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EVALUATION OF THREE *JAPONICA* AND ONE *INDICA* RICE VARIETIES FOR YIELD AND YIELD COMPONENTS

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ABSTRACT

Present research work was conducted during rice growing season of 2013 at the paddy experimental field of Tsukuba International Center, Japan International Cooperation Agency (JICA) Japan. The experiment was laid out in a Randomized Complete Block Design with three replications. Three *japonica* and one *indica* varieties of rice *viz.* Koshihikari, Fukuhibiki, Hitomebore and IR-50 were screened out. High yielding and best performing varieties in respect to yield and yield components were identified. All varieties were transplanted at spacing of 30 cm x 15 cm using three seedlings per hill. The results showed that varieties IR-50, Koshihikari and Hitomebore performed better in terms of yield as compared to Fukuhibiki by producing 7.77, 6.96 and 6.75 tons ha^{-1} more yield, respectively. The variety IR-50 with high paddy grain yield also retained high number of panicles/m^2, high ripening ratio and reasonable spikelets/m^2. On the basis of these results, IR-50, Koshihikari and Hitomebore gave high biological and economical yield, therefore these varieties are recommended for cultivation in specific rice growing areas.

Keywords: *indica*, *japonica*, rice varieties, yield, yield components

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for nearly half of the world's population; most of them are living in developing countries (Bakhsh *et al.,* 2012). The rice crop occupies one-third of the world's total area planted to cereals and provides 35 to 60% of the dietary calories consumed by more than 3 billion people (Fageria *et al.*, 2003). It is also the most important food crop in South and South-east Asia and is a staple food of the people of this region. In a study, Bishwajit *et al.* (2013) found that rice provides around 60 to 70% of calories and 50 to 55% of protein intake in the South Asian population. Iqra (2015) reported that Pakistan is the 4th largest producer and 3rd largest exporter of rice and exported around 3.29 million tons of rice during 2011-12. Pakistan has diverse agro-climatic conditions for growing several types of rice i.e. fine grain, coarse grain and round grain japonica type. Japan is the biggest consumer of japonica rice and imports 500,000 tons rice per year (Kashif, 2011). Therefore, there are large

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opportunities to grow japonica rice and export huge quantities of it to Japan and other consuming countries. Currently, most of the farmers producing rice rely on traditional technology with low use of improved inputs. Average rice yield in the developing countries is very low and ranges between 3 and 4 tons ha^{-1} (FAO, 2012). The major cause of low yield is due to non-availability of improved varieties, improper nutrient management, low plant population and less attention to plan and conduct research and development (FAO, 2011). Most of our rice growers depend on cultivation of low yielding local varieties.

To increase rice productivity in the various rice growing areas, farmers must have good knowledge of rice production and field management. Therefore research is needed to introduce or develop high yielding rice varieties with good eating/ cooking quality for the benefit of rice farmers and consumers. Among crop improving activities, varietal testing and selection have an important role at any location. An increase of rice production depends on the availability of high yielding varieties (Abd El-Wahab, 1998). The area under rice cultivation is same but population has become multiple. The opportunities available are to enhance yield of rice vertically rather to increase cultivated area (Cassman *et al.*, 2003). Alam *et al.* (2008) reported that among production factors varietal selection at any location has an important role. From the stand point of the above most important issue of low yield per hectare, the present research study was conducted with the aim to compare various yield characteristics of different rice varieties and to get knowledge about yield attributes of different rice varieties. The findings of the experiment may be useful to scholars, researchers and farmers to manage particular varieties for higher yield goal.

MATERIALS AND METHODS

This experiment was designed and conducted during the growing season of 2013 at the experimental field of Tskuba International Centre, JICA, Japan. Three *japonica* (Koshihikari, Fukuhibiki, Hitomebore) and one *indica* (IR-50) varieties of rice were tested. Around 30-day-old seedlings were transplanted in the field in a Randomized Complete Block Design (RCBD) with three replications. Before transplanting, the field was well ploughed and irrigated. Based on soil testing results of the field, basal dose of fertilizer at the rate of 50-100-60 kg ha^{-1} N, P and K in the form of ammonium sulfate (N 21%), super phosphate (P_2O_5 17.5%) and potassium chloride (K_2O 60%) were applied and field was then puddled properly. Field plots were then prepared as per layout plan. Prior to transplanting, nursery seedlings of all the varieties were treated with Imidacloprid Tiadinil pesticide V-Get Admire (granular) at the rate of 50 g per box against insect and blast disease during growth period. Plot size was kept as 7.5 m x 2.7 m. The row to row and plant to plant distance was kept as per standard (30 cm x 15 cm). Standard agronomic practices were carried out evenly in all the experimental units throughout growing period. A chemical weeding was done by application of Hokuto 1.5 kg per whole field area after 10 days of transplanting to ensure proper weed control. Top dressing was applied at panicle initiation stage as 20-20 kg ha^{-1} N and P. Thirty five to forty hills were uprooted from each plot to collect the yield and yield components data. Number of panicles from each hill were counted, averaged and converted into the number of panicles/m^2. Out of uprooted hills, for the yield components analysis, the most nearest two hills to average weight of panicles hill^{-1} were selected. Spikelets from each panicle of 2 selected hills were separated with the help of soccer threshing procedure. These were counted by using the multi auto grain counter and changed to the spikelet number per panicle. Counted spikelets were separated into mature and sterile spikelets using pure water for *indica* variety and saline solution of specific gravity 1.06 for *japonica* varieties (Shouichi *et al.*, 1976). In addition, ripening ratio in percentage was calculated by dividing total number of matured spikelets to the total number of counted spikelets and multiplied by 100. Selected mature spikelets were dried and counted again on grain counter and weighed by an electronic balance and finally moisture content for each grain sample was measured by the moisture meter. Percentage contribution of each variety for yield and yield components was computed by dividing the mean value of each trait by average value of all varieties of that trait and multiplied by 100. The data were statistically analyzed through computer software "Statistix 8.1". The analysis of variance (ANOVA) for all the traits was carried out according to Gomez and Gomez (1984) for determining significance among four rice varieties while means for different traits were separated using Tukey's Honesty Significant Difference (HSD) test at 5% probability level as described by Stewart (1995).

RESULTS

The data (Table 1) on comparison of mean values from the analysis of variance for different yield traits of rice varieties Koshihikari, Fukuhibiki, Hitomebore and IR-50 differed significantly for all yield traits with respect to each other except ripening ratio for which the varieties were statistically non-significant.

Paddy yield per hectare

Results clearly indicate that all varieties produced considerably higher grain yield, ranging from 5.81 to 7.7 tons ha^{-1} (Table 2). Higher paddy yield (7.77 tons ha^{-1}) was harvested from *indica* variety IR-50 while the lowest paddy yield (5.81 tons ha^{-1}) was produced by *japonica* variety Fukuhibiki.

Number of panicles per m^2

The results show non-significant differences among varieties IR-50 and Hitomebore Koshihikari but they differed significantly from variety Fukuhibiki. Results further revealed that variety IR-50 remained first by producing 432 number of panicle/m^2. The lowest number of panicles (285/m^2) were counted in variety Fukuhibiki.

Number of spikelets per panicle

In case of spikelets per panicle, the results showed significant difference among the rice varieties tested. The maximum number of spikelets per panicle (87) was shown by variety Koshihikari and maximum number of spikelets by Hitomebore.

Table 1. Mean squares from analysis of variance for yield and yield components in various varieties of rice (*Oryza sativa* L)

Characters	Sources of variation	Degrees of Freedom	Mean Squares	F-Ratio	P Values	CV%	SE	C.D 5%	C.D 1%
Yield Tons/ha	Replication Varieties Error	2 3 6	2.4051 1.9557 0.4619	4.2*	0.0629	9.96	0.55	1.10	1.46
Number of Panicals/ m^2	Replication Varieties Error	2 3 7	2001.75 13242.68 698.65	19.0**	0.0018	6.99	21.6	42.73	56.76
Number of Spikelets/ panicle	Replication Varieties Error	2 3 8	265.1415 194.6041 42.484	4.58*	0.0539	8.30	5.32	10.54	14.00
Ripening Ratio (%)	Replication Varieties Error	2 3 6	51.6469 37.106075 14.49491	2.56^{NS}	0.1509	4.42	3.11	6.15	8.18
1000- Grain Weight (g)	Replication Varieties Error	2 3 6	1.44083 13.76972 0.61639	22.3**	0.0014	3.00	0.64	1.27	1.69
Number of Spikelets/m^2 (x 10^3)	Replication Varieties Error	2 3 7	71.42799 84.77453 4.32699	19.6**	0.0017	7.02	1.70	3.36	4.47

** Significant at 0.05 probability level, * Significant at 0.05 probability level, NS= Non- significant

Table 2. Yield and yield components in various varieties of rice (*Oryza sativa* L.)

Varieties	Yield (Tons ha^{-1})	No. of panicles/ m^2	No. of Spikelets/ panicles	Ripening ratio (%)	1000-grain weight (g)	No. of Spikelets/ m^2 (x 103)
IR-50	7.77 a	432 a	80.3 ab	89.7 a	22.9 b	34.8 a
Koshihikari	6.96 ab	377 a	86.7 a	81.8 a	25.5 a	32.6 ab
Fukuhibiki	5.81 b	285 b	80.0 ab	84.8 a	27.9 a	22.8 c
Hitomebore	6.75 ab	419 a	67.4 b	88.0 a	26.9 a	28.3 bc
Means followed by a common letter in the column in each variety are not significantly different at 5% level by HSD. Each mean value is a mean of three replications.						
Average	6.8	378.3	78.6	86.1	25.8	29.6
F probability (%)	6.25	0.18	5.37	15.09	0.14	0.17
Percent increase or decrease of values from the average						
IR-50	114	114	102	104	89	117
Koshihikari	102	100	110	95	99	110
Fukuhibiki	85	75	102	98	108	76
Hitomebore	99	111	85	102	104	96
Difference between highest and lowest percent	29	39	25	9	19	41

Ripening ratio

Table 1 summarizes no significant difference among the varieties for ripening ratio. Nevertheless based on an average, variety IR-50 showed the highest ripening ratio of 89.7%, closely followed by Hitomebore 88%. The lowest ripening percentage (81.8) was indicated by variety Koshihikari.

1000-grain weight
Like other traits, 1000-grain weight also differed significantly among rice varieties, which ranged from 22.9 to 27.9 g. Maximum 1000-grain weight was recorded in variety Fukuhibiki (27.9 g), followed by variety Hitomebore (26.9 g). IR-50 showed less 1000-grain weight (22.9 g) among all the varieties.

Number of spikelets per m^2
By giving highest number of panicles/m^2, variety IR-50 also gave greater number (34.8) of spikelets/m^2, followed by Koshihikari (32.6) while lowest numbers of spikelets /m^2 were recorded from variety Fukuhibiki. Results presented in Table 1 further elucidate the differences between the values of different yield and yield contributing traits of the varieties studied. The variety IR-50, showed 29%, 39%, 9% and 41% more in yield, panicles, ripening and spikelets number, respectively than Japanese variety Fukuhibiki. Whereas Koshihikari produced 25% more number of spikelets per panicle than Hitomebore. Similarly in case of 1000-grain weight variety Fukuhibiki showed 19% superiority than *indica* variety IR-50.

Table 3. Contribution of yield components to yield

Variety	Yield (Tons ha^{-1})	Number of panicles/ m^2	Number of Spikelets/ panicles	Ripening ratio (%)	1000 grain weight (g)	Number of Spikelets/ m^2 (x 10^3)
IR-50	7.77	++		++	-	++
Koshihikari	6.96		++	-		+
Fukuhibiki	5.81	- -			++	- -
Hitomebore	6.75	+	- -	+	+	-

Remark ++, +, - and - - indicate highly positive effect, positive effect, negative effect and highly negative effect respectively.

Results presented in Table 3 illustrate the contributions of each yield component to paddy yield. Higher number of panicles/m^2, number of spikelets/m^2 and significantly highest ripening ratio by *indica* variety IR-50 positively contributed in paddy yield ha^{-1}. The japonica variety Koshihikari by producing significant number of spikelets per panicle along with better number of spikelets/ m^2 played an important role in increasing yield ha^{-1}. The 1000-grain weight contributed in paddy yield per hectare of variety Fukuhibiki. In variety Hitomebre, number of panicle/m^2, 1000-grain weight and better ripening ratio contribute reasonable effect on its yield. Table 3 further revealed that ripening ratio in case of Koshihikari and 1000-grain weight in variety IR-50 does not show any affirmative effect on yield. Similarly, in case of Japanese varieties in Fukuhibiki number of panicles/m^2, number of spikelets/m^2, and Hitomebore number of spikelets per panicles and number of spikelets/m^2 did not show significant role in boosting up the final paddy yield per hectare.

DISCUSSION
Researchers are developing rice varieties for the benefit of rice growers and consumers. They conduct research to improve rice for higher yields, resistance to pests and diseases, tolerance of environmental stresses, and less farm inputs requirement. Different studies showed that improved varieties had positive impact on rice productivity. The analysis of variance showed significant

differences among the varieties for most of the yield traits studied except ripening ratio (Table 2). Highly significant differences among varieties for most of the traits were might be due to existence of genetic differences among the varieties (Yaqoob *et al.,* 2012).

Among all the traits in any crop plants, yield is considered as the most important character. In rice, special attention is required to boost-up the yield to its maximum level, because it plays a vital role in strengthening the socio-economic condition of the growers and ultimately the country. The mean performance of the varieties presented in Table 1 indicate that variety IR-50 was found 12% higher than Koshihikari, 15% than Hitomebore and 34% than Fukuhibiki in paddy yield per hectare. Highest paddy yield produced by variety IR-50 was mainly due to highest number of panicle/m^2 and considerable number of spikelets/m^2. These results are in conformity with the findings of Eizenga *et al.* (2006); these researchers also found *indica* varieties superior than *japonica* in yield. Regarding mean performance based on number of spikelets/panicle, among all the varieties, Koshihikari had maximum number of spikelets per panicle (86.7) followed by IR-50 (80.3) while Hitomebore produced minimum number of spikelets (67.4) per panicle. It might be due to high capacity of number of total rachis branches, maximum number of spikelets on primary and secondary rachis branches in Koshihikari as compared to rest of varieties. Statistically no significant differences were found among means of *japonica* varieties (Koshihikari, Fukuhibiki, Hitomebore) but they differed significantly from *indica* variety IR-50 in yield contributing trait (1000-grain weight). Significant differences in rice genotypes for the trait 1000-grain weight have also been reported by earlier workers like Zheng-jin *et al.* (2006).

CONCLUSION

On the basis of present research, it is concluded that different varieties performed differently for various agronomic traits due to differences in their genetic makeup. The variety with high paddy yield was paired with maximum number of panicle/m^2 and number of spikelets/m^2. These investigations also show that varieties IR-50, Koshihikari and Hitomebore gave higher yields. Therefore these varieties are recommended for cultivation to get high productivity.

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