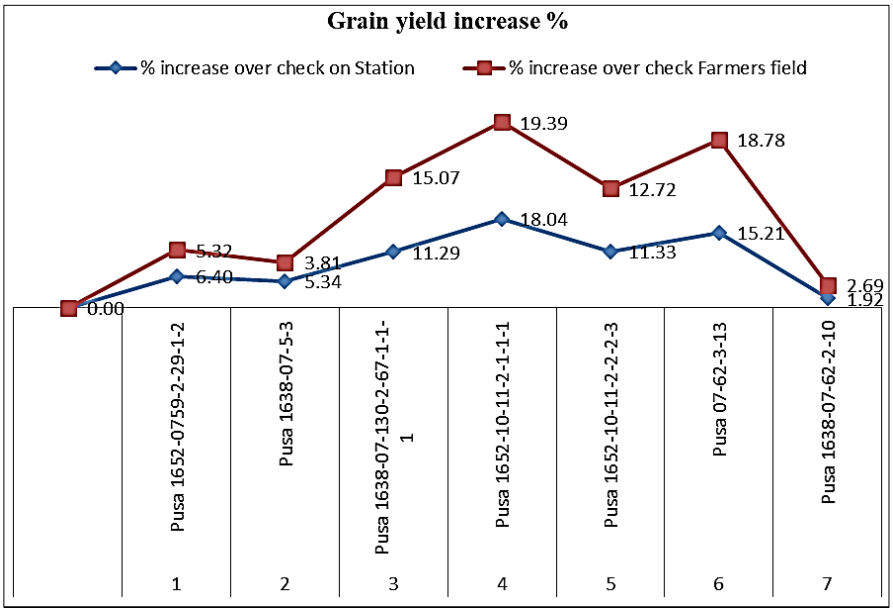

Fig 2: Grain yield increase over check

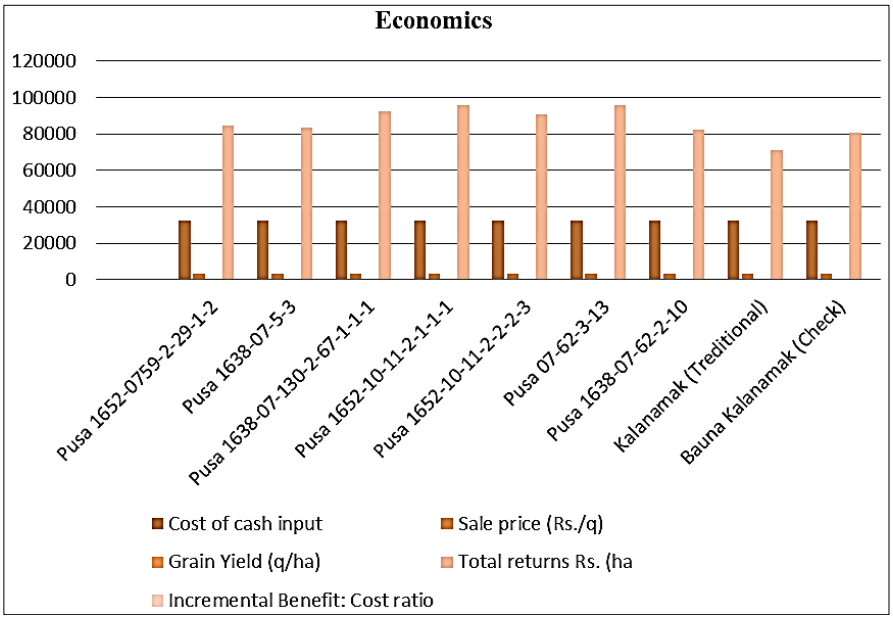

Fig 3: Economics of kalanamak rice line/varieties

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