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BC_2F_2 Local Rice Genotypes Field Test at Non-Tidal Swamp in South Sumatra Province

Milia Fitri[1*], Mery Hasmeda [2] and Rujito A. Suwignyo [2]

[1] Department of Crop Science, Post Graduate Program, University of Sriwijaya
[2] Department of Agroecotecnology, Faculty of Agriculture, University of Sriwijaya.

*Corresponding author

E-mail address: fitrimilia@yahoo.co.id (Milia Fitri).
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Abstract *:*
Non-tidal swamp is one of suboptimal land available to increase rice production in Indonesia. The problems is stagnant flooding during vegetative growth phase of the crop. Therefore, it is important to have rice varieties that tolerant flooding. Crossing and selection have been conducted to obtaine BC_2F_2 genotype from local swamp rice varieties, i.e. Siam, Pegagan and Pelita Rampak. This research was aimed at knowing the growth and production of several genotypes BC_2F_2 and their parental varieties, Siam, Pegagan and Pelita Rampak. The research was conducted in non-tidal swamp in Village Sako, sub-district Rambutan, District Banyuasin, South Sumatra from October 2017 to March 2018. Rice genotypes have been used BC_2F_2 Siam, BC_2F_2 Pegagan, and BC_2F_2 Pelita Rampak, and their parental varieties i.e. Siam, Pegagan, and Pelita Rampak. The results showed that genotype BC_2F_2 had vegetative and generative characters different from those of Siam, Pegagan, and Pelita Rampak. The production of the tested rice varieties was high, ranged from 4.52 to 7.95 tonnes per hectare. The best of each genotypes planted in the first season were SM 2, PGG 4, and PLR 3. While the best BC_2F_2 of each genotypes planted in the second season were SM 2, PGG 3, and PLR 3.

Keywords: flooding, selection, suboptimal land, tolerant

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1. Introduction

One of problems in cultivating rice in non-tidal swamp is excess water that occurs during submergence. The productivity of non-tidal swamp is low due to the lack of early ripening rice varieties tolerant to submergence. One of plants able to grow in the water saturated condition in non-tidal swamp is non-tidal swamp rice. Rice has a capability of internal aeration because aerenchyma tissue is well developed and has function as O_2 tunnel from leave to root and prevent metal ions and volatile compounds such as methane, etilen, and CO_2 from passing through to the root [1]. However, rice plant cannot grow maximal if being inundated for long time. Water stress condition decreases the photosynthesis and aerobic respiration and increases catabolism of energy reserve (carbohydrat, protein, lipid) finally the starvation of carbohydrate, chlorophyll degradation and leaf senescence [2].

Rice cultivation in non-tidal swamp is generally only once a year [3] i.e. when non-tidal swamp water surface is not too high, from May to June. Land preparation should be quick enough and on time in order to fully make used the available resources [4]. Shallow non-tidal swamp with water surface < 50 cm might potentially increase agricultural index (AI) to 200%.

The main obstacle of rice cultivation in shalow non-tidal swamp is the difficulty to predict the start of cropping season. Farmers tend to use agronomical adaptation by using old seedlings more ≥ 40 days old to avoid the planted seedling being inundated. The use of old seedling makes low adaptation, inconsistency in tiller formation, shallow rooting, and poor growth of the crop [5]. One way to increase non-tidal swamp rice production in South Sumatra is by crossing local non-tidal swamp rice varieties (Siam, Pegagan, and Pelita Rampak) with submergence tolerant variety (FR13A). Local rice variety has been identified to be tolerant biotic and abiotic stress, and then has good quality so that can be used as gene donor [6] as well as to keep bioplasma. Local rice varieties are tolerant to flooding, soil salinity, and resistant to pest and disease [7].

Genotipe BC_1F_1 (result of crossing between local variety of South Sumatra non-tidal swamp x FR13A) was more tolerant to submergence compared their parental varieties [8]. Early selection has been conducted to identify and select individuals supposed to have gene *Sub1* in BC_2F_1 using foreground selection [9]. The highest percentage of genom BC_2F_1 Siam was 92.1%, the highest percentage of genome BC_2F_1 Pegagan was 86.6%, and highest percentage of genome BC_2F_1 Pelita Rampak was 69.1%, and selfing BC_2F_1 was conducted to obtain BC_2F_2 [10].

This research was aimed at knowing the growth and production of several genotypes of BC_2F_2 and its parental varieties of local non-tidal swamp rice i.e. Siam, Pegagan, and Pelita Rampak in non-tidal swamp of South Sumatra Province.

2. Materials and Methods

The research was conducted in shallow non-tidal swamp in Village Sako, sub-district Rambutan, District Banyuasin, South Sumatra Province from October 2017 to March 2018. Materials used in the research were rice varieties of Siam, Pegagan, Pelita Rampak and rice genotypes of BC_2F_2 Siam, BC_2F_2 Pegagan, and BC_2F_2 Pelita Rampak each consisted of 5 individuals (Table 1), Urea fertilizer, SP-36, KCl, herbicide, insecticide, fungicide, and rodenticide. Equipment used in the research were seedling trays, dragnet, analytical scale, knapsack sprayer, sack, ruller, and "tampah".

The research was arranged in a Ramdomised Completely Block Design (RCBD) with 18 treatments (Table 1) and three replications, resulted in 54 plots. The size of each plot was 1.25 m x 2.25 m = 2.81 m^2. There were 32 rice clump in each plot. Plant samples were taken from the middle of the plots for 3 clumps per plot.

Land clearing was conducted before starting the research to free the land from seed before season rice crop. Seed preparation was conducted by soaking seeds for 24 hours before being incubated for 48 hours. The appearance of radicle indicated that the seeds were ready to be planted in seedling trays for 24 days, before being transplanted to the research plots. The seedlings were planted in the plots at spacing of 25 x 25 cm, one seedling per planting hole. Fertilizers applied were inorganic fertilizers consisted of 150 kg Urea, 100 kg SP-36, and 100 kg KCl/ha. Inorganic fertilizers were given 3 times i.e. at 7. 23 and 42 days after transplanting. First fertilizing consisted of 37.5 kg Urea, 100 kg SP-36 and 50 kg KCl per hectare, second fertilizing consisted of 75 kg Urea per hectare, and third fertilizing consisted of 37.5 kg Urea and 50 kg KCl per hectare. Crop maintenance was conducted through weeding and pest control according to conventionally and chemically.

Observation was conducted to record: plant height (cm), flag leaf angle (^{o}), total number of tiller, number of productive tiller, harvesting age (days), length of panicle (cm), number of seeds per panicle, weight of seeds per panicle, percentage of filled seeds (%) and 1000 seeds weight (g).

Spacing for each plant 25 cm x 25 cm, in the area experimental plot 1.25 m x 1 m = 1.25 m^2 there are 16 clumps. Population per hectare (ha) = (10.000 m^2/1.25 m^2) x 16 clumps = 128.000 clumps / ha.

Production per hectare (ton) = (weight of filled grain x Number of productive tiller x population per hectare) / 1.000.000. Weight of filled seeds obtained from Weight of seeds per panicle x filled seeds percentage.

Analysis of vegetative and generative characters (table 2) using SPSS windows software. If F arithmetic > F table 5% were considered significantly different and continued Least Significant Difference Test at the level 5%. Analysis correlation of varieties and genotypes tested (Table 3) using Microsoft Excel. Interval coefficient 0.00-0.199 has a very weak relationship level, interval coefficient 0.20-0.399 has a weak relationship level, interval coefficient 0.40-0.599 has a moderate relationship level, interval coefficient 0.60-0.799 has a strong relationship level, and interval coefficient 0.80-1.0 has a very strong relationship level [11]. Positive value in correlation data show direct correlation and otherwise.

Table 1. Varieties and Genotypes Tested

No	Notation	Percentage of Genome BC_2F_1 to parent ♀ (%)	Code of Origin	Genotype Origin
1	Siam	-	-	Parental Siam
2	SM 1	91.5	C1-13	BC_2F_2Siam
3	SM 2	90.7	C1-15	BC_2F_2 Siam
4	SM 3	90.5	C1-16	BC_2F_2 Siam
5	SM 4	89.6	C1-21	BC_2F_2 Siam
6	SM 5	86.3	C1-23	BC_2F_2 Siam
7	Pegagan	-	-	Parental Pegagan
8	PGG 1	73.2	C2-4	BC_2F_2Pegagan
9	PGG 2	70.1	C2-20	BC_2F_2 Pegagan
10	PGG 3	69.8	C2-16	BC_2F_2 Pegagan
11	PGG 4	69.3	C2-13	BC_2F_2 Pegagan
12	PGG 5	68.5	C2-15	BC_2F_2 Pegagan
13	Pelita Rampak	-	-	Parental Pelita Rampak
14	PLR 1	67.8	C3-32	BC_2F_2 Pelita Rampak
15	PLR 2	65.7	C3-10	BC_2F_2 Pelita Rampak
16	PLR 3	64.4	C3-18	BC_2F_2 Pelita Rampak
17	PLR 4	63.9	C3-4	BC_2F_2 Pelita Rampak
18	PLR 5	61.3	C3-16	BC_2F_2 Pelita Rampak

3. Results and Discussion

Vegetative and generative characters are presented in Table 2 while correlation amongst variables are presented in Table 3.

Table 2. Vegetative and generative characters of Siam, Pegagan, Pelita Rampak varieties and their Genotipe BC_2F_2

Individual name	Age of harves-ting (day)	Plant height (cm)	Flag leaf angle (°)	Total number of tiller	Number of productive tiller	Length of panicle (cm)	Number of seeds per panicle	Weight of seeds per panicle (g)	% filled seeds	1000 seeds weight (g)	Production per Ha (ton)
Siam	112	118.22 ab	17.22 abcd	26.22 abcde	21.33	24.63 ab	197.52 ab	2.88 abc	81.07	25.77 a	6.38
SM 1	105	158.81 fgh	31.85 fg	17.04 ab	16.63	25.66 bc	244.39 def	3.88 cde	84.18	26.40 abc	6.96
SM 2	124	159.67 fgh	25.55 abcdefg	15.00 a	12.67	27.29 cd	263.22 f	5.18 f	88.66	28.38 def	7.44
SM 3	122	154.59 efg	35.19 g	14.26 a	13.63	26.68 bcd	257.84 ef	4.77 ef	87.80	28.38 def	7.30
SM 4	105	162.00 gh	27.22 defg	15.44 a	14.66	27.07 bcd	247.04 def	4.33 def	87.70	27.96 bcdef	7.13
SM 5	116	152.57 defg	26.63 cdefg	20.64 abc	19.14	25.28 bc	243.42 def	3.39 bcd	76.96	26.00 ab	6.39
Pegagan	105	136.44 cd	20.56 abcde	26.22 abcde	15.11	26.17 bcd	215.22 bcd	3.43 bcd	87.64	29.39 f	5.81
PGG 1	107	153.44 defg	16.44 ab	22.22 abcd	14.55	28.08 cde	238.74 bcde f	3.65 cde	86.02	28.23 cdef	5.84
PGG 2	122	173.15 h	26.41 abcdefg	21.29 abc	14.78	29.03 de	267.23 f	3.77 cde	83.96	27.59 abcdef	5.99
PGG 3	110	172.48 h	16.96 abc	27.74 abcde	14.22	31.01 e	270.68 f	3.58 cd	69.20	27.41 abcde	4.52
PGG 4	110	167.38 gh	18.00 abcd	26.89 abcde	20.87	28.99 de	253.24 def	3.69 cde	80.70	28.01 cdef	7.95
PGG 5	105	152.59 defg	24.74 abcdef	25.63 abcde	19.22	26.95 bcd	242.01 cdef	3.27 bcd	81.98	27.00 abcd	6.59
Pelita Rampak	122	140.11 cde	30.22 efg	25.06 abcde	21.17	25.83 bc	200.28 abc	2.90 abc	79.56	28.26 cdef	6.25
PLR 1	110	103.78 a	17.56 abcd	31.00 cde	21.78	22.05 a	161.78 a	2.09 a	80.84	27.06 abcd	4.71
PLR 2	101	130.39 bc	23.47 abcdef	30.44 bcde	26.86	24.19 ab	162.78 a	2.73 abc	84.50	28.41 def	7.93
PLR 3	95	132.44 bc	15.70 a	37.45 e	20.20	25.56 bc	214.22 bcd	3.42 bcd	85.18	28.95 def	7.53
PLR 4	110	129.22 bc	16.67 abc	35.22 de	28.55	22.05 a	166.00 a	2.28 ab	86.00	29.37 ef	7.17
PLR 5	122	143.78 cdef	31.67 fg	18.33 abc	16.78	24.57 ab	220.93 bcde	3.72 cde	83.39	27.10 abcd	6.66
$LSD_{0.05}$		17.883	10.171	13.580		2.997	41.739	1.147		1.964	

Table 3. Variables correlation of varieties and genotypes tested

No	Variable	Plant height	Flag leaf angle	Total tiller	Productive tiller	Length of panicle	Number of seed per panicle	Weight of seed panicle	% filled seed	1000 seed weight	Production per hectare
1	Harvesting age	0.252 weak	0.532 moderate	-0.565 moderate	-0.327 weak	0.152 v. weak	0.306 weak	0.348 weak	-0.049 v. weak	-0.173 v. weak	-0.116 v. weak
2	Plant height		0.335 weak	-0.556 moderate	-0.627 strong	0.862 v. strong	0.908 v. strong	0.710 strong	-0.123 v. weak	-0.022 v. weak	0.106 v. weak
3	Flag leaf angle			-0.758 strong	-0.353 weak	0.083 v. weak	0.320 weak	0.496 moderate	0.225 weak	-0.194 v. weak	0.249 weak
4	Total tiller				0.725 strong	-0.333 weak	-0.640 strong	-0.782 strong	-0.250 weak	0.301 weak	-0.091 v. weak
5	Productive tiller					-0.658 strong	-0.825 v. strong	-0.814 v. strong	-0.096 v. weak	0.086 v. weak	0.261 weak
6	Length of panicle						0.861 v. strong	0.598 moderate	-0.323 weak	-0.012 v. weak	-0.098 v. weak
7	Number of seed per panicle							0.820 v. strong	-0.107 v. weak	-0.168 v. weak	-0.013 v. weak
8	Weight of seed per panicle								0.337 weak	0.071 v. weak	0.310 weak
9	% filled seed									0.495 moderate	0.549 moderate
10	1000 seed weight										0.281 weak

3.1 Plant Height

Figure 1. Plant height measurements just before sampling

Plant height of BC_2F_2 Siam (SM 1 to SM 5) and BC_2F_2 Pegagan (PGG 1 to PGG 5) were higher than their parents. While plant height of BC_2F_2 Pelita Rampak (PLR 1, PLR 2, PLR 3, and PLR 4) were lower even though PLR 5 was higher than its parents but it was not statistically significant (Table 2). Data in Table 3, plant height very significantly and positively correlated to length of panicle and number of seeds per panicle. Plant height significantly and positively correlated to weight of seeds per panicle, but significantly and negatively correlated to productive tillers. This happened because the higher the plant needed the more energy to support the plant growth. While research go on, the research plots were always inundated from the beginning until harvesting which might retard the O_2 absorption from roots. In this conditions, the plants tested still able to grow well because rice plant have capability to do internal aeration through aerenchyma space. Aerencyma space can develop through two methods: a). Schizogenous aeronchyma formed by separating cell and differentiation in cell enlargement, and b). Lysigenous aeronchyma formed by the death or lysis some cortex cells [1]. The ability of rice to adapt under condition of long stagnant flooding depended on combination between morphology and physiology adaptations [12].

The plant height is not always causing bad impact to the plant it self, but it depends on cropping season. If cultivated during first cropping season i.e. from April to May, which expected to be harvested in August or September, then the lower plant height is better compared to the higher ones, because the high rice plant is susceptible to fall down when flooding has gone. Based on the research, BC_2F_2 Siam, Pegagan, and Pelita Rampak more suitable to be cultivated in the first cropping season were SM 2, PGG 4, and PLR 3. While in second cropping season, plant with higher plant height was better than the lower ones because at harvesting time in February or march (planting in October or November) water condition was high so rice plant with lower plant height would suffer from panicle damage due to flood. BC_2F_2 Siam, Pegagan, and Pelita Rampak more suitable to be planted in second cropping season were SM 2, PGG 3, and PLR 3.

On the field test, it was known that all tested rice varieties had ability to produce root in almost all stem nodes. Root produced in lowest node is called as crown roots. While root produced in almost every node are called crown roots primordia. Mechanism of root formation is influenced by plant hormone and interaction among the hormones them selves [13]. Initiation of crown roots is influenced by auxin hormone. Auxin hormone is one of plant growth regulating hormone produce by plant. Crown roots primordia appear because the air content in the soil is low. This root functions as a defence mechanism against continuous excess water stress.

3.2 Flag leaf angle

Flag leaf angle is categorized into 4 categories i.e. (a) erect (<30°), (b) semi erect (45°), (c) horizontal (90°) and (d) descending (>90°) [14]. Flag leaf angle of SM 2, SM 4, and SM 5 was categorized as erect, while that of SM 1 and SM 3 was categorized as semi erect. Flag leaf angle of PGG 1 to PGG 5 were categorized as erect in accordance to their parents. Flag leaf angle of PLR 1, PLR 2, PLR 3, and PLR 4 categorized as erect, while that of PLR 5 was categorized as semi erect in accordance to its parent (Table 2). The advantage of erect flag leaf angle is more efficient in using sun radiation. Data in Table 3, significantly flag leaf angle negatively correlated with total number of tillers which meant that the larger of flag leaf angle so the lower of tiller number. This happened because the larger the flag leaf angle so the upper descending leaf would cover the lower leaves and tillers. The shaded lower leaves and tillers would not able to perform maximal photosynthesis to maximally produce carbohydrate. Tillers need a lot of energy to grow. The energy was derived from photosynthesis and respiration. The main substrate of respiration is carbohydrate. The limited carbohydrate made protein, lipid and chlorophyll became alternative substrates of respiration [15]. This condition existed continually caused the death of tillers so that the number of tiller was lowered. Flag leaf angle also negatively correlated to productive tillers and 1000 seed weight, but not significantly.

Figure 1. Flag leaf angle measurement

3.3 Total Number of Tillers

Total number of tiller of SM 1 to SM 5 were lower than their parents. Total number of tiller of PGG 1, PGG 2, and PGG 5 were below the number of tiller of their parents, but the number of tillers of PGG 3 and PGG 4 was above the number of tiller of their parents. The number of tiller of PLR 5 was smaller than that of their parents, while total number of tiller of PLR 1, PLR 2, PLR 3, and PLR 4 was higher than their parents (Table 2). Total number of tiller significantly correlated to number of productive tillers and the correlation was positive which meant that the higher the number of tiller so the higher the number of productive tillers (Table 3). Total number of tillers also significantly correlated to number of seeds per panicle and weight of seeds per panicle, but negatively correlated which meant that the more the total number of tiller so the less the number of seeds per panicle and the weight of seeds per panicle.

The result of field test was known that all tested rice varieties produced tillers from main stem and stem nodes. Tillers appeared from stem node were able to produce productive tillers, and from one plant could be produced four nodal tillers. Nodal tillers could live longer than the main stem and could be harvested latter. Crop maintenance such as fertilizing, weeding, and pest controlling made nodal tiller produce by main stem productive so the farmers could have multiple harvests in one cropping season without doing replanting.

3.4 Number of Productive Tillers

Number of productive tiller of SM 1 to SM 5 was lower than their parents. Number of productive tiller of PGG 1, PGG 2, and PGG 3 was below the number of their parents but PGG 4 and PGG 5 was above of their parents. The number of productive tiller of PLR 3 and PLR 5 was below of their parents but PLR 1, PLR 2, and PLR 4 was above of their parents (Table 2). Number of productive tiller significantly and negatively correlated to the panicle length, also very significantly and negatively correlated to the number of seeds per panicle, and weight of seeds per panicle (Table 3). The meaning that the more the number of productive tiller so the less the length of panicle then the number of seeds per panicle decreased because length of panicle very significantly and positively correlated to number of seeds per panicle. The shorter panicle length made the number of seeds per panicle reduced finally reduction in the weight of seeds per panicle. The higher number of productive tiller has tendency to reduce the percentage of filled seed. This happened due to the competition in obtained photosyntat. Main stem of rice plant produced the highest seed weight followed by next tiller, and the weight of seed per clump tend to be determined by primary, secondary and tertiary tillers [16].

3.5 Harvesting Age

Age of harvesting negatively correlated with total number of tiller which lead to the negative correation between age of harvesting with number of productive tillers because total number of tillers significantly and positively correlated to number of productive tillers (Table 3) which meant that the total number of tiller was higher so the number of productive tillers was higher too. Number of productive tiller decreased because the older tiller had reach their generative phase while the new ones were still in vegetative phase so most of available energy were used to support the generative tiller. Competition in obtaining energy for both the vegetative dan generative phases causes the some tillers fail to generative phase. The vegetatif tillers would degrade their chlorophyl then leaf senescence and finally died before harvesting. Prolonged stress could lead to serious reduction of energy resources which finally caused the plant died due to the catabolism carbohydrate, chlorophyll degradation, and chloroplast protein recycle [2].

3.6 Panicle Length, Number of seeds per Panicle, Weight seeds per Panicle, Weight of 1000 Seeds, and Percentage of Filled Seeds

Length of panicle very significantly correlated to number of seeds per panicle (Table 3), the longer the length of panicle so the higher the number of seeds per panicle. Number of seed per panicle very significantly correlated to the weight of seeds per panicle, the higher the number of seeds per panicle so the higher the weight of seeds per panicle. However, number of seeds per panicle was negatively correlated non-significantly to percentage of filled seeds that meant the higher the number of seeds per panicle so the lower the percentage of filled seeds, but not significantly. Percentage of filled seeds was low as PGG 3 because related to the panicle length, the longer of panicle length the more number of seeds per panicle but photosynthate is limited in filling seeds process. The empty seeds because lack of nutrient intake and reduced assimilate deposits during the filling seeds process [17]. Nevertheless, production per hectare was categorized as high (Table 2) ranged from 4.52 to 7.95 tonnes per hectare. This happened because BC_2F_2 contained gen *Sub1* from crossing between FR13A and local landraces in South Sumatra Province, so that could adapt to extreme (stagnant flooding). Landraces rice could be used as donor gene to increase rice adaptation ability about stagnant flooding and maintained its high productivity [12].

The results of the rice field test showed that BC_2F_2 genotype had a great diversity in vegetative and generative characters. Characters of height plant and seed weight per panicle of BC_2F_2 Siam and Pegagan were higher than their parents except weight of seeds per panicle of PGG 5, while those of BC_2F_2 Pelita Rampak were lower than its parent except character of PLR 5 plant height. Flag leaf angle categorized as erect, except that of SM 1, SM 3, and PLR 5. Total number of tiller and productive tillers of BC_2F_2 Siam were lower than its parent, while BC_2F_2 Pegagan and Pelita Rampak were more varied. The percentage of filled seeds and weight of 1000 seeds of BC_2F_2 Siam and Pelita Rampak were higher than their parents except weight of 1000 seed of PLR 1 and PLR 5, while BC_2F_2 Pegagan were lower than their parents. Length of panicle and number of seeds per panicle of BC_2F_2 Siam and Pegagan were higher than their parents, while BC_2F_2 Pelita Rampak were lower than their parents except number of seeds per panicle of PLR 3 and PLR 5.

Variables correlation in Table 3 were seven variables very strongly and strongly correlated i.e. plant height, flag leaf angle, total number of tiller, productive tiller, length of panicle, number of seeds per panicle, and weight of seeds per panicle. Plant height affected about productive tiller, length of panicle, number of seeds per panicle, and weight of seeds per panicle. Flag leaf angle affected about total number of tiller. Total number of tiller affected about the number of productive tiller, number of seeds per panicle, and weight of seeds per panicle. Number of productive tiller affected about the length of panicle, number of seeds per panicle, and weight of seeds per panicle. Seven variables strongly and very strongly correlated that influencing each other were then used as benchmark in determining the best BC_2F_2 to be planted in the first and second cropping seasons.

Data of the seven variables was ranged from smallest to the biggest. The smallest data was given score 1, the immediate higher was given score 2 and so on, and the highest was given score 5. The rank to determine best genotype to planted for first and second season were: for first season the lower of plant height is best and rated first etc. to fifth, for second season the higher of plant height is best and rated first etc. to fifth, the smaller of flag leaf angle is best and rated first etc. to fifth, the more of total number of tillers is best and rated first etc. to fifth, the more of number of productive tillers is best and rated first etc. to fifth, the more of panicle length is best and rated first etc. to fifth, the more of number of seeds per panicle is best and rated first etc. to fifth, the more of weight seeds per panicle is best and rated first etc. to fifth, after the seven variable that strong and very strong correlation is ranked and then in total. The BC_2F_2 Genotype have lower of total rank is best to planted in first or second season. Based on the result of ranking, BC_2F_2 Siam, Pegagan, and Pelita Rampak most suitable to be planted in the first season were SM 2, PGG 4, and PLR 3 and the most suitable to be planted in second cropping season were SM 2, PGG 3, and PLR 3.

4. Conclusion

BC_2F_2 genotype had different vegetative and generative characters than parental. There are seven variables that very strongly and strongly correlated i.e. plant height, flag leaf angle, total number of tiller, productive tiller, length of panicle, number of seeds per panicle, and weight of seeds per panicle. The production of the tested rice varieties was considerably high ranged from 4.52 to 7.95 tonnes per hectare. It was found that BC_2F_2 of Siam, Pegagan, and Pelita Rampak more suitable for first season cultivation were SM 2, PGG 4, and PLR 3, while BC_2F_2 of Siam, Pegagan, and Pelita Rampak more suitable for second cropping season were SM 2, PGG 3, and PLR 3.

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