

# Productivity and profitability of traditional scented rice (*Oryza sativa* L.) varieties under organic cultivation in north-west plains of India

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## Abstract

To study the performance of traditional scented rice varieties under organic cultivation, a field experiment was conducted at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand during *kharif* 2020 to evaluate ten traditional scented rice varieties namely Kubri Mamhani, Kudrat-5, Chinar-20, Kesho Pohnu, DRK, Kudrat-5, Pusa-1121, Type-3, Taraori and Tilak Chandan. The experiment was carried out using an organic farming method. The experiment with the randomised block design included three replications. Each hill was planted with two seedlings, spaced 25 cm apart by 12.5 cm. Sesbania green manure and 2.5 t vermicompost/ha were used as top dressing to rice crops. The highest number of panicles (273) and grain weight/m<sup>2</sup> (1.89) and yield (95.7q/ha) was recorded by Kudrat-5. Among different varieties, Tilak Chandan registered the highest panicle length (31.3 cm) and highest test weight was of variety Chinar-20 (26.8 g). The maximum number of grains/panicle (281) with filled grains (198) was registered in the variety Kudrat-1 while the maximum sterility was recorded in case of variety Tilak Chandan (43.4%). Variety Kudrat-5 recorded the maximum value of net return (1,19,654 ₹/ha) as well as B: C ratio (2.67). Hence, among ten traditional scented rice variety Kudrat-5 can be recommended to farmers.

**Key words:** Organic cultivation, Staple crops, Tillers, Transplanting, Yield

## 1. Introduction

The evolution of rice cultivation, highlighting the dominance of high-yielding varieties (HYV) post the Green Revolution, leading to the decline of traditional rice varieties due to the allure of increased yields (Eliazer Nelson *et al.*, 2019; Supriya *et al.*, 2023). About 30,000 different types of traditional rice, including coarse, fine, scented, and non-scented varieties, were grown in India prior to the HYV era (Ahuja *et al.*, 2008). Scented varieties, prized for their aroma, taste, affordability and resilience to climate change, faced reduced cultivation

due to the preference for hybrid varieties, causing a loss in genetic diversity. Intensive farming led to problems, shifting towards sustainable methods like organic farming. Farmers noticed declining fine aromatic rice quality due to environmental changes, suggesting organic farming's potential for restoration. The rising global demand for aromatic rice, coupled with consumers' willingness to pay a premium for organic alternatives, makes fine scented rice promising for organic cultivation (Supriya *et al.*, 2024). The main purpose of organic cultivation is



to establish and restore the ecosystem diversity, ensuring the sustainable development of agriculture (Kumar *et al.*, 2023; Ruan *et al.*, 2023), offering environmental and economic advantages over conventional farming. Keeping this in mind, a study evaluating ten traditional scented rice varieties to understand their yield attributes and economics in organic cultivation, with the objective to conserve these varieties while preserving their inherent qualities has been carried out.

## 2. Material and methods

A field trial was carried out during the *kharif* season of 2020 at the Norman E. Borlaug Crop Research Centre, situated within G. B. Pant University of Agriculture and Technology in Pantnagar, Uttarakhand. Ten treatments and three replications were used in the Randomized Block Design experiment. The net plot area was 5.75 m × 2.75 m (15.81 m<sup>2</sup>) while the gross plot size was 7.75 m × 3.75 m (29.06 m<sup>2</sup>). Kubir Mamhani, Kudrat-5, Chinar-20, Kesho Pohu, DRK, Kudrat-1, Pusa-1121, Type-3, Traori, and Tilak Chandan were the ten traditional fragrant rice types that were used in the treatment.

### 2.1 Yield attributes and yield

The 16 hills, used for counting of number of tillers were used for counting the number of effective tillers. The value had been multiplied by a factor to convert the values into per m<sup>2</sup> area. 10 panicles were selected for determination of panicle length (cm) and measured from the base of the first branch of rachis to the tip of the panicle. The same were threshed, filled and unfilled grains were separated and their number was counted. The average number of spikelets per panicle and the number of filled and unfilled grains/panicle were calculated by dividing the value by 10. Grain weight/panicle was calculated by taking the recorded grain weight and dividing it by the total number of panicles. Grain weight/panicle was calculated by taking the recorded grain weight and dividing it by the total number of panicles.

Total number of spikelets/m<sup>2</sup> = number of filled spikelets/m<sup>2</sup> + number of unfilled spikelets/m<sup>2</sup>.

Spikelet sterility percentage (%) was calculated by using following formula:

$$\text{Sterility percentage} = \frac{\text{Number of sterile spikelet/m}^2}{\text{Total number of spikelets/m}^2} \times 100$$

### 2.1 Economics

Gross return (₹/ha) was computed by converting the economic yield (grain and straw) into monetary term.

Net return (₹/ha) = Gross return (₹/ha) - Cost of cultivation (₹/ha)

### 2.2 Statistical analysis

HAU, Hisar, Haryana, designed OPSTAT for Randomized Block Design, which was used to evaluate the experimental data. To determine if there was a significant difference between the means of any two treatments, the crucial differences were computed at the five percent probability level (Gomez and Gomez, 1984).

## 3. Results and discussion

### 3.1 Yield attributing characters

The effective tillers refer to the tillers that bear a panicle with grains, also known as the number of panicles/m<sup>2</sup>. Significant variation was observed among all the varieties (Table 1). The highest number was recorded by Kudrat-5 (273), which was at par with varieties Kudrat-1 (259), Pusa 1121 (253), Type-3 (251), Kubri Mamhani (247) and DRK (245). The differences in the number of panicles per square meter could be attributed to the positive impact of organic matter, which facilitated the optimal release of nutrients and stimulated the growth of beneficial algae and bacteria. These microorganisms played a crucial role in supplying atmospheric nitrogen and enhancing the availability of phosphorus in the soil. Variations in spikes number/hill among rice varieties Badshahbhog, Vishnubhog, Dubraj, Tarunbhog and CG Sugandhit bhog (Gupta, 2017).

The panicle length also varied significantly due to varieties (Table 1). Tilak Chandan registered the highest panicle length (31.3 cm), which was at par with variety Type-3 (31.1 cm). Panicle length is influenced by genetic traits and density of planting of rice seedlings. Organic matter results in greater availability of nutrients and microbial stimulation which increases the sink capacity and ultimately resulted in panicle length variations of scented rice (Rina and Kalyan, 2014). Similar results for variations in panicle length was observed by Islam *et al.*, 2012 in five fine scented rice varieties viz. Rajshashi Swarna, Sikumul, Katribhog, Lal Pajam and Sanla. Varieties differed significantly for the grain weight/panicle (Table 1). It ranged from 1.16 g (Taraori) to 1.89 g (Kudrat-5). It was influenced by planting density. The grain size



Table 1: Yield attributes of traditional scented rice varieties under organic mode of cultivation

Variety	Number of panicles/m <sup>2</sup>	Panicle length (cm)	Grain weight / panicle (g)	1000 grain weight (g)	Grain number / panicle			Grain sterility (%)
					Total	Filled	Unfilled	
Kubri Mamhani	247	25.6	1.24	12.4	184	141	44	23.6
Kudrat-5	273	22.6	1.89	15.6	202	156	46	22.6
Chinar-20	207	22.5	1.52	26.8	165	122	42	25.8
Kesho Pohnu	217	29.5	1.54	23.4	156	96	60	38.4
DRK	245	22.7	1.29	11.4	159	102	57	35.9
Kudrat-1	259	24.4	1.48	13.6	281	198	84	29.7
Pusa 1121	253	26.8	1.55	25.4	77	48	31	39.4
Type-3	251	30.1	1.22	19.9	148	110	38	25.7
Taraori	235	28.6	1.17	21.1	101	79	22	21.5
Tilak Chandan	229	31.3	1.47	20.7	137	78	59	43.4
SEm±	11.30	0.50	0.05	0.20	1.10	2.30	1.40	0.40
CD at 5%	34.00	1.60	0.15	0.70	3.00	7.00	4.00	1.10
C.V.	8.10	3.50	6.15	2.21	1.21	3.58	5.00	2.08

is the indicator for grain weight, primarily determined by its inherent genetic characteristics (Lee *et al.*, 2015). Test weight (1000-grain weight) of different scented rice varieties ranged from 11.4 g (DRK) to 26.8 g (Chinar-20) and varied significantly (Table 1). Neetam and Neetam (2019) also reported similar variations of 1000-grain weight among different scented rice varieties. Significant variation observed, ranging from 77 (Pusa 1121) to 281 (Kudrat-1) in the total number of grains per panicle. The two factors i.e., genetic and environment are interconnected and exert mutual influence on each other. The presence of organic matter, coupled with the application of green manure (*Sesbania*), created favorable environmental conditions for the rice plants. These combinations provided the necessary nutrients required by the rice, further enhancing their growth and development (Setiawati *et al.*, 2020). The results were also supported by (Yadav and Meena, 2014). Kudrat-1 exhibited a significantly higher count of filled grains per panicle (198). The number of filled grains per panicle was influenced by the accumulation of dry matter and the efficient distribution of photosynthate (Setiawati *et al.*, 2020). Also, variations in the number of filled grains was observed by (Patel 2012). The presence of chaffiness in grains is an undesirable trait when aiming for higher grain yield. Number of unfilled grains per panicle ranged

from 22 (Taraori) to 84 (Kudrat-4). Less the photosynthate translocate, more the unfilled grains per panicle. There was a significant variation observed in the sterility percentage, ranging from 22.6% (Kudrat-5) to 43.4% (Tilak Chandan). Neetam and Neetam (2019) also stated that the application of green manure contributes in low sterility of two scented rice varieties Badshahbhog and Dubraj.

### 3.2 Yield

Grain yield, straw yield, biological yield and harvest index of all the varieties varied significantly (Table 2). Kudrat-5, among scented rice varieties, achieved the highest yield at 42.46 q/ha. This was attributed to its top effective tiller count (273) and grain weight/panicle (1.89 g). Additionally, its significant number of filled grains per panicle (156) and 1000-weight (15.6 g) contributed to the yield. The use of organic vermicompost and FYM resulted in 23-24% yield increase (Davari and Sharma, 2010). Green manure and vermicomposting enhanced plant metabolic and auxin activities. The presence of Humic acid in vermicompost improved the accessibility of native and supplementary nutrients in the soil, leading to increased rice crop productivity Yadav and Meena (2014). Highest straw yield was noted for the variety Kudrat-5 (53.3 q/ha). In the current



research, rice varieties exhibiting elevated effective tillers generated increased straw yield despite their shorter height. There was notable variation in biological yield, with Kudrat-5 demonstrating the significantly highest biomass production at 95.7 q/ha. The findings suggest that varieties with reduced height but high tillering contributed to greater overall biomass (Davari and

Sharma, 2010). The harvest index significantly varied among each variety, and the grain yield and straw yield values showed a strong correlation with the observed variances. Chinar-20 (48%) having the highest harvest index. Varieties with high grain and straw yield attained the highest harvest index (Bahuguna *et al.*, 2023, Supriya *et al.*, 2024).

Table 2: Yield and economics of different scented rice varieties

Variety	Yield (q/ha)			Harvest Index (%)	Cost of cultivation (₹/ha)	Return (₹/ha)		B: C ratio
	Grain	Straw	Biological			Gross	Net	
Kubri Mamhani	27.89	45.56	73.45	37.95	44850	109144	64269	1.43
Kudrat-5	42.46	53.27	95.72	44.09	44850	164529	119654	2.67
Chinar-20	26.53	29.14	55.66	47.57	44850	102399	57524	1.28
Kesho Pohu	29.04	34.07	63.11	45.95	44850	112297	67422	1.50
DRK	28.68	33.66	62.34	46.06	44850	110907	66032	1.47
Kudrat-1	37.54	46.49	84.03	44.64	44850	145422	100547	2.24
Pusa 1121	34.98	41.70	76.67	45.63	44850	135327	90452	2.02
Type-3	26.82	37.56	64.38	41.77	44850	104338	59463	1.33
Taraori	25.17	42.94	68.10	37.00	44850	98676	53801	1.20
Tilak Chandan	29.01	34.53	63.55	45.67	44850	112259	67384	1.50
SEm±	1.03	1.43	2.28	0.01	-	3962	3962	0.09
CD at 5%	3.08	4.27	6.84	0.02	-	11862	11862	0.27
C.V.	5.780	6.19	5.59	2.11	-	5.74	9.11	9.28

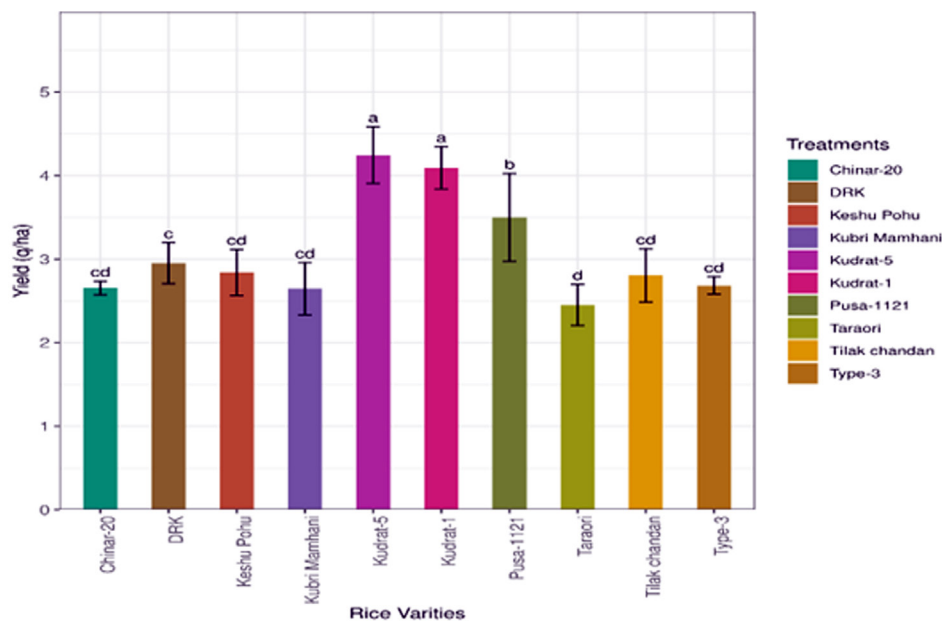


Fig 1: Grain Yield (q/ha), Straw Yield (q/ha) and Biological Yield (q/ha) and Harvest index (%) of different scented rice varieties



### 3.3 Economics

Data pertaining to economics are given in Table 2. The cost of cultivation for scented rice varieties was worked out to be 44,875 ₹/ha. It includes the nursery raising cost of 3,331 ₹/ha and *Sesbania* green manuring cost 1000 ₹. The gross return, net return and B: C ratio differed significantly among different rice varieties. Variety Kudrat-5 recorded the maximum value of gross return (1,64,529 ₹/ha), which

was found significantly higher than other varieties. Gross return is the outcome of grain and straw yield. In the present study, varieties namely Kudrat-5, Kudrat-1 and Pusa 1121 had higher values of grain yield and reasonable values of straw yield, in turn, recorded higher values of gross return. Kudrat-5 recorded the maximum value of net return (1,1,9654 ₹/ha). Since, net return is the amount of money provided by a variety after deducting the cost of cultivation from its respective gross return. In present study, the cost



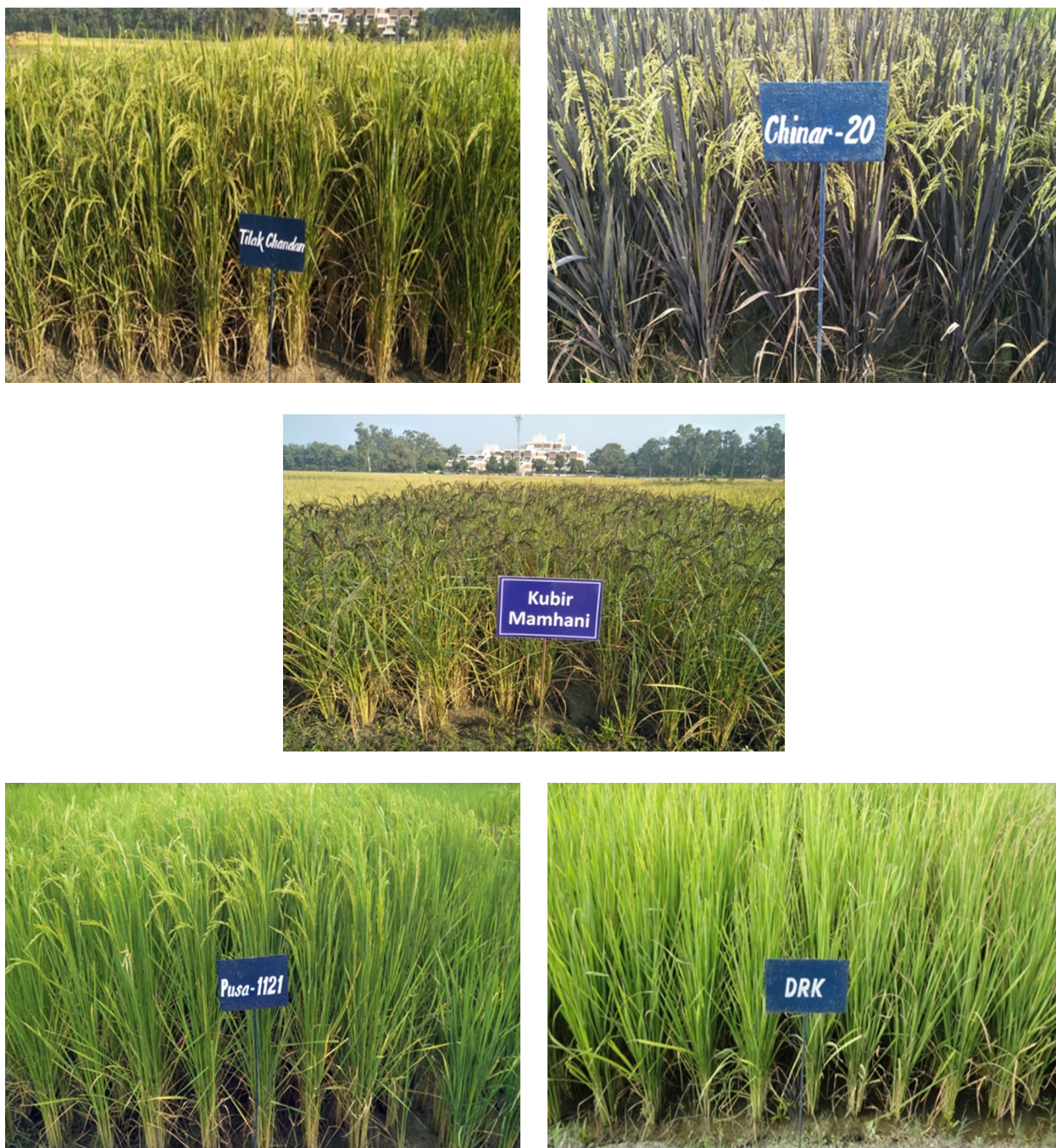


Fig 4.11: Different traditional rice varieties under organic farming (2020)

of cultivation is constant; therefore, varieties which gave higher gross return also gave higher values of net return. The maximum and significantly higher B: C ratio (2.67) was observed for variety Kudrat-5. Davari and Sharma, (2010) also reported that application of FYM or vermicompost increase 14-18% in net profit. Therefore, the varieties which provided higher net return also recorded higher values of B: C ratio (Kumar *et al.*, 2019).

### Conclusion

Based on the findings of the present experiment, it was concluded that out of ten different traditional scented rice varieties under organic cultivation, considering in terms of panicle/m<sup>2</sup>, grain weight/panicle, yield, quality, net return and B: C ratio, Kudrat-5 has outperformed and which can be considered for organic cultivation for use in the immediate future in the north-west plains of India.



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## Authors Contributions

All authors contributed equally for preparing the final version of the manuscript.

## Conflict of Interests

Authors declares no conflict of interests

## Ethical Approval

The article doesn't contain any study involving ethical approval.

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