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Variability in Grain Physico-Chemical Composition in Different Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes

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A B S T R A C T

The present investigation was carried out to study the physical characters such as hundred kernel weight, volume, density, colour, size and chemical composition such as moisture, protein, ash and minerals in different sorghum genotypes. The sorghum genotypes comprised of *rabi* local, advanced and released and *kharif* grains. There was significant variation in physical parameters such as hundred grain weight (2.19 to 4.33 g), volume (7.07 to 8.40 ml), density (0.29 to 0.54 g/ml), colour and size. Similarly, chemical composition *viz.*, moisture (4.39 to 9.29 %), protein (10.15 to 16.57 %), ash (1.53 to 9.29 %) and mineral content like iron (4.21 to 18.37 mg/100g) and zinc (0.44 to 1.70 mg/100g) of different sorghum genotypes showed significant variation. Among all the sorghum genotypes, *rabi* genotypes had showed significant higher values of physico-chemical composition compared to *kharif* genotypes except protein and zinc.

Introduction

Sorghum [Sorghum bicolor (L.) Moench] is an important staple food for more than 300 million people in Asia and Africa. Among the cereals, sorghum ranks fifth major cereal in terms of production and acreage in the world after wheat, maize, rice and barley. Sorghum has the potential for grain production even under low rainfall and they sustain adverse agro-climatic conditions. In India it is a staple food in the states of Maharashtra and parts of Karnataka, Madhya Pradesh, Tamil Nadu, Gujarat and Andhra Pradesh. Sorghum is cultivated in India during *kharif* (rainy) and *rabi* (post rainy) seasons. Sorghum is an excellent source of energy, contains 349 kcal, 10.4 g of protein, 1.9 g of fat and 72.6 g of carbohydrate and also has good amount of minerals particularly iron (4.1 mg/100g) and zinc (1.6 mg/100g) (Gopalan *et al.,* 2010). Modern genetic alterations are being used to modify cereals to increase their nutrient content. These approaches have the potential to have a major impact on the malnutrition of population groups who derive their dietary energy from a single cereal staple. Sorghum being a good source of nutrient a common food grain for most of the population, it can be well exploited for combating the deficiency of nutrients. Hence, better nutrient composition promotes nutritional empowerment of people dependent on sorghum as a staple food. Preliminary studies carried have shown that several genotypes in sorghum exhibit variation in nutrient content.

Development of a variety with good nutrient content would help the breeders and consumers. Keeping view of this, the investigation was carried out on *rabi* and *kharif* sorghum genotypes with a specific a objective to screen the sorghum genotypes for grain physico-chemical composition.

Materials and Methods

The experiment was conducted during the year 2014-2015 at the department of Food Science and Nutrition, College of Rural Home Science, University of Agricultural Sciences, Dharwad. A total 24 sorghum grains of different genotypes were procured from All India Coordinated Research Project on Sorghum, University of Agricultural Sciences, Dharwad based on superior agronomic characteristics the genotypes were classified as local land races of *rabi* sorghum genotypes, released and advanced *rabi* and *kharif* genotypes.

Physical characteristics of grains of different sorghum genotypes such as 100 grain weight (g), volume (ml/100 grains), density (Mishra and Gupta, 1995), colour of grains was assessed in spectrophotometer model Konica Minolta, CM- 2600/2500d and was measured in chromatic components of 'L' (black - 0 to white - 100), 'a' represents redness (+a values) to greenness (-a values) and 'b' represents yellowness (+b values) to blueness (-b values) and size of grains was recorded using digital caliper by measuring the dimensions at maximum points in 10 randomly selected grains (mm).

Seeds of each sorghum genotype were powdered and analysed for chemical composition. Chemical composition such as moisture, crude protein, ash content by (Anon., 2010) and mineral contents such as iron and zinc were determined by atomic absorption spectrometry method.

Results and Discussion

The hundred-kernel weight of *rabi* sorghum genotypes *viz*., local land races, released and advanced *and kharif* sorghum genotypes showed significant ($p<0.001$) variation among all the genotypes and also within the genotype groups (Table 1). In local land races the hundred-kernel weight ranged between 2.46 g (Byahatti local) to 4.18 g (Lakmapur local). In case of *rabi* released and advanced sorghum genotypes hundred grain weight ranged between 2.49 g (Annigeri) and 4.33g (SVD-0770). Whereas in *kharif* genotypes the kernel weight ranged between 2.19 g (SPV-2172) to 2.91 g (SPV-2250). Among the three different groups of sorghum genotypes, *rabi* released and advanced genotypes showed significant higher mean hundred-kernel weight (3.48 g). Hundred-kernel volume in local land races of *rabi* sorghum genotypes ranged from 7.43 ml (Byahatti local) to 9.10 ml (Lakmapur local). In *rabi* released and advanced sorghum genotypes volume ranged between 7.07 ml (Muguti) to 8.40 ml (SVD-0813) and in *kharif* sorghum genotypes ranged between 7.60 to 8.53 ml. On an average the hundred-kernel volume was highest in local *rabi* sorghum genotypes (Table 1). The hundred-kernel density of different *rabi* local sorghum genotypes ranged from 0.32 g/ml (Giddamaldandi) to 0.51 g/ml (Barsi jowar). Among *rabi* advanced and released genotypes, the least kernel density observed was found in Annigeri (0.31 g/ml) and highest in SVD-0770 (0.54g/ml). Where as in *kharif* grown genotypes the kernel density ranged between 0.29 g/ml (SPV-2172) to 0.34 g/ml (SPV-2250). *Rabi* advanced and released sorghum genotypes showed higher bulk density compared to other genotypes. From the observations all the *rabi* genotypes showed higher kernel density (0.54 g/ml) compared to *kharif* genotypes (0.34 g/ml). The values of L, a* and b* indicate, *rabi* released and advanced showed white chrome

with yellow shades on it compared to other genotypes. When we compare colour of *rabi* and *kharif* grown sorghum genotype, *rabi* genotypes showed lighter chrome compared to *kharif* genotypes.

Length, width and breadth of the twenty four sorghum genotypes showed highly significant ($p<0.001$) variation (Table 1). Length and width of the local genotypes of sorghum grains showed highest in Mudde mooti (4.94 and 4.23 mm), Byahatti local had least breadth (3.52 mm). Released and advanced *rabi* genotypes SVD-0770 showed higher values of length (4.96 mm), width (4.27 mm) and breadth (3.03 mm). In *kharif* genotypes SPV-2250 showed higher length (4.55 mm), width (3.52 mm) and breadth (2.43 mm). Compared to *kharif*, *rabi* genotypes showed significantly higher values of length, width and breadth. Samdhur *et al.*, (2013) observed wide variations in hundred-kernel weight, volume and density among *rabi* and *kharif* grown sorghum genotypes. These variations might be due to the influence of genetic and environmental factors.

Moisture content in grains of sorghum genotypes are presented in table 2. Moisture content in local *rabi* sorghum genotypes varied significantly ($p<0.001$) and ranged between 4.39 (Giddamaldandi) and 9.29 per cent (Madabavi local). In *rabi* advanced and released genotypes moisture content ranged between 4.69 (SPV-2217) and 8.10 per cent (SVD-0765). In *kharif* grown genotypes the range was between 5.61 (SPV-2172) and 5.89 per cent (SPV-2250). Comparatively, *rabi* local land races showed significant higher mean moisture (6.94 %) content than those of *rabi* released and advanced and *kharif* grown genotypes. The moisture content of sorghum genotypes almost close to the values (between 8.3 to 8.43%) reported by Gassem and Osman (2003).

Crude protein (Table 2) content of local land races of *rabi* sorghum genotypes ranged between 10.15 (Byahatti local) and 16.57 per cent (Ramke local) with a significant ($p<0.001$) variation. In *rabi* released and advanced genotypes the protein content ranged between 10.95 (Muguti) and 14.12 per cent (SVD-0765). In *kharif* genotypes protein content was least in SPV-2250 (14.57 %) and highest in SPV-2172 (15.52 %). The protein mean content was highest in sorghum grown in *kharif* (16.04 %) than in *rabi* genotypes (Fig 1). Geeta *et al.*, (2005) reported that the physico-chemical characterization of sorghum accessions showed a wide variation in protein (7.99 to 17.8 %) and reasoned that wide variation was due to influence of environmental condition.

Fig.1 Mean protein (%), ash (%), iron (mg/100g) and zinc (mg/100g) content in sorghum grains of *rabi* local land races, *rabi* released and advanced and *kharif* genotypes

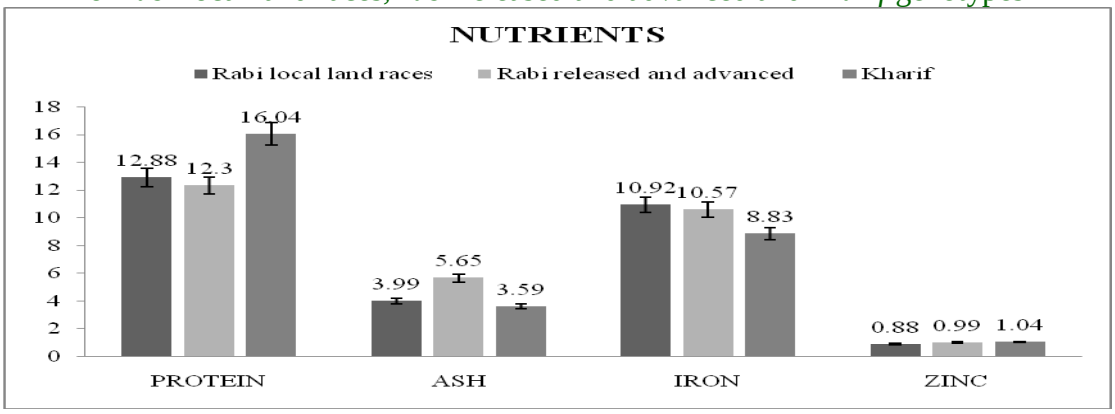

Table.1 Physical characteristics of grains of sorghum genotypes

Parameters / Genotypes	100 kernel weight (g)	Volume (ml)	Density (g/ml)	L*	a*	b*	Grain length (mm)	Grain width (mm)	Grain breadth (mm)
Local land races of *rabi* sorghum genotypes									
Lakmapur local	4.18±0.14^{a}	9.10±0.10^{a}	0.46±0.02^{b}	86.29±0.10^{de}	1.34±0.04^{g}	12.23±0.18^{bc}	4.42±0.29^{de}	4.12±0.24^{abc}	2.63±0.24^{bc}
Barsi zoot	3.29±0.04^{c}	8.17±0.15^{c}	0.40±0.01^{c}	83.88±0.06^{bc}	2.30±0.01^{d}	11.48±0.04^{ef}	4.65±0.31^{cd}	3.82±0.23^{de}	2.62±0.23^{cd}
Ramke local	3.68±0.09^{b}	8.10±0.17^{c}	0.45±0.02^{b}	85.85±0.08^{abc}	1.87±0.02^{d}	12.4±0.014^{ab}	4.82±0.15^{abc}	3.92±0.26^{bcde}	2.91±0.26^{a}
Kodamurki	3.38±0.01^{c}	8.20±0.10^{c}	0.41±0.01^{c}	86.49±0.05^{de}	1.67±0.04^{e}	12.40±0.15^{ab}	4.55±0.27^{de}	3.90±0.40^{cde}	2.85±0.40^{ab}
Madabavi local	3.29±0.05^{c}	7.53±0.06^{d}	0.44±0.00^{b}	84.40±0.06^{de}	1.96±0.02^{h}	11.19±0.17^{f}	4.46±0.24^{de}	3.89±0.07^{cde}	2.68±0.07^{bcd}
Chitapur local	3.04±0.15^{d}	7.47±0.14^{d}	0.41±0.03^{c}	85.05±0.04^{cd}	1.24±0.02^{e}	10.65±0.13^{g}	4.60±0.18^{cd}	3.84±0.10^{de}	2.61±0.09^{cde}
Byahatti local	2.46±0.23^{f}	7.43±0.12^{d}	0.33±0.03^{e}	81.62±0.23^{f}	1.66±0.03^{f}	12.49±0.31^{ab}	4.10±0.21^{f}	3.70±0.20^{e}	3.52±0.19^{def}
Barsi jowar	4.16±0.09^{a}	8.23±0.12^{c}	0.51±0.01^{a}	86.56±0.31^{ab}	1.49±0.11^{d}	11.78±0.30^{de}	4.85±0.19^{ab}	4.14±0.26^{ab}	3.03±0.26^{ef}
Tansalwadi	2.86±0.07^{de}	8.13±0.15^{c}	0.35±0.01^{d}	86.45±0.16^{de}	1.82±0.07^{d}	12.68±0.26^{a}	4.47±0.34^{de}	4.06±0.23^{ab}	2.51±0.23^{cdef}
Mudde mooti	3.06±0.13^{d}	7.50±0.15^{d}	0.41±0.02^{c}	85.76±0.04^{a}	2.05±0.04^{b}	12.24±0.13^{bc}	4.94±0.22^{a}	4.23±0.20a	3.01±0.20^{f}
Giddamaladandi	2.74±0.07^{e}	8.53±0.15^{b}	0.32±0.01^{e}	85.05±0.03^{e}	1.89±0.04^{cd}	11.93±0.04^{cd}	4.33±0.28^{e}	3.82±0.26^{de}	2.56±0.26^{cdef}
Mean ± SD	3.28±0.53	8.03±0.51^{d}	0.41±0.05	85.21±1.44	1.75±0.31	11.95±0.62	4.56±0.33	3.98±0.27	2.69±0.23
F Value	69.5***	52.28***	31.72***	361.83***	130.61***	34.48***	9.79***	4.81***	7.66***
SEM±	0.065	0.07	0.02	0.07	0.03	0.11	0.14	0.13	0.10
CD at 0.1%	0.19	0.21	0.06	0.23	0.07	0.31	0.40	0.38	0.29
Released and advanced *rabi* sorghum genotypes									
Muguti	3.73±0.08^{c}	7.07±0.12^{d}	0.53±0.01^{a}	85.29±0.26 ^{e}	1.87±0.04^{b}	11.76±0.04^{d}	4.78±0.26^{abc}	4.13±0.26^{ab}	2.82±0.26^{bc}
SVD-0770	4.33±0.05^{a}	8.17±0.15^{ab}	0.54±0.01^{a}	84.24±0.08 ^{g}	1.45±0.03^{e}	11.04±0.02^{f}	4.96±0.23^{a}	4.27±0.16^{a}	3.03±0.16^{a}
SVD – 0813	3.55±0.10^{d}	8.40±0.27^{a}	0.43±0.01^{c}	84.77±0.13 ^{f}	1.58±0.03^{d}	11.19±0.02^{f}	4.67±0.29^{bcd}	4.03±0.20^{b}	2.72±0.16^{cd}
M35 – 1	3.33±0.07^{f}	8.07±0.21^{b}	0.41±0.01^{d}	86.83±0.05 ^{c}	1.81±0.04^{b}	11.70±0.24^{de}	4.53±0.18^{d}	3.91±0.23^{b}	2.7±0.23^{cd}

SVD – 0765	3.44±0.02^{ef}	8.20±0.20^{ab}	0.42±0.01^{cd}	84.47±0.10 ^{g}	1.60±0.12^{d}	11.56±0.07^{e}	4.53±0.19^{d}	4.04±0.22^{c}	2.72±0.22^{c}
SVD – 0808	3.89±0.03^{b}	7.53±0.06^{c}	0.52±0.00^{a}	87.75±0.35 ^{a}	1.24±0.03^{f}	11.85±0.14^{d}	4.53±0.16^{d}	4.27±0.10^{a}	2.67±0.10^{cd}
DSV – 4	2.93±0.06^{g}	8.13±0.12^{ab}	0.36±0.01^{e}	83.79±0.03 ^{h}	2.56±0.02^{a}	14.10±0.07^{a}	4.25±0.32^{e}	3.97±0.20^{b}	2.32±0.20^{f}
IS – 4698	3.79±0.07^{bc}	7.97±0.06^{b}	0.48±0.01^{b}	85.22±0.09^{e}	1.64±0.27^{cd}	13.00±0.05^{b}	4.89±0.21^{ab}	4.27±0.10^{a}	2.95±0.10ab
DSV – 5	3.34±0.05^{f}	8.27±0.21^{ab}	0.40±0.02^{d}	87.20±0.16^{c}	1.72±0.06^{c}	12.42±0.06^{c}	4.57±0.28^{cd}	4.10±0.30^{ab}	2.49±0.27^{e}
SPV – 2217	3.50±0.08^{de}	7.53±0.15^{c}	0.47±0.02^{b}	86.45±0.07^{d}	1.65±0.03^{cd}	11.81±0.08^{d}	4.54±0.18^{d}	4.28±0.20^{a}	2.68±0.20^{de}
Annigeri	2.49±0.03^{h}	7.60±0.20^{c}	0.31±0.01^{f}	86.25±0.08^{d}	1.61±0.02^{d}	11.17±0.07^{f}	3.94±0.30^{f}	3.58±0.40c	2.42±0.40^{f}
Mean ± SD	3.48±0.47	7.90±0.42	0.44±0.06	85.66±1.27	1.70±0.32	11.96±0.88	4.56±0.37	4.08±0.30	2.66±0.27
F Value	189.28***	17.56***	119.76***	212.8***	141.15***	263.7***	14.78***	9.96***	17.57***
SEM±	0.04	0.09	0.02	0.08	0.03	0.05	0.14	0.12	0.10
CD at 0.1%	0.11	0.28	0.05	0.26	0.07	0.16	0.40	0.36	0.30
Kharif sorghum genotypes									
SPV-2172	2.19±0.08	7.60±0.10	0.29±0.01	85.14±0.03	1.56±0.03	12.40±0.02	3.83±0.22	3.28±0.17	2.44±0.17
SPV – 2250	2.91±0.05	8.53±0.15	0.34±0.01	85.23±0.06	1.50±0.02	12.25±0.12	4.55±0.30	3.52±0.24	2.43±0.24
Mean ± SD	2.55±0.39	8.06±0.52	0.313±0.03	85.18±0.06	1.53±0.03	12.32±0.11	4.18±0.44	3.39±0.23	2.62±0.29
F Value	180.12***	78.4***	74.79***	5.63 NS	6.76 NS	4.23 NS	36.25***	6.24*	14.65***
SEM±	0.04	0.08	0.07	0.03	0.02	0.05	0.15	0.11	0.13
CD at 0.1%	0.12	0.24	0.23	0.10	0.07	0.18	0.45	0.34	0.39
Over all									
Mean ± SD	3.32±0.55	7..97±047	0.42±0.07	85.41±1.31	1.71±0.30	11.98±0.73	2.53+0.36	3.96+0.32	2.59+032
F Value	116.36***	29.69***	73.12***	268.85***	131.63***	79.32***	13.63***	12.77***	9.77***
SEM±	0.05	0.08	0.02	0.08	0.03	0.08	0.04	0.05	0.05
CD at 0.1%	0.14	0.24	0.06	0.23	0.07	0.24	0.13	0.13	0.13

CD- Critical Difference

***The values are significantly different at p<0.001, NS-non significant, All values are calculated in triplicate and are expressed in terms of means ± SD

Table.2 Moisture, protein and ash content in grains of different sorghum genotypes

Nutrients / Genotypes	Moisture (%)	Protein (%)	Ash (%)
Local land races of *rabi* sorghum genotypes			
Lakmapur local	6.58±0.16^{e}	14.23±0.53^{ab}	1.53±0.13^{g}
Barsi zoot	4.94±0.11^{g}	11.84±0.79^{cd}	1.57±0.03^{fg}
Ramke local	7.77±0.28^{cd}	16.57±1.10^{a}	7.78±0.28^{d}
Kodamurki	7.38±0.37^{d}	11.32±1.76^{cd}	1.81±0.02^{e}
Madabavi local	9.29±0.11^{a}	13.88±1.46^{ab}	9.29±0.11^{a}
Chitapur local	6.85±0.03^{e}	11.67±0.72^{cd}	6.85±0.03^{d}
Byahatti local	7.96±0.62^{c}	10.15±1.81^{d}	1.61±0.15^{efg}
Barsi jowar	5.96±0.36^{f}	14.35±0.35^{ab}	1.64±0.04^{ef}
Tansalwadi	6.71±0.11^{e}	14.58±0.53^{a}	1.79±0.08^{ef}
Mudde mooti	8.55±0.14^{b}	11.73±1.14^{cd}	8.55±0.14^{b}
Giddamaladandi	4.39±0.26^{g}	12.48±0.53^{bc}	1.56±0.07^{g}
Mean ± SD	6.94±1.44	12.88±1.87	3.99±3.21
F Value	81.7***	8.5***	2.21***
SEM±	0.30	0.60	0.41
CD at 0.1%	0.91	1.81	1.23
Released and advanced *rabi* sorghum genotypes			
Muguti	6.31±O.46^{b}	10.95±0.51^{c}	6.32±0.46^{b}
SVD-0770	7.83±0.39^{a}	11.78±0.53^{bc}	7.83±0.39^{a}
SVD – 0813	6.21±0.61^{b}	11.90±0.35^{bc}	1.64±0.02^{d}
M 35–1	6.76±0.23^{b}	12.43±1.06^{b}	6.76±0.23^{b}
SVD – 0765	8.10±0.18^{a}	14.12±0.53^{a}	8.10±0.18^{a}
SVD – 0808	5.24±0.99^{c}	11.65±0.54^{bc}	5.24±0.99^{c}
DSV – 4	6.83±0.09^{b}	12.13±0.88^{bc}	6.83±0.09^{b}
IS – 4698	6.40±0.52^{b}	14.00±0.35^{a}	6.40±0.52^{b}
DSV – 5	5.28±0.37^{c}	12.25±0.35^{b}	1.60±0.04^{c}
SPV – 2217	4.69±0.41^{c}	12.37±0.72^{b}	4.69±0.41^{b}
Annigeri	6.76±0.18^{b}	12.72±0.72^{b}	6.76±0.18^{b}
Mean ± SD	6.40±1.08	12.30±1.05	5.65±2.17
F Value	14.84***	6.66***	84.56***
SEM±	0.25	0.31	0.35
CD at 0.1%	0.70	0.90	0.90
Kharif sorghum genotypes			
SPV-2172	5.61±0.08	15.52±0.40	5.61±0.08
SPV – 2250	5.89±0.24	14.57±0.88	1.60±0.07
Mean ± SD	5.75±0.22	16.04±0.84	3.59±2.21
F Value	3.53 ^{NS}	3.52 ^{NS}	42.8***
SEM±	0.10	0.39	0.04
CD at 0.1%	0.30	1.25	0.13
Over all			
Mean ± SD	6.59±1.26	12.92±1.75	4.72±2.80
F Value	33.26***	10.30***	276.51***
SEM±	0.21	0.263	0.17
CD at 0.1%	0.61	0.747	0.48

CD- Critical Difference, (a-g) Different letters as superscript denote significant differences ($p < 0.001$) between moisture (%), protein (%) and ash (%) content in grains of different sorghum genotypes, NS- non-significant, All values are calculated in triplicate and are expressed in terms of means ± SD

Table.3 Iron and zinc content in grains of sorghum genotypes

Minerals / Genotypes	Iron (mg/100g)	Zinc (mg/100g)
Local land races of *rabi* sorghum genotypes		
Lakmapur local	4.99±0.34^{h}	1.10±0.60^{b}
Barsi zoot	7.95±0.72^{g}	1.06±0.03^{b}
Ramke local	9.18±0.40^{f}	0.45±0.05^{d}
Kodamurki	9.29±0.55^{f}	1.70±0.04^{a}
Madabavi local	9.30±0.63^{f}	0.44±0.02^{d}
Chitapur local	10.06±0.70^{ef}	0.69±0.05^{d}
Byahatti local	10.99±0.24^{de}	0.97±0.03^{d}
Barsi jowar	11.58±0.66^{cd}	1.28±0.02^{b}
Tansalwadi	12.45±0.68^{c}	0.45±0.03^{d}
Mudde mooti	16.08±0.10^{b}	0.50±0.03^{d}
Giddamaladandi	18.37±0.80^{a}	1.09±0.02^{b}
Mean ± SD	10.92±3.62	0.88±0.42
F Value	127.66***	15.24***
SEM±	0.33	0.11
CD at 0.1%	0.96	0.31
Released and advanced *rabi* sorghum genotypes		
Muguti	4.21±0.23^{e}	1.38±0.14^{c}
SVD-0770	4.53±0.80^{e}	0.49±0.02^{h}
SVD – 0813	6.99±0.56^{d}	0.70±0.02^{f}
M 35–1	9.62±0.92^{c}	1.63±0.03^{a}
SVD – 0765	10.79±1.80^{bc}	0.59±0.01^{g}
SVD – 0808	11.33±1.66^{bc}	0.78±0.01^{e}
DSV – 4	12.33±1.46^{b}	0.85±0.02^{e}
IS – 4698	12.70±0.79^{b}	1.32±0.04^{d}
DSV – 5	12.70±1.12^{b}	0.62±0.02^{g}
SPV – 2217	14.71±0.71^{a}	1.49±0.03^{b}
Annigeri	16.43±1.03^{a}	1.13±0.03^{e}
Mean ± SD	10.57±3.92	0.99±0.39
F Value	38.15***	228.27***
SEM±	0.63	0.03
CD at 0.1%	1.87	0.08
Kharif sorghum genotypes		
SPV-2172	4.82±0.70	0.84±0.01
SPV – 2250	12.85±0.25	1.25±0.04
Mean ± SD	8.83±4.42	1.04±0.22
F Value	350.20***	335.90***
SEM±	0.30	0.02
CD at 0.1%	1.09	0.07
Over all		
Mean ± SD	10.59±3.80	0.95±0.39
F Value	59.41***	27.87***
SEM±	0.49	0.07
CD at 0.1%	1.40	0.21

CD- Critical Difference, (a-e) Different letters as superscript denote significant differences ($p < 0.001$) between iron (mg/100g) and zinc (mg/100g) content in grains of different sorghum genotypes

NS- non-significant, All values are calculated in triplicate and are expressed in terms of means ± SD

The ash content (Table 2) in local land races showed a wide variation, least was observed in Lakmapur local (1.53 %) and highest in Madabavi local (9.29 %). In released and advanced *rabi* genotypes, ash content ranged between 1.60 (DSV-5) and 8.10 per cent (SVD-0765) and in *kharif* grown genotypes ash content was least in SPV-2250 (1.60 %) and highest in SPV-2172 (5.61 %). *Rabi* released and advanced (5.65 %) genotypes showed significantly higher content of ash compared to local land races and *kharif* genotypes of sorghum (Fig 1). Kadam *et al.*, (2007) reported ash content was more in *rabi* (9.8 to 10.9 %) grown genotypes of sorghum compared to *kharif* (4.6 %) grown due to environmental influence on grains.

Grain iron and zinc contents of sorghum genotypes on dry weight basis are presented in table 3. Twenty four sorghum genotypes exhibited highly significant ($p<0.001$) variation in iron and zinc contents. Local genotypes of sorghum varied significantly for iron content ($p<0.001$) the values ranged between 4.99 mg/100g (Lakmapur local) and 18.37 mg/100g (Giddamaldandi). In case of *rabi* released and advanced genotypes significant variation ($p<0.001$) was found, lowest was in 4.21 (Muguti) and highest was in 16.43 mg/100g (Annigeri). In *kharif* grown genotypes iron content ranged between 4.82 mg/100g (SPV-2172) and 12.85 mg/100g (SPV-2250). Over all, *rabi* local land races (10.92 mg/100g) showed significant higher content of iron in grain compared to *rabi* released and advanced and *kharif* grown genotypes (Fig 1). Thus indicating season and genotype may influence the micronutrient content of grain. Similar variation in iron content was (0.90 to 20 mg/100g) also observed by Subramanian and Jambunathan (1980) due to inherent grain ash content with genotypic variability. The zinc content in sorghum genotypes *rabi* grown local genotypes of sorghum ranged between 0.44 mg/100g (Madabavi local) and 1.70 mg/100g (Kodamurki). Whereas in released and advanced *rabi* genotypes zinc was between 0.49 mg/100g (SVD-0813) and 1.49 mg/100g (SPV-2217) and in *kharif* genotypes zinc was highest in SPV-2250 (1.25 mg/100g) and lower in SPV-2172 (0.84 mg/100g). Among all the three types of sorghum genotypes, *kharif* genotypes showed highest mean value (1.04 mg/100g) compared to *rabi* grown genotypes (Fig 1). Nguni *et al.*, (2012) reported sorghum grain zinc ranged from 2.3 to 5.5 mg/100 g. Our estimated zinc values are lower than the reported values it may be due to varietal difference of sorghum grain, growing conditions of the crop and soil zinc content. The wide range in composition of trace elements indicated that sorghum is a good source of minerals. Grain iron and zinc contents higher than 5 mg/100 g and 3.7 mg/100 g respectively have been recommended for potential sorghum lines for use in the breeding programme for grain micronutrient enrichment (Kumar *et al.*, 2013). The results indicate that there is significant variation in iron and zinc content in all the three groups.

In conclusion, the physical characteristics of grains of all sorghum genotypes when analyzed, *rabi* sorghum genotypes showed higher hundred kernel weight, volume, density, colour and size when compared to *kharif* genotypes. Similarly chemical components *viz.*, moisture, protein, ash and mineral content of grains of sorghum genotypes differed significantly, among the *rabi* and *kharif* sorghum genotypes *rabi* genotypes showed higher moisture, ash and minerals like iron content except protein and zinc content. The study concludes that variations in physical characteristics and important nutrients like moisture, protein, ash and the iron and zinc contents in sorghum grains of different genotypes of different season were varied significantly.

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