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Trait interactions and yield determinants in maize: A correlation and path analysis approach under varying water conditions

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Abstract

This study aimed to evaluate the genotypic correlations and path coefficients of yield-contributing traits in maize under drought and normal conditions. Seventeen genotypes were assessed for 15 characters, with grain yield per plant being the primary dependent variable. Correlation analysis revealed significant positive associations between grain yield and traits such as cob weight, 100 kernel weight, cob width and kernel rows per cob under both the conditions, with stronger correlations observed in drought. Path analysis highlighted key traits with high positive direct effects on grain yield, including cob weight and 100 kernel weight under both conditions. Days to 50 per cent tasselling exhibited a positive effect in drought, while days to 50 per cent silking was more impactful in normal conditions. The study underscores the importance of trait selection in breeding programs, with cob weight, kernel rows and kernel weight emerging as vital targets for enhancing yield under water-limited conditions. These findings provide valuable insights for maize improvement strategies focused on increasing yield stability in varying environments.

Keywords: Correlation, path analysis, drought, normal, yield components

Introduction

Maize (*Zea mays* L.), a staple food and fodder crop, is cultivated extensively across the globe due to its versatility and adaptability to diverse agro-climatic conditions. In India, maize plays a pivotal role in agricultural economies, being grown primarily in states such as Karnataka, Madhya Pradesh, Maharashtra and Uttar Pradesh. Despite its widespread cultivation, maize yields in regions prone to drought stress often fall short of their potential. To enhance productivity, it is imperative to identify high-yielding genotypes, particularly those that can withstand adverse conditions like drought. The relationship between yield and its component traits must be well-understood to create effective selection strategies aimed at improving genotypes. The identification of yield-contributing characters that exhibit strong positive correlations with grain yield and direct or indirect effects on yield is crucial for devising an effective crop improvement program. Correlation and path coefficient analysis are powerful tools for this purpose. While correlation analysis provides insights into the interrelationships among traits, path analysis distinguishes between direct and indirect effects of yield-contributing characters.

Given the significance of such studies in maize improvement, the present research focuses on evaluating the genotypic performance of maize hybrids under managed drought and normal conditions. The goal is to identify traits that significantly influence yield, thereby aiding in the selection of promising hybrids suited for both normal and drought-prone environments. The findings of study will contribute to valuable insights into improving maize productivity through genetic selection.

Materials and Methods

The present study was conducted to assess the correlation and path coefficient analysis of various yield-contributing characters in maize. A total of 17 maize genotypes were used as the experimental material for this research. These genotypes were sourced from the Maize Improvement Project, Kasba Bawda, Kolhapur, Maharashtra. The field experiment was carried out during the *rabi* of 2023 at the research farm of the Maize Improvement Project, Kolhapur. The experimental layout followed a randomized block design (RBD) with three replications to ensure the accuracy of the results. Each plot consisted of standard spacing and agronomic practices were followed uniformly to raise a healthy crop.

To evaluate the relationship among various traits, the genotypic correlation coefficients were computed following the method described by Singh and Chaudhary (1977) [30]. The correlation analysis aimed to identify the characters that have a significant relationship with grain yield and their contributions to yield improvement. Furthermore, path coefficient analysis was performed according to the procedure suggested by Dewey and Lu (1959) [13] to differentiate the direct effects of traits on yield from their indirect effects via other characters. This method allows for a better understanding of the cause-and-effect relationship between traits, helping to pinpoint traits that have the most significant influence on grain yield.

Results and Discussion

Understanding the relationship between yield and its component traits plays a crucial role in developing effective selection strategies to produce desirable genotypes. In maize breeding, yield improvement largely depends on identifying traits that contribute positively to grain yield. Evaluating the genotypic correlation between yield and associated traits helps in determining the strength and direction of these relationships. Tables 1 and 2 represent the genotypic correlation coefficients between grain yield and its contributing characters under drought and normal conditions, shedding light on the key traits influencing yield in varying environments.

While correlation analysis provides insights into the association between traits, it does not reveal the cause-and-effect relationship. Therefore, path coefficient analysis is used to partition the correlation coefficients into direct and indirect effects, offering a more precise understanding of how individual traits contribute to yield through both their own influence and their effects on other traits. The direct and indirect impacts of various characteristics on grain yield per plant are detailed in Tables 3 and 4. This analysis highlights the traits with the highest positive and negative effects on yield, offering valuable information for breeders in the selection process.

Correlation studies

Grain yield is influenced by genetic, environmental, and management factors, making it a complex trait. Understanding the interrelations among these factors is crucial for effective breeding and selection methods. A key focus is on genotypic correlations, which reveal true genetic associations between traits, often obscured by environmental effects that can mask phenotypic correlations. Genotypic correlations are more important than phenotypic ones for understanding the heritable variation of traits. Therefore, this discussion emphasizes genotypic correlations, supported by data in Table 1 (drought conditions) and Table 2 (standard conditions), which illustrate the interactions between grain yield and its components. These insights highlight the importance of considering both genetic and environmental factors in breeding decisions, enabling more effective strategies for yield enhancement.

Grain yield per plant showed a significant positive correlation with cob weight in both drought (1.070) and normal conditions (1.037), indicating that larger cobs enhance yield, especially under stress (Shinde *et al*., 2020; Edmeades *et al*., 2005; Sofi *et al*., 2021; Blum, 2011) [28, 6, 14, 32]. Cob width had a stronger correlation in drought (0.967) than in normal conditions (0.533), emphasizing its role in kernel development under water scarcity (Otegui & Bonhomme, 1998; Campos *et al*., 2004; Cairns *et al*., 2012; Setter *et al*., 2011) [23, 9, 10, 26]. The relationship between proline levels and grain yield was also more pronounced in drought (0.904) than in normal conditions (0.660), highlighting its importance for stress adaptation (Ashraf &Foolad, 2007; Ali *et al*., 2011; Blum, 2011; Blum, 2014) [3, 2, 6, 7].

The number of kernel rows per cob (0.886 vs. 0.330) and kernels per row (0.841 vs. 0.753) showed stronger correlations with yield in drought, underscoring the need to maintain kernel numbers for yield stability (Fischer, 2013; Setter *et al*., 2011; Monneveux*et al*., 2006; Campos *et al*., 2004) [10, 15, 22, 26]. Cob length also correlated more strongly in drought (0.824) than in normal conditions (0.701), highlighting its importance during water scarcity (Chen *et al*., 2016; Otegui & Bonhomme, 1998; Campos *et al*., 2004; Ribaut & Ragot, 2007) [10, 11, 25, 23]. Additionally, 100 kernel weight was significantly associated with yield, showing a stronger correlation in drought (0.811) compared to normal conditions (0.709), emphasizing resource allocation to fewer, heavier kernels during stress (Blum, 2011; Cairns *et al*., 2012; Setter *et al*., 2011; Bänziger *et al*., 2000) [9, 6, 26].

Plant height (0.568 vs. 0.466) and cob height (0.548 vs. 0.396) showed stronger correlations with grain yield under drought, indicating that taller plants have an advantage in light acquisition and productivity during stress (Ribaut & Ragot, 2007; Meena *et al*., 2020) [25, 21]. Days to 50 per cent tasselling (0.405 vs. 0.561) and silking (0.430 vs. 0.560) also correlated significantly across environments, emphasizing the need for early reproductive synchronization to reduce stress impacts (Bolaños & Edmeades, 1996; Campos *et al*., 2004) [8, 10]. Days to 75 per cent dry husk positively correlated with yield (0.452 vs. 0.605), highlighting the importance of timely maturation and prolonged grain filling during drought (Hammer *et al*., 2009) [17].

In contrast, protein content had a negative and insignificant correlation with yield in both drought (-0.088) and normal conditions (-0.213), reflecting the trade-off between yield and quality under stress (Monneveux *et al*., 2006) [22]. The number of cobs per plot showed a weak correlation with yield in drought (0.405) but a stronger one in normal conditions (0.782), suggesting that while cob quantity is crucial in favourable environments, yield in drought relies more on the development of individual cobs (Otegui and Bonhomme, 1998) [23].

The duration until 50 per cent tasselling showed a strong correlation with the timing of 50 per cent silking (1.003) and 75 per cent dry husk (0.920) under drought conditions, highlighting synchrony in maize development (Bolaños & Edmeades, 1996; Monneveux *et al*., 2006) [22, 8]. Under normal conditions, the correlation with 75 per cent dry husk was even stronger (1.050), emphasizing the importance of timely development in favourable environments (Blum, 2014; Campos *et al*., 2004) [7. 10].

Plant height correlated well with cob height (0.728) and cob width (0.335) in drought conditions, suggesting taller plants produce larger cobs, crucial for grain yield (Ali *et al*., 2011; Cairns *et al*., 2012) [2, 9]. In normal conditions, plant height had strong correlations with cob height (0.906) and the number of cobs per plot (0.808), indicating that taller plants may better allocate resources for reproduction (Hammer *et al*., 2009; Edmeades *et al*., 2005) [17, 14].

Cob weight correlated significantly with 100 kernel weight (0.893) in drought conditions, linking heavier cobs to larger kernels, an important trait for breeding (Setter *et al*., 2011; Sofi *et al*., 2021) [32, 26]. This relationship persisted under normal conditions (0.778), confirming cob weight as a reliable indicator of grain quality (Chen *et al*., 2016; Fischer, 2013) [11, 15].

Additionally, 100 kernel weight positively correlated with cob width (0.860) in drought conditions, suggesting larger cobs yield heavier kernels, essential for high-quality grains (Ribaut and Ragot, 2007; Shinde *et al*., 2020) [25, 28]. This association remained significant under normal conditions, highlighting its consistency across environments.

Proline concentrations showed a positive correlation with 100 kernel weight (0.385) under drought conditions, indicating its role in kernel development during stress (Ashraf and Foolad, 2007; Blum, 2011) [3, 6]. In non-stressed conditions, proline also correlated positively with 100 kernel weight (0.433), suggesting it enhances kernel growth regardless of environmental challenges (Ali *et al*., 2011; Meena *et al*., 2020) [2, 21].

Cob width had strong positive correlations with the number of kernel rows per cob (0.870) and the number of cobs per plot (0.667) under drought, indicating that broader cobs support more rows and yield (Setter *et al*., 2011; Blum, 2014) [26, 7]. In normal conditions, the correlation with kernel rows per cob (1.077) further underscores the importance of cob structure for reproductive success (Cairns *et al*., 2012; Campos *et al*., 2004) [9, 10].

In summary, these relationships highlight the importance of genetic linkages in maize breeding, aiding in the identification of selection criteria to enhance drought resilience and optimize crop quality.

Path analysis studies

Path analysis is a statistical technique that helps researchers understand variable relationships by breaking down the correlation coefficient into direct and indirect effects. This method is particularly valuable in agriculture, where complex traits like yield are influenced by multiple characteristics. In this study, we used the Dewey and Lu methodology, 1959 [13] to evaluate how various traits contribute to yield. Yield is influenced by both direct effects from certain traits and indirect effects mediated through others. Some traits directly affect yield, while others influence it indirectly through intermediary traits.

To fully understand these relationships, it is crucial to analyse both direct and indirect effects. Our path coefficient analysis results, shown in Table 3, detail the significance and magnitude of each trait's influence on yield. This analysis helps to identify key traits for breeding programs aimed at improving yield and enhancing agricultural practices.

In drought conditions, key traits positively affecting yield per plant include days to 50 per cent tasselling (1.691), cob weight (0.587) and 100 kernel weight (0.367). Early flowering is crucial for optimizing water use before severe moisture deficits, as highlighted by Bolaños and Edmeades (1996) [8]. Cob weight and 100 kernel weight are also significant for yield under stress (Campos *et al*., 2004; Cairns *et al*., 2012) [9, 10]. Proline content, an Osmo protectant, helps to maintain cell turgor and reduce oxidative damage (Ashraf and Foolad, 2007) [3]. Additionally, the number of kernels per row is vital for grain formation and yield during water scarcity (Setter *et al*., 2011) [26].

In contrast, traits such as days to 50 per cent tasselling (-1.614), cob length (-0.271), number of kernel rows per ear (-0.184), plant height (-0.109), cob width (-0.057) and protein content (-0.023) showed negative direct effects on yield per plant. The negative impact of kernel rows may stem from reduced assimilate supply during drought, leading to fewer kernels and lower yield, as noted by Monneveux *et al.* (2006) [22] and Bolaños and Edmeades (1996) [8]. Additionally, the negative effect of plant height suggests that greater height does not guarantee higher yields in stressful conditions, possibly due to increased water needs and lower uptake efficiency (Hammer *et al*., 2009) [17].

A residual effect of 0.353 indicates that other unmeasured traits likely influence yield in drought, such as deeper roots, better stomatal control, or more effective carbohydrate allocation (Blum, 2011; Ribaut & Ragot, 2007) [6, 25]. Exploring these traits could aid in developing drought-resistant maize varieties.

Under typical conditions, key traits positively affecting yield per plant included days to 50 per cent silking (1.297), cob weight (1.112), cob height (0.452), cob length (0.141), cob width (0.111), number of kernel rows per cob (0.090) and number of kernels per row (0.029). These traits highlight the importance of reproductive development and cob morphology in optimal environments (Campos *et al*., 2004) [10]. Cob weight, in particular, is a vital yield component in both normal and drought conditions (Chen *et al*., 2016; Meena *et al*., 2020) [11, 21], while cob length, width and kernel rows further emphasize the significance of cob architecture in yield enhancement (Otegui and Bonhomme, 1998) [23].

Conversely, traits such as days to 50 per centtasselling (-0.949), plant height (-0.565), proline content (-0.246), days to 75 per cent dry husk (-0.240), 100 kernel weight (-0.167) and number of cobs per plot (-0.010) showed negative direct effects on yield per plant. Notably, proline's adverse effect in optimal conditions contrasts with its beneficial role during drought, suggesting its stress-response function may not enhance yield in favourable conditions (Ashraf and Foolad, 2007) [7]. The negative impact of plant height may indicate that taller plants prioritize vegetative growth over reproductive success, which is crucial for yield (Fischer, 2013) [15].

The observed residual effect of 0.176 in normal conditions suggests that other traits, like photosynthetic efficiency or nutrient absorption, also significantly influence grain yield (Blum, 2014; Campos *et al*., 2004) [7, 10]. While, the examined traits provide valuable insights, further investigation into additional physiological and genetic factors could improve our understanding of yield determinants in non-stressed environments.

In drought conditions, the character days to 50 per cent silking exhibited the highest positive indirect effect on yield per plant through days to 50 per cent tasselling (1.606) and days to 75 per cent dry husk (1.564) (Kumar *et al*., 2021; Ali *et al*., 2020) [1]. Conversely, the highest negative indirect effect was attributed to days to 50 per cent tasselling via days to 50 per cent silking (-1.619) and days to 75 per cent dry husk (-1.484) (Gupta *et al*., 2019; Singh *et al*., 2018) [16, 29]. For the character plant height, it displayed negative indirect effects on yield through all traits studied, with the highest negative effect being with cob height (-0.079) (Bhat *et al*., 2020; Das *et al*., 2019) [1]. In normal conditions, cob height showed a significant positive indirect effect on yield via plant height (0.409), while the most substantial negative indirect effect came from days to 50 per cent silking (-0.949) (Sharma *et al*., 2021; Kumar and Gupta, 2019) [16].

Cob width imparted a positive indirect effect on yield per plant through protein (0.100) under drought conditions, with the highest negative indirect effect attributed to cob weight (-0.052) (Ali *et al*., 2020; Pandey *et al*., 2018) [1, 24]. In normal conditions, cob width exhibited positive indirect effects through the number of kernel rows per cob (0.120), with a notable negative effect from protein (-0.021) (Yadav *et al*., 2020; Singh *et al*., 2021) [33, 31]. The character number of kernel rows per cob revealed a high positive indirect effect via days to 75per cent dry husk (0.031) in drought, whereas, it had the most substantial negative indirect effect via 100 kernel weight (-0.193) (Gupta **et al**., 2019; Kumar *et al*., 2020) [16].

Under normal conditions, the number of cobs per plot exhibited a significant positive indirect effect through cob width (0.027), while the highest negative indirect effect was observed from protein (-0.014) (Kumar *et al*., 2021; Yadav *et al*., 2020) [33]. The results clearly demonstrate how the interactions of various traits with yield can differ significantly under drought and normal conditions, emphasizing the necessity for strategic trait selection in maize breeding programs aimed at enhancing drought resilience (Kumar *et al*., 2021; Ali *et al*., 2020; Gupta *et al*., 2019; Singh *et al*., 2018; Sharma *et al*., 2021) [16, 1, 29, 27].

Table 1: Genotypic correlation coefficients of fifteen characters in 17 genotypes of maize in drought condition

	DFT	**DFS**	**PH**	**CH**	**DDH**	**CL**	**CW**	**NCPP**	**NKRC**	**NKR**	**CWE**	**HKW**	**PL**	**PT**	**YPP**
DFT	1.0000	1.0029	0.3468	-0.1448	0.9196	-0.0821	0.0319	-0.048	-0.0757	-0.0397	0.3517	-0.1253	0.283	0.1836	0.4052
DFS		1.0000	0.3711	-0.1093	0.9246	-0.0613	0.0672	-0.0421	-0.0636	-0.0218	0.385	-0.1017	0.3161	0.1541	0.4304
PH			1.0000	0.7275	0.1442	0.1916	0.3354	0.2705	0.0451	0.3698	0.4766	0.2205	0.4862	0.0324	0.5679
CH				1.0000	-0.1534	0.305	0.6513	0.3861	0.2396	0.4157	0.4745	0.2955	0.5541	-0.2003	0.548
DDH					1.0000	-0.2209	-0.0267	-0.0988	-0.1695	-0.1757	0.3277	-0.2327	0.4456	0.1357	0.4521
CL						1.0000	0.8992	0.5171	1.0263	0.9917	0.888	1.0193	0.4254	-0.0254	0.8237
CW							1.0000	0.6672	0.8699	0.8824	0.9061	0.8600	0.7449	-0.175	0.9673
NCPP								1.0000	0.5139	0.5877	0.4063	0.6533	0.0042	-0.3361	0.4054
NKRC									1.0000	1.0109	0.9381	1.0504	0.4672	-0.0016	0.8863
NKR										1.0000	0.9102	1.0205	0.4332	-0.0338	0.8407
CWE											1.0000	0.8927	0.7786	-0.043	1.0697
HKW												1.0000	0.3846	-0.1211	0.8109
PL													1.0000	0.1388	0.904
PT														1.0000	-0.088
YPP															1.0000

DFT= Days to 50 per cent tasselling, DFS= Days to 50 per cent silking, PH= Plant height, CH= Cob height, DDH= Days to 75 per cent dry husk, CL= Cob length, CW= Cob width, NCPP= Number of cobs per plot, NKRC= Number of kernel rows per cob, NKR= Number of kernel per row, CWE= cob weight, HKW= 100 kernel weight, PL= Proline, PT= Protein and YPP= Yield per plant.

Table 2: Genotypic correlation coefficients of fifteen characters in 17 genotypes of maize in normal condition

	DFT	**DFS**	**PH**	**CH**	**DDH**	**CL**	**CW**	**NCPP**	**NKRC**	**NKR**	**CWE**	**HKW**	**PL**	**PT**	**YPP**
DFT	1.0000	0.9996	0.6279	0.3034	1.0503	0.4654	0.3717	0.4944	0.2648	0.4443	0.5893	0.4200	0.1287	-0.0118	0.5608
DFS		1.0000	0.6228	0.3123	1.0593	0.4585	0.3628	0.5000	0.2699	0.4387	0.5879	0.4243	0.1225	0.0079	0.5598
PH			1.0000	0.9057	0.653	0.6925	0.852	0.8079	0.6585	0.6505	0.4318	0.6054	0.397	-0.2477	0.4663
CH				1.0000	0.2739	0.2889	0.5815	0.4186	0.297	0.3285	0.4154	0.3215	0.3654	0.0679	0.3963
DDH					1.0000	0.4609	0.5469	0.5043	0.1053	0.5008	0.6159	0.5172	0.0672	0.0298	0.6051
CL						1.0000	0.6921	1.1258	0.747	0.9894	0.7921	0.9971	0.4314	-0.2026	0.7008
CW							1.0000	0.8938	1.0772	0.7212	0.6773	0.6698	0.7023	-0.1857	0.5335
NCPP								1.0000	0.7983	1.1313	0.8489	1.1241	0.4784	-0.1846	0.7818
NKRC									1.0000	0.7043	0.4277	0.7036	0.6622	-0.2363	0.3538
NKR										1.0000	0.8334	0.9994	0.476	-0.1922	0.7534
CWE											1.0000	0.7707	0.7143	-0.2292	1.037
HKW												1.0000	0.4326	-0.162	0.7089
PL													1.0000	-0.4409	0.6597
PT														1.0000	-0.2129
YPP															1.0000

DFT= Days to 50 per cent tasselling, DFS= Days to 50 per cent silking, PH= Plant height, CH= Cob height, DDH= Days to 75 per cent dry husk, CL= Cob length, CW= Cob width, NCPP= Number of cobs per plot, NKRC= Number of kernel rows per cob, NKR= Number of kernel per row, CWE= cob weight, HKW= 100 kernel weight, PL= Proline, PT= Protein and YPP= Yield per plant.

Table 3: Direct(diagonal) and indirect (above and below diagonal) effects of different characters towards yield per plant at genotypic level in maize in drought condition

	DFT	DFS	PH	CH	DDH	CL	CW	NCPP	NKRC	NKR	CWE	HKW	PL	PT
DFT	-1.6138	-1.6186	-0.5596	0.2336	-1.4841	0.1325	-0.0514	0.0775	0.1221	0.064	-0.5676	0.2022	-0.4567	-0.2963
DFS	1.6964	1.6914	0.6277	-0.1849	1.5639	-0.1038	0.1137	-0.0713	-0.1075	-0.0369	0.6513	-0.172	0.5347	0.2606
PH	-0.0377	-0.0404	-0.1088	-0.0791	-0.0157	-0.0208	-0.0365	-0.0294	-0.0049	-0.0402	-0.0518	-0.024	-0.0529	-0.0035
CH	-0.0075	-0.0057	0.0376	0.0517	-0.0079	0.0158	0.0337	0.02	0.0124	0.0215	0.0246	0.0153	0.0287	-0.0104
DDH	0.0967	0.0972	0.0152	-0.0161	0.1051	-0.0232	-0.0028	-0.0104	-0.0178	-0.0185	0.0344	-0.0245	0.0468	0.0143
CL	0.0222	0.0166	-0.0519	-0.0826	0.0598	-0.2709	-0.2436	-0.1401	-0.2781	-0.2687	-0.2406	-0.2762	-0.1153	0.0069
CW	-0.0018	-0.0038	-0.0192	-0.0373	0.0015	-0.0515	-0.0573	-0.0382	-0.0498	-0.0505	-0.0519	-0.0493	-0.0427	0.01
NCPP	-0.0019	-0.0017	0.0109	0.0156	-0.004	0.0209	0.027	0.0404	0.0208	0.0238	0.0164	0.0264	0.0002	-0.0136
NKRC	0.0139	0.0117	-0.0083	-0.0441	0.0312	-0.1889	-0.1601	-0.0946	-0.184	-0.186	-0.1727	-0.1933	-0.086	0.0003
NKR	-0.0111	-0.0061	0.1033	0.1161	-0.0491	0.2769	0.2464	0.1641	0.2823	0.2792	0.2542	0.285	0.121	-0.0094
CWE	0.2063	0.2259	0.2795	0.2783	0.1922	0.5209	0.5315	0.2383	0.5503	0.5339	0.5866	0.5236	0.4567	-0.0252
HKW	-0.046	-0.0373	0.081	0.1085	-0.0855	0.3743	0.3158	0.2399	0.3857	0.3748	0.3278	0.3672	0.1412	-0.0445
PL	0.0938	0.1048	0.1612	0.1837	0.1477	0.141	0.2469	0.0014	0.1549	0.1436	0.2581	0.1275	0.3315	0.046
PT	-0.0043	-0.0036	-0.0007	0.0046	-0.0031	0.0006	0.0041	0.0078	0.000	0.0008	0.001	0.0028	-0.0032	-0.0232
YPP	0.4052	0.4304	0.5679	0.548	0.4521	0.8237	0.9673	0.4054	0.8863	0.8407	1.0697	0.8109	0.904	-0.088

R = 0.353

DFT= Days to 50 per cent tasselling, DFS= Days to 50 per cent silking, PH= Plant height, CH= Cob height, DDH= Days to 75 per cent dry husk, CL= Cob length, CW= Cob width, NCPP= Number of cobs per plot, NKRC= Number of kernel rows per cob, NKR= Number of kernel per row, CWE= cob weight, HKW= 100 kernel weight, PL= Proline, PT= Protein and YPP= Yield per plant.

Table 4: Direct (diagonal) and indirect (above and below diagonal) effects of different characters towards yield per plant at genotypic level in maize in normal condition

	DFT	DFS	PH	CH	DDH	CL	CW	NCPP	NKRC	NKR	CWE	HKW	PL	PT
DFT	-0.9490	0.9486	0.5959	-0.2879	-0.9967	-0.4417	-0.3528	-0.4691	-0.2513	-0.4217	-0.5592	-0.3986	-0.1222	0.0112
DFS	1.2967	1.2973	0.8079	0.4051	1.3742	0.5948	0.4706	0.6486	0.3502	0.5691	0.7626	0.5504	0.159	0.0103
PH	-0.3548	-0.3519	-0.5651	-0.5118	-0.369	-0.3913	-0.4814	-0.4565	-0.3721	-0.3676	-0.244	-0.3421	-0.2243	0.14
CH	0.1371	0.1411	0.4092	0.4519	0.1238	0.1306	0.2628	0.1891	0.1342	0.1484	0.1877	0.1453	0.1651	0.0307
DDH	-0.2517	-0.2539	-0.1565	-0.0656	-0.2397	-0.1105	-0.1311	-0.1209	-0.0252	-0.12	-0.1476	-0.124	-0.0161	-0.0071
CL	0.0655	0.0645	0.0974	0.0407	0.0648	0.1407	0.0974	0.1584	0.1051	0.1392	0.1114	0.1403	0.0607	-0.0285
CW	0.0413	0.0403	0.0947	0.0646	0.0608	0.0769	0.1112	0.0994	0.1197	0.0802	0.0753	0.0745	0.0781	-0.0206
NCPP	-0.0051	-0.0051	-0.0083	-0.0043	-0.0052	-0.0116	-0.0092	-0.0103	-0.0082	-0.0116	-0.0087	-0.0116	-0.0049	0.0019
NKRC	0.0238	0.0242	0.0591	0.0267	0.0095	0.0671	0.0967	0.0717	0.0898	0.0632	0.0384	0.0632	0.0595	-0.0212
NKR	0.0127	0.0125	0.0185	0.0094	0.0143	0.0282	0.0205	0.0322	0.0201	0.0285	0.0237	0.0285	0.0136	-0.0055
CWE	0.6553	0.6538	0.4801	0.4619	0.6849	0.8808	0.7532	0.944	0.4757	0.9268	1.1121	0.8571	0.7944	-0.2549
HKW	-0.0702	-0.0709	-0.1012	-0.0537	-0.0865	-0.1667	-0.112	-0.1879	-0.1176	-0.1671	-0.1288	-0.1672	-0.0723	0.0271
PL	-0.0436	-0.0415	-0.1346	-0.1239	-0.0228	-0.1462	-0.2381	-0.1622	-0.2245	-0.1613	-0.2421	-0.1466	-0.339	0.1494
PT	0.0029	-0.0019	0.0608	-0.0167	-0.0073	0.0498	0.0456	0.0453	0.058	0.0472	0.0563	0.0398	0.1082	-0.2455
YPP	0.5608	0.5598	0.4663	0.3963	0.6051	0.7008	0.5335	0.7818	0.3538	0.7534	1.037	0.7089	0.6597	-0.212

DFT= Days to 50 per cent tasselling, DFS= Days to 50 per cent silking, PH= Plant height, CH= Cob height, DDH= Days to 75 per cent dry husk, CL= Cob length, CW= Cob width, NCPP= Number of cobs per plot, NKRC= Number of kernel rows per cob, NKR= Number of kernel per row, CWE= cob weight, HKW= 100 kernel weight, PL= Proline, PT= Protein and YPP= Yield per plant.

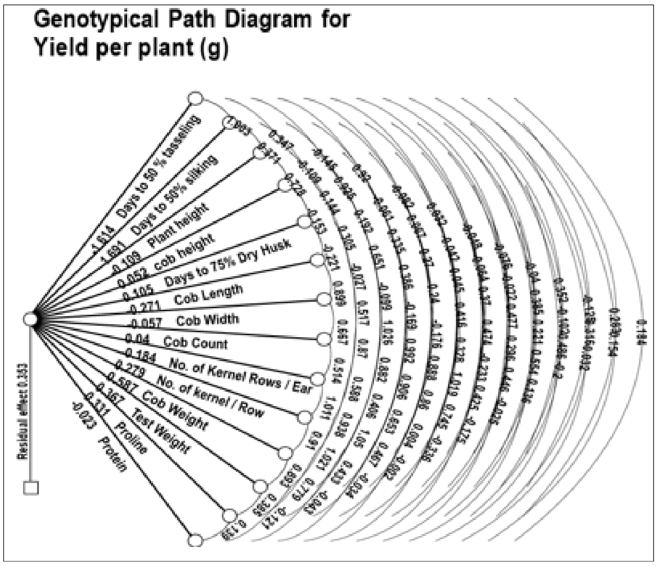

Fig 1: Genotypical path diagram for grain yield of maize in drought condition

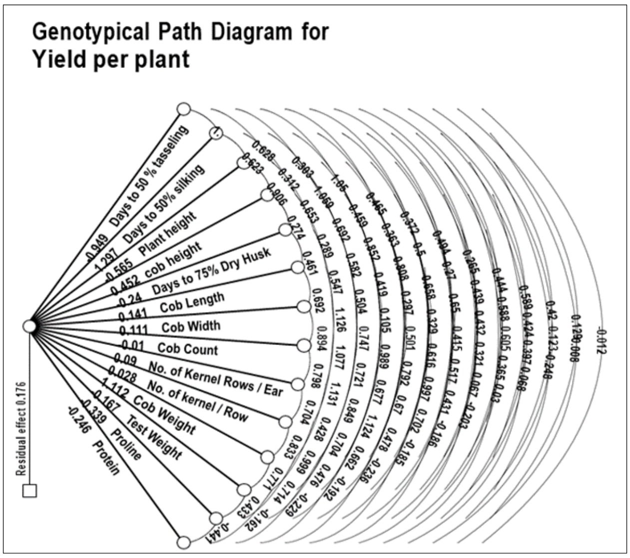

Fig 2: Genotypical path diagram for grain yield of maize in normal condition

Conclusion

The results of this study indicate that both genotypic correlation and path analysis are effective tools for identifying key traits contributing to yield in maize under drought and normal conditions. Cob weight, 100 kernel weight and the number of kernel rows per cob demonstrated significant positive correlations with yield in both environments, with their effects more pronounced under drought conditions. Path analysis further emphasized the role of cob weight and 100 kernel weight in yield enhancement, with days to 50 per centtasselling emerging as an important trait under drought stress. The study also identified traits like proline content and plant height as having differential impacts under varying conditions, highlighting the complexity of breeding for stress resilience. These findings support the targeted selection of traits such as cob morphology and kernel number in maize breeding programs aimed at improving yield under both optimal and water-deficit environments.

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