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CORRELATION AND PATH ANALYSIS IN DROUGHT TOLERANT RABI SORGHUM

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ABSTRACT

The material comprised of total 13 advanced breeding lines and three checks varieties of sorghum were evaluated for correlation coefficient and path analysis studies in complete randomized block design with three replications during rabi season of 2012 under soil moisture deficit condition at Parbahni (M.S.). This study aims to analyze and determine the traits having greater interrelationship with grain yield for production of high yielding rabi sorghum genotypes with considerable tolerance against soil moisture deficit conditions. Results revealed that SPAD chlorophyll meter reading (0.319) showed significant ($p<0.05$) and positive association of with grain yield, whereas panicle dry weight (0.369) and relative water content (0.391) exhibited highly significant ($P<0.01$) association with grain yield at phenotypic level. At genotypic level, total number of leaves (0.296), and SCMR (0.308) exhibited positive significant ($p<0.05$) association with grain yield while, panicle dry weight (0.368), relative water content (0.472) showed strong positive ($p<0.01$) association with grain yield. Seven characters exhibited positive direct effect on grain yield per plant. Total biomass (37.10) had highest direct effect on grain yield, followed by panicle dry weight (21.10), stem dry weight (21.17) and leaf dry weight (7.40). Total biomass (37.10) had highest direct effect on grain yield followed by panicle dry weight (21.10), stem dry weight (21.17) and leaf dry weight (7.40).

Key words: *Rabi* sorghum, correlation, path analysis and soil moisture deficit condition

INTRODUCTION

Sorghum *(Sorghum bicolor L)* the important cereal grain, occupies third position in respect of area and production. Its importance is ever increasing as the source of food for rural masses, food for teeming cattle population and raw material for the industries. Also with the present scarcity situation sorghum cultivation is the heart of dry land agriculture. Grain yield is complex trait, depend on many attributes characters. Yield potential accompanied with desirable combination of traits has always been the major objective of sorghum breeding program. Correlation measures the level of dependence traits and out of numerous correlation coefficients. It is often difficult to determine the actual mutual effects among traits (Ikanovic, *et al.*, 2011). The estimates of correlations alone may be often misleading due to mutual cancellation of component traits. So, it becomes necessary to study path coefficient analysis, which takes in to account the casual relationship in addition to degree of relationship (Mahajan, *et al.*, 2011). The path coefficient analysis initially suggested by Wright (1921) and described by Dewey and Lu (1959) allows partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Path analysis is necessary for better understanding of correlations among traits, which is a pathway for knowledge on specificity of the genetic material being studied. Ikanovic (2010) concluded that even if correlation values are similar for certain pairs of traits, direct effects for some of them and especially indirect effects via other traits can differ for some traits. Knowledge of the association between yield and its component characters and among the component characters themselves can improve the efficiency of selection in plant breeding (Lzge *et al.* 2006). Mallinath *et al.* (2004) stated that, plant height, test weight, and grain yield/panicle had showed positive significant association at both levels with all characters except days to 50% flowering and days to maturity. Therefore, this study aims to analyze and determine the traits having greater interrelationship with grain yield utilizing the correlation and path analysis for production of high yielding *Rabi* sorghum genotypes with considerable tolerance against soil moisture deficit conditions.

MATERIALS AND METHODS

The experimental material comprised of total 13 advanced breeding lines and three check varieties for post flowering drought tolerance of *post rainy* sorghum (*Sorghum bicolor* L.). The experiment was conducted in complete randomized block design with three replications during *Rabi* season of 2012 under soil moisture deficit condition at Sorghum Research Station, Vasantrao Naik Krishi Vidyapeeth, Parbahni. Each genotype was raised in 16 rows per plot of 5 m length in each replication. The row to row and plant to plant distance was kept at 45 and 15 cm,

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respectively. During sowing only pre-sowing irrigation was applied to ensure proper seed germination. All other recommended agronomical practices were followed to raise a good crop. Data were collected on plant height, seed vigor, days 50% flowering, days to physiological maturity, number of leaves per plant, leaf dry weight per plant at physiological maturity, stem dry weight per plant at physiological maturity, panicle dry weight per plant at physiological maturity, relative water content (%), SCMR at 50% flowering, total biomass per plant, 1000 grain weight, grain yield per plant. Leaves, panicle and stem were separated from 5 randomly selected plants from each entry, were sun-dried and weighed by electronic balance again to record air-dry weight. The estimates of direct and indirect contribution of various characteristics to seed yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In general the genotypic correlation was generally of higher magnitude than phenotypic correlation (Table 1), indicating the inherent association between various characters studied. Phenotypic correlation (Table 1) showed significant ($p<0.05$) and positive association of SPAD chlorophyll meter reading (0.319) with grain yield, whereas highly significant ($P<0.01$) association was with panicle dry weight (0.369) and relative water content (0.391). The contribution of panicle dry matter to grain yield in sorghum were also reported by Sanjana Reddy *et al.* (2012) and Dhutmal *et al.* (2014). RLWC is the ability of a plant to maintain high water in the leaves under moisture stress conditions and has been used as an index to determine drought tolerance in crop plants (Barrs *et al.* 1962). Blum *et al.* (1989) reported that higher leaf RLWC allows the plant to maintain turgidity, and this would exhibit relatively less reduction in biomass yield. Seedling vigor showed significant and negative correlation ($p<0.05$) with grain yield. Plant height (0.185) and days to physiological maturity (0.310) were found to have positive but non- significant correlation with grain yield. A positive correlation of SPAD chlorophyll meter reading (SCMR) at 50% flowering with grain yield indicates that higher chlorophyll concentration is vital for adaptation to water deficit conditions during post flowering growth period. A positive association between days to 50% flowering and grain yields suggested that the late maturing genotypes accumulates more dry matter for maximum expression of these characters (Saini and Paroda, 1978). Days to 50% flowering showed positive and significant correlation with days to maturity (0.97), leaves per plants (0.308) and panicle dry weight (0.362), whereas negative and significant association with SCMR (-0.573), stem dry weight (-0.457) and test weight (-0.458). Days to physiological maturity showed a similar trend as that of days to 50% flowering. The correlation of stem dry weight was positive and highly significant ($P<0.01$) with SCMR (0.601) and total biomass (0.808), whereas positive significant ($P<0.05$) with panicle dry weight (0.302) and positive non- significant with relative water content and test weight. Furthermore, panicle dry weight had a positive highly significant ($P<0.01$) correlation with relative water content (0.381) and total biomass (0.775). Relative water content had positive and non-significant correlation with SCMR and total biomass. Total biomass exhibited positive but non-significant correlation with grain yields furthermore, weak negative correlation with test weight, while test weight had weak negative association with grain yield. In other words panicle dry weight, days to 50 % flowering and total biomass are the important traits in improving plant productivity. While, physiological characters like RLWC, SCMR plays a vital role in improving grain yield under moisture stress condition by maintaining optimum turgor pressure at cellular level and photosynthetic activities, respectively .

At genotypic level, total number of leaves (0.296), and SCMR (0.308) exhibited positive significant (<0.05) association with grain yield while, panicle dry weight (0.368), relative water content (0.472) showed strong positive association with grain yield indicating the importance of SCMR, RLWC and panicle weight for obtaining higher grain yield under moisture deficit conditions. Stem dry weight had strong positive association ($p<0.01$) with SCMR (0.647) and total biomass (0.806) and positive association with panicle dry weight. Panicle dry was positively and significantly associated with relative water content (0.624) and total biomass (0.77) but found to have negative but significant association with test weight (-0.306). A strong positive ($p<0.01$) association was observed between relative water content and SCMR (0.333) and total biomass (0.413), while, SCMR was found to be positively associated with total biomass (0.338) and test weight (0.512) indicating the importance of SCMR and relative water content in the expression of these characters. In other words panicle dry weight, SCMR and RLWC plays an important role in improving grain yield under moisture stress condition. The results are in conformation with those found by Dhutmal *et al.* (2014). Due to mutual cancellation of component

Table 1: Correlation coefficient between grain yield and its component characters in sorghum

Traits	Plant height (cm)	Seed vigor	Days 50% flowering	Days to physiological maturity	Leaves per plant	Leaf dry weight (g/plant)	Stem dry weight (g/plant)	Panicle dry weight (g/plant)	Relative water content (%)	SPAD chlorophyll meter reading at 50% flowering	Total biomass (g/plant)	1000 grain weight (g)	Grain yield (g/plant)
Plant height (cm)	1.000	-0.133 (-0.433)	0.354 * (0.445)	0.310* (0.412)	0.109 (0.207	-0.242 (-0.278	-0.244 (-0.283	0.231 (0.293)	0.153 (0.231)	0.051 (0.168)	-0.056 (-0.051)	-0.291 * (-0.382)	0.185 (0.282)
Seed vigor		1.000	0.250 (0.424)	0.268 (0.467)	-0.016 (0.43)	0.219 (0.419)	-0.011) (0.099)	0.128 (0.353)	0.021 (-0.18)	-0.384 ** (-0.521)	0.111 (0.34)	-0.028 (-0.015)	-0.294* (-0.365*)
Days 50% flowering			1.000	0.978 ** (0.880)	0.308 * (0 .906)	0.152 (0.178)	-0.457 ** (-0.482)	0.362 * (0.388)	0.147 (0.325)	-0.573 ** -0.621)	-0.021 (-0.017)	-0.458 ** (-0.517)	0.038 (0.034)
Days to physiological maturity				1.000	0.284 (0.960)	0.169 (0.210)	-0.450 ** (-0.492)	0.337 * (0.367)	0.151 (0.279)	-0.578** (-0.637)	-0.028 (-0.028)	-0.458 ** (-0.509)	0.008 (0.027)
Total number of leaves per plant					1.000	0.264 (0.679)	-0.195 (-0.665)	0.161 (0.553)	0.065 (0.305)	-0.143 (-0.628)	0.035 (0.074)	-0.138 (-0.603)	-0.003 (0.296*)
Leaf dry weight (g/plant)						1.000	0.359 * 0.392)	0.194 (0.216)	-0.059 (-0.259)	0.014 (0.025)	0.517 ** (0.546)	-0.026 (-0.012	0.054 (0.109)
Stem dry weight (g/plant)							1.000	0.302 * (0.286)	0.113 (0.199)	0.601 ** (0.647)	0.808 ** (0.806)	0.216 (0.23)	0.023 (-0.002)
Panicle dry weight (g/plant)								1.000	0.381** 0.624)	-0.018 (-0.058)	0.775 ** (0.77)	-0.268 (-0.306)	0.369** (0.398**)
Relative water content (%)									1.000	0.157 (0.333)	0.267 (0.413)	-0.012 (-0.072)	0.391 ** (0.472**)
SPAD chlorophyll meter reading at 50% flowering										1.000	0.3311 * 0.338)	0.439 ** (0.512)	0.319* (0.308*)
Total biomass (g/plant)											1.0000	-0.035 (-0.046)	0.027 (-0.0064)
1000 grain weight (g)												1.0000	-0.075 (-0.148)

**Numbers in parenthesis indicates values of genotypic correlation * and ** Significant at 5% and 1% level of probabilities, respectively*

Table 2: Direct and Indirect effects (phenotypic) of characters on grain yield/plant in sorghum

Traits	Plant height (cm)	Seed vigor	Days 50% flowering	Days to physiological maturity	Total number of leaves per plant	Leaf dry weight (g/plant)	Stem dry weight (g/plant)	Panicle dry weight (g/plant)	Relative water content (%)	SPAD chlorophyll meter reading	Total biomass (g/plant)	1000 grain weight (g)
Plant height (cm)	-0.042	0.005	-0.015	-0.013	-0.004	0.010	0.010	-0.009	-0.006	-0.002	0.002	0.012
	(-0.532)	(0.230)	(-0.236)	(-0.219)	(-0.110)	(0.148)	(0.150)	(-0.155)	(-0.123)	(-0.089)	(0.026)	(0.203)
Seed vigor	0.0212	-0.159	-0.039	-0.0428	0.0026	-0.035	0.001	-0.020	-0.003	0.061	-0.017	0.004
	(0.032)	(-0.210)	(-0.042)	(-0.053)	(0.002)	(-0.043)	(0.002)	(-0.034)	(-0.004)	(0.078)	(-0.022)	(0.005)
Days 50% flowering	0.319	0.225	0.901	0.881	0.278	0.137	-0.412	0.326	0.133	-0.516	-0.019	-0.413
	(-0.408)	(-0.389)	(-0.917)	(-0.920)	(-0.831)	(-0.163)	(0.442)	(-0.356)	(-0.298)	(0.569)	(0.015)	(0.474)
Days to physio-	-0.221	-0.191	-0.697	-0.713	-0.202	-0.121	0.321	-0.240	-0.107	0.412	0.020	0.327
logical maturity	(0.529)	(0.599)	(1.289)	(1.285)	(1.234)	(0.269)	(-0.631)	(0.471)	(0.358)	(-0.818)	(-0.036)	(-0.654)
Total number of	-0.015	0.002	-0.043	-0.039	-0.139	-0.037	0.027	-0.022	-0.009	0.020	-0.005	0.019
leaves per plant	(0.047)	(0.098)	(0.206)	(0.218)	(0.228)	(0.154)	(-0.151)	(0.126)	(0.069)	(-0.143)	(0.016)	(-0.137)
Leaf dry weight	1.795	-1.629	-1.125	-1.256	-1.962	7.407	-2.661	-1.439	0.437	-0.103	-3.836	0.192
(g/plant)	(-0.050)	(0.075)	(0.032)	(0.037)	(0.122)	(0.179)	(0.070)	(0.038)	(-0.046)	(0.004)	(0.098)	(-0.002)
Stem dry weight	5.174	0.233	9.693	9.539	4.146	-7.608	21.179	-6.414	-2.399	12.740	17.112	-4.579
(g/plant)	(-0.034)	(0.012)	(-0.059)	(-0.060)	(-0.082)	(0.048)	(0.123)	(0.035)	(0.024)	(0.079)	(0.099)	(0.028)
Panicle dry weight	-4.882	-2.718	-7.643	-7.114	-3.400	-4.102	-6.390	21.103	-8.047	0.384	16.372	5.664
(g/plant)	(0.132)	(0.160)	(0.176)	(0.166)	(0.251)	(0.098)	(0.129)	(0.454)	(0.283)	(-0.026)	(0.349)	(-0.139)
Relative water	0.034	0.004	0.033	0.033	0.014	-0.013	0.0254	0.085	0.224	0.035	0.059	-0.002
content (%)	(0.035)	(-0.027)	(0.050)	(0.043)	(0.047)	(-0.040)	(0.030)	(0.096)	(0.155)	(0.051)	(0.064)	(-0.011)
SPAD chlorophyll	0.030	-0.227	-0.338	-0.341	-0.084	0.008	0.354	-0.010	0.092	0.589	0.195	0.2593
meter reading	(0.238)	(-0.742)	(-0.885)	(-0.908)	(-0.895)	(0.035)	(0.922)	(-0.082)	(0.475)	(1.425)	(0.482)	(0.7304)
Total biomass	-2.100	4.152	-0.799	-1.038	1.314	19.217	29.980	28.787	9.915	12.287	37.104	-1.313
(g/plant)	(0.058)	(-0.392)	(0.019)	(0.032)	(-0.085)	(-0.629)	(-0.929)	(-0.888)	(-0.476)	(-0.390)	(-1.153)	(0.052)
1000 grain weight	0.071	0.007	0.112	0.112	0.033	0.006	-0.053	0.065	0.0031	-0.107	0.008	-0.245
(g)	(0.265)	(0.010)	(0.358)	(0.353)	(0.417)	(0.0086)	(-0.159)	(0.212)	(0.050)	(-0.355)	(0.031)	(-0.693)

**Numbers in parenthesis indicates values of Direct and Indirect effects (genotypic)*

traits, the estimation of correlation alone may be often misleading so it is necessary to study the path co-efficient analysis, which takes into account,the casual relationship in addition to the degree of relationship. Hence genotypic and phenotypic correlation was partitioned into direct and indirect effects to know the relative importance of the components (Table 2).

Out of 12 characters, seven exhibited positive direct effect on grain yield per plant. Total biomass (37.10) had highest direct effect on grain yield followed by panicle dry weight (21.10), stem dry weight (21.17) and leaf dry weight (7.40). Similar results were found by Dhutmal *et al*, (2014) for days to 50 % flowering. Moreover, days to 50% flowering (0.901) and SCMR (0.589) showed weak but positive direct effect on grain yield. The indirect effect of total biomass on yield was through stem dry weight (28.78), panicle dry weight (28.70) and leaf dry weight (19.21). Furthermore, indirect relative water content had positive direct effect on grain yield (0.224). Its indirect effect was through panicle dry weight and total biomass. Moreover, SCMR had positive direct effect on grain yield (0.589), while, its indirect effect was via stem dry weight, relative water content and total biomass.

Thus, it may be concluded from the present study that the traits like total biomass, stem dry weight, panicle dry weight, leaf dry weight, and relative water content and SCMR had greater importance. Hence, due consideration should be given to these characters, while planning a breeding strategy for increased grain yield/ plant.

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