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RESEARCH PAPER

Association and path analysis in F_3 generation of single and three-way crosses of *rabi* sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract: F_3 families developed from crosses M 35-1 x Kodamurkhi local and M 35-1 x Kodamurkhi local x Biligund local were evaluated in family block design for nine productivity traits during *rabi* 2019. Number of green leaves, plant height, panicle length, panicle width and panicle weight showed positive and significant correlation with grain yield while SPAD showed negative association with plant height. Path analysis showed that panicle weight contributed high direct effect to grain yield per plant followed by number of green leaves, plant height, and panicle width in single cross whereas, number of leaves, number of green leaves and panicle length in three-way cross.

Keywords: Correlation, Path analysis, Sorghum, Three-way crosses

Introduction

Sorghum (*Sorghum bicolor* L. Moench 2n=20) is one of the valuable agricultural crops belongs to the family Poaceae having wide range of utility like food grain purpose, fodder for livestock, cattle feed, beverage and food industry. Globally, Sorghum occupies 40.075 million hectares area, producing 57.893 million tonnes production with the 1.445 tonnes per hectare productivity (FAOSTAT, 2019). In India, sorghum occupies an area of 1.90 and 2.60 million hectares in *kharif* and *rabi* seasons, respectively with total production of 4.70 million tonnes of sorghum grain. Productivity of *kharif* sorghum is higher (948 Kg/ha) than *rabi* (790 Kg/ha) sorghum (Anon., 2018). Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan and Tamil Nadu are the main sorghum growing states in India. Karnataka is one of India's main sorghum growing state and is second after Maharashtra in area and production. Around 50 percent of Karnataka's population relies on sorghum as a staple food crop. It is cultivated in major districts *viz.* Dharwad, Vijaypur, Kalburgi, Bellary, Belgaum, Raichur and Mysore.

Sorghum has a distinct characteristic of having both different degrees of pollination. This provides many advantages during breeding programme. The first one is no harmful recessive alleles present in this crop due to the inherent adaptation to self pollination and therefore varieties can be produced. An understanding of yield inheritance and its component related features, heritability, predicted genetic advance and association between each component trait and yield is necessary in order to plan an efficient selection procedure for the development of high yielding genotypes.

Development of breeding material by involving more number of distinct parents would through more variability for desirable traits and evolve more desirable transgressive segregants. The association of component traits with grain yield may also differ due to involvement of different parental combinations. Hence, the present study aims at, estimating the associations of growth and productivity traits with grain yield in single and three-way crosses and develop the suitable selection strategy for grain yield improvement in *rabi* sorghum.

Material and methods

The material for experiment comprised of F_3 generation of the single- and three-way cross developed by involving genetically diverse traditional genotypes of sorghum *viz,* M-35-1, Kodamurkhi local, Biligund local in combination of single cross (M 35-1 x Kodamurkhi local)) and three-way cross (M 35-1 x Kodamurkhi local x Biligund local) and evaluated in the family block design at All India Co-ordinated Sorghum Improvement Project, MARS, Dharwad during *rabi* 2019.

The observations were recorded for each cross for nine productivity traits *viz.,* SPAD meter reading, number of leaves per plant, number of green leaves per plant, plant height, panicle length, panicle width, panicle weight, grain yield per plant and 100 grain weight. Observation for SPAD meter reading, number of leaves per plant, number of green leaves per plant recorded at physiological maturity and plant height, panicle length, panicle width, panicle weight, grain yield per plant and 100 grain weight at the time of harvesting and post harvesting stages.

Statistical analysis to estimate degree of association between the traits, phenotypic correlation was computed by using the formula given by Webber and Moorthy (1952). The significance of correlation coefficient was tested by referring to the table value at N-2 degrees of freedom (df) given by Snedecor (1961). Path coefficient analysis was done to estimate direct and indirect effects of component traits on grain yield as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

Results and discussion

An understanding of yield inheritance and its components, heritability, predicted genetic advance and association between each component trait and yield is necessary in order to plan an efficient selection procedure for the development of high yielding genotypes. The result on correlation studies of grain yield per plant with other yield attributing characters revealed that grain yield was positively and significantly correlated with number of green leaves, plant height, panicle length, panicle width and panicle weight in the single cross F_3 population (Table 1). It was positively and non-significantly associated with chlorophyll (SPAD) meter reading, total number of leaves and hundred grain weight. The earlier reports also indicated that panicle weight was positively and significantly correlated with total number of leaves, plant height, panicle length and panicle weight (Arunah *et al*., 2015; Chittarpur *et al*., 2015; Girish *et al.*, 2016; Hundekar *et al.,* 2016; Soujanya *et al.,* 2018).

For three-way cross F_3 population the result on correlation studies of grain yield with other yield attributed traits revealed that grain yield is positive and significant correlated with total number of leaves, panicle length, panicle width and panicle weight (Swamy *et al.,* 2018; Sumita *et al.,* 2018) but on the other hand, it was positively non-significant associated with chlorophyll (SPAD) meter reading, plant height and negatively non-significant with number of green leaves and negatively significant associated with 100 grain weight (Table 2). It has been observed that panicle weight showed significant positive association with panicle length, panicle width and grain yield per plant and it showed non-significant negative correlation with total number of leaves as reported by earlier researchers (Jimmy *et al.,* 2017; Swamy *et al.,* 2018).

It suggests that the characters *viz*., total number of leaves, panicle length, panicle width and panicle weight were significantly associated with higher grain yield in both the cross types consistently and hence should be considered while selecting plants for grain yield improvement.

Path correlation analysis provides better understanding regarding intricate relationship among independent variables. This measure explains magnitude and significance of variables on yield and direct effectiveness of selection. For single cross, out of eight productivity traits four traits were found to have direct positive effect on grain yield per plant namely number of green leaves, plant height, panicle width and panicle weight (Table 3). Among these panicle weight had contributed highest positive direct effect (0.787), followed by panicle width (0.406), number of green leaves (0.140) and lastly plant height with little influence (0.050), whereas the highest direct negative effect was found with panicle length (-0.309) which was followed by total number of leaves (Khandelwal *et al*., 2015; Girish *et al*., 2016).

Table 1. Phenotypic correlation coefficients for productivity traits in F_3 generation of single cross (M35-1 x Kodamurkhi local)

	Chlorophyll (SPAD) meter reading	No. of leaves	No. of green leaves	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Grain yield per plant (g)	100 grain weight (g)
Chlorophyll (SPAD) meter reading	1								
No. of leaves	-0.18	1							
No. of green leaves	-0.037	0.23	1						
Plant height (cm)	-0.54**	0.41*	0.30	1					
Panicle length (cm)	-0.054	0.10	-0.04	0.17	1				
Panicle width (cm)	-0.24	0.11	0.107	0.39*	0.88**	1			
Panicle weight (g)	-0.057	0.37*	0.16	0.54**	0.57**	0.72**	1		
Grain yield per plant (g)	-0.19	0.245	0.36*	0.60**	0.44*	0.65**	0.88**	1	
100 grain weight (g)	0.12	0.05	0.085	0.11	0.22	0.31	0.28	0.26	1

*- Significant at 5% level of probability; **- Significant at 1% level of probability

Table 2. Phenotypic correlation coefficients for productivity traits in F_3 generation of three-way cross (M35-1 x Kodamurkhi local x Biligund local)

	Chlorophyll (SPAD) meter reading	No. of leaves	No. of green leaves	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Grain yield per plant (g)	100 grain weight (g)
Chlorophyll (SPAD) meter reading	1								
No. of leaves	0.03	1							
No. of green leaves	0.09	-0.05	1						
Plant height (cm)	-0.40*	0.12	0.25	1					
Panicle length (cm)	0.27	0.19	0.21	0.02	1				
Panicle width (cm)	0.34	-0.01	0.30	-0.34	0.42*	1			
Panicle weight (g)	0.18	-0.24	0.28	0.12	0.82**	0.57**	1		
Grain yield per plant (g)	0.11	-0.19	0.39*	0.165	0.72**	0.41*	0.87**	1	
100 grain weight (g)	0.59**	0.04	-0.23	-0.41*	0.18	0.01	0.04	-0.14	1

*- Significant at 5% level of probability; **- Significant at 1% level of probability

Table 3. Direct and indirect effects of productivity traits on yield at phenotypic level in F_3 generation of single cross (M35-1 x Kodamurkhi local)

	Chlorophyll (SPAD) meter reading	No. of leaves	No. of green leaves	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	100 grain weight (g)	Correlation with yield
Chlorophyll (SPAD) meter reading	-0.051	0.023	-0.005	-0.027	0.016	-0.098	-0.045	-0.003	-0.19
No. of leaves	0.009	-0.124	0.033	0.020	-0.031	0.040	0.298	-0.001	0.24
No. of green leaves	0.002	-0.029	0.140	0.015	0.012	0.043	0.133	-0.002	0.36*
Plant height (cm)	0.028	-0.051	0.042	0.050	-0.054	0.158	0.432	-0.003	0.60**
Panicle length (cm)	0.002	-0.012	-0.005	0.008	-0.309	0.355	0.410	-0.006	0.44**
Panicle width (cm)	0.012	-0.012	0.015	0.019	-0.270	0.406	0.495	-0.009	0.65**
Panicle weight (g)	0.003	-0.047	0.023	0.027	-0.161	0.256	0.787	-0.008	0.88**
100 grain weight (g)	-0.006	-0.006	0.012	0.005	-0.068	0.130	0.227	-0.029	0.26
Residual effect = 0.361									

*- Significant at 5% probability level, **- Significant at 1 % probability level

Table 4. Direct and indirect effects of productivity traits on yield at phenotypic level in F_3 generation of three-way cross (M35-1 x Kodamurkhi local x Biligund local)

	Chlorophyll (SPAD) meter reading	No. of leaves	No. of green leaves	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	100 grain weight (g)	Correlation with yield
Chlorophyll (SPAD) meter reading	-0.022	-0.003	-0.010	0.061	0.003	-0.068	0.146	0.012	0.118
No. of leaves	0.002	0.035	-0.011	-0.020	0.00	0.047	-0.216	-0.028	-0.192
No. of green leaves	0.001	-0.002	0.200	-0.043	0.003	-0.044	0.303	-0.026	0.391*
Plant height (cm)	0.008	0.004	0.051	-0.165	0.004	0.076	0.188	-0.002	0.165
Panicle length (cm)	-0.004	-0.001	0.042	-0.047	0.016	-0.098	0.809	0.007	0.723**
Panicle width (cm)	-0.006	-0.007	0.038	0.055	0.007	-0.229	0.56	-0.005	0.416*
Panicle weight (g)	-0.003	-0.007	0.061	-0.031	0.013	-0.134	0.985	0.006	0.89**
100 grain weight (g)	0.002	0.009	0.048	-0004	-0.001	-0.010	-0.053	-0.111	-0.120
Residual effect- 0.387									

*- Significant at 5% probability level, **- Significant at 1 % probability level

For three-way cross, the path effect was different from single cross as five characters were observed to have direct positive effect on grain yield per plant. Similar to the single cross panicle weight (0.98) contributed highest direct positive effect (Table 4). In the order of direct effects number of green leaves (0.200), panicle width (0.120), total number of leaves (0.035) and panicle length (0.016) has positive effect (Khadakbhavi *et al*., 2017). Whereas, plant height (-0.165) followed by 100 grain weight (-0.111) and SPAD meter value (-0.022) were found to have direct negative effect on grain yield per plant (Verma *et al*., 2016; Hundekar *et al.,* 2016). It can be concluded that characters influencing grain yield directly as well as indirectly in both the single- and three-way crosses must be given important weightage while practising selection.

Conclusion

Panicle weight, panicle length, number of green leaves, plant height and panicle width are important component traits in deciding grain yield. Hence, these characters should be considered while practising selection for grain yield improvement in *rabi* sorghum.

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