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Assessment of genetic variability, interrelationship, direct and indirect effect of seedling characters on fibre yield of jute under rainfed and irrigated condition

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ABSTRACT

Sixty genotypes of Corchorus olitorius were evaluated in rainfed as well as irrigated condition in field and pot culture to assess genetic variability, interrelationship between seedling characters and their direct and indirect effect on fibre yield. The seedling characters like root length, root volume, shoot length, root fresh weight, root dry weight, shoot fresh weight, shoot dry weight, leaf fresh weight and leaf dry weight showed significant positive correlation with one another and with fibre yield in field and pot under rainfed condition.While, in irrigated condition except shoot length, shoot fresh weight and shoot dry weight, rest of the characters revealed significant positively correlated with fibre yield. The root as well as shoot length in both the conditions in field and pot showed high heritability accompanied by high genetic advance indicating preponderance of additive gene action in controlling these characters and as a result these characters may be selected directly for improvement. In rainfed condition, shoot dry weight scored highest positive direct effect on fibre yield and it was followed by leaf fresh weight, root length, shoot length and root dry weight under pot culture whilein field,it was root fresh weight followed by shoot fresh weight, root volume, shoot length and leaf fresh weight. These characters could be use directly and effectively for the further improvement of fibre yield in moisture stress environment through evaluating stress tolerant lines.

Keywords **:** *Corchorus olitorius,* correlation, fibre, path analysis, seedling characters

Jute, the bastfibre, which is obtained from the bark of two cultivated species of the genus namely *Corchorus capsularis* and *Corchorus olitorius* L. of the family Malvaceae, In India, jute is grown over an area of 0.8 million hectare producing around 10 million bales (I bale = 180 kg) of fibre which is about 40 percent of the world production (Roy *et al.,*2011).The fibre of *C. olitorius*is finer, softer, stronger and more lustrous than that of *capsularis.* The fibre of *capsularis* is ordinarily whitish, and therefore called "white jute" by the trade. The *olitorius* fibre has either a yellowish, reddish or greyish colour, depending upon the nature of retting water (Kundu *et al.,* 1959). *C. olitorius varieties* are grown under highland condition whereas *C. capsularis* are more suited to low land condition. Thus, while the former can stand soil moisture stress, the latter can tolerate water logging. In West Bengal, jute is sown within first fortnight of April, which is often accompanied by unpredictable and very low rainfall which often exposes jute crop to moisture stress condition. It is observed from a series of experiments that water stress affects seed and seedling metabolism in jute. Under field condition, seed germination and establishment are most obviously affected by soil water deficits resulting poor crop stand. Root part is the most important underground functional part of the plants. A sound root system results in healthy crop growth and in turn helps to exploit the full potential of the crop (Bhattacharya *et al.,* 2008). Deep root penetration has been referred as the prime means of moisture stress resistance in the field crops (Lewitt, 1969).If the jute crop can survive the adverse initial dry spell, with the advent of monsoon and favourable weather conditions like adequate rainfall, high relative humidity and warm temperature condition, luxuriant growth and yield of jute can occur. For this purpose, there is need to conserve of adequate moisture in soil by employing agronomic practices like mulching, crop rotation, cover crops, conservation of tillage *etc.* and its continuous supply to jute plants is of paramount importance for achieving higher yield of the crop particularly under deficit water situation (Ghorai and Mitra, 2008). Besides this, yield by itself may not be the best criterion for selection (Yasin, 1973). It is influenced and inherited by genetic factors as well as environments. Genetic improvement of yield of any crop depends upon the nature and extent of genetic variability, heritability, nature of association of various components characters with yield which would help plant breeders a successful breeding programme. (Pervin, 2012).

Keeping these points in view, the present investigationwas undertaken with a view to assess the nature of variability, heritability, genetic advance and to determine the associationship of different seedling characters among themselves with fibre yield in rainfed condition comparing against normal irrigated condition by growing genotypes in pots and field under

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both conditions. The desirable seedling characters would be used in hybridization programme to develop stress tolerant cultivars.The seedling characters directly or indirectly affect the fibre yield because of its initial buffering capacity towards the drought or stress conditionduring early phase of growth.

MATERIALS AND METHODS

The experimental materials consisted of sixty genotypes of *Corchorus olitorius* of which 25 were indigenous, 16 genotypes were standard varieties, 14 were accessions of International Jute Organization (IJO) and 5 exotic varieties were from All India Network Project on Jute and Allied Fibres, Kalyani Centre, BCKV (in collaboration with CRIJAF, ICAR). Each genotypes of *Corchorus olitorius* were grown under two varying water regimes *viz,* i) fully rainfed condition and ii) irrigated conditionduring two successive years *i.e.* 5th April 2012 and 29th March 2013 and 11th April 2012 and 10th April 2013, in field and pot culture respectively. The experiment in each environment was laid out in Randomized Block Design with three replications. In field, each genotype was grown in a plot of 5 rows of 3 meter length maintaining 30 cm space between the rows. Recommended doses of major nutrients (N, P and K) were applied and normal cultural practices were followed. The earthen pots had 25 cm base, 30 cm top diameter and 35 cm height. The pots were filled with soil mixed with FYM and fertilizers recommended as basal dose. In each pot twelve seeds were sown and the seedlings were thinned out every week. Eight seedlings were maintained in each pot. Five seedlings from each pot and field were uprooted carefully to record data on root length, root volume, root fresh weight, root dry weight, shoot length, shoot fresh weight, shoot dry weight, leaf fresh weight and leaf dry weight. Fibre weight per plant was noted after harvesting. The analysis of variance based on pooled data of two co-nsecutive years in field as well as pot was performed as per Senapati *et al.,* (2006)*,* Correlation coefficients were performed as per Panse *et al* (1978), heritability (H) in broad sense was calculated following Lush (1940), genetic advance (GA), genetic advance as a per cent of mean as per Johnson (1955) and direct and indirect effects of component characters of fibre yield through path analysis were done as suggested by Dewey and Lu (1959) both at phenotypic and genotypic levels. All these statistical analysis were performed with the help of INDOSTAT software.

RESULTS AND DISCUSSIONS

Mean sum of squares showed significant differences among the genotypes of both the environments in field as well as pot culture for all 10 characters representing presence of considerable variability (Table 1 & 2). In case of rainfed condition, mean values of all characters under studied showed reduction in magnitude against irrigated in field as well as pot condition. In both the water regimes, the differences between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were minimum for all the characters, suggesting less influenced of environment in expression of these characters. The difference between PCV and GCV was found to be highest for root volume followed by root dry weight and root fresh weight in pot condition and shoot length followed by leaf fresh weight and root length in both the conditions of the field (Table 1) indicating high influence of environment on these characters irrespective of the status of soil moisture. Thus considerable amount of genetic components can be easily exploited for selection of superior lines in this crop. The shoot dry weight followed by root fresh weight under rainfed and normal environments in field (Table 2) and leaf fresh weight followed by leaf dry weight in pot (Table 1) had shown least difference between PCV and GCV indicating minimal influence of environment in their expression under both water regimes. These characters showed high heritability with moderate to low genetic advance (GA) signifying the inheritance of such traits might be under the control of both additive and non additive gene action for their expression under both the soil moisture regime. The root as well as shoot length in both the conditions in field and pot showed high heritability (0.96, 0.95 & 0.99, 0.98) accompanied by high genetic advance indicating preponderance of additive gene action in controlling their character and as a result these characters may be selected directly for improvement. Johnson *et al.* (1955) suggested that heritability and genetic advance should always be considered jointly during selection of a suitable line or progeny. The GA as % of mean found highest in root length (30.61%) followed by root volume in normal and leaf fresh weight (50.94%) followed by leaf dry weight in rainfed condition in pot culture while in field condition, shoot dry weight showed (66.21%) highest GA per cent of mean followed by root fresh weight in normal and shoot dry weight (73.69%) followed by root dry weight in rainfed situation.

Fibre yield showed highly significant and positive correlation coefficient with all characters in rainfed condition in pot indicated characters were directly affect the fibre yield when they subjected to phasic drought in their early life cycle. While, in irrigated condition except shoot length, shoot fresh weight and shoot dry weight, rest of the characters revealed significant positively correlation with fibre yield. The positive significant genotypic as well as phenotypic correlations coefficients were found among all the seedlings characters in rainfed environment in pot and field (Table 3 & 4). In case of irrigated regime, in pot, root length showed significant genotypic and phenotypic positive correlations with root volume, root dry weight and with shoot fresh weight and shoot dry weight at phenotypic level only (Table 3). Root volume also showed significant positive genotypic and phenotypic association with the root fresh weight, root dry weight, shoot fresh weight and shoot dry weight. Significant positive genotypic and phenotypic correlation coefficient were noticed between root fresh weight and root dry weight. Root dry weight showed significant positive association at phenotypic level only with shoot fresh weight and shoot dry weight. Significant positive correlation coefficient at phenotypic and genotypic levels were also evident between shoot fresh weight, leaf fresh weight, leaf dry weight and the character also showed significant phenotypic correlation with shoot dry weight. Shoot fresh weight showed significant positive phenotypic and genotypic correlation coefficient to shoot dry weight, leaf fresh weight and leaf dry weight. Similarly, shoot dry weight with leaf fresh weight and leaf dry weight and leaf fresh weight with leaf dry weight. In case of field condition in normal water regime, root length and root volume showed highly significant correlations with root fresh weight, root dry weight and also among themselves. Root length also showed significant correlation with shoot fresh weight only at phenotypic level. Highly significant genotypic as well as phenotypic correlation coefficients were evident root length and root volume, and root fresh weight with root dry weight, similar observation were also found between root volume and shoot fresh weight as well as shoot dry weight, between root fresh weight and root dry weight, between shoot length and leaf fresh weight as well as leaf dry weight, between shoot fresh weight and shoot dry weight, leaf fresh weight, leaf dry weight between shoot dry weight and leaf fresh weight and leaf dry weight. A significant correlation only at phenotypic level was also observed between root length and dry as well as fresh weight of shoot. Highly significant phenotypic and genotypic correlations were revealed by root fresh weight, root dry weight, shoot length, shoot fresh weight and shoot dry weight and similar observations also highlighted for root dry weight. Highly significant phenotypic and genotypic correlations were also evident between shoot length and shoot dry weight and shoot fresh weight and shoot dry weight, leaf fresh weight and leaf dry weight. Fibre yield was found significantly positive association with root volume, root fresh weight, root dry weight, shoot length, shoot fresh weight at both levels and leaf dry weight at phenotypic level only. Whereas, in rainfed condition it was positively highly significant with root volume, shoot length, shoot fresh weight, shoot dry weight and leaf fresh weight. C orrelation among seedling characters under rainfed conditions, clearly indicates that root will tend to go deeper to explore water as a result root weight will be increased. With the increase root length and root weight, shoot length and height also increased. Therefore, stress act as driving force for continuous increasing the root length to avoid drought. The significant positive correlations between different physiological characters with yield were reported by Mehdi and Ahsan, (2000); Anjum*et al*. (2003); Dhanda *et al.* (2004), Ali *et al*. (2011); Ali *et al*. (2011a), Ebrahim, (2012), Ali *et al*. (2013).

The direct and indirect effects of different seedling characters on fibre weight analyzed using path coefficient analysis at genotypic level (Table 5 & 6) at both regimes in field and pot condition. In case of pot, in irrigated condition, among the different contributing characters, leaf fresh weight registered the highest positive direct effect followed by shoot dry weight, root fresh weight, root length and shoot length and positive indirect effects via other characters on fibre yield. Out of these, root length and root fresh weight were found positively significant correlations with fibre yield. In rainfed, shoot dry weight scored highest positive direct effect on fibre yield and it was followed by leaf fresh weight, root length, shoot length and root dry weight. These characters also showed positively significant correlations with fibre yield. In case of field, under irrigated condition, root dry weight had highest positive direct effect on the fibre yield and it was followed by root volume, shoot length, shoot fresh weight and leaf dry weight. While in rainfed condition, root fresh weight was highest positive direct effect followed by shoot fresh weight, root volume, shoot length and leaf fresh weight. Almost all these characters showed positively significant correlation with fibre yield. These positively direct effect characters with significant genotypic

Table 1: Mean, range, variability, PCV, GCV, heritability (h^2) and genetic advance (GA) of *C. olitorius* genotypes grown under normal (N) against rainfed (R) condition in pot over two years

Parameter	Mean		Range		Mean sum of squares		PCV		GCV		h^2		GA		GA as % of mean	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Root length(cm)	8.09	6.97	5.47-10.13	3.85-9.62	0.8323***	0.641***	15.15	20.26	15.00	20.14	0.98	0.99	2.48	2.88	30.61	41.25
Root volume (c.c)	0.07	0.06	0.05-0.09	0.03-0.09	0.0001***	0.00004***	17.78	23.21	15.06	20.09	0.72	0.75	0.02	0.02	26.27	35.81
Root fresh weight (g)	0.14	0.12	0.12-0.17	0.10-0.15	0.0002***	0.0002***	7.12	9.06	6.81	8.79	0.91	0.94	0.02	0.02	13.40	17.58
Root dry weight (g)	0.06	0.05	0.05-0.07	0.04-0.06	0.00004***	0.00002***	6.71	8.42	6.32	8.11	0.89	0.93	0.01	0.01	12.25	16.08
Shoot length (cm)	29.41	23.68	21.67-38.21	14.75-37.39	10.6476***	6.786***	11.85	18.53	11.63	18.36	0.96	0.98	6.91	8.88	23.50	37.49
Shoot fresh weight(g)	0.39	0.30	0.33-0.49	0.19-0.35	0.0018***	0.001***	9.17	10.27	8.93	10.05	0.95	0.96	0.07	0.06	17.90	20.26
Shoot dry weight (g)	0.16	0.12	0.14-0.20	0.08-0.14	0.0003***	0.0002***	8.76	9.41	8.51	9.17	0.94	0.95	0.029	0.02	17.02	18.41
Leaf fresh weight (g)	0.36	0.26	0.29-0.48	0.13-0.37	0.0017***	0.001***	10.45	24.91	10.25	24.82	0.96	0.99	0.07	0.13	20.70	50.94
Leaf dry weight (g)	0.15	0.10	0.13-0.20	0.06-0.14	0.0003***	0.0001***	9.88	23.01	9.66	22.91	0.95	0.99	0.03	0.05	19.44	46.98
Fibre weight(g)	5.68	4.31	4.96-6.29	3.37-5.06	0.4064***	0.2344***	4.81	9.25	4.32	9.00	0.81	0.94	0.45	0.77	7.99	18.00

*Note: *, **, *** Significant at 5% , 1% and 0.1% level, respectively*

Table 2: Mean, range, variability, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance (GA) of *C. olitorius* genotypes grown under normal (N) against rainfed (R) condition in field over two years

Parameter	Mean		Range		Mean sum of squares		PCV		GCV		h2		GA		GA as % of mean	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Root length(cm)	6.72	7.92	5.30-8.80	6.45-9.90	0.565***	0.772***	10.88	10.61	10.68	10.40	0.96	0.96	1.45	1.66	21.58	20.99
Root volume (c.c)	0.06	0.05	0.05-0.08	0.04-0.07	0.00003***	0.00003***	13.09	13.52	12.88	13.30	0.97	0.97	0.02	0.01	26.11	26.98
Root fresh weight (g)	0.16	0.14	0.10-0.20	0.10-0.20	0.0003***	0.0002***	18.50	19.61	18.37	19.48	0.99	0.99	0.06	0.06	37.57	39.88
Root dry weight (g)	0.07	0.05	0.05-0.09	0.03-0.07	0.0001 ***	0.00002***	16.57	20.28	16.40	20.12	0.98	0.98	0.02	0.02	33.45	41.11
Shoot length (cm)	24.18	18.47	16.04-29.56	13.84-28.79	6.911***	3.959***	11.82	14.93	11.49	14.58	0.95	0.95	5.56	5.42	23.00	29.34
Shoot fresh weight(g)	0.82	0.66	0.61-1.15	0.40-1.00	0.009***	0.0058***	15.43	17.93	15.27	17.80	0.98	0.99	0.26	0.24	31.15	36.38
Shoot dry weight (g)	0.42	0.29	0.25-0.80	0.13-0.56	0.003***	0.0014***	32.29	35.93	32.21	35.85	1.00	1.00	0.28	0.21	66.21	73.69
Leaf fresh weight (g)	1.24	0.86	1.01-1.52	0.69-1.06	0.018***	0.0091***	9.59	8.97	9.36	8.72	0.95	0.95	0.23	0.15	18.83	17.47
Leaf dry weight (g)	0.17	0.12	0.12-.0.20	0.07-0.160	0.0004***	0.0002***	12.65	16.40	12.47	16.25	0.97	0.98	0.04	0.04	25.32	33.18
Fibre weight(g)	9.80	6.74	7.48-11.86	4.69-9.30	1.1374***	0.5717***	11.18	16.83	10.94	16.69	0.96	0.98	2.16	2.29	22.05	34.09

Table 3: Pooled analysis for genotypic (G) (Bold) and phenotypic (P) correlation co-efficient of pot grown seedlings characters of *C. olitorius* in normal (N) vs rainfed (R) condition

Characters			Root length (cm)	Root volume (cc)	Root fresh weight (g)	Root dry weight (g)	Shoot length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)
Root volume (cc)	N	G	**0.848*** **								
		P	0.731***								
	R	G	**0.734*** **								
		P	0.645***								
Root fresh weight (g)	N	G	**0.062**	**0.298*** **							
		P	0.098	0.271***							
	R	G	**0.336*** **	**0.565*** **							
		P	0.348***	0.496***							
Root dry weight (g)	N	G	**0.125***	**0.337*** **	**0.933*** **						
		P	0.158**	0.299***	0.931***						
	R	G	**0.382*** **	**0.602*** **	**0.950*** **						
		P	0.391***	0.524***	0.946***						
Shoot length (cm)	N	G	**0.061**	**0.020**	**-0.042**	**-0.007**					
		P	0.083	0.033	0.012	0.047					
	R	G	**0.564*** **	**0.603*** **	**0.411*** **	**0.503*** **					
		P	0.568***	0.527***	0.423***	0.507***					
Shoot fresh weight (g)	N	G	**0.082**	**0.150*** **	**0.001**	**0.058**	**0.104***				
		P	0.109*	0.149**	0.065	0.124*	0.138**				
	R	G	**0.588*** **	**0.529*** **	**0.445*** **	**0.507*** **	**0.552*** **				
		P	0.593***	0.468***	0.470***	0.527***	0.559***				
Shoot dry weight (g)	N	G	**0.077**	**0.144****	**-0.001**	**0.057**	**0.098**	**0.999*** **			
		P	0.105*	0.147**	0.066	0.126*	0.134*	0.997***			
	R	G	**0.601*** **	**0.537*** **	**0.446*** **	**0.512*** **	**0.560*** **	**0.998*** **			
		P	0.605***	0.476***	0.474***	0.533***	0.567***	0.995***			
Leaf fresh weight (g)	N	G	**-0.039**	**-0.084**	**-0.243*** **	**-0.237*** **	**0.138****	**0.268*** **	**0.260*** **		
		P	-0.011	-0.048	-0.171**	-0.157**	0.167**	0.299***	0.293**		
	R	G	**0.453*** **	**0.516*** **	**0.398*** **	**0.460*** **	**0.551*** **	**0.655*** **	**0.656*** **		
		P	0.457***	0.454***	0.404***	0.461***	0.554***	0.655***	0.655***		
Leaf dry weight (g)	N	G	**-0.039**	**-0.088**	**-0.244*** **	**-0.242*** **	**0.137****	**0.268*** **	**0.260*** **	**1.000*** **	
		P	-0.010	-0.048	-0.168**	-0.157**	0.168**	0.301***	0.294***	0.999***	
	R	G	**0.456*** **	**0.523*** **	**0.406*** **	**0.468*** **	**0.555*** **	**0.660*** **	**0.661*** **	**1.000*** **	
		P	0.461***	0.459***	0.413***	0.471***	0.558***	0.661***	0.661***	0.999***	
Fibre weight (g)	N	G	**0.149***	**0.150***	**0.315*** **	**0.261*** **	**0.028**	**-0.022**	**-0.016**	**-0.393*** **	**-0.396*** **
		P	0.202***	0.202***	0.418***	0.385**	0.119	0.102	0.112	-0.231***	-0.227***
	R	G	**0.647*** **	**0.573*** **	**0.385*** **	**0.440*** **	**0.594*** **	**0.697*** **	**0.707*** **	**0.488*** **	**0.492*** **
		P	0.650***	0.580***	0.424***	0.478***	0.602***	0.714***	0.724***	0.493***	0.499***

*Note: *, **, *** Significant at 5% , 1% and 0.1% level, respectively*

Table 4: Pooled analysis for genotypic (G) (Bold) and phenotypic (P) correlation co-efficient of field grown seedlings characters of *C. olitorius* under in normal vs rainfed condition

Characters			Root length (cm)	Root volume (cc)	Root fresh weight (g)	Root dry weight (g)	Shoot length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)
Root volume (cc)	N	G	**0.577*** **								
		P	0.587***								
	R	G	**0.637*** **								
		P	0.645***								
Root fresh weight (g)	N	G	**0.360*** **	**0.516*** **							
		P	0.371***	0.523***							
	R	G	**0.586*** **	**0.642*** **							
		P	0.592***	0.645***							
Root dry weight (g)	N	G	**0.374*** **	**0.527*** **	**0.999*** **						
		P	0.388***	0.536***	0.997***						
	R	G	**0.593*** **	**0.653*** **	**0.999*** **						
		P	0.597***	0.656***	0.997***						
Shoot length (cm)	N	G	**-0.093**	**0.055**	**0.272*** **	**0.265*** **					
		P	-0.054	0.084	0.283***	0.282***					
	R	G	**0.236*** **	**0.242*** **	**0.143** **	**0.151** **					
		P	0.254***	0.257***	0.156**	0.167**					
Shoot fresh weight (g)	N	G	**0.087**	**0.077**	**0.361*** **	**0.369*** **	**0.289*** **				
		P	0.111*	0.098	0.371***	0.380***	0.303***				
	R	G	**0.381*** **	**0.313*** **	**0.447*** **	**0.454*** **	**0.317*** **				
		P	0.394***	0.325***	0.454***	0.460***	0.324***				
Shoot dry weight (g)	N	G	**0.351*** **	**0.367*** **	**0.351*** **	**0.368*** **	**0.189*** **	**0.563*** **			
		P	0.355***	0.371***	0.354***	0.372***	0.194***	0.565***			
	R	G	**0.521*** **	**0.518*** **	**0.465*** **	**0.478*** **	**0.397*** **	**0.820*** **			
		P	0.520***	0.518***	0.468***	0.480***	0.396***	0.819***			
Leaf fresh weight (g)	N	G	**-0.035**	**0.031**	**-0.095**	**-0.098**	**0.063**	**-0.253*** **	**-0.140** **		
		P	0.007	0.064	-0.69	-0.068	0.097	-0.216***	-0.124*		
	R	G	**0.454*** **	**0.307*** **	**0.352*** **	**0.367*** **	**0.356*** **	**0.536*** **	**0.582*** **		
		P	0.479***	0.330***	0.365***	0.378***	0.371***	0.545***	0.577***		
Leaf dry weight (g)	N	G	**0.055**	**-0.025**	**0.043**	**0.045**	**0.071**	**0.148** **	**0.014**	**0.306*** **	
		P	0.084	0.002	0.061	0.065	0.098	0.167**	0.024	0.330***	
	R	G	**0.375*** **	**0.221*** **	**0.328*** **	**0.340*** **	**0.354*** **	**0.421*** **	**0.452*** **	**0.866*** **	
		P	0.389***	0.235***	0.337***	0.347***	0.362***	0.430***	0.455***	0.864***	
Fibre weight (g)	N	G	**-0.117**	**0.237*** **	**0.200*** **	**0.202*** **	**0.442*** **	**0.291*** **	**0.044**	**-0.136**	**0.139**
		P	-0.068	0.265***	0.220***	0.225***	0.465***	0.314***	0.058	-0.079	0.172*
	R	G	**0.036**	**0.185*** **	**0.070**	**0.074**	**0.383*** **	**0.380*** **	**0.294*** **	**0.158***	**0.106**
		P	0.066	0.205***	0.086	0.089	0.396***	0.392***	0.301***	0.188*	0.124

*Note: *, **, *** Significant at 5% , 1% and 0.1% level, respectively*

Table 5: Direct and indirect effect of different seedling characters on fibre yield per plant at genotypic level of *C. olitorius* under normal (N) against rainfed (R) condition in pot

Character		Root length (cm)	Root volume (cc)	Root fresh weight (g)	Root dry weight (g)	Shoot length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)	Genotypic correlation of fibre weight (g)
Root length (cm)	N	**0.335**	-0.181	0.034	-0.051	0.005	-0.102	0.097	-0.141	0.152	0.149*
	R	**0.212**	0.066	-0.008	0.020	0.101	-0.599	0.895	0.540	-0.580	0.647***
Root volume cc)	N	0.276	**-0.220**	0.192	-0.135	0.001	-0.187	0.192	-0.270	0.301	0.150*
	R	0.152	**0.092**	-0.013	0.031	0.105	-0.524	0.780	0.595	-0.644	0.573***
Root fresh weight (g)	N	0.017	-0.062	**0.678**	-0.398	-0.005	0.017	-0.020	-0.799	0.888	0.315***
	R	0.071	0.051	**-0.024**	0.051	0.073	-0.446	0.654	0.472	-0.516	0.385***
Root dry weight (g)	N	0.040	-0.069	0.623	**-0.433**	-0.003	-0.052	0.054	-0.776	0.877	0.261***
	R	0.078	0.054	-0.023	**0.053**	0.091	-0.496	0.731	0.535	-0.583	0.440***
Shoot length (cm)	N	0.018	-0.003	-0.038	0.014	**0.086**	-0.127	0.129	0.391	-0.442	0.028
	R	0.119	0.053	-0.010	0.027	**0.180**	-0.561	0.835	0.658	-0.707	0.594***
Shoot fresh weight (g)	N	0.025	-0.030	-0.008	-0.016	0.008	**-1.357**	1.440	0.784	-0.868	-0.022
	R	0.124	0.047	-0.010	0.026	0.099	**-1.021**	1.490	0.784	-0.842	0.697***
Shoot dry weight (g)	N	0.023	-0.029	-0.010	-0.016	0.008	-1.355	**1.443**	0.751	-0.830	-0.016
	R	0.127	0.048	-0.010	0.026	0.101	-1.019	**1.493**	0.786	-0.845	0.707***
Leaf fresh weight (g)	N	-0.016	0.020	-0.179	0.111	0.011	-0.352	0.358	**3.024**	-3.371	-0.393***
	R	0.096	0.046	-0.009	0.024	0.099	-0.669	0.982	**1.196**	-1.275	0.488***
Leaf dry weight (g)	N	-0.015	0.020	-0.178	0.113	0.011	-0.349	0.355	3.022	**-3.374**	-0.396***
	R	0.096	0.046	-0.010	0.024	0.100	-0.674	0.989	1.195	**-1.275**	0.492***

*Note: *, **, *** Significant at 5% , 1% and 0.1% level, respectively*

Table 6: Direct and indirect effect of different seedling characters on fibre yield per plant at genotypic level of *C.olitorius* in field under normal (N) against rainfed (R) condition

Character		Root length (cm)	Root volume (cc)	Root fresh weight (g)	Root dry weight (g)	Shoot length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Leaf fresh weight (g)	Leaf dry weight (g)	Genotypic correlation of fibre weight (g)
Root length (cm)	N	**-0.306**	0.303	-1.116	1.120	-0.042	0.021	-0.116	0.010	0.009	-0.117
	R	**-0.185**	0.245	2.367	-2.558	0.081	0.228	-0.127	0.015	-0.030	0.036
Root volume cc)	N	-0.176	**0.529**	-1.612	1.592	0.017	0.019	-0.122	-0.005	-0.005	0.237***
	R	-0.117	**0.386**	2.579	-2.798	0.083	0.184	-0.124	0.010	-0.017	0.185***
Root fresh weight (g)	N	-0.110	0.273	**-3.120**	3.040	0.110	0.093	-0.116	0.023	0.006	0.200***
	R	-0.108	0.246	**4.055**	-4.314	0.049	0.268	-0.113	0.011	-0.026	0.07
Root dry weight (g)	N	-0.113	0.277	-3.117	**3.042**	0.109	0.096	-0.123	0.023	0.007	0.202***
	R	-0.110	0.250	4.052	**-4.317**	0.054	0.275	-0.116	0.012	-0.027	0.074
Shoot length (cm)	N	0.031	0.022	-0.836	0.803	**0.411**	0.074	-0.062	-0.012	0.010	0.442***
	R	-0.043	0.091	0.566	-0.661	**0.354**	0.189	-0.096	0.011	-0.028	0.383***
Shoot fresh weight (g)	N	-0.025	0.039	-1.126	1.130	0.117	**0.259**	-0.186	0.058	0.024	0.291***
	R	-0.070	0.118	1.801	-1.968	0.111	**0.603**	-0.200	0.017	-0.033	0.380***
Shoot dry weight (g)	N	-0.107	0.195	-1.098	1.128	0.077	0.146	**-0.331**	0.032	0.002	0.044
	R	-0.096	0.197	1.879	-2.060	0.140	0.495	**-0.243**	0.019	-0.036	0.294***
Leaf fresh weight (g)	N	0.014	0.013	0.326	-0.322	0.022	-0.068	0.048	**-0.222**	0.052	-0.136
	R	-0.083	0.115	1.415	-1.557	0.124	0.322	-0.142	**0.033**	-0.069	0.158*
Leaf dry weight (g)	N	-0.015	-0.016	-0.116	0.123	0.025	0.036	-0.004	-0.067	**0.174**	0.139
	R	-0.069	0.083	1.324	-1.449	0.125	0.254	-0.110	0.028	**-0.080**	0.106

*Note: *, **, *** Significant at 5% , 1% and 0.1% level, respectively*

correlation with fibre yield could be use directly and effectively for the further improvement of fibre yield pariticularly in moisture stress environment through evaluating stress tolerant lines. However, other characters having negatively direct effect like root volume, root dry weight , leaf dry weight in normal condition in pot and root fresh weight in field, root fresh weight, shoot fresh weight, leaf dry weight in rainfed condition in pot whereas shoot dry weight in field showed positive significantly genotypic correlation with fibre yield. These characters indicated that the indirect selection could be made for high yielding *olitorius* genotypes through most of the characters having positive indirect effects. The residual effects of respective moisture regimes of field and pot indicating there were other contributors responsible for contribution to fibre yield per plant but not taken into consideration in the present study.

From the above study root length, root fresh weight, shoot fresh weight, shoot dry weight and leaf fresh weight showed superior performance in rainfed condition against irrigated situation. So these characters could be considered to evaluate stress tolerant lines during early phase of crop.

REFERENCES

Ali, M. A., Abbas, A., Awan, S. I., Jabran, K. and Gardezi, S. D. A. 2011. Correlated response of various morpho-physiological characters with grain yield in sorghum landraces at different growth phases. *J. Anim. Pl. Sci.*, **21**: 671-79.

Ali, Q., Ahsan, M., Mustafa, H.S.B. and Ejaz-ul-Hasan 2013. Genetic variability and correlation among morphological traits of maize (*Zea mays* L) seedling. *Alban. J. Agril. Sci.,* **12:**405-10.

Ali, Q., Elahi, M., Ahsan, M., Tahir, M.H.N., Basra, S.M.A., Farooq, J., Waseem, M. and Elahi, M. 2011a. Correlation and path coefficient studies in maize (*Zea mays* L.) genotypes under 40% soil moisture contents. *J. Bacteriol. Res.*, **3**:77-82.

Anjum, F., Yaseen, M. Rasool, E., Wahid A. and S. Anjum 2003. Water stress in barley (*Hordeum vulgare* L.) and effect on chemical composition and chlorophyll contents. *Pak. J. Agril. Sci.,* **40**:350-58

Bhattacharya, C., Patra, P. K. and Sarkar, G. 2008. Correlation studies in different root characters of jute (*Corchorus capsularis* L.) at six weeks growth stage. *Env. Eco.,* **26**:2075-77.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *J. Agron*., **51**: 515-18.

Dhanda, S. S., Sethi, G. S and Behl, R. K 2004. Indices of drought tolerance in wheat genotypes at early stages of plant growth. *J. Agron Crop Sci*., **1**: 6-12

Ebrahim, F. 2012. Changes chlorophyll b in response to drought stress in alfalfa (vs. Nick Urban) in climatic conditions of the South West Iran. *Adv. Stud. Biol.,***4**: 551-56

Ghorai, A. K. and Mitra, S. 2008. Water management in jute and ramie. In. *Jute and Allied Fibre Updates: Production and Technology.,* Karmakar, P. G.; Hazra, S. K.; Ramsubramanian, T.; Mandal, R. K.; Sinha, M. K. and Sen, H.S. (Eds), Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata., pp. 162-74.

Johnson, H. W., Robinson, H. F. and Comstock, R. E.1955. Estimates of genetic and environmental variability in soyabean. *Agron. J.*, **47**: 314-18.

Kundu, B. C., Basak, K. C. and Sarkar, P. B. 1959. Jute in India. *Indian Central Jute Committee Publication,* pp.1-9.

Levitt, J. 1969. *Introduction to Plant Physiology.* C.V. Mosby Cp., St. Lois, U.S. p.p.304

Lush, J. L.1940. Intra-sire correlation and regression of offspring in rams as a method of estimating heritability characters. *Proc. Ann. Soc. Anim. Product.,***33**: 292-301.

Mehdi, S. S. and Ahsan, M. 2000. Coefficient of variation, inter-relationship and heritability estimates for some seedling traits in maize in C1 recurrent selection cycle *Pak. J. Biol. Sci.*, **3**: 181-82.

Panse, V. G. 1957. Genetics of quantitative characters in relation to plant breeding.*Indian J. Genet*.**17**:318-28

Pervin, N. and Haque G.K.M.N. 2012. Variability in anatomical characters in relation to fibre content and quality in white jute. (*Corchorus capsularis* L.). *Int. Res. J. App. Life Sci.,* **4**:73-79.

Roy, S.K., Chakraborty, G., Roy, A., Haque, S., Sinha, M. K., Mitra, S. and Kale,V.A. 2011. Stability for fibre yield and its attributing traits in white jute *(Corchorus capsularis*L.). *J. Crop Weed,* **7**: 130-32.

Yasin, T.E. 1973. Gen otypic and phenotypic variances and correlation in field beans (*Vicia faba* L.). *Agril. Sci. Camb.,* **81**: 445-48.