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Multivariate analysis to ravel out the trait association for green cob weight and its component characters in sweet corn (*Zea mays* var. *saccharata*. L.)

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Abstract
Thirty single cross hybrids of shrunken sweet corn synthesized using six lines and five testers by Line × Tester mating design were evaluated for ten biometrical traits and four quality traits. Correlation analysis concluded that plant height, cob placement height, cob girth, cob length, number of kernels per row and number of kernel rows had the highest positive and significant relationship with green cob weight. Path analysis concluded that number of kernels per row followed by cob length and cob placement height exhibited a high positive direct effect on green cob weight. Therefore, formulating a breeding strategy by emphasizing the above traits during selection can be rewarding in enhancing green cob weight in sweet corn. The quality attributes of sweet corn *viz*, total soluble solids, total sugars, reducing sugars and non-reducing sugars had a non-significant association with green cob weight. Thus, there is no interdependency between green cob weight and quality traits and both these traits could be improved simultaneously without genetic drag.

Keywords: Association studies, genotypic correlation, path analysis and sweet corn

1. Introduction

Sweet corn (*Zea mays* var. *saccharata*) is the result of genetic mutations in maize which leads to the accumulation of high sugar and less starch (Mousavi *et al*., 2023) [8]. The four most important mutants that enhances the sugar are sugary (*su*), sugary enhanced (*se*), super sweet or shrunken (*sh2*) and brittle (*BT*) mutants (Lertrat and Pulam, 2007) [7]. Super sweet varieties with recessive *sh2* mutation contain four time's higher sugar (24%) and no water-soluble polysaccharide, making conversion of sugar to starch almost negligible. These corns remain sweet at least for 10 days after harvest if kept refrigerated and ideal for sale at distant market.

Yield is a polygenic trait with the complex nature of inheritance and its direct selection is mostly deceptive in virtue of high environmental effects. Hence, a breeding programme geared towards yield enhancement mainly exercises selection focusing the simply inherited and less complex yield component traits directly correlated with yield. Promptly, it challenges the necessity of extensive knowledge on the nature and strength of association existing between yield and its component traits. Such understanding to the above aspect could be accomplished by association analysis.

Statistically, Correlation studies assist the plant breeders in finding out the association between various plant characters and to choose the relevant selection criteria. In general, the association between the traits may be contributed by phenotype or genotype. But the genotypic correlation is the result of linkage and pleiotropy and it determines the extent to which the traits are fluctuating together at the genetic level. To hasten the selection progress, correlation analysis broadens the scope of indirect selection and multiple trait selection of the correlated trait in yield improvement programme. Furthermore, the simple correlation alone may lead to misconception, because the magnitude of strong correlation between the two characters considered might be influenced by the third character. Therefore, it extends the need for path analysis. Path coefficient is a regression coefficient which discloses whether the association of an independent trait with the dependent trait is specifically because of its direct effect or it is the consequence of indirect effects through other traits under study. With this backdrop, the association of green cob weight in sweet corn with various other plant traits was studied.

2. Materials and Methods

The present study was carried out during 2019-2020 at the experimental fields of Department of Millets, Centre for Plant Breeding and Genetics (CPBG), Tamil Nadu Agricultural University (TNAU), Coimbatore which is situated at 11° 07' 3.36" N Latitude and 76° 59' 39.91" E Longitude.

Six lines *viz.*, SC 11-07, SC 11-2, SC 1421-5-2-1, WNC 12069-2, WNC 12039-1 and USC 1-2-3-1 were crossed with five testers *viz.*, MRCSC 11, WNDMRSCY 19R763, DMSC 20, 951-7 and DMSC 36 in Line × Tester mating design during *Kharif* 2019. The resultant thirty hybrids along with their parents and standard check hybrid (Misthi) were evaluated during *Rabi* 2019-2020 with two replications. In the evaluation plot, all the entries were raised in two rows with recommended spacing of 60 x 25 cm. To maintain a healthy crop stand, appropriate agronomic and plant protection measures were followed.

Observations were recorded on ten quantitative traits *viz.*, days to 50% tasseling, days to 50% silking, anthesis silking interval, plant height (cm), cob placement height (cm), cob girth (cm), cob length (cm), number of kernels per row, number of kernel rows per cob and green cob weight (g) and four quality traits *viz.*, Total soluble solids (TSS-% brix) using hand refractometer, Total sugar (%) (Yemm and Willis (1954)) [17], Reducing sugar (%) (Somogyi (1952)), Non-reducing sugar (%) by deducing reducing sugar from total sugar.

Statistical analysis: The data were analyzed using TNAUSTAT-statistical package (2014)

- Genotypic correlation coefficients (r_g)-Johnson *et al.* (1955) [5].
- Path coefficient analysis-Dewey and Lu (1959) [3].

3. Results and discussion

Analysis of variance revealed significant variations among the test genotypes for all the fourteen agronomical and quality traits (Table 1). Genotypic correlation coefficients provide the information on nature and extent to which various morpho-agronomical traits are genetically associated with each other and also with the green cob weight. The estimated genotypic correlation coefficients uphold the degree of association among the agronomic and quality traits studied (Table 2).

3.1 Correlation between green cob weight and other traits

Green cob weight had the highest positive and significant relationship with plant height (0.745), cob placement height (0.664), cob girth (0.445), cob length (0.855), number of kernels per row (0.892) and number of kernel rows (0.740). Concluding on the basis of magnitude of correlation coefficients, green cob weight recorded a highly significant and strong positive relationship with the number of kernels per row followed by cob length. These findings were in line with those of various researchers in sweet corn who also reported a positive association of yield with the number of kernels per row and cob length (Suhaisini *et al.*, 2016; Chinthiya *et al.*, 2019; Praveena *et al.*, 2022) [24, 1, 11]. The highly significant and moderately favorable association was registered by plant height, kernel rows and cob placement height over green cob weight. Taller plants with a higher source to sink ratio i.e., more photosynthetic leaves could positively influence the cob weight. Such strong association was reported in sweetcorn by Sadaiah *et al.* (2013) [12] and Niji *et al.* (2018) [9] for the number of kernel rows and plant height, Sadaiah *et al.* (2013) [12] and Niji *et al.* (2018a) [9] for cob placement height and Chinthiya *et al.* (2019) [1] for plant height over yield. Green cob weight can be improved by emphasizing the positively associated traits during selection. The trait, cob girth registered a highly significant positive association with green cob weight. But, the degree of association was lower. Earlier positive association of green cob weight with cob girth was reported in sweet corn by Sadaiah *et al.* (2013) [12] and Xavier *et al.* (2019) [16].

Negative and significant association of green cob weight was detected with days to 50% tasseling (-0.414) and days to 50% silking (-0.359). This pointed out that simultaneous selection for the early flowering and increased cob weight could result in genotypes with increased cob weight and earliness. Such a negative significant correlation with green cob weight could be substantiated with the reports of Sadaiah *et al.* (2013) [12] in sweet corn. Anthesis silking interval recorded a negligible non-significant association with single plant green cob weight.

All the quality traits evaluated *viz.*, total sugar (0.183), reducing sugar (0.178), non-reducing sugar (0.152) and total soluble solids (0.189) were positively and non-significantly associated with green cob weight. Thus, there is no interdependency between green cob weight and quality traits and both these traits could be improved simultaneously without genetic drag. The development of sweet corn genotypes with improved sugar percentage and cob weight is feasible. The observed results of such non-significant association of green cob weight with quality traits corrobarates with the findings of Khanduri *et al.* (2010) [6] and Sadaiah *et al.* (2013) [12] for kernel sugars and total sugars, Suhaisini *et al.* (2016) [24] and Niji *et al.* (2018a) [9] for total sugars and Suzukawa *et al.* (2018) [15] for TSS in sweet corn.

3.2 Interrelationship among different traits

Days to 50% tasseling and days to 50% silking showed a positive significant association among themselves. This was in accordance with the results of Suhaisini *et al.* (2016) [24] and Niji *et al.* (2018a) [9] in sweet corn. Both of these traits were negatively correlated with cob girth and number of kernels per row. Also, days to 50% tasseling was negatively associated with plant height and cob length. In such a case, when a late flowering is coupled with a short grain filling period, most of the stored assimilates are directed towards vegetative growth and thereby exerting a negative impact on cob features *viz.*, cob length, cob girth and number of kernels per row. Such negative association was also reported in sweet corn by Sadaiah *et al.* (2013) [12].

A significant positive association of plant height was recorded with other traits *viz.*, cob placement height, cob girth, cob length, number of kernel per row and number of kernel rows. This revealed that the taller the plants with more photosynthates, the higher the cob weight since, most of the cob characters were associated with plant height in a favorable direction. These results agreed with the findings of Sadaiah *et al.* (2013) [12] and Chinthiya *et al.* (2019) [1] for the association of cob length and number of kernels per row with plant height in sweet corn.

The entire ear attributes *viz.*, cob girth, cob length, number of kernels per row and number of rows of the kernel was interdependent with the positive association among themselves and also with green cob weight. This indicated that an increase in cob length and cob girth will simultaneously result in more kernel numbers per row and could accommodate more kernel rows and they together had a positive influence on cob weight. These positive associations were similar to the results of Dagla *et al.* (2015) [1] and Chinthiya *et al.* (2019) [1] in sweet corn.

A significant and positive association of TSS was recorded with other biochemical traits *viz.*, total sugars, reducing sugars and non-reducing sugars. Furthermore, reducing and non-reducing sugars had a significant positive relationship with total sugars. It signified that a rise in reducing and non-reducing sugar content in sweet corn kernels will overall increase the total sugars in kernels. Similar findings of significant association of total sugars with non-reducing and TSS were reported in sweet corn by Suhaisini *et al.* (2016) [24] and Chinthiya *et al.* (2019) [1].

3.3 Path analysis

Correlation coefficients between two characters might be possibly due to the influence of some other character which is not under consideration in some instances. The cause and effect relationship of various independent traits on the dependent trait (green cob weight) was established by partitioning the genotypic correlation coefficients into their direct and indirect effects (Table 3). Therefore, a path coefficient obtained confides the actual contribution of the respective independent trait on the dependent trait. It is also helpful in formulating selection indices for genetic yield enhancement.

Outcomes of path analysis pointed out that the residual effect was low and it confirmed that the fourteen observed traits were appropriate and explained the variation in green cob weight. The trait, number of kernels per row (1.015) recorded a very high positive direct effect towards green cob weight. In addition, it indirectly contributed to cob weight through plant height, cob placement height, cob girth, cob length and number of kernel rows. Cob length also indirectly contributed to cob weight *via* number of kernels per row which pointed out that a lengthier green cob can accommodate more kernels and ultimately increase the cob weight.

The traits *viz.*, cob length (0.725) and cob placement height (0.337) exhibited a high positive direct effect. Zarei *et al.* (2012) [18] reported similar direct effect of cob length on cob weight in maize. Similarly, as that of number of kernels per row, cob length exerted high indirect positive effect on green cob weight via. plant height, cob placement height, cob girth, number of kernel rows and number of kernels per row. Total sugars (0.293) and number of kernel rows (0.118) were with moderate to low direct effect. Cob girth (0.081) and reducing sugars (0.014) had a negligible positive direct effect on the dependent trait. Similar results of low direct effect by number of kernel rows on cob weight were noticed by Ilker (2011) [4] in sweet corn.

A high direct negative effect was observed for plant height (-0.896) followed by non-reducing sugars (-0.419). The low direct negative effect was recorded by anthesis silking interval (-0.154) and total soluble solids (-0.107). Characters like days to 50% tasseling (-0.080) and days to 50% silking (-0.034) reported a negligible negative direct effect on green cob weight. The highest direct effect of plant height on green cob weight in an unfavorable direction was influenced by the indirect effects of number of kernels per row and cob length. As a result, plant height positively influences cob weight. This stated that direct selection for plant height might not be rewarding in the high yielding breeding programme. Comparable results of the negative direct effect of plant height on yield in maize were observed by Prasad and Shivani (2017) [10].

Table 1: Analysis of variances for quantitative and quality traits in sweet corn

Characters	Sources of Variation				
	Genotypes	Hybrids	Parents	Parents vs. Hybrids	Error
Days to 50% Tasseling	12.914**	4.5724**	26.5818**	118.1428**	0.8201
Days to 50% Silking	13.4598**	5.6529**	29.4818**	79.6387**	0.5122
Anthesis Silking Interval (ASI)	2.0598**	1.8736**	2.4273**	3.7842**	0.5049
Plant height	958.5606**	218.7384**	596.9647**	26029.365**	64.7952
Cob placement height	303.6699**	126.7245**	191.0952**	6560.834**	18.8939
Cob girth	3.6222**	1.5502**	7.5118**	24.8133**	0.3919
Cob length	8.3049**	4.4389**	2.6928*	176.5409**	1.4138
Number of kernels per row	102.9031**	15.7108**	27.7250**	3383.2604**	3.1216
Number of kernel rows per cob	6.6152**	4.4736**	5.3273**	81.6307**	0.3299
Total sugars	3.1525**	2.9363**	3.6113**	4.8336**	0.4237
Reducing sugar	0.1556**	0.0898**	0.3536**	0.0824*	0.0198
Non reducing sugar	2.9240**	2.6186**	3.7380**	3.6436**	0.4669
Total soluble solids	2.2074**	1.4297**	3.9953**	6.8823**	0.3256
Green cob weight	1841.7348**	628.0483**	342.6371**	52029.6192**	74.5225
Green cob yield	16.6077**	11.5133**	2.3808**	306.6146**	0.2108

*Significant at 0.05 level, **Significant at 0.01 level.

Table 2: Genotypic correlation coefficient values for various biometrical and quality attributes in sweet corn

Traits	D50%T	D50%S	ASI	PH	CPH	CG	CL	NKPR	NKR	TS	RS	NRS	TSS	GCW
D50%T	1	0.931**	-0.120	-0.333*	-0.178	-0.395**	-0.322*	-0.425**	-0.172	-0.178	0.122	-0.217	-0.123	-0.414**
D50% S		1	0.252	-0.244	-0.097	-0.358*	-0.230	-0.329*	-0.058	-0.202	0.197	-0.260	-0.148	-0.359*
ASI			1	0.217	0.206	0.075	0.227	0.230	0.298	-0.076	0.213	-0.131	-0.078	0.123
PH				1	0.866**	0.355*	0.739**	0.907**	0.609**	0.032	0.034	0.025	0.073	0.745**
CPH					1	0.250	0.576**	0.809**	0.600**	0.068	-0.044	0.082	0.153	0.664**
CG						1	0.480**	0.389*	0.455**	-0.124	-0.086	-0.111	-0.269	0.445**
CL							1	0.754**	0.740**	0.272	0.166	0.248	0.171	0.855**

NKPR								1	0.694**	0.143	0.143	0.118	0.204	0.892**
NKR									1	-0.029	0.136	-0.063	-0.072	0.740**
TS										1	0.347*	0.975**	0.837**	0.183
RS											1	0.131	0.414**	0.178
NRS												1	0.787**	0.152
TSS													1	0.189
GCW/P														1

*Significant at 5% level, ** Significant at 1% level.
D50%T-Days to 50% tasseling, D50%S-Days to 50% silking, ASI-Anthesis Silking Interval, PH-Plant height, CPH-Cob placement height, CG-Cob girth, CL-Cob length, NKPR-Number of kernels per row, NKR-Number of kernel rows, TS-Total sugar, RS-Reducing sugar, NRS-Non- reducing sugar, TSS-Total soluble solids, GCW-Green cob weight.

Table 3: Genotypic path coefficient analyses for various biometrical and quality attributes in sweet corn

Traits	D50%T	D50%S	ASI	PH	CPH	CG	CL	NKPR	NKR	TS	RS	NRS	TSS	Correlation coefficient for GCW
D50% T	-0.080	-0.032	0.018	0.298	-0.060	0.032	-0.233	-0.431	0.020	-0.052	0.002	0.091	0.013	-0.414
D50% S	-0.075	-0.034	-0.039	0.219	-0.033	0.029	-0.167	-0.334	0.007	-0.059	0.003	0.109	0.016	-0.359
ASI	0.010	-0.009	-0.154	-0.194	0.069	-0.006	0.164	0.234	-0.035	-0.022	0.003	0.055	0.008	0.123
PH	0.027	0.008	-0.033	-0.896	0.292	-0.029	0.536	0.921	-0.072	0.009	0.001	-0.011	-0.008	0.745
CPH	0.014	0.003	-0.032	-0.776	0.337	-0.020	0.418	0.822	-0.071	0.020	-0.001	-0.034	-0.016	0.664
CG	0.032	0.012	-0.012	-0.318	0.084	-0.081	0.348	0.395	-0.054	-0.036	-0.001	0.046	0.029	0.445
CL	0.026	0.008	-0.035	-0.662	0.194	-0.039	0.725	0.766	-0.087	0.080	0.002	-0.104	-0.018	0.855
NKPR	0.034	0.011	-0.035	-0.812	0.273	-0.032	0.547	1.015	-0.082	0.042	0.002	-0.049	-0.022	0.892
NKR	0.014	0.002	-0.086	-0.545	0.202	-0.084	0.467	0.705	0.118	-0.088	0.002	0.026	0.008	0.740
TS	0.014	0.007	0.012	-0.028	0.023	0.010	0.197	0.145	0.003	0.293	0.005	-0.408	-0.089	0.183
RS	-0.010	-0.007	-0.033	-0.030	-0.015	0.007	0.121	0.145	-0.016	0.102	0.014	-0.055	-0.044	0.178
NRS	0.017	0.009	0.020	-0.023	0.028	0.009	0.180	0.119	0.007	0.286	0.002	-0.419	-0.084	0.152
TSS	0.010	0.005	0.012	-0.065	0.052	0.022	0.124	0.207	0.009	0.245	0.006	-0.330	-0.107	0.189

D50% T-Days to 50% Tasseling, D50% S-Days to 50% Silking, ASI-Anthesis Silking Interval, PH-Plant height, CPH-Cob placement height, CG-Cob girth, CL-Cob length, NKPR-Number of kernels per row, NKR-Number of kernel rows, TS-Total sugar, RS-Reducing sugar, NRS-Non-reducing sugar, TSS-Total soluble solids, GCW-Green cob weight.
Residual effect: 0.2077.

4. Conclusion

Information emanated from the above outcome emphasized that for an effective yield enhancement programme using the present material, more attention should be given to number of kernels per row and cob length for the selection of genotypes for high green cob yield. While selecting the genotypes with lengthier cob, it eventually increases the number of kernels to be accommodated in a row and in turn both the traits positively contribute to green cob weight.

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6. References

1. Chinthiya A, Ganesan KN, Ravikesavan R, Senthil N. Combining ability and association studies on different yield contributing traits for enhanced green cob yield in sweet corn (*Zea mays* Var *saccharata*). Electronic Journal of Plant Breeding. 2019;10(2):500-511.
2. Dagla MC, Gadag RN, Kumar OSN. Genetic variability and correlation among yield and quality traits in sweet corn. Electronic Journal of Plant Breeding. 2015;6(2):500-505.
3. Dewey DR, Lu K. A correlation and path-coefficient analysis of components of crested wheatgrass seed production 1. Agronomy Journal. 1959;51(9):515-518.
4. Ilker E. Correlation and path coefficient analyses in sweet corn. Turkish Journal of Field Crops. 2011;16(2):105-107.
5. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybeans. Agronomy Journal. 1955;47(7):314-318.
6. Khanduri A, Prasanna BM, Hossain F, Lakhera PC. Genetic analyses and association studies of yield components and kernel sugar concentration in sweet corn. Indian Journal of Genetics and Plant Breeding. 2010;70(03):257-263.
7. Lertrat K, Pulam T. Breeding for increased sweetness in sweet corn. International Journal of Plant Breeding. 2007;1(1):27-30.
8. Mousavi SMN, Illés A, Szabó A, Shojaei SH, Demeter C, Bakos Z, *et al*. Stability yield indices on different sweet corn hybrids based on AMMI analysis. Brazilian Journal of Biology. 2023;84:e270-680.
9. Niji MS. Genetic variability, heritability and character association studies in sweet corn (*Zea mays* L. *saccharata*). Electronic Journal of Plant Breeding. 2018;9(3):1038-1044.
10. Prasad BVVV, Shivani D. Correlation and path analysis in maize (*Zea mays* L.). Journal of Genetics, Genomics and Plant Breeding. 2017;1(2):1-7.
11. Praveena MV, Talekar SC, Kachapur RM. Studies on correlation and path co-efficient analysis of single cross hybrids in sweet corn. International Journal of Plant Science. 2022;17(2):173-179.
12. Sadaiah K, Reddy VN, Kumar SS. Heterosis and combining ability studies for sugar content in sweet corn (*Zea mays saccharata* L.). IJSRP. 2013;3(3):1-5.
13. Somogyi M. Notes on sugar determination. Journal of biological chemistry. 1952;195:19-23.
14. Suhaisini B, Ravikesavan Rm Yuvaraja A. Genetic variability and correlation among yield and yield contributing traits in sweet corn. Madras Agricultural

Journal. 2016;103(10-12):293-296.
15. Suzukawa AK, Pereira CB, Garcia MM, Contreras-Soto RI, Zeffa DM, Coan MMD, *et al*. Diallel analysis of tropical and temperate sweet and super sweet corn inbred lines. Revista Ciência Agronômica. 2018;49:607-615.
16. Xavier LFS, Pestana JK, Sekiya A, Krause MD, Moreira RMP, Ferreira JM. Partial diallel and potential of super sweet corn inbred lines *bt2* to obtain hybrids. Horticultura Brasileira. 2019;37:278-284.
17. Yemm EW, Willis A. The estimation of carbohydrates in plant extracts by anthrone. Biochemical journal. 1954;57(3):508.
18. Zarei B, Kahrizi D, Aboughadareh AP, Sadeghi F. Correlation and path coefficient analysis for determining interrelationships among grain yield and related characters in corn hybrids (*Zea mays* L.). International Journal of Agriculture and Crop Sciences. 2012;4(20):1519-1522.