The Pharma Innovation Journal 2023; 12(1): 1789-1793

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(1): 1789-1793

www.thepharmajournal.com
Received: 16-10-2022
Accepted: 30-12-2022

RR Karpe
PG Scholar, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

RR Dhutmal
Associate Professor, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

SH Pohekar
PG Scholar, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

SA Patil
Ph.D. Scholar, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
RR Karpe
PG Scholar, Department of Agricultural Botany, College of Agriculture, VNMKV, Parbhani, Maharashtra, India

Correlation and path analysis in relation to drought tolerance in *Rabi* colored pericarp sorghum (*Sorghum bicolor* L. Moench)

RR Karpe, RR Dhutmal, SH Pohekar and SA Patil

Abstract
The material comprised of total 24 genotypes and three checks varieties of colored pericarp sorghum were evaluated for correlation coefficient and path analysis studies in complete randomized block design with two replications during *Rabi* season of 2021-22 under soil moisture deficit condition at VNMKV, Parbhani (M.S.). This study aims to analyze and determine the traits having greater interrelationship with grain yield for production of high yielding *Rabi* colored pericarp sorghum genotypes with considerable tolerance against soil moisture deficit conditions. Results revealed that leaf area index (G=0.5323, P=0.4693), relative water content (G=0.5395, P=0.4795), SPAD chlorophyll meter reading (G=0.9766, P=0.7235) and fodder yield per plant (G=0.4717, P=0.3982) showed significant and positive association of with grain yield at both genotypic and phenotypic level. Five characters exhibited positive direct effect on grain yield per plant *viz.* days to 50 percent flowering (G= 0.359, P=0.00), days to physiological maturity (G= 0.255, P= 0.264), seedling vigor (G=0.422, P=0.305), SPAD chlorophyll meter reading (G=1.134, P=1.161) and fodder yield per plant (G=1.645, P=0.718) at both genotypic as well as phenotypic level.

Keywords: Colored pericarp sorghum, correlation, path analysis, drought, *Rabi* sorghum

Introduction

Sorghum is one of the important cereal crops in the world occupying fifth position after maize, rice, wheat and barley (FAOSTAT 2021) [6]. Sorghum is the staple food in the human diet especially for poor and most food insecure people living in semi-arid tropics (Tonapi *et al.* 2011) [16]. It is used as whole grain or processed into flour, it is gluten free and have essential nutrients (proteins, vitamins and minerals) and nutraceuticals (phenolics, antioxidants and cholesterol lowering waxes) (Assefa *et al.* 2018) [1]. *Rabi* sorghum occupies large area mainly in the states of Maharashtra, Karnataka and Andhra Pradesh with an average productivity of 819 kg/ha (Low). It is an important component of dry land economy irrespective of its low productivity and its area is consistent over many years. Biotic and abiotic stresses are the reasons for low productivity (Bhat and Rao 2014) [2]. Drought is the major abiotic stress limiting crop growth. Water availability to the crop is becoming very essential to meet the production needs as the climate is changing frequently.

Sorghum bicolor is one of C_4 cereal and mainly due to its morphological and anatomical characteristics such as thick leaf wax, deep root system and physiological responses such as osmotic adjustment, stay green, quiescence it is highly suited for the drought environment. This crop can grow in high temperature, high light intensity and low water availability and it is highly efficient in fixing carbon dioxide due to its C_4 photosynthetic pathway (Sasaki and Antonio, 2009) [13]. The color of the sorghum grains varies from pale yellow through various shades of red and brown to deep purple and brown. Seed color ranges from shades of white to various shades of pink, orange, red and even brown, seed color occurs due to influences of pericarp thickness. Yellow pericarp color is not associated with yellow endosperm. Usually, red colored sorghum preferred in brewing industries. Whereas, flavanones which are loaded in yellow sorghum has somewhat higher total phenolic content than white sorghum. Due to existence of pigmented testa and high level of condensed tannins brown sorghum also known as tannin sorghum. Pericarp thickness, presence or absence of pigmented testa and endosperm color are some of the factors affecting sorghum kernel color (Shen *et al.* 2018 and Xiong *et al.* 2020) [14, 18].

Even though sorghum is considered as drought tolerant crop, growth and yield reduction occurs due to water stress. Identification of the traits (especially morphological and physiological) related to drought stress given higher importance in drought related studies. 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) [8]. 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) [11]. The path, coefficient analysis initially suggested by Wright (1921) [17] and described by Dewey and Lu (1959) [4] 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) [7] 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) [10].

Materials and Methods

The present investigation was undertaken to study genetic variability and character associated studies of twenty-seven genotypes of (*Sorghum bicolor* (L.) Moench) including three checks. Twenty-seven genotypes of colored pericarp sorghum including three checks were sown during *Rabi* 2021-22 in Randomized Block Design with two replications. The experiment was conducted at research farm, Department of agricultural botany, VNMKV, Parbhani. All the recommended cultural practices and packages were applied for growing healthy and good crop, in each entry, five plants are randomly selected from each replication and following observations were recorded for seedling vigor, days to 50% flowering, days to physiological maturity, plant height, leaf area index, relative water content, SPAD chlorophyll meter reading, grain yield per plant and fodder yield per plant. To understand the degree of relationship between different characters the genotypic and phenotypic correlation coefficients were carried out from their respective variances and co-variances as suggested by Johnson *et al.* (1955) [9]. The genotypic correlation coefficient among yield and its attributes were classified into direct and indirect effects with the path coefficient analysis as outlined by Sewall Wright (1921) [17] and Dewey and Lu (1959) [4].

Table 1: Genotypic correlation coefficient for grain yield and it's attributing characters in colored pericarp sorghum

	Days to 50% flowering	**Days to physiological maturity**	**Plant height**	**Leaf area index**	**Seedling vigor**	**Relative water content**	**SPAD chlorophyll meter reading**	**Fodder yield per plant**	**Grain yield per Plant**
Days to 50% flowering	1.000								
Days to physiological maturity	0.8928**	1.000							
Plant height	0.185	-0.0533	1.000						
Leaf area index	-0.0857	-0.0617	0.1639	1.000					
Seedling vigor	0.0903	-0.0078	0.0507	-0.3538	1.000				
Relative water Content	-0.2044	-0.1729	0.0655	0.2136	-0.5108 **	1.000			
SPAD chlorophyll Meter reading	-0.4587*	-0.4198 *	0.0599	0.5993 **	-0.6326 **	0.4284 *	1.000		
Fodder yield per Plant	-0.0514	-0.059	0.3086	0.6439 **	-0.4027 *	0.5484 **	0.3927 *	1.000	
Grain yield per Plant	-0.3068	-0.2495	0.013	0.5323 **	-0.7239 **	0.5395 **	0.9766 **	0.4717 *	1.000

*Significant at 5 percent level, **Significant at 1 percent level.

Table 2: Phenotypic correlation coefficient for grain yield and it's attributing characters in colored pericarp sorghum

	Days to 50% flowering	**Days to physiological maturity**	**Plant height**	**Leaf area index**	**Seedling vigor**	**Relative water content**	**SPAD chlorophyll meter reading**	**Fodder yield per plant**	**Grain yield per Plant**
Days to 50% flowering	1.000								
Days to physiological maturity	0.7982 **	1.000							
Plant height	0.1691	-0.0295	1.000						
Leaf area index	-0.0755	-0.059	0.1533	1.000					
Seedling vigor	0.0235	-0.0375	0.013	-0.2455	1.000				
Relative water Content	-0.1725	-0.1771	0.0655	0.1931	-0.4319 **	1.000			
SPAD chlorophyll Meter reading	-0.2548	-0.2869 *	0.0465	0.5327 **	-0.3415 *	0.3602 **	1.000		
Fodder yield per Plant	-0.0688	-0.0667	0.2875 *	0.6226 **	-0.3372 *	0.5143 **	0.2853 *	1.000	
Grain yield per Plant	-0.2955 *	-0.2135	0.0073	0.4693 **	-0.5549 **	0.4795 **	0.7235 **	0.3982 **	1.000

*Significant at 5 percent level, **Significant at 1 percent level

Table 3: Direct and indirect effects (genotypic level) of yield components on grain yield in color pericarp sorghum

	Days to 50% Flowering	Days to Physiologica l Maturity	Plant Height	Leaf Area Index	Seedling Vigor	Relative Water Content	SPAD Chlorophyll meter reading	Fodder Yield	Grain Yield per Plant
Days to 50% Flowering	0.356	0.09682	-0.01961	0.02378	0.00211	-0.00862	-0.53732	-0.01147	-0.3068
Days to Physiological Maturity	0.13168	0.255	0.00565	0.01712	-0.00018	-0.00729	-0.49174	-0.01317	-0.2495
Plant Height	0.02728	-0.00578	-0.055	-0.04551	0.00118	0.00276	0.07017	0.0689	0.013
Leaf Area Index	-0.01264	-0.00669	-0.01738	-0.889	-0.00827	0.00901	0.70201	0.1438	0.5323 **
Seedling Vigor	0.01332	-0.00085	-0.00537	0.09821	0.422	-0.02155	-0.74109	-0.08993	-0.7239 **
Relative Water Content	-0.03015	-0.01875	-0.00694	-0.05928	-0.01194	-0.322	0.50191	0.12246	0.5395 **
SPAD Chlorophyll meter reading	-0.06765	-0.04552	-0.00635	-0.16634	-0.01478	0.01807	1.134	0.0877	0.9766 **
Fodder Yield	-0.00758	-0.00639	-0.03271	-0.17874	-0.00941	0.02313	0.46008	1.645	0.4717 *

R = 0.338*
Significant at 5 percent level, **Significant at 1 percent level

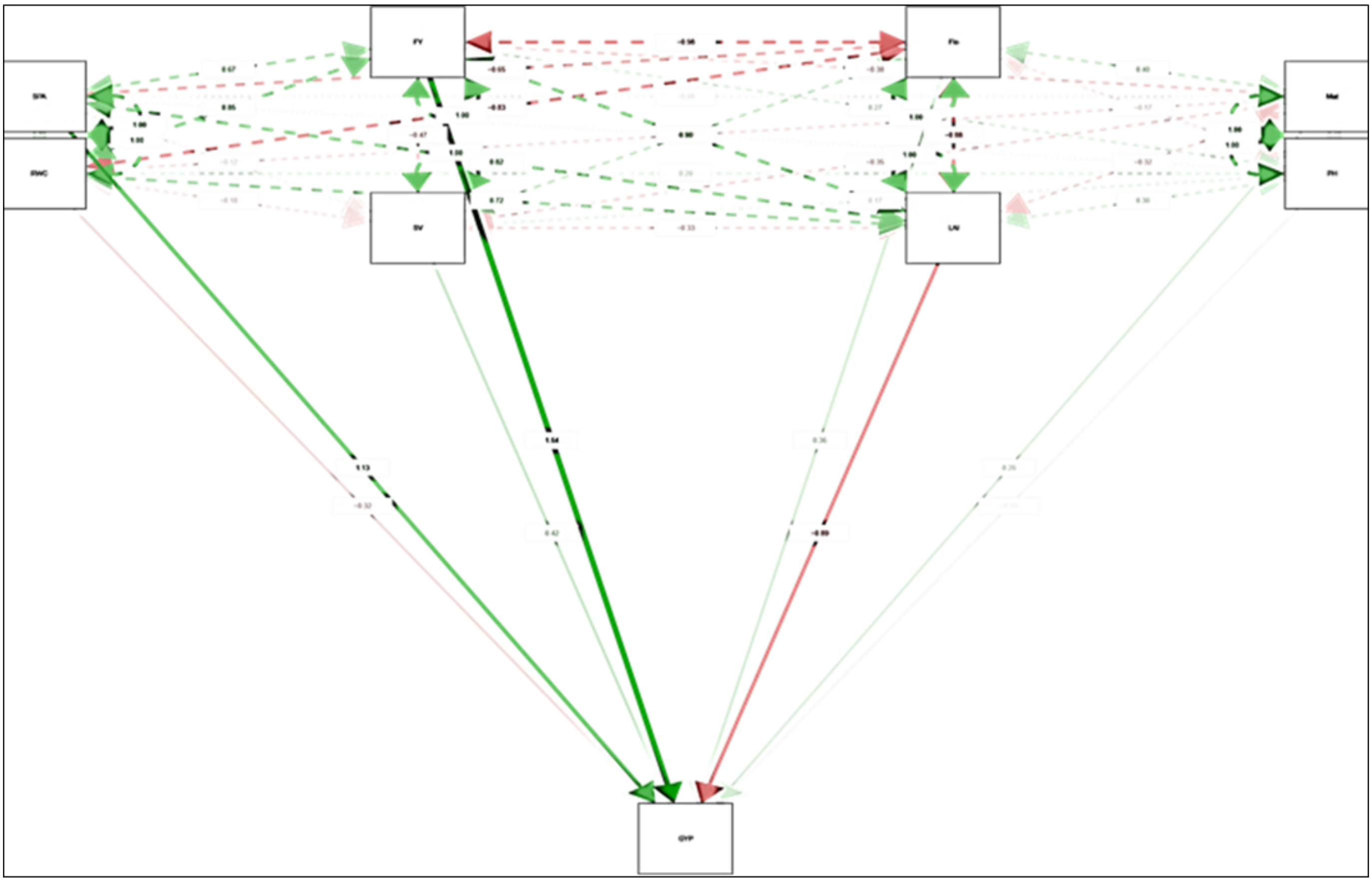

Fig 1: Genotypic path diagram for grain yield & its attributing traits in colored pericarp sorghum

Table 4: Direct and indirect effects (phenotypic level) of yield components on grain yield in color pericarp sorghum

	Days to 50% Flowering	Days to Physiological Maturity	Plant Height	Leaf Area Index	Seedling Vigor	Relative Water Content	SPAD Chlorophyll meter reading	Fodder Yield per plant	Grain Yield per Plant
Days to 50% Flowering	0.00	0.12126	0.00048	-0.00449	-0.0067	-0.02008	-0.13202	-0.00341	-0.2955 *
Days to Physiological Maturity	-0.19999	0.264	-0.00008	-0.0035	0.01071	-0.0206	-0.14865	-0.0033	-0.2135
Plant Height	-0.04237	-0.00448	-0.012	0.00911	-0.0037	0.00762	0.02404	0.01424	0.0073
Leaf Area Index	0.01892	-0.00895	0.00044	-0.505	0.07	0.02245	0.27605	0.03083	0.4693 **
Seedling Vigor	-0.00589	-0.00571	0.00004	-0.01461	0.305	-0.05025	-0.17688	-0.0167	-0.5549 **
Relative Water Content	0.04325	-0.02691	0.00019	0.01148	0.12306	-0.149	0.18662	0.02547	0.4795 **
SPAD Chlorophyll meter reading	0.06384	-0.04359	0.00013	0.03169	0.09727	0.04191	1.161	0.01413	0.7235 **
Fodder Yield	0.01724	-0.01013	0.00082	0.03703	0.09607	0.05984	0.14782	0.718	0.3982 **

R = 0.322
* Significant at 5 percent level, **Significant at 1 percent level

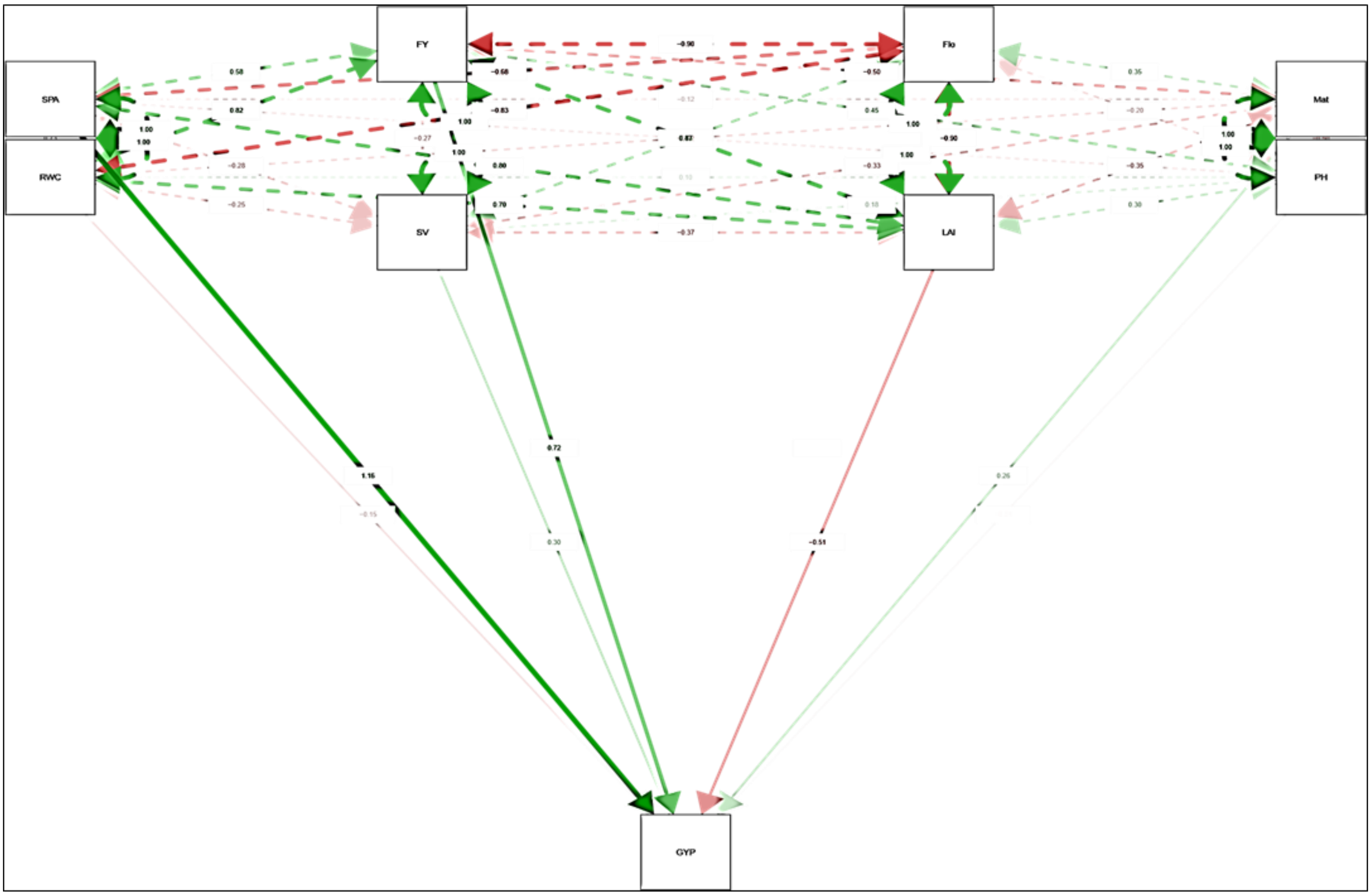

Fig 2: Phenotypic path diagram for grain yield & its attributing traits in colored pericarp sorghum

Results and Discussion

In the present study, (Table 1 and 2) significant and positive correlation of grain yield per plant was observed with traits *viz.*, leaf area index (G=0.5323, P=0.4693), relative water content (G=0.5395, P=0.4795), SPAD chlorophyll meter reading (G=0.9766, P=0.7235) and fodder yield per plant (G=0.4717, P=0.3982). With regards to seedling vigor, correlation in negative direction is desirable as the lower score represents high seedling vigor and higher score represent the lower one. Grain yield per plant exhibited significant association in desirable direction with seedling vigor (G = -0.7239, P = -0.5549) at both genotypic and phenotypic levels. The traits under evaluation confers a tolerance to varying degrees under drought conditions (Dhutmal *et al*. (2015) [5], Zinzala *et al.* (2018) [19]. These traits had significant contribution in the expression of grain yield in same direction. Such strong relation in either direction between the traits indicates that they are heritable and genetically controlled characters which could be inherited into desired genotypes. Selection may be practiced in positive or negative direction based on these characters towards improved grain yield. Results revealed the presence of large of scope for a breeder in selecting superior genotypes for grain yield under moisture deficit conditions commonly prevailed during post flowering growth stages in *Rabi* sorghum. Simultaneous increment in the grain as well as fodder yield as indicated by strong correlation in desirable direction is rewarding for the development of dual-purpose *Rabi* adopted colored pericarp sorghum suitable for *Rabi* sorghum areas where it is mostly cultivated on residual soil moisture.

These results are in agreement with the results reported by Cheralu and Rao (1989) [3] for grain yield, for fodder yield, Nirmal *et al.* (2013) [12] for Leaf area index Dhutmal *et al*. (2015) [5] for Relative water content and SPAD chlorophyll meter reading.

Path analysis creates a decision for grain yield improvement *i.e.*, to carry out the indirect selection for the trait which shows direct effect on the grain yield. Selection for a trait is effective when both the values of correlation and direct effect are higher and positive as this indicates its true association. Simultaneous consideration is made for indirect caused factors for selection if the direct effect is negative or negligible and correlation coefficient is positive. In order to reduce undesirable indirect effect, direct selection for the traits is followed if the direct effect is positive or high and correlation coefficient is negative.

The tables 3 and 4 represent the Direct and indirect effects at genotypic and phenotypic level for nine characters respectively.

Present study revealed presence of positive direct effect on grain yield for traits like days to 50 percent flowering (G= 0.359, P=0.00), days to physiological maturity (G= 0.255, P= 0.264), seedling vigor (G=0.422, P=0.305), SPAD chlorophyll meter reading (G=1.134, P=1.161) and fodder yield per plant (G=1.645, P=0.718) at both genotypic as well as phenotypic level. Results of the current investigation are in agreement with Dhutmal *et al*. (2015) [5] who reported positive direct effect of chlorophyll content on grain yield, Sushil *et al.* (2017) [15] days to 50 percent flowering and days to physiological maturity and Zinzala *et al.* (2018) [19] for fodder yield per plant.

Among all the traits negative direct effect on grain yield recorded for plant height (G=-0.055, P= -0.012), leaf area index (G= -0.889, P=-0.505) and relative water content (G=-0.322, P= -0.149) at both genotypic and phenotypic level.
Maximum positive indirect effect the trait SPAD chlorophyll meter reading (G=0.9766, P= 0.7435) and maximum negative indirect effect on grain yield recorded for the trait seedling vigor (G=-0.7339, P=-0.5549) at both genotypic and phenotypic level. At genotypic level residual effect value is 0.338 and at phenotypic level also the residual effect value is 0.322, this indicates almost the grain yield is due to the factors studied.

Conclusion

The approach to enhance sorghum yield should thus be comprehensive and take into account the direct and indirect involvement of each individual character. But there is clearly a limit to the number of characters that can be enhanced at the same time in any breeding method. Even with the use of molecular markers to assist selection, not many characters can be efficiently handled at one time because many of these characters are quantitative and several genes or genomic regions may account for their appearance. Thus, the breeder must make a pick between the many apparently related characters and spotlight on those that are most essential.
Thus, it may be concluded from present investigation that grain yield had significant association in desired direction with leaf area index, seedling vigor, relative water content, SPAD chlorophyll meter reading and fodder yield per plant. These drought tolerance related traits could serve as imperative characters in any selection programme for high yielding colored pericarp sorghum. The characteristics like relative water content, SPAD chlorophyll meter reading and fodder yield per plant had greater importance for indirect selection for grain yield, so these traits should be given due consideration while planning a breeding program for increased in grain yield in colored pericarp *Rabi* sorghum.

References

1. Assefa S, Shimelis H, Mwadzingeni L, Laing M. Agro-morphological characterisation and selection of sorghum landraces. Acta Agriculture Scandinavica, Section B-Soil and Plant science. 2018;68(7):585-595.
2. Bhat P, Rao SS. Early-maturing postrainy (rabi) season sorghum elite lines with enhanced drought tolerance; c2014. p. 1-6.
3. Cheralu C, Rao PG. Genetic variability and character association for yield and yield components in winter sorghum. J Res. A.P.A.U. 1989;17(1):4-7.
4. Dewey DR, Lu KH. A correlation and path analysis of components of Crested wheat grass seed production, Agron. J. 1959;51:513-518.
5. Dhutmal RR, Kalpande HV, More AW. Correlation and path analysis in drought tolerant Rabi sorghum. Ann. PI. Soil Res. 2015b;17(4):404-408.
6. FAOSTAT. Food and Agriculture Organization of the United Nations Database of agricultural production. FAO Statistical Databases; c2021.
7. Ikanovic J. Genotypic and phenotypic specificity of sorghum varieties, Sudan grass and their interspecific hybrids. Ph.D. Thesis, Faculty of Agriculture in Belgrade, Belgrade University, New York; c2010.
8. Ikanovic J, Djordje J, Radojka M, Vera P, Dejan Marija S, Sveto R. Path analysis of the productive traits in sorghum species. Genetika. 2011;43(2):253-262.
9. Johnson HW, Robinson HF, Comstock RE. Genotypic and Phenotypic correlation in soybean and their implication Selection. Agron J. 1955;47:477-485.
10. Lzge AU, Kadams AM, Gungula DT. Studies on character association and path analysis of certain quantitative characters among parental lines of pearl millet (*Pennisetum glaucum* L.) and their F1 hybrids in a diallel cross. African Journal of Agricultural Research. 2006;1(5):194-198.
11. Mahajan RC, Wadikar PB, Pole SP, Dhuppe MV. Variability, correlation and path analysis studies in sorghum. Research Journal of Agriculural Sciences. 2011;2(1):101-103.
12. Nirmal SV, Gadakh SR, Gaikawad AR, Patil VR. Phule Anuradha, New drought tolerant Rabi sorghum variety for shallow soil. Int. J Agric. Sci. 2013;9(2):799-801.
13. Sasaki T, Antonio BA. Sorghum in sequence; c2009. p. 457.
14. Shen S, Huang R, Li C, Wu W, Chen H, Shi J, *et al*. Phenolic compositions and antioxidant activities differ significantly among sorghum grains with different applications. Molecules. 2018;23(5):1203.
15. Sushil K. Studies on relationship among yield components and selection criteria for yield improvement in sorghum. International Journal of Plant Sciences. 2017;12(2):156-159.
16. Tonapi VA, Patil J, Rao BD, Elangovan M, Bhat BV, Rao KR. Vision 2030 Sorghum. Hyderabad: Directorate of Sorghum Research; c2011.
17. Wright S. Correlation and causation. Journal of Agricultural Research. 1921;20:557-587.
18. Xiong Y, Zhang P, Warner RD, Shen S, Fang Z. Cereal grain-based functional beverages, from cereal grain bioactive phytochemicals to beverage processing technologies, health benefits and product features. Critical Reviews in Food Science and Nutrition. 2020;(18):1-25.
19. Zinzala S, Davda BK, Modha KG, Pathak VD. Studies on variability, correlation and path coefficient analysis in sorghum (*Sorghum bicolor* (L). Moench). International Journal of Agriculture Sciences. 2018;10(19):7285-7287.