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Trait expression studies of indigenous *Joha* rice of Assam under organic and inorganic culture

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Abstract
The present investigation was conducted to evaluate 12 indigenous Joha rice genotypes for different yield characters under inorganic and organic cultures. The materials were characterized during sali season of 2015-16 at the Instruction-cum-Research (ICR), Assam Agricultural University (AAU), Jorhat using Randomized Block Design (RBD) with three replications. Analysis of variance revealed the existence of significant differences among the genotypes for all the traits under both inorganic and organic cultures. Among all the characters, panicle weight, grains/panicle, 1000-grain weight, grain yield/plant, straw yield/plant and harvest index exhibited moderate to high estimates of the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded under organic and inorganic culture. Also, high estimates of heritability were recorded for days to first flowering, days to 50% flowering, plant height, grains/panicle, 1000-grain weight, and harvest index. High heritability coupled with high genetic advance was observed only for 1000-grain weight under both the cultures. The correlation analysis revealed that under both the condition the grain yield/plant had a significant positive association with biological yield and harvest index at both genotypic and phenotypic level respectively. Thus, all these information could be effectively used to formulate a breeding programme for improvement of their adaptation under organic farming.

Keywords: GCV, PCV, heritability, genetic advance, correlation

Introduction
Rice (*Oryza sativa* L.) is one of the major cereal crops playing a significant role in the diet, culture, and economy of millions of people across the world. North East India especially Assam is one of the centers of origin has got wide ranges of variation of rice cultivars. Among the various groups of rice cultivated in Assam, aromatic rice locally known as *Joha* occupies an important position. *Joha* rice is very popular among the consumers of the region due to its unique quality (aroma), superfine kernel, good cooking quality compared to the other scented rice cultivars of India, but poor in yielding ability, photoperiod sensitive, late maturing, tall and have weak stem making them lodge. It is now globally well established that organic farming can improve the quality of scented rice. Along with the quality, improvement in grain yield per unit area is important to meet the food production demand of the growing population. Thus in the present investigation, 12 diverse *Joha* rice genotypes were evaluated for yield and yield contributing characters under two different growing conditions - inorganic and organic culture. The investigation was undertaken to study the changes in trait expression under organic culture and to identify the outstanding genotypes suitable for organic farming.

Method and material
Experimental Materials and crop management
The present investigation was carried out during *sali* season of 2015-16 at the ICR, AAU, Jorhat. Twelve *Joha* rice genotypes comprising of ten indigenous cultivars and two developed varieties were characterized for the present study (Table 1). The germinated seeds were sown on 16th July 2015 under both organic and inorganic culture. For inorganic culture in the nursery bed fertilizers were applied @ N: P: K:: 60:30:30 kg/ha and; FYM, vermicompost, and compost @5 t/ha were applied in the organic nursery bed. Twenty-seven days old seedlings were transplanted in the main field on 12th August 2015. Two seedlings were planted per hill with a spacing of 20×15cm. The experiment was laid out in RBD with three replications. All other essential agronomical practices and plant protection measures whenever necessary were adopted as per recommendations in Package of Practices for Assam (2007).
In the inorganic plot, vermicompost, compost, and FYM @ 10 tonnes/ha along with urea, single superphosphate and muriate of potash were applied @ N: P: K:: 20: 10: 10 kg/ha.

Same doses of vermicompost, compost, and FYM along with 5-ton paddy straw and sowing of Dhaincha was done @ 60 kg/ha. After 45 days of sowing the Dhaincha crop was incorporated into the soil by ploughing. Panchagabya (5 kg fresh cowdung + 5 litres of fresh cow urine + 1 kg curd + 1-litre fresh milk + 250 g Ghee) was applied (15th sept). Irrigation was applied to the crop when needed to maintain a water depth of 5 ± 2 cm. The details of chemical properties of soil and microbial properties of the experimental sites are presented in Table 2a and 2b.

Observations on plant traits

The data was recorded on ten randomly selected plants from each replication for eleven quantitative characters *viz*., days to first flowering (DF), days to 50% flowering (DFF), days to maturity (DM), plant height (PH), panicle weight (PW), grains/panicle (GPP), 1000-grain weight (TGW), grain yield/plant (GY), straw yield/plant, biological yield (BY) and harvest index (HI).

Statistical analysis

In order to assess and quantify the genetic variability among the genotypes forthe characters under study, genetic parameters were estimated as per standard procedure. Correlation coefficient (Johnson *et al*., 1955) [8] and path coefficient analysis (Dewey and Lu, 1959) [3] were performed using Windostat *v*. 9.2.

Result and discussion

Analysis of variance (Table 3) revealed the existence of significant differences among the genotypes for all the traits in both inorganic and organic culture. The mean performance of the genotypes for various characters is presented in Table 4. Considering the days to first flowering, 50% flowering and days to maturity together, two genotypes namely Kali Jeera and Kon *Joha* were found significantly earlier than all the genotypes for both organic and inorganic culture. Earliness is preferred to allow timely Rabi crops in the rice field as *Joha* rice cultivars are suitable for the shallow land situation. Semi-dwarf varieties are more resistant to wind and rain damage than their tall counterparts and also produce higher yields because more resources are allocated to the grains rather than to the vegetative parts (Zou *et al*., 2003) [15]. In view of this, under both organic and inorganic culture, the genotype Kunkuni *Joha* followed by Indrabhog and Kola *Joha* are comparatively dwarfing assumed importance. Panicle weight of Manimuni *Joha* and Kon *Joha* for organic culture was the highest, while in inorganic culture Indrabhog showed the highest followed by Jawalpool, Kon *Joha* and Bokul *Joha*.The genotypes Bokul *Joha* and Kali Jeera exhibited a higher number of grains/panicle under organic and inorganic culture than rest of the genotypes. Genotypes which produce a higher number of grains/panicle also show higher grain yield in rice (Kusutani *et al*., 2000; Dutta *et al*., 2002) [10, 6]. The genotype Kola *Joha* exhibited higher 1000-grain weight under both organic and inorganic culture and was followed by Indrabhog and Keteki *Joha.* The overall mean for 1000-grain weights under organic culture was more than in the inorganic culture. The grain yield/plant under inorganic and organic culture ranged from 7.53-13.19 g and 8.79-18.58 g, respectively. The genotype Kukrajhar Local *Joha* showed the highest grain yield/plant under organic culture, followed by Indrabhog and Keteki *Joha*, while in inorganic culture the genotype Keteki *Joha* showed the highest yield. Keteki *Joha* is an improved aromatic variety developed through hybridization, while Kukrajhar Local *Joha* is a landrace grown by default under organic condition; and as such the latter is better adapted to organic culture than the former. In organic culture, Kukrajhar Local *Joha* exhibited the highest straw yield/plant followed by Manimuni *Joha* and Kon *Joha*. And in inorganic culture, Manimuni *Joha* genotype accorded the highest mean followed by Harinarayan and Local *Joha*. The genotype Kukrajhar Local *Joha* under organic culture registered the highest biological yield and in inorganic culture, Manimuni *Joha* showed the highest yield followed by Keteki *Joha* and Jawalpool. Harvest index is a vital character having physiological importance. The high harvest index under organic culture for Indrabhog, Jawalpool and Keteki *Joha* indicated better source-sink translocation and thus assume importance in breeding varieties for organic farming. Indrabhog also exhibited the highest yield under inorganic culture.

The range, mean (±SEm) and genetic parameters for various characters are presented in Table 5. In the present investigation, the observed range of variation for different characters was considerable. The estimates of PCV were higher than those of GCV for all the characters indicating the environmental influence of varying degrees on these characters. Similar results were also obtained by Das and Sarma (2015) [2], Devi *et al*. (2016) and Sumanth *et al*. (2017) [13]. Moderate to high GCV and PCV were recorded for panicle weight, grains/panicle, 1000-grain weight, grain yield/plant, straw yield/plant and harvest index under both inorganic and organic culture indicating the presence of the ample variation among the genotypes. High PCV and GCV for grain yield/plant (Dhanwani *et al*., 2013; Sala and Shanthi, 2016; Shaikh *et al*., 2017; Sumanth *et al*., 2017) [4, 12, 14, 13] and spikelets/panicle (Dhanwani *et al*., 2013; Sumanth *et al*., 2017) [4, 13] was also reported in rice. In both the condition the difference of GCV and PCV were low to medium for most of the characters, this suggesting a little role of environment in the expression of those characters. Under both the culture, high estimates of heritability were recorded for days to first flowering, days to 50% flowering, plant height, grains/panicle, 1000-grain weight, and harvest index. The same magnitude of heritability was also recorded for days to maturity and panicle weight under inorganic culture and biological yield under organic culture. However, 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 only for 1000-grain weight under both the cultures indicating a predominance of additive gene action for these characters. This finding was in accordance with the findings of Sala and Shanthi (2016) [12] and Ajmera *et al.* (2017) [1].

The correlation coefficient estimates at the phenotypic and genotypic level are presented in Table 6a to 6b. The significant genotypic correlations were found to have a close agreement with phenotypic correlations in most of the cases with a few differing in magnitude, indicating the reliability of these associations for the breeding programme. In inorganic culture the correlation analysis revealed that grain yield/plant had strong to moderate positive correlation with days to first flowering (0.560**; 0.441**), days to 50% flowering (0.449**; 0.387*); 1000-grain weight (0.571**; 0.433**), biological yield (0.392*; 0.639**) and harvest index (0.830**; 0.641**) at both genotypic and phenotypic level respectively. Strong positive correlation was observed among days to first flowering, days to 50% flowering and days to maturity at both the level. For organic culture, grain

yield/plant had significant positive association with straw yield/plant (0.639**; 0.660**), biological yield (0.926**; 0.916**) and harvest index (0.790**; 0.712**) at both the level, respectively. Grain yield/plant also had significant positive association with days to maturity (0.451**) and 1000-grain weight (0.356*) at genotypic level. Significant positive association of grain yield/plant with days to maturity (Dhurai et al., 2016) [5], 1000 grain weight (Gangashetty *et al*., 2013; Das and Sarma, 2015; Kalyan *et al*., 2017) [7, 2, 9], biological yield (Das and Sarma, 2015; Kalyan *et al*., 2017) [2, 9] and harvest index (Dhurai *et al*., 2016; Kalyan *et al*., 2017) [5, 9] was also reported in earlier studies.Thus, these characters may serve as an effective selection parameter during breeding programme.

The path coefficient analyses for the characters were presented in Table 7a and 7b. Under inorganic culture among the characters, biological yield/plant exhibited the highest positive direct effect (1.547) on the grain yield/plant followed by, days to first flowering (0.035) and days to maturity (0.008). While in organic culture highest positive direct effect was recorded for biological yield/plant on grain yield/plant (1.766), followed by days to first flowering (0.017), panicle weight (0.005) and days to maturity (0.002). Similarly, for inorganic culture the highest positive indirect effect was recorded for straw yield/plant on grain yield/plant via biological yield/plant (1.211), followed by harvest index via straw yield/plant (1.115), 1000-grain weight via straw weight (0.523). In organic culture, straw yield/plant had the highest positive indirect effect on grain yield/plant via biological yield (1.558), followed by harvest index via biological yield (0.88), plant height (0.489). The residual effect for the inorganic path was 1.93% and it was negligible in case of organic culture.

Conclusion

The result of the present investigation revealed high genetic variation observed among the genotype for various morpho-physiological attributes is indicative of their inherent diversity with respect to adaptation and other morphological attributes. This information could be effectively used to formulate a breeding programme for improvement of their adaptation under organic farming. Based on the performance of the 12 *Joha* genotypes in inorganic and organic culture, improved cultivar Keteki *Joha*was found superior for inorganic culture and the landrace Kukrajhar Local *Joha* under organic culture. Indrabhog could also be considered for direct release under organic farming. These genotypes along with Kola *Joha*, Kali Jeera and Manimuni *Joha* could be further investigated for GE interaction over locations and years. Weed suppressing ability of Kunkuni *Joha*, Local *Joha* and Indrabhog needs to be correlated with plant type characters for future organic rice breeding.

Table 1: Details of rice genotypes used in the experiment

S. No	Name of the genotypes	Pedigree	Origin	Source
1	Keteki *Joha*	Sabitri/Badshabhog	Assam	ICR Farm, AAU, Jorhat
2	Bokul *Joha*	Sabitri/Badshabhog	Assam	ICR Farm, AAU, Jorhat
3	Kon *Joha*	Indigenous	Assam	ICR Farm, AAU, Jorhat
4	Kunkuni *Joha*	Indigenous	Assam	RARS, Karimganj
5	Local *Joha*	Indigenous	Assam	ICR Farm, AAU, Jorhat
6	Kukrajhar local *Joha*	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 *Joha*	Indigenous	Assam	RARS, Karimganj
11	Indrabhog	Indigenous	Assam	Deptt. of PBG, AAU, Jorhat
12	Kola *Joha*	Indigenous	Assam	ICR Farm, AAU, Jorhat

Table 2a: Chemical properties of the soil

		Initial (before planting)		After harvesting	
Organic culture					
S. No.	Characteristics	Value	Inference	Value	
1	pH	5.26	Acidic	5.35	Acidic
2	Available N (Kg/ha)	277.39	Medium	309.25	Medium
3	Available P (Kg/ha)	26.58	Medium	40.04	Medium
4	Available K (Kg/ha)	125.26	Low	158.05	Low
Inorganic culture					
1	pH	4.8	Acidic	4.96	Acidic
2	Available N (Kg/ha)	297.87	Medium	254.31	Medium
3	Available P (Kg/ha)	21.28	Medium	20.63	Medium
4	Available K (Kg/ha)	101.71	Low	114.54	Low

Table 2b: Microbial properties of the soil

Organic culture		Initial (before planting)	After harvesting
S. No.	Characteristics	Value	Value
1	Microbial biomass carbon (µg/g/ dry soil)	869.6	966.97
2	Dehydrogenage activity (µg TPF/g/day)	37.59	75.29
3	Phosphomonoesterase activity (µg PNP/g/hr)	33.86	64.21
Inorganic culture			
1	Microbial biomass carbon (µg/g/ dry soil)	124	132
2	Dehydrogenage activity (µg TPF/g/day)	13.66	19.8
3	Phosphomonoesterase activity (µg PNP/g/hr)	22.94	31.97

Source: Department of Soil Science, Assam Agricultural University, Jorhat

Table 3: Analyses of variance for 11 different characters in 12 *Joha* rice genotypes under inorganic and organic culture

Source of Variations	df	DF		DFF		DM		PH		PW	
		Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
Replicate	2	0.86	4.08*	0.00	1.19**	7.69*	34.11	38.47	22.41	0.45	0.95
Treatments	11	91.72**	88.98**	84.61**	84.75**	95.42**	174.45**	282.38**	389.11**	13.71**	26.18**
Error	22	1.50	1.08	0.70	0.19	1.97	26.84	13.01	11.16	1.23	6.65
CV (%)		1.22	1.06	0.74	0.40	0.96	3.57	2.88	2.63	8.10	17.07

Source of Variations	df	G/P		TGW		GYP		SWP		BYP		HI	
		Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
Replicate	2	195.94	324.92	0.36	0.08	1.22	3.19	6.56	4.47	12.76	15.20	1.47	0.41
Treatments	11	1789.00**	1784.49**	22.73**	31.33**	8.88**	27.90**	21.82**	20.68**	29.91*	79.58**	84.02**	61.24**
Error	22	206.88	208.30	0.29	0.46	1.81	1.97	6.33	4.03	12.90	10.45	5.84	3.29
CV (%)		10.69	9.69	4.10	5.10	12.89	10.76	14.82	11.17	13.11	10.42	6.33	4.34

*, ** Significant at 5% and 1% level, respectively

Table 4: Comparative mean performances for yield and yield contributing traits of the 12 *Joha* rice genotypes under inorganic and organic culture

Genotype	DF		DFF		DM		PH		PL		PW	
	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
Keteki *Joha*	111.00	106.00	123.33	117.67	159.00	151.67	139.52	151.05	25.12	25.42	1.27	1.57
Bokul *Joha*	102.67	104.33	113.67	116.33	146.33	152.33	125.37	122.04	24.83	22.77	1.54	1.43
Kon *Joha*	98.67	92.00[a]	111.00	104.33	143.33[a]	138.67	130.43	131.69	24.95	24.88	1.50	2.00[a]
Kunkuni *Joha*	98.33	100.00	110.67	111.33	145.33	144.67	109.73[a]	114.04[a]	23.86	23.88	1.36	1.30
Local *Joha*	111.00	106.00	122.67	118.00	157.00	147.67	116.17	117.55[a]	26.34	24.02	1.30	1.03
Kokrajhar Local	97.00	100.33	108.67	112.67	146.67	145.00	130.49	132.77	24.11	23.51	1.15	1.32
Kali Jeera	95.00[a]	91.33[a]	108.67	103.00[a]	146.33	129.33[a]	135.38	136.03	22.87	24.02	1.27	1.64[a]
Harinarayan	97.00	96.00	111.67	109.00	146.00	142.33	132.83	134.29	22.75	23.59	1.33	1.27
Jawalpool	99.00	93.00[a]	110.67	104.67	141.33[a]	139.67	129.13	129.34	24.98	24.59	1.63[a]	1.42
Manimuni *Joha*	94.00[a]	92.00[a]	106.67[a]	105.33	142.00[a]	141.33	125.67	127.29	22.73	24.28	1.22	2.04[a]
Indrabhog	99.00	100.00	108.67	113.00	142.00[a]	156.67	112.57[a]	112.47[a]	27.77	26.60	1.80[a]	1.44
Kola *Joha*	98.67	98.00	111.67	110.00	144.33	153.00	114.37[a]	114.35[a]	23.88	23.89	1.05	1.67[a]
Mean	100.11	98.25	112.33	110.44	146.64	145.19	125.14	126.91	24.52	24.29	1.37	1.51
SEm ±	0.71	0.60	0.48	0.25	0.81	2.99	2.08	1.93	1.11	1.20	0.06	0.15
CD, 5%	2.07	1.76	1.41	0.75	2.38	8.77	6.11	5.66	NS	NS	0.19	0.44

[a] Indicates genotypes ranked first based on CD for the trait in question; Low mean values for DF, DFF, DM and PH are desirable.

Genotype	G/P		TGW		GYP		SWP		BY		HI	
	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
Keteki *Joha*	96.82	122.51	15.33	15.42	13.19[a]	16.09[a]	16.92	19.23	30.11[a]	35.33	43.88[a]	45.62[a]
Bokul *Joha*	176.36[a]	187.15[a]	10.97	11.11	8.37	9.73	15.32	13.63	23.69	23.36	35.33	41.60
Kon *Joha*	143.33	180.23[a]	12.72	12.78	12.54[a]	12.59	15.48	19.88	28.02[a]	32.47	44.64[a]	38.86
Kunkuni *Joha*	105.42	136.03	11.75	11.45	10.04	10.58	16.37	18.39	26.41[a]	28.97	37.99	36.44
Local *Joha*	123.42	115.54	13.09	13.63	11.09[a]	13.52	19.63[a]	17.13	30.72[a]	30.66	36.14	44.18
Kokrajhar Local	119.87	152.99	11.20	11.78	10.54	18.58[a]	17.32	23.36[a]	27.86[a]	41.95[a]	38.42	44.39[a]
Kali Jeera	174.27[a]	180.44[a]	10.82	9.37	7.53	8.79	12.90	16.21	20.43	25.00	36.80	35.02
Harinarayan	138.30	134.83	12.24	12.34	8.75	9.96	20.18[a]	18.90	28.93[a]	28.86	30.32	34.48
Jawalpool	148.12	156.11	11.13	11.24	11.01[a]	13.84	18.84[a]	15.95	29.85[a]	29.79	36.75	46.35[a]
Manimuni *Joha*	143.00	139.34	11.90	11.20	9.38	14.22	21.77[a]	19.60	31.14[a]	33.82	30.02	42.10
Indrabhog	121.25	123.11	17.73	18.58	12.16[a]	16.76[a]	13.50	18.58	25.66[a]	35.33	47.32[a]	47.44[a]
Kola *Joha*	124.60	159.15	19.07[a]	20.13[a]	10.49	11.87	15.53	14.70	26.03[a]	26.57	40.56	44.65[a]
Mean	134.56	148.95	13.16	13.25	10.42	13.05	16.98	17.96	27.40	31.01	38.18	41.76
SEm ±	8.30	8.33	0.31	0.39	0.78	0.81	1.45	1.16	2.07	1.87	1.40	1.05
CD, 5%	24.36	24.44	0.91	1.14	2.28	2.38	4.26	3.40	6.08	5.47	4.09	3.07

[a] Indicates genotypes ranked first based on CD for the trait in question

Table 5: Estimates of range, mean and genetic variability parameters for the yield traits in 12 *Joha* rice genotypes

Character	Range		Mean		GCV (%)		PCV (%)		h^2_{bs}		GA, % of mean	
	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org	Inorg	Org
DF	94.00 – 111.00	91.33 – 106.00	100.11	98.25	5.5	5.5	5.6	5.6	95.3	96.4	11.0	11.1
DFF	106.67 – 123.33	103.00 – 118.00	112.33	110.45	4.7	4.8	4.8	4.8	97.6	99.3	9.6	9.9
DM	141.33 – 159.00	129.33 – 156.67	146.64	145.19	3.8	4.8	3.9	6.0	94.1	64.7	7.6	8.0
PH	109.73 – 139.52	112.47 – 151.05	125.14	126.91	7.6	8.8	8.1	9.2	87.3	91.9	14.6	17.5
PW	1.05 – 1.80	1.03 – 2.04	1.37	1.51	14.9	16.9	17.0	24.0	77.2	49.5	27.0	24.5
G/P	96.82 – 176.36	115.54 – 187.15	134.56	148.95	17.1	15.4	20.1	18.2	71.8	71.6	29.8	26.8
TGW	10.82 – 19.07	9.37 – 20.13	13.16	13.25	20.8	24.2	21.2	24.7	96.3	95.8	42.0	48.8
GY/P	7.53 – 13.19	8.79 – 18.58	10.42	13.05	14.7	22.5	19.6	25.0	56.6	81.4	22.8	41.9
SWP	12.90 – 21.77	13.63 – 23.36	16.98	17.96	13.4	13.1	20.0	17.2	44.9	57.9	18.5	20.6

BY	20.43 – 31.14	23.36 – 41.95	27.40	31.01	8.7	15.5	15.7	18.7	30.5	68.8	9.9	26.5
HI	30.02 – 47.32	34.48 – 47.44	38.18	41.76	13.4	10.5	14.8	11.4	81.7	85.5	24.9	20.0

*, ** Significant at 5% and 1% level, respectively

Table 6a: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among the yield traits of the 12 *Joha* rice genotypes under inorganic culture

Character	DF	DFF	DM	PH	PW	G/P	TGW	SWP	BYP	HI	GYP
DF		0.984**	0.887**	0.005	0.010	-0.441**	0.228	0.065	0.424**	0.308	0.560**
DFF	0.953 **		0.932**	0.117	-0.132	-0.420*	0.186	0.168	0.451**	0.163	0.449**
DM	0.850 **	0.908 **		0.236	-0.346*	-0.458**	0.076	0.137	0.333*	0.098	0.313
PH	0.029	0.115	0.221		-0.148	0.333*	-0.423**	0.167	0.116	-0.178	-0.068
PW	0.388 *	0.271	0.134	-0.260		0.178	-0.041	-0.449**	-0.302	0.393*	0.197
G/P	-0.332 *	-0.325	-0.344 *	0.220	0.250		-0.521**	-0.294	-0.853**	-0.443**	-0.887**
TGW	0.219	0.177	0.078	-0.389 *	0.000	-0.437 **		-0.356*	0.029	0.626**	0.571**
SWP	0.081	0.116	0.095	0.032	-0.056	-0.024	-0.208		0.783**	-0.758**	-0.266
BY	0.273	0.275	0.197	-0.006	0.098	-0.220	0.041	0.886 **		-0.188	0.392*
HI	0.250	0.182	0.099	-0.115	0.279	-0.338 *	0.538 **	-0.606**	-0.173		0.830**
GY/P	0.441 **	0.387 *	0.258	-0.066	0.301	-0.425 **	0.433 **	0.210	0.639 **	0.641 **	

*, ** Significant at 5% and 1% level, respectively

Table 6b: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among the yield traits of the 12 *Joha* rice genotypes under organic culture

Character	DF	DFF	DM	PH	PW	G/P	TGW	SW/P	BY	HI	GY/P
DF		1.003[a]	0.837**	-0.110	-0.718**	-0.482**	0.326	-0.070	0.133	0.400*	0.273
DFF	0.976 **		0.840**	-0.119	-0.699**	-0.516**	0.357*	-0.033	0.179	0.431**	0.318
DM	0.606 **	0.685 **		-0.441**	-0.360*	-0.518**	0.847**	-0.165	0.195	0.725**	0.451**
PH	-0.098	-0.117	-0.312		0.256	0.076	-0.352*	0.392*	0.277	-0.147	0.138
PW	-0.498 **	-0.477 **	-0.185	0.202		0.404*	0.013	-0.024	-0.070	-0.077	-0.095
G/P	-0.390 *	-0.431 **	-0.285	0.109	0.461 **		-0.389*	-0.409*	-0.529*	-0.379*	-0.537**
TGW	0.329 *	0.347 *	0.593 **	-0.331 *	0.002	-0.341 *		-0.136	0.151	0.579**	0.356*
SW/P	-0.066	-0.016	-0.072	0.283	0.196	-0.263	-0.078		0.882**	0.038	0.639**
BY/P	0.110	0.152	0.140	0.215	0.143	-0.353 *	0.143	0.906 **		0.503**	0.926**
HI	0.398 *	0.387 *	0.500 **	-0.137	-0.059	-0.248	0.522 **	-0.049	0.374 *		0.790**
GY/P	0.259	0.284	0.317	0.112	0.068	-0.377 *	0.327	0.660 **	0.916 **	0.712 **	

*, ** Significant at 5% and 1% level, respectively; [a] Spurious estimates

Table 7a: Direct (bold face) and indirect effects of yield component traits on grain yield/plant of the 12 *Joha* rice genotypes under inorganic culture

Character	DF	DFF	DM	PH	PW	GPP	TGW	SWP	BYP	HI	r_{iy}
DF	0.035	-0.040	0.007	0.000	0.000	-0.002	0.000	-0.096	0.656	0.002	0.560**
DFF	0.034	-0.040	0.007	0.000	0.001	-0.002	0.000	-0.248	0.697	0.001	0.449**
DM	0.031	-0.038	0.008	0.001	0.001	-0.002	0.000	-0.201	0.515	0.001	0.313
PH	0.000	-0.005	0.002	0.003	0.001	0.001	0.000	-0.246	0.179	-0.001	-0.068
PW	0.000	0.005	-0.003	0.000	-0.004	0.001	0.000	0.661	-0.467	0.003	0.197
GPP	-0.015	0.017	-0.004	0.001	-0.001	0.004	0.000	0.432	-1.319	-0.003	-0.887**
TGW	0.008	-0.008	0.001	-0.001	0.000	-0.002	0.000	0.523	0.045	0.005	0.571**
SWP	0.002	-0.007	0.001	0.000	0.002	-0.001	0.000	-1.470	1.211	-0.005	-0.266
BYP	0.015	-0.018	0.003	0.000	0.001	-0.003	0.000	-1.151	1.547	-0.001	0.392*
HI	0.011	-0.007	0.001	-0.001	-0.001	-0.002	0.000	1.115	-0.291	0.007	0.830**
Residual effect = 0.0193											

*, ** Significant at 5% and 1% level, respectively

Table 7b: Direct (bold face) and indirect effects of yield component traits on grain yield/plant of the 12 *Joha* rice genotypes under organic culture

Character	DF	DFF	DM	PH	PW	G/P	TGW	SWP	BYP	HI	r_{iy}
DF	0.017	-0.016	0.002	0.000	-0.004	0.001	-0.001	0.064	0.234	-0.025	0.273
DFF	0.017	-0.016	0.002	0.000	-0.004	0.001	-0.001	0.030	0.316	-0.027	0.318
DM	0.014	-0.013	0.002	0.001	-0.002	0.001	-0.002	0.151	0.345	-0.046	0.451**
PH	-0.002	0.002	-0.001	-0.003	0.001	0.000	0.001	-0.359	0.489	0.009	0.138
PW	-0.012	0.011	-0.001	-0.001	0.005	-0.001	0.000	0.022	-0.124	0.005	-0.095
G/P	-0.008	0.008	-0.001	0.000	0.002	-0.002	0.001	0.374	-0.935	0.024	-0.536**
TGW	0.006	-0.006	0.002	0.001	0.000	0.001	-0.003	0.125	0.267	-0.037	0.356*
SWP	-0.001	0.001	0.000	-0.001	0.000	0.001	0.000	-0.916	1.558	-0.002	0.639**
BYP	0.002	-0.003	0.000	-0.001	0.000	0.001	0.000	-0.808	1.766	-0.032	0.926**
HI	0.007	-0.007	0.002	0.000	0.000	0.001	-0.002	-0.035	0.888	-0.064	0.790**
Residual effect = 0.000											

*, ** Significant at 5% and 1% level, respectively

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