Evaluation of Rice (*Oryza Sativa*) Varieties Suitable for Organic Farming

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ABSTRACT

A field experiment was conducted to evaluate the rice varieties suitable for organic farming. The experiment was carried out in the *rabi* season of 2013-14 at Tamil Nadu Agricultural University, Coimbatore to study the yield, quality and economics of different rice varieties. The experiment was laid out in a RBD replicated thrice. The treatments consisted of 12 rice varieties *viz*., Bhavani, White ponni, Mappillai samba, Kitchili samba, IR 20, CO 43, CO(R) 48, CO(R) 51, CB 05022, KDML 105, Red kavuni and Jeeraga samba. The culture CB 05022 produced significantly higher grain yield of 4877 kg ha^{-1} and registered a yield increase ranging from 32 to 82 per cent over the other varieties under evaluation. With regard to quality parameters, grains of the culture CB 05022 was medium slender based on the kernel length and L/B ratio. The highest net return of ` 40,015 $ha^{-1}$ with B:C ratio of 2.28 was realised under the rice culture CB 05022 followed by Kitchili samba (net return: ` 32,423 ha^{-1}; B:C ratio: 2.04) and Jeeraga samba (net return: ` 31,431 ha^{-1}; B:C ratio: 2.01). It is inferred that varieties and cultures differ widely among themselves when grown under organic farming. In terms of grain yield, quality and economics, the culture CB 05022 performed better under the organic production system.

Key words: CB 05022, Hulling percentage, Kitchili samba, Mappillai samba, Milling percentage, Red kavuni, Soil health.

INTRODUCTION

The chemical era of modern agriculture concentrates on maximum output but over looks input efficiency as a result of which it has not been sustainable. Growing awareness of health and environmental issues associated with indiscriminative uses of chemical inputs has led to the interest of alternate agriculture. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment (Ramesh *et al*. 2005). Choice of variety is more critical in organic farming than conventional farming. Therefore, it is important to carry out trials with selected rice varieties under organic farming in order to generate information and advice on the most appropriate choice of variety for quality rice production and its marketing. High yielding varieties, which respond well to chemical inputs, may not be always suitable for organic farming. Instead, varieties which are hardy with less pest and diseases occurrence and capable of giving acceptable yield especially in the early phase of conversion are ideal. Selection of varieties for organic rice production is not far different from the varieties selected for conventional production system. Hence, varieties that perform well in a region can be selected. As the current high yielding varieties and hybrids are inadvertently selected for high input systems, they are likely to behave differently under organic conditions thus necessary field scrutiny if grown organically. Conventional varieties have been developed with the aim of combining high productivity and standardized quality under high input conditions. Two main areas apparent where organic farming system differs most significantly from conventional farming systems are the soil fertility management and pest and disease management. The varieties often perform differently in different environments due to genotype environment interactions; therefore it is important to evaluate rice varieties under organic farming systems. Keeping all the above information in view, a field experiment was carried out to study the evaluation of rice varieties suitable for organic farming with the objectives to identify rice varieties suitable for organic farming, study the yield and quality differences in rice varieties due to organic production practices.

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MATERIALS AND METHODS

Field experiments were carried out during *rabi* season of 2013 - 2014 at Tamil Nadu Agricultural University, Coimbatore to evaluate the rice varieties suitable for organic farming. The experiment was laid out in a randomized block design (RBD) with twelve varieties as treatments which were replicated thrice *viz*., V_1 : Bhavani, V_2 : White ponni, V_3 : Mappillai samba, V_4 : Kitchili samba, V_5 : IR 20, V_6 : CO 43,

V_7 : CO(R) 48, V_8 : CO(R) 51, V_9 : CB 05022 (CO 43 x ADT 39), V_{10}: KDML 105, V_{11} : Red kavuni and V_{12} : Jeeraga samba. Seeds of the rice varieties were treated with *Pseudomonas fluorescens* @ 10g kg^{-1} of seeds and *Azosprillum* and *Phosphobacteria* @ 30 g kg^{-1} of seeds before sowing. Then seeds were soaked in water for 24 hrs and incubated for another 12 hrs for inducing sprouting. The sprouted seeds were broad casted in a well prepared raised bed nursery. Neem cake @ 50 g m^{-2} and vermicompost @ 200 g m^{-2} was applied. Seeds of dhaincha (*Sesbania rostrata*) @ 25 kg ha^{-1} was sown in the main field and biomass was incorporated as *in situ* at 45 DAS. The field was well puddled with tractor mounted cage wheel and leveled with leveling board. The treatment plots were formed according to the layout plan. After accounting N contribution from the daincha incorporation, the remaining N was meet out from the organic manures (vermicompost and neem cake). Twenty one days old rice seedlings were transplanted in the main field at a spacing of 25 cm x 25 cm @ one seedling per hill. Irrigation was given as and when required to maintain 2.5 cm height in early stage and 5 cm height of water in later stages of crop growth period up to 15 days before harvest. One cono weeder weeding was done at 20 DAT followed by two hand weeding at 30 and 60 DAT, respectively. Soil of the experimental field was clay loam, moderately drained grouped under *Vertic Ustochrept* (belonging to Noyyal series) taxonomical classification. The soil of the experimental field was low in available N, medium in available P and high in available K. The normal climatic condition of the location (mean of 60 years) is as follows: mean annual rainfall of Coimbatore is 657 mm distributed over 47 rainy days. The annual mean of maximum and minimum temperatures are 31.5 and 21.4°C, respectively. The relative humidity ranges from 61 to 91 per cent in the forenoon and 14 to 68 per cent in the afternoon. The mean bright sunshine hours per day are 7.4 hours. During the experimental period, a total rainfall of 244.1 mm was received in 20 rainy days. The mean maximum and minimum temperatures were 30.5°C and 21°C, respectively and the mean relative humidity was 85.60 per cent in the forenoon and 51.00 per cent in the afternoon. The prevailing market prices of commodities were used to work out the economics of different treatments.

RESULTS AND DISCUSSION

Yield Attributes

Productive tillers $hill^{-1}$

The number of productive tillers $hill^{-1}$ was significantly influenced by the rice varieties evaluated under organic farming (Fig 1). CB 05022 (V_9) produced significantly higher number of productive tillers $hill^{-1}$ (14.73). The cultivar CO(R) 48 (V_7) produced 12.13 numbers of productive tillers $hill^{-1}$ which was on par with the variety White ponni (V_2). The Mappillai samba (V_3) produced lesser number of productive tillers $hill^{-1}$ (5.00) compared with other rice varieties evaluated under organic farming. The reason of difference in effective tillers $hill^{-1}$ is the genetic makeup of the variety, which is primarily influenced by heredity factors.

Panicle length

It is clearly evident from the results obtained that the panicle length was profoundly influenced by different varieties. Between the varieties, the higher panicle length of 28.53 cm was recorded in variety CO(R) 48 (V_7) followed by CO(R) 51 (V_5) and Jeeraga samba (V_{12}). The variety Kitchili samba (V_4) produced significantly shortest panicles (18.75 cm) and it was on par with KDML 105 (V_{10}) (Fig 1). In the present investigation, the variety CO(R) 48 has higher DMP and hence length of the panicle was high in that variety. Also the results indicated that the differences in length of panicles might be due to genetic makeup of the varieties, which coincides with the observations of Irfan *et al*. (2005).

Panicle weight

Panicle weight was significantly influenced of by the different rice varieties evaluated under organic farming (Fig 1). CB 05022 (V_9) obtained higher panicle weight of 3.09 g which was on par with the variety White ponni (V_2) and it was superior to all other varieties. The lower panicle weight of 1.22 g was found in the KDML 105 (V_{10}). Because of more number of filled grains $panicle^{-1}$ in CB 05022, there might be increase in panicle weight. Physiologically proper partitioning might have occurred from source to sink and as a result the panicle weight could have improved.

Number of filled grains $panicle^{-1}$

Among the varieties CB 05022 (V_9) recorded significantly higher number of filled grains $panicle^{-1}$ (151.20) which was superior to other varieties followed by White ponni (V_2) and it was on par with CO(R) 48 (V_7), Red kavuni (V_{11}), CO 43 (V_6). The variety KDML 105 (V_{10}) recorded significantly lower number of filled grains $panicle^{-1}$(45.33) compared with other varieties (Fig 1).

Fertility percentage

Bhavani (V_1) obtained higher fertility percentage of 88.18 per cent because of less number of unfilled grains (12.28), which was followed by CO(R) 48 (84.43%) and culture CB 05022 (84.28%). The lower fertility percentage of 77.90, 70.87 and 68.93 was recorded in Mapillai samba, CO 43 and CO(R) 51, respectively (Fig 1).

Thousand grain weight

Higher 1000 grain weight (27.42 g) was recorded in Mappillai samba, which might be due to its larger grain size (Fig 1). The lower 1000 grain weight (10.00 g) was found in Jeeraga samba, because of its smaller grain size. Larger variation in grain weight may be due to diverse genetic makeup of cultivars and their differential response to prevalent environment during grain filling stage.

Yield

Grain yield: Perceptible variation in rice grain yield was realized in the evaluation of rice varieties under organic production. The culture CB 05022 produced higher grain

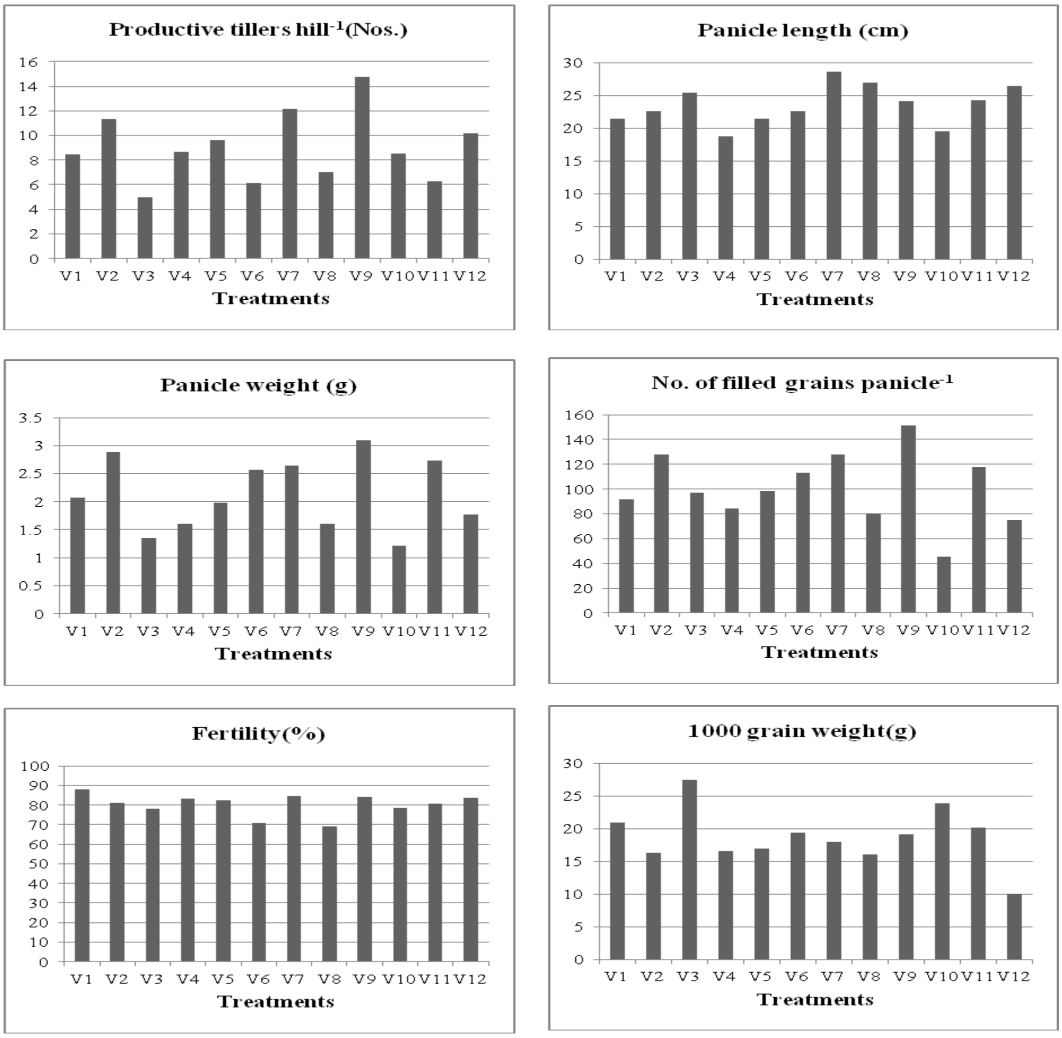

Fig 1: Yield attributes of rice varieties under organic farming.

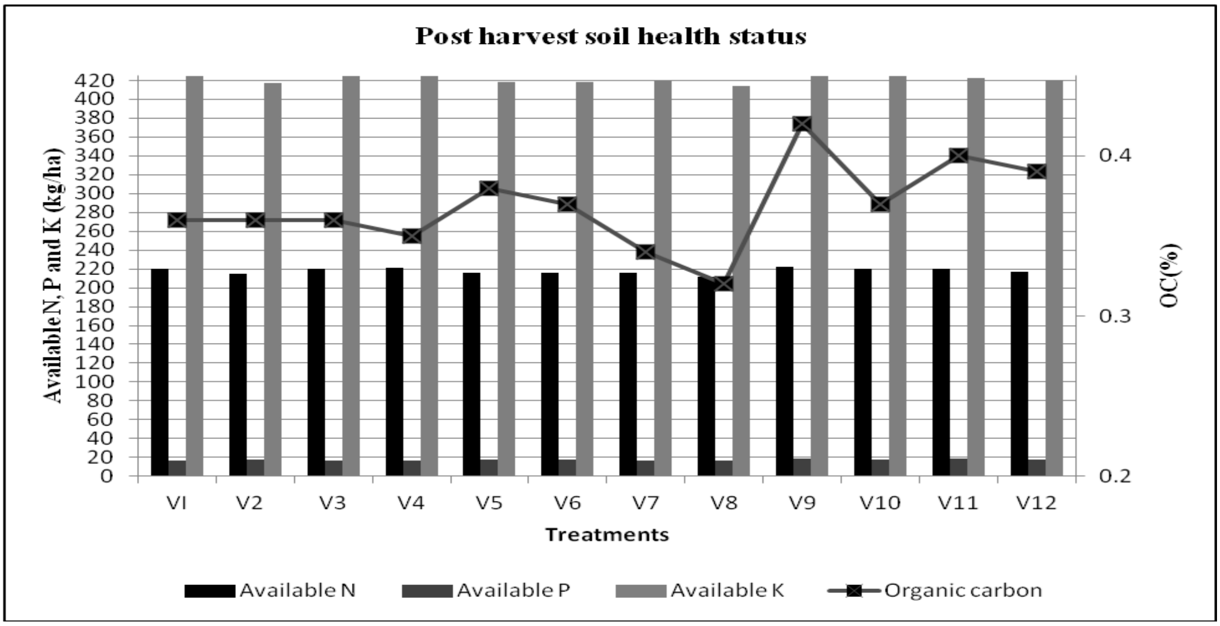

Fig 2: Post harvest soil health influenced by rice varieties under organic farming.

yield of 4877 kg ha^{-1} (Table 1) which was 32, 51, 52, 58, 60, 65, 67, 67, 70, 74 and 82 per cent yield increase, respectively over CO 48 (V_7), White ponni (V_2), Kitchili samba (V_4), Bhavani (V_1), IR 20 (V_5), Jeereaga samba (V_{12}), Red kavuni (V_{11}), Mappillai samba (V_3), CO(R) 43 (V_6), KDML 105 (V_{10}) and CO(R) 51 (V_8). The yield mainly depends on the yield contributing characters like the number of effective tillers hill^{-1}, number of grains panicle^{-1}, thousand grains weight and number of spikelet sterility. In the present investigation the culture CB 05022 had improved growth parameters *viz.,* number of tillers, LAI, DMP and CGR. As a result of increased growth characters observed under this culture, the yield components *viz.,* productive tillers hill^{-1} (14.73), filled grains panicle^{-1} (151.20) and panicle weight (3.09 g) were also higher compared with other varieties. Because of enhanced growth characters with improved yield components, which led to higher grain yield in the culture CB 05022. Lowest grain yield was recorded in CO(R) 51. This was quite natural due to lower tiller production, DMP and LAI. Balasubramaniyan (2003) noted that rice variety Ponni grew taller than IR 20 and recorded more panicle length (28.9 cm), filled grains (94.70) and grain filling percentage compared with IR 20 under the organic farming. Srilatha *et al*. (2011**)** reported that JGL-3855 rice variety recorded higher yield (7054 kg ha^{-1}) where compared to other varieties with organic production. Jagadeeshwar *et al*. (2012) reported that the varieties Sugandha samba produced higher grain yield (4.4 t ha^{-1}) during *kharif* and Tellahamas (5.1 t ha^{-1}) during *rabi* under the organic nutrient sources. Rao *et al*. (2013) observed that rice variety RNR 2465 recorded the highest number of panicles (372), total grains (133), filled grains panicle^{-1}(105) and thousand grain weight (23.04 g) and it leads to higher grain (4415 kg ha^{-1}) and straw yield (5865 kg ha^{-1}) under the organic production systems.

Straw yield

Straw yield was significantly influenced by the different rice genotypes evaluated under organic farming. Mappillai

Table 1: Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and economics of rice varieties under organic farming.

Treatments	Grain yield	Straw yield	Cost of cultivation*	Gross Return*	B : C Ratio*
V_1 : Bhavani	3080	4312	31190	44968	1.44
V_2 : White Ponni	3238	5474	31190	48686	1.56
V_3 : Mappillai samba	2926	7542	31220	62518	2.00
V_4 : Kitchili samba	3209	4991	31220	63643	2.04
V_5 : IR 20	3054	4276	31190	36954	1.18
V_6 : CO 43	2872	5358	31190	36757	1.18
V_7 : CO(R) 48	3688	5378	31190	44947	1.44
V_8 : CO(R) 51	2676	5446	31190	34929	1.12
V_9 : CB 05022	4877	6828	31190	71205	2.28
V_{10} : KDML 105	2800	3157	31220	53736	1.72
V_{11} : Red kavuni	2950	5140	31220	59335	1.90
V_{12} : Jeeraga samba	2963	7199	31220	62651	2.01
CD ($P \leq 0.05$)	235	310			

*Data statistically not analysed.

Table 2: Physical parameters of rice varieties under organic farming.

Treatments	Kernel length (mm)	Grain size	Kernel breadth (mm)	Scale	L/B ratio	Grain shape	Hulling percentage	Milling percentage
V_1 : Bhavani	5.6	Medium	1.9	4	2.95	Medium	78.0	72.8
V_2 : White Ponni	5.6	Medium	1.9	4	2.95	Medium	84.0	74.0
V_3 : Mappillai samba	5.6	Medium	1.8	4	3.11	Slender	81.6	73.6
V_4 : Kitchili samba	5.9	Medium	1.8	4	3.28	Slender	74.8	68.0
V_5 : IR 20	5.7	Medium	1.9	4	3.00	Medium	80.4	71.2
V_6 : CO 43	5.6	Medium	2.1	3	2.67	Medium	88.4	79.2
V_7 : CO(R) 48	5.8	Medium	1.8	4	3.22	Slender	76.0	68.4
V_8 : CO(R) 51	5.8	Medium	1.8	4	3.22	Slender	71.6	65.6
V_9 : CB 05022	5.9	Medium	1.9	4	3.11	Slender	70.0	60.0
V_{10} : KDML 105	7.0	Long	1.8	4	3.89	Slender	85.2	78.0
V_{11} : Red kavuni	5.6	Medium	2.0	4	2.80	Medium	76.0	66.8
V_{12} : Jeeraga samba	4.0	Short	1.8	4	2.22	Medium	82.8	77.2

*Data statistically not analysed.

samba (V_3) recorded significantly higher straw yield of 7542 kg ha^{-1} and followed by the variety Jeeraga samba (V_{12}) and CB 05022 (V_9). The varieties White ponni (V_2), CO(R) 51 (V_8), CO 43 (V_6) and CO(R) 48 (V_7) were produced statistically on par straw yield of 5474, 5446, 5358 and 5378 kg ha^{-1} respectively (Table 1). Significantly lesser straw yield was realized in KDML 105 (V_{10}) with 3157 kg ha^{-1}.

Economics

The cost of cultivation was varied slightly in all varieties from (` 31,190 to 31,220 $ha^{-1}$). The highest net return of ` 40,015 ha^{-1} was recorded in CB 05022 and with highest B:C ratio of 2.28 because of higher grain yield and it was followed by Kitchili samba, Jeeraga samba and Mappillai samba (Net return: ` 32423, ` 31431 and ` 31298 $ha^{-1}$ with B:C ratio 2.04, 2.01 and 2.00, respectively). The lowest grain yield was recorded in CO 51 and KDML 105 but KDML105 was economically viable because the cost of produce was higher (` 17.50 kg^{-1}) with B:C ratio of 1.72 (Table 1). The variety CO(R) 51 registered lowest net return of ` 3739 ha^{-1} with B:C ratio of 1.12. Income from a crop is determined by its yield level, produce market price and cost incurred on its cultivation. Eventually, under similar cost of production, the cultivars produced higher yields provide more returns and benefit per rupee invested. Hossain *et al*. (2008) observed that the B:C ratio of rice variety Fakhre malakand was highest (2.36) compared to all other varieties under organic production. Rao *et al*. (2013) reported that rice variety RNR 2465 recorded higher gross returns (` 91233 $ha^{-1}$), net returns (` 45483 ha^{-1}) due to higher grain yield. Ranjitha *et al*. (2013) found that the variety KRH 2 recorded maximum B:C ratio of 2.07 under SRI method of cultivation with the organic nutrient management practices.

Physical Quality Parameters

Kernel length and breadth

Among these varieties, KDML 105 (V_{10}) obtained higher kernel length of 7 mm and classified long size category. Jeeraga samba (V_{12}) recorded kernel length of 4.00 mm and classified as short. The other varieties, Bhavani (V_1), White ponni (V_2), Mappillai samba (V_3), CO 43 (V_6), Red kavuni (V_{11}), IR 20 (V_5), CO(R) 48 (V_7), CO(R) 51 (V_8), Kitchili samba (V_4) and CB 05022 (V_9) were registered the kernel length ranging from 5.6-5.9 mm and they were classified as medium size category (Table 2). The variety CO 43 (V_6) variety recorded numerically higher kernel breadth of 2.1 mm, and it was grouped under Scale 3. The all other varieties evaluated were registered kernel breadth ranging from 1.8 to 2.0 mm and they were grouped under Scale 4.

Length breadth ratio

Among the different rice varieties evaluated under organic farming, KDML 105 (V_{10}) recorded the higher L/B ratio of 3.89 and classified as slender grain shape group. The varieties like Kitchili samba (V_4), CO(R) 48 (V_7), CO(R) 51 (V_8), Mappillai samba (V_3) and culture CB 05022 (V_9) were recorded L/B ratio ranging from 3.28 to 3.11 and comes under slender grain shape category (Table 2). Remaining varieties Bhavani (V_1), White ponni (V_2), IR 20 (V_5), CO 43 (V_6), Red kavuni (V_{11}) and Jeeraga samba (V_{12}) were classified as medium in grain shape.

Hulling and milling percentage

Varieties evaluated under organic production, CO 43 (V_6) obtained higher hulling percentage (88.4%) followed by KDML 105 (V_{10}), White ponni (V_2), Jeeraga samba (V_{12}), Mappillai samba (V_3), IR 20 (V_5), Bhavani (V_1), CO(R) 48 (V_7), Red kavuni (V_{11}), Kitchili samba (V_4), CO(R) 51 (V_8) (Table 2). The culture CB 05022 (V_9) registered lower hulling percentage (70.0%). The seventy percent or more are the desirable hulling characteristics for rice (Rita and Sarawgi, 2008).The same trend was followed in milling percentage of various rice varieties evaluated under organic production.

Post harvest soil nutrient status

In present investigation, the soil available N was high in the culture CB 05022 (222 kg ha^{-1}) followed by Kitchili samba, Mappillai samba, KDML 105, Bhavani, Red kavuni and Jeeraga samba and it was ranged from 217 to 221kg ha^{-1} (Fig 2). By increasing the microbial load nutrient status level was increased. In the present study, the culture CB 05022 has higher population of microbes so it will reflect higher nutrient status of soil. The culture CB 05022 was recorded significantly higher available P of 18.8 kg ha^{-1} and lower in CO(R) 51 (16.1 kg ha^{-1}). Available K in soil was higher in the variety Kitchili samba of 429 kg ha^{-1} and OC was high in the plot with CB 05022 (0.42%).

CONCLUSION

Organic farming may not lead to higher production and income in the short run as its returns are of long term nature. It is initially a soil building process. Organic farming systems ensures built in capacity to maintain and increase soil health and fertility leading to sustained increase in yield and production and low variability of crops thus results in stabilization and a high jump in income and sustainability in agriculture. Based on the experimental results it may be concluded that the varieties varied widely among themselves for various parameters recorded under organic production system. In terms of yield, quality and economics, the culture CB 05022 was superior under organic farming. Kitchili samba, Mappillai samba and Jeeraga samba were the other promising varieties to support organic rice farming.

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