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Agronomic performances of indigenous aromatic rice cultivars under organic management practices during wet season

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Abstract
Indigenous aromatic small grain rice holds a significant position in local, national, and international markets due to their outstanding quality traits. The field experiment was conducted under the All India Co-ordinated Research Project on Integrated Farming System under Bidhan Chandra Krishi Viswavidyalaya at Gayeshpur, Nadia, and West Bengal during *kharif* season of 2022. The field experiment was conducted to explore the yield performances of indigenous aromatic rice cultivars under organic management for yield sustainability. Organic farming protocol was adopted in this experiment utilizing bio resources like cow urine and dung for seed treatment, organic manures like mustard oil cake and vermicompost, and biological pest control methods. In this experiment, seven different indigenous aromatic rice cultivars *viz*. Gobindabhog, Radhatilak, Radhunipagal, Kalojira, Harinakhuri, Lal Badshabhog and Dudheswar (local check) were tested. Among the cultivars, Kalojira performed significantly well with a grain yield of 2800 kg ha^{-1}which was 29.21% high as compared to local check Dudheswar (2017 kg ha^{-1}) under organic management in the new alluvial zone of West Bengal during wet season. Kalojira demonstrated comparable growth, yield attributes and yields when compared to the other five indigenous aromatic rice varieties studied. Furthermore, Kalojira also registered high net return amounting to Rs.62859/ha and had a favourable benefit-cost ratio (B:C ratio) of 2.22, outperforming the other varieties tested in this investigation.

Keywords: Aromatic rice cultivars, organic cultivation, crop growth, yield attributes, grain yield and B:C ratio

Introduction
The demand for organic food is consistently rising in developed and developing countries, experiencing an average annual growth rate of 20-25% (Ramesh *et al.*, 2005) [9]. Organic rice cultivation is becoming a trend recently and it will be developed in the future as the awareness of healthy food needs and environmental sustainability. Major aromatic rice-producing and exporting countries in the global market are India (basmati types), Pakistan (basmati types), and Thailand (jasmine types) (Sharma *et al.*, 2021) [11]. The majority of these rice cultivars are highly specific to particular regions, which means that each state in India has its own unique scented rice varieties. The Indian subcontinent is fortunate to have various aromatic rice varieties bestowed by nature, including the exceptional long-slender-grain Basmati rice known for its superior quality and delightful scent.

Indigenous scented rice varieties hold a significant position in local, national, and international markets due to their outstanding qualities (Banerjee *et al*., 2013) [1]. However, their cultivation area remains relatively low, accounting for less than 20% of the total rice cultivation in India. Nevertheless, these varieties are highly favoured by consumers due to their enticing aroma, grain size, cooking characteristics, and delicious taste (Bora *et al.*, 2014, Yadav and Meena, 2014) [2, 13]. The states of West Bengal, Orissa, Chhattisgarh, Bihar, and the North Eastern region of India have a high diversity of short, fine-grained, and highly scented rice varieties. West Bengal, blessed with diverse agro-climatic regions, has emerged as a geographically diverse hub for rice cultivation, including scented varieties (Figure 1). The unique cooking qualities and delightful aroma of many of these traditional rice varieties make them an appealing and cost-effective

alternative to the expensive Basmati rice (Mondal *et al.*, 2021) [5]. Indigenous landraces of aromatic rice in India have been on the verge of extinction with the introduction of miracle seeds of hybrid and high-yielding varieties and chemical-intensive farming against the backdrop of the green revolution (Ram *et al.*, 2011) [8]. The erosion of such vast genetic diversity, including aromatic rice, raises concerns among the farming community, environmentalists, scientists, policymakers, and rice enthusiasts. To safeguard these invaluable heirloom varieties, strategic research and promotional efforts must be streamlined to prevent further erosion. Geographical Indication (GI) is a vital instrument for the promotion of non-Basmati landraces like Gobindabhog, Tulaipanji, Badshabhog, Dudheswar, Seetabhog, Radhatilak, Radhunipagal, Kalonunia, Kalojira, Tulsimukul, among others. Till date only Gobindabhog, Kalonunia and Radhunipagal have got GI tag. These rice varieties enjoy high acceptance by retailers and consumers in both domestic and international markets so making the promotion of farmers' producer organizations in this field a much-needed initiative. In 2015, the Department of Agriculture of West Bengal, India introduced a pioneering scheme under the production and growth of *Rashtriya Krishi Vikas Yojana* (RKVY) XIIth Plan in India. The scheme, titled "Folk rice-collection, conservation, multiplication through distribution, and on-farm trial for popularization among the farming community of West Bengal," is the first initiative of its kind in India. The main purpose of organic cultivation is to establish and restore the ecosystem diversity, ensuring the sustainable development of agriculture (Supriya *et al.*, 2023; Ruan *et al.*, 2023) [12, 10], offering environmental and economic advantages over conventional farming.

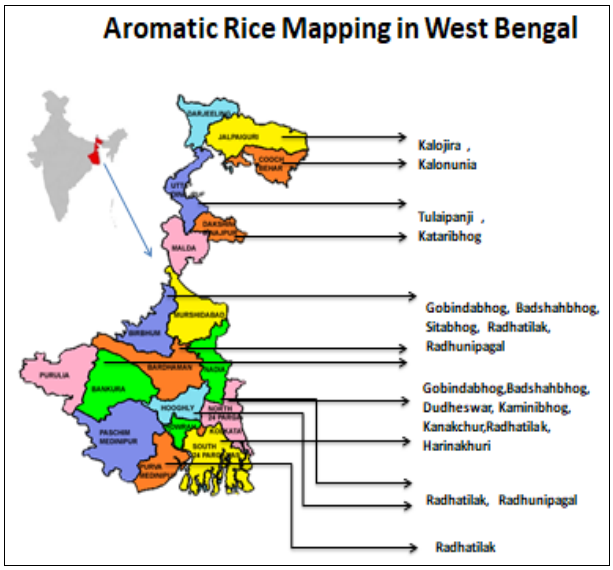

Fig 1: Geographical distribution of aromatic rice cultivars grown in West Bengal, India

In this study, we conducted a field experiment at University Research Farm and planted indigenous aromatic rice cultivars of diverse geographical locations using organic cultivation. The growth, yield attributes and production performance were investigated. In this paper, efforts have also been made to establish correlation between yield and its growth and yield attributes by organic cultivation without any synthetic fertilizers and pesticides which in turn would lead the superior quality produce. Our results would provide to restore aromatic indigenous rice biodiversity by organic cultivation and promotion of eco-friendly sustainable quality rice production for quality human health.

Materials and Methods

The field experiment was conducted under the All India Co-ordinated Research Project on Integrated Farming System under Bidhan Chandra Krishi Viswavidyalaya (State Agriculture University), at Gayeshpur, Nadia, and West Bengal during *kharif* season of 2022. The experimental site represents a subtropical humid climate and medium land topography of New Alluvial Zone of West Bengal, India. The research station is situated at $22^{0}58$'N latitude and $88^{0}29$'E longitude and the elevation of 9.75 m above the mean sea level (MSL). In this experiment, seven different indigenous aromatic rice cultivars *viz*. Gobindabhog, Radhatilak, Radhunipagal, Kalojira, Harinakhuri, Lal Badshabhog and Dudheswar (local check) were selected from the Rashtria Krishi Vikas Yojona (RKVY) Project on 'Bengal Aromatic Rice', Department of Agronomy Bidhan Chandra Krishi Viswavidyalaya, a State Agricultural University. All these landraces were selected based on their diverse agro-morphological characters and collection site or geographical locations of West Bengal, India (Figure 1). Organic rice cultivation technology was adopted in this experiment. Seeds were soaked in water for 12 hours. The soaked seeds were further soaked in cow dung extract made with 1 kg of fresh cow dung 4 litres of cow urine and diluted in 10 litres of water for 6 hours. The treated seeds were dried in shade before sowing in the nursery. Different organic sources of nutrients were used in the study. Their doses and time of application varied according to their nature and nutrient content. The recommended dose of fertilizer was 50:25:25 kg ha^{-1} (NPK) where 50% of the RDN was substituted by Vermicompost @ 1.8 t ha^{-1} applied as basal and rest 50% of RDN was applied through Mustard oil cake @ 0.5 t ha^{-1} in two top dressings at 60 DAT and 75 DAT respectively. For controlling the weeds one hand weeding was done before first top dressing and other before second top dressing. One litre of cow urine (stored for seven days) diluted in 10 litres of water and sprayed twice at tillering and pre flowering stage. Biological pest control measures by using neem leaf (*Azadirechta indica*), tobacco leaf (*Nicotiana tabacum*) and garlic extract (*Allium sativum*) for plant protection against pest and diseases of aromatic rice. Organic cultivation of these aromatic rice cultivars for this experiment was made without synthetic fertilizers, pesticides and growth regulators. The topography of land is medium land and the soil was sandy clay loam in texture belonging to the order Inceptisols of India and having pH value ranging from 6.9-7.1. Soil of this area is mostly fertile, deep and almost neutral in reaction developed from recent alluvial flood soils of the river Ganges. The experimental design followed was Randomized Block Design (RBD) having three replications with each plot of dimension 5m X 4m. The main irrigation channel was of 1.0m width. The plant to plant spacing as well as the row to row spacing was maintained at 20cm. The experimental site is situated in the New Alluvial Zone of West Bengal, which also experiences a subtropical and sub-humid environment. The average annual rainfall received in this area is between 1560 mm, which is essential for crop growth. During summer, the temperature in this place ranges from 26 °C to 38 °C while in winter the temperature ranges from 8°C to 26 °C.

Table 1: Meteorological data of the experimental station during crop season 2022.

Stand. week	Dates	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)		BSS (hour)
		Max.	Min.		RH-I	RH-II	
23-26	Jun 4-Jul 1	34.10	26.30	420.0	89.60	69.40	5.10
27-30	Jul 2-Jul 29	33.45	26.11	260.3	93.75	73.79	5.64
31-34	Jul 30-Aug 26	32.73	26.01	410.3	94.11	75.75	4.20
35-39	Aug 27-Sep 30	33.34	25.06	185.8	93.66	79.45	5.17
40-44	Oct 1-Nov 4	31.91	22.57	117.6	92.14	63.97	7.16
45-48	Nov5-Dec 2	29.50	15.56	0.00	83.25	48.50	8.33

Rainfall received during the crop-growing period June to October of 2022 was 1394 mm where the maximum rainfall was 420 mm received in June followed by August 410 mm, which were crucial for rice crop establishment and growth. Throughout growing period rice experimentation, the maximum relative humidity was consistently high ranging from 89.60 to 94.11% and the lowest minimum relative humidity ranged from 69.40 to 79.45%. During the cropping season, the number of bright sunlight hours ranged between 4.20 and 7.60 (Table 1). Agronomic traits like plant height (cm), dry matter production (g m^{-2}), crop growth rate (CGR, g m^{-2}) at different growth stages were recorded. The yield components were calculated for each landraces likely grain yield (kg ha^{-1}), number of panicles (no. m^{-2}) at harvest, and thousand grain weight (g) and grain weight was expressed on a 14% moisture basis.

The collected data were analyzed using the statistical technique of analysis of variance, specifically the RBD design method, as outlined by Gomez and Gomez (1984) [3]. The analysis was conducted in MS excel. The significance of various sources of variation was assessed through Fisher and Snedecor's F test, considering the appropriate degrees of freedom. In order to determine the significance of the 'F' statistics and calculate the critical difference (C.D.) at a 5% level of significance, we referred to the Fisher and Yates Table.

Results and Discussion

Crop growth

The crop growth in terms of plant height, leaf area index, tillering and dry matter production of indigenous aromatic rice varieties cultivated using organic sources of nutrients exhibited significant variations (Table 1 and Figure 1). Out of the seven varieties studied, 'Kalojira' consistently displayed the tallest plants, more tiller production, high leaf area development among the aromatic rice varieties grown under organic management at different dates after transplanting. Tiller numbers m^{-2}increased with the advancement of growth stages, irrespective of all the varieties, and attained their maximum at 105 DAT. Tillers were less in number at 45 DAT and ranged from 200.7 to 258.0 with a variation of 28.55%; 216.7 to 291.7 with a variation of 34.61% at 75 DAT. 'Kalojira' recorded the highest number of tillers at 105 DAT (310.0) but remained significantly at par with 'Lal Badshabhog', 'Radhunipagal' and 'Gobindabhog'. 'Radhatilak' recorded the lowest plant height at all the growth stages. The growth and development with regard to leaf area index (LAI) of the seven native varieties cultivated using organic methods showed significant variations at different stages of growth. Initially, at 45 DAT, there were no significant differences in LAI among the varieties. However, significant variations were observed at later growth stages, specifically at 75 and 105 DAT. At 75 DAT, the LAI ranged from 2.5 to 4.1, while at 105 DAT, it varied from 3.3 to 5.1. 'Kalojira' consistently exhibited the highest LAI at both 75 and 105 DAT. The dry matter accumulation in aerial parts (g m^{-2}) of seven indigenous rice cultivars grown during the wet season with organic management practices was found to be significant (Figure 2).

Table 2: Growth parameters of aromatic rice under organic management in the new alluvial zone during *kharif* season of 2022

Variety	Plant height (cm)		Tiller productions (no. m^{-2})		Leaf area index	
	105 DAT	Harvest	75 DAT	105 DAT	75 DAT	105 DAT
Gobindabhog	97.22	123.8	275.0	291.7	3.9	3.8
Radhatilak	95.67	139.9	216.7	233.3	2.5	3.3
Radhunipagal	101.89	141.7	266.7	283.3	3.6	3.8
Kalojira	109.56	146.2	291.7	310.0	4.1	5.1
Harinakhuri	89.44	115.9	258.3	275.0	3.8	3.8
LalBadshabhog	101.44	136.7	283.3	308.3	3.9	4.9
Dudheswar	95.89	123.3	225.0	250.0	3.3	3.3
S.Em (±)	3.05	3.9	13.61	14.03	0.25	0.26
C. D (p=0.05)	9.40	12.1	41.93	43.23	0.76	0.79

DAT-days after transplanting

The crop growth analysis in terms of crop growth rate (CGR) and net assimilation rate (NAR) showed an increasing trend from 75 to 105 DAT. The increasing height of plants because of crop elongation and the production of tillers over the growth stages might have contributed to a gradual increase in DM accumulation in all the cultivars. DM of different cultivars ranged from 100.0 (g m^{-2}) to 115.8 (g m^{-2}) with 15.80% variation at 45 DAT, 200.8 to 271.5 (g m^{-2}) with 35.20% variation at 75 DAT, and 407.7 (g m^{-2}) to 603.9 (g/m^2) with 48.12% variation. One of the important physiological traits of the plant is crop growth rate (CGR). The data on crop growth rate have been presented in Figure 2. Crop growth rates were taken at three different growth stages i.e., at 30-45, 45-75 and 75-105 DAT. Growth rate increased linearly in all the varieties. Among the seven varieties 'Kalojira' recorded the highest crop growth rate between 30-45, 45-75 and 75-105 DAT i.e. 1.6, 4.0 and 11.1 (g $m^{-2}day^{-1}$) respectively as compared to other varieties, however, no significant variation in growth rate was observed between the cultivars at 45-75 DAT. 'Dudheswar' recorded the lowest CGR at all growth stages. The variation in CGR values at different stages were to the tune of 66.66 and 66.23% at 45-75, 75-105 DAT respectively.

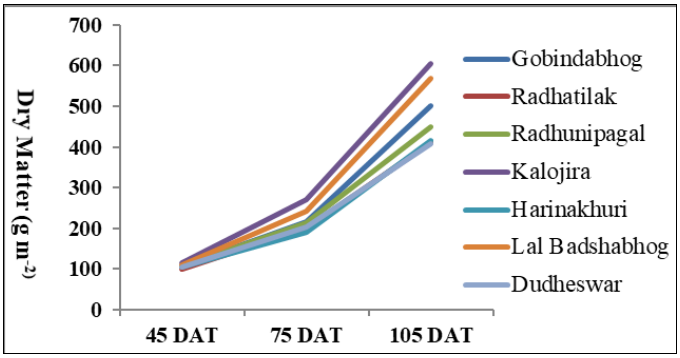

Fig 2: Dry matter production of indigenous aromatic rice cultivars under organic management

Table 3: Crop growth analysis of aromatic rice cultivars under organic management during *kharif* season

Variety	CGR (g $m^{-2}day^{-1}$)		NAR ((g $m^{-2}day^{-1}$)	
	45-75 DAT	75-105 DAT	45-75 DAT	75-105 DAT
Gobindabhog	4.1	9.4	1.7	2.5
Radhatilak	2.8	7.0	1.6	2.4
Radhunipagal	2.8	7.9	1.2	2.2
Kalojira	4.0	11.1	1.6	2.4
Harinakhuri	2.5	7.5	1.1	2.0
LalBadshabhog	3.3	10.9	1.2	2.5
Dudheswar	2.4	6.8	1.2	2.1
S.Em (±)	0.48	0.55	0.26	0.16
C. D (*p*=0.05)	1.46	1.69	NS	NS

DAT- days after transplanting, CGR: Crop growth rate; NAR-net assimilation rate

Yield components

The panicle length data presented in Table 3 demonstrated significant variations among the rice genotypes. The panicle length ranged from 21.5 to 30.4 cm, with a variation of 41.39%. The variety 'Kalojira' exhibited the longest panicle length at 30.4cm, followed by 'Lal Badshabhog' at 30.3cm and 'Radhunipagal' at 26.7 cm. On the other hand, 'Dudheswar' had the shortest panicle length at 21.5cm. The single panicle weight (g) of seven indigenous rice varieties grown under organic management varied significantly. The panicle weight of different rice varieties ranged from 2.0 g to 2.8 g among the varieties. The variety 'Kalojira' recorded the highest panicle weight, i.e., 2.8 g, followed by 'Lal Badshabhog' and 'Gobindabhog', i.e., 2.6 g and 2.4 g, respectively; however, it remained on par with 'Lal Badshabhog'. The lowest panicle weight was found in 'Dudheswar' and 'Radhatilak'. A perusal of productive tillers revealed that the number of panicles per m^2 varied from 198 to 278 among the rice varieties. The highest number of panicles per m^2 was recorded in 'Kalojira' (278). The varieties 'Lal Badshabhog' and 'Gobindabhog' were on par with 'Radhunipagal. The lowest number of panicles per m^2 was recorded by 'Dudheswar' (200). The number of filled grains per panicle ranged from 189 to 234 (Table 4) among the varieties. The highest number of filled grains per panicle was recorded by 'Kalojira' (234). The varieties 'Lal Badshabhog' and 'Gobindabhog' were on par with 'Kalojira' (234).The lowest number of filled grains (189) per panicle $^{-1}$was recorded by 'Harinakhuri'. It was found from the data presented in Table 4 that grain filling, in terms of percentage of chaffy grains, varied significantly among seven indigenous rice varieties grown under organic management. The chaff percentage of rice cultivars ranged from 2.9 to 15.8%. Variety 'Dudheswar' showed the highest percentage of chaffs, while variety 'Kalojira' showed the lowest percentage of chaffs, i.e., 15.8% and 2.9%, respectively. Other than 'Radhunipagal' and 'Kalojira', they were statistically at par. Variety 'Kalojira' showed the lowest percentage of chaffy grains and thus produced the highest grains per panicle, which might be due to the effects of organic nutrition, better translocation of photosynthates and genetic traits of the variety. The test weight, which is a crucial yield parameter for any crop, exhibited significant variations Table 4 ranging from 10.0 to 14.40 g among the rice varieties. 'Dudheswar' displayed the highest test weight, while 'Gobindabhog' had the lowest test weight at 14.4 and 10.03 g, respectively. Generally, test weight is considered a genetic trait influenced by external factors.

Table 4: Yield attributes of aromatic rice varieties under organic management in new alluvial soils during *kharif* season

Variety	Panicle length (cm)	Panicle weight (g)	Paniclesm^{-2}	Filled grains/ panicle	Chaffs (%)	Test weight (g)
Gobindabhog	25.9	2.4	215	221	8.9	10.03
Radhatilak	24.4	2.0	202	201	13.9	10.83
Radhunipagal	26.7	2.2	243	213	7.1	10.17
Kalojira	30.4	2.8	278	234	2.9	12.67
Harinakhuri	25.8	2.1	198	189	14.1	12.07
LalBadshabhog	30.3	2.6	237	223	11.4	10.27
Dudheswar	21.5	2.0	200	207	15.8	14.40
S.Em (±)	0.91	0.12	11.12	5.97	3.20	0.05
C.D (*p*=0.05)	1.98	0.38	34.25	18.39	6.98	0.11

Yield performances

The grain yield, which is an indicator of land productivity, was significantly influenced by indigenous rice cultivars in the new alluvial zone of the lower Indo-Gangetic plains of West Bengal (Table 4). There were notable variations among the aromatic rice cultivars, amounting to 38.82%. Among the tested varieties, 'Kalojira' demonstrated the highest grain yield of 2800 kg ha^{-1}, surpassing all other varieties. The next highest yielding varieties after Kalojira were Lal Badshabhog with a yield of 2367 kg ha^{-1} and 'Gobindabhog' with a yield of 2333 kg ha^{-1}, without any significant difference in yield between these two varieties. 'Radhatilak' exhibited the lowest grain yield of 2017 kg ha^{-1}owing to its lower panicle number, panicle weight, and chaff percentage. Kalojira achieved 18.29% and 20% higher grain yields compared to the two popular indigenous aromatic rice varieties of West Bengal, LalBadshabhog and Gobindabhog, respectively. Paul *et al.* (2021) reported similar results.

'Kalojira' exhibited the highest straw yield of 6500 kg ha^{-1}, followed by 'Lal Badshabhog' with a yield of 6433 kg/ha. Conversely, 'Radhatilak' displayed the lowest straw yield of 5567 kg ha^{-1}, primarily due to its poor vegetative growth. The findings of Sahu *et al.* (2017) were consistent with the results mentioned earlier. Among the varieties, 'Kalojira' demonstrated the highest biomass yield of 9300 kg ha^{-1}, followed by 'Lal

Badshabhog' with a yield of 8800 kg ha^{-1}. On the other hand, 'Radhatilak' displayed the lowest biomass yield of 7617 kg ha^{-1} primarily due to its poor vegetative growth.

The harvest index serves as an indicator of the source-to-sink relationship, reflecting a variety's ability to efficiently allocate photosynthetes to its economically important parts. The data presented in the Table 4 indicated that all of the varieties had statistically similar harvest indexes. The superior harvest index in Kalojira can be attributed to a higher percentage of grain filling and greater grain weight per plant compared to other rice genotypes. On the other hand, both Radhatilak and Radhunipagal displayed the lowest harvest index of 26.5%. The findings of Patra *et al.* (2022) [7] align with the results mentioned earlier regarding the harvest index.

Table 5: Yield performances of aromatic rice under organic management in new alluvial soils during *kharif* season

Variety	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biomass yield (kg ha^{-1})	Harvest index (%)
Gobindabhog	2333	6233	8567	27.2
Radhatilak	2017	5567	7617	26.5
Radhunipagal	2167	6000	8167	26.5
Kalojira	2800	6500	9300	30.2
Harinakhuri	2117	5717	7833	27.0
LalBadshabhog	2367	6433	8800	26.9
Dudheswar	2100	5800	7900	26.6
S.Em (±)		167.77	162.45	0.99
C. D (p=0.05)	256.29	516.96	500.55	NS

Correlations between grain yield with growth and yield attributes

Pearson's correlation analysis on the association of grain yields of aromatic rice cultivars with growth indices, yield attributes are presented in Table 5. The association of grain yields in terms of correlation coefficients showed high level of statistical significance at p<0.01with growth indices like DM at harvest(r=0.925), yield attributes like panicle weight (r=0.947) and statistical significance at p<0.05 with tillers per hill (r=0.816), Mean LAI (r=0.740), panicle length (r=0.767). This superior performance over the growth period was attributed to the slow and steady supply of nutrients throughout growth period (Manjunath *et al.*, 2009, Laila *et al*., 2022) [, 4].

Table 6: Association of grain yields of aromatic rice varieties with straw yield, biomass, harvest index, yield attributes and growth parameters

Parameters	Correlation (r-value)	Level of significance
Panicle weight	0.947**	+ ve at 1%
Paniclesm^{-2}	0.871**	+ ve at 1%
Filled grains/panicle	0.850**	+ ve at 1%
DM at harvest (g/m2)	0.925**	+ ve at 1%
Tillers/hill	0.816*	+ ve at 5%
Mean LAI	0.740*	+ ve at 5%
Panicle length	0.767*	+ ve at 5%
Straw yield	0.637	+ ve
Biomass yield	0.687	+ ve
Harvest index	0.505	+ ve
Plant height	0.463	+ ve
Test weight	0.052	+ ve
Chaffs (%)	-0.827	- ve

Significance at 5% level: 0.707; at 1% level: 0.834

Production economics

The cost of cultivation of indigenous rice cultivars using organic management practices in the alluvial soil of the lower Indo-Gangetic plains of West Bengal was Rs. 51391 per hectare. The gross returns ranged from Rs. 84,583 to Rs.1,14,250 per hectare, while the net returns varied from Rs. 33,192 to Rs. 62,859 per hectare. Among the varieties, Kalojira achieved the highest benefit-cost (B:C) ratio of 2.22 followed by Lal Badshabhog with a B:C ratio of 1.92. Therefore, based on the economic analysis presented in the table, it can be concluded that cultivating Kalojira is more financially rewarding compared to the other varieties, considering the same investment amount. Banerjee *et al.* (2013) [1] found similar results.

Table 6: Economics of aromatic rice under organic management in new alluvial soils during *kharif* season of 2022

Variety	Cost of cultivation (Rs.ha^{-1})	Gross return (Rs.ha^{-1})	Net return (Rs.ha^{-1})	B:C ratio
Gobindabhog	51391	97250	45859	1.89
Radhatilak	51391	84583	33192	1.64
Radhunipagal	51391	90833	39442	1.76
Kalojira	51391	114250	62859	2.22
Harinakhuri	51391	88375	36984	1.72
LalBadshabhog	51391	98916	47525	1.92
Dudheswar	51391	88000	36609	1.71
C. D (p=0.05)	-	8731.49	8731.49	0.12

Price of grain @ Rs.40kg^{-1}; Price of straw @Rs.1Kg^{-1}

Conclusion

Based on the results, it can be concluded that Kalojira exhibited superior performance in terms of grain yield compared to Lal Badshabhog and Radhunipagal, which are well-performing varieties. Kalojira achieved a significantly higher grain yield, with an increase of 18.29% and 29.21%, respectively, in the new alluvial zone of West Bengal during the wet season. Additionally, Kalojira demonstrated comparable growth, yield attributes and yields when compared to the other five indigenous aromatic rice varieties studied. Furthermore, Kalojira also registered higher net return amounting to and had a favourable benefit-cost ratio (B:C ratio) of 2.22, outperforming the other varieties tested in this investigation.

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