COMPETITION AMONG WILD RICE, LANDRACE, IMPROVED CULTIVAR AND F_1 HYBRID RICE

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ABSTRACT

Four genotypes, namely Oryza rufipogon, F_1 of IR68888A/Chaite-6, Chaite-6 and Ratodhan were grown in crop and competition environment at Rampur, Nepal to study the effect of genotypes mixture on the characters. Univariate, multivariate and correlation methods of analysis were applied. Seven characters namely panicle length, panicle number, grain yield, harvest index, internode length and leaf width showed significantly different response in crop and competition environment. The performance of cultivar was poor in competition environment than hybrid and wild rice. Hybrid and wild rice showed longer panicle length in competition environment. Significant reduction in panicle number was found in cultivars. The pattern of tiller number over the growth period showed that the competition started after 50 days of seeding. Grain yield of cultivars was significantly reduced in competition environment. Considering the most important characters, hybrid was best competitor and local landrace (Ratodhan) was poorest competitor. Significant variations in culm characters were not found between two environments but leaf characters varied significantly. Highest increment in plant height was found in F_1 grown in competition than crop environment. Relationship between characters was affected by growing environment. Among 162 pairs of characters r-value of six and 36 pairs were highly significant different from zero in crop and competition environment respectively. Multivariate analysis indicates that growing environment does not suppress the genetic characters. Competition among the tested genotypes exists even in the recommended spacing. Competition should be studied in detail planting at different spacing.

Keywords: Crop environment, competition environment, mixture, grain yield, rice

INTRODUCTION

Rice is the principle crop in Nepal where different kinds of landraces as well as wild species are found. Nepalese farmers have been practicing the mixture of different landraces. In the survival capacity of the genotypes, many factor e.g. types of neighbors, resources availability, abiotic and biotic stresses play important roles. Growing environment is also equally important in the expression of characters in genotypes. Since genotypes are generally evaluated under several environmental conditions, the differential competing abilities of genotypes under different environments inflate the genotype · environment interaction (Frey, 1983). Sakai (1955) concluded from a study of paired mixtures of six rice varieties that variation in plant characters due to competition effects must be considered in the estimation of heritabilities. In a soybean mixture of

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three cultivars, Muraw and Weber (1957) showed that within five years of propagation, Bavender special, an unadapted profusely branching type constituted 70% of the mixture, where as Adams a well adapted cultivar had been eliminated. Jennings and de Jesus (1968) studied the survival of five rice cultivars in a mixture and found that TN1, Ch242 and M6, non-tillering and short cultivars were practically eliminated from the mixture in a year of propagation. Whereas BJ and MTV, tall leafy cultivars dominated yield. Abilities of these fine cultivars in pure stands were exactly inversed to their capabilities to survive in mixtures. Competition among homozygous genotypes indicates that adapted varieties are highly competitive against unadapted types (Allard, 1960). For mixtures the relationship between competitive ability and yield in pure stands has been showed to be negative (Sunsen, 1949; Sakai and Gotah, 1955; Schutz and Brim, 1967). Harlen and Martini (1938) suggest that agronomically poor types are also poor competitors. Most study on competition has been done on inter-varietal mixture to know the survival capacity. Here diverse genotypes were taken to study on the survival capacity of species mixture, and the competitiveness of different genetic make-up individual.

MATERIALS AND METHODS

A field study was conducted at the Institute of Agriculture and Animal Science (IAAS), Nepal (224 m above sea level, 84°29'E and 27°23'N) in two types of environment, crop and competition environment (Fasoula and Fasoula, 1997). Four different genotypes *(*wild rice: *Oryza rufipogon*, local cultivar: Ratodhan, improved cultivar: Chaite-6, and F_1 hybrid: IR68888A/Chaite-6) were grown in crop environment of having the plot size 1.2 m · 1.2 m and 20 cm · 15 cm spacing. Four types of genotypes mixture (wild rice + IR68888A/Chaite-6, wild rice + Chaire-6, wild rice + ratodhan and Chaite-6 + IR68888A/Chaite-6) were grown in the same spacing of crop environment in competition environment. In mixture plot, two genotypes were planted in alternate rows. F_1 seeds were produced using the CMS line IR68888A and cultivar Chaite-6 as procedure described by Joshi (1999). Being felt difficulty to get seed of wild rice, about 300 tillers of plant were collected from Maidi Tal, Kaski, Nepal, and these tillers had been directly transplanted in the field. Random selection was made for others genotypes. Ratodhan were collected from the Germplasm Center of IAAS, Chaite-6 from National Rice Research Program (NRRP), Hardinath and IR68888A from IRRI, Philippines.

Nursery of all experimental material except wild rice had been developed in greenhouse at tray. Only compost was used as manure in nursery beds. Pre-germinated seeds were planted as randomized plan that was done using MSTAT-C. Eighteen days old seedlings were transplanted one seedling per hill in the field, which was fertilized @ 100:60:60 kg $N:P_2O_5:K_2O$ ha^{-1}. Field was laid out in RCBD with two replications. Standard agronomical practices were followed. Data on following observations (Table 1) were recorded from the central two rows of each plot as described in IRTP (1980).

Table 1: Evaluated characteristics in rice genotypes

SN	Code for character	Parameter measured
1.	DTF	Days to 50% flowering

2.	DTM	Days to maturity
3.	PlHt	Plant height, cm
4.	PanNo	Panicle number per 2 rows
5.	SpkNo	Spikelet number per panicle
6.	Fert	Fertility, %
7.	GrY	Grain yield per 2 rows, g
8.	1000-gr	1000-grain weight, g
9.	StrY	Straw yield per 2 rows, g
10.	HI	Harvest index, %
11.	CulL	Culm length, cm
12.	CulD	Culm diameter, cm
13.	NdsNo	Nodes number per plant
14.	IstIntL	First internode length, cm
15.	LstIntL	Last internode length, cm
16.	PanL	Panicle length, cm
17.	LfShL	Leaf sheath length, cm
18.	LfBlL	Leaf blade length, cm
19.	LfW	Leaf width, cm

STATISTICAL ANALYSIS

Genotypes grown in crop and competition environment were used as different entry to compare the performance among genotypes in two environments. Analysis of variance and mean separation using DMRT were done to test the effect of environment on yield and other characters. Contrasts for crop vs. competition environment were also calculated for each character. Correlations among 18 characters were estimated. Major concern to estimate correlation was to know the effect of environment in association of different characters. Grouping was done using the Euclidean distance methods of clustering to know the environment effects considering multiple characters. Percentage contribution of four rice genotypes in grain and straw yield was estimated for both environments. Tillering and plant height development pattern over the growth period were studied. MINITAB 12, MSTATC and MS-Excel were used to analyze the data.

RESULTS AND DISCUSSION

Means and contrast information of four different genotypes grown in two environments for 22 characters are given in Table 2. All the mean squares except for days to maturity were highly significant different. But contrast information indicates that only seven characters namely panicle length, panicle number, grain yield, harvest index, internode length and leaf width showed significantly different response in crop and competition environment. Generally the performances of commercial cultivars were poor in competition environment than hybrid and wild rice.

Table 2: Mean and contrast information of four different genotypes grown in crop and competition environment

a. Agronomical characters

Entry	DTF	DTM	PlHt	SpkNo	PanL	PanNo	Fert	GrY	1000-grwt	StrY	HI
Crop environment											
F_1	76de	114	75.50f	112bc	21.90bcd	107bc	7.715c	19.00e	18.55cde	305.0c	5.130b
Chaite-6	85b	114	84.50ef	97bc	21.30cd	114bc	82.21ab	165.0ab	20.10bc	208.0cde	30.31a
Ratodhan	81c	111	120.0cde	110bc	21.30cd	100cd	93.38ab	194.5a	21.20ab	175.5de	33.76a
OR	95a	129	170.5ab	72bc	18.30e	183a	96.43a	54.08de	16.66e	607.0a	7.390b
Competition environment											
OR + F_1											
OR	95a	129	195.5a	78bc	20.30cde	165a	94.53ab	50.70de	16.66e	541.0ab	7.865b
F_1	75de	114	102.5def	127b	24.30ab	67e	3.305c	12.00e	17.52de	271.5cd	3.815b
OR + Chaite-6											
OR	95a	129	140.0bcd	48c	21.20cd	135b	94.79ab	25.52de	16.67e	523.5ab	4.595b
Chaite-6	82bc	114	81.00ef	89bc	19.50de	73de	80.82b	69.00d	20.00bc	92.00e	29.60a
Chaite-6 + F											
Chaite-6	81bc	114	85.00ef	97bc	20.90cde	87cde	81.91ab	124.5bc	22.30a	153.0de	29.51a
F_1	74e	114	115.0def	226a	26.00a	111bc	10.95c	32.50de	19.10bcd	448.5b	5.810b
OR + Ratodhan											
OR	95a	129	157.0bc	65bc	22.00bcd	167a	93.26ab	42.40de	16.66e	533.5ab	6.780b
Ratodhan	78cd	111	112.5def	109bc	22.50bc	69e	83.77ab	116.0c	21.00ab	127.5e	31.63a
P value	0.00	>.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CV, %	1.81	0.00	13.69	26.60	5.39	10.67	8.96	26.56	4.90	15.65	14.77
Contrast, Crop vs. competition environment											
SS			638.0	261.3	10.26	1430	21.66	12840	0.806	808.5	93.88
P value			0.15	>0.05	0.02	0.01	>0.05	0.00	>0.05	>0.05	0.00

Means followed by the same letter/s are not significantly different at 0.05 level using DMRT. F_1 = IR68888A/Chaite-6, OR = Oryza rufipogon, SS = Sum of square, CV = Coefficient of variation.

b. Culm and leaf characters

Entry	CulL	CulD	NdsNo	IstIntL	LstIntL	AvIntL	LfShL	LfBlL	FLL	Bl/Sh	LfW
Crop environment											
F_1	53.60f	1.270bc	3b	2.67d	24.17d	13.41d	28.70b	54.60de	83.30cde	1.90cd	0.86bcd
Chaite-6	63.20ef	1.350abc	4b	2.66d	32.67c	17.67c	29.00b	56.10cd	85.10cde	1.93cd	0.76cd
Ratodhan	98.70cde	1.640a	4b	4.66c	31.67c	18.17c	28.20b	62.90bc	91.10bc	2.23a	0.78cd
OR	152.2ab	1.290bc	8a	5.50bc	48.50b	27.00b	28.88b	56.75cd	85.63cd	1.96bcd	0.72d
Competition environment											
OR + F_1											
OR	175.2a	1.280bc	8a	7.83a	53.50ab	30.67a	28.60b	52.50de	81.10de	1.83d	0.75cd
F_1	78.20ef	1.400ab	4b	1.67d	35.00c	18.33c	32.80a	65.10b	97.90b	1.99bcd	0.80bcd
OR + Chaite-6											
OR	118.8bcd	1.320abc	7a	6.83ab	54.50a	30.67a	26.90b	48.70e	75.60e	1.81d	0.76cd
Chaite-6	61.50ef	1.040c	4b	1.50d	30.50c	16.00c	26.40b	52.95de	79.35de	2.00bcd	0.80bcd
Chaite-6 + F_1											
Chaite-6	64.10ef	1.260bc	4b	1.33d	35.17c	18.25c	27.00b	54.40de	81.40cde	2.01bcd	0.90abc
F_1	89.00def	1.380abc	4b	1.66d	32.33c	17.00c	35.10a	72.20a	107.3a	2.05abc	0.95ab
OR + Ratodhan											
OR	135.0bc	1.230bc	7a	7.83a	50.00ab	28.92ab	28.00b	50.90de	78.90de	1.82d	0.81bcd
Ratodhan	90.00def	1.470ab	4b	1.83d	30.83c	16.33c	26.80b	57.40cd	84.20cde	2.14ab	1.01a
P value	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
CV, %	17.0	10.72	19.2	19.43	6.33	4.91	5.06	5.15	4.72	4.20	7.62
Contrast, Crop vs. competition environment											
SS	486.9	0.043	2.08	0.02	190.72	46.6	0.35	3.57	1.69	0.014	0.023
P value	0.21	0.17	0.17	>0.05	0.00	0.00	>0.05	>0.05	>0.05	0.18	0.03

Means followed by the same letter/s are not significantly different at 0.05 level using DMRT. F1 = IR68888A/Chaite-6, OR = Oryza rufipogon, SS = Sum of square, CV = Coefficient of variation.

F_1 hybrid had longest panicle length grown in mixture with Chaite-6. Hybrid and wild rice showed longer panicle length in competition environment but panicle length of cultivars was decreased in competition environment. Wild rice had highest number of panicle in mixture of Ratodhan followed by in combination with hybrid. Tillering capacity of wild rice was found highest. Rooting from each node in wild rice helped to increase the number of tillers. In crop environment wild rice had highest panicle number across the environment, it indicated that wild rice did not get any benefit grown in other genotypes for that characters. Significant reduction in panicle number was found in cultivars. More tillering of F_1 and wild rice in mixture (Figure 1) indicated that these are more competitive than cultivated cultivars for resource utilization. The pattern of tiller number over the growth period showed that the competition started after 50 days of seeding. All genotypes yielded less in competition than crop environment. Low grain yield was observed in hybrid and wild rice in both environments because of low spikelet fertility rate. Ratodhan yielded highest grain in crop environment and Chaite-6 in competition environment. Improved cultivar was found high yielder than local landraces. But grain yield of cultivars was significantly reduced in competition environment. Considering the grain and straw yield hybrid was best competitor (Figure 2) and local landrace (Ratodhan) was poorest competitor. There are different reports on the grain yield of crop in mixture. Soybean varietal blends, according to Probst (1943) were not superior in yield to the best variety. In soybean trials Hinson and Hanson (1962) found no yield superiority for blends over the best variety but within the mixtures certain varieties yielded more at the expense of others. For corn, Stringfield (1927) found no difference in yield, moisture content at harvest, percentage of root lodging, or percentage of broken stalks in mixtures compared with pure stand of similar or dissimilar hybrids.

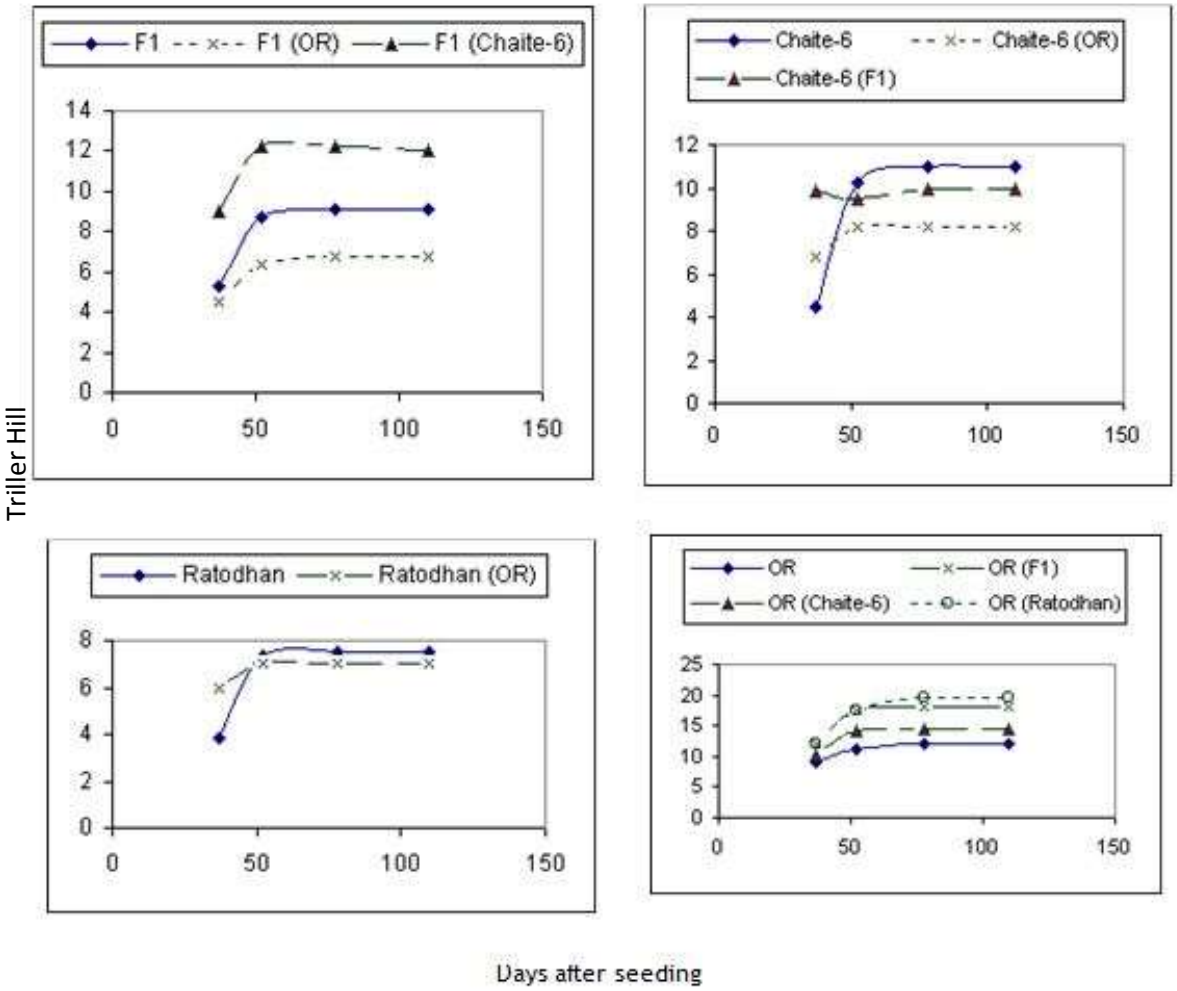


Figure 1: Triller number per hill counted in different dates of seeding of rice genotypes grown in crop and competition environments. Mixture genotypes are indicated in parenthesis. OR = 0. rufipogon, F1 = IR68888A/Chaite - 6.

Significant increment in length of internodes was found in hybrid grown in competition compared to crop environment. Significant variations in culm characters were not found between two environments but leaf characters varied significantly. The flag leaf width and flag leaf length did not show much variation except for wild rice across the environments. The nodes per panicle were double in wild rice as compared to other genotypes and wild rice has highest internode length for both crop and competition environment. Neighbor effect was not only in grain but other agronomical as well as morphological character were also affected. Little variation was found in hybrid and wild rice for plant height (Figure 3). Highest increment in plant height was found in F_1 grown in competition than crop environment. Plant was varied after 50 days of seeding which support the statement of competition start at latter stage of development. Plant height and

tillering ability were two obvious traits of importance to survival of rice in mixtures. What is most obvious from the study of survival of cultivars in mixtures is the lack of a positive relationship between yield and ability to survive. Jennings and Aquino (1968) determined that, even though competition between tall and short rice plant did not begin until 50-60 days after germination tall plants had vigorous vegetation, a decided competitive advantages for light interception.

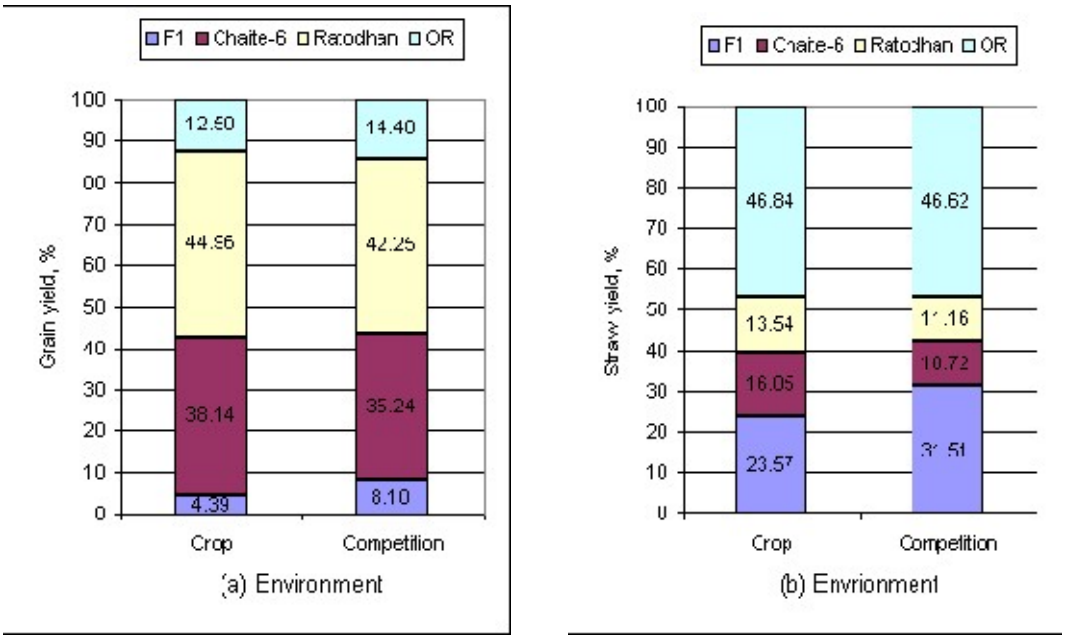


Figure 2.Percentage contribution of four rice genotypes in grain (a) and straw (b) yield grown in two environments. OR= *O. rufipogon*, F_1=IR68888A/Chaite-6.

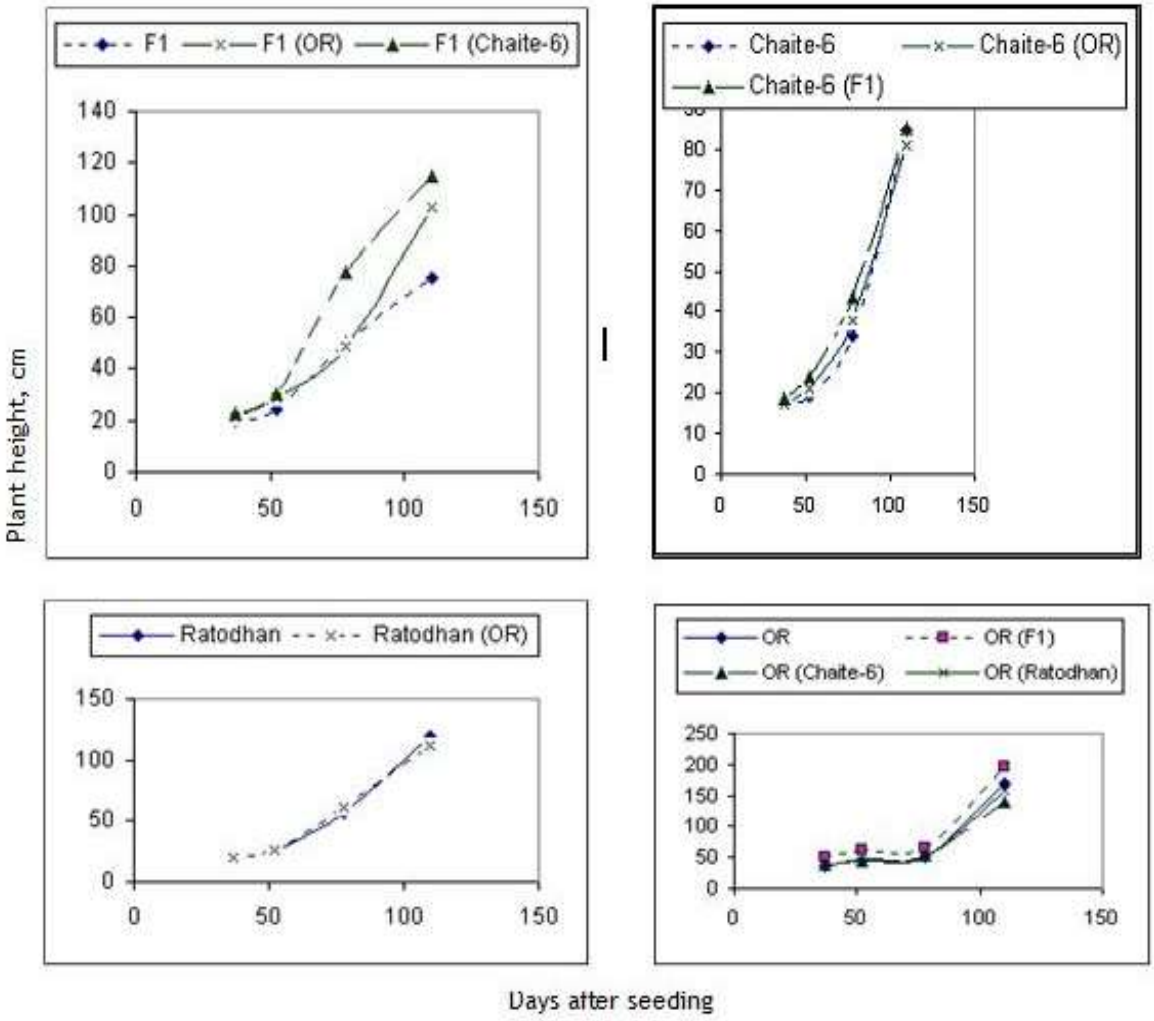


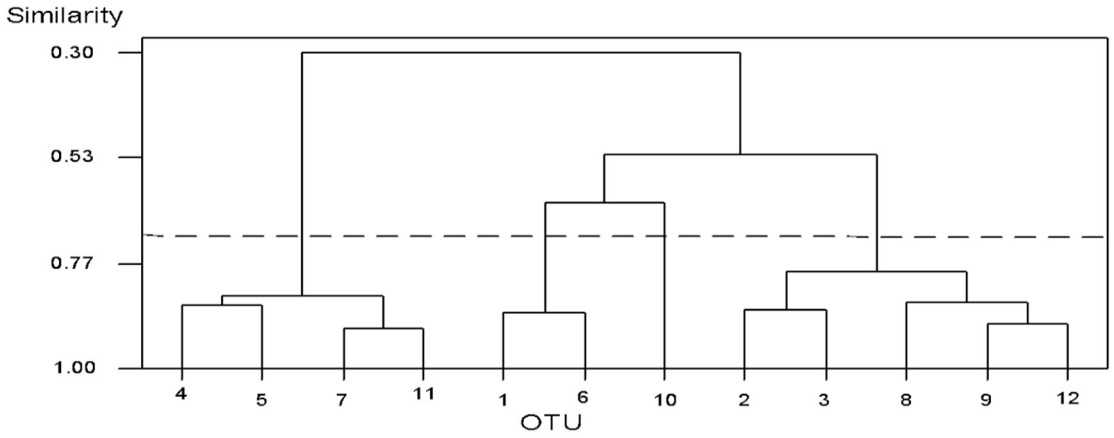
Figure 3: Trend of plant height of rice genotypes grown in crop and competition environments

Mixtures of genotypes are indicated in parenthesis. OR= *O. rufipogon*. F_1= IR68888A/Chaite-6.

Correlation matrix of 18 characters measured in crop and competition environment are given in Table 3. Relationship between characters was affected by growing environment. Among 162 pairs of characters r-value of six and 36 pairs were highly significant different from zero in crop and competition environment respectively. The negative association was found in 14 pairs of characters in crop environment and 22 pairs in competition. Similarly, 23 pairs showed positive association in crop environment and 12 pairs in competition environment. In both environments 69 pairs were not significant different from zero but non-significant pairs were 115 in crop and 75 in competition environment. Spikelet number was negative to grain yield in competition. This might be due to the high spikelet sterility. Thousand grains weight was negative association with fertility in competition, which may be due to the size of grain. The r-value for yield and yield components was similar for both environments. More variation in r-value was found in leaf and culm characters among the

environment. Multivariate analysis indicated that growing environment did not suppress the genetic characters (Figure 4). Distinct three groups were obtained by cluster analysis using 21 variables. The group was based on the genetic make up i.e. wild rice, hybrid and cultivated cultivars.

Figure 4. Dendrogram obtained by cluster analysis using 21 variables measured in four different rice genotypes. 1=F_1, 2= Chaite-6, 3= Ratodhan, 4= WR, 5= WR (F_1), 6= F_1 (WR), 7= WR (Chaite-6), 8= Chaite-6 (WR), 9= Chaite-6 (F_1), 10= F_1 (Chaite-6), 11= WR (Ratodhan), 12= Ratodhan (WR).



In mixture the tallness of the plant is the important characters to give better performances (Pendleton and Seif, 1962). Here wild rice had highest plant height but due to lodging problems it did not perform well. Due to erectness and long culm of F_1 hybrid, its performance was good in mixture. Result indicated that for mixture planting best combination should be considered otherwise competitiveness would result in poor benefit. During the selection pressure considering the correlation, it is equally important to consider the growing environment. Wildness and perenniality of the wild rice make them more competitors. Generally F_1 rice hybrid showed the heterosis for yield and other characters. This might be due to the more competitiveness for resources available. Competition among the tested genotypes existed even in the recommended spacing. Competition should be studied in detail planting at different spacing.

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Table 3: Correlation matrix of 18 characters measured in crop (first row) and competition (second row) environment

	DTF	DTM	PlHt	PanNo	SpkNo	Fert	GrY	1000-grwt	StrY	HI	CulL	CulD	NdsNo	IstIntL	LstIntL	PanL	LfShL	LfBlL
DTM	0.87** 0.94**																	
PlHt	0.82* 0.71**	0.78* 0.80**																
PanNo	0.89** 0.79**	0.96** 0.90**	0.74* 0.82**															
SpkNo	-0.77* -0.73**	-0.73* -0.55*	-0.68 -0.24	-0.63 -0.23														
Fert	0.71* 0.74**	0.32 0.52*	0.66 0.35	0.39 0.43	-0.38 -0.73**													
GrY	-0.04 -0.20	-0.51 -0.42	-0.08 -0.30	-0.39 -0.32	0.29 -0.04	0.64 0.46												
1000-grwt	-0.57 -0.57*	-0.87** -0.75**	-0.49 -0.67*	-0.79* -0.63*	0.63 0.24	0.15 -0.02	0.81* 0.68**											
StrY	0.75* 0.62**	0.97** 0.82**	0.72* 0.80**	0.92** 0.88**	-0.68 -0.06	0.13 0.08	-0.65 -0.58*	-0.94** -0.75**										
HI	-0.14 -0.32	-0.59 -0.60*	-0.19 -0.54*	-0.48 -0.57*	0.35 -0.08	0.56 0.37	0.99** 0.88**	0.88** 0.79**	-0.74* -0.83**									
CulL	0.83* 0.73**	0.79* 0.81**	1.00** 0.99**	0.75* 0.82**	-0.69 -0.27	0.66 0.40	-0.09 -0.27	-0.51 -0.66**	0.72* 0.78**	-0.20 -0.51*								
CulD	-0.16 -0.25	-0.43 -0.15	-0.01 0.12	-0.29 -0.04	0.44 0.46	0.36 -0.29	0.71* 0.07	0.54 0.01	-0.42 0.12	0.65 -0.15	-0.01 0.09							
NdsNo	0.95** 0.84**	0.94** 0.88**	0.91** 0.75**	0.93** 0.82**	-0.74* -0.50*	0.60 0.50*	-0.22 -0.31	-0.68 -0.65**	0.87** 0.70**	-0.33 -0.49	0.92** 0.76**	-0.20 -0.05						
IstIntL	0.64 0.92**	0.57 0.97**	0.81* 0.79**	0.64 0.88**	-0.36 -0.58*	0.59 0.54*	0.08 -0.39	-0.36 -0.71**	0.58 0.78**	-0.06 -0.56*	0.82* 0.79**	0.46 -0.13	0.74* 0.92**					
LstIntL	0.96** 0.88**	0.88** 0.96**	0.91** 0.81**	0.86** 0.85**	-0.78* -0.55*	0.70* 0.50*	-0.08 -0.36	-0.59 -0.74**	0.79* 0.81**	-0.19 -0.58*	0.91** 0.82**	-0.13 -0.12	0.98** 0.79**	0.72* 0.91**				
PanL	-0.83** -0.52*	-0.84** -0.32	-0.73* -0.18	-0.87** -0.15	0.58 0.68**	-0.47 -0.79**	0.21 -0.39	0.70 -0.01	-0.84** 0.15	0.34 -0.43	-0.75* -0.24	-0.01 0.52*	-0.88** -0.34	-0.80* -0.26	-0.88** -0.32			
LfShL	0.18 -0.51*	0.13 -0.23	-0.03 0.05	0.13 -0.02	-0.58 0.78**	-0.12 -0.86**	-0.23 -0.51*	-0.32 -0.20	0.20 0.30	-0.23 -0.56*	-0.03 0.01	-0.21 0.31	0.08 -0.23	-0.02 -0.27	0.09 -0.19	-0.14 0.73**		
LfBl	0.01 -0.79**	-0.27 -0.58*	0.30 -0.28	-0.24 -0.36	-0.16 0.84**	0.48 -0.89	0.54 -0.24	0.44 0.13	-0.29 -0.08	0.51 -0.22	0.28 -0.32	0.57 0.27	-0.01 -0.56*	0.36 -0.57*	0.05 -0.51*	0.13 0.78**	0.24 0.88**	
LfW	-0.60 -0.59*	-0.44 -0.63**	-0.53 -0.34	-0.43 -0.46	0.32 0.40	-0.57 -0.20	-0.23 0.51*	0.28 0.60*	-0.39 -0.37	-0.11 0.45	-0.54 -0.35	-0.34 0.23	-0.56 -0.60*	-0.63 -0.55*	-0.67 -0.55*	0.71 0.39	0.16 0.17	0.04 0.47

*, **, significantly different from zero at 1 and 5% level respectively