



Studies of biochemical traits expression in *Joha* rice (*Oryza sativa*) of Assam in response to Organic and Inorganic culture

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Abstract

Twelve diverse genotype of *Joha* rice comprising ten local germplasm and two improved genotypes were tested for important biochemical traits under organic and inorganic culture. Two different sites of practices used in a randomized block design with three replicates. The analysis of variance shows that the mean squares of all the biochemical character have significant difference among the genotypes in both organic and inorganic culture. The highest coefficient of variation (CV %) was recorded for Chlorophyll b content under organic (9.32%) and inorganic (16.08%) condition. The mean performance of all the genotypes for the biochemical characters revealed that except iron content character all the biochemical characters have higher mean performance for inorganic culture than organic culture. The genetic parameter analysis shows that the iron content was recorded highest in value for both culture conditions. Most of the biochemical character except amylose content and crude protein content shows better response in inorganic condition than organic condition. The characters were shows negatively correlation with the grain yield per plant in both genotypic and phenotypic level. The crude protein character shows significant negative correlation with yield in both organic and inorganic culture. Based on the performance of 12 *Joha* genotype in inorganic and organic culture, *Bokul Joha* was found superior for both cultures, which is improved cultivar of aromatic rice. The genotypes *Kunkuni Joha*, *Kali Jeera*, *Keteki Joha* and *Local Joha* could be investigated for GE interaction over location and years.

Keywords: traits, biochemical, coefficient of variation, correlation, genotypic and phenotypic

Introduction

Rice is the most widely consumed staple food for a large part of the world's human population, especially in Asia. It is the most important grain with regard to human nutrition and caloric intake, providing more than one-fifth of the calories consumed worldwide by humans. Nutritionally rice is one of the major cereal grain consumed more than half of the world's population.

Joha rice is only grown in the Northeast region of India. A special class of scented rice, it is completely different from the famous Basmati rice. It has a delicate texture and rich in anti-oxidant compounds. When the constituents of *Joha* rice were extracted with ethanol, it was found to contain proteins, phenolic compounds, flavonoids, carbohydrates and volatile oils. The rice has high level of acetyl and pyroline, which gives it the sweet aroma. It also has more multivitamins than any other variety of rice.

Scented or aromatic rice is special rice which emits aroma after cooking. It is an important commodity worldwide and command premium prices in local and international market over non-scented varieties because of their superior grain quality and pleasant aroma (Nayak *et al.*, 2002) [16]. Indian sub-continent is a home for aromatic rice diversity (Bisne and Sarawgi, 2008) [3] and grown in almost all the states, covering more than 30 per cent of the total cultivated area (Adhikari *et al.*, 2012; Chakravorty *et al.*, 2013; Sarma *et al.*, 2016) [1, 7, 19]. The aromatic rice of Assam has a unique class grown under sali or winter rice traditionally which is known as "*Joha*". Because of the special flavor and economic value, it bears special significance in the present globalized era. Traditionally, many varieties of aromatic rice

are grown by the farmers of Assam maintaining a diverse gene pool of aromatic rice which differs in various aspects such as aroma intensity, durability, grain shape and size, production potentialities etc. Agro-morphological characterization of germplasm accessions is fundamental criteria in order to provide information of plants (Lin, 1991) [15]. Though a large number of aromatic rice is existed suiting agro-climatic conditions of Assam but its characterization is not sufficient. The goal of the present study was to examine and differentiate among few biochemical characters of native aromatic rice landraces of Assam under organic and inorganic culture along.

Method and Material

- The present investigation was carried out during Sali season of 2015 at the ICR, AAU Jorhat. Twelve *Joha* rice genotypes comprising of ten indigenous cultivars and two developed varieties were taken for the study (Table 1). The experiment was conducted in randomized block design with three replications. Healthy seeds from each genotype were sown in nursery bed under different condition. The germinated seeds were sown on 16th July of 2015 under both organic and inorganic condition. Application of required essential agronomical practices was followed from package and practices for Assam (2009). For organic condition the seed was treated with *azospirillum* along with bio pesticide *P.*

fluorescence and *T. harzianum* @10gm each per kg of seed. In inorganic condition during land preparation application of vermicompost, compost, FYM @10 ton per ha along with N: P: K @20:10:10 kg per ha. While in organic condition application of vermicompost, compost, FYM @ 10 ton/ha along with 5-ton paddy straw (organic) and sowing Dhaincha @ 60 kg/ha. Panchagabya (5 kg fresh cowdung +5 liters of fresh cow urine + 1 kg curd + 1 liter's fresh milk + 250 g Ghee) was applied during vegetative stage.

The crop season was characterized by high morning relative humidity (>90%) and low evening relative humidity (<80%). Maximum temperature was above 31°C in first five months and minimum temperature was above 24.4°C in first four months.

Observations of the traits

Table 1: Details of rice genotypes used in the experiment

SL. No	Name of the genotypes	Pedigree	Origin	Source
1	Keteki <i>Joha</i>	Sabitri/Badshabhog	Assam	ICR Farm, AAU, Jorhat
2	Bokul <i>Joha</i>	Sabitri/Badshabhog	Assam	ICR Farm, AAU, Jorhat
3	Kon <i>Joha</i>	Indigenous	Assam	ICR Farm, AAU, Jorhat
4	Kunkuni <i>Joha</i>	Indigenous	Assam	RARS, Karimganj
5	Local <i>Joha</i>	Indigenous	Assam	ICR Farm, AAU, Jorhat
6	Kukrajhar local <i>Joha</i>	Indigenous	Assam	Deptt. of Agronomy, AAU, Jorhat
7	Kali Jeera	Indigenous	Assam	RARS, Karimganj
8	Harinarayan	Indigenous	Assam	Deptt. of PBG, AAU, Jorhat
9	Jawalpool	Indigenous	Assam	RARS, Karimganj
10	Manimuni <i>Joha</i>	Indigenous	Assam	RARS, Karimganj
11	Indrabhog	Indigenous	Assam	Deptt. of PBG, AAU, Jorhat
12	Kola <i>Joha</i>	Indigenous	Assam	ICR Farm, AAU, Jorhat

Result and Discussion

From the analyses of variance (Table no. 2) revealed the existence of significant differences among the genotypes for all the biochemical traits in response to both organic and inorganic culture. From the ANOVA table it revealed that there is the presence of significant different in inorganic

The chlorophyll content of flag leaf at maximum tillering was estimated for randomly five sampled hills per plot using the methods of Arnon (1949)^[4].

Amylose content was determined by the method described by Juliano (1971)^[13]. Total nitrogen was estimated as per Kjeldahl method modified by Scales and Harrison (1920) was converted to protein values by multiplying nitrogen percentage with the factor 6.25. Iron content was determined calorimetrically according to the method described by Wong (1928)^[23]. Amylose, Iron and Total nitrogen content were recorded from the rice seed.

Statistical analysis

In order to assess and quantify the biochemical content variability among the genotypes for the characters under study were estimated as per standard procedure. Correlation coefficient (Johnson *et al.*, 1955)^[12] and path coefficient analysis (Dewey and Lu, 1959)^[9] were performed using Windostat v. 9.2.

culture response for the trait total chlorophyll content. The estimates of highest coefficient of variation (CV, %) was for chlorophyll a content in inorganic (16.08%) and organic (9.32%) culture. That is indicates of sampling error and environmental effects on the character.

Table 2: Analyses of variance for 6 different characters in 12 *Joha* rice genotypes under inorganic and organic culture

Sources	DF	Chlorophyll a (mg 10 g ⁻¹)		Chlorophyll b (mg 10 g ⁻¹)		Total Chlorophyll (mg 10 g ⁻¹)		Amylose content (%)		Crude protein (%)		Iron content (mg 100g ⁻¹)	
		Inorg	Orgn	Inorg	Orgn	Inorg	Orgn	Inorg	Orgn	Inorg	Orgn	Inorg	Orgn
Replication	2	0.0461	0.0119	0.0235	0.0006	0.1318*	0.0108	0.1295	0.1606	0.0555	0.0018	0.0000	0.0001
Genotypes	11	0.1376**	0.0896**	0.1455**	0.0462**	0.5426**	0.2541**	4.64003**	10.60422**	6.63206**	7.43987**	0.24922**	0.30174**
Error	22	0.0165	0.0059	0.0130	0.0026	0.03082	0.0089	0.0557	0.0749	0.4605	0.0618	0.0002	0.0004
CV (%)		11.67	8.04	16.08	9.32	9.70	6.27	0.0173	0.0239	0.0597	0.0263	0.0215	0.0260

In Table no 3 represents the mean comparison of the characters for the genotypes under inorganic and organic culture.

The chlorophyll pigments play important role in the photosynthetic process as well as biomass production. Genotypes maintaining higher leaf chlorophyll a and chlorophyll b during growth period may be consider potential donor for the ability of producing higher biomass and photosynthetic capacity (Hassan *et al.*, 2009)^[11]. Total chlorophyll content was observed higher under inorganic than the organic culture. Total Chlorophyll content of the plant under inorganic culture was highest in the genotypes Kali Jeera, followed by the Jawalpool and Indrabhog. In

organic culture the genotype Kunkuni *Joha* shows highest and followed by Keteki *Joha* and Indrabhog.

Amylose content of rice grain is considered to be one of the most important compositional indices of rice cooking and processing behaviour. The varieties having very low amylose (3-10%) content are sticky, moist and tender when cooked. The varieties having a high content of amylose (>25%) become very hard when cooked. As such intermediate amylose (20-25%) containing varieties which on cooking remain fluffy and soft are mostly preferred over other varieties. The result present investigation revealed that amylose content ranged from 11.09 per cent for Kola *Joha* to 15.58 per cent for Jawalpool under inorganic culture,

while in organic culture the ranged was 8.29 per cent for Kunkuni Joha to 14.67 per cent for Jawalpool. Most of the genotypes were having low amylose content (3-15%) class. The variation in amylose content of the rice grain for different genotypes may be attributes primarily due to the difference in their genetic makeup. It has been reported that methods of rice processing results in significant differences in the amylose content in the grains (Dutta and Barua, 1978) [10].

Rice proteins are nutritionally superior over most of the other cereals, but major limitations are that it is available in low quantities and most part of it (7-8%) is lost during the milling (Juliano *et al.*, 1964) [13]. The better nutritive value

of rice protein is mainly due to better amino acid balance (Sikka *et al.*, 1989) [21]. In the present investigation the protein content ranged from 8.27 per cent for Jawalpool to 13.4 per cent for Bokul Joha under inorganic culture, while in organic culture the ranged was 6.70 per cent for Jawalpool to 11.82 per cent for Kali Jeera.

The overall mean of the genotypes for the iron content was 0.62 mg 100 g⁻¹. The iron content was ranged from 0.20 mg 100 g⁻¹ for *Kon Joha* to 1.22 mg 100 g⁻¹ for *Bokul Joha*.

The mean performance of all the genotypes for the biochemical characters revealed that except iron content character all the biochemical characters have higher mean performance for inorganic culture than organic culture.

Table 3: Comparative mean performances for yield and yield contributing traits of the 12 *Joha* rice genotypes under inorganic and organic culture

Genotypes	Chlorophyll a (mg 100g ⁻¹)		Chlorophyll b (mg 100g ⁻¹)		Total Chlorophyll (mg 100g ⁻¹)		Amylose content (%)		Crude protein (%)		Iron content (mg 100g ⁻¹)	
	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
Keteki Joha	0.95	1.21	0.54	0.70	1.49	1.90	3.53	9.87	11.05	9.71	0.87	0.96
Bokul Joha	0.76	0.95	0.36	0.58	1.12	1.53	3.13	11.66	13.45	10.46	1.22	1.36
Kon Joha	0.98	0.82	0.62	0.50	1.59	1.31	2.73	11.55	12.40	10.26	0.20	0.26
Kunkuni Joha	1.11	1.25	0.64	0.76	1.75	2.01	4.27	8.29	10.79	8.30	0.83	1.02
Local Joha	1.14	0.85	0.76	0.41	1.90	1.26	4.51	13.25	11.09	9.51	0.68	0.78
Kokrajhar Local	1.21	0.95	0.70	0.63	1.92	1.58	3.31	11.02	11.47	8.74	0.45	0.48
Kali Jeera	1.51	0.96	1.14	0.54	2.65	1.50	5.40	14.67	13.25	11.82	0.25	0.32
Harinarayan	1.13	0.77	0.67	0.48	1.80	1.24	3.69	11.50	11.82	10.77	0.51	0.62
Jawalpool	1.22	0.99	1.04	0.53	2.25	1.52	5.58	14.47	8.27	6.70	0.36	0.46
Manimuni Joha	1.05	0.73	0.70	0.33	1.76	1.06	2.49	10.31	9.56	8.22	0.80	0.88
Indrabhog	1.34	1.15	0.86	0.68	2.20	1.83	3.54	10.77	10.74	7.58	0.66	0.81
Kola Joha	0.80	0.80	0.48	0.48	1.28	1.29	1.09	10.15	12.54	11.40	0.59	0.69
Mean	1.10	0.95	0.71	0.51	1.81	1.50	3.61	11.46	11.37	9.46	0.62	0.72
SEM ±	0.07	0.04	0.07	0.03	0.10	0.05	0.14	0.16	0.39	0.14	0.01	0.01
CD, 5%	0.22	0.13	0.19	0.09	0.30	0.16	0.40	0.46	1.15	0.42	0.02	0.03

Genetic variability

Genetic variability refers to the presence of gene differences among the individuals of the population. Variability results due to differences either in the genetic constitution of the individuals in a population or in the environment where they are grown. The existence of variability is essential for resistance to biotic and abiotic factors as well as for wide adaptability. Fisher (1918) [18] partitioned the total phenotypic variance into genotypic variance and environmental variance. Selection is effective only when there is a significant genetic variability among the individuals in a population and presence of this genetic variability is the prerequisite for the success of breeding programme in any crop including rice. Hence it is essential for breeders to assess the genotypic variation of the materials under investigation by estimating various genetic parameters.

Knowledge on nature and amount of genetic variability present in a gene pool and the heritability of the traits are important for achieving genetic improvement of quantitative traits. Thus, information on genetic parameters such as variance, coefficient of variation and heritability are useful. Moreover, the environmental influence on the traits can be understood by the estimation of heritability.

Under inorganic culture the estimates of highest genetic coefficient of variability (GCV) was recorded for iron content (46.61%). Moderate estimates were obtained for chlorophyll a, chlorophyll b, total chlorophyll content.

Similarly, the highest estimates of phenotypic coefficient of variability (PCV) for inorganic culture was recorded for iron content (46.7%)

The estimation of the high GCV and PCV for both cultures was recorded for iron content indicating the presence of the sample variation among the 12 genotypes for the character. The GCV provides information for comparison of the genetic variability and indicates the validity of the traits for selection. However, it does not provide a clear picture of the genetic gain to be achieved from selection unless the heritable fraction of the variation is known (Burton, 1952), indicating the importance of heritability estimation.

High heritability combined with high genetic advance is desirable for the selection-based genetic improvement of a character. High heritability coupled with high genetic advance was observed for iron content and chlorophyll content for both cultures. This indicated that along with additive gene action, non-additive gene action might be importance for these characters.

Heritability in conjunction with genetic advance is more useful than heritability alone in predicting the resultant effects for selecting the best genotype for a given trait (Johnson *et al.*, 1955) [12]. The genetic advance reveals the magnitude of improvement that could be made in a particular character by selecting a certain portion of the population in a desired direction. In inorganic culture the genetic advance (GA) calculated as per cent of the mean was highest (95.9%) for iron content.

Table 4: Estimates of range, mean and genetic variability parameters for the yield traits in 12 *Joha* rice genotypes

Characters		Range	Mean±SEM	GCV (%)	PCV (%)	h ² _{bs} (%)	GA, % of mean
Chlorophyll a	Inorganic	0.76-1.51	1.10±0.07	18.26	21.67	0.71	31.69
	Organic	0.73-1.25	0.95±0.04	17.54	19.30	0.83	32.85
Chlorophyll b	Inorganic	0.36-1.14	0.71±0.07	29.65	33.73	0.77	53.96
	Organic	0.33-0.76	0.55±0.03	21.92	23.82	0.85	41.55
Total Chlorophyll	Inorganic	1.12-2.65	1.81±0.10	22.83	24.81	0.85	43.28
	Organic	1.06-2.01	1.50±0.05	19.04	20.04	0.90	37.26
Amylose content	Inorganic	11.09-15.58	13.61±0.14	9.09	9.25	0.96	18.38
	Organic	8.29-14.67	11.46±0.16	16.35	16.52	0.98	33.33
Crude protein	Inorganic	8.27-13.45	11.67±0.39	12.62	13.96	0.82	23.49
	Organic	6.707-11.82	9.46±0.14	16.58	16.79	0.98	33.74
Iron content	Inorganic	0.20-1.22	0.62±0.01	46.61	46.66	0.99	95.91
	Organic	0.26-1.36	0.72±0.01	43.93	44.01	0.99	90.34

Character interrelationship

Information on both genotypic and phenotypic correlation coefficient is important in selection programme. Only when characters have high heritability, the genetic correlation assumes importance. Otherwise, environmental correlation is the chief determinant of the phenotypic correlation. Thus, the magnitude and even the direction of the genetic correlation cannot be determined from the phenotypic correlation alone. Moreover, grain yield is a complex character governed mostly by polygenes and it is the resultant expression of several interrelated characters, thus it is imperative to obtain information on the characters which influence grain yield. This will help in formulating suitable selection criteria for the indirect selection of grain yield.

The highest coefficient of variation was for Chlorophyll b in both organic and inorganic culture indicating that the environmental effects also sampling error for this character. The Chlorophyll pigments play an important role in photosynthetic process as well as biomass production. Genotypes maintaining higher leaf chlorophyll a and chlorophyll b during its growth period may considered potential donor for the ability to producing higher food materials. Above mention table 2 the mean performances of the genotypes under inorganic and organic condition. From the table all the genotypes were perform better in inorganic condition as compare to the organic condition. These results indicated that due to the application and proper management of fertilizer, nutrients may help the plants for better quality production. These results were supported by Hassan *et al.*, (2009) [11].

Table 5: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among the quality traits and grain yield of the 12 *Joha* rice genotypes under inorganic and organic culture

Organic	CHLa	CHLb	TCHL	AC	CP	FeC	GYP
CHLa		9.78	0.996	-0.098	0.094	-0.098	0.238
CHLb	8.26**		0.992	-0.092	-0.042	0.011	0.228
TCHL	9.69**	9.39*		-0.191	-0.120	0.028	0.232
AC	-0.102	-0.091	-0.193		0.109	-0.510	-0.212
CP	-0.102	-0.039	-0.141	0.101		-0.011	-0.621
FeC	0.018	0.009	0.273	-0.503	-0.110		-0.088
GYP	0.179	0.127	1.652	-0.202	-0.527*	-0.069	
Inorganic	CHL a	CHL b	TCHL	AC	CP	FeC	GYP
CHLa		1.019*	1.005*	-0.187	0.073	0.035	-0.164
CHLb	0.766**		1.005*	0.201	-0.118	0.041	-0.175
TCHL	0.940**	0.940**		-0.388	-0.191	-0.075	-0.168
AC	0.186	0.209	0.394		-0.314	-0.249	-0.20

CP	-0.067	-0.124	-0.191	-0.281		0.055	-0.438**
FeC	-0.034	-0.041	-0.075	-0.246	0.060		0.101
GYP	-0.169	0.114	-0.151	-0.134	-0.249	-0.083	

Conclusion

The genotype Kali Jeera shows higher biochemical content then other genotypes in both organic and inorganic condition. The amylose content in the Jawalpool genotype recorded high (15.58%) as compare to other genotypes which is referred to intermediate amylose content class that indicates the rice is fluffy and soft after the cooking which is mostly proffered. It has been reported that methods of rice processing results in significant differences in the amylose content in the grains (Dutta and Barua, 1978) [10]. Most of the biochemical character except amylose content and crude protein content shows better response in inorganic condition than organic condition. Genotype Bokul Joha was recorded higher iron content in organic condition then inorganic condition. Thus, there is a scope for enhancing iron content of Joha rice through organic culture. From the study of genetic variability (table 3), it was revealed that the character iron content shows higher GCV, PCV an heritability as compare to all other nutritional characters under both organic and inorganic culture. The estimation of the high GCV and PCV for both cultures was recorded for iron content indicating the presence of the sample variation among the 12 genotypes, which is supported by the findings of Singh *et al.*, (1986) [20]. The nutritional characters were shows mostly high heritability in both organic and inorganic culture. High heritability coupled with genetic advance was observed for iron content and chlorophyll content for both cultures indicating predominance of additive gene action for these characters. The results were supported by Panse and Sukhatme (1973) [17]. Heritability in conjunction with genetic advance is more useful than heritability alone in predicating the resultant effects for selecting the best genotype for a given trait (Johnson *et al.*, 1995) [12]. The genetic advance was recorded highest for the iron content (95.9%) in inorganic culture. The similar finding was observed by Amunda and Thiyanganjan (2008) [2] and Vanja and Babu (2006) [22]. Information on both genotypic and phenotypic correlation coefficient is important in selection programme. Only when characters have high heritability, the genetic correlation assumes importance. Otherwise, environmental correlation is the chief determinant of the phenotypic correlation. Moreover, grain yield is complex character governed mostly by polygene and it is the resultant expression of several interrelated

characters, thus it is imperative to obtain information on the characters which influence grain yield. The characters were shows negatively correlation with the grain yield per plant in both genotypic and phenotypic level. The crude protein character shows significant negative correlation with yield in both organic and inorganic culture. Based on the performance of 12 *Joha* genotype in inorganic and organic culture, *Bokul Joha* was found superior for both cultures, which is improved cultivar of aromatic rice. The genotypes *Kunkuni Joha*, *Kali Jeera*, *Keteki Joha* and *Local Joha* could be investigated for GE interaction over location and years.

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