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Estimation of Correlation Coefficients and Path for Yield Traits in Grain Mold Tolerant F_3 Progenies of Sorghum

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Abstract: ***Study comprised of F_3 generation sorghum material obtained from eight resistant × susceptible crosses along with respective parents and popular checks DSV 6 (resistant), 296 B (susceptible), was carried out with an objective to assess the nature of association between grain yield and its component traits and the direct and indirect effects on grain yield. Correlation studies revealed days to maturity at genotypic level and days to flowering at both genotypic and phenotypic levels showed highly significant negative correlation with grain yield. Negative correlation is desirable for these traits as less number of days to flower reduces the crop duration, this in turn is helpful in terms of economic cultivation of sorghum crop. At both phenotypic and genotypic levels, plant height exerted highly significant positive correlation with grain yield. Path analysis study in the present investigation revealed that, out of six characters, two characters viz., days to flowering and plant height had positive direct effect on grain yield. While the character days to maturity showed high negative direct and indirect effect on grain yield and panicle length had non-significant association with grain yield, hence panicle length may not be useful as a criterion for selection for increased grain yield.***

Keywords: sorghum, grain, correlation, path.

1. Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) being an important staple food for more than 300 million people and feed for cattle in Asia and Africa, among the cereals, it ranks fifth in the world in production next only to wheat, maize, rice and barley. In India, sorghum is cultivated in the three seasons *viz*., rainy, post rainy and summer. Rainy season sorghum is being gradually replaced by high value crops like soybean, sunflower, maize and cotton. This is because sorghum grains are usually caught the September – October rains and thus mold develops on the grains, by which grains become black in colour, poisonous and nutritionally poor and grains are unfit for consumption. Consumption of moldy grains cause health hazards. Development of grain mold tolerant sorghum varieties is the need of the day. Even though host plant resistance is the novel method for management both pests and diseases, successes are very low in the history of host plant resistance. This is due to association of undesirable traits in the wild type source material and low yield or non-adaptability of the segregate or resultant material.

Therefore the study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits in genetic gain for the primary trait under consideration. Correlations remain same over seasons and locations. Correlation trends and values were similar among parents and hybrids as well as during rainy and post rainy seasons [1]. Plant height, number of leaves per plant, number of internodes per plant, panicle length, panicle breadth, number of primaries per panicle, test weight, number of grains per panicle and fodder yield per plant had positive association with grain yield per plant at both the locations [2]. Hence a positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. On the other hand, a negative correlation between two desirable traits impedes or makes it impossible to achieve a significant improvement in both traits. However, simple correlations do not give an insight into the true biological relationships of these traits with yield. Yield, being quantitative in nature is a complex trait with low heritability and depends upon several other components with high heritability [3]. These traits are in turn interrelated. Their interdependence influences the direct relationship with yield and as a result the information obtained on their association becomes unreliable.

The path coefficient analysis initially suggested by Write [4] and described by Dewey and Lu [5] allows partitioning correlation coefficient into direct and indirect contributions of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Hence, this study is aimed to analyze and determine the traits having greater interrelationship with grain yield utilizing the correlation and path analysis.

2. Material and Methods

In the present study, the experimental material comprised of F_3 generation material obtained from eight resistant × susceptible crosses along with respective parents and popular checks DSV 6 (resistant), 296 B (susceptible), planted in a randomized complete block design with three replications in medium deep black soil under rainfed condition at Sorghum Improvement Project, University of Agricultural Sciences, Dharwad during rainy season. Each treatment was of three rows of 6 m length with inter row spacing of 45 cm and intra row spacing of 15 cm. All the recommended practices were followed to raise good crop of *kharif* sorghum. Observations were recorded on five competitive plants chosen at random in each sub-plot. Measurements were recorded at appropriate stages of plant growth on all the six quantitative characters *viz.*, days to flowering, days to maturity, plant height (cm), panicle length (cm), seed weight (g) and grain yield per plant (g) following recommendations of ICRISAT descriptor list for sorghum [6]. The mean of five plants in each replication for each character was used for analysis of variance. Correlation coefficient was computed from variance and covariance components as suggested by Burton [7], Wright [8][9] and Narasimharao and Rachie [10]. The correlation coefficient was partitioned into direct and indirect causes according to Dewey and Lu [5], and Wright [8].

Screening for grain mold:

The experiment was grown under mist formation unit to facilitate mist formation on panicles from flowering to the physiological maturity to provide high humidity (>90% RH). This high humidity keeps the panicles moist for longer period. Moisture on panicle along with surrounding temperature creates the favourable condition for mold development. The mist was created by installing perforated GI pipes horizontally at the height of 10 feet above the ground on iron poles. These perforated pipes with minute holes were connected to high pressure bore well pump so that fine mist is formed and spread over the panicle when the water is passed through the perforated pipes. The mist formation unit was run for one hour thrice a day morning, afternoon and at evening. From each entry 10 plants of uniform height and flowering were tagged. The visual panicle grain mold rating was scored on 1-9 scale.

3. Results and Discussion

The analysis of variance involving 154 sorghum F_3 progenies of resistant × susceptible crosses including parents and displayed considerable amount of differences in their mean performance with respect to all the characters studied, which indicates that the genotypes under study were genetically diverse (Table 1).

Correlations

Yield being the result of combined effects of several component characters and environment, understanding of the interaction of characters among themselves and with the environment is of great use in the plant breeding. Correlation studies provide information on the nature and extent of association between any two pairs of metric characters. Hence, it would be possible to bring genetic up gradation in one character by selection of the other of a pair. There may not be any gene for yield as such, but operates only through its components [3]. Obviously, knowledge about character association will surely help to identify the character to make selection for higher yield. With a view to determine the extent and nature of relationship prevailing among yield contributing characters, an attempt has been made to study the character association in the F_3 material of resistant × susceptible crosses of sorghum both at phenotypic and genotypic levels.

In the present investigation the estimates of genotypic correlation in general were higher than those of phenotypic correlation (Table 2 & 3). These higher genotypic values whenever observed are contributed to the relative stability of the genotypes [11][12].

Days to flowering showed highly significant negative correlation with grain yield at genotypic level which is in agreement with earlier findings[13][14][2]. Negative correlation is desirable for these traits as less number of days to flower reduces the crop duration, this helpful in terms of economic cultivation of sorghum crop. However, in contrast to this, significant positive correlation between days to flowering and grain yield are reported by earlier findings [15][16]. A highly non significant and positive association at both levels was found between days to flowering and plant height. These results are in line with the earlier findings [17][18]. However, it had positive and highly significant association with days to maturity at both phenotypic and genotypic levels. Days to maturity expressed highly significant negative correlation with grain yield which confirms earlier reports [14]. This negative correlation helps to select the early maturing genotypes with high grain yield. A highly significant and positive association at both phenotypic and genotypic level was found between days to maturity plant height and 1000 grain weight.

At both phenotypic and genotypic levels, plant height exerted highly significant positive correlation with grain yield. This result confirmed the earlier findings [19][20][21]. The significant correlation of plant height with grain yield can be used to the indirect selection for grain yield. Further selection for any one of these traits results in development of dual purpose sorghum varieties which meet the both important demands of farmer, grain yield and fodder.

Panicle length recorded the non significant association with grain yield at genotypic level, but it had positive correlation with grain yield at phenotypic level. This result confirmed the earlier findings [20], [22]-[24]. These results indicate that length of panicle does not play vital role in increase grain yield of the sorghum crop as length may be elongation of panicle with out increase in rachis and grain number. Characters which are strongly associated with grain yield and contributing to grain yield indirectly and positively are number of primaries per panicle, test weight, number of grains per panicle and fodder yield [25].

Path Analysis

The path co-efficient analysis, a statistical device developed by Wright [4], which takes into account the cause and effect relation between the variable is unique in partitioning the association into direct and indirect effect through other independent variables. The path co-efficient analysis also measures the relative importance of causal factors involved. This is simply a standardized partial regression analysis, wherein total correlation value is subdivided into causal scheme. Path diagram describes the importance and facilitates the understanding of the nature of cause and effect system [26]. In the present study, the path co-efficient analysis was carried out at both phenotypic and genotypic level and the results are discussed below.

Partitioning of yield and yield components into direct and indirect effects at both location are shown in table 4 & 5. Even though, days to flowering had highly significant negative correlation with grain yield, it showed highly positive direct effect on grain yield at both phenotypic and genotypic level. In addition to this, days to flowering recorded high heritability estimates and moderate genetic advance. Similar to these results, earlier researchers reported high positive direct effect of days to flowering on grain yield [27] [28]. Days to maturity showed high negative direct and indirect effect on grain yield at both phenotypic and genotypic level. Further, days to maturity recorded the low phenotypic and genotypic co-efficient of variance. Hence, days to maturity may not be useful as a criteria in selection for increased yield.

Through path analysis, it is evident that positive and highly significant correlation of plant height with grain yield was reflected by its direct effect which was high at both levels. Similar results of positive contribution of plant height on grain yield were obtained by earlier findings [27] - [30]. This suggests considerable contribution of plant height and its potentiality for improvement for grain yield.

In the present study, panicle length had non-significant association with grain yield. The direct effect of panicle length on grain yield was negligible. In addition to this it had negative indirect influence on grain yield at both phenotypic and genotypic level. Whereas, positive direct effect is reported by earlier findings [16]. The result suggest that due to its negative indirect effect and non significant association with grain yield, this trait may not be useful as a criterion for selection for increased grain yield.

4. Conclusion

Correlation studies revealed days to maturity at genotypic level and days to flowering at both genotypic and phenotypic levels showed highly significant negative correlation with grain yield. Negative correlation is desirable for these traits as less number of days to flower reduces the crop duration, this in turn is helpful in terms of economic cultivation of sorghum crop. At both phenotypic and genotypic levels, plant height exerted highly significant positive correlation with grain yield. Path analysis study in the present investigation revealed that, out of six characters, two characters viz., days to flowering and plant height had positive direct effect on grain yield. While the character days to maturity showed high negative direct and indirect effect on grain yield and panicle length had non-significant association with grain yield.

5. Future Research

Further improvement in combining grain yield and mold resistance is possible through conventional breeding, which should include expanded systematic screening and selection in segregating progenies of specifically planned crosses. Such progenies should involve guinea resistant sorghums in the crosses and exploit open panicles, large glume coverage in addition to grain hardness. Genotypes with hard grains, loose panicles, medium to long glume coverage and red and black coloured glumes had low incidence of grain mold [14]. Sorghum hybrid CSH 16 grains have very good lustre, and less grain mould score as compared to other released varieties [31]. However progress from such programmes is expected to be slow because grain mould resistance expresses late in the life cycle of the crop is difficult to measures has complex inheritance and is significantly influenced by the environment. Therefore this program should be complemented with marker technology by identifying markers for genes contributing to resistance.

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Authors Profile

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Dr. Mallikarjun Kamatar has a vivid research experience of 30 years in s breeding sorghum, millets, wheat, chickpea, cotton, and tobacco crops, development of disease resistant and nutritional quality sorghum genotypes. Dr. Kamatar has fabricated nutritional and therapeutic food products from foxtail millet and little millet to suit diabetics, growing children and common public.

Table 1: Analysis of variance for F_3 material of sorghum

Source	d.f.	Days to flowering	Days to maturity	Plant height	Panicle length	1000 g wt.	Grain yield/ plant
Replication	2	17.12	0.50	183.81	5.82	15.57	25.06
Treatment	153	52.96**	229.09**	282.38**	24.67**	190.26**	309.17**
Error	306	8.85	24.02	68.13	2.31	6.60	16.51

* Significant at 5% probability ** Significant at 1% probability

Table 2: Phenotypic correlation co-efficient, between different traits in F_3 material of sorghum including parents and cheeks

Character	Days to flowering	Days to maturity	Plant height	Panicle length	1000 gr. Wt	GYP
Days to flowering	1.000	0.188	0.108	-0.190*	-0.019	-0.146
Days to maturity		1.000	0.175*	-0.018	0.350**	-0.208*
Plant height			1.000	-0.238**	0.033	0.216**
Panicle length				1.000	-0.067	0.060
1000 gr. Wt					1.000	0.128**
Grain yield/plant						1.000

* Significant at 5 per cent probability ** Significant at 1 per cent probability

Table 3: Genotypic correlation co-efficient, between different traits in F_3 material of sorghum including parents and cheeks

Character	Days to flowering	Days to maturity	Plant height	Panicle length	1000 gr. wt	GYP
Days to flowering	1.000	0.258**	0.151	-0.251**	-0.039	-0.091
Days to maturity		1.000	0.218**	-0.027	0.425**	-0.214*
Plant height			1.000	-0.275**	0.032	0.244**
Panicle length				1.000	-0.098	0.017
1000 gr. wt					1.000	0.028
Grain yield/plant						1.000

* Significant at 5 per cent probability ** Significant at 1 per cent probability

Table 4: Direct and indirect effects on grain yield at phenotypic level in F_3 material of sorghum

Character	Days to flowering	Days to maturity	Plant height	Panicle length	1000 grain wt.	Correlation with grain yield
Days to flowering	0.454	-0.477	0.036	-0.071	-0.088	-0.146
Days to maturity	0.425	-0.485	-0.046	-0.095	0.003	-0.208*
Plant height	-0.145	0.156	0.264	-0.064	0.005	0.216**
Panicle length	-0.021	0.040	-0.013	0.056	-0.002	0.060
1000 gr. wt	0.025	0.043	0.087	-0.038	0.010	0.128**

* Significant at 5% probability ** Significant at 1% probability Residual effect 0.467

Table 5: Direct and indirect effects on grain yield at genotypic level in F_3 material of sorghum

Character	Days to flowering	Days to maturity	Plant height	Panicle length	1000 grain wt.	Correlation with grain yield
Days to flowering	0.904	-0.780	0.045	-0.080	0.002	-0.091
Days to maturity	0.901	-0.816	-0.075	-0.142	-0.082	-0.214*
Plant height	-0.081	0.025	0.297	-0.087	0.028	0.244**
Panicle length	-0.168	0.103	-0.035	0.116	0.001	0.017
1000 gr. wt	0.061	0.049	0.081	-0.031	-0.01	0.028

* Significant at 5% probability ** Significant at 1% probability Residual effect 0.356