



Character association of seed yield and its components in some lentil (*Lens culinaris* Medik.) genotypes under normal and late sown condition

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ABSTRACT

Character association in forty eight genotypes of lentil was studied for nine different agro-morphological characters in normal and late sown conditions. Normal sown condition was taken into consideration as optimum environment and late sown as heat stressed environment. The correlation study revealed consistent positive significant character association (at genotypic and phenotypic levels) of pods per plant with seed yield per plant in both sowing conditions. So this character may be considered for yield improvement. From path coefficient analysis study it was revealed that pods per plant showed consistently positive direct effect on seed yield/plant for both sowing conditions.

Key words: Correlation, Heat stress, Late sown, *Lens culinaris*, Normal sown, Path coefficient analysis.

INTRODUCTION

Lentil (*Lens culinaris* Medik.) is an important pulse crop and rich source of protein. It is also called poor man's meat. As it is a cool season food legume, heat stress has harmful impact on its growth and development. Breeding suitable genotypes that tolerate heat stressed condition and produce higher yield is very much needed in present climatic situation. So for this, knowledge of the important traits and their relationship with seed yield is necessary. Correlation coefficients between yield attributing characters and their inter relationship can be of immense importance in selecting desirable genotypes for higher yield. To facilitate selection for high yield in breeding, it is essential to study the association of yield components and give more attention to those which have highest influence on yield (Mekonnen *et al.*, 2014) by path analysis which was developed by Wright, (1921) and applied by Dewey and Lu, (1959). It partitions correlation into direct and indirect effects. Therefore, correlation and path analysis study is very much essential for effective selection. Keeping these facts in view, present investigation was planned to study correlations and path analysis of different agro-morphological traits in forty eight lentil genotypes under normal (considered as normal environment) and late sown (considered as heat stressed environment) condition.

MATERIALS AND METHODS

Plant material: Forty eight genotypes of lentil consisting of thirty genotypes received from NBPGR, New Delhi, seven genotypes from Berhampore Pulses and Oilseeds Research Station, West Bengal and eleven genotypes were local collections from different regions.

➤ **Field experiments:** The genotypes were sown in randomized block design (RBD) with three replications in each of the environments. Sowing was done on November for three years (2010, 2011 and 2012) as normal sowing at Calcutta University Experimental Farm, Baruipur, South 24 Parganas, West Bengal and on second week of December, 2010 and fourth week of December, 2012 as late sown at the same location of Calcutta University Experimental Farm, as well as at Farmer's field of Udaynarayanpur, Howrah, West Bengal.

Characters studied: The mean data of nine different agro-morphological traits *viz.* plant height (cm.), branch number/plant, number of pods/plant, pod length (cm.), seeds/pod, 100 seed weight (g.), harvest index (%), days to maturity and seed yield per plant (g.) were recorded.

Statistical analysis: Correlation and path coefficient analysis were done using the software Statistical Package for Agricultural Research (SPAR 2.0).

RESULTS AND DISCUSSION

Correlations

Normal sown condition: Genotypic correlation for three years and their pooled mean was studied and presented in Table 1 A and B. Positive significant association with seed yield per plant was observed for the characters plant height, branch number, pods per plant, harvest index for consecutive three years. Whereas pooled genotypic correlation revealed the same outcome except branch number and harvest index. For phenotypic correlation (Table 1C.) seed yield per plant revealed the similar outcome except branch number and harvest index which was found to be positively and

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Table-1(C). Phenotypic Correlations.

	Plant height			Branch number			Pods/Plant			Pod length			Seeds/Pod			100 seed weight			Harvest index			Days to maturity			Seed yield/Plant			
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
Plant height	1.00	1.00	1.00	0.45**	0.44**	0.26	0.51**	0.50**	0.29*	0.04	0.23	-0.08	0.05	0.03	-0.19	0.27	-0.01	0.33*	0.02	-0.40	-0.15	0.52**	0.57**	0.22	0.60**	0.30*	0.41**	
Branch number	1.00	1.00	1.00	0.61**	0.40**	0.62**	1.00	1.00	1.00	0.14	0.06	-0.17	-0.04	0.02	0.0004	-0.12	-0.01	-0.14	0.29*	-0.24	0.29*	0.27	0.01	0.55**	0.26	0.41**		
Pods/Plant				1.00	1.00	1.00	1.00	1.00	1.00	-0.07	0.15	-0.07	0.01	-0.01	-0.04	-0.11	-0.20	-0.10	-0.01	-0.04	-0.03	0.12	0.30*	0.08	0.83**	0.84**	0.68**	
Pod length				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.03	-0.10	0.48**	0.28*	0.03	0.39**	0.20	-0.08	0.13	0.05	0.15	-0.22	0.06	0.18	0.20	
Seeds/Pod				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.01	-0.14	-0.04	0.10	-0.05	0.15	0.07	0.01	-0.18	0.11	-0.04	0.11	
100 seed weight				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75**	0.10	0.21	0.27	0.03	0.05	0.40**	0.002	0.32*		
Harvest index				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.006	-0.37*	0.07	0.39**	0.36*	0.27	
Days to maturity				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.28*	0.12	0.13	
Seed yield/Plant				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

significantly correlated for two years. Pooled phenotypic correlation (Table 1D.) also revealed the same result i.e. positive significant association with seed yield per plant for the characters plant height, branch number, pods per plant, 100 seed weight and harvest index were recorded . Seed yield per plant was found to be positively, significantly associated with plant height and pods per plant both at genotypic and phenotypic levels (individual and pooled) indicating that utilizing these traits will be beneficial for yield improvement of lentil. Affirmative, significant correlation for plant height and pods/plant with seed yield also observed by Sharma *et al.*, (2014) and Dalbeer *et al.*, (2013). Positive significant correlation of pods per plant also observed by Tadesse *et al.*,(2014). At genotypic level plant height was positively and significantly correlated with branch number, pods per plant and days to maturity for three years and with 100 seed weight for two years and with all these characters for pooled analysis. When interrelationships at phenotypic level were studied it was found that plant height had shown positive and significant association with pods per plant for three years, with branch number per plant and days to maturity for two years. Branch number conferred affirmative, significant correlation with pods per plant for three years. Pooled correlation also revealed the same result.

Late sown condition: Estimates of correlation coefficient at genotypic level for individual four environments in late sown condition and their pooled analysis was studied and presented in Table 2 A and B. Positive significant association with seed yield per plant was observed for the characters pods per plant and harvest index for four environments; pod length, seeds per pod and 100 seed weight for three environments. In case of genotypic correlation of pooled data, positive and significant association with seed yield per plant was observed for pods/plant, pod length, seeds/pod, 100 seed weight and harvest index. At genotypic level, pods per plant were positively significantly correlated with pod length and seeds per pod for three environments. When pooled genotypic correlation between characters was studied then pods per plant showed positive significant correlation with seeds per pod, 100 seed weight and harvest index. Pod length was significantly and positively associated with seeds per pod for four environments and also for the pooled analysis. Phenotypic correlation for four environments and their pooled analysis was studied and presented in Table 2 C and D .Positive significant association with seed yield per plant was observed for the characters pods/plant and harvest index for four environments and 100 seed weight for three environments. From overall observation in late sown condition it was noticed that pods per plant and harvest index exerted the significant positive correlation consistently with seed yield/plant. For phenotypic correlations over the environments it was observed that pods per plant were positively and significantly correlated with seeds per pod

Table 1(D). Phenotypic correlations of pooled mean.

	Plant height	Branch no.	Pods/Plant	Pod length	Seeds/Pod	100 seed weight	Harvest index	Days to maturity	Seed yield/Plant
Plant height	1.000000	0.519015**	0.468462**	0.057891	-0.083271	0.244847	-0.186372	0.510333**	0.487533**
Branch no.		1.000000	0.627276**	0.022092	-0.055719	-0.067909	-0.273688	0.266674	0.434800**
Pods/Plant			1.000000	0.001307	-0.014926	-0.184452	-0.044976	0.241734	0.743555**
Pod length				1.000000	0.253320	0.309601*	0.119268	0.004379	0.122737
Seeds/Pod					1.000000	-0.061695	0.096321	-0.068047	0.068271
100 seed weight						1.000000	0.492445**	0.134023	0.341165*
Harvest index							1.000000	-0.116194	0.388762**
Days to maturity								1.000000	0.235745
Seed yield/Plant									1.000000

Table 2.(A-D): Genotypic and phenotypic correlations under late sown conditions.

(I and II denotes late sowing in 2nd week of December in 2010-11 at Barupur and Udaynarayanpur respectively. III and IV denotes late sowing in 4th week of December in 2012-13 at Barupur and Udaynarayanpur respectively)

	Branch number				Pods/Plant				Pod length				Seeds/Pod				100 seed weight				Harvest index				Days to maturity				Seed yield/Plant								
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV					
Plant height	1.00	1.00	1.00	1.00	0.47**	0.33*	0.04	0.463**	0.64**	0.11	0.23	0.075	0.19	0.08	0.25	0.011	0.15	0.34*	0.21	-0.069	0.14	0.0020	0.51**	0.186	-0.49**	-0.60**	0.15	-0.670**	0.07	-0.26	0.28*	0.682**	0.24	0.130	0.29**	0.070	
Branch number					1.00	1.00	1.00	1.00	1.000	0.41**	0.30*	0.30*	0.132	-0.11	0.03	0.47**	0.166	-0.28*	0.40**	0.40**	0.076	-0.06	-0.04	0.08	0.027	0.88**	-0.32*	0.16	-0.412**	0.69**	-0.22	0.22	0.295*	0.05	0.30*	0.30*	-0.045
Pods/Plant									1.00	1.00	1.00	1.00	0.32*	0.40**	0.41**	0.189	0.40**	0.39**	0.37**	0.153	-0.08	-0.37**	0.24	0.207	-0.17	0.31*	0.13	0.097	-0.06	-0.22	-0.38**	0.1000	0.60**	0.79**	0.81**	0.695**	
Pod length													1.00	1.00	1.00	1.00	0.88**	0.34*	0.82**	0.838**	0.08	0.15	0.30*	0.212	0.33*	-0.01	0.19	-0.051	-0.74**	-0.05	-0.03	0.0190	0.41**	0.47**	0.50**	0.170	
Seeds/Pod													1.00	1.00	1.00	1.00	1.000	0.03	0.23	0.05	-0.101	0.32*	-0.29*	0.05	-0.136	-0.58**	-0.40**	-0.10	-0.098	0.41**	0.56**	0.34*	0.56**	0.546**			
100 seed weight													1.00	1.00	1.00	1.00	1.000	0.33*	0.02	0.08	0.158	-0.03	-0.04	-0.06	0.1390	0.58**	0.27	0.37**	0.441**								
Harvest index													1.00	1.00	1.00	1.00	1.000	-0.48**	-0.03	-0.27	-0.513*	0.43**	0.34*	0.56**	0.546**												
Days to maturity													1.00	1.00	1.00	1.00	1.000	0.00	-0.22	-0.31*	0.37**	0.037															
Seed yield/Plant													1.00	1.00	1.00	1.00	1.000	0.00	1.00	1.00	1.000	0.00	1.00	1.00	1.000	0.00	1.00	1.00	1.000	0.00	1.00	1.00	1.000				

Table 2(B): Genotypic correlations of pooled mean

	Plant height	Branch no.	Pods/Plant	Pod length	Seeds/Pod	100 seed weight	Harvest index	Days to maturity	Seed yield/Plant
Plant height	1.000000	1.061492**	-0.498218**	0.782737**	0.338711*	0.286338*	-0.506450**	0.558228**	-0.2222129
Branch no.		1.000000	-0.817992**	0.763867**	-0.007987	0.397671**	-1.373972**	0.808419**	-0.277182*
Pods/Plant			1.000000	0.203583	0.690181**	0.350102*	0.793047**	-0.478513**	0.843135**
Pod length				1.000000	0.897499**	0.626382**	0.193370	-0.283153*	0.656449**
Seeds/Pod					1.000000	0.281222*	0.238254	-0.507570**	0.592211**
100 seed weight						1.000000	0.476077**	-0.035546	0.760933**
Harvest index							1.000000	-0.723702**	0.940586**
Days to maturity								1.000000	-0.452883**
Seed yield/Plant									1.000000

Table-2(C). Phenotypic Correlations.

	Plant height				Branch number				Pods/Plant				Pod length				Seeds/Pod				100 seed weight				Harvest index				Days to maturity				Seed yield/Plant				
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV					
Plant height	1.00	1.00	1.00	1.00	0.06	0.32*	0.03	0.435**	0.48**	0.11	0.23	0.077	0.27	0.07	0.24	0.018	0.19	0.33*	0.20	-0.031	-0.09	0.004	0.48**	0.180	-0.41**	-0.58**	-0.13	-0.646**	0.06	-0.25	0.26	0.656**	0.21	0.13	0.27	-0.070	
Branch number					1.00	1.00	1.00	1.00	0.23	0.30*	0.30*	0.131	-0.30*	0.04	0.43**	0.159	-0.20	0.38**	0.37**	0.069	-0.02	-0.03	0.07	0.028	-0.46**	-0.31*	0.15	-0.404**	0.38**	-0.22	0.22	0.289*	0.02	0.30*	0.30*	-0.046	
Pods/Plant									1.00	1.00	1.00	1.00	0.15	0.36*	0.38**	0.182	0.28*	0.37**	0.34*	0.145	-0.08	-0.36*	0.24	0.199	-0.17	0.31*	0.13	0.095	-0.06	-0.22	-0.38**	0.1000	0.59**	0.77**	0.80**	0.682**	
Pod length													1.00	1.00	1.00	1.00	0.56**	0.32*	0.71**	0.680**	0.02	0.15	0.26	0.203	0.13	-0.02	0.17	-0.050	-0.37*	-0.04	-0.02	0.018	0.20	0.42**	0.45**	0.168	
Seeds/Pod														1.00	1.00	1.00	1.00	0.02	0.23	0.04	-0.091	0.19	-0.27	0.05	-0.115	-0.41**	-0.38**	-0.09	-0.084	0.27	0.53**	0.33*	0.038				
100 seed weight															1.00	1.00	1.00	1.00	0.00	0.02	0.23	0.04	-0.091	0.19	-0.27	0.05	-0.115	-0.41**	-0.38**	-0.09	-0.084	0.27	0.53**	0.33*			
Harvest index																1.00	1.00	1.00	1.00	0.00	0.02	0.23	0.04	-0.091	0.19	-0.27	0.05	-0.115	-0.41**	-0.38**	-0.09	-0.084	0.27	0.53**	0.33*		
Days to maturity																	1.00	1.00	1.00	1.00	0.00	0.02	0.23	0.04	-0.091	0.19	-0.27	0.05	-0.115	-0.41**	-0.38**	-0.09	-0.084	0.27	0.53**	0.33*	
Seed yield/Plant																		1.00	1.00	1.00	1.00	0.00	0.02	0.23	0.04	-0.091	0.19	-0.27	0.05	-0.115	-0.41**	-0.38**	-0.09	-0.084	0.27	0.53**	0.33*

Table 2(D). Phenotypic Correlations of pooled mean

	Plant height	Branch no.	Pods/Plant	Pod length	Seeds/Pod	100 seed weight	Harvest index	Days to maturity	Seed yield/Plant
Plant height	1.000000	0.274763	0.198927	0.115676	0.190715	0.066626	-0.500739**	0.189744	0.135077
Branch no.	1.000000	1.000000	0.278939*	0.096467	0.187566	-0.010024	-0.291511*	0.146263	0.189516
Pods/Plant	1.000000	1.000000	1.000000	0.261096	0.316496*	-0.089864	0.110894	-0.129293	0.716969**
Pod length	1.000000	1.000000	1.000000	1.000000	0.608782**	0.145286	0.064601	-0.102671	0.314121*
Seeds/Pod	1.000000	1.000000	1.000000	1.000000	1.000000	0.059720	-0.015106	-0.266288	0.382956**
100 seed weight	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.162078	-0.003575	0.407974**
Harvest index	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	-0.354546*	0.395220**
Days to maturity	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	-0.211781
Seed yield/Plant	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000

* and ** 5% and 1% level of significance respectively

for three environments (also for pooled) and for two environments with pod length. Whereas pod length showed positive, significant correlation with seeds/pod consistently for four environments and pooled also.

Path coefficient analysis: Path analysis is very much necessary to understand causal relationship for effective selection because correlation study alone is not sufficient. It partitions correlation into direct and indirect effects.

Normal sown condition: Direct and indirect effects of yield contributing traits towards seed yield per plant was presented in Table 3 A and B. From path analysis positive, direct effect on seed yield/plant was found for pods/plant for consecutive three years and branch number, seeds/pod, 100 seed weight and days to maturity for two years. Pooled analysis also exhibited the similar outcome. In pooled data, 100 seed weight had highest positive direct effect followed by pods per plant. Similar outcome was observed by some previous workers. Positive direct effect of pods per plant on seed yield was also observed by Sarwar *et al.*, (2013), Mekonnen *et al.*, (2014), Sharma *et al.*, (2014), Tyagi and Khan (2010). Positive direct effect of 100 seed weight on seed yield was also observed by Rasheed *et al.*, (2008), Dalbeer *et al.*, (2013), Mekonnen *et al.*, (2014), Younis *et al.*, (2008).

Branch number conferred positive indirect effect on seed yield via pods per plant, and pod length for consecutive three years, 100 seed weight and days to maturity for two years, pods/plant, pod length, harvest index and days to maturity for pooled analysis. Pods per plant had positive indirect effect on seed yield via seeds per pod for three years, via branch number, pod length and days to maturity for two years and via branch number, pod length, seeds/pod, harvest index and days to maturity for pooled mean. Seeds per pod had positive indirect effect on seed yield per plant via pods per plant and harvest index for two years, via plant height, pods per plant and harvest index for pooled mean. 100 seed weight had conferred positive indirect effect on seed yield per plant via plant height, branch number, pod length, harvest index and days to maturity for two years and only days to maturity for pooled mean. Days to maturity had positive indirect effect on seed yield per plant via pods/plant, seeds/pod and harvest index for three years, via branch number, 100 seed weight for two years and via branch number, pods per plant, 100 seed weight and harvest index for pooled mean.

Late sown condition: Direct and indirect effects of yield contributing traits towards seed yield per plant was presented in Table 4 A and B. From path analysis it was revealed that pods per plant exerted highest, positive direct effect on seed yield in all of the four environments, followed by harvest index, 100 seed weight and plant height. Path analysis of pooled mean also exhibited the similar kind of association except harvest index.

Table 3: (A-B) Path Coefficient Analysis for normal sown condition
A.Path Coefficient Analysis for three consecutive years

	Plant height			Branch no.			Pods/Plant			Pod length			Seeds/Pod			100 seed weight			Harvest index			Days to maturity			
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	
Plant height	-0.50	-0.74	0.49	0.44	0.04	-0.02	0.17	1.01	0.25	0.04	0.01	-0.01	0.03	0.01	0.05	0.33	-0.01	-0.07	0.003	0.07	-0.09	0.13	0.07	-0.04	0.02
Branch no.	-0.35	-0.65	0.19	0.63	0.04	-0.05	0.29	1.31	0.46	0.08	0.01	0.03	-0.21	0.004	-0.001	0.007	-0.22	0.0002	-0.03	0.06	-0.11	0.07	-0.04	0.0007	0.0007
Pods/Plant	-0.22	-0.45	0.19	0.46	0.04	-0.03	0.40	1.50	0.64	0.17	0.01	-0.06	0.003	0.007	0.01	-0.22	-0.23	0.02	-0.003	0.01	-0.02	0.03	0.03	-0.04	0.005
Pod length	0.07	-0.20	-0.01	-0.16	0.10	-0.003	-0.21	0.36	-0.08	-0.33	0.05	0.52	0.09	-0.004	-0.16	0.46	0.04	-0.11	0.04	0.01	0.06	0.02	-0.01	-0.02	-0.02
Seeds/Pod	-0.03	-0.04	-0.11	-0.29	0.001	-0.0004	0.003	0.05	-0.04	-0.07	-0.001	0.40	0.45	0.21	-0.21	-0.004	-0.17	0.007	0.02	-0.002	0.08	0.02	-0.001	-0.01	-0.01
100 seed weight	-0.18	0.01	0.19	0.005	-0.02	0.0001	-0.10	-0.54	-0.07	-0.17	0.003	0.33	-0.002	-0.05	0.008	0.91	0.64	-0.17	0.09	-0.02	0.09	0.05	-0.004	0.003	0.003
Harvest index	-0.01	0.51	-0.11	-0.15	-0.03	0.01	-0.01	-0.19	-0.02	-0.13	-0.01	0.08	0.08	0.004	-0.04	0.70	0.10	-0.04	0.11	-0.10	0.40	0.001	0.04	0.004	0.004
Days to maturity	-0.37	-0.52	0.14	0.27	0.02	-0.001	0.09	0.67	0.05	-0.03	0.01	-0.17	0.05	0.004	0.04	0.25	0.028	-0.01	0.0007	0.05	0.03	0.17	-0.09	0.06	0.06

Residual effect, I=0.14, II=0.15, III=0.29

Table 3(B) Path Coefficient analysis of pooled mean of normal sown condition

	Plant height			Branch no.			Pods/Plant			Pod length			Seeds/Pod			100 seed weight			Harvest index			Days to maturity		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Plant height	-0.6593	-0.4698	0.0548	0.9228	0.8494	0.0778	0.0036	-0.0805	0.4457	0.0111	0.0684	0.0684	0.0560	0.0380	-0.0080	-0.0473	0.0232	-0.0367	0.0918					
Branch no.	-0.4458	0.0085	-0.0218	-0.5322	0.0634	-0.1178	0.0036	-0.0146	-0.6837	0.0326	0.0560	0.0380	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918					
Pods/Plant	0.0085	0.1629	-0.0034	0.0634	-0.5322	-0.1178	0.0036	0.1397	0.8673	-0.0061	-0.0080	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918	0.0918					
Pod length	0.0085	0.1629	-0.0034	0.0634	-0.5322	-0.1178	0.0036	0.1397	0.8673	-0.0061	-0.0080	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918	0.0918					
Seeds/Pod	0.0085	0.1629	-0.0034	0.0634	-0.5322	-0.1178	0.0036	0.1397	0.8673	-0.0061	-0.0080	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918	0.0918					
100 seed weight	-0.1840	0.2686	-0.0917	-0.5329	-0.7748	-0.0612	0.0036	-0.0146	-0.6837	0.0326	0.0560	0.0380	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918					
Harvest index	0.2686	-0.4913	0.0469	0.5651	0.0469	0.0238	0.0036	-0.0146	-0.6837	0.0326	0.0560	0.0380	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918					
Days to maturity	-0.4913	0.0469	0.0469	0.5651	0.0469	0.0238	0.0036	-0.0146	-0.6837	0.0326	0.0560	0.0380	-0.0080	-0.0473	0.0232	-0.0367	0.0918	0.0918	0.0918					

Residual effect =0.2960

Table 4: (A-B) Path Coefficient analysis for late sown condition
 A.Path coefficient analysis for four trials in late sown condition

	Plant height				Branch number				Pods/Plant				Pod length				Seeds/Pod				100 seed weight				Harvest index				Days to maturity			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Plant height	0.02	0.002	0.18	0.22	-0.06	-0.001	-0.0003	0.018	0.46	0.12	0.15	0.039	0.09	-0.004	0.04	-0.002	-0.04	0.002	-0.02	-0.019	-0.07	-0.003	-0.17	-0.003	0.02	0.038	-0.07	-0.515	0.02	0.01	-0.01	0.150
Branch no.	0.01	0.0001	0.007	0.102	-0.14	-0.002	-0.008	0.039	0.30	0.31	0.20	0.069	-0.05	-0.001	0.08	-0.030	0.08	0.003	-0.04	0.021	-0.03	-0.03	-0.31	-0.001	0.07	0.002	0.006	-0.317	0.19	0.01	-0.01	0.065
Pods/Plant number	0.01	0.0002	0.04	0.016	-0.06	-0.001	-0.002	0.005	0.72	1.03	0.66	0.525	0.14	-0.02	0.07	-0.035	-0.10	0.003	-0.04	0.043	-0.04	-0.06	0.001	0.06	0.074	0.008	0.042	-0.06	0.074	0.02	0.01	0.022
Plant Pod	0.004	0.0001	0.04	0.003	0.02	-0.0001	-0.004	0.007	0.23	0.41	0.27	0.099	0.45	-0.05	0.17	-0.185	-0.24	0.002	-0.09	0.239	0.04	0.10	0.01	0.043	0.11	-0.0001	0.09	-0.039	-0.21	0.002	0.001	0.004
length Seeds/ Pod	0.003	0.001	0.04	-0.015	0.04	-0.001	-0.003	0.003	0.28	0.40	0.24	0.080	0.40	-0.02	0.14	-0.155	-0.27	0.01	-0.11	0.285	0.01	0.15	0.002	-0.020	0.11	-0.001	0.02	-0.105	-0.16	0.02	0.004	-0.021
100 seed weight	-0.003	0.0000	0.09	0.041	0.010	0.0001	-0.001	0.001	-0.06	-0.39	0.16	0.108	0.04	-0.01	0.05	-0.039	-0.01	0.002	-0.006	-0.028	0.50	0.65	0.03	0.205	0.11	0.0001	0.04	0.121	-0.01	0.002	0.003	0.030
Harvest index	-0.001	-0.001	-0.03	-0.148	0.12	0.001	-0.001	-0.016	-0.12	0.32	0.09	0.051	0.15	0.001	0.03	0.009	-0.09	-0.002	-0.006	-0.03890	0.16	0.01	0.003	0.032	0.35	0.005	0.46	0.770	-0.14	0.002	0.01	-0.113
Days to maturity	-0.001	-0.001	0.05	0.151	-0.090	0.001	-0.002	0.011	-0.05	-0.23	-0.25	0.052	-0.34	0.002	-0.005	-0.003	0.16	-0.003	0.01	-0.028	-0.02	-0.03	-0.002	0.028	-0.17	-0.0001	-0.12	-0.395	0.28	-0.05	-0.04	0.220

Residual effect, I=0.34, II=0.12, III=0.28, IV=0.37

Table 4 (B). Path coefficient analysis of pooled mean.

	Plant height				Branch no.				Pods/Plant				Pod length				Seeds/Pod				100 seed weight				Harvest index				Days to maturity			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Plant height	0.5302	-0.2965	-0.0925	-0.6719	0.1843	0.3122	0.0710	-0.2589	0.0710	0.1926	0.1313	0.2354	0.0165	0.3357	-0.4638																	
Branch no.	0.5628	-0.2794	-0.1518	-0.6557	-0.0043	0.4335	0.1926	-0.3750	0.1926	0.1926	0.1926	0.1926	0.1926	0.1926																		
Pods/Plant	-0.2642	0.2285	0.1856	-0.1748	0.3756	0.3817	-0.1112	0.2219	-0.1112	0.2219	0.2219	0.2219	0.2219	0.2219																		
Pod length	0.4150	-0.2134	0.0378	-0.8584	0.4884	0.6829	-0.0271	0.1313	-0.0271	0.1313	0.1313	0.1313	0.1313	0.1313																		
Seeds/Pod	0.1796	0.0022	0.1281	-0.7704	0.5441	0.3066	-0.0334	0.2354	-0.0334	0.2354	0.2354	0.2354	0.2354	0.2354																		
100 seed weight	0.1518	-0.1111	0.0650	-0.5377	0.1530	1.0902	-0.0667	0.0165	-0.0667	0.0165	0.0165	0.0165	0.0165	0.0165																		
Harvest index	-0.2685	0.3838	0.1472	-0.1660	0.1296	0.5190	-0.1402	0.3357	-0.1402	0.3357	0.3357	0.3357	0.3357	0.3357																		
Days to maturity	0.2960	-0.2258	-0.0888	0.2431	-0.2762	-0.0388	0.1015	-0.4638	0.1015	-0.4638	-0.4638	-0.4638	-0.4638	-0.4638																		

Residual effect=0.4663

When indirect effect on seed yield were studied it was seen that Plant height had positive indirect effect on seed yield via pods per plant for four environments; via 100 seed weight and days to maturity for three environments; via pod length for two environments and positive indirect effect via seeds per pod, 100 seed weight and harvest index for the pooled mean. Pods per plant had positive indirect effect on seed yield via plant height for four environments, via harvest index and days to maturity for three environments, via pod length, seeds/pod and 100 seed weight for two environments and via branch number, seeds/pod, 100 seed weight and days to maturity for the pooled mean. 100 seed weight had positive indirect effect on seed yield via harvest index for four environments, via plant height, branch number, days to maturity for three environments, via pods/plant, pod length for two environments and via plant height, pods/plant, seeds/pod, days to maturity for the pooled mean.

CONCLUSION

Considering the correlation coefficient with respect to yield in both normal and late sown condition it was

observed that there was a slight change in correlation of normal sown condition with that of late sown condition. For normal sown condition seed yield per plant was positively significantly correlated (genotypic and phenotypic) with plant height and pods per plant. It suggests these traits may be used as selection criteria for seed yield/plant under normal sown condition. In late sown condition seed yield per plant was significantly correlated (genotypic and phenotypic) with pods per plant and harvest index. So these two traits may be useful as selection criteria for seed yield in late sown condition. Consistent positive significant character association at genotypic and phenotypic level in normal and late sown condition was observed for pods per plant with seed yield/plant which proved pods/plant to be major yield attributing character. The path coefficient analysis revealed that the positive direct effects on seed yield per plant were consistently exhibited by pods per plant for both sowing conditions. On the other hand, the indirect effects of pods per plant through some other characters also indicated that direct selection by pods per plant to select high yielding genotypes will be effective.

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