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Performance of paddy (*Oryza sativa* L.) cultivars under different farming types for their growth and yield under transplanted condition

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Abstract
A Field experiment was conducted at Agricultural Research Station, Kathalagere during *kharif* season of 2020 to study the performance of paddy cultivars under different farming types in irrigated situation of Bhadra command area. Experiment was laid out in split-plot design with four farming types (conventional, organic, natural farming and absolute control) in main plots and four paddy cultivars (Chinnaponni, Mysore mallige, RNR-15048 and KRH-4) in subplots comprising 16 treatment combinations replicated thrice. Among the different farming types, conventional farming recorded significantly higher growth attributing characters *viz.,* plant height (94.57 cm), number of tillers hill^{-1} (31.13), leaf area index (3.02), dry matter accumulation hill^{-1} (87.50 g) and yield attributes like number of productive tillers hill^{-1} (28.51), number of panicles hill^{-1} (27.31), number of filled grains panicle^{-1} (216.50), test weight (20.04 g), grain yield (5915 kg ha^{-1}) and straw yield (7931 kg ha^{-1}) as compared to organic, natural farming and absolute control. In case of paddy cultivars, the growth characters like plant height (102.20 cm), number of tillers hill^{-1} (29.94), leaf area index (3.11) dry matter accumulation hill^{-1} (87.25) and yield attributes like number of productive tillers hill^{-1} (29.15), number of panicles hill^{-1} (28.71), number of filled grains panicle^{-1} (226.75), test weight (21.38 g), grain yield (6550 kg ha^{-1}) and straw yield (7556 kg ha^{-1}) were recorded maximum in hybrid KRH-4 as compared to RNR-15048, Chinnaponni and Mysore mallige. Amidst the farming types, the highest net return (Rs. 66790 ha^{-1}) and B:C ratio (2.77) was observed in natural farming. Among the cultivars, KRH-4 recorded higher net returns of Rs. 84688 ha^{-1} and B:C ratio of 2.88.

Keywords: Farming types, cultivars, yield, net return, B:C ratio

Introduction
Rice (*Oryza sativa* L.) is an important and extensively cultivated staple food crop and feeds more than half of the world's population. At the time of green revolution, the priority was to get higher production to feed burgeoning population of the country and technologies were developed to meet this national objective. In the last few decades, varieties with higher genetic potential fitting into intensive cultivation system and responsive to high input use (irrigation and fertilizer) were developed and popularized. Several long-term field experiments indicated a declining trend in grain yield under intensified rice cropping with constant and high fertilizer inputs. Hence, enhancement and maintenance of system productivity and resource quality is essential for sustainable agriculture. An integrated approach involving organic manures and chemical fertilizers will go a long way in building up of the soil fertility on a permanent basis and the system will supply most of the nutrients in a judicious way and nutrients uptake by the crop will be enhanced (Dutta and Bandyopadhyaya, 2003) [3].

The natural inputs used in organic and natural farming are easily available, releases nutrients slowly, supplies macro and micro nutrients and provides favourable soil environment for microbial population (Shashidhara, 2000; Devakumar *et al.*, 2008) [14, 2]. General acceptance of organic and natural farming is not only due to the greater demand for pollution-free food but also due to natural advantage in supporting the sustainability in agriculture. Though conventional farming helps in getting substantial yields, indiscriminate use of inorganic fertilizers and continuous farming has resulted in various soil hazards ultimately leading to lower productivity. Additionally, over emphasis on conventional farming has resulted in deterioration of soil and plant health. Restoring soil health by reverting to non-chemical agriculture has assumed great importance to attain sustainability in production (Pandey *et al.*, 2008) [11].

In this search for eco-friendly alternate systems of farming, organic and natural farming are increasingly becoming popular among the farming community with limited use of cow dung and cow urine.

With the advent and introduction of new high yielding varieties of rice for large scale cultivation have washed away all the local varieties of rice for main stream. Unfortunately, the modern agriculture trend enhanced the erosion of agro biodiversity resulting in loss of valuable local germplasms. On the other hand, local cultivars of paddy are showing inherent resistance to pest and diseases with lesser use of inputs provides quality food with least cost. Hence, performance of different cultivars of paddy is being tried under different farming types in this experiment.

Material and Methods

A field experiment was conducted during *kharif* season of 2020 at Agricultural and Horticultural Research Station, (AHRS) Kathalagere, Davanagere district. Different treatments were imposed in the permanent plots maintained with different farming types since three years. The soil was acidic in nature (6.3), medium in available nitrogen (284.89 kg N ha^{-1}), high with respect to phosphorus, (65.64 kg P_2O_5 ha^{-1}) and medium in potassium (281.65 kg K_2O ha^{-1}) status. The experiment was laid out in a split-plot design having four farming types (M) as main plots *viz.*, M_1: Conventional farming, M_2: Organic farming, M_3: Natural farming and M_4: Absolute control and four paddy cultivars (S) as subplots *viz.*, S_1: Chinnaponni, S_2: Mysore mallige, S_3: RNR-15048 and S_4: KRH-4 in three replications.

Seeds of the paddy cultivars were sown in different nursery beds of plot size 10 m x 2 m @ 20 kg ha^{-1} for KRH-4 and 62.5 kg ha^{-1} for Chinnaponni, Mysore mallige and RNR-15048. As per the different farming types, in conventional farming seeds were treated with carbondezim @ 2 g kg^{-1} of seeds, in organic farming with *Azosprillum* and PSB each at 600 g $ha^{-1}$of seeds and in natural farming, seeds were treated with beejamrutha. In the main field twenty-five days old seedlings of cultivars *viz.*, Chinnaponni, Mysore mallige and RNR-15048, were planted @ 2-3 seedlings $hill^{-1}$ with a spacing of 20 cm × 10 cm and KRH-4 @ one seedling $hill^{-1}$ with the spacing of 15 cm x 15 cm.

In conventional farming, recommended FYM @ 7.5 t ha^{-1} was applied three weeks before transplanting and rec. dose of N, P_2O_5 and K_2O were given in the form of Urea, Diammonium Phosphate and Muriate of Potash, respectively. Nitrogen was given in three splits, 50 per cent as basal and 25 per cent at tillering (30 DAT) and remaining 25 per cent at panicle initiation (60 DAT) stage. Full dose of P_2O_5, K_2O and $ZnSO_4$ (20 kg ha^{-1}) were given as basal dose at the time of transplanting.

In organic farming, recommended dose of FYM and rec. dose of N was applied through FYM on N equivalent basis. Whereas, in natural farming, ghana jeevamrutha @ 1000 kg ha^{-1} was applied to well-prepared soil three weeks before transplanting and jeevamrutha @ 500 lit ha^{-1} through manual sprinkling to soil at the time of transplanting and at 30, 60 and 90 days after transplanting.

Preparation of jeevamrutha, ghanajeevamrutha and beejamrutha: Jeevamrutha is prepared by mixing ten kg local cow dung with 10 litres cow urine. Two kg local jaggery, two kg pulse flour and handful of garden soil is added and the volume is made upto 200 litres. The drum is kept in the shade and covered with wet gunny bag and the mixture is stirred clockwise thrice a day and incubated for 7 days. Ghanajeevamrutha preparation is similar to jeevamrutha where 100 kg cow dung is spread on the polythene sheet and same ingredients and procedure of jeevamrutha is followed, except no water is added.

Beejamrutha is prepared by taking five kg cowdung in a cloth and hanged in 20 litres of water upto 12 hours. Later 50 g lime is added ito1 litter water and kept it overnight. The next morning, bundle of the cow dung is squeezed in that water thrice continuously, so that all essence of cow dung is accumulated in that water. Handfull of soil is added and stirred. Finally 5 liter cow urine and lime water solution is added and mixed well.

The data was analysed statistically for test of significance following the procedure described by Gomez and Gomez (1984) [5]. The results have been discussed at the probability level of five per cent. The level of significance used in “F” and “t” test was p = 0.05. Critical difference values were calculated wherever the “F” test was found significant. The mean values of interaction effects were found non significant for grain yield, straw yield and yield parameters. In order to get precise information, the above mentioned parameters were separately subjected to Duncan’s Multiple Range Test (DMRT) using the corresponding error mean sum of squares and degrees of freedom values under SPSS program.

Results and Discussion

Growth and development parameters

Plant height is considered as an important morphological character influencing growth and development of crop plants. Plant height was significantly taller in conventional farming (94.57 cm) as compared to natural farming (87.10 cm) but is was on par with organic farming (89.79 cm) (Table1). Increased plant height under conventional farming could be due to the readily available inorganic forms of nutrients, particularly nitrogen, which is a key element of protoplasm and plays a favourable function in cell division and elongation. The improvement in plant height under organic farming is due to applied FYM provides proper nourishment and ensures optimum growth. It also helps in the release of nutrients favourable for the crop growth. The use of jeevamrutha and ghanajeevamrutha might have increased the plant height by stimulating the activity of microorganisms that make the plant nutrients more easily available to the crops. The results obtained are in accordance with results of Manjunath *et al.*, 2009 [9] and Yogananda *et al.*, 2015.

Plant height varied significantly among the cultivars due to the variation in their genetic makeup which might be highly affected by genetic factors. Among the cultivars, KRH-4 (102.20 cm) recorded significantly taller plant height which was superior over RNR-15048 (90.79 cm), Chinnaponni (89.60 cm) and Mysore mallige (72.73 cm).

Number of tillers $hill^{-1}$, leaf area index (LAI) and dry matter accumulation (g $hill^{-1}$)

Among the farming types, conventional farming recorded significantly higher number of tillers $hill^{-1}$(31.13) and dry matter accumulation (87.50 g $hill^{-1}$) as compared to other farming types. Leaf area index recorded in conventional farming (3.02) was statistically on par with organic farming (2.98) (Table1). This could be owing to the fact that, chemical fertilizers can rapidly deliver the required quantity of nutrients in a balanced proportion coinciding with the crop requirement, which improved leaf initiation and expansion, and resulted in increased leaf area and leaf area index. The organic farming performed better than natural farming by recording higher growth attributes which might be due to the added FYM increased the soil organic matter and improved the physical and biological properties of the soil and also maximum availability of nutrients to the crop at right time in right proportion. The application of jeevamrutha at regular intervals (3-4 times) acts as a stimulus in the plant system which in turn increased the production of growth regulators in the cell system and action of growth hormones such as IAA and GA_3 resulted in better growth and yield of paddy. The results are in accordance with Usman *et al.* (2003) [18], Tomar *et al.* (2018) [17] and Sutar *et al.* (2019) [16].

Among the paddy cultivars KRH-4 excelled over other cultivars by recording significantly higher number of tillers hill^{-1} (59.27), LAI (3.11) and dry matter accumulation (87.25 g hill^{-1}) as compared to other paddy cultivars. It might be due to the fact that, hybrid (KRH-4) produces longer roots and broad leaves which enabled better absorption, assimilation and translocation of nutrients which resulted in superior yield attributes compared to other cultivars. These results are in accordance with Gangaiah *et al.* (2019) [4].

Table 1: Plant height, number of tillers hill^{-1}, leaf area index (LAI) and dry matter accumulation (g hill^{-1}) of paddy as influenced by different farming types and cultivars

Treatments	Plant height (cm)	Number of tillers hill^{-1}	LAI	Dry matter accumulation (g hill^{-1})
Farming Types				
M_1	94.57	31.13	3.02	87.50
M_2	89.79	28.73	2.98	81.75
M_3	87.10	26.44	2.93	77.00
M_4	83.88	23.70	2.86	72.50
S.Em±	1.92	0.52	0.056	1.56
C.D @ 5%	6.64	1.81	0.172	5.39
Cultivars Of Paddy				
S_1	89.60	26.40	2.89	78.00
S_2	72.73	25.72	2.84	70.75
S_3	90.79	28.04	2.94	82.75
S_4	102.20	29.94	3.11	87.25
S.Em±	1.06	0.47	0.03	0.91
C.D @ 5%	3.09	1.38	0.10	2.66
Interaction				
M_1S_1	93.63	28.51	2.96	83.00
M_1S_2	77.33	30.10	2.92	78.00
M_1S_3	95.60	31.33	3.00	91.00
M_1S_4	111.70	34.21	3.20	98.00
M_2S_1	90.56	25.42	2.92	80.00
$M_2 S_2$	73.50	28.30	2.88	72.00
$M_2 S_3$	92.50	29.54	2.97	85.00
$M_2 S_4$	102.60	31.10	3.15	90.00
M_3S_1	88.56	23.62	2.86	77.00
M_3S_2	71.50	25.10	2.82	68.00
M_3S_3	89.56	26.45	2.93	80.00
M_3S_4	98.80	29.25	3.09	83.00
M_4S_1	85.70	21.36	2.82	72.00
M_4S_2	68.60	22.10	2.75	65.00
M_4S_3	85.50	23.36	2.88	75.00
M_4S_4	95.70	25.21	3.00	78.00
S.Em±	2.12	0.95	0.072	1.82
C.D @ 5%	NS	NS	NS	NS
C.V (%)	6.51	7.15	9.01	7.30

NS- Non significant DAT- Days after transplanting
M_1- Conventional farming, S_1- Chinnaponni
M_2- Organic farming S_2- Mysore mallige
M_3- Natural farming S_3- RNR-15048
M_4-Absolute control S_4- KRH-4

Yield and yield attributes

Increased number of productive tillers hill^{-1} (28.51), number of panicles hill^{-1} (27.31) was observed in conventional farming. However, number of filled grains panicle^{-1} (216.50), test weight (20.04 g), grain yield (5915 kg ha^{-1}) and straw yield (7931 kg ha^{-1}) were recorded higher in conventional farming compared to natural farming but it was statistically on par with organic farming (Table 2). The increased yield under combined application of FYM and fertilisers might be attributed to the quick supply of essential nutrients in required quantity and added FYM acts as a storehouse of several micro and macronutrients which increased nutrient availability and fertilizer use efficiency. The better yield attributes under organic farming might be due to steady and continuous supply of N throughout the crop growth period, along with gradual transformation and mineralization of organics and solubilisation of water insoluble P compounds by organic acids released during organic manures decomposition. Natural farming performed better as it contains higher microbial load and growth harmones which might have enhanced the mobilization of nutrients and facilitated for release of adsorbed nutrients in the soil which resulted in increased yield attributes. This is in accordance to the findings of Muhammad *et al.* (2003) [10], Kumar and Singh (2006) [6] and Ramesh *et al.* (2018) [12].

Among the paddy cultivars, KRH-4 recorded significantly higher number of productive tillers hill^{-1} (29.51), number of panicles hill^{-1} (28.71), panicle length (22.90 cm) and test weight (21.30 g) as compared to other cultivars. However, number of filled grains panicle^{-1} (226.75), grain yield (6550 kg ha^{-1}) and straw yield (7556 kg ha^{-1}) recorded in KRH-4 was statistically on par with RNR-15048. Better performance of the cultivars, might be due to hybrid vigour in KRH-4 and high yielding capacity of RNR-15048, enabled them for better utilization capacity of available nutrients, moisture and space resulted in superior yield and yield attributes. Similar findings were documented by Yogananda and Reddy (2004) [21], Anand *et al.* (2018) [1] and Lavanya and Reddy (2019) [7].

Interaction effect among different farming types and cultivars of paddy

Interaction effect between different farming types and cultivars of paddy were found significant for yield and yield parameters. Higher grain and straw yield was recorded in (M_1S_4) KRH-4 under conventional farming (8200 kg ha^{-1} and 9525 kg ha^{-1}) which was statistically on par with (M_2S_4) KRH-4 under organic farming (7700 kg ha $^{-1}$ and 8900 kg ha^{-1}) and (M_1S_3) RNR-15048 under conventional farming (7300 kg ha $^{-1}$ and 8100 kg ha^{-1}) (Table 2).

The yield components such as productive tillers hill^{-1}, number of panicles hill^{-1}, number of filled grains panicle^{-1} and test weight were recorded higher in KRH-4 under conventional farming. It was mainly due to the growth habit of hybrid which produces vigorous root system, more tillering and remain green for longer period of time thus accumulating more dry matter. Combined use of chemical fertilizers and FYM supply the nutrients in available form and helps in better translocation of photosynthates from source to sink which led to better yield attributing characters in KRH-4. The higher leaf area per plant recorded in hybrid under conventional farming was responsible to capture more solar radiation resulting in high photosynthetic rate which in turn resulted in higher dry matter production. Similar findings in the present study are in agreement with Anand *et al.* (2018) [1] and Venkatesha *et al.* (2015) [19].

Table 2: Yield and yield attributes of paddy as influenced by different farming types and cultivars

Treatments	Productive tillers hill^{-1}	No. of panicles hill^{-1}	Number of filled grains panicle	Test weight (g)	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})
Farming Types						
M_1	28.51	27.31	216.50	20.04	5915	7931
M_2	26.83	25.81	206.25	19.71	5399	7243
M_3	23.76	23.10	197.00	19.16	4832	6255
M_4	19.33	18.67	176.75	17.51	2525	4025
S.Em±	0.49	0.16	3.17	0.34	198	264
C.D @ 5%	1.66	0.57	10.97	1.19	685	913
Cultivars OF Paddy						
S_1	21.76	21.00	180.75	17.55	3376	5890
S_2	21.03	20.20	173.00	17.06	3001	5500
S_3	26.48	25.63	216.00	20.44	5744	6507
S_4	29.15	28.71	226.75	21.38	6550	7556
S.Em±	0.41	0.38	3.97	0.29	343	368
C.D @ 5%	1.21	1.10	11.58	0.85	1001	1076
Interaction						
M_1S_1	25.25^{ef}	24.00^{de}	193.00^{cd}	18.00^{ef}	4210^{bc}	7200^{abcd}
M_1S_2	24.52^{efg}	23.00^{ef}	185.00^{de}	17.65^{ef}	3950^{bcd}	6900^{bcd}
M_1S_3	30.25^{bc}	29.00^{b}	238.00^{ab}	21.52^{abc}	7300^{a}	8100^{abc}
M_1S_4	34.00^{a}	33.25^{a}	250.00^{a}	23.00^{a}	8200^{a}	9525^{a}
M_2S_1	22.95^{fgh}	22.00^{efg}	185.00^{de}	17.85^{ef}	3890^{bcd}	6570^{bcde}
M_2 S_2	23.10^{fgh}	22.00^{efg}	175.00^{de}	17.40^{ef}	3380^{cd}	6100^{cdef}
M_2 S_3	29.25^{c}	28.00^{bc}	225.00^{ab}	21.10^{bc}	6625^{a}	7400^{abcd}
M_2 S_4	32.00^{ab}	31.25^{a}	240.00^{ab}	22.50^{ab}	7700^{a}	8900^{ab}
M_3S_1	20.85^{hij}	21.00^{fgh}	177.00^{de}	17.50^{ef}	3303^{cd}	6090^{cdefg}
M_3S_2	19.65^{jkl}	20.00^{gh}	170.00^{de}	17.00^{f}	2875^{cd}	5800^{cdefgh}
M_3S_3	26.30^{de}	26.00^{cd}	216.00^{bc}	20.15^{cd}	6050^{ab}	6328^{cde}
M_3S_4	28.25^{cd}	28.00^{bc}	225.00^{ab}	22.00^{abc}	7100^{a}	6800^{bcd}
M_4S_1	18.00^{kl}	17.00^{i}	168.00^{de}	16.85^{f}	2100^{cd}	3700^{fhi}
M_4S_2	16.85^{l}	15.80^{i}	162.00^{e}	16.20^{f}	1800^{d}	3200^{i}
M_4S_3	20.10^{ijk}	19.52^{h}	185.00^{de}	19.00^{e}	3000^{cd}	4200^{efghi}
M_4S_4	22.35^{ghi}	22.35^{efg}	192.00^{cd}	18.00^{f}	3200^{cd}	5000^{defghi}
S.Em±	0.83	0.76	7.94	0.58	686	737
C.D @ 5%	-	-	-	-	-	-
C.V (%)	7.21	8.35	12.30	7.12	10.26	12.02

M_1- Conventional farming, S_1- Chinnaponni
M_2- Organic farming S_2- Mysore mallige
M_3- Natural farming S_3- RNR-15048
M_4-Absolute control S_4- KRH-4

Economics

Economic evaluation plays a major part in technology recommendation and adaptation, as the yield produced by various treatments show their benefits only when the production cost is lower and the net return is higher, ultimately benefiting the producers. Among the farming types, natural farming recorded lower cost of cultivation (Rs. 37,708 ha^{-1}) and higher net return (Rs. 66,790 ha^{-1}) which in turn gave higher B:C ratio (2.77). This might be due to fact that low cost is incurred for the preparation of ghanajeevamrutha and jeevamrutha as it is prepared by using locally available raw materials which ultimately reduced the cost on external inputs and increased the net returns. Though the grain yield was higher under organic farming, the net return (Rs. 55,449 ha^{-1}) and B:C ratio (1.90) was low due to high cost of cultivation (Rs. 61,858 ha^{-1}) as the cost incurred towards FYM is more. Lowest net return and B:C ratio was recorded in absolute control because of reduced grain yield (Table 3). The results are in line with Mahanta *et al.* (2021) [8] and Siddaram *et al.* (2010) [15].

Among the cultivars, KRH-4 recorded maximum gross return (Rs. 1,29,763 ha^{-1}) and net return (Rs. 84,688 ha^{-1}) which ultimately lead to higher B:C ratio (2.88). This is due to higher production of grain and straw yield. Minimum net return and B:C ratio was recorded in Chinnaponni and Mysore mallige due to lower grain and straw yield. The results are in line with Ranjitha *et al.* (2013) [13].

Table 3: Cost of cultivation, gross return, net returns and B:C ratio of paddy as influenced by different farming types and cultivars

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C
Farming Types				
M_1	51128	109819	59965	2.15
M_2	61858	117307	55449	1.90
M_3	37708	104498	66790	2.77
M_4	30071	47650	18086	1.58
S.Em±	-	-	-	-
C.D @ 5%	-	-	-	-
Cultivars of Paddy				
S_1	45355	78800	33445	1.74
S_2	44980	61213	18014	1.36
S_3	45355	109498	64142	2.41
S_4	45075	129763	84688	2.88
S.Em±	-	-	-	-
C.D @ 5%	-	-	-	-
Interaction				
M_1S_1	51120	91400	40279	1.79
M_1S_2	50932	74050	28216	1.45
M_1S_3	51370	124900	73529	2.43
M_1S_4	51090	148925	97835	2.91
M_2S_1	61850	96040	34190	1.55
M_2 S_2	61662	73700	12038	1.20
M_2 S_3	62100	136588	74488	2.20
M_2 S_4	61820	162900	101080	2.64
M_3S_1	37700	82059	44359	2.18
M_3S_2	37512	63300	25788	1.69
M_3S_3	37950	124303	86353	3.28
M_3S_4	37670	148328	110658	3.94
M_4S_1	30750	45700	14950	1.49
M_4S_2	29812	33800	6012	1.13
M_4S_3	30000	52200	22200	1.74
M_4S_4	29720	58900	29180	1.98
S.Em±	-	-	-	-
C.D @ 5%	-	-	-	-
C.V (%)	-	-	-	-

M_1- Conventional farming, S_1- Chinnaponni
M_2- Organic farming S_2- Mysore mallige
M_3- Natural farming S_3- RNR-15048
M_4-Absolute control S_4- KRH-4
NS- Non significant

Conclusion

From the above results, it is concluded that growth and yield parameters of paddy were significantly higher in conventional farming which was followed by organic and natural farming. Among the cultivars, KRH-4 recorded higher grain and straw yield which was on par with RNR-15048. Among the farming types, maximum net returns and B:C ratio was found in natural farming, whereas among the paddy cultivars, KRH-4 recorded higher net return and B:C ratio than the other cultivars.

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