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# Response of rice varieties under organic and natural farming practices

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**Abstract**
A field experiment was conducted during *Kharif*, 2024 at the Regional Agricultural Research Station (RARS), Karjat, Maharashtra, to evaluate the response of rice (*Oryza sativa* L.) varieties under organic and natural farming practices. The study was laid out in a split plot design with three replications, comprising three management practices *viz.*, organic farming ($M_1$), natural farming ($M_2$), and integrated practices of organic + natural farming ($M_3$) in the main plots, and six rice varieties differing in maturity duration with same grain type *viz.*, *Karjat* 4 ($V_1$), *Ratnagiri* 5 ($V_2$), *Trombay Karjat Kolam* ($V_3$), *Karjat* 6 ($V_4$), *Karjat* 8 ($V_5$), and *Ratnagiri* 8 ($V_6$) in sub plots. A field experiment assessed rice growth and yield under organic, natural, and integrated farming practices. Growth parameters under production systems showed that integrated farming ($M_3$) recorded significantly higher plant height (92.24 cm) and tillers hill$^{-1}$ (10.20) over individual farming practices. Further, results revealed that the integrated approach ($M_3$) recorded the highest yield-contributing characters such as number of panicles hill$^{-1}$ (8.41), panicle weight (3.15 g), and number of total grains panicle$^{-1}$ (233.12), ultimately achieving the maximum grain yield (4208.78 kg ha$^{-1}$), straw yield (5470.35 kg ha$^{-1}$), and biological yield (9679.13 kg ha$^{-1}$). Among the different rice varieties, *Ratnagiri* 8 was superior in both growth characters i.e. height (104.24 cm) and tillers (10.27) as well as significantly outperformed all others with superior yield attributes and recorded the highest grain yield (5637.94 kg ha$^{-1}$), straw yield (6804.60 kg ha$^{-1}$), and harvest index (45.33%). The interaction analysis indicated that the combination of organic farming with *Ratnagiri* 8 ($M_1V_6$) was significantly superior and producing the significantly highest grain yield (5916.64 kg ha$^{-1}$). These findings highlight the importance of varietal selection along with integrated approach of organic + natural farming practices among the farming practices in enhancing rice productivity, and sustainability in the *kharif* season under Konkan region of Maharashtra.

**Keywords:** Rice, organic farming, natural farming, varieties, yield parameters, sustainability

## Introduction
Rice (*Oryza sativa L.*), often referred to as the "global grain," is the most important staple crop for human consumption, contributing significantly to global food security and dietary requirements. In India, rice holds a central role in the agricultural economy, ranking second worldwide in area (51.4 million ha) and production (149.07 mt) after China (Anonymous, 2022a) [2]. It contributes 43% of total food grains and 46% of cereals, serving as a primary livelihood source for rural populations (Mahajan *et al.* 2017) [9]. Maharashtra accounts for 1.69 million ha under rice with 4.0 mt productions and an average productivity of 2.37 t ha$^{-1}$, lower than other major states. In Konkan region, 3.67 lakh hectares are used for rice cultivation, yielding 8.93 lakh tons with productivity of 2.43 tons per hectare. However, challenges such as soil fertility decline, water scarcity, pest and disease incidence, high input costs, and climate change necessitate sustainable alternatives for productivity enhancement. Organic farming, based on the use of farmyard manure, compost, vermicompost, green manures, and biofertilizers, enhances soil fertility, microbial activity, nutrient use efficiency, and crop quality while reducing environmental risks (Sharma, 2002) [13]. Practices like green manuring with *Sesbania spp.* and incorporation of *Gliricidia sepium* biomass have shown to improve rice productivity and soil health (Mhetre, 2022) [10]. To promote such practices, the ICAR launched the Network Project on Organic Farming (NPOF) in 2004-05. Recently, natural farming, a

holistic, chemical-free system relying on on-farm inputs such as *Beejamrut*, *Jeevamrut*, and *Ghanjeevamrut*, has gained momentum due to its ecological and economic advantages. Selection of suitable crop and their varieties is crucial under organic and natural systems. All crops and varieties are not suitable for organic and natural farming practices. Hence, sustainable farming practices coupled with proper varietal selection which are responsive to different farming practices offers scope for improving productivity, profitability, and soil health under organic and natural rice farming systems. In this context, the proposed research entitled "Response of rice (*Oryza sativa* L.) varieties under organic and natural farming practices" was designed and conducted to evaluate the response of different rice varieties grown under organic and natural farming practices.

**Materials and Methods**

The present investigation entitled "Response of rice varieties (*Oryza sativa* L) to organic and natural farming practices" was carried out during *Kharif*, season in 2024 at the Model Agronomic Experiment Farm, Regional Agricultural Research Station (RARS), Karjat, Dist.

Raigad (M.S.). The location is situated in the subtropical region at $18^0$54'49.1" N latitude and $73^0$19'31" E longitude having elevation of about 52 m above mean sea level. The climate is warm and humid which is very much favourable for rice crop. The soil of the experimental field was categorized under inceptisol soil order and as clay loam in texture, neutral in reaction (pH 6.63), and contained high in organic carbon (12.76 g $kg^{-1}$). Initial nutrient analysis indicated that the soil was low to medium in available nitrogen (168.10 kg ha1), medium in available phosphorus (9.68 kg $ha^{-1}$), and high in available potassium (260.80 kg $ha^{-1}$), reflecting a balanced fertility profile suitable for rice cultivation. The field experiment was conducted in a split plot design with three replications. The main plot treatments comprised three farming practices, *viz.*, $M_1$: Organic farming, $M_2$: Natural farming, and $M_3$: Integrated organic + natural farming, while the sub-plot treatments included rice varieties differing in maturity duration. Among these, $V_1$: *Karjat* 4 and $V_2$: *Ratnagiri* 5 were early duration varieties, $V_3$: *Trombay Karjat Kolam* and $V_4$: *Karjat* 6 were mid-late duration varieties, and $V_5$: *Karjat* 8 and $V_6$: *Ratnagiri* 8 were late duration varieties. All collected data were subjected to analysis of variance (ANOVA) as per Fisher's method and the results were interpreted in accordance with the statistical procedures described by Gomez and Gomez (1984) [8].

**Results and Discussion**

**1.1 Growth studies**

The data pertaining to the crop growth studies *viz.*, plant height and number of tillers $hill^{-1}$ of rice at harvest as influenced by different individual treatments are presented in Table 1 and interaction treatment data in Table 2. The treatment $M_3$ i.e. Integration of Organic + Natural farming recorded maximum plant height (92.24 cm) and number of tillers $hill^{-1}$, (10.20) which was at par with $M_1$ (Organic farming) and significantly superior over $M_2$ (Natural farming practices) at harvest. This observation is in agreement with the results of Jambhulkar *et al*. (2024), who also reported improved plant height and tillering in rice under organic and natural farming systems. The results revealed significant differences among rice varieties with respect to growth attributes at harvesting stage. Rice variety *Ratnagiri* 8 consistently outperformed over other varieties in terms of height (104.24 cm) and tillering ability (10.27) maintained its superiority. These findings are in agreement with Anonymous (2023-24) [4] with different rice varieties for growth performance under organic farming. Plant height was found highest and significantly superior in combination of $M_2V_6$ i.e. Natural Farming Practices with variety *Ratnagiri* 8 (104.87 cm) over rest of the combinations except $M_3V_6$ and $M_1V_6$ treatment combinations at harvest. In the tillering, the treatment combination of $M_1V_6$ (combination of Organic farming in variety *Ratnagiri* 6) showed the highest tiller number (11.13) over the combination of Organic farming with variety *Karjat* 4 ($M_1V_1$) and *Ratnagiri* 5 ($M_1V_2$), Natural Farming with Variety *Karjat* 4 ($M_2V_1$), *Trombay Karjat Kolam* ($M_2V_3$), *Karjat* 6 ($M_2V_4$) and *Karjat* 8 ($M_2V_5$) and Integrated treatment with *Karjat* 4 ($M_3V_1$) and statistically equivalent results observed in rest of the treatment combinations. Comparable trend was documented by Amrutha *et al.* (2021) [1] and Sweta *et al.* (2017) [14] who found enhanced functional growth under integrated systems.

**1.2 Yield contributing character**

The data pertaining to the yield contributing character parameters *viz.*, number of panicles $hill^{-1}$, length of panicle (cm), **w**eight of panicle (g) and total number of grain $panicle^{-1}$ as influenced by different farming practices and varieties are presented in Table 1. The statistical analysis of the data revealed that, the combined application of Organic + Natural practices ($M_3$) exhibited the highest number of panicles $hill^{-1}$ (8.41), panicle weight (3.15 g) and total grain count per panicle (233.12) as compared to rest of the treatments under the study. The data indicated that the length of panicle in rice did not influenced by different Management practices. However, integrated practice and only Organic practice produced numerically maximum panicle length (21.60 cm). These findings align with Yeptho *et al*. (2023) [15], Pradeep (2010) [12], and *Sweta et al*. (2017) [14]. This may be attributed to efficient nutrient use and balanced physiological activity, as similarly reported by Panwar *et al*. (2022) [11], who observed improved grain setting under integrated farming systems. Number of panicles $hill^{-1}$, length of panicle (cm), weight of panicle (g), and total number of grain $panicle^{-1}$ was significantly influenced by the different rice varieties under study. Among the six rice varieties, *Ratnagiri* 8 recorded significantly the highest number of panicles $hill^{-1}$ (8.58), panicle length (24.18 cm), panicle weight (4.38 g), total number of grains $panicle^{-1}$ (284.11). These findings align with previous studies that its higher tillering potential, its strong sink strength and effective grain filling due to better nutrient availability and plant vigor as well as better reproductive development. The growth and yield contributing characters were reflecting in to grain and straw yield. These results are in line with Amrutha *et al.* (2021) [1], Anonymous (2022c) [3], Anonymous (2023-24) [4], and Anonymous (2024) [5], who evaluated different rice varieties at per their locality under organic and integrated production systems. These results emphasize the varietal suitability at respective regions. The data pertaining interaction between management practices and rice varieties exhibited statistically significant the data presented in Table 3 and 4 indicated that the treatment combination $M_1V_6$ i.e. Organic practices in variety *Ratnagiri* 8 produced significantly higher number of panicle $hill^{-1}$ (9.00), panicle length (24.93 cm), and total number of grains per panicle (307.67) demonstrating significant superiority over other combinations. No significant

interaction effect was observed between management practices and varieties with respect to panicle weight. This finding are line with the Sweta *et al*. (2017) [14] revealed similar results of yield contributing parameters.

**1.3 Yield studies**

The data concerning grain yield (kg ha$^{-1}$), straw yield (kg ha$^{-1}$), biological yield (kg ha$^{-1}$) and harvest index (%) of rice as influenced by different management practices with different rice varieties is presented in Table.5. Grain yield of rice was markedly influenced by different management practices. The treatment Integration of Organic + Natural Farming practices ($M_3$) recorded the maximum grain yield (4208.78 kg ha$^{-1}$), straw yield ((5470.35 kg ha$^{-1}$), biological yield (9679.13 kg ha$^{-1}$). The grain yield was increased in integrated farming practices to the tune of 6.08% and 0.66% over natural farming and organic farming alone, respectively the harvesting index there were no statistically significant variations observed among the different management practices under study. These results corroborate the findings of Dekhane *et al*. (2019) [6], who highlighted the role of organic inputs in improving grain weight and yield and similarly reported by Panwar *et al*. (2022) [11]. The data concerning grain yield (kg ha$^{-1}$), straw yield (kg ha$^{-1}$), biological yield (kg ha$^{-1}$) and harvest index (%) was significantly influenced by the different rice varieties under study. Among the six rice varieties Among the Varieties, The rice variety *Ratnagiri* 8 ($V_6$) recorded significantly the highest grain yield (5637.94 kg ha$^{-1}$), straw yield (6804.60 kg ha$^{-1}$), biological yield (12442.54 kg ha$^{-1}$), and the harvest index (45.33%) These findings revealed that the variety *Ratnagiri* 8 exhibited the best performance over rest of the varieties under study. These results are in line with Amrutha *et al*. (2021) [1], Anonymous (2022c) [3], Anonymous (2023-24) [4], and Anonymous (2024) [5], who evaluated different rice varieties at per their locality under organic and integrated production systems. These results emphasize the varietal suitability at respective regions. The data pertaining interaction between Management Practices and rice varieties exhibited statistically significant the data presented in Table 6, 7, 8. The interaction analysis revealed that the management practices of Organic Farming in collaboration with variety *Ratnagiri* 8 ($M_1V_6$) recorded the highest grain yield (5916.64 kg ha$^{-1}$), straw yield (7361.08 kg ha$^{-1}$), biological yield of (13277.72 kg ha$^{-1}$) and significantly superior over rest of the treatment combinations. The interaction between different management practices and rice varieties did not result in a significant variation in harvest index (%) These findings are in line with by Amrutha *et al.* (2021) [1] in rice crop and Anonymous (2022c) [3], and Anonymous (2024) [5] in different crops tested under various centres of AINP-OF.

**Table 1:** Growth and yield contributing characters as influenced by different treatments

| Treatments | Plant height at harvest (cm) | Number of tillers at harvest | Number of panicles hill$^{-1}$ | Length of panicle (cm) | Weight of panicle (g) | Total number of grains panicle |
|---|---|---|---|---|---|---|
| **Main plot: Management practices (M)** | | | | | | |
| $M_1$: Organic Farming | 90.03 | 10.02 | 8.40 | 21.60 | 3.14 | 229.96 |
| $M_2$: Natural Farming | 88.24 | 9.78 | 7.99 | 21.24 | 2.93 | 213.49 |
| $M_3$: Organic+ Natural Farming | 92.24 | 10.20 | 8.41 | 21.60 | 3.15 | 233.12 |
| S.E.m.± | 0.70 | 0.07 | 0.07 | 0.16 | 0.04 | 3.64 |
| C.D. at 5% | 2.74 | 0.29 | 0.28 | N.S. | 0.16 | 14.27 |
| **Sub plot (Varieties) (V)** | | | | | | |
| $V_1$: *Karjat*4 | 73.93 | 9.07 | 7.84 | 19.31 | 2.22 | 192.36 |
| $V_2$: *Ratnagiri* 5 | 84.62 | 10.04 | 8.07 | 21.50 | 2.62 | 201.36 |
| $V_3$: *Trombay Karjat Kolam* | 98.63 | 10.18 | 8.44 | 22.50 | 3.34 | 259.20 |
| $V_4$: *Karjat* 6 | 88.42 | 10.27 | 8.27 | 18.84 | 2.84 | 206.36 |
| $V_5$: *Karjat*8 | 91.15 | 10.18 | 8.40 | 22.55 | 3.05 | 209.76 |
| $V_6$: *Ratnagiri*8 | 104.24 | 10.27 | 8.58 | 24.18 | 4.38 | 284.11 |
| S.E.m.± | 0.62 | 0.17 | 0.10 | 0.15 | 0.12 | 4.66 |
| C.D. at 5% | 1.80 | 0.50 | 0.28 | 0.42 | 0.34 | 13.47 |
| **Interaction effect (M X V)** | | | | | | |
| S.E.m.± | 1.08 | 0.30 | 0.17 | 0.25 | 0.20 | 8.08 |
| C.D. at 5% | 3.11 | 0.86 | 0.49 | 0.73 | N.S. | 23.32 |
| **General mean** | 90.17 | 10.00 | 8.27 | 21.48 | 3.07 | 225.52 |

**Table 2:** Interaction of management practices (M) and varieties (V) on plant height (cm) and number of tillers hill$^{-1}$ of rice at harvest

| Management practices | Plant height (cm) | | | | | | Number of tillers hill$^{-1}$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Varieties | | | | | | Varieties | | | | | |
| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
| $M_1$ | 73.47 | 85.21 | 97.07 | 86.55 | 93.93 | 103.93 | 8.33 | 9.53 | 10.27 | 10.67 | 10.20 | 11.13 |
| $M_2$ | 68.39 | 78.83 | 99.29 | 88.70 | 89.35 | 104.87 | 10.07 | 10.47 | 9.67 | 9.60 | 9.80 | 9.07 |
| $M_3$ | 79.95 | 89.84 | 99.54 | 90.01 | 90.17 | 103.93 | 8.80 | 10.13 | 10.60 | 10.53 | 10.53 | 10.60 |
| SE(m)± | 1.08 | | | | | | 0.30 | | | | | |
| CD at 5% | 3.11 | | | | | | 0.86 | | | | | |

**Table 3:** Interaction effect of different management practices (M) and different rice varieties (V) on number of panicles per hill and length of panicle as influenced periodically by different management.

| Management practices | Number of panicle hill$^{-1}$ | | | | | | Length of panicle ( cm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Varieties | | | | | | Varieties | | | | | |
| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ |
| $M_1$ | 7.73 | 8.07 | 8.47 | 8.47 | 8.67 | 9.00 | 18.96 | 21.40 | 22.35 | 19.30 | 22.68 | 24.93 |
| $M_2$ | 7.80 | 8.20 | 8.07 | 7.80 | 8.00 | 8.07 | 19.95 | 22.03 | 22.07 | 18.40 | 21.46 | 23.56 |
| $M_3$ | 8.00 | 7.93 | 8.80 | 8.53 | 8.53 | 8.67 | 19.02 | 21.09 | 23.08 | 18.83 | 23.52 | 24.05 |

| | | |
|---|---|---|
| SE(m)± | 0.17 | 0.25 |
| CD at 5% | 0.49 | 0.73 |

**Table 4:** Interaction effect of management practices (M) and varieties (V) on total number of grains per panicles of rice as influenced by different management practices

| Management practices | Total number of grain panicle$^{-1}$ | | | | | |
|---|---|---|---|---|---|---|
| | Varieties | | | | | |
| | **$V_1$** | **$V_2$** | **$V_3$** | **$V_4$** | **$V_5$** | **$V_6$** |
| $M_1$ | 181.93 | 191.07 | 269.87 | 216.33 | 212.87 | 307.67 |
| $M_2$ | 197.80 | 207.27 | 222.93 | 196.47 | 193.67 | 262.80 |
| $M_3$ | 197.33 | 205.73 | 284.80 | 206.27 | 222.73 | 281.87 |
| SE(m)± | 8.08 | | | | | |
| CD at 5% | 23.32 | | | | | |

**Table 5:** Grain yield, straw yield, biological yield (kg ha$^{-1}$) and harvest index (%) of rice as influenced by different management practices

| Treatments | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|
| **Main plot: (Management practices) (M)** | | | | |
| $M_1$: Organic farming | 4181.00 | 5467.57 | 9648.57 | 43.23 |
| $M_2$:Natural farming | 3967.58 | 5140.72 | 9108.30 | 43.44 |
| $M_3$:Organic+ Natural farming | 4208.78 | 5470.35 | 9679.13 | 43.34 |
| S.E.m.± | 30.45 | 31.80 | 57.26 | - |
| C.D. at 5% | 119.58 | 124.85 | 224.85 | - |
| **Sub plot: varieties (V)** | | | | |
| $V_1$: *Karjat*4 | 3370.36 | 4501.83 | 7872 | 42.82 |
| $V_2$:*Ratnagiri* 5 | 3725.91 | 4876.83 | 8602 | 43.31 |
| $V_3$:*Trombay Karjat Kolam* | 4168.50 | 5515.72 | 9684 | 43.04 |
| $V_4$: *Karj*at 6 | 3765.73 | 5038.87 | 8804 | 42.76 |
| $V_5$:*Karjat 8* | 4046.28 | 5419.42 | 9465 | 42.75 |
| $V_6$:*Ratnagiri* 8 | 5637.94 | 6804.60 | 12442.54 | 45.33 |
| S.E.m.± | 68.86 | 82.86 | 145.81 | - |
| C.D. at 5% | 198.89 | 239.32 | 421.12 | - |
| **Interaction effect (M X V)** | | | | |
| S.E.m.± | 119.27 | 143.52 | 252.54 | - |
| C.D. at 5% | 344.48 | 414.51 | 729.40 | - |
| General mean | 4119.12 | 5359.55 | 9478.67 | 43.34 |

**Table 6:** Interaction effect of management practices (M) and varieties (v) on grain yield (kg ha$^{-1}$) of rice as influenced by different treatments.

| Management practices | Grain yield | | | | | |
|---|---|---|---|---|---|---|
| | Varieties | | | | | |
| | **$V_1$** | **$V_2$** | **$V_3$** | **$V_4$** | **$V_5$** | **$V_6$** |
| $M_1$ | 3249.99 | 3572.21 | 4263.87 | 3958.32 | 4124.98 | 5916.64 |
| $M_2$ | 3522.21 | 3813.87 | 3866.65 | 3580.54 | 3786.10 | 5236.09 |
| $M_3$ | 338.88 | 3791.65 | 4347.98 | 3758.32 | 4227.76 | 5761.09 |
| SE(m)± | 119.27 | | | | | |
| CD at 5% | 344.48 | | | | | |

**Table 7:** Interaction effect of management practices (M) and varieties (v) on straw yield (kg ha$^{-1}$) of rice as influenced by different treatments

| Management practices | Straw yield | | | | | |
|---|---|---|---|---|---|---|
| | Varieties | | | | | |
| | **$V_1$** | **$V_2$** | **$V_3$** | **$V_4$** | **$V_5$** | **$V_6$** |
| $M_1$ | 4355.54 | 4669.43 | 5649.98 | 5216.65 | 5552.76 | 7361.08 |
| $M_2$ | 4699.98 | 4997.20 | 5113.87 | 4774.98 | 5052.76 | 6205.53 |
| $M_3$ | 4449.98 | 4963.87 | 5783.31 | 5124.98 | 5652.76 | 6847.19 |
| SE(m)± | 143.52 | | | | | |
| CD at 5% | 414.51 | | | | | |

**Table 8:** Interaction effect of management practices (M) and varieties (v) on biological yield (kg ha$^{-1}$) of rice as influenced by different treatments

| Management practices | Biological yield | | | | | |
|---|---|---|---|---|---|---|
| | Varieties | | | | | |
| | **$V_1$** | **$V_2$** | **$V_3$** | **$V_4$** | **$V_5$** | **$V_6$** |
| $M_1$ | 7605.53 | 8241.63 | 9913.85 | 9174.96 | 9677.74 | 13277.72 |
| $M_2$ | 8222.19 | 8811.08 | 8980.52 | 8355.52 | 8838.85 | 11441.62 |
| $M_3$ | 7788.86 | 8755.52 | 10158.29 | 8883.30 | 9880.52 | 12608.28 |

| | |
|---|---|
| SE(m)± | 143.52 |
| CD at 5% | 414.51 |

## Conclusion

The present investigation demonstrated that integrated farming practice that include organic + natural farming practices ($M_3$) significantly enhanced growth character and yield-attributing characters and grain yield of rice compared to individual management practices. Among the tested varieties, *Ratnagiri* 8 ($V_6$) consistently outperformed others, and its combination with integrated organic + natural farming exhibited the highest yield performance. Therefore, the integrated approach of organic and natural farming in conjunction with variety *Ratnagiri* 8 can be recommended as a viable strategy for achieving higher production and productivity of rice cultivation under Konkan conditions.

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