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Variability, Heritability and Genotypic advance of *Sorghum* (*Sorghum bicolor* L. Moench) Landraces

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ABSTRACT

Few studies have been undertaken on the existing Sorghum diversity in Metekel zone agricultural areas of Ethiopia. Hence, the objective of this study was to determine the extent and degree of genotypic and phenotypic variability in yield and yield related quantitative traits of Sorghum landrace collections of the area. 25 Sorghum landraces and one regionally released Sorghum variety called 'Emohay' as a check were tested in Randomized Complete Design (RCBD) with three replications during 20011/2012 rainfed cropping season for a year at Pawe district. A plot size of 7.5 m^2 with two rows and 5 m length with spacing of 0.75 m between rows, 0.15 m between plants and 1.5 m between blocks was used. The analysis of variance revealed the existence of a significant variability among the landraces for most quantitative traits. 11 Sorghum landraces with a better grain yield performance ranging between 41.38 to 48.9 q/ha were obtained indicating the possibility of identifying superior genotypes to be selected among the landraces. A Sorghum landrace with an accession number of 021 pw-2010 was identified as the highest grain yielder (48.9 q/ha). The lowest ratio of GCV to PCV was obtained for days to 95% maturity while the highest PCV to GCV ratio was obtained for plant height. Generally, a lower ratio of genotypic variance to phenotypic variance were recorded for days to flowering, days to maturity, leaf length, leaf width, single leaf area, number of leaves per a plant, plant height, head length, head width, head weight and grain yield indicating that the traits will be highly influenced by the environment.

Keywords: Genetic advance; Heritability; *Sorghum* landraces; Traits; Variability

Introduction

In Ethiopia, *Sorghum* is an important food crop (as a forage for animals and injera (flat pancake like traditional bread) and a local drink as 'tela' and 'areke') and is widely grown in the high land, low land and semi arid areas of the country including Metekel zone where the areas of land race collections are located which are the area of *Sorghum* domestication with a high genetic diversity of cultivated *Sorghum* and its wild forms. As one of the leading traditional food cereals in Ethiopia, in terms of both total production and area, major research efforts have been directed towards the improvement and stabilization of *Sorghum* yields [1].

Nationally, *Sorghum* improvement involves the manipulation of indigenous and introduced germplasm to develop adapted varieties for various ecological zones [2]. It has been noted that systematic characterizations and evaluation of plant genetic resources are basics for the efficient use of material through conventional methods bringing genetic improvement of the crops for quantitative traits which requires reliable estimates of genetic variability and advancement in respect to the breeding material that is presently at hand in order to plan an efficient breeding program. However, the diversity of *Sorghum* is high in Ethiopia, the extent and distribution of the genetic variability of the crop in different areas with different agro-ecology has not been properly studied yet including the study area. Thus, this study was aimed at determining the extent and degree of variability in morpho agronomic quantitative characters of different *Sorghum* landrace collections.

Materials and Methods

Description of the experimental site

The experiment was conducted at Pawe district of north western Ethiopia, from mid-2011 to early 2012 main cropping rainfed season using a collection of *Sorghum* landraces collected from five districts of Metekel zone in Benishangul-gumuze regional state which is located at about 580 km north west of Addis Ababa and 230 km from Bahir Dar at 36o25`E longitude, 11o12'N latitude and at an altitude of 1150 meters above sea level. The area is characterized by hot humid conditions with mean maximum and minimum temperatures of 32^{o}C and 16^{o}C respectively with the annual rainfall ranging from 1500-1800 mm with five and half months rainy season [3]. The total rainfall during the growing this research season was about 1659 mm. The soil type is haplic-acrisols, very deep (>150 cm) and clay in texture with a soil pH ranging from 5.5 to 6.9 where the subsurface soils have higher pH values than surface soils [4]. The organic carbon (0.2 to 2.8%) and total nitrogen (0.02 to 0.19%) contents of the soil decrease with soil depth.

Experimental materials

Twenty five landraces and one standard check in Table 1 were tested though a landrace with an accession number 032 pw-2010 did not emerge in all plots [5]. The landraces were received from Pawe agricultural research center and the local check is a released variety recommended for high and intermediate altitude zones in the country.

Experimental design and procedures

The Randomized Complete Block Design (RCBD) with 3 replications was used. Each treatment was planted in a plot area of 7.5 m^2 (2 rows, each 5 m long, with a spacing of 0.75 m between rows, 0.15 m between treatments and 1.5 m between blocks). During planting the seeds were drilled in rows [6]. Inorganic fertilizers such as DAP (100 kgh^{-1}) and Urea (50 $kgha^{-1}$) were applied at planting and vegetative stages of the crop, respectively.

Measurements and observations were recorded following the IBPGR and ICRISAT descriptor list. The quantitative traits such as numbers of leaves per plant, leaf length (cm) leaf width (cm), single leaf area (cm^2), plant height (cm), head length (cm), head width (cm) and head weight (g) were collected and measured by taking the mean value of five sampled plants, which were tagged randomly before the time of data collection [7]. Days to emergence, days to flowering, days to maturity were also collected and measured on plot bases.

Statistical analysis

Analysis of Variance (ANOVA) was performed in Table 2 for each measured quantitative trait in RCBD ANOVA in order to compare the relative importance of main model terms: Replication (r), Genotype (g) and Error (e) on 11 quantitative traits to explore the level of variation among twenty-five collection of *Sorghum* landraces using SAS statistical computer software with version 9.2 [8].

The RCBD ANOVA was computed using the mathematical model:

$$Y_{ij}=\mu+r_j+g_i+e_{ij}$$

Where

Y_{ij}=the observation of the i^{th} treatment in the j^{th} replication,

r_j=the effect of the j^{th} replication and

g_i=the effect of the i^{th} treatment,

e_{ij}=experimental error effect [9].

The genetic parameters (Phenotypic and genotypic variances) were estimated from the expected mean squares using the random model where the expected mean squares considered according to Falconer as:

$$(\delta^2 g)=MSg-MSe/r$$

Where, $\delta^2 g$ is genotypic variance,

MSg is genotypic mean square,

MSe=Error Mean Squares,

r is the number of replications [10].

$(\delta^2 p)=\delta^2 g+\delta^2 e=MSg/r$

Where

$\delta^2 g$ is phenotypic variance;

$\delta^2 e$ is environmental variance

where

$\delta^2 e=MSe/r$

The presence of variability was also estimated using phenotypic variance, genotypic variance, Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV). The PCV and GCV were calculated according to the Burton method as:

$$\mathbf{PCV} = \sqrt{\delta^2{}_p} \;/\; (\bar{\mathrm{y}})\, x100 \;;\; GCV = \sqrt{\delta^2{}_g} \;/\; (\bar{\mathrm{y}})\, x100$$

Where $\bar{Y}$ is mean value of trait Y.

Estimation of broad sense Heritability (H)

Although the genotypic coefficient of variation revealed the extent of genetic variability present in the landraces for various traits, it does not provide full scope to assess the heritable variation among the quantitative traits of the treatments which is useful for permanent genetic improvement due to its predictive role to indicate heritability of the phenotypic value as a guide to breeding value [11]. Heritability in broad sense (H) for all the traits was computed using the formula given by Falconer which is expressed as a percentage of the ratio of the genotypic variance ($\delta^2 g$) to the phenotypic variance ($\delta^2 p$) and was estimated on genotype mean base as described by Allard [12].

Heritability (H)=$\delta^2 g/\delta^2 p \times 100$

Where

H is heritability in broad sense,

($\delta^2 g$) is genotypic variance, and

($\delta^2 p$) is phenotypic variance.

Estimation of genotypic advance

Genotypic Advance in absolute unit (GA) and as percent of the Mean (GAM), assumed selection of superior 5% of the genotypes was estimated in accordance with the methods illustrated by Johnson, et al. as:

GA=K $\delta^2 p$ H

Where

K is the standardized selection differential of 5% selection intensity [13].

(K=2.063), $\delta^2 p$ is phenotypic standard deviation on mean basis; H is heritability in broad sense. Genetic advance as percent of the mean was calculated to compare the extent of predicted advance of different traits under selection, using the formula:

$$GAM = \frac{GA}{\bar{x}} x100,$$

Where

$\bar{x}$ is mean of the population where selection employed.

Accession No	Local name	Collection area	Altitude	Seed colour	Accession No	Local name	Collection area	Altitude	Seed colour
033 pw-2010	Bobea	V.49	894	Red	021pw-2010	Jarsisa	Iccid	890	White
037 pw-2010	Bobea	V.1	1044	Brown	050pw-2010	Bobea	Dibate	-	White
035 pw-2010	Bobea	V.1	1044	White	056pw-2010	Bobea	Dibate	-	White
043 pw-2010	Bobea	G/beless	980	Brown	005pw-2010	Bobea	V.23	-	Red
044 pw-2010	Bobea	V.1	1044	White	049pw-2010	Bobea	Baruda	-	Red
045 pw-2010	Bobea	V.1	1044	Red	055pw-2010	Bobea	Zeghe	-	White
026 pw-2010	Auto	Icide	915	Brown	031pw-2010	Bobea	V.1	1044	White
030 pw-2010	Auto	Icide	915	Brown	032pw-2010	Bobea	V.49	894	White
047 pw-2010	Bobea	Baruda	-	red	027pw-2010	Auto	Iccid	915	Red
001 pw-2010	Mehareb	Almehal	680	White	041pw-2010	Bobea	V.1	1044	White
003 pw-2010	Tirequash	Almehal	685	White	042pw-2010	Bobea	V.1	1044	Red
012 pw-2010	Gergesa	Banguze	808	White	023pw-2010	-	Dechagree	862	Brown
020 pw-	Drisisa	Icica	890	White	Emohay	-	-	-	Brown
Where: V-1=Village 1; V-49=Village 49									

Table 1: List of the *Sorghum* landraces and the standard check.

Source of variation	df	Mean square	Expected mean
Replications	(r-1)	MSr	δ^2e-gδ^2r
Genotypes	(g-1)	MSg	δ^2e-rδ^2g
Error	(r-1) (g-1)	MSe	δ^2e
Total	rg-1		
Where: DF: Degrees of Freedom; r: Number of replications; g: Number of genotypes; MSr: Mean Square of replications; MSg: Mean Square of renotypes; MSe: Mean Square of Error.			

Table 2: Analysis of variance for 11 traits for the 25 *Sorghum* landraces.

Results and Discussion

Variability of the measured quantitative traits

Morphological variation with the tested quantitative characters was recorded among 25 landraces of *Sorghum bicolour* collected from different areas of Metekel zone, Ethiopia [14]. The ANOVA results of 11 quantitative traits of the *Sorghum* land race collections indicated that there was a significant difference among the tested landraces ($P \leq 0.05$) for their days to 50% flowering, days to 85% maturity, number of leaves per a plant, plant height, head weight and grain yield. A high significant difference was also observed ($p<0.01$) for their traits of leaf length, single leaf area and head length. But the land races were not significantly varied for the traits of head width and leaf width

[15]. The observed significant variations indicated the presence of genetic variability among the *Sorghum* landraces for those traits with a significant mean square value (Table 3) [16].

A higher variation for a trait in the breeding materials correlates with a greater ability for its improvement through selection and a Coefficient of Variation (CV) is important for comparing the variability in experiments with variables measured in different units. A large coefficient of variation (usually a CV>30%) is often associated with increased experimental variability [17]. Therefore, a grain yield with the highest Coefficient of Variation (CV=19.08) has a greatest ability to be improved through selection and days to 50% flowering with a lowest value of Coefficient of Variation (CV=2.65) correlated with the least ability for its improvement among the measured quantitative traits. A non-significant mean square value observed for leaf width and head width showed that the *Sorghum* land race collections are genetically almost similar concerning these two characters indicating that selecting for these characters will not show any impact on the genetic improvement of the landraces [18]. Previous studies indicated a significant variation for many of the traits like head length and head width, days to 95% maturity. Negash also reported that days to 95% maturity, leaf width, leaf length, leaf area, plant height and grain yield have a significant difference between *Sorghum* landraces collection from Western region of Ethiopia.

Source of variation	**Mean Squares**											
	df	DTF	DTM	LFW	LFL	SLA	NOL	PH	HL	HW	HWt	GRY
Replication	2	0.04	287.5	0.14	59.69	2583.82	3.09	1435.88	9.75	4.85	3.18	1272149
Genotype	24	399.94*	273.61*	1.79	202.99*	2541 1.48**	12.62*	975 1.24*	60.28**	3.29	313.88*	6710 61.10*
Error	48	1.94	17.92	0.52	12.44	4941.29	0.74	418.65	4.38	1.34	172.35	325204.4
R^2		0.95	0.89	0.63	0.89	0.72	0.89	0.92	0.87	0.57	0.47	0.54
C.V		2.65	2.68	10.22	3.54	10.01	6.19	5.79	7.13	14.42	15.97	19.08

*: Significant at 0.05 level of significance, **: Significant at 0.01 level of significance, R^2: Efficiency of the model, CV: Coef-ficient of Variation; DTF: Days To 50% Flowering; DTM: Days To 85% Maturity; LFW: Leaf Width; LFL: Leaf Length; SLA: Single Leaf Area; NOL: Number of Leaves per plant; PH: Plant Height; HL: Head Length; HW: Head Width; HWt: Head Weight; GRY: Grain Yield in gram per plot; DF: Degrees of Freedom

Table 3: Effects of sowing date on leave area and number of branches per plant of selected variety of soyabean.

Variability estimates of the *Sorghum* landraces based on 11 quantitative traits

A wide range of values in the collected quantitative traits was observed in Table 4. The *Sorghum* landraces showed a range of variability in their days to 50% flowering (41-128 days), days to 95% maturity (130-170 days), leaf length (71.8-112.8 cm), number of leaves (458-895), leaf width (8-17 cm) and in single leaf area (7.07-9.6 cm^2) with a broad range of variability in their grain yield per plot (4538 gram to 2174 gram) or 60 quintal per hectare to 28.9 quintal per hectare). Mean grain yield of the landraces was 2988.63 g/plot that is 39.84 q/ha.

The landrace with an accession number of 021 PW-2010 was the highest yielder landrace (48.9 q/ha) which is almost less by 11 quintals when compared to the local check variety called 'Emohay' having a grain yield potential of 60 quintal per hectare [19]. 11 landraces gave a grain yield ranging between 40.20–40.00 quintal per hectare showing an indication for the possibility of developing high grain yielding *Sorghum* varieties from the available *Sorghum* landrace collections for Pawe and other agroecologically similar areas of north-western Ethiopia.

Formerly, a mature *Sorghum* leaves with a width of 6.5 to 13.46 cm at the widest point and the number of leaves on the main stem which vary approximately from 7 to 21 was reported. In a related study, a leaf length ranged from 45.22 to 126.37 cm was also reported. The variability in plant height among the landraces was high and ranged between 423 to 203 cm. Variability in plant height of Ethiopian *Sorghum* ranged from 72 to 61.5 cm has been reported by Berhane and Yilma. Variation in head length ranged from 43.20 to 19.00 cm, a head weight ranged from 120.80 to 47.00 gm and head width ranged from 12 to 5 cm were also observed in this study. Almost similar result with study was obtained by Wasihun.

So as to strengthen the presence of the evaluated *Sorghum* landraces based on their quantitative traits, different variability statistical parameters such as Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV) of each trait were calculated to determine the patterns of genetic variation among the characterized *Sorghum* landraces. Generally, the GCV were lower in magnitude than the PCV. Similar results were obtained by Bello, et al. while studying the genetic variability of the cultivated *Sorghums*. Abdi, et al. and Addisu also reported a variability result on the quantitative characteristics of different *Sorghum* germplasms [20]. So as to strengthen the presence of the evaluated *Sorghum* landraces based on their quantitative traits, different variability statistical parameters such as Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV) of each trait were calculated to determine the patterns of genetic variation among the characterized *Sorghum* landraces (Table 4). Generally, the GCV were lower in magnitude than the PCV. Similar results were obtained by Bello, et al. while studying the genetic variability of the cultivated *Sorghums*. Abdi, et al. and Addisu also reported a variability result on the quantitative characteristics of different *Sorghum* germplasms.

Traits	N	R	Min.	Max.	Mean	MSg	MSE	GV	PV	GCV	PCV	H	GA	GAM
DTF	75	41	87	128	113.64	399.94	1.94	130.27	133.31	10.1	10.2	97.8	5.78	5.1
DTM	75	40	130	170	157.83	273.61	17.92	85.23	91.2	5.9	6.1	93.5	2.06	12.7
LFW	75	4.8	4.8	9.6	7.07	1.79	0.52	0.42	0.6	9.2	11	70	1.39	19.7
LFL	75	41	71.8	112.8	99.61	202.99	12.44	63.52	67.66	8	8.3	93.9	16.83	16.9
SLA	75	437	458	895	702.31	25411.48	4941.29	8453.86	8470.3	13	13.1	99.8	220.96	31.5
NOL	75	9	8	17	13.88	12.62	0.74	3.96	4.24	14.4	14.8	94.3	4.2	30.3
PH	75	220	203	423	353.19	9751.24	418.65	3110.86	3250.4	15.8	16.2	95.7	116.35	33
HL	75	24.2	19	43.2	29.33	60.28	4.38	18.63	20.09	14.8	15.3	92.8	9.64	32.9
HW	75	7	5	12	8.04	3.29	1.34	0.65	1.09	10.1	13	59.7	1.77	22.1
HWt	75	73.8	47	120.8	82.19	313.88	172.35	47.18	104.63	8.4	12.5	45.1	13.6	16.6
GRY	75	2364	2174	4538	2988.6	671061.1	325204.4	115285.6	223687	11.4	15.9	51.6	724.31	24.33

DTF: Days to 50% Flowering; DTM: Days to 95% Maturity; LFW: Leaf Width (cm), LFL: Leaf Length (cm), SLA: Single Leaf Area (cm^2); NOL: Number of Leaves per plant; PH: Plant Height (cm); HL: Head Length (cm); HW: Head Width (cm); HWt: Head Weight (g); GRY: Grain Yield (g), N: Number of Observations; R: Range; Min: Minimum Value; Max: Maximum Value; MSg: Mean Square of Genotype; MSE: Mean Square of Error; SD: Standard Deviation; GV: Genotypic Variance; PV: Pheno-typic Variance; GCV: Genotypic Coefficient of Variation; PCV: Phenotypic Coefficient of Variation; H: Heritability; GA-Genetic Advance; GAM: Genetic Advance as Percent of the Mean

Table 4: Genetic parameters for eleven quantitative traits in *Sorghum* genotypes.

The phenotypic and genotypic variation among the *Sorghum* landraces

Across the eleven characters, the Genotypic and Phenotypic Coefficient of Variation (GCV and PCV) ranged from 5.9% to 6.1% for days to 95% maturity and 15.8% to 16.2% for plant height, respectively. Negash and Wasihun obtained the lowest PCV and GCV for days to 95% maturity. Addisu also reported the lowest genotypic and phenotypic coefficients of variation for 95% days to maturity (8.22% and 8.75% respectively) but in contrast, he recorded the highest GCV and PCV for days to 50% flowering [21]. Godbharle, et al. reported high genotypic and phenotypic coefficient of variation for plant height, head width and head length, and low GCV and PCV for days to flowering (5.86% and 6.85% respectively). If the PCV was higher than the GCV for the traits, the traits will be highly influenced by environment and the reverse is true. The high ratios of the phenotypic variance to genotypic variance for days to flowering, days to maturity, leaf length, leaf width, single leaf area, number of leaves per plant, plant height, head length, head width, head weight and grain yield indicated that the traits will be highly influenced by environment.

The broad sense heritability estimates of the quantitative traits

High heritability estimates for single leaf area (99.62%), days to 50% flowering (97.8%), plant height (95.7%), number of leaves per plant (94.3%), leaf length (93.9%), and days to 95% maturity (93.5%) and leaf width (70%) were obtained, indicating a high response of these traits to the phenotypic selection of the *Sorghum* landraces. Similarly, a high heritability for head length (96%), days to 50% flowering (95%), and days to 95% maturity (99%) was reported by Bello, et al., Mahajan, et al. also reported a high heritability estimate for plant height (92.12%), head width (92.97%) and days to 50% maturity (89.57%). With the same fashion, Deepalakshmi and Ganesamurthy reported a high heritability in days to 50% flowering (94.6%), 95% days to maturity (90.80%). Negash also reported a high heritability for days to 50% flowering (77%), plant height (78.50%) and head length (84.80%). Wasihun also reported high heritability for days to 50% flowering (97%), days to 95% maturity (99%), leaf length (75%), single leaf area (75%), and plant height (94%) [22].

According to Singh, if heritability of a trait is very high, say 80% or more, selection for that trait is easy, but the masking effect of the environment is high on traits with low heritability (less than 40%) [23]. Therefore, selection for single leaf area (99.62%), days to 50% flowering (97.8%), plant height (95.7%), number of leaves per plant (94.3%), leaf length (93.9%) and 95% days to maturity (93.5%) will be easy for plant breeders. A low heritability estimates for head width (59.7%), head weight (45.1%) and grain yield (51.6%) was recorded in the present study indicating that the masking effect of the environment is high on these traits and selection for the traits will not be easy for the *Sorghum* breeder. Far with the result of the present study, Deepalakshmi and Ganesamurthy and Wasihun reported a high heritability for head weight (96.90%) and grain yield (94%) respectively. A lowest heritability in head weight (45.10%) and a highest heritability in single leaf area (99.62%) were observed. Bellow, et al. reported a lowest heritability in grain yield (10%) but Deepalakshmi and Ganesamurthy reported the highest heritability in grain yield (98.7%). In general, from the observed high heritability estimates for most quantitative traits of the studied *Sorghum* landraces, it is possible to recommend that selection for those quantitative traits would be effective [24].

Estimates of the Genotypic Advance (GA) of the *Sorghum* landrace collections

The genotypic coefficient of variation along with heritability estimate provides reliable estimates of the amount of genetic advance expected through phenotypic selection. In this study estimate of Genetic Advance (GA) ranged from 1.39 cm for leaf width to 724.31 gram per plot or 9.65 quintal per hectare for grain yield [25]. That is the resultant population obtained after crossing the best 5% of the *Sorghum* landraces will produce a new population whose leaf width is increased by 1.39 cm and whose yield is better than the older population by 9.65 quintal per hectare. Low predicted response to selection was observed for leaf length (16.83 cm), head weight (13.6 cm), head length (9.64 cm), days to 50% flowering (5.78 days), number of leaves per plant (4.20) and days to 95% maturity (2.06), head width (1.77 cm) and for leaf width (1.39 cm). A higher value of genotypic advance was observed for single leaf area (220.96 cm^2), plant height (116.35 cm) and grain yield (724.31 g/plot or 9.65 q/ha). Wasihun reported high values of Genetic Advance (GA) for grain yield (880.33 g/plot) and single leaf area (152.25 cm^2). Negash also reported high values of genetic advance for plant height (82.2 cm) and single leaf area (91.3 cm^2) with a genetic advance less than 10 for number of leaves per plant, head length, head width and head weight. Godbharle, et al. reported a high value of genetic advance in kharif *Sorghum* [26]. Deepalakshmi and Ganesamurthy also reported high values of genetic advance for plant height (31.45 cm) and head length (29.12 cm).

Negash also reported high values of genetic advance for plant height (82.2 cm) and single leaf area (91.3 cm^2) with a genetic advance less than 10 for number of leaves per plant, head length, head width and head weight. Godbharle, et al. reported a high value of genetic advance in kharif *Sorghum*. Deepalakshmi and Ganesamurthy also reported high values of genetic advance for plant height (31.45 c m) and head length (29.12 cm).

The estimate of Genetic Advance as percent of the Mean (GAM) as percent of the mean helps in understanding the type of gene action involved in expressing various polygenic characters when considered jointly with heritability. High value of GAM is an indicative of additive gene action whereas low values are indicative of non-additive gene action. Thus, days to 50% flowering estimated high heritability (97.8%) and low genetic advance as percent of the mean (5.78%) indicating that this character is affected by environment and is controlled by non-additive gene action and it will have poor response for selection. Days to 95% maturity (H=93.5%; GAM=12.7%), leaf width (H=70%; GAM=19.7%), leaf length (H=93.9%; GAM =16.9%), head length (H=92.8; GAM=32.9%), head width (H=45.1%; GAM=16.6%), and grain yield (H=51.6%; GAM=24.33%), which expressed high heritability with moderate GAM, appeared less affected by environmental fluctuations and governed by both additive and non-additive gene action, suggesting the possibility of improving these traits through simple selection which has been also confirmed by Deepalakshmi and Ganesamurthy and Godbharle, et al.

Conclusion

The observed significant mean square value from the statistical analysis of variance for the quantitative traits suggests that there is variability between the *Sorghum* landraces. The obtained range of variability for days to 50% flowering, days to 95% maturity, grain yield, plant height, head length, head weight, head width, and in their leaf width and leaf length confirms the presence of variability among the *Sorghum* landraces directing the possibility of improving the landraces. The recorded high ratios of the Phenotypic Variance (PV) to Genotypic Variance (GV) for days to 95% maturity, leaf length, leaf width, single leaf area, number of leaves per plant, plant height, head length, head width, head weight and grain yield indicates that these traits will be highly influenced by the environment.

A high heritability (more than 80%) of single leaf area (99.62%), days to 50% flowering (97.8%), plant height (95.7%), number of leaves per plant (94.3%), leaf length (93.9%) and 95% days to maturity (93.5%) confirms that selection based on these traits will be easy for plant breeders. A lower heritability for head width (59.7%), head weight (45.1%) and grain yield (51.6%) indicate that the masking effect of the environment is relatively high on these traits and selection of the *Sorghum* landraces based on these traits will not be easy.

An estimate of a high heritability (97.8%) and a low genetic advance as percent of the mean (5.78%) for days to 50% flowering indicates that the observed variability on the trait is affected by environment and is co ntrolled by non-additive gene action saying that it will have a poor response for selection. Days to 95% maturity (H=93.5%; GAM=12.7%), leaf width (H=70%; GAM=19.7%), leaf length (H=93.9%; GAM=16.9%), head length (H=92.8; GAM=32.9%), head width (H=45.1%; GAM=16.6%), and grain yield (H=51.6%; GAM=24.33%), which expressed high heritability with moderate GAM, seem less affected by environment and administered by both additive and non-additive gene action, suggesting the possibility of improving these traits through simple selection of the landrace collections.

Conservation and utilization of available *Sorghum* landraces in the collection areas must be given a great attention and the high performing accessions of *Sorghum* landraces screened in this study should further be evaluated under a wide range of environments to find widely adapting landraces.

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