Amazonian Journal of Plant Research *©2017 Universidade Federal do Pará*
This paper is available online free of all access charges – Faculdade de Engenharia Agronômica
https://www.ajpr.online - Amaz. Jour. of Plant Resear. 4(2):572-579. 2020

Amazonian Journal of Plant Research

Original Paper

Comparative efficiency of yield and yield contributing characters in F_4 Generations of *Oryza sativa* L.

Kamrul Islam[1], M. S. R. Bhuiyan[2], Mahbuba Jamil Tithi[1] and Md. Maksudul Haque[3]*

1 Agriculture Extension Officer, Ministry of Agriculture, Bangladesh

2 Professor, Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh

3 Senior Scientific Officer, Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Dhaka 1207, Bangladesh

Received: 07 May, 2020. Accepted: 10 June, 2020
First published on the web June, 2020
Doi: 10.26545/ajpr.2020.b00067x

Abstract

The knowledge about the relative efficiency of the different breeding methods may greatly help the plant breeder in selecting a better method to be adopted in a particular crop. In the present experiment, thirteen characters were studied to find out the suitable traits for the improvement of rice yield. Plant height exhibited the highest plant height (133.9 cm) in G_{23} where as the minimum plant height (91.69 cm) was observed in G_{21}. The lowest days to maturity (139.5 days) were observed in G_{13} and the maximum days to maturity (146.1days) was observed in G_{15}. The highest number of effective tiller per plant (16.53) was observed in G_{20}; whereas the minimum number of primary branches/plant (9.936) was observed in G_{17}. The highest yield (10.26 ton/ha) was recorded in G_{17} and the minimum number of yield (7.281 ton/ha) was recorded in G_{23}. The seven (7) genotypes viz. G_{17}, G_9, G_{16}, G_{14}, G_{27}, G_{15} and G_{13} were selected as early high yielding Boro lines for future use. Visual selection based on the number of tillers and number of panicles per plant was very effective for increasing yield in bulk and pedigree methods. So direct selection based on these traits would be effective for improvement of these F4 materials.

Key-words: Comparative Efficiency, Yield, Character, F4 Generations and *Oryza sativa* L.

Introduction

Rice is one of the most important staple food crops of the world and over half of the global population depends on it for their feed (Sasaki, 2005). The world population will grow up to 8.5 billion till 2030 and 9 billion in 2050 for that to feed this growing population about 40% more rice will be required (Singh et al., 2013). Currently, the issue of food security is a global and has become the main agenda in all countries as a result of the shrinking of agricultural land, global climate change, and population growth (Ma et al., 2018).

Rice is central to the lives of billions of people around the world and one of the oldest domesticated grain (~10,000 years). It is staple food for 2.5 billion people and growing the largest single use of land for producing food, covering 9% of the earth's arable land. It provides 21% of global human per capita energy and 15% of per capital protein. Asia accounts for over 90% of the world's production of rice. India and Indonesia are the major countries in Asia producing the 85% of the rice produced in the world which is used for direct human consumption.

Enhancement of grain yield remains the principal objective of most breeding programmes. Several selection procedures (pedigree selection, bulk population breeding, single-seed descent, etc.) have been proposed for improving grain yield of selfpollinated crops. However, only a few of these procedures have been used extensively in rice. The

Md. Maksudul Haque
E-mail: maksudulhq@gmail.com

knowledge about the relative efficiency of the different methods may immensely help the plant breeder in choosing a better method to be adopted in a particular crop.

The quantitative characters are the best indicators of yield. Yield is a complex character, which is effected by a number of its component characters and the environment, where it is grown. Thus selection for grain yield becomes difficult unless the associations between the yield contributory characters are known. So, measurement of correlation coefficient helps to identify the relative contribution of component characters towards yield (Panse, 1957). The correlation between grain yield and a component character may sometimes be misleading due to an over estimation or underestimation for its association with other characters. Thus yield components have influence on ultimate yield both directly and indirectly (Tukey, 1954). The diversity of phenotypic characters of a plant is the appearance of plant traits in a growing environment is the result of interaction between genetic and environmental factors (Hao et al., 2010; Kumar et al., 2010). If the diversity of phenotypes is high, the opportunity to produce superior varieties is greater. There are various desired phenotypes, particularly at the harvest time, the plant height, the panicle length, the weight of a thousand grains, the grain content and the potential yield (Ishak, 2012; Sutaryo, 2014; Mara et al., 2015).

Plant breeders still use the approach although this is an old method. Morphological characters are important for the preliminary assessment of genotypes (Hien et al., 2007). In order to evaluate variation among genotypes, grain morphology was also taken into account as vital factor (Mathure et al., 2011). Morphological and physiological characterization is a traditional and general approach for the determination of genetic diversity as well as variation (Hien et al., 2007). However, they play crucial role in the selection and utilization of proper parents in breeding program. Moreover, yield and yield contributing characters are very helpful through which overall performance of genotypes could be determined. Considering the above facts the present study, has, therefore, been undertaken to assess the character association and contribution of the characters towards grain yield in F4 generation of rice and to find out the direct and indirect effect of component characters on grain yield in F4 generation of rice.

Material and methods

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka – 1207. Twenty seven (27) genotypes (22 F_4 materials and 5 check varietis) of *Oryza sativa* L were selected for experiment. Among them, twenty two were F_4 materials and 5 check varieties (Table 1). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

Table 1. List of genotypes, their serial number and their sources of collection.

Serial No.	Designation	Source
G_1	BR 21	BRRI
G_2	BR 24	BRRI
G_3	BRRI dhan 28	BRRI
G_4	BRRI dhan 29	BRRI
G_5	BRRI dhan 36	BRRI
G_6	BR 21 X BRRI dhan 28, S-5, P-1	SAU
G_7	BR 21 X BRRI dhan 28, S-5, P-2,	SAU
G_8	BR 21 X BRRI dhan 28,S-5, P-3	SAU
G_9	BR 21 X BRRI dhan 28,S-5, P-4	SAU
G_{10}	BR 21 X BRRI dhan 28, S-5, P-6	SAU
G_{11}	BR 21 X BRRI dhan 29, S-6, P-1	SAU
G_{12}	BR 21 X BRRI dhan 29, S-6, P-2	SAU
G_{13}	BR 21 X BRRI dhan 29, S-6, P-3	SAU
G_{14}	BR 21 X BRRI dhan 29, S-6, P-4	SAU
G_{15}	BR 21 X BRRI dhan 29, S-6, P-5	SAU
G_{16}	BR 21 X BRRI dhan 29, S-6, P-6	SAU
G_{17}	BR 21 X BRRI dhan 29, S-6, P-7	SAU
G_{18}	BR 21 X BRRI dhan 36, S-1, P-1	SAU
G_{19}	BR 21 X BRRI dhan 36, S-1, P-2	SAU
G_{20}	BR 21 X BRRI dhan 36, S-1, P-3	SAU
G_{21}	BR 21 X BRRI dhan 36, S-1, P-4	SAU
G_{22}	BR 21 X BRRI dhan 36, S-1, P-5	SAU
G_{23}	BR 24 X BRRI dhan 28, S-10, P-2	SAU

G_{24}	BR 24 X BRRI dhan 28, S-10, P-5	SAU
G_{25}	BR 24 X BRRI dhan 29, S-5, P-1	SAU
G_{26}	BR 24 X BRRI dhan 29, S-5, P-3	SAU
G_{27}	BR 24 X BRRI dhan 29, S-5, P-4	SAU

Results and Discussion

The present study was undertaken with 27 genotypes (22 F_4 materials and 5 check varietis) of *Oryza sativa* L. Seedlings were transplanted in the main field in Randomized Complete Block Design (RCBD) with three replications. Data on various yield attributing characters such as, days to flowering, days to maturity, plant height (cm), total number of tiller /plant, total number of effective tiller/plant, panicle length (cm), number of primary branches per panicle, number of secondary branches per panicle, number of filled grain per panicle, number of unfilled grain per panicle, Yield/ Plant (gm), thousand seed weight (g) and yield (ton/ hectare were recorded.

Days to flowering

In this study out of 22 genotypes of F_4 generations, the maximum period (122.7 days) for days to flowering was seen in G_{20} (BR 21 × BRRI dhan 36, S-1, P-3). On the other hand, check variety BR 21 took 122.7 days and BRRI dhan 29 took 136.3 days to flowering. The minimum days of flowering (117.7 days) was recorded in G_6 (BR 21 × BRRI dhan 28, S-5, P-1). The rest of the genotypes showed different flowering time (Table 2).

Table 2. Mean performance of yield and yield contributing characters of 27 genotypes of rice.

Genotypes	F	M	PH	NTT	NET	PL	NPB	NSB	TNSP	NFG	NUFG	YP	TSW	Y (t/ha)
G_1	122.7	151.9	106.2	14.17	13.53	24.59	9.921	33.55	196.8	178.6	18.23	38.03	19.46	8.300
G_2	121.3	141.3	117.9	12.83	11.75	24.83	10.18	34.36	198.7	171.1	27.60	29.16	21.63	7.239
G_3	125.7	148.8	92.20	15.72	15.18	22.34	9.186	23.68	134.9	111.3	23.53	33.27	20.75	8.175
G_4	136.3	161.6	100.3	15.99	15.02	25.63	11.21	35.74	182.6	153.1	29.50	41.91	17.74	9.380
G_5	121.3	147.0	115.3	14.73	14.31	24.49	10.24	31.59	167.1	151.1	16.00	36.58	20.96	9.012
G_6	117.7	141.5	132.2	12.18	10.97	27.04	12.26	36.83	207.9	178.0	29.83	40.66	24.09	7.302
G_7	121.3	141.0	121.4	11.53	11.21	25.40	11.01	37.86	184.0	164.2	19.73	38.20	26.29	8.476
G_8	119.7	141.1	127.4	13.49	13.21	27.02	11.72	34.81	201.0	178.4	22.60	47.87	24.50	8.665
G_9	122.0	142.3	113.2	12.35	12.20	25.23	10.70	32.82	165.8	146.2	19.53	35.14	21.88	9.131
G_{10}	120.0	141.7	124.9	10.95	10.33	25.48	10.93	34.14	184.9	156.7	28.17	35.52	25.13	8.388
G_{11}	120.3	142.4	102.7	12.81	12.47	22.56	10.78	39.74	190.9	170.6	20.27	35.64	21.42	8.557
G_{12}	118.0	143.1	106.9	13.61	13.38	21.82	10.23	34.96	176.3	142.7	33.60	28.19	19.38	7.678
G_{13}	118.0	139.5	109.3	11.48	11.25	22.74	10.20	35.69	181.0	164.1	16.90	34.65	21.71	8.461
G_{14}	119.3	141.1	108.8	11.66	11.07	23.04	9.844	29.71	162.6	143.0	19.63	31.52	18.88	8.786
G_{15}	119.0	146.1	103.4	12.63	12.12	22.42	11.00	32.11	164.4	151.8	12.60	32.96	20.59	8.416
G_{16}	119.3	139.7	111.1	11.19	10.87	24.04	12.24	38.58	203.8	189.6	14.17	32.28	20.21	8.989
G_{17}	119.0	143.1	111.3	10.36	9.936	23.60	10.34	39.85	200.5	185.0	15.50	39.60	21.21	10.26
G_{18}	121.0	140.3	108.5	12.60	12.40	21.79	10.67	26.90	154.9	142.1	12.77	33.57	23.34	8.060
G_{19}	120.0	143.4	105.7	14.85	14.26	22.37	10.00	29.31	134.3	117.4	16.90	29.02	20.80	7.711
G_{20}	122.7	145.9	95.90	17.07	16.53	21.41	11.29	35.01	178.0	161.5	16.57	36.24	19.46	8.513
G_{21}	121.3	143.0	91.69	16.23	15.05	21.36	10.68	28.69	155.5	134.4	21.10	34.68	18.96	8.589
G_{22}	120.0	141.0	97.21	14.65	13.96	21.39	10.03	29.04	145.8	133.4	12.37	37.48	21.13	7.531
G_{23}	120.3	146.0	133.9	12.24	11.64	25.62	10.21	33.17	176.7	155.1	21.63	32.99	22.09	7.281
G_{24}	123.0	142.9	115.4	13.87	12.91	23.40	10.63	30.31	151.7	138.2	13.47	33.83	20.42	8.716
G_{25}	118.0	141.1	119.8	13.08	12.85	25.27	10.97	34.29	180.3	163.8	16.57	33.82	21.05	8.408
G_{26}	119.0	142.8	116.4	13.26	12.76	23.96	11.50	34.45	175.9	161.1	14.77	33.26	18.25	8.823
G_{27}	121.0	145.0	116.3	13.70	13.33	24.21	10.97	36.10	161.4	141.9	19.50	34.58	19.34	7.373
Maximum	136.3	161.6	133.9	17.07	16.53	27.04	12.26	39.85	207.9	189.6	33.60	47.87	26.29	10.26
Minimum	117.7	139.5	91.69	10.36	9.936	21.36	9.186	23.68	134.3	111.3	12.37	28.19	17.74	7.239
Mean	121.025	143.877	111.305	13.304	12.759	23.816	10.701	33.454	174.731	154.989	19.742	35.208	21.136	8.378
CV (%)	1.38	0.79	12.38%	5.21%	5.03%	3.86%	4.41%	6.79%	4.35%	3.83%	22.02%	4.30%	4.99%	6.36%

DF = Days to flowering, DM = Days to maturity, PH= Plant height, NTT = Number of total tiller per plant, NET=Number of effective tiller per plant, PL= Panicle length, CV (%) = Coefficient of Variation, NPB= Number of primary branches per panicle, NSB= Number of Secondary branches per panicle, NFG = Number of filled grain per panicle, NUFG= Number of unfilled grain per panicle, TNSP= Number of total spikelet per panicle, CV (%) = Coefficient of Variation, YP= Yield per plant (gram), TSW= Weight of thousand seed (gram), Y (t/ha) = Yield (ton per hectare), CV (%) = Coefficient of Variation.

Days to maturity

In this study out of 22 genotypes of F_4 generations, the highest number of days to maturity (146.1days) was recorded in G_{15} (BR 21 × BRRI dhan 29, S-6, P-5). On the other hand, check variety BR 21 took 151.9 days for maturity and BRRI dhan 36 took 147.0 days for maturity. G_{13} (BR 21 × BRRI dhan 29, S-6, P-3) took minimum days (139.5 days) for maturity. G_{16} was also suitable for selection as early lines aspect of early days to maturity. The rest of the genotypes showed different maturity times in (Table 2). Variation of days to maturity in 22 genotypes of F_4 populations is presented in Figure 1. According to Pramudyawardani et al. (2015), flowering stage is controlled by the action of dominant additive genes, therefore the more dominant genes are present in one individual, the longer the heading date and it correlates with the length of harvesting time.

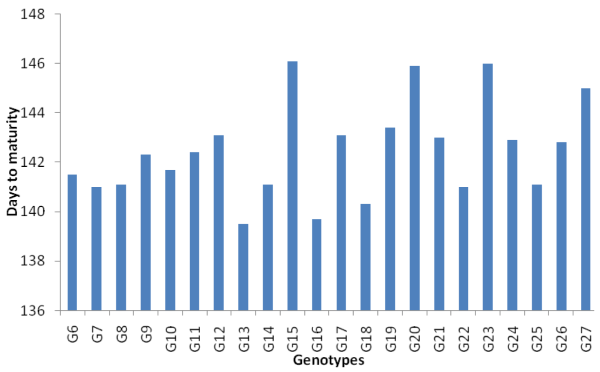

Fig. 1. Variations in days to maturity of 22 genotype of F_4 generations.

Plant height (cm)

In this study out of 22 genotypes of F_4 generations, the highest plant height (133.9cm) was recorded in G_{23} (BR 24 × BRRI dhan 28, S-10, P-2) and the minimum plant height (91.69cm) was recorded in G_{21} (BR 21 × BRRI dhan 36, S-1, P-4). G_{20} (BR 21 × BRRI dhan 36, S-1, P-3) was also suitable for selection as short plant height. The rest of the genotypes showed differential plant height (Table 2). Abdullah et al. (2008) has also confirmed that plants which have a height of 90-110 cm are relatively resistant to lodging. Kustera (2008), assumed that the higher the plant is, the heavier weight is the plant will bear at the base of the stem therefore the lodging resistance of the plant will decrease.

Number of total tillers per plant

Out of 22 genotypes of F_4 generations, the highest number of tillers per plant (17.07) was recorded in G_{20} (BR 21 × BRRI dhan 36, S-1, P-3) and the minimum number of tillers per plant (10.36) was recorded in G_{17} (BR 21 × BRRI dhan 29, S-6, P-7). G_{21} was also suitable for selection in this aspect. The rest of the genotypes showed differential number of tillers per plant (Table 2). The number of tillers will be maximal if the plant has good genetic traits coupled with favorable environmental conditions or in accordance with plant growth and development, the number of productive tillers is an important character in determining potential yield (Husna, 2010). This is due to the number of productive tillers that has a direct effect on the number of produced panicles, the more productive tillers the higher the amount of graincan be obtained (Fadjry et al., 2012). A large number of tillers is better balanced with a large number of productive tillers or a small number of unproductive tillers (Dewi et al., 2009).

Number of effective tillers per plant

In this study out of 22 genotypes of F_4 generations, the highest number of effective tillers per plant (16.53) was recorded in G_{20} (BR 21 × BRRI dhan 36, S-1, P-3) and the minimum number of effective tillers per plant (9.936) was recorded in G_{17} (BR 21 × BRRI dhan 29, S-6, P-7). G_{20} (BR 21 × BRRI dhan 36, S-1, P-3) was suitable for selection in aspect of this trait. The rest of the genotypes showed different number of effective tillers per plant (Table 2). Variation of number of effective tillers per plant in 22 genotypes of F_4 populations is presented in Figure 2. Abdullah et al. (2008) also stated that if the rice which has high potential yield should have the moderate number of tillers (12-18 stems) however they are all productive.

Panicle length (cm)

In this study, out of 22 genotypes of F_4 generations, the highest number of panicle length (27.04 cm) was recorded in G_6 (BR 21 × BRRI dhan 28, S-5, P-1) which was closely followed by G_8 (BR 21 × BRRI dhan 28, S-5, P-3) (27.02) and the minimum panicle length (21.36 cm) was recorded in G_{21} (BR 21 × BRRI dhan 36, S-1, P-4). G_6 and G_8 were suitable for selection as they showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential panicle length (Table 2). Rusdiansyah (2006) grouped panicle lengths into three groups, short (≤20 cm), medium (20-30 cm), and long (> 30 cm). All of thetestedlines, 11 of them include to the medium category and the remaining genotype9 linesare included to the long category. The results of the study by Lestari et al. (2011) has showed that panicle length was positively and significantly correlated to the number of filledgrains, the total number of grains per panicle, and the weight of thousandgrains.

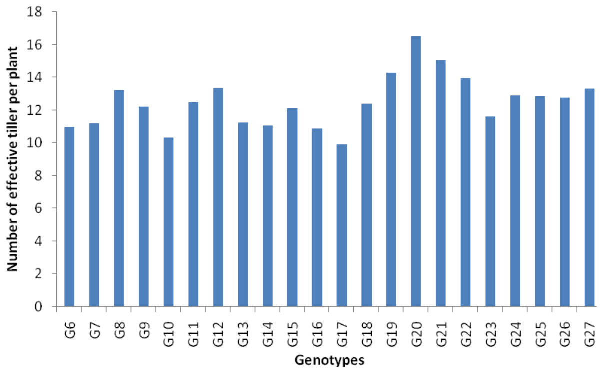

Fig. 2. Variations of number of effective tiller per plant in 22 genotypes of F_4 generations.

Number of primary branches per panicle

In this study, out of 22 genotypes of F_4 generations, the highest number of primary branches per panicle (12.26) was recorded in G_6 (BR 21 × BRRI dhan 28, S-5, P-1) which was closely followed by G_{16} (BR 21 × BRRI dhan 29, S-6, P-6) (12.24) and the minimum number of primary branches per panicle (9.844) was recorded in G_{14} (BR 21 × BRRI dhan 29, S-6, P-4). G_6 and G_{16} were suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential number of primary branches per panicle (Table 2).

Number of secondary branches per panicle

In this study, out of 22 genotypes of F_4 generations, the highest number of secondary branches per panicle (39.85) was recorded in G_{17} (BR 21 × BRRI dhan 29, S-6, P-7) and the minimum number of secondary branches per panicle (26.90) was recorded in G_{18} (BR 21 × BRRI dhan 36, S-1, P-1). G_{17} was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential number of secondary branches per panicle (Table 2).

Number of filled grains per panicle

In this study, out of 22 genotypes of F_4 generations, the highest number filled grains per panicle (189.60) was recorded in G_{16} (BR 21 × BRRI dhan 29, S-6, P-6) and the minimum number of filled grains per panicle (133.4) was recorded in G_{22} (BR 21 × BRRI dhan 36, S-1, P-5). G_{16} was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential number of filled grains per panicle (Table 2).

Number of unfilled grains per panicle

In this study, out of 22 genotypes of F_4 generations, the highest number unfilled grains of per panicle (33.60) was recorded in G_{12} (BR 21 × BRRI dhan 29, S-6, P-2) and the minimum number of unfilled grains per panicle (12.37) was recorded in G_{22} (BR 21 × BRRI dhan 36, S-1, P-5) which was closely followed by G_{18} (BR 21 × BRRI dhan 36, S-1, P-1) (12.77). G_{22} and G_{18} were suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential number of unfilled grains per panicle (Table 2). The level of empty and filled grain in rice is influenced by genetic, environmental factors, including abiotic stress, and the time of stress occurring (Dulbari et al., 2018). Kausar et al. (1993) stated that the weight of grain is controlled by the genetic nature of the plant itself.

Total number of spikelet per panicle

In this study out of 22 genotypes of F_4 generations, the highest number of spikelet per panicle (207.9) was recorded in G_6 (BR 21 × BRRI dhan 28, S-5, P-1) and the minimum number of spikelet per panicle (134.3) was recorded in G_{19} (BR 21 × BRRI dhan 36, S-1, P-2). G_6 was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential number of spikelet per panicle (Table 2). Variation of total number of spikelet per panicle in 22 genotypes of F_4 populations is presented in Figure 3. These characters are closely related to the potential production of a plant, According to Safitri et al. (2016), one of the characters possessed by superior varieties (> 9 tons ha-1) which the number of grains per panicle ranges from 150-250 grains with filled percentage of 85-95%. Based on this study there are lines that meet the requirements of superior varieties according to Safitri et al. (2016). However, there are 5 lines that have more than 150 grain numbers and the percentage of grain content exceeding 85%.

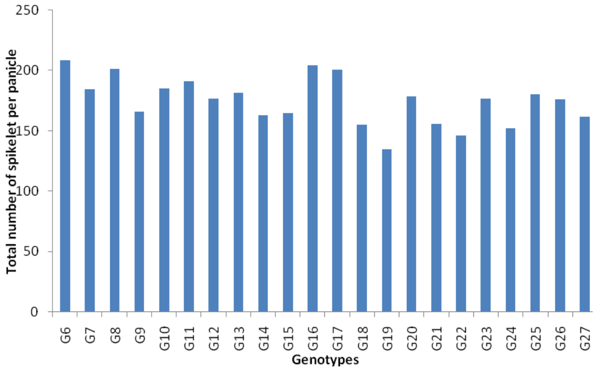

Fig. 3. Variations in total number of spikelet/panicle of 22 genotypes of F_4 generations.

Yield per plant (g)

In this study, out of 22 genotypes of F_4 generations, the highest yield per plant (47.87 g) was recorded in G_8 (BR 21 × BRRI dhan 28, S-5, P-3) and the minimum number of yield per plant (28.19 g) was recorded in G_{12} (BR 21 × BRRI dhan 29, S-6, P-2). G_8 was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed different number of yield per plant (Table 2). Variation of yield per plant in 22 genotypes of F_4 populations is presented in Figure 4.

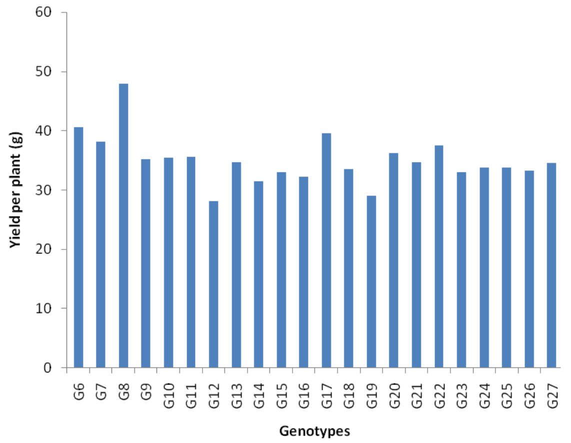

Fig. 4. Variations in yield per plant of 22 genotypes of F_4 generations.

1000 seed weight (g)

In this study, out of 22 genotypes of F_4 generations, the highest 1000 seed weight (26.29 g) was recorded in G_7 (BR 21 × BRRI dhan 28, S-5, P-2) and the minimum 1000 seed weight (18.25 g) was recorded in G_{26} (BR 24 × BRRI dhan 29, S-5, P-3) which was closely followed by G_{14} (BR 21 × BRRI dhan 29, S-6, P-4) (18.88 g). G_7 was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. The rest of the genotypes showed differential 1000 seed weight in (Table 2). Variation of thousand seed weight in 22 genotypes of F_4 populations is presented in Figure 5.

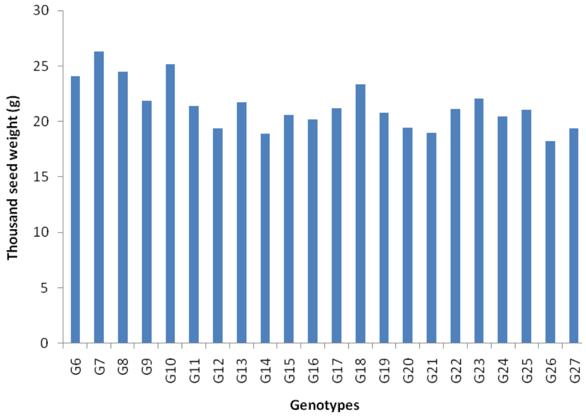

Fig. 5. Variations in thousand seed weight of 22 genotypes of F_4 generations.

Yield (ton/ ha)

In this study, out of 22 genotypes of F_4 generations, the highest yield (10.26 ton/ha) was recorded in G_{17} (BR 21 × BRRI dhan 29, S-6, P-7) and the minimum number of yield (7.281 ton/ha) was recorded in G_{23} (BR 24 × BRRI dhan 28, S-10, P-2). The second maximum yield per hectare (9.131) was recorded in G_9 (BR 21 × BRRI dhan 28, S-5, P-4). G_7 was suitable for selection as it showed the better performance than the check varieties in aspect of this trait. Again, the yield (ton/ha) of G_9 (9.131) was also close to BRRI dhan 29 and BRRI dhan 36. So, G_9 was also suitable for selection. The rest of the genotypes showed different yield (ton/ha) (Table 2). Variation of yield per hectare in 22 genotypes of F_4 populations is presented in Figure 6.

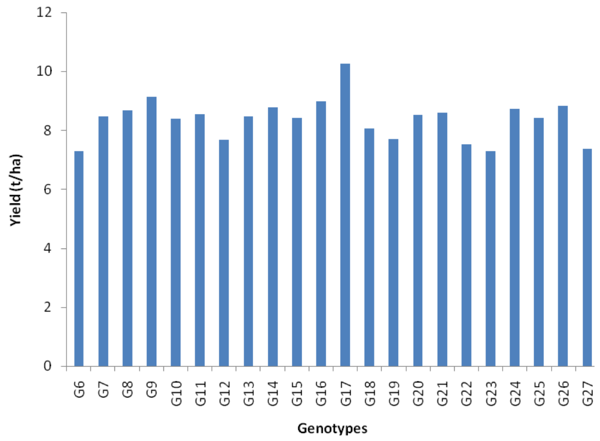

Fig. 6. Variations in yield per hectare of 22 genotypes of F_4 generations.

Conclusion

Days to maturity, plant height, total number of tiller per plant, panicle length, number of secondary branches per panicle and thousand seed weight also were the important contributors to yield per hectare which could be taken in consideration for future hybridization program. The seven (7) genotypes viz. G_{17} (BR 21 × BRRI dhan 29, S-6, P-7), G_9 (BR 21 × BRRI dhan 28, S-5, P-4), G_{16} (BR 21 × BRRI dhan 29, S-6, P-6), G_{14} (BR 21 × BRRI dhan 29, S-6, P-4), G_{27} (BR 24 × BRRI dhan 29, S-5, P-4), G_{15} (BR 21 × BRRI dhan 29, S-6, P-5), G_{13} (BR 21 × BRRI dhan 29, S-6, P-3) were selected as early high yielding Boro lines for future use.

Conflict of interest: All authors declare no conflict of interest.

References

Abdullah B, Tjokrowidjojo S, Sularjo. 2008. Development and The Production of New Types of Rice In Indonesia. Agricultural Research and Development Journal. 27 (1): 1-9

Dewi IS, Trilaksana AC, Purwoko BS, Trikoesoemaningtyas. 2009. Characterization of Double Haploid Lines Resulting from Rice Anther Culture. Germplasm 15:1-12

Dulbari, Santosa E, Sulistyono E, Agusta H, Guntoro D, Zaman S, Koesmaryono Y. 2018. Production and Rice Quality of Two Rice Varieties After Lodging and Flooding. JIPI. 23(1):75-82

FadjryD, Arifudin K, Syafruddin K, Nicholas. 2012. Assessment of Adaptive New Superior Varieties of Rice on New Aperture Rice Fields to Increase Production> 4 tons/ha of GKP in Merauke Regency, Papua Province. Proceedings of the National Innovation System Research Incentives: 29-36

Hao XB, Ma XF, Hu PS, Zhang ZX, Sui GM, Hua ZT. 2010. Relationship Between Plant Type and Grain Quality of Japonica Hybrid Rice In Northern China. Rice Sci17:43-50

HIEN, N.L. et al. 2007. Genetic diversity of morphological responses and the relationships among Asia aromatic rice (*Oryza sativa* L.) cultivars. Tropics 16:343-355

HusnaY. 2010. The Effect of The Use of Planting Distance on The Growth of 1 Student of The Faculty of Agriculture, University of Riau 2 Lecturer in The Faculty of Agriculture, University of Riau, JOM Faperta Vol.2 No.2 October 2015 and Production of Lowland Rice (*Oryza Sativa*L.) IR42 Varieties Using TheSRI (System of Rice Intensification) Method. Journal of TheDepartment of Agriculture. Faculty of Agriculture. Riau University.

Ishak. 2012. Agronomic Traits, Heritability and Interactions of Gxe Mutant Lines of Upland Rice (*Oryza Sativa*L.). J. Agron. Indonesia 40:105-111.

Kausar K, Akbar M, Rasul E, Ahmad AN. 1993. Physiological Responses of Nitrogen, Phosphorus and Potassium on Growth and Yield of Wheat. Pakistan J. Agric. Res 14:2-3

Kumar BMD, Shadakshari YG, Krishnamurti SL. 2010. Genotype X Environment Interaction and Stability Analysis for Grain Yield and its Components in Halugidda Local Rice Mutants. J. Plant Sci 1:1286-1289

Kustera, A. 2008. Diversity of Genotypes and Phenotypes of Hybrid Rice lines in Kahuman Village, Polanharjo, Klaten. Thesis. Sebelas Maret University School of Agriculture. Surakarta

Lestari AP, Abdullah B, Junaedi A, Aswidinnoor H. 2011. Agronomics Characteristics and Its Correlation of New Plant Type Promising Rice Lines. Buletin Plasma Nutfah 17(2): 96-103

Ma X, Mau M and Sharbel TF. 2018. Genome Editing for Global Food Security. *Trends in biotechnology*, 36(2): 123-127

Mara KKS, Purwoko BS, Sulistyono E, Dewi IS. 2015. Appearance of Agronomy and Tolerance Test of Shade Lines in Upland Haploid Rice from Anther Culture. J. Agron. Indonesia 43:1-7

MATHURE, S. et al. 2011. Characterisation of aromatic rice (*Oryza sativa* L.) germplasm and correlation between their agronomic and quality traits. Euphytica. 179:237- 246

Panse, V. G. 1957. Genetics of quantitative characters in relation to plant breeding. Indian J. Genet. PL Breed. 17: 318-328

Pramudyawardani EF, Suprihatno B, Mejaya MJ. 2015. The Potential Yields of the Ultra-Fast and Very Early Lowland Rice Fields Hope. Journal of Agricultural Food Research 34 (1): 1-11

Rusdiansyah. 2006. Identification ff Upland Rice and Local Lowland Rice Originating from Sembakung and Sebuku Districts, Nunukan Regency. Samarinda (ID): Mulawarman University Samarinda

Safitri H, Purwoko BS, Dewi IS, Ardie SW. 2016. Morpho-Physiological Response of Rice Genotypes Grown Under Saline Conditions. J ISSAAS. 22(1):52-63

SASAKI, T. 2005. The map-based sequence of the rice genome. Nature. 436:793-800

SINGH, V.K. et al. 2012. Incorporation of blast resistance into "PRR78", an elite Basmati rice restorer line, through marker assisted backcross breeding. Field Crops Research 128:8-16

Sutaryo, B. 2014. Agro-Morphological Appearance and Genetic Of 12 Rice Genotypes in Technically Watered Rice Fields. J. Agricultural Sciences17:13-24

Tukey, J. W. 1954. Causation, segregation and path analysis of causal path. Biometrics 15: 236-258

Cite this article as:

Kamrul Islam, M. S. R. Bhuiyan, Mahbuba Jamil Tithi and Md. Maksudul Haque. 2020. Comparative efficiency of yield and yield contributing characters in F_4 Generations of *Oryza sativa* L. in olive orcherds. **Amaz. Jour. of Plant Resear.** 4(2): 572-579.

Submit your manuscript at
https:// www.ajpr.online