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Genetic Divergence and Character Association Studies on Germplasm Accessions of Rice (*Oryza sativa* L.)

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ABSTRACT: In this study, fifty rice germplasm accessions were used along with five checks, namely Dagad deshi, RRF-127, RRF-140, DRR Dhan 42 and MTU 1010, for evaluating genetic variability, heritability and genetic advance. The study was conducted at Germplasm section, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *kharif* 2022. The findings of the analysis of variance revealed extremely large genotype differences for each of the 19 quantitative characteristics under investigation. High PCV and GCV values were observed for number of effective tillers per plant, number of filled grains per panicle, number of unfilled grains per panicle, grain yield per plant, biological yield per plant and harvest index. Heritability values were found to be high for all the characters. High heritability with high genetic advance shown by characters such as days to 50% flowering, plant height, number of effective tillers per plant, number of filled grains per panicle, 100 seed weight, flag leaf length, flag leaf breadth, grain yield per plant, biological yield per plant, harvest index, paddy breadth, paddy L/B ratio and brown rice L/B ratio. This suggested that the inheritance of these features was impacted by additive gene activity, indicating additive gene action.

Keywords: Rice, PCV, GCV, heritability, germplasm accessions and genetic advance.

INTRODUCTION

Rice (*Oryza sativa* L.) (2n = 24), a plant belonging to the Poaceae family and subfamily Oryzoidea, is a staple food for half the world's population. The extent of genetic variability among the genotypes in a population that segregates determines the range of genetic variability and improves the potential for selection. Understanding the level of heritable variation in the factors under study is crucial to grasping the genotype's potential for future breeding programmes.

Before deciding on an acceptable breeding strategy for genetic improvement, an assessment of yield variability and its component traits becomes critically necessary. When determining the degree of variability present in the germplasm, genetic metrics like genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are helpful. Heritability in combination with high genetic advance would be a more beneficial tool in predicting the outcome of selecting the optimal genotypes for yield and its attributes. Estimates of heritability aid plant breeders in choosing superior genotypes from a variety of genetic populations (Johnson *et al.*, 1955). Heritability also reveals how much a character will be passed down to succeeding generations, which makes understanding it crucial for selection-based improvement (Sabesan *et al.*, 2009; Singh *et al.*, 2015). A character's heritability tells us how easily it can be passed down to subsequent generations.

MATERIALS AND METHODS

The experimental material includes fifty lines of germplasm accessions of rice including five checks, namely Dagad deshi, RRF-127, RRF-140, DRR Dhan-42 and MTU-1010 received from the DBT Network Rice Project. The experiment was laid out as Randomized Block Design (RBD) experiment with two replications. 21 days old seedlings were planted in 20 x 15 cm spacing. All the agronomical operations were made for good crop growth. Five plants in each replication were taken for the record of observations. The mean of five plants was used for later analysis. All yield and yield related observations were recorded for evaluation of PCV, GCV, GA and heritability analysis.

RESULTS

Analysis of variance. Analysis of variance was performed on the replication wise mean data for yield and yield attributing traits of rice germplasm accessions. The analysis of variance revealed significant differences in all of the 19 attributes studied, such as days to 50% flowering, plant height, panicle length, number of effective tillers per panicle, number of filled grains per panicle, number of unfilled grains per panile, spikelet fertility %, 100 seed weight, flag leaf length and breadth, grain yield/ plant, biological yield/ plant, harvest index, paddy length, paddy breadth, paddy L/B ratio, brown rice length, brown rice breadth, brown rice L/B ratio. Table 1 shows the results of analysis of variance, as well as the significant difference for each of the features studied. This indicates that the material utilized in this investigation have genetic variability among them.

Table 1: Analysis of variation for yield and yield attributing traits.

		Mean sum of squares		
Sr. No.	**Source of variation**	**Replication**	**Treatment**	**Error**
	Degrees of freedom	**1**	**54**	**54**
1	Days to 50% flowering	2.945	223.055**	3.853
2	Plant height (cm)	23.147	951.389**	6.49
3	Flag leaf length (cm)	2.689	59.277**	1.036
4	Flag leaf width (cm)	0.001	0.127**	0.002
5	Panicle length (cm)	0.231	13.234**	0.971
6	Number of effective tillers per plant.	0.018	6.336**	0.59
7	No. of filled grains per panicle	12.852	2204.456**	1.947
8	No. of unfilled grains per panicle.	1.021	183.629**	10.366
9	Spikelet fertility percent (%)	1.23	93.906**	4.496
10	100 seed weight (g)	0.026	0.475**	0.014
11	Grain yield per plant (g)	0.983	148.073**	14.254
12	Biological yield per plant (g)	1.731	31.5668*	4.103
13	Harvest index (%)	14.039	159.674**	31.177
14	Paddy length (mm)	0.012	1.136**	0.012
15	Paddy breadth (mm)	0.006	0.205**	0.004
16	Paddy L/B ratio	0.008	0.435**	0.007
17	Brown rice length (mm)	0.002	0.704**	0.01
18	Brown rice breadth (mm)	0.022	0.076**	0.009
19	Brown rice L/B ratio	0.035	0.297**	0.01

** Significance at 1% level of probability.

Estimation of phenotypic and genotypic coefficient of variation

The extent of variation in genes found among the parents used for hybridization determines how much genetic variability there in a segregating population and thus provides a better opportunity for selection. Therefore, before deciding on an effective breeding strategy for genetic improvement, it is crucial to examine the variability of yield and its component features.

Better possibilities for creating desirable forms of a crop plant are ensured by greater variety in the initial breeding material. Thus, the main goal of germplasm conservation is to gather and maintain genetic variation in a collection of native crop species so that it will be available to both present and future generations. The degree of variability present in the germplasm can be determined using genetic parameters like the genotypic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV).

Table 2 shows the values of the genotypic and phenotypic coefficients of variation. The GCV and PCV were shown to have a significant association for all characters. All of the traits had greater phenotypic coefficients of variability than genotypic coefficients of variability, showing that environmental factors as well as genotypes play a role in the apparent variation. Similar findings were given by Babu *et al.* (2012), Lingaih *et al*. (2014), Patel *et al.* (2014), Rashmi *et al*. (2017), Saha *et al*. (2019), Loitongbam *et al*. (2020), Roy *et al*. (2020).

The values of PCV ranged from 8.925 to 36.14. High values of PCV were observed for the following traits: number of effective tillers per plant (27.418), number of filled grains per panicle (29.372), number of unfilled grains per panicle (33.011), 100 seed weight (20.128), biological yield per plant (26.312), harvest index (28.179) and grain yield per plant (36.14). Moderate values were observed for the characters days to 50% flowering (11.062), plant height (17.518), panicle length (11.017), flag leaf length (16.881), flag leaf breadth (19.034), paddy breadth (11.633), brown rice L/B ratio (13.962) and paddy L/B ratio (16.058). Low PCV values were observed for the traits like spikelet fertility percent (8.925), paddy length (9.478), brown rice length (9.475) and brown rice breadth (9.007).

Among the characters studied, the range of GCV is from 8.507 to 31.711. High values of GCV are obtained for number of effective tillers per plant (24.975), number of filled grains per panicle (28.722), number of unfilled grains per panicle (31.197), grain yield per plant (31.711), biological yield per plant (23.89) and harvest index (23.122). Moderate values are observed for days to 50% flowering (10.873), plant height (17.041), panicle length (10.236), 100 seed weight (19.558), flag leaf length (16.588), flag leaf breadth

(18.73), paddy breadth (11.405), paddy L/B ratio (15.81) and brown rice L/B ratio (13.516). Lower GCV values are obtained for spikelet fertility percent (8.507), paddy length (9.375), brown rice length (9.331) and brown rice breadth (8.009).

High PCV and GCV values were observed for number of effective tillers per plant, number of filled grains per panicle, number of unfilled grains per panicle, grain yield per plant, biological yield per plant and harvest index. Prasad *et al*. (2017) and Saha *et al*. (2019) reported high PCV and GCV values for number of filled grains per panicle, number of unfilled grains per panicle and grain yield per plant.

Genetic advance as percent of mean and Heritability

Heritability is the ratio of genotypic variance to total or phenotypic variance (Broad sense) and the ratio of additive genetic variance to phenotypic variance (Narrow sense). Genetic advance is the improvement in the mean genotypic value of selected plants over the parental population.

It is quite challenging to determine whether or not the observed variability is heritable. A character's heritability tells us how easily it can be passed down to subsequent generations. The reliability of phenotypic value is expressed using heritability estimates as a forecasting tool. High heritability therefore aids in the efficient selection of a particular feature.

It is expected that selection for qualities with high heritability and genetic advance will collect more additive genes, further enhancing their performance. It aids in evaluating how the environment affects the genotype and the reliability of character expression. In general, genetic advance and heritability estimates work better together to predict the genetic gain under selection than heritability estimates alone.

Heritability values were found to be high for all the characters. The traits include: days to 50% flowering (96.604%), panicle length (86.332%), number of effective tillers per plant (82.972%), number of filled grains per panicle (95.624), number of unfilled grains per panicle (89.313%), spikelet fertility percent (90.861%), 100 seed weight (94.41%), flag leaf length (96.565%), flag leaf breadth (96.83%), grain yield per plant (82.438%), biological yield per plant (76.994), harvest index (67.329%), paddy length (97.845), paddy breadth (96.122), paddy L/B ratio (96.931%), brown rice length (96.995%), brown rice breadth (79.067%), brown rice L/B ratio (93.715%).

Genetic advance as percent mean was found high in days to 50% flowering (22.014%), plant height (34.886%), number of effective tillers per plant (46.863%), number of filled grains per panicle (57.858%), number of unfilled grains per panicle (60.736%), 100 seed weight (39.149%), flag leaf length (33.58%), flag leaf breadth (37.967%), grain yield per plant (44.683%), biological yield per plant (57.32%), harvest index (39.083%), paddy breadth (23.034%), paddy L/B ratio (32.064%) and brown rice L/B ratio (26.955%).

Moderate values of genetic advance as percent means were observed for panicle length (19.593%), spikelet fertility percent (16.705%), paddy length (19.104%), brown rice length (18.932%) and brown rice breadth (14.671%). Moderate estimates of genetic advance values show that these traits are influenced by non-additive gene effects.

High heritability with high genetic advance shown by characters such as days to 50% flowering, plant height, number of filled grains per panicle, number of effective tillers per plant, 100 seed weight, flag leaf length, flag leaf breadth, grain yield per plant, biological yield per plant, harvest index, paddy breadth, paddy L/B ratio and brown rice L/B ratio. The results are in agreement with Padmaja *et al*. (2008), indicating the role of additive gene action in controlling these characters. Sumanth *et al*. (2017) reported similar results for plant height, flag leaf length, biological yield per plant and grain yield per plant.

High heritability with moderate values for genetic advance as percent mean shown by panicle length, spikelet fertility percent, paddy length, brown rice length and brown rice breadth.

Table 2: Genetic parameters for various yield and yield related characters.

Characters	Mean	Range		CV	PCV %	GCV %	Heritability %	GA	GA as %
		Min	Max				(Broad sense)		of mean
Days to 50% flowering	96.3	68	126	2.038	11.062	10.873	96.604	21.198	22.014
Plant height (cm)	127.5	74	172.5	1.989	17.518	17.041	98.645	44.472	34.886
Panicle length (cm)	24.2	16.72	28.86	4.072	11.017	10.236	86.332	4.74	19.593
Flag leaf length (cm)	32.53	21.19	45.11	3.128	16.881	16.588	96.565	10.924	33.58
Flag leaf breadth (cm)	1.33	0.92	2.18	3.388	19.034	18.73	96.83	0.507	37.967
Number of effective tillers per plant.	6.8	3.4	10.7	11.313	27.418	24.975	82.972	3.181	46.863
No. of filled grains per panicle	114.3	52.5	185.4	6.144	29.372	28.722	95.624	66.126	57.858
No. of unfilled grains per panicle.	29.84	18.1	55.9	10.91	33.011	31.197	89.313	18.12	60.736
Spikelet fertility percent (%)	78.6	59.02	88.38	2.701	8.925	8.507	90.861	13.129	16.705
100 seed weight (g)	2.45	1.36	3.42	2.004	20.128	19.558	94.416	0.961	39.149
Grain yield per plant (g)	11.7	3.6	19.6	17.334	36.14	31.711	82.438	15.299	44.683
Biological yield (g)	34.24	20.7	64	11.026	26.312	23.89	76.994	6.698	57.32
Harvest index (%)	34.7	14.05	51.55	16.105	28.179	23.122	67.329	13.549	39.083
Paddy length (mm)	7.9	6.38	10.2	1.393	9.478	9.375	97.84	1.528	19.104
Paddy breadth (mm)	2.78	2.14	3.63	2.29	11.633	11.405	96.122	0.64	23.034
Paddy L/B ratio	2.9	1.9	5.8	17.278	16.058	15.81	96.931	0.939	32.064
Brown rice length (mm)	6.3	5.3	8.01	1.642	9.475	9.331	96.995	1.195	18.932
Brown rice breadth (mm)	2.28	1.74	2.66	4.12	9.007	8.009	79.067	0.334	14.671
Brown rice L/B ratio	2.8	2.01	3.77	3.515	13.962	13.516	93.715	0.755	26.955

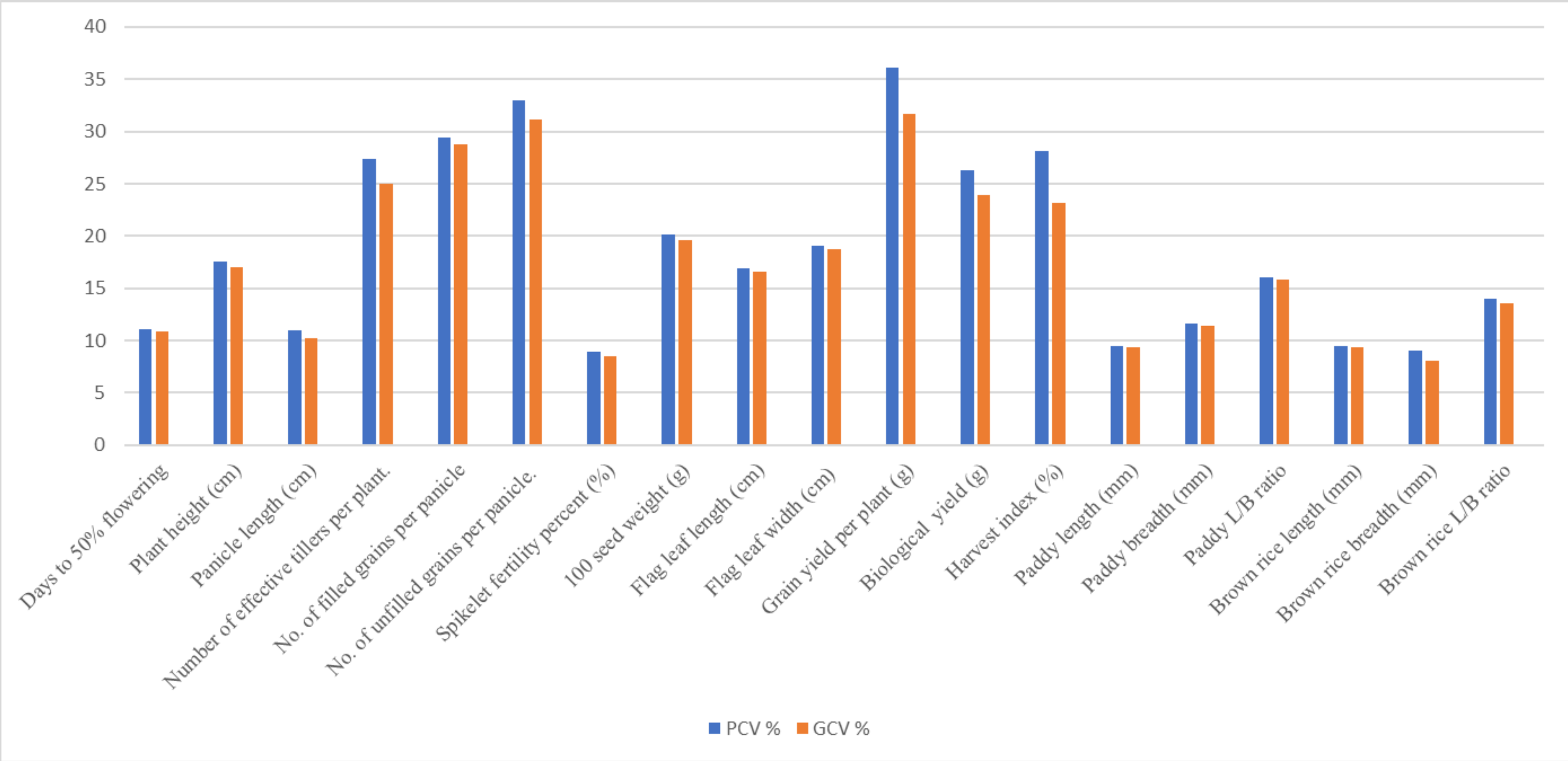

Fig. 1. PCV and GCV for yield and its attributing traits.

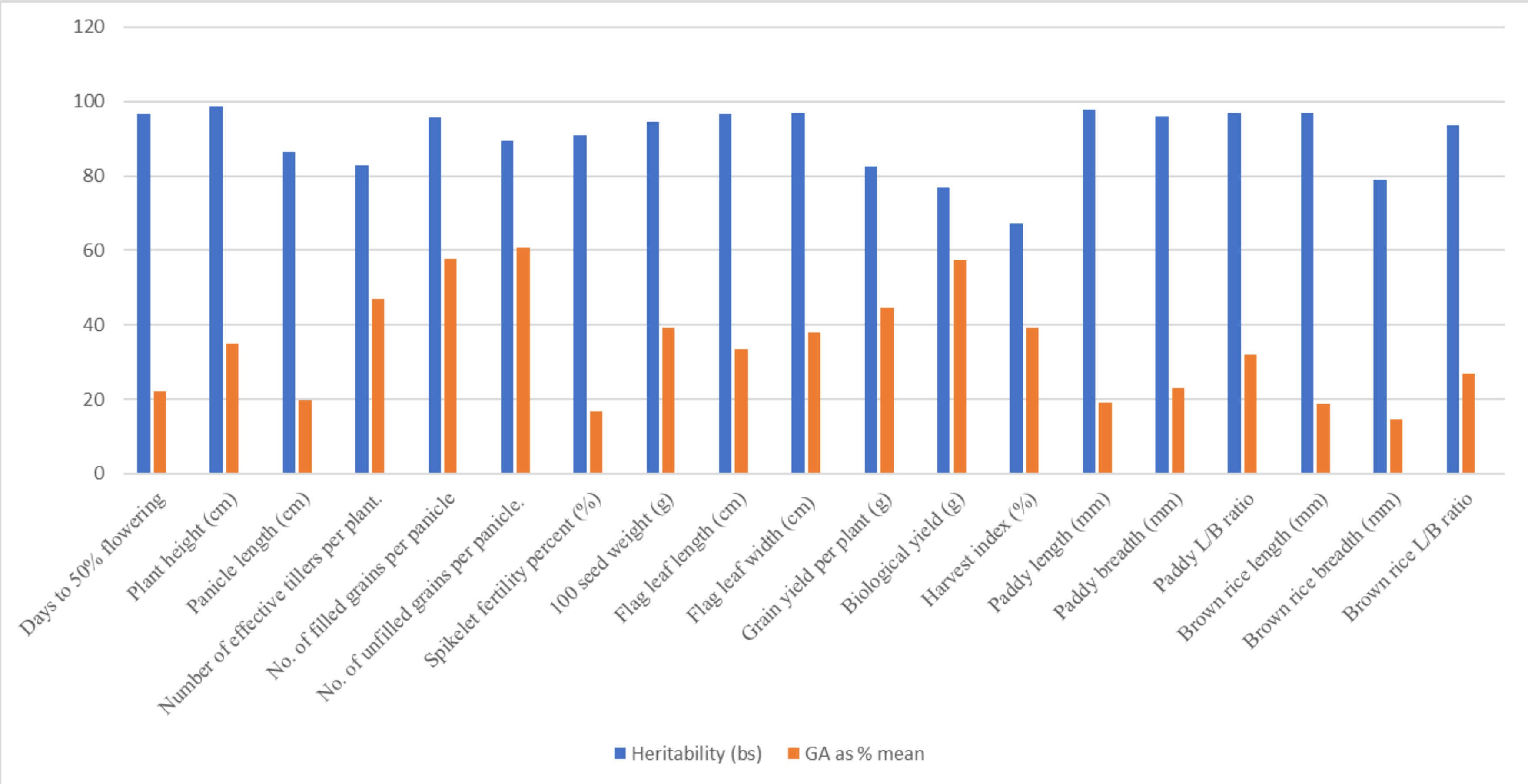

Fig. 2. Heritability and genetic advance as percentage of mean for yield and its attributing traits.

CONCLUSIONS

The results of the analysis of variance showed that there were extremely significant genotype differences for each of the quantitative traits. In the study of PCV and GCV, number of effective tillers per plant, number of filled and unfilled grains per panicle, grain yield per plant, biological yield per plant, and harvest index are characteristics with high PCV and GCV values. High heritability with high genetic advance shown by characters such as days to 50% flowering, plant height, number of effective tillers per plant, number of filled grains per panicle, number of effective tillers per plant, 100 seed weight, flag leaf length, flag leaf breadth, grain yield per plant, biological yield per plant, harvest index, paddy breadth, paddy L/B ratio and brown rice L/B ratio. The study showed an additive gene effect for the above characters.

FUTURE SCOPE

It is clear from the current study that the genotypes examined may be an effective source of material for future breeding programmes. High heritability along with high genetic advance indicates that the heritability is due to additive gene action and is found least influenced by environment. Hence, the desirable characters with high heritability coupled with genetic advance can be used for selection. High estimates of variability also suggest that the germplasm lines used for the study have a broad genetic background, suggesting an opportunity of genetic improvement through selection for these qualities.

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Conflict of interest. None.

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