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Association Studies for Yield and Yield Components in Maize (*Zea mays* L.) Inbred Lines

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A B S T R A C T

An experimental study was conducted to evaluate the relationship between yield and its components in maize through correlation and path studies. Yield is the foremost consideration in the breeding of any crop. Since yield depends upon many yield contributing characters, it becomes essential to study the contribution of each character to the yield. Correlation is an important parameter in estimating the relative importance of various characters on grain yield. From this studies, cob length recorded significant and highly positive correlation on grain yield followed by cob weight and ear weight. These characters were significantly and positively inter correlated among the yield components. Hence, cob length, cob weight and ear weight should be given more importance while formulating selection indices for grain yield improvement in maize. Path analysis revealed that the characters like cob length, days to silking, flag leaf width showed very high positive direct effects on yield, while number of kernals per row, flag leaf length showed high positive direct effect on yield. Hence, during selection due weightage should be given to the above characters for increasing the yield in maize.

Introduction

Maize (*Zea mays* L.) occupies a prominent position in global agriculture and is an important cereal crop of India. Maize is used as human food, animal feed and industrial raw materials and also used as source for more number of industrial products. Grain yield is a complex quantitative trait that depends on a number of factors. Thus, knowledge of interrelationships between grain yield and its contributing components will improve the efficiency of breeding programs through the use of appropriate selection indices. Studies on correlation coefficients of different plant characters are useful criterion to identify desirable traits that contribute to improve the dependent variable. Correlation coefficient is one of the important biometrical tools for formulating a selection index as it reveals the strength of relationship among the group of characters. This also helps to decide the

dependability of the characters that have little or no importance. The relationship of a character with yield and other component characters could also be useful for the proper choice of parents for hybridization programme. Yield being a complex character, direct selection could be an efficient approach without knowing its genetic background. The knowledge of the degree of relationship between yield and yield component characters will aid the breeders to launch successful crop improvement programmes. The present study was therefore conducted to assess the genetic relationships among yield components, through association analysis for enhancing the usefulness of selection for grain yield improvement in maize.

Materials and Methods

The experimental material for the study was undertaken at Department of Millets, Tamil Nadu Agricultural University, Coimbatore during *Kharif*, 2014. The present study was carried out with fifteen maize inbred lines and it was laid out in Randomised Block Design with three replications. Each genotype was planted in one row plots of four meter length adopting spacing of 60 x 20 cm. All the recommended agronomic practices were followed throughout the cropping period. Observations were recorded from five randomly selected plants in each treatment, all the three replications for twelve characters *viz.*, days to 50% tasseling, days to 50% silking, plant height (cm), ear width (cm), flag leaf length (cm), flag leaf width (cm), cob weight (g), cob length (cm), number of kernel rows, number of kernels per row, 100 seed weight (g) and single plant yield (g). Standard statistical procedures were used for the analysis of variance and partitioning the total variation into variation due to treatments and replications according to procedure given by correlation (Johnson *et al.*, 1955) and path analysis (Dewey and Lu, 1959).

Results and Discussion

Grain yield being complex in inheritance and subjected to environmental fluctuations, direct selection for yield based on *per se* performance does not give expected results as high genotype and environment interaction will restrict improvement. Selection based on simply inherited and highly heritable yield attributes is most effective and reliable approach as compared to direct selection on yield itself.

Understanding the nature and extent of association of different yield components with yield and inter relationship among themselves is an essential pre requisite for the formulation of breeding procedure for effective improvement of yield. The aim of correlation studies is primarily to know the suitability of various characters for indirect selection.

Correlation studies provide information on the nature and extent of association between any two metric traits and it will be possible to bring about genetic upgradation in one trait by selection of the other of a pair (Table 1).

Examination on correlation among component characters revealed that strong associations are present among desirable component characters *viz.*, cob length (0.763), ear weight (0.537) and cob weight (0.502). Hence, selection criteria should consider all these characters for the improvement of grain yield. Undesirable association of some of the component characters might act as deterrent for the formulation of a comprehensive selection programme involving these traits. During selection programme, these factors might be considered with a caution. Study of inter relationships of the yield components among themselves besides their correlation with yield itself would be more revealing and useful as correlation between any two characters is influenced by other inter related characters.

Table.1 Genotypic correlation coefficients for yield and yield contributing traits in maize inbred lines

	DT	DS	PH	EW	FLL	FLW	CWGT	CLTH	KR	NK	HSWT	SPY
DT	1.000	0.888**	0.594*	0.432	0.358	-0.192	0.257	0.533*	0.230	0.614*	0.308	0.058
DS		1.000	0.642**	0.520*	0.426	-0.214	0.355	0.525*	0.317	0.699*	0.413	0.177
PH			1.000	0.607*	0.628*	-0.217	0.316	0.626*	0.427	0.492	-0.199	0.094
EW				1.000	0.239	-0.008	0.283	0.419	0.180	0.647*	-0.361	0.537*
FLL					1.000	-0.318	0.466	0.667**	0.685*	0.324	0.109	0.269
FLW						1.000	-0.428	-0.717	-0.307	-0.291	-0.262	0.070
CWGT							1.000	0.721**	0.261	0.591*	0.032	0.502*
CLTH								1.000	0.639*	0.607*	0.143	0.763**
KR									1.000	0.276	0.115	0.310
NK										1.000	-0.065	0.240
HSWT											1.000	-0.008
SPY												1.000

*Significant at 0.05% level of probability ** Significance at 0.01% level of probability

DT: Days to tasselling
DS: Days to silking
PH: Plant height (cm)
EW: Ear weight (g)
FLL: Flag leaf length (cm)
FLW: Flag leaf width (cm)
CWGT: Cob weight (g)
CLTH: Cob length (g)
KR: Number of kernel per ear
NK: Number of kernals per row
HSWT: 100 seed weight (g)
SPY: Single plant yield (g)

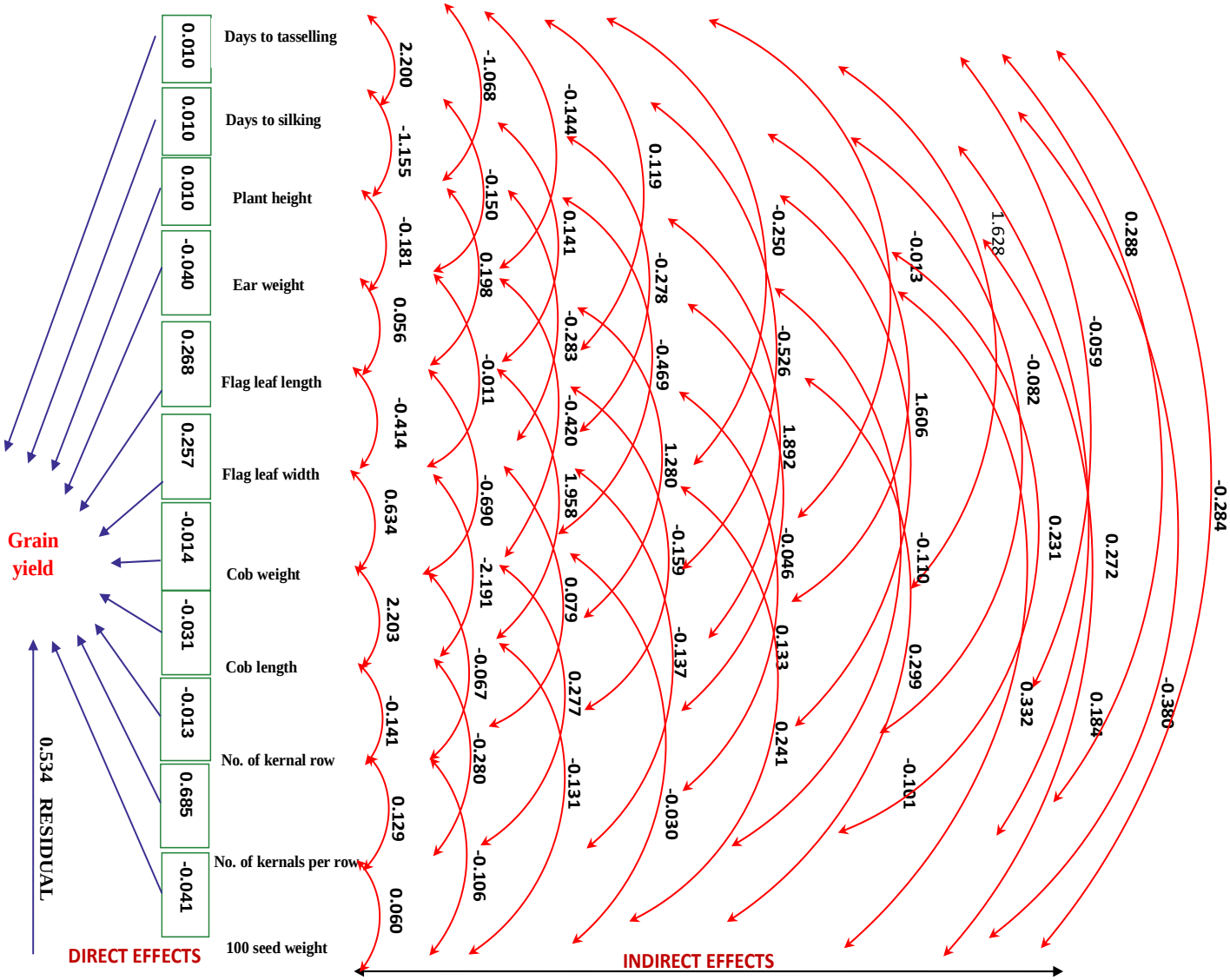
Table.2 Direct (Diagonal) and indirect effects for yield and yield contributing traits in maize inbred lines

	DT	DS	PH	EW	FLL	FLW	CWGT	CLTH	KR	NK	HSWT	SPY
DT	**-1.990**	2.200	-1.068	-0.144	0.119	-0.250	-0.381	1.628	-0.059	0.288	-0.284	0.058
DS	-1.767	**2.477**	-1.155	-0.150	0.141	-0.278	-0.526	1.606	-0.082	0.272	-0.380	0.158
PH	-1.181	1.591	**-1.799**	-0.181	0.198	-0.283	-0.469	1.892	-0.110	0.231	0.184	0.072
EW	-0.859	1.115	-0.975	**-0.334**	0.056	-0.011	-0.420	1.280	-0.046	0.299	0.332	0.737**
FLL	-0.713	1.055	-1.076	-0.057	**0.331**	-0.414	-0.690	1.958	-0.159	0.133	-0.101	0.269
FLW	0.382	-0.529	0.391	0.003	-0.105	**1.302**	0.634	-2.191	0.079	-0.137	0.241	0.070
CWGT	-0.512	0.879	-0.569	-0.095	0.154	-0.557	**-1.482**	2.203	-0.067	0.277	-0.030	0.502*
CLTH	-1.060	1.301	-1.114	-0.140	0.212	-0.933	-1.068	**3.056**	-0.141	0.280	-0.131	0.563*
KR	-0.457	0.786	-0.768	-0.060	0.204	-0.399	-0.386	1.670	**-0.258**	0.129	-0.106	0.555*
NK	-1.221	1.435	-0.885	-0.212	0.094	-0.379	-0.875	1.825	-0.071	**0.470**	0.060	0.240
HSWT	-0.613	1.023	0.359	0.120	0.036	-0.342	-0.048	0.437	-0.030	-0.031	**-0.920**	-0.008

Residual effect = 0.534

DT: Days to tasselling
DS: Days to silking
PH: Plant height
EW: Ear weight
FLL: Flag leaf length
FLW: Flag leaf width
CWGT: Cob weight
CLTH: Cob length
KR: Number of kernel per ear
NK: Number of kernals per row
HSWT: 100 seed weight
SPY: Single plant yield

Fig. 1. PATH DIAGRAM



Days to tasseling had positive highly significant intercorrelation with days to silking (0.888), number of kernels per row, plant height (0.594) and cob length (0.533). Days to silking had positive significant inter correlation with number of kernals per row (0.699), plant height (0.642), cob length (0.525) and ear weight (0.520). Plant height recorded significant positive inter correlation with flag leaf length (0.628) cob length (0.626) and ear weight (0.607). Ear weight recorded positive significant inter correlation with number of kernals per row (0.647). Flag leaf length showed positive significant inter correlation with kernel rows per ear (0.685) and cob length (0.667). Cob weight exhibited significant positive inter correlation with cob length (0.721) and number of kernals per row (0.591). Cob length recorded significant positive inter correlation with kernel rows per ear (0.639) and number of kernals per row (0.607). Similar results were reported by Praveen *et al.,* (2014).

The correlation coefficient which measures the association between any two characters may not necessarily be the proof of a direct casual relationship as it doesn't indicate about the contribution of the variation in one character in relation to variation observed in the other. Correlation coefficients are helpful in determining the component of a complex trait like yield; they do not provide an exact picture of the relative importance of direct and indirect influence of each of the component characters towards yield. Path coefficient analysis furnishing the cause and effect of different yield components would provide better index for selection rather than correlation coefficients. Path coefficient analysis is a statistical tool developed by Wright (1921) which partitions the association into direct and indirect effects through other independent variables. Hence, the path coefficient analysis was undertaken to know the direct and indirect effects in maize. In this study, the phenotypic character association among the yield components revealed positive association of grain yield per plant with cob length, cob weight and ear weight, which is similar to the findings of Jawaharlal *et al.,* (2011), Raghu *et al.,* (2011), Zerei *et al.,* (2012) and Praveen *et al.,* 2014. Cob length (3.056) exhibited very high positive direct effect on single plant yield followed by days to silking (2.477) and flag leaf width (1.302) (Table 2). The characters *viz.,* number of kernals per row (0.470) and flag leaf length (0.331) showed high direct effects on grain yield. Thus these characters turned-out to be the major components of single plant yield and hence direct selection for these traits would be rewarding for yield improvement to reduce the undesirable effect of other component traits studied. Similar results of direct positive effect of 100-kernels weight on grain yield was reported by Muhammad Rafiq *et al.,* (2010), Ram Reddy *et al.,* (2012), Zarei *et al.,* (2012) and Praveen *et al.,* (2014) who found positive direct effect of 100-kernels weight on grain yield.

Regarding the indirect effects, days to silking recorded very high positive indirect effect on single plant yield through days to tasseling (2.200), plant height (1.591), ear weight (1.115), flag leaf length (1.055), cob length (1.301), number of kernals per row (1.435) and 100 seed weight (1.023), while number of kernel rows (0.786) exhibited high indirect effect. Plant height recorded high indirect effect through flag leaf width (0.391) and 100 seed weight (0.359). Flag leaf length recorded moderate indirect effect through cob length (0.212) and number of kernel rows (0.204). Cob length showed very high indirect effects on yield through cob weight (2.203), flag leaf length (1.958), plant height (1.892), number of kernels per row (1.825), number of kernels rows (1.670), days to tasseling (1.628), days to silking (1.606) and ear weight (1.280) and 100 seed weight (0.437). 100 seed weight

showed high positive direct effect through ear weight (0.332).

From the above results it is inferred that, the characters *viz.*, cob length, ear width, number of kernals per row and number of kernals per ear will be targeted for selection process to increase the sweet corn yield.

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