Original Research Article

Association Analysis over Different Environments in Soybean [*Glycine max* (L.) Merrill]

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A B S T R A C T

The correlation and path analysis gives better insight, into cause and effect relationship between different pairs of characters. The present study was carried out on 24 genotypes for eight quantitative characters in three environments. The genetic correlation study revealed that single plant yield showed positive significant correlation with plant height, days to 50% flowering, number of clusters per plant and number of pods per plant in all the three environments studied. On the other hand, hundred seed weight showed negative non-significant correlation with single plant yield on the environments studied. Path analysis revealed that number of pods per plant had the highest direct effect on the single plant yield and it was followed by the number of clusters per plant. Based on the association analysis characters like number of pods per plant, number of clusters per plant, plant height and days to 50% flowering should be given more consideration in breeding for higher grain yield in soybean.

Introduction

The soybean is one such crop with utmost potential as it provides cholesterol free oil (20%) and high quality protein (40%). It is a rich source of amino acids, vitamins, minerals and fats (James, 2010). It is rightly called as "Golden gift of nature to mankind". Soybean is considered to be the crop of the century as it holds high yielding ability with high nutritional content will play a crucial role in eradication of the malnutrition.

Yield is a complex quantitative character which has association with various characters. It is essential to know the correlation among yield and other important traits for effective selection. Correlation between two characters

is of evolutionary interest mainly due to linkage, pleiotropy and heterozygosity. A positive correlation between desirable characters is helpful to the plant breeder because it helps in synchronized improvement of both the characters. Negative correlation on the other hand, will suppress the simultaneous expression of both characters.

The path coefficients are standard partial regression coefficients which splits the correlation coefficient into direct and indirect effects. Thus the correlation and path analysis in combination, can give a better insight, into cause and effect relationship between different pairs of characters (Faisal *et al.,*

2007). Hence the present study was carried out to study the correlation and path analysis at different environments.

Materials and Methods

The present probe was carried out to study the correlation and path analysis of 24 soybean genotypes over the different environments. The examine was executed during the *kharif, rabi* and Summer seasons of 2016-17over the three environments namely, Tamil Nadu Agricultural University, *kharif* 2016, Coimbatore (E1), Agricultural College and Research Institute, *rabi* 2016, Madurai (E2) and Tamil Nadu Agricultural University, summer 2017, Coimbatore (E3).

The weather parameters prevailed during three crop seasons were depicted in the Figure 1. The randomized block design (RBD) was followed with three replications. Each genotype was sown in a single row of three meter length in each replication with a spacing of 30 x 10 cm. Normal cultural practices were followed as per standard recommendation.

Observations were recorded on five plants selected at random from a row of each accession. Data were recorded for eight biometric characters *viz.,* plant height, days to 50% flowering, days to maturity, number of primary branches, number of clusters per plant, number of pods per plant, hundred seed weight and single plant yield. Genetic parameters, correlation coefficients were computed according to the method suggested by Singh and Chaudhry (1979). The significance of genotypic correlation coefficients was tested with the help of standard errors. Path coefficients were worked out by the methods used by Dewey and Lu (1959), whereas, genetic distances were calculated from mean with the help of computer software GENRES version 7.01.

Results and Discussion

The genetic correlation study revealed that single plant yield showed the positive significant correlation with plant height, days to 50% flowering, number of clusters per plant and number of pods per plant in all the three environments (Table 1). Number of primary branches also exhibited positive direct correlation with single plant yield in environments E1 and E2 whereas it revealed positive non-significant correlation in the environment E3. Days to maturity showed positive non-significant correlation in all the three environments studied. On the black side, it observed non-significant negative correlation with hundred seed weight in all the environments. Plant height was positively correlated (0.75, 0.89 and 0.55) with the single plant yield in all the environments. It was buttressed by Malik *et al.,* (2007), Udensi *et al.,* (2012) and Burno *et al.,* (2017). On the other hand, plant height negatively significant with single plant yield was reported by Mebrahtu and Devine (2008) and Li *et al.,* (2013). Even though plant height in turn increases the plant vigour and may lead to unnecessary vegetative growth, it is recommended to have the crop with semi dwarf stature to improve the yield (Diondra, 2008). Machikowa and Laosuwan (2011) reported the negative correlation between the number of pods per plant and single plant yield. On the contrary, Showkat and Tyagi (2010), Chavan *et al.,* (2016) and Burno *et al.,* (2017) observed positive significant correlation with the yield. In the present study, number of pods per plant showed the highest significant positive correlation in all the environments studied (0.87, 0.97, and 0.91). Showkat and Tyagi (2010) reported that the positive correlation between the number of pods per plant was strongly associated with the indirect effects of other traits like number of seeds per pod and hundred seed weight.

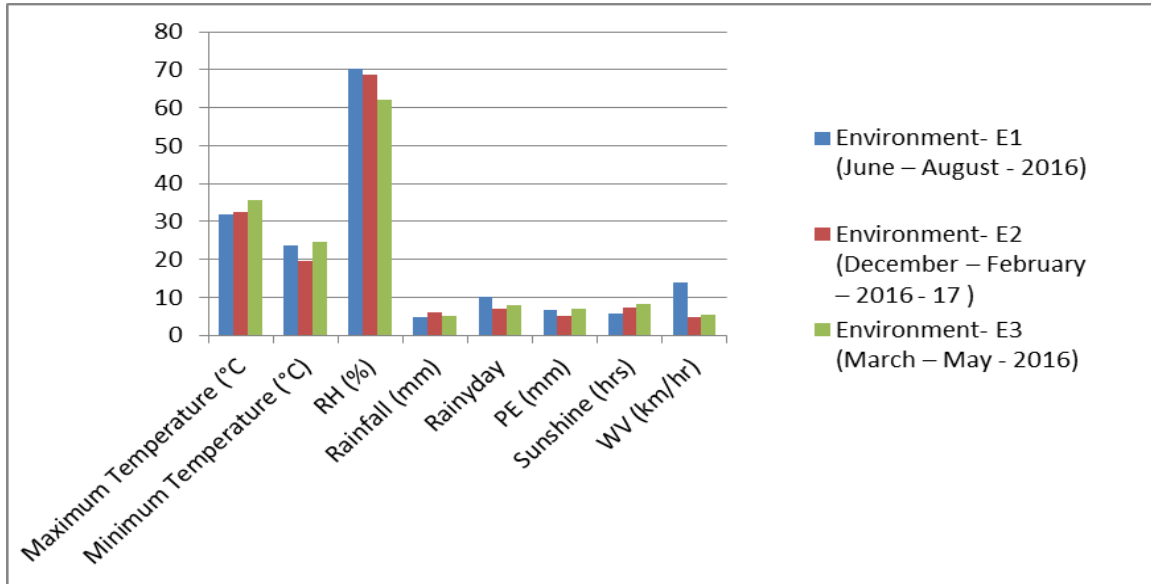**Fig.1** Weather parameters prevailed during the crop season

Table.1 Genotypic correlation of 24 soybean germplasm over the environments

CORRELATION		PH	DF	DM	NPB	NCP	NPP	HSW	SPY
PH	E1	1	0.74*	0.70*	0.67*	0.86*	0.81*	-0.52*	0.75*
	E2	1	0.51*	0.43*	0.63*	0.83*	0.86*	-0.004	0.89*
	E3	1	0.83*	0.71*	0.51*	0.83*	0.75*	-0.46*	0.55*
DF	E1		1	0.80*	0.54*	0.62*	0.53*	-0.49*	0.47*
	E2		1	0.76*	0.25	0.48*	0.45*	-0.32	0.44*
	E3		1	0.86*	0.47*	0.68*	0.70*	-0.34	0.54*
DM	E1			1	0.48*	0.59*	0.50*	-0.57*	0.31
	E2			1	-0.01	0.41*	0.35	-0.18	0.36
	E3			1	0.36	0.53*	0.51*	-0.26	0.37
NPB	E1				1	0.83*	0.72*	-0.37	0.68*
	E2				1	0.71*	0.81*	-0.11	0.82*
	E3				1	0.59*	0.49*	-0.22	0.34
NCP	E1					1	0.93*	-0.62*	0.81*
	E2					1	0.95*	0.04	0.95*
	E3					1	0.76*	-0.27	0.62*
NPP	E1						1	-0.66*	0.87*
	E2						1	0.10	0.97*
	E3						1	-0.16	0.91*
HSW	E1							1	-0.37
	E2							1	-0.07
	E3							1	-0.19
SPY	E1								1
	E2								1
	E3								1

*significance at 5% level.

PH	:	Plant height	**NCP**	:	Number of clusters per plant
DF	:	Days too fifty percent flowering	**NPP**	:	Number of pods per plant
DM	:	Days to maturity	**HSW**	:	Hundred seed weight
NPB	:	Number of primary branches	**SPY**	:	Single plant yield

Table.2 Path analysis of 24 soybean germplasm over the environments

Path analysis		PH	DF	DM	NPB	NCP	NPP	HSW	SPY
PH	**E1**	**0.226**	0.173	-0.209	0.052	-0.255	0.916	-0.150	0.75
	E2	**0.032**	0.036	-0.024	-0.019	0.642	0.026	-0.078	0.89
	E3	**0.036**	0.004	-0.033	-0.043	-0.010	0.753	-0.152	0.55
DF	**E1**	0.166	**0.235**	-0.238	0.042	-0.184	0.597	-0.142	0.47
	E2	0.020	**0.056**	-0.041	-0.009	0.334	0.027	-0.081	0.44
	E3	0.030	**0.005**	-0.040	-0.039	-0.008	0.704	-0.114	0.54
DM	**E1**	0.157	0.187	**-0.300**	0.037	-0.175	0.565	-0.165	0.31
	E2	0.009	0.028	**-0.083**	-0.003	0.124	0.003	-0.029	0.36
	E3	0.026	0.004	**-0.047**	-0.030	-0.007	0.509	-0.087	0.37
NPB	**E1**	0.151	0.127	-0.143	**0.077**	-0.246	0.820	-0.108	0.68
	E2	0.019	0.016	-0.007	**-0.033**	0.589	0.051	-0.012	0.82
	E3	0.019	0.002	-0.017	**-0.084**	-0.007	0.496	-0.072	0.34
NCP	**E1**	0.194	0.146	-0.177	0.064	**-0.297**	1.061	-0.179	0.81
	E2	0.026	0.024	-0.013	-0.024	**0.787**	0.038	-0.071	0.95
	E3	0.030	0.003	-0.025	-0.050	**-0.013**	0.762	-0.089	0.62
NPP	**E1**	0.182	0.123	-0.149	0.056	-0.277	**1.136**	-0.193	0.87
	E2	-0.007	-0.013	0.002	0.015	-0.261	**0.115**	0.053	0.97
	E3	0.027	0.003	-0.024	-0.042	-0.009	**1.005**	-0.054	0.91
HSW	**E1**	-0.117	-0.115	0.170	-0.029	0.184	-0.756	**0.290**	0.75
	E2	-0.011	-0.021	0.011	0.002	-0.253	-0.028	**0.221**	0.89
	E3	-0.017	-0.002	0.012	0.018	0.003	-0.161	**0.334**	0.55

Residual effect at E1: 0.34
Residual effect at E2: 0.44
Residual effect at E3: 0.24

PH	:	Plant height	NCP	:	Number of clusters per plant
DF	:	Days too fifty percent flowering	NPP	:	Number of pods per plant
DM	:	Days to maturity	HSW	:	Hundred seed weight
NPB	:	Number of primary branches	SPY	:	Single plant yield

Board *et al.,* (1999) and Liu *et al.,* (2010) concluded that hundred seed weight was important for improving the yield and it should be considered primary index in selecting the cultivars, as it shows high and positive significance with the yield. Despite of this, the present study revealed that hundred seed weight showed negative and non-significant correlation with the yield. It was supported by Ramteke *et al.,* (2010), Arshad *et al.,* (2014) and Kumar *et al.,* (2015). The reason for this correlation was well explained by Bizeti *et al.,* (2004) that hundred seed weight was not important in improving the yield but was essential in maintaining the soybean yield when number of pods per plant and number of seeds per pod changed. The study suggested that selection for number of pods per plant, number of clusters per plant, plant height and days to 50% flowering would be effective for increasing seed yield.

The present examine on path analysis (Table 2) revealed that number of pods per plant had the highest and direct effect on the single plant yield in the environment E1 and E3, whereas number of clusters per plant had the

highest direct effect on single plant yield in the environment E2. Concomitant results were reported by Iqbal *et al.,* (2003), Mukesh and Singh (2009), Arshad *et al.,* (2014) and Ivan *et al.,* (2017). Hundred seed weight showed moderate direct effect on the single plant yield. Number of pods per plant showed low direct effect on the yield. Plant height and days to 50% flowering showed negligible direct effect. The characters like number of primary branches and days to maturity showed negative direct effect on the single plant yield. The results were in conformity with the findings of Kumar *et al.,* (2015).

The number of pods per plant considered to have the highest effect on the single plant yield, which in turn had negligible indirect effects by other characters. The hundred seed weight had negative indirect negligible effect on all other character in all the environments. Days to maturity also considered to have indirect negative effect on all other characters except hundred seed weight in all the environments studied. Number of clusters per plant had negative negligible indirect effect. In contrast, all other characters have positive negligible indirect effect (Moe and Girdthai, 2013). In the present study, the estimate of residual effect was high with 0.34, 0.44 and 0.24 which indicated the adequacy of the characters chosen for the study.

In conclusion, characteristics correlated well with single plant soybean yield were number of pods per plant, number of clusters per plant, plant height and days to 50% flowering should be given more consideration in breeding for higher grain yield in soybean.

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